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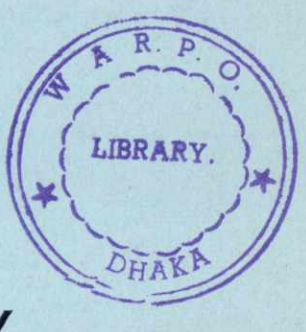

MEGHNA ESTUARY STUDY

DRAFT DEVELOPMENT PLAN

VOLUME 4 : PART 1
FEASIBILITY STUDY
CHAR MONTAZ - KUKRI-MUKRI INTEGRATED DEVELOPMENT PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
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ADP	Annual Development Plan
BADC	Bangladesh Agricultural Development Corporation
BIWTA	Bangladesh Inland Water Transport Authority
BWDB	Bangladesh Water Development Board
CDSP	Char Development and Settlement Project
CERP	Coastal Embankment Rehabilitation Project
CIP	Chandpur Irrigation Project
CMG	Canal Maintenance Group
CPP	Cyclone Protection Project
DAE	Department of Agricultural Extension
DDCC	District Development Co-ordination Committee
DLS	Department of Livestock Services
DOE	Department of Environment
DOF	Department of Forestry
EIA	Environmental Impact Assessment
EMG	Embankment Maintenance Group
FAP	Flood Action Plan
FD	Forest Department
FPCO	Flood Plan Co-ordination Organisation
GOB	Government of Bangladesh
GPP	Guidelines for People's Participation
HYV	High Yielding Variety
LAED	Land Accretion and Estuary Development Division (of BWDB)
LCS	Landless Contracting Society
LGED	Local Government Engineering Department
LRP	Land Reclamation Project
MES	Meghna Estuary Study
MHW	mean high water
MLW	mean low water
MWR	Ministry of Water Resources
O&M	Operation and Maintenance
PMU	Project Management Unit
RIDP	Remote Island Development Programme
RRI	River Research Institute
SDE	Sub Divisional Engineer
SMG	Struture Maintenance Group
SO	Sectional Officer
SRP	Systems Rehabilitation Project
TDCC	Thana Development Co-ordination Committee
TNO	Thana Nirbahi Officer
WARPO	Water Resources Planning Organisation
WMB	Water Management Board
WMC	Water Management Committee
WUA	Water User Association
WUG	Water User Group

SUMMARY

This feasibility study for the Char Montaz - Kukri Mukri Integrated Development Project has been prepared as part of the Meghna Estuary Study. The proposed project is centred around the promotion of accretion through the construction of cross dams between the chars south of Bhola. Previous studies of potential interventions of this type have concluded that they would not be economically viable. However, the development of low cost construction methods under MES together with recent data on expected accretion after construction have positive implications for the viability of the project.

Morphology

As a part of the feasibility study for the construction of cross dams, a morphological study has been carried out to ascertain the effects of cross dam construction on the morphological development of the area. The objectives of this study were:

- to draw up an inventory of all relevant reports and data
- to describe the morphological development of the project area during recent decades
- to improve the understanding of the morphological behaviour in the area with the aid of remote sensing imagery, historical bathymetric and field data on the processes of land formation
- to assess long term changes of land formation and char development
- to predict the morphological impact of cross dam construction over the next 10 to 30 years.

Based on the development of land in the area over the last 25 to 30 years it is concluded that without the construction of any cross dams the natural gain of new land at the +1.5 m PWD level, the minimum level at which land should be embanked in this area, will be approximately 100 ha per year over the whole project area or some 43 ha per year in the area directly affected by the proposed cross dams. The impact of the cross dams on land accretion to the +1.5 m PWD level is summarised below:

ha at or above +1.5 m PWD

Year	No intervention	With cross dams
5	212	3,821
10	425	5,507
15	638	6,210
20	850	6,532

Present situation in the project area

The estimated 1996 population of the project area is some 18,500 persons, made up almost entirely of fishermen and farmers will small holdings. Fishing constitutes the largest single source of income for most households, although crop and livestock production are important for many of them.

The area has very limited existing infrastructure with the embankment of polder 55/4 on Char Montaz being the single most important item. The embankment serves as an unpaved road but inside the embankment there is only a network of tracks. There is no similar infrastructure on other chars.

Agriculture in the area is typified by low yields (often less than 1 mt/ha for rice) and low cropping intensities. Major constraints are soil salinity, the low organic content of soils and the vulnerability of the area to damage from high tides and storms and a lack of inputs and extension support. These constraints can only be mitigated by the construction of embankments to keep out tides and storms and permit proper water management. Cattle, goats and poultry are a common feature of the household economy, but productivity is low. Aquaculture is very limited in extent and also experiences low productivity. The marine fisheries of the area are important to the local population and contribute significantly to household incomes.

Based on the analysis of satellite imagery, mangrove forests were estimated, in 1996, to cover some 6,600 ha of the whole project area.

Future without the project

With no intervention, land area will continue to accrete at a rate similar to the past, i.e. about 43 ha per year. Without the project the development of both physical and social infrastructure in the project area is expected to be much slower than with the project. In particular, embankments and roads are less likely to be constructed.

Without project interventions, including the embanking of existing and newly accreted land, the existing constraints to production would decline only very slowly or not at all since the land would remain vulnerable to saline intrusion from high tides. The risk of damage to crops from tides and floods would be unchanged. Agricultural yields and cropping intensities are unlikely to change significantly.

Without the project, allocation of agricultural land to landless and functionally landless households is unlikely to occur and newly accreting land is likely to be claimed by existing powerful interests in the area rather than being entrusted to the Forest Department for mangrove forestry.

For both livestock and aquaculture, some expansion will occur without the project, in line with growth of the local human population and the accretion of land area, but improvements in productivity are likely to occur only very slowly.

Some of the accreting area will be planted in mangroves. Based on the assumptions used in the feasibility study, after 30 years the total area of mangroves would be some 950 ha more than at present.

Proposed interventions

The interventions proposed under the project are:

- construction of three small cross dams to join Char Montaz to Bhola in year 1; viz. cross dam A1 A-3, connecting Char Rustom with Char Haldor, cross dam A1 A-4, connecting Char Haldor with Char Burhan and cross dam A1 A-5, connecting Char Burhan with Bhola. In addition cross dam A1 A-6 between Kukri Mukri and Char Aicha will be constructed.

- construction of two cross dams at the southern end of Char Montaz in year 2; viz. cross dam A1 A-7 connecting Char Montaz with Char Taposhi and cross dam A1 A-8, connecting Char Montaz with Andar Char.

- rehabilitation and upgrading of 30.1 km or primary and 5.5 km of secondary embankments, as well as installation of 14 sluices and improvement of drains for 5,230 ha on Char Montaz in years 1 and 2;

- construction of 24.1 km of primary embankment plus 14 sluices and drainage for 2,883 ha on Kukri Mukri in years 6 and 7;

- construction of 19.6 km of primary and 3.1 km of secondary embankments together with 11 sluices and drainage for 3,040 ha on the chars and newly accreted land between Char Montaz and Bhola in years 6 and 7.

On newly accreted land in the estuary, mangrove forests have an important role to play. For the Char Montaz - Kukri Mukri Integrated Development Project, the following sequence of land development has been adopted:

- except for land which will accrete very rapidly to +1.5 m PWD in the first five years after completion of the first group of cross dams, all new land reaching the level of +0.7 m PWD will be planted in mangroves;

- mangrove forest which has reached the age of 15 years may be cleared for agriculture and other uses provided that a minimum depth of 1 km of forest is maintained all along the future coast at all times as an essential part of the protective barrier providing security to the population against storms;

- existing forest which will be inside the proposed new polders will be cleared for agriculture after construction of the embankments.

Integrated development

The economic viability of interventions to promote land accretion, such as the cross dams proposed in this project, is severely restricted by the long period between the intervention and the start of the flow of benefits. Furthermore, because of such problems as soil salinity, low soil fertility and flooding from tides and storms, levels of production initially achieved in newly accreted areas are low. Interventions to promote accretion, therefore, constitute only one component of an integrated approach to the development of a project area, the aim of which will be to maximise the benefits that can be achieved from land accretion. Integrated development for the Char Montaz - Kukri Mukri project area, includes:

- promoting the safety of the population
- embanking areas to protect against tides and storms when the land has reached an appropriate level
- providing adequate infrastructure for drainage and water management
- providing appropriate infrastructure for transport and communications
- establishing coastal forests as part of the protection system for the local population and to promote the stability of the land
- promoting measures to reduce soil salinity and increase agricultural production
- promoting improved aquaculture and livestock production systems
- supporting the development of settlement and village infrastructure
- improving the access of the population to the education and health services provided by government.

Impact of the project

Construction of the cross dams will result in the accretion of an estimated 5,572 ha of new land at +1.5 m PWD by year 15. With implementation of the project the additional net area available for agriculture will be almost 3,600 ha. At full development, rice production is estimated to be some 9,000 mt per year greater than without the project. The construction of embankments and improvement of water management will lead gradually to increases in crop yields and cropping intensities and the replacement of salt tolerant by non-salt tolerant crops and varieties. The livestock component of the project will lead to substantial increases in the production of livestock and livestock products. Aquaculture development will lead to an increase in production of fish, at full development, of about 245 mt of carp and 40 mt of shrimp per year. The area of mangrove forest will increase by about 2,400 ha.

Under the project, an estimated 2,570 landless and functionally landless households established in the project area will be allocated agricultural land and land will also be available for an additional 860 households to be resettled in the project area from other areas.

Environmental assessment

An EIA has been carried out, assessing the likely impacts over a 15 year period, and is presented as a separate report. It is concluded that there are not major impacts that cannot be mitigated for, although the monitoring of the impacts of cross dam construction on fisheries habitats is vital.

Under the Department of the Environment classification the proposed intervention would appear to be in the highest Class D (Red) under Section 66 (flood control embankment, polder, dike etc.). Before the project can go ahead the DOE will need to review and approve the EIA in order to grant a Site Clearance Certificate. Before a full Environmental Clearance Certificate can be granted a No Objection Certificate will be required from the Local Authority. However, there is little experience in the implementation of these procedures so far in Bangladesh and the process should only commence when firm funding is available for project implementation. Under World Bank Operational Directive 4:01 the proposed intervention would probably be classified as Class A (the highest), although it could possibly be down graded to Class B as the extent of the effected area is relatively small by international standards.

Economic assessment

The proposed project will be implemented over a period of seven years. Total base costs amount to Tk 502.9 million (US$ 10.4 million). Including physical and price contingencies the estimated total cost is Tk 730.1 million (US$ 13.2 million).

Project benefits quantified for the economic analysis are increases in agricultural, aquacultural and livestock production and the net value of forestry production. All residents of the project area will be beneficiaries of the project; the present population of the area is projected to reach about 30,000 by year 10 if the project is implemented.

The EIRR is 16.6 per cent and the NPV is Tk 134.7 million. Furthermore, in the overall assessment of the project, account should be taken of the long lag between investment and the accrual of benefits as well as the accrual of non-quantified benefits such as improved safety and well being of the vulnerable section of the Bangladeshi population living on these estuarine chars and the positive impacts of expanded areas of mangroves.

This result is relatively sensitive to changes in both costs and benefits, but significantly more so to benefits than to costs. A 10 per cent increase in costs combined with a 10 per cent decrease in benefits would reduce the EIRR 12.4 per cent.

Project implementation

Because of the limited cross dam experience currently available within BWDB and because of the new design and installation technology proposed, it is strongly recommended that there is some involvement of foreign experts in the planning and supervision of the implementation of these cross dams.

It is important that an effective institutional structure be established for the implementation of the project's integrated development activities.

1. INTRODUCTION

1.1 Background of the project

This feasibility study for the Char Montaz - Kukri Mukri Integrated Development Project has been prepared in the context of the Meghna Estuary Study (MES) (FAP Study 5B). The proposed project is centred around the construction of cross dams between the various islands south of Bhola to encourage the accretion of land so that they will form a continuous southward extension of Bhola.

The project arises from the general interest in enhancing the accretion of land and improving land use as well as increasing the safety and security of the population in the MES study area. In previous studies on the use of cross dams to enhance land accretion in the estuary area, it has usually not been possible to show that such interventions could be justified on economic grounds alone, in part because of the low fertility and other characteristics of newly accreted land and the low yields achieved for agricultural production, but also because of the relatively high cost of cross dam construction. A number of studies done under FAP (FAP 1 and 9B) have also confirmed the general conclusion that at the present stage of socio-economic development of Bangladesh, works to protect agricultural land are generally not feasible from an economic point of view.

However, the proposed new method for constructing cross dams, which is significantly cheaper than the more traditional methods assessed in the previous studies, offers the opportunity to reassess the potential costs and benefits of enhancing land accretion in the estuary. The use of these low cost methods to promote accretion and protect against erosion has led, as in the present case, to different conclusions.

1.2 Objectives and scope of the study

The overall development objectives of the MES are:

- to increase the physical safety of the population living in the south eastern coastal areas of Bangladesh
- to promote sustainable development in these areas
- to increase the social security for the population in the coast areas and on the islands.

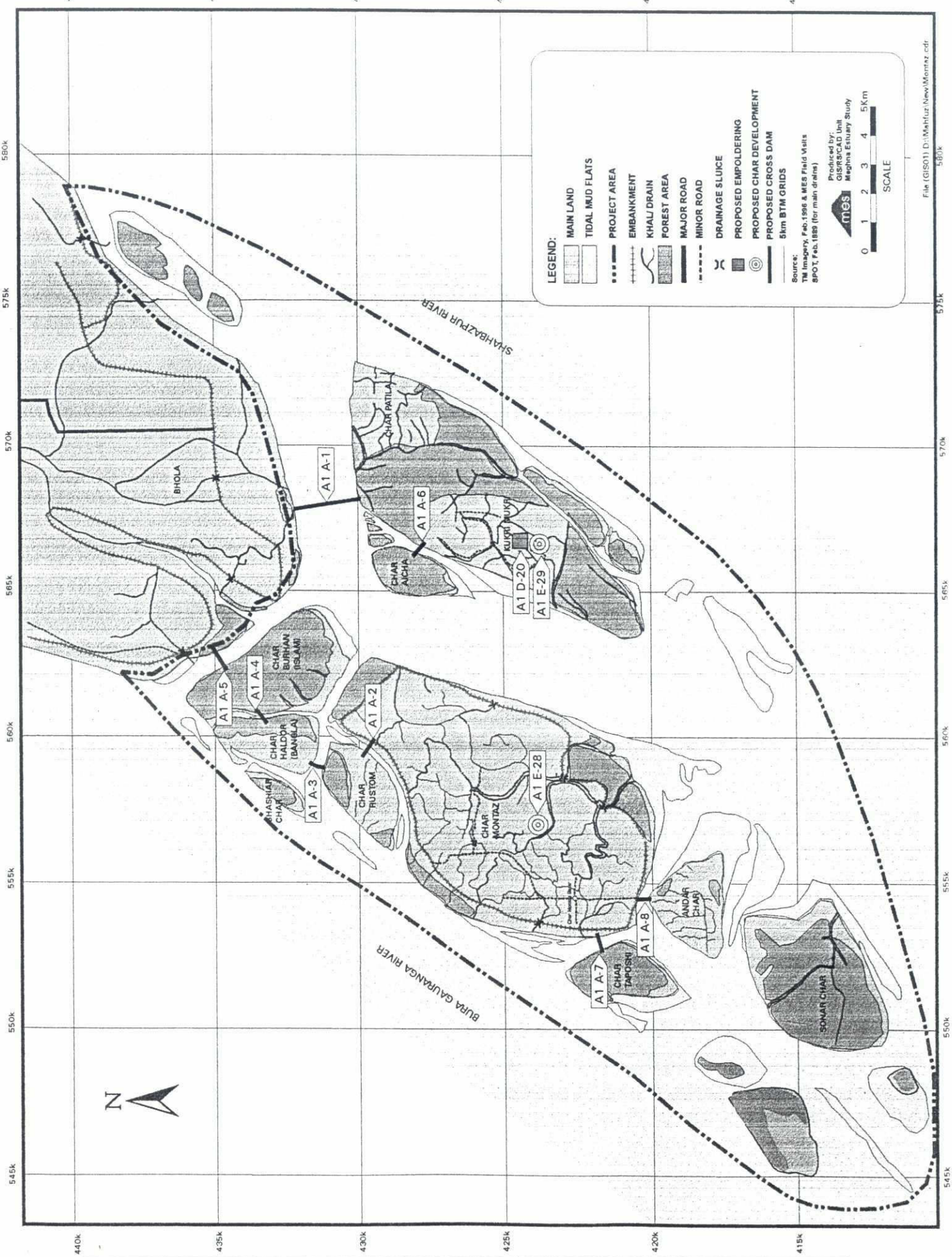
Among the immediate objectives of the Study is the preparation of a development plan with priority projects and programmes for flood protection, agricultural and socio-economic development prepared for early implementation. This feasibility study for the Char Montaz - Kukri Mukri Integrated Development Project is one of these priority projects. The study assesses the technical, socio-economic and environmental viability and the economic feasibility of the proposed project.

1.3 Project area

The project area lies immediately to the south of Bhola in Char Montaz union of Galachipa thana and in Kukri Mukri union of Char Fasson thana (see Figure 1.1) and in particular consists of the islands of Char Montaz, Char Rustom, Char Haldor, Char Burhan, Char Taposhi, Andar Char, Kukri Mukri and Char Aicha.

The area is located between longitude and east and latitude and north. The total existing land area is some ha. The area is low lying and flat and much of it can be submerged by high spring tides, especially during the monsoon season.

Figure 1.1: Project area map



1.4 Project approach

Interventions, such as cross dams, which accelerate the accretion of new land, present a dilemma from the economic point of view. Newly accreted land is saline, subject to tidal intrusions and low in fertility. For land to accrete to a sufficient level so that it can be successfully embanked and so that effective drainage and water management can gradually eliminate soil salinity takes a considerable number of years. The organic matter content of the soils is initially very low and increases only slowly. As long as these soil conditions prevail, agricultural yields are low. There is thus a long delay between investment in a cross dam and the commencement of a significant flow of benefits.

For these reasons it is appropriate to adopt an integrated development approach to the proposed development activities for chars in the Meghna estuary. By combining land accretion with land development and designing projects that incorporate cross dams, embankments, drainage and water management together with measures to increase the productivity and production of agriculture, livestock and aquaculture and other activities it is possible to design feasible development projects for these areas.

1.5 Key assumptions

The preparation of a feasibility report requires the making of assumptions, especially with regard to the reliability and processing of data. For this study, the critical assumptions refer to the sequence of land development on newly accreted land and the role of mangrove forests on the estuarine chars. In particular, it is assumed that:

- new land reaching the level of +0.7 m PWD will be planted in mangroves
- mangrove forest which has reached the age of 15 years may be cleared for agriculture and other uses provided that a minimum depth of 1 km of forest is maintained all along the future coast at all times as an essential part of the protective barrier providing security against storms to the population
- existing forest which will be inside the proposed new polders will be cleared for agriculture after construction of the embankments.

1.6 Structure of the report

Subsequent chapters of this report describe the present situation in the project area (chapter 2) and the expected future situation if the project is not implemented (chapter 4). The morphology of the area is discussed (chapter 3) and engineering interventions for the development of the area are proposed (chapter 4). Taking into account the proposed engineering interventions, a package of measures for the integrated development of the area is proposed (chapter 6) and the expected future developments in the area with the implementation of these various measures are estimated (chapter 7). An environmental assessment of the project area is included in chapter 8 and the economic assessment of the project is included in chapter 9. Implementation issues are presented in chapter 10.

The appendices to the main report contain technical and other information not presented in the main report on morphology, engineering design, project costs, economic analysis and production activities. The Environmental Impact Assessment is presented in a separate volume as a stand alone report.

2 MORPHOLOGICAL DEVELOPMENTS

2.1 Introduction

Within the framework of the Meghna Estuary Study, the possibility of implementing the Char Montaz - Kukri Mukri cross dams has been declared priority. The project area is shown in Figure 1.1. The cross dams will accelerate accretion because flow velocities in the closed channel section will be drastically reduced. Bank erosion due to the current will also stop in the channels.

To reduce the construction costs of such dams, the MES proposes to use geotextiles. Geotextiles will be spread out along the bottom across the channel and the space under the geotextile is filled with sand. This geotextile with sand act as a base for the cross dam to protect the bed against erosion during construction.

As a part of the Integrated Development Plan for Char Montaz - Kukri Mukri area, a morphological study has been carried out to ascertain the effects of cross dam construction on the morphological development of the area. Four options have been studied:

Option 1: Future without major intervention but with cross dam A1 A-2 implemented as pilot scheme in 1998/1999

Option 2: Cross dams A1 A-2 installed followed by construction of A1 A-3, A-4, A-5 and A-6 in 2001/2002

Option 3: Cross dams A1 A-2 A-3, A-4, A-5 and A-6 installed, followed by construction of A1 A-7 and A-8 in 2002/2003

Option 4: Cross dams A1 A-2, A-3, A-4, A-5, A-6, A-7 and A-8 installed, followed by construction of A1 A-1 in 2011/2012.

2.2 Objectives of the morphological study

The objectives of the present morphological study, carried out as a part of the Feasibility Study, are as follows:

- to draw up an inventory of relevant reports, bathymetric maps, aerial photographs, satellite imagery, cross-sectional soundings, water levels, flow velocities, discharges, sediment concentration and grain size distribution
- to describe the morphological development of the study area during the last decades (in terms of accretion and erosion and land levels)
- to improve the understanding of the morphological phenomena in the area with the aid of satellite imagery as well as other historical data on bathymetry and land formation
- to assess long term changes of land formation and char development
- to predict the morphological impact of cross dam construction for an intermediate time period (10-30 years)

Figure 2.1: Effect of cross dam construction on accretion

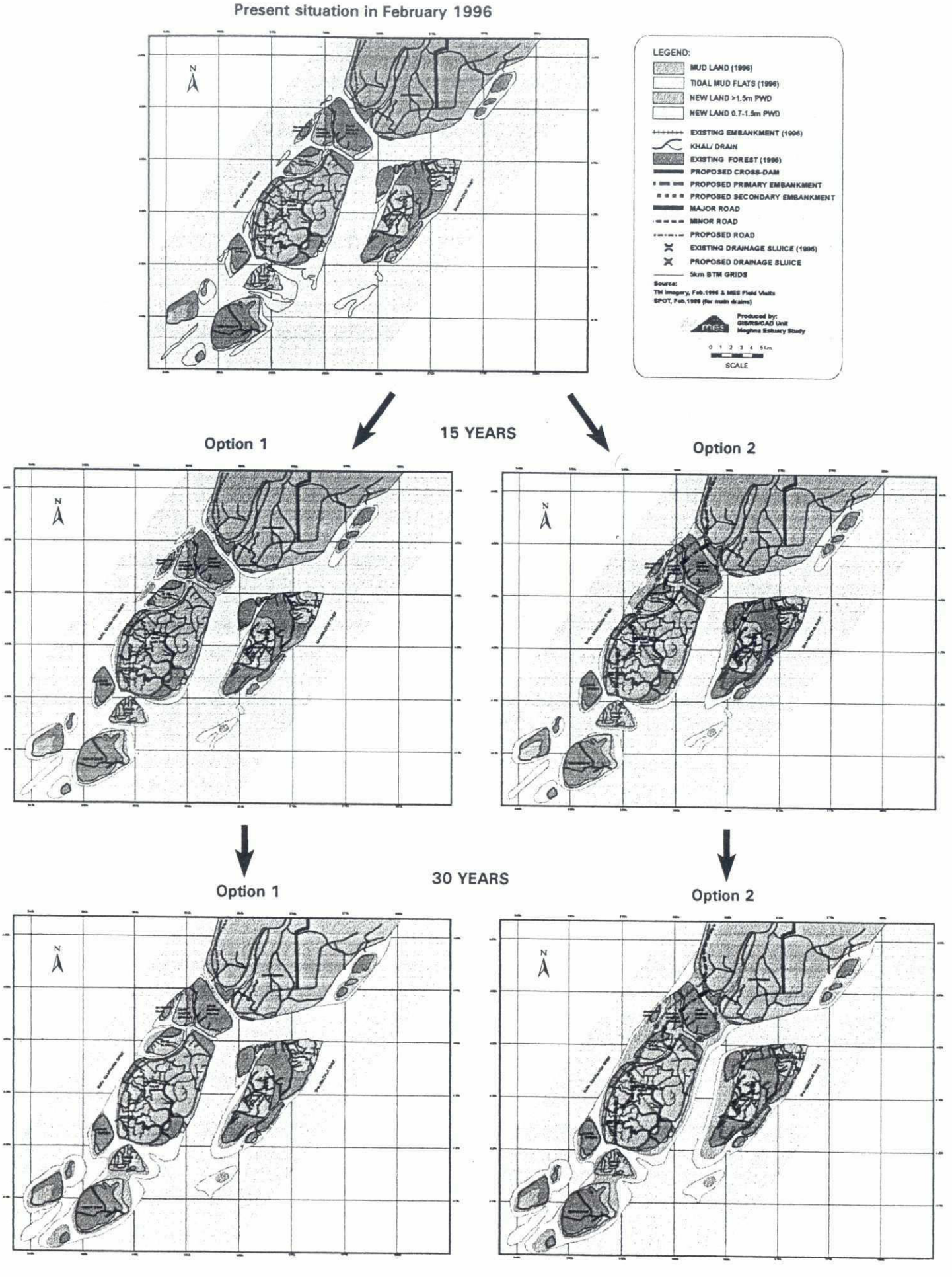
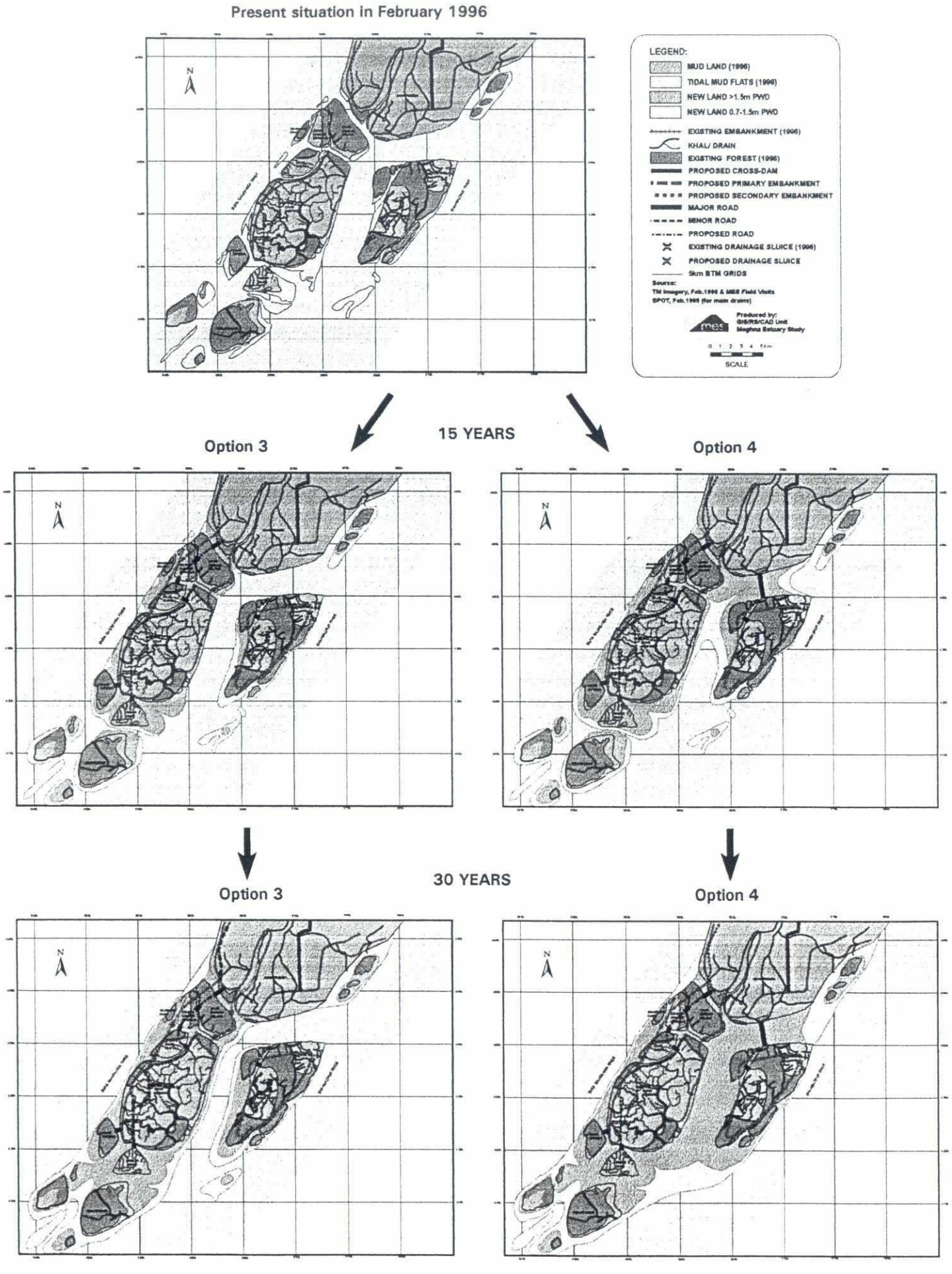


Figure 2.1: Effect of cross dam construction on accretion (continuous)



2.3 Physical features

The complex changes in the system's driving forces: the tides, the river discharges and the waves are responsible for the morphological changes in the Char Montaz - Kukri Mukri area. The combination of these forces induces a complicated mechanism of enormous water and sediment displacements, moving continuously via the tidal channels between Char Montaz-Kukri Mukri and Char Montaz-Rangabali. Yet at first glance and on a small scale of time and space, these forces seem hardly to affect the character of the landscape as a whole when talking in terms of days.

The net changes are very small and often difficult to measure. But because these forces work constantly and over a long time, they affect the morphological development of the project area.

2.3.1 Tidal movement

The water movement in the Char Montaz-Kukri Mukri Channel as well as Char Montaz-Rangabali Channel is governed by various phenomena. Generally, the tidal motion dominates during pre-monsoon and post-monsoon periods. However, fresh water from the river plays a very important role, especially during the monsoon. During storms and cyclones, the short waves and storm surges are important morphological factors.

The tide in the area of interest is semi-diurnal with the M2-tide and the S2-tide as the major tidal constituents

The tidal range at gauge station Kochopia which is representative for the project area varies between about 0.7- 3.0 metres. In this study water level data of Khepupara and Galachipa are used as representative gauge stations since no long time series of Kochopia are available. Table I.2 shows the tidal water level characteristics at Galachipa.

The mean high water level varies due to neap-spring tide conditions between +1.9 - +2.5 m PWD. The Highest Astronomical Tide (HAT) at Galachipa is about +3.0 m PWD and the Lowest Astronomical Tide (LAT) level is about -0.9 m PWD. From the long term time series of Khepupara an exceedance frequency curve has been estimated from water level data (Figure 2.2). From Figure 2.2 it can be seen that near Khepupara a land level of about +1.5 m PWD remains inundate about 20-30 per cent of the time. With respect to the water level data at Khepupara it should be mentioned that the tidal range is higher than that in the project area. So, it can be expected that the land level in the project area which has silted up to a level of about +1.5 m PWD will inundate less than 20-30 per cent of the time.

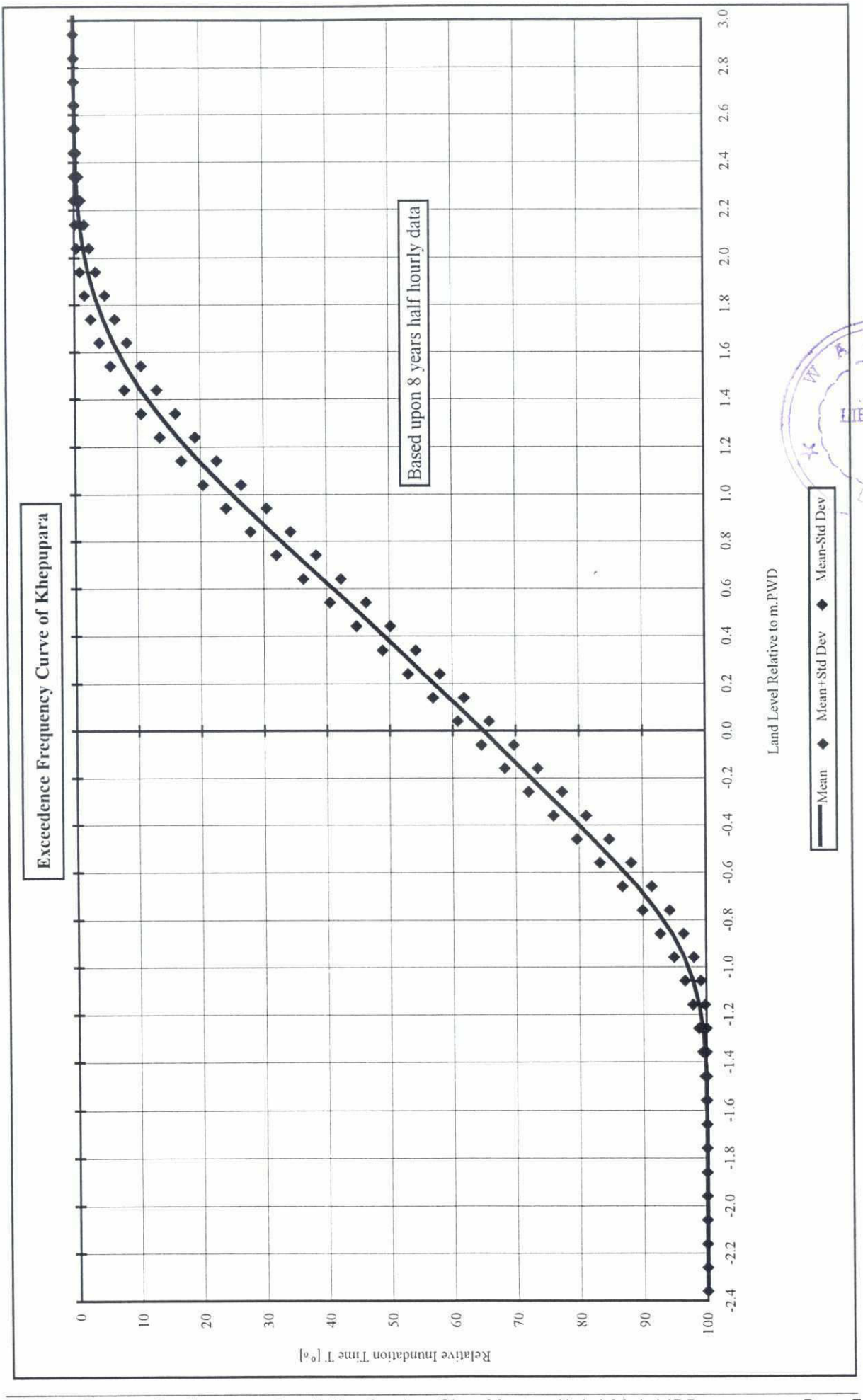
Salinity data from LRP and MES indicate an enormous seasonal effect due to the influence of the huge fresh water discharge from the Tetulia River and Lower Meghna River on the salinity in the project area. Approximately during the period from mid August to mid October the salinity in the project area drops considerably and the water becomes almost completely fresh.

After the monsoon, the salinity raises again and the sea water intrudes the project area. Salinity measurements indicate that the salinity gradient in the areas near the Tetulia river is steeper than in the surrounding waterways. The longitudinal gradient which can be more than 4.0 *10-4 ppt/m might induce a turbidity maximum which has a positive effect on the process of flocculation and settlement of sediment in the project area, particularly during pre-monsoon and post-monsoon.

2.3.2 Currents and discharges

Currents and discharges in the channels are tide dominated, even in the monsoon season when large quantities of fresh water from the Tetulia River and Shahbazpur Channel pass through the channels. During spring tide in the pre- and post-monsoon, the net tidal volume of the tidal channels in the project area are mostly ebb dominated.

Figure 2.2: Exceedance frequency curve for Khepupara



Current measurements in the dry season (pre- and post-monsoon) indicate that the maximum ebb velocity in the deeper parts of the channel is about 1.1 to 2.2 m/s and maximum flood velocity is about 1.1 to 2.4 m/s.

2.3.3 Waves

Waves often have an important influence on the erosion and deposition processes. Waves generate an orbital velocity which is superimposed on the normal velocities in an area, thus stimulating erosion from the bottom and preventing settling of suspended sediment. In shallow areas the waves may break thus generating a lot of turbulence in the water which is even more effective for generating erosion. Although LRP and MES could not collect any wave data in the project area, it is expected that the wave influence is of minor importance with respect to the erosion and deposition processes.

2.3.4 Sediment concentration

Sediment concentration measurements during pre-monsoon and post-monsoon indicate that the maximum depth averaged sediment concentration during neap and spring tide varies between 200 to 700 mg/l and 400 to 1,200 mg/l respectively. The depth averaged sediment concentration during the monsoon is not known but it can be expected that the concentration is more than 1,000 mg/l. The sediment concentration data indicate that the time mean sediment content of the water in the Char Montaz - Kukri Mukri area amounts to about 400 mg/l.

2.4 Morphological developments

The Char Montaz - Kukri Mukri area is part of a dynamic morphological system in which practically nothing is fixed by measures like bank protection or embankments. Hence, channels can freely migrate resulting in loss of land on one side and gain on the other.

Construction of the proposed cross dam units in the project area will change the water movement in the vicinity of the Char Montaz - Rangabali channel and Char Montaz - Kukri Mukri channel. This will interfere with the dynamic (equilibrium) conditions between water movement and sediment transport and the dimensions of the channels and tidal flats. Consequently, changes in the morphology of the area have to be taken into account. To evaluate the changes in land formation of the area, different sounding maps and satellite imagery from recent decades have been studied.

2.4.1 Land formation and char development

Comparison of aerial photography of 1957 and satellite imagery from 1973 to 1996 shows distinctly the dynamic behaviour of the coastline, as well as the channels, in the area of interest (Figure 2.3). The imagery shows that Kukri Mukri and Char Montaz and the adjacent islands are relatively young islands which started to emerge in the 1950s. During the 1960s and 1980s the higher parts of Char Montaz silted up to about MHW line. The coastline development of Char Montaz and Kukri Mukri during recent decades shows a natural tendency to shift in an south-westerly direction.

Bathymetric surveys, carried out by MES, indicate that the major channels in the project area are shallow. The channel depth tends to increase slightly towards the south. The average channel depth is about 5.5 metres.

Land formation and char development over the period 1973/74 to1996 has been estimated from satellite imagery. The net rate of accretion of new land is about 361 ha per year (Table 2.1). The net average gain of intertidal area is about 149 ha per year. Taking into account the total area of about 60,500 ha, a net accretion factor can be calculated.

Figure 2.3: Coastline development of the Char Montaz-Kukri Mukri project area, 1973-1996

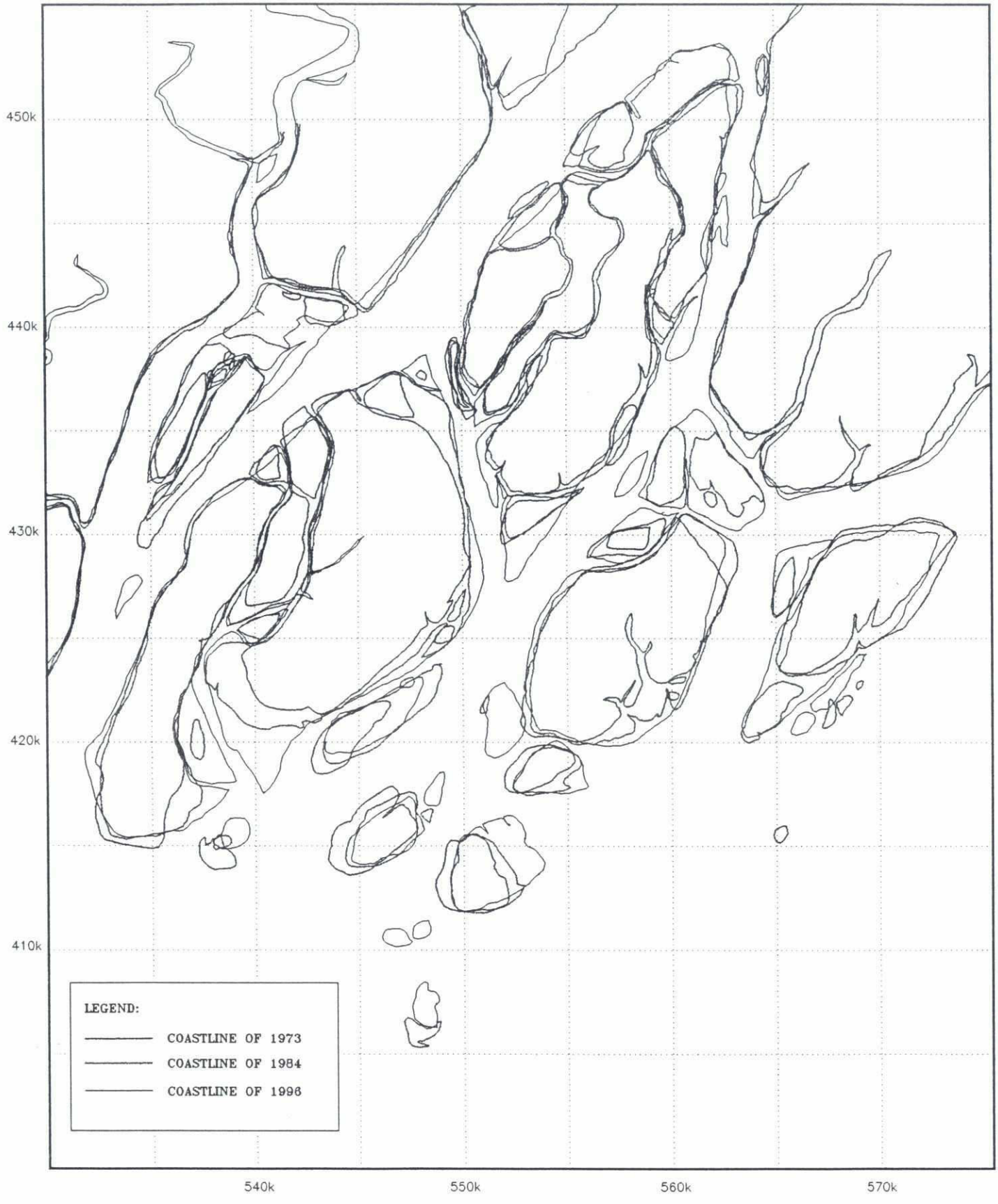


Table 2.1: Land formation and char development, 1973/74 to 1996

Total Project Area: 60,500 ha	Area (ha)	Rate (ha/year)	Net Average Rate (ha/year)	Net Accretion Factor (ha/year/ha)
Gain of land	9,289	404	361	0.0060
Loss of land	983	43		
Gain of intertidal area	4,040	76	149	0.0025
Loss of intertidal area	620	27		

2.4.2 Land levels

Land levels of Char Montaz

The topography of the area is generally flat and closely related to the accretion and reclamation history of the land. Land levels of the low lying land located outside the existing embankment varies from approximately 0.7 metres above PWD to about 1.6 metres above PWD near the existing embankment. According to local information, the land level for embankment is about +1.4 to +1.5 m PWD. The higher part of Char Montaz is used for agriculture.

The area outside the existing embankment is unprotected and is inundated seasonally by shallow to moderate floods and suffers severely from storm surges. The rest of the land outside the embankment consists of low lying land (below +1.5 m PWD) which is frequently inundated.

Land levels of Kukri Mukri

According to the land level data, the island topography of Kukri Mukri is generally flat. The island is nearly unprotected. The higher parts of Kukri Mukri are embanked. Based upon local information, the land level for embankment in this area is about +1.4 to +1.5 m PWD. The area outside the existing embankment is unprotected and is inundated seasonally especially during the monsoon period. The land elevation of the unprotected areas varies between +0.7 and +1.5 m PWD. The higher part of Kukri Mukri is used for agriculture. The lower areas consists mainly of mangrove forest and low lying land, shoals and drying mud flats.

Land levels of Char Taposhi and Char Andar

The major part of Char Taposhi and Char Andar is covered with mangrove forest and low lying land. The satellite images indicate that these islands are young. The islands starts to emerge during the 1970s. No land level data of Char Taposhi and Char Andar are available. From the existing land use it can be expected that the land level is about +0.7 to +1.3 m PWD.

Characteristic land levels for land use

Table 2.2 shows the characteristic land levels for land use in the project area. Areas with a level of +1.5 m PWD are used as agricultural land and are suitable for embanking. Land above the level +1.5 m PWD remains inundated for less than 25 per cent of the time. Land levels which reach a level of about +0.7 to +1.2 m PWD can be used for mangrove forest. This land level will remain inundated for about 50 per cent of the time.

Table 2.2: Characteristic land levels for land use

Level Rise (metres above PWD)		Potential Land Use
from	to	
below LLWS	+0.7	A to B'
below LLWS	+1.2	A to B"
below LLWS	+1.5	A to C
+0.7	+1.2	B' to B"
+0.7	+1.5	B' to C

Notes: A = channel area and mudflats (<PWD +0.7m)
B' = low lying saline land and mangrove forest (+0.7 m PWD < B' < +1.2 m PWD)
B" = single crop poor agricultural land (+1.2 m PWD < B" < +1.5 m PWD)
C = agricultural land suitable for embanking (> +1.5 m PWD)

2.5 Morphological impact of cross dams

2.5.1 Estimation of accretion rate and area of accretion due to cross dams

To predict the accretion rate due to the construction of the cross dams, a number of parameters have to be determined, such as the ultimate area of accretion, the coefficient 'n' and the characteristic accretion time t. The impact of the cross dam on the flow velocities is estimated by using 2D-hydraulic simulations. The cross dams will accelerate accretion because flow velocities in the closed channel section will drastically be reduced. Near the dam the flow reduction will be more than 60 percent.

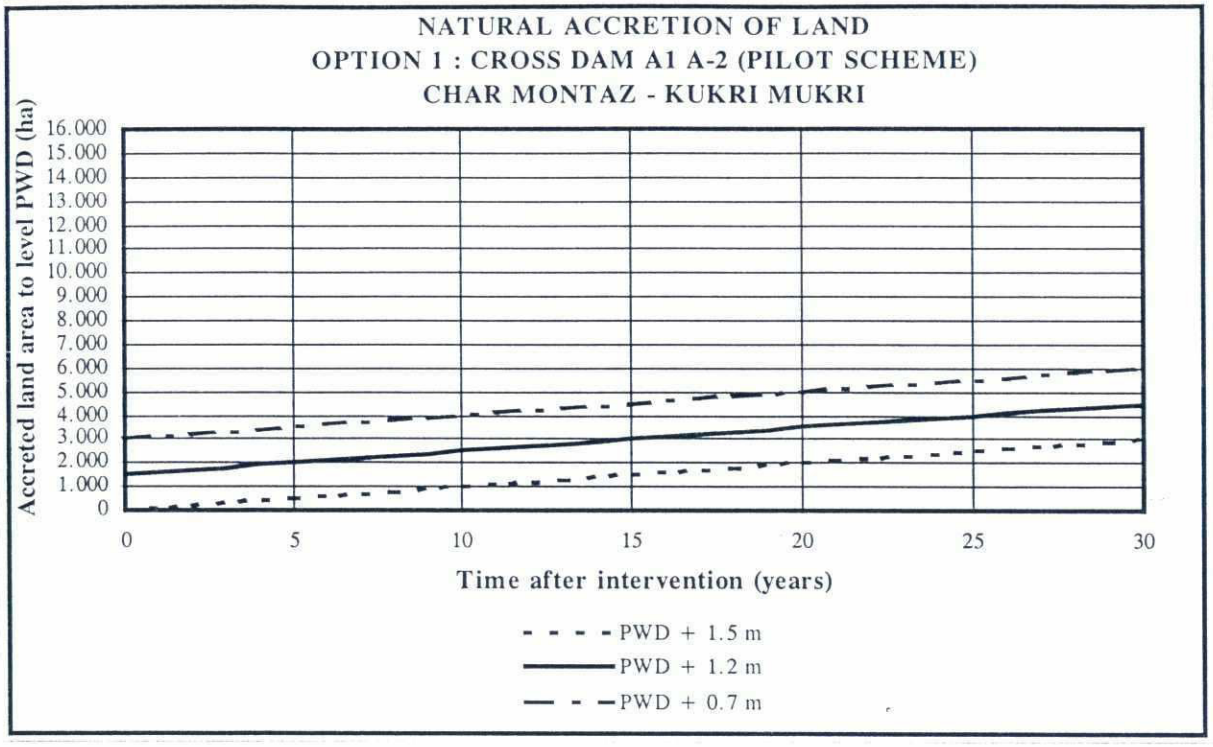
For accretion at dam sites, a mean sediment content of 400 mg/l is taken. It is assumed that in the areas with very low flow velocities 60-90 percent of the sediment in the water settles out and the dry bulk density of the deposits will amount to about 1,200-1,300 kg/m^3.

2.5.2 Option 1: Future without major intervention but with cross dam A1 A-2

With Option 1, Future without major interventions, only cross dam A1 A-2 will be constructed as a pilot scheme. Subsequently the nature will take its own course. In this case, the rate of natural gain of new land in the project area will be approximately 95 ha per year (for a total project area of 15,982 ha).

According to the natural shift of the coastline in recent decades, formation of newly accreted land (to approximately level +1.4 to +1.6 m PWD) and char development can be expected especially on the south-western sides of the islands and the islands will extend towards the south. The secondary tidal channels between the islands will silt up during this period and the islands will be connected. The channel between Char Montaz and Kukri Mukri is expected to remain open in the near future without any intervention. The estimated natural accretion is shown below.

Figure 2.4: Option 1 - natural accretion of land

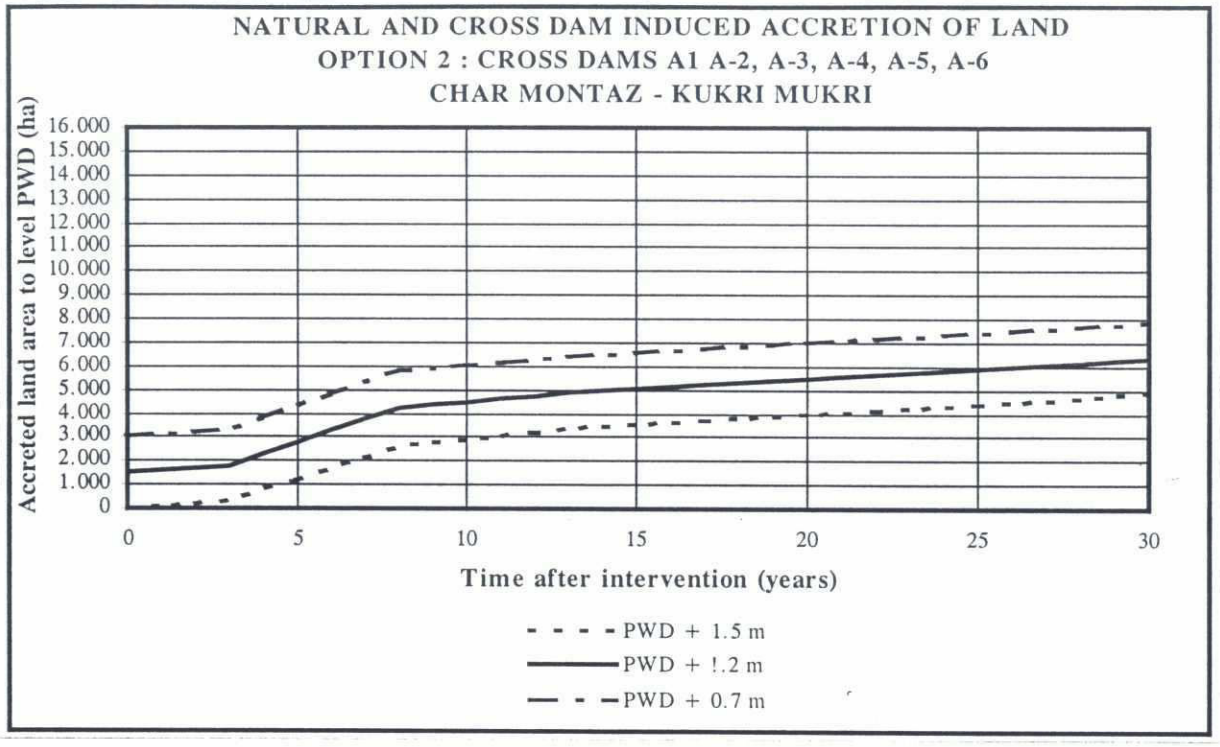


2.5.3 Option 2 - Cross dams A1 A-3, A-4, A-5, A-6 in year 3 (2001/02)

The implementation of the cross dam Unit A1 will initiate a strong reduction of tidal current velocities in the small tidal channels in the northern part of Char Montaz and a reduction of the sediment transport capacity. Consequently the deeper parts of the tidal channels will be functioning as effective sediment traps. From this it can be assumed that especially the deeper parts of the tidal channels will rapidly decrease in size due to the implementation of these cross dams.

Results of the accretion computation showing the areas that will be accreted in different years after the implementation of the cross dams under Option 2 is shown on the next page.

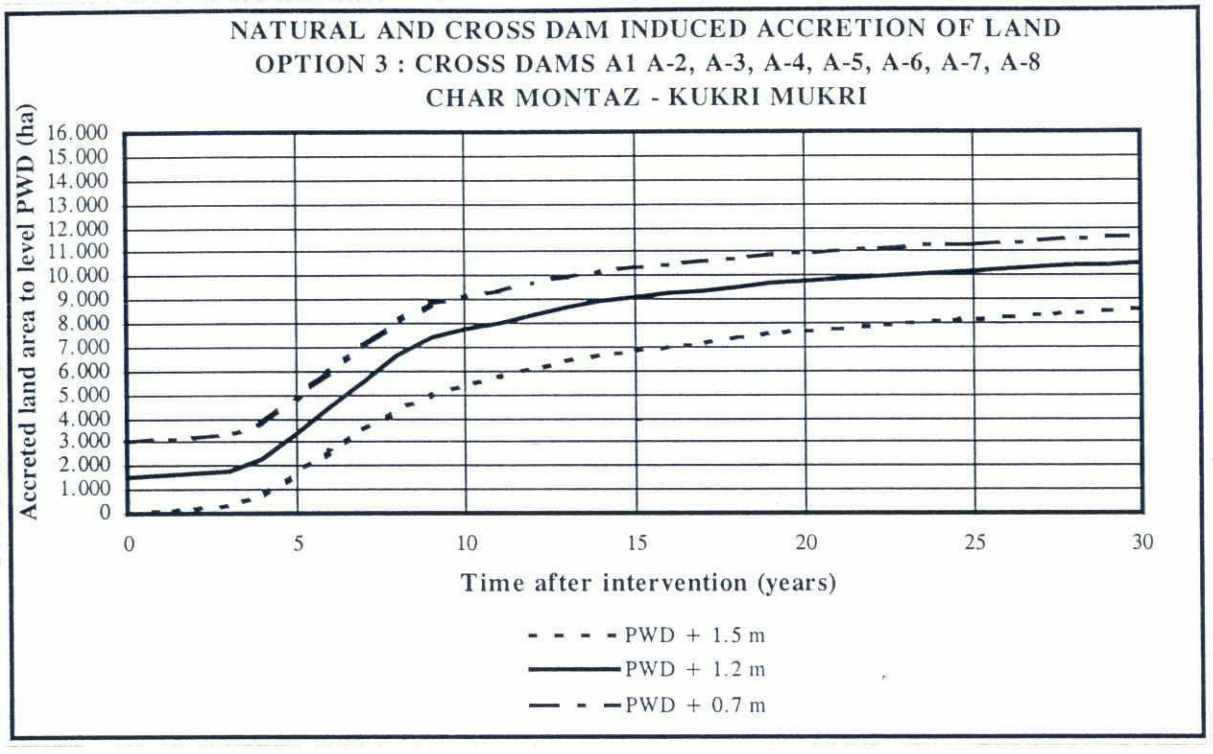
Figure 2.5: Option 2 - natural and induced accretion of land



2.5.4 Option 3 - Cross dams A1 A-7, A-8 installed in year 4 (2002/03)

The implementation of cross dams A1 A-7 and A-8 after 5 years will stimulate accretion of new land in the southern part of Char Montaz by blocking the flood flow entering the area between Char Andar and Char Taposhi completely thus creating a funnel in which sediments will be trapped. It also traps the outgoing ebb water. The effect of these cross dams is shown in the figure below.

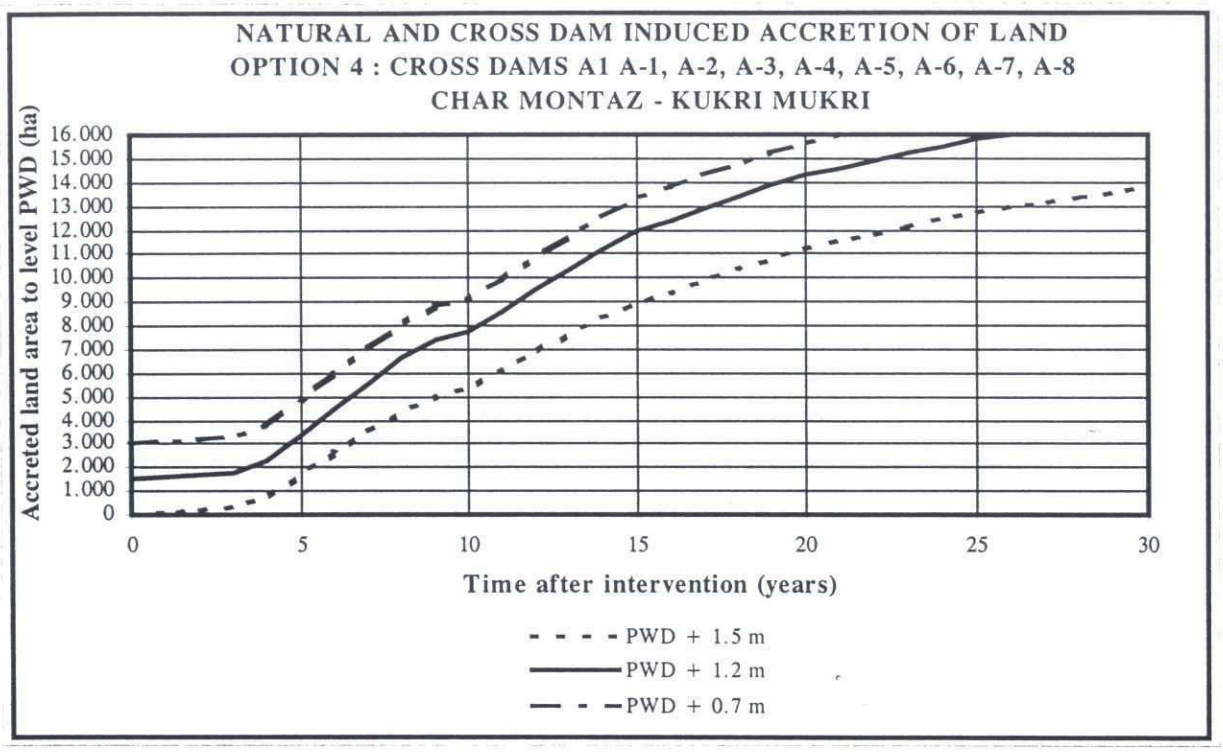
Figure 2.6: Option 3 - natural and induced accretion of land



2.5.5 Option 4 - Cross dam A1 A-1 installed year 10 (2008/09)

The implementation of cross dam A1 A-1 after 10 years will stimulate accretion of new land southward of the cross dam between Char Montaz and Kukri-Mukri at both sides of the cross dam. Due to the construction of this cross dam, the in- and outgoing tides in the Char Montaz-Kukri Mukri Channel will be blocked. The strong reduction of tidal current velocities in the Char Montaz-Kukri Mukri Channel will initiate a reduction of the sediment transport capacity (which is related exponentially to current velocity) in the channel. Consequently the deeper parts of the tidal channels function as effective sediment traps. From this it can be assumed that especially the deeper tidal channel will decrease in size due to the construction of the cross dam. The effect of this cross dam is shown in the figure below.

Figure 2.7: Option 4 - natural and induced accretion of land



3. PRESENT SITUATION IN THE PROJECT AREA

3.1 Physical setting

3.1.1 Topography

The most recent mapping for the project area are the preliminary drafts of Finmap sheets, dated 1992/94. Most of Char Montaz has a level of about +1.2 m PWD; the relatively low level may be a factor contributing to drainage congetion. On Kukri Mukri the present average level is about +1.25 m PWD. In this case, empoldering is proposed only in year 6 in order to allow for possible further rise in the land level before embankments are constructed.

3.1.2 Climate

The mean annual rainfall at Char Montaz is about 2,550 mm, with June and July receiving the highest rainfall. However, annual variations can be significant. The hottest month is May when the mean average temperature is 29°C and the coolest month is January, when the mean average temperature is about 20°C. Monthly evapotranspiration is highest in April and May and lowest is in January and February.

3.1.3 Soils

The project area is part of the young lower Meghna estuarine flood plain. In general, the soils are seasonally flooded, poorly drained and have developed from moderately fine textured silt loams.

Soil data for the project area has been collected by SDRI, but it has not yet been published. However, six soil samples were collected on Char Montaz by MES staff and were analysed by SDRI. Salinity levels are still relatively high, at least in some areas. The intrusion of saline water

inside the embankment, because of ineffective operation of sluices, is a problem for the development of agriculture in the area. Analysis of the samples also indicated that pH levels are higher in some areas that is recommended for agriculture. As in other, similar areas, the levels of organic matter in the soils are generally low. Soil development on the estuarine chars is a long a slow process, even after the construction of embankments provides the opportunity for the gradual reduction of salinity levels.

3.1.4 Land use

Of the total of 13,300 ha at present in the project area (not including Char Taposhi and Andar Char), 32 per cent is forested. The remainder is either cultivated, in fish ponds (a reported 166 ha) or is low lying mud flat and grassland used for the grazing of cattle and goats.

Crop production on Char Montaz and Kukri Mukri can be limited by flooding and storm surges during the monsoon which can damage standing crops. Salinity and lack of water in the dry season are limiting factors for cultivation, especially of Aus and Rabi crops. A single crop of the local salt resistant T. Aman is usual in most of the area and on about 20 per cent of the area, the rice crop is followed by rabi crops such as khesari, chilli, sweet potato and groundnut.

3.1.5 Flooding

There has only been limited data on land levels on Char Montaz and Kukri Mukri available to MES. Land levels are generally assumed to be around mean high water level.

Peak tides inundate land outside the existing embankments and also sometimes inside through the drainage system which is not always managed effectively to stop saline intrusion. Even higher areas will be flooded during cyclones which are generally accompanied by tidal surges.

The large river discharge in the monsoon period dilutes the salinity of the sea water in the estuary, but in winter the sea water remains sufficiently saline for the intrusion of sea water in this season to cause more serious damage to crops than in the monsoon. For successful crop production, flooding by saline water during the dry season requires rain to leach residual salt from the soil in the following monsoon.

3.1.6 Cyclones

The area is in one of the most cyclone hazard prone parts of the Bay of Bengal. In the past, major cyclones have taken a large toll of both human life and livestock. Although the population on Char Montaz is protected by the embankment, those living on Kukri Mukri and other chars are without this protection. On Kukri Mukri there are three cyclone shelters.

3.2 Socio-economic setting

The socio-economic setting of the project area is profoundly influenced by the dynamic physical environment in which communities are living. The tides, flooding, storms and processes of erosion and accretion are major parameters of existence.

A household survey was carried out in February 1998 to provide background information on the socio-economic setting of the project area and information for three aspects of project formulation: economic viability, social desirability and possible development strategies. The survey investigated settlement patterns, demography, occupations, land ownership, credit and indebtedness, income and sources of income, communications, literacy, education and health.

3.2.1 Demography

At the time of the 1991 census, the population of the mauzas constituting the project area was 13,478 with an average household size of 5.82 (see Table 3.1).

Table 3.1: BBS Demographic Data 1981 and 1991, by Mauza

THANA	UNION	MAUZA	LGED J. L. No.	BBS Code	B B S AREA 1981(ha)	Mapped Area (ha)	Population 1981	Population Density 1981 per km2	Population 1991	Population Density 1991 per km2	Change in Pop. Density 81-91 (%)	Population Growth 81-91 (%)	Estimated Population 1996 3/	Estimated Population 1996 4/	Estimated Population 2000 4/	Households 1981	Households 1991	Mean HH Size 1981	Mean HH Size 1991
Galachipa	Char Montaz	Char Bastin	174	785783227	312.42	312	279	89	859	275	208	11.9	1,507	1,067	1,268	33	121	8.45	7.10
		Char Laksmi 1/	172	785783281	1393.73	1,394	883	63	1,564	112	77	5.9	2,081	1,942	2,309	121	288	7.30	5.43
		Char Margaret	173	785783297	176.85	177	705	398	740	417	5	0.5	758	919	1,093	107	122	6.59	6.07
		Char Montaz	171	785783302	2587.96	2,588	3,440	133	4,792	185	39	3.4	5,656	5,950	7,075	529	793	6.50	6.04
		Char Prasanna 2/	170	785783313	732.48	732	1,272	174	1,380	188	8	0.8	1,437	1,714	2,037	169	215	7.53	6.42
Charfasson	Kukri Mukri	Char Kukri Mukri	122	092547169	2534.94	2,535	2,875	113	4,122	163	43	3.7	4,936	5,118	6,086	542	712	5.30	5.79
		Char Patila	121	092547366	1142.02	1,142	183	16	1,401	123	666	22.6	3,876	1,740	2,068	34	279	5.38	5.02
Project Area Totals						8,881	9,637	109	14,858	167	54	4.4	20,252	#####	21,937	1,535	2,530	6.28	5.87

Notes: 1/ Also known as Char Rustom
2/ Also known as Andar Char.
3/ Based on mauza growth rates
4/ Based on average project area growth rate, except Char Prasanna.

Table 3.2: BBS Key Data for Char Montaz - Kukri Mukri

THANA	UNION	MAUZA	LGED J. L. No.	BBS Code	Households Owning Agricultural Land 1981 No.	Households Owning Agricultural Land 1981 %	Dwelling Unit Owning Agricultural Land 1991 No.	Dwelling Unit Owning Agricultural Land 1991 %	Change in % HH Owning Land 81-91	Population Aged 10-29 in Cultivation 1981 No.	Population Aged 10-29 in Cultivation 1981 %	Population over 10 in Agriculture 1991 No.	Population over 10 in Agriculture 1991 %	% Change in Pop. in Agr. 1981-1991	Literacy 1981 No.	Literacy 1981 %	Literacy 1991 No.	Literacy 1991 %	Change in Literacy % 1981-1991	HH with Potable Water 1981 No.	HH with Potable Water 1981 %	HH with Potable Water 1991 No.	HH with Potable Water 1991 %	Change % HH Potable Water 81-91
Galachipa	Char Montaz	Char Bastin	174	785783227	21	63.6	36	29.8	-33.9	85	30.5	204	23.7	-6.7	34	12.2	92	10.7	-1.5	5	15.2	114	94.2	79.1
		Char Laksmi 1/	172	785783281	98	81.0	83	28.8	-52.2	244	27.6	410	26.2	-1.4	82	9.3	202	12.9	3.6	42	34.7	200	69.4	34.7
		Char Margaret	173	785783297	76	71.0	27	22.1	-48.9	248	35.2	180	24.3	-10.9	111	15.7	47	6.4	-9.3	54	50.5	120	98.4	47.9
		Char Montaz	171	785783302	302	57.1	463	58.4	1.3	601	17.5	1,113	23.2	5.8	654	19.0	1,174	24.5	5.5	185	35.0	609	76.8	41.8
		Char Prasanna 2/	170	785783313	99	58.6	94	43.7	-14.9	255	20.0	157	11.4	-8.7	216	17.0	219	15.9	-1.1	59	34.9	213	99.1	64.2
Charfasson	Kukri Mukri	Char Kukri Mukri	122	092547169	304	56.1	292	41.0	-15.1	402	14.0	932	22.6	8.6	289	10.1	1,039	25.2	15.1	436	80.4	535	75.1	-5.3
		Char Patila	121	092547366	18	52.9	77	27.6	-25.3	41	22.4	445	31.8	9.4	28	15.3	202	14.4	-0.9	2	5.9	196	70.3	64.4
	Project Area Total				918	59.8	1,072	42.4	-17.4	1,876	19.5	3,441	23.2	3.7	1,414	14.7	2,975	14.4	-0.3	783	51.0	1987	78.5	27.5

Notes: 1/ Also known as Char Rustom
2/ Also known as Undar Char; excluded from project area totals

60

In the survey sample of 160 households (110 on Char Montaz and 50 on Kukri Mukri) the total population was 990, with a household size of 6.2. About 40 per cent of this sample population was under 15 years of age and about 10 per cent over 55 (see Appendix IV.4).

The BBS data imply significant in-migration to both Char Montaz and Kukri Mukri between 1981 and 1991 since growth rates are well above the national average. The estimated overall population density of the project area rose from 103 per km^2 to 165 per km^2 during the period.

About 5 per cent of the population on Char Montaz lives in cluster villages established under various settlement programmes. On Kukri Mukri the proportion is much higher, at about 36 per cent.

3.2.2 Land ownership

According to the household survey data, about 30 per cent of households on Char Montaz and just over 20 per cent on Kukri Mukri are functionally landless. Another 40 per cent and almost 50 per cent, respectively, have less than one hectare (see Appendix IV.4).

According to the BBS census data, about 60 per cent of households owned land at the time of the 1981 census, but this had fallen to 42 per cent in 1991 (see Table 3.2). Together with the high population growth rates in the area, this implies the in-migration of landless households. Throughout the project area, many landless, marginal and small farmers operate land of absentee land owners who live outside the area. Usually the crop is distributed 50:50 between the landowner and sharecropper.

3.2.3 Credit and indebtedness

Over 50 per cent of surveyed households expressed a need for credit and in the year prior to the survey most of these had received credit from some source. The most common sources of credit are NGOs operating in the area. Credit is principally used for income related purposes - either agriculture or fishing - but a significant number of loans appear to have a social purpose. (see Appendix IV.4)

3.2.4 Income and sources of income

Households typically have income from a number of different sources. Of the various sources, fishing is the most important. This is shown in the household survey data. Although agriculture is the principal occupation of about 45 per cent of the heads of households interviewed and fishing is the principal occupation of only 37 per cent, the latter makes a much larger contribution to average household income - Tk 7,500 to Tk 10,000 compared with just under Tk 5,000 for agriculture. Livestock also play an important role in the household economy, although its contribution to cash income is relatively small, at about Tk 2,200 per year. Other significant sources of income include remittances from family members working outside the area. (see Appendix IV.4)

3.2.5 Communications

Communications to and from both Char Montaz and Kukri Mukri are entirely by water transport. The principal routes are towards Galachipa (a daily connection from Char Montaz) and Patuakhali. The restricted nature of the communications system hampers transport for goods both into and out of the area. Improved accessibility would have a beneficial effect on production as well as on services available to the population.

3.2.6 Education and literacy

The 1991 census found the literacy rate in the area to be 14.4 per cent, compared with 14.7 per cent at the time of the 1981 census, effectively no change during the period.

The data from the household survey found literacy rates of around 30 to 35 per cent of the population over 5 years. The rate for women was about 25 per cent. These rates probably reflect differing definitions of literacy compared with the national census rather than any large change in literacy in just a few y ears. On Char Montaz only 18 per cent of children in the 5 to 12 age group were reported to be attending primary school, while for Kukri Mukri the comparable figure was 32 per cent.

3.2.7 Health

The thana health complex for the project area is at Galachipa on the mainland and is the only available source of health data for the area. This data reflects the health situation in the urban and surrounding areas of the thana headquarters and is not directly applicable to the project area. However, it indicates that the most commonly reported diseases in the area are diarrhoea, intestinal parasites, peptic ulcers, respiratory tract infections and malaria and other fevers.

3.3 Physical infrastructure

The physical infrastructure of the project area, apart from the embankment around Char Montaz, is very limited. On Char Montaz there are five cyclone shelters but no killas. Kukri Mukri has three cyclone shelters and also has no killas. The crest of the embankment provides the major access route to areas on Char Montaz, supplemented by a network of local tracks. On Kukri Mukri there are no roads.

3.3.1 Hydraulic infrastructure

General

Nine chars south of Bhola with a total area of 16,600 ha form the Char Montaz - Kukri Mukri Study area. With the exception of the largest char, Char Montaz that comprises 6,610 ha, all chars are unprotected. Only Char Montaz and two other chars are inhabited. The other two chars are Kukri Mukri, with an area of 4,300 ha, and Char Andar with an area of only 400 ha.

Char Kukri Mukri

During the cyclone of 1991, around 980 inhabitants of Kukri Mukri lost their lives, which was around 20 per cent of the population at that time. At present nearly 6,700 people live on this char. Kukri Mukri consist of two parts where cultivation takes place, Patila in the north and Kukri Mukri in the south. A forest area and the Patila Dona Khal separate these two parts. Out of 4,300 ha, 2,400 ha is under forest. Some 700 ha of cultivable land is found at Patila and 1,200 ha at Kukri Mukri in the south (see Figure 3.1).

Char Montaz

During the sixties, under the Coastal Embankment Project, (CEP) the empoldering of Char Montaz was planned for the first time. The construction of this polder named 55/4 started late, in 1987. Progress was slow and by October 1990 only 30 per cent of the primary embankment had been constructed. The polder was finally completed in 1991. At present Char Montaz has nearly 16,000 inhabitants, a number that increased rapidly after the embankment was completed.

The actual gross area of Char Montaz is 6,610 ha. The infrastructure build by BWDB consists of a ring embankment of 30 km, four major drainage sluices and 15 small flushing sluices, all placed in the ring embankment. The embankment protects a total area of 5,230 ha. Figure 3.1 shows the ring embankment and location of the existing drainage sluices. A fairly dense natural network of drains (khals) is found inside the polder area. Despite the reported drainage problems, no improvements of these drains have been planned by BWDB. No secondary protection or compartment embankment exists in this polder and only a few roads have been constructed.

