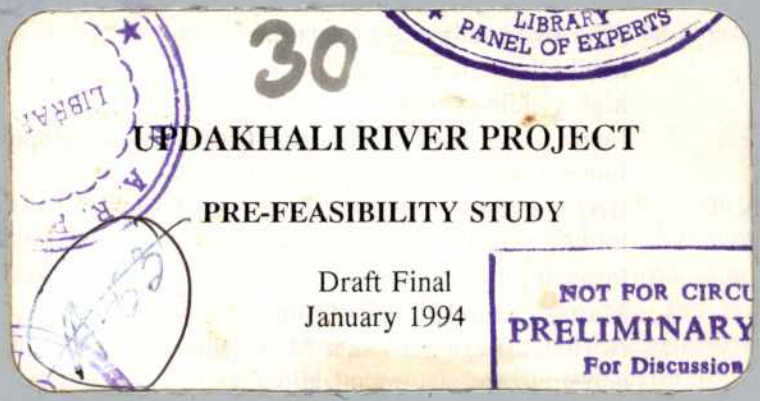
Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Flood Plan Coordination Organisation

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)



Shawinigan Lavalin (1991) Inc.
Northwest Hydraulic Consultants

in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services
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Nature Conservation Movement

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NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

UPDAKHALI RIVER PROJECT

PRE-FEASIBILITY STUDY

Draft Final
January 1994

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Acronyms and Abbreviations

AEZ	agroecological zone
AST	Agriculture Sector Team
b	broadcast
BBS	Bangladesh Bureau of Statistics
BFRSS	Bangladesh Fisheries Resource System Survey
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
DAE	Department of Agricultural Extension
DPHE	Department of Public Health Engineering
DSSTW	deep-set shallow tube well
DTW	deep tube well
ERR	economic rate of return
EMP	Environmental Management Plan
FAP	Flood Action Plan
FFW	Food for Work
FPCO	Flood Plan Coordination Organization
FW	future with project scenario
FWO	future without project scenario
HTW	hand tube well
HYV	high yielding variety
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Evaluation
ISPAN	Irrigation Support Project Asia Near East
LLP	low-lift pump
l, lt	local, local transplanted
MPO	Master Planning Organization
NERP	Northeast Regional Water Management Planning Organization
NGO	non-governmental organization
NHC	Northwest Hydraulic Consultants
PD	person-day
PWD	Pakistan Water Department
RCC	reinforced concrete
SLI	SNC-Lavalin International
STW	shallow tubewell
SWMC	Surface Water Modelling Centre
WARPO	Water Resources Planning Organization

US $1 = Tk 38

MPO Land Classification Terminology

Class F0	Land inundated to a depth of less than 0.3 m
Class F1	Land inundated to a depth of between 0.3 m - 0.9 m
Class F2	Land inundated to a depth of between 0.9 m - 1.8 m
Class F3	Land inundated to a depth of more than 1.8 m
Class F4	Land inundated to a depth of more than 1.8 m and on which deep water *aman* cannot be grown

Executive Summary

The project is in a deeply flooded area where *boro* rice is the only crop that can be grown. More than 80% of the area's population depend on this crop as their primary source of income and food. This crop is routinely damaged by pre-monsoon flooding.

It is proposed to construct 25 km of 2 m high submersible embankments around the project area. The embankment alignment would follow existing roads and river banks (*kanda*) as much as possible. Ancillary structures would include five drainage regulators, two pipe drainage sluices, and 21 irrigation inlet structures. To improve drainage in the area, the Gunai River would be induced to redevelop along its lower reach below Jatrabari, by closing Jatrabari Dhala to which most of the Gunai flow has recently shifted and excavating a 17.5 km pilot channel.

The project will reduce flash food damage to the *boro* crop, both directly with flood control and indirectly with improved drainage to allow earlier plantation and thus earlier harvesting; this would promote shifts from l *boro* to HYV *boro*.

Closure of the Jatrabari will force country boats using this channel to take an alternate, more circuitous route.

Fisheries impacts will be complex and are difficult to assess:

- Fish migration will be blocked for a significant part of the pre-monsoon migration window, until water control structures are opened and the submersible embankment overtops. Fish passes might provide some mitigation, but their incorporation has been deferred until feasibility, when information on their effectiveness and cost in the Bangladesh context should be available from the initiative *Fisheries Engineering*. Also, the redevelopment of the lower Gunai could have some positive impact on fish migration.

- Pre-monsoon water quality within the project area will be reduced due to reduced flushing, but post-monsoon water quality in areas draining to the revitalized lower Gunai may improve. This drainage area includes part of Updakhali River Project itself, plus parts of the proposed Dharmapasha-Rui Beel Project area and of the ongoing Singar Beel Project area.

- *Beel* area is currently decreasing, with some being filled in with silt brought in through Jatrabari Dhala, the new course of the Gunai flow. The impact of the project on this process is very uncertain. There are two possibilities. Either the project will have no impact on *beel* area, if this *beel* infilling is a short-term adjustment to the new course of the Gunai that will be essentially complete by the time of project closure of the Jatrabari (say 1998). Alternatively, if the infilling is an ongoing process, the project will slow or stop the loss of *beel* area.

- The redevelopment of the lower Gunai will increase river/channel area.

The project is not without potential significant adverse impacts and unresolved issues. Implementation of this project is recommended only after resolution of these matters.

NERP DOCUMENTS

The Northeast Regional Water Management Plan is comprised of various documents prepared by the NERP study team including specialist studies, the outcome of a series of public seminars held in the region, and pre-feasibility studies of the various initiatives. A complete set of the Northeast Regional Water Management Plan Documents consists of the following:

Northeast Regional Water Management Plan

- Main Report
- Appendix: Initial Environmental Evaluation

Specialist Studies

- Participatory Development and the Role of NGOs
- Population Characteristics and the State of Human Development
- Fisheries Specialist Study
- Wetland Resources Specialist Study
- Agriculture in the Northeast Region
- Ground Water Resources of the Northeast Region
- Surface Water Resources of the Northeast Region
- Regional Water Resources Development Status
- River Sedimentation and Morphology
- Study on Urbanization in the Northeast Region
- Local Initiatives and People's Participation in the Management of Water Resources
- Water Transport Study

Public Participation Documentation

- Proceedings of the Moulvibazar Seminar
- Proceedings of the Sylhet Seminar
- Proceedings of the Sunamganj Seminar
- Proceedings of the Sherpur Seminar
- Proceedings of the Kishorganj Seminar
- Proceedings of the Narsingdi Seminar
- Proceedings of the Habiganj Seminar
- Proceedings of the Netrokona Seminar
- Proceedings of the Sylhet Fisheries Seminar

Pre-feasibility Studies

- Jadukata/Rakti River Improvement Project
- Baulai Dredging
- Mrigi River Drainage Improvement Project
- Kushiyara Dredging
- Fisheries Management Programme
- Fisheries Engineering Measures
- Habiganj-Khowai Area Development
- Flood- and Erosion-Affected Villages Development Project
- Pond Aquaculture
- Applied Research for Improved Farming Systems
- Manu River Improvement Project
- Narayanganj-Narsingdi Project
- Narsingdi District Development Project
- Northeast Region Environment Management, Research, and Education Project (NEMREP)
- Upper Kangsha River Basin Development
- Upper Surma-Kushiyara Project
- Surma Right Bank Project
- Surma-Kushiyara-Baulai Basin Project
- Kushiyara-Bijna Inter-Basin Development Project
- Dharmapasha-Rui Beel Project
- ***Updakhali River Project***
- Sarigoyain-Piyain Basin Development

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ANNEX D: Fisheries Model

ANNEX E: Figures

1. INTRODUCTION

1.1 General Information

BWDB Division:	Netrokona WD
District:	Netrokona
Thana(s):	Kalmakanda and Madhyanagar
MPO Planning Area:	Part of 21 and 23
Gross Area:	5960 ha
Net Area:	4890 ha
Population:	33,900 (1991), 35,400 (1993), 40,100 (2000) and 50,800 (2015)

1.2 Scope and Methodology

This is a pre-feasibility study that was undertaken over a period of one month in early 1993. The study team consisted of a water resources engineer, a socioeconomist, an agronomist, a fisheries specialist, and a wetland resources specialist. Additional analytical support was provided by an environmental specialist and economist.

1.3 Data Base

Project analysis presented in this document was based on secondary data supplemented by information obtained during field inspection and discussions with project area residents. Information and data sources used by the various analysts are as listed below.

Engineering analysis. Existing topographic maps, historic climatological and hydrological records, river and *khal* cross-sections surveyed by BWDB Morphology Directorate and by SWMC, BWDB reports, MPO reports, personal field observations and interviews with beneficiaries, recommendations by BWDB officials and by local representatives.

Agricultural analysis. Data published in *Land Resources Appraisal for Agricultural Development in Bangladesh* (AEZ Reports) for soils information, data published by the Water Resources Planning Organization (WARPO) for agricultural inputs, data assembled through the *Agriculture Specialist Study* by NERP, interviews with individuals and groups of farmers in different areas and on each land type, and hydrological data developed by the hydrology and engineering sections of NERP.

Fisheries analysis. Topographic maps, BFRSS data, CIDA Inception Report, NERP Fisheries Specialist Study, field observations and local interviews, information provided by local representatives during field seminars held in Sylhet on June 26, 1992 and in Sunamganj on February 13, 1993.

Wetland analysis. Topographic maps, local revenue department records, personal field observations and interviews with local people, and the *Wetland Specialist Study* published by NERP.

Socioeconomic analysis. Published BBS data on demographic features, education and agriculture; reports of the Directorate of Public Health Engineering, and the NERP data base on Population and Human Development, personal field observation and field interviews with various cross-section of local people, the opinions and suggestions from various local level representatives including NGO personnel and the Honourable Members of the Parliament.

1.4 Report Organization

- Chapter 2: Biophysical features of the project area.
- Chapter 3: Current status of development and resource management including a summary of the types of problems faced by people living in the area.
- Chapter 4: Previous studies directed towards development of the area's water resources.
- Chapter 5: Future-without-project scenario; trends that are occurring and which will continue if no interventions are made.
- Chapter 6: Water resource development options considered previously.
- Chapter 7: Description of proposed development.
- Chapter 8: Outstanding issues.

The annexes consist of detailed information to support the main body of the report.

2. BIOPHYSICAL DESCRIPTION

2.1 Location

The Updakhali River Project covers a gross area of 5960 ha in the northern part of Netrokona District, between latitudes 24°58'N and 25°04'N, and longitudes 90°50'E and 90°57'E. The area is bounded in the north by the Updakhali River, in the south and southeast by the Gunai River, in the west by the Netrokona-Kalmakanda road, and in the east, by the Neamatpur-Banogaon road (Figure 1). This latter road was taken as the project boundary to exclude Ghoraduba Beel, the largest *beel* and *beel* fishery in the vicinity.

2.2 Climate

Area climate is monsoon tropical with hot wet summers and cool dry winters. The climatological station nearest to the area is in Mymensingh. Mymensingh highest recorded temperature was 29.8 C in July/August; the lowest was 16.6. 9 C in January. Lowest mean monthly temperature is 18.5 C January; the highest is 28.5 C in August. The lowest mean monthly potential evapotranspiration is 87 mm/month in December; the highest is 162 mm/month in April. The climatological data for Mymensingh station is given in Table A.1.

Mean annual rainfall gradually increases from southwest to northeast across the Northeast Region as a whole. In the project area, mean annual rainfall ranges from about 4500 mm in the southwest to about 5500 mm in the northeast. At Durgapur, the nearest rainfall station, mean annual rainfall is 3528 mm, and the monthly mean varies from 4 mm in January to 839 mm in July. Over 76% of rainfall occurs during June through September.

2.3 Land (Physiography)

2.3.1 General Description

The project is located on the western side of the central deeply-flooded Sylhet Depression. The project landscape does not slope in any particular direction overall; rather, drainage is into the numerous isolated *beels*, and thence down small drainage channels which fall into the boundary rivers.

Project land levels range from 3.05 to 7.22 m PWD. The area-elevation data is given in Table A.2 and the curve is shown in Figure 2.

2.3.2 Soils

The area lies in the western subregion of the Sylhet Basin (AEZ 21a). Two main kinds of soils occur in the area: (1) on higher land which dries out seasonally, grey silty clay loams or clays with developed profiles, and (2) on lower land which stays wet throughout the year, grey, often bluish grey or greenish grey, clays with raw alluvium at shallow depth; grey heavy clays

predominate in basins. On ridges, small inclusions of dark grey loamy and clayey Old Brahmaputra soils are found.

Noncalcareous Grey Floodplain Soils (ridge and basin sites) and Acid Basin Clays (basin centres) are the major components among the six general soil types occur in the area. Noncalcareous Alluvium, Noncalcareous Dark Grey Floodplain Soils, Peat, and Grey Piedmont Soils also occur.

Soil reaction is strongly or very strongly acidic. Organic matter content ranges from 0.5 to 2.0% in ridge soils and from 2.0 to 4.0% in basin soils. Basin soils remaining wet year-round or nearly so generally have 2.0 to 5.0 % organic matter in the cultivated layer.

