DGIS/DANIDA GOB

MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MEGHNA ESTUARY STUDY

DRAFT DEVELOPMENT PLAN

VOLUME 4 : PART 2
ENVIRONMENTAL IMPACT ASSESSMENT
CHAR MONTAZ - KUKRI-MUKRI INTEGRATED DEVELOPMENT PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
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GLOSSARY, ACRONYMS AND ABBREVIATIONS

The spelling of Bangla words is not standardised, with frequent differences between vowel use. The following use the standard set by ISPAN in their reports based upon the work of a professional editor with a large international academic publishing house.

ADB	-	Asian Development Bank
ARTI	-	Acute Respiratory Tract Infection
BARC	-	Bangladesh Agricultural Research Council
BBS	-	Bangladesh Bureau of Statistics
BCAS	-	Bangladesh Centre for Advanced Studies
Bigha	-	Bengali unit of land area equal to 0.33 acre or 0.134ha
BIWTA	-	Bangladesh Inland Water Transport Authority
BWDB	-	Bangladesh Water Development Board
CARDMA	-	Coastal Area Resource Development and Management Association (an NGO)
CDL	-	Community Development Library (an NGO)
CDSP	-	Char Development and Settlement Project
CERP	-	Coastal Embankment Rehabilitation Project
Char	-	Bangla word for accreted land
cm	-	Centimetre
CPP	-	Cyclone Protection Project
CSPS	-	Cyclone Shelter Preparatory Study
Danida	-	Danish Government aid agency
DEM	-	Digital Elevation Model
DFO	-	District Forestry Officer
DoE	-	Department of Environment (of the Government of Bangladesh)
DoF	-	Department of Fisheries (of the Government of Bangladesh)
Ec	-	Electrical Conductivity, a measure used for indicating salinity, calibrated in parts per million (ppm) or Siemens/cm
EC	-	European Commission
EGIS	-	Environment and GIS Support Programme for the Water Sector, successors to ISPAN FAP 16/19 funded by the Netherlands Government
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
ESCAP	-	Economic and Social Commission for Asia and the Pacific (a UN organisation)
FAO	-	Food and Agriculture Organisation of the United Nations
FAP	-	Flood Action Plan
FCD/I	-	Flood Control, drainage and Irrigation
FINMAP	-	Mapping component to the Flood Action Plan provided by Finland
FPCO	-	Flood Plan Co-ordination Organisation (of the Ministry of Water Resources) now incorporated into WARPO
g	-	gram
Ghat	-	Ferry landing stage (Bangla)
GIS	-	Geographical Information System
GPA	-	Guidelines for Project Assessment
ha	-	hectare
HDI	-	Human Development Index (Measure developed by UNDP)
ICLARM	-	International Center for Living Aquatic Resources Management
IEC	-	Important Environmental Components
IEE	-	Initial Environmental Examination
IFADEP	-	Integrated Food Assisted Development Project
ISPAN	-	Irrigation Support Programme for Asia and the Near East, funded by USAID and responsible for the Environmental and GIS components of FAP. Now succeeded by EGIS.
IUCN	-	International Union for the Conservation of Nature and Natural Resources
Khal	-	A Bangla word for a water channel excavated by human intervention
Khas	-	Government owned land
Killa	-	A raised area of ground for retreat during times of flood

km	-	Kilometre
LGED	-	Local Government Engineering Department
LRP	-	Land Reclamation Project
m^3/s	-	Cubic metres per second
Mauza	-	A Bangla word for the smallest government administration area corresponding to a village revenue unit.
MES	-	Meghna Estuary Study
MOEF	-	Ministry of Environment and Forest
MoL	-	Ministry of Land
MPO	-	Master Plan Organisation (for the water sector in Bangladesh, now WARPO)
MWR	-	Ministry of Water Resources
NCS	-	National Conservation Strategy
NEMAP	-	National Environmental Management and Action Plan
NGO	-	Non-Government Organisation
NMIDP	-	National Minor Irrigation Development Programme
NWMP	-	National Water Management Plan
pH	-	Measure of acidity and alkalinity of water (log of hydrogen ion concentration)
RIDP	-	Remote Island Development Project, an NGO working at Char Montaz
Sadar	-	Government Administrative designation for a town centre headquarters
SMU	-	Study Monitoring Unit
SOB	-	Survey of Bangladesh
SRDI	-	Soil Resources Development Institute
SRP	-	Systems Rehabilitation Project
SWMC	-	Surface Water Modelling Centre, previously FAP 25
Thana	-	Government administration unit between a Union and Zila, has been known in the past as an Upazila (Bangla word)
TOR	-	Terms of Reference
UNDP	-	United Nations Development Programme
Union	-	Government administration unit between a Mauza and a thana. The lowest level from which representatives are elected.
WARPO	-	Water Resources Planning Organisation of the Ministry of Water Resources

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Aims and objectives of the Environmental Impact Assessment (EIA)

The Char Montaz-Kukri Mukri Integrated Development Project is one of three Feasibility Studies carried out as part of the Meghna Estuary Study. The aim of the EIA is to ensure that planning and implementation of projects takes place in an environmentally sound and sustainable manner. The EIA report has been drafted as self standing document so that any potential funding agency can review it in isolation from the main Meghna Estuary Study and Char Montaz-Kukri Mukri Feasibility Study reports.

Methodology

The EIA has followed the FPCO/WARPO EIA Guidelines as far as is possible and appropriate. These guidelines are based upon the practise outlined in World Bank Operational Directive 4:01 on environmental assessment. Impacts have been identified and where possible quantified and valued.

A broad comparative environmental assessment of the full overall phased 30 year intervention programme (Option 4) has been carried out. A detailed EIA has been carried out for the construction of seven cross dams and an associated programme of embankment construction and rehabilitation, drainage provision and remodelling plus an integrated rural development programme (Option 3), assessing the likely impacts over a 30 year period.

Interventions

An outline of the proposed set of interventions is given in Section 2. The derived intervention phasing is to construct four small cross dams (with one as a Pilot Project first) at the northern end of Char Montaz, plus one on the western side of Kukri Mukri, known as Option 2. This would be immediately followed by the construction of two cross dams at the southern end of Char Montaz, known as Option 3. An integrated development programme has been drawn up which aims to use the newly accreted land in a sustainable manner. The final intervention (Option 4), proposed for consideration but not subjected to a full EIA, would be construction of a large cross dam from the north of Kukri Mukri, linking it to Bhola. There would also be a programme of appropriate embankment construction for Kukri Mukri as part of Option 3.

The primary aim of the interventions is to speed up the natural accretion process that would probably eventually happen even without human intervention, working with natural trends rather than against them.

Baseline environmental situation

An outline of the present environmental conditions in the project area is given in Section 3. 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 could be drawn up for the area, as well as for assessing impacts in with and without intervention conditions. The baseline data provides the framework to identify likely impacts due to the proposed interventions, 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 inshore 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 no secondary schooling availability in the area. In Char Montaz the provision of a health centre was considered to the highest priority issue in the area, followed by provision of a cyclone shelter.

- relative 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 at Kukri Mukri with sustainable development for planned human in-migrants. However the area has a favourable rural energy balance when compared to the rest of Bangladesh.

A simple needs assessment was carried out in both Char Montaz and Kukri Mukri intervention areas and included six social groups (see Table I.11). A major conclusion is that by far the majority of people interviewed in all social groups at Kukri Mukri wished to have an embankment to protect them from saline intrusion and cyclones as an overwhelming first priority, whereas at Char Montaz all social groups considered that provision of a health centre was the greatest priority need for the area. The overall second priority at Char Montaz was for accretion of more land, but construction of cyclone shelters followed by improved road access were also high priorities, depending upon the social group. The construction of cross dams would address the issue of provision of improved access. The second overall priority at Kukri Mukri was for construction of cyclone shelters and the third improved road access. Creation of more accreted land was considered a low priority at Kukri Mukri.

Other projects, particularly those that involve construction of embankments, have been reviewed and their experiences borne in mind when carrying out the environmental assessment.

Predicted impacts

The likely impacts of the proposed interventions have been identified using a comparative matrix technique as outlined in Section 5.

The main predicted positive impacts have been identified and described in Section 6 and are:

- accelerated land accretion

- greater physical security for the population resident behind on or inside embankments
- reduction of saline inflow
- reduction in cyclone damage
- reduction in rainfall flooding
- reduction in surface water salinity
- reduction in soil salinity
- improvements in terrestrial bio-diversity
- increases in homestead, livestock and agricultural production
- increases in the total forested area
- increases in aquaculture production
- improved access

The main identified negative impacts are indicated in the conclusions below. None of these are considered to be serious enough to undermine the viability of the proposed project. The most significant problem is that the intervention costs are high, relative to other intervention possibilities in the national context and especially on a per household basis.

CONCLUSIONS

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 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. It is considered unwise to embark upon this full process until the project is confirmed as going ahead with suitable agreed arrangements in place for funding.

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

The needs assessment indicated that the first priority of people living on Char Montaz was for provision of a health centre followed by more land accretion and thirdly improved access. The proposed interventions address the second and third priorities. The highest priority in Kukri Mukri was for embankment construction. The proposed intervention addresses this desire, although waiting to confirm that no further major rise in land level is likely to naturally occur before construction of such an embankment commences.

For the proposed Option 3 the main conclusion is:

- The main predicted benefit is land accretion, the additional amount created by all interventions at year 30 to +1.5 m PWD level (the level at which embankment construction can be considered) due to the cross dams being over five times that of the natural, without intervention, rate. The primary issue is how can this additional created resource be used and how can potential benefits be realised at household level. Another benefit is likely to be wage

paid labour opportunities during the construction of the cross dams.

A planning framework is needed for rational resource use management and the two critical issues that need to be addressed are:

- land rights and land allocation procedure
- forestry management policy, especially thinning, clearing and handing over land for agricultural use, as well as planting on newly accreted land

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 (a minimum of 15 years and possibly 30). In addition the total project costs are quite high at Tk 479 million (1998 prices), bearing in mind the relatively small number (4,060 households at 1996 population levels) of beneficiary households. The costs per hectare of embanked cultivated land has been calculated to be Tk 61,000. 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 trial cross dam in the Pilot Scheme these are negligible and there is no reason on environmental grounds to prevent such a type of intervention being tested. However monitoring of both the Pilot Scheme and the Nijhum Dwip first cross dam should allow any unpredicted negative impacts to be identified. The results of this monitoring could then be fed into the final designs and implementation schedules of Options 2 and 3. Option 4 in year 10 would be dependant upon the monitoring of Nijhum Dwip and Options 2 and 3 at Char Montaz-Kukri Mukri.

Possible negative impacts that have been identified are not considered to be insurmountable, although monitoring data will be required to quantify some of these. The issues include:

- induced change to fish habitats and migration presently going through channels between the islands. However the biggest threat to fish populations is over-fishing, which will continue irrespective of the project.
- changes to wading bird habitats, however replacement habitats for bird life are being formed all the time.
- disruption to dolphin habitat and movement, however replacement habitats are also forming all the time.
- the increased stress on existing conservation management issues in the forested areas caused by human in-migration, although the proposed intervention will actually increase the area of forested habitat available but this needs to be managed in an integrated manner.
- the disruption to existing ghats by accelerated sedimentation.
- possible changes in human nutrition patterns and risk of malaria.
- the disruption to the existing waterborne navigation through existing channels that will have accelerated accretion.
- the improved access to Char Montaz from Bhola using the proposed cross dams may encourage in-migration which has simultaneous positive and negative impacts.
- the disruption due to direct construction impacts which can be minimised and probably turned into benefits by careful planning and implementation.

RECOMMENDATIONS

On environmental grounds there would seem to be no major objection for the construction of the first cluster of four cross dams in northern Char Montaz, including the Pilot Project, plus the small cross dam west of Kukri Mukri and the associated integrated development project. However the two cross dams connecting Char Montaz with the islands south of it should bear in mind the results of the first Nijhum Dwip cross dam, particularly the effect on fisheries, before a firm decision to go ahead is taken. A full and detailed appraisal of likely impacts based upon the practical experience of other cross dams should be carried out before consideration is given to constructing the large cross dam north of Kukri Mukri.

The major concern is that the capital costs of construction are high in beneficiary per-capita terms and there are perhaps more effective ways of using such resources and higher priorities, especially in a country wide context.

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 (estimated total project costs are US$ 10 million at 1998 prices), that the first phases (Options 2 and 3, including the Pilot Scheme) will go ahead. 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.

FUTURE ENVIRONMENTAL WORK PROGRAMME

Assuming that the Project were to go ahead, the following environmental work programme would need to be implemented as part of the project planning and implementation programme:

- continue monitoring of erosion and accretion
- continue and expand the water and soil salinity monitoring
- studies of inshore marine habitats, fish ecology (particularly the fish spawning and breeding grounds), along with a baseline survey of fisheries catch and a stock assessment
- construction management assessment
- a baseline human nutrition survey
- a detailed navigation survey and negotiated arrangement with users for any required relocation of ghats
- an evaluation of the impacts of the project on household livelihoods five years after the construction of the first set of cross dams
- monitoring of the incidence of malaria in the area

A phased programme for this work, linked to the proposed construction works has been drawn up.

1. PROJECT SETTING

1.1 Background

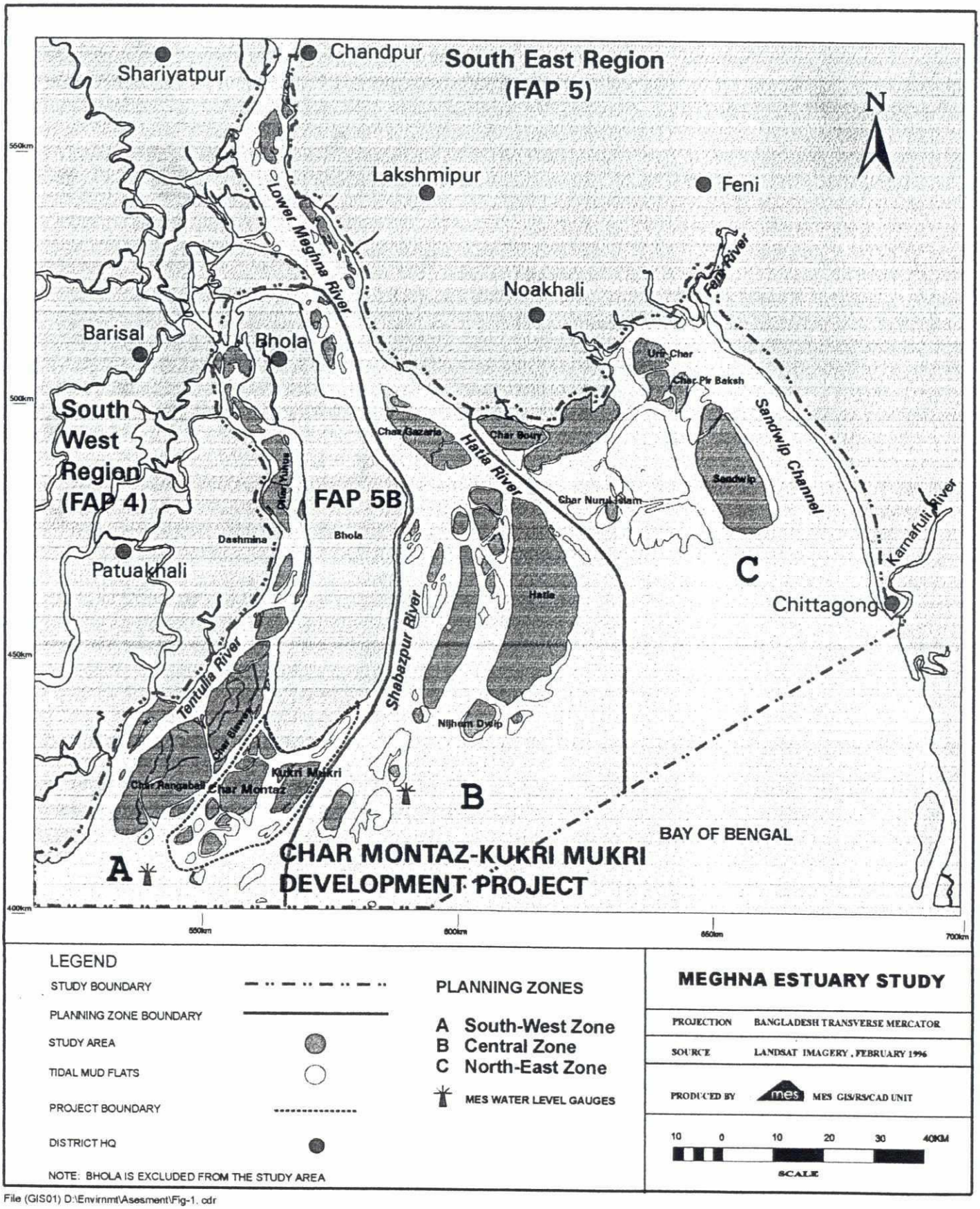
The Char Montaz-Kukri Mukri Integrated Development Project is one of the three selected priority projects of the Meghna Estuary Study (MES) to be taken to Feasibility Study. The MES aims to draw up a regional land and water resources Master Plan for the designated study area (see Figure 1.1), with a planning horizon of 25 years and a phased intervention programme. The main output will be a Draft Master Plan which following review and comments will be issued as the MES Master Plan. In addition a Draft Development Plan for the immediate 0 to 5 and 5 to 10 year period will also be produced, which will concentrate on the three identified Feasibility Studies for the period year 0 to 5 and a further three Pre-Feasibility Studies for the period 5 to 10 years. The Master Plan for the study area is to fit within the regional planning framework for the water sector as outlined in the National Water and Flood Management Strategy for Bangladesh (Ref: FPCO, 1995). The National Strategy is now under review and due to be re-formulated as part of the National Water Management Plan (NWMP).

The MES follows on from the Land Reclamation Project (LRP), a long term study for the coastal area of Bangladesh, which produced its final reports, including Feasibility Study for the South Hatia Cross-Dams, in 1990 (Ref: Land Reclamation Project, 1990) and the Sandwip Cross-Dam. A significant conclusion of the LRP work was that engineering interventions using the current technology to promote land accretion were found to be uneconomic when judged by conventional cost-benefit analysis. The follow-up studies to the LRP have been split between the Char Development and Settlement Project (CDSP) and the MES. The MES aims to address the coastal process issues of land and water management, whereas the CDSP concentrates on those areas of recently stabilised land accretion already considered to be part of the "mainland". The concept and understanding of coastal Chars (a Bengali word meaning any accreted land) should not be confused with the very different river Chars which have been subject to separate study (Ref: ISPAN, 1995b-f). More details of the LRP and CDSP as they relate to the Char Montaz-Kukri Mukri proposed intervention are given in Sections 4.4.1 and 4.4.2.

The major aim of the first year of the MES was to set up the data collection programmes for providing baseline information on the study area. This data collection work initially concentrated on the physical environmental processes, particularly erosion, accretion and collection of climatic and bathymetric data to allow the Surface Water Modelling Centre (SWMC) to build a refined hydro-dynamic model of the area. In the second year of the study programmes were mobilised for collection of data on the human environment, using existing secondary sources where available, and also primary data for issues and locations likely to be subject to Pre-feasibility and Feasibility Study. An assessment of environmental baseline conditions in the MES area was carried out to allow identification of environmental constraints to development and also identifying possible interventions for selection, using a set of rational criteria. A comparative assessment of 20 different types of possible intervention and their likely environmental consequences was presented in the Interim Development Plan (Ref: DHV Consultants BV, December 1997).

The erosion and accretion data collection programme of the MES has used time series satellite imagery, covering the period 1973 to 1996, to map changes in land extent in 6 yearly increments. From the mapping it is possible to identify those areas with continuous, if variable, erosion and also those places with consistent accretion. A major finding of the LRP work was that using the conventional technology of the time it was not possible to arrest erosion or intervene to promote accretion in a cost effective manner. Such a situation constitutes a significant constraint to intervention possibilities to be considered by the MES. In response to these findings, technical trials and Pilot Projects (including one proposed at Char Montaz) are being implemented by the MES to test the technical feasibility of using geotextile materials to see if they offer a significantly cheaper alternative solution for erosion control and accretion promotion measures.

Figure 1.1: Location map



File (GIS01) D:\Envirnmt\Asesment\Fig-1. cdr

An early trial was also implemented using geotextile cages containing sand filled jute sacks to test the technical feasibility of cross dam construction for accretion promotion between Hatia and Nijhum Dwip Islands. The new technique is estimated to significantly reduce the fill requirement, and hence the cost of a cross dam over conventional earth fill embankments, by over 50 per cent. If proven technically successful then the new technology for cross dam construction could provide a cost effective option for implementation in areas of continuous accretion in other parts of the MES area.

As part of standard procedures for the water sector in Bangladesh it is necessary to carry out an environmental appraisal for any proposed intervention, using the Guidelines for Environmental Impact Assessment (Ref: FPCO, October 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 present report aims to cover the requirement for a self standing Environmental Impact Assessment (EIA) of the proposed intervention.

However 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 cross dam and embankment intervention 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 Environmental Clearance Certificates are valid for twelve months and then have to be renewed annually. As these Rules and procedures are very recent, there has been little experience with their operation.

An Initial Environmental Examination (IEE) for a similar type of cross dam at Nijhum Dwip was drafted in May 1997, (prior to the Environmental Rules being made public), as the Nijhum Dwip cross dam was at that stage expected to be implemented as a priority Pilot Project under the MES. However it was eventually decided not to implement such a trial and the IEE was not submitted. However the proposed Nijhum Dwip cross dam has now been studied as one of the three Feasibility Studies of the MES, and a full EIA has been carried out. The proposed full construction programme for Nijhum Dwip is scheduled to be before Char Montaz, with the exception of the first small Pilot Scheme cross dam at Char Montaz. The Nijhum Dwip EIA has formed the model for the work at Char Montaz, as the nature of the intervention at Nijhum Dwip was fixed much earlier than that at Char Montaz, which allowed very site and intervention specific data collection and analysis to be carried out over a 12 month period.

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.

1.2 Aims and objectives of the EIA

The aim of the environmental assessment component of the Study is to ensure environmentally sound project planning and implementation takes place. The objective of the EIA is to produce a self standing report, for Government and international donor use, to assess if the proposed trial, other cross dams and embankment construction at Char Montaz-Kukri Mukri is likely to result in

any significant negative impacts which negate the potential benefits of the proposed intervention. The report has been drawn up in a manner which allows it to be reviewed by outside agencies with little understanding and experience of coastal conditions in Bangladesh.

The EIA aims to establish the baseline conditions in the proposed intervention area and to carry out a needs assessment of the local population to see if the proposed intervention fits within their aims and aspirations. Once the existing situation has been established, then a scoping exercise has been carried out to identify if any major impacts are likely to occur and see if any of these could have significant negative effects that may render the proposed cross dam trial ill advisable.

1.3 Methodology for EIA

As far as is possible and practical the EIA follows the format outlined in the FPCO Guidelines for Environmental Impact Assessment (Ref: FPCO, October 1992) and the EIA Manual (Ref: ISPAN, April 1995a). These Guidelines and Manual follow the spirit and philosophy of World Bank Operational Directive 4:01 on Environmental Assessment (Ref: World Bank, 1991) which is now widely accepted as the norm for most funding agencies. A fundamental objective is that no person is to be made worse off as a result of an intervention and all negative impacts have to be mitigated for, with the cost of mitigation included in the economic analysis of the project. In addition World Bank Operational Directive 4:30 on Involuntary Resettlement (Ref: World Bank, 1990) follows the philosophy that all people displaced by a proposed project are to be compensated for, regardless or not of if they have a legal right to the land they occupied.

The institutional framework for implementing and enforcing EIA in Bangladesh is allowed for in the Environmental Protection Act (now Law) of 1995, an English translation of which has recently been issued (Ref: Abdas 1998). A listing of all environmental legislation up to 1993 is contained in reference ISPAN 1993. The Law delegates the Department of Environment as the responsible body for enforcing EIA. The overall policy objectives for environmental management in Bangladesh were contained in the National Conservation Strategy (NCS) and these were formulated into an implementation strategy as part of the National Environmental Management and Action Plan (NEMAP Ref: Ministry of Environment and Forest, 1995).

Other donors have their own EIA Guidelines, but by following the FPCO/WARPO Guidelines it is normally the case that most donor requirements will be satisfied. The Asian Development Bank Guidelines (Ref: Asian Development Bank, June 1991 and November 1991) are arranged by the nature of the proposed intervention and this can cause great confusion when an intervention cuts across different sectors. The European Commission have their own Directive, DG VIII, (Ref: European Commission, 1995?) and the EC's country office in Dhaka have put out their own notes for EIA (Ref: European Commission, Dhaka, June 1996). It is assumed that by following the FPCO Guidelines as far as is practical and appropriate then the EIA will be considered adequate by the two donor governments of the MES.

The EIA includes impact identification, quantification and valuation, as well as mitigation requirements which are to be part of an Environmental Management Plan (EMP). The results of the full EIA can then be fed into a multi-criteria analysis following the format of the Guidelines for Project Assessment (GPA - Ref: FPCO, May 1992, modified with a new Annex 1 in March 1994). It should however be recognised that the GPA was drawn up in the early stages of the Flood Action Plan (FAP) and was primarily intended to be used for analysis of inland flood management interventions, not coastal situations attempting to justify interventions to promote land accretion. The GPA methodology relies heavily upon agricultural benefits to justify interventions and attempts to use this methodology during the LRP work have shown that it is very difficult to achieve these objectives for land accretion interventions in the coastal areas of Bangladesh.

1.4 Scope, resources and limitations of the EIA

The original Terms of Reference for the MES were drawn up in 1992 before most of the procedures and EIA guidelines for the FAP were in place. The inadequate discipline cover and restricted man months for international specialists was noted in the Inception Report (Ref: DHV

Consultants BV et al, April 1996) and proposals made to address this to some degree by providing inputs from specialists in forestry, fisheries and livestock. However there was no provision for a full time international Deputy Team Leader position with specific responsibility for non-engineering issues, a post which has been found desirable on most integrated regional studies for the water sector in Bangladesh. The result is that some difficulty was experienced in maintaining continuity of supervision of the work.

The non-engineering components of the MES were only fully mobilised by the beginning of March 1997, and even then the fisheries and forestry international specialists could not be started, as formal approval of the Inception Report (Ref: DHV Consultants BV et al, April 1996) and the revised Terms of Reference had still not been given over one year after submission. There was discipline cover with local specialists in broad environmental issues, soil and land resources, agriculture, forestry, fisheries, socio-economics, participation, economics and general rural development. In addition the work on coastal morphology, climatology, bathymetry, remote sensing and GIS was fed into the environmental assessment component. However the local staffing of some of these components was not continuous and ensuring adequate international supervision and co-ordination was problematic.