Figure 3.1: Present situation in February 1996

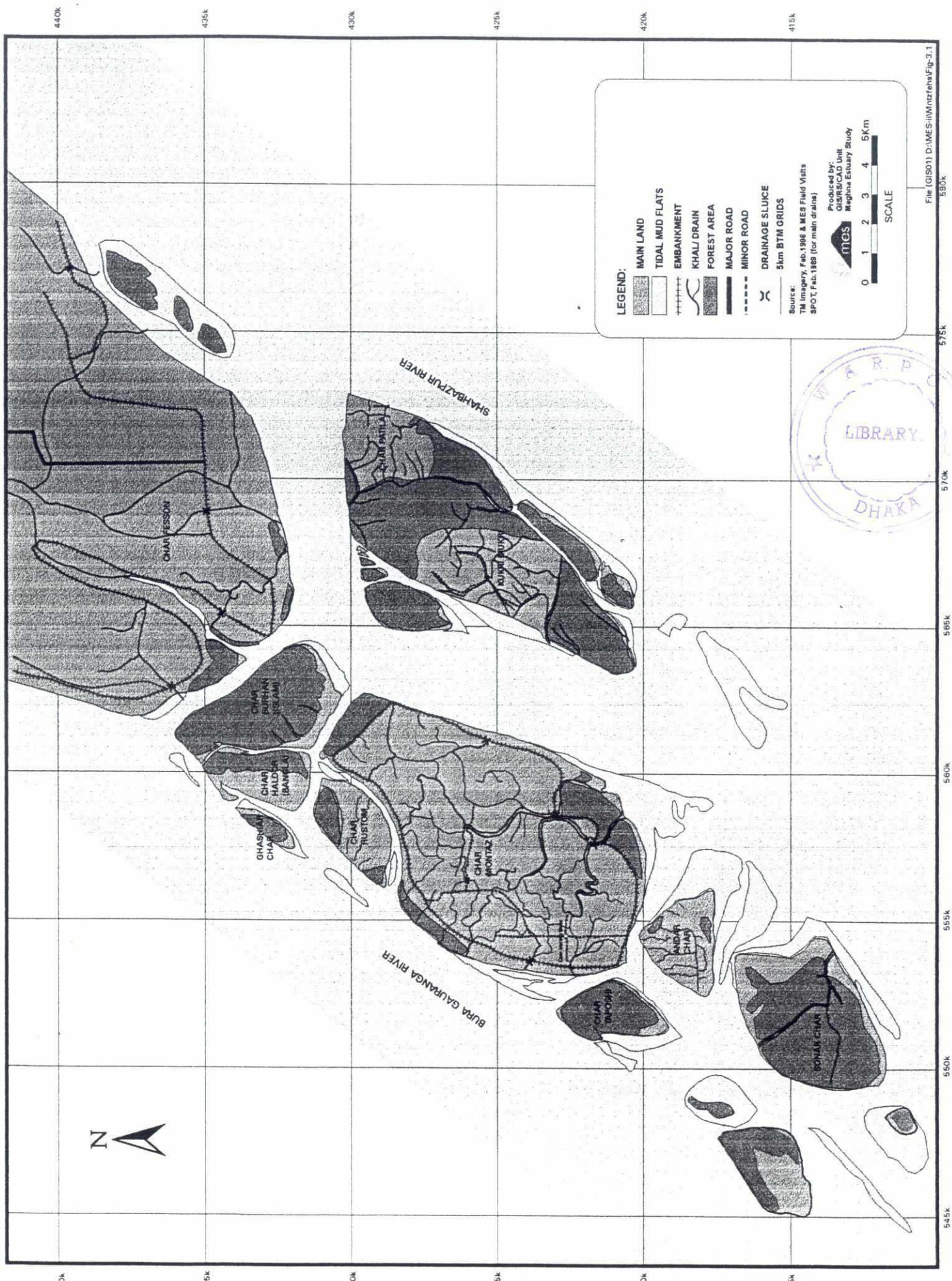
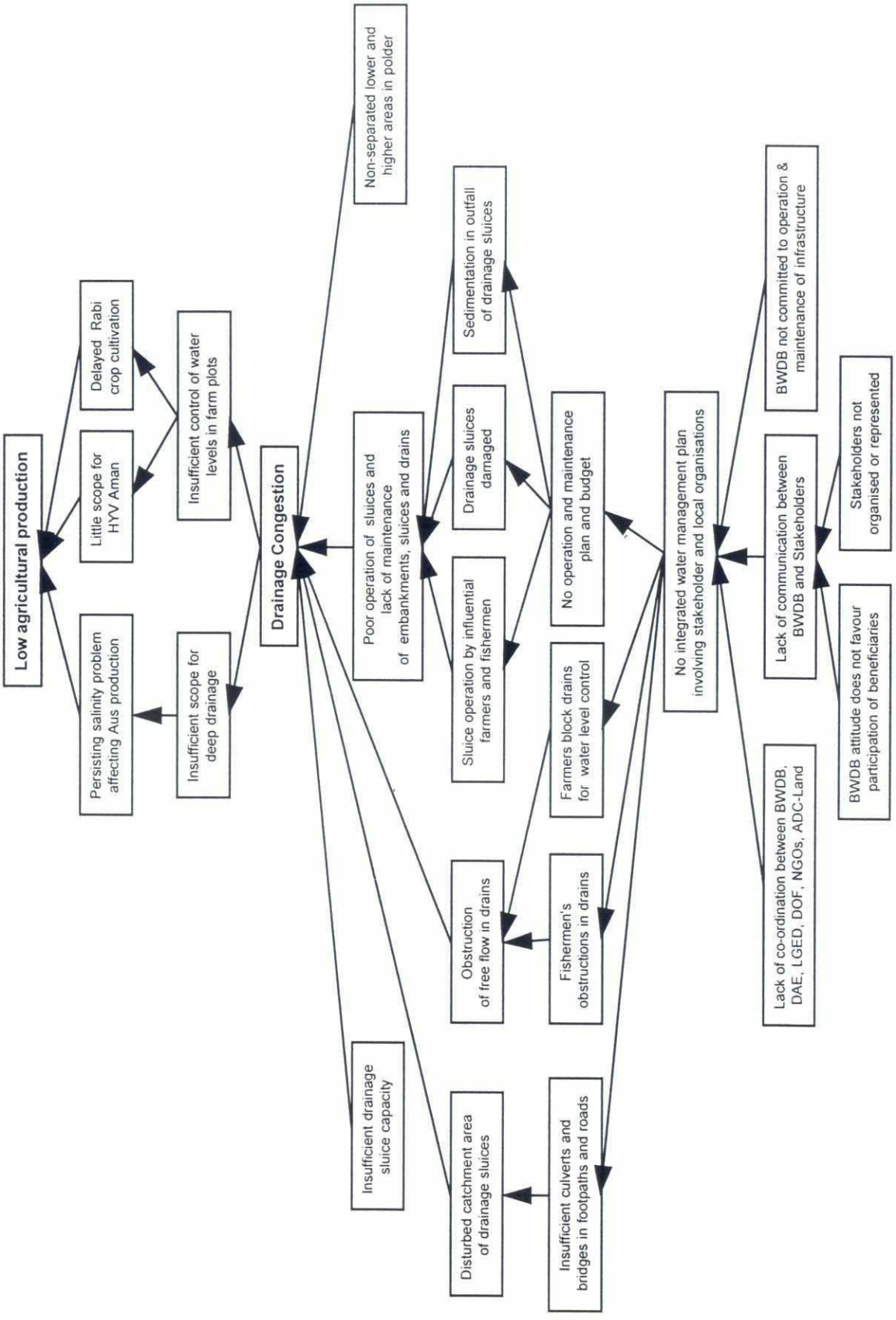


Figure 3.2 : Water management problem tree for Char Montaz



The sea-facing primary embankment was designed with a crest width of 4.25 metres and a level of +4.92 m PWD. The side slope designs are 1:5 on the seaward side and 1:2 on the country side. The average ground level is +1.5 m PWD. The embankment is also used as inspection and unpaved rural road.

The four drainage sluices together comprise a total of 10 vents with a total sluice cross-section of 28 m^2. All drainage sluices are composed of two or more box culverts with cross-section of 1.52 x 1.83 metres each. This means a drainage ratio[1] of 236 ha/m^2 sluice cross-section for the entire polder. All four drainage sluices are equipped with flap gates on the seaward side for drainage and vertical gates on the country side for water retention.

3.4 Water management

Water management, which in the case of polders comprises the use of embankments, sluices and drains to improve the control over water levels and water salinity, is only possible on Char Montaz in polder 55/4. In the case of unprotected land within the feasibility study area, water management is virtually impossible.

3.4.1 Polder management

Overall polder management is the responsibility of BWDB. Polder 55/4 falls under the Galachipa O&M Sub-Division, headed by a Sub-Division Engineer (SDE), and the Patuakhali O&M Division headed by the Executive Engineer (XEN). The Ministry of Water Resources has issued guidelines for People's Participation (GPP) in August 1994. These guidelines also prescribe the involvement of water users in water management of FCD schemes of BWDB (like polders). The GPP guidelines have not yet been implemented in polder 55/4. Nevertheless, sluice committees do exist for the operation of the drainage sluices.

A lack of O&M, in particular maintenance, has been observed in polder 55/4. One of the constraints of BWDB is a lack of O&M funds. O&M are financed by an Annual Development Plan (ADP) or through the National Revenue Budget. Since this polder is considered complete, an ADP is no longer prepared. Hence, only the revenue budget of BWDB can be used for O&M. Occasionally O&M is carried out under the food for work programme as has happened elsewhere. The revenue budget has basically two headings, "establishment" and "works". O&M costs are made under the heading "works". However, due to insufficient revenue funds only minor emergency maintenance works are carried out under this heading. Even in case of an emergency, it is not unusual that these works are delayed due to shortage of funds.

3.4.2 Operation

No BWDB staff is present in polder 55/4 for the operation of sluices or to supervise the use of main drains and embankments. As mentioned earlier, sluice committees have been established for the existing drainage sluices after completion of the polder, It seems that these committees indeed function and are manned by influential persons of the local community. Although operation is not always done in a transparent way, according interviewed stakeholders (mainly farmers and fishermen), no major complaints were expressed by the local population met during field surveys.

The overall mode of sluice operation supported by most farmers is the following:

- *End of the dry-season, April to June*: Vertical gates are opened and flap gates pulled up. Initially the drains are filled with slightly saline water. Later on, when water salinity has dropped, water levels in the drains are raised to flood and soak the fields (expected in June). Fishermen prefer to open the sluice gates earlier, in March and April, to let fish fry enter the khal system.

[1] Total area of the polder (ha) divided by the total cross-section of all drainage sluices (m^2)

- *Monsoon, July to September*: Vertical lift gates still open and flap gates left down. The emphasis is clearly on drainage.

- *Post-monsoon, October to December*: Vertical gates closed and flap gates are still left down. No drainage is allowed. Water levels around the polder are lowering. The main rice crop, Aman, still requires a water layer in the field. The emphasis now is on water retention to prevent early depletion of the rice fields. Fishermen are reported to open sluices in this period to increase the catch of fish near sluices.

- *Dry season, January to March*: Vertical gates still closed and flap gates are still left down. Water retention inside the polder is the main objective.

3.4.3 Maintenance

No regular systematic inspections and surveys of the infrastructure are presently made by BWDB. Hence, no routine or periodic maintenance plans are prepared or implemented (which is not surprising if no maintenance funds are available). Emergency maintenance works may be proposed by the SDE and based on field inspection reports of the Sectional Officer (SO). So far, no emergency maintenance works for polder 55/4 have been implemented by BWDB since completion of the polder in 1991. According to members of the sluice committees, the SO of the Galachipa Subdivision, residing at a distance of 50 km, visits polder 55/4 only once a year (during the monsoon) or in the case of an emergency. The population has reported damage to BWDB officials several times, apparently with little effect so far.

The result of this situation is damaged hydraulic infrastructure with obvious signs of deferred maintenance, due to occasional storms and yearly wear and tear. The primary embankment has lost its strength at several places due a mediocre quality of works, wave action, rain cuts, presence of rodents, use of the embankment crest for transport, grazing and passage of cattle, plantations, uncontrolled construction of local markets and homestead on the slopes etc. Flap gates of drainage sluices are damaged or rusting and a number of hinges of flap gates are broken (4) and some of the vertical lift gates (3) are defective and can not be operated. All 15 smaller flushing sluices are reported non-operational. It is assumed that most gates are broken or have disappeared. Further, recent accretion hampers operation of a number of these flushing sluices.

3.4.4 Drainage

The farming population claims the occurrence of severe drainage congestion during the monsoon, affecting crop production (mainly Aman rice), at various places. The main locations with severe drainage congestion are Char Bastin and Char Lakshmi in the mid-west and northwest part of the polder. No O&M monitoring is carried out by BWDB, which means that no water levels are measured inside the polder to verify statements made.

The population mentioned the following causes:

- an insufficient number of sluices and an insufficient capacity of the existing sluices; a sluice on the west side of Char Bastin has been planned, but never constructed.

- increasing activity of fishermen in important drains. The ADC-Land leases drains at the district level (Patuakhali) to influential persons of the local community. Leaseholders consider these drains their property. Therefore, they feel that they have the right to install bamboo piling and nets, which block the free flow in drains, or even to construct cross dams in the drains.

The local community did not mention the presence of a large number of footpaths and rural roads without sufficient culverts or bridges, known to be a serious cause of drainage congestion

in other polders[2]. The reason is that in the case of the relatively young polder 55/4, only a few roads have been constructed so far. At the same time, in the absence of sufficient rural roads, drains continue to fulfil a need for transport and small boats are frequently used throughout the polder.

3.4.5 Salinity

Since the construction of the primary ring embankment, saline floods are no longer occurring inside the polder. The protected land of polder 55/4 can be considered rather old. On the satellite image of 1973/74, almost the entire polder area appears as high land. However, five years after empoldering, dry season soil salinity levels are still too high for a successful second rice crop (Aus). Farmers claimed that soil salinity levels initially increased after completion of the polder, but was neutralised in the following years by letting water in from April onwards (see remarks on operation). According to farmers, soil salinity is now decreasing and several farmers expressed their hope to start Aus cultivation on a large scale within two to three years.

A graphical overview of the water management problem of Char Montaz is presented in a problem tree (see Figure 3.2). The figure also shows that the overall drainage congestion is also the result of structural causes (e.g. insufficient drainage sluice capacity), but certainly also due to a number of institutional shortcomings.

3.5 Agriculture

Agriculture in the project area is typified by low yields and low cropping intensities. To a large extent, these are the result of soil salinity and a low level of soil fertility combined with damage from flooding and pests. Crop losses can be as high as 50 per cent or more. In extreme cases, in unprotected areas, a whole crop may be lost.

In the uprotected areas on Kukri Mukri the intrusion of saline water at certain times cannot be prevented. In the dry season, the salinity of the water in the surrounding channels is relatively high and spring high tides can lead to the intrusion of salt water in agricultural areas. Also in the dry season, the salinity of surface soils can increase due to the capillary rise of saline ground water. The rains of the next monsoon season are required to leach this salt from the soil. Salinity is not such a serious problem during the monsoon season, but flooding from tides or storm surges can damage crops.

The potential for irrigation in the project is limited to supplementary irrigation by LLP from khals inside the embanked area. Ground water sources for dry season irrigation are at a depth of about 300 metres. The extent of this resource, which is used for domestic water supply, is unknown. However, pumping from this depth, given the conditions in the project area, would not be viable for crop production.

About 70 per cent of households involved in agriculture have holdings of 1 ha. or less. The table compares data on farm sizes from the household survey.

Table 3.3: Farm sizes

Farm Size (ha)	Char Montaz	Kukri Mukri
0 - 0.02	30%	22%
0.02 - 0.2	21%	24%
0.02 - 1.0	18%	24%
1.0 - 3.0	20%	20%
> 3.0	11%	10%

An agro-economic survey for the project was undertaken in February 1998 in Char Montaz and Kukri Mukri. This survey provides some background information on agricultural production in

[2] Polder 55/1, SRP, October 1993 and Polder 43/2c, EIP.

the area. The small sample size means the survey provides indicative information only. Differences in yields between those inside and those outside the embankment appear to be slight at present. This is because the poor condition of infrastructure and water management inside the embankment mean that conditions are not greatly different from those where there is no embankment. Pest attacks are common and reduce yields, regardless of location. However, farmers inside the embankment grow more rabi crops and have a higher cropping intensity.

The major constraints to production identified by the farmers interviewed were soil salinity and the low fertility of the soil and lack of water in the dry season. Pest attacks were also commonly mentioned. Farmers saw solutions in land accretion, improvements in drainage and measures to facilitate irrigation. In unprotected areas, tidal intrusion was the priority problem and the construction of embankments the priority solution.

Because detailed data is not available, the present cropped area in the project area has estimated as 70 per cent of the total non-forested area, or about 5,300 ha. Based on data from the household survey and the agro-economic survey the main cropping patterns in the area have been identified. These are summarised in the table.

Table 3.4: Cropping patterns and intensities

unit: per cent of cultivated area

Cropping Pattern	Char Montaz (with embankment)	Kukri Mukri (no embankment)
fallow - LT Aman - rabi	40%	20%
fallow - LT Aman - fallow	60%	80%
Cropping Intensity	140%	120%

Rabi crops grown typically include chilli, groundnut, khesari, mung, and sweet potato. The conditions in the chars result in generally low crop yields. Crops are regularly damaged by flooding, salinity and pests. Yields actually achieved for rice, for example, may often be below 1 mt/ha.

Among the constraints to production in the project area are the lack of extension services and the lack of access to markets, either local markets or to wider, regional markets. Both of these constraints are linked to the isolation of the area and the poor transportation links to outside areas. The limited transportation links also make agricultural inputs difficult to obtain and relatively expensive (compared to areas with better and cheaper transportation links) and tend to reduce the prices that can be obtained for any surpluses farmers produce.

3.6 Livestock

Livestock are an integral part of the household economy in the project area, being kept for draft purposes, to provide food and as a source of income. On newly accreted land, the first plant species to establish itself is usually uri grass. This provides fodder and the basis for supporting cattle, goats and sheep.

The cattle in the area are usually of the zebu type, fairly well adapted to the local climate and environment, but with low productivity. The average cow produces only about 1-2 litres of milk per day during lactation.

The buffaloes are the Indian water buffalo type and are preferred by farmers as tough draft animals that can survive on the coarser roughage available on chars and in forest undergrowth. The milch buffaloes produce a little more milk than cows.

The cattle and buffaloes of large and medium farmers are usually grazed on the newly accreted chars and in the forests or in the fields after harvest. Cattle owning landless and marginal farmers, who have less access to land and less crop residues, face more difficulty in obtaining fodder. The availability of fodder may be especially a problem during July to November when

the fields are in crops and during the dry season from November to March when weed production is at a minimum. Marginal farmers typically tether their animals on the river banks, fallow lands and pond dykes or stall feed them to avoid the risks of theft or loss on the chars or in the forest.

The chicken and ducks are of the deshi type, are raised around the homestead and are usually the responsibility of the women. The chickens typically produce 40-45 eggs and the ducks 60-80 eggs per year.

The spending on feed supplements or veterinary care for livestock is virtually zero. However, the household survey on Char Montaz and Kukri Mukri indicated that a little less than 10 per cent of household cash income is generated from the sale of livestock and livestock products. Household consumption of livestock products and the use of draft animals in crop production provide additional benefits.

The estimated livestock population of the project area is given in the following table.

Table 3.5: Estimated 1997 livestock population in project area

Mauza	No. Households	Cattle	Goats	Poultry
Char Bastin	223	1,137	464	2,400
Char Lakshmi	402	2,050	836	4,320
Char Margaret	119	607	1,263	1,280
Char Montaz	982	5,008	2,042	10,560
Char Kukri Mukri	894	4,560	1,860	9,610
Char Patila	810	4,131	1,685	8,710
Total	3,430	17,493	8,150	36,880
Average / household		5.1	2.08	10.75

Source: BBS; RIDP survey 1996.

According to 1983-84 census the average number of cattle per household was 4.65, goats and sheep 2.34 and poultry 7.80. For cattle and goats, these numbers were above the national and regional averages. A more recent survey of 1,771 households in 5 villages was carried out by the Remote Island Development Programme (RIDP) an NGO working in Char Montaz in 1996. This survey found 5.1 cattle (of which 29 per cent were buffaloes), 2.08 goats and 10.75 chickens and ducks per households. Of the poultry, 71 per cent chicken and 29 per cent ducks. These results from this extensive survey have been used in the analysis for the project, notwithstanding the somewhat different results obtained by the MES household survey of the project area. (see Appendix IV.4)

The present off take rate, according to BBS data for 1988-89, is 18 per cent for cattle, 17 per cent for buffaloes, 15.5 per cent for goats and 8.5 per cent for sheep.

Growth rates for livestock in the area, especially for goats and poultry, are relatively low. According the local farmers, this is due to losses in the 1991 cyclone and the prevalence of disease.

The inhabitants of the project area have a relatively high dependence on livestock. Since no other production system can ensure year round employment and income for the population, especially for poorer households. The mostly single crop agriculture provides extensive fallow land after the rice harvest available for cattle grazing and access to the forest for and other grazing areas in monsoon months when the fields are occupied with rice, has probably encouraged some farmers to rear more animals than in other regions of the country.

However, the grazing facilities in the new chars and in the forests are mostly used by the large and influential farmers as they can afford to hire herdsmen and do not depend on animals for

ploughing the crop land. The small and marginal farmers and share croppers are not organised and cannot collectively plan and utilise the grazing facilities in the forest.

Animal health is a constraint to livestock production. The services of the Thana Livestock Development Centre do not extend to the area and animal diseases are generally not reported. Accurate data on the mortality and morbidity or economic impact of animal diseases are not available. But according to the farmers, animal diseases adversely affect livestock and poultry productivity.

The main diseases of cattle and buffaloes reported by DLS and observed during field investigations include various worms and parasites, anthrax, black quarter, haemorrhagic septicaemia and foot and mouth disease. Rinderpest caused a huge loss of cattle in the early sixties but is now reported to be well under control. Most of these diseases could be prevented by routine vaccination or treated with antibiotics and other medicines.

Among chickens, Newcastle Disease (NCD) is common and takes the heaviest toll. Outbreaks of fowl pox sometimes occur in young chickens and coccidiosis, intestinal worms and lice infestations are also common. There is a relatively low incidence of disease among ducks but the duck population is not increasing. According to farmers, during the dry spell and intrusion of saline water in the fields and canals the common species of snails cannot survive and there is a shortage of duck feed in the winter months.

The availability of fodder, especially during the dry season, is a major constraint to livestock production in the project area. This may lead to the sale of livestock at low prices, especially by marginal and non-farm households. Fodder availability may also constrain potential future expansion of livestock production although it could be alleviated by the cultivation of salt tolerant varieties of keshari and cow pea as fodder crops in the dry season.

Further data on livestock in the project area is given in Appendix IV.2

3.7 Fisheries

Fisheries is an important activity in the project area and has a vital role in nutrition, income generation, as well as in export earning. Approximately 37 per cent of the households depend on fishing for the principal part of their livelihoods and another 23 per cent have fishing as a secondary occupation. There are two types of fisheries in the project area:

- *Capture fisheries*:, carried out at sea in the inshore and offshore waters and in inland water bodies such as beels, khals, rivers and the flood plain.

- *Aquaculture*: which comprises the pond raising of carp *spp* and shrimps in respectively fresh and brackish water.

Annual production in the Char Montaz project area is estimated at of 5,150 mt of fish,[3] of which the major portion is contributed by marine fisheries. A breakdown among the different categories is presented below in Table 3.6.

Table 3.6: Fish production in the Char Montaz - Kukri Mukri study area

Category	Annual Production (mt)	Percentage of Total Production
Aquaculture	30	1.0
Marine fisheries	2,119	99.0
Total	2,149	100.0

[3] The production is based on secondary data obtained from Thana fisheries officers and on a RRA survey and is therefore indicative only.

3.7.1 Fisheries production and fish consumption

In the last decade the fish production in Bangladesh increased annually by approximately 3 per cent, from 790,000 mt in 1985 to 1,170,000 mt in 1996[4] and a similar growth has been reported for the project area by thana fisheries officers. All three components of the sector - aquaculture and inland and marine fisheries - have contributed to this growth.

Even if the statistical data reflect the trends in the field,[5] it does not mean that the fisheries are in a healthy state. Growth is most likely due to the increased number of fishermen, while at the same time the catch per fishermen is decreasing. The latter is the first sign of over-exploitation of fish stocks.

Total protein availability in Bangladesh has been estimated at around 40 g/person/day, of which 27 g is provided by fish, the remainder coming from meat, eggs and milk. This may be compared with a recommended daily protein requirement of 45.3 g/person/day. In the project area fish is the main and cheapest source of animal protein.

3.7.2 Marine fisheries

Four main types of gear are being used by fishermen in the project area.

- Push nets. The rapid expansion of shrimp culture in Bangladesh has resulted in a tremendous demand for the seed of tiger shrimp (Bagda). Within the project area a large number of push nets are operated for seed fishing by part-time fishermen. The income generated by this activity is seasonal and varies between Tk 60 and Tk 2,000 per month.

- Drift gill nets are placed in the river to catch Hilsha (95 per cent of the catch). Other species caught include pomfret, Spanish mackerel, croaker, and snapper.

- The estuarine set bag net (behundi) is a traditional gear, operated year round, which is fixed by wooden poles in the river in areas with water depth less than 5 metres. The fish enter through the mouth and end up in the bag. This type of net is rather destructive as it catches a large number of juvenile fish and shrimp, but it is the most widely used because investment costs are low.

- The marine set bag net is an enlarged version of the estuarine set bag net and is operated offshore in areas with a depth of 10 to 30 metres. The fishing season is during the dry season when fresh water run off is low.

Fishermen in the project area mainly live on Char Montaz, Char Lakshmi and Kukri Mukri. The marine fishing village survey of 1984/85 (DoF, 1986) indicated that 37 per cent of the households (45 HH, 65 fishermen) in Char Lakshmi were fisherfolk's households. MES surveyed the village again in 1998, but no information was available for the other villages. A comparison of the status of fisheries in 1984 and 1998, in Char Lakshmi is presented in Table 3.7.

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4 Bangladesh Fisheries Resources Survey System (BFRSS), 1996. See volume 6 of the MES master plan report.

5 A number of studies (MIS, FAO, FAP 17, etc.) indicated that the BFRSS is hampered by its small sample size, an outdated frame and logistic problems in analyses of data.

Table 3.7: Fisheries in Char Lakshmi in 1984 and 1998

	1984/1985 (DOF/FAO)	1998 (MES)
Total population	883	2,081
Total no. of households	121	357
No. of fishing households	45	133
No. of fishermen	65	780
% of fishing households	37.3%	37.4 %
No. of boats	25	76

Fish marketing

There are two fish landing stations in the project area, one is located at Char Muktaria (south Hatia) and the other on Nijhum Dwip. Both the ghats are used by fishermen for off loading, icing, drying and selling their catch. These two ghats are purely unofficial. Marketing of fish is mainly done at the two fish landing sites, or alternatively at sea to collecting vessels.

Fish marketing is poorly developed in the area and transport costs to major market centres are relatively high. These factors depress the prices and those received by fishermen are generally low. (see Appendix IV.3)

Fisheries ecology and migration

Biologically, the estuary provides spawning and nursery areas for a large number of fish and crustaceans which spend the remainder of their life cycles at sea or in fresh water. Further the estuary provide avenues of entry and exit for the migration of anadromous and catadromous fishes.

Within the Meghna estuary the species known to be estuarine dependent, that is for which the passing of a portion of their life cycles in the estuary is obligatory for the completion of their life cycles include hilsha, golda (fresh water prawn), shrimp species and catfish (*Pangasius spp.*) These are important species with a total annual catch valued at about US$ 125 million. Hilsha accounts for over 90 per cent of this value.

3.7.3 Inland fisheries

Some fishing is carried out in the inland water bodies of the study area during the monsoon, i.e. in the khals and flooded land. The principal species caught are taki, shing, puti and chingri.

3.7.4 Aquaculture

The most common aquaculture practices in Bangladesh are the rearing of Indian carp in fresh water ponds and the raising of tiger shrimp in brackish water ponds. According to the Hatia Thana Fisheries Officer there are an estimated 166 ha of ponds in the project area, of which 50 ha are cultured ponds, 16 ha culturable ponds and 100 ha shrimp ponds.

The present production is estimated at about 45 mt/year of carp or 824 kg/ha/year. The latter is comparable with the average production rate of 800-1,000 kg/ha/year for non-managed ponds in the whole of Bangladesh. The number of ponds most likely covers only the large ponds and the number of ponds suitable for aquaculture development could be higher.

Shrimp and prawn culture in the project area does not exceed 10 to 12 mt per year.

3.8 Forestry

The systematic establishment of mangrove plantations in coastal areas started in 1965 as part of the Government's programme of cyclone protection measures. The original aims of the programme were to provide protection against tidal surges and to improve the stabilisation and extension of coastal land through increased accretion. Plantations established under the programme include areas around Char Montaz and on Char Kukri Mukri. Although it is now recognised that apart from protection purposes, the plantations may play an important economic role if managed for commercial production purposes, the Government and Forest Department have thus far taken no initiatives in this respect.

In line with this, it is assumed that the mangrove plantations in the project area are maintained solely for their protective purposes. Also, as mentioned earlier, it is part of the key project assumptions to continue planting new mangrove areas as land accretes, and to always maintain an area of mangrove on the foreshore, also after embankment.

As seen in Table 3.8, the total present mangrove forest area in the study area is estimated at 6,600 ha., of which 1,829 ha was planted between 1970 and 1985 and is thus already mature for harvesting. The volumes shown represent total standing tree volumes. This volume represents both firewood and timber, in an assumed ratio of 40 : 60. The actual utilisation rate would be somewhat lower than the numbers shown (5-15% less).

Table 3.8: Existing forest stock

Year of Planting	Five Year Totals[1] Char M. + Kukri M	Average Volume[2] (m^3/ha)	Total Volume[2] (m^3)
1970-75	479	227.0	108,800
1976-80	1,360	206.8	281,200
1981-85	2,355	189.5	446,433
1986-90	981	133.0	130,426
1991-95	984	39.7	39,108
1996-98	465	2.5	1,167
Total	6,624		1,007,135

Sources: (1) Forest Department; (2) MES Technical Note, Forest Res. Assessment, January 1998.

The principal species planted in the accreted land of both Char Montaz and Kukri Mukri are Keora (Sonneratia apetala) representing about 90 per cent, with Baen (Avicennia sp.), Gewa (Excoecaria sp.) and others making up the remainder.

Thinning operations were carried out in some of these plantations during 1988 to 1990 in areas of age of 9 years. Because of the high cost and relatively low returns, thinning has been discontinued as a regular activity in the plantations. Moreover, since the coastal afforestation project's central aim has been land stabilisation and protection, very little attention has been paid to management and silviculture. Thinning can be avoided by using an initial tree spacing larger than that applied (1.2 to 1.5 metres); e.g. 1.7 x 1.7 metres would be adequate.

A sizeable proportion of the Keora trees have been infested by stem borer causing trees to die and creating blank spots inside the plantation areas. This is particularly the case in older plantations which are now on relatively high land due to heavy accretion. This changes unfavourably the ecological growth conditions. Existing plantation forests are also being guarded by local forest staff against encroachment and pilferage. Encroachment has not been a major problem in this area.

4. FUTURE WITHOUT PROJECT

4.1 Land accretion and land development

With no intervention, land area will continue to accrete at a rate similar to the past. Based on a study of land formation and char development between 1973/74 and 1996, it is estimated that with no intervention the accretion of new land in the whole project area over the next 30 years will be almost 3,000 ha or about 100 ha per y ear (Appendix I, Table I.5). Based on these observations, future accretion with no project intervention has been estimated (see Table 4.1).

Table 4.1: Estimated accretion at +1.2 m PWD without the project

unit: ha

Year	North of Char Montaz	South of Char Montaz
5	69	144
10	138	288
15	206	431
20	275	575
25	344	719
30	412	862

Based on Appendix I, Tables I.5 and I.8

The general land development sequence recommended by MES for newly accreted land is for it first to be planted in mangroves. This helps to stabilise the land, promotes further accretion and the development of the soils and provides protection from tides and cyclones. After 15 years, forest may be cleared for agriculture provided a coastal belt is retained for protective purposes.

Given the recent history of mangrove planting in this area, it is likely that without the project a relatively high proportion of newly accreting land will be planted in mangrove. The development of newly accreted land around Char Montaz and Kukri Mukri, in this case, is expected to proceed as follows:

- 75 per cent of land reaching the level of +1.2 m PWD will be planted in mangrove
- there will be no clearing of mangrove forest after 15 years
- remaining land will be used for the grazing of livestock.

4.2 Physical and social infrastructure

Without the project, physical infrastructure in the project area will develop only slowly. Embanking of areas on Kukri Mukri and on the chars between Char Montaz and Bhola will not occur in the foreseeable future but may occur eventually.

Improvements in transport and communications will be slow to materialise. There are no official BIWTA routes in the area and none are expected, but there are regular private sector services connecting the area with the mainland. Both Char Montaz and Kukri Mukri will continue to be dependent on boats for all communications. There may be a gradual improvement in the frequency and regularity of private boat services to the mainland.

The safety and security of the population is a relatively high priority. On Char Montaz the population is protected by the existing embankment. On Kukri Mukri the construction of additional killas and cyclone shelters is likely to be continued under either regular government of NGO programmes in the coming years.

Other social infrastructure in the area will continue to expand gradually in accordance with Government's regular programmes. The area is relatively well provided with primary schools, but there is a shortage of high schools. Health services in the area are also very limited.

4.3 Water management

4.3.1 Unprotected land

Without intervention, the situation of unprotected land will remain unchanged from a water management or drainage perspective. Agriculture will be limited to only one, low yielding rice crop during the monsoon and a large and increasing number of people and property will remain exposed to harmful floods. Due to (slow) natural accretion, newly emerging lands are expected to be planted in forest.

4.3.2 Flood protection

The flood protection embankment of polder 55/4 will continue to degrade. Gradually the embankment will loose its strength and capability to stop saline flooding, increasing the risk of inundation. Infrastructure inside the polder such as roads, ponds and homesteads may be damaged and standing crops may be lost. Agricultural production will be hampered in subsequent years due to raised soil salinity level (re-salinisation). Continuing deterioration of the hydraulic infrastructure may eventually lead to a costly rehabilitation programme.

4.3.3 Drainage

As has happened in older polders, drainage is expected to worsen as more rural roads and footpaths are constructed without sufficient bridges and culverts. Population density is still low in this rather new polder, but is increasing rapidly. Urbanisation and the creation of homesteads and fish ponds may lead to increasing obstruction of drains. Roads will affect the catchment areas of sluices and areas may be deprived of proper drainage.

4.3.4 Desalinisation

In case saline floods re-enter the polder area through broken sluices or breached embankments, desalinisation will be slowed down and come to a halt or even reverse into a process of resalinisation.

4.4 Agriculture

Agriculture in the project area is constrained by exposure to high tides and storms in unprotected areas and to soil salinity, low soil fertility and a lack of inputs and extension support. Without project interventions and unless new embankments were built, salinity would decline only very slowly or not at all, since the land would remain vulnerable to saline intrusion from high tides. The risk of damage to crops from tides and floods would be unchanged. Fertility may gradually rise as the organic content of soil rises. Farmers' access to information and technical support would improve only slowly although the possibility of gradually improving communications may provide some stimulus to production through better access to markets.

Overall, it is unlikely that yields or cropping intensities would increase significantly from those obtained at present. In particular, expansion of Rabi crops would continue to be inhibited by the saline conditions. Even inside the Char Montaz embankment, if there is no improvement in operation and maintenance, production conditions are unlikely to improve greatly.

Without project interventions, the land accreting naturally in the project area will be relatively small and will be used for mangrove forestry or grazing and not for agriculture.

4.5 Livestock

Although livestock and poultry at present contribute only modest amounts to household cash income they are nevertheless an important component of the household economy, contributing draft power and dietary supplements in the form of milk, eggs and meat.

As new land accretes, the land available for the grazing of large and small ruminants will increase. The livestock population of the project area is already relatively large and the average number of livestock owned per household is not expected to increase in the future. Increases in livestock population will be related to the increasing numbers of households in the area. Successful livestock production in the project area depends on the safety of the animals, especially during cyclones. This is an issue for Kukri Mukri where unless the number of killas in the area increases, then it is unlikely that livestock populations would increase very significantly, or at least that investments will be made to improve livestock productivity.

Gradually improving communications with the area and better access to markets may act as a stimulus for livestock production in the area. However, the lack of veterinary and extension services are not likely to change significantly in the near term without the project and this will inhibit livestock production.

Overall, without the project, livestock populations will increase, but current levels of productivity are expected not to change significantly. Per household ownership of livestock will not change significantly in the future. Future growth in livestock populations is therefore dependent on the future number of households. The carrying capacity of the area is also a factor that will impose restrictions on total livestock numbers. Estimated livestock populations in the future without the project are given in Table 4.2.

Table 4.2: Livestock population, without project

Year No.	Year	Cattle & Buffaloes	Goats	Chickens
1	2001	18,886	7,702	39,808
5	2005	21,824	8,901	46,002
10	2010	24,887	10,150	52,458
15	2015	27,357	11,157	57,663

4.6 Fisheries

Marine fisheries are at present the single most important source of income for households in the project area. There are early signs, however, that the resource is being over fished and that total output will fall, possibly leading to falling incomes. If this occurs, agriculture and livestock will assume relatively more important roles in the local economy.

At present there are about 166 ha of fish and shrimp ponds in the project area. Some fish ponds are located outside the embankment and these face the same risk from floods, tides and storms as other crops, but a production cycle is possible between the end of October and May or June when the risk of damage is low. Even inside the Char Montaz embankment, production during this period will be favoured to minimise the risk of flooding if the infrastructure deteriorates. Without implementation of the project, the accretion of new land will be too small for new fish ponds to be created on this area.

4.7 Forestry

Past afforestation programmes on Char Montaz and Kukri Mukri have resulted in the present forest cover in the area. The existing programme is currently scheduled to continue until 2000. Without the project, some afforestation will be implemented in the future, and it is assumed that, on average, 75 per cent of new land accreting to or above the +1.2 m PWD level will be planted in mangroves. Without the project, forest will not be cleared for agriculture after 15 years and neither will existing forest on Char Montaz or Kukri Mukri be cleared for this purpose. The forest will provide fuel wood for local communities but there is likely to be only minimal, harvesting for timber.
After 30 years, the forest on newly accreted land will amount to some 300 ha, in addition to the existing area of approximately 6,600 ha.

5. PROPOSED INTERVENTIONS

The Char Montaz - Char Rustom cross dam, A1 A-2, will be implemented under a pilot scheme during the 1998/1999 winter season. It is also proposed to construct cross dam A1 A-1, connecting Kukri Mukri with Bhola only after 10 years; therefore this cross dam will not be considered as a part of this project.

The physical interventions proposed under this project are:

- construction of three small cross dams to join Char Montaz to Bhola. These are cross dam A1 A-3, connecting Char Rustom with Char Haldor, cross dam A1 A-4, connecting Char Haldor with Char Burhan and cross dam A1 A-5,connecting Char Burhan with Bhola. In addition cross dam A1 A-6 between Kukri Mukri and Char Aicha will be constructed.

- construction of two cross dams at the southern end of Char Montaz; cross dam A1 A-7 connecting Char Montaz with Char Taposhi and cross dam A1 A-8, connecting Char Montaz with Andar Char.

- rehabilitation and upgrading of the embankments, sluices and water management infrastructure on Char Montaz;

- empoldering of an area on Kukri Mukri and the area between Char Montaz and Bhola to provide more secure conditions for the population and for production, and development of appropriate water management infrastructure;

- construction of cross dam A1 A-1 between Bhola and Kukri Mukri, after the project.

5.1 Cross dams

The objective of the proposed cross dams is to block the tidal currents in the channels between the chars. These dams will stop the tidal flow between the islands and thus enhance accretion at both sides of the dams eventually creating one united land mass.

5.1.1 Basic data

The basic data for the present study on these closure dams were obtained from:

- results of surveys and hydraulic and morphologic studies

- Feasibility Study on Nijhum Dwip cross dams

- Bangladesh tide tables, 1997.

The design of the dam is based on the experience of pilot schemes executed at Haimchar and Khorki in the period March till June 1998.

Reference levels

The following reference levels have adopted in this study:

Public Works Department Datum (PWD)
General horizontal reference datum defined by the Public Works Department. This datum is applied in the whole of Bangladesh.

Chart Datum (CD)
A local datum used as reference for tide levels. Chart datum is a plane below which tide seldom falls. The relationship between the Chart datum used at Khepupara for Char Montaz and the Public Works datum is :

CD = PWD - 1.96 m

Topographic data

Existing topographic data have been retrieved and used for the preparation of the feasibility study.

Bathymetric data

Various bathymetric surveys have been carried out in the Char Montaz area. The most recent surveys were carried out in February 1997. It is expected that after the heavy 1998 flooding the cross section will have changed, fresh surveys will be done during the 1998/1999 winter season at the alignments of the proposed cross dams.

Water levels

Tidal information is obtained from the Bangladesh Tide Tables 1997, published by the Department of Hydrography of the Bangladesh Inland Water Transport Authority. The tidal station relevant for the area is Khepupara. The tidal levels for this station are given in the table.

Table 5.1: Tidal levels at Khepupara

	Levels with respect to:	
	CD	PWD
Lowest Astronomical Tide	- 0.323	-2.28
Mean Low Water Spring	0.195	- 1.76
Mean Low Water Neap	1.025	- 0.93
Mean Low Water	2.060	0.10
Mean High Water Neap	3.096	1.14
Mean High Water Spring	3.925	1.96
Highest Astronomical Tide	4.445	2.45

Currents

Information on currents prevailing in the channel at Char Montaz and Kukri Mukri is not yet available because the detailed 2-D model has not been prepared due to lack of data in the shallow areas. However since in recent years natural siltation was considerable, currents in the channels will be moderate.

After detailed surveys of the shallow area have been completed, the detailed 2-D model with 200 metre grid spacing will be calibrated and the effect of the proposed interventions on water levels and currents will be simulated.

Soils

Geotechnical survey data for the cross dam alignments in the Char Montaz - Kukri Mukri project area are not available. For the time being it has been assumed that the soil conditions will be similar to the conditions for the Nijhum Dwip cross dam. In general the survey indicated:

- densities around 1.9 mt/m^3
- moderate SPT values and results of unconfined compression tests which agree with the classification of "stiff silt".

- consolidation Cc values are normal but the shear test values are lower than expected.

Construction materials

In the immediate vicinity of the channel separating Bhola, Char Montaz, Kukri Mukri and other chars, the only available construction material is earth. For construction of an earthen dam one should preferably use clayey soil, with 15 percent clay particles. This requirement would qualify the soil as a medium plasticity clay, a lower boundary of 10 percent could be accepted.

"Hard" materials, such as rock or boulders are not available near the closure site would, if required, have to be imported from elsewhere. Local sand (with the required grain size) and sylhet sand to be used for filling synthetic bags and geobags, have to be brought from elsewhere.

Bamboo and bullah poles, which may be used for cross dam elements or for temporary works.

5.1.2 Cross dam design

Previous feasibility studies carried out during LRP showed that constructing dams using conventional methods is not really economically viable.
Moreover it is judged that the earthen dam with a core of gunny bags, as designed by LRP for the Nijhum Dwip cross dam, will not be able to withstand prolonged attack by waves. When overtopping of the dam occurs during e.g. cyclone conditions, the relatively local fill material of the dam, that has not much cohesion and will be loosely packed anyhow, will easily be washed away as can be observed throughout the Meghna Estuary. Protection of the embankment, with concrete slabs on a geotextile/sand filter similar to the protection of the Feni dam and the Sandwip cross dam, would be required to ensure that the cross dams will not be eroded either by current or wave erosion. Such protection would further increase the cost of the cross dams.

An alternative design and construction method for cross dams has been developed under the Meghna Estuary Study. This type of cross dam differs from conventional methods by the use of geotextile materials and construction methods using prefabricated elements. Based on the findings and lessons learned during implementation and monitoring of Haimchar and Khorki erosion control pilot schemes, MES has developed the concept of a permeable cross dam consisting of a geotextile bed protection, a low under water dam of concrete blocks or synthetic bags filled with stabilised earth, A-frames made of GI pipe, anchored in the low dam and geotextile screens, fixed to the A-frames, for partial closure of the cross section of the channel.

A comparison between the cross dam of conventional design and the innovative design of MES is indicated in Figure 5.1. It is estimated that taking into account current rates for materials and labour as well as the need for concrete slab protection, the cost of the permeable cross dam would be about 50 per cent of the conventional cross dam with adequate protective measures.

A section and side view of the permeable cross dam is indicated in Figure 5.2.

Figure 5.1 : Conventional and MES cross dam design

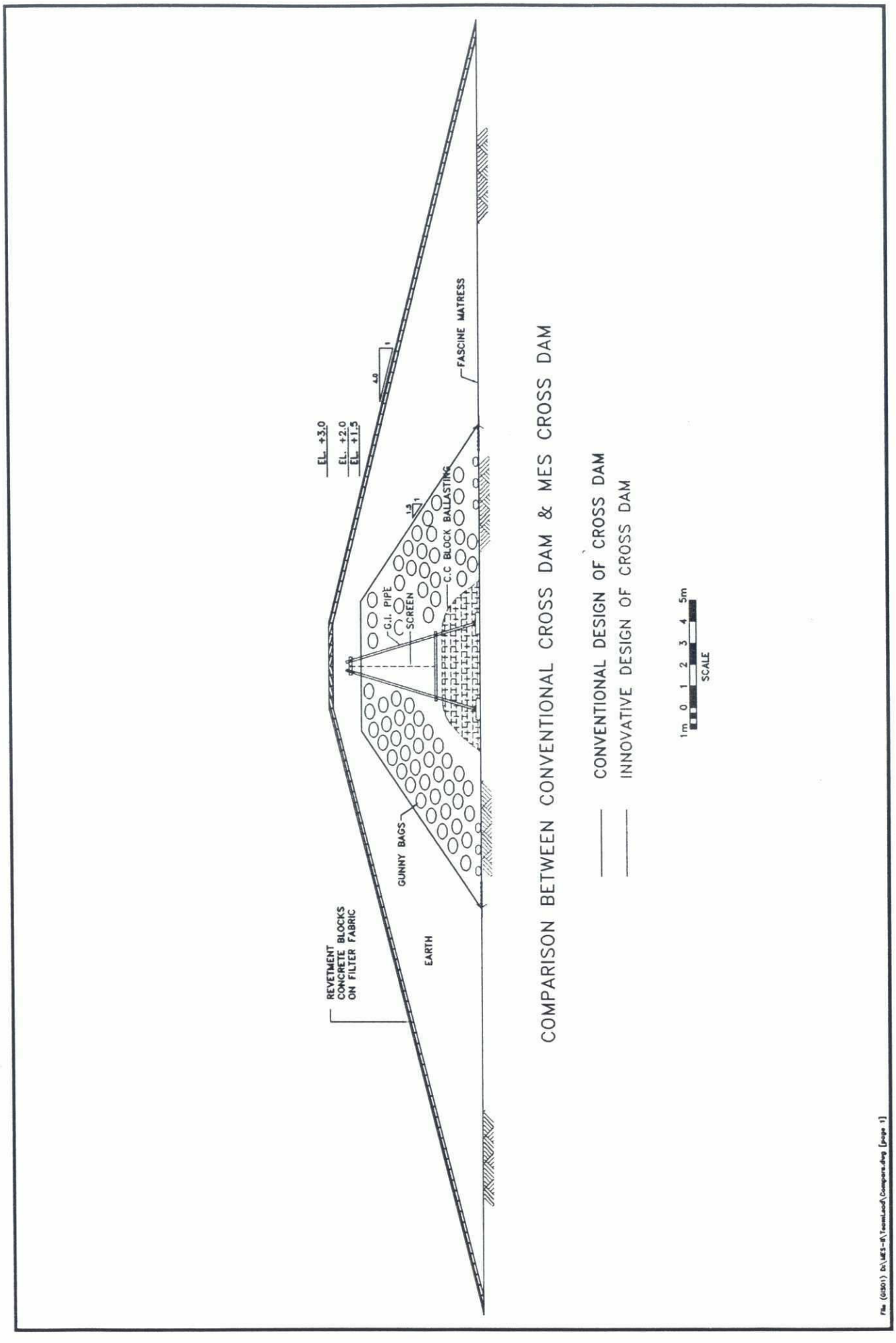
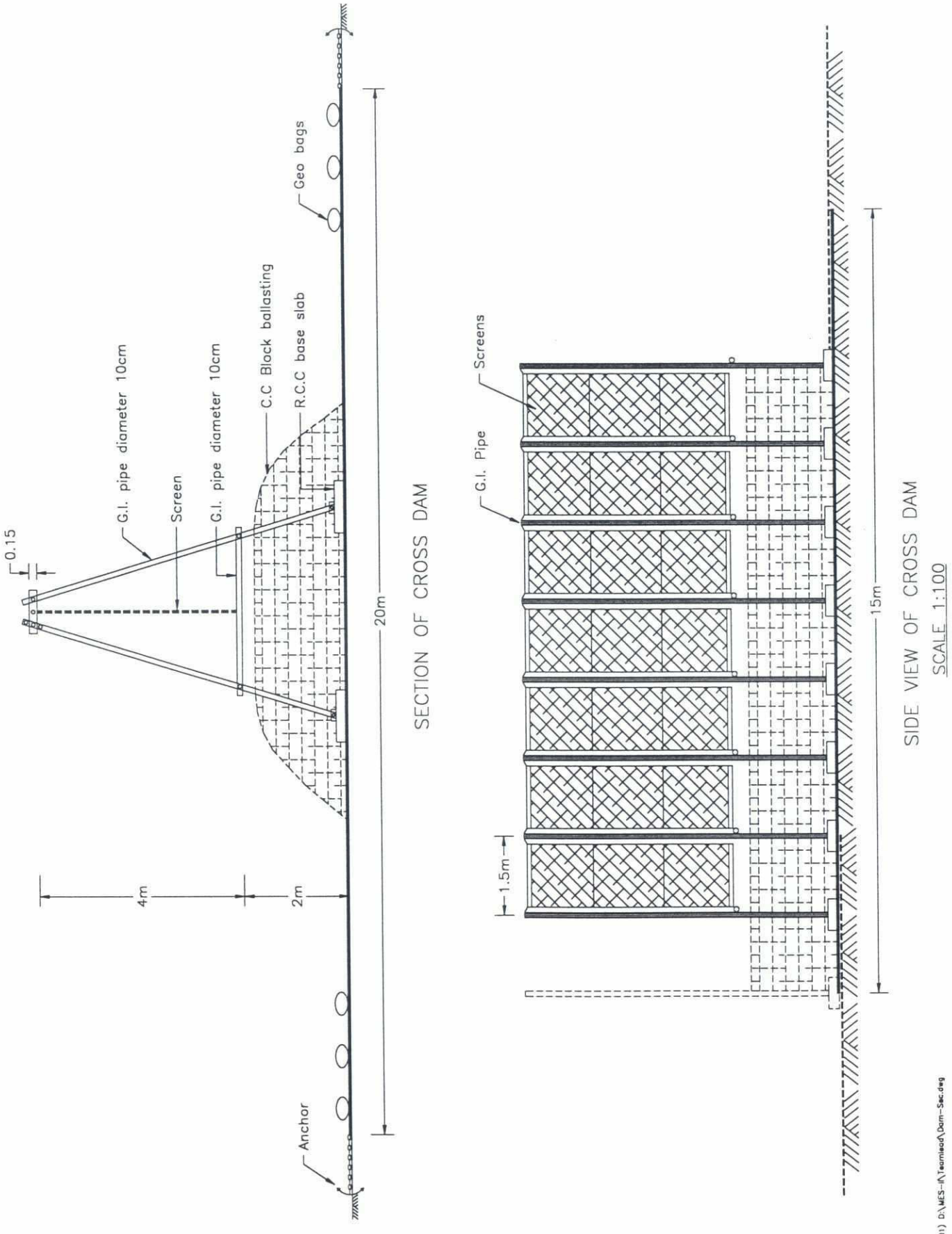


Figure 5.2: Section and side view of the cross dam at Char Montaz



The screens of the cross dam are manufactured with a very heavy woven geotextile that will be able to transfer the dynamic loading by waves and flowing water to the A-frame. The A-frames consist of 5 or 6 inch GI pipe; the c.o.c distance between A-frame depends on the actual loading by the screens and will be 1.5 to 2.0 metres. The ratio between screen area and total area above the low under water dam will vary between 0.60 and 0.90. It will be possible to adjust this ratio by narrowing the gap in between screens as well as between a screen and the under water dam.

The loading of the concrete blocks on the foot slab of the A-frames has to be sufficient to ensure the stability of the A-frame under the combined loading by water pressure and waves. Based on computer calculations of water levels after full closure, it may be assumed that the maximum head difference at the permeable cross dam will be about 0.30 metres. The waves will exert dynamic forces on the screens, since the screens are flexible and have gaps in between individual screens, it is estimated that a static head of 0.20 metres in addition to the 0.30 metres water pressure, or 0.50 total static head, will be a reasonable assumption for the horizontal loads that have to be transferred by the A-frame in to the under water dam and channel bed. By providing sufficient slack in the screens, the loading will be mostly on the downstream leg of the A-frame; the pulling force on the upstream leg of the A-frame will be relatively small. The legs of the A-frame have to be designed for buckling, some stiffeners may be required to ensure the stability under all loading conditions.

The size of the concrete ballast blocks will have to be adequate to withstand the forces of the current passing through the permeable cross dam. The maximum velocities will be about 2.5 m/sec. Concrete blocks 0.4 m x 0.4 m x 0.4 m will be stable under these conditions.

The bed of the channels at the alignment of the cross dam consists of silty sand/sandy silt. This bed material has a low resistance to scouring, therefor bed protection of adequate width has to be provided to ensure that the under water dam of concrete blocks will not be undermined by scouring. The total width of the bed protection will be about 25 metres, so that on each side of the under water dam the bed will be protected over a width of about 9 metres. This width may be increased if required.

The Char Montaz cross dam pilot scheme, to be implemented in the 1998/1999 winter season, will provide valuable data to establish the design criteria for the bed protection of cross dams.

The cross dam configuration as described above can be optimally be applied given the following site conditions:

- water depths at low water not exceeding five metres
- tidal flow conditions with a considerable period of slack water.

5.1.3 Proposed cross dams

The area south of Bhola has been accreting rapidly in the past 25 years. At present a number channels between Bhola and the chars south of Bhola have more or less stabilised. Without intervention these channels would gradually lose more and more discharge capacity and will eventually be filled up completely. It is not possible to predict when the channels will be closed naturally.

By constructing permeable cross dams the flow velocities in the channels between the chars will be reduced substantially; this will accelerate accretion and cause these channels to silt up much earlier than would be the case without interventions. The flow through the permeable cross dams may be reduced gradually by enlarging the screens and dumping more ballast blocks on the under water dam.

The cross dams that may be implemented in the course of time are indicated in Table 5.2.

Table 5.2 Details of proposed cross dams

Dam Number	Located between	8 m height (m)	6 m height (m)	4 m height (m)	Protect. embank. (m)	Total length (m)
A1 A-1	Bhola - Kukri Mukri	800	1200	200	100	2300
A1 A-2	Char Montaz - Char Rustom		96	74	50	220
A1 A-3	Char Rustom - Char Haldor	50	200	100	50	400
A1 A-4	Char Haldor - Char Burhan				50	50
A1 A-5	Char Burhan - Bhola		170	130	300	600
A1 A-6	Kukri Mukri - Char Aicha			100	50	150
A1 A-7	Char Montaz - Char Taposhi	50	200	200	50	500
A1 A-8	Char Montaz - Andar Char	100	150	100	50	400

5.1.4 Implementation of the cross dams

Cross dam A1 A-1 will be constructed after expiry of the Development Plan period, it is expected that by that time the cross section at the selected alignment will have be reduced naturally by sedimentation.

Cross dam A1 A-2 will be constructed in the1998/1999 winter season as a pilot scheme to investigate the viability of the proposed innovative design for the permeable cross dams.

Cross dams A1 A-3, A-4, A-5, A-6 are planned for construction during the 2001/2002 winter season. Dams A-4 and A-6 are very small dams, in the period between now and the year of construction the section will have decreased even further. The quantities of work for dams A-3 and A-5 will be similar in magnitude as for Nijhum Dwip, timely execution of the works will require strict adherence to the implementation schedule.

Cross dams A1 A-7, A-8 are planned for construction during the 2002/2003 winter season. By that time considerable experience will be available in cross dam construction therefore construction of these two dams not be a problem. However the location of the dam is quite exposed to the south; so timely execution of the works will be essential.

The schedules for implementation of the cross dams are given in Figure 5.3 and Figure 5.4. The actual requirements for execution of the works depend on the channel depth prior to the start of the works. If the channel falls dry over its full length during low tide, installation of the bed protection and A-frames will be relatively easy. Under the present conditions waterborne equipment like a Twin Hull Pontoon, an auxiliary pontoon, tug boats etc. will be required for installation of the bed protection and A-frames in the deeper part of the channels.

5.1.5 Cost estimates of the cross dams

The layout, design and the estimate of quantities of work of the cross dams have been based on surveys during MES. During the 1998 extreme flooding substantial changes may have occurred along the proposed alignments of the two cross dams. In the period before start of the implementation the situation will change again. A fresh estimate of quantities will be required at the time the amount involved for a construction loan has to be determined. The unit rates are based on current rates of the BWDB O&M circle of Bhola. These unit rates will also have to be adjusted at a later stage.

Table 5.3 provides the detailed cost estimate for cross dams A1 A-3, A-4, A-5, A-6, Table 5.4 gives the detailed cost estimate for cross dams A1 A-7, A-8 and Table 5.5 shows an indicative cost estimate for cross dam A1 A-1.

Figure 5.3 : Implementation schedule of Char Montaz - Kukri Mukri cross dams A1 A-3, A-4, A-5, A-6

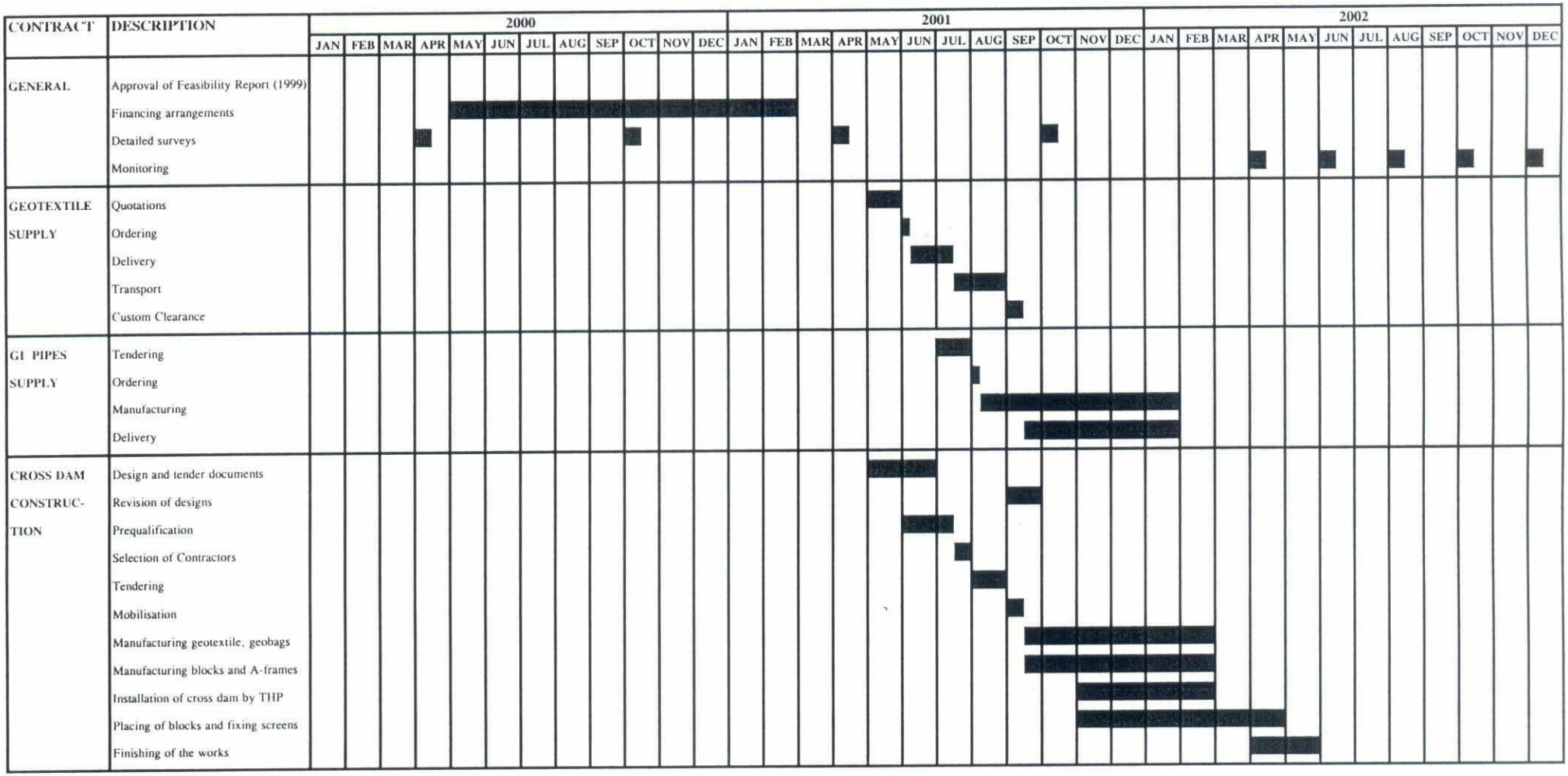


Figure 5.4 : Implementation schedule of Char Montaz - Kukri Mukri cross dams A1 A-7, A-8

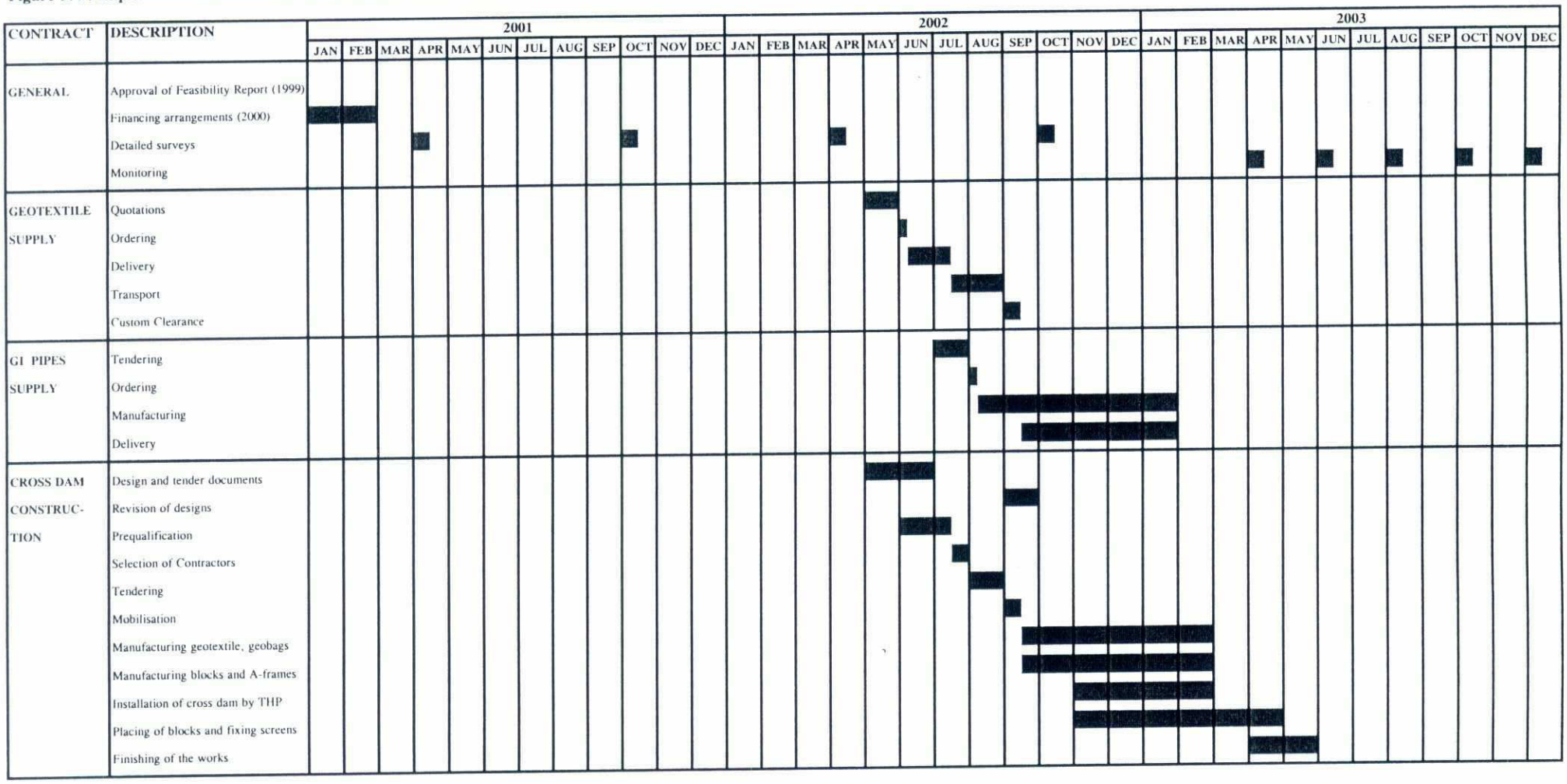


Table 5.3 : Cost estimate Char Montaz cross dams A1 A-3, A-4, A-5 and A-6 (base costs)

Cross dam section with A-frame 8 m height	50	meter length
Cross dam section with A-frame 6 m height	370	meter length
Cross dam section with A-frame 4 m height	330	meter length
Embankment, protected	450	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	36,055	3,281,005
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	9,750	1,116,375
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	16,000	1,332,000
4	Propex 6088 Screens	m2	78	3,143	243,544
5	Sewing yarn	kg	1,125	324	363,938
6	Transport cost of geotextile materials	L.S.			210,000
	Sub-total				**6,546,862**
7	Local Sand (F.M = 1.3)	m3	550	7,045	3,874,750
8	Sylhet Sand (F.M = 2.1)	m3	1,000	640	640,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	998	498,750
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	25,200	3,024,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	85,400	17,080,000
14	G.I. Pipe, 6" diameter	m	2,200	500	1,100,000
15	G.I. Pipe, 5" diameter	m	1,600	3,330	5,328,000
16	G.I. Pipe, 4" diameter	m	700	2,640	1,848,000
17	G.I. Pipe, 3" diameter	m	600	2,250	1,350,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,720	171,950
21	Shil-Barak Bamboo, 3" diameter	nos	192	14,250	2,736,000
22	Synthetic Bag	nos	18	133,950	2,411,100
23	Steel anchor (15 kg)	nos	550	375	206,250
24	Steel chain	m	250	1,650	412,500
25	Hardware material	m	3,500	750	2,625,000
	Sub-total				**43,306,300**
26	Labour cost	m	3,340	840	2,805,600
27	Equipment cost	m	4,000	863	3,450,000
28	Earth work	m3	50	25,200	1,260,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				**10,015,600**
	Total				**59,868,762**
30	Contingencies 10 % and rounding				5,987,238
	Total, including contingencies				**65,856,000**
	Sub-total foreign cost US$				**139,300**
	Sub-total local cost Taka				**59,309,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table 5.4 : Cost estimate Char Montaz cross dams A1 A-7 and A-8 (base costs)

Cross dam section with A-frame 8 m height	150	meter length
Cross dam section with A-frame 6 m height	350	meter length
Cross dam section with A-frame 4 m height	300	meter length
Embankment, protected	100	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	28,025	2,550,275
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	10,400	1,190,800
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	13,750	1,144,688
4	Propex 6088 Screens	m2	78	3,575	277,063
5	Sewing yarn	kg	1,125	258	289,688
6	Transport cost of geotextile materials	L.S.			210,000
	Sub-total				**5,662,514**
7	Local Sand (F.M = 1.3)	m3	550	6,050	3,327,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	550	550,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,064	532,000
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	5,600	672,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	93,500	18,700,000
14	G.I. Pipe, 6" diameter	m	2,200	1,500	3,300,000
15	G.I. Pipe, 5" diameter	m	1,600	3,150	5,040,000
16	G.I. Pipe, 4" diameter	m	700	2,400	1,680,000
17	G.I. Pipe, 3" diameter	m	600	2,400	1,440,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,975	197,500
21	Shil-Barak Bamboo, 3" diameter	nos	192	15,200	2,918,400
22	Synthetic Bag	nos	18	150,500	2,709,000
23	Steel anchor (15 kg)	nos	550	400	220,000
24	Steel chain	m	250	1,760	440,000
25	Hardware material	m	3,500	800	2,800,000
	Sub-total				**44,526,400**
26	Labour cost	m	3,340	820	2,738,800
27	Equipment cost	m	4,000	825	3,300,000
28	Earth work	m3	50	5,600	280,000
29	Mobilization/demobilization	L.S.			2,000,000
	Sub-total				**8,318,800**
	Total				**58,507,714**
30	Contingencies 10 % and rounding				5,850,286
	Total, including contingencies				**64,358,000**
	Sub-total foreign cost US$				**120,500**
	Sub-total local cost Taka				**58,695,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table 5.5 : Cost estimate Char Montaz cross dam A1 A-1 (base costs)

Cross dam section with A-frame 8 m height	800	meter length
Cross dam section with A-frame 6 m height	1200	meter length
Cross dam section with A-frame 4 m height	200	meter length
Embankment, protected	100	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	78,400	7,134,400
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	28,600	3,274,700
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	38,000	3,163,500
4	Propex 6088 Screens	m2	78	11,350	879,625
5	Sewing yarn	kg	1,125	715	804,375
6	Transport cost of geotextile materials	L.S.			320,000
	Sub-total				**15,576,600**
7	Local Sand (F.M = 1.3)	m3	550	17,250	9,487,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	1,520	1,520,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	2,926	1,463,000
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	5,600	672,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	299,000	59,800,000
14	G.I. Pipe, 6" diameter	m	2,200	8,000	17,600,000
15	G.I. Pipe, 5" diameter	m	1,600	10,800	17,280,000
16	G.I. Pipe, 4" diameter	m	700	1,600	1,120,000
17	G.I. Pipe, 3" diameter	m	600	6,600	3,960,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	6,350	635,000
21	Shil-Barak Bamboo, 3" diameter	nos	192	41,800	8,025,600
22	Synthetic Bag	nos	18	459,000	8,262,000
23	Steel anchor (15 kg)	nos	550	1,100	605,000
24	Steel chain	m	250	4,840	1,210,000
25	Hardware material	m	3,500	2,200	7,700,000
	Sub-total				**139,340,100**
26	Labour cost	m	3,340	2,220	7,414,800
27	Equipment cost	m	4,000	2,225	8,900,000
28	Earth work	m3	50	5,600	280,000
29	Mobilization/demobilization	L.S.			4,000,000
	Sub-total				**20,594,800**
	Total				**175,511,500**
30	Contingencies 10 % and rounding				17,551,500
	Total, including contingencies				**193,063,000**
	Sub-total foreign cost US$				**331,400**
	Sub-total local cost Taka				**177,486,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

5.2 Embankments and water management

5.2.1 Improvement of polder 55/4

The interventions mentioned below will contribute to a) improving primary protection and secondary protection and b) reducing the present drainage congestion. These engineering interventions do not stand on their own, but are part of a water management component described under 6.5.

The first part of the interventions, carried out in year 1 and 2, will improve the physical safety of Polder 55/4 through the implementation of deferred maintenance of primary embankments and sluices and the construction of a secondary compartment embankment.

The second package of interventions, planned for years 6 and 7, comprises the empoldering of old and new char land at two locations. One location is north of Char Montaz and will connect polder 55/4 with Bhola by the creation of an additional compartment north of polder 55/4. The other location is Char Kukri Mukri, where a part of the char will be empoldered.

The main physical interventions are:

- repair of primary embankments and construction of secondary embankments.
- repair of existing sluices and the increase of sluice capacity.
- improvement of drainage channels.

Repair of primary embankment and construction of compartment embankments

A first step in restoring the primary flood protection will be the implementation of a periodical maintenance programme to repair the primary flood protection embankment.

Table 5.6: Existing design of the primary embankment

Type	Crest Level (m PWD)	Freeboard (m)	Crest Width (m)	Slope R/S	Slope C/S
Primary Embankment	4.92	1.22	4.25	1:5	1:2

A topographical survey is necessary to assess the present state of the embankment and the need for repair. A provision of 8,800 m^3/km is taken for the repair of the 34 km primary embankment (see Appendix III for basic cost data).

The Cyclone Protection Project II (FAP-7) found that 4 out of 9 polders investigated suffered from major flood damage[6]. The inventory for the Coastal Embankment Rehabilitation Project (CERP) found that 21 polders were severely damaged by storm surges (and lack of maintenance). Major flooding causing re-salinisation of the soils and a lasting damage to agriculture is not unlikely in the case of coastal polders.

Secondary flood protection embankments can improve physical safety of polders facing the Bay of Bengal. These embankments will divide the polder into compartments and in case of a breach in the primary embankment, intrusion of saline floods can be limited to only a part of the polder. If properly planned, the advantages of a secondary embankment are multiple and therefore economically effective. The secondary embankment can be used for:

[6] Final project preparation report, volume 3, annex XII, FAP 7, 1992

- flood protection
- rural roads
- the creation of independent drainage sluice units.

Similar to primary embankments, flood levels are a measure for the height of secondary protection embankment. Secondary embankments can be used for rural roads and reduce the need for additional roads, although the location of the secondary protection embankment will be defined by the catchment areas of the drainage sluices. An advantage of roads that follow hydrological boundaries, like the road on top of an embankment, is that these roads do not require any culvert or bridge, which reduces the costs of a rural road network.

In the case of Char Montaz (polder 55/4) the construction of one compartment embankment is proposed. This will divide the present polder 55/4 into two compartments, MO-1 and MO-2 (see Figure 5.5). The alignment of compartment embankment should coincide as much as possible with the hydrological boundary of catchment areas of existing sluices. The design of the secondary protection embankment for polder 55/4 will be adjusted to meet the requirements for an unpaved rural road, type R-2 (minimum crest width of 3.60 m).

Table 5.7: Features of the secondary embankment

Type	Crest Level (m PWD)	Freeboard (m)	Crest Width (m)	Slope R/S	Slope C/S
Secondary Embankment	4.62	0.90	3.60	1:2	1:2

The planning of a secondary flood protection embankment cum compartment embankment cum rural road requires effective co-operation between the local Government bodies, LGED and BWDB.

Table 5.8: Estimated costs for primary and secondary embankments

Embankment Type	Type of Work	Length (km)	Rate (Tk '000 per km)	Cost (Tk '000)
Primary	Resectioning	30.1	384	11,558
Secondary cum R-2 road	New Construction	5.5	1,264	6,952
			Total	**18,510**

Repair and modification of drainage sluices

The drainage congestion reported by the population of Char Montaz need to be tackled with physical interventions as well as with institutional interventions.

An analysis of drainage ratio indicators (catchment area, ha, per m^2 sluice cross section) of nearby coastal polders, implies that the drainage congestion of Char Montaz is indeed partly caused by insufficient sluice capacity.

All four drainage sluices of polder 55/4 (Char Montaz) consist of a number of box-type culverts with rectangular cross-sections of 1.52 by 1.83 metres, a standard much used by BWDB for coastal sluices. The present drainage ratio of polder 55/4 is 188 ha/m^2. A high ratio means less drainage capacity (large catchment area per sluice unit). The drainage capacity of polder 55/4, Montaz, is low compared to the drainage capacity of other, recently rehabilitated polders like polder 55/1, with a drainage ratio of 129 ha/m^2 and polder 73/2 (South Hatia) with 162 ha/m^2.