Fertility level is medium to high with low phosphorus (P) and high zinc (Zn) content. Permeability is generally slow, except in some loamy ridge soils of Grey Floodplain. Moisture-holding capacity is moderate in deep loamy ridge soils, but low in basin clays. Un-irrigated soils become very hard when dry; basin clays develop wide cracks. Soils which dry out in the dry season become very hard and develop wide cracks, but irrigated *boro* rice cultivation ensures that most soils stay wet.

2.4 Water (Hydrology)

2.4.1 River System

The Updakhali and Gunai, which bound the project on the north and south/southwest, the distributaries of the Old Someswari River. The Updakhali also receives drainage from Lengura River and many other hill streams to the north (Figure 3).

The Gunai splits at Bir Sidli from the Old Someswari. On the southern boundary of the project, the Gunai also receives drainage through Gholamkhali Khal, a principal distributary of the Upper Kangsha. About one kilometre downstream from the Gunai-Gholamkhali confluence, at Jatrabari, the flow passes through a newly eroded channel, Jatrabari Dhala, into Pakhanunia Beel within the project area. Thus, the combined flow of the Gunai and Gholamkhali Khal now use the project area as its floodway. Beyond Jatrabari, the Gunai is heavily silted up and almost dead; it joins the Updakhali near Madhyanagar.

There is a BWDB water level measurement gauge on the Updakhali River at Kalmakanda. Table A.3 provides pre-monsoon and monsoon water levels taken this station for various recurrence intervals. Discharge of the Gunai or Updakhali has not been measured.

2.4.2 Flooding

Pre-monsoon flooding causes extensive damage to the *boro* crop, the main crop grown in the area. Pre-monsoon floodwater originating in the Someswari and Kangsha Rivers enters the area from the Updakhali and Gunai, both through creeks and channels and as overbank spill. Even when these rivers are flowing below their banks, flow enters the project area through Jatrabari Dhala. Backwater from the Baulai can also influence water levels at this time.

Monsoon flooding results is mainly due to backwater condition in the Baulai to the east.

2.4.3 Drainage

Post-monsoon drainage determines the availability of land for *boro* cultivation. Water drains off the land into the various isolated *beels* whence it passes through *khals* (Isabpur, Barkapan, Jatrabari Dhala, Sripur and Kutigaon) to the Updakhali and Gunai (Figure 1).

The heavy siltation of the Gunai below Jatrabari is causing post-monsoon drainage congestion in areas draining into the Gunai.

2.4.4 Water Bodies

Open water bodies

About 92% (5370 ha) of the area is seasonally inundated to a depth greater than 0.3 m, of which *beels* and channels account for 9% (480 ha).

The larger water bodies are Rangamati Jan, Uglar Beel, Jaingra Beel, Guadoba Beel, Baushir Khal, Meda Beel, and Pakhanunia Beel.

Closed water bodies

About 60 ha of the area is occupied by about 530 ponds.

2.4.5 Surface Water Availability

On Feb 93 during the field visit, ample water was observed in the Updakhali. The Gunai dries out completely during the dry season. As has been mentioned, river discharges have not been measured. Some *beels* and channels are perennial.

2.4.6 Ground Water

Table 2.1 shows the usable and available ground water recharge, computed from WARPO estimates of *thana* ground water resources. Though the data indicates little scope for STW irrigation, an AST 1991 census found 600 ha of land irrigated by STWs. The Updakhali Subproject Feasibility Report (1990; see Chapter 4)) also identified 139 STWs in the area.

2.5 Land/Water Interactions

2.5.1 Siltation

The Updakhali below Kalmakanda looks clear. Presumably the source streams (the western hill rivers and streams including the Someswari and Lengura) drop their sediment load on the western floodplain before the water reaches the Updakhali.

As has been mentioned, the Gunai is heavily silted up below Jatrabari. The *beels* in the project area are being silted up by sediment brought in with the Gunai-Gholamkhali flow.

2.5.2 River Erosion

The Updakhali appears to be quite stable. Upstream, the Gunai is also stable but at Jatrabari the new channel is developing with every pre-monsoon flood.

Table 2.1 : Usable and Available Recharge

Usable Recharge (Mm3)			Available Recharge (Mm3)		
STW	DSSTW	DTW	STW	DSSTW	DTW
0.00	3.03	16.38	0.00	2.20	11.74

2.5.3 Crop Damage

Early flash floods destroy maturing *boro* or young *aus* and deep water *aman* (broadcast *aman*). *Boro* damage is further aggravated by slow drainage of rainfall runoff. Deep or very deep monsoon flooding, often with rapidly rising water levels, prevents cultivation of deep water *aman* in much of the area. Wave action sometimes uproots deep water *aman*.

2.6 Wetlands and Swamp Forest

2.6.1 Natural Wetlands

Almost all (90%) of the area is inundated in the monsoon, but only 340 ha retains water in the dry season (see Section 2.4.4 for a list of the larger permanent water bodies).

Though the wetlands of the area are flat and relatively shallow, high waves during the monsoon season prevent the formation of much floating or rooted floating aquatic vegetation. Dense submerged vegetation is found; the most common species are Hydrilla verticillata, Blyxa sp., Vallisnaria spiralis, Potamogeton sp. and Ottelia alismoides. In the higher areas, especially around the homesteads, various grass species are found but the high grasses (e.g. reeds) are absent.

Waterfowl and wildlife in the area is relatively sparse, presumably due to the high levels of disturbance from human activity.

2.6.2 Swamp Forest Trees

Two small patches of swamp forest exist near Bausari village, east of Jatrabari Dhala. In addition, many individual swamp forest trees can be found scattered all over the project, and it is reasonable to assume that they were quite common in the past.

3. SETTLEMENT, DEVELOPMENT, AND RESOURCE MANAGEMENT

3.1 Human Resources

3.1.1 Land Use and Settlement Pattern

Land Use
Current land use is summarized in Table 3.1.

Table 3.1: Current Land Use

Use	Area (ha)
Cultivated (F0+F1+F2+F3)	4890
Homesteads	200
Beels	340
Ponds	60
River Channels	140
Hills	-
Fallow[1]	180
Infrastructure[2]	150
Total	5960

[1] Multi-use land, wetlands, grazing lands, village grounds. Includes F4 land.
[2] Government-owned land not appearing elsewhere.

Settlements
Settlements are mainly found in the form of villages along river levees and road sides; these are densely settled. A few settlements are sparsely scattered across the floodplain. Settlements are very sparse in the lowest areas.

Flood Damage to Housing
Generally, households located on higher lands are not damaged by floods. Damage to homesteads during monsoon flooding is common in haor areas; in addition, these homesteads often experience wave erosion.

Coping Strategies
On higher lands, homesteads platforms are usually raised about one meter to avoid monsoon flooding. Within villages in the haor areas, homesteads may be raised 3 to 4 meters. Measures are taken to protect homesteads against wave erosion. Typically, a seasonal protection wall is made from earth, bamboo, and locally-available grasses; a few homesteads are protected by hard retaining walls.

Monsoon flood waters stay in the low-lying eastern part of the project area for about five months beginning in early June. If flooding is severe, villagers make platforms inside their houses and shift their belongings to safer places if possible. In such situations, the poor suffer the most.

3.1.2 Demographic Characteristics

The total population of the area is about 33,900 of whom 16,628 are female; gender ratio is 104 (males to 100 females). There are about 6,470 households in 50 villages.

The cohort distribution for males and females is shown in Table 3.2.

Average population density is 501 persons per km^2. Average household size is 5.2 persons.

Table 3.2: Population Distribution by Age Group (%)

Sex	Population Age Group (Years)						Total
	0-4	5-9	10-14	15-54	55-59	>60	
Male	15.8	15.7	13.7	45.5	2.1	7.2	100.00
Female	16.9	16.7	12.4	46.8	1.7	5.5	100.00
Total	16.3	16.2	13.1	46.1	1.9	6.4	100.00

Source: BBS, 1981 Population Census

3.1.3 Quality of Life Indicators

Quality of life is usually determined by several key indicators. Those described here are literacy, access to health, sanitation, and pure drinking water facilities.

Literacy

The literacy rate is very low. In the 1981 census, in Kalmakanda thana literacy at 5 years of age and above was 16% overall; for females it was 10%. In the 1991 census, literacy in Netrokona district was 18% overall. Possibly literacy has increased slightly in the last ten years.
In the 1981 census, in Kalmakanda thana school attendance was 18% for all children five to nine years old, and 16% for girls. Attendance was 15% for all youths five to 24 years old, and 12% for females.

The situation is worst for the rural poor. They cannot afford to send their children to school. Moreover, many villages, especially in the eastern part of the project area, lack primary schools. On average, in Netrokona district there are 4.3 primary schools per 10,000 population (BANBEIS, 1990).

Access to Health Services

Though Netrokona district headquarters and Kalmakanda thana headquarters both have hospital facilities, access to health services is generally limited for rural villagers and is out of reach of the poor. Netrokona district has one hospital for every 159,000 persons, one hospital bed for every 5,900 persons, and one doctor for every 21,600 persons (Directorate General of Health Services, 1992). Immunization coverage low: in Kalmakanda thana, reportedly only 23% children below two years old have been immunized (1990).

Rural Water Supply

Detailed information on access to rural water supply for drinking purposes is not available. The rural areas of Netrokona district have one working tube well for 108 persons according to DPHE (1991-2). Access to potable water by the poor is less than optimal as most tube wells are located in the houses of the rich.

Sanitation

Specific information on sanitation facilities are not available. Open space defecation was seen during field visits to be a common practice in rural villages, particularly for males. Sanitary latrines are uncommon, except for very well-off and educated families. Women generally use

kutcha latrines or defecate at a fixed spot protected by banana leaves or bamboo mats. In the haor areas, males generally defecate in open running water during the monsoon season.

3.1.4 Employment and Wage Rates

Village employment opportunities are mostly in agriculture. The major crop is *boro*. T. *aman* and jute are also grown. Employment for men mainly consists of peak agricultural activities, like transplanting and harvesting of crops. *Boro* transplanting occurs between December to mid-February and harvesting occurs in late April and May; for t. *aman* these periods are July/August and November/December respectively. Seasonal employment is available with well-off farmers during winter months for *boro* cultivation.

Wage rates for male agricultural labourers vary from Tk 30 to 45 with two meals per day during peak agricultural months. During other months, wage rates are Tk 20 to 30 with or without a meal.

Some poor people migrate to Netrokona and Mymensingh towns in the slack months, to work as rickshaw pullers, construction workers, or in household activities. Many labourers migrate to Sunamganj to collect and transport stones and sand.

Employment opportunities outside the home for women are limited in the area. A few women are reported to be employed as seasonal labourers by well-off farmers. A few poor women are also employed by the Rural Maintenance Program of CARE. Some women migrate to Mymensingh and Netrokona towns for household work, but their numbers are very limited; many villages have no migrant woman labourers. Some poor women are involved in gathering wild vegetables and collecting fuel.

During *boro* harvesting, many labourers migrate in from other parts of Netrokona district, and from Mymensingh and Comilla districts.

3.1.5 Land Ownership Pattern

More than 49.0% of households are landless (less than 0.2 ha cultivable land); of these, 1.6% have no homestead land. Small (0.21 to 1.00 ha), medium (1.01 to 3.00 ha) and large farmers (more than 3.00 ha) account for 25.0%, 19.4%, and 6.1% of the population respectively.

The price of agricultural land varies from Tk 5,000 to Tk 15,000 per bigha (0.12 ha) depending on land quality, in particular cropping intensity.

3.1.6 Land Tenure

Owner-operation is common in the area; large land owners share out their lands to tenants for operation. Land owners receive one-half of the produce of land share cropped out; they provide no inputs, except for HYV rice, when they provide 50% of input costs. In the low-lying *boro* areas, *rangjama* or leasing out land against an advance payment in cash or in kind, is common; the usual rate varies from three to four maunds of rice (Tk 600 to 800) per bigha (0.12 ha) per year. The heavy advance payment renders this arrangement inaccessible to most.

3.1.7 Fishermen

Fishing is an important activity in the area, and competition over the fish resource is increasing every year. Traditional and non-traditional fishermen catch fish to generate income. In addition, subsistence fishing is extremely common.

There are an estimated 150 to 200 traditional fisherman households in the area. Traditional fishermen live on fishing and have been engaged in the profession for generations. The *jalmohals* are generally leased out to them through their cooperatives, though in practice the rich among them act as financiers and appropriate most of the profit. Traditional fishermen also hire themselves out as skilled fishing labourers. Additional information on fishing practices is given in Section 3.5.1.

Non-traditional fishermen are an emerging group arising out of the landless agricultural population. They fish in open water, during the monsoon months especially, and sell the catch. The numbers of such non-traditional fishermen are increasing gradually. Nearly 30 to 35% of the households are reportedly engaged in catching fish for sale.

3.1.8 Situation of Women

Women play an important role in agricultural production, but their contributions tend to be devalued and under-reported. Women do not generally work out in the fields, but some poor women are working outside their homes (see Section 3.1.4). Most women's work takes place within the homestead; a key activity is post-harvest processing of rice (drying, winnowing, parboiling and storing). Most women also tend homestead gardens and raise poultry, in addition to their responsibilities for housework and child care.