It is now generally accepted in Bangladesh that any primary data collection for EIA requires a set of seasonal data to be collected over a 12 month period. Steps were taken to do this for the Nijhum Dwip studies but for Char Montaz this was not possible, as the nature of the intervention was decided later on in the planning process, due to the need to first have results from the morphological studies. It was thus possible to collect detailed field data sets in Char Montaz from only January 1998 to April 1998, there was no flood season data collection. In addition the bathymetry data for the area is poor, with the result that accretion predictions and hence benefit quantification are not particularly reliable and certainly inferior to that of the Nijhum Dwip Feasibility Study.

1.5 Interface with other study components

An inter-disciplinary approach was followed for the non engineering components of the study, covering the above listed subject areas. A logical framework analysis was also developed for the overall MES which demonstrated what data was needed at which stage to allow rational decision taking for the planning process. The environmental assessment work was carried out as a component within the overall framework of the MES. For the Nijhum Dwip EIA all work was carried out in a fully integrated manner with staff jointly visiting the field for data collection.

1.6 Layout and format of the EIA report

The layout of the report follows the contents list in Chapter 6 of the EIA manual (Ref: ISPAN April 1995a), as far as is possible and sensible for an EIA in a coastal area.

1.7 Acknowledgements

During the course of the work many people have been consulted at all levels of society, in Dhaka, at Regional, thana and union level and also on the site. In addition a large body of knowledge was already held by staff working on the study due to their previous activities on similar studies in the country, particularly those in coastal areas and under the FAP. A listing of contacts and liaisons is given in Appendix III.

2. THE PROPOSED INTERVENTION

2.1 Regional planning framework

The MES area forms the sixth regional study started under the Flood Action Plan, although it is now classified within the South East Region (originally called FAP 5, nor FAP 5a). The area interfaces with the original South West Regional Study (FAP 4) and the South East Regional Study (FAP 5), the boundaries of which are shown in Figure 1.1.

The overall aim of the MES is to draw up a 25 year phased land and water development programme for the area based upon an understanding of the present environmental conditions, likely future trends and identification of environmental constraints to development. The work already carried out for the MES clearly demonstrates that erosion and accretion patterns are the two most significant variables determining the availability and human use of the resources in the MES area. The mapping of erosion and accretion trends carried out by the MES, using time series satellite imagery for the last 23 years in six year increments, has allowed those areas of continuous erosion and continuous accretion to be identified. The mapping forms a major source of information for identifying potential intervention sites (see Volume 2 of the Master Plan).

The analysis of the erosion and accretion mapping indicates that the Char Montaz-Kukri Mukri area is surprisingly old, being indicated on the 1917 map (see Figure 2.1). Whilst the area has consistent areas of continual accretion, particularly between it and southern Bhola, there are also areas of main bank edge erosion on the north east end of Kukri-Mukri and the north east, north west and south east corners of Char Montaz (see Figure 2.2). The morphological processes would seem to be more complex than Nijhum Dwip.

2.2 Previous studies

Whilst the LRP had identified the possibilities for cross dam construction at Nijhum Dwip and carried out a Feasibility Study (Ref: Land Reclamation Project, December 1990), no such similar work was carried out in the Char Montaz area. A major conclusion of the LRP work at Nijhum Dwip that is relevant to the present Char Montaz Study, was that the cost of the interventions (two cross dams were proposed) could not be justified by the predicted economic returns, as accretion was a natural on-going process in any case and, although the cross dams accelerated the rate at which this occurred, it was still a significant time before benefits could be attributed to the construction work. As part of the LRP Feasibility Study a special component looked at soil salinity conditions in the Nijhum Dwip area (Ref: LRP, November 1990). Unfortunately the date of collection of the soil samples is not given in the report, (the data is obviously highly sensitive to localised flood conditions in the area, both in terms of seasonality, date of last saline intrusion and the 28 day lunar cycle of tides), and the sample locations are also not mapped. The only conclusion that can be drawn from the results that are given is that soil salinity generally increases with depth. A preliminary environmental reconnaissance of the 1990 Nijhum Dwip cross dam proposal was carried out by the Bangladesh Centre for Advanced Studies (BCAS) and was written up as an LRP report (Ref: Rahman and Huq, June 1990). The preliminary conclusions of the reconnaissance report were that the proposed interventions had some minor negative impacts on the natural environment but overall there were significant overall benefits which outweighed these. These conclusions have direct relevance to the situation at Char Montaz-Kukri Mukri, where conditions are very similar.

The proposed intervention at Char Montaz attempts to take the LRP 1990 work to a further stage of development by using more cost effective construction technology in the hope of demonstrating that cross dam construction using geotextiles can be economically cost justified.

Meghna Estuary Study
Char Montaz / Kukuri-Mukuri Environmental Assessment
Figure 2.1
Change in South Bhola Island Extent 1917-1996

Meghna Estuary Study
Char Montaz / Kukuri-Mukuri Environmental Assessment

Landsat Image of February 1996

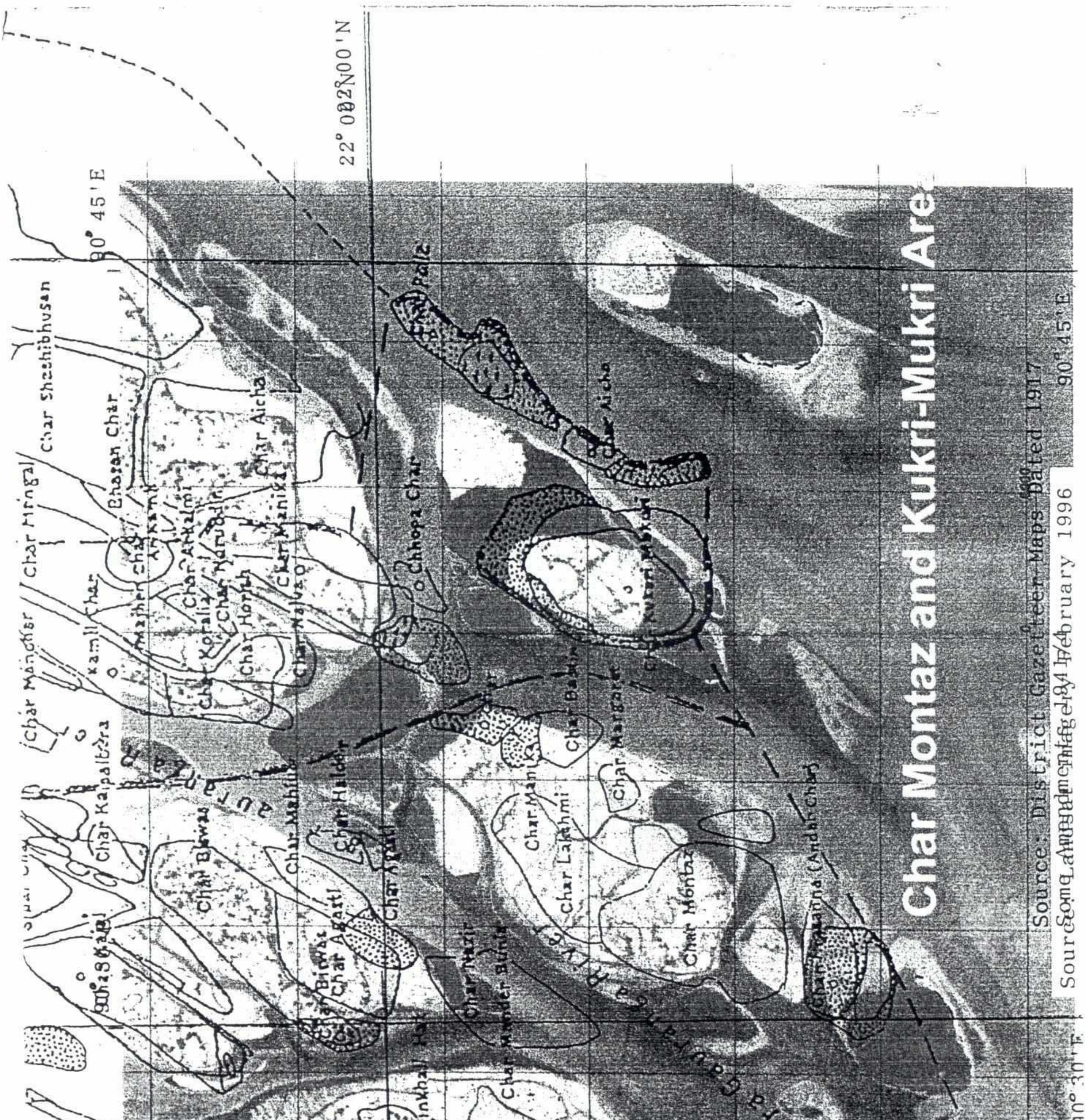
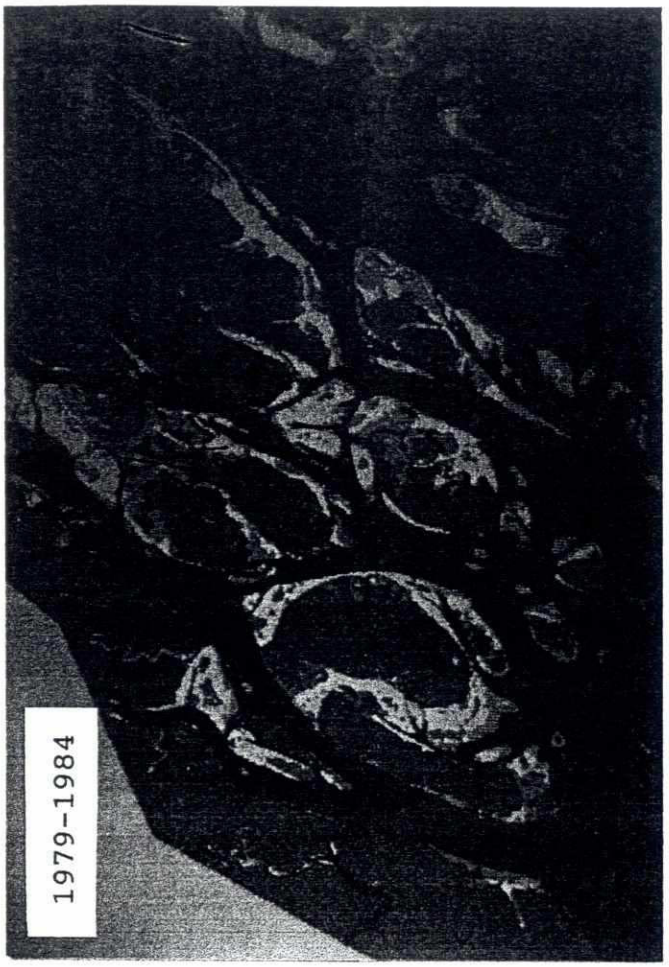
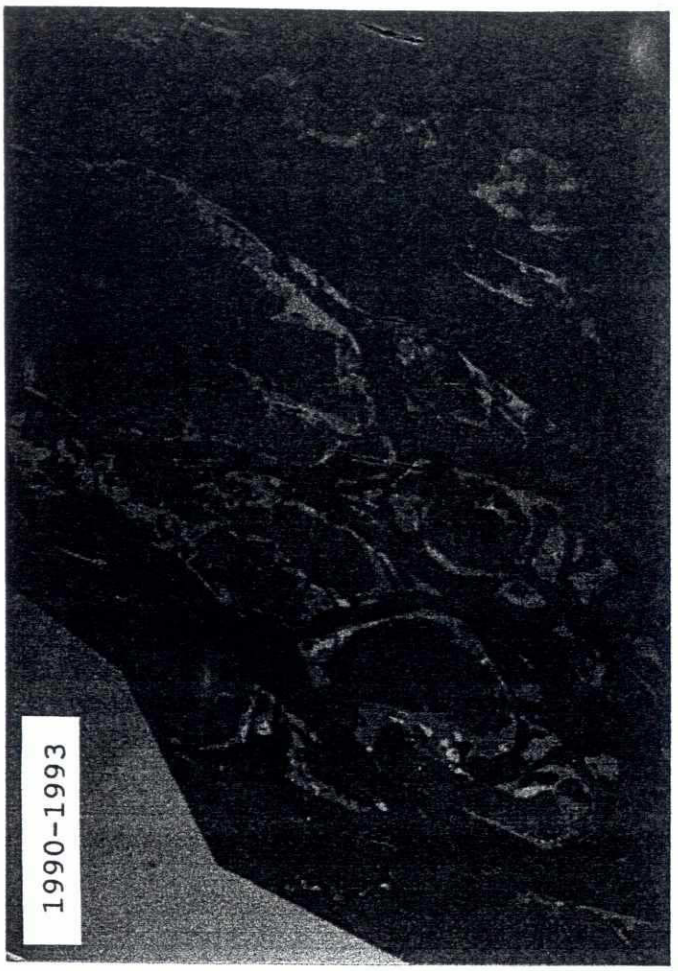
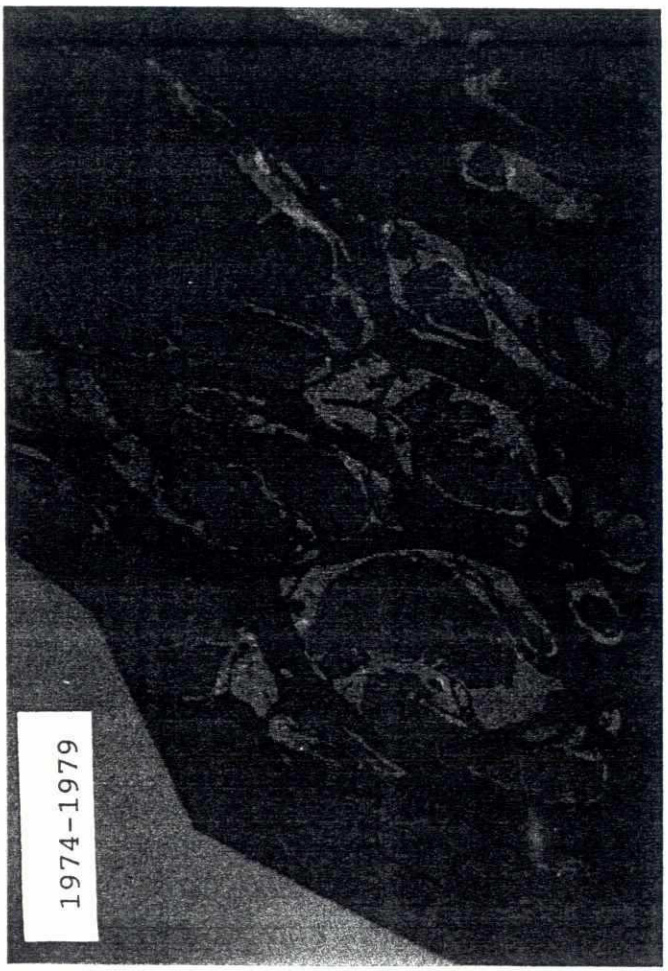
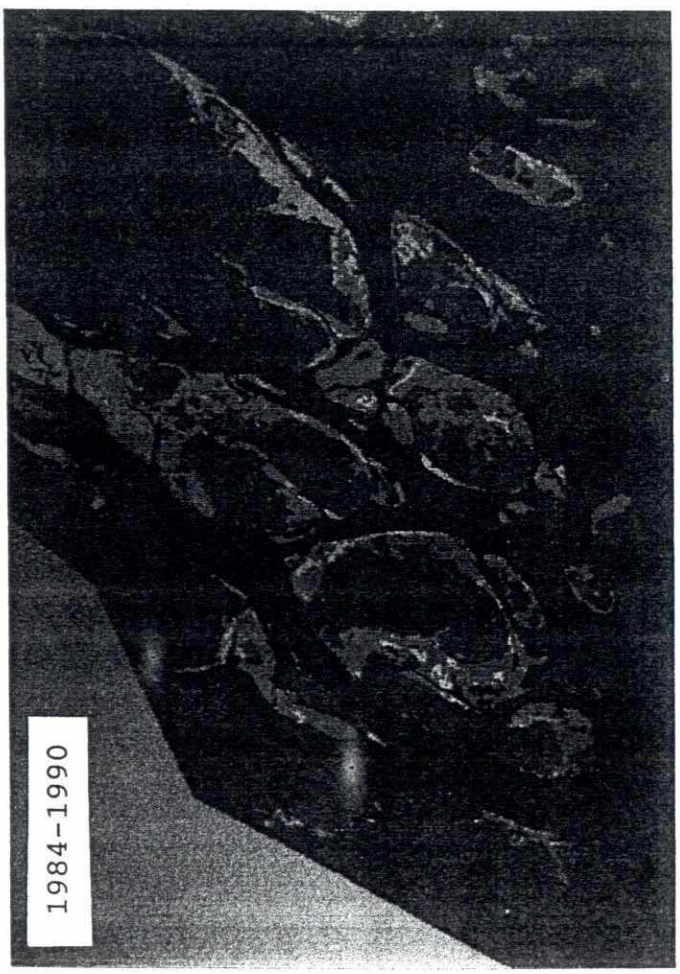


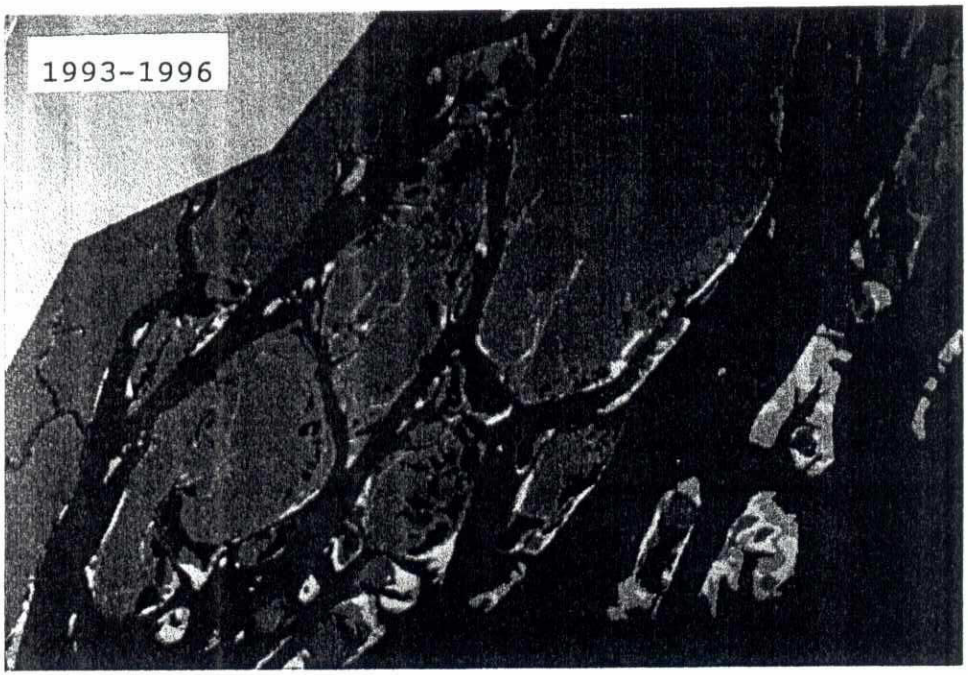
Figure 2.2 : Erosion and accretion patterns South Bhola 1973-1996

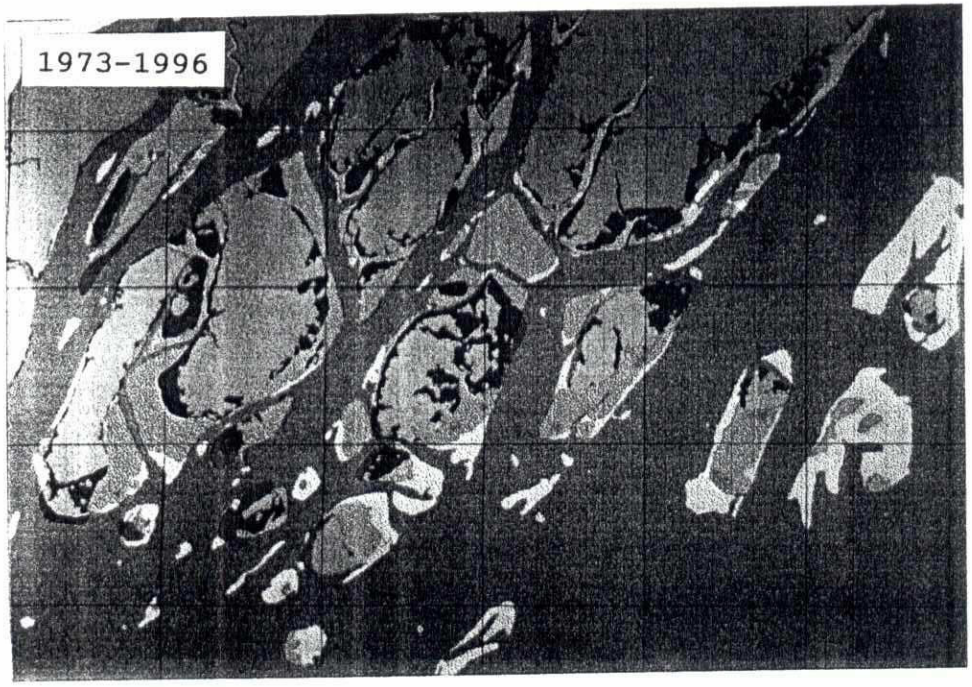






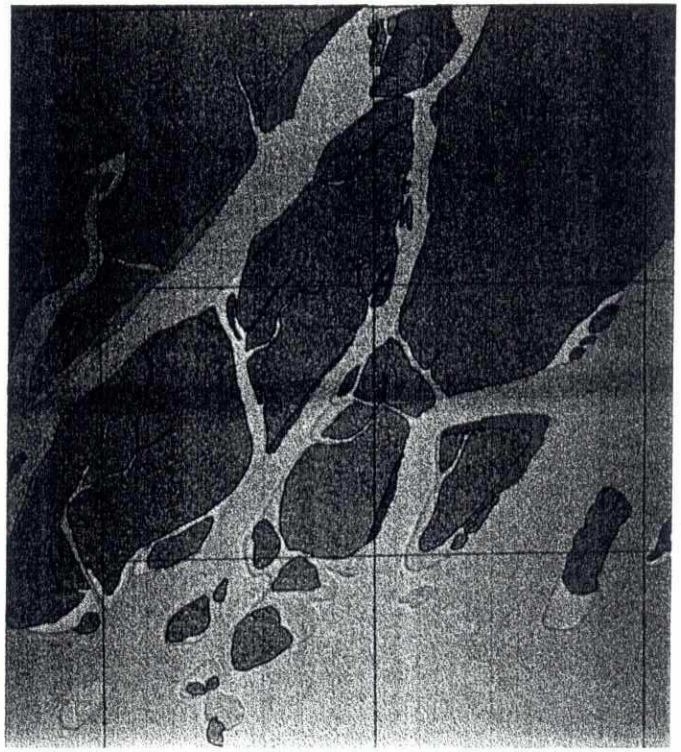






Change Categories

- Water from water
- Water from mud
- Mud from water
- Mud from mud
- Land from land
- Water from land
- Mud from land
- Land from water
- Land from mud
- Longterm stable land



Predicted Erosion
and Accretion
1996-2025

2.3 Trial interventions and MES pilot schemes

As stated above, the aim of trials in the MES programme is to test new innovative construction techniques for accretion promotion and erosion management using geotextiles. The aim is to demonstrate that these techniques will substantially reduce construction costs when compared to traditional techniques, (by over 50 per cent in the case of a cross dam for accretion promotion), and hence make such interventions more cost effective. It has been decided that proposed cross dam A1 A-2 (see Figure 2.3) will be constructed as a Pilot Scheme in advance of the main intervention strategy. The philosophy behind such cross dams is to accelerate natural accretion, and in some cases provide a closure where under natural conditions this would not occur.

2.4 Alternatives

In all eight cross dams have been proposed for construction in the Char Montaz-Kukri Mukri area as shown in Figure 2.3. The main alternatives are the sequence and timing in which these can be constructed. As explained in Section 2.3 above, cross dam A1 A-2 has been selected as a Pilot Project for early implementation. It has been decided that the most rational approach is to complete the cluster of cross dams north west of Char Montaz (A1 A-3, A1 A-4 and A1 A-5) at year 1. At the same time it is also proposed to build the small cross dam west of Kukri Mukri (A-6). Cross dams A-7 and A-8 south of Char Montaz are proposed for construction in year 2, whilst the largest cross dam (A1) connecting Kukri Mukri to Southern Bhola is proposed for year 10, so that the results of the other dams can be monitored and further natural accretion can take place so as to reduce the length of the dam and hence its costs. The life of the project over which economic analysis is being carried out is 30 years, during which time benefits from cross dam construction are converted into economic ones by the embanking (years 6/7 for Kukri Mukri and new land north of Char Montaz) and drainage of land (years 1/2 along with embankment rehabilitation in Char Montaz).

The present situation shown in Figure 2.5 and the predicted future without intervention conditions at year 30, known as Option 1, (see Figure 2.4) are used as a basis for environmental analysis, so that the benefits attributable to the intervention can be separated from those which would have occurred naturally.

2.5 The proposed intervention

Whilst the proposed intervention has been drawn up bearing in mind the results of the needs assessment for the area, there were different priorities in Char Montaz than Kukri Mukri. In Char Montaz the overwhelming priority was for health service provision, with creation of more accreted land a second priority. In Kukri Mukri the top priority was construction of an embankment followed by construction of a cyclone shelter and construction of new access roads (a role for which construction of cross dams is an intrinsic part) as a third priority. There were no significant differences in preference social group for these stated top priorities. The results of the needs assessment are given in Table I.11.