Figure 5.5: Option 2 - situation after 5 Years

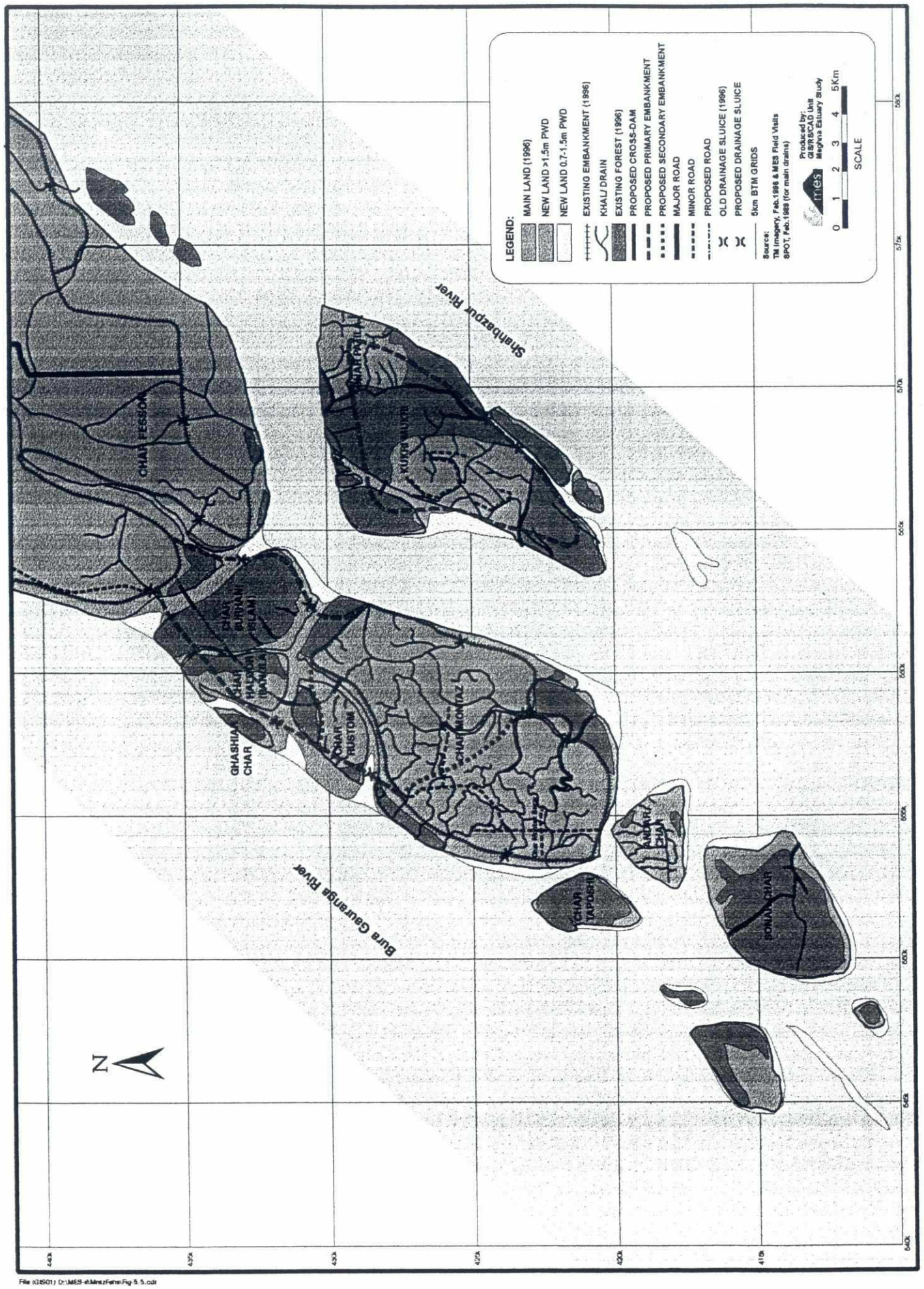


Table 5.9: Drainage ratio of existing coastal polders

Polder	*Name*	Total Catchment Area (ha)	Total Sluice Cross Section (m^2)	Average Drainage Ratio (ha/m^2)
55/1	Galachipa	10,900	85.3	129
55/3	Char Biswas-Kajal	9,850	61.2	161
55/4	***Montaz***	***5,230***	***27.80***	***188***
58/1	Manpura Hazinat	3,050	18.0	170
58/2	Shakuchia-Manpura	3,250	25.0	130
72	Sandwip	18,700	87.3	214
73/2	South Hatia	12,300	73.2	168

For the repair of drainage sluices, mainly mechanical works, the provision of a lump sum of Tk 0.4 million will be made to repair 6 flap gates and 4 vertical lift gates of the four existing sluices.

Additional sluices are required. Severe drainage congestion has been reported in the northwest central area of the polder. The planned Montaz-Rustom cross dam on the northwest side of Char Montaz will result in new accretions in that area, which will exclude the construction of an additional sluice. Also other alternative locations for the construction of new sluices are difficult to find in the case of Char Montaz. Recent and on-going land accretion on the west side and south-east side of the char make it impossible to find a suitable location. The only viable option at this moment is to increase of the capacity of already existing sluices.

The table below shows the existing drainage ratio for each drainage sluice (D/S). It is proposed to increase the capacity of D/S-1 with an additional 2 vent sluice and D/S-3 also with an additional 2 vent sluice.

Table 5.10: Future drainage sluices

Sluice Code	Km	Nos. Vents	Cross section (m^2)	Compartment	Catchment (ha)	Capacity (ha/m^2)
D/S 1	2.25	2+2	11.12	MO-2	2,760	125
D/S 2	6.61	4	11.12			
D/S 3	9.87	2+2	11.12	MO-1	2,470	148
D/S 4	18.65	2	5.56			
Total		18	50.04		5,230	136

MO-2 will have the largest future capacity. The main reason for this is the existing drainage congestion in the northwest area. Other interventions such as re-excavation of main drains, removal of eventual cross dams and a commitment of the Government agencies to maintain the drainage capacity will contribute to solve the present problem.

Sluice D/S-4 will remain as it is. Accretion near the outfall hampers operation of this sluice. The 15 small flushing sluices, that need repair, have been designed for flushing water into the polder. The present flushing sluices are seriously damaged and out of operation, a provision for 12 new surface sluices has been made, mainly meant for drainage.

Table 5.11: Cost of new additional drainage sluices

Compartment Code	Additional Type of Sluice	Qty.	Cost (Tk '000)
MO-1	Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
MO-2	Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
MO-1 and MO-2	Surface Sluices	12	9,264
		Total	21,264

Re-excavation of drainage channels

An overall drainage plan for the entire polder is needed and requires an institutional intervention (discussed in chapter 6.5). Such a plan will earmark khals that will act as primary and secondary drain inside the polder. The formulation of such an overall drainage plan and the results of a detailed drainage study will be used to formulate a channel re-excavation and drain linkage plan.

At this stage a provision will be made for re-excavation of 2.4 km primary drain per 1,000 ha, as explained in Appendix III.

Table 5.12: Excavation and re-excavation of drains

Compartment Code	Catchment Area (ha)	LS Cost (Tk '000)
MO-1	2,470	1,423
MO-2	2,760	1,590
	Total	3,013

To improve the effectiveness of drainage sluices and in particular to cope with drainage congestion along the ring embankment, the construction of a ring drain is proposed. The construction of this drain will be realised during the construction of the compartment embankment and repair of the primary embankment. The effectiveness of this drain needs to be included in a detailed design drainage study.

Construction of rural bridges and culverts in polder 55/4

Only a few roads and footpaths have so far been constructed in polder 55/4. Although exact data are lacking, no major obstruction (cross dam) has been observed in main drains of the polder. Rural bridges are and will be used where roads cross a main or secondary drain (in line with a future master drainage plan for polder 55/4). In this way, navigation with small country boats, also at present an important way of transport for farming will remain possible. It is here assumed that on the basis of a drainage plan, sufficient bridges and culverts will be constructed along with the development of a road network.

Measures to stimulate desalinisation

The experience of LRP shows that shallow tertiary or field drains have no significant effect on de-salinisation. De-salinisation of the soil appears to be a slow natural process. LRP found that deep drainage is the only major agent for de-salinisation of flood protected land. Thus, apart from sufficient deep main drains (at least 2.00 metres deep), no additional physical interventions will be taken to accelerate de-salinisation. The re-excavation of main and secondary drains has already been discussed above.

5.2.2 Empoldering of char land (years 6 and 7)

Five years after the construction of cross dams new land with a land level of +1.5 m PWD or more will be formed between the small chars north of Char Montaz and between Kukri Mukri and a small char northwest of Kukri Mukri.

This situation is expected to be favourable for the empoldering of the land between Char Montaz and Bhola and the empoldering of the larger Char Kukri Mukri.

The interventions required for empoldering are:

- construction of primary and secondary protection embankments
- construction of new sluices
- modification of the existing drainage network.

Construction of primary and secondary embankments for new land

Empoldering of the area north of Bhola will be realised by the construction of two primary embankments with a total length of 19.6 km. Both embankments will connect the primary embankment of polder 55/4 with the primary embankment of Bhola, as shown in Figure 5.5. The cross section of the primary embankment will be similar to that of polder 55/4 (given above).

The already existing compartment MO-2 of polder 55/4 will be increased by the construction of a new secondary embankment of 3.1 km at the north of Char Rustom, connecting the new western primary embankment with the most northern corner of polder 55/4. By placing two bridges in the old primary embankment of polder 55/4 east of Char Rustom, a bigger compartment MO-2 with a total of 3,370 ha will be created and will solve remaining drainage problems in the northwest central area of polder 55/4. The remaining northern part of the new protected land will form compartment MO-3 with an area of 2,020 ha. The new area of polder 55/4 will increase thus from 5,230 ha to 7,860 ha.

Natural accretion in the south and accretion stimulated by a cross dam in the northwest of Char Kukri Mukri improves the scope to empolder 3,146 ha of Char Kukri Mukri. The possible alignment of the primary embankment is shown in Figure 5.6.

In both cases, polder 55/4 and the empoldered area of Kukri Mukri, the foreshore, with a land level between 0.7 and 1.5 metres and one kilometre wide, will be planted with trees that will form a protective green belt around the island.

Table 5.13: Estimated cost of primary and secondary embankments

Compartment	Embankment Type	Length (km)	Rate (Tk '000 per km)	Cost (Tk '000)
MO-2	Primary	3.4	2,383	8,102
	Secondary	3.1	1,264	3,918
MO-3	Primary	16.2	2,383	38,605
Kukri Mukri	Primary	24.1	2,383	57,430
			Total	108,055

Construction of new sluices for new land

Excess rainfall will leave empoldered land through drainage sluices and smaller additional surface sluices. Four surface sluices are planned in every 10 km primary embankment.

Figure 5.6: Option 2 - situation after 15 years

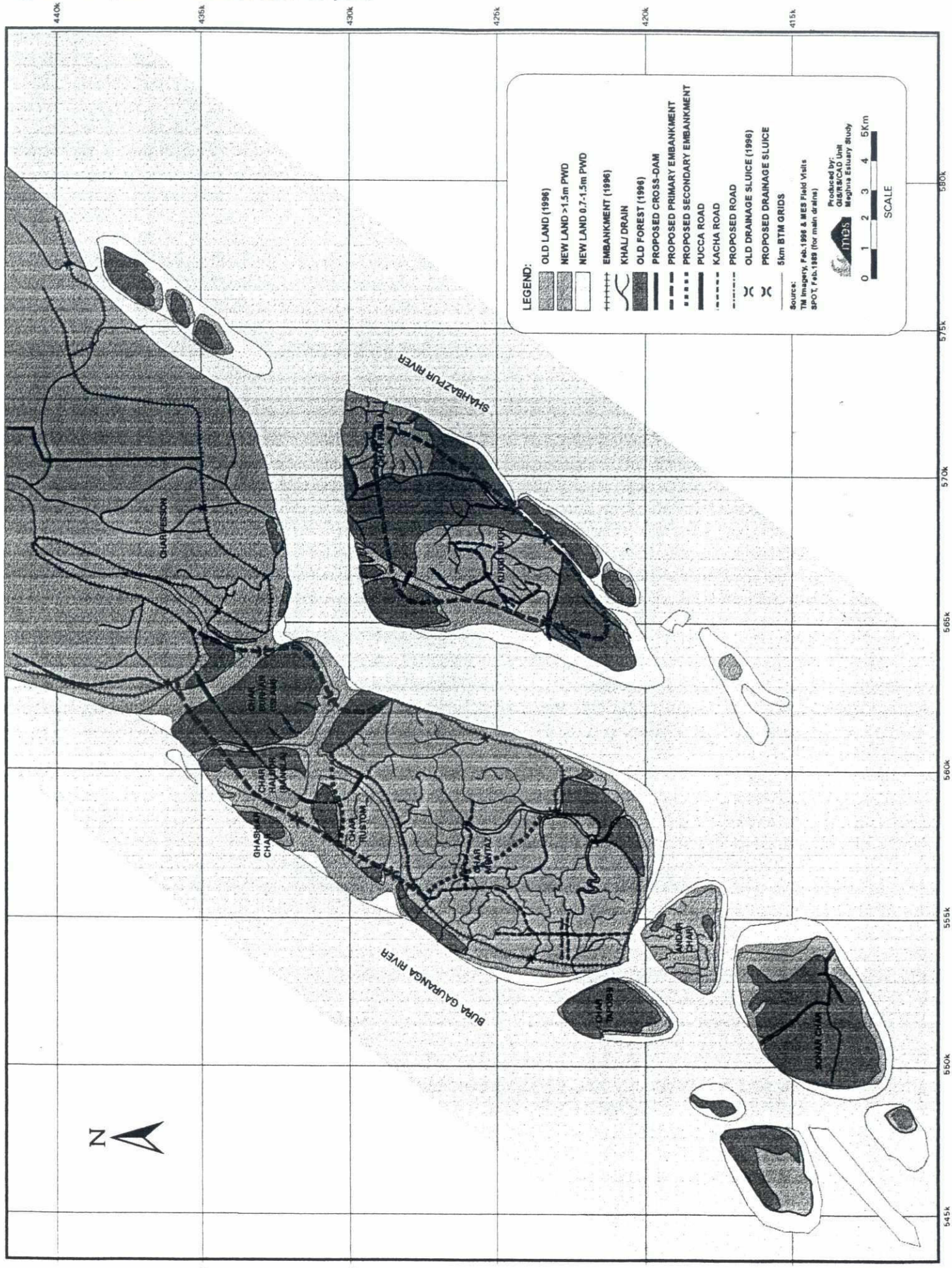


Table 5.14: Cost of new sluices

Compartment Code	Additional New Sluices	Quantity	Cost (Tk '000)
MO-2	D/S 5, Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
	Surface Sluices	1	772
MO-3	D/S 6, Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
	D/S 7, Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
	D/S 8, Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
	Surface Sluices	6	4,632
Kukri Mukri	D/S-1, Box Culvert (1.52x1.83m) Sluice, 3 vents	1	9,000
	D/S-2, Box Culvert (1.52x1.83m) Sluice, 3 vents	1	9,000
	D/S 3, Box Culvert (1.52x1.83m) Sluice, 2 vents	1	6,000
	Surface Sluices	11	8,492
		Total	61,896

For the purpose of this study a ratio of 150 ha/m^2 drainage sluice cross section will be taken for an estimation of the required drainage sluice capacity (see Appendix III). Drainage sluices will be equipped with vertical gates for water retention. The construction of surface sluices and the construction of a minor drain along the primary embankment will mitigate local drainage congestion.

The polder on Kukri Mukri will consist of one compartment of 2,883 ha. The polder will be provided with 3 standard box-culvert drainage sluices with a total of 8 vents. The drainage ratio will be 142 ha/m^2. The construction of cross dams at a medium term will ultimately create new additional compartments and a connection to the "main land" of Bhola.

Table 5.15: Future drainage situation in polder 55/4 and Kukri Mukri

Compartment	Sluice Code	Nos. Vents	Cross section (m^2)	Catchment (ha)	Capacity (ha/m^2)
MO-1	D/S-3	4	11.12	2,470	148
	D/S-4	2	5.56		
MO-2	D/S-1	4	11.12	3,370	121
	D/S-2	4	11.12		
	D/S-5	2	5.56		
MO-3	D/S-6	2	5.56	2,020	121
	D/S-7	2	5.56		
	D/S-8	2	5.56		
Kukri Mukri	D/S-1	3	8.34	2,883	142
	D/S-2	2	5.56		
	D/S-3	3	8.34		

Improvement of drainage network of newly empoldered land

A natural network of khals will form the basis of a future drainage network. A detailed drainage study and field survey will define the need for upgrading khals, which will function as primary and secondary drain. A minor drain will be constructed along the primary embankment as mentioned earlier. Besides, a provision has been made for re-excavation of 6 km primary drain, 12 km secondary drain and 2 km of new primary drain (linkage) per 1,000 ha.

Table 5.16: Excavation and re-excavation of drains

Compartment Code	Catchment Area (ha)	LS Cost[7] (Tk '000)
MO-2	610[8]	830
MO-3	2,020	2,749
Kukri Mukri	2,883	3,924
	Total	7,503

5.2.3 Total costs

The total investment for the above described physical interventions for repair of the existing polder 55/4, 5,230 ha, and empoldering of 6,200 ha new land is estimated at:

Table 5.17: Total costs

Sl. No	Description	Total Cost (Tk '000)	Cost per ha (Tk)
Improvements polder 55/4 (5230 ha):			
1	Repair of Primary/Construction of Secondary Embankments	18,510	3,540
2	New Sluices (Additional) and Repair of Existing Sluices	21,664	4,140
3	Improvement of Drainage Channels	3,013	580
	Sub-Total	**43,187**	**8,260**
Empoldering of new land (5,513 ha)			
4	Construction of Primary and Secondary Embankment	108,055	19,600
5	New Drainage Sluices	61,896	11,230
6	Improvement of Drainage Channels	7,503	1,300
	Sub-Total	**177,454**	**32,188**
	Grand Total	**220,641**	

[7] Drainage improvement costs new land, 1,361,000 Tk/1000 ha (see annex WM/MK)
[8] The new area of MO-2 only.

6. INTEGRATED DEVELOPMENT FOR THE PROJECT AREA

6.1 Development concept

Interventions to promote land accretion, such as the cross dams proposed in this project, generally cannot be shown to be economically feasible because of the long lapse between the intervention (and the investment) and the start of the flow of benefits. Furthermore, because of such problems as soil salinity, low soil fertility and flooding from tides and storms, levels of production initially achieved in newly accreted areas are low.

For this reason, interventions to promote accretion must be included as one component of an integrated package of development measures for a project area. An integrated approach to development, in this context, will aim to maximise the benefits that can be achieved from land accretion. This will be done by such measures as:

- promoting the safety of the population (including the providing of cyclone shelters and killas where appropriate)
- embanking areas to protect against tides and storms when the land has reached an appropriate level
- providing adequate infrastructure for drainage and water management
- providing appropriate infrastructure for transport and communications
- establishing coastal forests as part of the protection system for the local population and to promote the stability of the land
- promoting measures to reduce soil salinity and increase agricultural production
- promoting improved aquaculture and livestock production systems
- supporting the development of settlements and village infrastructure
- improving the access of the population to education and health services, where necessary.

For the Char Montaz - Kukri Mukri project area, this integrated approach is followed in order to maximise benefits from the expected land accretion and from the area as a whole.

6.2 Land accretion

The accretion of land with and without the proposed cross dams is discussed in detail in Chapter 2 and Appendix I. The areas expected to accrete for each of the future with project scenarios are given in Appendix I, Tables I.8 to I.11. These future scenarios or options are designated as follows:

F0 No interventions

F1 Construction of Unit A1 cross dams in year 1, i.e. Char Rustom - Char Haldor, Char Haldor - Char Burhan, Char Burhan - Bhola and Kukri Mukri - Char Aicha; and

construction of Unit A2 cross dams in year 2, i.e. Char Montaz - Char Taposhi and Char Montaz - Andar Char;

F2 Construction of Unit A3 cross dam after year 10, i.e. Kukri Mukri - Bhola.

In addition, the cross dam between Char Montaz and Char Rustom will be constructed during 1988/89 under the Char Montaz cross dam pilot scheme.

For this feasibility study, only the first of the future scenarios is taken into consideration. Scenarios F2 constitutes a long term proposal for the development of the area. Table 6.1 gives the areas expected to accrete in the area of influence of this intervention option, and in the future with no intervention, together with an estimate of the availability of land for different purposes.

6.3 Land development

Newly accreted land is saline, is generally of low fertility and is usually still subject to frequent flooding from tides and storms. In the MES area, it is recommended that all newly accreted land be planted in mangroves for an initial 15 year period. Placing the land under forest cover helps to increase stability, promotes further accretion and helps to increase the organic matter content of the soils, apart from providing essential protection from cyclones.

Thus, the principal sequence for land development which should be followed for newly accreted land in the Char Montaz area, with the project, is as follows:

- all newly accreted land reaching the level of +0.7 m PWD is planted in mangroves as it accretes and is left in forest for 15 years
- starting in year 16, new land that has been in forest for 15 years may be cleared
- 1 km depth of mangrove forest is retained outside embankments along all coasts at all times as an important element in the cyclone protection system
- land not in forest and not under cultivation may be used for the grazing of livestock - this includes cultivated land when it is not under crops
- based on the current situation in the area, fish ponds are assumed to occupy 2.5 per cent of gross agricultural area.

6.4 Needs assessment

A needs assessment was carried out on Char Montaz and Kukri Mukri as part of the socio-economic survey. On Char Montaz, the highest stated priority was the need for a health centre, while on Kukri Mukri the construction of embankments to reduce saline water intrusion was the highest priority. Other high priorities are the accretion of more land, the construction of embankments. (see Appendix IV.4, Table IV.4.41).

The rankings are evaluated by location of respondent and by social group. While there are minor variations among the groups, there is a notable consistency of ranking regardless of group. The interventions proposed for the project are consonant with the needs expressed by beneficiaries in this assessment.

6.5 Project interventions

In addition to the physical interventions described in Chapter 5, a number of other interventions are proposed to support productive activities in the project area.

6.5.1 Safety of the population

The improved safety and security of the population is a major objective of the MES project. The rehabilitation of embankments proposed for Char Montaz will enhance the safety of the population in that area.

Table 6.1: Accretion of land for development options

Unit: ha.

No	Year	F0 = Future without Project - No Cross Dams									F1 = Future with Project Cross Dams								
		Accretion Level (m PWD) 1/			Land Use						Accretion Level (m PWD) 1/			Land Use					
					Annual Increments			Cumulative Totals						Annual Increments			Cumulative Totals		
		+0.7	+1.2	+1.5	Forestry	Agriculture	Fish	Forestry	Agriculture	Fish	+0.7	+1.2	+1.5	Forestry	Agriculture	Fish	Forestry	Agriculture	Fish
1	2001	43	43	43	32	0	0	32	0	0	444	430	403	294	150	4	294	150	4
2	2002	85	85	85	32	0	0	64	0	0	1,466	1,468	1,257	873	150	4	1,166	300	8
3	2003	128	128	128	32	0	0	96	0	0	2,489	2,507	2,112	873	150	4	2,039	450	11
4	2004	170	170	170	32	0	0	128	0	0	3,511	3,545	2,966	873	150	4	2,911	600	15
5	2005	213	213	213	32	0	0	159	0	0	4,532	4,582	3,821	918	103	3	3,829	703	18
6	2006	255	255	255	32	0	0	191	0	0	5,165	5,260	4,359	634			4,462	703	18
7	2007	298	298	298	32	0	0	223	0	0	5,396	5,517	4,646	231			4,693	703	18
8	2008	340	340	340	32	0	0	255	0	0	5,626	5,773	4,932	231			4,923	703	18
9	2009	383	383	383	32	0	0	287	0	0	5,857	6,030	5,219	231			5,154	703	18
10	2010	425	425	425	32	0	0	319	0	0	6,087	6,284	5,507	231			5,384	703	18
11	2011	468	468	468	32	0	0	351	0	0	6,292	6,507	5,742	205			5,589	703	18
12	2012	510	510	510	32	0	0	383	0	0	6,361	6,595	5,858	70			5,658	703	18
13	2013	553	553	553	32	0	0	414	0	0	6,431	6,684	5,975	70			5,728	703	18
14	2014	595	595	595	32	0	0	446	0	0	6,500	6,772	6,091	70			5,797	703	18
15	2015	638	638	638	32	0	0	478	0	0	6,569	6,861	6,210	69			5,866	703	18
16	2016	680	680	680	32	0	0	510	0	0	6,638	6,946	6,320	70	59	1	5,876	762	19
17	2017	723	723	723	32	0	0	542	0	0	6,661	6,980	6,374	23	175	4	5,724	936	23
18	2018	765	765	765	32	0	0	574	0	0	6,683	7,013	6,427	23	175	4	5,572	1,111	28
19	2019	808	808	808	32	0	0	606	0	0	6,706	7,047	6,481	23	175	4	5,420	1,285	32
20	2020	850	850	850	32	0	0	638	0	0	6,729	7,082	6,532	24	184	5	5,260	1,469	37
21	2021	893	893	893	32	0	0	669	0	0	6,754	7,116	6,582	25	127	3	5,158	1,595	40
22	2022	935	935	935	32	0	0	701	0	0	6,761	7,129	6,606	8	46	1	5,120	1,642	41
23	2023	978	978	978	32	0	0	733	0	0	6,769	7,143	6,632	8	46	1	5,081	1,688	42
24	2024	1,020	1,020	1,020	32	0	0	765	0	0	6,776	7,156	6,656	8	46	1	5,042	1,734	43
25	2025	1,063	1,063	1,063	32	0	0	797	0	0	6,784	7,170	6,681	8	46	1	5,004	1,780	44
26	2026	1,105	1,105	1,105	32	0	0	829	0	0	6,792	7,182	6,705	9	41	1	4,971	1,821	46
27	2027	1,148	1,148	1,148	32	0	0	861	0	0	6,801	7,196	6,730	9	14	0	4,966	1,835	46
28	2028	1,190	1,190	1,190	32	0	0	893	0	0	6,808	7,209	6,754	8	14	0	4,960	1,849	46
29	2029	1,233	1,233	1,233	32	0	0	924	0	0	6,816	7,223	6,779	8	14	0	4,953	1,862	47
30	2030	1,275	1,275	1,275	32	0	0	956	0	0	6,823	7,236	6,803	8	14	0	4,947	1,876	47

Notes:
1/ Cumulative total accreted to or above indicated level at year end. Only area affected by proposed interventions is included in feasibility study estimates.
2/ Agricultural areas are gross areas. The area available for cultivation is taken 70% of gross area to allow for khals, drainage canals and other infrastructure and settlement areas.
3/ Land designated for agriculture may be used for grazing livestock when not in crops.
4/ Future without project, no forest clearing after 15 years.
5/ New fish pond area equal to 2.5% of new, non-forested area at or above +1.2 m PWD.

The proposed embankment on Kukri Mukri will provide the safety and security for the population that is at present lacking.
It is not proposed to construct more cyclone shelters or killas under the project as any additional requirements for Kukri Mukri and the other, smaller chars are expected to be met from other government and NGO projects.

6.5.2 Roads and transport

As discussed in Chapter 5, provision has been made for all embankments constructed or rehabilitated under the project to have the capacity to carry roads along their crests. The embankments will then become part of the road network in the project area. This road network will have a positive impact, not only the safety and security of the population, but also on all types of economic activity. By improving access to markets for inputs and outputs, roads will especially benefit agricultural production.

With successful implementation of the Unit A1 cross dams, Char Montaz will be joined to Bhola in project year 5. Embankments will be constructed for the area between the existing polder on Char Montaz and Bhola in years 6 and 7. Once these are completed, road access to Char Montaz from Bhola will be possible.

6.5.3 Settlements

New agricultural land in the project area, whether from newly accreted land or from the clearing of existing forest will first be allocated to landless families already in the area. According to BBS census data for 1991, 58 per cent of households in the area are landless. This will amount to some 2,164 households in 2001, the assumed starting year of the project. These households, although they have no land, do have homesteads and it is therefore assumed that settlement activities for these households will not be required. Settlements will be required for households moved into the area from outside to settle on surplus land. The estimate of the number of households for which land will be available is based on the following assumptions:

- existing cultivated land in the project area is all occupied and not available for redistribution
- cultivated area is estimated at 70 per cent of gross non-forested area
- land available for allocation to households goes first to landless households already living in the project area
- available land is allocated at the rate of 0.8 ha of cultivable land per household
- settlements are only constructed on land allocated inside embankments.

Furthermore, only land available inside the existing and proposed polders by year 7 is considered for inclusion in possible settlements under the project. The estimate of the number of households that may be settled in the project area is given in the table.

Table 6.2: Estimate of settlement requirements

Net Cultivated land available in polders in year 7	ha	7,500
Cultivated area belonging to existing population	ha	4,750
Total area for allocation	ha	2,750
Estimated households in 2006	HH	4,420
Of which, landless households (58%)	HH	2,570
Land for project area landless households	ha	2,060
Land available for non-project area households	ha	690
Number of settler households	HH	862

Cluster settlements will be constructed for these new settler households, including housing, ponds, water supply and sanitation and access roads, if needed. The exact location of settlements and the precise model to be used for their development can be decided by year 5 of the project.

6.5.4 Agriculture

The most important project interventions aimed at improving agricultural production will be the rehabilitation and construction of embankments and the associated drainage infrastructure. The main impact of establishment of an embankment and drainage systems is that the tidal inundation with saline water is terminated and the process of desalinisation will take place during the monsoon season when the high rainfall will leach the salt from the soil. After establishment or rehabilitation of the embankment and the drainage system the main benefits for the empoldered area will be:

- reduced risk of damage from saline intrusion
- reduced risk of damage from flooding during high tides or cyclones
- improved water management.

Specific support for the improvement of agricultural production is not proposed under the project. Rather as salinity declines over the years it will be possible for the farmers to grow higher yielding less salt tolerant varieties of paddy crops and to gradually expand the area of Rabi crops. Rehabilitation and construction of embankments the drainage system will also reduce the frequent losses due to either saline intrusion or water logging. Improved water management might also provide a source, however limited, of water for irrigation during the Rabi season.

Although soil salinity and cyclone damage are the major problems for farming development, particular attention should be given to other constraints for farming. At present the availability of seed, fertiliser and pesticides is low as well as the extension service is insufficient, too few extension officers, and a general low level of training of the extension officers. Due to the remoteness of the area there is limited access to markets or larger trade centres. Problems of crop losses caused by pests, loss of animals due to diseases and low health status, lack of appropriate credit facilities, land use conflicts, secured land tenure, market access and low income generation are other problems that have been reported in surveys and observations from the field.

Integrated Pest Management, homestead development and programmes for women, micro-credit support, income generating activities, livestock fodder development and special focused agricultural research to address problems identified during the MES surveys could be very relevant components of an integrated char development project. The impacts of such individual components are, however, difficult to predict and have been disregarded in the feasibility study.

It is also important to note that development of subsistence level farming often is a slow process with a relatively low rate of adoption of 'improved' methods. Farming systems in the coastal chars and islands of MES area are adapted to the high risk of crop damage by flooding, salinity and pest attack and the general low level of resources. Change of practice might provide potentially higher yields, but might also involve higher risks. Crops and animals often have a multipurpose use. Therefore, a change of practice might have wider consequences than initially expected. A typical example is the lack of straw particularly for fodder in some areas in Bangladesh as a result of the introduction of HYVs which produce higher grain yield but only small amounts of straw. Introduction of methods or varieties that produce a higher yield from an individual crop might reduce production of other crops. HYV requires higher levels of inputs, which might represent too high a risk for the resource poor farmer, or the farmer might not have the resources or the credit to purchase fertiliser to obtain the potential higher yields.

Establishment and rehabilitation of embankments and drainage systems provides the fundament for the development of the farming system. Farmers will benefit from the improvements to the extent that their resources allow. An integrated farming system development programme focused on the needs of the farm household and an improved management of the resources will enable farmers to benefit to a higher extend from the improved farming conditions. Such a programme for the estuary area should be within the responsibility of the relevant ministries and is, however, beyond the scope of the feasibility study.

6.5.5 Fisheries

Project interventions in the fisheries sector are restricted to the promotion and upgrading of production in existing and new ponds. There are no activities for the marine fisheries sector.

Experience elsewhere in Bangladesh has indicated that a major bottleneck for the development of carp rearing and the overcoming of the relatively low production rates is the poor management, caused by lack of knowledge on the part of the pond owners and operators. A carp rearing development programme and extension programme should include the existing cultured, culturable ponds as well as any new ponds in the accreted land.

Carp culture is a well known activity in Bangladesh and therefore the husbandry techniques are not further described.

The present production rate in the area of around 825 kg/ha/year for cultured ponds can be increased to an average of about 2,000 kg/ha/year if proper husbandry techniques are applied. This production rate will be less then the average of 2,200 kg/ha/year obtained elsewhere in Bangladesh due to the physical properties of soil and water in the coastal area. Increasing the production of existing ponds and introduction of carp rearing in the newly accreted land can only be achieved if an aquaculture extension programme is carried out in the project area. The present and future yields that can be achieved as a result of the proposed aquaculture extension programme are summarised in Table 6.3.

Table 6.3: Present and future aquaculture yields

Unit: kg/ha

	Carp		Shrimp
	Culturable Ponds	Cultured Ponds	
present & without project	250	800 -825	130
with project	-	2,000	400

The basis of an aquaculture development programme is the transfer of knowledge through extension officers. Experience in FAP 20 indicates that the availability of credit is not a prerequisite for a successful programme. Interested pond owners and operators are given a basic training after which the extension officer visits each pond operator once a month at the pond site and provides further on site training. Experience with similar programmes in Bangladesh (FAP 20, MAEP) indicate that one extension officer can cover 60 ponds (12 ha) per year and that it takes two years to bring the pond to the proposed production level of 2,000 kg/ha/year.

The costs of a 5 year aquaculture extension programme are presented in Table 6.4. This programme should be implemented through a suitably qualified and experienced NGO.

Table 6.4: Cost for aquaculture development programme

OPERATING COSTS		No./Unit Cost	Monthly Tk	Annual Tk
Extension officers	No.	3	9,000	360,000
Supporting staff	No.	1	7,000	84,000
Administration	No.	1	9,000	72,000
Petrol	litres	35	3,675	44,000
Training	lump sum	60000		60,000
Logistic support/office	lump sum	125000		125,000
Office costs	lump sum	185000		185,000
annual fish fortnight	lump sum	10000		10,000
Miscellaneous + O&M (15%)				94,000
TOTAL				1,034,000
EQUIPMENT (for 5 years)				
Motorcycles	No.	4		616,000
Training material	lump sum			44,000
Office equipment	lump sum			220,000
Miscellaneous (10%)				88,000
TOTAL				968,000
Total Cost (5 year Programme)				6,138,000

Shrimp culture

The present area of shrimp ponds in the project area is estimated at 100 ha. These have very low yields. A major bottleneck of shrimp farming at present is the ravaging impact of the White Spot disease which has reduced production levels and the average size of shrimps produced. Future development of shrimp production will only be possible when the present non-sustainability of shrimp farming is overcome through the production of pathogen free post-larvae. Nevertheless, it is proposed to include shrimp production in the aquaculture programme, although for only a limited number of ponds. Provided the current disease problem is overcome, yields can be increased from 130 kg/ha to 400 kg/ha.

6.5.6 Livestock

The project area has good potential for livestock development, for cattle and goats as well as for poultry. The further development of livestock production in the area, however, will depend upon improved safety and security for animals, in the form of killas or embankments where livestock can be kept during floods and cyclones, as well as on improved access to markets as the remoteness of the area is a serious constraint to the development of production. Without these, the risks of loss may outweigh any incentives to invest in this sector.

To promote livestock development in the area, a two part programme is proposed that will:

- provide general training for livestock owners in improved husbandry methods, improved animal health and other topics

- provide intensive training and credit for selected farmers wishing to adopt a more intensive approach to livestock production.

The second part of this programme will provide for the development of more intensive methods of raising and managing draft cattle, milch cows, beef cattle, goats and chickens (either for egg or broiler production). The programme should be implemented by a suitably qualified and experienced NGO working in co-operation with DLS.

Service delivery for the livestock sector would be improved through a participatory approach. Interested youths, nominated by their communities, would be trained as Livestock Field Workers (LFW). The LFW would reside in his own community and would earn his livelihood through selling his services to the community and maintaining liaison with DLS and other input suppliers. The LFW would also act as a model livestock operator, would assist with demonstrations and support livestock activities taken up by the farmers with credit support. The LFW in co-operation with DLS field staff would vaccinate animals against prevalent diseases and offer basic veterinary services.

Similarly, for poultry development, Women Poultry Workers would be trained to work within their communities advising women on improved husbandry practices and providing vaccination services for chickens and ducks. The WPW would also be a model poultry operator, would assist with demonstrations and support poultry activities taken up with credit support. Where practicable, destitute women would be selected for this training.

The implementing NGO would arrange training and support for the LFWs and the WPWs in co-operation with DLS. The DLS would support with continuous training facilities in the Thana Veterinary Hospital to improve skills and with inputs free of cost or at cost price as made available by the Government on a priority basis. The project would assist in the establishment of demonstration farms with improved animals and chickens. The farmers participating in project activities will be expected to bear the cost of inputs and the services of LFW and WPW so as to avoid any dependency culture for free inputs and services.

The LFW and WPW will be trained so that they are able to provide advice on feeds and feeding, preservation of crop residues, green grass and crop by-products for fodder during lean months and inclement periods. They are also expected to maintain close collaboration with the DLS for routine disease surveillance, preservation and dispatch of samples for laboratory diagnosis and to call on expert services needed from the DLS from time to time by the farmers of the area.

At a later stage, the LFW may be encouraged to maintain a good quality breeding bull to improve the milk production potential of cattle or buffaloes. The farmers would be encouraged to pay for the bull services and maintenance of the bull. Similarly, destitute women may be encouraged to rear good quality breeding bucks and charge for the coverage to the farmers.

The NGO, together with the LFWs and WPWs will also explore the opportunities in the area for feasible activities such as mini-milk processing and marketing and the marketing of eggs, chicken and other livestock products.

Livestock credit projects

In addition to the training and demonstration activities aimed at all livestock operators, the programme would provide specific training and support to men and women interested in taking up more intensive livestock and poultry production activities with credit support. Training on improved management and health care should be provided to the selected farmers prior to the provision of credit. Monitoring and follow up support would be provide through the implementing NGO and its staff. Liaison with the local Livestock Officer would be maintained for speedy and effective solution of any problems of general importance.

The total cost of the Livestock Programme is estimated to be Tk 4.4 million over 5 years (see Table 6.5). In addition, the credit requirements of the initial five year programme will be part of project funding and amount to an estimated Tk. 3.2 million.

Table 6.5: Estimate of cost for livestock development programme

Item	No.	Monthly/Unit Cost	Annual Cost	Total Cost
Extension Officers	2	18,000	216,000	1,080,000
Support/Admin. Staff	2	14,000	168,000	840,000
Logistics Support & Office			250,000	1,250,000
Fuel		2,450	29,400	147,000
Training for Farmers	100	200	20,000	100,000
Demonstrations	12	5,000	60,000	300,000
Training for LFWs	3	3,000	9,000	45,000
Training for WPWs	5	1,500	7,500	37,500
Field Equipment for WPWs	5	1,000	5,000	25,000
Bicycles for LFWs	3	4,000	12,000	60,000
Materials & Equipment				
Motorcycles	2	154,000		308,000
Training Materials				30,000
Office Equipment				200,000
TOTAL (Five Year Programme)				4,422,500

It is estimated that some 400 livestock owners will participate in the credit programme during its initial five year period. (Table 6.6) Loan funds will be recycled when loans are repaid by livestock operator borrowers, allowing more livestock owners to participate in the programme. This should provide the financial basis for an on-going livestock support programme in the project area.

Table 6.6: Credit requirements - annual additions during project years

Type of Project	Unit Cost (Tk)	Number of Additional Units in each Year					Total
		1	2	3	4	5	
Draft Cattle	15,000	5	5	5	5	5	375,000
Milch Cow	6,300	5	5	5	5	5	157,500
Beef Fattening	9,500	10	10	10	10	10	475,000
Goat Fattening	5,000	10	10	10	10	10	250,000
Goat Rearing	3,000	10	10	10	10	10	150,000
Chickens - layers	18,000	5	3	2	2	3	270,000
Chickens - broilers	5,100	5	3	2	2	3	76,500
Annual Credit Input		397,000	350,800	327,700	327,700	350,800	1,754,000

6.5.7 Forestry

Afforestation on newly accreted land is an important component of the proposed project activities.

The implementation of the strategy for mangrove plantations is outlined in sections 3.8 and 6.3. Mangrove forests have important functions in the char lands, for cyclone protection, as they break wind and wave action, they provide fuel wood, timber and other products for the population and forage for livestock, they promote further land accretion and help to stabilise newly accreted land, and improve the organic matter content of newly accreted soils.

The implementation, in particular the clearing of forest after 15 years, will require a firm policy commitment on the part of government and effective co-ordination between the Ministry of Lands and the Forest Department.

The project has proposed the construction of new embankments on Kukri Mukri and in the area between Char Montaz and Bhola. Since the embankments will halt tidal intrusions, any existing mangrove forest inside the new polder will have to be cleared (or the species composition will have to be changed). The project proposes the clearance of these areas to make way for agricultural production. Specifically, existing forest inside the new polders on Kukri Mukri and the chars to the north of Char Montaz will be cleared in years 6 and 7. These forests will, in effect, be replaced by new forested areas on newly accreted land totalling 4,900 ha by year 30 (see Table 6.1).

Clearing forest generates revenue from the sale of timber and fuel wood. The thinning of new forest after 8 years also generates a small amount of revenue. Because of the combination of clearing of existing forest inside polders and planting new forest on newly accreted land, the forestry activities proposed for the project will be self-financing (see Appendix VI, Table VI.27).

6.6 Integrated water management

6.6.1 Project formulation and planning

In the case of major interventions such as cross dams and empoldering, the participation of the local population and local organisations is a pre-requisite. In project planning, the following steps are distinguished; a) needs assessment, b) preliminary design, c) impact assessment, d) (pre-) feasibility study and e) detailed design.

Empoldering of new land will create possibilities to manipulate water levels and water salinity inside the flood protected area. To ensure that the infrastructure fulfil the needs expressed and to ensure sustainability and proper use of the infrastructure, participation of the local population and organisations is required. SRP developed in 1997-1998 a methodology named Rapid Water Management Appraisal (RWMA). It is recommended to conduct such an appraisal before finalisation of the feasibility studies and before detailed design studies are carried out.

Needs assessments have been carried out by the MES team during the study. Preliminary designs have been made along with impact assessments and its feasibility has been studied. However, due to delays in the collection and processing of hydraulic and morphological data, the formulation of the MES master plan has been delayed. Finalisation of the formulation of major interventions for Char Montaz and Kukri Mukri took place at the end of the MES study. At this stage, too little time was left for a RWMA and thorough consultation with the local population and organisations on interventions proposed in this feasibility study. It is therefore recommended to undertake consultation and a RWMA before final and detailed design studies are carried out.

During the planning process of cross dams and polders, the following representatives and organisations should be consulted:

1) Thana Development Co-ordination Committee (TDCC) or, depending on the size or boundaries of the project, the District Development Co-ordination Committee (DDCC). Possible conflicts with existing land and water use plans and practices, potential inter-agency conflicts and co-ordination will be discussed in these committees. The TDCC and DDCC should be kept informed.

2) Project Committee (PC). In the case of MES no project committee has been established. It is recommended to set up such a committee to assist further studies. The PC will comprise representatives locally elected persons such as the Union Parishad members and Chairmen, who represent the interest of all stakeholders. The PC should ensure that all stakeholders are heard and their views incorporated in the final needs assessments and RWMA. The PC

will decide for or against a final proposal for the construction of cross dams and empolderment. The PC may eventually continue as the Water Management Committee (WMC) and function during project implementation and during future management of the polder.

3) Stakeholders. After the identification of stakeholders, consultation of stakeholders can take place at Parishad or Gram level. The main function is to hear the opinion of the various stakeholders such as farmers, fishermen, boat owners, traders, town dwellers etc. about their needs and comments on proposed interventions. In the case of existing polders (Montaz), stakeholders may first be organised at block level. Blocks (hydrological units) will be defined by a RWMA.

6.6.2 Participation in water management

Effective drainage, operation and maintenance programmes require the involvement and co-operation of stakeholders and other relevant organisations. Issues to be decided with the stakeholders include, for example:

- what will be considered a primary or secondary drain?
- what will be the policy regarding fishing in main drains and near sluices?
- which drainage channels should remain accessible for country boats, when should sluices be opened and closed?
- what are the target water levels for drains?
- what will be the yearly routine and periodic maintenance programme?
- what will be the amount for a flood protection fee (local cost recovery)?

All these questions related to water management, but can not be answered by BWDB only. The involvement of stakeholders, local Government bodies such as DOF and LGED and also NGOs are required. Figure 6.1 shows an institutional framework which makes use of the already existing organisations. This set-up, which is subject to approval of new GPP, may prove to be workable and capable of dealing with issues related to water management.

To involve stakeholders and to ensure representation of the various interest groups, the organisation of stakeholders, such as farmers, fishermen, boat owners, traders etc. is needed. Experience with the present GPP, which focuses more on irrigation projects, has not always been successful. Recent national workshops on people's participation in water management revealed a number of shortcomings of the present GPP concerning FCD schemes like polders. A revision of the GPP is under preparation. Anticipating expected changes, it is envisaged that there should be three important parties involved in water management; BWDB, the so-called Water Management Committee and the stakeholder's Organisation (see Figure 6.1).

The role of BWDB will be mainly limited to planning and implementation of *periodic maintenance* of embankments and sluices, involving stakeholders and local Government Representatives. Further, BWDB will participate in a thana and district level co-ordination committee to discuss issues related to maintenance in the context of overall land and water use.

The new Water Management Committee (WMC) comprises local politicians and advisers. Two WMC will be formed. One covering Kukri Mukri and another for the three Char Montaz compartments. A complication is formed here by an odd administrative boundary, separating the area covered by the three compartments MO-1, 2 and 3 between two Districts, Patuakhali and Bhola. Similarly two thanas, Galachipa and Char Fasson and two unions, Char Montaz and Char Kalmi cover the area.

The Union Chairmen of Char Montaz Union, covering the largest area, will most likely be the chairmen of the new WMC for Char Montaz. The Union Chairman of the northern Char Kalmi Union will be a member (vice chairman) of the WMC, representing the stakeholders of a part of compartment MO-3. Both chairmen will appoint the advisers of the WMC. The role of the WMC

is mainly that of planning and decision making in operation and maintenance. Also arbitration in water management conflicts, cost recovery, formulation of an annual and seasonal water management plan for the polder and defining the function of infrastructure in the context of a land and water use plan will be handled by the WMC.

The Stakeholders will be organised in two tiers only. In the case of Char Montaz, the bottom tier will be at compartment level, named Water Management Block and a second tier will comprise all three compartments MO-1, 2 and 3, named Water Management Board (WM-Board). The members of this board are proposed by the Blocks, but are subject to approval and appointment by the WMC. The members of the WM-Board are the chief executives of O&M and must receive remuneration and a (modest) office facility from the local government for their (time consuming) efforts.

WMC, BWDB, WM-Blocks and the local WM-Board will meet at least twice, seasonally (pre-monsoon) and annually (post-monsoon). O&M plans and budgets will be prepared and finalised by WMC and BWDB with participation of the stakeholders. Implementation is done by the BWDB and local WM-Board.

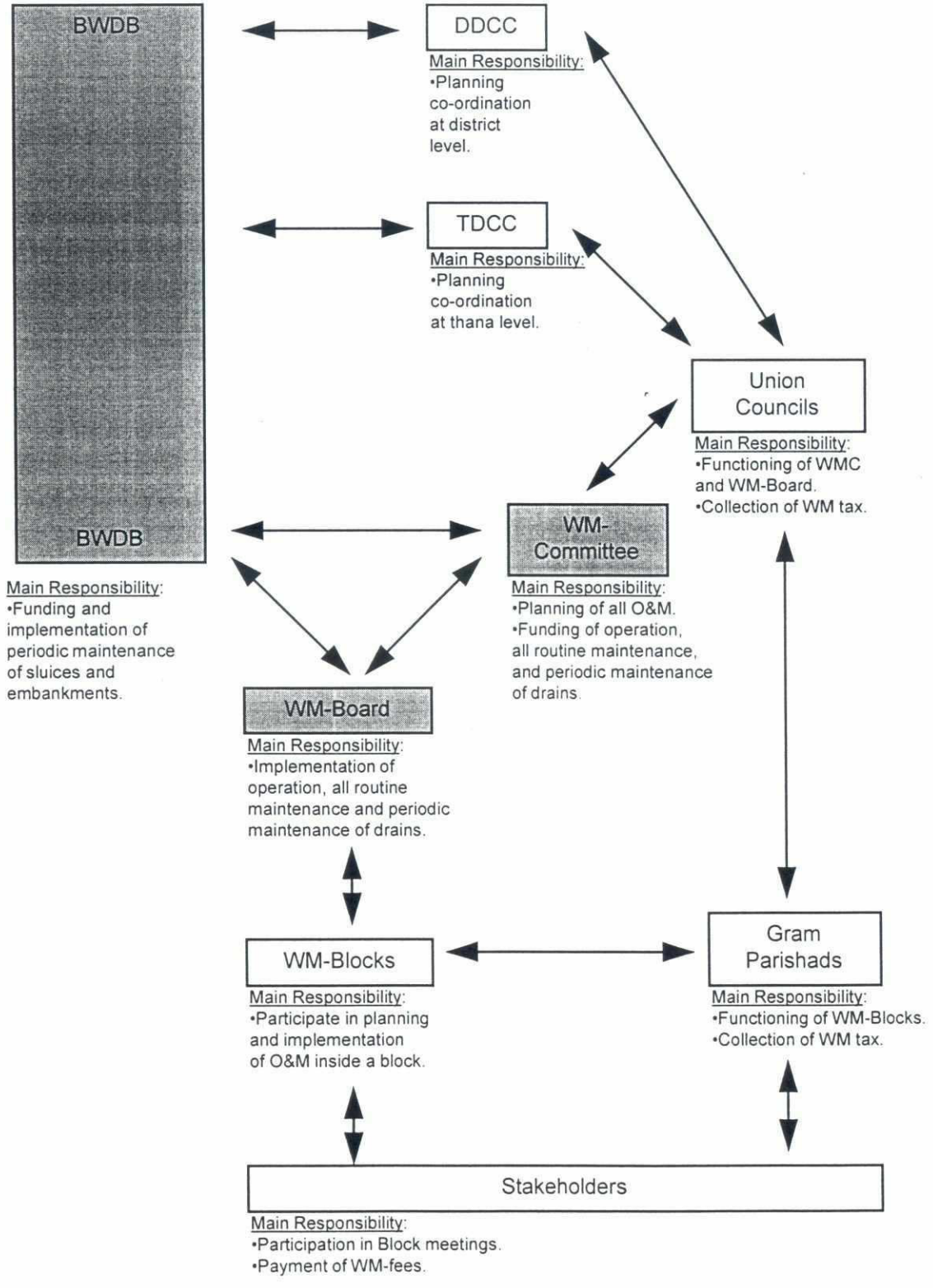
It is expected that the present GPP idea of a "Project Council" or "Polder Council" will be discontinued under the new GPP. The already existing TDCC is the most appropriate platform to co-ordinate the inter-linked activities of BWDB, LGED, DOF and DAE and other GOs and NGOs. In the TDCC, a water management plan will be presented by the WMC. After discussion eventual consequences of the plan will be endorsed by the TDCC of Galachipa and Char Fasson. The water management plan should be in line with a land and water use plan (if any such plan exists).

One of the consequences of linking Char Montaz with Bhola may be a shift in administrative district and thana boundaries as well as a change in BWDB jurisdiction boundaries recommended for practical reasons. It is recommended to bring Char Montaz under BWDB's O&M Char Fasson Subdivision instead of O&M Galachipa Subdivision. Similarly Char Montaz may come under Bhola district and Char Fasson thana.

In the case of Kukri Mukri, the WMC will cover one compartment only, but this will change if accretion continues and Kukri Mukri becomes part of Bhola mainland after the construction of other cross dams. Accretion may be stimulated by the construction of a cross dam between Bhola and Kukri Mukri (see Master Plan).

The institutional framework for water management as described above will be subject to a final version of a revised GPP, which is expected to become effective in 1999. In the absence of a revised GPP, the chances for improved water management are limited. WUCs and WUA depend too much on BWDB and have no formal power and are therefore rather inactive. Polder Councils are depending on the willingness and resources of TNOs and other GOB officials, which is very much limited. The BWDB's role under the current GPP, which is regarded as the motor of people's participation in water management, is far from their traditional engineering role. The new GPP should provide the stakeholders with a formal say, through the WMC, formed and chaired by elected people's representatives. Besides, these WMC will have the means to implement a water management plan. A local budget is raised through the collection of a local water tax (collected through the Union Council) and implementation is assured by a local WM-Board with the backing of the WMC and Union Councils.

Figure 6.1 : Institutional Framework for Water Management in Polders



6.6.3 Management, operation & maintenance

The WMC will formulate an operation plan that describes water level targets to be met in drainage channels on a monthly basis and a set of instructions for the operation of sluices. The WM-Board will appoint a sluice operator and ensure the daily operation of sluices and monitor the water levels in the drainage channels through gauge readers.

BWDB has to build-up skills and experience in preparing a sound periodic maintenance plan. Based on an inventory of the hydraulic infrastructure and period maintenance criteria, a periodic maintenance plan can be prepared and implemented. Periodic maintenance plans are based on actual field inspections, surveys and needs expressed by the WM-Blocks and WM-Board. The periodic maintenance plan requires approval from the WMC.

Based on the operation plan and formulated targets, financial and physical indicators need to be identified and data will be collected and used to evaluate the yearly performance of the three compartments MO-1, 2 and 3. This will be a task of the WMC.

The implementation of an O&M programme requires the regular presence of a Sub-Divisional Engineer of BWDB, trained in periodic maintenance planning, budgeting, implementation and monitoring.

6.6.4 Water management and O&M budget

One of the conditions for successful implementation is the availability of sufficient periodic maintenance funds under the heading "works" of the revenue budget allocated to BWDB. The height of the O&M budget will depend on the maintenance standards applied but will be at least near to one to two per cent of the estimated new price of the infrastructure. BWDB will provide funds for periodic and emergency maintenance of embankments and sluices as well as their own establishment.

Stakeholders such as landowners, farmers, fishermen, house owners, shopkeepers and traders will pay a local polder tax. Polder tax revenue should cover the budget requirement for the implementation of a routine maintenance plan for sluices and embankments, but also the routine and periodic maintenance plan for drains. It should also cover establishment costs such as the remuneration of the local WM-Board members and their employees such as sluice operators and gauge readers. The Union Council through their local tax system will be entitled to collect the polder tax.

6.6.5 Involvement of landless and destitute women

Routine maintenance should be carried out by Embankment Maintenance Groups (EMG) and Channel Maintenance Groups (CMG) consisting of destitute women and the landless, eventually supported by NGOs. Funds will be provided by the Union Council.

For periodic maintenance of embankments, BWDB will employ local Labour Contracting Societies (LCS) for earth works (status of D-Class contractor). Both groups will consist of landless and destitute women and will be trained by BWDB.

There is no guarantee that with the above described institutional set-up O&M will improve. However, transparency and accountability are clearly increased. Moreover, the physical safety has now become the shared responsibility of the local population, local institutions like Union Councils, WMC and a local WM-Board, and a national institute, BWDB.

7. IMPACT OF THE PROJECT

7.1 Physical infrastructure

The major impacts of the project will result directly from the physical infrastructure to be constructed or rehabilitated, including:

- six small cross dams
- re-sectioning of 30.1 km of primary embankment
- construction of 5.5 km of new secondary embankments on Char Montaz
- installation of 14 drainage sluices of various types and re-excavation of drains for 5,230 ha on Char Montaz
- construction of 24.1 km of primary embankments on Kukri Mukri together with 14 sluices and associated drainage works for 2,883 ha
- construction of 19.6 km of primary embankments and 3.1 km of secondary embankments between Char Montaz and Bhola, together with 11 sluices and associated drainage works for 3,040 ha.

The cross dams will result in the accretion of new land which can be used for forestry, agriculture and grazing. The predicted accretion is summarised in Table 7.1, which shows the total areas expected to accrete to or above particular levels for given years (see also Chapter 2).

Table 7.1: Natural and induced accretion of land with the project

unit: ha

Year	F1		
	+0.7 m PWD	+1.2 m PWD	+1.5 m PWD
5	4,532	4,582	3,821
10	6,087	6,284	5,507
15	6,569	6,861	6,210
20	6,729	7,082	6,532
25	6,784	7,170	6,681
30	6,823	7,236	6,803

The proposed embankments will increase the security of the population living in the area and will lead to improved conditions for agriculture and the raising of livestock as well as other possible economic activities.

Although designed eventually to carry roads, there will be no hard surface roads constructed on the embankments by the project. Nevertheless, access along the embankments will contribute to productive activities by facilitating access to local markets and boat ghats. Access to education, health and other government services will also be facilitated and people will be able to move more easily to safety when there are cyclones.

7.3 Social infrastructure

The project will construct an estimated 28 cluster settlements for 860 households. These settlements will be for households from outside the project area who will be settled on land that is surplus after landless households already living in the area have been allocated land.

The project will have no other direct impact on social infrastructure, except that by facilitating the development of a basic road network the project will also facilitate access to social services for all households living in the area.

7.4 Water management

Improved physical safety

The expected impact of the water management interventions and development activities will be improved and more sustainable physical safety achieved by applying the prevailing design standards for primary and secondary protection of polder areas.

Reduced drainage congestion

A second impact is the reduction of drainage congestion. This will create the conditions required for further improvement of crop production, such as the introduction of HYV Aman rice varieties and higher cropping intensities and the introduction of a second rice crop and other Rabi crops.

Reduction of soil salinity

Proper operation of drainage sluices and improved protection against re-salinisation by the intrusion of saline floods will allow, although slowly, a further reduction of soil salinity levels in the polders.

Improved internal transport

A third impact is increased accessibility to the polder area. Compartment bunds and embankments form flood free roads and main and secondary drains, provided with low cost bridges (steel structure) will form a reliable and cheap opportunity for transport of farm inputs and produce.

7.5 Agriculture

Implementation of the project will lead to an increase in the land available for agriculture in the project area and over time there will be gradually rising yields and cropping intensities as salinity declines and security from storm and other damage increases.

7.5.1 Land area

The existing land available for agriculture in the project area is estimated at 70 per cent of the gross non-forested land above +1.5 m PWD. The proportion not included covers homestead areas, khals, drainage canals and other non-cultivated areas. With the project, existing forest areas inside new polders will be cleared for agriculture and some newly accreted land also becomes available. Net areas available for agriculture are given in Table 7.2.

Table 7.2: Net areas available for agriculture

unit: ha

Source	Without Intervention	With Intervention
Existing agricultural land	5,637	5,637
New, from forest, etc. (net)	0	2,279
Newly accreted land	0	1,313
Total	5,637	9,229

Source: Appendix VI, Table VI.1

With no intervention, only a small amount of land will accrue and it is assumed that most of this will be planted in forest. The remainder would stay as grazing land. When the cross dams are constructed, all the land in channels between the existing chars that is projected for inclusion in future polders (amounting to about 700 ha.) will not be forested, but remaining newly accreted land will all be forested. Some of this may be cleared for agriculture after 15 years, but the proportion that can be cleared for agriculture is limited by the requirement to maintain a 1 km coastal forest margin at all times.

Crop yields

Crops yields in the project area are low because of the saline conditions and low nitrogen levels. With improved conditions as a result of project implementation, yields will rise slowly, partly as a result of changes to non-salt tolerant varieties and partly as a result of more secure conditions. The changes in crop yields for major crops, expected as a result of the project, are given in Table 7.3. Crop budgets are given in Appendix VI, Tables VI.2 and VI.3. (Some additional information from survey data is available in Appendix IV.1.)

Table 7.3: Crop yields

Crop	Inside Embankment		Outside Embankment	
	Present	With Project	Present	With Project
B. Aus	1.0	1.2	1.0	1.0
T. Aus	1.1	1.4	1.1	1.2
LT Aman	1.4	2.0	1.3	1.5
Ground nut	0.9	1.4	1.0	1.2
Pulses	0.5	0.7	0.5	0.7
Chilli (dried)	0.4	0.6	0.4	0.6

Cropping intensity

Cropping intensities will also increase gradually from the present average of about 110 per cent - 120 per cent for areas outside embankments and around 130 per cent - 140 per cent for areas inside the existing embankment on Char Montaz. It is expected that for areas inside embankments, cropping intensity will rise slowly to an average 165 per cent and for areas outside embankments to about 135 per cent over the coming 15 to 20 years.

For newly accreted areas, both yields and cropping intensities will initially be at much lower levels than those currently achieved for existing land. Yields are expected to start at about 50 per cent of present levels and the initial cropping intensity is 75 per cent. Rabi crops (usually just keshari to begin with) are started on a small scale after about 5 or 6 years. Present and future cropping intensities and cropping patterns are indicated in the farm budgets in Appendix VI, Tables VI.4 to VI.11.

In the project analysis, the transition from present production conditions or initial conditions on new land to those expected with implementation of the project is expected to take about 20 years.

7.6 Livestock

With some additional areas available for grazing and fodder production and greater security from flooding and cyclones, livestock populations will increase although the total number will be constrained by the carrying capacity of the available grazing land. The proposed Livestock Improvement Programme, although it will directly affect only a minority of livestock owners, is expected to have an impact on livestock production in the area generally, gradually improving production methods and raising productivity.

Livestock populations are projected to increase in line with increases in the number of households in the project area. Average livestock ownership per household is not expected to increase greatly. Livestock ownership per household is estimated on the basis of data from the Remote Island Development Programme survey of 1996 (Table 7.4). For comparison data from the MES survey carried out in February 1998 is included in the table.

Table 7.4: Livestock per household

	Cattle & Buffaloes	Goats & Sheep	Poultry
No./Household, 1996 (RIDP)	5.1	2.08	10.75
No./Household, 1998 (MES)	5.19	3.65	15.64

The estimate of the human population of the project area is based on the estimate for 2000 (see Table 3.1), projected forward with a declining growth rate. The rate of decline of the growth rate in the with project situation is 5 per cent and 7 per cent for the without project case, with a minimum rate of 2 per cent per annum with the project and 1.8 per cent per annum without the project. The average number of persons per household is 5.8. Taking all these factors together results the estimated future livestock populations given in Appendix VI, Table VI.12.

Changes in livestock productivity will be reflected in declining mortality rates, increasing average size of animals due to more and better fodder and better animal health and increased output of milk and eggs. Some key livestock production parameters, with and without the project are given in the following table.

Table 7.5: Livestock production parameters

	Cattle & Buffaloes		Goats & Sheep		Poultry	
	without	with	without	with	without	with
Adult mortality (%)	5	4	8	3	60	30
Juvenile mortality	13	8	25	5		
Conception rate	50	60	120	160		
Average live weight	200	250	20	20		
Milk (litres/lactation)	150	200				
Eggs (per year)					40	60

Note: Parameters for without project situation are the same as the present.

With project implementation, the transition from the present to the future situation is assumed to occur over 10 to 12 years. These changes, combined with increasing populations, have a significant impact on livestock production.

Based on this data, the annual off-take of animals (cattle and goats) can be calculated and the output of milk and eggs. Broiler chicken production is not included because of the difficulty of estimating production. Production estimates are given in Table 7.6 (details are in Appendix VI, Table VI.13).

Table 7.6: Livestock production

Year	Cattle (head)	Goats (head)	Milk ('000 litres)	Eggs ('000)
4	690	3,607	862	1,007
10	1,715	6,880	1,305	1,613
15	2,430	9,061	1,565	1,980

The direct benefits of the Livestock Improvement Programme are relatively small. The programme is expected to benefit some 400 livestock owners during its initial 5 year period and further owners in subsequent years if the programme is maintained. The pool of credit built up will provide the means for an ongoing programme, albeit at a less intense level, under the supervision of the implementing NGO. Over time the numbers will gradually decline as needs change. Production models for the various programme components are also in the Appendix (see Appendix VI, Tables VI.14 to VI.17).

7.7 Fisheries

The project is expected to lead to a small increase in the area of fish ponds and to significant improvements in productivity.

The area of ponds currently estimated to be in the project area is 166 ha. which represents 2 per cent of the gross non-forested area. In new areas it is assumed that 2.5 per cent of the gross new agricultural land area will be converted to ponds. A high proportion of these ponds will be in borrow pits created by the construction of new embankments. At present, there is almost no shrimp cultivated in the project area. This will change in the future and it is assumed that one third of new ponds will be devoted to shrimp.

The areas with and without project implementation is summarised in the table.

Table 7.7: Fish ponds

unit: ha

	Culturable	Cultured	Shrimp	Total
Present	16	50	100	166
Future without project - F0	16	50	100	166
Future with project - F1	-	144	133	277

The proposed fisheries development programme will increase productivity of fish ponds, with average annual yield in properly managed cultured fish ponds rising to 2,000 kg/ha from the average of about 800 kg/ha under present operating systems. Shrimp yields will depend on resolving the White Spot disease issue, but this is expected in the medium to long run. Yields are expected to rise from about 130 kg/ha currently achieved in the MES area to about 400 kg/ha without the disease and with improved technology and management (see Appendix VI, Tables VI.18 to VI.22).

Full transition to with project productivity levels is expected to take up to 10 years.

The estimated present production of fish from ponds is some 44 mt/year and about 13 mt/year of shrimp. The impact of the increased pond area and the improvement of productivity through the improvement programme will be a significant increase in aquaculture outputs. These are summarised in Table 7.8.

Table 7.8: Aquaculture output at full development

Unit: mt/year

	Without Intervention	With Intervention
carp	44	288
shrimp	13	53

7.8 Forestry

The project will promote the expansion of forest, especially around the coasts of the islands and on the chars south of Char Montaz. Forests are an essential component of the protective system for increasing the security of the population in the area. Forested area increases significantly with implementation of either project option. Forested area is also expected to increase without the project, although it is not expected that all accreting land would be forested and there would be no clearing of existing forest areas or of forest on newly accreted land once it has reached 15 years of age.

Without the project, the area under forest will be larger in 30 years time than in the F1 case. The situation is summarised in Table 7.9 (see also Table 6.1).

Table 7.9: Impact of the project on forested areas

unit: ha.

	Present	Cleared	New Forest	Total
Present	6,624	-	-	6,624
Future without project - F0	6,624	-	956	7,580
Future with project - F1	6,624	(2,555)	4,947	9,016

Note: Includes area on Bhola to be incorporated in project area polder.

With either project option the clearing of existing forest inside the new polders will produce significant amounts of timber and fuel wood in the early stages of the project. This benefit is not obtained in the without project case. The estimated volume of timber to be harvested is some 100,000 m^3 and of fuel wood is about 160,000 m^3.

8. ENVIRONMENTAL ASSESSMENT

8.1 Aims and objectives of the environmental assessment

The Char Montaz-Kukri Mukri Integrated Development Project is one of the three selected priority projects of the Meghna Estuary Study to be taken to feasibility study. The aim of the environmental assessment component of the Study is to ensure environmentally sound project planning and implementation takes place. The assessment procedures to be followed are those given in the FPCO/WARPO EIA Guidelines (Ref: FPCO, 1992). These EIA Guidelines follow the spirit of World Bank Operational Directive 4:01 (Ref: World Bank, 1991) which have become the international standard for such work.

The recently enacted Environmental Conservation Rules of Bangladesh (Ref: Abdus, 1998, Chapter III of which contains a translation into English of the Rules which are published in Bangla in the Government Gazette) contain the Ministry of Environment and Forest legal procedures for EIA as allowed under the Environmental Conservation Act of 1995. These procedures include the criteria for grading different types of proposed interventions and the steps required for granting of Environmental Clearance Certificates. Further details are given in the Department of Environment EIA Guidelines for Industries (DoE, 1997).

These Environmental Rules have primarily been drawn up for dealing with the construction of new industrial operations. Under the classification outlined in the Rules, the proposed interventions at Char Montaz-Kukri Mukri would appear to fall into Category D (Red) under item number 66 (Flood Control Dam, Polder, Dyke etc). The procedure since August 1997 for such classified projects is for an Initial Environmental Examination (IEE) to be carried out and submitted to the Department of Environment for granting of Location Clearance. Once this clearance is given then a full EIA is to be carried out, again for submission to the Department of Environment, for granting of an Environmental Clearance Certificate. In addition a No Objection Certificate is required from the Local Government authorities before an Environmental Clearance Certificate can be issued. The Certificates are valid for twelve months and then have to be renewed. As these Rules and procedures are very recent, there has been little experience with their operation.

A full EIA for the proposed set of interventions at Char Montaz-Kukri Mukri has been carried out and is given as a separate stand alone document as Volume 4 Part 2 of the Development Plan. A summary of the results is given below.

It must be remembered that the primary aim of the intervention is to speed up the natural accretion process that will happen even without human intervention, working with natural trends rather than against them.

The delineated project area for the feasibility study is given in Figure 1.1 and includes the unembanked parts of southern Bhola and the offshore island strings south west of it, including Char Montaz (which is embanked) and Kukri Mukri.

8.2 Proposed interventions

The nature of the proposed intervention has been outlined in chapters 5 and 6 above. The intervention has been drawn up bearing in mind the results of the needs assessment for the area which sampled people's views by the two island locations in the area and also by various social groups. The results of the needs assessment are given in Appendix IV.4, Tables IV.4.41 and IV.4.42. Environmental considerations have also been incorporated into project design to minimise possible negative impacts and reduce the need for specific mitigation programmes.

8.3 Baseline environmental conditions and future trends

An outline of the present environmental conditions in the project area has been given in Sections 2, 3 and 4 above. A more detailed description following the systematic order given in the EIA Guidelines is given in Section 3 of the EIA Report.

Baseline data collection for both the natural and human environment has been carried out for the area to allow identification of the existing environmental constraints and also likely future trends so that an appropriate set of interventions can be drawn up for the area, as well as for assessing impacts in with and without intervention conditions. This baseline data provides the framework to identify likely impacts due to the proposed intervention, assess their importance and then set up data collection programmes to allow quantification, valuation and also monitoring of Important Environmental Components (IEC's) and variables.

The main processes that have been identified are erosion and accretion patterns, with the primary risks and constraints being cyclones (causing loss of life and disruption), saline water intrusion and soil salinity, including problems of capillary rise in the dry season. The principal environmental conditions and constraints to economic development in the area have been identified and include the following issues with respect to the proposed cross dams and utilisation of their predicted benefits:

- the nature of the system for allocating land rights and managing land use on newly accreted land
- the present pattern of surface water quality, and particularly soil salinity, caused by saline inflow and how this changes as land accretes
- groundwater quality and availability for drinking water
- rainfall drainage in embanked areas
- low agricultural yields and poor marketing systems for agricultural production as well as fisheries, primarily due to poor communications
- crop losses due to pest attack
- large areas of unembanked land which support a significant number of grazing animals
- over-exploitation of the in-shore fisheries which are at an unsustainably high level
- human food intake and nutrition levels which are relatively good at present, probably because a lot of what is produced is eaten rather than sold
- poor health facility provision, a lack of sanitation facilities and recent low secondary schooling availability in the area
- relatively high levels of malaria, probably due to the forest vegetation cover

- the present low economic returns to mangrove forestry and the conflicting aims of conservation on Kukri Mukri and sustainable development for planned human in-migrants, but the area does have one of the most favourable rural energy balances in the country.

A simple needs assessment has been carried out in two different parts of the intervention area and including six social groups. A major conclusion is that by far the majority of people interviewed in Kukri Mukri feel that construction of an embankment is the highest priority intervention where as at Char Montaz the priority request was for a health centre, followed by creation of more accreted land. There were far less differences across social groups than at Nijhum Dwip.

As part of the environmental assessment process, the EIA work carried out for the Brahmaputra Right Embankment (Ref: Halcrow, 1992), the FAP 21/22 Bank Protection Project (Ref: Rhein-Ruhr Ing, 1993) and the Coastal Embankment Rehabilitation Project (Ref: Bird, 1993) was reviewed. The issues raised by these projects were born in mind when considering the proposed Nijhum Dwip intervention.

8.4 Scoping of important environmental components

The delineation of likely environmental impacts created by the proposed interventions, (known by the term "bounding" in the FPCO/WARPO EIA Guidelines and Manual), has been made based upon the outputs of the hydro-dynamic model. The model indicates that the impacts are likely to be in the mudflats and in-shore areas (defined as within 5km of the coast) within the islands south of the northern limit of the defined project area as shown in Figure 1.1. Any possible impacts and constraints outside these areas are considered to be external issues and are dealt with as a separate item in the analysis.

A scoping exercise was carried out using the field data from the needs assessment, and also amongst the study team, to identify the Important Environmental Components (IEC's). A master environmental checklist compiled for all work in the MES was used as outlined in the MES Interim Development Plan, (Ref: DHV, 1997, the environmental assessment matrix given in Tables 8.1 and 8.2 of the Interim Development Plan gives the full listing of the checklist).

The identified IEC's are listed systematically in the left hand column of the scoping matrix given as Figure 19 in Appendix II of the EIA report. The second column shows those issues considered to be important by the study team and the third column those identified by local people. The rating has fixed the present situation at zero for all issues to allow a comparative assessment to be carried out for the future situation at year 30. This time period is the economic return period for the study and also that by which most impacts are expected to be apparent, as well as being the time horizon for which sedimentation predictions have been made. Four scenarios have been assessed:

- the without intervention situation at year 30 assuming present trends, know as Option 1

- construction of one cross dam in a pilot scheme three years prior to construction of four cross dams (one from west Kukri Mukri) at year 1 of the proposed project, plus rehabilitation of the Char Montaz embankment and drainage system. This is known as Option 2

- Option 2 plus construction of two cross dams on southern Char Montaz at year two and construction of new embankments with appropriate drainage on Kukri Mukri and north of Char Montaz in year six. This is known as Option 3.

- Option 3 plus the construction of a large cross dam between north Kukri Mukri and southern Bhola. This is known as Option 4.

Table 8.1 : Important environmental components matrix for one cross dam at year 15-16

IMPORTANT ENVIRONMENTAL COMPONENTS	Technical Priority	Local Priority Char Montaz	Local Priority Kukri Mukri	NOW	Future Without Intervention	Future With Successful Intervention	Difference Due to Intervention	Future With Project With Mitigation	Residual Impact
NATURAL ENVIRONMENT									
Natural Physical Environment									
Climate									
Storm Surges	*	*13	*1	0	0	0	0	0	0
Cyclones	*	*4	*2	0	0	0	0	0	0
Hydrology									
Surface Water:									
Quantity:									
Rainfall flooding				0	-1	+2	+3	+2	+3
Tidal/Sea flooding	*	*13	*1	0	0	+2	+2	+2	+2
Drainage		*7	*12	0	-1	+2	+3	+2	+3
Quality:									
Salinity	*	*13	*1	0	-1	+2	+3	+2	+3
Erosion		*12	*13	0	-1	0	+1	0	+1
Sedimentation			*9	0	+1	+2	+1	+2	+1
Accretion	*	*2	*7	0	+1	+2	+1	+2	+1
Groundwater:									
Availability:									
Domestic water supply	*	*5	*4	0	-1	0	+1	0	+1
Land									
Soil:									
Quality:									
Chemistry	*			0	0	+1	+1	+1	+1
Capability	*			0	0	+1	+1	+1	+1
Natural Biological Environment									
In-Shore Marine Habitats:									
Fauna	*			0	0	-1	-1	-1	-1
Fish	*			0	-1	-2	-1	-2	-1
Natural Risks and Hazards									
Storms/Cyclones	*	*4	*2	0	-1	+1	+2	+1	+2
Rainfall Flooding		*7	*12	0	-1	0	+1	0	+1
HUMAN ENVIRONMENT									
Social Environment									
Human Population	*	*9	*9	0	+1	+2	+1	+2	+1
Settlement Pattern and History	*	*9	*9	0	+1	+2	+1	+2	+1
Land Holding and Tenure	*	*2	*7	0	-1	+1	+2	+1	+2
Common Resource Rights:									
Fish	*			0	-1	-2	-1	-2	-1
Domestic Water Supply	*	*5	*4	0	0	+1	+1	+1	+1
Sanitation	*	*8	*8	0	-1	0	+1	+1	+1
Health									
Waterborne Disease	*	*1	*6	0	-1	+1	+2	+1	+2
Insect-borne Disease	*			0	-1	-1	0	-1	0
Nutrition				0	0	+/-	+/-	?	+/-
Education and Literacy	*	*6	*5	0	+1	+2	+1	+2	+1
Economic Environment									
Agriculture	*	*2	*7	0	+1	+2	+1	+2	+1
Agricultural Wage Paid Labour				0	0	0	0	0	0
Homestead Production				0	+1	+2	+1	+1	+1
Livestock				0	+1	+4	+3	+4	+3
Forestry	*	*11	*11	0	+1	+2	+1	+2	+1
Fisheries				0	-1	-2	-1	-2	-1
Infrastructure and Communications									
Roads and Embankments	*	*3	*3	0	0	+2	+2	+2	+2
Navigation	*	*	*	0	0	-1	-1	0	0
Social Risk and Hazards									
Storms/Cyclones	*	*4	*1	0	0	+2	+2	+2	+2
Erosion		*12	*13	0	-1	0	+1	0	+1
Disease	*	*1	*6	0	-1	-1	0	-1	0
Crop Pest Attack	*		*	0	-1	0	+1	0	+1
EXTERNAL ISSUES									
Upstream Constraints and Impacts				0	0?	0?	0?	0?	0?
Downstream Constraints and Impacts				0	0(+/-)	(+/-)?	(+/-)?	(+/-)?	(+/-)?
DIRECT CONSTRUCTION IMPACTS									
Land Acquisition				0	0	0	0	0	0
Compensation				0	0	-0.5	-0.5	0	0
Resettlement				0	0	0	0	0	0
Construction Operations				0	0	-0.5	-0.5	+0.5	+0.5
Construction Employment				0	0	+1	+1	+1	1

LEGEND:
* Identified Significant Component
*1 Rank Number of IEC
RATING OF IMPACTS
+4 Very significant positive impact/trend
+3 Significant positive impact/trend
+2 Moderate positive impact/trend
+1 Slight positive impact/trend
0 Present baseline condition
-1 slight negative impact/trend
-2 Moderate negative impact/trend
-3 Significant negative impact/trend
-4 Very significant negative impact/trend
? Unknown, insufficient data to assess trend/impact
+/- Simultaneous positive and negative impacts

NOTES:
1.Local Priorities are ranked from the needs assessment.
2. Is is assumed that the new drainage provision is completely effective.
3. The existing and future government infrastructure provision levels are assumed to be adequate to take account of predicted population increases.
4. The settlement/Char development component includes adequate infrastructure provision (domestic water supply, sanitation, health centres, schools and cyclone shelters) to keep pace with additional planned in-migration as part of a managed programme.
5. Present NGO activities are assumed to be expanded to include income generating activities for women.
6. The analysis is at year 30 for Option 2 and 3 pased over 6 yearsone cross dam constructed in y

Figure 8.2 : Quantification matrix for significant impacts for one cross dam at year 15-16

IMPACTS (BENEFITS AND DISBENEFITS)	YEAR 30 Without Intervention	YEAR 30 With Successful Option 3	Difference Due to Option 3
Accreted Land Area 0.7m	6300ha	11848ha	5548ha
Accreted Land Area 1.2m	4800ha	10761ha	5961ha
Accreted Land Area 1.5m	3300ha	8828ha	5528ha
Existing Landless Households Allocated Agricultural Land (hh)	0	2570hh	2570hh
Additional Human Settlement Programme (hh)	0	860hh	860hh
New Agricultural Land Inside Embankment (ha)	0	2771ha	2771ha
New Agricutural Land Outside Embankment (ha)	0	821ha	821ha
Livestock - Large	35750	42000	6250
Livestock - Small	14600	17000	2400
Livestock - Poultry	75000	89000	14000
Existing Forest (ha)	6620ha	6620ha	6620ha
New Forest (ha)	960ha	4940ha	4000ha
Cleared Forest (ha)	0ha	2555ha	2555ha
Total Forest	6620ha	2380ha	9000ha
Aquaculture Fish (ha and tonnes)	66ha/44mt	144ha/288mt	78ha/244mt
Aquaculture Shrimps (ha and tonnes)	100ha/13mt	133ha/53mt	33ha/40mt
In-Shore Fisheries (can not quantify)	-	--	-
Human Nutrition (can not quantify) all hh depend on fish	+/-	+/-	+/-
New and rehabilitated embankment with capability for road	0	75.1km	75.1km
New secondary embankment with local road	0	8.6km	8.6km

Source: MES 1998

Notes: Assumes all unembanked land above 0.7m is planted

Total Benificary Households in 1996 = 3200hh, plus 860hh in Settlement Programme

Drainage Rehabilitation and New Provision = 11120ha

The EIA work was then focused on the impacts of constructing Option 3, followed by the integrated land development programme as outlined in chapter 6, above. A matrix extracting the Important Environmental Components (IEC's) for the impacts of Option 3 has been constructed and is given as Table 8.1. The matrix indicates the priority issues from a technical standpoint and also those from the local people, ranked by the results of the needs assessment. The local people's priority column in the table forms the basis for a Public Response document that is often produced as part of an EIA.