3.1.9 People's Perception

General

Local people were asked about their perception of their problems. Their responses were related mainly to water, its impact on their livelihood, and their suggestions regarding possible interventions that would address these problems. This information was collected through personal interviews, group discussions, and meetings with people during the relatively short field work in the area. Also, opinions and suggestions were sought in a one-day seminars held in Netrokona and Sunamganj district headquarters with the Honourable Members of the Parliament, district and thana level officials, union parishad chairman, and representatives from village-level organizations and NGOs.

Problems

The basin's major problems were described as flash flooding and drainage congestion. Flash flooding, in both the pre-monsoon and monsoon periods, are felt to be the most serious problem. Pre-monsoon flash floods damage the *boro* crop between April and May.

According to residents, the flash floods enter through the *khals* and spill over the river banks, inundating the low-lying *boro* fields. They believe that the intensity of flash flooding is increasing because the rivers and *khals* are silting up and because rainfall is increasing in the upper catchment area.

Drainage congestion is seen to be a serious threat to timely transplantation of *boro* rice. Residents felt that the rivers draining the area, including the Kangsha, Gholamkhali, Updakhali, and Baulai/Dhanu, are silting up.

On the eastern side, damage to homesteads from monsoon wave action is felt to be a serious problem. Many villages are eroding fast and their very existence is threatened in some locations.

Suggestions
Numerous suggestions were put forward by local people. The most common were:

- For quick drainage of flash flood water from upland rivers, dredge the Baulai/Dhanu River from the outfall of the Kangsha River at Gaglajur Bazar
- For quick drainage of flood waters, re-excavate and straighten (loop cuts) the Kangsha, Someswari, Gholamkhali, Gunai, and Updakhali Rivers
- Protect crop land from sand deposition, and explore possibilities for removing and better use of deposited sand
- Close Jatrabari Dhala and Thakur Bari Khal permanently
- Construct a sluice gate at Ahammak Khali and Sabatia Khals.
- Take measures to protect the most vulnerable villages from wave erosion
- Lease *jalmohal* only to local fishermen
- Allow poor and subsistence fishermen to catch fish in the flood plains
- Conserve fish habitat to increase fish production
- Afforest river ridges and *kanda* to reduce monsoon wave intensity
- Ghoraduba Beel: some wanted to keep this *beel* out of the project area to allow free passage of fish from the river, and some wanted it included.

3.1.10 Local Initiatives

Information on specific local water management initiatives in the project area was not collected during the field visit. People did state that it is their traditional practice to organize themselves in times of crisis arising from flash floods and drainage congestion.

Their main activity is to protect *boro* crops by building dams on small canals to stop the inflow of pre-monsoon flash floods. Canal re-excavation for quick drainage and earthen cross-dams in the upland rivers/streams for *boro* irrigation are also undertaken. These latter activities are generally done voluntarily by farmers around a particular canal or field. Sometimes they raise *chanda* (voluntary money contributions) to perform the work. More recently, wheat and cash has been allotted by the union parishad.

3.2 Water Resources Development

3.2.1 Flood Control & Drainage

There is no water development project in the area.

3.2.2 Irrigation

Surface Water
According to the AST Irrigation Census (1991), LLPs irrigated 300 ha and traditional technologies 600 ha of *boro* rice.

Ground Water
The AST census indicates that STWs irrigated about 600 ha.

3.3 Other Infrastructure

There are about 40 km of village roads in or adjacent to the project area, including the Neamatpur-Banogaon road (6 km) and the Netrokona-Kalmakanda road (8 km). More information on transportation and navigation is given in Section 3.6.

3.4 Agriculture

Flooding and drainage congestion damages crops almost every year. During April and May, flash floods destroy maturing local and HYV *boro* rice. Post-monsoon drainage in areas drained by the Gunai is slow because it is silted up. Present cropping patterns and crop production are given in Tables 3.3 and 3.4.

Information with respect to average yields obtained under damage-free conditions, crops damaged, percent of the crop area damaged, yield reduction due to crop damage etc. were collected by interviewing farmers in the project. These data were analyzed to obtain the total production and are presented in Table 3.4.

Crop marketing patterns within the project area, like in other areas of Bangladesh, are largely traditional. Producers are compelled to dispose of part or, in some cases, all of their crops immediately upon harvest. The reason for farmers' inability to store their crops is variously: (1) a need for cash; (2) lack of proper storage facilities (these typically consist of granaries located inside the household's main house); (3) crop loan obligations; or (4) tenure crop division arrangements. The producers are then frequently obliged to replace this food grain at a much higher price to meet daily consumption requirements. It is estimated that only 20 to 25% of the production actually enters commercial markets. Private traders handle about 90% of this amount.

Homestead agriculture production varies with the level and size of homesteads. On higher homesteads, which tend to be larger as well, trees (banana, mango, jackfruit, betel nut, bamboo, and so on) are common, providing fruit, fuel, and building material for use/consumption or sale. Lower, smaller homesteads have fewer trees. Most of the vegetables consumed by farming families are produced on the homestead plot, or on lower land adjoining it. Most farms keep poultry and many have cattle.

Table 3.3: Present Crop Patterns

Crop Pattern	F0	F1	F2	F3	Total
b aus - lt aman		100 (20)			100
b aus - rabi		350 (70)			350
b aus - lt aman - rabi		50 (10)			50
b aman - rabi			177 (10)		177
b-aman - fallow			265 (15)		265
b aman - HYV boro			265 (15)		265
HYV boro - fallow			1063 (60)	786 (30)	1849
l boro - fallow				1834 (70)	1834
Total		500	1770	2620	4890

Numbers within parentheses indicate percent of each land type.

Table 3.4: Present Crop Production

Crop	Damage Free Area			Damaged Area			Total Production
	(ha)	(t/ha)	(t)	(ha)	(t/ha)	(t)	
b aus	500	1.3	650				650
b aman	708	1.5	1062				1062
lt aman	150	2.1	315				315
l boro	825	2.6	2146	1009	1.66	1674	3820
HYV boro	1374	4.5	6182	740	3.40	2515	8697
pulses	87	0.9	78				78
oilseeds	289	0.8	231				231
vegetables	17	4.0	69				69

Source: NERP estimates.

Homesteads are an integral part of the farming system. Courtyards are used for post-harvest activities (threshing, winnowing, parboiling, drying). Cow dung and compost made of domestic waste are used to fertilize agricultural land.

3.5 Fisheries

3.5.1 Floodplain Fishery

About 35 important permanent and seasonal *beels* exist within the area. The largest of these, which are most important for fish production, are listed in Section 2.4.4. *Beels* serve as overwintering refuges for the species present in the area.

Most of the large fisheries are leased by a few rich influential persons for a period, usually of three years. They generally reside outside the area and appropriate the profits from the catch; local fishermen derive only a small fraction of the benefits. Also, lessees usually hire fishermen from outside areas to work as labourers for the final catch.

Farmers and fishermen (i.e. *jalmohal* lessees) commonly have very different water management objectives, which often leads to tension and conflict. Measures taken by fisheries lessees include dams to retain water in *beels*, which delays *boro* plantation in the peripheral zone around the *beel*. Later in the winter season, *beels* may be completely drained to catch 'all' the fish, which reduces the surface water available for irrigation.

Reportedly, fisheries lessees exclude local fishermen from their *jalmohal* areas during the monsoon months when their lease rights are not in force. This practice was also noted by Minken (1992).

It seems clear that *jalmohal* lessees exercise significant control over water management in the area, and feasibility studies of future water resources development should investigate this issue carefully.

3.5.2 Fish Species Present

Of the 155 species identified in the region, about 65 species inhibit the project area. The most common of these species are listed in Table 3.5. Species composition is dominated by *chotomach* (about 70%), followed by catfish (about 20%), and carp (about 10%).

The giant freshwater prawn M. rogenbergii and Ilish Hilsa ilisha, both highly valuable species, are also available in small amounts in the Gunai and Updakhali Rivers adjacent to the project.

3.5.3 Duars

Duars, deep holes in the rivers, provide refuge for the larger mother fish during the winter season and are an indispensable part of a typical floodplain fishery. These fish then migrate to a suitable spawning ground for breeding when water levels begin to rise. In the rivers adjacent to the project area, there are four *duars*: two in the Updakhali and two in the Gunai.

Table 3.5: Major fish species

Boromach	Chotomach
Catla, rui, mrigel, kalibaus, ghonia, boal, air, ghagot, rita, chital, gazar, shoal, mohashoal	*Singi, magur, gang magur, koi, kholisha, lati, cheng, pabda, tengra, gulsha, bajori, bheda, fali, napit, darkina, mola, chata, dhela, chela, tit puti, puti, sarputi, kani pabda, pabda, chanda, boicha, tatkini, kanipona, baashpata, batashi, bacha, rani, chapila, keski, laso, tara baim, baim, gutum, cirka, kaikka, shilon, poa, ek tuitta, chanda, golda chingri, icha*

3.5.4 Migration and Breeding

Most of the species (all but *pangus* and the major carps) breed more or less everywhere in the area, on the shallow floodplain around the permanent water bodies. Localized breeding migration can be seen for *boal, ghonia, sarputi, chapila, pabda, fali, koi, singi, magur, puti, chanda, tengra, gulsha, kholisha, along, bheda, laso, lati, shoal, gazar* and some other smaller varieties. Particular areas reported to be breeding grounds include Moishaura Beel, Uglar Beel, Baushir khal, Guadoba Beel, Udaipurar Khal area, Moda Beel, Govindapur area, and Chengti Beel area.

Fishermen reported that previously carp spawned in Moishaura Beel and Ghoraduba Beel, but that these areas were destroyed by the rapid sedimentation following the shift of the Gunai-Gholamkhali flow into the project area.

Spawning triggers include favourable conditions of flooding, temperature, rain, thunder, and availability of grassy or rocky areas. When favourable conditions and flooding coincide, fish migrate from the *beels* to adjacent grassy areas and to the rivers, and from the rivers to the *beels*. Most species tend to move from the river up the *khal* to the *beel* and adjacent floodplain.

3.5.5 Production trends

No production data are available. Using habitat areas and standard production per unit area values gives an openwater fishery production estimate of 379 tonnes per year (Table 3.6). This is the major source of fish in the area (floodplain 47%, *beels* 40%, and channel 3%). Aquaculture production is estimated to be 36 tonnes per year (10% of the total).

Openwater fish production has reportedly declined by about 30% over the last five years (i.e. 6% annually). Possible causes include:

- *Beel* siltation. Over the last 50 years, the *beel* depth, area, and the persistence through the dry season has reportedly declined about 70%
- Over-fishing
- Loss of fish habitat, particularly encroachment of agriculture into *beels*
- Fishing of reproductive stock from *duars* using *chat jal, current jal*, and similar gear

- Fish ulcerative disease, which correlates well with *beel* water pollution from HYV cultivation

- Lack of proper aquaculture extension services to pond owners

Table 3.6: Present Fish Production

Area Type	Area (ha)	Unit Prod'n (kg/ha)	Total Prod'n (T)
Beel	340	410	139
Floodplain	4890	44	215
River/ channel	140	175	25
Pond	60	600	36
Total	5430		415

Source: BFRSS

3.5.6 Fishing Practice

Floodplain
Subsistence fishing occurs mainly during the monsoon flood. Large-scale *beel* fishing occurs from November to February. In most cases, *beel* fishing is done on an annual basis.

Piles for biological management are maintained only in Moda Beel. *Katha* are commonly installed in August and September as the water is receding from the floodplain; these attract fish which are then more easily caught during annual *beel* fishing. *Shawra* and mango tree branches are widely used; branches of the preferred species, *hizal* and *koroch*, are scarce.

Closed Water
Ponds are mainly used for household purposes (bathing, washing clothes and dishes, occasionally watering homestead vegetable plots, and so on) during the winter and dry season, but some are also suitable for aquaculture. Pond fish culture practices are different here than in other parts of the country. Most ponds (about 90%) are located in flood-prone areas, so owners usually do not release fingerling into them; rather, fish from the floodplains are trapped during flood recession, in most cases by installing *kathas*. In some cases, supplementary feed is given to attract more fish and to enhance growth once fish are enclosed. The fish are usually harvested during the dry season.

3.6 Transportation/Navigation

As mentioned in Section 3.3, there are about 40 km of roads in or adjacent to the project area, including the Neamatpur-Banogaon road (6 km) and the Netrokona-Kalmakanda road (8 km) (Figure 1). During the monsoon, only the Netrokona-Kalmakanda road is not inundated, and even it is usable by motorized vehicles. It is currently being upgraded with a brick surface.

As a result, during the monsoon, country boats become the primary means of transportation. Currently thirty medium-sized motorized country boats ply along a route of about 25 km between Kalmakanda and Thakurakona, which passes through the Jatrabari Dhala (Thakurakona is located about 10 km southwest of the project area on the Netrokona-Kalmakanda road, which is shown on Figure 3; Thakurakona itself is not shown). If Jatrabari Dhala were closed, these boats would be diverted to the Jatrabari-Madhyanagar-Kalmakanda route which is about twice as long (+20 km).