The range of incremental interventions that have been considered are:

- construction of Cross Dam A1 A-2 as a Pilot Project three years prior to commencement of construction of the main phased programme for the rest of the area
- construction of cross dams A1 A-3, A1 A-4 and A1 A-5 at northern Char Montaz in year 1
- construction of cross dam A-6 in west Kukri Mukri in year 1
- rehabilitation of the existing embankments and remodelling of the drainage inside the existing embankments of Char Montaz in years 1 and 2

Figure 2.3: Proposed Interventions

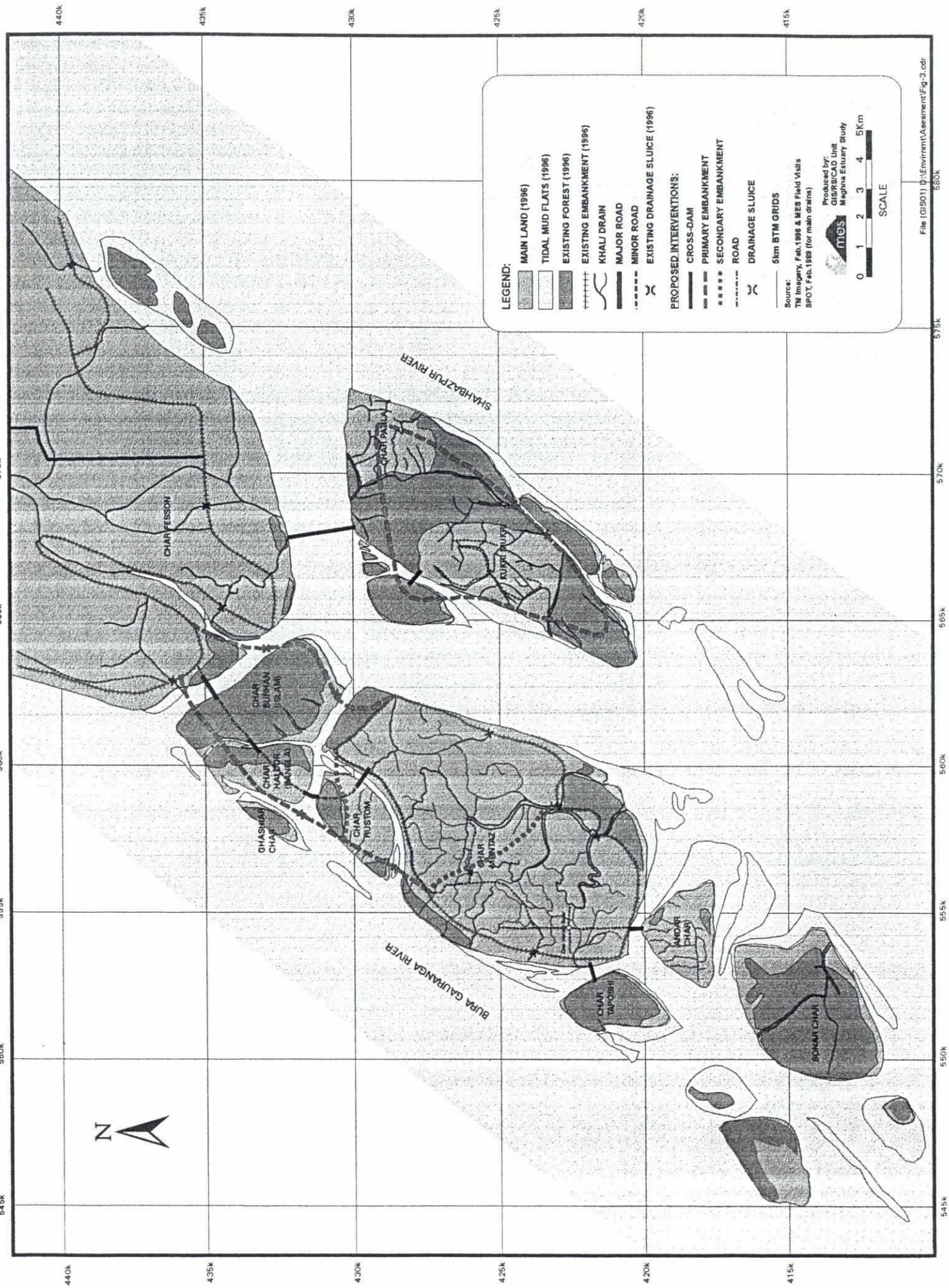


Figure 2.4: Land accretion predictions with and without interventions

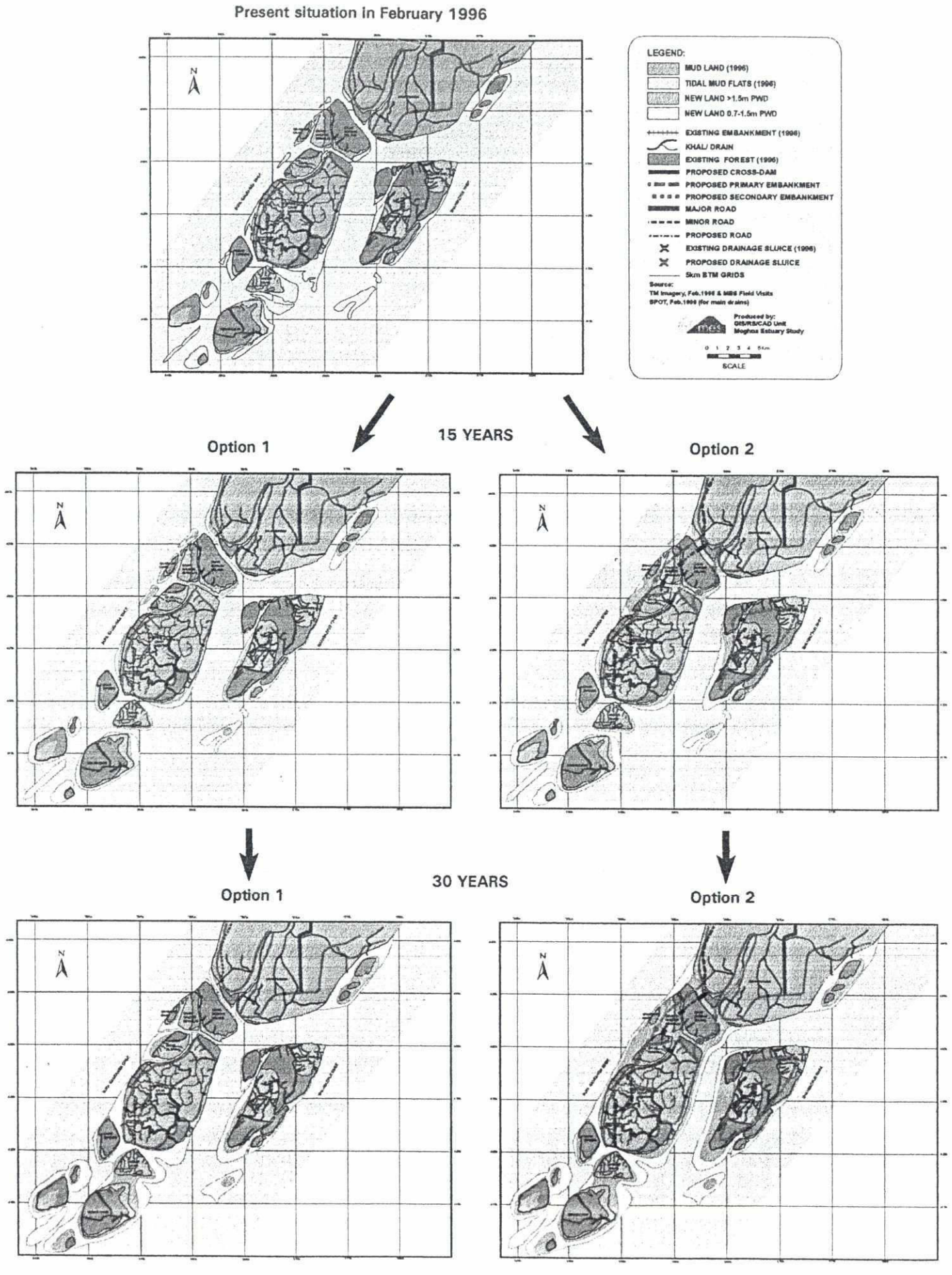
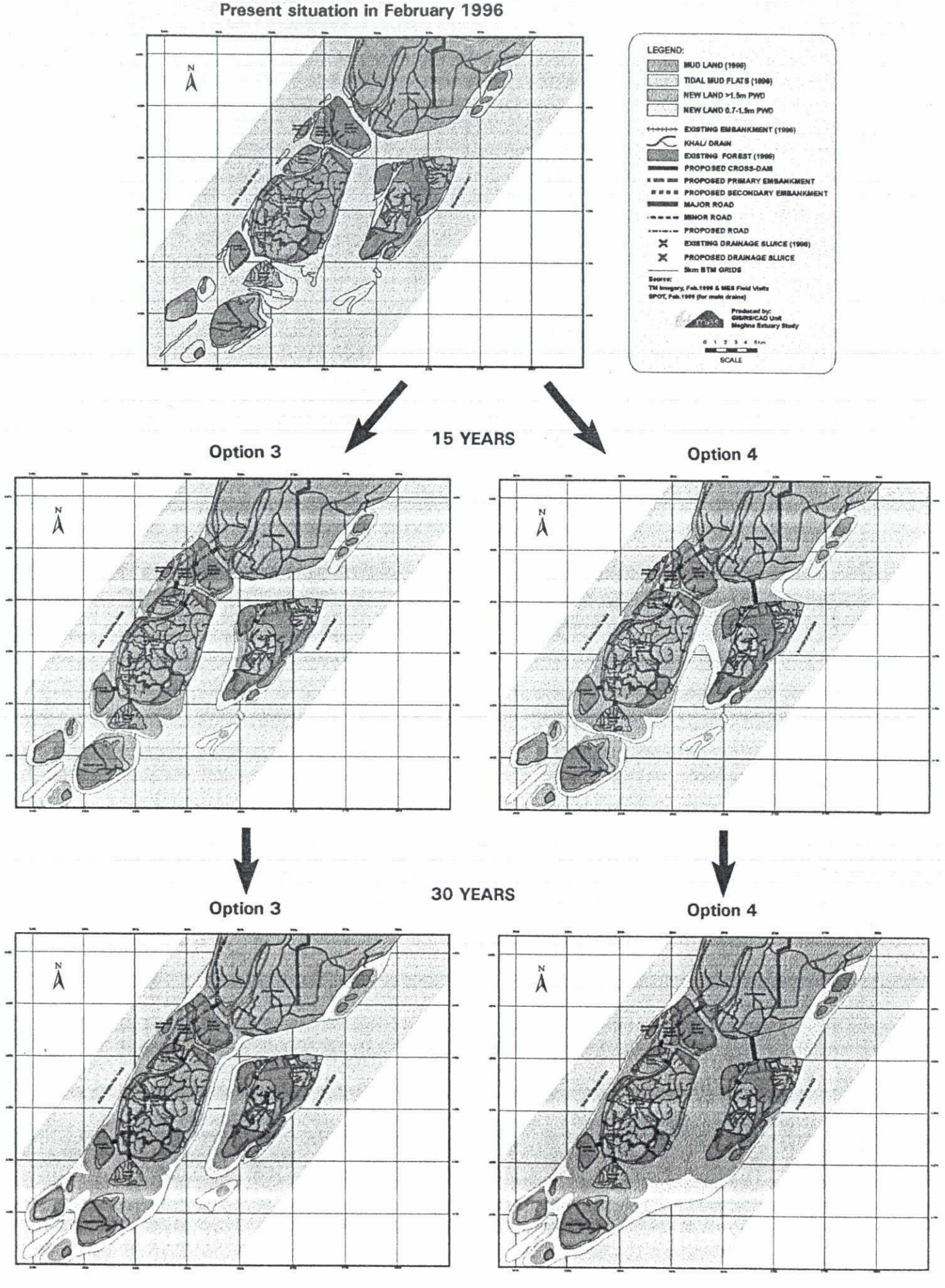


Figure 2.4: Land accretion predictions with and without interventions (continuous)



- construction of cross dams A-7 and A-8 south of Char Montaz in year 2

- construction of new embankments and drainage provision in northern Char Montaz and Kukri Mukri in years 6 and 7

- construction of cross dam A-1 from Kukri Mukri to Bhola in year 10.

The construction of cross dams will use geotextile gabions containing sand filled jute bags, all enclosed within bamboo cages. The cost of this technique is estimated to be between 30 per cent-50 per cent of a conventional earth fill embankment. The objective is to speed up natural land accretion and close the low flow channels between islands.

Embankment construction and rehabilitation for sea facing conditions would use the design criteria from the CPP II project, and only carried out on condition that the land had accreted to an appropriate height, calculated for the area to be 1.5 metres above PWD level. Embankment construction and rehabilitation would also be accompanied by appropriate drainage provision, including excavation and water control structure construction, management and operation. The embankments would total 75.1 km in length and also act as multipurpose roads and possibly linear settlements, including social forestry. A further 8.6 km of secondary embankment with crest roads would be constructed.

In order to generate productive use of the newly accreted land, an integrated management programme would be implemented, based upon its level and location. This approach includes:

- the planting and sustainable management of forestry in areas outside embankments on land above 0.7m, with a minimum band of tree cover on the seaward side of any embankment of 1 km. The area available for planting would be 4,940 ha by year 30, of which 4,000 ha is attributable to the cross dam intervention. Cutting of forestry which is over 16 years old on land that has accreted to over 1.5 metres for consideration to turning the land over to agriculture, has also be included in the programme. The forestry component is proposed to be carried out by the Forest Department and be self funding from sales of thinned and felled timber and forest products.

- the allocation of agriculture land holdings to 2,570 households presently resident in the area who are functionally landless.

- the settlement of an additional 860 households in the 30 year period, (over and above predicted without project human population increase), in cluster settlements with the appropriate infrastructure (house construction, water supply, sanitation, school, aquaculture pond etc).

- the implementation of an aquaculture programme using the borrow pits from embankment construction. In addition presently cultivated and culturable ponds will also be included in the programme giving a total area of 144 ha for fish and 133 ha for shrimps.

- implementation of a livestock improvement programme to increase both the number and quality of animals which can graze the land outside embankments which is subject to occasional saline flooding.

Using the hydro-dynamic model, predictions have been made of the likely land accretion that will occur as a result of the construction of the cross dams. This is shown for levels 0.7 metres (the level at which forestry can be planted), 1.2 metres (the level at which seasonal cultivation can be considered) and 1.5m, the level at which the construction of embankments can be considered. The outputs are shown in Table I.12 and cover the scenarios of no intervention construction, five

cross dams by the end of year one (Option 2), seven cross dams by the end of year three (Option 3) and all interventions (Option 4). The analysis is given for a 30 year period and the morphological impacts are shown as a series of maps in Figure 2.4. These model outputs form the basis for impact analysis.

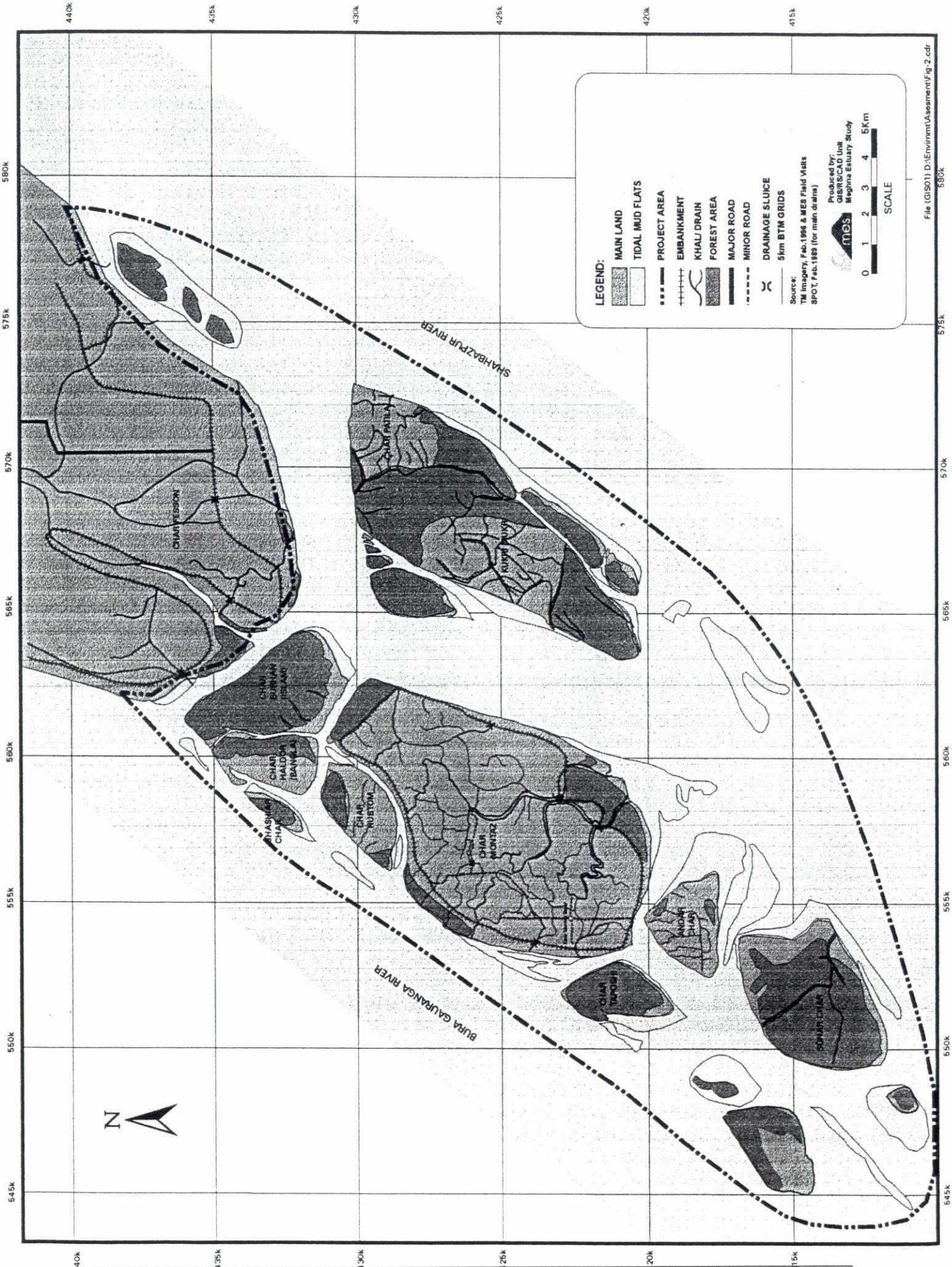
An important assumption is that in all intervention scenarios it is envisaged that on-going government provision of services, (water supply, sanitation, health, education, cyclone shelters and agricultural extension), would continue based upon an extrapolation of past human population increases and the project would only carry out such work for the additional in-migrants (860 households over the life of the project).

It is also envisaged that there will be NGO promotion of income generating activities for women and NGOs would also provide assistance with extension for the livestock improvement and aquaculture programmes of the project. It is assumed that the waterborne navigation system in the area will remain in the private sector and there will be no government or project specific assistance to this except for any mitigation that my be deemed necessary as a result of the impacts caused by the proposed intervention.

The implementation schedule is given in Figure 9.1.

The delineated project area for the Feasibility Study is given in Figure 2.5 and as well as the embanked island of Char Montaz and the unembanked island of Kukri Mukri, includes coastline of part southern Bhola and all the intermediate islands plus the offshore islands and tidal mudflats south of Char Montaz. The aim is to include all those areas which could be impacted, both positively and negatively, by the proposed interventions. The delineation of impact areas is discussed in Section 5.3 below.

Figure 2.5: Project map



3. DESCRIPTION OF THE EXISTING ENVIRONMENT

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 could 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.

3.1 Natural physical environment

3.1.1 Topography and bathymetry

The most up to date base map of the area has been made using the latest Landsat multi-spectral satellite imagery (dated February 1996 shown in Figure 3.1) that was available when the studies commenced. The most detailed satellite imagery available for the area is French SPOT panchromatic data of February 1989 produced for LGED at 1:50,000 scale. This SPOT imagery has been used as a basis for drawing up the LGED 1:50,000 maps for each thana which show most of the existing infrastructure and Mauza boundaries. In addition landsat imagery comparable to that of February 1996 has been obtained for 1973, 1979, 1984, 1990 and 1993. Using digital superimposition and analysis techniques the erosion and accretion patterns have been mapped. The results of this work are indicated below. More recent imagery dated November 1997 and March 1998 is available for the area and these confirm on-going natural trends.

With regard to topographic data, the Survey of Bangladesh (SOB) maps of the area are now badly out of date for such a dynamic place, as most of the sheets date from the early 1960's. The best available mapping for the land areas are the preliminary drafts of the Finmap 1:10,000 sheets dated 1992/4 which use the revised datum common for the whole country with the exception of Hatia and Sandwip. However the Finmap map sheets do not include land levels in the forested areas and the air photography from which the bases were constructed has not been made available to the Meghna Estuary Study. The Finmap levels show that land levels inside the Char Montaz embankment are lower than those outside it. This may be an indication that the embankment was built too early, before natural accretion had sufficient time to build up to 1.5 metres above mean sea level, the level which is believed to be the highest that land would reach under unembanked conditions. However it may also be the case that both Char Montaz and Kukri Mukri, at approximately 1.25 metres above mean sea level, have already reached their natural maximum and the construction of the embankment at Char Montaz has actually caused the land outside it to accrete to a higher level. What ever the reason, the situation also partly explains the difficulty in draining some of the areas inside the existing embankments.

The original bathymetry data for areas around the islands is much poorer than for the Nijhum Dwip area. However the MES data collection programme has recently re-surveyed the area and in time digitally based up to date charts can be produced.

There are also significant historical maps of the area, the oldest of which would appear to be the Rennell's map dated 1776 (Ref: Rennell, 1776). At this time of 220 years ago it appears that there was no land in existence in the present location of Char Montaz and Kukri Mukri, nor for the southern half of Bhola. However the island system to the west of Char Montaz (Char Biswas) was in existence, and if anything was larger, extending more to the east into what is now the Bura Gauranga River. The Bakerganj and Patuakhali District Gazetteers of 1980 and 1982 respectively, (Ref: Government of the People's Republic of Bangladesh, 1980 and 1982) contain maps of the area with additions up to 1917, amendments in 1941/44 and some updates to 1971. These maps have been compiled together and are shown as an overlay to the February 1996 Landsat image in Figure 2.1. The difficulty in using this data is that it is not clear which pieces were additions, amendments or updates at which time. The implications for erosion and accretion trends raised by the map are discussed in Section 3.1.5 below.

Figure 3.1: Landsat image of February 1996

An airborne reconnaissance of the area was made on 1st February 1997, however the visibility was poor and due to restrictions the photographs taken can not be included in the report.

3.1.2 Climate

Detailed climatic data for the Patuakhali area has been collected since 1962, a shorter time period than most of the old district head quarters towns for the country, as it was established much later from part of Bakerganj. However some data does exist for Patuakhali back to 1905 and for the old Bakerganj District the records go back to 1892, although the location in which they were collected is not so representative of the project area as Patuakhali. The seasonal variation in mean data for the period 1962 to 1989 for Patuakhali is summarised for in Figure II.1. The most important parameter is rainfall and the mean monthly rainfall data for Patuakhali is shown in more detail in Figure II.2 and Table I.1. The mean annual rainfall was 2,546 mm for the period 1962 to 1989, however for the period 1905 to 1974 the mean was 2,806 mm, the highest being 6,206 mm in 1909 and the lowest 1,787 mm in 1944. However in addition to the variation from year to year being so great, there can be similar enormous differences in daily rainfall. Such variations are critical in assessment of the drainage conditions in the area and the sizing of channels and structures. Study of the daily rainfall records for nearby Hatia show that 120 mm of rainfall in a day is a common occurrence in July of most years and this can be as high as 180 mm. Similar daily rainfall amounts can also occur in pre-monsoon storms in April of some years and continue into October for late monsoon years. Temperatures are more moderated when compared to inland Bangladesh due to the effect of the sea. However humidity remains high throughout the year and fog is common in winter. Pre-monsoon storms can be sudden and violent with high localised winds. Cyclonic storms also occur and these are discussed below. More recent and detailed climatic data has been obtained from the relevant government departments and has been integrated into the SWMC hydro-dynamic model developed for the whole MES area.

3.1.3 Surface water hydrology

Tides and surges

Daily maximum and minimum water levels have been given for the Char Montaz area using the BWDB gauge at Dashmina, located halfway up the west side of Bhola island but sited on the west bank of the Tentulia river. Year round plots of this data have been analysed for 1990, 1991, 1992, 1996 and 1997 and sample outputs for the complete year of 1997 plus parts of 1991 and 1992 are given in Figure II.3. The lack of data for 1987 to 1989 and 1993 to 1995 is a serious constraint to rational analysis. The plots that do exist show the influence of the 28 day lunar cycle and also the daily variation, the effects of seasonal changes in water level causes by the monsoon fed river system and in addition the sudden peak surges that occur during the cyclone prone times. Comparative analysis of the water level and local rainfall data can only be carried out using daily rainfall data. Unlike inland Bangladesh, it would appear that the variations in sea water levels are far more significant in determining flooding than local rainfall. The major exception is in areas that have been embanked and where the drainage system is inadequate, resulting in induced flooding behind embankments, such as occurs in the main part of Char Montaz but not Kukri Mukri. The "normal" high tide would seem to reach a level of +2.2 m PWD but peak tides of +2.7 m PWD occur in many years during the months of March to June. However the highest peak levels are up to 3.2 metres in July/August when upstream river levels are highest. These peak tides inundate land outside the existing embankments and also inside them in places where the drainage does not have a working water management system to stop saline intrusion or conversely allow full use of the daily tidal range to adequately drain monsoon rainfall run-off. The highest levels of all occur during cyclone surges. The timing of cyclone surges relative to high tide, the lunar cycle and seasonal river flood times is critical in determining the peak water level. On 28th July 1992 the peak level recorded was 3.2 metres at Dashmina (see Figure II.3e), but could have been 0.7 metres more if it had occurred 8 days later. The surge of 28th September 1997 caused a rise of 1.2 metres but at the lowest stage of the lunar cycle. Had it occurred 10 days earlier, the peak level would have been 3.7m. The cyclone of 30th April 1991 caused abnormally low water levels to -0.3m, even though it occurred at a lunar peak (see Figure II.3B), probably due to the location of its landfall track north of Chittagong and the direction of movement. However the two latter

events were outside the monsoon influenced seasonal peak time of July and August, unlike that of July 1992. There is evidence that the cyclone season is developing earlier in the autumn and this should be cause for concern.

As part of the MES, two automatic water level recorders have been set up to the west and east of the project area as shown in Figure 1.1. Unfortunately it has not yet been possible to directly correlate the level data from Dashmina with that from the two new recorders as the time period of operation for the new recorders is too short. However this should be possible in the near future.