8.5 Impact identification, quantification and valuation

The comparative assessment given in Table 8.1 allows the significant impacts of the proposed intervention, (both positive and negative) to be identified. In addition, the comparison to a without project situation allows the impacts of the project to be separated from future trends. The need for mitigation can also be identified and the effectiveness of mitigation can be assessed. The final column allows the overall residual impact to be seen. Of concern are those residual impacts which are negative, i.e. those impacts for which mitigation is either impossible or unable to prevent the post project situation being worse off than that before it caused as a result of the intervention.

The primary conclusions from the analysis are given below, split between positive and negative impacts. The direction of the impact is viewed from the perspective of long term sustainable human use of resources and where significant and possible these have been quantified:

8.5.1 Identified positive impacts

Land accretion

From the morphological modelling it is estimated that land accretion is accelerated to the point where the area of land at level 1.5 metres (3,000 ha) in year 7 is the same as that in year 30 without intervention (see Table 18 in the EIA report). The total area of land accreted to level 1.5 metres after 30 years with Option 2 is almost three times that (8,828 ha) in the without intervention situation. At year 30 it is predicted that there will be 11,848 ha of land above 0.7 metres (the level at which forestry planting can commence), 5,548 ha of which are attributable to the intervention. In addition the low flow channel between islands will be closed by the cross dams, some of which may not happen under natural conditions.

Embanking of land for agricultural use and human settlement

The additional accreted land allows embankments to be constructed earlier and to enclose a larger area of land. In turn this new land allows those households resident in the area, (and also the predicted increase based upon past trends), who have no agricultural land, estimated to be 2,570 households, to be allocated a cultivable plot. In addition a further 860 households can eventually be settled into the area, with both a house plot and an agricultural land allocation.

Reduction in cyclone damage

The effects of cyclone surges will be reduced in the new embankment locations as the waves are dissipated by the kilometre wide forestry belt and also by the seaward side run-up slope. Analysis carried out by the CPP project indicated that such planting can dissipate 2 metres of wave energy in a 1991 type cyclone and this is equivalent to increasing the protection of an embankment designed to stop a 1 in 30 year event to a 1 in 50 situation.

Reduction in rainfall flooding

Assuming that the newly constructed and rehabilitated drainage systems operate fully as intended, then there will be less rainfall flooding in embanked areas with resulting reductions in agricultural crop losses.

Reduction in surface water salinity

Surface water salinity inside the rehabilitated and new embankments will be reduced as sea water intrusion will be prevented by the embankments and appropriate operation of the drainage system.

Reduction in soil salinity

Soil salinity inside the rehabilitated and new embankments will be reduced as there will less saline intrusion and the drainage system should allow flushing of the soils with monsoon rainfall fresh water. However capillary rise is still likely to remain a significant problem for many years.

Change in bank edge erosion risk

The bank edge erosion that presently occurs on the north east corner of Kukri Mukri is likely to continue. However, the erosion on the eastern side may possibly be slightly reduced under Option 3 (and certainly under option 4) as the inter-island channel accretes. The interventions are unlikely to make the erosion any worse than it would be without any intervention.

Improvement in terrestrial bio-diversity

The multi-purpose use of the new embankments, including possible linear settlements and social forestry, is likely to improve bio-diversity of terrestrial flora and fauna. The overall area of forestry outside the embankments will be significantly greater than without the project (although it will be in a corridor strip rather than a concentrated block), with benefits for terrestrial ecology.

Increase in agricultural production

Increased agricultural production is likely to occur as a result of accreted land being embanked and used for all year cropping within the constraints of irrigation water availability. This is estimated to be 2,771 ha by year 30. In addition some land which will be forested and by year 16 after planting is over 1.5 metres and lies more than one kilometre from the sea (estimated to be 820 ha by year 30), could be cleared for seasonal agricultural use and grazing. In addition it is proposed to try and introduce an integrated pest management programme in an attempt to address the serious problem of losses from pest crop attack.

Increase in homestead production

The settlement programme, allocation of cultivable land and increased security are likely to produce a significant increase in homestead production at the household level. However it is difficult to quantify this at present, although it has been estimated that an additional 14,000 poultry could be produced. Socio-economic monitoring at household level would be required to quantify and value this benefit.

Increase in livestock production

It has been estimated that the additional accreted land available outside the new embankments and cleared of forestry after 16 years growth would allow an additional 6,250 large livestock and 2,400 small livestock to be reared by year 30. In addition the proposed livestock extension programme would increase the quality of the livestock.

Increased forestry area

The area that could be put under forestry with a sustainable management system is estimated to be 4,940 ha by year 30, 4,000 ha of which are attributable to the project. The economic and financial analysis of the project has assumed that the forestry component will be self funded by the Forest Department and thus no benefits and costs have been put into the project calculations. After year 16 forest could be progressively cleared and turned over to agriculture, with up to 2,555 ha being available by year 30. The overall result would be that an additional 2,380 ha of

forest cover would exist at year 30 than is there at present, but this would be 920 ha less than at year 30 with no cross dams, assuming the Forest Department were to continue planting all newly accreted land.

Increased aquaculture production

As part of the targeted aquaculture programme using the borrow pits from embankment construction and also bringing the presently under-used ponds into full production, an extra 111 ha of ponds could be cultivated by year 30. In the with project situation it is estimated that 288 mt of fish would be produced, 244 mt of which would be attributable to the intervention. There would also be a targeted shrimp aquaculture programme.

Income generation opportunities

Homestead production would be further increased as a result of the proposed income generation programme for women implemented under an NGO. Such a programme would be linked to community forestry and maintenance on the embankments.

Improved access

As a direct result of cross dam and embankment construction there would be significantly better road access from Char Montaz to Bhola. This would allow better marketing with secondary benefits to agricultural production. There has been a strongly stated desire by most social groups in Char Montaz for better road links. The benefits that this creates can not be easily quantified, let alone valued, but they are significant.

8.5.2 Identified negative impacts

Changes in in-shore marine habitats

There are likely to be changes in the extent and location of in-shore marine habitats in the area, some of which are likely to happen despite the intervention. However there is little doubt that this process would be accelerated by the construction of cross dams and in particular movement through the channels in which the cross dams are located would cease. From the sedimentation analysis is also apparent that similar new habitats will appear away from the cross dams. The crucial question is if the fauna (including fish) using the present tidal mudflats will move to the new locations as replacement habitats. Monitoring of the situation over the next five years would be required to obtain an understanding of the situation. These habitats include those of wading birds, for the which the area is significant but not the most important in the country, (Ref: Thompson P and Johnson D, 1996) and also Gangetic dolphins. The Gangetic dolphin is classified as threatened under the IUCN Red Book (the world-wide register of threatened and endangered species). However dolphins are relatively common in the area, where its presence is not disturbed by human persecution, unlike further inland where it is caught for medicinal use. Like fish resources and wading birds, monitoring is required to see if the dolphin populations will move to the natural replacement habitats that are likely to emerge. The fish resources are under serious threat of over-fishing, irrespective of project interventions, and this process is likely to increase in the future even without the proposed intervention. It is not possible to quantify the future situation or additional effects of the proposed intervention without a significant period of study to investigate long term trends rather than seasonal fluctuations.

Conservation management

The increased intensity of human use of resources on Char Montaz and Kukri Mukri, which is likely to increase as a result of the proposed project, will put further stress on the Forest Department's attempts to manage Kukri Mukri as a conservation area. Such a policy would appear to be misguided bearing in mind the length of time that the area has been settled and the increasing human population from in-migration. The overall conclusion is that such strategies would be best reserved for more important national designated areas such as the Sundarbans, Hill Tracts and

forest areas near Sylhet. It is now necessary to achieve a mixed sustainable management strategy which balances human needs and use of resources with maintenance of significant forested habitats. The proposed intervention will result in a larger area of forest being in existence than at present, even if a full clearance programme were to be instigated after year 16. However the forested area would be in a coastal strip rather than a consolidated block.

Fisheries

The predicted trend is that fisheries in the area are now likely to decline in the future, irrespective of the project, due to over-fishing. It is not possible to quantify this trend without a significant data collection programme, which is considered an urgent priority if the project were to go ahead. The proposed cross dams are likely to cause a further change in fish habitat and an additional reduction in fisheries catch. Again it is not possible to quantify this without a baseline catch assessment and monitoring. In addition there is likely to be some temporary disruption to fishing operations by the closure of channels between islands and the possible need to relocate some ghats.

Human nutrition

The declining fish resources, a trend which will happen irrespective of the project, when combined with increasing human populations and a possible change in fish marketing patterns, is likely to result in a reduction in human protein intake. The population at present has surprisingly high levels of nutrition, partly due to the fact that a large number of households catch and directly consume fish, (per capita consumption of fish in the area is considerably higher than the average for the country). Improved access to the area could cause more fish to be sold rather than directly consumed. It is not possible to quantify this impact and there could be complex two-way trends with some households improving their nutrition and others suffering a reduction. A monitoring programme for human nutrition will be required to identify and quantify any change.

Malaria

The baseline studies of the area have indicated an existing problem with falciparum malaria, probably as a result of the large forested areas creating a habitat for the mosquito carrier. As the proposed intervention involves planting larger areas of forest cover than exist at present, the malaria risk could increase. It has been assumed that a health centre will be provided on Char Montaz as part of on-going government service provision but monitoring of malaria will be required and appropriate steps will need to be taken if it is found to be an increasing problem.

Navigation

The closing of the channels between islands will obviously prevent waterborne navigation through them and may also require some ghats to be relocated. However discussions with local people indicate that the improved access offered by a direct road connection is considered superior to navigation. Negotiations would have to take place to arrange a suitable re-location site for any ghat that requires moving. The new sites must be seen to be an acceptable replacement. However the biggest disruption would be likely to occur under Option 4 which has not been subject to detailed analysis. A detailed navigation survey would be required to address this issue.

Changes in access

Whilst the improved access to Char Montaz from southern Bhola that is likely to result from the construction of a road on top of the cross dams and connecting embankments will be considered a benefit, there are also likely to be some simultaneous negative impacts. These include additional induced in-migration which would put more pressure on existing resources and facilities. There may also be a risk of more social conflict as a result. Careful management, including fair and transparent procedures for new land allocation are critical in handling such conditions.

Direct construction impacts

Whilst, unusually for embankment construction projects in Bangladesh, there are likely to be few problems with land acquisition, compensation and involuntary resettlement, there are likely to be direct construction issues which if well managed can be overcome and in many cases increase potential benefits, particularly employment opportunities. There are also likely to be issues liked to the collection and handling of construction materials. A checklist of these issues has been prepared and included as Appendix V of the EIA report and is further discussed under mitigation issues below.

8.5.3 Impact quantification

Impact quantification has been carried out as far as is possible at this stage of the study and is summarised in Table 8.2. The main problems are the lack of data on in-shore fisheries and the uncertainty of complex two way trends with human nutrition. The quantification is for year 30 and shows the effect of a forestry cutting programme starting year 16 outside embankments which would reduce the forested area but increase that for seasonal cultivation and livestock grazing areas.

8.5.4 Impact valuation

Impact valuation has been carried out where possible and is given in Table 8.3. The main problems include the impossibility of giving land valuations based upon their traded value and the lack of data on in-shore fisheries and human nutrition. The benefits of land accretion have been valued by use of the land, both for agriculture and forestry. The valuation is purely in financial terms up to year 30, assuming thinning and cutting of forestry commencing at year 8 and 16 respectively. Benefits of the livestock programme are also given, both in terms of value of surplus animals and animal products, as well as expressed as a per household benefit. The broad conclusions of the analysis are that returns to agriculture inside the embankment are greater than those for the livestock programme by year 30. The net returns to forestry are positive but low. Forestry activities are assumed to be carried out on a self-funding basis by the Forest Department.

The overall economic analysis is in Chapter 9, the total project costs without contingencies are estimated to be Tk 479 million (US$ 10 million) at 1998 prices. The fundamental problem is that the costs of infrastructure construction are relatively high (particularly for embankments, roads, water control structures and drainage system) and the returns to agriculture are long term, particularly because of the slow rate of soil salinity reduction even after construction of the embankments. The crucial question is whether a donor can be found who will be prepared to fund such a programme and under what conditions. If no donor can be found then does the Government of Bangladesh consider the project to be of such importance that it is prepared to fund it itself? If this were to be the case then careful consideration would need to be made as to the alternative use such money could be put to.

Based on 1996 population projections and planned settlers, the capital costs amount to some Tk 78,000 per benefited household. This figure should be considered against Tk 76,000 for Nijhum Dwip and other water sector possible interventions in the country [Tk 23,000 per household for flood proofing and Tk 9,851 per household for flood management at Jamalpur (Ref: SOGREAH et al, June 1997), Tk 6,900 per head (equivalent to Tk 38,709 per household) for cyclone shelter provision or Tk 13,710 per household for both drainage and irrigation provision at Noakhali North (Ref: Sir M MacDonald and Partners, October 1993) for instance].

It must also be recognised that there are limitations of a purely economic approach to project analysis. The Guidelines for Project Assessment address this by using a multi-criteria analysis, ranking likely benefits (particularly those which can not be easily quantified or valued) against policy objectives. The results of this analysis follow in Section 9.

Figure 8.3 : Valuation matrix for significant impacts for one cross dam at year 15-16

IMPACTS (BENEFITS AND DISBENEFITS)	YEAR 30 Without Intervention	YEAR 30 With Successful Option 3	Difference Due to Option 3	Total Valuation of Benefit Year 30 Option 3 Thousand Taka
Accreted Land Area 0.7m (Note 1)	+	+ +	+	+
Accreted Land Area 1.2m (Note 1)	+	+ +	+	+
Accreted Land Area 1.5m (Note 1)	+	+ +	+	+
Net Benefit on Existing Agricultural Land Outside Embankment Tk/ha/yr	5290	8740	3450	-2692
Net Benefit on Existing Agricultural Land Inside Embankment Tk/ha/yr	7408	13659	6251	44452
Net Benefit on New Agricultural Land Outside Embankment Tk/ha/yr	0	8740	8740	7176
Net Benefit on New Agricultural Land Inside Embankment Tk/ha/yr	0	13659	13659	31142
Surplus Livestock - Large Thousand Tk	4076	24660	20584	20584
Surplus Livestock - Small Thousand Tk	5132	12206	7074	7074
Milk Production Thousand Tk	10725	21077	10352	10352
Egg Production Thousand Tk	3768	6664	2896	2896
HH Net Benefit From Livestock Improvement Tk/hh/yr	0	6240	6240	
Mangrove Forestry Planting Costs Tk/ha	-13775	-13775	-13775	see below
Mangrove Forestry Thinning and Clearing Net Revenue Tk/ha	19500	19500	19500	see below
Mangrove Forestry Net Revenue Tk/ha 16 years after planting	5725	5725	extra area	
Aquaculture Fish Tk/ha/yr (Cultured Pond)	14144	47329	33185	
Aquaculture Shrimps Tk/ha/yr (without intervention assumes disease)	8625	44484	35859	
In-Shore Fisheries (can not quantify or value)	-	--	-	-
Human Nutrition (can not quantify or value)	+/-	+/-	+/-	+/-

Source: MES 1998

Notes:

1. Accreted land can not be valued directly (tradable/intrinsic value), only by its economic use, see agricultural benefit section
2. The economic and financial analysis assumes that the forestry programme is to be self financing by the Forest Department
3. Assumes thinning of forestry at year 8 and cutting of mature forestry at year 16

8.5.5 External impacts and constraints

There are no obvious upstream impacts created by the proposed intervention, however any future upstream development, particularly that in the Bhola area (which lies outside the remit of the MES) and the planning unit west of Char Montaz, would need to bear in mind possible induced impacts downstream on the Char Montaz - Kukri Mukri area. The construction of the cross dams may thus pre-empt possible development options in Rangabali - Char Biswas, presently scheduled for pre-feasibility study.

As discussed above, the outputs of the sedimentation analysis indicated that in the with Option 3 situation, accretion of tidal mudflats is likely to occur to the south of Char Montaz and Kukri Mukri. Whilst this may provide replacement in-shore marine habitats, the ability of species to quickly colonise these areas is unknown, although the past morphological development of the area has followed these trends, if at a slower rate.

8.6 Environmental mitigation

The predicted effects of environmental mitigation programmes can be seen in the matrix of Table 8.1 by deducting column six from column eight. Due to the fact that the interventions have been carefully designed there is little need for specific targeted mitigation programmes. These are indicated below.

8.6.1 Ghat relocation

It may be necessary to relocate any ghats presently found adjacent to channel that would become accreted. Relocation could be done with careful negotiation with the affected parties to come to an acceptable equivalent location. It would seem best to select new sites on main channel that will not be subject to accretion. There are not expected to be major costs associated with this relocation. However consideration could be given to establishing a boat centres at new sites based upon the ideas as recommended and costed in the BIWTA study (Ref: BIWTA, 1994).

8.6.2 In-shore marine habitats

It is expected that replacement in-shore marine habitats will be naturally formed, but monitoring of this will be required and in particular the extent to which dolphins, fish and wading birds are able to relocate to these areas. The degree to which this natural habitat replacement mitigates the negative impacts of the intervention will also need to be monitored, along which investigations to identify the locations of fish spawning and breeding sites, specifically to discover if these are on tidal mudflats or in the deeper inter-island channels.

8.6.3 Fisheries

Irrespective of the project there is a need for fisheries management programme aimed at keeping fish catch levels within sustainable limits to prevent serious future decline. A detailed baseline catch assessment is needed plus studies into fish ecology to fully understand the present situation, followed by a monitoring programme to see the effects of sedimentation on fish habitat change and how this effects fisheries production. Once this is done then the need for and nature of a specific mitigation programme for in-shore fisheries can be decided. The proposed fisheries management programme would encompass optimisation of gear use, destructive gear replacement and alternative income generation programmes for fisherfolk, as well as continuous monitoring of fish catch and stocks. The proposed aquaculture intervention may act as partial mitigation for some fish dependant households, however the techniques and experience required are very different from open water fisheries.

8.6.4 Malaria

Mitigation of malaria is possible by the treatment of cases with appropriate drugs and also a health education programme which helps eradicate mosquito habitats and reduces the risk of humans

being bitten. It is assumed that a health centre will be constructed on Char Montaz as part of on-going government programmes. Following monitoring of malaria cases then suitable programmes can be drawn up and implemented to address any increase that may occur.

8.6.5 Direct construction impacts

An environmental management component for construction operations will need to be set in place so that potential problems can be identified in advance and steps taken to avoid or minimise negative impacts. A master checklist for such work has been prepared and is given as an Appendix to the EIA report. With care a well implemented construction management plan can provide additional benefits.

8.7 Residual impacts

The possible residual environmental impacts can be seen in the last column of the matrix given as Table 8.1. It can be seen that the positive residual impacts far outweigh the negative, however there are some negative impacts which are unlikely to be fully mitigated for:

- reduction in in-shore marine habitats, particularly for fish and a lesser extent Gangetic dolphins, with implications for common good fishing and professional fishing household livelihoods.

- the human nutrition implications of the change in fish availability are uncertain at present but the negative impacts on nutrition from changes in fish consumption patterns could outweigh the benefits from greater agricultural production.

8.8 Environmental risk

The following basic assumptions have been made when assessing the proposed intervention:

- the procedures for land allocation will be improved to ensure that they are systematic, fair, equitable and timely. If this is not done then full potential benefits of the intervention are unlikely to be attained. The experience of the CDSP with this problem should be borne in mind.

- the proposed drainage systems will be fully effective in preventing saline intrusion and also disposing of monsoon rainfall flooding.

It should also be remembered that the proposed technology for cross dam construction using geo-textiles has not been tried in Bangladesh. The pilot scheme for the first cross dam aims to test this technology.

It is also assumed that if the project goes ahead then it will be in the fully integrated form as proposed. However if a more limited intervention of just cross dam construction were to be implemented then specific mitigation measures (presently incorporated in the many components of the integrated programme), may need to be implemented.

Evidence from the 1991 cyclone indicates that the overall risk of cyclone damage will be reduced by dissipation of waves due to suitably designed embankments and forestry planting. In addition there would likely to be a reduction in loss of human and livestock lives, although this would be greatly enhanced by construction of suitable cyclone shelters and raised earthworks platforms (killas).

8.9 Environmental monitoring and management

As part of an EIA it is normal to draw up an Environmental Management Plan (EMP) which includes the appropriate mitigation measures and also a suitable monitoring programme which

allows data collection for feedback into decision taking. Assuming that the project goes ahead then the following items will need to be monitored:

- accretion and erosion patterns using time series satellite imagery. Such work will indicate the effectiveness of the intervention and also any induced impacts on in-shore marine habitats and navigation. The outputs will be crucial in assessment of the viability of constructing the Option 4 cross dam.

- water salinity and soil salinity using the same sample sites established during the feasibility study.

- in-shore fish catch assessment, a study of fish ecology (specifically on spawning and breeding grounds) and assessment of stocks, as well as monitoring of the impacts of changed accretion patterns on fish habitats and stocks.

- incidence of malaria

- human nutrition levels in relation to fish consumption

- household socio-economics related to predicted project benefits

- external issues, particularly induced accretion and any proposed upstream developments.

In addition monitoring of construction management should be carried out using the checklist given as Appendix V of the EIA report as a basis for data collection and analysis.

It would be necessary to re-run the feasibility of construction of the Option 4 cross dam after 10 years based upon the observed benefits and also the predicted benefits of construction of the Option 3 interventions. A further review will be required at year 15 - 16 when a decision is required as to the cutting of newly planted forestry.

The main mitigation step would be relocation of any ghats. Other mitigation measures may be necessary depending upon the results of monitoring programmes.

Details of environmental monitoring are given in Figure 10.1. The implementation of the monitoring programmes could be carried out by the proposed locally based project management unit. Alternatively the Environmental Cell that is presently being established at WARPO, as part of the National Water Management Plan, could take responsibility for the work within the framework of the proposed coastal area management unit at WARPO. The Department of Fisheries already have plans to carry out a major fish resource assessment for the area which with appropriate institutional liaison could carry out the required fisheries monitoring for the proposed intervention.

8.10 Conclusions of the environmental assessment

The EIA has been carried out for Option 3, assessing the likely impacts over a 30 year period. The philosophy is to construct the pilot scheme and then closely monitor the impacts for a three year period, before taking a decision about construction Option 2 quickly followed by Option 3. Option 4 would not be considered until Year 10 and be dependant upon the performance of Option 3.

Under the Department of the Environment environmental classification the proposed intervention would appear to be in the highest Class D (Red) under Section 66 (flood control embankment, polder, dike etc). Before the project can go ahead the DoE will need to review and approve the EIA before they can grant a Site Clearance Certificate. Before a full Environmental Clearance Certificate can be granted a No Objection Certificate will be required from the Local Authority. However there is little experience in the implementation of these procedures so far in Bangladesh and it is therefore considered unwise to embark upon this process until agreed arrangements are in place for the funding of the project.

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Under World Bank Operational Directive 4:01 the proposed intervention would probably be classified as Class A (the highest), although it could possibly be down graded to Class B, as the extent of the effected area is relatively small by international standards.

The fundamental problem with the proposed intervention is that whilst the cross dams significantly speed up land accretion, the predicted positive economic impacts of utilising such land are long term (between 15 and 30 years) and the construction costs are relatively high at Tk 94,000 per beneficiary household. A case could be made on social benefit grounds for going ahead with the project, but this would need to be considered against other development priorities in the country. There are likely to be some residual negative impacts, but for the pilot scheme these are not considered to be serious enough to prevent such a trial type of intervention to be tested. However monitoring of these negative impacts and also any from Nijhum Dwip, would be allow quantification and valuation to be refined and feed this information into the planning of Option 2 and 3 interventions.

8.11 Future environmental work programme

It is considered ill-advised to continue with any further field studies for the project until a firm undertaking has been given, including commitment of the necessary funds, for implementation. In addition a suitable, locally based inter-disciplinary and decentralised institutional structure will need to be established for detailed project planning and implementation. The procedures for allocation of new land through the Ministry of Land will also need to be streamlined to be operational in a transparent, fair, equitable and timely manner at local level.

Following such undertakings, then a programme of detailed public consultation will be required to obtain local people's views on the proposed intervention, the outcome of which should be a public response document and the granting of a No Objection Certificate by the Local Authority. This could then be followed by a formal application to the Department of Environment for an Environmental Clearance Certificate.

The monitoring programmes established under the project need to be continued:

- monitoring of erosion and accretion from satellite imagery, including the effects of the pilot scheme.

- water and soil salinity monitoring at least two times a year and preferably increased to four times.

In addition the following new monitoring will need to be established:

- studies of in-shore marine habitats, fish ecology (particularly the fish spawning and breeding grounds), along with a baseline survey of fisheries catch and a stock assessment.

Assuming that the project goes ahead then the following programmes would need to be implemented:

- construction management assessment, including drawing up environmental criteria for detailed engineering design and environmental management clauses for construction contracts and a monitoring programme also to be implemented during the construction period based upon the prepared check list given in Appendix V of the EIA report

- a baseline human nutrition survey should be instigated prior to construction and should be repeated five years after construction of the first cross dam.

- negotiated arrangements for the relocation of any ghats

- an evaluation of the impacts of the project on household livelihoods five years after the construction of the cross dams, using the existing baseline study as a comparison

- monitoring of the incidence of malaria in the area.

9. ECONOMIC ASSESSMENT

9.1 Project costs

9.1.1 Cross dams

The cost estimate for construction of the cross dams for the Char Montaz - Kukri Mukri Integrated Development Project has been made in accordance with the relevant FAP Guidelines for Project Assessment. The base costs are divided into:

- materials
- labour
- equipment
- other costs.

Costs of materials and local labour is based on the BWDB Standard Schedules of rates for the Feni and Bhola W.D. Circles (1998). These rates include site overheads, profit and risk of the contractor and taxes.

As some labour will have to be hired from outside of the project area, costs for transport and accommodation of labour have been included in the cost item for mobilisation/demobilisation.

The costs for transport of materials to the project location, if materials have to be acquired from outside of the area, are not included in the rates.

The rates for hiring equipment are based on experience gained during the Haimchar and Khorki Bank Protection Pilot Schemes.

The main construction materials are:

- geotextile for screens, bed protection and ballast bags
- PVC pipes for screen floats
- local sand and sylhet sand
- concrete blocks and slabs
- concrete for beams and anchors
- G.I pipes for A-frames
- earth filled gunny bags
- bamboo
- hardware materials

Three types of person power can be distinguished:

- management and supervision
- skilled labour
- unskilled labour.

The main equipment to be used will be

- an installation pontoon
- auxiliary pontoons
- tugboats

- engine boats
- a mobile crane.

The costs for the cross dams are summarised in Table 9.1. In year 1 cross dams will be constructed to connect the chars between Char Montaz and Bhola and between Kukri Mukri and Char Aicha. In y ear 2 cross dams will be constructed between Char Montaz and Char Taposhi and Char Montaz and Andar Char (see Figure). Details of the costs for the cross dams are given in Appendix V.

Table 9.1: Cost estimate for cross dams (base costs)

Unit: Tk '000 (current prices)

	Year 1 Cross Dams (Tk '000)	Year 2 Cross Dams (Tk '000)	
Materials	58,079	56,494	
Labour	2,805	2,739	
Equipment	3,450	3,300	
Other	2,500	2,000	
Subtotal	66,834	64,533	
Contingencies (10%)	6,683	6,453	
Total	73,517	70,986	

9.1.2 Embankments and drainage infrastructure

Details for the costs of embankments and drainage infrastructure are given in Chapter 5 and Appendix III. These costs are summarise in Table 9.2.

Table 9.2: Base costs for embankments, sluices and drainage

Unit: Tk '000 (current prices)

	Char Montaz	Kukri Mukri	Montaz-Bhola
Embankments	18,510	57,430	50,625
Sluices	21,664	32,492	29,404
Drainage	3,013	3,924	3,579
Subtotal	43,187	93,846	83,608
Contingencies (10%)	4,319	9,385	8,361
Total	47,506	103,231	91,969

9.1.3 Settlements

Cluster settlements will be required for an estimated 860 households (see Chapter 6.6). A cost estimate for these settlements has been made based on an estimate of the CDSP made in 1997. There will be 28 villages each of 30 households. This estimate, adapted for the Char Montaz Project, is given in Table 9.3.

Table 9.3: Base cost for 28 cluster settlements

unit: Tk '000

Item	Cost per Village	Total Cost
Cluster villages (ponds, raised homesteads)	560	15,680
Deep Tubewells (2 per village)	100	2,800
Latrines	30	840
Access road	15	420
Land Surveying	5	140
Design and Supervision	70	1,960
Dwelling materials	720	20,160
Administration, Staff Costs, etc.	85	2,380
TOTAL	1,585	44,380

Source: Communication from CDSP, September 1997

The CDSP model has been followed in order to obtain a cost estimate for the project analysis for this particular project component. It may well be that when the requirements for and design of these settlements is finalised several years into the project, some other settlement model may be found to be more appropriate to local circumstances. This should not present a problem provide it is not more expensive than the present estimate.

9.1.4 Fisheries

The proposed fisheries development programme is described in Chapters 6.6 and 7.7. The programme provides extension and training for pond operators. The cost of this five year programme, estimated at Tk 6.7 million, comprises staff and training costs, administrative support and the cost of essential equipment. The costs are summarised in Table 9.4 (see also Appendix IV.3, Table IV.3.9).

Table 9.4: Costs of the fisheries development programme

Item	Annual Cost	Programme Total
Extension and Support Staff	516,000	2,580,000
Training	70,000	350,000
Office/Logistics Costs	354,100	1,770,500
Miscellaneous Expenses(10%)	94,000	470,000
Equipment & Materials	-	968,000
Contingencies (10%)	-	613,850
TOTAL		6,752,350

9.1.5 Livestock

The proposed development programme is described in Chapters 6.6 and 7.5. The cost of this five year programme, estimated at Tk 8 million, comprising Tk 4.8 million for staff, training and support and Tk 3.2 million for a line of credit for livestock improvement activities.

The costs are summarised in Table 9.5

Table 9.5: Base costs of the livestock development programme

Tk '000

Item	Annual Cost	Programme Total
Extension and Support Staff	384	1,920
Training / Demonstrations	114	572
Office/Logistics Costs	279	1,397
Miscellaneous Expenses(10%)	78	390
Equipment & Materials		538
Total Programme Cost		4,817
Line of Credit		3,152
TOTAL		7,969

9.1.6 Analysis of project costs

Project costs have been analysed using COSTAB.[9] The analysis has used the following parameters:

- the project is implemented over a period of 7 years and the phasing of project costs follows the implementation schedules in Chapter 10.1;
- projections for domestic and international inflation are from World Bank estimates of selected macroeconomic indicators made in July 1997 (see Table 9.6);

[9] Costs analysis programme of the World Bank.

- the exchange rate used at report preparation is US$ 1 = Tk 47 while constant purchasing parity exchange rates are used for subsequent years;

- physical contingencies are included at 10 per cent for all items, except that no contingencies are included for BWDB project overhead and administration costs;

- the foreign exchange component of costs has generally been assumed at 5 per cent for all items where a specific estimate is not made (see Table 9.6);

- cost estimates include taxes, which are estimated based on currently applicable rates for equipment, materials and contractual services (see Table 9.7);

- project financing is calculated on the basis of a Foreign Donor financing 100 per cent of foreign exchange costs and not more than 85 per cent of local costs (excluding taxes), except that the GOB is assumed to finance 100 per cent of land acquisition and project overhead and administration costs.

In addition, the cost of detailed engineering and design has been included at 10 per cent of civil works base costs. BWDB administration and project management cost have been included at 7.5 per cent and 2.5 per cent of base costs, respectively.

Table 9.6: Inflation and exchange rates

	to start	01/02	02/03	03/04	04/05	05/06	06/07	07/08
Annual rates:								
Domestic Inflation (%)	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
International Inflation (%)	5.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Compounded rates:								
Domestic Inflation (%)	10.0	12.8	18.4	24.3	30.5	37.0	43.9	51.1
International Inflation (%)	5.4	6.7	9.2	11.8	14.5	17.2	20.0	22.9
CPP Exchange Rates	48.1	50.8	52.1	53.4	54.8	56.2	57.6	59.1

Notes: 1/ CPP = constant purchasing parity

Table 9.7: Taxes, foreign exchange and contingencies

unit: per cent

Item	Foreign Exchange	Taxes & Duties	Contingencies
Cross dams:			
- geotextiles	58	42	10
- other inputs	5	4.5	10
- labour	0	4.5	10
Embankment - materials	5	4.5	10
Land acquisition	0	4.5	10
BWDB overheads	0	0	0

Total project baseline costs are estimated at Tk 502.9 million (US$ 10.4 million). With physical and price contingencies, the total comes to Tk 730.1 million (US$ 13.2 million). Of this amount, foreign exchange costs are estimated at 7 per cent of the total.

A summary of project costs for each option is given in Tables 9.8. Further cost analysis is found in the tables in Appendix V.

Under the financing assumptions mentioned above, Government's contribution to the project would be Tk 157.9 million (US$ 2.87 million) or 21.6 per cent of total costs. The Donor contribution would be US$ 10.3 million. The largest expenditures under the project are expected in the first two and final two years of the project, when cross dams would be constructed.

Table 9.8: Summary of project costs

Bangladesh
Char Montaz - Kukri Mukri Integrated Development P

	(Local '000)			(US$ '000)			% Foreign	% Total Base
	Local	Foreign	Total	Local	Foreign	Total	Exchange	Costs
I. Investment Costs								
A. Civil Works								
1. Cross Dams								
Geotextiles	11,320	15,633	26,953	236	325	561	58	5
Geotextile transportation	382	527	909	8	11	19	58	-
Other materials	100,838	5,307	106,145	2,098	110	2,209	5	21
Equipment	6,185	326	6,510	129	7	135	5	1
Labour	5,531	291	5,822	115	6	121	5	1
Mobilisation	3,990	210	4,200	83	4	87	5	1
Subtotal Cross Dams	128,245	22,294	150,539	2,668	464	3,132	15	30
2. Embankments								
Materials & Equipment	227,898	11,995	239,893	4,742	250	4,991	5	48
Subtotal Civil Works	356,143	34,288	390,432	7,410	713	8,124	9	78
B. Development of Settlements								
Settlements & Dwellings	40,638	2,139	42,777	846	45	890	5	9
Water Supply & Sanitation	3,631	191	3,822	76	4	80	5	1
Subtotal Development of Settlements	44,269	2,330	46,599	921	48	970	5	9
C. Income Generation								
2. Livestock								
Livestock	4,587	56	4,644	95	1	97	1	1
Livestock LIne of Credit	3,309	-	3,309	69	-	69	-	1
Subtotal Livestock	7,897	56	7,953	164	1	165	1	2
3. Aquaculture	4,462	102	4,563	93	2	95	2	1
Subtotal Income Generation	12,358	158	12,516	257	3	260	1	2
D. Project Management								
BWDB Administration /a	29,282	-	29,282	609	-	609	-	6
Project Management /b	9,761	-	9,761	203	-	203	-	2
Subtotal Project Management	39,043	-	39,043	812	-	812	-	8
Total Investment Costs	451,814	36,777	488,591	9,401	765	10,166	8	97
II. Recurrent Costs								
A. Protection Works O&M								
Civil Works O&M	14,313	-	14,313	298	-	298	-	3
Total Recurrent Costs	14,313	-	14,313	298	-	298	-	3
Total BASELINE COSTS	466,127	36,777	502,903	9,698	765	10,464	7	100
Physical Contingencies	42,708	3,678	46,386	889	77	965	8	9
Price Contingencies	170,295	10,511	180,806	1,644	104	1,748	6	17
Total PROJECT COSTS	679,129	50,966	730,095	12,231	946	13,177	7	126

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

9.2 Project benefits

9.2.1 Project beneficiaries

The project beneficiaries are all the present inhabitants of the project area. An estimate of the population has been made based on the 1981 and 1991 mauza level census data pro-rated by area. The 1996 population of the project area is estimated at 18,500 comprising an estimated 3,150 households (see Chapter 3.2).

9.2.2 Quantified benefits

The benefits of the Char Montaz - Kukri Mukri Integrated Development Project accrue from the expansion of production in agriculture, livestock, fisheries and forestry that will arise from the project interventions. The benefits quantified for the analysis are:

- agricultural production on existing and new land
- fish pond production
- livestock production
- forest products from the harvesting of mature mangrove forests.

An important feature of any project involving the accretion of new land in the Meghna Estuary is that there is a relatively long time interval between the investment in infrastructure and the commencement of the flow of benefits arising from those investments. In the present case, this problem is partly overcome by adopting an integrated approach to the whole area and through the opportunity to expand production in the area in the short to medium term by clearing mature forest which will be inside future polders. This may be done without impinging on the coastal mangrove margin which is so essential as part of the security system for the population.

Agriculture: Agricultural benefits arise from the increases in crop yields and cropping intensity discussed in Chapter 7.5 together with the increase in total area under cultivation. Total benefits from agriculture (in economic prices) are given in Appendix VI, Table VI.24.

Fisheries: Fisheries benefits included in the analysis are only those from the expansion and improvement of aquaculture in the project area (see Chapter 7.6). Table VI.25 in Appendix VI gives the total benefits from aquaculture.

Livestock: Total livestock benefits are estimated in Appendix VI, Table VI.14.

Forestry: Forestry activities proposed under the project are self-financing - i.e. planting and maintenance activities can be financed from the revenues from the clearing of forest in the proposed new polders. Only net benefits are taken into the analysis. These are in Appendix VI, Table VI.27.

9.2.3 Non-quantified benefits

A number of potential benefits, both quantifiable and non-quantifiable, have not been quantified because data is not available for making the necessary estimates. Several of these may have an impact on overall benefits if quantification were possible. Benefits that are in principle quantifiable but which have not been quantified include:

- potential benefits from improved transportation within the project area and between the area, the nearby mainland and the wider region have not been specifically quantified;

- the effect of the improved safety for the people that embankments will provide;
- chicken production has not been included in the livestock benefits because of the difficulties of estimation;
- the impact of the construction of cross dams on marine fisheries which may be at least mildly negative, although data is not at present available to estimate the extent of this impact;
- the pressure of the increasing population in the area, which is heavily dependent on marine fisheries for its livelihood, on marine fisheries resources and may also have a negative impact.

9.3 Economic analysis

The project life for the economic analysis is 30 years. All prices in the analysis are expressed in constant 1998 US dollars or Taka and an exchange rate of US$ 1 = Tk 47.00 has been used throughout the analysis. The discount rate is 12 per cent.

A Standard Conversion Factor of 0.902 is used to convert financial to economic prices[10], for both costs and benefits, except for agricultural labour and the other cases noted below. For agricultural labour, a conversion factor of 0.85 has been used in line with other recent studies.[11]

9.3.1 Prices

Financial and economic import parity prices have been estimated for rice, TSP and potash and export parity prices for urea. These prices are based on World Bank price projections for 2010. The prices are adjusted for quality, transport, handling, marketing, processing and distribution costs to derive both financial and economic farm gate prices. For the economic prices transport, handling, marketing, processing and distribution costs are further adjusted by the standard conversion factor. The relationship between the calculated farm gate financial and economic prices gives a conversion factor for the crop. (see Appendix VI, Tables VI.29)

Where data has been available, prices of other outputs are based on national farm gate price data from the Department of Agricultural Marketing. Current prices have been adjusted to 1997 taka using the food, beverage and tobacco component of the consumer price index published by the Bangladesh Bureau of Statistics. Prices for the four most recently available years have been averaged to obtain the prices used in the analysis. For pulses, a composite price for mung and keshari has been used obtained by weighting the prices of the components according to the relative areas of the respective crops in the project district.

Financial and economic prices for agriculture are summarised in Table 9.9.

For fisheries and forestry, market prices (based on data collected in the project area) have been used.

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10 Estimated by the World Bank in July 1997 for 1997/98 fiscal year.

11 e.g. Kalni-Kushiyara River Management Study, May 1997.

Table 9.9: Prices for agricultural inputs and outputs (Tk/mt)

Crop	Conversion Factor	Financial Price	Economic Price
Traded crops:			
Rice	1.027	6,346	6,515
- aus	1.151	5,658	6,515
- aman	0.967	6,741	6,515
- boro	1.120	5,819	6,515
Wheat	1.022	6,237	6,377
Jute 1/	1.075	9,275	9,968
Non-traded crops:			
Oilseeds (mustard)	0.902	16,712	15,074
Ground nut	0.902	16,793	15,147
Pulses (2)	0.902	11,961	10,789
Chillis (dried)	0.902	51,327	46,297
Sweet Potato	0.902	2,458	2,217
Inputs:			
Urea (3)	0.982	5,860	5,755
Muriate of Potash	0.977	9,277	9,060
TSP	0.978	10,013	9,790
By-products:			
Rice straw	0.902	1,200	1,082
Jute Stems	0.902	2,500	2,255

Notes: Traded crops and inputs based n WB price projections. Non-traded crops and inputs (including financial prices for rice) based on four year averages of national farm gate price data.

1) Based on average 1996 world price.
2) Composite of mung and keshari.
3) Existing subsidy on urea assumed eliminated in medium term.

9.4.2 EIRR and NPV

The EIRR is 16.6 per cent and the NPV is Tk 134.7 million. (The calculation is shown in Appendix VI, Table VI.28)

This is therefore a viable project with an acceptable rate of return. The project has a relatively large existing land area on which production improvements can be expected if drainage and water management improves. The total investment per cultivated hectare is about Tk 61,000.

It is noted, however, that cross dam construction can only possibly be viable if it is part of an integrated development package. The estimated benefits of the project depend on the construction of the proposed embankments and the implementation of effective water management to reduce soil salinity, promote improved agricultural production and provide a more secure environment for investment in more productive livestock and fisheries activities. Without these complementary investments, the construction of cross dams alone is unlikely to be an economically viable use of scarce resources.

9.4.3 Sensitivity analysis

The sensitivity analysis is given in Tables 9.10. The EIRR is more sensitive to changes in benefits than to changes in costs; for changes in costs of -10% or +10%, the EIRR sensitivity indicator[12] is +0.96 and -0.78, respectively, while for the same changes in total benefits, the sensitivity indicator is -1.87 and +1.99, respectively. However, the impact of individual benefit components, with the exception of agriculture, is rather small.

The impact of a combined increase in costs by 20 per cent and shortfall in benefits by 20 per cent would make the project non-viable, but this is a relatively unlikely scenario.

From the tables it is noted that the impact of forestry benefits on EIRR appears to be small. This is because forestry activities are self-financing and only the net benefits are brought into the analysis. However, it is important to recognise that not clearing the forests inside the proposed polders implies not constructing the polders themselves and therefore not gaining almost all of the benefits of agriculture, livestock and fisheries.

As mentioned in chapter 10, some foreign technical assistance will most probably be required to assist with the design and installation of the Char Montaz - Kukri Mukri cross dams. The cost of this possible input has not been included in the analysis. However, it is estimated that it would amount to about US$ 100,000. Taking into account contingencies and the conversion factor, this comes to about one per cent of economic costs. This level of additional costs will not have a significant effect on the results of the economic analysis.

12 Sensitivity indicator defined as the percentage change in EIRR divided by the percentage change in the parameter.

Table 9.10: Sensitivity analysis (EIRR)

		Change in Variable			
		- 20%	- 10%	+ 10%	+ 20%
Base case	16.6				
Total Costs		20.0	18.2	15.3	14.2
O&M Costs		16.7	16.7	16.6	16.6
Total Benefits		10.5	13.5	19.9	23.2
Benefits from:					
- agriculture		13.0	14.8	18.5	20.4
- aquaculture		16.3	16.5	16.8	17.0
- livestock		16.6	16.6	16.7	16.7
- forestry		16.0	16.3	17.0	17.3
Lag benefits 1 year	14.7				
	Costs	Benefits	EIRR		
Total Costs & Total Benefit	+ 20%	- 20%	8.7		
	+ 10%	- 10%	12.4		
	- 10%	+10%	21.7		
	-20%	+ 20%	28.0		
Switching Values:	IRR = 12%		Project Life	EIRR	
Total Costs	+42.9		20 years	14.8	
Total Benefits	- 15.0		15 years	10.7	

9.4 Financial analysis

Implementation of the project is expected to lead to rising household incomes for beneficiaries, although the changes will be relatively slow to appear. Table 9.11 gives the expected changes in household income, based on the assumptions used in the project analysis.

Table 9.11: Agricultural net revenues per hectare (financial)

Unit: Tk./year

		Present & Without Project	With Project 1/
Existing Land	Inside Embankment	6,509	13,681
	Outside Embankment	5,209	8,756
New Land	Year 1	606	606
	Year 5	834	834
	Year 16 - outside	5,209	8,756
	Year 16 - inside	-	13,681

Notes: 1/ With project returns for existing land from project year 16.
2/ For new land, years refer to period from start of cultivation.

Thus, while without the project no major change is expected in the returns to agriculture, with the project, for households inside the proposed polders can expect a doubling in income from agriculture over about 15 years and those outside the polders can expect increases of about 60 - 65 per cent, arising from the impact of improved market access and some effect of the improved protection provided by the coastal forest. Despite the increases, per hectare returns to agriculture will remain modest at best: for households allocated 0.8 ha. by the Ministry of Lands, the increase inside the polders is projected at only Tk. 5,700 per year.

Aquaculture will also contribute to rising household incomes. With project implementation, by year 6, the additional area of ponds in the project area is expected to be about 130 ha. Together with the existing 104 ha., this implies a total of 1,150 to 1,200 ponds, or about 1 for every 5 households. Expected per hectare returns for ponds are given in Table 9.12. For those households with ponds, improved aquaculture management and techniques introduced under the project will have a significant impact on incomes.

Table 9 12: Net revenues for aquaculture (financial)

Unit: Tk./year

	Culturable Ponds (carp)	Cultured Ponds (carp)	Shrimp
Per Hectare:			
Present & Without Project	8,500	14,440	8,925
With Project	-	47,630	45,085
Per Pond:			
Present & Without Project	1,700	2,888	1,785
With Project	-	9,526	9,017

Note: Average pond size is 2,000 m^2.

Improved livestock production under the project will also bring significant benefits to households. For those participating in the intensive livestock activities under the credit programme, annual benefits may range from about Tk 2,300 per year for milch cows to almost Tk 13,000 for intensive broiler chicken production (see Appendix VI, Tables VI.15 to VI.17).

The Livestock Improvement Programme and the improved production and safe conditions in the project area with project implementation will benefit livestock production generally, as has already been noted. The expected average per household net benefit of this general improvement with the project amount to only Tk 480 per year in year 5 but rise to Tk 6,700 per year in year 15. (see Appendix VI, Tables VI.13)

9.5 Multi-criteria analysis

Relevant data for the multi-criteria analysis is presented in Table 9.13.

If successfully implemented, the project will lead to increases in the production of principal crops. These increases also represent increases in local per capita availability, given the population growth assumptions used in the analysis (see Appendix VI, Table VI.12). However, the full level of increases will only be achieved if water management and drainage infrastructure are properly operated and maintained. Even then, production increases will accrue only over a long period as conditions inside the polders improve.

In general, if the project is successfully implemented, the qualitative measures will be either positive or neutral, while if the project is not implemented these measures will tend to be neutral or negative. The social impacts in the with project situation will generally be slightly positive.

9.6 Project risks

If the project is only partially funded, there is a risk that the cross dams will be implemented and the associated polders will not be fully upgraded or developed so that sufficient benefits would not be generated to justify the initial investment.

There is also a small risk that the impact of cross dam construction on marine fisheries will be much greater than anticipated, with significant negative consequences. Studies to enhance the knowledge of fisheries in the area have been proposed in volume 6 of the Master Plan report.

There is a risk that the development of agricultural and livestock production will be less than anticipated and that the benefits accruing to the project will be less than estimated. This could occur because salinity does not decline as quickly as expected (perhaps because of poor water management), access to input and output markets for producers is more slow to develop than expected or for other, unforeseen reasons.

There is a risk of failure associated with the proposed cross dams. However, the design and construction methods proposed for the cross dams are the subject of trials during 1998 at Khorki on Bhola and at Mollakandi near Haimchar. As a result of these trials, the design of components has been modified and additional pilot schemes will be implemented at Hanarchar and Char Montaz (Char Montaz - Char Rustom cross dam). If required, the designs for the project will be further modified on the basis of the performance of these pilot schemes. There is, therefore, reasonable confidence that the interventions will prove to be successful.

9.7 Conclusions and recommendations

With the relatively low cost design and construction approach for cross dams proposed by MES, this feasibility study has demonstrated the economic viability of this type of intervention to promote land accretion in the estuary area. The economic viability of this project is also aided by the fact that the embankment on Char Montaz was constructed some years ago and is a sunk cost, although some expenditure on upgrading is required under this project.

In the overall assessment of the project, account must be taken of the long lag between investment and the accrual of benefits as well as the accrual of non-quantified benefits such as improved safety and well-being of this most vulnerable section of the Bangladeshi population living on the chars and islands and the positive impacts of expanded areas of mangroves.

It is recommended that the project be implemented (i.e. Option 3, including the cross dams between Char Montaz and Char Taposhi and Andar Char), including the cross dams, the upgrading of the embankments and water management structures on Char Montaz, the construction of embankments and water management structures on Kukri Mukri and in the area between Char Montaz and Bhola and all the associated development activities which are essential to generate the benefits required to justify the interventions.

Whether or not to construct the cross dam between Bhola and Kukri Mukri must depend on a review of the situation nearer to the proposed time of implementation.

Table 9.13 : Multi-Criteria Analysis

			Project		
			One cross dam		Two cross dams
1	**Economic**	**Measurable Unit**			
	EIRR	Percent (%)	12.2		10.4
	NPV	Million Tk.	6.8		-56.3
2	**Financial**				
a.	Total Investment Cost	Million Tk.	697		892
	Foreign Ex. Component	Million Tk.	38.5		65.5
b.	O&M Cost (annual)	Million Tk.	5.4		5.4
3	**Quantitative**		**Without**	**With**	**Increment**
a.	Production	Metric Ton			
	Rice	"	3700	12750	9050
	Wheat	"	-	-	-
	Pulses	"	196	900	704
	Fish (aquaculture)	"	69	445	376
b.	Employment (Farm)	Man-Month	13450	43250	29800

Note: Quantities refer to one cross dam

4. Qualitative		Project	
		With	**Without**
a.	**Physical Envioronment**		
	Accretion	+2	+1
	Erosion	0	-1
	Surface Water Quality	+1	-1
	Reduction in salinity intrusion	+2	0
	Reduction in Cyclone damage	+1	-1
b.	**Biological/Ecological**		
	Bio-diversity conservation (crop species)	+1	+1
	Bio-diversity (aquatic species)	-1	0
	Fish (Culture)	-2	-1
	Fish (Capture)	-2	-1
c.	**Quality of Life**		
	Income distribution	+/0	0
	Nutrition	+/-	0
	Transport System	+2	0
	Potable Water supply & Sanitation	0	-1
	Housing and settlement	+2	+1
	Health and Disease vectors	+1	-1
d.	**Social Impacts**		
	Displacement of population/settlement	+1	0
	Impact on women	+1	0
	Impact on Fishermen	-1	0
	Social Conflicts	0	0
	Poverty alleviation	+1	0
	Acceptance by population	+1	0

Rating of Impacts

+ Postive Trend - Negative Trend

0 No change from baseline situation

Note: qualitative impacts are similar for both cross dams

10. PROJECT IMPLEMENTATION

10.1 Time schedule for activities

The proposed schedule of activities for the seven year project is given in Figure 10.1.

The major construction activities are foreseen in the first 2 years of the project, these activities will include the construction of the cross dams A1 A-3 A-4, A-5, A-6 in the first year, cross dams A1 A-7 A-8 in the second year and the rehabilitation of the embankments and drainage system on Char Montaz. In years 6 and 7, the empoldering of Kukri Mukri and the new land formed between south Bhola and Char Montaz has been planned. Activities for fisheries and livestock development are scheduled for the first 5 years of the project.

It is noted that for the implementation of cross dams the timely procurement and delivery of geotextile materials will be essential. Therefore a separate supply contract will have to be tendered well ahead of award of the civil works contract.

10.2 Technical assistance

Although in the past several cross dams have been constructed in the estuary, recent experience on the side of BWDB staff appears to be very limited. Moreover, the design and installation technology proposed for the closure of the channels will only have been used for the Char Montaz Cross Dam Pilot Scheme and the Nijhum Dwip cross dams. Furthermore, the workable period is very limited compared to the magnitude of the works; strict adherence to a very tight time schedule will be required to ensure timely completion of the closure works.

Therefore it is recommended to provide for limited involvement of foreign experts in planning and supervision of the implementation of the Char Montaz - Kukri Mukri cross dams.

Foreign consultancy services may also be required for special studies or projects related to environmental impact assessment, char development and settlement programmes and fisheries. In the medium term this expertise should be made available through WARPO (Estuary and Coastal Zone Management Section) and in the long run through the Integrated Coastal Zone Management Programme.

10.3 Engineering considerations

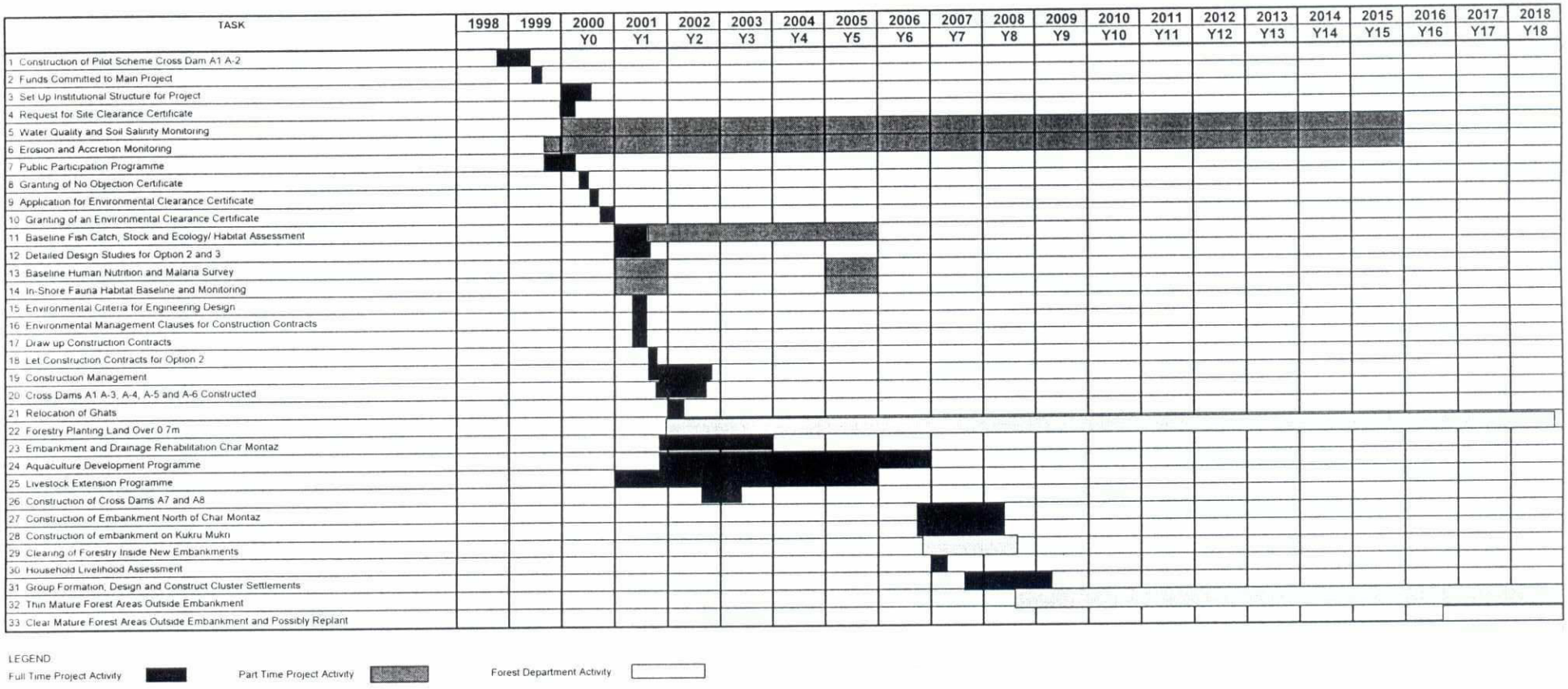
10.3.1 Contractual aspects

Since the cross dams have to be constructed in a mobile channel that is continuously shifting and changing its depth, it is strongly recommended to reimburse the contractor for actual work done and on unit rates as per contract. This implies payment as per progress on the basis of (periodic) re-measurement. Apart from considerations of risk sharing, re-measuring of the works has the advantage that the location of the dam can be shifted without any complication in case morphological changes have occurred.

It is further recommended to pre-qualify only contractors who, besides the required financial strength, have experience in similar works and, even more important, have proven affinity to the type of hydraulic engineering works envisaged.

If, during detailed evaluation of the tenders for the closure works, it appears that the lowest bidder does not have the required capabilities and manpower, the contract should be awarded to a contractor who has the experience and affinity with the works. Albeit the contractual cost of the cross dams may become higher in case the contract is not awarded to the lowest bidder, the final cost may be far less because the contract could be completed in time, before inclement weather progressively hampers execution of the works.

Figure 10.1 : Implementation schedule and environmental management programme for option 3



It is recommended to involve foreign experts, familiar with contracting and execution of engineering works like cross dams, during the process of pre-qualification as well as tender evaluation and award of contract.

10.3.2 Closure operations

The bed levels of the channel vary, in the deepest part of the channel the bed level is about -6.0 m PWD.

It is proposed to close the deeper part of the channels with a permeable dam. The permeable dam will consist of A-frames at c.o.c distance of 2.0 metres, made of 5 or 6 inches diameter G.I steel pipe. The A-frames will be placed on concrete foundation slabs, the slabs will be embedded in a low underwater dam of concrete block. Between the A-frames geotextile screens will be installed to reduce the flow across the dam. The maximum height of the A-frames will be 8 metres, the permeable dam will have a crest level of +2.0 m PWD.

To prevent scouring close to the underwater dam, the bed of the channel will be covered with a geotextile bed protection consisting of a layer of non-woven for preventing wash out of bed material and a woven to provide the necessary tensile strength of the sheets. The bed protection will be ballasted with concrete block and geobags and provided with steel anchors along the edges.

The installation of the bed protection and A-frames will be executed with the help of a special Twin Hull Pontoon that has been designed for placing a section of 12 metres bed protection and A-frames during slack water. It should be possible to install two sections of 12 metres per day, taking into account unavoidable delays the weekly progress should be 150 metres. The deeper part of the channel should be closed first. Since the total length of the dams to be constructed in year 1 is about 750 metres, the time required to install the permeable cross dam with the THP will be about 6 weeks. In year 2 about 600 metres permeable cross dam will have to be constructed, which will take about 5 weeks continuous work.

During installation of the bed protection and A-frames the section of the channel should be reduced as little as possible to avoid scouring of the unprotected bed. Only initial ballasting of the bed protection shall be executed. When the installation by THP has been completed, the under water dam can be completed and finally the geotextile screens will be fixed in between the A-frames.

Besides the THP, auxiliary barges will be required for placing of the under water dam. Two tug boats will be required to handle all waterborne equipment.

Skilled labour (cobblers) will be required for manufacturing of the bed protection and experienced divers have to ensure that all underwater connections are properly and securely made.

10.4 Institutional arrangements

The multi-sector nature of the Char Montaz Kukri Mukri Project, requires it to have an integrated institutional structure for planning and implementation. In the present absence of an authority for carrying out integrated coastal management, it may be necessary to create a special group at project level, rather like that formed for the Jamalpur Refinement Study and implementation of flood proofing.

Whilst such an institution could come under either WARPO or BWDB, there would have to be the active participation of LGED, the Ministry of Land, the Forest Department, Ministry of Agriculture, DPHE and the Department of Fisheries at the minimum. However the difficulties experienced by the CDSP in dealing with a large number of government organisations should be born in mind. In addition such an institution would need to be locally based, probably in Char Montaz, to be effective.

10.5 Agriculture, livestock, fisheries and forestry programmes

The implementation of the components of the Integrated Development Project could be carried out directly by the government departments concerned, under the integrated institutional structure outlined in Section 10.4. However there is a very strong case to be made for using NGOs in this role, due to their experience in operating in such an inter-disciplinary manner and also their experience in the project area.

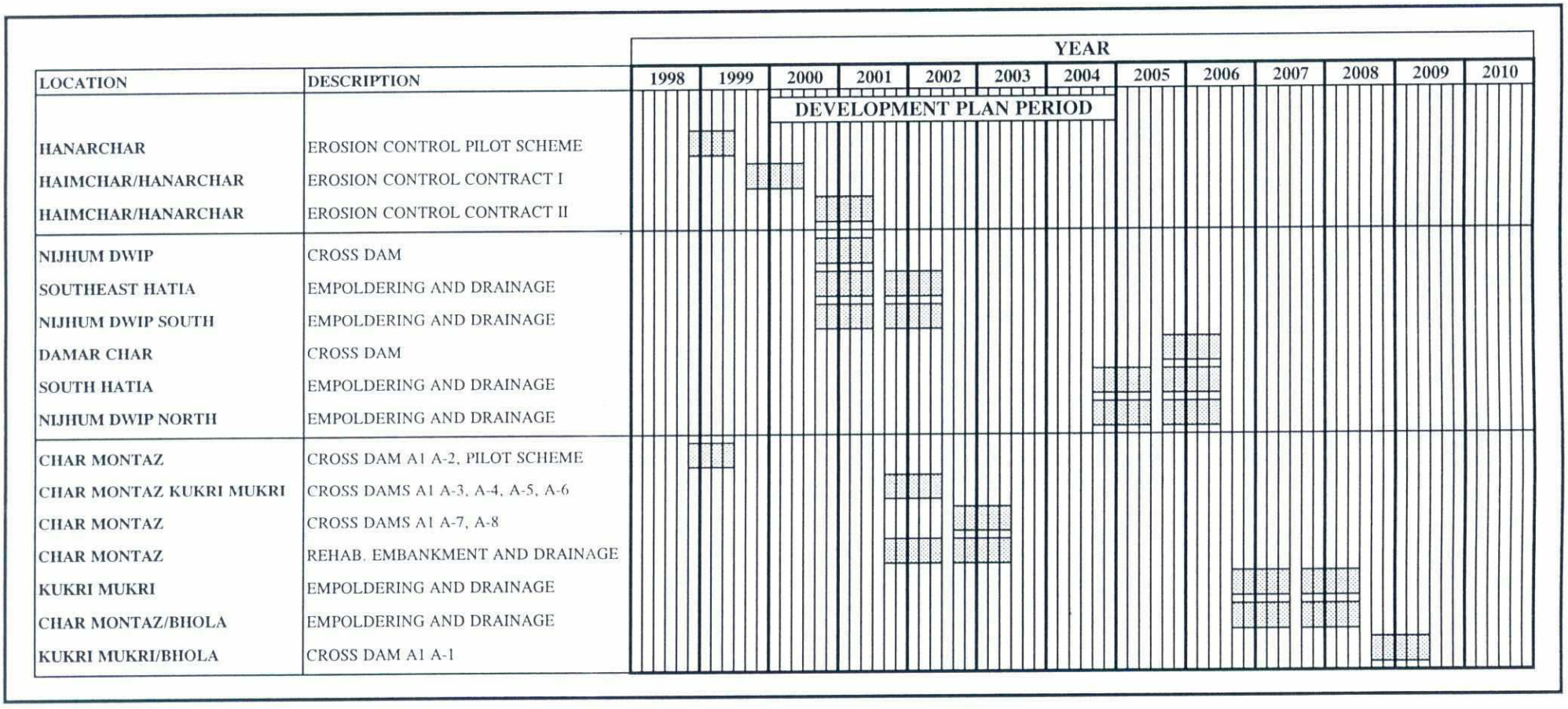
Again the experience of the Jamalpur Refinement Study, where the consultant formed a partnership with local NGOs for some elements of the planning and execution of the works, could be followed. The exception is for forestry, where the Forest Department are very well placed to implement the planting programme as they already have an active presence in the area.

10.6 Beneficiary Participation

As part of the feasibility study a needs assessment was made in the project area, covering both different locations within it and different social groups. The results of the needs assessment indicated that the proposed intervention was in line with the priorities of the majority of local people.

It is not now advisable to carry out any more participation work in the area until a firm commitment is given to go ahead with implementation of the project and adequate resources are made available to do this. Once such a stage is reached then an appropriate programme for beneficiary participation can be designed and mobilised.

Figure 10.2 : Overall planning of priority projects



LOCATION	DESCRIPTION
HANARCHAR	EROSION CONTROL PILOT SCHEME
HAIMCHAR/HANARCHAR	EROSION CONTROL CONTRACT I
HAIMCHAR/HANARCHAR	EROSION CONTROL CONTRACT II
NIJHUM DWIP	CROSS DAM
SOUTHEAST HATIA	EMPOLDERING AND DRAINAGE
NIJHUM DWIP SOUTH	EMPOLDERING AND DRAINAGE
DAMAR CHAR	CROSS DAM
SOUTH HATIA	EMPOLDERING AND DRAINAGE
NIJHUM DWIP NORTH	EMPOLDERING AND DRAINAGE
CHAR MONTAZ	CROSS DAM A1 A-2, PILOT SCHEME
CHAR MONTAZ KUKRI MUKRI	CROSS DAMS A1 A-3, A-4, A-5, A-6
CHAR MONTAZ	CROSS DAMS A1 A-7, A-8
CHAR MONTAZ	REHAB. EMBANKMENT AND DRAINAGE
KUKRI MUKRI	EMPOLDERING AND DRAINAGE
CHAR MONTAZ/BHOLA	EMPOLDERING AND DRAINAGE
KUKRI MUKRI/BHOLA	CROSS DAM A1 A-1

REFERENCES

Abdus Sattar Syed, Introduction to Environmental Laws of Bangladesh, Ace Data Products, Dhaka, Bangladesh, 1998.

Bangladesh Action Plan for Flood Control, Guidelines for Project Assessment, May 1992
Bangladesh Inland Water Transport Authority (BIWTA), Experimental Project for Improving the Efficiency and Profitability of Country Boat Operation, National Oceanographic and Maritime Institute, Dhaka, Bangladesh, 1994.

Bangladesh Tide Tables, 1997

Bird A, Coastal Embankment Rehabilitation Project (CERP), Environmental Considerations for Project Implementation, for BCEOM/Kampsax, Cambridge, England, 1993.

DHV Consultants BV, Interim Development Plan, Meghna Estuary Study, for the Bangladesh Water Development Board, Ministry of Water Resources, Dhaka, Bangladesh, 1997.

FPCO (now WARPO), Guidelines for Environmental Impact Assessment, FPCO, Ministry of Irrigation, Water Development and Flood Control, Dhaka, Bangladesh, October 1992.

Halcrow, River Training Studies on the Brahmaputra River, Environmental Impact Assessment, for the Bangladesh Water Development Board, Dhaka, Bangladesh, 1992.

Land Reclamation Project, Results of Surveys and Hydraulic / Morphologic Studies, 2nd draft, August 1988.

Land Reclamation Project, Feasibility Study on South Hatia Cross-dam, December 1990

Land Reclamation Project, Pre-feasibility Study Report for Nijhum Dwip, April 1988.

Meghna Estuary Study, Nijhum Dwip Cross-dam Pilot Scheme, March 1997

Rhein-Ruhr Ing et al, Bank Protection and River Training (AFPM) Pilot Project FAP 21/22, Final Report Planning Study, Volume IV, Annex 8, Environmental Assessment, for the Flood Plan Co-ordination Organisation, Ministry of Irrigation, Water Development and Flood Control, Dhaka, Bangladesh, 1993.

Sener Ingenieria y Sistemas SA et al., Cyclone Shelter Preparatory Study, Stage I: Feasibiltiy Phase Draft Final Report, for the European Union, June 1996.

SOILTECH International Limited, Report on Sub-soil Investigation for Land Reclamation Division, August 1989

World Bank, 1991, Operational Directive 4:01 Environmental Assessment, The World Bank, Washington, USA, 1991.

APPENDICES

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1. RESEARCH METHODS

1.1 MERIS database and data analysis

For the Char Montaz - Kukri Mukri feasibility study the Meghna Estuary Resource Information System (MERIS) has been used to obtain information about morphological and sedimentological, hydraulic and morphometric, hydro-meteorological data, historical bathymetric and coastline maps and other information regarding the Meghna Estuary system. A substantial portion of the MERIS database is based on data from the field and monitoring surveys, as well as specific project surveys executed by the Survey and Study Division (SSD, a division of LRP) between 1982 and 1994. MERIS also contains data derived from field and monitoring surveys executed by the MES.

The tides have been studied on the basis of water level data at the gauge stations Galachipa, Khepupara and Kochopia. Discharge measurements along the flow transects in the project area have provided data on the spatial distribution of discharges and current velocities.

Sediment concentration samples at different heights in the water column as well as bottom samples, were taken during the flow transect measurements in order to record sediment transport and sediment characteristics.

A time series of satellite images from the period 1973 to 1996 has been used to examine the extent of land and intertidal mudflats area for each date and to assess the changes in the project area.

However, with respect to the project area, it is apparent that the collection of data from 1990 to date is limited and fragmented.

1.2 Estimation of accreted land area

As a consequence of construction of a cross dam, siltation of the channel will occur and accretion of new land will start along the dam and the banks of the closed channels. In such a case, the rate of accretion can be taken as proportional to the instantaneous area which will emerge ultimately:

$$\frac{dA}{dt} = \alpha (A_o - A) \qquad (1)$$

where:

A	=	area of accreted land with a certain level above PWD at time t after closure
A_o	=	total area of ultimate accretion
α	=	empirical coefficient

Integration yields:

$$A = A_o(1 - e^{(-\alpha t)}) \qquad (2)$$

At time $t=0$ $dA/dt = \alpha A_o$ or $\alpha = (dA/dt)/A_o = 1/\tau$ where τ is a characteristic accretion time. Thus Equation 2 becomes:

$$A = A_o(1 - e^{(-\frac{1}{\tau} * t)}) \qquad (3)$$

3.3 Estimation of characteristic shoaling rate

Once τ and A_o are known, the initial accretion rate dA/dt of new land can be calculated using Equation 3. The quantity A_o can be determined from the local situation or from results of 2D-hydraulic models. The characteristic shoaling rate 'n' can be determined using the following relationship, which describes the shoaling rate due to a cross dam:

$$\frac{dh}{dt} = -\beta * c * T * (\frac{(u_o - u)}{u_o})^2 h = -n*T * h \qquad (4)$$

where:

β	=	coefficient dependent: on dry bulk density, fall velocity, representative value of depth averaged sediment concentration, one representative water depth during relative inundation period
n	=	characteristic shoaling rate
c	=	average silt content of water
h	=	water depth below PWD
$(\Delta u/u)^2$	=	relative reduction of the local flow velocity due to closure
T	=	relative inundation time

Equation 4 describes the process of sediment laden water flow in an area with reduced flow. Due to flow reduction, part of the sediment will settle, and will not be eroded again during the next flood or ebb tide. This Equation demonstrates that the highest shoaling rate will occur in the deep channels close to the dam where $T = 1$ and $(\Delta u/u)^2 = 1$ and h is the largest. Equation 4 can be solved analytically for channels which are inundated throughout the year ($T = 1$) and where there are no tidal flats. Integration of Equation 4 yields:

$$h = h_o e^{-n*(t - t_o)} \qquad (5)$$

where:

h	=	reduced water depth below PWD = 0 at time t after closure
h_o	=	initial water depth below PWD = 0 at t_o

Furthermore, Equation 4 indicates that near the dam where the flow reduction is almost 100 per cent the characteristic accretion time 'n' is equal to:

$$n = \beta * c \qquad (6)$$

For intertidal zones where mudflats are present between LLW (extreme Low Water Level) and HHW (extreme High Water Level), Equation 4 must be solved numerically. Above LLW the area is not always inundated which causes a reduction in the relative inundation time per year ($T < 1$). The water depth varies between 0 and HHW, considered bed level (extreme HW). In the case of intertidal areas the relative inundation time T, which can be derived from long term water level measurements, must be taken into account.

Starting at LLW the deposition dh in a certain period can be calculated with Equation 4, taking first estimates of the mean values of T and h in that period. The resulting value should be added to LLW. Starting from the level (LLW + dh) the deposition in the next period can be calculated and so on. In this way the accretion curve or shoaling curve can be constructed which asymptotically will approach to HHW ($h \rightarrow 0$ and $T \rightarrow \infty$).

The period required for silting up from a certain level at time t_0 to another specified level at time t_1 can be derived form the shoaling curve.

2. PHYSICAL FEATURES

The tide in the area of interest is semi-diurnal with the M2-tide and the S2-tide as the major tidal constituents (see Table I.1).

Table I.1: Major tidal constituents at Khepupara

Constituent Name	Amplitude (m)	Phase (degree)	Remarks
Z0	1.56	-	Mean Water Level (CD)
K1	0.14	15.7	Daily components
S2 (Solar)	0.37	4.1	Half daily components
M2 (Lunar)	0.82	318.6	Half daily components
N2	0.17	309.3	Half daily components
M4	0.07	184.4	Shallow Water constituents

Note: Harmonic analysis of observed water level data at Khepupara during January - July 1997

Table I.2 shows the tidal water level characteristics at Galachipa.