3.7 Wetland Resources Utilization and Management

The most important natural wetlands product is fodder: the people of the project area are fully dependent on these materials, particularly during the monsoon when flood water covers almost all the grazing lands. Plants such as Nymphaea sp. *shapla*, Nymphoides sp. *chandmela* and grasses are commonly used. These materials do not appear in the markets; people collect their own requirement by themselves.

To estimate economic value and employment, values of Tk 40 ha^{-1} and 0.5 pd ha^{-1} based on data collected in other projects are used. The area from which these wetland fodder plants is taken (mostly F3 land which remains fallow in summer) is about 4,000 ha. This gives an estimated total gross value of Tk 0.16 million $year^{-1}$. The estimated employment in gathering is 0.002 million md $year^{-1}$.

Another important natural wetland product is biomass fuel. All the woody shrubs and grasses are used. Saplings of swamp forest trees are heavily exploited, which is suppressing natural regeneration. Fuel is in very short supply and exploitation pressures are intense.

Other wetland products and services are:

- Food. Mostly from Nymphaea sp. *shapla*, Aponogeton sp. *ghachu* and Ottelia alismoides *panikola*.
- Bio-fertilizer. From various wetland plants.
- Medicinal plants. Polygonum sp. *kukra* and many others.

These common property resources are of some importance to the poor, who are the most likely to engage in wetland gathering, to eat wetland food in times of scarcity, to depend on income from wetland products, and so on. Fodder and building materials tend to be collected by men, and food and medicinal materials tend to be collected by women.

Information on resource management practices is not available.

4. PREVIOUS STUDIES

A feasibility study for Updakhali Subproject was prepared in May 1990 by the Bangladesh Water Development Board, financed by the Asian Development Bank and the European Economic Community. The boundaries of this project are shown in Fig. 1.

The project concept of this previous study is identical to that presented here (protect *boro* by submersible embankment). The main difference is that the previous study included Ghoraduba Beel; the present study excludes it. Also, the present study looks at aspects not considered in the previous work (fisheries and navigation impacts, the drainage congestion due to Gunai siltation).

5. WITHOUT-PROJECT TRENDS (NULL OPTION)

Independently of future water resources development, certain trends will be occurring in the area:

- Net population growth: about 1.8% per year up to 2000 and 1.5% per year up to 2015. These values are based on NERP estimates for future rural population growth, modified to reflect past local population growth rates relative to past regional population growth rates. Projected population will be 40,100 by 2000 and 50,800 by 2015.

- Food grain production growth: 3% per year. Without intervention, HYV *boro* area may increase slightly as the b *aman*/HYV *boro* crop pattern area increases; FWO production would be 500 tonnes more than the present production of about 14,500 tonnes. The FWO crop pattern and FWO crop production are given in Tables 5.1 and 5.2.

- Openwater fisheries production: FWO is estimated to be 343 T/yr, which is the present production of 379 T/yr less 36 T/yr production from 87 ha of *beel* that is expected fill in during 1994-1999 with Gunai/Gholamkhali sediment carried into the area by Jatrabari Dhala. This estimate does not reflect the overall annual 6% decline observed in recent years, in order to avoid underestimating negative project impacts on fisheries. Indeed, future biological fisheries management interventions (i.e. restore habitat, regulate exploitation of brood stock, etc.) could increase fish production greatly. The economic model includes a calculation of the sensitivity of project ERR to a 20% increase fisheries production impact magnitude.

- River course changes: It is anticipated that the Gunai, which recently eroded a new channel into Pakhanunia Beel, will gradually infill the *beels* and lowlands, and then form a new channel towards the northeast to the Updakhali. The lower Gunai will continue to silt in; by 1998 (earliest date project could be completed), its cross-section would be reduced to about 2 m x 40 m. In addition to this, field observations suggest that the Gunai could shift to a new course upstream of Jatrabari Dhala.

- Loss of arable land to settlement: Negligible. Though population is increasing, settlements will expand slowly if at all, because of the prohibitively heavy effort involved in building new high (3 m or more) platforms and protecting the fresh fill from wave action.

Table 5.1: Future-Without-Project Crop Pattern

Crop Pattern	F1	F2	F3	Total
b-aus - lt aman	100(20)			100
b aus - rabi	350 (70)			350
b aus - lt aman - rabi	50 (10)			50
b aman - rabi		177(10)		177
b aman - fallow		177(10		177
b aman - hyv boro		354(20)		354
hyv boro - fallow		1062 (60)	786(30)	1848
l boro - fallow			1834(70)	1834
Total	500	1770	2620	4890

Numbers within parentheses indicate percent under each land type.

Table 5.2: Future-Without-Project Crop Production

Crop	Damage Free Area			Damaged Area			Total Production (t)
	Area (ha)	Yield (t/ha)	Total (t)	Area (ha)	Yield (t/ha)	Total (t)	
b aus	500	1.3	650				650
b aman	708	1.5	1062				1062
lt aman	150	2.1	315				315
l boro	825	2.6	2146	1009	1.66	1674	3820
hyv boro	1431	4.6	6584	771	3.40	2620	9204
pulses	87	0.9	78				78
oilseeds	289	0.8	231				231
vegetables	17	4.0	69				69

Source: NERP estimates.

6. DEVELOPMENT OPTIONS

6.1 Problems

The *boro* crop is damaged annually by pre-monsoon flash floods from the distributaries of western Someswari and Kangsha Rivers, which back up due to high water levels in the Baulai to the east. These flood waters enter the area through channels and as overbank spill from the Updakhali and Gunai, and through bridge openings in the Netrokona-Kalmakanda Road.

Crop damage occurs even at low floods, due to the new channel of the Gunai-Gholamkhali which enters the area at Jatrabari.

Beels are being filled with sediment carried into the area by the Gunai-Gholamkhali flow.

The part of the area which drains to the Gunai suffers from post-monsoon drainage congestion due to siltation of the Gunai below Jatrabari. A substantial amount of cultivable land remains under deep water. The area is increasing annually as the lower Gunai continues to silt up.

Rapid and deep monsoon flooding restrict the cultivation of monsoon crops.

6.2 Water Resources Development Options

The options are:

- Re-excavate the lower Gunai to improve drainage
- Construct water control structures at the *khal* openings, including the Gunai-Gholamkhali channel at Jatrabari, to exclude flash floods and sediment
- Construct submersible embankments on reaches where overbank spills are occurring

Full flood embankments would not be appropriate because the accumulated rainfall runoff within the project would be almost equal to external levels, with the abundant rainfall accumulating starting in April. In addition, impacts on the area's rich fish resources would be more negative; a full flood embankment would be vulnerable to erosion from the intense monsoon wave action; and the drainage of upland areas would be adversely affected by the reduction in the floodway for the peripheral rivers.

7. PROPOSED UPDAKHALI RIVER PROJECT

7.1 Rationale

Boro rice is the main crop of the area, and will remain so, given the hydrologic setting. The main benefit of the project would be to significantly lessen flash flood damage to this crop. The project would also reduce sedimentation of the area from the Gunai-Gholamkhali, which could be of some benefit to both agriculture and the openwater fishery.

The project is not without significant adverse impacts and unresolved issues. These are noted in the Evaluation sections of Chapter 7, and in the list of outstanding issues given in Chapter 8. Implementation of this project is recommended only after resolution of these matters.

7.2 Objectives

The objectives of the project are:

1. To protect *boro* rice crop from early flash flood damage
2. To allow earlier *boro* transplantation by improving post-monsoon drainage
3. To promote cultivation of HYV *boro* from local *boro*; and,
4. To reduce sediment inflows which are harmful to agriculture and fisheries.

7.3 Description

The project consists of submersible embankments and regulating structures, including a structure at Jatrabari Dhala, and re-excavation of the lower Gunai.

The project area has been revised from that of the earlier Updakhali Subproject study to exclude Ghoraduba Beel, the largest *beel* in the vicinity, due to the large fishery there. We feel this *beel* should be considered for improved biological management measures such as fisheries habitat enhancement, sanctuary status, or less frequent harvesting.

7.3.1 Flood Protection

Embankments
A 25.0 km embankment would be constructed in the east and south from Neamatpur to Dakshin Atkapara; in the north, the banks of the Updakhali from Kalmakanda to Neamatpur are high enough to prevent spill for the design conditions. On the west, all the bridge openings in the Netrokona-Kalmakanda road would be closed off.

The embankment is designed for the 1:10 year pre-monsoon flood level (highest level before 15 May). It has a height of about 2.0 m, 3.66 m crest width, and 2:1 side slopes on both sides.

Sufficient setbacks should be provided along the lower Gunai, as the channel is expected to develop after the closure of Jatrabari Dhala.

Design embankment crest elevations are shown in Table 7.1. Details are provided in Annex B.

The embankment alignment can make use of the existing Neamatpur-Bonogaon village road, the homesteads along Barkapan Khal and the banks of the Gunai.

Closures and Structures for Flood Control
Five regulators will be constructed, on Jatrabari Dhala, Isabpur Khal, Barkapan Khal, Sripur Khal, and Kutigaon Khal. All bridge openings on Netrokona-Kalmakanda Road will be closed. Additional information on structures is provided in Section 7.3.3.

Table 7.1: Design Embankment Crest Elevations

Locations	Section (km)	Crest Level (m PWD)
Neamatpur	0.00	6.34
Dakshin Atkapara	25.00	6.34

Table 7.2: Pre-Monsoon Flood Depth (1:2 yr flood before 15 May)

Flood Depth (m)	Cultivable Area (ha)	
	Pre-Project	Post-Project
0.00-0.30	4170	4890
0.30-0.90	720	0
0.90-1.80	-	-
>1.80	-	-
Total	4890	4890

Before closing Jatrabari Dhala, the current channel used by the Gunai/Gholamkhali flow, the likelihood of a shift to a channel further upstream, which would bypass the structure, should be studied.

Impact on Flooding
Pre-monsoon flood depth will be reduced and flood-free area increased as shown in Table 7.2.

Monsoon flood depths will remain unchanged; these are shown in Table 7.3.

7.3.2 Drainage

The post-monsoon drainage of the project will be effected through the *khals* leading to the five regulators, four of which fall into the Gunai.

To induce natural development of the lower Gunai after closing Jatrabari Dhala, it would be re-excavated (pilot channel) by 20 m x 2 m for 17.5 km from Jatrabari to the Updakhali confluence would be re-excavated. Development of the lower Gunai is necessary for adequate drainage of this project and also for the success of the proposed Dharmapasha-Rui Beel Project and the ongoing Singar Beel Project parts of which also drain into the lower Gunai. Closure of Jatrabari Dhala will increase flows in the lower Gunai, which will help to sustain the re-excavated section.

The lower Gunai once developed should have a cross-section on the order of 4 m x 80 m for 17.5 km; this corresponds to an increase in river fisheries habitat area of 70 ha. Migration access

and water quality in the areas draining to the lower Gunai may improve. These areas include over half of Updakhali River Project (area south of village road along Barkhapan Khal), some of the proposed Dharmapasha-Rui Beel Project area, and some of the ongoing Singar Beel Project area.

Drainage of the area west of the Netrokona-Kalmakanda road is effected through a drainage channel parallel to and west of the road. Thus the bridge closures will not affect drainage of the western area.

The existing natural drainage system of *khals* and *beels* within the project will be used for drainage of the project area.

Table 7.3: Monsoon Flood Depth (1:2 yr max annual flood)

Flood Depth (m)	Cultivable Area (ha)	
	Pre-Project	Post-Project
0.00-0.30	0	0
0.30-0.90	500	500
0.90-1.80	1770	1770
>1.80	2620	2620
Total	4890	4890

Post-project values do not reflect cultivable land acquired for infrastructure. Production impacts of land acquisition are documented in the Evaluation section.

The re-routing and channelization of the lower Gunai between the embankments of this Project and those of the ongoing Singar Beel Project and of the proposed Dharmapasha Rui Beel Project could adversely affect upland drainage. Results of the regional surface water model would provide some insight on this point.

7.3.3 Structures

Five reinforced concrete box regulators with vertical lift gates would be constructed: two four-vent structures (Barkapan Khal, Jatrabari Dhala) and three two-vent structures (Sripur Khal, Isabpur Khal, Kutigaon Khal). Vents will be 1.52 m x 1.83 m, BWDB's standard size.

Provision has also been made for two pipe drainage sluice structures (0.90 m ϕ) to effect local drainage and 21 LLP irrigation inlets (0.45 m ϕ).

7.3.4 Expected Benefits

The benefits expected from the project relate to agriculture. Changes in pre-monsoon land type (Table 7.2) are expected to be associated with changes in area under different cropping patterns (Table 7.4). Projected crop production is estimated assuming that current yields of damage-free areas would be obtained in newly protected areas (Table 7.5).

Annual foodgrain production is expected to increase about 3891 tonnes (+26%) from 15051 tonnes (FW) to 18942 tonnes (FWO), due to reduced risk of flood damage to *boro* crops and consequent shifts from local *boro* to HYV *boro*. No increase in monsoon rice or non-cereal production is anticipated.

Increased foodgrain production implies a increased per-person cereal availability from 474 (FWO) to 597 (FW) gm per person per day, an increase of +26% (Table 7.6); allowing 10% for seed and 65% conversion of paddy to rice. Current Bangladesh average consumption is 440 gm per person-day.