Rainfall flooding patterns

The SWMC previously produced a course hydro-dynamic model that was developed for the Cyclone Shelter Project (Ref: Sener Ingenieria y Sistemas SA, 1996) based upon LRP discrete sets of bathymetry data collected over 12 different years. The Digital Elevation Model (DEM) for land levels used for the SWMC course model was based upon old data. However the 1:10 000 Finmap data has recently been digitised to provide an up to date and consistent data set and when combined with the MES bathymetry data collected during 1997 will provide a much more accurate flood simulation model. The model is presently being developed and the outputs will soon be available but in the meantime the course model run for cyclone conditions in 1979 and 1991 has been viewed and enquiries made in the field to ascertain the duration of flooding in specific places for different years. One of the conclusions of the agro-economic survey for the South Hatia area was that flood durations tend to be longest inside the embankments, due to impeded rainfall drainage. However flood durations appear to be never longer than 12 to 15 days and the flooding is with non-saline water. A similar situation could be expected from the embanked area at Char Montaz. The recent rehabilitation of the Southern Hatia area under the Systems Rehabilitation Project appears to have solved this problem to a greater extent, illustrating the need for embankment and drainage rehabilitation works at Char Montaz. The flooding from saline water drains rapidly but requires the rainfall leaching of the following monsoon to wash out the immediate residual salinity and permit crop cultivation.

Water quality and chemistry

There is no existing water quality data collected by the DOE for the Char Montaz-Kukri Mukri area. The nearest sampling points are Chandpur and Chittagong (Ref: Department of the Environment, 1993). The MES bathymetry work has collected once-off water salinity data at time of survey, however it was recognised that systematic seasonal sampling in the Char Montaz-Kukri Mukri area is required. As part of the Feasibility Study, water samples were collected on just one occasion at 13 points on Char Montaz between 14th-15th February 1998. The sampling locations are shown in Figure 3.2 and the results in Table I.2. The sites include open surface water inside and outside the existing embankments as well as ponds and groundwater.

The most important parameter measured was electrical conductivity as an indicator of salinity. Study of the water levels (see Figures 7 and 8) shows that there were probably saline intrusions around 4th and 21st August 1997.

The conclusions of the data are that groundwater salinity is considerably lower than surface water for the dry season period, with the highest salinity levels being on the west side of Char Montaz adjacent to the main channel. This is rather surprising, as it had been hoped that the reputed freshwater lens in the Tentulia river would produce lower salinity levels in that area. The salinity values for open surface water inside the embankment during February 1998 were only fractionally lower than those in the smaller channels outside the embankment, indicating that the embankment is not effective in preventing saline intrusion. The lowest values were in the two groundwater sources (these are from the third aquifer, some 300 metres deep) and the second lowest in ponds which are normally rain fed. The shortcomings of the data set are that they are only peak dry season data and the geographical coverage should ideally be wider to include Kukri Mukri and the main channels around the project area. It is thus considered imperative that the water quality sampling be continued into the next stage of the MES, if the Char Montaz-Kukri Mukri project is to go ahead. The sampling needs to be carried out in the same locations plus additional ones, and

initially for four times a year as part of the proposed environmental monitoring programme. Interpretation of the results needs daily rainfall records for the area and also continuous water levels.

The main conclusions are that groundwater is too valuable and must not be considered for irrigated agriculture and should be reserved only for domestic use. In the dry season the groundwater salinity levels were considerably lower than on Nijhum Dwip and are not presently problematic. There is obviously a requirement to rehabilitate the Char Montaz embankment as well as sorting out its drainage system and operation.

In addition the surface soil sampling work has included salinity measurement, the data interpretation of which has to be integrated with that for water salinity. This is discussed in Section 3.1.5 below.

There would appear to be very little risk of agro-chemical pollution as application rates are very low due to their high cost and the difficulty of access to the area resulting in poor availability. This is consistent with the findings of the NMIDP work on the subject (Ref: Halcrow et al, February 1995).

3.1.4 Ground water hydrology

The depth to safe groundwater for domestic use is relatively great when compared to other parts of Bangladesh. The water quality sampling has included two groundwater points, both are inside the embankment, one in south west Char Montaz and the other in the north east of the island. The conclusions of the data are that groundwater salinity is considerably lower than surface water for the dry season period. The main conclusion is that groundwater is too valuable a resource to be wasted on irrigated agriculture and should be reserved only for domestic use.

3.1.5 Land resources

Erosion and accretion

The broad picture for land erosion and accretion for the Char Montaz-Kukri Mukri area between 1917 and 1996 can be seen in Figure 2.1. The detailed picture between 1973 and 1996 can be seen in Figure 2.2, with the six yearly steps between this. The broad conclusions are that the Char Montaz-Kukri Mukri area has been subject to considerable natural accretion in the last 23 years but also significant erosion in the north east corner of Kukri Mukri and minor erosion in the north west, north east and south west corners of Char Montaz. Much of the accretion had occurred as tidal mud flats prior to 1973, but consolidated since 1984. The significant erosion on the north east tip of Kukri Mukri has occurred since 1984.

A predictive sedimentation simulation has been made of the area using the new bathymetry data and running the SWMC model with the MES sediment data. The results of this are shown in Table I.12 and mapped in Figures 10 and 18. From this mapping it can be seen that the north eastern part of Kukri Mukri is predicted to have significant accelerating bank edge erosion. The eastern side of Char Montaz is also predicted to erode, where as the minor channels between islands to the northwest and south are predicted to infill. Kukri-Mukri is predicted to accrete in a south west direction.

It has been predicted in the morphological studies that the natural rate of future accretion without any intervention will be approximately 100 ha a year up to level +1.5m. The predicted amounts of accretion are shown in Table I.12 and the locations are shown in Figure 2.4.

Soil

The SRDI have collected detailed soil data for the project area, but unlike Nijhum Dwip, it is unfortunately not yet published. Attempts have been made to obtain copies of the unpublished data sets and a map, but at the time of writing this had not as yet been released to the Study,

although Figure II.4 has been allocated for a copy of the SRDI thana soil map of the area as soon as it is received. The broad soil reconnaissance survey which covers the whole of the MES area (Ref: SRDI, 1965-66 and 1971-72) subdivides the Char Montaz and Kukri Mukri areas into just two classes and is of no use for Feasibility Study level work. As part of the field data collection for the MES Feasibility Study six soil samples were collected on Char Montaz and analysed by SRDI. The locations of the samples are shown in Figure 3.2 and the results of the chemical analysis in Table 3.1, with the rating of analytical values for Bangladesh in Table 3.2. The samples were taken between 13th and 17th February 1998, the height of the dry season. From the water levels at Dashmina it can be seen that the last flood that could have caused a saline intrusion was between 12th and 16th November 1997. There was a significant cyclone surge on 27th September 1997 (fortunately at the low point in the lunar cycle) and the peak level due to monsoon run-off was between 18th and 25th August 1997.

Table 3.1: Surface soil analytical data

Station	Sodium (milli equ per 100 gm soil)	Total Nitrogen (%)	Organic matter (%)	Phosphorus (Microgram / gm soil)	Zinc (Microgram / gm soil)	Boron (Microgram / gm soil)	EC (mmhos/ cm)	PH
1	8.83	0.05	0.97	3.28	0.8	0.60	17.85	7.5
2	4.93	0.04	0.81	2.25	1.0	0.68	7.03	8.1
3	4.31	0.04	0.81	4.00	0.8	0.86	5.42	8.3
4	0.36	0.06	1.24	1.99	0.8	0.35	0.60	8.1
5	4.73	0.15	2.97	1.50	2.2	0.07	7.14	5.0
6	1.11	0.10	1.97	2.30	1.0	0.46	2.01	6.5

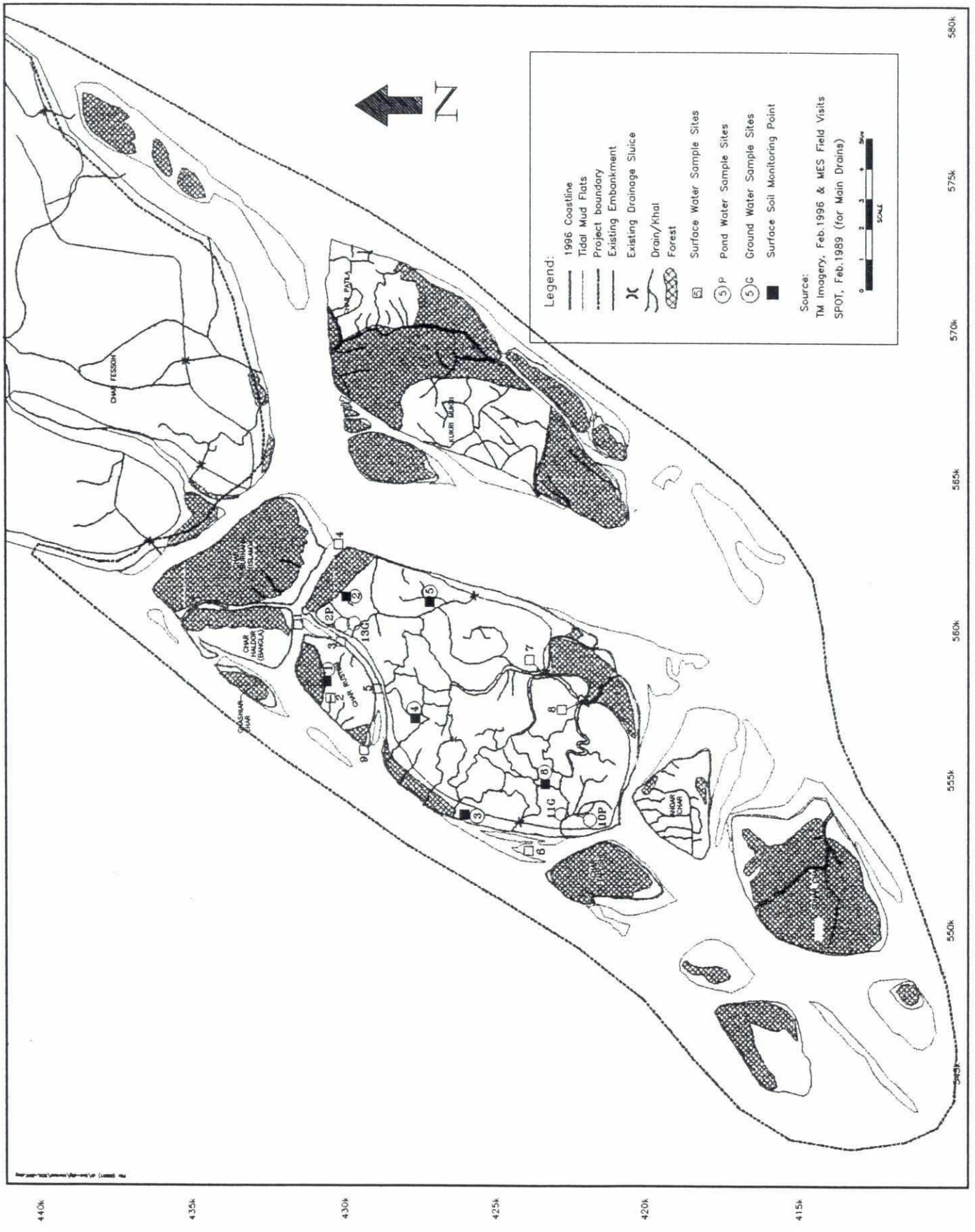
Note : Soil samples were collected during 13-17 February 1998 and were analyzed in the SRDI laboratory, Dhaka
Source: Field Survey 1998

Table 3.2: Rating of analytical values of soil nutrient components

Nutrient components	Low	Medium	High
Calcium (Ca) Mill equivalent / 100ml Soil	< 2.1	2.1-4.0	4.1-18.0
Magnesium (Mg) Mill equivalent / 100ml Soil	< 0.81	0.81-2.0	2.1-9.0
Potassium (K) Mill equivalent / 100ml Soil	< 0.21	0.21-0.40	0.41-1.50
Calcium-Magnesium Ratio	< 1.3	1.3-1.7	1.8-3.1
Magnesium-Potassium Ratio	< 1.7	1.7-2.0	2.1-7.0
Nitrogen (N) PPM/ml Soil	< 76	76-150	151-300
Phosphorus (P) PPM/ml Soil	< 13	13-25	26-75
Sulpher (S) PPM/ml Soil	< 13	13-25	26-75
Boron (Bo) PPM/ml Soil	< 0.21	0.21-0.50	0.51-4.0
Copper (Cu) PPM/ml Soil	< 1.1	1.1-3.0	3.1-10.0
Iron (Fe) PPM/ml Soil	< 21	21-40	41-200
Manganese (Mn) PPM/ml Soil	< 5.1	5.1-10.0	11.0-50.0
Zinc (Zn) PPM/ml Soil	< 2.1	2.1-4.0	4.1-18.0

Source : SRDI Thana Land and Soil utilisation Guide for Hatia March 1995 (in Bangla)
Note : pH Values for Agriculture 5.6-7.3

Figure 3.2: Water Sampling and Soil Salinity Monitoring Points



The analysis of the February 1998 soil samples indicate:

- the dry season Ec values on the western side of the embanked part of Char Montaz are lower than outside it. However the Ec values inside the embankment in the north east part of Char Montaz are higher than that on the west side outside the embankment but lower than those on the north west outside the embankment. The highest Ec value is on Char Rustom which is not embanked at all and lies to the north west of Char Montaz. The conclusion would seem to be that the embankment is probably partly effective in preventing saline intrusion on the west side of the island but inadequate for the north east of the island. No soil samples were taken in the south east, but the water quality analysis indicates that the Ec values are similar to those on land outside the western embankment and hence the south eastern embankment is probably ineffective. There would appear to be an urgent need to sort out the embankment and drainage system in the area and set up effective water management. The SRDI soil salinity data for Nijhum Dwip indicated increasing salinity with depth in April 1994, a finding confirmed by the LRP published data set of 1990. It should be expected that the same is true for the Char Montaz-Kukri Mukri area.

- the highest pH values were found in soil both inside and outside the embankment and were above the recommended levels for agriculture. The lowest pH values were in the east side of Char Montaz.

- the levels of organic matter in soil are generally low and not surprisingly lowest on the newer accreted land outside the embankment, although one point in the north east inside the embankment was also low. Unsurprisingly organic content appears to be a function of land age.

- sodium levels in Char Montaz soil were found to be much higher than at Nijhum Dwip, which were high compared to the analytical standard. Although the fact that the Nijhum Dwip samples were taken in September while the Char Montaz ones were taken in February may explain part of this, the generally higher salinity levels in Char Montaz probably account for this. Zinc levels at Char Montaz were found to be higher than Nijhum Dwip but still low overall, although higher inside the embankment than outside it. Both phosphorus and boron levels were generally higher outside the Char Montaz embankment than inside it, but did not have such wide ranges as at Nijhum Dwip, although the number of samples taken was far less at Char Montaz.

A broad conclusion is that soil development is relatively slow process and improvements take a considerable length of time to occur, even after saline intrusion has been prevented by embankment construction and drainage system operation. It is imperative that further sets of soil data are collected over a wider area and in both March and September. Regular Ec measurements also need to be taken at the same and also additional locations four times a year for at least the next five years.

The problem of soil capillary rise was identified at Nijhum Dwip and documented by both LRP and CDSP. It should be expected that the same problem exists at Char Montaz-Kukri Mukri and it is likely to be even worse as water and surface salinity levels have been found to be higher than Nijhum Dwip. There is some generalised work on soil salinity carried out for coastal areas of Bangladesh by BARC (Ref: Bangladesh Agricultural Research Council, 1990?), but this is not specific enough to the study area.

3.2 Natural biological environment

3.2.1 Flora

Using a master list of flora species for Bangladesh, consultations have been made with appropriate residents in the area and staff of the Forest Department to produce a listing for the project area. This listing is given as Table I.3. These is considerable planted mangrove cover in the area, (see the habitat map given as Figure 3.3), although most is single species and of uniform ages, much

of it past its prime growth stage. The greatest bio-diversity is normally found in the planted homestead vegetation and also along the embankments. There is an abundance of wood available to the residents of the area and this fact contributes to the favourable rural energy balance discussed below. There appear to be no endangered flora species in the area.

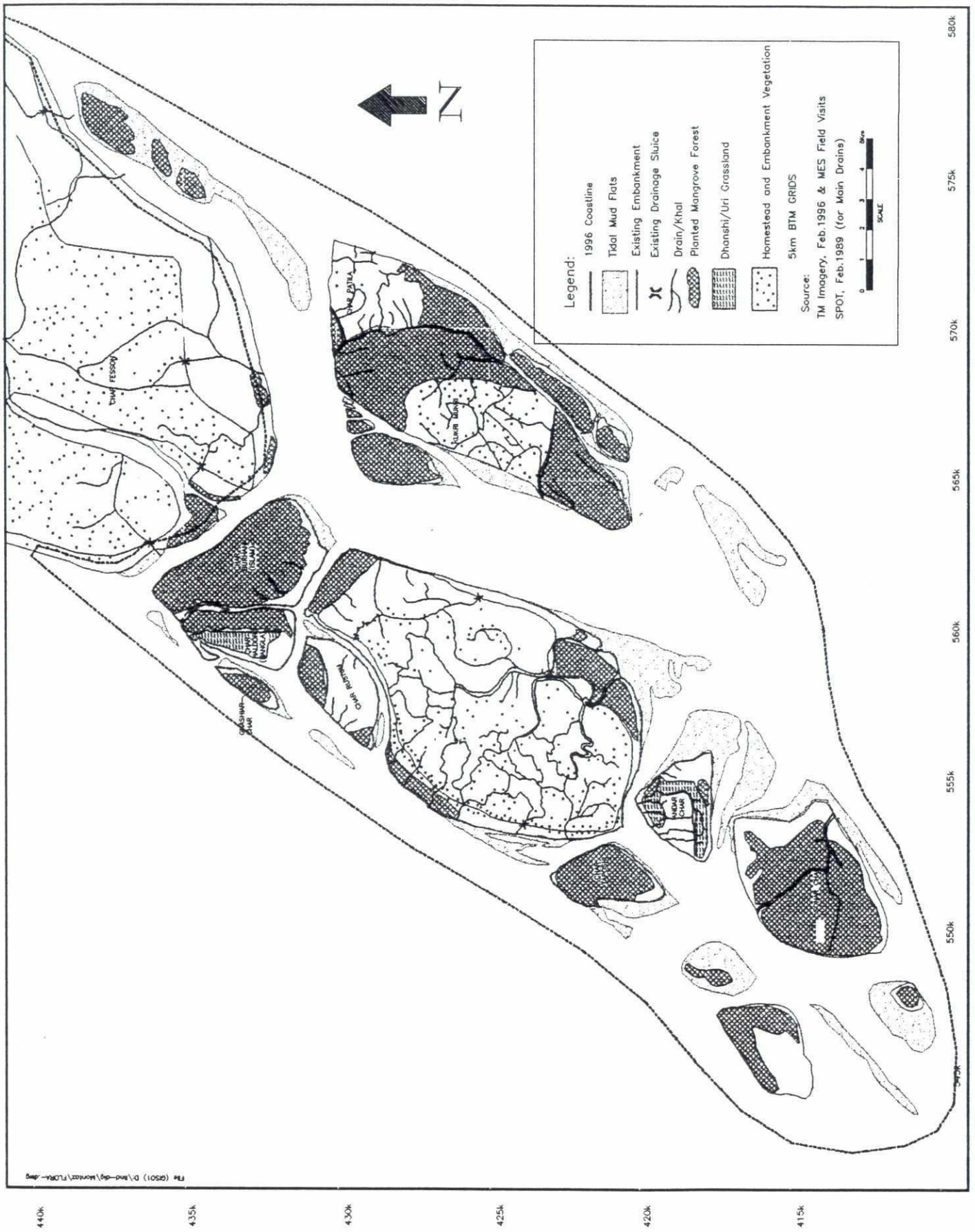
3.2.2 Fauna

Again using a definitive master checklist for the coastal area and also the work of the Bhola Irrigation case study EIA (Ref: ISPAN, 1994), a fauna listing has been prepared for the Char Montaz-Kukri Mukri area and is given as Table I.4 with the habitats mapped in Figure 3.3. The main internationally threatened species is the Gangetic dolphin, however it is relatively common in the bigger channels between the islands. Whilst local people claim not to ever catch or kill it, there is known persecution in other parts of Bangladesh and its oil is sold in markets in Dhaka for medicinal purposes. There appear to be many alternative habitats available for the Gangetic dolphin, the most important constraint to its survival is persecution rather than lack of suitable habitats. There are also otters in the area and these are internationally threatened.

Spotted deer, monkeys and pythons have artificially introduced to some of the forested areas during the mangrove planting programme, as part of a policy to establish conservation areas. The Forest Department declared Kukri Mukri a Wildlife Sanctuary in 1981 (Ref: Khan M A R, 1982) but this appears to have never been formally established according to law. The fact that Kukri Mukri has existed for a surprisingly long time and had nearly 5,000 people resident on it in 1996, has probably rendered such an aim unworkable. There is now a need for suitable management that allows coexistence of controlled human activity with the flora and fauna of the area.

The tidal mudflats off the southern end of the island chains in the study area are well recognised for their water bird populations and are specifically mentioned in the Asian Wetlands Directory, (Ref: Asian Wetlands Bureau). Whilst the Char Montaz and Kukri Mukri areas are not so important as those at Nijhum Dwip, they are of national significance. The listing of birds has been made using that of Thompson and Johnson (Ref: Thompson and Johnson, 1996). It would seem that tidal mud flats are a major habitat and these areas are expanding all of the time as accretion continues.

Figure 3.3: Flora Fauna and fish habitats



3.2.3 Fish

A definitive listing of fish species found in the area is given as Table I.5, split between three locations:

- inland (nominally freshwater)
- inshore (found within 5 km of the shore)
- offshore species (those species found more than 5 km from the shore)

The fish sampling work that was carried out at Nijhum Dwip produced a significant surprise in that some species thought of only as living in fresh water habitats were found in the sea. The conclusion is that there is insufficient knowledge on the habitats and breeding conditions of fish in the area, particularly Hilsha. A detailed habitat and fish ecology survey would need to be undertaken if the project were to go ahead.

3.3 Natural hazards

3.3.1 Cyclones and tornadoes

The coastal area of Bangladesh lies in a high cyclone hazard risk area as storms develop over the Bay of Bengal and move northwards. The timing of the cyclones relative to the daily and lunar tide cycle, as well as the monsoon flood season, is critical in determining the height of the surge. The location and speed of the cyclone tract and the intensity of the winds are key factors in determining the likely loss of life and damage.

The high risk cyclone times are October/November and March/April and maps of their past tracks have been given by BUP, (Ref: Bangladesh Unnayan Parishad, 1993). The SWMC coarse model for the 1970 and 1991 cyclones made for the recent Cyclone Shelter Preparatory Study has been observed (Ref: Sener Ingenieria y Sistemas SA, June 1996). However as stated above, this model is in the process of being refined with more accurate bathymetry and DEM data. A risk map constructed by the Cyclone Shelter Preparatory Study (CSPS), based upon the landfall location of past tracks has also been analysed, and whilst it would appear that the Project Area lies in the second least risk incidence area when compared to the rest of coastal Bangladesh, there remains the fact that the effects of cyclones in the area are far more severe than in other places. This is due to the fact that at Char Montaz the embankment is in poor condition and in some places has no mangrove cover on its seaward side, whilst Kukri Mukri has no embankment what so ever and has 5,000 people settled on it.

The 1970 cyclone was particularly serious for the project area due to the location of the track and the fact that the surge caused water to get behind embankments making it difficult to drain. The 1985 cyclone, despite being regarded as a mild event in national terms, also caused deaths and damage in the project area as it passed close by. The 1991 cyclone, despite being far more intense than the 1985 event, caused fewer deaths, as the track passed to the south. The 1991 surge actually caused water levels to fall in the area, although the back-surge did inundate Kukri Mukri.

3.3.2 Saline water intrusion

Saline water intrusion into the area is a regular occurrence during high lunar cycle tides, annual high water levels in July and August (when the river system is in flood) and also during cyclones and storm surges. The timing of storm surges relative to daily and lunar tidal conditions, as well as annual flood cycles, is critical in determining the degree of intrusion. Regular intrusion occurs both on unembanked land and also through low parts and drainage holes in the embankment, as they were not fitted with gates or operated in an appropriate manner. Such intrusion damages crops or the threat of it prevents people from plating crops where and when they would like to. However the high amounts of rainfall in the area mean that one monsoon season's rainfall can be adequate to wash out the residual surface salinity and allow farming in the post monsoon period. There is an urgent requirement to rehabilitation the Char Montaz embankment, remodel the drainage system

and operate it in an efficient manner.

3.3.3 Monsoon rainfall flooding

As part of the farming survey carried out in 1997 in Nijhum Dwip, data was collected on the maximum length of flooding of agricultural land in the previous years. The data showed that flood duration was longest in the poorly drained land inside the embankment but did not exceed 12 to 15 days and normally occurs in the period of August and September. However with a normal tidal range of some 2.5 metres there should not really be a problem with drainage, as the appropriate operation of the gates in an adequately designed drainage system should easily be able to cope with such conditions. The indications are that a similar situation exists on the embanked part of Char Montaz. A main cause of rainfall flooding in the project area would seem to be the fact that the land levels inside the embankment are lower than those outside it, possibly due to the fact that the embankment in Char Montaz may have been built too early before adequate natural accretion had taken place.

It has often been claimed that rising sea levels brought about by global warming will cause a catastrophe for Bangladesh. The most recent work carried out on this issue using the latest world circulation model from the University of East Anglia (Ref: Bangladesh Unnayan Parishad 1993), indicates that the maximum rise is likely to be 0.27 metres by the year 2030. The present rate of natural land accretion in the Meghna estuary is far in excess of this. In essence the benefits of land accretion to Bangladesh in the Meghna Estuary due to erosion in the upper catchment of its rivers more than compensates for any potential disbenefits due to global warming. The biggest problem is likely to occur in areas that have already been embanked with inadequately high earthworks, such as Char Montaz. However 0.27 metres is a small proportion of the presently needed embankment height to protect against 1 in 30 year cyclones.

3.3.4 Seismic activity

The national seismic risk zoning map of Bangladesh (Ref: Geological Survey of Bangladesh, November 1979) indicates that the project area lies in a medium level risk seismic area when compared to the land to the east. However it should be noted that the seismic risk gradient is quite steep to the east towards the Chittagong Hill Tracts, which lie in an area of high risk. The effects of earthquakes in saturated alluvial deposits can be catastrophic for any embankment due to liquefaction. Past evidence is that such infrequent but severe earthquakes in Bangladesh occur during the monsoon period when water levels are high and the implications for embankment failure are the most serious. However the effects of the lunar cycle on water levels are far greater than those of the monsoon flood season, so that the timing of seismic activity is more sensitive to the lunar cycle than the monsoon flood annual cycle.