Table I.2: Tidal water level characteristics

Water levels m PWD	Galachipa
LAT	-0.9
MLWS	-0.4
MLWN	0.2
ML	1.1
MHWN	1.9
MHWS	2.5
HAT	3.0

Source: Bangladesh Tide Tables, 1996

3. MORPHOLOGICAL DEVELOPMENT

3.1 Land formation and char development

Land formation and char development over the period 1973/74 to1996 has been estimated from satellite imagery. The net rate of accretion of new land is about 361 ha per year (Table I.3). The net average gain of intertidal area is about 149 ha per year. Taking into account the total area of about 60,500 ha, a net accretion factor can be calculated.

Table I.3: Land Formation and Char Development, 1973/74 to 1996

Total area (60,499 ha)	Area (ha)	Rate (ha/year)	Net Average Rate (ha/year)	Net Accretion Factor (ha/year/ha)
Gain of land	9,289	404	361	0.0060
Loss of land	983	43		
Gain of intertidal area	4,040	176	149	0.0025
Loss of intertidal area	620	27		

3.2 Land levels

Table I.4 shows the characteristic land levels for land use in the project area.

Table I.4: Characteristic land levels for land use

Level Rise (metres above PWD)		Potential Land Use		
From	to			
below LLWS	+0.7	A	to	B'
below LLWS	+1.2	A	to	B"
below LLWS	+1.5	A	to	C
+0.7	+1.2	B'	to	B"
+0.7	+1.5	B'	to	C

A = channel area and mud flats (<PWD + 0.7 m)
B' = low lying saline land and mangrove forest (>PWD + 0.7m and <PWD + 1.2 m)
B" = single crop poor agricultural land (>PWD + 1.2 m and <PWD + 1.5m)
C = agricultural land suitable for embanking (>PWD + 1.5 m)

4. MORPHOLOGICAL IMPACT OF CROSS DAMS

4.1 Option 1: Future without intervention

With Option 1, Future without intervention, no cross dams will be constructed and consequently the nature will take its own course. In this case, the rate of natural gain of new land in the project area will be approximately 361 ha per year (for a total project area of about 16,000 ha). According to the natural shift of the coastline in recent decades, formation of newly accreted land (to approximately level +1.4 to +1.6 m PWD) and char development can be expected especially on the southwestern sides of the islands and the islands will extend towards the south. The secondary tidal channels between the islands will silt up during this period and the islands will be connected. The channel between Char Montaz and Kukri Mukri is expected to remain open in the near future without any intervention.

Table I.5 shows the expected morphological development in 2025. The estimate of newly accreted land during this intermediate time period is based upon the longterm rate of natural gain of new land.

Table I.5: Option 1 - expected morphological development, intermediate period

T_0 = 2000 Years	New accreted intertidal area (ha)	New accreted land (ha)
0	0	0
5	196	477
10	393	954
15	589	1431
20	786	1908
25	982	2385
30	1178	2862

* Newly accreted area is estimated by using the net accretion factor 0.006. Total area = 16,000 ha

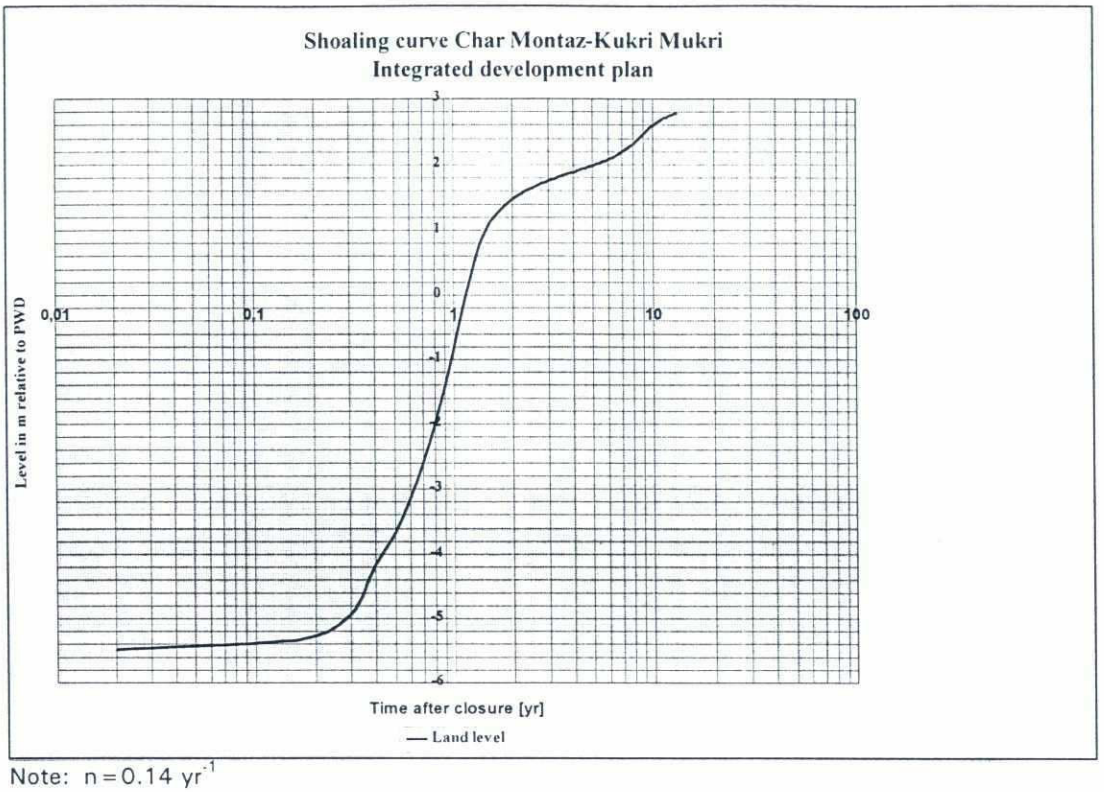
4.2 Estimation of accretion rate and area of accretion due to cross dam

To predict the accretion rate due to the construction of the cross dams, a number of parameters have to be determined, including the ultimate area of accretion A_0, the coefficient 'n' of Equation 4 and 5 and the characteristic accretion time *t* of Equation 3. The impact of the cross dam on the flow velocities is estimated by using bathymetric maps. From the 2D-hydraulic simulations it is known that the cross dams will accelerate accretion because flow velocities in the closed channel section will drastically be reduced. Near the dam the flow reduction is almost 100 per cent. For accretion at dam sites, a mean sediment content of 400 mg/l is taken. It is assumed that in the areas with very low flow velocities about 60-90 percent of the sediment in the water settles out and the dry bulk density of the deposits will amount to about 1,200-1,300 kg/m^3. With 706 tides the shoaling rate parameter 'n' can be estimated according to:

$$n = \frac{0.60 * 0.4 * 706}{1250} = 0.14$$

For the calculation of the characteristic periods for land level rise a characteristic shoaling rate n of about 0.14 yr^{-1} is taken.

Figure I.1: Expected shoaling of channels and tidal flats due to cross dam construction



Note: $n = 0.14\ yr^{-1}$

Figure I.1 shows the time that is required for the bed to rise from a certain level to another higher level in an area with strong flow reduction. Relevant time periods related to characteristic levels for land use are shown in Table I.6.

Table I.6: Characteristic periods for land level rise

Level Rise (m above PWD)		Period $t\text{-}t_0$	Potential Land Use		
From	to	(years)			
below LLWS	+0.7	1.4	A	To	B'
Below LLWS	+1.2	1.7	A	To	B"
Below LLWS	+1.5	2.2	A	To	C
+0.7	+1.2	0.3	B'	To	B"
+0.7	+1.5	0.8	B'	To	C

A = channel area and mud flats (<PWD + 0.7 m)
B' = low lying saline land and mangrove forest (>PWD + 0.7m and <PWD + 1.2m)
B" = single crop poor agricultural land (>PWD + 1.2 m and <PWD + 1.5 m)
C = agricultural land suitable for embanking (>PWD + 1.5 m)

The above estimates are believed to be conservative to realistic. Table I.6 provides the initial accretion rates in different areas after the construction of closure dam(s). Division of the ultimate accretion area A_0 by the initial accretion rates yields the characteristic accretion time τ. Table I.7 shows a number of relevant quantities for the accretion computations applying Equation 3.

Table I.7: Relevant quantities for accretion computation

Area of ultimate accretion A_0 (ha)		Initial accretion area (ha)*	Accretion level (m above PWD)	Characteristic shoaling period in year (n = 0.14)	Average initial accretion rate (ha/year)	Characteristic accretion time τ in years
Unit A1	2,223	1,800	0.7	1.4	1200	1.9
			1.2	1.7	1029	2.2
			1.5	2.2	818	2.7
Unit A2	4,548	1,500	0.7	1.4	1000	4.5
			1.2	1.7	857	5.3
			1.5	2.2	682	6.7
Unit A3	9,211	1,200	0.7	1.4	800	11.5
			1.2	1.7	686	13.4
			1.5	2.2	546	16.9
Total Area	15,982					

* Initial accretion area based upon interpretation of the bathymetric maps

Table I.8 : Land formation at intermediate time-scale due to Option 2

Feasibility Study Char Montaz Kukri Mukri: Option 2 Cross-dam Unit A1							
T0=2000 yr	Cross-dam Unit A1			Natural accretion	Total Option 2		
	Area= 2223 ha			Area=13759 ha	Total Area= 15982 ha		
Years	0.7	1.2	1.5	1,2*	0.7	1,2*	1.5
0	0	0	0	0	0	0	0
5	2073	2003	1870	411	2073	2414	1870
10	2213	2201	2167	821	2213	3023	2167
15	2222	2221	2214	1232	2222	3453	2214
20	2223	2223	2222	1643	2223	3866	2222
25	2223	2223	2223	2053	2223	4276	2223
30	2223	2223	2223	2464	2223	4687	2223

* Natural gain of land is included. Landlevel is assumed to be 1.2 m PWD

Table I.9 : Land formation at intermediate time-scale due to Option 3

Feasibility Study Char Montaz Kukri Mukri: Option 3 Cross-dam Unit A1 and after 5 years Cross-dam Unit A2											
T0=2000 yr	Cross-dam Unit A1			Natural accretion	Cross-dam Unit 2			Natural accretion	Total Option 3		
	Area= 2223 ha			Area=13759 ha	Area= 4548 ha			Area=9211 ha	Total Area 15982 ha		
Years	0.7	1.2	1.5	1.2*	0.7	1.2*	1.5	1.2*	0.7	1.2*	1.5
0	0	0	0	0	0	0	0	0	0	0	0
5	2073	2003	1870	411	0	0	0	0	2073	2414	1870
10	2213	2201	2167	0	3033	3186	2399	275	5246	5662	4566
15	2222	2221	2214	0	4043	4268	3532	550	6266	7039	5746
20	2223	2223	2222	0	4380	4689	4068	825	6603	7737	6290
25	2223	2223	2223	0	4492	4854	4321	1100	6715	8177	6544
30	2223	2223	2223	0	4529	4918	4441	1375	6752	8516	6664

* Natural gain of land is included. Landlevel is assumed to be 1.2 m PWD

Table I.10 : Land formation at intermediate time-scale due to Option 4

Feasibility Study Char Montaz Kukri Mukri: Option 4 Cross-dam Unit A1 and after 5 years cross-dam Unit A2 and after 10 years cross-dam Unit A3														
T0=2000 yr	Cross-dam Unit A1 Area= 2223 ha			Natural accretion Area=13759 ha	Cross-dam Unit A2 Area= 4548 ha			Natural accretion Area=9211 ha	Cross-dam Unit A3 Area = 9211 ha			Total Option 4 Total Area 15982 ha		
Years	0.7	1.2	1.5	1.2*	0.7	1.2	1.5	1.2*	0.7	1.2*	1.5	0.7	1.2*	1.5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2073	2003	1870	411	0	0	0	0	0	0	0	2073	2414	1870
10	2213	2201	2167	0	3033	3186	2399	275	0	0	0	5246	5662	4566
15	2222	2221	2214	0	4043	4268	3532	0	3245	3138	2361	9510	9627	8107
20	2223	2223	2222	0	4380	4689	4068	0	5346	5111	4116	11949	12023	10406
25	2223	2223	2223	0	4492	4854	4321	0	6708	6471	5422	13423	13547	11966
30	2223	2223	2223	0	4529	4918	4441	0	7590	7408	6393	14342	14549	13057

Table I.11 : Summary of results

Summary Results of the Feasibility Study Char Montaz Kukri Mukri Integrated Development Planning Project										
	Option 1 No Intervention Total area= 15982	Option 2 Cross-dam Unit A1			Option 3 Cross-dam Unit A1&A2			Option 4 Cross-dam Unit A1,&A2&A3		
		Total area 15982 ha			Total area 15982 ha			Total area 15982 ha		
Years	1.2*	0.7	1.2*	1.5	0.7	1.2*	1.5	0.7	1.2*	1.5
0	0	0	0	0	0	0	0	0	0	0
5	477	2073	2414	1870	2073	2414	1870	2073	2414	1870
10	954	2213	3023	2167	5246	5662	4566	5246	5662	4566
15	1431	2222	3453	2214	6266	7039	5746	9510	9627	8107
20	1908	2223	3866	2222	6603	7737	6290	11949	12023	10406
25	2385	2223	4276	2223	6715	8177	6544	13423	13547	11966
30	2862	2223	4687	2223	6752	8516	6664	14342	14549	13057

4.3 Option 2: cross dam Unit A1

The implementation of the cross dam Unit A1 will initiate a strong reduction of tidal current velocities in the small tidal channels in the northern part of Char Montaz and a reduction of the sediment transport capacity. Consequently the deeper parts of the tidal channels will be functioning as effective sediment traps. From this it can be assumed that especially the deeper parts of the tidal channels will rapidly decrease in size due to the implementation of the cross dam Unit A1.

Results of the accretion computation showing the areas that will be accreted in different years after the implementation of cross dam Unit A1 (Option 2) are shown in Table I.8.

4.4 Option 3: cross dam Unit A1 and after five years cross dam Unit A2

The implementation of cross dam Unit A2 after 5 years will stimulate accretion of new land in the southern part of Char Montaz by blocking the flood flow entering the area between Char Andar and Char Taposhi completely thus creating a funnel in which sediments will be trapped. It also traps the outgoing ebb water.

Results of the accretion computations for option 3 are shown in Table I.9.

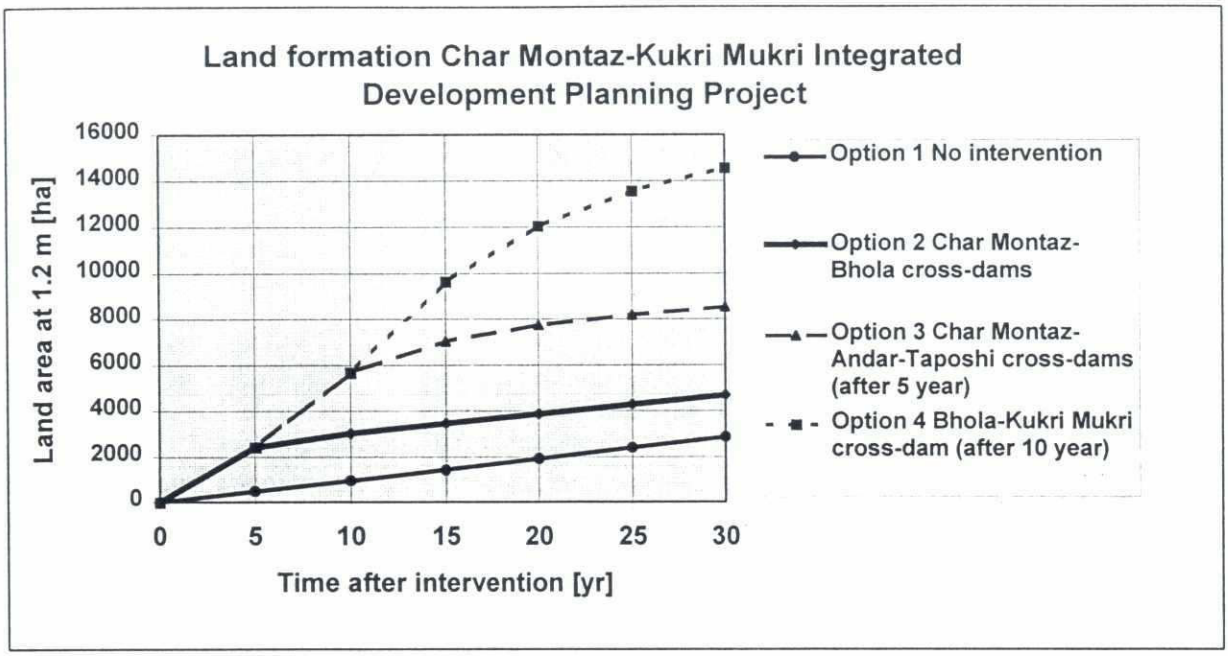
4.5 Option 4: Options 1 and 2 and after 10 years cross dam Unit A3

The implementation of cross dam Unit A3 will stimulate accretion of new land southward of the cross dam between Char Montaz and Kukri Mukri on both sides of the cross dam. Due to the construction of the cross dam Unit A3, the ingoing and outgoing tides in the Char Montaz - Kukri Mukri channel will be blocked. The strong reduction of tidal current velocities in the channel will initiate a reduction of the sediment transport capacity (which is related exponentially to current velocity) in the channel. Consequently the deeper parts of the tidal channels function as effective sediment traps. From this it can be assumed that especially the deeper tidal channel will decrease in size due to the construction of the cross dam.

Results of the accretion computations for option 4 are shown in Table I.10.

A summary of the morphological impact due to construction of the cross dams is given in Table I.11 and Figure I.2.

Figure I.2: Expected accretion of land due to cross dam construction, intermediate time period (2000-2030)



5 IDENTIFICATION OF FURTHER INVESTIGATIONS

5.1 Objectives

Within the framework of the MES, four development options for implementing of cross dams at Char Montaz - Kukri Mukri have been described and for each of these options the expected morphological changes have been delineated. With respect to the implementation of these options the following morphological studies and investigations can be identified:

1. Data collection and field surveys
1A. Topography and bathymetry
1B. Hydraulic and morphological data collection
2. Data processing and data analysis
3. Mathematical model investigations
4. Morphological interpretation.

5.2 Results

The outcome of the hydraulic and morphological study should be:

1. a quantitative assessment of the accretion and erosion rate along the Char Montaz - Rangabali and Char Montaz - Kukri Mukri channels and adjacent islands during and after implementation of the cross dam

2. an assessment of the closing method and procedures during the various construction stages

3. improvements in the knowledge and understanding of land formation and char development due to the implementation of cross dams.

5.3 Task description

1. Data Collection and Field Surveys

The morphological and hydraulic impact due to closure and implementation of the cross dam requires data on:

A. Topography and bathymetry for the whole project area

This gives an indication of the sediment budget. All bathymetric data and levelling data should be defined with reference to PWD. New information (coastline, land use, infrastructure) derived from recent remote sensing imagery should be incorporated.

B. Hydraulic and morphological data

- Land levelling data along the channel and adjacent islands.
- Water levels, flow velocities and discharge measurements along the channels
- Cross-sectional profiles
- Sediment concentrations and grain sizes of suspended sediment, grain sizes of bed sediment.

2. Data Processing and Data Analysis

Data processing and data analysis include:

- laboratory analysis of sediment data
- analysis of current velocities, water levels and bathymetry
- calculation of the discharge and sediment transport
- assessment of the accretion and erosion rate along the channels and adjacent islands during and after implementation of the cross dam
- analysis of the accretion and erosion rates using bathymetric information.

3. Mathematical Model Investigations

A 2D mathematical model investigation programme should be executed for the Char Montaz – Kukri Mukri area to obtain an insight into the hydrodynamic and morphodynamic behaviour of the channels and intertidal area under various hydraulic conditions during and after implementation of the cross dam. The mathematical model investigation should be carried out by the Surface Water Modelling Centre (SWMC).

4. Morphological analysis and interpretation

Based on the data analysis and the results of the mathematical investigations, the future morphodynamic behaviour has to be studied and the predictions for accretion and erosion in the channels and intertidal zones have to be updated and corrected where necessary.

ENGINEERING DESIGNS

1. RESULTS OF COMPUTER SIMULATION WITH MIKE21

The water levels and discharges in the channel between Char Rustom and Char Haldor (cross dam A1 A-3) and the channel between Char Burhan and Bhola (cross dam A1 A-5) have been simulated with the help of the two-dimensional hydrodynamic model MIKE21 by the Surface Water Modelling Centre. The results of the simulations are given in the next pages.

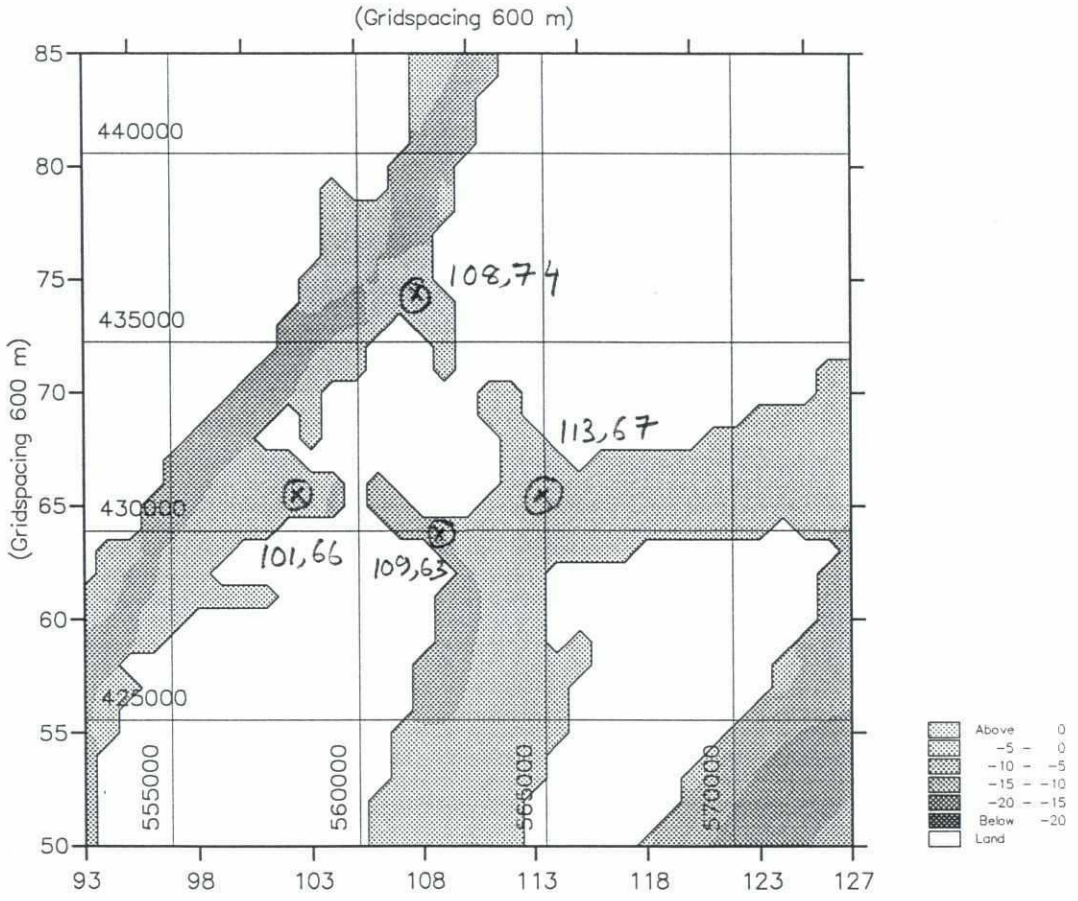
The calculations have been performed on the basis of detailed model that has a grid spacing of 600 metres for the winter season as well as the monsoon season. The location of the points for which water level data have been given is indicated in the figure. Due to the calculated phase differences in the water levels in the main channels east and west of the cross dams, the head differences become unrealistically high. The maximum head differences calculated with the 600 metre grid model are given in the table below

		Without dam		With dam	
		+	-	+	-
Cross dam A1 A-3	Dry season	0.45 (0.05)	0.25 (0.20)	0.60 (0.10)	0.50 (0.40)
Cross dam A1 A-3	Monsoon season	0.30 (0.10)	0.20 (0.15)	0.40 (0.20)	0.50 (0.30)
Cross dam A1 A-5	Dry season	0.50 (0.30)	0.30 (0.20)	1.00 (0.50)	0.60 (0.50)
Cross dam A1 A-5	Monsoon season	0.60 (0.30)	0.45 (0.40)	1.00 (0.40)	1.00 (0.60)

However, based on observations in the field, it appears that the calculated head differences are unrealistically high. Moreover, in recent years rapid siltation has occurred in the channels, which could not have happened if strong tidal currents were still prevailing.

Taking into account phase differences, the figures between brackets indicated more realistic head differences at the cross dams. The detailed model with a 200 metre grid will predict the head differences more accurately, after the model has been updated with the bathymetry of the shallow areas.

bathy bathy13



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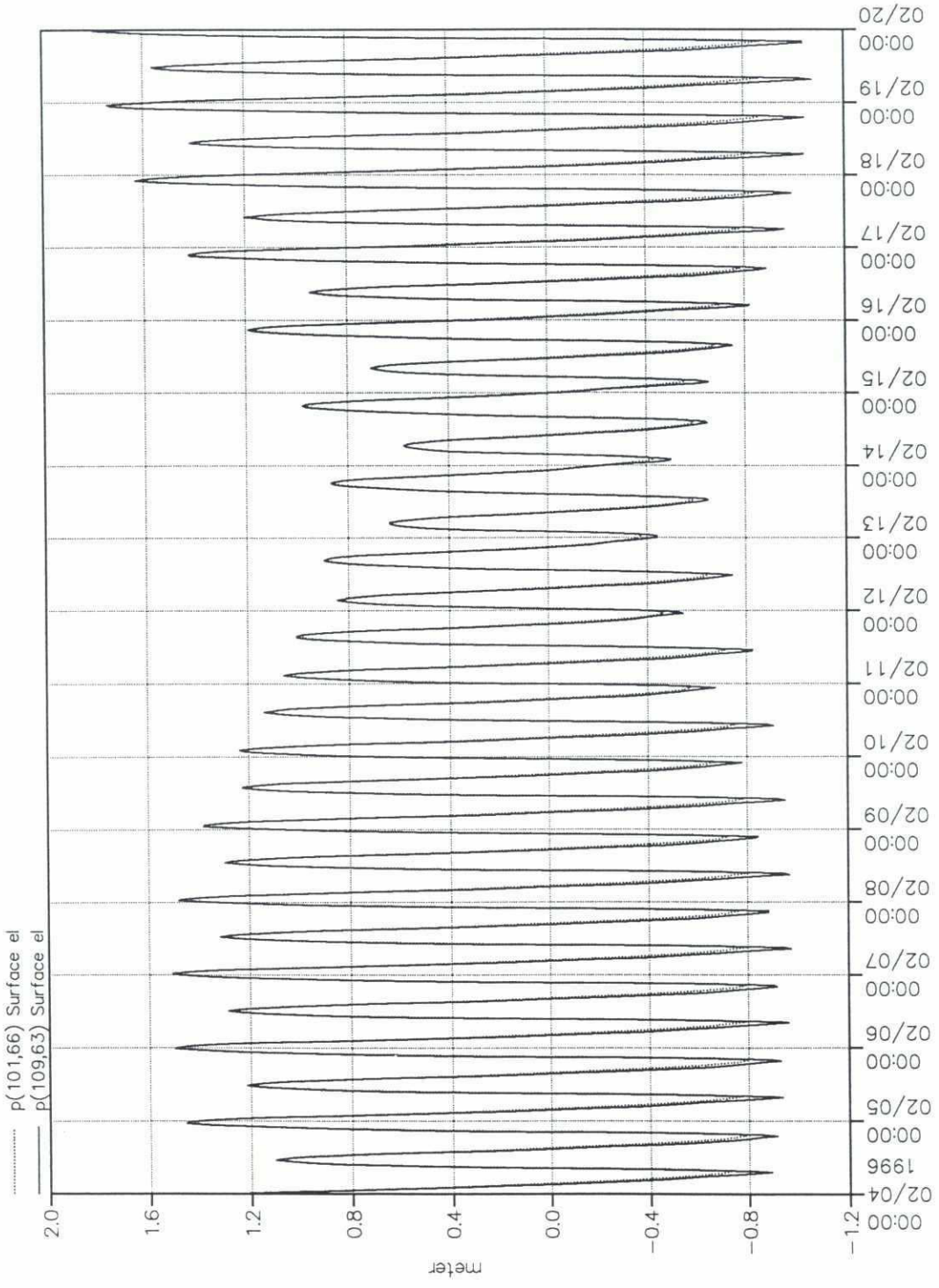

MIKE 21

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Project: Meghna Estuary Study

SWMC

Water level during Dry 1996 without intervention Char Momtaz

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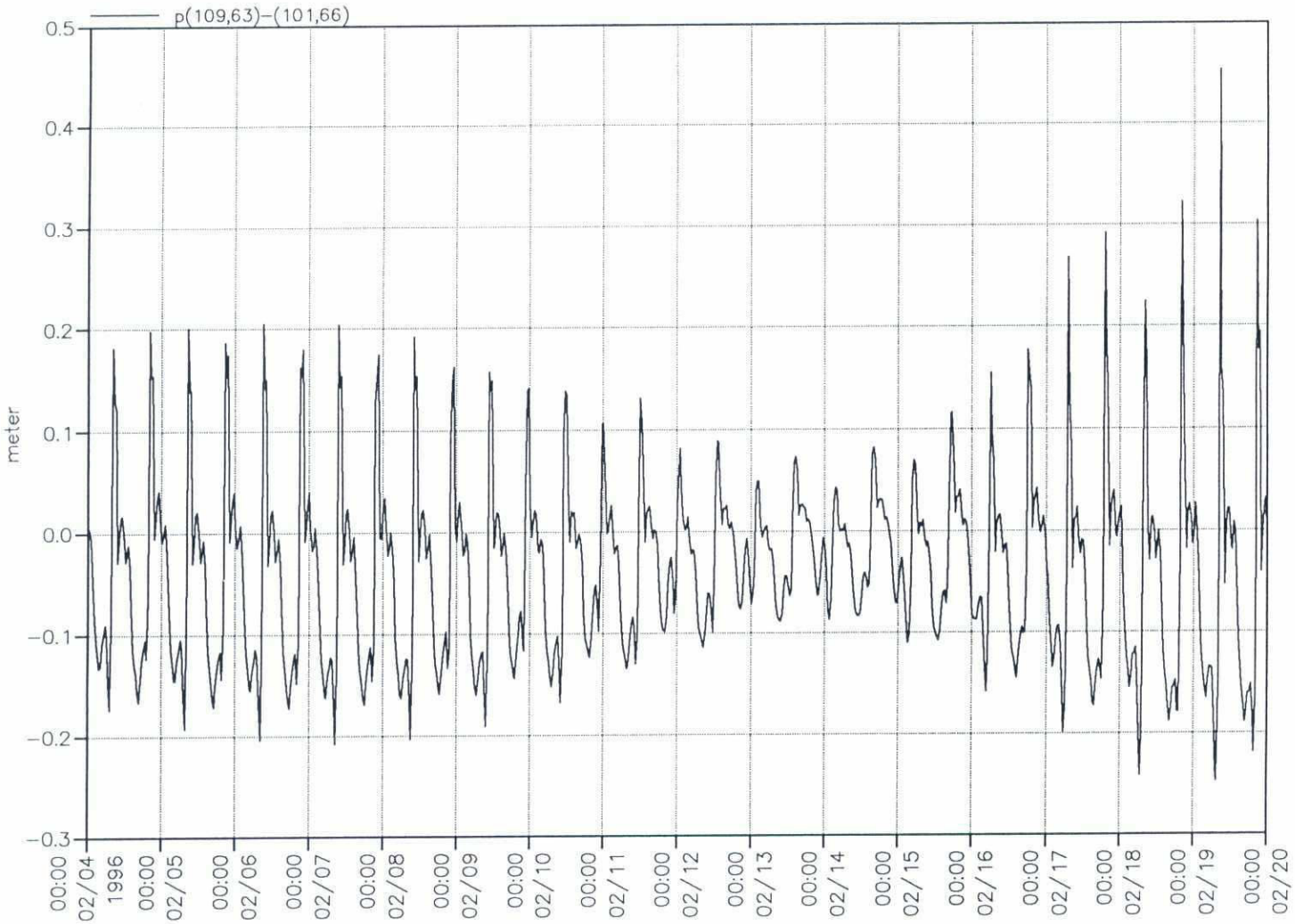

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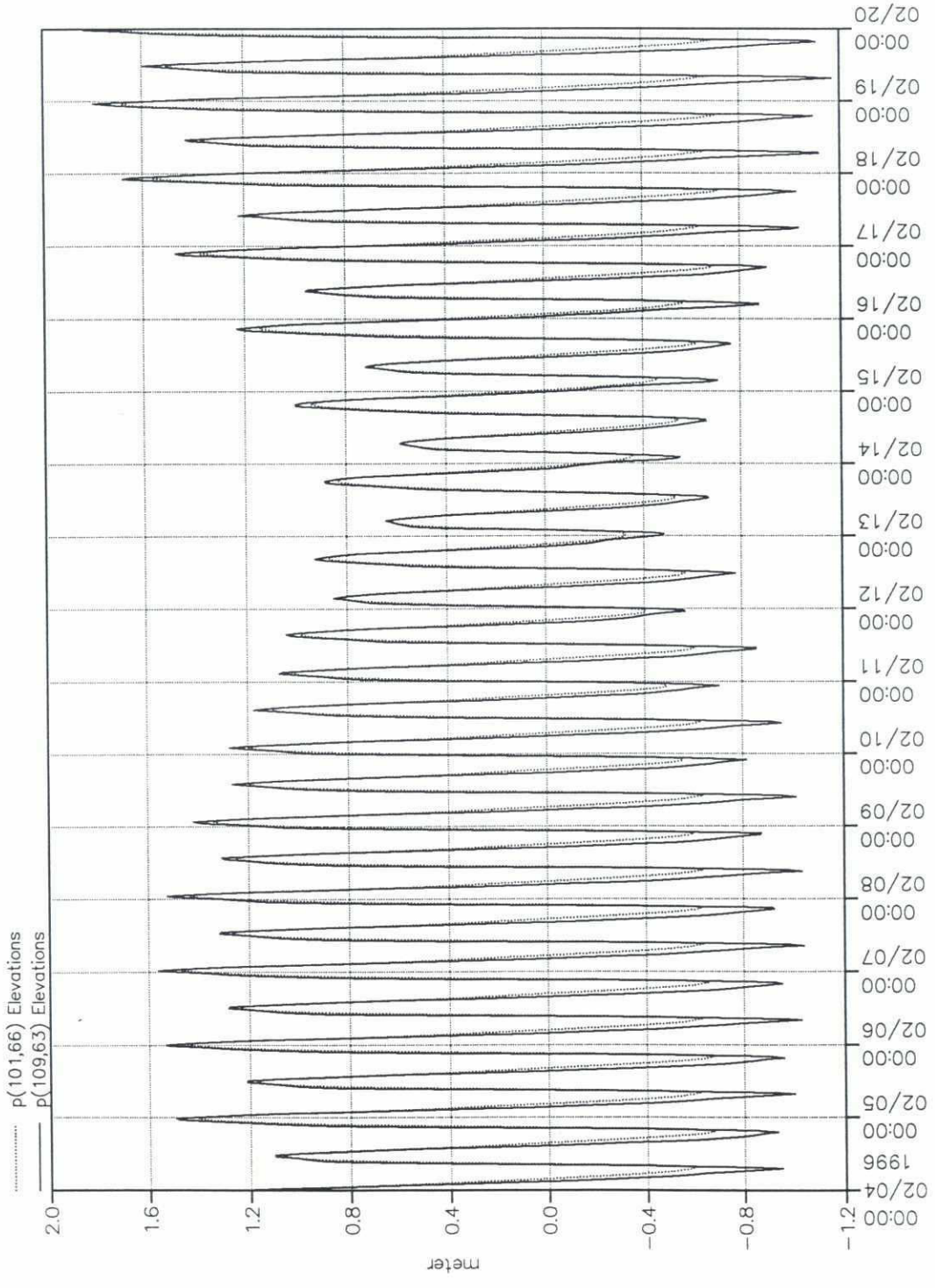

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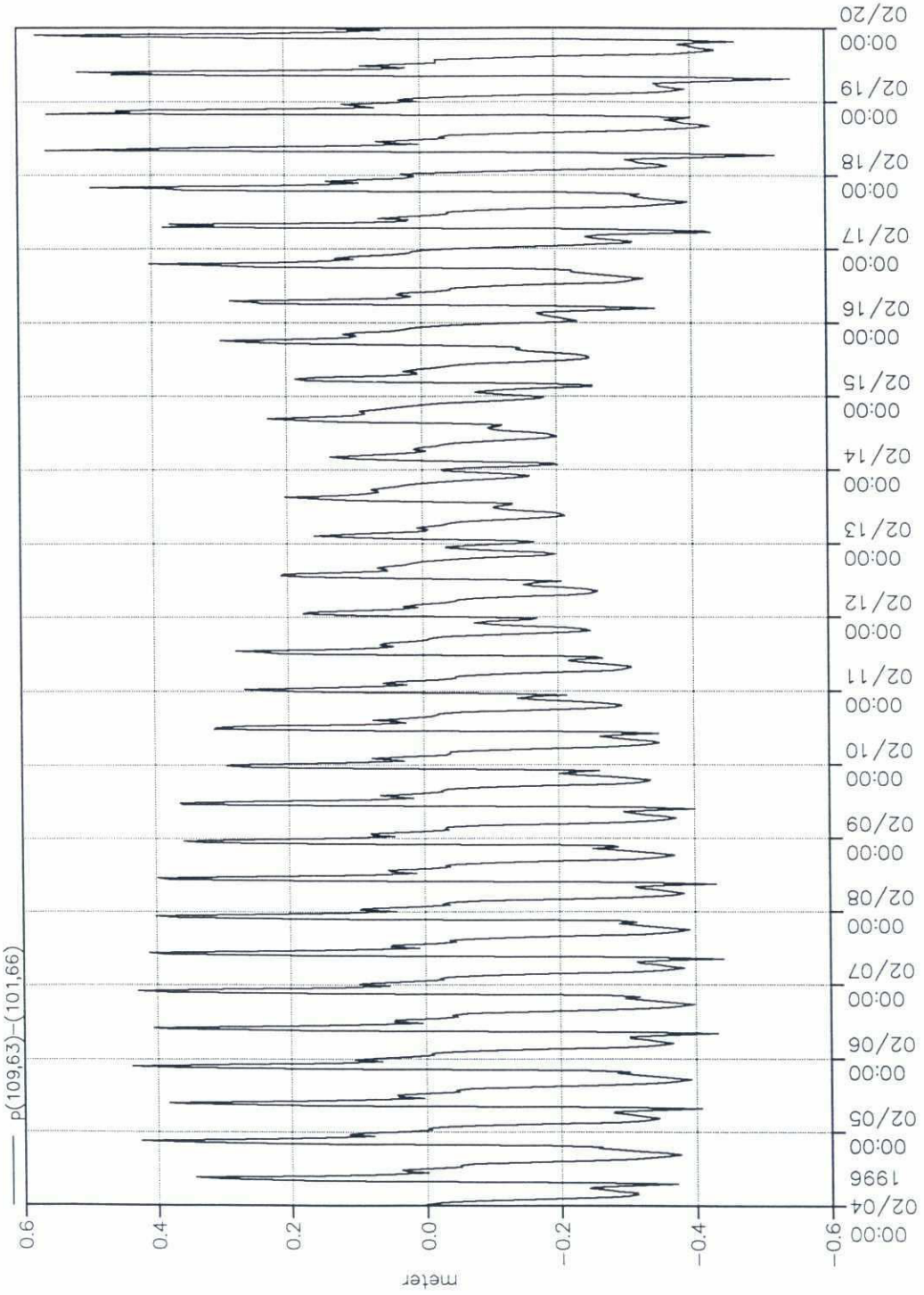

MIKE 21

SWMC

Client: Meghna Estuary Study

Project: Meghna Estuary Study

Water level difference Dry 1996
with intervention 1 ,
Char Momtaz

File:

Date: Tue Oct 13 1998

Scale:

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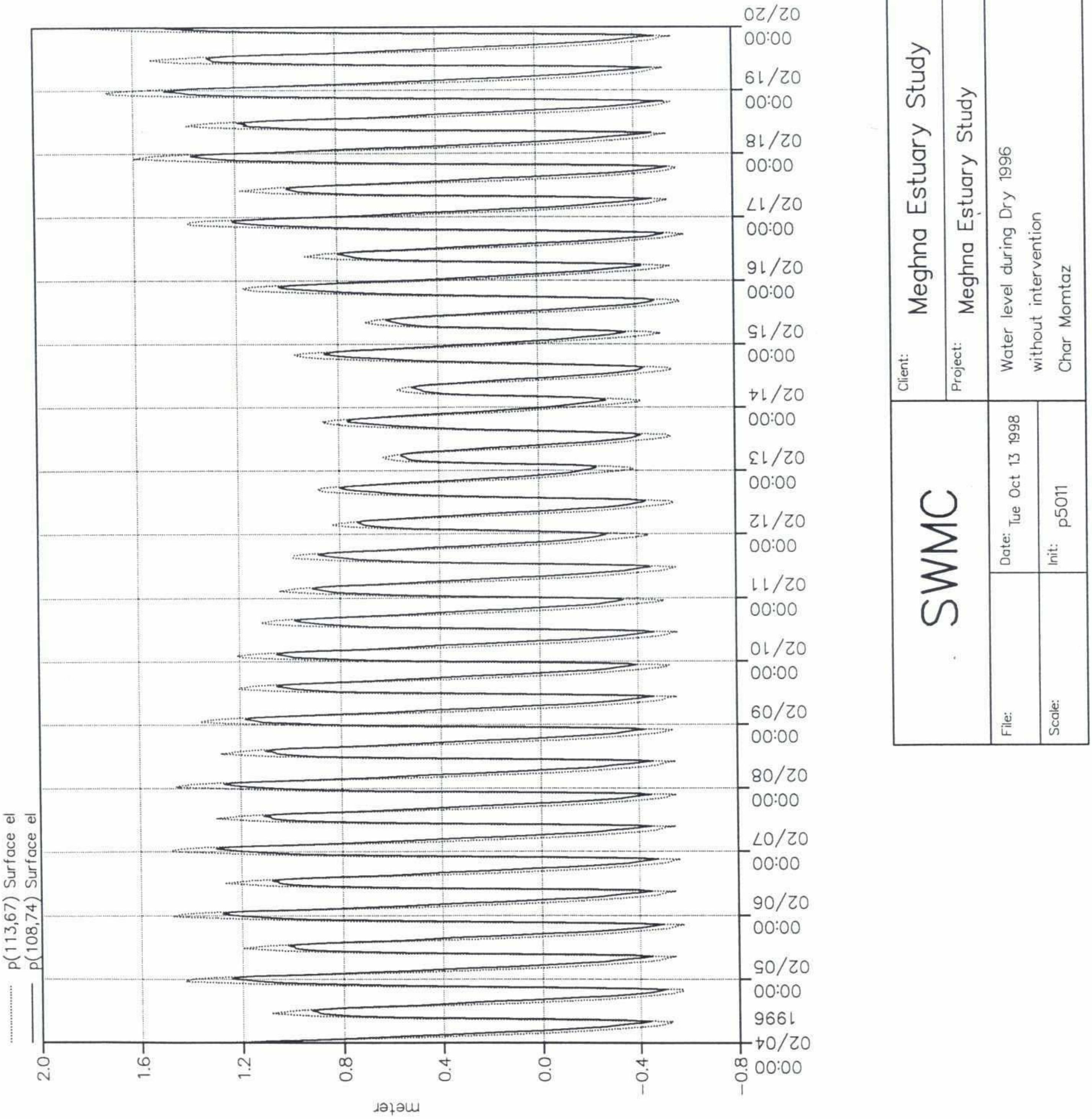

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00:00 02/05
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00:00 02/07
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00:00 02/10
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00:00 02/17
00:00 02/18
00:00 02/19
00:00 02/20
MIKE 21
Drawing no.
Client: Meghna Estuary Study
Project: Meghna Estuary Study
Water level during Dry 1996
without intervention
Char Momtaz
SWMC
Date: Tue Oct 13 1998
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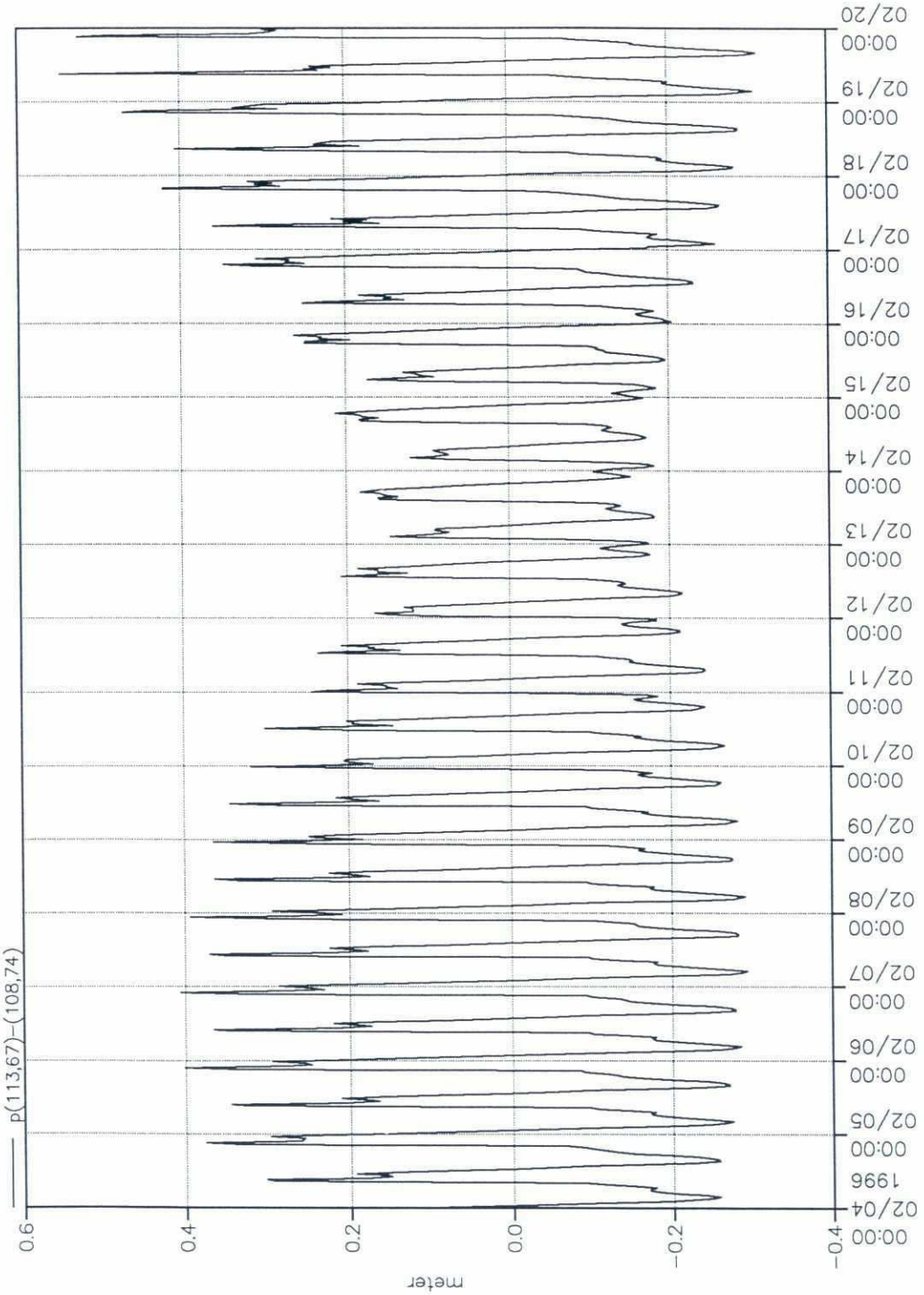


MIKE 21

SWMC

Client: Meghna Estuary Study

Project: Meghna Estuary Study

Water level difference Dry 1996
without intervention
Char Momtaz

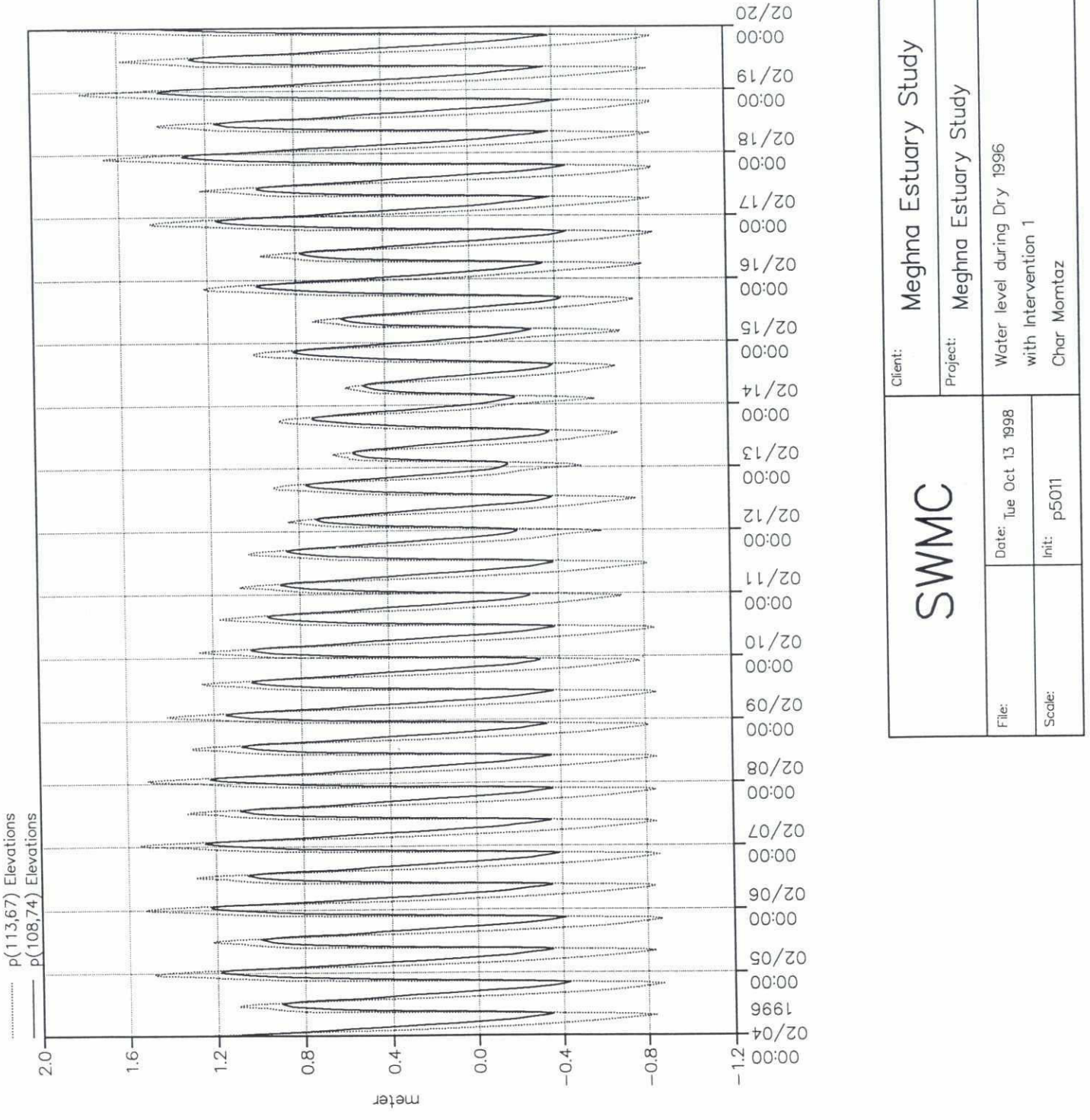
File:

Date: Tue Oct 13 1998

Scale:

Init: p5011

Drawing no.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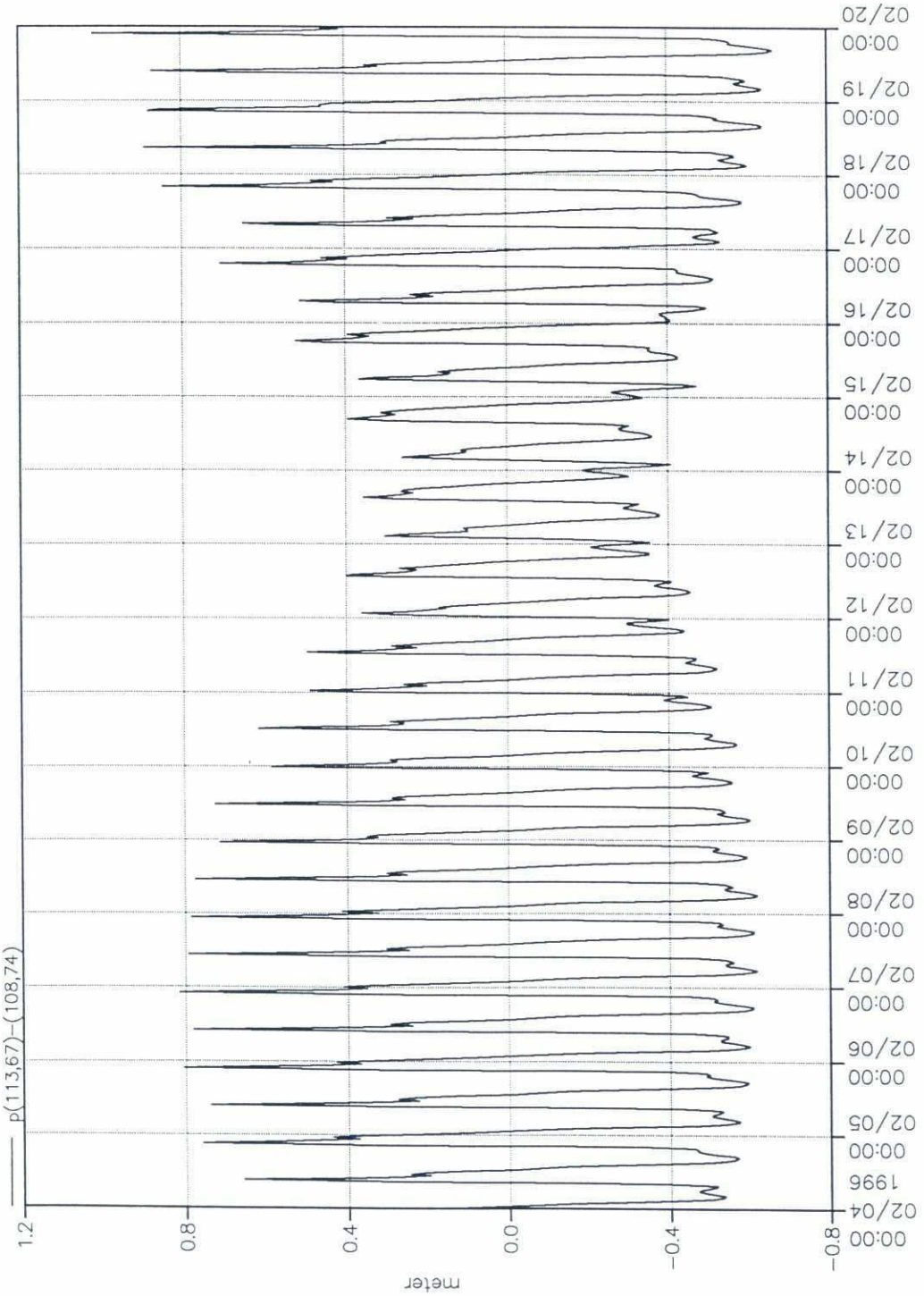
MIKE 21
SWMC
Client: Meghna Estuary Study
Project: Meghna Estuary Study
File:
Date: Tue Oct 13 1998
Scale:
Init: p5011
Water level during Dry 1996
with Intervention 1
Char Momtaz
Drawing no.



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	Project: Meghna Estuary Study		
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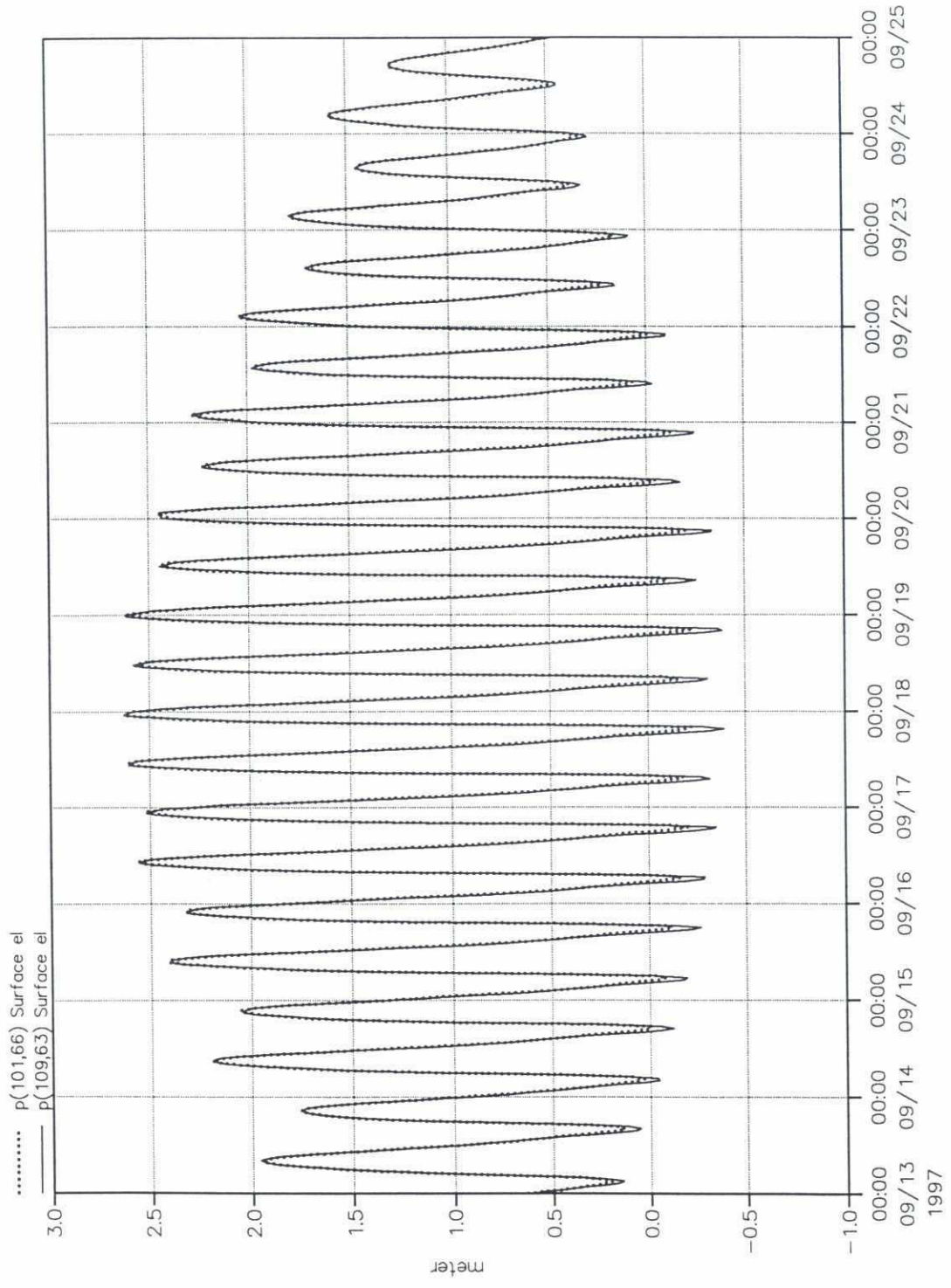

MIKE 21

SWMC

Client: Bangladesh Water Development Board

Project: Meghna Estuary Study

Water level during Monsoon 1997 without intervention Char Momtaz

File:

Date: Tue Oct 13 1998

Drawing no.

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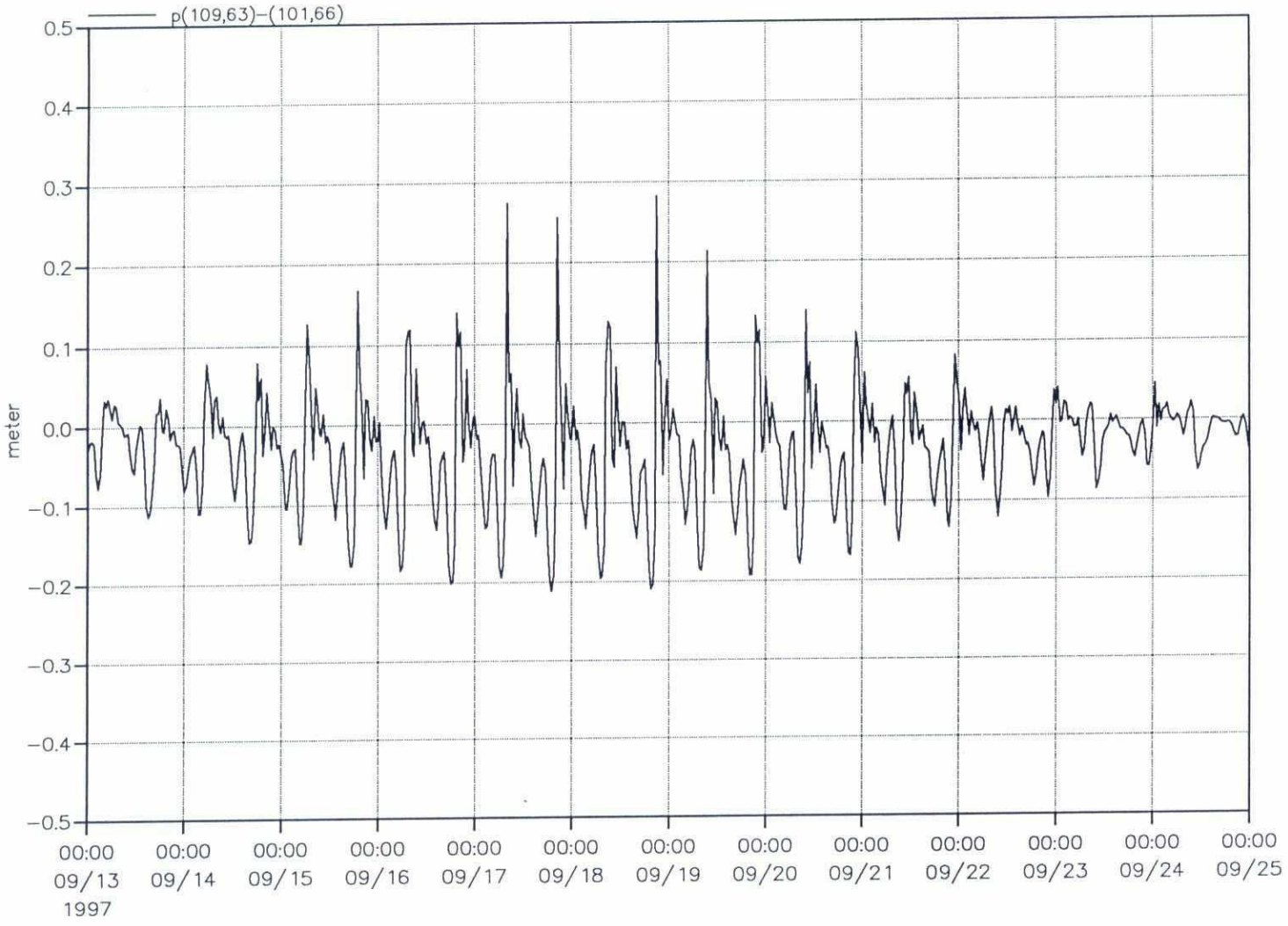

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		Project: Meghna Estuary Study	
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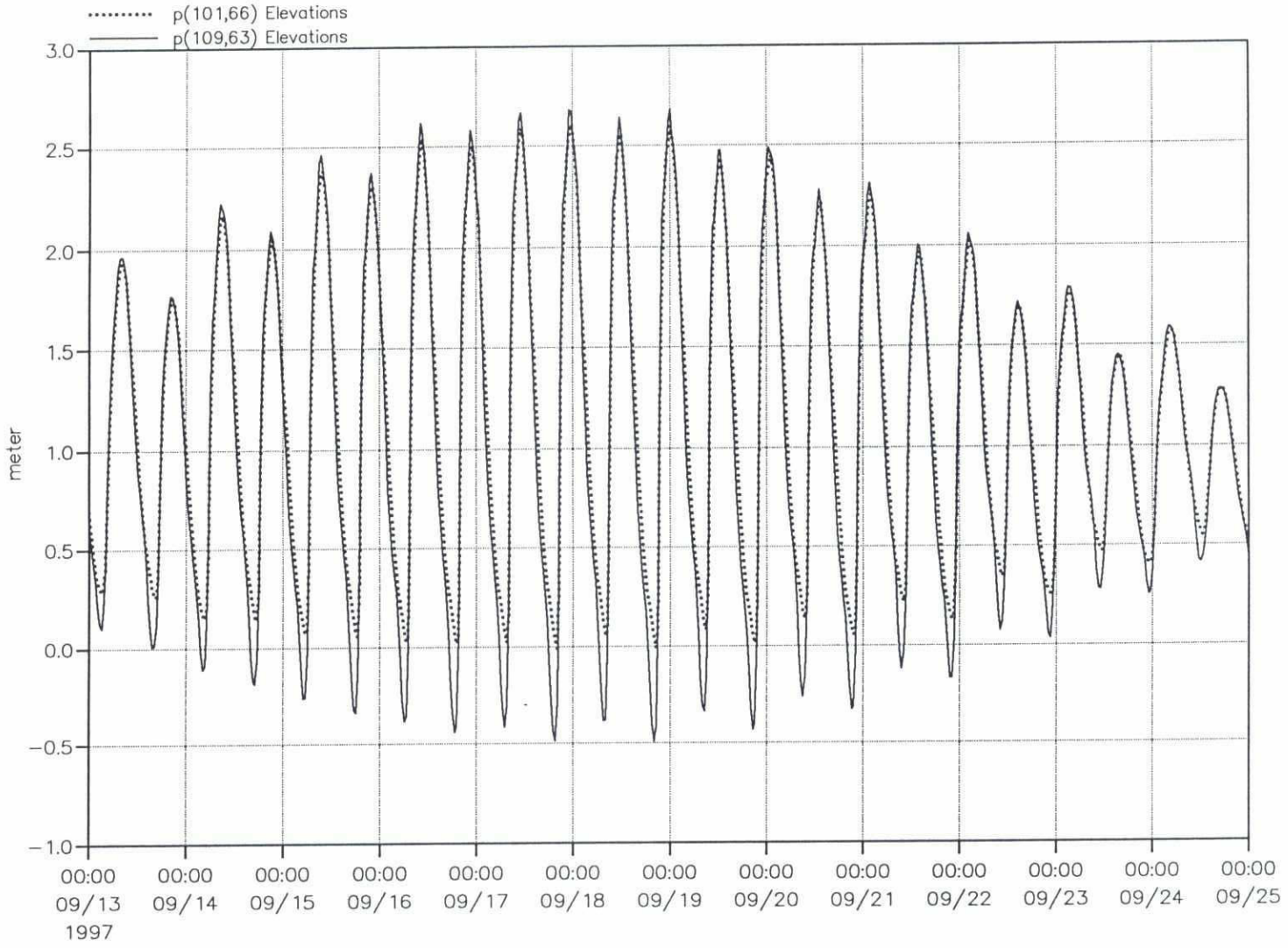
Appendix II



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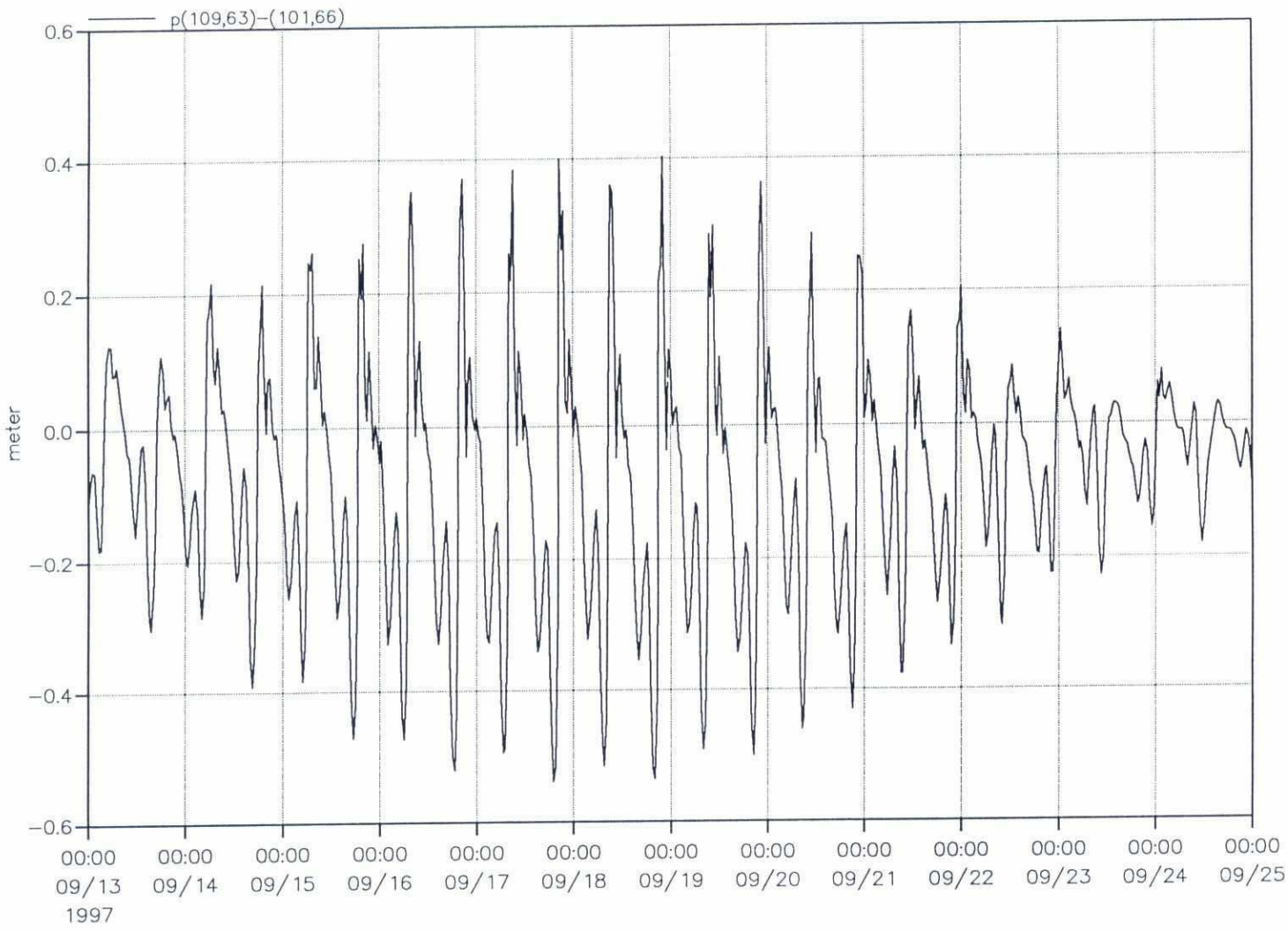

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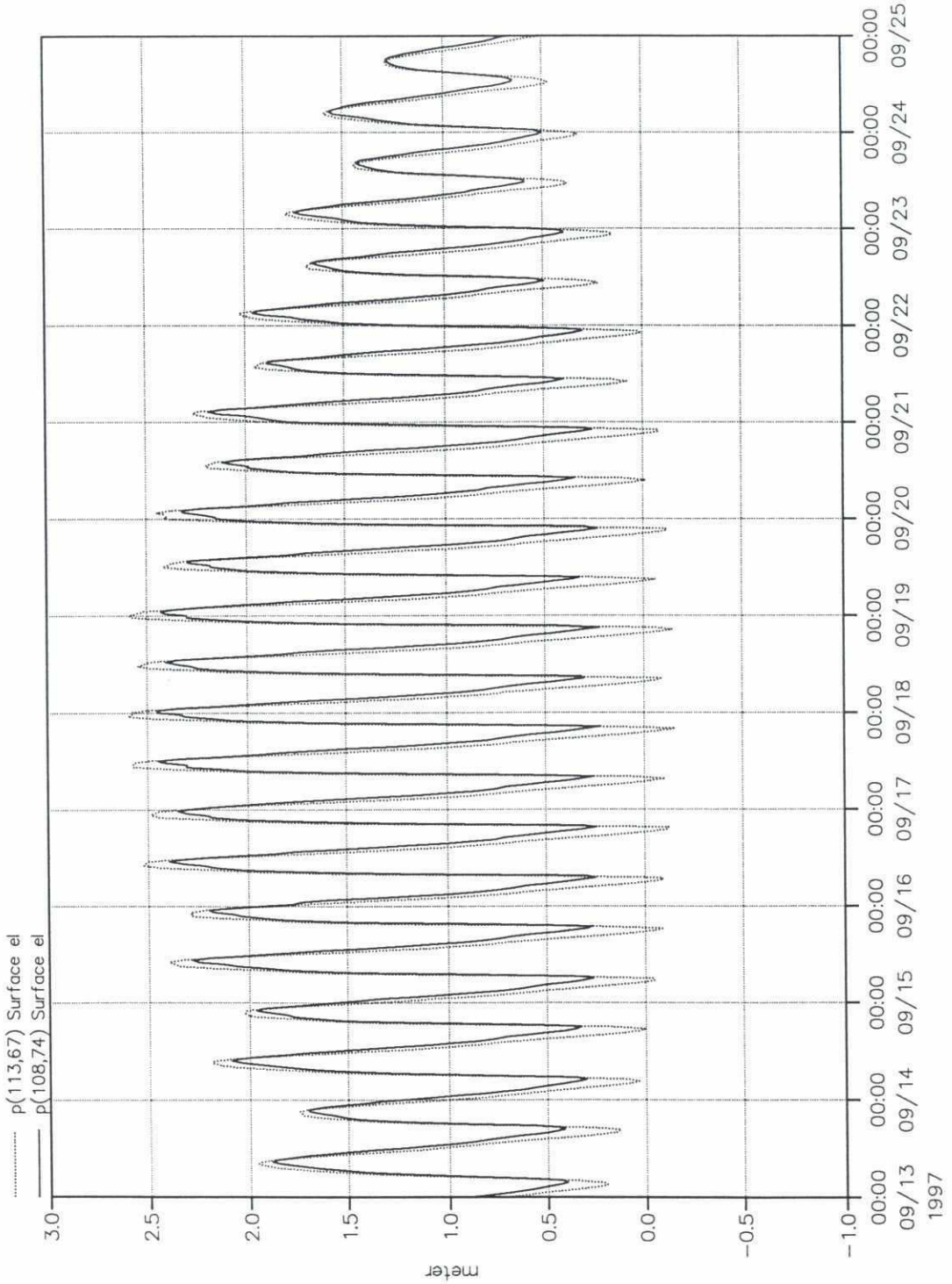


MIKE 21

Client: Bangladesh Water Development Board

Project: Meghna Estuary Study

SWMC

File:

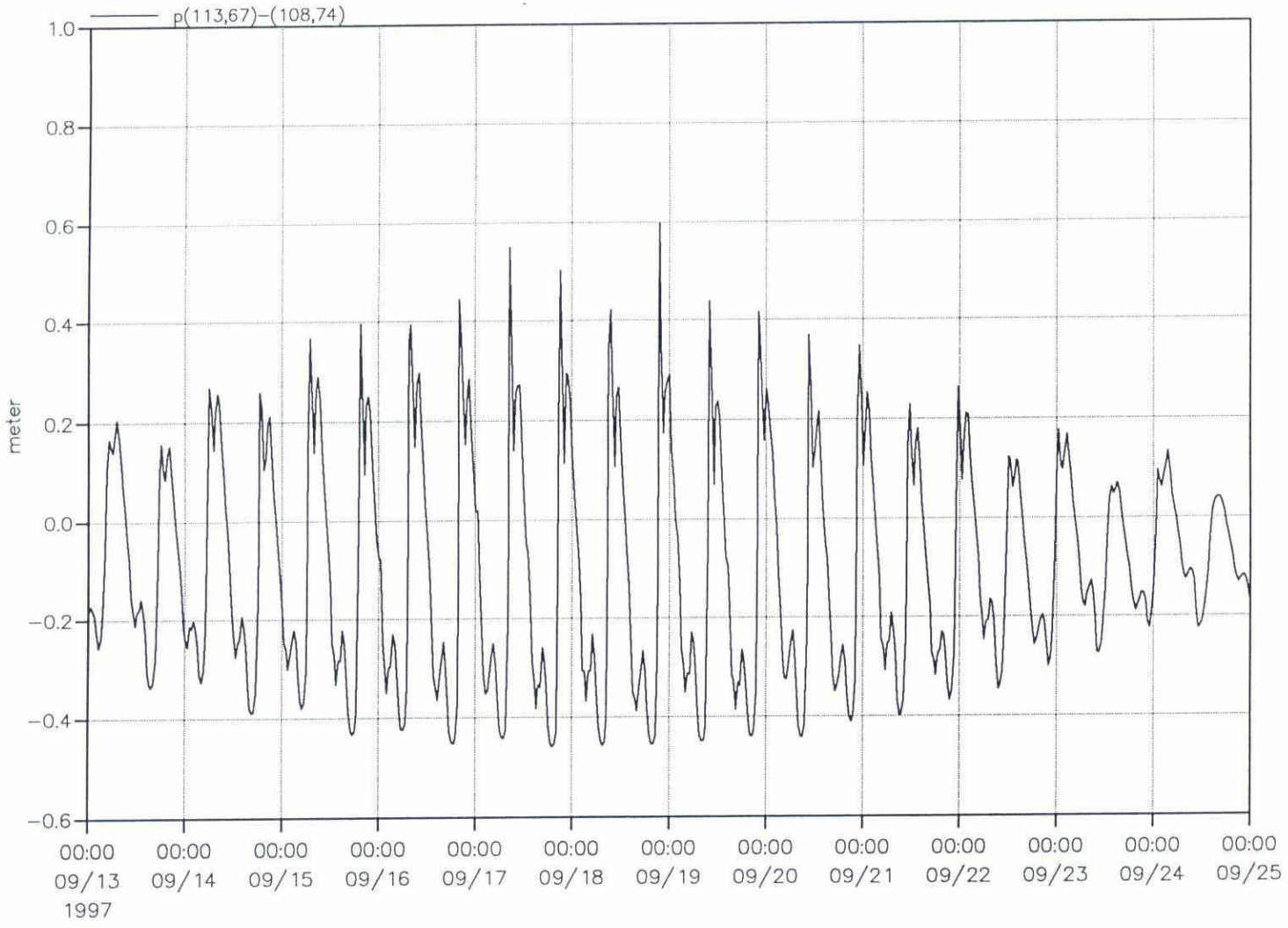
Date: Tue Oct 13 1998

Scale:

Init: p5011

Water level during Monsoon 1997
without intervention
Char Momtaz

Drawing no.