7.3.5 Mitigation Measures

Fish passes would have been included in the project infrastructure described here, if information had been available on their effectiveness, design, and cost parameters in the Bangladesh context. This information is to be generated under the NERP potential initiative *Fisheries Engineering*. This potential initiative has been given Priority A within the Regional Plan, and should have yielded some results by the time feasibility studies of Updakhali River Project, assigned Priority C, are being completed. Consideration should be given to providing fish passes at some or all of the five water control structures.

Table 7.4: Future-With-Project Crop Production

Crop	Area (ha)	Yield (T/ha)	Prod (T)
b aus	500	1.3	650
b aman	708	1.5	1062
lt aman	150	2.1	315
l boro	786	2.5	1965
HYV boro	3250	4.6	14950
pulses	87	0.9	78
oilseeds	289	0.8	231
vegetables	17	4.0	69

Table 7.5: Future-With-Project Cropping Patterns

Cropping Patterns	F1	F2	F3	Total
l boro			786 (30)	786
HYV boro		1062 (60)	1834 (70)	2896
b aus-rabi	350 (70)			350
b aus-lt aman	100 (20)			100
b aus-lt aman-rabi	50 (10)			50
b aman-rabi		177 (10)		177
b aman-HYV boro		354 (20)		354
b aman		177 (10)		177
TOTAL	**500**	**1770**	**2620**	**4890**

Numbers within parentheses indicate percent of relevant land type.

Land acquisition and earthwork volume have been lessened by aligning embankments along the existing Neamatpur-Bonogaon village road, the homesteads along Barkapan Khal and the banks of the Gunai.

7.4 Project Operation and Maintenance

Under this development plan, operation and maintenance requirements would be substantial. Mainly, requirements would be to repair the submersible embankment damaged by erosion by spilled river flood water (after May 15) and by wave action.

7.5 Organization and Management

During the early part of the feasibility study process, a client group should be organized to oversee project development. This client groups should include farmers, fishermen, a local MP nominee, and relevant thana-level technical officers. The group's purpose would be to ensure that the area's problems are clearly understood and adequately reflected in the feasibility work, and that technical solutions proposed address problems in an acceptable manner.

The group's activities would include: periodic briefings during the feasibility work; confirm the conclusions of the feasibility study; kept informed of design details proposed by BWDB design engineers; and monitor construction carried out by BWDB.

BWDB would be responsible for undertaking technical work related to implementation of the project, in accordance with current practice, but should be responsive to the client group described above. Their general tasks would include completion of final designs, preparation of tenders, pre-qualification of contractors, contract awards, and construction supervision. The general management of BWDB activities would be under the Executive Engineer stationed in Sylhet. Construction supervision would be carried out by sub-divisional field staff.

The Department of Agricultural Extension (DAE) is responsible for the provision of extension services to the farmers within the project.

Once implemented, the organization and management of this project would have low dependency on central government. The extent to which project targets are realized will be determined by how effectively it serves people's needs and how actively the local community participates in all stages of project development.

Bangladesh Rural Development Board (BRDB) is responsible for assisting with command area development through farmers' training and by organizing farmers into cooperatives which will then have access to short-term crop production loans. Medium-term credits are available to these cooperatives from all nationalized banks.

The supply of all agricultural inputs has been deregulated and the distribution placed into the hands of the private sector.

7.6 Cost Estimates

Total project costs are Tk 78.3 million.

The estimates of land requirement and physical works are based on preliminary designs and layout plans prepared using four inch to one mile topographic maps, and historic hydrological data. Earthwork costs are estimated generously, on the basis of an entirely new embankment though actual volumes should be considerably less due to the incorporation of existing homesteads and roads.

Land costs reflect the current prices obtained from field interviews: single-cropped land costs an estimated Tk 120,000/ha; double-cropped land Tk 300,000/ha; and, homestead and garden land (including high ridges along the rivers) Tk 500,000/ha. Earthwork costs are based on BWDB Schedule of Rates for Mymensingh O & M Circle indexed to June 1991 prices. Structure costs are based on parametric costs developed for the region, also indexed to June 1991 prices in accordance with the FPCO Guidelines for Project Assessment.

The summary of total costs is presented in Table 7.7 with details provided in Annex B.

Table 7.6: Indicators of Food Availability (grams/person-day)

Food	Present (1993)	FW (2000)	FW (2015)	FWO (2015)
Cereals	688	757	597	475
Non-Cereals	31	26	20	20
Fish	34	19	15	20

Table 7.7: Capital Cost Summary

Item	('000 Tk)
Structures	31,300
Embankments	7,200
Channels	10,000
Bridges	-
Buildings	-
Land Acquisition	6,000
BASE COST	54,500
Physical Contingencies (25%)	13,625
SUBTOTAL	68,125
Study Costs[1] (15% of Subtotal)	10,220
TOTAL	**78,345**
Net Area (ha)	4,890
Unit Cost (Tk/ha)	1,6000

[1]Includes preparation of EIA and Environmental Management Plan.

7.7 Project Phasing and Disbursement Period

Three years are required to implement the project. One year (year zero) is required for completion of feasibility studies and conducting field surveys. Preparation of detail designs should start in year one and be completed in the same year. Land acquisition should commence in year zero, be implemented in phases preceding construction, and completed in year one. Construction activities should start in year one and be completed in year two. An itemized implementation schedule is shown in Table 7.8.

7.8 Evaluation

7.8.1 Environmental

The key areas of environmental impact for this project are described briefly below. Additional information is given in Annex C, Initial Environmental Evaluation.

Land Use
Land use changes are summarized in Table 7.9. A total of 50 ha of land (about 0.8% of the project gross area) will be required for construction of embankment and structures. This land will be available from fallow *kanda*.

Agriculture
Increased foodgrain production and per-person cereal availability is documented in Section 7.3.4, Expected Benefits and Table 7.10. No increase in non-cereal production is anticipated.

Openwater fisheries production
Impacts on production are assessed using a simplified model reflecting our current understanding of and information about the system. The model is described and parameter values given in Appendix D.

FW and FWO fish production are characterized in Table 7.11. The overall annual openwater fisheries production impact is -81 tonnes, a 24% decrease in annual production. This implies a decrease in openwater-source fish availability per person as shown in Table 7.10.

Table 7.8: Implementation Schedule

Activity	Year (% Completion)		
	0	1	2
Preconstruction Activities			
Feasibility Study	100		
Engineering Investigation	70	30	
Detail Designs		100	
Land Acquisition	20	80	
Construction Activities			
Construction of Embankments		50	50
Excavation of Channels		50	50
Construction of Structures		30	70
Construction of Bridges			
Project Buildings			

Aquaculture production
The project will not protect ponds from monsoon flooding. No change in aquaculture production is anticipated.

Homestead flooding
The project will not protect homesteads from flooding.

Wetland Habitats and Grazing Area
Table 7.12 shows impacts on:

- 'Winter grazing area'. Defined as F0, F1, and F2 lands that lie fallow in the dry season (winter) plus any perennially-fallow highlands. This land would have limited residual moisture. While it is clear that animals do graze on such areas, productivity per unit area is not known.

- 'Winter wetland'. Defined as F3 land that lies fallow in the dry season, plus any perennially-fallow lowland (F4), *beel*, and channel areas. This land would likely have considerable residual moisture and could support a range of wetland plant communities.

- 'Summer wetland'. Defined as F1, F2, and F3 land that lies fallow in the summer, plus perennially-fallow lowland (F4 area), *beel*, and perennial channel areas. This land would

be inundated to >0.3 m and would support submerged, free-floating, rooted floating, and sedge/meadow plant communities.

Overall, the impact of the project would be to decrease winter grazing area by 11%. There would be no change in winter and summer wetland area.

There would be no impact on swamp forest trees.

The economic loss associated with reduced winter grazing area would be Tk 160,000 per year, if an annual economic production from these areas of Tk 40 ha^{-1} is assumed. The associated employment loss would be 2000 pd yr^{-1} assuming 0.5 pd $(ha\ yr)^{-1}$ in harvesting.

Table 7.9: Changes in Land Use

Use	Change in area (ha)
Cultivated	
Homesteads	
Beels	
Ponds	
Channels	
Hills	
Fallow[1]	-50
Infrastructure[2]	

[1] Multi-use land, wetlands, grazing lands, village grounds.
[2] Government-owned land not appearing elsewhere.

Transportation/navigation
Closure of the Jatrabari Dhala will double the length of the navigation route between Thakurakona and Kalmakanda (see Section 3.6). Current transportation costs on this route are an estimated Tk 9 million (over US$ 200,000) annually (assuming, based on very cursory field information, 30 boats operating each carrying 30 persons, making two round trips of 40 km per day, 6 days/week, for a total of 1,500 persons travelling round-trip per day, or 560,000 per year, at fares of Tk 0.4/km-person). All other things being equal, the cost for this transportation would double as a result of the project. More likely, the increased costs for water transport will displace some travel to the Netrokona-Kalmakanda Road.

The project will not affect flooding of the existing road system.

Higher flood levels
Pre-monsoon flood levels in the Gunai could increase somewhat. Regional flooding analysis, ongoing under NERP, will provide improved understanding of this impact.

7.8.2 Social

The key areas of social impact (or lack thereof) for this project are described below. Additional information is given in Annex C, Initial Environmental Evaluation.

Employment
There will be an overall decrease in employment of 0.093 million person-days per year. This is composed of:

- an increase in owner-labour employment of 0.021 million pd yr^{-1}, of which very roughly 20% is post-harvest processing activities traditionally done by women of the household. This increase is cancelled out by . . .

Table 7.10: Changes in Fish Production Indicators

Regime	FWO		FW		FW-FWO
	Area (ha)	Production (T/yr)	Area (ha)	Production (T/yr)	Prod'n Impact (T/yr)
Floodplain (F1+F2+F3)	4890	215	4890	172	-43
Beels	253	104	253	66	-37
Channel/River	140	25	210	24	-1
Total	5,283	344	5,353	262	-81

- an net decrease in employment opportunities for landless people of 0.114 million pd yr^{-1}, composed of changes in the following areas:

  - Agricultural hired labour: +0.031 million pd yr^{-1}, of which about 10% is for post-harvest processing traditionally done by women hired in (mainly by larger farmers) for the purpose.

  - Fishing labour[1]: -0.074 million pd yr^{-1}. In addition to this, there would be a corresponding loss in support activities such as net-making and post-catch processing (mainly drying) much of which is done by women.

  - Wetland labour (gathering wetland products): -0.002 million pd yr^{-1}. Fodder and building material is gathered mainly by men. Food, fuel, and medicine is gathered mainly by women.

Displacement impacts due to land use changes

The project embankment will connect the homesteads as a part of embankment and there will be no displacement by project construction. Rather, the embankment will serve as road for the villagers during winter and help farmers to stockpile the paddy during harvesting time when a large flood (higher than design flood) will be about to submerge the standing crops.

Conflicts

Improved drainage will encourage farmers to extend cultivation further into the *beels*. This will bring them into conflict with fishermen who will find the fishing area reduced. This conflict could affect the way the regulator is operated, which would have a direct bearing realization of the potential agricultural benefits of the project.

It is also possible that land owners outside the project in the Ghoraduba Beel area may cut the project's eastern embankment in an attempt to force inclusion of the area in the project.

7.

[1]Information on wages in the various fisheries habitats is very sketchy. For this reason, and for inter-comparability with agricultural hired employment, here the incremental net financial returns due to openwater fisheries impacts, divided by a standard daily wage of Tk 50, is used.

Equity

The net equity impact would appear to be strongly *regressive*. Who benefits?

- Landowners, in proportion to land holdings, benefit directly from investment in agriculture production. This is the main benefit (96% in economic terms) of the project and its distribution is quite *regressive*.

Who loses?

- Families dependent upon fishing labour. These families are mainly landless and tend to be poorer than average. *Regressive*.
- Families involved in gathering wetland products. These families are mainly landless and tend to be very poor. *Regressive*.
- Families dependant upon water transport. The water transport employees are generally very poor than average. *Regressive*.

Table 7.11: Floodplain Grazing and Wetland Changes

Land Type	Winter Grazing Area			
	FWO	FW	Change	%
sc/wf F0	0	0	0	
sc/wf F1	100	100	0	
sc/wf F2	177	177	0	
Fallow Highland	180	130	-50	
Total	457	407	-50	-11

Land Type	Winter Wetland			
sc/wf F3	0	0	0	
F4, Beel, Channel	480	480	0	
Total	480	480	0	0

Land Type	Summer Wetland			
wc/sf F1	0	0	0	
wc/sf F2	1062	1062	0	
wc/sf F3	2620	2620	0	
F4, Beel, Channel	480	480	0	
Total	4,162	4,162	0	0

FW areas shown here do not reflect cultivable land acquired for infrastructure (see Land Use, Section 7.8.1). 'sc' - summer cultivated. 'wc' - winter cultivated. 'sf' - summer fallow. 'wf' - winter fallow.

Gender Equity

The net gender equity impact would appear to be *regressive*. Employment opportunities gained in post-harvest processing of crops would likely be more than balanced by losses of opportunities in fisheries and wetlands.