3.3.5 Insect pest attack

During the needs assessment and the farming survey of Nijhum Dwip it transpired that farmers perceived insect pest attack on standing crops to be the most important source of lost crops. It would be logical to expect that there are similar problems in the Char Montaz-Kukri Mukri area. The data from the Nijhum Dwip work was hampered by being a set of relatively small sample sizes due to the need to spread it over four different type locations. However broad analysis indicated that the losses due to pest attack were higher than those due to saline intrusion or monsoon flooding.

3.4 Socio-economic environment

3.4.1 Administration

The administration map of the area down to Mauza level is given in Figure 3.4 based upon the LGED thana map, as the BBS Small Area Atlas was inadequately detailed (Ref: BBS, 1986-1995). There are real difficulties in matching the BBS boundaries with the latest land formation taken from satellite imagery in February 1996. The BBS boundaries are thus a general indication, probably

based upon old mapping, where as the census data units probably work to natural boundaries, such as bank edges, forested limits and drainage channels. The area considered to be covered by the Feasibility Study is clearly shown in Figure 3.4 and includes the unembanked part of the southern union of Bhola and the island strings south west of it. However the detailed work has concentrated on the islands of Char Montaz and Kukri Mukri. The two islands are in different thanas, with Char Montaz comprising five Mauzas (though the southern one is a separate island and only comes into play for Option 3) and Kukri Mukri has two Mauzas.

The land areas for each Mauza have been calculated by digitising the LGED Mauza boundaries as an overlay to the February 1996 Landsat image and then rationalising the boundaries. This was necessary as the BBS acreages were obviously inconsistent. The total land area of the Option 2 studied Mauzas is 8,149 ha as shown in Table 3.3, with an extra 732 ha added for the Option 3 southern island of Undar Char.

The key BBS census data for both 1981 and 1991 (Ref: BBS, 1985 and 1992/1995) has been tabulated down to Mauza level and is given in Tables 8 and 9. The density data was calculated using the digitised areas from the Landsat image and the LGED map. The predicted human populations for the area are given in Table 3.3 using the techniques as shown in the notes.

The key BBS parameters given in Tables 3.3 and 3.4 have been mapped for 1981 and 1991 and a change map between the two also produced, so that the trends in the last ten years can be seen over both time and spatially. This allows an idea to be gained of the likely future without intervention situation. The interpretation of this mapped data is given in the appropriate sections below.

3.4.2 Demography

The BBS human population numbers, including household size and density data are indicated in Table 3.3. The biggest problem is the delineation of Mauza boundaries and possible changes between the two census years. The data tie reasonably well to the MES socio-economic household survey data taken for 160 households, 110 on Char Montaz and 50 on Kukri Mukri, although in the MES sample data set the average household size was 6.2 rather than the 5.8 of the 1991 BBS 100 per cent data set. Interpretation of the 1981 data indicates that the highest human population densities were inside the embankment on the eastern side of Char Montaz with some 400 people per km^2. Overall the population density was just over 100/km^2 in 1981, the lowest densities were on unembanked land at the north east erosion prone part of Kukri Mukri. In the period 1981 to 1991 the average population density increased by 54 per cent to 165/km^2. A significant proportion of this increase is from in-migration to both the embanked parts of north west and north east Char Montaz and particularly the unembanked north east part of Kukri Mukri where the population density increased over seven fold, but still to only 123 people per km^2. Overall the population densities are some of the lowest in the country, but the low returns to agriculture due to poor soils mean that the estimated 1996 population of just around 20,000 struggle to obtain cash income.

There has been a slight reduction in overall mean household size over the ten year period, but there are big variations from Mauza to Mauza. The BBS data indicate that the mean household size was 6.28 in 1981 and it fell to 5.87 in 1991, however there were greater falls in the northern part of Char Montaz but in western Kukri Mukri mean household size was shown to have increased during the period. The MES socio-economic household survey found the average household size in the sampled area to be larger than the overall mean figure, however this may be due to sampling and the fact that the location of the sample was slightly weighted in favour of Char Montaz where household sizes are larger. The definition of a household is also inconsistent in the BBS data from 1981 to 1991, as the concept of a dwelling unit was introduced in 1991.

The age profiles of residents in the Project area are given in Volume 4, Rural Development. Figure 2.1 in Volume 4 illustrates the very unusual situation in Char Montaz and Kukri Mukri, with an ageing population, due either to high infant mortality, in-migration of elderly people, out-migration of young people or a combination of these factors. The effects of deaths from cyclones in 1970, 1985 and 1991 also complicate interpretation of this data.

Table 3.3: 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	18,449	21,937	1,535	2,530	6.28	5.87

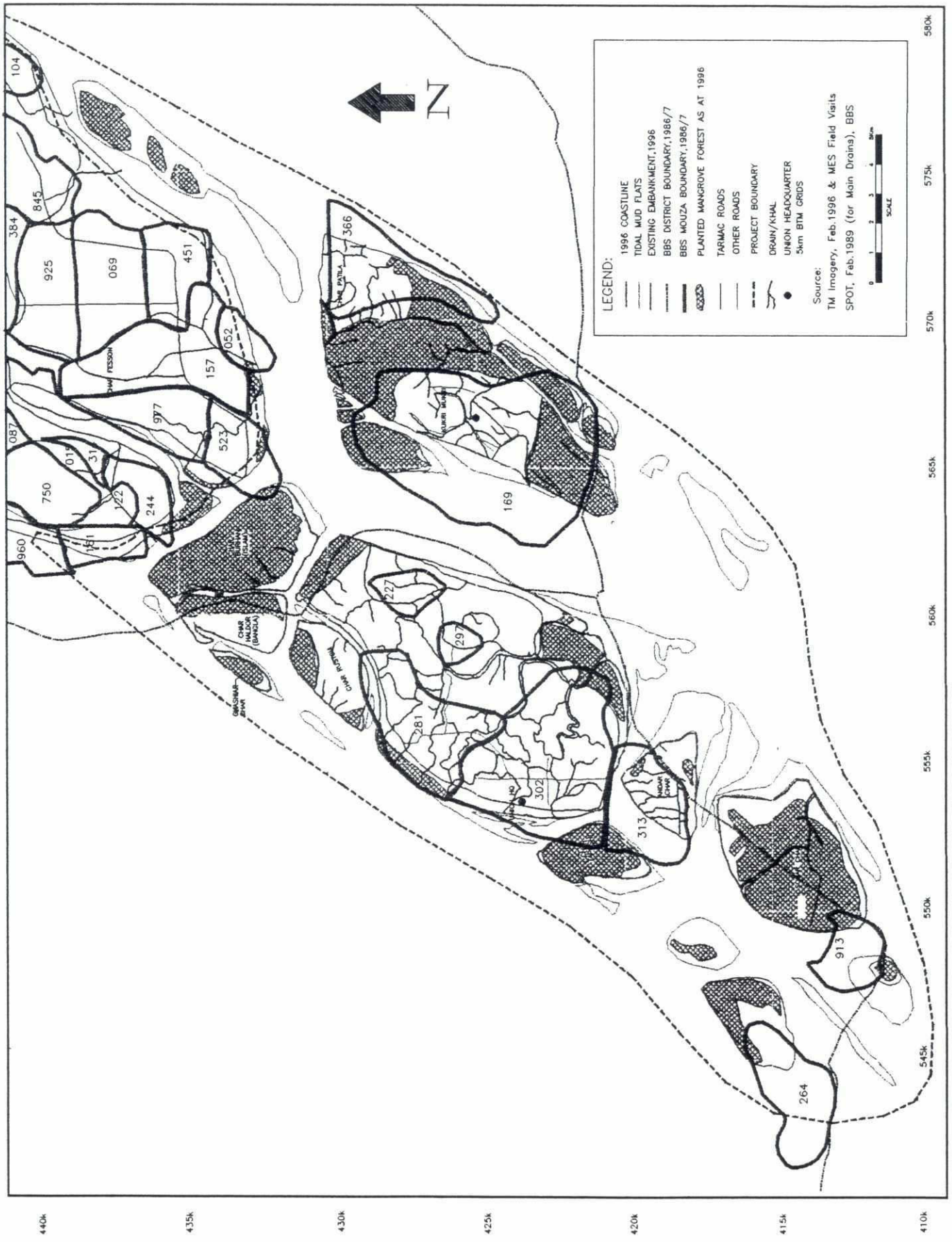
Notes:
1/ Also known as Char Rustom
2/ Also known as Andar Char.
3/ Based on mauza growth rates
4/ Based on average project area growth rate, except Char Prasanna.

Table 3.4: 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

Figure 3.4: Administration Boundaries



3.4.3 Settlement pattern and history

The 1776 Rennell's map shows no land in existence in the project area at this time. According to the 1917 map, that was amended in 1941/4, there was no land in existence at north east Kukri Mukri nor at north west and eastern Char Montaz. It would appear that major land accretion occurred in the 1950's but it did not consolidate until after 1984. Land stabilisation appears to have been significantly helped by the planting of mangroves. The accretion patterns from 1973 have already been outlined in Section 3.1.5.

The main parts of Char Montaz and Kukri Mukri Mauzas appear to have been settled for some time. There were high numbers of human deaths during the 1970 cyclone (about 63,000 in Galachipa Thana and 57,000 in Char Fasson Thana) and up to 100 in both the 1985 and 1991 events. In some cases whole communities are likely to have been wiped out in the 1970 cyclone with the areas being subsequently re-colonised, as was also the case in Nijhum Dwip. Only 5 per cent of the households on Char Montaz live in formally planned cluster settlements, where as the proportion for Kukri Mukri is much higher at 36 per cent. The reasons that people came to be living in the area are shown in Table I.6b and demonstrate that landlessness was a significant issue in Char Montaz, where as on Kukri Mukri the majority of households in the survey inherited their land from relations already living there. Most formal settlement programmes in coastal Bangladesh have included giving rights to allocated agricultural land to settlers, resulting in unusually stratified land holding patterns. However the socio-economic survey results shown in Table I.6 show that agricultural land holding sizes are widely spread. The BBS data indicating the proportion of households owning agricultural land is given in Table 3.4. In 1981 60 per cent of the households owned agricultural land but by 1991 this figure had fallen to 42 per cent, mainly due to the fact that many landless in-migrants came into the area. The areas of lowest agricultural land holding in 1981 are the areas of greatest population increase, with the notable exception of Char Margaret in eastern Char Montaz where land holding has become concentrated amongst a minority, despite there being little population rise.

The present settlement pattern of the area is indicated in Figure 3.5, with most homesteads being inside and on the embankment on Char Montaz, although there are some outside of the embankment on the western side. There are widely scattered homesteads across the older part of Kukri Mukri, but in the north east of the island there are a few nucleated settlements.

A major issue is the procedure for land allocation, both for homesteads and agricultural land, on newly accreted land. The Ministry of Land are the statutory body responsible for land allocation, although this power is devolved down to the district administration. The rational use of any newly accreted land requires a systematic, transparent, equitable and timely allocation system, without which the proposed project will fail to achieve its aims and objectives. Experience with the CDSP has shown that allocation has been slow and problematic, however the Char Montaz-Kukri Mukri area does not at present have the additional serious problems of unscrupulous land occupation by influential people found in the CDSP area.

Informal discussion with local people has indicated that land is trading at about Tk 47,000 per hectare, with little difference in value according to land level.

3.4.4 Women's issues

The MES household socio-economic survey addressed the needs of women in an informal way and in addition the needs assessment deliberately targeted a sample of women in two locations in the project area. The conclusions of the needs assessment found some differences in priorities between women and men, but nothing like as many as in the other two MES Feasibility Studies. The main reason for this appears to be that the men in Char Montaz-Kukri Mukri place higher priorities on the issues that women in general think are more important (health, water supply and sanitation), than those in other parts of the MES study area. The significant differences between women's and men's priorities were that women in both Char Montaz and Kukri Mukri were much more keen to have cluster settlements than men, possibly to reduce the level of social isolation when compared to living in scattered homesteads.

Figure 3.5: Settlement pattern

Women in Char Montaz placed less priority on construction of drainage than men, and were also surprisingly less concerned about increasing the provision of safe drinking water. Women in Kukri Mukri placed a very low level of importance in creating more land and also, surprisingly, were less concerned than men to provide more schools. As part of the socio-economic survey work cases of women carrying out fishing and boat operations as their main economic activity were recorded. This is very unusual in Bangladesh, but may be cases of daughters assisting their fathers who are professional fishermen and boatmen.

3.4.5 Drinking water availability

The availability of "safe" drinking water (defined as either tap or tubewell sources) by Mauza for 1981 and 1991 is given in Table 3.4. The overall level of provision has risen from 51 per cent of households in 1981 to 78 per cent in 1991, a relatively high figure for rural Bangladesh. The only safe sources are from deep (300m) groundwater, which is below the aquifer that has been giving high levels of natural arsenic pollution in other parts of the country. However the "safe" provision levels have fallen in Kukri Mukri Mauza, probably due to the fact that they were relatively high in 1981 and may be water supply provision has not kept pace with population growth. The other reason may be that some of the water points have failed. In such situations the result is that women may be forced to walk longer distances to obtain safe drinking water and in some cases human health is being compromised by drinking from other unsafe sources, particularly in the monsoon season. There would appear to be a high priority need to solve this problem.

3.4.6 Human health and sanitation

The thana health complex data for Galachipa has been obtained for the period January 1992 to December 1996, entered into a database and analysed. This is shown for 12 diseases in Table I.7 with a summary by year in Table I.8. The data is shown graphically for the six most important diseases over the full five year period in Figure 3.6. Care has to be taken when interpreting this data as it is biased towards the urban thana headquarters location (not actually in the project area but on the mainland to the west) and records only those who visited the Health Centre. In many ways the unreported disease cases from remote areas are probably the most important! There are also three months when no data was recorded, often during flood or cyclone times, when record keeping understandably takes a lower priority than directly assisting people under difficult circumstances. However the data gives clear indications of the main diseases in the wider area and their seasonal cycles related to water management issues, as well as longer term trends over the five year period.

The conclusions are that diarrhoeal disease is the most significant problem (although worm has higher incidence numbers it is relatively easy and quick to treat), followed by peptic ulcers (often a function of spicy diet) and anaemia. However the level of Acute Respiratory Tract Infection (ARTI) should be of greater concern as this can cause mortality and is a function of high humidity levels throughout the year (fog is common in the winter) and linked to tuberculosis. The data for diarrhoeal disease and ARTI have been plotted separately in Figure 3.7. From this it can be seen that reported cases of ARTI have been generally rising over the last five years and there are seasonal peaks in September to November every year, as flood water recedes and temperatures fall. There are also similar significant seasonal variations in diarrhoeal disease outbreaks with high levels in 1992 and 1996 plus an odd outbreak in April 1994. In Hatia such an occurrence was in the aftermath of a cyclone surge. Unfortunately the water level recorder at Dashmina was not operational at this time so it is not possible to confirm if this was the case. The skin diseases are probably related to bathing in polluted ponds and/or farmers wading in flooded rice fields plus fishermen wading whilst setting nets. The skin disease data shows a sudden increase in January 1994 which has been maintained since. It is not know if the recording system was changed or if there was another factor which increased the reported cases. It could be that improved treatment was made available and more suffers came to the health centre. A similar occurrence happened at Hatia in October 1993. The diarrhoeal disease data looks strange in that there is a marked decline from April 1995 till October 1996 when it suddenly increases.

Figure 3.6: Monthly Recorded Disease Cases at Galachipa Health Complex January 1992 to December 1996

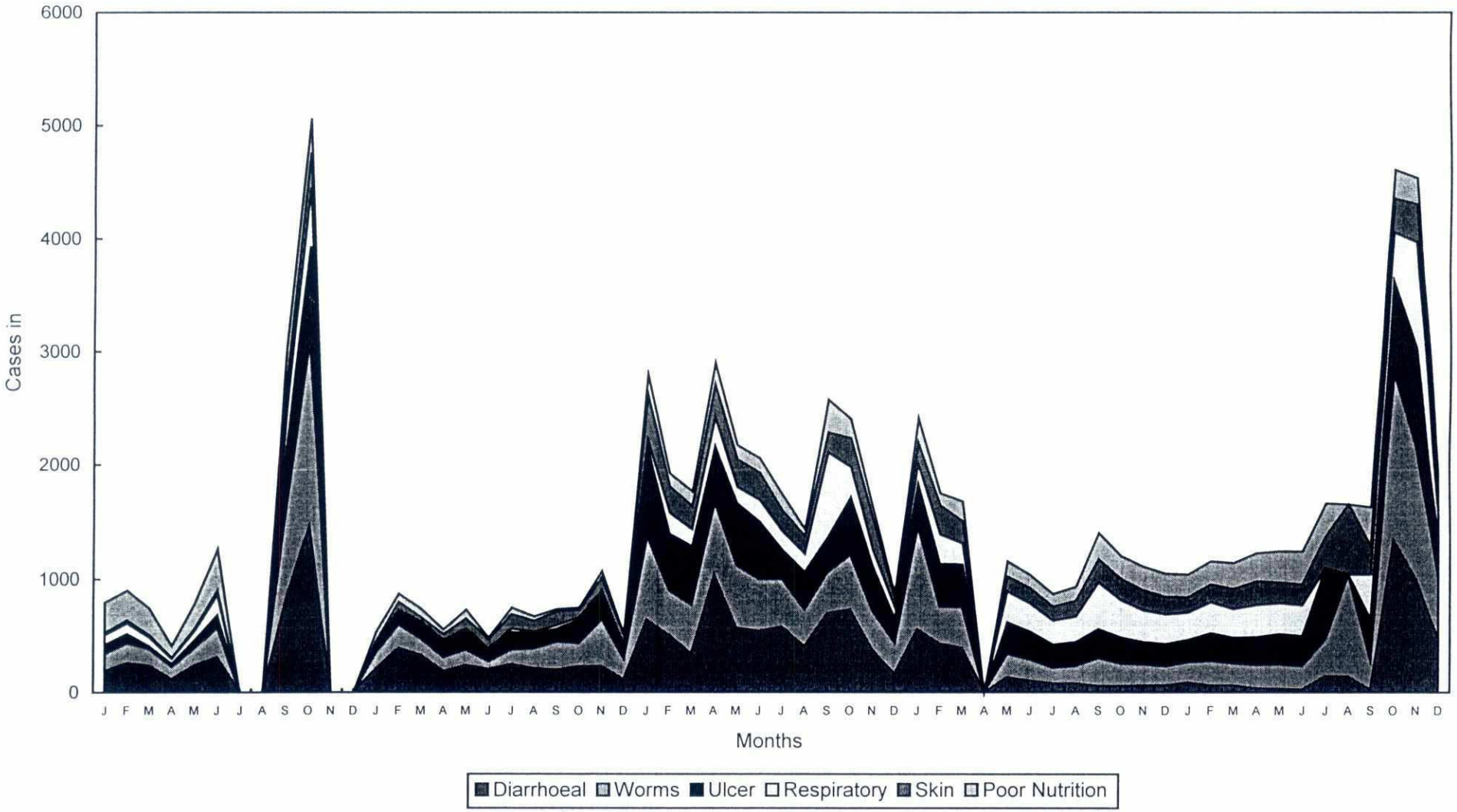
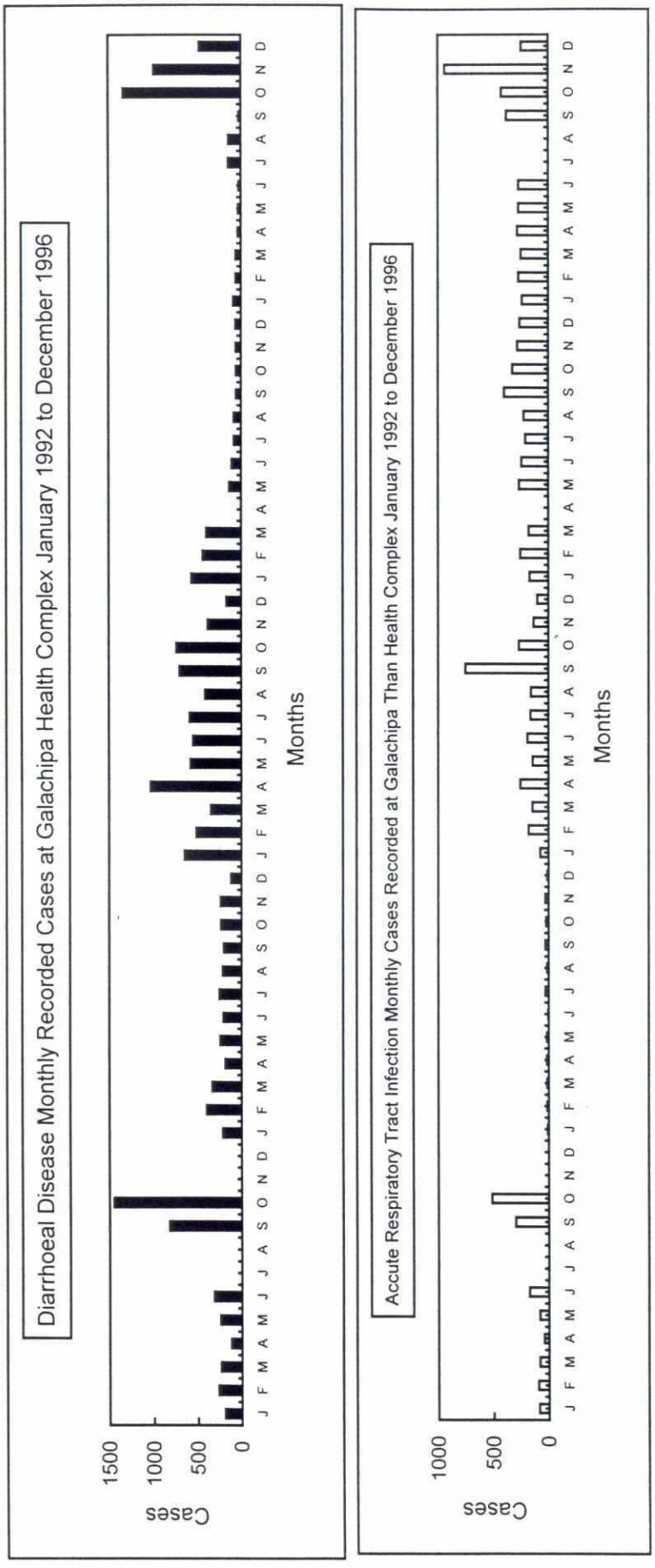


Figure 3.7: Diarrhoeal and ARTI diseases for Galachipa 1992-1996



The provision of sanitation facilities according to the 1991 BBS census data is very low indeed, to the point of being non existent. This lack of provision is likely to lead to serious health problems and is probably one of the reasons for the high incidence of diarrhoeal disease in the area.

Fieldwork for the Nijhum Dwip Feasibility Study indicated that malaria was being reported as a significant problem, probably related to the extensive forest cover being a good habitat to the mosquito vector. As conditions at Char Montaz-Kukri Mukri looked to be similar, a fever and malaria survey was also carried out and the results are shown in Table I.9.

The conclusions are that the malaria is probably not plasmodium falciparum, as there were no deaths recorded, despite no malaria treatment being used, just treatment for the fever being prescribed. Of the 40 households sampled, all reported fever outbreaks in the previous year, in some cases up to 5 attacks in the 12 month period. Although only one case was medically confirmed as being malaria (it requires a visit to a Health Centre which has a microscope for a analysis of blood tests), it is likely that some 50 per cent of these were probably malaria. Some 60 per cent of the households consulted a doctor and simple drugs to control fever were given. The fever cases were concentrated in three distinct periods, the height of the dry season (March), after the start of the monsoon (May to July) and increasing as the flood levels fall to a peak in November. It could be the case that some of the fever is linked to dysentery rather than malaria. However there seems little doubt that malaria is prevalent in the area (rigors occurred in 15 of the 84 attacks), probably vivax carried by culex mosquitos, as the nearby forest cover provides a suitable habitat. The incidence of fever is indirectly related to flooding, both a positive and inverse correlation. One peak occurs in March when conditions are driest and disease vectors tend to be concentrated, another approximately two weeks after the start of the heavier pre-monsoon rains and the third as isolated still rainfall fed pools emerge on the falling flood. Far more intensive data collection would be needed to study this further, but the conclusion is that malaria is a problem in the area but is not of the dangerous type which causes fatalities.

Overall there is a very strong feeling that the existing health service provision for the area, and particularly Char Montaz, is inadequate and the there were unanimous demands for this to be improved as the highest priority in the area.

3.4.7 Human nutrition

A simple nutrition survey was carried out in the area sampled over four different case type locations stratified by household land owning based upon the MES socio-economic survey (see Table I.6a). The results of the nutrition survey are given in Table I.10 and the main conclusions are that most households are well fed, significantly better than much of Bangladesh. Whilst a small minority of the poor landless and one marginal household eat only twice a day, by far the majority eat regularly and have high intakes of protein from fish. The number of time vegetables and milk were consumed was also high, although fruit consumption was low, possibly because of the time of year of the survey (March). Consumption of red meat was low, as is the case in most of lowland rural Bangladesh, as was pulses (with the exception of two households, one of whom conversely had very low fish consumption).

The biggest constraint to the data is that it recorded the number of times people ate, not the actual quantity of food consumed. Only a highly detailed specific nutrition survey can give this data and it would be required for an adequate sample size and to collect data every two months over a twelve month period.

The best fish consumption data that presently exists is from the fisheries assessment of Nijhum Dwip. The per capita consumption of fish in the Nijhum Dwip area was estimated to be 66g/day, which compares well with a minimum protein requirement of 45g/day, and a consumption level of all protein of 40g/day in all Bangladesh, 27g/day of which comes from fish.

The main conclusion is that most people are well fed, partly because they eat what they produce rather than selling it. This is particularly the case with fish. There is a risk that if communications were to improve then people would sell more of their produce for cash rather than eating it. This

could result in people having high disposable incomes but being less well nourished. Nutritional education is an important issue along with the need for crop substitution and diversification.

3.4.8 Education

The levels of literacy as collected in the 1981 and 1991 BBS census are shown in Table 3.4. Overall the literacy rate was virtually static at 14 per cent in the ten year period, a low level by comparison to the rest of the country, many areas of which have made impressive gains in the last 10 years. However this simple figure hides a decline in Char Margaret from 16 per cent to 6 per cent, and an increase from 10 per cent to 25 per cent in Kukri Mukri. In general the provision of school places has probably not kept pace with this in-migration. The overall literacy rates for the area are extremely low, even by national standards for remote areas. However recently targeted programmes of school construction may result in an improved situation in the near future. The provision of more schools was rated a low priority in the needs assessment but there may be complex reasons for this. Any intensification of agriculture may mean that some children are required to work on the land and be restricted from attending school. A real problem in the recent past has been the lack of secondary education facilities and many students had to leave the area to find this, many of whom may never return. However the construction of multi-purpose cyclone shelters used as schools since 1991 may be addressing this issue and it is not yet apparent in the BBS data sets.