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		Project: Meghna Estuary Study	
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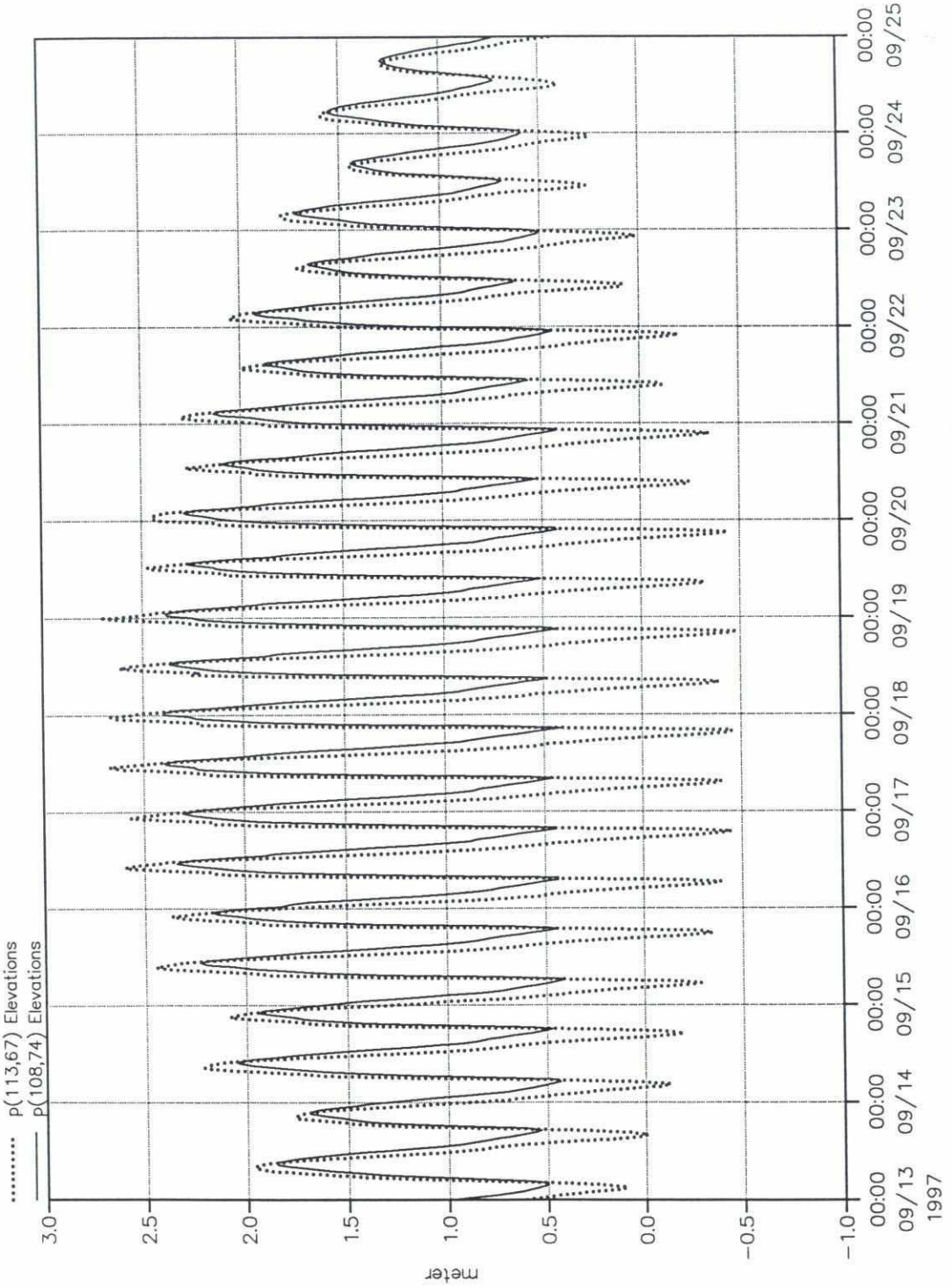

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	Project: Meghna Estuary Study		
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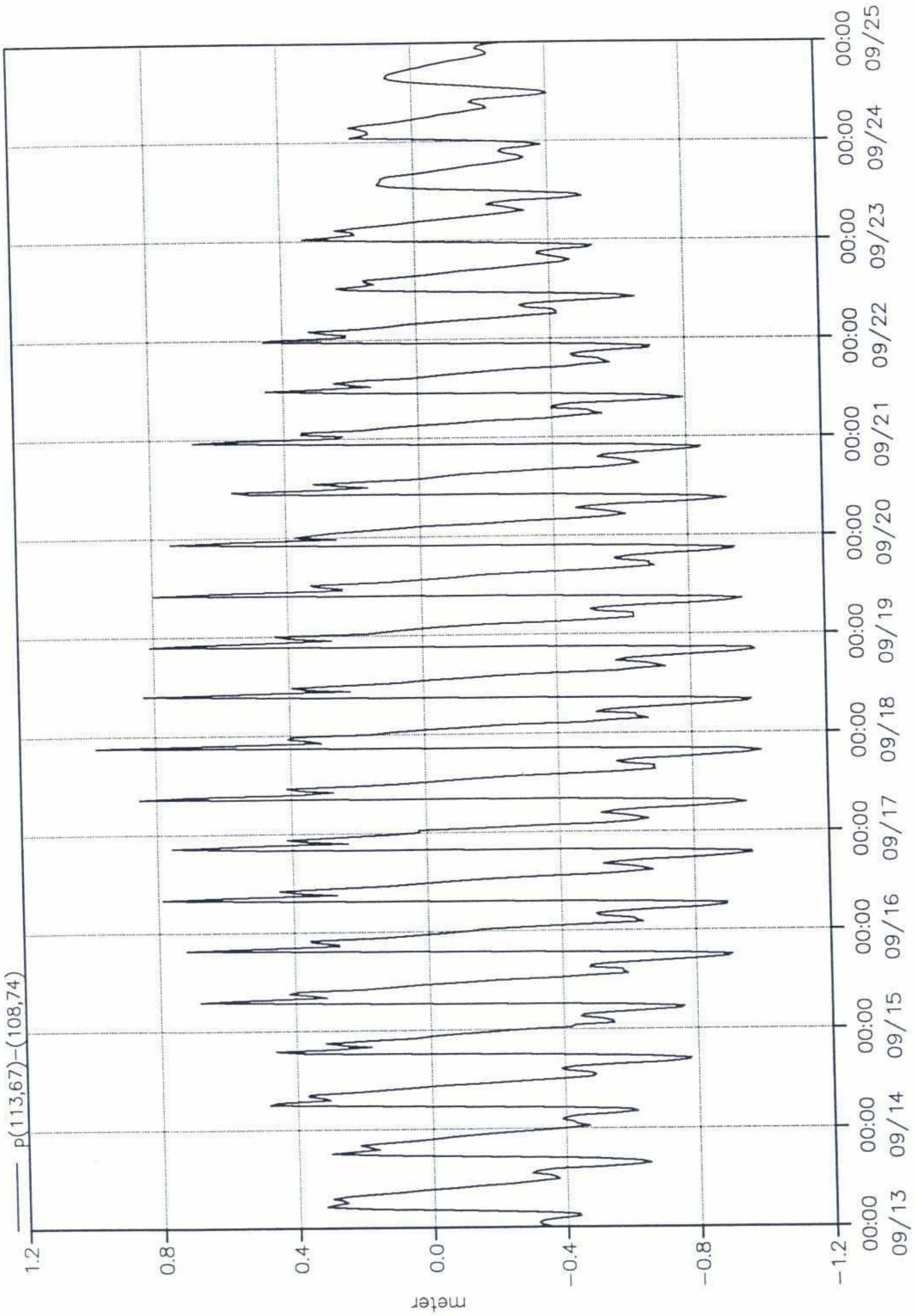


SWMC

Client: Bangladesh Water Development Board

Project: Meghna Estuary Study

MIKE 21

Water level difference during Mon 1997 due to intervention 1 Char Momtaz

Drawing no.

File:

Date: Tue Oct 13 1998

Scale:

Init: p5011

2. SOIL DATA

During the preparations for the South Hatia Cross-dams (1990) a sub-soil investigation was executed on behalf of BWDB at both ends of the proposed cross dam alignment. The location of the borings as well as the boring charts are given in this Annex. The full report is available in the MES library database.

This is the only report on geotechnical investigations in the area. Although the distance between the two sites is considerable, it may be assumed that the channel bed in the Char Montaz - Kukri Mukri area will have similar soil properties. However, recent deposits will not have consolidated and therefore will be rather soft.

The loading by the cross dam on the foundation will be quite small. Only the under water dam of geobags, stabilised soil bags and concrete blocks will be placed on the bed. The loads from the A-frames will be spread over a larger area by the woven part of the bed protection.

SOILTECH
INTERNATIONAL LIMITED
DHAKA

Client:- LAND RECLAMATION DIV. BWDB SONAPUR

Site:- HATIA—NIZUM DWIP CROSS DAM
SOUTH HATIA, NOAKHALI

Bore chart of Boring No :- 1

DATE	REDUCED ELEVATION	DEPTH (m)	THICKNESS (m)	STRATA ENCOUNTERED	LOG	DIA. OF BORING	STANDARD PENETRATION TESTS blows/0.30 m (10 20 30 40 50 60 70 80 90)	REMARKS (G.W.T., SOIL SAMPLES, VANE SHEAR TESTS Lbs./sq in.)
13-6-89	REDUCED ELEV. 7.58 ft	2.35	2.35	Pale brown & grey stiff SILT & fine SAND		9.55 m m ϕ Percussion method	10	0.85
		3.10	0.75	Grey loose micacious fine SAND with silt			10	1.85
		5.00	1.90	Grey med. stiff to stiff SILT trace fine sand & clay			9	2.85
		8.50	3.50	Grey med. stiff to stiff SILT with fine sand			7	3.85
		10.00	1.50	Grey med. dense fine SAND laminated with thin layers of silt			10	4.85
							5	5.85
							12	6.85
							15	7.85
							17	8.85
							20	9.85

Water level 7.83 ft (Av.)

DISTURBED SAMPLE

UNDISTURBED SAMPLE

DRN:

DATE - 5-8-89

SCALE - 1:100

SOILTECH
INTERNATIONAL LIMITED
DHAKA

Client:- LAND RECLOMATION DIV. BWDB SONAPUR

Site:- HATIA-NIZUM DWIP CROSS DAM
NIZUM DWIP, NOAKHALI

Bore chart of Boring No : 2

DATE	REDUCED ELEVATION	DEPTH (m)	THICKNESS (m)	STRATA ENCOUNTERED	LOG	DIA. OF BORING	STANDARD PENETRATION TESTS blows/ 0.30 m (10 20 30 40 50 60 70 80 90)	REMARKS (G.W.T, SOIL SAMPLES) VANE SHEAR TESTS Lbs./sq in.

REDUCED ELEV. 7·99 ft

Water level 7·5 ft. (Aver)

17-6-89

2·00 — Grey med. stiff SILT laminated with thin layers of fine sand

8·00 — Grey med. dense fine SAND finely laminated with thin layers of silt

10·00

9·55 m 100 mm ϕ Percussion method

Depth	N	Remarks
0.85	8	
1.85	7	
2·85	18	
3.85	15	
4·85	25	
5.85	23	
6.85	27	
7.85	29	
8·85	29	
9.85	27	

DISTURBED SAMPLE.... ▣ UNDISTURBED SAMPLE... ■

DRN- Khatu- DATE - 6-8-89 SCALE - 1 :100 PLAN NO. ST-4528

SOILTECH
INTERNATIONAL LIMITED
DHAKA

Client :- LAND RECLAMATION DIV. BWDB SONAPUR

Site :- HATIA-NIZUM DWIP CROSS DAM
NIZUM DWIP, NOAKHALIA

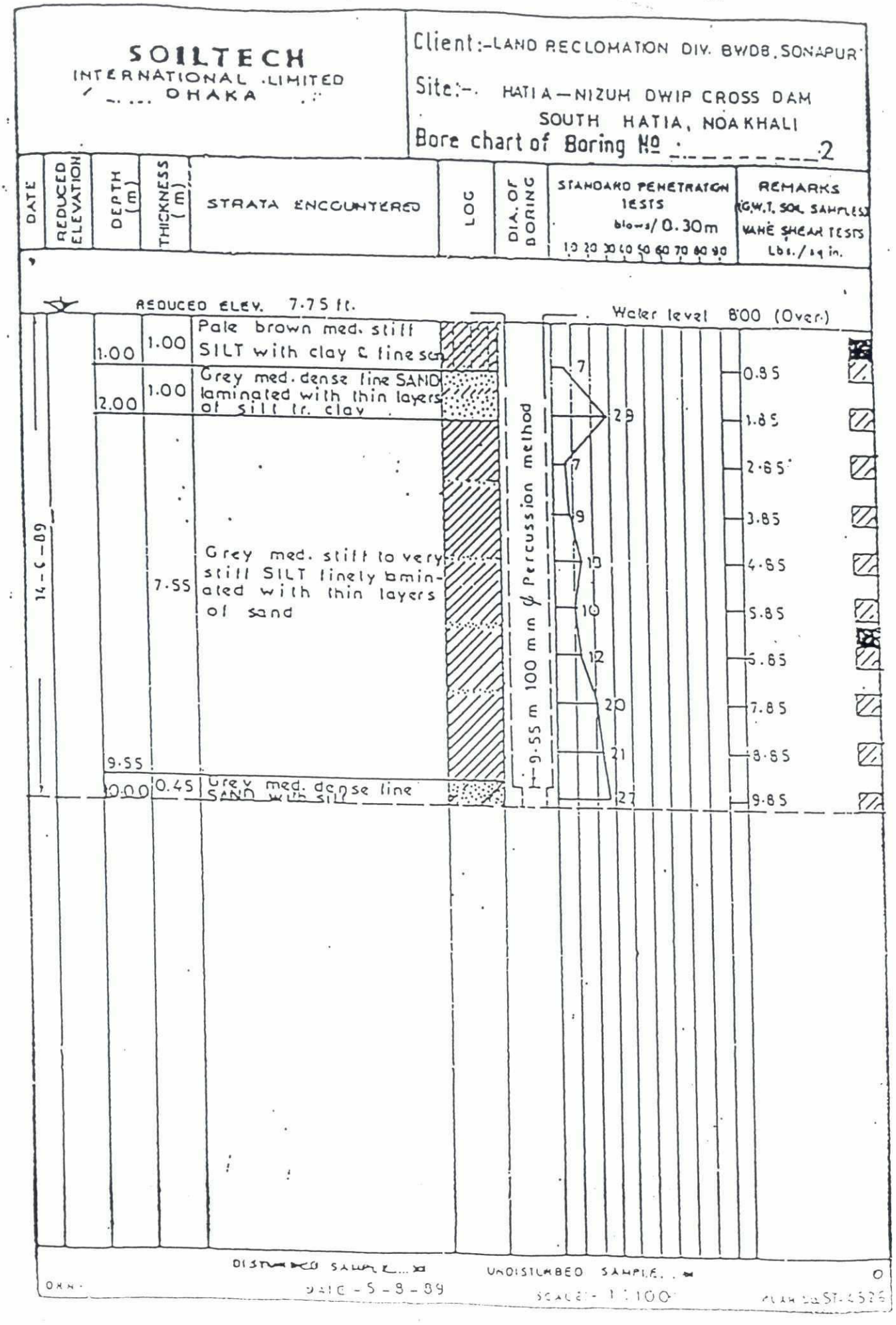
Bore chart of Boring No. 1

DATE	REDUCED ELEVATION	DEPTH (m)	THICKNESS (m)	STRATA ENCOUNTERED	LOG	DIA. OF BORING	STANDARD PENETRATION TESTS blows/0.30 m (10 20 30 40 50 60 70 80 90)	REMARKS (G.W.T. SOIL SAMPLES) VANE SHEAR TESTS Lbs./sq in.
16-6-89	REDUCED ELEV. 7.94 ft.	7.00	7.00	Grey med. stiff to stiff SILT finely laminated with thin layers of fine sand		9.55 m 100 mm ϕ Percussion method	7, 5, 4, 5, 7, 10	0.85, 1.85, 2.85, 3.85, 4.85, 5.85, 6.85, 7.85, 8.85, 9.85
		10.00	3.00	Grey med. dense fine SAND laminated with thin layers of silt			13, 20, 23, 26	

Water level 7.25 ft. (AV)

DISTURBED SAMPLE..... UNDISTURBED SAMPLE.....

DRN [signature] DATE - 6 - 8 - 89 SCALE:- 1 : 100 PLAN NO ST-4527


SOILTECH
INTERNATIONAL LIMITED
DHAKA
Client:-LAND RECLOMATION DIV. BWDB, SONAPUR
Site:-. HATIA—NIZUM DWIP CROSS DAM
SOUTH HATIA, NOAKHALI
Bore chart of Boring No. 2
DATE
REDUCED ELEVATION
DEPTH (m)
THICKNESS (m)
STRATA ENCOUNTERED
LOG
DIA. OF BORING
STANDARD PENETRATION TESTS
blows/ 0.30m
10 20 30 40 50 60 70 80 90
REMARKS (G.W.T. SOIL SAMPLES VANE SHEAR TESTS Lbs./sq in.
REDUCED ELEV. 7.75 ft.
Water level 8'00 (Over.)
14-6-89
1.00
1.00
Pale brown med. stiff SILT with clay & fine sa
2.00
1.00
Grey med. dense fine SAND laminated with thin layers of silt tr. clay
7.55
Grey med. stiff to very stiff SILT finely lamin-ated with thin layers of sand
9.55
0.00
0.45
Grey med. dense fine SAND with silt
9.55 m 100 m m ϕ Percussion method
7
28
7
9
15
10
12
20
21
27
0.85
1.85
2.85
3.85
4.85
5.85
6.85
7.85
8.85
9.85
DISTURBED SAMPLE
UNDISTURBED SAMPLE
DATE - 5-8-89
SCALE - 1:100

3. DESIGN CRITERIA

The proposed designs for both cross dams and permeable spurs have been based on the lessons learned from the trials (Nijhum Dwip and Char Alexander) and the pilot schemes (Haimchar and Khorki) implemented by the Meghna Estuary Study in 1998.

The designs for Sandwip and South Hatia cross dams have been studied as well as reports on the implementation of cross dams outside the estuary. As far as applicable the criteria used in these designs have been taken into account.

Also the lessons learned during implementation and monitoring of the pilot schemes have been taken to heart. In particular the use of local natural materials like bullah, bamboo and soil as fill material in synthetic bags has been reviewed carefully. It appears that more durable materials are required for a structure that has to last for a number of years until accretion render the cross redundant. The use of materials like bullah, bamboo in caissons installed at the Haimchar and Khorki pilot schemes limited the water depth to about 5 meters below low tide. The steel pipes for the A-frames will allow construction of permeable cross dams in deeper waters, if necessary the diameter of the GI pipes can be increased.

The proposed permeable cross dam at Char Montaz will provide valuable information with regard to the adequacy of the bed protection as well as the erosion pattern and stability of the unprotected river bed on both sides of the permeable cross dam.

The durability and efficiency of the geotextile screens, installed in between the A-frames, will be monitored in detail to establish design parameters for later designs. In particular the behaviour of the screens in waves will be observed very carefully.

Proven design criteria are not available for this innovative design; the performance of the new pilot schemes will provide valuable data for establishing design criteria. Other features like the area of the bed protection, the size of blocks, the fill material for geobags etc. have been based on the experience with the existing pilot schemes.

Special attention will be given to the behaviour and durability of the G.I. pipe A-frame. As an alternative reinforced concrete A-frame may be considered; however, since concrete frames will be much heavier that G.I. pipe A-frames, heavier equipment for installation of the cross dam will be required.

4. ENGINEERING DESIGNS

A standard section and side view of the Char Montaz - Kukri Mukri cross dams is given on the next page.

The hydrodynamic forces acting on the permeable cross dam will be water pressure caused by head differences on both side of the dam and by waves.

As mentioned under section 1 of this appendix, under normal tide conditions, during the winter and monsoon periods, the maximum head difference will be about 0.40 - 0.60 metres at full closure. Since the dam will be permeable, the actual head difference at the dam will be less.

During a cyclone the water levels will be very high and the cross dam will overtop over its full length. This additional discharge in the channel will reduce the head difference at the dam.

The wave forces acting on the permeable cross dam can not be determined accurately. Limited data are available on wave height and wave direction. Moreover the shallow areas in the channels will have an effect on both wave height and wave direction at the alignment of the dam. During cyclones the wave height will increase, however under those circumstances the dam will be submerged at high tide when the waves will be highest.

Wave forces act on the A-frames and on the geotextile screens. The forces on the circular pipes will be quite limited. Since the screens are very flexible and close 70 - 80 per cent of the opening only, it is expected that the dynamic wave forces to be transferred to the channel bed through the A-frames will be relatively small. Since the cross dams are located in relatively narrow channels, the fetch length will be small. Also the bigger waves from the open water will not reach the dam sites because of the shallowness of the channels.

For the analysis of the stability and strength of the A-frames and geotextile screens, it has been assumed that the forces exerted by on these components of the cross dam can be represented by a static head of 0.4 metres for the head differences plus a static head of 0.1 metres for wave forces.

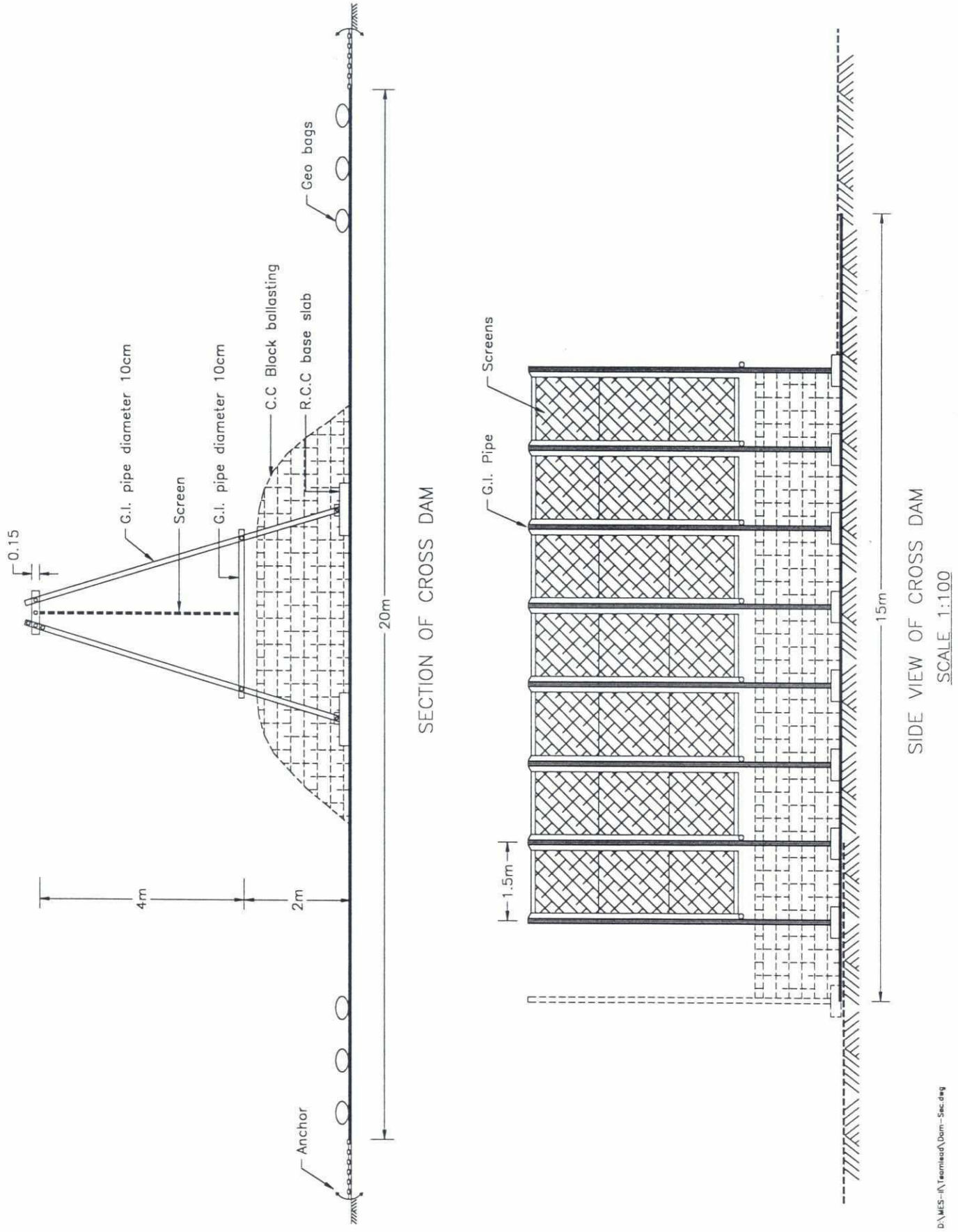
The water/wave pressure will cause tensile forces in the geotextile screens. By providing sufficient slack in the screens, the tensile forces can be limited. By using heavy geotextile for the screens (tensile strength 100 kN/m1) a safety factor in excess of 3 has been assured.

The legs of the G.I. pipe A-frames have to be designed for buckling under the pressure forces exerted by the screens. If required stiffeners in the plane of the A-frame can be provided. The base plate of the A-frames, in combination with the geotextile bed protection, will transfer the loads to the river bed. The concrete blocks or stabilised bags of the under water dam will provide loading of the base plate of the A-frames in case of tensile forces in one of its legs occur.

Since the bed of the channel may consist of rather soft deposits, differential settlement has to be taken into account in the design as well as during implementation of the works. By postponing the final connection of the top of adjacent A-frames until the under water dam has been completed, differential movement of the frames may be limited. In any case the interconnections of frames and screens have to allow certain movements of the frames.

The bed protection of the cross dam consists of a composite of heavy woven geotextile top layer and a medium thick non-woven under layer. The top layer will provide tensile strength in case of differential settlement of the underwater dam and A-frames as well as in case erosion occurs at the edges of the protection and slidings occur. Under these circumstances the bed protection will be loaded by steel anchors and geobags, the related tensile forces will be transferred to the under water dam through the woven component of the bed protection.

Figure II.1: Section and side view of the cross dam at Char Montaz



The underlayer of non-woven geotextile will, in combination with the woven top layer, prevent wash out of the fine sand and silt of the cross dam foundation. The bed protection will extend 6 - 8 metres beyond the under water dam, depending on the height of the A-frames. Since the permeable cross dam is based on a new design concept, pertinent design criteria are not available. Some scouring has been along the edges of the protection has been taken into account.

However, since the flow through the permeable dam will be very much reduced compared to the open channel, the slits in between the geotextile screens will induce strong turbulence in the flow passing through the dam it is expected that the length of the bed protection will be sufficient to prevent deep scour hole along its edges. Moreover the periods of maximum erosive forces will be relatively limited while at slack water sedimentation will even occur at the cross dam.

The cross dam pilot scheme at Char Montaz and the Nijhum Dwip cross dam will provide the necessary data to refine the assumptions with regard to scour hole depth and required width of the bed protection.

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WATER MANAGEMENT AND DRAINAGE

Design criteria and basic cost data

1. LAND LEVEL FOR EMPOLDERING

After ten years of accretion most of the old char land will have reached a land level which is near to the mean high water level (MHWL). In cases where accretion is stimulated, for example by a cross dam, a land level near to MHWL may be reached after 5 years. Land levels equal to MHWL are still inundated approximately 10 per cent of the time of the year. Older char land that has reached MHWL is characterised by a more or less flat surface. Detailed topographical maps show that for about 80 per cent of the area the land level is within a range of 0.30 metres.

The minimum land level considered for empoldering is important from a drainage point of view. The lower the land, the more problematic drainage by gravity will be. Technically land levels below MHWL can be empoldered too, but with land levels equal to or above MHWL it is expected that flood protection is still economically feasible. In other words, the height of the embankment, the sluice capacity to be installed and the modifications required to improve the natural drainage network of creeks, as defined in detailed design studies, are expected to be affordable in economic terms. The final decision for empolderment is an economical rather than a technical decision.

MHWL varies from place to place in the estuary and is influenced by overall wind and sea current directions, location of land bodies and differences in gravity. Hence, there is no absolute PWD land level for empoldering, which is valid for the entire estuary. The level for empoldering is always linked to the local MHWL. In case of char Montaz and Kukri Mukri, the land level of +1.5 m PWD is approximately MHWL and is considered a minimum level for empoldering for this study

2. FLOOD PROTECTION EMBANKMENTS

2.1 Primary (sea) embankments

Height

Only agricultural damage is most likely and it is assumed that sufficient facilities are available for the local population in case of cyclone storm surge, such as an early warning system, cyclone shelters and killas for livestock. In line with CPP-II (FAP-7) and SRP (EC) a 1:20 years flood frequency is considered the design height of embankments, increased with a freeboard of 1.22 metres.

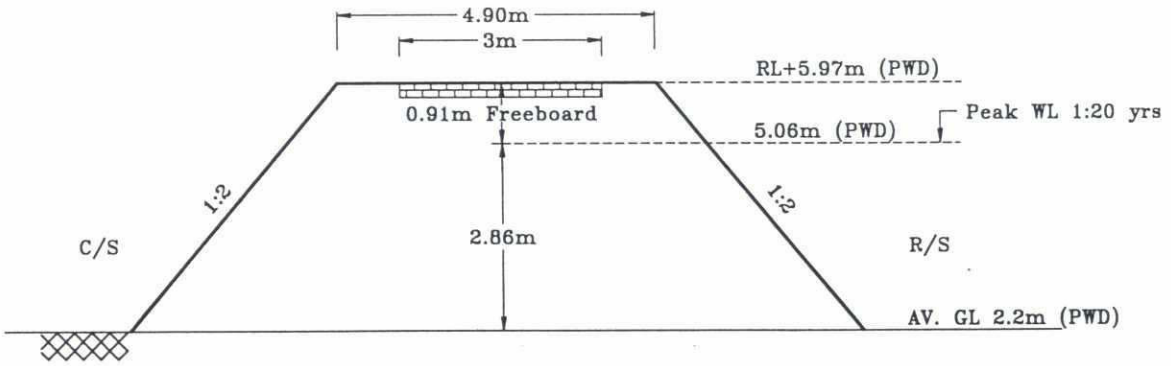
Side slopes

Unless stability considerations indicate otherwise, a side slope of 1:2 is adopted for the countryside and 1:5 for the seaside.

Crest width

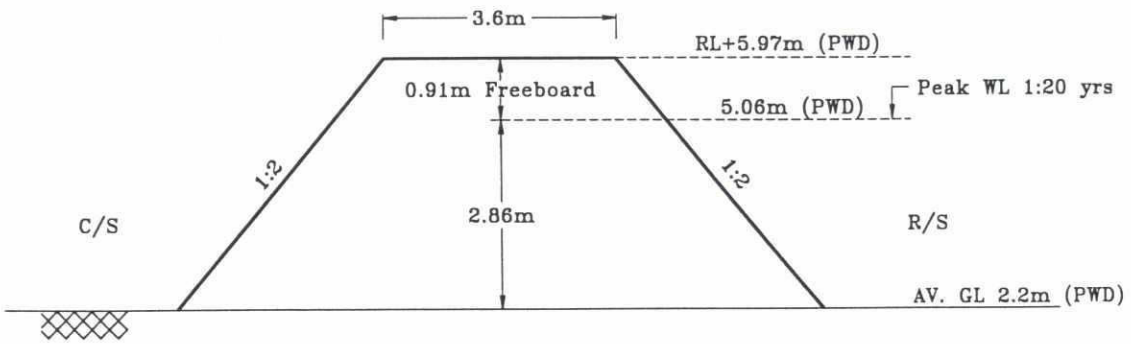
In case of sea facing embankments, inspection roads (also used during emergency repairs) are considered a necessity. A minimum crest width of 4.25 metres is therefore maintained. This width is also sufficient to use primary embankments as fair weather R-2 rural roads, which require a crest width of only 3.6 metres.

Figure III.1 : Typical secondary embankment with LGED unpaved R-2 road



TYPICAL SECONDARY EMBANKMENT WITH LGED PAVED R-1 ROAD

(not to scale)



TYPICAL SECONDARY EMBANKMENT WITH LGED UNPAVED R-2 ROAD

(not to scale)

2.2 Secondary (compartment) embankments

Height

The same criteria used for primary embankments are applied in the case of secondary embankments or compartment embankments. Compartment embankments are supposed to take over the function of a primary embankment in case of failure of the primary embankment. Since wave action will be less a free board of 0.91 metres is considered sufficient.

Side slopes

Unless stability considerations indicate otherwise, a side slope of 1:2 is adopted for both sides.

Crest width

The minimum crest is considered 2.5 metres. however, these embankments will be used as roads and a crest width of 3.6 metres will be applied to allow the construction of an R-2 rural road.

Table III.1: Physical features of primary and secondary embankments

Type	Crest Level[1] (m PWD)	Freeboard (m)	Crest Width (m)	Slope R/S	Slope C/S
Primary embankment	4.92	1.22	4.25	1:5	1:2
Secondary embankment	4.62	0.91	3.60	1:2	1:2

Based on the above criteria and the BWDB standard schedule of rates the costs of embankments have been calculated.

Table III.2: Estimated costs per kilometre embankment

Type	Volume (m^3)	Rate[2] (Tk/m^3)	Construction Costs per Km (Tk '000)	Land Acquisition[3] (Tk '000)	Turfing Costs[2] (Tk '000)	Total Costs (Tk '000)
Primary Embankment New Construction	55,500	30.9	1,715	445	223	2,383
Primary Embankment Resectioning	8,800	30.9	272	nil	112	384
Secondary Embankment New Construction	30,700	30.9	949	182	133	1,264

3. DRAINAGE SLUICES

Final detailed drainage design studies can be carried out when accretion has been completed. For the purpose of this study, historical data have been used to define the required sluice capacity with a so called drainage ratio. The drainage ratio is defined as the inverse of the available drainage sluice cross section for a given catchment area, expressed in ha/m^2.

[1] Based on present design of primary embankments for Char Montaz.
[2] Standard Schedule of Rates, 1995, prices converted to 1998 prices.
[3] A land cost of 114,000 Tk/ha is assumed for this region.

Table III.3: Drainage ratio of existing polders

Polder	Name	Total Catchment Area (ha)	Total Sluice Cross Section (m^2)	Average Drainage Ratio (ha/m^2)
55/1	Galachipa	10,900	85.3	129
55/3	Char Biswas-Kajal	9,850	61.2	161
58/1	Manpura Hazinat	3,050	18.0	170
58/2	Shakuchia-Manpura	3,250	25.0	130
72	Sandwip	18,700	87.3	214
73/2	South Hatia	12,300	73.2	168
			Average	162

In comparing existing and recently rehabilitated polders in the study area, it was found that the average drainage ratio is 162 ha/m^2. Seen the problematic drainage situation in a number of these polders, and for purpose of planning in this study only, the design drainage ratio is set on the slightly higher side, at 150 ha/m^2.

3.1 Drainage sluice

Like in most polders, the standard BWDB box-culvert drainage sluice has been selected with a cross section of 2.78 m^2 (1.52 x 1.83 metres) per vent. In most cases such drainage sluices comprise one to five vents.

3.2 Surface sluice

The purpose of a surface sluice is to solve local drainage congestion along the flood protection embankment. Land near the coast line of chars may be slightly lower and at the same time a number of minor creeks are blocked by the primary embankment. Therefore a provision of 4 minor drainage sluices per 10 km primary embankment has been made[4] with a pipe diameter of 1.22 metres. On both sides of the sluice a flap gate will be provided. This sluice may also be used to flush water in the polder if required. Where required, a minor drain will be constructed along the primary embankment, on the country side, separated by a berm of 2 metres.

The cost of a standard drainage sluice varies from 4.5 million[5] to 8.3 million[6] taka. A need for pile foundations can increase the cost of a sluice considerably, but also the requirement of improved flap gates and vertical lift gates, which last longer and have a better performance. For this study an average provision has been taken for pile foundation

Table III.4: Costs of drainage and surface sluices

Type of Sluice	LS Costs (Tk)
Surface Sluice Diameter 1.22 m provided with two flap gates (c/s and r/s). 1 vent	772,000
Box Culvert Sluice 1.52x1.83m provided with vertical lift gate (c/s) and improved flap gate (r/s). 2 vent 3 vent	 6,000,000 9,000,000

[4] Average found in rehabilitated Polder 55/1
[5] BWDB, 1998, Patuakhali O&M Division.
[6] CDSP, 1996, Char Bhatir Tek.

Figure III.2 : Schematic layout of standard box-culvert drainage sluice

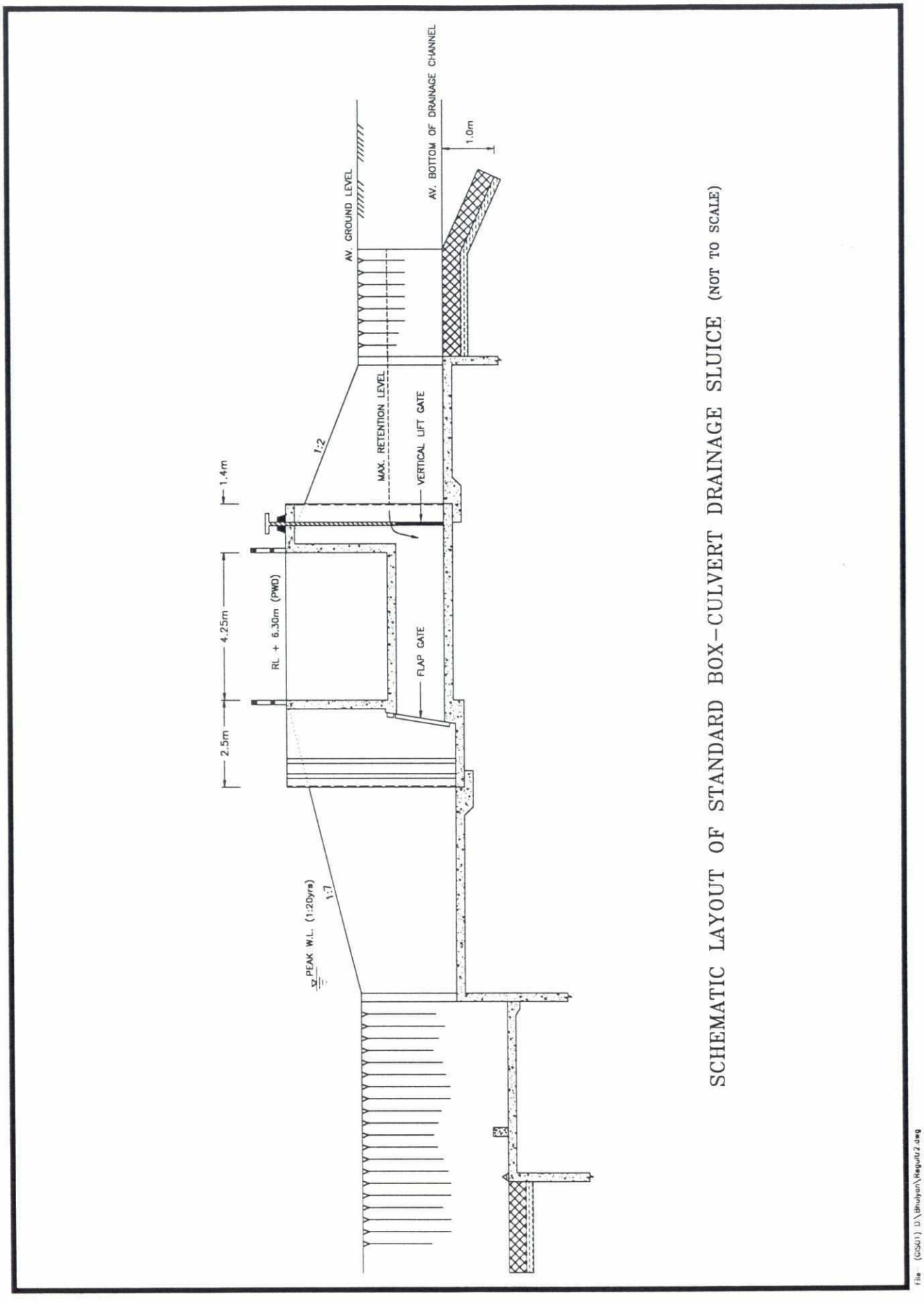
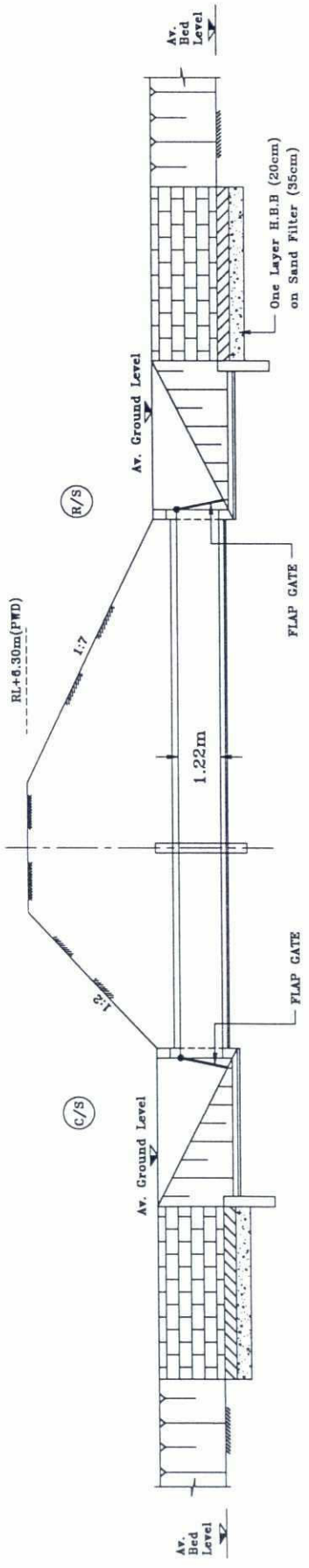


Figure III.3 : Typical 1.22m ϕ surface sluice



TYPICAL 1.22m Ø SURFACE SLUICE (Not to Scale)

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4. DRAINAGE CHANNELS

Starting point is the natural creek system formed during accretion. It is expected that primary drains can be selected at an interval of 2 to 3 km and secondary drains with spacing between 1 and 2 km, resulting in average secondary drainage areas of 30 to 40 ha. Additional tertiary drains may be selected or constructed to drain isolated low pockets.

The existing drains are considered sufficient to meet the drainage requirements. Nevertheless, several rehabilitation design studies show costs to improve the drainage network, varying from 85 to 643 Tk/ha catchment area[7]. These costs cover in most cases the re-excavation of a few primary drain sections in a rehabilitated polder. In the case of new polders these cost may be much higher (SRP-EC). The current practice of BWDB is not to modify the existing drainage network.

For this study, a provision of re-excavation of 30 per cent of primary drains and a lump sum for the excavation of connecting drains (between primary drains and primary drains and sluices) have been taken, based on an average density of drains and historical re-excavation costs. In the case of existing polder land, no provision for connecting drains has been made. Re-excavation of primary drains is expected to maintain a depth of around 2 m, recommended for the stimulation of deep drainage, which plays a major role in the desalinisation of the subsoil.

Table III.5: Costs for improvement of drains per 1,000 ha

Description	Length (km)	Volume[8] (m^3)	Rate[9] (Tk/m^3)	Cost (Tk '000)
Re-excavation Primary Drains (30%)	2.4	26,400	21.8	576
Excavation of Drains	n.a.	38,000	21.8	785
			Total	1,361

5. BRIDGES AND CULVERTS

In the case of Char Montaz, it is assumed that all required bridges and culverts are in place and where new bridges and culverts are required, that these will be provided under regular development plans (ADP) of the local Government and LGED.

[7] SRP-CE, 1992-4, polder 73/1AB, 58/3, 73/2 and 35/1.

[8] An average volume of 6000 m3 per km was found for re-excavation of primary drains in polder 73/2, South Hatia, SRP 1994.

[9] Based on 1995 Standard Schedule of Rates.

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AGRICULTURE

The tables contained in this annex contain data from the agro-economic survey carried out in Char Montaz and Kukri Mukri in March 1998. The number of households included in the survey was small and not selected on a fully random basis. These results have therefore been used as indicative only.

The survey has data provides a comparison between the present situations inside and outside the existing embankment. It will be noted that, because of current drainage constraints inside the embankment, production outside the embankment, barring major flood or tidal damage, appears to be quite comparable to that inside. Solving these drainage problems would, however, create better production conditions inside the embankment and eventually lead to higher yields and cropping intensities.

Table IV.1.1 : Agricultural Production Data

Land holding category	Mean gross cultivated area per farm hh (ha)	Mean net cropped area per farm hh (ha)	Mean crop production per farm hh (Kg)	Mean production consumed per farm hh (Kg)	Mean production sold out per farm hh (Kg)	Mean farm income per hh (Tk.)
Landless	0	0	0	0	0	0
Marginal	1.37	1.64	635	523 (82%)	112	1135
Small	1.73	1.84	1475	1166 (79%)	308	2244
Medium	4.29	5.09	3677	1664 (45%)	2012	13672
Large	5.68	7.59	6557	2237 (34%)	4320	29500
Total	2.57	3.08	2323	1154 (50%)	1167	8039

Source: MES field survey, February-March 1998, sample size 39 farming hh

Note: Land holding size is area of agricultural land owned by each farm hh grouped in to UNDP classification.
Land areas included worked land not owned by the farming hh cropped area includes multiple cropping of the same land.

Table IV.1.2 : Agricultural Production

Area	Farmer's		Total cultivated area (acre)	Total cropped area (acre)	Total crop production (Kg.)	Production consumed (kg)	Production soldout (kg)	Total income (Tk.)	Production per farmer (Kg)	Income per farmer (Tk.)
	No.	Category								
Char Montaz Kurri-Mukri	7	Landless	0.00	0	0	0	0	0	0	0
	4	Marginal	13.60	16.23	2540	2092	448	4540	635	1135
	12	Small	51.37	54.65	17697	13996	3701	26934	1475	2245
	12	Medium	127.34	151.15	44121	19973	24148	164060	3677	13672
	4	Large	56.15	75.08	26230	8950	17280	118000	6558	29500

Source: Information collected from different households by the field staff during February, 1998 to March 1998

Table IV.1.3 : Production, crop sale and value obtained by difference classes for farmers in Char Montaz

Village	Farmers Status	LT Aman					Khesari					Sweet Potato					Garlic					Chilli					Linseed				
		Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg
Char Montaz	Landless	7800	3240	41	27750	8.50	560	280	50	3500	12.50	1000	800	80	2000	2.50	10	8	80	240	30.00	-	-	-	-	-	120	120	100	1800	15.00
	Marginal	1200	400	33	200	5.00	120	40	35	400	10.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Small	14570	6260	43	37360	6.00	570	100	17	1300	13.00	480	240	50	600	2.50	95	43	45	648	15.00	160	88	55	1250	14.50	-	-	-	-	-
	Medium	25000	9400	37	65200	7.00	2360	1300	55	25460	20.00	2200	1920	57	2100	1.00	112	77	70	1345	17.00	180	110	60	2200	20.00	170	150	88	2250	15.00
	Large	-	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Household survey conducted by field investigators during February and March 1998

Table IV.1.4 : Production, crop sale and value obtained by difference classes for farmers in Char Kukri Mukri

Village	Farmers Status	LT Aman					Khesari					Chilli				
		Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg	Product Kg	Sale Kg	Sale %	Value Tk.	Avg. price Tk./Kg
Char Kukri Mukri	Landless	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Marginal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Small	6600	1640	25	12300	7.50						80	40	50	800	20.00
	Medium	1000	2560	25	19100	7.50	160	80	50	800	10.00	240	160	66	3200	20.00
	Large	18000	####	82	96500	6.50	480	400	83	5000	12.50	-	-	-	-	-

Note: Household survey conducted by field investigators during February and March 1998

LIVESTOCK

1. THE PRESENT SITUATION

Under the Char Montaz Kukri Mukri Development Project (NIDP) livestock development is an activity in which considerable achievements can be made through project intervention.

The islanders keep livestock as part and parcel of the household, mainly for draft purposes and the others as followers and sideline income or distress sales. The surplus manpower especially the children are being utilised to tend the animals in the grasslands in the new accredited chars and in the forests. The powerful land grabbers, however, put the animals in the grass lands under the care of herdsmen to establish their preliminary rights over the land.

The peculiarity of local livestock situation is that with the accretion of new lands the Uri grass comes first, the farmers prefer to put their animals in the grass land, if the land is under the control of Forest Department (FD), the FD do not allow free grazing and the farmers then adopt cut and carry system and stall feed the animals. The FD then starts plantation in rows using Uri grass as protective cover against wave action and flushing of seedlings. The FD usually does not restrict the cut and carry system but with the growth of the seedlings the grass production gradually declines and hence carrying capacity is reduced. The FD then allows foraging following the growth of plants to safe height or after first thinning in the 9th year of plantation.

2. LIVESTOCK BREEDS

The cattle are nondescript zebu type, fairly adopted to the local climate and environment, cow produces about one to two litres of milk per day.

The buffaloes are Indian water buffalo type and are preferred by the farmers as tough draft animals and can survive on coarser roughage available in chars and forest undergrowth. The milch buffaloes produce little more milk than cows.

The chicken and ducks are of deshi type and are reared in the back yard as scavengers. The chicken produce 40-45 eggs and ducks 60-80 eggs per year.

The cattle and buffaloes owned by large and medium farmers are usually reared in the free grazing lands in the newly accreted chars and in the forests or in the harvested crop fields. The landless and marginal farmers face most difficulty during the months of July - November when the crop fields are in crops and during the dry spell in November - March when weed production is minimum. The marginal farmers cannot afford to put the animals in the chars for fear of theft or in the forest for fear of loss and going wild. They usually tether their animals in the river banks, fallow lands, pond dykes and stall fed.

The animals are maintained on nearly zero inputs and the farmers spend very little on feed supplements and veterinary care although on average about 9 per cent to 10 per cent of household income is generated through the sale of livestock and livestock products, excluding home consumption and the contribution of draft animals to crop production.

3. LIVESTOCK POPULATION DYNAMICS

According to BBS Agriculture and Livestock Census 1983-84 the six project mauzas with 1,246 households had 5,795 cattle and buffalo, 2,807 sheep and goats and 8,840 chickens and ducks. The households were found to rear on average 4.65 cattle, 2.25 goat and sheep and 7.1 poultry, indicating that the animal population per household in the area is higher than national average.

The 1983 - 84 Agricultural Census indicates that among the cattle population 38 per cent are adult male, 40 per cent are adult female, 22 per cent young stock. Of them 45 per cent of adult female cattle are in milk, 55 per cent of adult female are dry and 37 per cent of the adult female cattle are used for work. Similarly 58 per cent of the adult buffaloes are male, 33 per cent are adult female and 9 per cent young stock, 27 per cent of adult female buffaloes are in milk and 73 per cent of adult female buffaloes are dry. 72 per cent of adult female buffaloes are used for work.

In sheep and goats 40 per cent are males and 60 per cent are females in the herd.

Among poultry 85 per cent of the flock are chicken and 15 per cent are ducks.

Livestock production on the chars is susceptible to severe losses from cyclones, especially if the livestock is in unprotected areas. In the project area, very heavy losses were experience in the April 1991 cyclone, for example. After such an event, there may be fodder shortages which aggravate losses through starvation and make the animals more prone to disease.

Severe cyclone losses can also lead to a severe shortage of draft power, delayed cultivation or even no cultivation for a season. To overcome these losses, farmers buy animals from non-affected areas or hire power tillers. The losses suffered in the project are in 1991 cyclone are reported to have been compensated over the past few years.

The socio-economic sample survey of 160 households in Char Montaz and Kukri Mukri, conducted in February 1998 found average household ownership of 4.46 head of cattle and buffalo, 0.94 head of sheep and goats and 26.62 chickens and ducks. However, a larger survey of 1771 households carried out by the NGO the Remote Island Development Programme (RIDP) in 1996 found averages of 5.1 head of cattle, 2.08 goats and sheep and 10.75 chickens and ducks. Both surveys indicate increases in holdings of cattle and poultry since the 1983-84 Census of Agriculture and Livestock, but a decline or even fall in the numbers of sheep and goats. Given the breadth of the RIDP survey, this is the preferred basis for estimating future livestock populations in the project area. Future per household holdings are not expected to be significantly different from these numbers, given the various fodder, health and space constraints on livestock populations.

4. CONSTRAINTS TO LIVESTOCK PRODUCTION AND SERVICE DELIVERY

The farmers are not aware of the facilities available at Thana Livestock Development Centre (TLDC) and the routine use of the services extended by the centre. The animal and poultry diseases are usually not reported by the farmers to the veterinary hospitals and the disease surveillance system is yet to be fielded in the area. Accurate data on mortality and morbidity or economic impact of animal diseases are not available. But according to the farmers, animal diseases are adversely affecting the livestock and poultry productivity and agricultural practice. The present mortality rate as estimated by the local officers of the Department of Livestock Service (DLS) is as follows:

Table IV.2.1: Livestock mortality

Species	Death Rate (% p.a.)
Buffalo	6
Cattle	10
Calves (cow/buffalo)	25
Goat/Sheep	8
Kid/Lamb	25
Chicken	60

The above death rates are similar to those estimated by the Char Development and Settlement Project (CDSP) for their without project situation.

5. ANIMAL HEALTH

5.1 Common diseases of bovines and ovines

The main diseases as reported by DLS and observed during field investigation are worms: mainly stomach and intestinal worms, Liver fluke and Scabies in Goat.

Bacterial diseases - anthrax, black quarter (BQ), haemorrhagic septicaemia (HS).

Viral Disease - foot and mouth disease (FMD)

Rinderpest caused huge loss of bovines in the early sixties and is reported well under control at present although antibody titre level is known to be below protective level.

Many of the disease are preventable through routine vaccination and curable by chemotheraputic agents and antibiotics.

5.2 Diseases of poultry

In chickens New Castle Disease (NCD) is common and takes heaviest mortality and occasional out break of fowl pox is also reported in young chickens. Coccidiosis, intestinal worms and lice infestation are also common.

There is relatively less incidence of disease in ducks but the duck population is not increasing, according to farmers during the dry spell and intrusion of saline water in the fields and canals the common species of snails cannot survive and there is shortage of duck feed in the winter months.

6. FODDER

The second most important constraint in livestock production is the fodder shortage especially during the dry spell when the weed production is at a minimum. The non-farm households including the marginal farmers who do not have access to crop residues live straw etc. are often forced to sell stock often at inconvenient price. The erosion affected landless and marginal farmers expecting to be settled in near future under the Government settlement programme now depend seasonally on fishing and the women and children only earn through rearing animals and chickens.

It is envisaged that under the settlement programme a part of the land would be reserved as community grazing land, sufficient to provide fodder for at least 3 months to the livestock of the settlers. The community grazing lands are to be managed by the settlers and would not be converted as crop land.

Embankments and the pond dykes would include suitable fodder tree species like Babla (Acacia nilotica), Ipil ipil (Lucaena leucocephala) and dubla grass (Cynodon dactylon) and Arhor (Cajanus cajan) to cater for emergency needs during the dry spell and any other eventualities.

Another option is to include fodder crops in the cropping pattern. Khesari (Lathyrus sativa) is a well adapted species which may be promoted and the farmers encouraged to use it as fodder crop and not for human consumption. Other salt tolerant varieties should be investigated and introduced into the area.

The urea treatment of straw may be promoted based on experience of DANIDA in the district.

It is expected that livestock owners would be served by an NGO which would assist with various development activities. The NGO, in co-operation with DLS, would arrange short duration training on improved husbandry of cattle, goats, sheep and poultry and would support individual households interested in improved livestock production methods with credit facilities, training and demonstrations.

The present and future average performance parameters for livestock are presented in the tables at the end of this annex.

7. LIVESTOCK DEVELOPMENT

7.1 Manpower development (development of change agents)

The service delivery of the Department of Livestock Service (DLS) is aimed to be improved through participatory approach. A local unemployed youth to be nominated by the community is to be trained as Livestock Field Worker (LFW) who is expected to reside in the island and earn his livelihood through selling his services to the community and maintaining liaison with DLS and other input suppliers. The LFW would also act as model livestock producer and operate a demonstration farm and specifically serve the livestock activities taken up by the farmers with credit support. The LFW in co-operation with DLS field staff would vaccinate all the animals against prevalent diseases and offer first aid to sick animals and deworm the animals at least twice or thrice a year.

Similarly for poultry development suitable women with basic education would be trained as Women Poultry Workers/vaccinators (WPW) and drug dispensers and would work with local women, advising them on better poultry husbandry and vaccinating all the chicken and ducks. Where practicable, preference for these positions would be given to destitute women. The WPW are also expected to act as model poultry producers and to operate a demonstration farm and specifically serve the poultry activities taken up by the householders with credit support.

The NGO would arrange for the training for the LFW and the WPW with close co-operation of DLS and their deployment in the village. The project is expected to bear the cost of training, field equipment, bicycle and initial support for their establishment in the trade. The DLS is expected to support with continuous training facilities in the Thana Veterinary Hospital to improve skill and perfection and inputs free of cost and at cost price made available by the Government on a priority basis. The project is likely to assist in the establishment of demonstration farms with improved animals and chicken.

The settler farmers are to be encouraged and expected to bear the cost of the inputs and the services of LFW and WPW and carefully avoid the dependency culture for free inputs and services.

The LFW and the WPW are expected to advise the farmers and the housewives on improved animal and poultry husbandry i.e. feeds and feeding, preservation of crop residues, green grass and crop by-products for feeding during lean months and bad weather. They are also expected to maintain close collaboration with the DLS for routine disease surveillance, preservation and dispatch of samples for laboratory diagnosis and call on expert services needed from the DLS from time to time by the farmers of the area.

The LFW at a later stage may be encouraged to maintain a good quality breeding cow bull/buffalo to improve the milk production potential of cattle/buffalo. The farmers would be encouraged to pay for the bull services and maintenance of the bull. Similarly the destitute women may be encouraged to rear good quality breeding bucks and charge for the coverage to the farmers.

The LFW is also to explore other feasible opportunities like mini-milk processing and marketing facilities and profitable marketing of eggs, chicken and other livestock products.

7.2 Farmer training

The farmers interested to take up livestock activities with credit support would be trained by the NGOs in co-operation with the DLS for brief period on improved management and health care of animals prior to access to credit.

Similarly the housewives interested to take up poultry project with credit support would be trained for short period on specific type of activity and health care before sanctioning of credit.

7.3 Monitoring of credit projects

The NGOs operating the credit would monitor the projects as part of their routine activities and take up necessary issues to the notice of local Livestock Officer for speedy and effective solution of any problem.

7.4 Types of livestock projects

The specific type of livestock activities to be taken up by the respective household would strictly depend upon the location and farm specific suitability and the choice of the of the household. Several activities are suggested with estimated profit margin. They are as follows: For details refer to vol. 2, Annex 6, estimated cost and benefits of livestock projects.

A. Draft cattle
B. Milch cow
C. Beef fattening
D. Goat fattening
E. Goat rearing
F. Chickens - layers
G. Chickens - broilers

Table IV.2.2: Livestock population in the project area

Mauza/Union	All House-holds	Non farm HH	Farm HH	Cattle & Buffaloes	Sheep & Goats	Poultry
Char Montaz	430	129	301	1,641	985	4,022
Char Margaret	105	44	61	918	414	579
Char Lakshmi	159	47	112	1,603	249	1,129
Char Bastin	39	13	26	473	317	256
Char Prasanna	130	35	95	606	414	1,905
Char Kukri Mukri	504	135	369	1,154	804	2,816
Char Patila	9	6	3	6	38	39
Total	1376	409	967	6,401 (4.65)	3,221 (2.34)	10,746 (7.80)

Sources: The Bangladesh Census of Agriculture Livestock, 1983-84
Zila Series: Noakhali, November 1988, BBS.
Figures in parenthesis indicate average number of animals per household

Table IV.2.3: Estimated livestock population in project area, 1996

Mauza	Number of Households	Average Number per Household			Total Livestock Population		
		Cattle	Goat	Poultry	Cattle	Goat	Poultry
Char Bastin	223	5.1	2.08	10.75	1,137	464	2,400
Char Lakshmi	402	5.1	2.08	10.75	2,050	836	4,320
Char Margaret	119	5.1	2.08	10.75	607	1,263	1,280
Char Montaz	982	5.1	2.08	10.75	5,008	2,042	10,560
Char Kukri Mukri	894	5.1	2.08	10.75	4,560	1,860	9,610
Char Patila	810	5.1	2.08	10.75	4,131	1,685	8,710
Total	**3,430**	5.1	2.08	10.75	**17,493**	**8,150**	**36,880**

Sources: BBS; Cyclone Shelter Preparatory Study; Consultants' estimates.

Table IV.2.4: Average performance parameters of livestock

Item	Unit	Cattle	Buffalo	Goat/sheep	Poultry
Adult body weight	kg.	150-180	350-450	16-26	1-2
Milk production (per location)	kg.	200-250	550-600	-	-
Reproduction	%	50	55	120	-
Egg production		-	-	-	40
Mortality	%	25	20	30	60

Table IV.2.5: Technical parameters for cattle model

Item	Unit	Present	With project
Mortality adult	%	5	4
Youngsters	%	13	8
1-3 years	%	7	5
Conception rate	%	50	60
Milk production	kg	150	200

Table IV.2.6: Technical parameters for goat model

Item	Unit	Present	With project
Mortality adult	%	8	3
Youngsters	%	25	5
Conception rate	%	120	160

Table IV.2.7: Technical parameters for chicken model

Item	Unit	Present	With project
Egg production		40	60
Mortality	%	60	30
Supplementary feed	kg/bird	-	2

Table IV.2.8: Estimates of growth in livestock population

Type of Animal	Growth Rate 1983-84 to 1988-89 (%) 1/	Annual Growth Rate	Cyclone Shelter Preparatory Study 2/	MES estimate growth rate	
				Without project	With project
Cattle	-1.7	-0.34	2.8	2.2	2.8
Buffalo	36.6	7.32		2.2	2.8
Goat	39	7.8	5.3	2.5	5
Sheep	24	4.8			
Chicken	26	5.2	24.1	5	7.3
Duck	13	2.6			

1/ BBS 1994, survey on Livestock and Poultry in Bangladesh 1988-89.
2/ Cyclone Shelter Preparatory Study, Volume 4 Livestock, Sener Ingenieria Sistemes Sa.,1996.

Table IV.2.9: Indicative unit costs for livestock programme

Item	Cost per unit (Tk)
Demonstrations	5,000
Training for farmers	200
Training of one Livestock Field Worker (LFW)	3,000
Training of five Women Poultry Workers	1,500
Field Equipment for LFW	2,500
Equipment for WPW (Vaccination kit box)	600
Bicycle for LFW	4,000

Table IV.2.10: Credit projects

Type of Project	Unit Cost (Tk)	No. of Additional Units in Each Year					Total (Tk '000)
		Year 1	Year 2	Year 3	Year 4	Year 5	
Draft Cattle	15,000	6	9	9	12	12	720
Milch cow	6,300	6	9	9	12	12	302
Beef fattening	9,500	12	12	18	24	24	855
Goat fattening	5,000	12	12	18	24	24	450
Goat rearing	3,000	12	12	18	24	24	270
Chickens - Layers	18,000	4	4	5	5	6	432
Chickens - Broilers	5,100	4	4	5	5	6	123
Total (Tk '000)		430	494	622	791	814	3,152

Table IV.2.11: Cost of livestock development programme

Item	No.	Monthly/Unit Cost	Annual Cost	Total Cost
Extension Officers	2	18,000	216,000	1,080,000
Support/Admin. Staff	2	14,000	168,000	840,000
Logistics Support & Office			250,000	1,250,000
Fuel		2,450	29,400	147,000
Training for Farmers	100	200	20,000	100,000
Demonstrations	12	5,000	60,000	300,000
Training for LFWs	3	3,000	9,000	45,000
Training for WPWs	5	1,500	7,500	37,500
Field Equipment for WPWs	5	1,000	5,000	25,000
Bicycles for LFWs	3	4,000	12,000	60,000
Materials & Equipment				
Motorcycles	2	154,000		308,000
Training Materials				30,000
Office Equipment				200,000
TOTAL (five year programme)				4,422,500

FISHERIES

1. PRESENT SITUATION OF FISHERIES AND AQUACULTURE

1.1 Introduction

Fisheries is an important component in the Char Montaz-MES project area which contributes vital role in nourishment, income generation, as well as in export earning. Approximately 37 per cent (MES socio-economic survey 1998) of the total households of the project area are engaged in this profession for their livelihood. The statistics of available water bodies with present annual total fish catch, catch/area (kg/ha) of the project is furnished in XXX.

There are two types of fisheries in the project area:

- *Capture fisheries:*, carried out at sea in the inshore and offshore waters and in inland water bodies such as beels, khals, rivers and the flood plain.
- *Aquaculture*: which comprises the pond raising of carp spp and shrimps in respectively fresh and brackish water.

1.2 Statistics

A preliminary survey executed under the aegis of MES indicated estimated an annual production of 597 mt of fish. A breakdown of the annual yield among the different categories is presented below in Table IV.3.1.

Table IV.3.1: Fish production in the Char Montaz MES study area

Category	Annual production (mt.)	Percentage of total production
Aquaculture	30	5
Marine fisheries	567	95
Total	597	100

The figures indicate that the major proportion of the fish production is contributed by marine fisheries. This production is based on secondary data obtained from Thana fisheries officers and on a RRA survey and underestimates the catch as if it were totally consumed by the total population (17,108 persons) it would indicate a per capita daily consumption of 95 grams.

Approximately 2,120 mt of fish is caught in the Char Montaz study area if estimated by summing the annual catch of the different gears operated at Char Montaz (Table IV.3.2).

Table IV.3.2: Estimated annual catch of the Char Montaz study area

Gear Type	Char Montaz	Kukri Mukri	Total	CPUE (kg/year)	Annual Catch (mt)
Fishing Households	646	265	911	0	
ESBN in Project area	47	120	168	4,300	721
MSBN	0	0	0	6,800	0
Hilsha gear	236	48	285	4,000	1,138
Long line	16	0	16	9,000	142
Lift net	79	96	175	50	9
Cast net	1214	963	2,177	50	109
Fishing income (Tk/year)	13121	11,544	12,662		
Average fish price (Tk/kg)	30	30	30		
Fish sold per fishing HH (kg/year)	437	385	822		
Total fish sold (mt/year)	758	463	1,222		2,119

Note: Estimated from the results of the MES frame survey and average catches of the different gear (BoBP).

1.3 Fisheries production and fish consumption

In the last decade the fish production in Bangladesh increased annually with approximately 3 per cent, from 790,000 mt in 1985 to 1,170,000 mt in 1996 (BFRSS, 1996)) and a similar growth has been reported for the project area (MES, 1996). Major contributors to this growth are:

- the development of aquaculture
- marine artisanal and flood plain fisheries.

Even if the statistical data reflect the trends in the field[1], it does not mean that fisheries is in healthy stage growth is most likely due to the increased number of fishermen while at the same time the catch per fishermen decreased. The latter is the first sign of over exploitation of fish stocks.

With a total population of 117.5 million the availability of fish protein is 27 g/person/day and total availability is 40 g/person/day with 13 g/person/day available through meat, eggs and milk. A progressive decline in protein intake over the last 30 years has been indicated before (INFS, 1983) and at present we arrived at a situation of protein deficiency.

Table IV.3.3: Average per capita protein intake in Bangladesh.

	1962-64	1975-76	1981-82	1995-96	Requirement
Protein intake (g/capita/day)	57.9	58.5	48.4	40.0	45.3

In the project area fish is the main and cheapest source of animal protein, as it is a fishing area.

1.4 Marine Fisheries

1.4.1 Fishing practices

Four main types of gears are being used, namely, push nets, gill nets, estuarine set bag nets (behundi) and marine set bag nets.

- Push nets. The rapid expansion of shrimp culture in Bangladesh has resulted in a tremendous demand for the seed of tiger shrimp (Bagda). Within the project area a large number of push nets are operated for seed fishing by part-time fishermen. The income generated by this activity is seasonal and varies between Tk 60 and Tk 2,000 per month.

- Gill nets are almost all drift gill nets placed in the Lower Meghna and its estuary. The majority (95 per cent) of the catch consists of Hilsha (Shad). Other species caught are pomfret, Spanish mackerel, croaker, snapper, etc.

- The estuarine set bag net is a traditional gear which is fixed by wooden poles in the estuary/river in areas with water depth less than 5 m depth. The fish comes with the current (tide), enters through the mouth and ends up in the bag. The gear is operated throughout the year although there is seasonal variation in the daily catch. The catch mainly consists of Bombay Duck, croaker, brown shrimp and ribbon fish. From a fisheries point of view the ESBN is rather destructive as it catch a large number of juvenile fish and shrimp. But it includes the largest number of fisherfolk as the investments are relatively low, they can be operated throughout the year and the fishing grounds are within reach of their non-motorised boats.

[1] A number of studies (MIS, FAO, FAP 17, etc.) indicated that the BFRSS is hampered by its small sample size, an outdated frame and logistic problems in analyses of data.

- The marine set bag net is more or less an enlarged version of the estuarine set bag net and is operated offshore, in areas with a depth range of 10-30 m where the salinity is 20-30 per cent. The fishing season is during the winter months when there is no fresh water run off and no fishing takes place during the monsoon period due to the weather conditions at sea. The majority of the catch consist of Pomfret, Bombay Duck and Anchovy followed by shrimps

1.4.2 Fishing community

Fishermen in the project area are mainly living in Char Montaz, Char Lakshmi and Kukri Mukri. The marine fishing village survey of 1984/85 (DOF, 1986) indicated that 37 per cent of the households (45 HH, 65 fishermen) in Char Lakshmi were fisherfolk's households. MES surveyed the village again in 1998 , no information was available for the other villages. A comparison of the status of fisheries in 1984 and 1998, in Char Lakshmi is presented in Table IV.3.4.

The figures indicate an almost threefold increase of the total population, the number of fishing households and number of boats, and a fourfold increase of the number of fishermen. In contrast with Nijhum Deep the percentage of fisherfolk households in Char Lakshmi did not change over this period

Table IV.3.4: Fisheries in Char Lakshmi in 1984 and 1998

	1984/1985 (DOF/FAO)	1998 (MES)
Total population	883	2,081
Total no. of households	121	357
No. of fishing households	45	133,789
No. of fishermen	65	780
% of fishing households	37.3%	37.4 %
No. of boats	25	76

Table IV.3.5: Local prices for fish Char Montaz

Species	Tk/kg
Chewa	5 - 6
Catfish	10 - 12
Shrimp (large)	90 - 125
Hilsha	30 - 40
Boal	20 - 25
Powa	7 - 8

Source: MES field survey, March 1997

1.4.4 Fisheries ecology and migration

Biologically, the estuary provides spawning and nursery areas for a large number of fish and crustacean which spend the remainder of their life cycles at sea, or in fresh water. Further the estuary provide avenues of entry and exit for migration of anadromous and catadromous fishes.

Within the Meghna estuary the following species are known to be **"estuarine dependent"**, that is that passing a portion of their life cycles in the estuary is **obligatory** for the completion of their life cycles.

- **Hilsha or Indian Shad** (*Tenualosa ilisha).* Hilsha in Bangladesh most likely comprises of a and of a marine/estuarine stock. Adults of the riverine stock migrate from the sea/estuary into the Meghna going further upstream into the Meghna/Pabna/Jamuna and Old Brahmaputra river (anadromous migration). They spawn upstream in these rivers and their

larvae are transported downstream with the river flow towards the nursery grounds in the river and estuary/sea (de Graaf *et al.*, in press). A major nursing area is located in the Meghna river in and around Chandpur from Mushiganj to Hazimara. Another important nursing area is located in the estuary/sea from Kuakata (Pathuakali) to Dubla Island. The marine stock spawns in the lower stretches of the Meghna river near Hatia, Sandwip and Bhola. The most important spawning place in the estuary are located south of Hatia and the Hatia main channel, south of Sandwip and South-east of Char Fasson.

- **Golda or fresh water prawn**, *Macrobrachium rosenbergii*. Golda is caught in the inland water of Bangladesh and is a major export product. Golda is depending on the estuary for completion of their life cycle. During the reproduction period berried female migrate downstream towards the estuary (catadromous migration). Larvae of Macrobrachium can survive for five days in freshwater but brackish water is required for their development. After nursing in the estuary the juveniles migrate upstream against the river current and grow-out in the inland waters.

- **Shrimps**: Bagda (Tiger shrimp, *Penaeus monodon*), Horina (Brown shrimp, *Metapenaeus monoceros*) Chaga (White shrimp, *Penaeus indicus)*. In general marine shrimp follow a diadromous life cycle involving migration between the sea and the estuary. Adult shrimp reproduce at sea and their post larvae are carried by the tide towards the estuarine mangrove areas and the near shore estuarine waters of Teknaf, Cox's Bazaar, Noakhali and Patuakhali. They feed and grow-out to juvenile stage in the estuary, after which they migrate to the open sea.

- **Pangash or Catfish** (*Pangasius spp)*. The major nursing areas for some catfish species are the estuary of the Lower Meghna.

The annual catch and value of these "estuarine dependent" species in Bangladesh is presented in Table IV.3.6.