Notes on Qualitative Impact Scoring

The qualitative criteria shown in Table 7.13 are scored on an 11 level scale of -5 to +5. Scoring of those criteria that are impacts (some are not, like 'responds to public concerns') is shown in Table 7.15. The scoring procedure is analogous to that used in the FAP 19 EIA case studies, but simplified to eliminate half-point scores (1.5, 2.5, 3.5, etc). Here, each score sums across five equally weighted logical (true/false) criteria, with each 'true' counting for a value of one and each 'false' for zero. The sign reflects whether the impact is positive or negative.

7.8.3 Economic

The project has an economic rate of return of 20%, which compares well to the required rate of 12% as prescribed by government. It is a relatively low investment project, at Tk 78.3 million or Tk 16000 per hectare, and it covers a geographic area of 5960 ha gross. The rate of return,

Table 7.12: Qualitative Impact Scoring

		True=1 False=0					
Qualitative Impact	Impact Sign	Sensitive	Magnitude	Immediate	Sustainable Pos Impact/ Irreversible Neg Impact	No Mitigation Required/ Possible	Score
Fisheries Biodiversity	-1	1	0	1	0	0	-2
Navigation	-1	1	1	1	0	1	-4
Fish/Agri/Navig Conflicts	-1	0	0	1	1	1	-3

however, is quite sensitive to the timing of the benefits, and a delay in benefits by two years would reduce the ERR to 15%. The other sensitive variable is the increases in capital costs (a 20% increase in capital costs would reduce the rate of return to 17%). For a sensitivity to a 20% reduction in fish benefit (20% increase in fish losses), the ERR would decrease to 17%.

The foreign costs associated with the project are low, at 9% (excluding FFW contributions), making it a relatively small project from a donor perspective. Donor funding considerations would clearly need to include funding local costs.

Almost all of the benefits of the project relate to increased rice production, mostly resulting from shifts to HYVs. Average crop yields would increase as a result of reduced flood damage, though the cropping intensity would not increase. There will be no increase in non-cereal production. Floodplain fish production fall to about 61% of future-without-project production. The value of the lost fisheries output amounts to about 27% of the value of increased agricultural output. Some amount of the benefit would result from embankment which serves as road during winter. A small amount of disbenefits would result from loss of food, shelter, and tree products that are currently harvested from the seasonal wetlands. A summary of salient data in provided in Table 7.13.

It is anticipated that the established crop marketing system will handle incremental crop production without any reduction in prevailing average price levels. Assuming the current annual growth in the demand for grain remains about 3%, the increased cereal production is unlikely to present any marketing difficulties.

A significant caution is that the economic benefits are based largely on assumed shifts in cropping patterns, and if this did not occur, the project would not be viable. Lessons of the past have shown that producers have not always responded as predicted, and this case warrants special efforts in predicting producer responses.

7.8.4 Summary Analysis

From a multi-criteria perspective (Table 7.14), the project is not particularly attractive:

- Benefits derive entirely from increased rice production.
- Impacts on the openwater fishery and winter grazing land would be negative.

- Navigation would have to be re-routed a significant distance, which would likely increase transportation costs
- Employment opportunities for hired labourers would decrease, and in excess of employment created for owners.
- Gender equity of impacts is negative, in that women's total employment opportunities would decrease.
- Pre-monsoon flood levels in the Gunai would increase somewhat.
- Conflicts between farmers, fishermen, and water transport workers would increase.

The positive aspects of the project would be:

- Rate of return is acceptable.
- Substantial increase in rice production.
- Increased economic returns to land owners.
- Submersible embankment could be used for transportation in winter months.
- Project responds to some public concerns.

Table 7.13: Summary of Salient Data

Economic Rate of Return (ERR)	24%			
Capital Investment (Tk million)	78			
Maximum O+M (Tk million / yr)	2			
Capital Investment (Tk/ha)	16,021			
Foreign Cost Component	9%			
Net Project Area (ha)	4890			
Land Acquisition Required (ha)	50			

AGRICULTURAL IMPACTS		Present	FWO	FW
Incremental Net Econ Output (Tk million / yr)	18.8			
Cropping Intensity		1.2	1.2	1.2
Average Yield (tonnes/ha)		2.6	2.7	3.3
Average Gross Margins (Tk/ha)		13201	13460	17021
Owner Labour (md/ha)		122	122	126
Hired Labour (md/ha)		43	44	49
Irrigation (ha)		3957	4045	4045
Incremental Cereal Prod'n (' 000 tonnes / yr)	4			
Incremental Non-Cereal (' 000 tonnes / yr)	0			
Incremental Owner Labour (' 000 pd / yr)	21			
Incremental Hired Labour (' 000 pd / yr)	31			

FISHERIES IMPACTS		Flood plain	Beels	River/ Channel	Spawning
Incremental Net Econ Output (Tk million / yr)	-2.6	-1.0	-1.6	-0.0	-
Impacted Area (ha)		4890	253	210	-
Average Gross Margins (Tk/ha)		1540	28700	12250	-
Remaining Production on Impacted Area, %		80	64	96	-
Incremental Fish Production (tonnes / year)		-43	-37	-1	-
Incremental Labour ('000 pd / yr)	-74	-28	-46	-1	-

FLOOD DAMAGE BENEFITS				
Households Affected		-		
Reduced Econ Damage Households (Tk M / yr)	-			
Roads/Embankments Affected -km		-		
Reduced Econ Damage Roads (Tk M / yr)	-			

OTHER IMPACTS				
Wetland Incr Net Econ Output (Tk million / yr)	0.16			
Wetland Incremental Labour ('000 pd / yr)	-2.0			
Acquired Cult & Homestead Lands, Incr Net Econ Output (Tk million / yr)	0			
Persons Displaced by Homestead Acquisition	0			

Table 7.14: Multi-Criteria Analysis

Economic		
Indicator	**Units**	**Value**
Economic Internal Rate of Return (EIRR)	per cent	24
EIRR, Increase Capital Costs by 20%	per cent	20
EIRR, Delay Benefits by Two Years	per cent	17
EIRR, Increase Fisheries Losses by 20%	per cent	20
Net Present Value	Tk '000	43,189

Quantitative Impacts			
Indicator	**Units**	**Value**	**Percent[1]**
Incremental Foodgrain Production	tonnes	-3891	+26
Incremental Non-Cereal Production	tonnes	0	0
Incremental Openwater Fish Production	tonnes	-81	-24
Change in River/Channel Fisheries Habitat	ha	+70	+50
Homesteads Displaced Due to Project Land Acquisition	homesteads	0	0
Homesteads Protected From Floods	homesteads	0	0
Roads Protected From Floods	km	0	0
Gunai Pre-Monsoon Flood Levels	m PWD	(Note 2)	
Incremental Owner Employment	million pd/yr	+0.021	+3
Incremental Hired Employment (Agri+Fishing+Wetland)	million pd/yr	-0.043	-8

Qualitative Impacts (ranked from -5 ...0... +5)	
Impact	**Rank**
Fisheries Biodiversity	-2
Navigation	-4
Fish/Agri/Navig Conflicts	-3
Socioeconomic Equity	
Gender Equity	
Decentralized Organization and Management	
Responds to Public Concerns	+3

[1] Percent changes are calculated relative to future-without-project values of: total production of cereal, non-cereal, and fisheries; total floodplain area; total number of homesteads (for displacement due to land acquisition); flood-affected homesteads; flood-affected roads; Kushiyara water level; and total employment for owners and hired labourers.

[2] Ongoing NERP regional surface water modelling is to provide quantification of this.

8.1

8.2

8.3

8.4

8.5

8. OUTSTANDING ISSUES

8.1 Jatrabari Dhala Closure

The navigation/transportation impacts of the closure, and the likelihood of an avulsion to a channel upstream that would bypass the closure, need to be investigated carefully.

8.2 Fish Passes

Provision of fish passes at some or all of the structures should be evaluated, once information on their cost and performance parameters is available.

8.3 Fisheries Impacts

The impacts of this project on the openwater fishery are complex, and have important implications for human diets and employment in the project area. The initial assessment suggests that these impacts are significantly and probably unacceptably negative (24% loss in production, leading to losses of similar scale in fish consumption and fisheries employment; overall (agricultural + fisheries + wetland) decreases by 8%). The feasibility-level EIA will have to investigate whether these initial estimates are correct.

8.4 Conflicts

The potential for greater conflict among fishermen, farmers, and boatmen needs to be investigated carefully.

8.5 Water Levels

Gunai water levels and their implications for upland drainage should be evaluated, once better information is available from the regional surface water model.

ANNEX A

TABLES

Table A.1: Climatological Data

Station: Mymensingh

Location: 24°46N:90°24'E

Month	Temperature			Rain[1]			Evaporation (mm)	Relative Humidity (Per %)	Sunshine Hours (hrs/day)	Wind Speed (km/s)	Potential Evapotranspiration (mm)
	M Max (°C)	M Min (°C)	Mean (°C)	M Max (mm)	M Min (mm)	Mean (mm)					
Jan	20.2	16.9	18.5	43	0	4	2.3	74	8.0	6	91
Feb	22.9	18.5	20.9	64	0	13	3.3	68	7.5	4	106
Mar	26.4	21.5	25.0	108	0	39	4.4	67	8.1	5	149
Apr	29.0	23.1	27.7	415	30	162	5.9	71	7.7	6	162
May	29.5	20.9	27.6	912	138	414	5.5	79	6.4	6	160
Jun	29.4	21.7	28.1	1140	150	707	4.7	84	4.5	5	132
Jul	29.8	21.7	28.4	1863	465	839	4.6	85	3.5	5	134
Aug	29.8	21.7	28.5	1340	343	610	4.6	84	3.7	5	134
Sep	29.7	21.5	28.4	1525	64	533	3.9	84	3.9	4	122
Oct	29.9	21.4	27.1	615	7	217	3.9	81	7.0	4	124
Nov	25.3	21.1	23.7	107	0	16	2.9	75	8.0	3	105
Dec	21.3	18.2	19.9	91	0	11	2.4	75	8.4	3	87
Year	26.0	21.1	25.4	4943	2511	3528	4.0	77	6.4	4	1506

Source: BMD; [1] BWDB Durgapur Raingauge

A2

Table A.2: Area-Elevation
Updakhali River Project

Elevavion (m,PWD)	Area (ha)
3.1	101
3.5	105
4.0	303
4.5	707
5.0	1716

Elevavion (m,PWD)	Area (ha)
5.5	2625
6.0	3331
6.5	4846
7.0	5552
7.2	5960

Table A.3 : Updakhali River Flood Level

Period	Station No. & Name	Period Record	Water Level m,PWD					
			2-yr	5-yr	10-yr	20-yr	50-yr	100-yr
Pre-monsoon (Prior to May 15)	263.1 Kalmakanda	1964-89	4.94	5.50	5.74	5.92	6.07	6.15
Monsoon		1964-89	7.79	8.29	8.70	9.16	9.86	10.49

Table A.4: Water Bodies in Updakhali River Project

Thana	Open Water Bodies in Project Area (Dry Season) Area(1) (ha)	Closed Water Bodies in Project Area			
		No.of Ponds	Pond Area[2] (ha)	Average Pond Size (ha)	Pond Concentration (nos/km^2)
Kalmakanda	340	502	57	0.11	8.9
Madhyanagar	-	31	3	0.10	9.2
Total	**340**	**533**	**60**	-	-

Source: [1] CIDA (1989); [2] BFRSS, 1986

ANNEX B

ENGINEERING ANALYSES

ANNEX B : ENGINEERING ANALYSES

1. Area under different flood phase

Areas under different flood phases for pre-project conditions have been obtained from area - elevation curve for a 2-yr flood event for pre- and monsoon flood levels of Updakhali River at Kalmakanda only. The effect of Gunai, the other river that causes flooding in the project area could not be taken in the analysis as it is not gauged.

The two - year flood levels of Updakhali River at Kalmakanda has been computed by frequency analysis using GEV-III distribution. The values are 4.94 m,PWD and 7.79 m,PWD respectively for pre- and monsoon periods. The corresponding areas under different flood phases are given in Tables 7.2 and 7.3.

In project conditions, all lands are assumed to be free of flood under pre-monsoon conditions considering that the beels and channels which have been emptied by the fishermen and farmers have adequate capacity to store the run-off from the pre-monsoon rainfall. However, there will be no change in land type in monsoon with and without project.

2. Embankment Crest Level

The embankment has been designed for a 10-yr pre-monsoon flood level (5.74 m,PWD) of Updakhali River at Kalmakanda. The crest level is fixed at 6.34 m,PWD by adding 0.30 m for possible confinement effect due to the construction of proposed projects including Singar Beel and Rui-Beel projects and another.30 m to take care of spill due to wave.

In absence of any water level measurement in Gunai River, a uniform crest level from Neamatpur to Dakshin Atkapara has been fixed based on Updakhali River level at Kalmakanda only. This is considered adequate for this pre-feasibility study; however, in feasibility stage of study, it is recommended to measure Gunai level at Madhyanagar and Dakshin Atkapara for improved analysis.

3. Quantity and Cost Estimate

The following structural components are required for the scheme.

a. Flood Embankment.