3.4.9 Landscape aesthetics, cultural and archaeological sites

The issue of landscape aesthetics is not often one that is raised in Bangladesh, however the coastal areas do have a very unique landscape. Away from the cyclone periods the areas have a unique tranquillity, being unusually quiet and peaceful (especially when compared to the rest of Bangladesh) and aesthetically restful. Despite the fact that the land is very flat, the planted vegetation provides variety and orientation. Due to the relatively short history of settlement in the area there would appear to be no significant cultural or archaeological sites. The only issue would be disturbance of graveyards, some of which could be quite large as a result of recent cyclone deaths.

3.5 Economic development

It should be noted that despite being remote and producing low levels of cash income the project area is not regarded as one of the poorest parts of Bangladesh, these lie in the north west, north central and north east parts of the country. Its general socio-economic level is such that it is not identified as an area for inclusion in the IFADEP work. However the UNDP Human Development Index (HDI) does place Bhola district (in which Kukri Mukri is located) at position 55 out of 60 (i.e within the bottom 8 per cent of the countries Districts), where as Patuakhali (in which Char Montaz is located) is at position 15 out of 60. As the project area straddles two districts with quite different characteristics the HDI classification data is of little use for Project analysis and in any case inevitably hides severe inequality within the districts. The separate components of economic development are outlined below:

3.5.1 Common resource rights

The availability and use of common resource rights ("free goods", although there are costs associated with their collection) is very high in the area, especially when compared to the rest of Bangladesh. There is abundant open grazing land, especially in the areas outside the embankments. There are also abundant supplies of domestic fuel wood in the form of dead branches in the mangrove forest areas. A lot of the dung produced by animals remains on the land, as there is little need to collect and use it for domestic fuel due to availability of fuel wood. Due to the large areas of grazing land there is a reduced requirement for rice straw fodder and when combined with the availability of fuelwood, means that the abundance of common good resources produces a very favourable rural energy balance.

In addition there is widespread catching of "free good" fish. The sample survey work in the study area indicates that 18 per cent of households at Char Montaz and 12 per cent at Kukri Mukri are primarily dependant upon open water fishing for their economic livelihood. A significant proportion have fishing as their secondary source of cash income. At Char Lakshmi 37 per cent of households were dependant on fishing for cash income (see Table 3.6b). In addition many more households catch fish occasionally for direct consumption and fish constitutes by far the most important part of peoples diets in the area (see Table I.10). The abundant availability of "free good" fish is the major reason why levels of human nutrition are so relatively good in the area.

3.5.2 Agriculture

According to the BBS census data (see Table 3.4) some 42 per cent of the households in the area own agricultural land. This figure was 60 per cent in 1981 and has probably fallen due to recent in-migration of landless people into the area. However there is significant spatial variations in this figure, with one very high figure for 1981 in a Mauza which lies on the western side of Char Montaz within the embanked area. The trend has been a significant fall everywhere, except on the south west part of Char Montaz which has been inhabited for the longest time.

From the 1981 BBS data (see Table 3.4), it can be seen that only 20 per cent of the population had agriculture as their main occupation. Care has to be taken with this data, as women often give housework as their main occupation even though they may be in a household primarily dependant upon agriculture and may do significant agricultural work themselves. Even so the proportion of households with agriculture as their main occupation is very low for rural Bangladesh but is probably a reflection of the limited opportunities in newly accreted land with an in-migrant population. By 1991 the proportion had risen slightly to 23 per cent, although there are considerable variations across the area, the lowest being 11 per cent on the island south of Char Montaz where professional offshore fishing communities are likely to be based. Some 46 per cent of the households sampled in the 1996/7 MES survey at Char Montaz have agriculture or agricultural labouring as their primary economic occupation, where as the figure for Kukri Mukri was 48 per cent. This compares with 20 per cent of people over the age of 10 in the BBS data in 1991, which should probably be doubled to 40 per cent to gain a comparable figure for households. A conclusion is thus that fishing is more important in newly accreted land and decreases as the land becomes more productive and agriculture assumes higher importance economically, even if a high proportion of the crops produced are directly consumed rather than sold. The proportion of households dependant upon wage paid agricultural labour in Char Montaz is 9 per cent and for Kukri Mukri 6 per cent. These rates are low by national comparison, perhaps a reflection of the fact that there is little cash around and most households will use family labour rather than hiring in from outside.

The total agricultural production and the amount sold for cash as recorded in the 160 sample households in Nijhum Dwip is given in Table I.6e, split by the two different areas. A significant conclusion is that 46 per cent of crops by weight are directly consumed, the rest being sold for cash which brings in just under Tk 5,000 per year, equivalent to 28 per cent of all cash income in Char Montaz and 34 per cent in Kukri Mukri. The conclusion is that a significant proportion of agricultural production is sold for cash (much higher than at Nijhum Dwip for instance), but agricultural production overall produces a much smaller part of total household income than fishing, but about twice that from livestock. The differences in production split by land holding size are given in Table 3.5. However care needs to be taken with the data as the sample sizes were small, although the data for the proportion of agricultural production sold cross checks reasonably well. From Table 3.5 it can be seen that functionally landless families (those owning less than 0.02 ha, just enough for a homestead plot), do not work agricultural land, a very different situation than at Nijhum Dwip where such arrangements are common. However it would seem that marginal, small and even medium land holding farmers work larger land areas per household than they own, making suitable arrangements to rent or share crop additional land.

A schematic cropping pattern for the area is given as Figure 3.8, based upon an analysis of the farming survey. It aims to show the seasonal pattern of crop types and the areas cultivated. It is not considered appropriate to try and produce a set of cropping patterns according to MPO flood depth as this is not a significant parameter effecting crop selection in coastal areas.

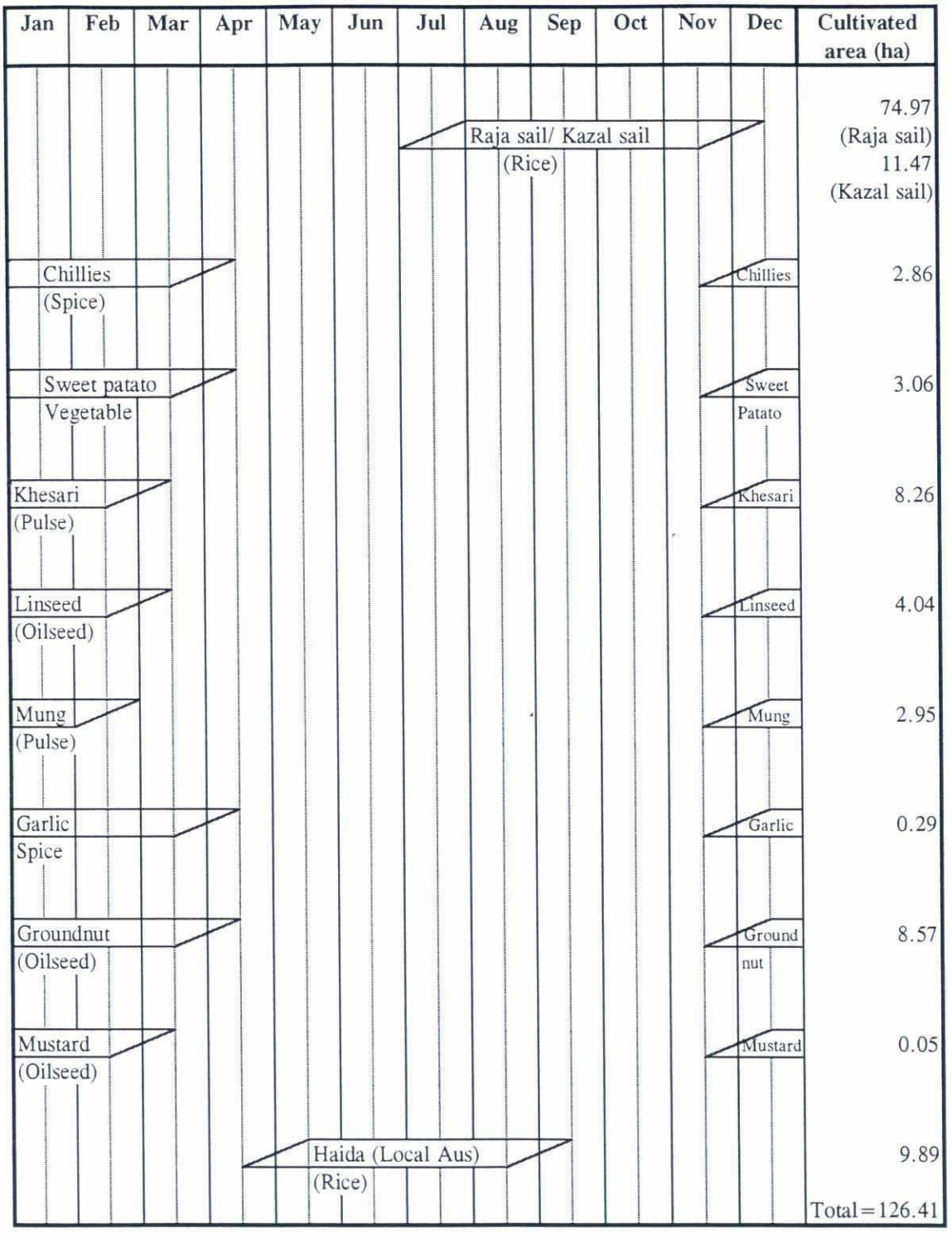
Table 3.5: Agricultural Production Data

Land holding category (UNDP)	Mean annual gross cultivated area per farm hh (ha)	Mean annual net cropped area per farm hh (ha)	Cropping intensity	Mean annual crop production per farm hh (Kg)	Mean annual production consumed per farm hh (Kg)	Mean annual production sold out per farm hh (Kg)	Mean annual farm income per hh (Tk.)
Landless	0	0	0%	0	0	0	0
Marginal	1.37	1.64	120%	635	523 (82%)	112	1135
Small	1.73	1.84	106%	1475	1166 (79%)	308	2244
Medium	4.29	5.09	119%	3677	1664 (45%)	2012	13672
Large	5.68	7.59	134%	6557	2237 (34%)	4320	29500
Total	2.57	3.08	120%	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.

Figure 3.8: Cropping Pattern Diagram



Source:
MES Field Survey 1998

3.5.3 Forestry

Existing forestry situation

There is extensive existing planted mangrove forest in the area, the locations of which can be seen in Figure 2.5 and the 1996 satellite image in Figure 3.1. This planting was carried out from the 1970's onwards with the aim of using mangrove forest to stabilise land and accelerate the natural accretion processes. In addition the organic matter from the trees would improve soil quality and where grazing was allowed underneath the canopy, then the animal dung also added to soil quality and organic build up.

There are other proven direct benefits of planting mangrove, one of the most important being its ability to dissipate wave energy. It was estimated by the CPP that a band of mangroves of at least 200 metres width dissipated 2 metres of wave energy in a 1991 type cyclone event. There are direct engineering and economic benefits to this, either the height of proposed coastal protection embankment can be reduced by 2 metres and still maintain the stated protection at a substantial reduction in cost. Better still is to build the embankment to the original design height but the return period of the protection given will improve. The CPP work estimated that mangrove planting would increase the design return period of protection from a 1 in 30 year cyclone to a 1 in 50 year event.

Using the February 1996 Landsat imagery the three main mangrove forest areas in the Option 2 intervention area have been measured:

Char Montaz	=	533 ha
Char Rustom	=	131 ha
Char Haldor	=	211 ha
Char Burhan	=	1,065 ha
Kukri Mukri	=	2,018 ha
Char Aicha	=	324 ha
Total	=	4,282 ha

However this well intentioned planting work was not followed through as a self sustaining rolling programme. Very little thinning was carried out and no significant cutting or planting up of newly accreted areas was done. The programme was thus unable to generate any revenue from which to fund planting of the new areas as they accreted. A sustainable forestry management plan is proposed below which aims to maximise the benefits of land accretion created by the proposed cross dam.

Proposed Forestry Phased Development Programme

The proposed phased forestry development programme for the Char Montaz-Kukri Mukri area follows an overall development philosophy for the use of newly accreted land. The first step is that as soon as is possible then any newly accreted land should be planted with suitable mangrove species. Observations at Char Montaz have indicated that the required minimum land level to do this in the area is +0.7m, a situation where the land is submerged for approximately 50 per cent of the time. Planted mangroves should be thinned at approximately 8 years of age and considered for clearing and then possibly replanting or turning over to agriculture at 16 years. The minimum requirement is for at least a one kilometre wide band of mangrove to remain on the seaward edge of all land at all times to dissipate wave energy and assist in land stabilisation. Embankment construction can be considered when the land reaches +1.5 m PWD and if embankments are constructed then the forested area inside would be cleared. Any new embankment would be located to ensure that a minimum distance of one kilometre of land above 0.7 metres is kept on its seaward side.

The practical implementation of such a strategy at different times and phased with the engineering interventions, is given in the series of maps in Figure 2.3.

During the first five years of the project implementation up to 3,850 ha of land could be considered for forestry planting in the area. However to achieve this programme approximately 858 ha of mangrove that is past maturity, lies at least a kilometre from the coastline and would be inside a newly constructed embankment, would need to be cut by year five and a maximum total of 2,555 ha by the end of year 7. This land could then be turned over to agriculture and allocated to households presently having little or no agricultural land or unembanked land less than a kilometre from the coast. The practical implementation of such a programme for different options and at different years is shown in Figure 2.3. The overall aim is to end up with a zone of forestry around the whole of the coastline and where possible to plant species which have greater social and economic benefit. Tree species selection relative to environmental conditions is critical in determining economic returns, as those for mangrove planting are relatively poor. Work on the Coastal Palm Project has indicated that returns for other species can be significantly higher, although start-up costs are greater than for mangroves.

It has been assumed that the Forest Department will set up a sustainable, self funded programme for planting and management in the area. A 30 year programme has been designed and phased according to the likely accretion rates of land with the cross dams in place. The phasing for the programme is given in Figure 9.1. A considerable amount of planting could start immediately and is not dependant upon the cross dam construction programme. The forestry programme would need to be monitored and reviewed to ensure that targets are met. A detailed review would also need to be made before year 10, when consideration for constructing the last and largest cross dam will be studied. With the full 30 year programme for Option 3, a total of nearly 5,000 ha of land would be forested and a maximum 2,555 ha of mature forest cut and turned over to agriculture. With Option 4 even more forestry could be planted. In all cases considerably more forest would be planted than cut.

3.5.4 Livestock

The existing numbers of livestock per household in the area are high by Bangladesh standards, the 1996 estimates to Mauza level collected by the Remote Island Development Project (RIDP, an NGO) and confirmed by the work of the CSPS give totals of 17,500 cattle/buffalo, 8,150 goats/sheep and 37,000 poultry. This is equivalent to about 5 cattle/buffalo, 2 goats/sheep and 11 poultry per household. It should be noted that quite large numbers of ducks are kept for eggs. There is extensive free grazing land in the area, particularly in areas outside the embankment and those areas inside the embankment where only one crop a year is grown. However some of the grassland outside the embankment is of poor quality due to saline intrusion and there can be a shortage of grazing inside the embankment whilst crops are growing. However a more significant constraint is the limited availability of livestock water that is not saline. Livestock water supply has to compete with human domestic consumption from groundwater sources. The returns at household level for livestock on Nijhum Dwip are given in Table I.6e. The mean household returns to livestock are less than half those from cropping but cash income from fisheries is significantly greater than both of the others put together.

3.5.5 Fishing

The degree to which households benefit from "free good" fish has been discussed in Section 3.5.1 above. A major benefit from such fishing activities is the high level of human nutrition found in the area when compared to other parts of Bangladesh.

The fish catch statistics for local thanas supplied by the Thana Fisheries Officer were studied but were considered inappropriate for the area as the sampling frame is thana-wise and does not adequately reflect local conditions at Char Montaz or Kukri Mukri. A catch assessment was carried out in the study area and compared to historical data collected by the DoF in 1984/5. The results of this work are summarised in Table 3.6 and the returns from fishing per household in Table I.6e. From this data it can be seen that marine fishing is by far the most important source of cash income in the area (roughly 60 per cent of all household cash income at Char Montaz and 52 per cent at Kukri Mukri) and some 18 per cent of households at Char Montaz and 12 per cent at Kukri Mukri list fishing as their main economic activity. It would appear that unlike Nijhum Dwip, full time fishermen do not usually carry out farming as a secondary occupation.

Table 3.6: Fisheries data

Table 3.6a: Fisheries in Char Montaz Kukri Mukri

Category	Annual production (mt)	Percentage of total production
Aquaculture	30	1
Marine fisheries	2119	99
Total	**2149**	**100**

Source : MES Field survey 1998

Table 3.6b: Fishing households in Char Lakshmi

	1984/85 (DoF/FAO)	1997 (MES)
Total population	883	2081
Total no. of households	121	357
No. of fishing households	45	133
No. of fishermen	65	780
% of fishing households	37	37
No. of boats	25	76

Source : DoF/FAO 1984-85; MES Field survey 1998

There are however serious constraints to development of fisheries, primarily due to severe over exploitation of the resources in the area. The future situation looks bleak and the work of the Bay of Bengal project would seem to indicate that an urgent management programme is needed to restrict catch levels, otherwise the stocks are likely to collapse. There are also other issues affecting fisheries development in the project area, including the lack of storage facilities and credit which allows the trade to be dominated by exploitive traders who pay very low prices to producers. In economic and nutrition terms it would be better if most families ate even more of the fish they caught rather than sold it for cash to purchase rice.

3.5.6 Rural energy

As previously outlined in the common resources section above, the area has a relatively favourable rural energy balance when compared to the rest of the country. There is a plentiful supply of fuel wood and extensive grazing lands are available so that demand for rice straw as fodder is relatively low except at a few specific times of the year. Animal dung is used much less for fuel than in other areas of Bangladesh and hence increases the fertility of the soil without having to resort to chemical fertilisers with their associated high cost and water quality problems.

3.5.7 Wage paid employment

The possibilities for wage paid employment in the area, even as farm labour, are very restricted. However during the needs assessment exercise there were no special calls for provision of wage paid labour, unlike Nijhum Dwip where women were particularly requesting cottage industry employment opportunities to be set up. It is probably the case there due to the lower levels of real functional landlessness (30 per cent and 22 per cent as opposed to 33 per cent at Nijhum Dwip, but at Char Montaz-Kukri Mukri the majority of fishermen, some 18 per cent and 12 per cent of households, appear to be full timers with little agricultural land, making the relevant functionally landless numbers lower still at around 11 per cent), most people work their own land and have less need for wage paid labour. However the use of labour intensive construction techniques for the cross dam would be beneficial in the short term, even if not a sustainable form of cash income, especially if construction activities were programmed at the right time of the year.

3.5.8 Industry

The only industrial operation in the area is some fish drying. The forestry sector should generate far more sustainable jobs than it presently does and the proposed forestry development programme has been deliberately planned to give modest but sustainable employment over a long period of time.

3.5.9 Access and transport

Waterborne navigation

The only access to Char Montaz and Kukri Mukri is by boat. The main private sector ferry and launch service routes are from Galachipa, (the thana headquarters for Char Montaz) which itself is fed by the main BIWTA service to Patuakhali and northern Bhola, with a link to Barisal, Khulna and Mongla in the west and also to Chandpur, Dhaka and Chittagong. From north Bhola there is also a direct link to Rahmatkhali on the east side of Meghna, which then has good road links to the eastern part of the country. The tidal window at Rahmatkhali is quite wide and water levels deep enough to allow medium sized local private ferries to operate at least twice a day during daylight. There is also a Class III designated BIWTA registered route from northern Bhola down the western side of Bhola island which continues southwards to Char Montaz and the islands to the south west of it. There are local launch services within the project area which connect the immediate islands, along with daily private trawler services which can each carry up to 150 passengers. These run from Char Montaz launch ghat and connect to Rangabali, Char Biswas, Panpatti, Ulania and Galachipa. There are also occasional services run for special events such as market days from Char Montaz and boats can be chartered by the day for carrying cargo as required. In addition there are up to 2,000 trawlers and other fishing boats operating in the area, primarily between May and September.

Road network

The road network on Char Montaz and Kukri Mukri is extremely poor and on Char Montaz is dependant upon the state of the embankment crest. There is no motorised transport what so ever, not even rickshaws. The only means of transport between ferry ghats is by walking and the occasional bicycle. The need for a direct road connection between both Char Montaz and Kukri Mukri was considered the third most wanted priority in both places and across all social groups, with the exception of landless labourers in Char Montaz who had it as a lower priority than other people.

3.6 Social risks and hazards

The human implications of both natural events (see Section 3.3 for an outline of these) and also man made conditions are dealt with below by category:

3.6.1 Storms and cyclones

Cyclones are the primary cause of direct hazard death in Bangladesh, often made worse by the secondary impacts of disease. There have been severe cyclonic storms in the study area in 1960, 1970, 1985 and 1991. The cyclone of 1970 was the most severe in Bangladesh this century and killed up to 275,000 people. The track was south-west to north-east across the Meghna Estuary, passing directly over the north of Bhola and south of Lakshipur town. The project area lay on the landfall site of the surge with a large tidal wave and the land was then without embankments and limited mangrove cover. Galachipa Thana had the highest number of deaths (62,986 equivalent to 20 per cent) of any thana and Char Fasson the second highest at 56,995 (equivalent to 34 per cent). However at union level the rates for the project area were worse still, with 40 per cent in both of the unions which lie in the area (Ref: Sener Ingenieria y Sistemas SA, June 1996). The 1960 cyclone was unusual in that it was south to north directly up the Meghna river, but there were few deaths in the project area as it occurred at a relatively low tide condition. Most of the problems stemmed from the funnelling of the surge up towards Chandpur. The 1986 event, whilst

too mild to be recorded on the tract map (see Volume 8 of the Master Plan), did kill up to 100 people in the thanas of the project area. The 1991 event, whilst the second worst this century, passed to the south and again there were less than 100 human deaths in the thanas. The number of livestock deaths is considerable in such events but accurate numbers are difficult to ascertain. Follow-up work on the effects of the cyclone were carried out by BCAS (Ref: BCAS, 1991 and 1992) and CDL (Ref: CDL, January 1992a and 1992b).

Since the 1991 cyclone an extensive programme of cyclone shelter construction has been carried out and multipurpose use is made of these for schools. The CSPS list four major structures with a capacity for 3,000 people on Char Montaz to serve an estimated 1996 population of 6,100 in the Mauza and 10,000 on the island. On Kukri Mukri there is only one purpose built cyclone shelter with a capacity of 750 places. There are five schools but these are not designed for the purpose of cyclone shelters and they have a combined capacity of 1,500 people. There is also a Killa (a raised open platform) which it is estimated could provide sanctuary for 750 people. The estimated 1996 population of Kukri Mukri island is 8,800, there is thus a shortfall in places of at least 6,550. This is a very serious situation indeed as the island has no embankment. However the cost of provision is high at US$ 150 per person and recent indications are that some donors are not able to fund such works. The cost of raised platforms (Killas), primarily intended for livestock is less, but they provide far less security, although the borrow pits produced are often turned into a pond for aquaculture, but in the case of Kukri Mukri, which is unembanked, such a pond must be of limited use. There is a significant policy issue as to if any human settlement should be at all encouraged in such a risky place, and if so then weather all new settlement should be located on or behind a coastal embankment and/or adequate cyclone shelter provision be made, despite its cost.

3.6.2 Floods and saline intrusion

The main source of flooding is from high lunar tides, particularly in the late monsoon season when upstream river levels are high, normally in August, (see Figure II.3). The main problem with these floods are that they produce saline inflow to non embanked land and also to those embanked areas which do not have operational water control structures that are appropriately used. There is an identified need to sort out the drainage system and its operation as well as rehabilitation the embankments on Char Montaz. The social implications of this saline inflow are damage and destruction of standing crops, as well as causing long term residual soil salinity. In embanked areas flooding can occur at times of heavy rainfall when there are an inadequate number or size of openings or they are poorly located. However this rainfall flooding is normally short lived, even in places where land levels are lower inside embankments than outside them, as even the daily tidal range is great. The peak flooding occurs during cyclone surges, such as 1970, resulting in saline inflow which requires a monsoon season to flush out.

3.6.3 Bank erosion

Despite the fact that the project area is subject to significant accretion processes, there are also places where erosion has occurred. The analysis of erosion and accretion has been given in Section 3.1 and the long term pattern illustrated in Figure 3.2, with the changes since 1973 and predicted change to 2025 in Figure 2.1. The areas at greatest risk are north eastern Kukri Mukri and east Char Montaz. Although the rate of erosion at Kukri Mukri is greater, the direct human implications are less significant, as population densities are lower and there is no embankment. However the relatively high rate of erosion will make selection of an embankment alignment for the area in year 5 difficult and may question the viability of this intervention if it needs constant retirement. Char Montaz is already embanked and the erosion will threaten the embankment, which under the proposed intervention programme is scheduled to be rehabilitated. The rate of erosion thus has implications for the viability and also location of embankment construction and rehabilitation.

3.6.4 Earthquakes

The area is subject to infrequent but severe earthquakes as outlined in Section 3.3.4 above. The last severe earthquake in eastern Bangladesh was on 12th June 1897 during which most buildings built of rigid materials were seriously damaged. The human casualties were relatively few as most buildings were then of lightweight construction. However if such an event were to happen today it is likely that the casualties would be much higher. The fact that the project area has low population densities and few buildings are constructed of rigid materials makes the likelihood of deaths from building collapse low. However a more important aspect within Bangladesh is that the most severe earthquakes have occurred during the monsoon period when the river systems are full and water levels are higher. However for the project area the lunar tidal cycle is more important in influencing high water levels, thus if an embankment failure due to an earthquake were to occur and at a high lunar tide, the consequences for local people living immediately behind such an embankment could be more serious.

3.6.5 Famine

There were famines in the area during, 1866, 1943 and 1970/71 plus 1974. The 1943 Bengal famine was mainly due to food grains being diverted to the war effort against the Japanese, where as the 1970 famine was due to the effects of the 1970 cyclone and later compounded by the war with Pakistan up to 1974. As the local economy is of a more subsistence nature than most of Bangladesh it is less likely to be effected by such events.

3.6.6 Disease

The main disease threat to humans are diarrhoeal diseases brought about by high faecal pollution levels in surface water due to lack of sanitation provision compounded by high population densities. These have been discussed in Section 3.4.6 above and numbers of cases are shown in Figure 3.7 and Table I.7.