Table IV.3.6: Annual catch and value major estuarine dependent fish species

Species	Annual catch (mt.)	Value (million US$)
Hilsa	235,000	117.5
Fresh water prawn	405	1.62
Tiger shrimp	700	3.5
Brown shrimp	2.300	2.3
White shrimp	350	0.7
TOTAL		**125**

2. DEVELOPMENT OF FISHERIES AND AQUACULTURE

2.1 Inland fisheries

Inland fisheries is limited in the project area and will not be impacted by the proposed interventions. Improvement of inland fisheries could however be considered in the frame of a development plan. The installation of "Beel resident fish sanctuaries" for maintaining the recruitment of these species could be considered. Quantitative figures for such a development can not be given at present as practical experiences with this option in Bangladesh are limited.

2.2 Marine fisheries

The construction of cross dams in principle alters the habitat of fish as water changes to land and impacts on fisheries can be expected. Within the intertidal area, the estuary serves as a nursing and breeding area of a large number of economic important estuarine dependent fish and shrimp species such as: Hilsha, Bagda, Golda, Pangash etc. Reduction of this area will certainly have a negative impact on these species. However quantification of these impacts is difficult as data/knowledge of the system is lacking. The proposed accelerated land reclamation must be treated carefully, but no quantification for this subject are given as:

- 25 per cent of the total fish catch of Bangladesh consists of Hilsha (*Tenualosa ilisha*) and according to FRI three major spawning areas are located in the MES area. Two of them located exactly in the area where accelerated land reclamation is proposed (Nijhum Dwip and Char Montaz). The results of the FRI study however does not allow a conclusion to be drawn as to if Hilsha spawns at the mud flat or in the main channel.

- one cross dam most likely will not have a significant impact. The cumulative impact of a number of cross dams could however have a impact similar to that of FCD/FCDI schemes on the inland fisheries, especially if Hilsha spawns on the mudflat. With the present knowledge we do not know if in the future the spawning places will move with the changing land/water patterns. Considering the economic importance of Hilsha (250,000 mt/year, US$ 100 million per year), the large number of households depending on it for its livelihood and the fact that most interventions are irreversible, a very cautious approach is essential.

- the numerous creeks and mud flats in the intertidal area serves as nursing area for three other important economic important species; Bagda, Golda and Pangash. The studied interventions will reduce this specific habitat and will reduce the survival of the post larvae/fry of these species, which are already under heavy pressure due to the earlier mentioned shrimp fry collection

Reference is also made to Volume 6, Fisheries and Aquaculture, of the Master Plan report.

2.3 Aquaculture

The introduction of aquaculture in the newly accreted land will be a element of the development plan this can be either carp culture, shrimp culture or both.

2.3.1 Carp culture

The rearing of carp in fresh water at present is not positively or negatively impacted by the proposed activities. Experience elsewhere in Bangladesh (FAP 20, MAEP) indicated that a major bottleneck for the development of carp rearing and the relative low production rates is the poor management techniques used. This is caused by "lack of knowledge" of the pond owners and operators.

A carp rearing development programme should include the existing cultured, culturable ponds in the existing area and new ponds to be excavated in the accreted land and a carp culture extension programme.

Carp culture is a well known activity in Bangladesh and therefore the husbandry techniques are not further described. For each activity a production and economic model is made based on the production and development of one hectare of pond production. These models are further used to indicate the costs and benefits obtained through carp culture under the different scenario's.

2.3.2 Further development of existing ponds.

The at present production rate of 825 kg/ha/year can be increased to 2,000 kg/ha/year if proper husbandry techniques are applied. The production rate will be less then the average production rate of 2,200 kg/ha/year as obtained elsewhere in Bangladesh and is caused by physical properties of soil and water in the coastal area. The production parameters for culturable ponds, cultured ponds and for ponds where the production was increased through an aquaculture extension program are presented in Tables VI.18 to VI.20.
Increasing the production of existing ponds and introduction of carp rearing in the newly accreted land can only be achieved if an aquaculture extension programme is carried out in the project area.

The basis of an aquaculture development programme is the transfer of knowledge through an extension officer. Experience in FAP 20 has indicated that the availability of credit is not a prerequisite for a successful programme. Interested pond owners and operators are given a basic training after which the extension officer visited each pond operator once a month at the pond site and provides further on site training. Experiences with similar programmes in Bangladesh (FAP 20, MAEP) indicated that one extension officer can cover 60 ponds per year and that it takes two year to bring the pond at the proposed production level of 2,000 kg/ha/year. The costs of a aquaculture extension programme are presented in Table IV.3.10.

Table IV.3.10: Cost of an aquaculture development project

AREA DEVELOPMENT PARAMETERS				
Average pond size	2000	m2		
Total pond area	200	ha		
Development time	5			
No of ponds covered per year	200			
No of Ponds/extension officer	60	per year		
Operating costs per ha	7027	Tk/ha	Development of one pond takes two year	
Total area developed in 5 years	200	ha		
Investment cost / ha	4840	Tk/ha	Investment replaced in 5 years	
OPERATING COSTS			Monthly costs Tk	Annual total Tk
Extension officers	3	No.	9,000	360,000
Supporting staff	1	No.	7,000	84,000
Administration	1	No.	9,000	72,000
Petrol	35	litre	3,675	44,100
Training	60,000	lump sum		60,000
Logistic support/office	125,000	lump sum		125,000
Office costs	185,000	lump sum		185,000
annual fish fortnight	10,000	lump sum		10,000
Miscellaneous + O&M (15%)				141,015
TOTAL				1,081,115
EQUIPMENT (5 year programme)				
Motorcycles	4	No.	616,000	
Training material		lump sum	44,000	
Office equipment		lump sum	220,000	
Miscellaneous (10%)			88,000	
TOTAL			968,000	

2.3.3 Shrimp culture

A major bottleneck of shrimp farming at present is the ravaging impact of the White spot disease which reduced production levels and average size of produced shrimps. Future developments can only be put in the perspective of solving the present non-sustainability of shrimp farming through the production of pathogen free post larvae, through the integration of proper husbandry techniques and through proper planning.

However, in order to get an idea of the future perspective the present production parameters and future production parameters are presented in Tables VI.1 and VI.22.

Appendix IV.4

SOCIO-ECONOMIC SURVEY

The annex contains

- results of the needs assessment for Char Montaz and Kukri Mukri
- results of the socio-economic household survey for Char Montaz and Kukri Mukri

The socio-economic household survey was implemented in Urir Char, Bara Baishdia, Char Majid and Nijhum Dwip at the same time as in Char Montaz and Kukri Mukri. The results for all areas are included here as they provide a useful comparison with the situation in the project area.

For further comment and analysis of these results, reference is made to Volume 4, Rural Development, of the Master Plan report.

Table IV.4.1: Population characteristics of the study area

Population Characteristics	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Total Households Surveyed	160	97	270	102	110	50
Total Population	1158	583	1648	620	684	306
Economically Active Population	302	137	518	160	217	92
Average Size of Households	7.2	6.0	6.1	6.1	6.2	6.1
Economic Dependency Ratio	283.4	325.6	218.2	287.5	215.2	232.6

$$\text{Economic Dependency Ratio} = \frac{\text{Total Population - Economically Active Population}}{\text{Economically Active Population}} \times 100$$

Table IV.4.2 : Sex distribution of the sample households

Age	Location											
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid		Char Montaz		Kukri-Mukri	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<5	105 17.2 %	81 14.8 %	65 21.6 %	57 20.2 %	94 10.9 %	83 10.6 %	52 16.7 %	33 10.7 %	32 9.4 %	44 12.8 %	20 12.1 %	17 12.1 %
5-14	199 32.6 %	186 33.9 %	81 26.9 %	101 35.8 %	237 27.5 %	240 30.6 %	124 39.9 %	143 46.3 %	102 29.9 %	105 30.6 %	46 27.7 %	42 30.0 %
15-24	92 15.1 %	93 17.0 %	42 14.0 %	35 12.4 %	176 20.4 %	170 21.7 %	35 11.3 %	35 11.3 %	70 20.5 %	61 17.8 %	41 24.7 %	26 18.6 %
25-34	82 13.4 %	79 14.4 %	37 12.3 %	43 15.3 %	114 13.2 %	109 13.9 %	21 6.8 %	43 13.9 %	32 9.4 %	45 13.1 %	18 10.8 %	19 13.6 %
35-44	41 6.7 %	48 8.8 %	30 10.0 %	21 7.5 %	77 8.9 %	95 12.1 %	38 12.2 %	28 9.1 %	33 9.7 %	33 9.6 %	13 7.8 %	12 8.6 %
45-54	30 4.9 %	22 4.0 %	17 5.7 %	16 5.7 %	73 8.5 %	47 6.0 %	27 8.7 %	24 7.8 %	28 8.2 %	23 6.7 %	12 7.2 %	14 10.0 %
55>	61 10.0 %	39 7.1 %	29 9.6 %	9 3.2 %	92 10.7 %	41 5.2 %	14 4.5 %	3 1.0 %	44 12.9 %	32 9.3 %	16 9.6 %	10 7.1 %
Total	610 100.0 %	548 100.0 %	301 100.0 %	282 100.0 %	863.0 100.00 %	785 100.0 %	311 100.0 %	309 100.0 %	341 100.0 %	343 343.0 %	166 100.0 %	140 100.0 %
Sex Ratio	111.3		106.7		109.9		100.7		99.4		118.6	

Sex ratio = males per 100 females

Table IV.4.3 : Literacy rate of household members

Literacy Status	Location											
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid		Char Montaz		Kukri- Mukri	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Illiterate	247 48.9 %	276 59.0 %	118 50.0 %	121 53.8 %	231 30.0 %	237 35.0 %	175 67.6 %	243 88.0 %	198 64.1 %	225 75.3 %	80 54.8 %	91 74.0 %
School Attendance	258 51.1 %	191 40.9 %	188 50.0 %	104 46.2 %	538 70.0 %	456 65.0 %	84 32.4 %	33 12.0 %	111 35.9 %	74 24.8 %	66 45.2 %	32 26.0 %
Total	505 100.0 %	467 100.0 %	236 100.0 %	225 100.0 %	769 100.0 %	693 100.0 %	259 100.0 %	276 100.0 %	309 100.0 %	299 100.0 %	146 100.0 %	123 100.0 %

Note: Population five years and over

Table IV.4.4 : Main occupation of household heads

Occupation	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Agriculture	38 23.8 %	61 62.9 %	119 44.1 %	62 60.8 %	41 37.3 %	21 42.0 %
Agricultural Labour	2 1.3 %	17 17.5 %	24 8.9 %	24 23.5 %	10 9.1 %	3 6.0 %
Business	12 7.5 %	7 7.2 %	38 14.1 %	5 4.9 %	9 8.2 %	5 10.0 %
Fishing	81 50.6 %	3 3.1 %	55 20.4 %	1 1.0 %	20 18.2 %	6 12.0 %
Boat Labour	3 1.9 %	0 0.0 %	4 1.5 %	0 0.0 %	21 19.1 %	3 6.0 %
Service	10 6.3 %	4 4.1 %	13 4.8 %	0 0.0 %	3 2.7 %	1 2.0 %
Others	14 8.8 %	5 5.2 %	17 6.3 %	10 9.8 %	6 5.5 %	11 22.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.5 : Main occupation of household members

Occupation	Location											
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid		Char Montaz		Kukri-Mukri	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture	12 2.6 %	2 0.4 %	23 11.2 %	0 0.0 %	90 15.0 %	1 0.1 %	24 10.9 %	0 0.0 %	22 9.4 %	0 0.0 %	9 7.5 %	0 0.0 %
Agricultural Labour	7 1.5 %	0 0.0 %	4 1.9 %	0 0.0 %	45 7.5 %	2 0.3 %	28 12.7 %	3 1.0 %	11 4.7 %	2 0.6 %	2 1.7 %	0 0.0 %
Business	3 0.7 %	0 0.0 %	4 1.9 %	0 0.0 %	18 3.0 %	0 0.0 %	0 0.0 %	0 0.0 %	14 6.0 %	0 0.0 %	7 5.8 %	0 0.0 %
Fishing	84 18.5 %	2 0.4 %	2 1.0 %	0 0.0 %	57 9.5 %	0 0.0 %	2 0.9 %	0 0.0 %	16 6.8 %	1 0.3 %	10 8.3 %	0 0.0 %
Boatman	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 0.2 %	0 0.0 %	0 0.0 %	0 0.0 %	36 15.4 %	4 1.2 %	9 7.5 %	0 0.0 %
Service	10 2.2 %	5 0.9 %	5 2.4 %	0 0.0 %	18 3.0 %	5 0.6 %	0 0.0 %	0 0.0 %	5 2.1 %	0 0.0 %	5 4.2 %	0 0.0 %
Student	171 37.7 %	140 25.7 %	73.0 35.4 %	72 25.7 %	225 37.4 %	223 28.7 %	64 29.0 %	29 9.8 %	63 26.9 %	56 16.5 %	40 33.3 %	25 18.4 %
Housewife	0 0.0 %	206 37.9 %	0 0.0 %	103 36.8 %	0 0.0 %	353 45.5 %	0 0.0 %	97 32.7 %	0 0.0 %	152 44.7 %	0 0.0 %	63 46.3 %
Dependent	154 33.9 %	185 34.0 %	93 45.2 %	105.0 37.5 %	141 23.4 %	188 24.2 %	102 46.2 %	168 56.6 %	64 27.4 %	124 36.5 %	32 26.7 %	47 34.6 %
Others	13 2.9 %	4 0.7 %	2 1.0 %	0 0.0 %	7 1.2 %	4 0.5 %	1 0.5 %	0 0.0 %	3 1.3 %	1 0.3 %	6 5.0 %	1 0.7 %
Total	454 100.0 %	544 100.0 %	206 100.0 %	280 100.0 %	602 100.0 %	776 100.0 %	221 100.0 %	297 100.0 %	234 100.0 %	340 100.0 %	120 100.0 %	136 100.0 %

Table IV.4.6 : Secondary occupation of household heads

Occupation	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Agriculture	62 38.8 %	5 5.2 %	65 24.1 %	6 5.9 %	13 11.8 %	4 8.0 %
Agricultural Labour	11 6.9 %	3 3.1 %	11 4.1 %	28 27.5 %	14 12.7 %	1 2.0 %
Absentee Land Owner	2 1.3 %	0 0.0 %	1 0.4 %	0 0.0 %	0 0.0 %	0 0.0 %
Business	5 3.1 %	6 6.2 %	14 5.2 %	5 4.9 %	8 7.3 %	7 14.0 %
Fishing	16 10.0 %	12 12.4 %	48 17.8 %	23 22.6 %	8 7.3 %	1 2.0 %
Boatman	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	17 15.5 %	5 10.0 %
Service	1 0.6 %	2 2.1 %	1 0.4 %	0 0.0 %	0 0.0 %	0 0.0 %
Others	2 1.3 %	0 0.0 %	0 0.0 %	1 1.0 %	3 2.7 %	1 2.0 %
No Secondary Occupation	61 38.1 %	69 71.1 %	130 48.2 %	39 38.2 %	47 42.7 %	31 62.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.7 : Secondary occupation of household members

Occupation	Location											
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid		Char Montaz		Kukri-Mukri	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Agriculture	51 11.2 %	0 0.0 %	0 0.0 %	0 0.0 %	17 2.8 %	0 0.0 %	0 0.0 %	0 0.0 %	5 2.1 %	2 0.6 %	0 0.0 %	0 0.0 %
Agricultural Labour	3 0.7 %	0 0.0 %	0 0.0 %	0 0.0 %	13 2.2 %	0 0.0 %	10 4.5 %	3 1.0 %	6 2.6 %	0 0.0 %	1 0.8 %	0 0.0 %
Absentee Land Owner	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Business	1 0.2 %	0 0.0 %	0 0.0 %	0 0.0 %	1 0.2 %	0.0 0.0 %	0 0.0 %	0 0.0 %	2 0.9 %	0 0.0 %	1 0.8 %	0 0.0 %
Fishing	2 0.4 %	2 0.4 %	1 0.5 %	0 0.0 %	41 6.8 %	1 0.1 %	8 3.6 %	0 0.0 %	2 0.9 %	0 0.0 %	4 3.3 %	2 1.5 %
Boatman	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	14 6.0 %	0 0.0 %	1 0.8 %	0 0.0 %
Service	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Others	1 0.2 %	2 0.4 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 0.4 %	0 0.0 %	2 1.7 %	0 0.0 %
No Secondary Occupation	396 87.2 %	540 99.3 %	204 99.0 %	280 100.0 %	530 88.0 %	775 99.9 %	203 91.9 %	294 99.0 %	204 87.2 %	338 99.4 %	111.0 92.5 %	134 98.5 %
Total	454 100.0 %	544 100.0 %	206 100.0 %	280 100.0 %	602 100.0 %	776 100.0 %	221 100.0 %	297 100.0 %	234 100.0 %	340 100.0 %	120 100.0 %	136 100.0 %

Table IV.4.8 : Settlement pattern of households in sample areas

Population Characteristics	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
% in Cluster Settlement	116 72.5 %	9 9.3 %	195 72.2 %	31 30.4 %	5 4.6 %	18 36.0 %
% in Single Settlement	44 27.5 %	88 90.7 %	75 27.8 %	71 69.6 %	105 95.5 %	32 64.0 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.0 %

Table IV.4.9 : Settlement pattern preferences of households

Preference for Settlement Pattern	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	41 25.6 %	8 8.3 %	97 35.9 %	31 30.4 %	15 13.6 %	8 16.00 %
Single	119 74.4 %	89 91.8 %	173 64.1 %	71 69.6 %	95 86.4 %	42 84.00 %
Total	160 100.0 %	97 100.0 %	270 100.0 %	102 100.0 %	110 100.0 %	50 100.00 %

Table IV.4.10 : Household structure in the sample areas

Household Structure	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Average household size	7.2	6.0	6.1	6.1	6.2	6.1
% Female headed households	4 2.5 %	2 2.1 %	9 3.3 %	12 11.8 %	3 2.7 %	4 8.0 %
% of Households with seasonal out-migrat	41 25.6 %	4 4.1 %	14 5.2 %	35 34.3 %	5 4.6 %	1 2.0 %

Table IV.4.11 : Land ownership of households

Land Holding (hectares)	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Functionally Land less 0.00 - 0.02	53 33.1 %	28 28.9 %	28 10.4 %	2 2.0 %	33 30.0 %	11 22.0 %
Marginal farmer 0.02 - 0.20	3 1.9 %	4 4.1 %	53 19.6 %	20 19.6 %	23 20.9 %	12 24.0 %
Small farmer 0.20 - 1.00	100 62.5 %	53 54.6 %	108 40.0 %	73 71.6 %	20 18.2 %	12 24.0 %
Medium farmer 1.01 - 3.03	3 1.9 %	11 11.3 %	55 20.4 %	6 5.9 %	22 20.0 %	10 20.0 %
Large farmer Above 3.03	1 0.6 %	1 1.0 %	26 9.6 %	1 1.0 %	12 10.9 %	5 10.0 %

Table IV.4.12 : Operational holdings of households

Reasons	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri Mukri
	hectares	hectares	hectares	hectares	hectares	hectares
Own land farming	58.9 47.2 %	43.6 58.6 %	129.1 37.5 %	36.3 58.4 %	49.8 33.0 %	27.4 38.4 %
Lease in	7.0 5.6 %	0.0 0.0 %	43.3 12.6 %	0.0 0.0 %	33.4 22.2 %	5.8 8.2 %
Mortgage in	12.8 10.3 %	2.5 3.3 %	7.5 2.2 %	0.8 1.3 %	3.2 2.2 %	0.0 0.0 %
Share Crop in	46.0 36.9 %	28.4 38.1 %	164.3 47.7 %	25.1 40.4 %	64.4 42.7 %	38.2 53.5 %
Others	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %
Total	124.7 100.0 %	74.5 100.0 %	344.2 100.0 %	62.1 100.0 %	150.8 100.0 %	71.4 100.0 %

Note : Land leased, mortgaged or share cropped in will not necessarily equal to the land share cropped, leased and mortgaged out (Table-13) due to household sampling.

Table IV.4.13 : Own land not cultivated

Reasons	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
	hectares	hectares	hectares	hectares	hectares	hectares
Share crop out	16.7 66.2 %	9.3 70.3 %	107.4 84.3 %	8.5 84.4 %	8.0 54.7 %	4.7 78.5 %
Lease out	0.0 0.0 %	0.8 5.9 %	11.3 8.8 %	0.0 0.0 %	6.0 41.3 %	1.3 21.5 %
Mortgage out	7.0 27.6 %	1.5 11.6 %	8.8 6.9 %	1.6 15.6 %	0.6 4.0 %	0.0 0.0 %
Others	1.6 6.2 %	1.6 12.2 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %	0.0 0.0 %
Total	25.2 100.0 %	13.2 100.0 %	127.4 100.0 %	10.1 100.0 %	14.6 100.0 %	6.0 100.0 %

Note : Land leased, mortgaged or share cropped out will not necessarily equal to that land share cropped, leased or mortgaged in (Table-12) due to household sampling.

Table IV.4.14 : Reasons for settlement in the sample areas

Reasons	Location					
	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Landless	51 31.9 %	16 16.5 %	34 12.6 %	55 53.9 %	47 42.7 %	11 22.0 %
River erosion	92 57.5 %	80 82.5 %	6 2.2 %	39 38.2 %	13 11.8 %	2 4.0 %
Inheritance	2 1.3 %	0 0.0 %	205 75.9 %	2 2.0 %	21 19.1 %	30 60.0 %
Others	15 9.4 %	1 1.0 %	25 9.3 %	6 5.9 %	29 26.4 %	7 14.0 %

Table IV.4.15 : Land title status

Location	% Title Deed to Homestead			% Title Deed to Agricultural Land			% Applied for Khas land	% Household Settled without Legal Authority
	Husband	Wife	No owner-ship	Husband	Wife	No owner-ship		
Nijhum Dwip	98 61.3 %	94 58.8 %	57 35.6 %	105 65.6 %	96 60.0 %	55 34.4 %	153 95.6 %	38 23.8 %
Urir Char	68 70.1 %	16 16.5 %	29 29.9 %	63 65.0 %	18 18.6 %	34 35.1 %	63 65.0 %	27 27.8 %
Bara Baishdia	234 86.7 %	10 3.7 %	29 10.7 %	204 75.6 %	7 2.6 %	66 24.4 %	172 63.7 %	1 0.4 %
Char Majid	38 37.3 %	0 0.0 %	64 62.8 %	38 37.3 %	0 0.0 %	64 62.8 %	88 86.3 %	63 61.8 %
Char Montaz	67 60.9 %	4 3.6 %	39 35.5 %	51 46.4 %	9 8.2 %	48 52.7 %	57 51.8 %	35 31.8 %
Kukri-Mukri	34 68.0 %	3 6.0 %	13 26.0 %	27 54.0 %	3 6.0 %	23 46.0 %	14 28.0 %	9 18.0 %

Table IV.4.16A : Loss of land by households

Location	Land loss in last 10 years by reasons						
	Area (hectares)						
	Household with less than 1.0 ha			Household with 1.0 ha and over			
	A	B	C	A	B	C	Total
Nijhum Dwip	0 0.0 %	0 0.0 %	7 43.8 %	1 6.3 %	2 12.5 %	6 37.5 %	16 100.0 %
Urir Char	5 7.5 %	1 1.5 %	0 0.0 %	58 86.6 %	2 3.0 %	1 1.5 %	67 100.0 %
Bara Baishdia	98 44.0 %	1 0.5 %	16 7.2 %	87 39.0 %	5 2.2 %	16 7.2 %	223 100.0 %
Char Majid	0 0.0 %	3 11.5 %	21 80.8 %	1 3.9 %	0 0.0 %	1 3.9 %	26 100.0 %
Char Montaz	4 15.4 %	4 15.4 %	6 23.1 %	4 15.4 %	3 11.5 %	5 19.2 %	26 100.0 %
Kukri-Mukri	0 0.0 %	1 50.0 %	1 50.0 %	0 0.0 %	0 0.0 %	0 0.0 %	2 100.0 %

Table IV.4.16B : Gain of land by households

Location	Land gain in last 10 Years by reasons						Total
	Area (ha)						
	Household with less than 1.0 ha			Household with 1.0 ha and over			
	A	B	C	A	B	C	
Nijhum Dwip	1 1.2 %	4 4.8 %	2 2.4 %	74 88.1 %	0 0.0 %	3 3.6 %	84 100.0 %
Urir Char	0 0.0 %	5 22.7 %	0 0.0 %	4 18.2 %	11 50.0 %	2 9.1 %	22 100.0 %
Bara Baishdia	0 0.0 %	25 36.2 %	6 8.7 %	4 5.8 %	30 43.5 %	4 5.8 %	69 100.0 %
Char Majid	1 3.5 %	5 17.2 %	0 0.0 %	20 69.0 %	3 10.3 %	0 0.0 %	29 100.0 %
Char Montaz	0 0.0 %	8 28.6 %	5 17.9 %	1 3.6 %	5 17.9 %	9 32.1 %	28 100.0 %
Kukri-Mukri	0 0.0 %	3 30.0 %	3 30.0 %	1 10.0 %	1 10.0 %	2 20.0 %	10 100.0 %

LOSS (Reason) :

A: Erosion

B: Distribution among family members, gift, matrimonial, other methods of loss

C: Direct sale, mortgage out, sale to buy other asset.

GAIN (Reason) :

A: Khas land

B: Direct purchase, mortgage in, purchase against sale of other asset

C: Inheritance, matrimonial, gift, other methods of gain

Table IV.4.17 : Income and sources of income of households - agriculture

Location	Average Production (kg)						Average self consumption (kg)						Average Cash Income (Tk.)						Total Average Cash Income (Tk)
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	
Nijhum Dwip	1731	0	11	232	19	1	1312	0	3	152	16	0	2436	0	71	119	150	3	2779
Urir Char	1851	3	72	214	42	40	1451	3	43	130	16	3	2179	0	249	260	1046	211	3945
Bara Baishdia	2115	0	0	0	0	0	1441	0	0	0	0	0	3581	0	10	0	0	20	3611
Char Majid	982	0	44	66	14	9	833	0	12	32	9	2	807	0	497	35	167	47	1553
Char Montaz	1437	76	4	0	7	20	629	15	2	39	4	9	3883	649	38	36	39	184	4831
Kukri-Mukri	1461	19	1	9	1	16	695	6	0	5	1	6	4603	118	6	1	0	186	4914

Category A : Paddy

Category B : Wheat

Category C : Sunflower, Soyabean, Oil seeds, Groundnut, Pulse

Category D Potato, Sweet Potato, Vegetables

Category E : Onion, Garlic, Chilli

Category F : Fruits, Others

Note: In Char Montaz and Kukri-Mukri B = Pulse

Table IV.4.18 : Income and sources of income of households - livestock

Location	Average number per owning household						Average Cash Income (Tk.)						Total Average Cash Income (Tk)
	A	B	C	D	E	F	A	B	C	D	E	F	
Nijhum Dwip	484	37	621	5067	1	32534	1356	137	218	134	0	350	2196
	3.0	0.2	3.9	31.7	0.0	203.3							
Urir Char	338	63	256	1630	20	13050	3095	72	160	253	0	277	3866
	3.5	0.6	2.6	16.8	0.2	134.5							
Bara Baishdia	640	238	691	7026	60	7847	928	564	149	72	0	128	1842
	2.4	0.9	2.6	26.0	0.2	29.1							
Char Majid	160	0	72	1409	0	0	671	0	156	393	0	0	1221
	1.6	0.0	0.7	13.8	0.0	0.0							
Char Montaz	369	123	104	2928	5635	5245	1009	587	54	379	228	37	2294
	3.4	1.1	0.9	26.6	51.2	47.6							
Kukri-Mukri	146	32	42	797	1910	302	912	820	92	255	90	6	2175
	2.9	0.6	0.8	15.9	38.2	6.0							

Category A : Bullock, Dry cow, Milk cow, Calves

Category B : Buffalo

Category C : Sheep, Goat

Category D : Poultry

Category E : Milk

Category F : Eggs

Table IV.4.19 : Value of fishing for self consumption and cash sale

Location	Average Per Household in Taka					
	Open Water			Culture Fishing		
	Value of Fish Caught	Self Consumption	Cash Sale	Value of Fish Culture	Self Consumption	Cash Sale
Nijhum Dwip	20,913	3,825	17,088	499	213	179
Urir Char	13,658	2,106	11,552	1,120	622	856
Bara Baishdia	15,549	1,653	13,896	2,542	663	280
Char Majid	1,921	379	1,542	466	542	1,380
Char Montaz		-	10,043			112
Kukri-Mukri		-	7,420			20

Foot Note : The table shows only a fragment catch account (25% of the total catch). The rest catch goes to money lender, trader, agent. (Dadan)

Table IV.4.20 : Own farm employment of households

Location	Days Employed		
	< 50	50 - 100	above 101
	% of Households	% of Households	% of Households
Nijhum Dwip	4 4.2 %	32 33.3 %	60 62.5 %
Urir Char	2 2.9 %	19 27.5 %	47 68.1 %
Bara Baishdia	5 5.0 %	8 8.0 %	85 85.0 %
Char Majid	8 12.7 %	26 41.3 %	30 47.6 %
Char Montaz	5 9.4 %	9 17.0 %	39 73.6 %
Kukri-Mukri	1 4.4 %	13 56.5 %	9 39.1 %

Table IV.4.21 : Income transfer from migrant labour working outside

Location	Average Seasonal Yearly Income (Tk)	Average Full Time Yearly Income (Tk)	% of Seasonal Migrant Income Family	% of Full time Migrant Income Family
Nijhum Dwip	4,314	21,840	28.1	3.1
Urir Char	6,571	21,712	24.7	16.5
Bara Baishdia	13,673	42,228	5.6	18.2
Char Majid	3,540	5,743	49.0	14.7
Char Montaz	11,000	18,000	1.8	0.9
Kukri-Mukri	15,000	12,000	2.0	2.0

Table IV.4.22 : Children attending primary school

Location	Total Primary School age (5-12 yrs.) Children	Total Children Attending Primary School	Percentage of attending Primary School
Nijhum Dwip	353	257	72.8
Urir Char	168	116	69.1
Bara Baishdia	394	315	80.0
Char Majid	239	84	35.2
Char Montaz	174	32	18.4
Kukri-Mukri	72	23	31.9

Table IV.4.23 : Number of primary school age children

Location	Number of primary school age children						Mean per household
	% of Households						School-age going children
	0	1	2	3	4	= > 5	
Nijhum Dwip	21 13.1 %	33 20.6 %	37 23.1 %	38 23.8 %	25 15.6 %	6 3.8 %	2.2
Urir Char	20 20.6 %	20 20.6 %	32 33.0 %	17 17.5 %	7 7.2 %	1 1.0 %	1.7
Bara Baishdia	58 21.5 %	90 33.3 %	81 30.0 %	25 9.3 %	13 4.8 %	3 1.1 %	1.5
Char Majid	7 6.9 %	17 16.7 %	31 30.4 %	31 30.4 %	13 12.8 %	3 2.9 %	2.3
Char Montaz	22 20.0 %	33 30.0 %	31 28.2 %	18 16.4 %	5 4.6 %	1 0.9 %	1.6
Kukri-Mukri	12 24.0 %	15 30.0 %	14 28.0 %	7 14.0 %	2 4.0 %	0 0.0 %	1.4

Table IV.4.24 : Diseases the family suffered last year

Location	% of Member suffered from diseases					Treatment received	Hospital or Health centre visit by household
	A	B	C	D	E	Yes	Yes
Nijhum Dwip	343 64.4 %	92 17.3 %	14 2.6 %	4 0.8 %	80 15.0 %	512 96.1 %	50 31.3 %
Urir Char	76 46.1 %	41 24.9 %	16 9.7 %	0 0.0 %	32 19.4 %	163 98.8 %	22 22.7 %
Bara Baishdia	211 35.6 %	104 17.5 %	82 13.8 %	4 0.7 %	192 32.4 %	569 96.0 %	112 41.5 %
Char Majid	117 47.4 %	92 37.3 %	13 5.3 %	0 0.0 %	25 10.1 %	216 87.5 %	8 7.8 %
Char Montaz	85 44.0 %	34 17.6 %	37 19.2 %	0 0.0 %	37 19.2 %	162 83.9 %	25 22.7 %
Kukri-Mukri	34 46.6 %	15 20.6 %	12 16.4 %	0 0.0 %	12 16.4 %	50 68.5 %	9 18.0 %

A.Fever,Cough,Typhoid,Malaria

B. Diarrhea, Cholera, Dysentery

C. Ulcer, Gastric

D. TB

E. Others

Table IV.4.25 : Service received from NGOs

Location	Service received from NGO	Type of Service			
	Yes	Material aid	Credit	Technical aid	Other
Nijhum Dwip	125 78.1 %	123 98.4 %	1 0.8 %	0 0.0 %	1 0.8 %
Urir Char	12 12.4 %	12 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Bara Baishdia	4 1.5 %	0 0.0 %	1 25.0 %	2 50.0 %	1 25.0 %
Char Majid	61 59.8 %	29 47.5 %	24 39.3 %	4 6.6 %	4 6.6 %
Char Montaz	52 47.3 %	15 28.9 %	37 71.2 %	0 0.0 %	0 0.0 %
Kukri-Mukri	16 32.0 %	0 0.0 %	16 100.0 %	0 0.0 %	0 0.0 %

Table IV.4.26 : Family planning information received by households

Location	Received Family Planning Information
	Yes
Nijhum Dwip	95 59.4 %
Urir Char	62 63.9 %
Bara Baishdia	246 91.1 %
Char Majid	78 76.5 %
Char Montaz	22 20.0 %
Kukri-Mukri	8 16.0 %

Table IV.4.27 : Availability of fishery and agricultural extension services to households

Location	Service available			
	Agricultural Extension		Fishery Extension	
	Yes	No	Yes	No
Nijhum Dwip	0 0.0 %	160 100.0 %	1 0.6 %	159 99.4 %
Urir Char	0 0.0 %	97 100.0 %	0 0.0 %	97 100.0 %
Bara Baishdia	0 0.0 %	270 100.0 %	0 0.0 %	270 100.0 %
Char Majid	42 41.2 %	60 58.8 %	40 39.2 %	62 60.8 %
Char Montaz	0 0.0 %	110 100.0 %	0 0.0 %	110 100.0 %
Kukri-Mukri	0 0.0 %	50 100.0 %	0 0.0 %	50 100.0 %

Table IV.4.28 : Frequency of services available to households (agriculture and fisheries)

Location	Agricultural Extension Service Available				Fishery Extension Service Available			
	% of Households							
	Weekly	Monthly	Half-Yearly	No visit	Weekly	Monthly	Half-Yearly	No visit
Nijhum Dwip	0 0.0 %	0 0.0 %	0 0.0 %	160 100.0 %	1 0.6 %	0 0.0 %	0 0.0 %	159 99.4 %
Urir Char	0 0.0 %	0 0.0 %	0 0.0 %	97 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %	97 100.0 %
Bara Baishdia	0 0.0 %	0 0.0 %	0.0 0.0 %	270 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %	270 100.0 %
Char Majid	0 0.0 %	15 14.7 %	27 26.5 %	60 58.8 %	0 0.0 %	15 14.7 %	25 24.5 %	62 60.8 %
Char Montaz	0 0.0 %	0 0.0 %	0 0.0 %	110 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %	110 100.0 %
Kukri-Mukri	0 0.0 %	0 0.0 %	0 0.0 %	50 100.0 %	0 0.0 %	0 0.0 %	0 0.0 %	50 100.0 %

Table IV.4.29 : Credit and indebtedness of households last year

Location	Need of Loan			
	Yes		No	Total
	Received	Not received		
Nijhum Dwip	86 53.8 %	44 27.5 %	30 18.8 %	160 100.0 %
Urir Char	52 53.6 %	16 16.5 %	29 29.9 %	97 100.0 %
Bara Baishdia	158 58.5 %	41 15.2 %	71 26.3 %	270 100.0 %
Char Majid	32 31.4 %	60 58.8 %	10 9.8 %	102 100.0 %
Char Montaz	65 59.1 %	10 9.1 %	35 31.8 %	110 100.0 %
Kuk-Mukri	25 50.0 %	0 0.0 %	25 50.0 %	50 100.0 %

Table IV.4.30 : Credit and indebtedness of households last year

Location	Purpose				Total Average Amount	Total Av. Amount Paid	Total Av. Amount Not Paid
	A	B	C	D			
Nijhum Dwip	46 53.5 %	5 5.8 %	12 14.0 %	30 34.9 %	6847	10376	7001
Urir Char	34 65.4 %	3 5.8 %	13 25.0 %	5 9.6 %	4620	4577	2210
Bara Baishdia	55 34.8 %	23 14.6 %	83 52.5 %	8 5.1 %	7986	3117	8215
Char Majid	17 53.1 %	5 15.6 %	7 21.9 %	3 9.4 %	2315	2326	354
Char Montaz	25 38.5 %	17 26.2 %	4 6.2 %	31 47.7 %	5456	1799	3951
Kukri-Mukri	6 24.00 %	14 56.00 %	1 4.00 %	6 24.00 %	5600	1214	2908

Note : Some loans have multiple purposes

A. Agri Input, Agri Implements/Equipment, Anin

B. Debt repayment, Land purchase, Trad

C. Food, Education, Social obligation, Dowr

D. Fishing

Table IV.4.31 : Sources of credit

	Sources	Location					
		Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kukri-Mukri
Non Institutiona	Money lender	64 74.4 %	16 30.8 %	129 81.7 %	4 12.5 %	7 10.8 %	3 12.0 %
	Friends/ Relatives	11 12.8 %	3 5.8 %	5 3.2 %	7 21.9 %	2 3.1 %	0 0.0 %
	Traders	4 4.7 %	7 13.5 %	3 1.9 %	1 3.1 %	11 16.9 %	4 16.0 %
	Others	11 12.8 %	1 1.9 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %
Institutional	Commercial Bank	1 1.2 %	0 0.0 %	7 4.4 %	0 0.0 %	2 3.1 %	1 4.0 %
	BKB	1 1.2 %	27 51.9 %	27 17.1 %	0 0.0 %	3 4.6 %	3 12.0 %
	Grameen Bank	0 0.0 %	1 1.9 %	0 0.0 %	1 3.1 %	1 1.54 %	0 0.0 %
	Co-operative	1 1.2 %	0 0.0 %	0 0.0 %	2 6.3 %	0 0.0 %	0 0.0 %
	NGO	0 0.0 %	0 0.0 %	1 0.6 %	17 53.1 %	51 78.5 %	16 64.0 %
	Others	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	1 4.0 %

Table IV.4.32 : Loans received

Location	Amount in Taka				Total
	< 2000	2000 - 4000	4000 - 6000	> 6000	
Nijhum Dwip	26 30.2 %	27 31.4 %	14 16.3 %	19 22.1 %	86
Urir Char	14 26.9 %	13 25.0 %	17 32.7 %	8 15.4 %	52
Bara Baishdia	42 26.6 %	27 17.1 %	29 18.4 %	60 38.0 %	158
Char Majid	21 65.6 %	6 18.8 %	5 15.6 %	0 0.0 %	32
Char Montaz	6 9.2 %	37 56.9 %	10 15.4 %	12 18.5 %	65
Kukri-Mukri	14 56.0 %	5 20.0 %	2 8.0 %	4 16.0 %	25

Table IV.4.33 : Households current need for credit

Land Holding Class (hectares)	Location											
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid		Char Montaz		Kukri-Mukri	
	Need		Need		Need		Need		Need		Need	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
0 - 0.02	47 29.4 %	6 3.8 %	25 25.8 %	3 3.1 %	21 7.8 %	7 2.6 %	1 1.0 %	1 1.0 %	16 14.6 %	17 15.5 %	3 6.0 %	8 16.0 %
0.02 - 0.20	3 1.9 %	0 0.0 %	4 4.1 %	0 0.0 %	45 16.7 %	8 3.0 %	15 14.7 %	5 4.9 %	8 7.3 %	15 13.6 %	3 6.00 %	9 18.0 %
0.2 - 1.0	83 51.9 %	17 10.6 %	37 38.1 %	16 16.5 %	90 33.3 %	18 6.7 %	43 42.2 %	30 29.4 %	12 10.9 %	8 7.3 %	3 6.0 %	9 18.0 %
1.0 - 3.0	2 1.3 %	1 0.6 %	10 10.3 %	1 1.0 %	40 14.8 %	15 5.6 %	3 2.9 %	3 2.9 %	15 13.6 %	7 6.4 %	4 8.0 %	6 12.0 %
> 3.0	0 0.0 %	1 0.6 %	1 1.0 %	0 0.0 %	19 7.0 %	7 2.6 %	1 1.0 %	0 0.0 %	10 9.1 %	2 1.8 %	5 10.0 %	0 0.0 %

Table IV.4.34 : Reasons for current need for credit

Landholding Class (hectares)	Location																							
	Nijhum Dwip				Urir Char				Bara Baishdia				Char Majid				Char Montaz				Kukri-Mukri			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
0 - 0.02	13	12	4	18	6	13	3	3	12	0	0	9	1	0	0	0	2	6	1	7	1	0	0	2
	9.6 %	8.9 %	3.0 %	13.3 %	6.5 %	14.1 %	3.3 %	3.3 %	1.4 %	2.8 %	4.2 %	1.4 %	1.6 %	0.0 %	0.0 %	0.0 %	3.3 %	9.8 %	1.6 %	11.5 %	5.6 %	0.0 %	0.0 %	11.1 %
0.02 - 0.20	2	0	0	1	1	2	1	0	7	9	22	7	10	1	2	2	4	1	1	2	2	1	0	0
	1.5 %	0.0 %	0.0 %	0.7 %	1.1 %	2.2 %	1.1 %	0.0 %	3.3 %	4.2 %	10.2 %	3.3 %	15.9 %	1.6 %	3.2 %	3.2 %	6.6 %	1.6 %	1.6 %	3.3 %	11.1 %	5.6 %	0.0 %	0.0 %
0.2 - 1.0	40	18	4	21	18	10	6	3	22	29	33	6	26	13	1	3	1	6	0	5	1	2	0	0
	29.6 %	13.3 %	3.0 %	15.6 %	19.6 %	10.9 %	6.5 %	3.3 %	10.2 %	13.5 %	15.4 %	2.8 %	41.3 %	20.6 %	1.6 %	4.8 %	1.6 %	9.8 %	0.0 %	8.2 %	5.6 %	11.1 %	0.0 %	0.0 %
1.0 - 3.0	0	0	0	2	8	1	0	1	10	16	9	5	2	0	0	1	5	8	0	2	1	2	1	0
	0.0 %	0.0 %	0.0 %	1.5 %	8.7 %	1.1 %	0.0 %	1.1 %	4.7 %	7.4 %	4.2 %	2.3 %	3.2 %	0.0 %	0.0 %	1.6 %	8.2 %	13.1 %	0.0 %	3.3 %	5.6 %	11.1 %	5.6 %	0.0 %
> 3.0	0	0	0	0	1	0	0	0	4	5	8	2	1	0	0	0	3	4	0	3	3	1	1	0
	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %	0.0 %	0.0 %	0.0 %	1.9 %	2.3 %	3.7 %	0.9 %	1.6 %	0.0 %	0.0 %	0.0 %	4.9 %	6.6 %	0.0 %	4.9 %	16.7 %	5.6 %	5.6 %	0.0 %

A. Agri Input, Agri Implements/Equipment, Animal

B. Debt repayment, Land purchase, Trade

C. Food, Education, Social obligation, Dowry

D. Fishing

Table IV.4.35 : Preferred current sources of household loans

Landholding Class (hectares)	Location																							
	Nijhum Dwip				Urir Char				Bara Baishdia				Char Majid				Char Montaz				Kukri-Mukri			
	Preferred Sources				Preferred Sources				Preferred Sources				Preferred Sources				Preferred Sources				Preferred Sources			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
0 - 0.02	14	0	4	29	7	1	1	16	12	0	0	9	0	1	0	0	1	2	4	9	0	1	0	2
	10.4 %	0.0 %	3.0 %	21.5 %	7.6 %	1.1 %	1.1 %	17.4 %	5.6 %	0.0 %	0.0 %	4.2 %	0.0 %	1.6 %	0.0 %	0.0 %	1.6 %	3.3 %	6.6 %	14.8 %	0.0 %	5.6 %	0.0 %	11.1 %
0.02 - 0.20	1	1	0	1	2	0	0	2	26	1	5	13	3	9	0	3	1	4	0	3	1	1	1	0
	0.7 %	0.7 %	0.0 %	0.7 %	2.2 %	0.0 %	0.0 %	2.2 %	12.1 %	0.5 %	2.3 %	6.1 %	4.8 %	14.3 %	0.0 %	4.8 %	1.6 %	6.6 %	0.0 %	4.9 %	5.6 %	5.6 %	5.6 %	0.0 %
0.2 - 1.0	32	8	8	35	21	2	2	12	52	0	8	30	15	12	0	16	0	1	2	9	0	1	0	2
	23.7 %	5.9 %	5.9 %	25.9 %	22.8 %	2.2 %	2.2 %	13.0 %	24.2 %	0.0 %	3.7 %	14.0 %	23.8 %	19.1 %	0.0 %	25.4 %	0.0 %	1.6 %	3.3 %	14.8 %	0.0 %	5.6 %	0.0 %	11.1 %
1.0 - 3.0	0	0	0	2	7	1	0	2	18	1	3	18	1	1	0	1	0	5	6	4	1	1	0	2
	0.0 %	0.0 %	0.0 %	1.5 %	7.6 %	1.1 %	0.0 %	2.2 %	8.4 %	0.5 %	1.4 %	8.4 %	1.6 %	1.6 %	0.0 %	1.6 %	0.0 %	8.2 %	9.8 %	6.6 %	5.6 %	5.6 %	0.0 %	11.1 %
> 3.0	0	0	0	0	1	0	0	0	10	0	2	7	1	0	0	0	2	1	1	6	3	1	0	1
	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %	0.0 %	0.0 %	0.0 %	4.7 %	0.0 %	0.9 %	3.3 %	1.6 %	0.0 %	0.0 %	0.0 %	3.3 %	1.6 %	1.6 %	9.8 %	16.7 %	5.6 %	0.0 %	5.6 %

Table IV.4.36 : Households' need for seasonal loans

Land Holding Class (hectares)	Location							
	Nijhum Dwip		Urir Char		Bara Baishdia		Char Majid	
	Seasonal Loan		Seasonal Loan		Seasonal Loan		Seasonal Loan	
	Yes	No	Yes	No	Yes	No	Yes	No
0 - 0.02	18 11.3 %	35 21.9 %	14 14.4 %	14 14.4 %	7 2.6 %	21 7.8 %	0 0.0 %	2 2.0 %
0.02 - 0.20	0 0.0 %	3 1.9 %	2 2.1 %	2 2.1 %	32 11.9	21 7.8 %	7 6.9 %	13 12.8 %
0.2 - 1.0	27 16.9 %	73 45.6 %	35 36.1 %	18 18.6 %	84 31.1 %	24 8.9 %	57 55.9 %	16 15.7 %
1.0 - 3.0	1 0.6 %	2 1.3 %	10 10.3 %	1 1.0 %	49 18.2 %	6 2.2 %	6 5.9 %	0 0.0 %
> 3.0	0 0.0 %	1 0.6 %	1 1.03 %	0 0.0 %	20 7.4 %	6 2.2 %	1 1.0 %	0 0.0 %

Table IV.4.37 : Household purpose of seasonal loan

Location	Purpose of Seasonal Loan							
	A		B		C		D	
	Available	Not available	Available	Not available	Available	Not available	Available	Not available
	Farming							
Nijhum Dwip	4 8.7 %	6 13.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	0.0 0.0 %	2 4.4 %
Urir Char	13 21.0 %	28 45.2 %	0 0.0 %	1 1.6 %	0 0.0	0 0.0 %	0 0.0 %	0 0.0 %
Bara Baishdia	3 1.6 %	90 46.6 %	0 0.0 %	4 2.1 %	0 0.0 %	4 2.1 %	1 0.5 %	7 3.6 %
Char Majid	46 64.8 %	6 8.5 %	0 0.0 %	0 0.0 %	0 0.0 %	0 0.0 %	2 2.8 %	0 0.0 %
	Non-Farming							
Nijhum Dwip	3 6.5 %	16 34.8 %	1 2.2 %	3 6.5 %	0 0.0 %	0 0.0 %	2 4.4 %	9 19.6 %
Urir Char	5 8.1 %	10 16.1 %	0 0.0 %	1 1.6 %	0 0.0	2 3.2 %	1 1.6 %	1 1.6 %
Bara Baishdia	0 0.0 %	43 22.3 %	2 1.0 %	13 6.7 %	0 0.0 %	6 3.1 %	0 0.0 %	20 10.4 %
Char Majid	9 12.7 %	0 0.0 %	4 5.6 %	0 0.0 %	0 0.0 %	0 0.0 %	4 5.6 %	0 0.0 %

A. Agricultural Input, Agricultural Implements/Equipment, Animal

B. Debt repayment, Land purchase, Trade

C. Food, Education, Social Obligations, Dowry

D. Fishing

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Table IV.4.38 : Distribution of households by income from farm production

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kuri-Mukri
< 2000	92 57.5 %	37 38.1 %	160 59.3 %	54 52.9 %	38 34.6 %	12 24.0 %
2000 - 4000	16 10.0 %	10 10.3 %	8 3.0 %	18 17.7 %	11 10.0 %	3 6.0 %
4000 - 6000	6 3.8 %	10 10.3 %	6 2.2 %	9 8.8 %	11 10.0 %	3 6.0 %
> 6000	14 8.8 %	14 14.4 %	34 12.6 %	3 2.9 %	22 20.0 %	11 22.0 %
No agricultural income	32 20.0 %	26 26.8 %	62 23.0 %	18 17.7 %	28 25.5 %	21 42.0 %
Mean Income in Tk.	2225	2889	2782	1280	4831	4914

Note : Mean income is base on total samples

Table IV.4.39 : Distribution of households by income from livestock and poultry

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid	Char Montaz	Kuri-Mukri
< 2000	123 76.9 %	60 61.9 %	205 75.9 %	80 78.4 %	77 70.0 %	40 80.0 %
2000 - 4000	16 10.0 %	12 12.4 %	18 6.7 %	14 13.7 %	12 10.9 %	3 6.0 %
4000 - 6000	7 4.4 %	4 4.1 %	7 2.6 %	5 4.9 %	5 4.6 %	1 2.0 %
> 6000	11 6.9 %	17 17.5 %	22 8.2 %	3 2.94 %	13 11.8 %	5 10.0 %
No livestock and poultry income	3 1.9 %	4 4.1 %	18 6.7 %	0 0.0 %	3 2.7 %	1 2.0 %
Mean Income in Tk.	2196	3866	1842	1221	2361	2185

Note : Mean income is base on total samples

Table IV.4.40 : Distribution of households by income from open water fishing

Yearly Income range (Tk.)	Nijhum Dwip	Urir Char	Bara Baishdia	Char Majid
< 5000	18 11.3 %	11 11.3 %	75 27.8 %	86 84.3 %
5000 - 15000	66 41.3 %	10 10.3 %	65 24.1 %	12 11.8 %
15000 - 25000	20 12.5 %	1 1.0 %	23 8.5 %	0 0.0 %
> 25000	14 8.8 %	2 2.1 %	22 8.2 %	0 0.0 %
No fishing income	42 26.3 %	73 75.3 %	85 31.5 %	4 3.9 %
Mean Income in Tk.	12602	2858	9521	1481

Table IV.4.41 : Needs Assessment of Char Montaz and Kukrimukri Ranked by Social Group

	Possible intervention	Land owning farmers		Share cropping farmers		Landless labourers		Full time fishermen		Women		Boat operators		Overall intervention	
		Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri	Char Montaz	Kukri-mukri
A.	Construction of a cyclone shelter	4	2	5	3	5	3	5	2	5	3	3	2	4.50	2.50
B.	Construction of livestock Killa	9	8	7	9	9	10	10	9	11	9	10	11	9.33	9.33
C.	Creation of more accreted land	2	7	2	7	2	2	3	8	2	11	5	8	2.67	7.17
D.	Reduction in coastal erosion	12	13	12	13	12	13	12	13	12	13	12	12	12.00	12.83
E.	Planting of mangrove forestry	10	12	11	11	11	11	11	11	10	10	11	10	10.67	10.83
F.	Construction of an embankment to reduce saline water inflow	13	1	13	1	13	1	13	1	13	1	13	1	13.00	1.00
G.	Construction of drainage system to reduce monsoon flooding	5	9	4	10	7	9	8	12	9	12	9	13	7.00	10.83
H.	Build new cluster settlements	11	11	10	12	10	12	9	10	3	2	8	7	8.50	9.00
I.	Build new access roads	3	3	3	2	6	4	4	4	4	4	2	4	3.67	3.50
J.	Provide safe drinking water supplies	7	4	6	4	3	5	2	6	8	5	6	3	5.33	4.50
K.	Provide sanitation facilities	8	10	9	8	8	8	6	7	6	8	7	6	7.33	7.83
L.	Build schools	6	5	8	6	4	7	7	5	7	7	4	5	6.00	5.83
M.	Build health centres	1	6	1	5	1	6	1	3	1	6	1	12	1.00	6.33

Source: MES Field Surveys March 1998, 112 people interviewed

Note: Ranking is 1 for highest priory to 13 for the lowest

* Suggested intervention by social group

Table IV.4.42 : Need assessment of Char Montaz and Kukri-Mukri ranked by social group and location

	Possible intervention	Land owning farmers		Share cropping farmers		Landless labourers		Full time fisherman		Women		Boat operators		Overall intervention ranking	
		Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri	Char Montaz	Kukri-Mukri
A.	Construction of a cyclone shelter	4	2	5	3	5	3	5	2	5	3	3	2	4	2
B.	Construction of livestock Killa	9	8	7	9	9	10	10	9	11	9	10	11	10	10
C.	Creation of more accreted land	2	7	2	7	2	2	3	8	2	11	5	8	2	7
D.	Reduction in coastal erosion	12	13	12	13	12	13	12	13	12	13	12	12	12	13
E.	Planting of mangrove forestry	10	12	11	11	11	11	11	11	10	10	11	10	11	11
F.	Construction of an embankment to reduce saline water inflow	13	1	13	1	13	1	13	1	13	1	13	1	13	1
G.	Construction of drainage system to reduce monsoon flooding	5	9	4	10	7	9	8	12	9	12	9	13	7	12
H.	Build new cluster settlements	11	11	10	12	10	12	9	10	3	2	8	7	9	9
I.	Build new access roads	3	3	3	2	6	4	4	4	4	4	2	4	3	3
J.	Provide safe drinking water supplies	7	4	6	4	3	5	2	6	8	5	6	3	5	4
K.	Provide sanitation facilities	8	10	9	8	8	8	6	7	6	8	7	6	8	8
L.	Build schools	6	5	8	6	4	7	7	5	7	7	4	5	6	5
M.	Build health centres	1	6	1	5	1	6	1	3	1	6	1	12	1	6

Source: MES Field Surveys March 1998, 112 people interviewed

Note: Ranking is 1 for highest priory to 13 for the lowest

* Suggested intervention by social group

APPENDIX - V

PROJECT COST ANALYSIS

Table V.1 : Unit cost per metre cross dam (4 m a-frame)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	26.00	2,366
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13.00	1,489
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	15.00	1,249
4	Propex 6088 Screens	m2	78	3.25	252
5	Sewing yarn	kg	1,125	0.60	675
6	Transport cost of geotextile materials	L.S.			
	Sub-total				6,031
7	Local Sand (F.M = 1.3)	m3	550	6.00	3,300.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.60	600
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1.33	665
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	0.00	0
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	100.00	20,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	8.00	12,800
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	2.00	1,200
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	1.75	175
21	Shil-Barak Bamboo, 3" diameter	nos	192	19.00	3,648
22	Synthetic Bag	nos	18	155.00	2,790
23	Steel anchor (15 kg)	nos	550	0.50	275
24	Steel chain	m	250	2.20	550
25	Hardware material	m	3,500	1.00	3,500
	Sub-total				49,503
26	Labour cost	m	3,340	1.00	3,340
27	Equipment cost	m	4,000	1.00	4,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				7,340
	Total				**62,874**

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.2 : Unit cost per metre cross dam (6 m a-frame)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	32.50	2,958
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13.00	1,489
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	15.00	1,249
4	Propex 6088 Screens	m2	78	4.75	368
5	Sewing yarn	kg	1,125	0.60	675
6	Transport cost of geotextile materials	L.S.			
	Sub-total				6,739
7	Local Sand (F.M = 1.3)	m3	550	7.00	3,850.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.60	600
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1.33	665
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	0.00	0
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	155.00	31,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	10.00	16,000
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	2.00	1,200
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	2.60	260
21	Shil-Barak Bamboo, 3" diameter	nos	192	19.00	3,648
22	Synthetic Bag	nos	18	190.00	3,420
23	Steel anchor (15 kg)	nos	550	0.50	275
24	Steel chain	m	250	2.20	550
25	Hardware material	m	3,500	1.00	3,500
	Sub-total				64,968
26	Labour cost	m	3,340	1.00	3,340
27	Equipment cost	m	4,000	1.00	4,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				7,340
	Total				**79,047**

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.3 : Unit cost per m cross dam (8 m a-frame)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	39.00	3,549
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	13.00	1,489
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	20.00	1,665
4	Propex 6088 Screens	m2	78	6.25	484
5	Sewing yarn	kg	1,125	0.35	394
6	Transport cost of geotextile materials	L.S.			
	Sub-total				**7,581**
7	Local Sand (F.M = 1.3)	m3	550	9.00	4,950
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.80	800
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1.33	665
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	0.00	0
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	165.00	33,000
14	G.I. Pipe, 6" diameter	m	2,200	10.00	22,000
15	G.I. Pipe, 5" diameter	m	1,600	0.00	0
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	3.00	1,800
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	3.60	360
21	Shil-Barak Bamboo, 3" diameter	nos	192	19.00	3,648
22	Synthetic Bag	nos	18	250.00	4,500
23	Steel anchor (15 kg)	nos	550	0.50	275
24	Steel chain	m	250	2.20	550
25	Hardware material	m	3,500	1.00	3,500
	Sub-total				**76,048**
26	Labour cost	m	3,340	1.00	3,340
27	Equipment cost	m	4,000	1.00	4,000
28	Earth work	m3	50	0.00	0
29	Mobilization/demobilization	L.S.			
	Sub-total				**7,340**
	Total				**90,969**

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.4 : Unit cost per metre cross dam (protection embankment)

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	30.00	2,730
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	0.00	0
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	10.00	833
4	Propex 6088 Screens	m2	78	0.00	0
5	Sewing yarn	kg	1,125	0.50	563
6	Transport cost of geotextile materials	L.S.			
	Sub-total				4,126
7	Local Sand (F.M = 1.3)	m3	550	4.50	2,475.00
8	Sylhet Sand (F.M = 2.1)	m3	1,000	0.40	400
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	0.00	0
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0.00	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0.00	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	56.00	6,720
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	10.00	2,000
14	G.I. Pipe, 6" diameter	m	2,200	0.00	0
15	G.I. Pipe, 5" diameter	m	1,600	0.00	0
16	G.I. Pipe, 4" diameter	m	700	0.00	0
17	G.I. Pipe, 3" diameter	m	600	0.00	0
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0.00	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0.00	0
20	PVC Pipe, 22 mm diameter	m	100	0.00	0
21	Shil-Barak Bamboo, 3" diameter	nos	192	0.00	0
22	Synthetic Bag	nos	18	0.00	0
23	Steel anchor (15 kg)	nos	550	0.00	0
24	Steel chain	m	250	0.00	0
25	Hardware material	m	3,500	0.00	0
	Sub-total				11,595
26	Labour cost	m	3,340	0.20	668
27	Equipment cost	m	4,000	0.00	0
28	Earth work	m3	50	56.00	2,800
29	Mobilization/demobilization	L.S.			
	Sub-total				3,468
	Total				**19,189**

Note : These costs exclude taxes, duties and DVA on geotextiles

Table V.5 : Cost estimate Char Montaz cross dams A1 A-3, A-4, A-5 and A-6 (base costs)

Cross dam section with A-frame 8 m height	50	meter length
Cross dam section with A-frame 6 m height	370	meter length
Cross dam section with A-frame 4 m height	330	meter length
Embankment, protected	450	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	36,055	3,281,005
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	9,750	1,116,375
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	16,000	1,332,000
4	Propex 6088 Screens	m2	78	3,143	243,544
5	Sewing yarn	kg	1,125	324	363,938
6	Transport cost of geotextile materials	L.S.			210,000
	Sub-total				**6,546,862**
7	Local Sand (F.M = 1.3)	m3	550	7,045	3,874,750
8	Sylhet Sand (F.M = 2.1)	m3	1,000	640	640,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	998	498,750
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	25,200	3,024,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	85,400	17,080,000
14	G.I. Pipe, 6" diameter	m	2,200	500	1,100,000
15	G.I. Pipe, 5" diameter	m	1,600	3,330	5,328,000
16	G.I. Pipe, 4" diameter	m	700	2,640	1,848,000
17	G.I. Pipe, 3" diameter	m	600	2,250	1,350,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,720	171,950
21	Shil-Barak Bamboo, 3" diameter	nos	192	14,250	2,736,000
22	Synthetic Bag	nos	18	133,950	2,411,100
23	Steel anchor (15 kg)	nos	550	375	206,250
24	Steel chain	m	250	1,650	412,500
25	Hardware material	m	3,500	750	2,625,000
	Sub-total				**43,306,300**
26	Labour cost	m	3,340	840	2,805,600
27	Equipment cost	m	4,000	863	3,450,000
28	Earth work	m3	50	25,200	1,260,000
29	Mobilization/demobilization	L.S.			2,500,000
	Sub-total				**10,015,600**
	Total				**59,868,762**
30	Contingencies 10 % and rounding				5,987,238
	Total, including contingencies				**65,856,000**
	Sub-total foreign cost US$				**139,300**
	Sub-total local cost Taka				**59,309,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.6 : Cost estimate Char Montaz cross dams A1 A-7 and A-8 (base costs)

Cross dam section with A-frame 8 m height	150	meter length
Cross dam section with A-frame 6 m height	350	meter length
Cross dam section with A-frame 4 m height	300	meter length
Embankment, protected	100	meter length

Sl. No.	Description	Unit	Unit rate (Taka)	Total quantity	Cost (Taka)
1	Propex 6284 + RIG EDY 200.1 Bed Mattresses	m2	91	28,025	2,550,275
2	Propex 6288 + RIG EDY 200.1 Bed Mattresses	m2	115	10,400	1,190,800
3	Propex 6282 + RIG EDY 250.1 Geobags	nos	83	13,750	1,144,688
4	Propex 6088 Screens	m2	78	3,575	277,063
5	Sewing yarn	kg	1,125	258	289,688
6	Transport cost of geotextile materials	L.S.			210,000
	Sub-total				**5,662,514**
7	Local Sand (F.M = 1.3)	m3	550	6,050	3,327,500
8	Sylhet Sand (F.M = 2.1)	m3	1,000	550	550,000
9	R.C.C. Slab (1.0 m x 0.6 m x 0.15 m), footing A-frame	nos	500	1,064	532,000
10	R.C.C.beam 200 mm diameter in PVC pipe for bottom screens	nos	3,450	0	0
11	R.C.C. Slabs (1.1 m x 1.1 m x 0.125 m) for anchor blocks bottom screens	nos	1,000	0	0
12	C.C. Block (0.5 m x 05 m x 0.125 m), slope protection	nos	120	5,600	672,000
13	C.C. Block (0.4 m x 0.4 m x 0.4 m), ballast	nos	200	93,500	18,700,000
14	G.I. Pipe, 6" diameter	m	2,200	1,500	3,300,000
15	G.I. Pipe, 5" diameter	m	1,600	3,150	5,040,000
16	G.I. Pipe, 4" diameter	m	700	2,400	1,680,000
17	G.I. Pipe, 3" diameter	m	600	2,400	1,440,000
18	PVC Pipe, 200 mm diameter, closed at both ends	nos	5,500	0	0
19	PVC Pipe, 200 mm diameter, for anchor beam, open	nos	3,550	0	0
20	PVC Pipe, 22 mm diameter	m	100	1,975	197,500
21	Shil-Barak Bamboo, 3" diameter	nos	192	15,200	2,918,400
22	Synthetic Bag	nos	18	150,500	2,709,000
23	Steel anchor (15 kg)	nos	550	400	220,000
24	Steel chain	m	250	1,760	440,000
25	Hardware material	m	3,500	800	2,800,000
	Sub-total				**44,526,400**
26	Labour cost	m	3,340	820	2,738,800
27	Equipment cost	m	4,000	825	3,300,000
28	Earth work	m3	50	5,600	280,000
29	Mobilization/demobilization	L.S.			2,000,000
	Sub-total				**8,318,800**
	Total				**58,507,714**
30	Contingencies 10 % and rounding				5,850,286
	Total, including contingencies				**64,358,000**
	Sub-total foreign cost US$				**120,500**
	Sub-total local cost Taka				**58,695,000**

Note : These cost exclude taxes, duties and DVA on geotextiles.

Table V.7: Detailed costs

Bangladesh
Char Montaz - Kukri Mukri Integrated Development Project

(Local '000)	Unit	Unit Cost	Base Cost 01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total
I. Investment Costs										
A. Cross Dams										
1. Cross Dams A1 A-3, A1 A-4, A1 A-5, A1 A-6										
a. A-frame section - 8 metre										
Geotextiles	metre	15.6	782	-	-	-	-	-	-	782
Local materials	metre	76.0	3,802	-	-	-	-	-	-	3,802
Equipment costs	metre	4.0	200	-	-	-	-	-	-	200
Labour	metre	3.3	167	-	-	-	-	-	-	167
Subtotal A-frame section - 8 metre			4,952	-	-	-	-	-	-	4,952
b. A-frame section - 6 metre										
Geotextiles	metre	13.9	5,146	-	-	-	-	-	-	5,146
Local materials	metre	65.0	24,038	-	-	-	-	-	-	24,038
Equipment costs	metre	4.0	1,480	-	-	-	-	-	-	1,480
Labour	metre	3.3	1,236	-	-	-	-	-	-	1,236
Subtotal A-frame section - 6 metre			31,900	-	-	-	-	-	-	31,900
c. A-frame section - 4 metre										
Geotextiles	metre	12.4	4,108	-	-	-	-	-	-	4,108
Local materials	metre	49.5	16,336	-	-	-	-	-	-	16,336
Equipment costs	metre	4.0	1,320	-	-	-	-	-	-	1,320
Labour	metre	3.3	1,102	-	-	-	-	-	-	1,102
Subtotal A-frame section - 4 metre			22,866	-	-	-	-	-	-	22,866
d. Protected embankment										
Geotextiles	metre	8.5	3,832	-	-	-	-	-	-	3,832
Local materials	metre	11.6	5,218	-	-	-	-	-	-	5,218
Earth work	metre	2.8	1,260	-	-	-	-	-	-	1,260
Labour	metre	0.7	301	-	-	-	-	-	-	301
Subtotal Protected embankment			10,611	-	-	-	-	-	-	10,611
e. Other costs										
Geotextile transportation	L.S.		433	-	-	-	-	-	-	433
Mobilisation	L.S.		2,000	-	-	-	-	-	-	2,000
Subtotal Other costs			2,433	-	-	-	-	-	-	2,433
Subtotal Cross Dams A1 A-3, A1 A-4, A1 A-5, A1 A-6			72,761	-	-	-	-	-	-	72,761
2. Cross Dams A1 A-7 & A1 A-8										
a. A-frame section - 8 metre										
Geotextiles	metre	15.6	-	2,347	-	-	-	-	-	2,347
Local materials	metre	76.0	-	11,407	-	-	-	-	-	11,407
Equipment costs	metre	4.0	-	600	-	-	-	-	-	600
Labour	metre	3.3	-	501	-	-	-	-	-	501
Subtotal A-frame section - 8 metre			-	14,855	-	-	-	-	-	14,855
b. A-frame section - 6 metre										
Geotextiles	metre	13.9	-	4,868	-	-	-	-	-	4,868
Local materials	metre	65.0	-	22,739	-	-	-	-	-	22,739
Equipment costs	metre	4.0	-	1,400	-	-	-	-	-	1,400
Labour	metre	3.3	-	1,169	-	-	-	-	-	1,169
Subtotal A-frame section - 6 metre			-	30,176	-	-	-	-	-	30,176
c. A-frame section - 4 metre										
Geotextiles	metre	12.4	-	3,734	-	-	-	-	-	3,734
Local materials	metre	49.5	-	14,851	-	-	-	-	-	14,851
Equipment costs	metre	4.0	-	1,200	-	-	-	-	-	1,200
Labour	metre	3.3	-	1,002	-	-	-	-	-	1,002
Subtotal A-frame section - 4 metre			-	20,787	-	-	-	-	-	20,787
d. Protected embankment										
Geotextiles	metre	8.5	-	852	-	-	-	-	-	852
Local materials	metre	11.6	-	1,160	-	-	-	-	-	1,160
Earth work	metre	2.8	-	280	-	-	-	-	-	280
Labour	metre	0.7	-	67	-	-	-	-	-	67
Subtotal Protected embankment			-	2,358	-	-	-	-	-	2,358
e. Other costs										
Geotextile transportation	L.S.		-	433	-	-	-	-	-	433
Mobilisation	L.S.		-	2,000	-	-	-	-	-	2,000
Subtotal Other costs			-	2,433	-	-	-	-	-	2,433
Subtotal Cross Dams A1 A-7 & A1 A-8			-	70,609	-	-	-	-	-	70,609
Subtotal Cross Dams			72,761	70,609	-	-	-	-	-	143,370
B. Other Civil Works										
1. Embankments										
a. Char Montaz										
Primary embankments - resectioning	km	384.0	5,779	5,779	-	-	-	-	-	11,558
Secondary embankments	km	1,264.0	-	6,952	-	-	-	-	-	6,952
Sluices - 2 vents	unit	6,000.0	6,000	6,000	-	-	-	-	-	12,000
Surface sluices	unit	772.0	4,632	4,632	-	-	-	-	-	9,264
Drains /a	ha	0.6	-	1,506	1,506	-	-	-	-	3,012
Subtotal Char Montaz			16,411	24,869	1,506	-	-	-	-	42,787
b. Kukri Mukri										
Primary embankment	km	2,383.0	-	-	-	-	-	28,715	28,715	57,430
Sluices - 2 vents	unit	9,000.0	-	-	-	-	-	9,000	-	9,000
Sluices - 3 vents	unit	9,000.0	-	-	-	-	-	9,000	9,000	18,000
Surface sluices	unit	772.0	-	-	-	-	-	4,246	4,246	8,492
Drains	ha	1.4	-	-	-	-	-	1,962	1,962	3,924
Subtotal Kukri Mukri			-	-	-	-	-	52,923	43,923	96,846
c. Char Montaz - Bhola										
Primary Embankments	km	2,383.0	-	-	-	-	-	23,353	23,353	46,707
Secondary embankments	km	1,264.0	-	-	-	-	-	1,959	1,959	3,918
Sluices - 2 vents	unit	6,000.0	-	-	-	-	-	12,000	18,000	30,000
Surface sluices	unit	772.0	-	-	-	-	-	2,316	2,316	4,632
Drainage	ha	1.4	-	-	-	-	-	1,790	1,790	3,579
Subtotal Char Montaz - Bhola			-	-	-	-	-	41,418	47,418	88,837
Subtotal Embankments			16,411	24,869	1,506	-	-	94,341	91,341	228,470

Table V.7: Detailed costs (cont'd)

Bangladesh
Char Montaz - Kukri Mukri Integrated Development Project

(Local '000)			Base Cost							
C. Project Management										
1. Implementing Agencies										
Project Management /b	unit		1,859	1,394	930	930	930	1,859	1,394	9,296
BWDB Administration	Tk		5,578	4,183	2,789	2,789	2,789	5,578	4,183	27,888
Subtotal Implementing Agencies			7,437	5,578	3,718	3,718	3,718	7,437	5,578	37,184
D. Development of Settlements										
Village Development	village	560.0	-	-	-	-	-	7,840	7,840	15,680
Materials for dwelling	village	720.0	-	-	-	-	-	10,080	10,080	20,160
Water supply and sanitation	village	130.0	-	-	-	-	-	1,820	1,820	3,640
Access roads	village	15.0	-	-	-	-	-	210	210	420
Surveying, design, supervision	village	160.0	-	-	-	-	-	2,240	2,240	4,480
Subtotal Development of Settlements			-	-	-	-	-	22,190	22,190	44,380
E. Income Generation Support										
1. Fisheries Development										
Extension & Support Staff	Tk		516	516	516	516	516	-	-	2,580
Training of farmers	Tk		70	70	70	70	70	-	-	350
Logistics & Support	Tk		90	90	90	90	90	-	-	448
Equipment & Materials	Tk		968	-	-	-	-	-	-	968
Subtotal Fisheries Development			1,644	676	676	676	676	-	-	4,346
2. Livestock Development										
Extension & Support Staff	Tk		384	384	384	384	384	-	-	1,920
Training of Livestock Workers	Tk.		67	67	34	-	-	-	-	168
Training & Demonstrations	Tk		80	80	80	80	80	-	-	400
Logistics & Support	Tk		279	279	279	279	279	-	-	1,397
Equipment & Materials	Tk		538	-	-	-	-	-	-	538
Line of Credit	Tk		430	494	622	791	814	-	-	3,152
Subtotal Livestock Development			1,779	1,305	1,399	1,535	1,558	-	-	7,574
Subtotal Income Generation Support			3,422	1,980	2,075	2,210	2,233	-	-	11,920
Total Investment Costs			100,032	103,036	7,299	5,929	5,952	123,968	119,109	465,324
II. Recurrent Costs										
Cross Dams /c	Tk.		-	910	1,793	1,793	1,793	883	-	7,172
Embankments & sluices /d	Tk.		-	328	825	855	855	855	2,741	6,459
Total Recurrent Costs			-	1,238	2,618	2,648	2,648	1,738	2,741	13,631
Total			100,032	104,274	9,917	8,577	8,600	125,706	121,850	478,955

\a Excavation and re-excavation of drains.
\b BWDB Project Management at 2.5% of civil works base costs.
\c O&M for cross dam at 1.25% base costs for 4 years.
\d O&M at 2% of civil works base costs.