Length	:	25.0 km
Top width	:	3.66 m
Side slope	:	2:1 on both side
Average height	:	2.0 m
Earthwork	:	16.85 x 1000 x 25 m^3 = 421,250 m^3

b. Re-excavation of Gunai River

Re-excavation of 20 m x 2.00 m pilot channel of length 17.5 km
Earthwork : (20 + 2 x 2.0) x 2 x 17.5 x 1000 m^3 = 840,000 m^3

It is assumed that this project will bear the cost of re-excavation of 483,600 m^3 of earthwork (58%); the remaining cost will be borne by Dharmapasha-Rui Beel Project.

c. Structures

R.C.B Drainage Regulator. A total of 14-vents (1.52 m x 1.83 m) are required to flush the project area after harvesting of boro crop. It is to be noted that the postmonsoon drainage requirements are far less than that of flushing.

The 14-vents are distributed at the following five khal outfall

Isabpur khal	: 2 vents
Barkapan khal	: 4 vents
Jatrabari Dhala	: 4 vents
Sripur khal	: 2 vents
Kutigaon khal	: 2 vents

Pipe Drainage Sluice. Two pipe drainage sluices (0.90 m ϕ) are also proposed to effect local drainage.

LLP Irrigation Inlet. Another 20 nos. of LLP irrigation inlet structures (0.45 m ϕ) are proposed for the project.

Table B.1: Bill of Quantities

Item	Description of Item	Unit	Quantity	Rate (Tk/Unit)	Amount (MTK)
Structure	1.Drainage Regulator				
	2-vent	No.	3	5.0	15.0
	4-vent	No.	2	7.0	14.0
	2. Pipe Drainage Sluice(0.9 m ϕ)	No.	2	0.55	1.1
	3. LLP Irrigation Inlet	No.	21	0.055	1.2
Sub-total					31.3
Embankment	Earthwork in Construction of 25.0 km of embankment from Neatmatpur to Dakshin Atkapara	Mm^3	0.42	17.14	7.2
Re-excavation	Earthwork in re-excavation of Gunai River (pilot project) for a length of 17.5 km	Mm^3	0.48	20.85	10.0
Land acquisition	Land acquisition for embankment construction	ha	50	0.12	6.0
TOTAL					**54.5**

ANNEX C

INITIAL ENVIRONMENTAL EXAMINATION

ANNEX C: INITIAL ENVIRONMENTAL EXAMINATION

C.1 Introduction

This Initial Environmental Examination (IEE) (pre-feasibility level Environmental Impact Assessment or EIA) follows the steps specified in the *Bangladesh Flood Action Plan Guidelines for Environmental Impact Assessment* (ISPAN, 1992). These steps are illustrated in Figure 2 of ISPAN (1992).

Much of the information required for the IEE/EIA appears in the main body of the study. The section and chapter references given below cite this information.

C.2 Alternative 1: Proposed Partial Flood Control Project

C.2.1 Project Design and Description (Step 1)

As in Section 7.3, Project Description.

C.2.2 Environmental Baseline Description (Step 2)

As in Chapter 2, Biophysical Description, and Chapter 3, Settlement, Development, and Resource Management.

C.2.3 Scoping (Step 3)

Technical:

Literature review: Presented in Chapter 4, Previous Studies.

Local community: As described in Section 3.1.9, People's Perception.

C.2.4 Bounding (Step 4)

Physical:

Gross area: 5960 ha.
Impacted (net) area: 4890 ha.
Impacted area outside project:none

Temporal:

Preconstruction: years 0 through year 1
Construction: year 1 through year 2
Operation: Embankment, structures and channel maintenance will be required; there are no other operational requirements.
Abandonment: after year 50.

Cumulative impacts:

With other floodplain infrastructure: none
With pre-existing no-project trends. Described in Chapter 5.

C.2.5 Field Investigations (Step 5)

Field investigations were limited to seven to ten days of informal reconnaissance by a multi-disciplinary team.

C.2.6 Impact Assessment (Step 6)

At this level of detail, a screening matrix (Table C.1) was filled out by the project team. Impacts are designated by:

+	positive impact
-	negative impact
•	neutral impact (such as conversion from one productive land use to another)
?	insufficient information to designate

Impacts are discussed in Section 7.8.

C.2.7 Quantify and Value Impacts (Step 7)

Quantification and evaluation of impacts is documented in Section 7.8 and Tables 7.9 through 7.13.

C.2.8 Environmental Management Plan (Step 8)

At a pre-feasibility level, this section focuses on "identification of broad management options and major constraints" (p. 28, ISPAN, 1992).

Mitigation and enhancement. Ghoraduba Beel which is the largest Beel in the vicinity and rich in fish resources has been kept outside the project and to be declared as fish sanctuary.

Compensation. Land acquisition will be required for construction of embankment and structures. Market value compensation is required to be paid and independent monitoring is required to ensure that proper compensation does occur.

Monitoring. There is a need to define monitoring needs and methodologies at regional, institutional (BWDB), and projects levels. This exercise should reflect (i) the need for greater people's participation in all project activities, which would include monitoring project function and opportunities for discussion with BWDB and (ii) the need for greater emphasis on operation and maintenance, of which monitoring can play an important role.

People's participation. There is a need at regional, institutional, and project levels to maintain enthusiasm for people's participation, and to develop effective and efficient public participation modalities.

Disaster management (contingency planning). The project will improve pre-monsoon flooding conditions and thus permit farmers to shift to more intensive and higher input agriculture. The risks associated with this relate to gradual deterioration of embankment as result of no on-going maintenance and a gradual return to present (pre-) project conditions.

EMP institutionalization. Arrangements for sharing EMP responsibility between BWDB and local people would need to be worked out. Project implementation should be contingent upon agreement on this matter between BWDB and local people.

Residual impact description. This should be generated as part of the feasibility-level EIA.

Reporting and accountability framework. At a national or regional scale, there is a need to develop satisfactory reporting/accountability arrangements involving BWDB, DOF and DOE,

probably through an Environmental Cell within BWDB linked to DOE and DOF. At the project level, the client committee and local BWDB staff should develop reporting/accountability arrangements satisfactory to themselves. Project implementation should be contingent upon development of satisfactory arrangements at the local level, at a minimum.

Budget estimates. These should be generated as part of the feasibility study.

Environmental Screening Matrix

Screening matrix PHASE	Normal/ Abnormal	Important Environmental Component Activity	Land Use	Agri-culture	Fisheries	Water Quality	Water Quantity	Human Health	Social Issues	Wild Plants & Animals	Hazards	Other
Preconstruction	Normal	Surveys & instrumentation: landmark, topographic, benchmark, hydrologic, climatic, socio-economic, land use, natural resource		•	•	•	•	•	•	•	•	
		Land acquisition		•					—			
		People's participation activities		+	+							
	Abnormal											
Construction	Normal	Site preparation: vegetation removal, infrastructure removal/relocation, resettlement, levelling, temporary structure installation (access roads, godowns, accommodations, garages and parking sites, cooking and eating facilities, waste disposal sites, water supply, drainage, sanitary facilities)		•	•	•	•	•	•	•	•	
		Canal excavation: labor and materials mobilization, crossdam construction, spoil transport, spoil disposal		—	—							
		Embankment construction: labor and materials mobilization, topsoil removal, soil taking and transport, compaction, turfing, paving		—								
		Structure (sluice gate, culvert, pump house, and so on) construction: labor and material mobilization, de-watering, excavation, pile driving, foundation works, structure construction, earthwork filling, turfing, paving		—								
		Tube well installation: boring, distribution facilities, electrification N/A										
	Abnormal	Suspension of construction before completion, construction delays		—	+							
		Incorrect construction practices or techniques		—	?							

Environmental Screening Matrix

Environmental Screening Matrix

Screening matrix / PHASE	Normal/ Abnormal	Activity / Important Environmental Component	Land Use	Agri-culture	Fisheries	Water Quality	Water Quantity	Human Health	Social Issues	Wild Plants & Animals	Hazards	Other
Construction (continued)	Abnormal (cont'd)											
Operation	Normal	Pre-monsoon flood protection		+	—							
		Monsoon flood protection N/A										
		Surface water irrigation N/A										
		Ground water irrigation N/A										
		Drainage										
		Agriculture: operation of institutions, extension, credit, seed distribution, fertilizer and pesticide storage and use, farmer groups		+								
		Water management: activities of BWDB, subproject implementation committee, local water user groups, structure committees and guards		+								
	Abnormal (relative to FWO, not FW normal)	Pre-monsoon flooding (due to extreme event, infrastructure failure)		—	+							
		Monsoon flooding (due to extreme event, infrastructure failure) N/A										
		Embankment overtopping		—	+							
		Under- and over-drainage							?			
		Improper operation (public cuts, mistiming of scheduled O&M events etc)										
		Riverbed aggradation/degradation		—	—							
Abandonment	Normal	Re-occupation of infrastructure sites										
		Reclamation of materials										
	Abnormal											

ANNEX D

FISHERIES MODEL

FISHERIES MODEL

This annex briefly describes the model used to analyze fisheries impacts for the project.

The openwater fishery ecosystem is extremely complex. Impacts on production are assessed here using a highly simplified model. The limitations of the model mirror the limitations of the current understanding of and information about the system.

The major system processes about which some insight exists are:

- Migration access and timing. It seems to be accepted that:
  - a multiplicity of access points is desirable (i.e. that closing any or some channels is still deleterious,
  - the most important channels are those at the downstream end of the system (that with flood onset, fish mainly migrate upstream and onto the floodplain, and downstream out of the beels into the river), and
  - delay of flooding, as in partial flood control schemes, is highly disruptive

- Overwintering (dry season) habitat extent.

- Wet season habitat (floodplain grazing extent and duration). [It is expected that production also varies as a function of land type (F1, F2, F3) — probably such that shallower (F1, F2) land is more productive than deeper (F3) land — but as data to show this has been lacking it has been neglected from the model.]

- Habitat Quality. Habitat quality would include water quality, vegetation, and other conditions (presence of preferred types of substrate e.g. rocks, sand, brush). Water quality would appear to be most relevant during low volume/flow periods, and during the time of flood onset and recession when contaminants can disperse or accumulate.

- Spawning. Production outside the project area can also be impacted if habitats suitable for spawning within the project are adversely affected. It is believed that most of the region's fish production stems from spawning occurring in: mother fishery areas, which are those exhibiting extensive, well-interconnected, and varied habitats with good water quality; key beels; and river duars. Duars are somewhat a separate problem as they are located in rivers and larger channels, not on the floodplain.

The foregoing is represented quantitatively here as:

FWO production =

$$(R_0 * P_{R0}) + (B_0 * P_{B0}) + (W_0 * P_{W0})$$

FW production =

$$[M * Q * (R_1 * P_{R0})] + [M * Q * (B_1 * P_{B0})] + [M * (W_1 * P_{W0})]$$

Thus,

$$\text{Impact} = \text{FW} - \text{FWO production} =$$

$$\{ [(M * Q * R_1) - R_0] * P_{R0} \} +$$

$$\{ [(M * Q * B_1) - B_0] * P_{B0} \} +$$

$$\{ [(M * W_1) - W_0] * P_{W0} \}$$

where

sub-0 and sub-1 refer to FWO and FW respectively

R, B, and W are river/channel, beel, and floodplain (F1+F2+F3) areas, in ha

P is the unit FWO production in kg/ha for the respective habitats. Estimated regional average values are 175, 410, and 44 respectively.

M is the FW quality-weighted migration access remaining, relative to FWO conditions (range 0 to 1 for negative impacts, >1 for positive impacts)

Q is the FW acceptability of habitat/water quality relative to FWO conditions (range 0 to 1 for negative impacts; >1 for positive impacts).

A_M is the area of mother fishery and key beels affected times a factor (range 0 to 1 for negative impacts, >1 for positive impacts) reflecting the degree of degradation/enhancement

T is the estimated annual regional fish production attributable to spawning exported from mother fisheries/key beels (a constant of 50,000 tonnes, which is 50% of the total regional fish production of 100,000 tonnes)

A_T is the estimated regional mother fishery/key beel area (a constant of 100,000 ha).

Estimated values for this project is shown in Tables D.1. Where standard values, established for the region or for a particular project type, are used, this is noted. Comments on project-specific values are also shown.

It is estimated that one person-day is required to capture half kilogram of fish on the flood plain, eight kilograms in the beel, three kilograms in river/channel and nine kilograms in pond.

Table D.1 : Fisheries Parameters

Updakhali River Project
(Partial Flood Control)

Var	Value	Stnd value?	Comments
M	0.8	0.7[a]	(1) Negative impact on migration of submersible embankments which would eliminate migration for a significant part of the pre-monsoon migration window. (2) Positive impact on migration of redevelopment of lower Gunai.
Q	0.8	0.7[a]	(1) Deterioration of pre-monsoon water quality from increased agro-chemical usage with expansion of HYVs plus restricted flushing/circulation during one month delay of pre-monsoon floods. (2) Positive impact on post-monsoon water quality of redevelopment of lower Gunai.
R_0	140		FWO river/channel area.
R_1	210		Re-development of the lower Gunai will increase the river/channel area by about 70 ha.
B_0	253		FWO *beel* area = present area less 87 ha that will be silted in by 1998, due to new Gunai/Gholamkhali avulsion into Jatrabari Dhala.
B_1	253		Project has no impact on *beel* area. This assumes that effects of Gunai/Gholamkhali avulsion have stabilized by the time project excludes this flow from the area. Project could have a positive impact on *beel* area, if this *beel* sedimentation would otherwise continue.
W_0	4890		FWO F1+F2+F3 area, based on monsoon flood depths.
W_1	4890		No project impact on monsoon flood depths.
P_{R0}	175	175	NERP field estimate.
P_{B0}	410	410	NERP field estimate.
P_{W0}	44	44	NERP field estimate.
A_M	0	100000	No mother fishery or other regionally important spawning sites in this area.