3.6.7 Pollution

There is no industrial pollution in the area, the only occasional problems stem from oil leakage from ships much of which occurs from bilge pumping causing localised effects on fish. However this is not a serious problem and are oil pollution from ship tank cleaning is quite a rare occurrences. The ship breaking operation north of Patenga has no influence on the project area. There is however a risk that one day a major oil spill problem could occur in the Bay of Bengal and the area would seem ill prepared for such an incidence.

3.6.8 Social instability

There would seem to be little social instability in the area when compared to other parts of Bangladesh, despite quite high levels of in-migration and possible conflict of rights on emerging land. The greatest threat comes from cyclones which can cause high mortality and disproportionately kill certain sections of the community, particularly the young and old plus females more than males.

3.6.9 Economic instability

The household survival strategy for the area seems to centre on risk minimisation by balancing farming activities with livestock keeping and fishing. The main economic instability stems from the aftermath of cyclones when the social and economic system can be severely dislocated and households have to rebuild their lives, often without key members and also having to care for wider family members who have been left without elders. Cyclones also destroy and damage private and public infrastructure which is costly to replace. There is also an underlying uncertainty in erosion prone areas which discourages longer term investment in economic activities which can not easily be relocated. The lack of a transparent, fair and efficient land allocation system with secure legal tenure also creates economic uncertainty.

3.7 Conclusions

The main natural environmental processes that have been identified as effecting the project area are erosion and accretion patterns, with the primary risks and constraints being cyclones (causing loss of life and destitution), 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.
- ground water 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 inshore 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 insufficient secondary schooling availability in the area.
- relative 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 and sustainable development for planned human in-migrants. However the area has one of the most favourable rural energy balances in the country.

4. PROJECT SCOPING AND PUBLIC CONSULTATION

4.1 Local people

As part of the Feasibility Study a simple needs assessment has been carried out in the two main islands of the intervention area and including six different social groups. Individuals were asked to rank 13 possible interventions by preference and in total some 112 people were interviewed representing approximately 4 per cent of all households. The results of this work are presented by location and social group in Table I.11. A major conclusion is that by far the majority of people interviewed at Kukri Mukri feel that construction of an embankment to prevent saline water intrusion is the highest priority, where as at Char Montaz the highest priority for all people was for provision of a health centre, followed by accretion of more land. Assuming that a health centre were to built on Char Montaz by the appropriate government authority, then the proposed intervention falls in line with peoples stated priority wishes. In addition there was a call for better road access which was rated as a third priority in both places. The construction of cross dams and embankments is an intrinsic part of improving road access. The second most called for

intervention on Kukri Mukri was construction of cyclone shelters, which is not surprising as the area is very vulnerable being unembanked and the present level of provision is very poor as stated in Section 3.6.1 above.

The main significant differences in response by location were for embankment provision at Kukri Mukri (not surprisingly, as Char Montaz already has one), and construction of a drainage system, creation of new accreted land, plus the provision of health centres at Kukri Mukri, for the reasons explained above.

There were significantly less differences in preference by social group than occurred at Nijhum Dwip. The major difference for women was a higher preference for the construction of cluster villages, possibly in preference to scattered homesteads which may be perceived to be socially isolated. The issues which women considered to be a higher priority than men at Nijhum Dwip (water supply and sanitation provision for instance) were judged to be of the same priority by men. Extreme examples of differences were the very low priority given to health centre provision by boat operators at Kukri Mukri (at present they totally control access in the area and would probably loose significant trade if a health centre were provided). Landless labourers and land owning farmers at Kukri Mukri rated provision of a drainage system higher than other groups in the area, whilst share cropping farmers at Char Montaz also did the same.

It is now considered undesirable to have any more detailed follow up people's participation programme until a public commitment can be given that the project will go ahead and funds have been committed to it. Local people's expectations have already been raised and it is ill advised to increase these further. Assuming that the project were to go ahead, then a detailed participation exercise would need to be mobilised based upon an appropriate strategy. This should take into consideration the experience of the 1994 Guidelines (Ref: Ministry of Water Resources, 1994) which were subsequently withdrawn and the recently unveiled re-draft, as well as the programme for the Jamalpur Project (Ref: SOGREAH/Halcrow, 1996).

As part of the Environmental Assessment methodology outlined in the Environmental Rules (Ref: Department of the Environment, 1997) it is necessary to obtain a No Objection Certificate from the local authority before an Environmental Clearance Certificate can be granted. The detailed study participation programme will need to produce a public response document and yield a No Objection Certificate. The timing of this process has been indicated in the programme shown in Figure 9.1.

4.2 Local government

Visits were made to government offices at the district, thana and union level in the area to collect relevant information and data held by them. At the same time the ideas and options for the proposed project were explained and discussed and the views of government officials solicited. In addition meetings were held with the elected representatives in the area. A list of those people seen is given as Appendix III.

4.3 NGOs

There is presently only one NGO, the Remote Island Development Project (RIDP) working in the area, with an office on Char Montaz. It has a poverty alleviation agenda and targets its activities at the household level and also vulnerable groups. Liaison was made with them whilst collecting data in the field. RIDP have also been carrying out livestock counts for provision of Killas for the Cyclone Shelter Preparatory Study.

4.4 Other projects

4.4.1 Land Reclamation Project (LRP)

The LRP (not reclamation in the true sense of regaining land that has previously been lost to human use, it was concerned with accretion of entirely new land) was the forerunner of the CDSP

and MES. It looked at possibilities for accretion promotion in the coastal area and carried out an initial Feasibility Study for two cross dams at South Hatia (Ref: Land Reclamation Project, 1990). The conclusions of the study were that the construction costs of the cross dams plus the necessary land embankments were too high to be justified by the predicted benefits. The present MES Feasibility Study is addressing this problem by testing more cost effective cross dam construction techniques using geotextiles. The LRP also commissioned an environmental scoping study for these cross dams (Ref: Rahman A and Huq S, 1990), the conclusion of which was that there were no really serious negative impacts that would render it ill advisable. The results of the LRP work have been reviewed in the light of the proposed cross dam construction programmes at Char Montaz-Kukri Mukri as conditions are very similar.

4.4.2 Char Development Settlement Project (CDSP)

The CDSP followed on from the LRP by taking over the land based components of the LRP, specifically the newly accreted lands south of Noakhali created by the large coastal cross dam constructions of the 1960's, and also other new land accretion in southern Feni. Liaison was made with the CDSP and issues of common interest discussed, particularly the long term implications of soil salinity for agriculture on accreted land that may be 15 or even 30 years old. The CDSP review of environmental issues relevant to their work was also assessed (Ref: Goffau, 1994).

4.4.3 FAP South West Regional Study (FAP 4)

Under the FAP the country was divided into five planning regions, the area to the west of the MES area, including Bhola Island, being designated the South West Region (see Figure 1.1). The main outcome of the FAP 4 study was the drawing up of a list of possible discrete water resources based interventions rather than a phased area based management programme (Ref: Halcrow, August 1993). A follow-up study carried out Feasibility Studies for seven of the identified projects, none of which lie in the MES area. Whilst the development of some of these seven projects may have long term implications for western part of the MES, including possible changes in salinity levels, there are unlikely to be any impacts or constraints in Char Montaz-Kukri Mukri area which would affect the viability of the proposed intervention. The situation with regard to the Ganges Barrage and Gorai augmentation project is discussed below.

4.4.4 FAP South East Regional Study (FAP 5)

The FAP 5 study area was to the east of Meghna and as shown in Figure 1.1. The outcome of the study was a phased area management plan for the region with a subdivision into 13 planning units. An environmental baseline description of the area was given (Ref: Sir M MacDonald and Partners, August 1991, 1992 and August 1993) and the environmental implications of the implementation of the proposed plan were also assessed. Two detailed Feasibility Studies were also carried out, the Noakhali North Drainage and Irrigation Feasibility Study (Ref: Sir M MacDonald and Partners Limited, 1993) being particularly relevant to the MES work as it tackles the need for remodelling the drainage system of existing cultivated land to mitigate the induced flooding and drainage congestion created by the construction of coastal cross dams to the south. The findings of the Noakhali study were that the cost of the proposed intervention can easily be justified by the benefits to agriculture created by reducing flood extent and increasing access to irrigation water in the dry season. Strictly speaking the costs of drainage remodelling should have been apportioned against the benefits of construction of the coastal cross dams when they were studied. This would have reduced the overall benefit calculation of the cross dams. This situation illustrates the need to address changed drainage patterns as result of cross dam construction as part of integrated project analysis.

The South East Regional Study phased programme has no proposed interventions that directly impinge on the Char Montaz-Kukri Mukri area.

4.4.5 Cyclone Protection Project and Coastal Embankment Rehabilitation Project

The CPP project carried out studies for the phased rehabilitation of the coastal embankment following the 1991 cyclone. The study had multi-disciplinary components, including forestry, and came up with revised design criteria for coastal embankments. A significant finding was that the planting of mangroves on the seaward side of coastal embankments significantly dissipates wave energy and is cost effective (Ref: Kampsax, 1992). In those places where there was no existing mangrove cover the damage to the embankment in the 1991 cyclone had been significantly worse than in those places were it existed. An Initial Environmental Examination of the CPP was also carried out, (Ref: Environmental Resources Limited, 1992), which concluded that implementation of the works was of a high priority and should go ahead, but care would need to be taken over significant issues, particularly resettlement of those people living on the existing embankment that was to be re-sectioned and land acquisition on new alignments. The need for all coastal work to be carried out within the framework of an integrated coastal zone management programme was also raised and reference made to the work of ESCAP (Ref: ESCAP, 1987?) and CARDMA (Ref: CARDMA, 1988 and 1989).

The implementation of the project was known as CERP and the first phase construction was mobilised in 1993. A monitoring of direct construction impacts was carried out (Ref: Bird, October 1993) which highlighted the need for appropriate measures to be taken for the Phase II works. The phase II works is presently ongoing and has a large forestry component, but does not include any work in the Char Montaz-Kukri Mukri area.

4.4.6 Cyclone shelters

Many shelters have been constructed in the coastal area since the 1991 cyclone. However the level of provision in Char Montaz and Nijhum Dwip is inadequate, as shown by the Cyclone Shelter Preparatory Study (CSPS) and summarised in Section 3.6.1 above. The CSPS aimed to set criteria for locating, sizing and designing of shelters, including a risk assessment methodology. A risk map based upon landfall locations of cyclone tracks was produced and has been assessed for the Char Montaz area (see Section 3.3.1 above). The number of shelters in the project area has been evaluated by the CSPS and an assessment also made of loss of human life and livestock (Ref: Sener Ingenieria y Sistemas SA, 1996). In addition, in conjunction with SWMC, the study produced a preliminary cyclone surge hydro-dynamic model of the area. The model is to be refined at a later stage by combining the MES bathymetry data and digitisation of the Finmap 1991 land levels. As part of the early stage of the CSPS the need for an integrated coastal management plan was identified (Ref: Mott MacDonald, 1992). The conclusions of the CSPS are that the costs of adequate shelter provision are high at around US$ 150 per head and feedback is required as to a policy for provision.

4.4.7 Systems Rehabilitation Project (SRP)

As part of a country wide assessment of 63 selected existing FCD/I projects that were actually constructed, the North Hatia Polder 73/1A Sub Project and South Hatia polder No 73/2 (the embanked parts of Hatia) were studied (Ref: Halcrow, 1994). The conclusions were that major works were required to ensure that it achieved its designed objectives. Specifically the sea facing embankment needed to be re-sectioned and raised to fulfil an adequate design criteria for cyclone protection, and the drainage system needed remodelling and provided with adequate outlet structures with gates that are operated in an appropriate manner to prevent saline intrusion and yet allow drainage of monsoon rainfall run-off at low tide. These works have subsequently been carried out and the crucial factor is their sustainability. The performance of this rehabilitation work has direct relevance to the proposed interventions, specifically the rehabilitation of the Char Montaz embankment and remodelling of the drainage system, as well as its operation.

4.4.8 Ganges Barrage and Gorai Augmentation

The idea of constructing a barrage across the Ganges just downstream of the Gorai intake has recently been revived, linked to diversion of dry season Ganges water into the Gorai system. Such an intervention may well affect the velocity and sediment load downstream of it and hence into the Meghna at Chandpur, although this is likely to be insignificant as the Jamuna/Brahmaputra system carries far higher sediment concentrations than either the Ganges/Padma or the Meghna. The greater importance would be the effects of increased dry season flows of less saline water into the Gorai system and downstream of it. This may reduce salinity levels in the Tentulia system and be marginally beneficial to the Char Montaz-Kukri Mukri Project.
The EIA work being carried out for the Gorai projects should address these issues.

4.4.9 Forestry

There have been extensive studies and implementation programmes for forestry development in the coastal areas of Bangladesh over the last 25 years. All of the mangroves in the MES study area are planted and none are natural woodland. A National Forestry Master Plan (Ref: Asian Development Bank, 1993) has been drawn up and under it regional sub-plans have been developed, with the Nijhum Dwip area being covered by the recently issued Noakhali area Integrated Forest Management Plan (Ref: Canonizado, 1998). There is as yet no similar plan for the Char Montaz-Kukri Mukri area, but the format and content of the Noakhali Report may act as a pointer to policy. The Noakhali plan outlines a proposed planting programme for the area but still fails to address the issue of sustainability and the need to fund the planting programme from revenue. The proposed forestry component of the Char Montaz-Kukri Mukri Project has tried to address this issue. The forestry situation in the MES area has also been addressed as part of the Coastal Green Belt Project, the Coastal Tree and Palm Project, (Ref: Fountain, 1993) and as a part of the CPP (Ref: Kampsax, May 1992, Appendix H). As mentioned above the CERP Phase II project has a significant forestry component.

4.4.10 Other embankment projects

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 Char Montaz-Kukri Mukri intervention.

4.5 Project planning response to consultation

As stated in Section 4.1 above a needs assessment was carried out in the project area. The results of the assessment confirmed that the basis for the intervention was in line with peoples wishes, as promotion of land accretion and embankment construction were their most desired intervention after provision of a health centre. The Char Montaz-Kukri Mukri Integrated Development Plan takes note of the other conclusions, and where appropriate has incorporated additional wishes as components in the proposed intervention.

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5. ENVIRONMENTAL SCOPING AND BOUNDING

5.1 Environmental scoping

5.1.1 Technical scoping exercise

An environmental 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). The basis for selection of the IEC's was the master environmental checklist compiled for all work in the MES as outlined in the MES Interim Development Plan, (Ref: DHV, 1997, the environmental assessment matrix given in Figures 8.1 and 8.2 gives the full listing of the checklist). The master list was adapted for local conditions at Char Montaz-Kukri Mukri and the main environmental constraints to development, identified from the conclusions of the baseline environmental description in Section 3.7 above, were borne in mind. The resulting scoping matrix is given as Figure 5.1, with the second column identifying the priority issues on technical grounds.

5.1.2 Local people's priority issues

Columns three and four of the scoping matrix give local people's priority issues based upon the results of the needs assessment discussed in Section 4.5 above and split between the two areas.

5.2 Identification of likely important environmental components

The scoping matrix given in Figure 5.1 indicates the likely direction and degree of induced change as a result of the proposed interventions. 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. The 30 year time period is that prescribed by the Guidelines for Project Assessment and used for the economic return period for the study. It is also the period 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 continue, known as Option 1.

- construction of one cross dam in a Pilot Scheme three years prior to construction of four cross dams (one at 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, including a road link. 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.

Figure 5.1: Scoping matrix of important environmental components

	Technical Priority	Local Priority Char Montaz	Local Priority Kukri Mukri	NOW	OPTION 1 Year 30 Without Project	OPTION 2 Year 30 With Five Cross-Dams	OPTION3 Year 30 With Seven Cross-Dams	OPTION 4 Year 30 With Eight Cross-Dams
NATURAL ENVIRONMENT								
Natural Physical Environment								
Climate:								
Rainfall				0	0	0	0	0
High Tides				0	0	0	0	0
Storm Surges	*	*13	*1	0	0	0	0	0
Cyclones	*	*4	*2	0	0	0	0	0
Hydrology:								
Surface Water:								
Quantity:								
Rainfall flooding				0	-1	+1	+2	+2
Tidal/Sea flooding	*	*13	*1	0	0	+1	+2	+3
Drainage		*7	*12	0	-1	+1	+2	+2
Irrigation				0	0	+1	+1	+1
Quality:								
Salinity	*	*13	*1	0	-1	+1	+2	+3
Irrigation water supply				0	-1	+1	+1	+1
Erosion		*12	*13	0	-1	0	0	0
Sedimentation				0	+1	+2	+3	+4
Accretion	*	*2	*7	0	+1	+2	+3	+4
Groundwater:								
Availability:								
Domestic water supply	*	*5	*4	0	-1	0	0	0
Quality:								
Salinity				0	0	0	0	0
Land:								
Topography				0	+1	+2	+3	+4
Land Type				0	+1	+3	+3	+4
Soil:								
Type				0	0	+1	+1	+1
Quality								
Chemistry	*			0	0	+1	+1	+1
Waterlogging				0	-1	+1	+1	+1
Erosion				0	0	+1	+1	+1
Capability	*			0	0	+1	+1	+1
Natural Biological Environment								
Terrestrial Habitats:								
Flora				0	+1	+2	+3	+4
Fauna				0	+1	+1	+1	+1
Freshwater Habitats:								
Flora				0	+1	+2	+3	+4
Fauna				0	+1	+2	+3	+4
Fish				0	+1	0	0	0
In-Shore Marine Habitats:								
Flora				0	+1	-1	-1	-2
Fauna	*			0	0	-1	-2	-3
Fish	*			0	-1	-2	-3	-4
Off-Shore Marine Habitats:								
Flora				0	0	0	0	0
Fauna				0	0	0	0	0
Fish				0	-1	-2	-2	-2
Bio-Diversity and Conservation				0	+1	+1	+1	+1
Sensitive Areas				0	0	0	0	0
Natural Risk and Hazards								
Storms and Cyclones	*	*4	*2	0	-1	+1	+2	+2
Rainfall Flooding		*7	*12	0	-1	0	0	0
Seismic Activity				0	0	0	0	0
HUMAN ENVIRONMENT								
Social Environment								
Political and Institutional Administration				0	0	+1	+2	+3
Human Population	*	*9	*9	0	+1	+2	+3	+4
Gender Issues				0	0	0	+1	+2
Settlement Pattern and History	*	*9	*9	0	+1	+2	+3	+4
Land Holding and Tenure	*	*2	*7	0	-1	+1	+1	+2
Common Resource Rights:								
Fish	*			0	-1	-2	-3	-4

	Technical Priority	Local Priority Char Montaz	Local Priority Kukri Mukri	NOW	OPTION 1 Year 30 Without Project	OPTION 2 Year 30 With Five Cross-Dams	OPTION3 Year 30 With Seven Cross-Dams	OPTION 4 Year 30 With Eight Cross-Dams
Fuelwood				0	0	+1	+2	+3
Grazing				0	+1	+1	+1	+2
Fodder				0	+1	+2	+2	+2
Domestic Energy and Fuel				0	+1	+1	+2	+3
Domestic Water Supply	*	*5	*4	0	0	+1	+1	+1
Sanitation	*	*8	*8	0	-1	0	0	0
Health:								
Waterborne Disease	*	*1	*6	0	-1	+1	+1	+1
Insect-borne Disease	*			0	-1	-1	-1	-1
Mental Health				0	0	+1	+1	+1
Nutrition				0	0	+/-	+/-	+/-
Education and Literacy	*	*6	*5	0	+1	+2	+2	+2
Archaeological and Cultural Sites				0	0	0	0	0
Landscape Aesthetics				0	0	0	0	0
Economic Environment								
Agriculture	*	*2	*7	0	+1	+2	+3	+4
Agricultural Wage Paid Labour				0	0	0	0	0
Homestead Production				0	+1	+2	+3	+4
Livestock				0	+2	+3	+4	+4
Forestry	*	*11	*11	0	+1	+2	+2	+3
Fisheries				0	-1	-2	-2	-3
Industry				0	0	0	0	0
Other Non-Farm Wage Paid Employment	*			0	0	0	0	0
Infrastructure and Communications:								
Roads and Embankments	*	*3	*3	0	0	+2	+3	+4
Navigation	*	*	*	0	0	-1	-2	-3
Energy and Power				0	0	+1	+1	+1
Telecommunications				0	0	+1	+1	+1
Social Risk and Hazards								
Storms/Cyclones	*	*4	*1	0	0	+2	+2	+2
Rainfall Flooding				0	-1	+2	+2	+2
Erosion		*12	*13	0	-1	0	0	0
Earthquakes				0	0	0	0	0
Famine				0	0	+1	+1	+1
Disease	*	*1	*6	0	-1	-1	-1	-1
Crop Pest Attack	*		*	0	-1	0	0	0
Pollution				0	0	0	0	0
Social Instability/Conflict				0	0	0	0	0
Economic Instability				0	0	+1	+1	+1
EXTERNAL FACTORS								
Upstream Constraints				0	0?	0?	0?	0?
Upstream Impacts				0	0?	0?	0?	0?
Downstram Constraints				0	0	0	0	0
Downstram Impacts				0	0	(+/-)?	(+/-)?	(+/-)?
DIRECT CONSTRUCTION IMPACTS								
Land Acquisition				0	0	0	0	0
Compensation				0	0	0	0	0
Resettlement				0	0	0	0	0
Construction Operations (with management)				0	0	+0.5	+0.5	+0.5
Construction Employment				0	0	+1	+2	+3

LEGEND:
* Identified significant component/issue with ranking
RATING OF IMPACTS:
+4 Very Significant positive trend/impact
+3 Significant positive trend/impact
+2 Moderate positve trend/impact
+1 Slight positive trend/impact
0 Present baseline condition
-1 Slight negative trend/impact
-2 Moderate negative trend/impact
-3 Significant negative trend/impact
-4 Very Significant negative trend/impact
+/- Simultaneous positive and negative trend/impact
? Insufficient data to assess

NOTES:
1. It is assumed that the any new drainage provision is completely effective
2. The exisiting and future government infrastructure provision levels are assumed to be adequate to take account of predicted population increases.
3. The settlement/Char development component includes adequate infrastructure provision (domestic water supply, sanitation, health centres, schools and cyclone shelters) to keep place with additional planned in-migration as part of a planned programme of new land allocation.
4. Present NGO activities are assumed to be expanded to include income generating activities for women.

One of the conclusions from the analysis is that the additional accretion benefits of the last cross dam are considerable (see Table I.12), but quite long term, where as those for Option 2 tail off after year 13 and for Option 3 after year 24. As the phasing of the interventions is to make Option 4 conditional upon the performance of Option 3 it was decided to do the detailed environmental analysis for Option 3 up until year 30, by which time all benefits would be on stream, including those from forestry planting and cutting.

A matrix extracting the Important Environmental Components (IEC's) for the impacts of Option 3 at year 30 is given as Figure 5.2. The matrix abstracts the priority issues from a technical standpoint and also those from the local people, the latter ranked by the results of the needs assessment, plus any significant predicted induced impacts.

5.3 Bounding of possible impact areas

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 outputs are given in Table I.12 and are mapped in Figure 2.4. The model indicates that all the direct impacts are likely to be in the inter island channels, mud-flats and inshore areas (defined as within 5 km of the coast) south of the northern limit of the defined project area as shown in Figure 2.5. 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 in Section 7.

Figure 5.2: Important environmental components matrix for phase 1

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 constructe

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6. ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Assessment methodology

The impact assessment methodology follows that of the EIA Guidelines and manual. Firstly impacts are identified, then where possible quantified and valued. Comparative matrix techniques have been used to do this and for displaying results of quantification and valuation.

The comparative assessment given in Figure 5.2 allows the significant impacts (both positive and negative) of Option 3 at year 30 to be identified. The analysis has been carried out using a comparison to a without project situation 30 years after construction of the cross dam. The analysis allows the impacts of the project separated from future trends that would occur irrespective of the intervention. The need for mitigation can also be identified and its effectiveness can be assessed. The final column allows the overall residual impacts 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, brought about as a result of the intervention.

6.2 Assessment by important environmental component

The results of the impact assessment are given below split firstly between positive impact and negative impact and then by issue, working systematically from the natural environment IEC's to the human environment. The direction of the impact is viewed from the perspective of long term sustainable human use of resources. For significant impacts and where and possible these have been quantified.

6.3 Identified positive impacts

6.3.1 Land accretion

From the morphological modelling outputs in Table I.12 it is estimated that land accretion under Option 3 is accelerated to the point where the area of land at level 1.5 metres (3,300 ha) is reached by year 7 instead of year 30. The total area of land accreted to level 1.5 metres after 30 years under Option 3 is almost three times that (8,828 ha) as 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 channels between the islands will be closed by the cross dams, some of which would not happen under natural conditions.

6.3.2 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 settled into the area during year 6/7, with both a house plot and an agricultural land allocation.

6.3.3 Reduction in cyclone damage

The effects of cyclone surges will be reduced as on the new embankments waves will be 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.

6.3.4 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.

6.3.5 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.

6.3.6 Reduction in soil salinity

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

6.3.7 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 of char Montaz may possibly be 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.

6.3.8 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.

6.3.9 Increase in agricultural production

Increased agricultural production is likely to occur as a result of accreted land being embanked and available 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 high and lies more than 1 km from the sea (estimated to be up to 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.

6.3.10 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.

6.3.11 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.

6.3.12 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 only the net benefits have been put into the project economic analysis. 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 there is a present, but this would be 920 ha less than at year 30 with no cross dams, assuming that the Forest Department were to continue planting all newly accreted land.

6.3.13 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.

6.3.14 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.

6.3.15 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.

6.4 Identified negative impacts

6.4.1 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 mud flats 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 worldwide 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. Such a programme has been proposed under the environmental monitoring programme.

6.4.2 Conservation management

The increased intensity of human use of resources on Char Montaz-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 like 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.

6.4.3 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 programme. However it would seem that the effect of the interventions in Option 3 will not have a significant impact over the decline that is likely to take place due to over-fishing, irrespective of the project.

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.

6.4.4 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.

6.4.5 Malaria

The baseline studies of the area have indicated a significant 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.

6.4.6 Waterborne 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 indicated 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 for those lost. 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 at an appropriate date.

6.4.7 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 dam 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.

6.5 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 E and is further discussed under mitigation issues below.

6.6 Impact quantification

Impact quantification has been carried out as far as is possible at this stage of the study and is summarised in Figure 6.1. The main problems are the lack of data on in-shore fisheries and the uncertainty of complex two way trends with human nutrition. The quantifications are for year 30 and shows the effect of a forestry cutting programme starting at year 16 outside the embankments which would reduce the forested area but increase that for seasonal cultivation and livestock grazing.