Table V.8: Expenditure accounts by years, base costs

Bangladesh
Char Montaz - Kukri Mukri Integrated Development Pr

	Base Cost (Local '000)								Foreign Exchange		Base Cost (US$ '000)								Foreign Exchange	
	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total	%	Amount	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total	%	Amount
I. Investment Costs																				
A. Civil Works																				
1. Cross Dams																				
Geotextiles	14,562	12,391	-	-	-	-	-	26,953	58.0	15,633	303	258	-	-	-	-	-	561	58.0	325
Geotextile transportation	455	455	-	-	-	-	-	909	58.0	527	9	9	-	-	-	-	-	19	58.0	11
Other materials	53,187	52,958	-	-	-	-	-	106,145	5.0	5,307	1,107	1,102	-	-	-	-	-	2,209	5.0	110
Equipment	3,150	3,360	-	-	-	-	-	6,510	5.0	326	66	70	-	-	-	-	-	135	5.0	7
Labour	2,946	2,876	-	-	-	-	-	5,822	5.0	291	61	60	-	-	-	-	-	121	5.0	6
Mobilisation	2,100	2,100	-	-	-	-	-	4,200	5.0	210	44	44	-	-	-	-	-	87	5.0	4
Subtotal Cross Dams	76,399	74,140	-	-	-	-	-	150,539	14.8	22,294	1,590	1,543	-	-	-	-	-	3,132	14.8	464
2. Embankments																				
Materials & Equipment	17,232	26,113	1,582	-	-	99,058	95,908	239,893	5.0	11,995	359	543	33	-	-	2,061	1,996	4,991	5.0	250
Subtotal Civil Works	93,631	100,252	1,582	-	-	99,058	95,908	390,432	8.8	34,288	1,948	2,086	33	-	-	2,061	1,996	8,124	8.8	713
B. Development of Settlements																				
Settlements & Dwellings	-	-	-	-	-	21,389	21,389	42,777	5.0	2,139	-	-	-	-	-	445	445	890	5.0	45
Water Supply & Sanitation	-	-	-	-	-	1,911	1,911	3,822	5.0	191	-	-	-	-	-	40	40	80	5.0	4
Subtotal Development of Settlements	-	-	-	-	-	23,300	23,300	46,599	5.0	2,330	-	-	-	-	-	485	485	970	5.0	48
C. Income Generation																				
2. Livestock																				
Livestock	1,416	851	816	781	781	-	-	4,644	1.2	56	29	18	17	16	16	-	-	97	1.2	1
Livestock LIne of Credit	452	519	653	831	855	-	-	3,309	-	-	9	11	14	17	18	-	-	69	-	-
Subtotal Livestock	1,868	1,370	1,469	1,611	1,635	-	-	7,953	0.7	56	39	28	31	34	34	-	-	165	0.7	1
3. Aquaculture	1,726	709	709	709	709	-	-	4,563	2.2	102	36	15	15	15	15	-	-	95	2.2	2
Subtotal Income Generation	3,593	2,079	2,178	2,321	2,345	-	-	12,516	1.3	158	75	43	45	48	49	-	-	260	1.3	3
D. Project Management																				
BWDB Administration /a	5,856	4,392	2,928	2,928	2,928	5,856	4,392	29,282	-	-	122	91	61	61	61	122	91	609	-	-
Project Management /b	1,952	1,464	976	976	976	1,952	1,464	9,761	-	-	41	30	20	20	20	41	30	203	-	-
Subtotal Project Management	7,809	5,856	3,904	3,904	3,904	7,809	5,856	39,043	-	-	162	122	81	81	81	162	122	812	-	-
Total Investment Costs	105,033	108,188	7,664	6,225	6,249	130,167	125,064	488,591	7.5	36,777	2,185	2,251	159	130	130	2,708	2,602	10,166	7.5	765
II. Recurrent Costs																				
A. Protection Works O&M																				
Civil Works O&M	-	1,300	2,749	2,780	2,780	1,825	2,878	14,313	-	-	-	27	57	58	58	38	60	298	-	-
Total Recurrent Costs	-	1,300	2,749	2,780	2,780	1,825	2,878	14,313	-	-	-	27	57	58	58	38	60	298	-	-
Total BASELINE COSTS	105,033	109,488	10,413	9,005	9,030	131,991	127,942	502,903	7.3	36,777	2,185	2,278	217	187	188	2,746	2,662	10,464	7.3	765
Physical Contingencies	9,722	10,363	651	510	513	12,418	12,209	46,386	7.9	3,678	202	216	14	11	11	258	254	965	7.9	77
Price Contingencies																				
Inflation																				
Local	12,401	19,081	2,668	2,904	3,535	60,367	68,174	169,130	-	-	258	397	56	60	74	1,256	1,418	3,519	-	-
Foreign	938	1,197	10	-	-	1,348	1,501	4,994	100.0	4,994	20	25	0	-	-	28	31	104	100.0	104
Subtotal Inflation	13,338	20,279	2,678	2,904	3,535	61,715	69,675	174,125	2.9	4,994	278	422	56	60	74	1,284	1,450	3,623	2.9	104
Devaluation	1,293	1,759	11	-	-	1,682	1,936	6,681	82.6	5,517	-119	-192	-29	-32	-39	-682	-782	-1,875	-	-
Subtotal Price Contingencies	14,631	22,038	2,689	2,904	3,535	63,397	71,611	180,806	5.8	10,511	159	230	27	29	34	602	668	1,748	5.9	104
Total PROJECT COSTS	129,387	141,889	13,753	12,420	13,077	207,807	211,762	730,095	7.0	50,966	2,547	2,723	257	227	233	3,606	3,584	13,177	7.2	946
Taxes	12,682	12,550	524	448	470	9,225	9,430	45,329	-	-	250	241	10	8	8	160	160	837	-	-
Foreign Exchange	15,873	15,394	108	-	-	9,684	9,906	50,966	-	-	312	295	2	-	-	168	168	946	-	-

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Table V.9: Expenditure accounts by years, totals including contingencies

Bangladesh
Char Montaz - Kukri Mukri Integrated Development Pro

	Totals Including Contingencies (Local '000)								Totals Including Contingencies (US$ '000)							
	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total
I. Investment Costs																
A. Civil Works																
1. Cross Dams																
Geotextiles	18,060	16,136	-	-	-	-	-	34,197	355	310	-	-	-	-	-	665
Geotextile transportation	564	592	-	-	-	-	-	1,156	11	11	-	-	-	-	-	22
Other materials	65,965	68,966	-	-	-	-	-	134,931	1,298	1,324	-	-	-	-	-	2,622
Equipment	3,907	4,376	-	-	-	-	-	8,282	77	84	-	-	-	-	-	161
Labour	3,654	3,745	-	-	-	-	-	7,399	72	72	-	-	-	-	-	144
Mobilisation	2,605	2,735	-	-	-	-	-	5,339	51	52	-	-	-	-	-	104
Subtotal Cross Dams	94,754	96,549	-	-	-	-	-	191,303	1,865	1,853	-	-	-	-	-	3,718
2. Embankments																
Materials & Equipment	21,372	34,006	2,163	-	-	156,800	159,405	373,745	421	653	40	-	-	2,721	2,698	6,533
Subtotal Civil Works	116,126	130,555	2,163	-	-	156,800	159,405	565,049	2,286	2,506	40	-	-	2,721	2,698	10,251
B. Development of Settlements																
Settlements & Dwellings	-	-	-	-	-	33,856	35,549	69,405	-	-	-	-	-	588	602	1,189
Water Supply & Sanitation	-	-	-	-	-	3,025	3,176	6,201	-	-	-	-	-	52	54	106
Subtotal Development of Settlements	-	-	-	-	-	36,881	38,725	75,606	-	-	-	-	-	640	655	1,295
C. Income Generation																
2. Livestock																
Livestock	1,756	1,108	1,115	1,121	1,177	-	-	6,277	35	21	21	20	21	-	-	118
Livestock LIne of Credit	560	676	893	1,193	1,289	-	-	4,611	11	13	17	22	23	-	-	85
Subtotal Livestock	2,316	1,784	2,009	2,313	2,466	-	-	10,888	46	34	38	42	44	-	-	204
3. Aquaculture	2,140	924	970	1,019	1,069	-	-	6,122	42	18	18	19	19	-	-	116
Subtotal Income Generation	4,457	2,708	2,979	3,332	3,535	-	-	17,010	88	52	56	61	63	-	-	319
D. Project Management																
BWDB Administration /a	6,603	5,200	3,640	3,822	4,013	8,428	6,637	38,342	130	100	68	70	71	146	112	698
Project Management /b	2,201	1,733	1,213	1,274	1,338	2,809	2,212	12,781	43	33	23	23	24	49	37	233
Subtotal Project Management	8,804	6,933	4,853	5,096	5,351	11,237	8,849	51,123	173	133	91	93	95	195	150	930
Total Investment Costs	129,387	140,196	9,995	8,428	8,886	204,918	206,979	708,788	2,547	2,691	187	154	158	3,556	3,503	12,796
II. Recurrent Costs																
A. Protection Works O&M																
Civil Works O&M	-	1,693	3,759	3,992	4,192	2,889	4,783	21,307	-	32	70	73	75	50	81	381
Total Recurrent Costs	-	1,693	3,759	3,992	4,192	2,889	4,783	21,307	-	32	70	73	75	50	81	381
Total PROJECT COSTS	129,387	141,889	13,753	12,420	13,077	207,807	211,762	730,095	2,547	2,723	257	227	233	3,606	3,584	13,177

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Table V.10: Procurement account by financiers

Bangladesh Char Montaz - Kukri Mukri Integrated Develo	(Local '000)									(US$ '000)								
	Donor		The Government		Total		For. Exch.	Local (Excl. Taxes)	Duties & Taxes	Donor		The Government		Total		For. Exch.	Local (Excl. Taxes)	Duties & Taxes
	Amount	%	Amount	%	Amount	%				Amount	%	Amount	%	Amount	%			
A. Civil Works																		
1. Cross Dams																		
Geotextiles	20,504	58.0	14,848	42.0	35,353	4.8	20,504	0	14,848	399	58.0	289	42.0	688	5.2	399	0	289
Materials & Equipment	133,728	85.8	22,223	14.3	155,951	21.4	7,798	141,136	7,018	2,599	85.8	432	14.3	3,030	23.0	152	2,743	136
Subtotal Cross Dams	154,232	80.6	37,071	19.4	191,303	26.2	28,302	141,136	21,866	2,997	80.6	721	19.4	3,718	28.2	550	2,743	425
2. Other Civil Works																		
Materials & Equipment	320,487	85.8	53,259	14.3	373,745	51.2	18,687	338,240	16,819	5,602	85.7	931	14.2	6,533	49.6	327	5,912	294
3. Development of Settlements	64,832	85.8	10,774	14.3	75,606	10.4	3,780	68,423	3,402	1,111	85.8	185	14.3	1,295	9.8	65	1,172	58
Subtotal Civil Works	539,551	84.2	101,104	15.8	640,655	87.7	50,770	547,799	42,087	9,710	84.1	1,836	15.9	11,546	87.6	942	9,827	777
B. Income Generating Activities	14,488	85.2	2,522	14.8	17,010	2.3	196	16,256	558	272	85.2	47	14.8	319	2.4	4	305	11
C. Technical Assistance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D. Project Implementation Costs	-	-	51,123	100.0	51,123	7.0	-	49,398	1,725	-	-	930	100.0	930	7.1	-	899	31
E. Recurrent Costs	18,111	85.0	3,196	15.0	21,307	2.9	-	20,348	959	324	85.0	57	15.0	381	2.9	-	364	17
Total	572,150	78.4	157,945	21.6	730,095	100.0	50,966	633,801	45,329	10,306	78.2	2,871	21.8	13,177	100.0	946	11,395	837

Table V.11: Local and foreign costs and taxes, by financier

Bangladesh Char Montaz - Kukri Mukri Integrate	(Local '000)						(US$ '000)					
	Donor		The Government		Total		Donor		The Government		Total	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
I. Foreign	50,966	100.0	-	-	50,966	7.0	946	100.0	-	-	946	7.2
II. Local (Excl. Taxes)	521,184	82.2	112,616	17.8	633,801	86.8	9,361	82.1	2,034	17.9	11,395	86.5
III. Taxes	-	-	45,329	100.0	45,329	6.2	-	-	837	100.0	837	6.3
Total Project	572,150	78.4	157,945	21.6	730,095	100.0	10,306	78.2	2,871	21.8	13,177	100.0

Table V.12: Economic costs

Bangladesh
Char Montaz - Kukri Mukri Integrated Development P

Economic Costs	Base Cost (Local '000)								Base Cost (US$ '000)								Foreign Exchange	
	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total	01/02	02/03	03/04	04/05	05/06	06/07	07/08	Total	%	Amount
I. Investment Costs																		
A. Civil Works																		
1. Cross Dams																		
Geotextiles	8,446	7,187	-	-	-	-	-	15,633	176	150	-	-	-	-	-	325	100.0	325
Geotextile transportation	264	264	-	-	-	-	-	527	5	5	-	-	-	-	-	11	100.0	11
Other materials	46,076	45,878	-	-	-	-	-	91,955	959	955	-	-	-	-	-	1,913	5.8	110
Equipment	2,729	2,911	-	-	-	-	-	5,640	57	61	-	-	-	-	-	117	5.8	7
Labour	2,552	2,491	-	-	-	-	-	5,043	53	52	-	-	-	-	-	105	5.8	6
Mobilisation	1,819	1,819	-	-	-	-	-	3,639	38	38	-	-	-	-	-	76	5.8	4
Subtotal Cross Dams	61,886	60,550	-	-	-	-	-	122,436	1,288	1,260	-	-	-	-	-	2,547	18.2	464
2. Embankments																		
Materials & Equipment	14,928	22,622	1,370	-	-	85,815	83,086	207,822	311	471	29	-	-	1,786	1,729	4,324	5.8	250
Subtotal Civil Works	76,814	83,172	1,370	-	-	85,815	83,086	330,258	1,598	1,731	29	-	-	1,786	1,729	6,872	10.4	713
B. Development of Settlements																		
Settlements & Dwellings	-	-	-	-	-	18,529	18,529	37,058	-	-	-	-	-	386	386	771	5.8	45
Water Supply & Sanitation	-	-	-	-	-	1,656	1,656	3,311	-	-	-	-	-	34	34	69	5.8	4
Subtotal Development of Settlements	-	-	-	-	-	20,185	20,185	40,369	-	-	-	-	-	420	420	840	5.8	48
C. Income Generation																		
2. Livestock																		
Livestock	1,225	733	703	672	672	-	-	4,006	25	15	15	14	14	-	-	83	1.4	1
Livestock LIne of Credit	407	468	589	749	771	-	-	2,985	8	10	12	16	16	-	-	62	-	-
Subtotal Livestock	1,633	1,201	1,292	1,422	1,444	-	-	6,991	34	25	27	30	30	-	-	145	0.8	1
3. Aquaculture	1,497	611	611	611	611	-	-	3,941	31	13	13	13	13	-	-	82	2.6	2
Subtotal Income Generation	3,129	1,812	1,903	2,033	2,055	-	-	10,932	65	38	40	42	43	-	-	227	1.4	3
D. Project Management																		
BWDB Administration /a	5,045	3,784	2,522	2,522	2,522	5,045	3,784	25,224	105	79	52	52	52	105	79	525	-	-
Project Management /b	1,761	1,321	880	880	880	1,761	1,321	8,804	37	27	18	18	18	37	27	183	-	-
Subtotal Project Management	6,806	5,104	3,403	3,403	3,403	6,806	5,104	34,028	142	106	71	71	71	142	106	708	-	-
Total Investment Costs	86,749	90,088	6,676	5,436	5,457	112,806	108,375	415,587	1,805	1,874	139	113	114	2,347	2,255	8,647	8.8	765
II. Recurrent Costs																		
A. Protection Works O&M																		
Civil Works O&M	-	1,120	2,368	2,395	2,395	1,572	2,479	12,329	-	23	49	50	50	33	52	257	-	-
Total Recurrent Costs	-	1,120	2,368	2,395	2,395	1,572	2,479	12,329	-	23	49	50	50	33	52	257	-	-
Total BASELINE COSTS	86,749	91,208	9,044	7,831	7,853	114,378	110,854	427,916	1,805	1,898	188	163	163	2,380	2,306	8,903	8.6	765
Physical Contingencies	7,994	8,610	564	443	445	10,757	10,575	39,389	166	179	12	9	9	224	220	820	9.3	77
Price Contingencies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total PROJECT COSTS	94,743	99,818	9,608	8,273	8,297	125,135	121,429	467,305	1,971	2,077	200	172	173	2,604	2,527	9,723	8.7	842
Taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Foreign Exchange	14,078	13,003	87	-	-	6,730	6,556	40,454	293	271	2	-	-	140	136	842	-	-

\a BWDB administration costs - 7.5% of civil works base costs
\b BWDB overhead costs - 2.5% of civil works base costs

Table V.13: Inflation and exchange rates

Bangladesh Char Montaz - Kukri Mukri Integrated Development	Up to Negotiation	Up to Project Start	01/02	02/03	03/04	04/05	05/06	06/07	07/08
Inflation (in %'s) /a									
All goods & services									
Annual rates									
Local	5.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Foreign	2.7	5.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Compounded rates									
Local	5.0	10.0	12.8	18.4	24.3	30.5	37.0	43.9	51.1
Foreign	2.7	5.4	6.7	9.2	11.8	14.5	17.2	20.0	22.9
Exchange rates (Local/Foreign) /b									
All goods & services									
Rates actually used	47.0	48.1	50.8	52.1	53.4	54.8	56.2	57.6	59.1
Constant purchasing parity rates	47.0	48.1	50.8	52.1	53.4	54.8	56.2	57.6	59.1
% deviation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

\a Yearly values are within each project year
\b Yearly values are at project year midpoints

APPENDIX - VI

ECONOMIC ASSESSMENT

Table VI.1: Land available for agriculture and fisheries

No	Year	Existing Land not Forested		Existing Forest for Clearing 2/ (with project)			New Land				Cumulative Net Areas Available 4/			
							F0: No Intervention		F1: With Cross Dams		F0: No Intervention		F1: With Cross Dams	
		IE	OE	Char Montaz & other	Kukri Mukri	OE	IE	OE	IE	OE	IE	OE	IE	OE
0		5,230	2,823								3,661	1,976	3,661	1,976
1	2001	5,230	2,823					0		150	3,661	1,976	3,661	2,081
2	2002							0		150	3,661	1,976	3,661	2,186
3	2003							0		150	3,661	1,976	3,661	2,291
4	2004							0		150	3,661	1,976	3,661	2,396
5	2005			450	408			0		103	3,661	1,976	4,262	2,468
6	2006	350		550	570			0	703	(703)	3,661	1,976	5,783	1,976
7	2007	1,905	(1,554)	362	215			0		0	3,661	1,976	7,520	888
8	2008							0		0	3,661	1,976	7,520	888
9	2009							0		0	3,661	1,976	7,520	888
10	2010							0		0	3,661	1,976	7,520	888
11	2011							0		0	3,661	1,976	7,520	888
12	2012							0		0	3,661	1,976	7,520	888
13	2013							0		0	3,661	1,976	7,520	888
14	2014							0		0	3,661	1,976	7,520	888
15	2015							0		0	3,661	1,976	7,520	888
16	2016							0		59	3,661	1,976	7,520	929
17	2017							0		175	3,661	1,976	7,520	1,052
18	2018							0		175	3,661	1,976	7,520	1,174
19	2019							0		175	3,661	1,976	7,520	1,296
20	2020							0		184	3,661	1,976	7,520	1,424
21	2021							0		127	3,661	1,976	7,520	1,513
22	2022							0		46	3,661	1,976	7,520	1,545
23	2023							0		46	3,661	1,976	7,520	1,578
24	2024							0		46	3,661	1,976	7,520	1,610
25	2025							0		46	3,661	1,976	7,520	1,642
26	2026							0		41	3,661	1,976	7,520	1,671
27	2027							0		14	3,661	1,976	7,520	1,680
28	2028							0		14	3,661	1,976	7,520	1,690
29	2029							0		14	3,661	1,976	7,520	1,700
30	2030							0		14	3,661	1,976	7,520	1,709

Notes: 1/ IE = inside embankment; OE = outside embankment

2/ Location (IE or OE) at time of clearing.

3/ F0 = option with no interventions; F1 = with cross dams and other interventions

4/ Adjusted for khals, canals, homestead areas, roads, etc.

5/ Non-forested areas not cultivated at present (on Char Rustom, etc.) excluded from initial situation but included as existing land IE in years 6 and 7 when the polder is constructed.

1876.1

Table VI.2: Crop budgets - present and future without project (per ha)

	Crops	IE/OE 1/	Yield (mt/ha) Main Product	Yield (mt/ha) By-product	Labour Mandays	Animal Pairdays	Seed (kg)	Fertiliser (kg) Urea	Fertiliser (kg) TSP	Fertiliser (kg) MP	Pesticides (kg)	Irrigation (unit)	Financial Prices Revenue (Tk)	Financial Prices Input Cost (Tk)	Financial Prices Labour Cost (Tk)	Financial Prices Net Income (Tk)	Economic Prices Revenue (Tk)	Economic Prices Input Cost (Tk)	Economic Prices Labour Cost (Tk)	Economic Prices Net Income (Tk)
1	B.Aus	IE	1.0	1.5	70	15	90	30					7,458	2,441	3,500	1,518	8,139	2,216	2,975	2,948
2	T. Aus	IE	1.1	1.7	90	20	30	40	20				8,264	2,690	4,500	1,075	9,007	2,264	3,825	2,918
3	LT Aman	IE	1.4	2.1	100	20	30	50	20	10			11,957	2,841	5,000	4,116	11,394	2,322	4,250	4,823
4	HYV Aman	IE	2.0	2.0	120	30	35	80	30	10	0.5		15,882	4,409	6,000	5,473	15,195	3,660	5,100	6,435
5	B.Aus	OE	1.0	1.5	70	15	90	30					7,458	2,441	3,500	1,518	8,139	2,216	2,975	2,948
6	T. Aus	OE	1.1	1.7	90	20	30	40	20				8,264	2,690	4,500	1,075	9,007	2,264	3,825	2,918
7	LT Aman	OE	1.3	1.9	100	20	30	40	20		0.5		11,043	2,940	5,000	3,104	10,526	2,490	4,250	3,787
8	Ground nut	IE	0.9		40	10	50						15,114	2,500	2,000	10,614	13,633	2,255	1,700	9,678
9	Ground nut	OE	1.0		40	10	50						16,793	2,500	2,000	12,293	15,147	2,255	1,700	11,192
10	Sweet Potato	IE & OE	3.0		70	12	200	50	50				7,373	2,594	3,500	1,279	6,650	1,911	2,975	1,764
11	Pulses	IE & OE	0.5		40	20	30						5,980	2,540	2,000	1,440	5,394	2,291	1,700	1,403
12	Oil seeds	IE & OE	0.5		40	10	5						8,356	1,110	2,000	5,246	7,537	1,001	1,700	4,836
13	Chilli (dried)	IE & OE	0.4		80	15	5	10	10	10			20,531	2,002	4,000	14,529	18,519	1,636	3,400	13,483
14	Coconuts 2/	IE & OE	200.0										1,000	0	0	1,000	902	0	0	902

Notes 1/ IE = inside embankment; OE = outside embankment

2/ Coconuts included at equivalent of 5 trees per cultivated ha., each bearing 40 nuts per year.

Table VI.3: Crop budgets - with project (per ha)

	Crops	IE/OE 1/	Yield (mt/ha) Main Product	Yield (mt/ha) By-product	Labour Mandays	Animal Pairdays	Seed (kg)	Fertiliser (kg) Urea	Fertiliser (kg) TSP	Fertiliser (kg) MP	Pesticides (kg)	Irrigation (unit)	Financial Prices Revenue (Tk)	Financial Prices Input Cost (Tk)	Financial Prices Labour Cost (Tk)	Financial Prices Net Income (Tk)	Economic Prices Revenue (Tk)	Economic Prices Input Cost (Tk)	Economic Prices Labour Cost (Tk)	Economic Prices Net Income (Tk)
1	B.Aus	IE	1.2	1.8	90	15	90	50	30				8,950	2,858	4,500	1,592	9,767	2,331	3,825	3,611
2	T. Aus	IE	1.4	2.1	100	20	30	60	20				10,442	2,807	5,000	2,635	11,394	2,379	4,250	4,765
3	LT Aman	IE	2.0	3.0	120	25	30	70	40	10	1.0		17,082	4,159	6,000	6,924	16,278	3,339	5,100	7,839
4	HYV Aman	IE	2.4	2.4	140	40	35	80	20	10	1.0		19,058	5,559	7,000	6,499	18,234	4,788	5,950	7,497
5	B.Aus	OE	1.2	1.5	90	15	90	50	30				8,590	2,858	4,500	1,232	9,442	2,331	3,825	3,286
6	T.Aus	OE	1.3	1.8	100	20	30	60	20				9,516	2,807	5,000	1,709	10,418	2,379	4,250	3,789
7	LT Aman	OE	1.5	2.2	100	20	25	60	30	10	0.5		12,752	3,207	5,000	4,544	12,154	2,566	4,250	5,338
8	Ground nut	IE	1.4		55	10	50	50	50	20			23,510	3,479	2,750	17,281	21,206	2,543	2,338	16,326
9	Ground nut	OE	1.2		40	10	50	40	20	5			20,152	2,981	2,000	15,171	18,177	2,485	1,700	13,992
10	Sweet Potato	IE & OE	6.0		100	20	300	70	50	10			14,745	3,904	5,000	5,841	13,300	3,019	4,250	6,031
11	Pulses	IE & OE	0.7		40	20	30	20					8,373	2,657	2,000	3,715	7,552	2,406	1,700	3,446
12	Oil seeds	IE & OE	0.7		50	10	5						11,699	1,110	2,500	8,089	10,552	1,001	2,125	7,426
13	Chilli (dried)	IE & OE	0.6		120	15	5	40	10	10			30,796	2,177	6,000	22,619	27,778	1,809	5,100	20,869
14	Coconuts 2/	IE & OE	250.0										1,250	0	0	1,250	1,128	0	0	1,128

Notes 1/ IE = inside embankment; OE = outside embankment

2/ Coconuts included at equivalent of 5 trees per cultivated ha., each bearing 50 nuts per year.

Table VI.4: Farm budget - existing land (1 ha)
(present & without project) financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.00	0	0.00	0
LT Aman	1.00	4,116	1.00	3,104
HYV Aman	0.00	0	0.00	0
Ground nut	0.10	1,061	0.04	492
Sweet potato	0.05	64	0.03	38
Chilli	0.05	726	0.03	436
Pulses	0.16	230	0.08	115
Oilseeds	0.04	210	0.02	105
Coconuts		1000		1000
Total	1.40	7,408	1.20	5,290

Based on Table VI.1

Table VI.5: Farm budget - existing land (1 ha)
(present & without project) economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.00	0	0.00	0
LT Aman	1.00	4,823	1.00	3,787
HYV Aman	0.00	0	0.00	0
Ground nut	0.10	968	0.04	448
Sweet potato	0.05	88	0.03	53
Chilli	0.05	674	0.03	404
Pulses	0.16	225	0.08	112
Oilseeds	0.04	193	0.02	97
Coconuts		902		902
Total	1.40	7,873	1.20	5,803

Based on Table VI.1

Table VI.6: Farm budget - existing land (with project) (1 ha)
financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.35	922	0.30	513
LT Aman	0.35	2,423	0.70	3,181
HYV Aman	0.30	1,950	0.00	0
Ground nut	0.20	3,456	0.10	1,517
Sweet potato	0.12	701	0.04	234
Chilli	0.08	1,809	0.06	1,357
Pulses	0.20	743	0.12	446
Oilseeds	0.05	404	0.03	243
Coconuts		1250		1250
Total	1.65	13,659	1.35	8,740

Based on Table VI.1

Table VI.7: Farm budget - existing land (with project) (1 ha)
economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.35	1,668	0.30	1,137
LT Aman	0.35	2,744	0.70	3,736
HYV Aman	0.30	2,249	0.00	0
Ground nut	0.20	3,265	0.10	1,399
Sweet potato	0.12	724	0.04	241
Chilli	0.08	1,670	0.06	1,252
Pulses	0.20	689	0.12	413
Oilseeds	0.05	371	0.03	223
Coconuts		1127.5		1127.5
Total	1.65	14,507	1.35	9,529

Based on Table VI.1

Table VI.8: Farm budget - newly accreted land (1 ha)
cultivation year 1 financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.00	0	0.00	0
LT Aman	0.00	0	0.75	1,164
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.00	0
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.75	1,164

Based on Table VI.1

Table VI.9: Farm budget - newly accreted land (1 ha)
cultivation year 1 economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.00	0
T. Aus	0.00	0	0.00	0
LT Aman	0.00	0	0.75	1,420
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.00	0
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.75	1,420

Based on Table VI.1

Table VI.10: Farm budget - newly accreted land (1 ha)
cultivation year 5 financial prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.30	278
T. Aus	0.00	0	0.00	0
LT Aman	0.00	0	0.50	947
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.07	62
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.87	1,286

Based on Table VI.1

Table VI.11: Farm budget - newly accreted land (1 ha)
cultivation year 5 economic prices

Crop	Inside Embankment		Outside Embankment	
	Cropping Pattern	Net Revenue	Cropping Pattern	Net Revenue
B. Aus	0.00	0	0.30	540
T. Aus	0.00	0	0.00	0
LT Aman	0.00	0	0.50	1,155
HYV Aman	0.00	0	0.00	0
Ground nut	0.00	0	0.00	0
Sweet potato	0.00	0	0.00	0
Chilli	0.00	0	0.00	0
Pulses	0.00	0	0.07	60
Oilseeds	0.00	0	0.00	0
Total	0.00	0	0.87	1,754

Based on Table VI.1

Table VI.12: Estimate of livestock populations

No	Year	Livestock per Household			Without Project		With Project			Livestock (without project)			Livestock (with project)		
		Cattle & Buffaloes	Goats & Sheep	Poultry	Population	Estimated Households	Population	Estimated Households	New Settlement Households	Cattle & Buffaloes	Goats & Sheep	Poultry	Cattle & Buffaloes	Goats & Sheep	Poultry
0															
1	2001	5.10	2.08	10.75	21,552	3,703	21,552	3,703		18,886	7,702	39,808	18,886	7,702	39,808
2	2002	5.10	2.08	10.75	22,434	3,855	22,453	3,858		19,659	8,018	41,437	19,675	8,024	41,472
3	2003	5.10	2.08	10.75	23,288	4,001	23,344	4,011		20,407	8,323	43,014	20,457	8,343	43,119
4	2004	5.10	2.08	10.75	24,112	4,143	24,225	4,162		21,129	8,617	44,536	21,228	8,658	44,746
5	2005	5.10	2.08	10.75	24,905	4,279	25,093	4,312		21,824	8,901	46,002	21,989	8,968	46,349
6	2006	5.10	2.08	10.75	25,668	4,410	28,218	4,848	430	22,492	9,173	47,410	24,727	10,085	52,121
7	2007	5.10	2.08	10.75	26,399	4,536	29,131	5,005	430	23,133	9,435	48,760	25,527	10,411	53,807
8	2008	5.10	2.08	10.75	27,097	4,656	30,026	5,159		23,745	9,684	50,051	26,311	10,731	55,460
9	2009	5.10	2.08	10.75	27,765	4,771	30,902	5,310		24,330	9,923	51,283	27,079	11,044	57,079
10	2010	5.10	2.08	10.75	28,400	4,880	31,759	5,457		24,887	10,150	52,458	27,830	11,350	58,662
11	2011	5.10	2.08	10.75	29,005	4,984	32,596	5,601		25,417	10,366	53,575	28,563	11,649	60,207
12	2012	5.10	2.08	10.75	29,580	5,082	33,412	5,741		25,920	10,571	54,636	29,278	11,941	61,714
13	2013	5.10	2.08	10.75	30,124	5,176	34,206	5,877		26,398	10,766	55,642	29,974	12,225	63,181
14	2014	5.10	2.08	10.75	30,667	5,269	34,979	6,010		26,873	10,960	56,644	30,651	12,501	64,608
15	2015	5.10	2.08	10.75	31,219	5,364	35,729	6,139		27,357	11,157	57,663	31,309	12,769	65,995
16	2016	5.10	2.08	10.75	31,781	5,461	36,458	6,264		27,849	11,358	58,701	31,947	13,030	67,340
17	2017	5.10	2.08	10.75	32,353	5,559	37,187	6,389		28,350	11,562	59,758	32,586	13,290	68,687
18	2018	5.10	2.08	10.75	32,935	5,659	37,931	6,517		28,861	11,771	60,833	33,238	13,556	70,061
19	2019	5.10	2.08	10.75	33,528	5,761	38,689	6,648		29,380	11,982	61,928	33,903	13,827	71,462
20	2020	5.10	2.08	10.75	34,131	5,864	39,463	6,781		29,909	12,198	63,043	34,581	14,104	72,891
21	2021	5.10	2.08	10.75	34,746	5,970	40,252	6,916		30,447	12,418	64,178	35,273	14,386	74,349
22	2022	5.10	2.08	10.75	35,371	6,078	41,057	7,055		30,995	12,641	65,333	35,978	14,673	75,836
23	2023	5.10	2.08	10.75	36,008	6,187	41,878	7,196		31,553	12,869	66,509	36,698	14,967	77,353
24	2024	5.10	2.08	10.75	36,656	6,298	42,716	7,340		32,121	13,100	67,706	37,431	15,266	78,900
25	2025	5.10	2.08	10.75	37,316	6,412	43,570	7,486		32,699	13,336	68,925	38,180	15,571	80,478
26	2026	5.10	2.08	10.75	37,987	6,527	44,442	7,636		33,288	13,576	70,166	38,944	15,883	82,087
27	2027	5.10	2.08	10.75	38,671	6,645	45,330	7,789		33,887	13,821	71,429	39,723	16,201	83,729
28	2028	5.10	2.08	10.75	39,367	6,764	46,237	7,945		34,497	14,069	72,714	40,517	16,525	85,404
29	2029	5.10	2.08	10.75	40,076	6,886	47,162	8,103		35,118	14,323	74,023	41,327	16,855	87,112
30	2030	5.10	2.08	10.75	40,797	7,010	48,105	8,265		35,750	14,580	75,356	42,154	17,192	88,854

Notes: 1/ Rate of growth of livestock per capital declines by 5% p.a. from 2000 for cattle and goats and by 7.5% for poultry.

2/ Based on current year population and conception and mortality rates.

Table VI.13 : Estimate of livestock production

No	Year	Production without Project				Production with Project				Value of Production (without Project)					Value of Production (with Project)					Total Benefit
		Surplus Cattle Sold 2/	Surplus Goats Sold 2/	Milk Production '000 litres)	Egg Production ('000)	Surplus Cattle Sold 2/	Surplus Goats Sold 2/	Milk Production '000 litres)	Egg Production ('000)	Surplus Cattle Tk '000	Surplus Goats Tk '000	Milk Production Tk '000	Egg Production Tk '000	Total Tk '000	Surplus Cattle Tk '000	Surplus Goats Tk '000	Milk Production Tk '000	Egg Production Tk '000	Total Tk '000	Tk '000
0																				
1	2001	(74)	2,535	567	796	320	2,528	708	796	(444)	2,535	5,666	1,990	9,747	2,401	2,528	7,082	1,990	14,001	4,255
2	2002	(21)	2,661	590	829	437	2,867	758	864	(125)	2,661	5,898	2,072	10,506	3,278	2,867	7,583	2,160	15,888	5,382
3	2003	33	2,785	612	860	560	3,226	810	934	197	2,785	6,122	2,151	11,254	4,203	3,226	8,097	2,336	17,862	6,608
4	2004	86	2,905	634	891	690	3,607	862	1,007	518	2,905	6,339	2,227	11,988	5,173	3,607	8,624	2,517	19,921	7,933
5	2005	139	3,021	655	920	(1,165)	3,198	916	1,081	837	3,021	6,547	2,300	12,705	(8,736)	3,198	9,162	2,704	6,328	(6,377)
6	2006	192	3,133	675	948	1,050	4,820	1,056	1,260	1,151	3,133	6,748	2,371	13,403	7,874	4,820	10,561	3,149	26,403	13,000
7	2007	243	3,241	694	975	1,208	5,302	1,117	1,345	1,461	3,241	6,940	2,438	14,080	9,063	5,302	11,168	3,363	28,896	14,816
8	2008	294	3,345	712	1,001	1,372	5,806	1,179	1,433	1,764	3,345	7,124	2,503	14,734	10,291	5,806	11,785	3,582	31,465	16,730
9	2009	343	3,444	730	1,026	1,541	6,332	1,241	1,522	2,059	3,444	7,299	2,564	15,366	11,558	6,332	12,411	3,805	34,107	18,741
10	2010	391	3,539	747	1,049	1,715	6,880	1,305	1,613	2,345	3,539	7,466	2,623	15,973	12,859	6,880	13,045	4,033	36,818	20,845
11	2011	437	3,630	763	1,071	1,893	7,449	1,369	1,706	2,622	3,630	7,625	2,679	16,556	14,194	7,449	13,687	4,265	39,594	23,038
12	2012	482	3,717	778	1,093	2,075	8,038	1,433	1,800	2,890	3,717	7,776	2,732	17,114	15,559	8,038	14,334	4,500	42,432	25,317
13	2013	502	3,790	792	1,113	2,260	8,648	1,499	1,895	3,009	3,790	7,919	2,782	17,500	16,953	8,648	14,987	4,739	45,327	27,827
14	2014	511	3,858	806	1,133	2,346	8,857	1,533	1,938	3,064	3,858	8,062	2,832	17,815	17,596	8,857	15,326	4,846	46,625	28,809
15	2015	520	3,927	821	1,153	2,430	9,061	1,565	1,980	3,119	3,927	8,207	2,883	18,136	18,226	9,061	15,655	4,950	47,891	29,755
16	2016	529	3,998	835	1,174	2,492	9,251	1,597	2,020	3,175	3,998	8,355	2,935	18,463	18,689	9,251	15,974	5,051	48,964	30,502
17	2017	539	4,070	851	1,195	2,542	9,436	1,629	2,061	3,232	4,070	8,505	2,988	18,795	19,063	9,436	16,293	5,152	49,944	31,149
18	2018	548	4,143	866	1,217	2,593	9,625	1,662	2,102	3,290	4,143	8,658	3,042	19,133	19,444	9,625	16,619	5,255	50,943	31,809
19	2019	558	4,218	881	1,239	2,644	9,817	1,695	2,144	3,349	4,218	8,814	3,096	19,478	19,833	9,817	16,951	5,360	51,961	32,484
20	2020	568	4,294	897	1,261	2,697	10,014	1,729	2,187	3,410	4,294	8,973	3,152	19,828	20,230	10,014	17,290	5,467	53,001	33,172
21	2021	578	4,371	913	1,284	2,751	10,214	1,764	2,230	3,471	4,371	9,134	3,209	20,185	20,634	10,214	17,636	5,576	54,061	33,876
22	2022	589	4,450	930	1,307	2,806	10,418	1,799	2,275	3,533	4,450	9,299	3,267	20,548	21,047	10,418	17,989	5,688	55,142	34,593
23	2023	600	4,530	947	1,330	2,862	10,626	1,835	2,321	3,597	4,530	9,466	3,325	20,918	21,468	10,626	18,349	5,801	56,245	35,326
24	2024	610	4,611	964	1,354	2,920	10,839	1,872	2,367	3,662	4,611	9,636	3,385	21,295	21,897	10,839	18,716	5,917	57,370	36,075
25	2025	621	4,694	981	1,379	2,978	11,056	1,909	2,414	3,728	4,694	9,810	3,446	21,678	22,335	11,056	19,090	6,036	58,517	36,839
26	2026	632	4,779	999	1,403	3,038	11,277	1,947	2,463	3,795	4,779	9,986	3,508	22,068	22,782	11,277	19,472	6,157	59,687	37,619
27	2027	644	4,865	1,017	1,429	3,098	11,502	1,986	2,512	3,863	4,865	10,166	3,571	22,466	23,238	11,502	19,861	6,280	60,881	38,416
28	2028	655	4,952	1,035	1,454	3,160	11,732	2,026	2,562	3,933	4,952	10,349	3,636	22,870	23,702	11,732	20,259	6,405	62,099	39,229
29	2029	667	5,042	1,054	1,480	3,224	11,967	2,066	2,613	4,003	5,042	10,535	3,701	23,282	24,177	11,967	20,664	6,533	63,341	40,059
30	2030	679	5,132	1,073	1,507	3,288	12,206	2,108	2,666	4,076	5,132	10,725	3,768	23,701	24,660	12,206	21,077	6,664	64,608	40,907

Notes:
1/ Rate of growth of livestock per capital declines by 5% p.a. from 2000 for cattle and goats and by 7.5% for poultry.
2/ Based on current year population and conception and mortality rates.

Table VI.14: Benefits from livestock improvement programme

economic prices

No	Year	Number of Units Participating							Net Revenue of Participating Units						Total Net Revenue (Tk '000)
		Draft Cattle	Milch Cows	Beef Fattening	Goat Fattening	Goat Rearing	Chickens Layers	Chickens Broilers	Draft Cattle	Milch Cows	Beef Fattening	Goat Fattening	Goat Rearing	Chickens Layers	Chickens Broilers	
0																
1	2000	5	5	10	10	10	5	5	19	11	48	39	26	26	53	222
2	2001	10	10	20	20	20	8	8	38	21	96	79	52	42	85	413
3	2002	15	15	30	30	30	10	10	58	32	144	118	77	52	106	587
4	2003	20	20	40	40	40	12	12	77	43	192	158	103	62	127	762
5	2004	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
6	2005	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
7	2006	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
8	2007	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
9	2008	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
10	2009	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
11	2010	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
12	2011	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
13	2012	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
14	2013	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
15	2014	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
16	2015	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
17	2016	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
18	2017	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
19	2018	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
20	2019	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
21	2020	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
22	2021	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
23	2022	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
24	2023	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
25	2024	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
26	2025	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
27	2026	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
28	2027	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
29	2028	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952
30	2029	25	25	50	50	50	15	15	96	53	240	197	129	78	159	952

Notes 1/ Each unit is assumed to participate directly in the programme and require credit for 4 years.
2/ Benefits are only counted for units actually in the programme.

Table VI.15: Livestock improvement - production models (cattle)

Item	Unit	Unit Cost	Draft Bullocks			Milch Cows			Beef Fattening		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		360			360			360		
Stock	head		2	12,000	10824	1	4,000	3608	2	5,000	4510
Fodder:											
- straw	kg	0.5	2,160	1,080	974	720	360	325	1,440	720	649
- urea	kg	5.9	108	633	622	36	211	207	72	422	414
- molasses block	kg	7.0	180	1,260	1,137	90	630	568	180	1,260	1,137
- other supplements	kg	7.0	288	2,016	1,818	360	2,520	2,273	144	1,008	909
Straw treatment pit		60.0	1	60	54	1	60	54	1	60	54
Veterinary costs				500	451		400	361		500	451
Miscellaneous costs (10%)				555	501		418	377		397	358
Operating costs				6,104	5,556		4,599	4,165		4,367	3,973
Family labour	days	50.0	40	2,000	1,700	40	2,000	1,700	40	2,000	1,700
Interest cost 1/		15%		2,258	2,040		945	852		1,405	1,267
Total costs				10,362	9,297		7,544	6,718		7,772	6,940
Gross revenue											
- labour	days	50	150	7,500	6375						
- draft power		50	150	7,500	6765						
- milk	litres	10				842	8,424	7,598			
- sale of calf 2/	head	1500				0.92	1,380	1,245			
- sale of steers 2/	kg	30							433.92	13,018	11,742
Total Revenue				15,000	13,140		9,804	8,843		13,018	11,742
Net Revenue				4,638	3,843		2,260	2,126		5,246	4,802

Notes: 1/ Interest at 15% p.a. on cost of livestock + 50% of operating costs for draft and milch cattle; + 100% for beef fatteni

2/ Reflects reproduction and/or mortality rates.

Table VI.16: Livestock improvement - production models (poultry)

Item	Unit	Unit Cost	Layers			Broilers		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		360			60		
Stock	head		50	5,000	4510	250	1,750	1578.5
Feed - layers	kg	8.0	2,160	17,280	15,587	0	0	0
Feed - broiler	kg	3.0				600	1,800	1,624
Housing		1,000.0	1	1,000	902	1	500	451
Equipment		1,000.0	1	1,000	902	0	0	0
Heating		250.0	0	0	0	1	250	226
Veterinary costs				500	451		500	451
Miscellaneous costs (10%)				1,978	1,784		305	275
Operating costs				21,758	19,626		3,355	3,026
Family labour	days	50.0	60	3,000	2,550	10	500	425
Interest cost 1/		15%		2,708	1,658		126	388
Total costs				27,466	23,834		3,981	3,839
Gross revenue								
- eggs 2/	egg	2.5	12600	31,500	26775	0	0	0
- culled layers 2/	head	50	50	2,500	2255		0	0
- broiler chickens	head	30				240	7,200	6494.4
Total Revenue				34,000	29,030		7,200	6,494
Net Revenue (per cycle)				6,534	5,196		3,219	2,655
Net Revenue (per year)				6,534	5,196		12,876	10,620

Notes: 1/ Interest at 15% p.a. on cost of livestock + 60% of operating costs for layers an
2/ Reflects reproduction and/or mortality rates.

Table VI.17: Livestock improvement - production models (goats)

Item	Unit	Unit Cost	Goat Fattening			Goat Rearing 3/		
			Quantity	Financial Costs (Tk)	Economic Costs (Tk)	Quantity	Financial Costs (Tk)	Economic Costs (Tk)
Production cycle	days		270			360		
Stock	head		5	2,500	2255	2	1,500	1353
Fodder:								
- straw	kg	0.5	0	0	0	0	0	0
- urea	kg	5.9	0	0	0	0	0	0
- molasses block	kg	7.0	135	945	852	72	504	455
- other supplements	kg	7.0	135	945	852	72	504	455
Straw treatment pit		60.0	0	0	0	0	0	0
Veterinary costs				300	271		300	271
Miscellaneous costs (10%)				219	198		131	118
Operating costs				2,409	2,173		1,439	1,298
Family labour	days	50.0	35	1,750	1,488	35	1,750	1,488
Interest cost 1/		15%		545	491		441	398
Total costs				4,704	4,152		3,630	3,183
Gross revenue								
- sale of goats 2/	kg	50	179.45	8,973	8,093			
- sale of kids 2/	head	1050				6.08	6,384	5,758
Total Revenue				8,973	8,093		6,384	5,758
Net Revenue				4,269	3,941		2,754	2,575

Notes: 1/ Interest at 15% p.a. on cost of livestock + 100% of operating costs.
2/ Reflects reproduction and/or mortality rates.
3/ Production mature kids twice per year. (First year production would be less than 2 full cycles.)

Table VI.18: Crop budget for fish culture (1 ha. pond)
(cultured pond - present and future without project situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	7.0	50.0	42.5	350	298
labour	mandays	40.0	50.0	42.5	2,000	1,700
Total labour cost					2,350	1,998
Inputs:						
fingerlings	No.	2,000.0	1.0	0.9	2,000	1,804
lime	kg	100.0	3.0	2.7	300	271
organic fertiliser	kg	7,000.0	0.5	0.5	3,500	3,157
urea	kg	60.0	5.9	5.8	352	345
MP	kg	30.0	9.3	9.1	278	272
TSP	kg	70.0	10.0	9.8	701	685
mustard cake	kg	600.0	6.0	5.4	3,600	3,247
rice bran	kg	1,500.0	3.0	2.7	4,500	4,059
Total Inputs					15,231	13,840
Total Inputs + Labour					17,581	15,838
Yield	kg/ha	800.0	40.0	36.1	32,000	28,864
Net Revenue					14,419	13,026

Table VI.19: Crop budget for fish culture (1 ha. pond)
(culturable pond - present and future without project situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	5.0	50.0	42.5	250	213
labour	mandays	5.0	50.0	42.5	250	213
Total labour cost					500	425
Inputs:						
fingerlings	No.	1,000.0	1.0	0.9	1,000	902
lime	kg	0.0	3.0	2.7	0	0
organic fertiliser	kg	0.0	0.5	0.5	0	0
urea	kg	0.0	0.0	0.0	0	0
MP	kg	0.0	0.0	0.0	0	0
TSP	kg	0.0	0.0	0.0	0	0
mustard cake	kg	0.0	6.0	5.4	0	0
rice bran	kg	0.0	3.0	2.7	0	0
Total Inputs					1,000	902
Total Inputs + Labour					1,500	1,327
Yield	kg/ha	250.0	40.0	36.1	10,000	9,020
Net Revenue					8,500	7,693

Notes: 1/ Lower output price for culturable ponds reflects smaller average size of fish.

Table VI.20: Crop budget for fish culture (1 (cultured pond - future situation)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	7.0	50.0	42.5	350	298
labour	mandays	100.0	50.0	42.5	5,000	4,250
Total labour cost					5,350	4,548
Inputs:						
fingerlings	No.	8,000.0	1.0	0.9	8,000	7,216
lime	kg	100.0	3.0	2.7	300	271
organic fertiliser	kg	12,000.0	0.5	0.5	6,000	5,412
urea	kg	100.0	5.9	5.8	586	575
MP	kg	40.0	9.3	9.1	371	362
TSP	kg	100.0	10.0	9.8	1,001	979
mustard cake	kg	800.0	6.0	5.4	4,800	4,330
rice bran	kg	2,000.0	3.0	2.7	6,000	5,412
Total Inputs					27,058	24,557
Total Inputs + Labour					32,408	29,105
Yield	kg/ha	2,000.0	40.0	36.1	80,000	72,160
Net Revenue					47,592	43,055

Table VI.21: Crop budget for shrimp culture (1 ha. pond)
(low output - present situation with disease)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	4.0	50.0	42.5	200	170
labour	mandays	30.0	50.0	42.5	1,500	1,275
Total labour cost					1,700	1,445
Inputs:						
post-larvae	No.	10,000.0	0.8	0.7	8,000	7,216
lime	kg	100.0	3.0	2.7	300	271
feed	kg	500.0	10.0	9.0	5,000	4,510
rice bran	kg	500.0	3.0	2.7	1,500	1,353
MP	kg	20.0	9.3	9.1	186	181
TSP	kg	40.0	10.0	9.8	401	392
Total Inputs					15,386	13,922
Total Inputs + Labour					17,086	15,367
Yield	kg/ha	130.0	200.0	180.4	26,000	23,452
Net Revenue					8,914	8,085

Table VI.22: Cropb Budget for shrimp culture (1 ha. pond)
(future situation - no disease)

	Unit	Quantity	Unit Price (Tk)		Costs/Revenues (Tk)	
			Financial	Economic	Financial	Economic
Labour:						
pond preparation	mandays	10.0	50.0	42.5	500	425
labour	mandays	120.0	50.0	42.5	6,000	5,100
Total labour cost					6,500	5,525
Inputs:						
post-larvae	No.	20,000.0	0.8	0.7	16,000	14,432
lime	kg	200.0	3.0	2.7	600	541
feed	kg	500.0	10.0	9.0	5,000	4,510
rice bran	kg	0.0	3.0	2.7	0	0
MP	kg	150.0	9.3	9.1	1,392	1,359
TSP	kg	300.0	10.0	9.8	3,004	2,937
Organic fertiliser	kg	5,000.0	0.5	0.5	2,500	2,255
Total Inputs					28,496	26,034
Total Inputs + Labour					34,996	31,559
Yield	kg/ha	400.0	200.0	180.4	80,000	72,160
Net Revenue					45,004	40,601

Table VI.23: Forest - mangrove (per ha.)

	Unit	Plantation Establishment				Thinning (year 8)				Harvesting (year 15)			
		Quantity	Unit Cost	Financial (Tk)	Economic (Tk)	Quantity	Unit Cost	Financial (Tk)	Economic (Tk)	Quantity	Unit Cost	Financial (Tk)	Economic (Tk)
Labour	days	85	70	5,950	5,058	23	70	1,610	1,369	1500	70	105,000	89,250
Materials	Tk	1	625	625	564	1	3,150	3,150	2,841	1	3,150	3,150	2,841
Overhead costs	Tk	1	5,000	5,000	4,510	1	70	70	63	1	70	70	63
Maintenance													
- labour	days	30	70	2,100	1,785	0	70	0	0	0	70	0	0
- materials	Tk	3	150	450	406	0	150	0	0	0	150	0	0
Total costs				14,125	12,322			4,830	4,273			108,220	92,154
Revenue													
Firewood	cu.m.					14	450	6,300	5,683	49	450	22,050	19,889
Timber	cu.m.									51	3500	178,500	161,007
Total								6,300	5,683			200,550	180,896
Net Revenue	Tk							1,470	1,410			92,330	88,742

Notes: 1/ The 40:60 ratio of timber:fuelwood is modified with a 15% reduction in timber to take account of stem borer infestation of Keora in many places.

Table VI.24: Forest - non-mangrove (per ha.)

	Unit	Plantation Establishment				Thinning (year 8)				Harvesting (year 25)			
		Quantity	Unit Cost	Financial (Tk)	Economic (Tk)	Quantity	Unit Cost	Financial (Tk)	Economic (Tk)	Quantity	Unit Cost	Financial (Tk)	Economic (Tk)
Labour	days	170	70	11,900	10,115	23	70	1,610	1,369	675	70	47,250	40,163
Materials	Tk	1	1,126	1,126	1,016	1	4,500	4,500	4,059	1	4,500	4,500	4,059
Overhead costs	Tk	1	5,000	5,000	4,510	1	70	70	63	1	70	70	63
Maintenance													
- labour	days	46	70	3,220	2,737	0	70	0	0	0	70	0	0
- materials	Tk	6	120	720	649	0	150	0	0	0	150	0	0
Total costs				21,966	19,027			6,180	5,491			51,820	44,285
Revenue													
Firewood	cu.m.					14	550	7,700	6,945	12	550	6,600	5,953
Timber	cu.m.							0	0	27	4900	132,300	119,335
Total								7,700	6,945			138,900	125,288
Net Revenue	Tk							1,520	1,455			87,080	81,003

Note: Non-mangrove firewood price at 125% mangrove; timber at 140% mangrove.

Table VI.25: Benefits from agriculture

economic prices

No	Year	Future without Project									Future with Project (F1)									
		Annual Increments (ha)			Cumulative Totals (ha)			Benefits (Tk '000)		Total	Annual Increments (ha)				Cumulative Totals (ha)				Benefits (Tk '000)				Total
		Existing		New	Existing		New	Existing	New	Benefits	Existing		New		Existing		New		Existing		New		Benefits
		IE	OE	OE	IE	OE	OE		OE	FWO	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	IE	OE	F1
0											3,661	1,976			3,661	1,976	0	0					
1	2000	3,661	1,976	0	3,661	1,976	0	40,289	0	40,289	3,661	1,976	0	105	3,661	1,976	0	105	21,244	11,467		149	32,860
2	2001			0	3,661	1,976	0	40,289	0	40,289	0	0	0	105	3,661	1,976	0	210	23,379	11,960		313	35,653
3	2002			0	3,661	1,976	0	40,289	0	40,289	0	0	0	105	3,661	1,976	0	315	25,482	12,446		486	38,414
4	2003			0	3,661	1,976	0	40,289	0	40,289	0	0	0	105	3,661	1,976	0	420	27,617	12,940		667	41,224
5	2004			0	3,661	1,976	0	40,289	0	40,289	601	0	0	72	4,262	1,976	0	492	33,237	13,433		811	47,481
6	2005			0	3,661	1,976	0	40,289	0	40,289	1,029	0	492	(492)	5,291	1,976	492	0	41,662	13,919	863	0	56,444
7	2006			0	3,661	1,976	0	40,289	0	40,289	1,737	(1,088)	0	0	7,028	888	492	0	54,823	6,479	1,491	0	62,793
8	2007			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	58,913	6,701	2,118	0	67,732
9	2008			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	62,965	6,919	2,746	0	72,630
10	2009			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	67,058	7,141	3,374	0	77,572
11	2010			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	71,147	7,363	4,001	0	82,511
12	2011			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	75,199	7,581	4,629	0	87,409
13	2012			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	79,292	7,803	5,256	0	92,351
14	2013			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	83,382	8,025	5,884	0	97,290
15	2014			0	3,661	1,976	0	40,289	0	40,289	0	0	0	0	7,028	888	492	0	87,434	8,243	6,511	0	102,188
16	2015			0	3,661	1,976	0	40,289	0	40,289	0	0	0	41	7,028	888	492	41	91,527	8,465	7,139	58	107,189
17	2016			0	3,661	1,976	0	40,289	0	40,289	0	0	0	122	7,028	888	492	163	93,481	8,465	7,139	238	109,323
18	2017			0	3,661	1,976	0	40,289	0	40,289	0	0	0	122	7,028	888	492	285	95,430	8,465	7,139	432	111,466
19	2018			0	3,661	1,976	0	40,289	0	40,289	0	0	0	122	7,028	888	492	408	97,388	8,465	7,139	636	113,628
20	2019			0	3,661	1,976	0	40,289	0	40,289	0	0	0	128	7,028	888	492	536	99,343	8,465	7,139	860	115,806
21	2020			0	3,661	1,976	0	40,289	0	40,289	0	0	0	89	7,028	888	492	625	100,941	8,465	7,139	1,032	117,577
22	2021			0	3,661	1,976	0	40,289	0	40,289	0	0	0	32	7,028	888	492	657	101,954	8,465	7,139	1,146	118,704
23	2022			0	3,661	1,976	0	40,289	0	40,289	0	0	0	32	7,028	888	492	689	101,954	8,465	7,139	1,345	118,903
24	2023			0	3,661	1,976	0	40,289	0	40,289	0	0	0	32	7,028	888	492	721	101,954	8,465	7,139	1,631	119,189
25	2024			0	3,661	1,976	0	40,289	0	40,289	0	0	0	32	7,028	888	492	754	101,954	8,465	7,139	2,004	119,562
26	2025			0	3,661	1,976	0	40,289	0	40,289	0	0	0	29	7,028	888	492	782	101,954	8,465	7,139	2,469	120,027
27	2026			0	3,661	1,976	0	40,289	0	40,289	0	0	0	10	7,028	888	492	792	101,954	8,465	7,139	2,978	120,536
28	2027			0	3,661	1,976	0	40,289	0	40,289	0	0	0	10	7,028	888	492	802	101,954	8,465	7,139	3,510	121,068
29	2028			0	3,661	1,976	0	40,289	0	40,289	0	0	0	10	7,028	888	492	812	101,954	8,465	7,139	4,065	121,623
30	2029			0	3,661	1,976	0	40,289	0	40,289	0	0	0	10	7,028	888	492	821	101,954	8,465	7,139	4,644	122,202

Table VI.26: Benefits from aquaculture

economic prices

No	Year	Existing Pond Areas			New Pond Areas (ha.)						Total Ponds in Production												Net Benefits (Tk '000) F1 - F0
					F0 No Intervention		F1 Cross Dams		New Ponds from Forest		Cumulative Areas - F0						Cumulative Areas - F1						
											Existing			New		Total Benefit	Existing			New		Total Benefit	
		Cultured	Culturable	Shrimp	Cultured	Shrimp	Cultured	Shrimp	Cultured	Shrimp	Cultured	Culturable	Shrimp	Cultured	Shrimp	(Tk '000)	Cultured	Culturable	Shrimp	Cultured	Shrimp	(Tk '000)	
0		50	16	100							50	16	100	0	0		50	16	100				
1	2000				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	50	16	100	3	1	1,587	5
2	2001				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	53	13	100	5	2	2,095	512
3	2002				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	56	10	100	8	3	2,629	1,047
4	2003				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	60	6	100	11	5	3,201	1,618
5	2004				0.0	0.0	2	1	15	6	50	16	100	0	0	1,583	63	3	100	27	12	3,810	2,227
6	2005				0.0	0.0	0	0	20	8	50	16	100	0	0	1,583	66	0	100	47	20	4,522	2,939
7	2006				0.0	0.0	0	0	10	4	50	16	100	0	0	1,583	66	0	100	57	24	5,335	3,752
8	2007				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	6,194	4,612
9	2008				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	7,052	5,469
10	2009				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	7,900	6,317
11	2010				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	8,748	7,165
12	2011				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	9,110	7,527
13	2012				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	9,447	7,865
14	2013				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	9,761	8,178
15	2014				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	57	24	10,048	8,465
16	2015				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	58	25	10,251	8,669
17	2016				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	66	0	100	61	26	10,347	8,764
18	2017				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	66	0	100	64	27	10,389	8,806
19	2018				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	66	0	100	67	29	10,436	8,853
20	2019				0.0	0.0	3	1	0	0	50	16	100	0	0	1,583	66	0	100	70	30	10,500	8,918
21	2020				0.0	0.0	2	1	0	0	50	16	100	0	0	1,583	66	0	100	73	31	10,582	8,999
22	2021				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	73	31	10,674	9,091
23	2022				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	74	32	10,770	9,187
24	2023				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	75	32	10,870	9,287
25	2024				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	76	33	10,974	9,392
26	2025				0.0	0.0	1	0	0	0	50	16	100	0	0	1,583	66	0	100	77	33	11,083	9,501
27	2026				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	77	33	11,191	9,608
28	2027				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	77	33	11,286	9,703
29	2028				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	77	33	11,364	9,781
30	2029				0.0	0.0	0	0	0	0	50	16	100	0	0	1,583	66	0	100	78	33	11,427	9,844

Notes 1/ For areas see Table 6.1
2/ No distinction is drawn between ponds inside or outside the embankments.

Table VI.27: Benefits from forestry

No	Year	New Mangrove Forest Annual Increments F0	F1	Non-Mangrove Planted F1	Forest Thinning (year 8) Annual Increments F0	F1	Non-Mangrove F1	Forest Harvesting Forest Cleared 1/ F1	Annual Increments F0	F1	Planting Costs F0	F1	Net Revenues Thinning & Harvesting F0	F1	Net Benefits (Tk '000) F0	F1
0																
1	2000	32	294	0				0	0		393	3,617	0	0	(393)	(3,617)
2	2001	32	873	0				0	0		393	10,751	0	0	(393)	(10,751)
3	2002	32	873					0	0		393	10,751	0	0	(393)	(10,751)
4	2003	32	873					0	0		393	10,751	0	0	(393)	(10,751)
5	2004	32	918					858	0		393	11,306	0	76,140	(393)	64,835
6	2005	32	634					1,120	0		393	7,806	0	99,391	(393)	91,585
7	2006	32	231					577	0		393	2,840	0	51,204	(393)	48,364
8	2007	32	231		32	294	0	0	0		393	2,840	45	414	(348)	(2,427)
9	2008	32	231		32	873	0	0	0		393	2,840	45	1,230	(348)	(1,610)
10	2009	32	231		32	873		0	0		393	2,840	45	1,230	(348)	(1,610)
11	2010	32	205		32	873		0	0		393	2,520	45	1,230	(348)	(1,290)
12	2011	32	70		32	918		0	0		393	856	45	1,293	(348)	437
13	2012	32	70		32	634		0	0		393	856	45	893	(348)	37
14	2013	32	70		32	231		0	0		393	856	45	325	(348)	(531)
15	2014	32	69		32	231		0	0		393	844	45	325	(348)	(519)
16	2015	32	70		32	231		0	0	59	393	856	45	5,534	(348)	4,678
17	2016	32	23		32	231		0	0	175	393	277	45	15,810	(348)	15,533
18	2017	32	23		32	205		0	0	175	393	277	45	15,774	(348)	15,496
19	2018	32	23		32	70		0	0	175	393	277	45	15,583	(348)	15,306
20	2019	32	24		32	70		0	0	184	393	290	45	16,382	(348)	16,092
21	2020	32	25		32	70		0	0	127	393	302	45	11,342	(348)	11,040
22	2021	32	8		32	69		0	0	46	393	92	45	4,188	(348)	4,095
23	2022	32	8		32	70		0	0	46	393	92	45	4,189	(348)	4,097
24	2023	32	8		32	23		0	0	46	393	92	45	4,123	(348)	4,030
25	2024	32	8		32	23		0	0	46	393	92	45	4,123	(348)	4,030
26	2025	32	9		32	23		0	0	41	393	105	45	3,661	(348)	3,557
27	2026	32	9		32	24		0	0	14	393	105	45	1,267	(348)	1,162
28	2027	32	8		32	25		0	0	14	393	92	45	1,268	(348)	1,176
29	2028	32	8		32	8		0	0	14	393	92	45	1,244	(348)	1,152
30	2029	32	8		32	8		0	0	14	393	92	45	1,226	(348)	1,134

Notes 1/ Existing forest cleared; based on Tables 6.1
2/ Existing forest inside south Hatia and Nijhum Dwip polders.

Table VI.28: EIRR and NPV

No	Year	Project Costs F1 One Cross Dam Investment	Project Costs F1 One Cross Dam O&M	Agricultural Benefits Future Without Project	Agricultural Benefits Future With Project F1	Aquacultural Benefits Future Without Project	Aquacultural Benefits Future With Project F1	Livestock Benefits Future Without Project	Livestock Benefits Future With Project F1	Forestry Benefits Future Without Project	Forestry Benefits Future With Project F1	Total Benefits Future Without Project	Total Benefits Future With Project F1	Net Benefits F1 - F0	Net Revenue F1
1	2001	94,743	0	40,289	32,860	1,583	1,587	9,747	14,223	(393)	(3,617)	51,225	45,054	(6,171)	(100,914)
2	2002	99,818	0	40,289	35,653	1,583	2,095	10,506	16,301	(393)	(10,751)	51,985	43,297	(8,688)	(108,506)
3	2003	9,608	0	40,289	38,414	1,583	2,629	11,254	18,449	(393)	(10,751)	52,733	48,742	(3,991)	(13,599)
4	2004	8,273	0	40,289	41,224	1,583	3,201	11,988	20,683	(393)	(10,751)	53,467	54,356	889	(7,384)
5	2005	8,297	0	40,289	47,481	1,583	3,810	12,705	7,281	(393)	64,835	54,184	123,407	69,223	60,926
6	2006	125,135	0	40,289	56,444	1,583	4,522	13,403	27,355	(393)	91,585	54,882	179,906	125,025	(110)
7	2007	121,429	0	40,289	62,793	1,583	5,335	14,080	29,848	(393)	48,364	55,558	146,339	90,781	(30,648)
8	2008	0	4,121	40,289	67,732	1,583	6,194	14,734	32,417	(348)	(2,427)	56,258	103,917	47,659	43,538
9	2009	0	4,121	40,289	72,630	1,583	7,052	15,366	35,059	(348)	(1,610)	56,890	113,130	56,240	52,119
10	2010	0	4,121	40,289	77,572	1,583	7,900	15,973	37,770	(348)	(1,610)	57,497	121,632	64,135	60,014
11	2011	0	4,121	40,289	82,511	1,583	8,748	16,556	40,547	(348)	(1,290)	58,080	130,516	72,436	68,315
12	2012	0	4,121	40,289	87,409	1,583	9,110	17,114	43,384	(348)	437	58,638	140,340	81,702	77,580
13	2013	0	4,121	40,289	92,351	1,583	9,447	17,500	46,280	(348)	37	59,024	148,115	89,091	84,970
14	2014	0	4,121	40,289	97,290	1,583	9,761	17,815	47,577	(348)	(531)	59,339	154,097	94,758	90,637
15	2015	0	4,121	40,289	102,188	1,583	10,048	18,136	48,843	(348)	(519)	59,660	160,560	100,900	96,779
16	2016	0	4,121	40,289	107,189	1,583	10,251	18,463	49,917	(348)	4,678	59,986	172,035	112,049	107,927
17	2017	0	4,121	40,289	109,323	1,583	10,347	18,795	50,896	(348)	15,533	60,319	186,099	125,781	121,659
18	2018	0	4,121	40,289	111,466	1,583	10,389	19,133	51,895	(348)	15,496	60,657	189,246	128,589	124,468
19	2019	0	4,121	40,289	113,628	1,583	10,436	19,478	52,914	(348)	15,306	61,001	192,284	131,283	127,162
20	2020	0	4,121	40,289	115,806	1,583	10,500	19,828	53,953	(348)	16,092	61,352	196,352	135,000	130,879
21	2021	0	4,121	40,289	117,577	1,583	10,582	20,185	55,013	(348)	11,040	61,709	194,211	132,502	128,381
22	2022	0	4,121	40,289	118,704	1,583	10,674	20,548	56,094	(348)	4,095	62,072	189,567	127,495	123,374
23	2023	0	4,121	40,289	118,903	1,583	10,770	20,918	57,197	(348)	4,097	62,442	190,967	128,525	124,403
24	2024	0	4,121	40,289	119,189	1,583	10,870	21,295	58,322	(348)	4,030	62,819	192,411	129,593	125,472
25	2025	0	4,121	40,289	119,562	1,583	10,974	21,678	59,469	(348)	4,030	63,202	194,036	130,834	126,713
26	2026	0	4,121	40,289	120,027	1,583	11,083	22,068	60,640	(348)	3,557	63,592	195,306	131,714	127,593
27	2027	0	4,121	40,289	120,536	1,583	11,191	22,466	61,834	(348)	1,162	63,989	194,723	130,734	126,612
28	2028	0	4,121	40,289	121,068	1,583	11,286	22,870	63,051	(348)	1,176	64,394	196,581	132,187	128,066
29	2029	0	4,121	40,289	121,623	1,583	11,364	23,282	64,293	(348)	1,152	64,805	198,432	133,627	129,506
30	2030	0	4,121	40,289	122,202	1,583	11,427	23,701	65,560	(348)	1,134	65,224	200,322	135,098	130,976
														EIRR	16.65
														NPV	134,665

Table VI.29: Financial and economic prices (1997 prices): import parity

			Rice (b)				Wheat				TSP				Muriate of Potash			
			1997		2010		1997		2010		1997		2010		1997		2010	
	Unit	SCF	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic	financial	economic
World Bank price forecast (1, 2)	$/mt	-	330	330	302	302	165	165	136	136	160	160	120	120	118	118	105	105
Quality adjustment (3)	$/mt	-	248	248	226	226	132	132	109	109	160	160	120	120	118	118	105	105
Freight and insurance	$/mt	-	30	30	30	30	54	54	54	54	45	45	45	45	45	45	45	45
CIF Port of Entry	$/mt	-	278	278	256	256	186	186	163	163	205	205	165	165	163	163	150	150
Border price in taka (4)	Tk/mt	-	13,056	13,056	12,054	12,054	8,727	8,727	7,658	7,658	9,629	9,629	7,736	7,736	7,681	7,681	7,069	7,069
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586	650	586	650	586	550	496	550	496	550	496	550	496
Regional centre/wholesale price	Tk/mt	-	13,706	13,643	12,704	12,641	9,377	9,313	8,308	8,245	10,179	10,125	8,286	8,232	8,231	8,177	7,619	7,565
Marketing costs and margins - regional (6)	Tk/mt	0.9	685	618	635	573	469	423	415	375	509	459	414	374	412	371	381	344
Transport and handling to secondary marke	Tk/mt	0.9	810	731	810	731	810	731	810	731	550	496	550	496	550	496	550	496
Marketing costs and margins - local	Tk/mt	0.9	855	771	788	711	567	511	496	447	562	507	463	417	460	415	427	386
Price ex-processor	Tk/mt	-	11,356	11,523	10,471	10,626	7,531	7,649	6,587	6,692	11,800	11,587	9,713	9,520	9,652	9,459	8,977	8,790
Adjustment for processing	Tk/mt	-	7,609	7,720	7,016	7,120	7,531	7,649	6,587	6,692	11,800	11,587	9,713	9,520	9,652	9,459	8,977	8,790
Processing cost	Tk/mt	0.9	320	289	320	289	0	0	0	0	0	0	0	0	0	0	0	0
Transport and handling to farm gate	Tk/mt	0.9	350	316	350	316	350	316	350	316	300	271	300	271	300	271	300	271
Farm gate price	Tk/mt	-	6,939	7,116	6,346	6,515	7,181	7,333	6,237	6,377	12,100	11,857	10,013	9,790	9,952	9,729	9,277	9,060
Notes:																		
(1) WB price forecast in constant 1990 dollars (1997 data)			279	279	255	255	139	139	115	115	135	135	101	101	100	100	89	89
(2) MUV factor for 1997			1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842	1.1842
(3) Quality adjustment			0.75	0.75	0.75	0.75	0.80	0.80	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(4) Exchange rate - Taka:US$			47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00
(5) Processing ratio			0.67	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(6) Marketing costs - regional			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
(7) Marketing costs - local			0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Notes:

(a) Standard conversion factor = 0.902 is World Bank July 1997 estimate for 1997/98 fiscal year.

(b) Rice processing and marketing costs based on "Commodity Report on Foodgrain" Research & Planning Section, Department of Agricultural Marketing, September 1997.

Table VI.30: Financial and economic prices (1997 prices): export parity

			Jute (a)		Urea			
			1997		1997		2010	
	Unit	SCF	financial	economic	financial	economic	financial	economic
World Bank price forecast	$/mt	-	399	399	189	189	147	147
Quality adjustment	$/mt	-	399	399	189	189	147	147
Freight and insurance	$/mt	-	50	50	45	45	45	45
FOB Port of Entry	$/mt	-	349	349	144	144	102	102
Border price in taka (4)	Tk/mt	-	16,403	16,403	6,790	6,790	4,787	4,787
Port dues and transport/handling to regional	Tk/mt	0.9	650	586	650	586	650	586
Subsidies	Tk/mt		0	0	1,100	0	0	0
Regional centre/wholesale price	Tk/mt	-	15,753	15,817	5,040	6,204	4,137	4,200
Marketing costs and margins - regional (6)	Tk/mt	0.9	1,575	1,421	504	455	414	373
Transport and handling to secondary marke	Tk/mt	0.9	810	731	550	496	550	496
Marketing costs and margins - local	Tk/mt	0.9	1,337	1,206	609	550	510	460
Price ex-processor / local market	Tk/mt	-	12,031	12,459	6,704	7,704	5,610	5,529
Adjustment for processing	Tk/mt	-	12,031	12,459	6,704	7,704	5,610	5,529
Processing cost	Tk/mt	0.9	2,406	2,492	0	0	0	0
Transport and handling to farm gate	Tk/mt	0.9	350	0	250	226	250	226
Farm gate price	Tk/mt	-	9,275	9,968	6,954	7,930	5,860	5,755
Notes:								
(1) WB price forecast in constant 1990 dollars (1997)			399	399	160	160	124	124
(2) MUV factor for 1997			1.00	1.00	1.1842	1.1842	1.1842	1.1842
(3) Quality adjustment			1.00	1.00	1.00	1.00	1.00	1.00
(4) Exchange rate - Taka:US$			47.00	47.00	47.00	47.00	47.00	47.00
(5) Processing ratio			1.00	1.00	1.00	1.00	1.00	1.00
(6) Marketing costs - regional			0.10	0.10	0.10	0.10	0.10	0.10
(7) Marketing costs - local			0.10	0.10	0.10	0.10	0.10	0.10

Note: Current subsidy on domestically produced urea assumed to be eliminated in medium term.

Table VI.31: Groundnut price (Tk/mt)

Year	Index 85/86 = 10	current	1997
1990/91	148.05		0
1991/92	157.58	18,130	22,163
1992/93	157.80	14,250	17,395
1993/94	162.74	15,770	18,666
1994/95	176.73	14,280	15,565
1995/96	190.08	15,340	15,546
1996/97	192.63		
5 year average			17,867
4 year average			16,793
yield (mt/ha)		1.00	

Table VI.32: Mustard price (Tk/mt)

Year	Index 85/86 = 10	current	1997
1990/91	148.05		0
1991/92	157.58	13,730	16,784
1992/93	157.80	14,160	17,285
1993/94	162.74	15,030	17,791
1994/95	176.73	15,300	16,677
1995/96	190.08	15,800	16,012
1996/97	192.63	16,370	16370
5 year average			16,827
4 year average			16,712
yield (mt/ha.)			

Table VI.33: Chilli price (dried) (Tk/mt)

Year	Index 85/86 = 10	current	1997
1990/91	148.05	58,840	76,558
1991/92	157.58	57,220	69,947
1992/93	157.80	26,050	31,800
1993/94	162.74	39,580	46,850
1994/95	176.73	52,260	56,962
1995/96	190.08	57,030	57,795
1996/97	192.63	43,700	43,700
5 year average			47,421
4 year average			51,327
yield (mt/ha)		0.97	

Table VI.34: Sweet potato price (Tk/mt)

Year	Index 85/86 = 10	current	1997
1990/91	148.05	1,820	2,368
1991/92	157.58	1,920	2,347
1992/93	157.80	1,830	2,234
1993/94	162.74	1,930	2,284
1994/95	176.73	2,400	2,616
1995/96	190.08	2,660	2,696
1996/97	192.63		
5 year average			2,435
4 year average			2,458
yield (mt/ha)		8.00	

Table VI.35: Price for Pulses Crop Budget (Tk/mt)

	weighting - mung:keshari		1:4			
Year	Index 85/86 = 10	Mung current	Keshari current	Mung 1997	Keshari 1997	Composite 1997
1990/91	148.05	19,800	8,440	25,762	10,981	13,938
1991/92	157.58	18,980		23,202	0	4,640
1992/93	157.80	18,040	8,820	22,022	10,767	13,018
1993/94	162.74	18,750	8,980	22,194	10,629	12,942
1994/95	176.73	19,820	7,510	21,603	8,186	10,869
1995/96	190.08	21,300	8,790	21,586	8,908	11,443
1996/97	192.63	22,260	10,170	22,260	10,170	12,588
5 year average		20,034	8,854	21,933	7,698	12,172
4 year average		20,533	8,863	21,911	9,622	11,961
yield (mt/ha)		0.63	0.76			0.73

These price estimates are based on:

1. Price index for food, beverage & tobacco, Bangladesh Bureau of Statistics & ADB
2. Farm level prices from Department ofAgricultural Marketing
3. Weighting based on areas of respective crops in Greater Comilla district.
4. Average areas and yields calculated from Yearbook of Agricultural Statistics 1995, Bangladesh Bureau of Statistics (October 1997)