[a] Default values for submersible flood protection only (no drainage improvement).

ANNEX E

FIGURES

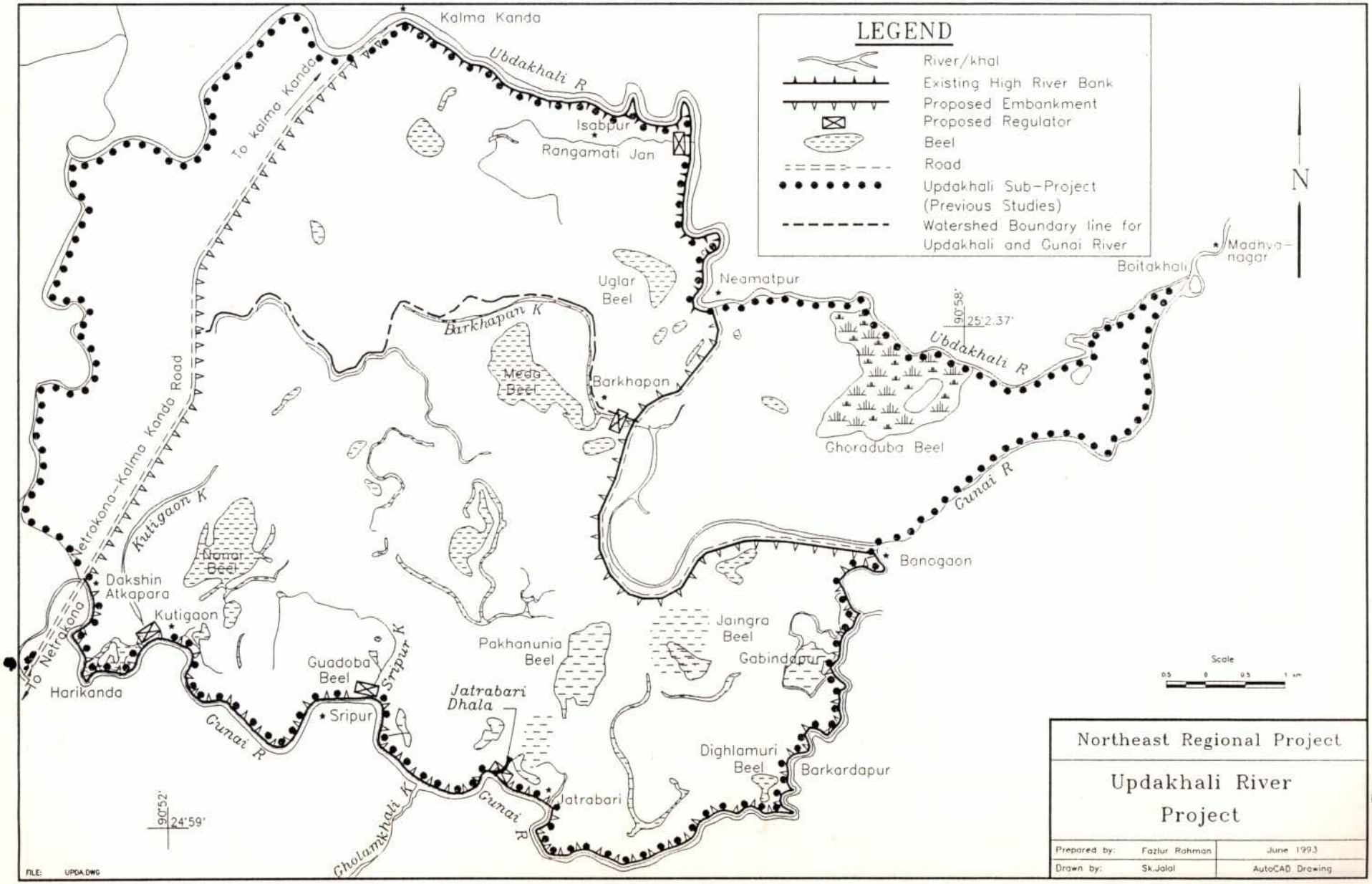
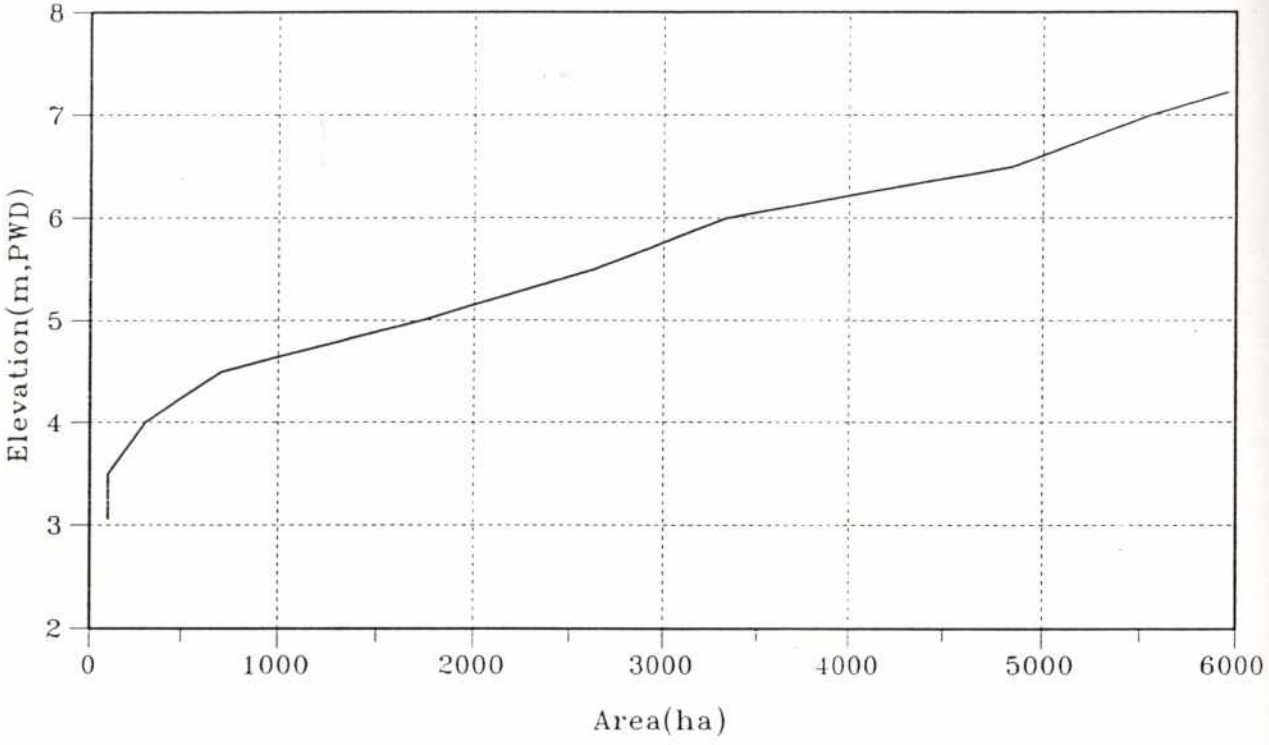

LEGEND
River/khal
Existing High River Bank
Proposed Embankment
Proposed Regulator
Beel
Road
Updakhali Sub-Project (Previous Studies)
Watershed Boundary line for Updakhali and Gunai River
N
Kalma Kanda
Ubdakhali R
To kalma Kanda
Isabpur
Rangamati Jan
Uglar Beel
Neamatpur
Barkhapan K
Meda Beel
Barkhapan
Boitakhali
Madhya-nagar
90°58'
25°2.37'
Ubdakhali R
Ghoraduba Beel
Gunai R
Netrokona-Kalma Kanda Road
Kutigaon K
Nonar Beel
Dakshin Atkapara
Kutigaon
To Netrokona
Harikanda
Banogaon
Jaingra Beel
Gabindapur
Pakhanunia Beel
Guadoba Beel
Sripur K
Sripur
Jatrabari Dhala
Gunai R
Dighlamuri Beel
Barkardapur
Jatrabari
90°52'
24°59'
Gholamkhali K
Gunai R
Scale
0.5 0 0.5 1 km
FILE: UPDA.DWG
Northeast Regional Project
Updakhali River Project
Prepared by: Fazlur Rahman
June 1993
Drawn by: Sk.Jalal
AutoCAD Drawing

Figure 1

Area Elevation Curve
Updakhali River Project



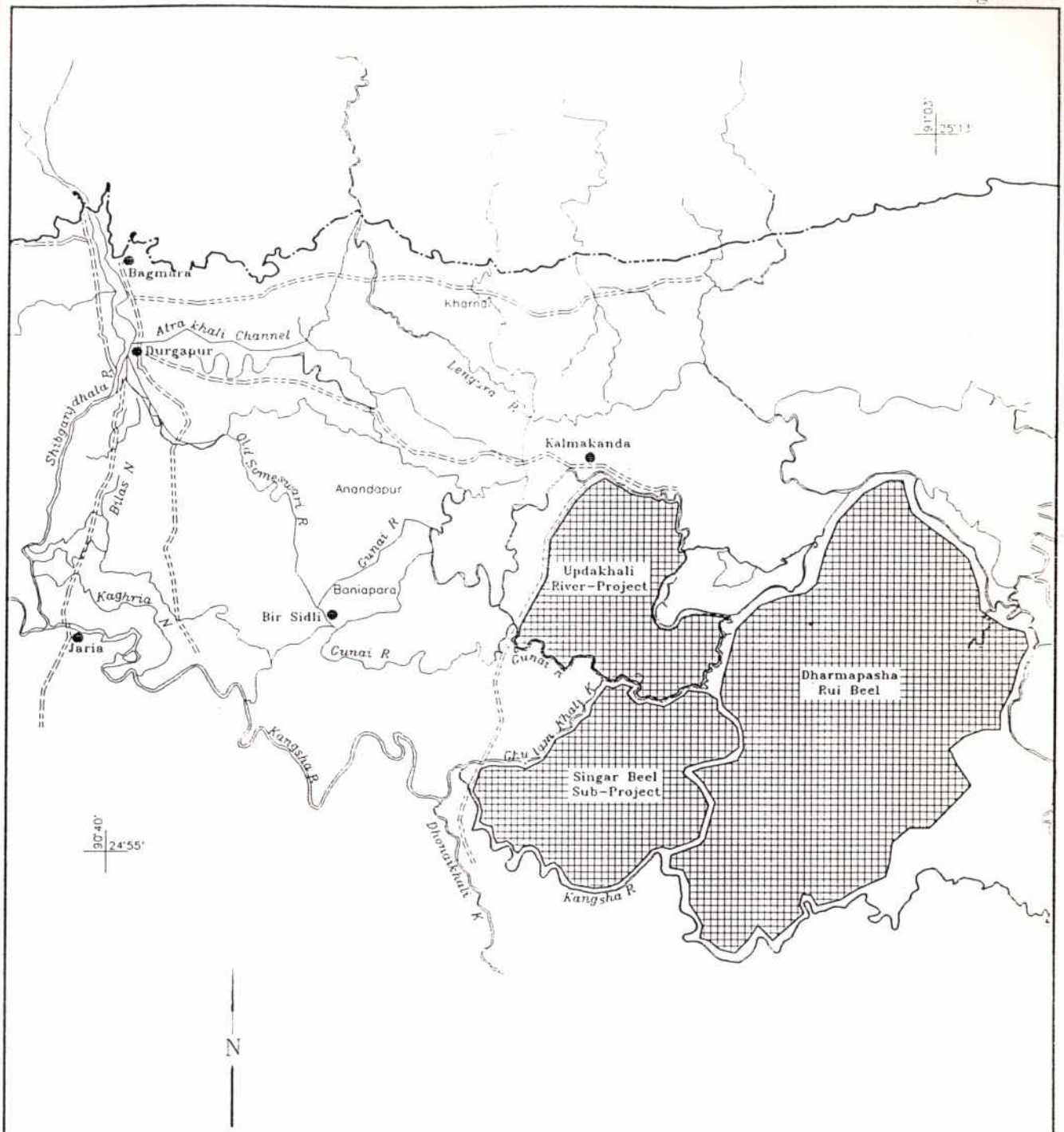
Data :

El(m,PWD)	3.06	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.22
Area(ha)	101	101	303	707	1716	2625	3331	4846	5552	5956

Northeast Regional Project

Area-Elevation-Storage Curve
Updakhali River Project

Prepared by : F.Rahman/NR | January 1994



LEGEND

- International Boundary
- Road
- River/Khal
- Beel
- Proposed Project

Northeast Regional Project

Updakhali River Project Vicinity Map

Prepared by: FR/NR	January 1994
Drawn by: Sk.Jalal	AutoCAD Drawing

FILE: NERP-230.DWG