6.7 Impact valuation

Impact valuation has been carried out where possible and is given in Figure 6.2. 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 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 returns to forestry are positive but low and it has not been included in the project financial analysis, the assumption being that it will be carried out on a self-funding basis by the forest Department.

The overall economic analysis is in Chapter 9 of the Feasibility Study Report. The 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 systems) 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 if 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 upon the human population at year 15, the total project costs amount to Tk 78,000 per benefited household. This should be considered against 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 analysis 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 off this analysis are given in Section 9 of the Feasibility Study.

Figure 6.1 : Quantification matrix for significant impacts for option 3 at year 30

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

Figure 6.2 : Valuation matrix for significant impacts for option 3 at year 30

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

7. EXTERNAL AND CUMULATIVE IMPACTS

7.1 External impacts

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 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 mud flats 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. The proposed environmental monitoring programme will address these issues.

The scenario for sea level change in the area is for a rise of rise of 0.27m by the year 2030 (Ref: Bangladesh Unnayan Parishad, 1993). The recent natural rates of accretion in the area are considerably faster and higher than this and sea level rise is not considered a major constraint. However the design of the proposed embankments should take the predicted changes into account, although when compared to the requirement to cope with cyclones the added height required is very small.

7.2 Cumulative impacts

It is considered that there will be no significant cumulative impacts as a result of constructing Option 3. However if this were to be just the first stage of a major intervention strategy for cross dam construction throughout the whole MES area then there could be concerns as to likely compounded impacts. The situation would in any case be reviewed during the reassessment process after the Pilot Scheme and Nijhum Dwip first cross dam.

8. ENVIRONMENTAL MANAGEMENT

8.1 Mitigation measures

The predicted effects of environmental mitigation programmes can be seen in the Figure 5.2 by deducting column seven from column nine. Due to the fact that the interventions have been carefully designed, there is little need for specific targeted mitigation programmes. Those that would be required are indicated below:

8.1.1 Ghat relocation

It may be necessary to relocate any ghats presently found adjacent to channels that would become accreted. Relocation could be done by careful negotiation with the affected parties to come to an acceptable equivalent location. It would seem best to select new sites on the main channels 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 boat centres at new sites based upon the ideas as recommended and costed in the BIWTA study (Ref: BIWTA, 1994).

8.1.2 In-shore marine habitats

It is expected that re-placement in-shore marine habitats will be naturally formed, but monitoring of this will be required and in particularly the extent to which dolphins, fish and wading birds are able to re-locate 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 mud-flats or in the deeper inter-island channels.

8.1.3 Fisheries

Irrespective of the project there is a need for a 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 their present open water fisheries system.

8.1.4 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.

8.1.5 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 IV. With care a well implemented construction management plan can provide additional benefits.

8.2 Environmental enhancements

Environmental enhancements are those additional positive impacts that can be gained by mitigation measures which more than compensate for induced negative impacts. The main scope for these is in construction management and this is reflected in the rating shown in Figure 5.2.

8.3 Compensation measures

The relocation of any ghats in the mitigation measures above is the only major compensation measure required. With careful management no person should be worse off and there will be no major cost attached to this. There is no requirement for private land acquisition, compensation or resettlement for the construction of cross dams. The re-sectioning of the existing embankment should be done by taking land from the seaward side upon which there should be few land rights. The planning of the re-sectioning construction programme will have to address the need for first working on the pieces where there are no homesteads and then formerly relocating embankment residents onto the newly built embankment to allow the remainder to be worked on. The new embankments at Kukri Mukri and northern Char Montaz would be located on cleared forest land which is already publicly held. Care would be needed in the provision of drainage to minimise any land take and develop a strategy for the disposal and reuse of excavated material. The proposed environmental contributions into the detailed design phase would address these issues. With careful and sensitive planning it could be possible to minimise any requirement for direct compensation payment.

8.4 Environmental risk and contingency planning

The following basic assumptions have been made when assessing the proposed intervention and they have implications for the risks involved in constructing and managing the project:

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

- the proposed drainage system 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 geotextiles 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). A successfully implemented project would provide an overall reduction in risk to human lives and livelihoods.

8.5 Environmental monitoring and management

As part of an EIA it is normal to draw up an Environmental Management Plan (EMP). Such a plan should include 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 at year ten.

- water salinity and soil salinity using the same sample sites established during the Feasibility Study plus additional ones. Initially this should be done on four occasions each year.

- 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.

- malaria incidence.

- 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.

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In addition monitoring of construction management issues should be carried out using the checklist given as Appendix IV 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 of the first dam 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.

8.6 Quantified and costed EMP

A programme for project implementation has been given in Figure 9.1 which includes the re-location any ghats and the environmental monitoring activities. The implementation of the monitoring programmes could best be carried out by the proposed locally based project management unit. Alternatively the Environmental Cell that is currently 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. There are no major costs attached to the monitoring programmes as they would be part of the on-going planning and management of project implementation.

8.7 Institutional management of the EMP

It is proposed that the environmental management and monitoring requirements for the project would be carried out as part of the overall planning and management programme for the project. An inter-disciplinary approach to the whole proposed intervention is required for it to be implemented, and as indicated above, a locally based decentralised structure has been proposed.

8.8 Residual impacts

The possible residual environmental impacts can be seen in the last column of the matrix given as Figure 5.2. 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 inshore 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.

Neither of these residual negative impacts are thought significant enough to seriously undermine the benefits of construction of one cross dam.

9. CONCLUSIONS, RECOMMENDATIONS AND ENVIRONMENTAL WORK PROGRAMME

9.1 Conclusions

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 of 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. It is considered unwise to embark upon this process until agreed arrangements are in place for funding of the project.

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

The needs assessment indicates that embankment construction is considered to be the highest priority intervention for all social groups resident in Kukri Mukri. For Char Montaz the provision of more accreted land was the second highest priority for all social groups after provision of a health centre.

For the proposed Option 3 the main conclusion is:

- the main predicted benefit is land accretion, the rate due to the cross dams being over three times that of the natural, without intervention, rate. The primary issue is how can this additional created resource be used and how can potential benefits be realised at household level. Another benefit is likely to be wage paid labour opportunities during the construction of the cross dam.

A planning framework is needed for rational resource use management and the two critical issues that need to be addressed are:

- land rights and land allocation procedure

- forestry management policy, especially thinning, clearing and handing over land for agricultural use, as well as planting on newly accreted land.

The fundamental problem with the proposed intervention is that whilst the cross dam significantly speeds up land accretion, the predicted positive economic impacts of utilising such land are long term (a minimum of 15 years and possibly 30). In addition the construction costs are relatively high at Tk 78,000 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 Pilot Scheme these are not considered to be serious enough to prevent such a trial type of intervention being tested. However monitoring of these negative impacts and also any from the Nijhum Dwip cross dam would be required to allow quantification and valuation to take place and feed this information into the planning of Options 2 and 3.

Possible negative impacts that have been identified are not considered to be insurmountable, although monitoring data will be required to quantify some of these. The issues include:

- induced change to fish habitats presently using the inter-island channels. However it is thought that this will not seriously effect fish production levels as the area has experienced similar natural changes in the past and new replacement habitats are emerging all of the time. The biggest threat to this is over-fishing which will continue irrespective of the project.

- changes to wading bird habitats. These habitats are changing naturally and the intervention is merely speeding these up. Replacement habitats for bird life are being formed all the time.

- disruption to dolphin habitat and movement. Again this appears to be naturally compensated for as alternative habitat areas already exist and additional ones are being created. The main

constraint to dolphin numbers in Bangladesh appears to be loss due to persecution, not lack of suitable habitats.

- the increased stress on existing conservation management issues on Kukri Mukri. This could be minimised by not promoting any additional in-migration to that of the planned new settlers and managing new development in a systematic and sustainable way. The proposed intervention will actually increase the area of forested habitat available but this needs to be managed in an integrated manner.

- the disruption to any existing ghats which lie on accreting channels and will require relocation.

- possible changes in human nutrition patterns and risk of malaria. These will need to be monitored.

- the disruption to any existing waterborne navigation through the channels in which cross dams are to be constructed. However overall access to Char Montaz should be greatly improved by the project as continuous access will be possible by land along the series of cross dams.

- the improved access to Char Montaz from Southern Bhola using the proposed cross dams may encourage in-migration which has simultaneous positive and negative impacts and would need to be suitably managed using land allocation policy.

- the disruption due to direct construction impacts can be minimised by careful planning and implementation. The benefits of targeting wage paid labour opportunities during construction can go some way towards off-setting any disruption to local residents.

9.2 Recommendations

On environmental grounds there would seem to be no major objection for the construction of the Pilot Scheme and in principle to Option 2 and 3 and the associated integrated development project components. A full appraisal of the performance of the Pilot Scheme and the first cross dam at Nijhum Dwip should be carried out in the three years prior to commencement of construction of Option 2 quickly followed by Option 3. The major concern is that the capital costs of construction are high in beneficiary per-capita terms and there are perhaps more effective ways of using such resources and higher priorities, especially in a country wide context.

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, that Options 2 and 3 will go ahead. 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.

9.3 Future environmental work programme

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

- monitoring of erosion and accretion from satellite imagery, including the effects of the first cross dam if it is built

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

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

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

Once it is certain that construction of the project will go 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. A monitoring programme should also be implemented during the construction period based upon the prepared check list given in Appendix IV.

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

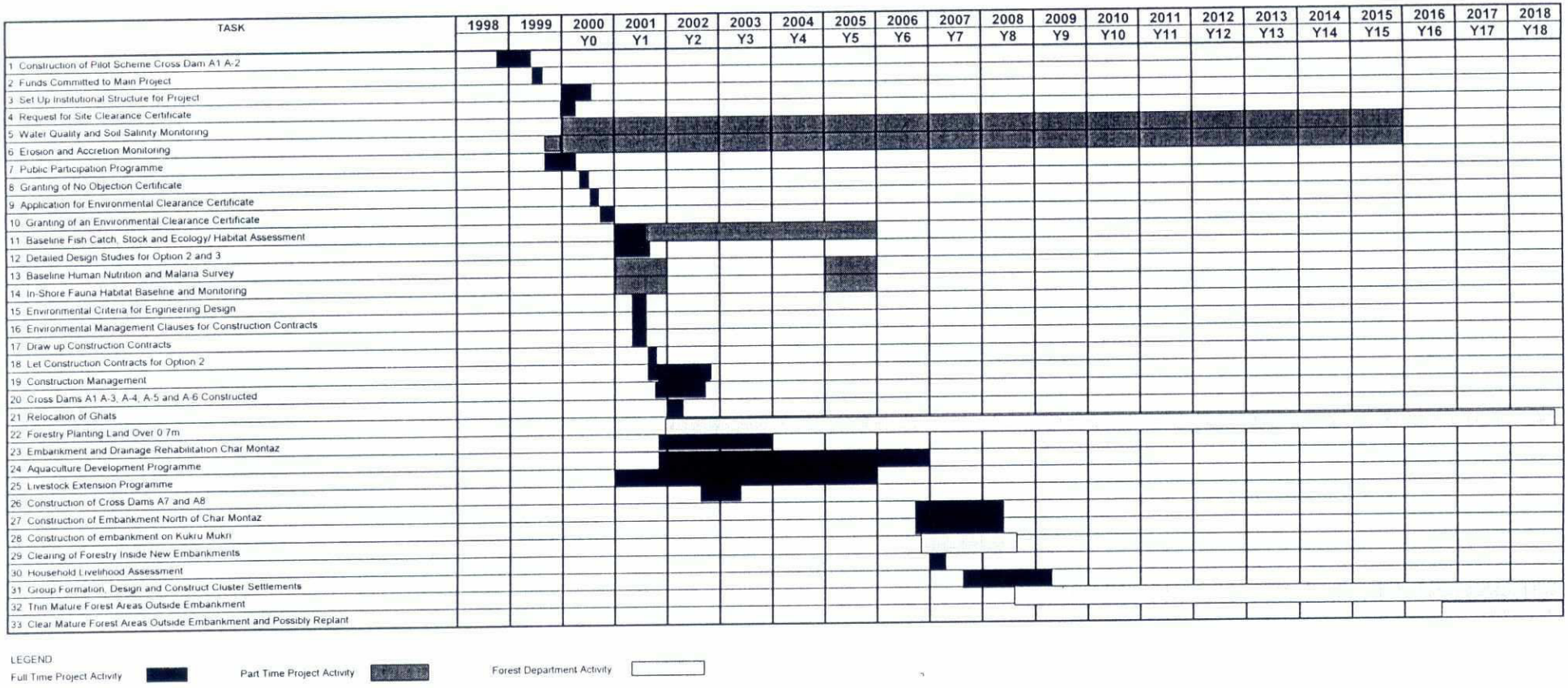
- negotiated arrangements for relocation of any ghats

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

- monitoring of the incidence of malaria in the area.

A programme for this is shown in Figure 9.1.

Figure 9.1 : Implementation schedule and environmental management programme



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APPENDICES

LIST OF TABLES

Table I.1 : Monthly rainfall at Patuakhali (R-266) from 1962 to 1989

Year	Monthly Total Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	13	25	0	108	216	653	227	214	256	464	0	0	2176
1963	0	0	0	35	269	498	562	290	257	464	0	0	2375
1964	0	19	0	286	152	565	431	285	283	374	66	0	2461
1965				20	204	722	536	655	475	258	0	25	2895
1966	23	0	16	22	64	835	192	418	307	247	30	50	2204
1967	16	0	107	60	147	367	654	617	339	195	0	0	2502
1968	0	0	75	86	136	1166	540	348	214	213	20	0	2798
1969	0	0	152	78	116	525	585	923	670	84	1	0	3134
1970	6	33	34	98	166	541	815	510	704		263	0	3170
1971	30	2	13		195	887	860	590		92	173	0	2842
1972	0	58	0	65	108	365	351	798	90	108	6	0	1949
1973	0	2	9	72	400	398	544	437	477	230	215	182	2966
1974	15	0	135	37	249	294	862	582	341	287	21	0	2823
1975	0	0	0	18	293	311	542	206	468	308	147	0	2293
1976	0	11	0	34	254	473	521	532	219	158	12	0	2214
1977	0	44	0	253	366	777	529	402	266	102	19	6	2764
1978	0	0	8	85	291	463	410	569	449	147	89	0	2511
1979	0	0	0	42	66	511	416		527	72	49	60	1743
1980	0	31	37	13	263	379	522	595	206	191	0	0	2237
1981	28	13	217	307	191	477	777	506	163	36	0	8	2723
1982	0	42	0	118	71	493	280	486	450	10	1	2	1953
1983	34	87	90	62	413	439	428	460	242	312	15	41	2623
1984	10	0	0	86	215	739	410	568	210	161	0	0	2399
1985	4	4	52	24	193	288	385	337	192	118	49	0	1646
1986	1	0	6	71	191	330	539	187	886	164	303	0	2678
1987	0	0	18	283	131	458	732	664	162	131	89	6	2674
1988	0	14	14	34	312	801	671	396	234	195	160	0	2831
1989	0	0	0	86	232	343	651	255	545	391	0	0	2503
Mean	7	14	36	92	211	539	535	475	357	204	62	14	2546

Table I.2: Water quality data

No sample	Type of water source	Date	Time	Tide (L, H)	Temperature (^{0}c)	Conductivity (mS/cm)	P^H	Dissolved Oxygen (0_2) (ppm)	$CaCO_3$ (ppm)	CO_2 (ppm)	Sediment (L.M.H)
		Dry									
1	SW	15.02.98	14.30	H	25.0	6.28	8.2	12.5	156.25	Nil	L
2	SW	15.02.98	14.00	H	24.5	6.38	8.3	11.6	165.00	Nil	L
3	SW	15.02.98	13.20	H	26.0	5.41	8.5	11.5	165.00	Nil	L
4	SW	15.02.98	13.40	H	24.0	6.68	8.3	11.7	160.00	Nil	L
5	SW	15.02.98	12.15	H	26.0	5.36	8.6	11.8	141.25	Nil	L
6	SW	15.02.98	10.54	L	23.0	13.60	8.8	12.7	240.00	Nil	H
7	SW	14.02.98	17.00	N.A	24.5	4.78	8.8	12.5	127.50	1.5	N.A
8	SW	14.02.98	14.30	N.A	25.0	6.60	8.1	12.5	225.00	4.5	N.A
9	SW	15.02.98	15.13	H	24.0	20.90	8.1	12.1	342.50	Nil	L
10	SW	14.02.98	14.50	N.A	24.0	4.71	8.5	12.0	82.50	2.0	N.A
11	GW	14.02.98	15.25	N.A	29.5	1.96	7.6	8.1	35.00	7.0	N.A
12	SW	15.02.98	12.45	N.A	27.0	4.00	8.0	10.8	142.50	11.0	N.A
13	GW	15.02.98	13.50	N.A	31.0	1.26	7.8	8.7	20.00	Nil	N.A

Note: SW = Surface water, GW = Ground water, PO = Pond.

L = Low, M = Medium, H = High , S = Suspended, ns = Non-suspended
NA= Not appropriate

Source: Field survey, 1998

Table I.3 : Flora species list

Scientific Name	Family	English Name	Local Name
Abelmoschus esculentus	Malvaceae	Lady's finger	Dheras
Acacia auriculiformis	Leguminosae		Akashmoni
Acacia nilotica	Leguminosae	Babul tree	Babla
Acanthus illicifolius	Acanthaceae		Hargozakata
Achras sapota		Sapota	Safeda
Aegle marmelos	Rutaceae	Wood apple	Bel
Albizia lebbeck	Leguminosae	Indian walnut	Sirish
Albizia procera	Leguminosae	White siris	Koroi
Allium cepa		Onion	Peaj
Allium sativum		Garlic	Rosun
Alocasia indica	Araceae	Glant taro, Arum	Mankachu
Alternanthera philoxeroides	Amaranthaceae		Helencha
Amaranths lividus		Amaranths	Danta
Annona reticulata		Bullock heart	Nona
Anthocephalus chinensis	Rubiaceae		Kadam
Areca catechu	Palmae	Betel nut	Supari
Artocarpus chaplasha			Chambal
Artocarpus heterophyllus	Moraceae	Jackfruit	Kanthal
Averrhoa carambola		Carambola	Kamranga
Azadirachta indica	Meliaceae	Margosa tree	Nim
Bambusa tulda	Gramineae	Bamboo	Jowa bans
Barringtonia acutangula		Indian Oak	Hijal
Basella alba	Basellaceae	Malabar night shade	Pui
Benincasa hispida	Cucurbitaceae	White gourd	Chalkumra
Bombax ceiba	Bombacaceae	Red silk cotton tree, kapok	Shimul
Borassus flabellifer	Palmae	Palm tree	Tal
Brassica oleracea var. botrydis	Cruciferae	Cauliflower	Fulkapi
Bruguiera gymnorhiza	Rhizophoraceae		Kankra
Cajanus cajan	Leguminosae	Pigion pea	Arohar
Calamus viminalis	Palmae	Rattan, cane	Bet
Callophyllum inophyllum	Gultiferae		Ponyal
Calotropis gigantia	Asclepiadaceae		Akanda
Calotropis procera	Asclepiadiacea	Milk weed	Swet akanda
Capsicum annum	Solanaceae	Chilly	Kachamarich
Carica papaya	Caricaceae	Papaya	Pepe
Carissa carandus		Karanda	Karamcha
Citrus aurantifolia	Rutaceae	Lemon	Lebu
Citrus grandis	Rutaceae	Grapefruit	Jambura
Cassia fistula	Leguminosae		Bandarlathi, Sonali
Casuarina equisetifolia	Casuarinaceae		Jhau
Chrysopogon aciculatus	Gramineae		Chorekanta
Chrysopogon aciculatus	Graminae		Premkata
Clynogyne dichotoma	Marantaceae		Patipata
Cocos nucifera	Palmae	Coconut palm	Narikel, Dab
Codiaeum variegatum	Euphorbiaceae		Patabahar
Colocasia esculenta	Araceae	Common arum	Kachu

Scientific Name	Family	English Name	Local Name
Cucurbita maxima	Cucurbitaceae	Pumkin	Mistikumra
Curcuma longa		Turmeric	Halud
Cynodon dactylon	Gramineae	Bahama grass	Durba, Durbaghas
Dalbergia sisso	Leguminosae	Sissoo	Sishookat
Delonix regia	Leguminosae		Krishnachura
Derris indica	Leguminosae		Karanja
Derris trifoliata	Leguminosae		Gilalata
Diospyros peregrina	Ebenaceae	Wild mangosteen	Gab
Dolichos lablab		Country bean	Sim
Elettaria cardamomum		Cardamum	Alachi
Enhydra fluctuans	Composiatae		Helencha
Eriocaulon sp	Eriocaulaceae		Ghaspata
Erythrina variegata	Leguminosae	Ceral tree	Mandar
Eugenia javanica		Waxapple	Jamrul
Euphorbia hirta	Euphorbiaceae		Dudhia
Exoecaria agallocha	Euphorbiaceae		Gewa
Ficus altissima	Moraceae		Bot
Ficus benghalensis	Moraceae	Banyan tree	Bot
Ficus hispida	Moraceae	Banyan tree	Kakdumur
Ficus religiosa	Moraceae		Panbot
Gumelina arbaria		White teak	Gamari
Hibiscus esculentus		Okra	Dharas
Hibiscus tiliaceus	Malvaceae		Bhola
Imperata cylindrica	Gramineae		Ulukhor
Ipomoea aquatica	Convolvulaceae	Water bird weed	Kalmi
Ipomoea batatus	Convolvulaceae	Sweet potato	Misti alu
Ipomoea fistulosa	Convolvulaceae	Moon flower	Dholkalmi
Lablab purpureus	Leguminosae	Common Bean	Sim
Lagenaria siceraria	Cucurbitaceae	Bottle gourd	Lau
Lannea coromandelica	Anacardiaceae		Bhadi, Jiga
Lathyrus sativus	Leguminosae	Chicklingvetch	Khesari
Leucaena leucocephala	Leguminosae		Telikadam
Luffa acutangala	Cucurbitaceae	Ribbed luffa	Jhinga
Mangifera indica	Anacardiaceae	Mango	Am
Manilkarka zapota	Sapotaceae	Sapota	Safeda
Momordica charantea	Cucurbitaceae	Bitter gourd	Karalla
Momordica cochinchinensis		Spiny gourd	Kankrol
Moringa oleifera	Moringaceae	Horse Raddish, ben oil tree, Round drum	Sajna
Musa sapientum	Musaceae		Kola
Myriostachya wightiana	Gramineae		Dhanshi
Nymphaea nouchali	Nymphaeaceae	Water lily	Shapla
Oryza sativa	Gramineae	Paddy	Dhan
Pandanus foetidus	Pandanaceae		Kewakata
Peper betel		Betel leaf	Pan
Phoenix sylvestris	Palmae	Date palm	Khejur
Phyllanthus amaras	Euphorbiaceae		Bhui amla
Pimenta acris		Bay leaf	Tejpata
Polyalthia longifolia	Annonaceae		Debdaru, Saralgoch

Scientific Name	Family	English Name	Local Name
Pongamia pinnata	Leguminosae	Indian beach	Karanja, Karamcha
Psidium guajava	Myrtaceae	Guava	Peyara
Punica granatum		Pomegranate	Dalim
Raphanus sativus		Radish	Mula
Ricinus communis	Euphorbiaceae	Castor oil plant	Veranda
Saccharum spontaneum	Gramineae	Thatch grass	Kash, Kaicha
Samanea saman	Leguminosae	Raintree	Raintree
Solanum melongena		Eggplant	Begun
Sonneratia apetala	Sonneratiaceae		Keora
Sonneratia caseolaris	Sonneratiaceae		Saila/Shyola
Spinacea oleracea	Chenopodiaceae	Spinach	Palongshak
Swietenia mahagoni	Meliaceae		Mehogini
Syzigium cumini	Myrtaceae	Black plum	Jam
Tamarindus indica	Leguminosae	Tamarind	Tetul
Terminalia arjuna	Combretaceae	Arjuna tree	Arjun
Terminalia catappa		Indian almond	Badam
Trichosanthes anguina	Cucurbitaceae	Snakegourd	Chichinga
Trichosanthes diocia		Pulwal	Patal
Typha elephantina	Typhaceae	Elephant grass	Hoglapata
Vigna mungo	Leguminosae	Black gram	Mash kalai
Vigna radiata	Leguminosae	Green gram	Moog
Vigna sinensis	Leguminosae	Cowpea, String bean	Barbati
Vitex negundo	Verbenaceae		Nishinda
Xanthium indicum	Compositae		Ghagra
Xeromphis spinosa	Rubiaceae		Mainakata
Zizyphus jujuba	Rhamnaceae	Indian jujube	Baroi
Zizyphus mauritiana	Rhamnaceae	Indian plum	Kul

Source: Master List from Bangladesh National Herbarium and Field Verification, 1997 - 1998.

Note : The Flora species list consists of Timber species, Economic tree species and Vegetable species

Table I.4 : Fauna species list

Bangla Name	English Name	Scientific Name	Remarks
REPTILES			
Ajagar	Python	Python molurus	I
Anjila	Skink	Mabuya carinata	C
Atail kacho	Blind snake	Typlina porrectus	C
Darash sap	Rat snake	Ptyas mucosus	C
Dora sap	Checkered keelback	Xenochrophis piscator	C
Gokhra sap	Cobra	Naja naja	UC
Jalbora	Dogfaced water snake	Cerberus phynchops	UC
Kalo gui	Monitor lizard	Varanus bengalensis	IT
Kasim	Flap - shell turtle	Lissemys punctata	C
Kochchop	Tortoise	Kachuga tecta	C
Laldora	Rednecked keelback	Rhabdophis subminiata	C
Matia sap	Olive keelback	Enhydris enhydris	C
Roktochosa	Garden lizard	Calotes sp.	UC
Sona gui	Yellow lizard	Varanus flaviscence	UC
Tiktikee	Wall lizard	Hemidactylus	C
Tokkhok	Gecko	Gecko gecko	UC
AMPHIBIANS			
Kotkoti bang	Skipper frog	Rana Cyanophlyctis	UC
Kuno bang	Toad	Bufo melanostictus	C
Sona bang	Bullfrog	Rana tigrina	UC
BIRDS			
Ababil	Palm swift	Cypslurus pervus	C
Bali hans	Lesser whistling teal	Dendrocygna javanica	C
Baz	Kestrel	Falco tinnunculus	C
Bhatsalik	Common myna	Acridotheres tristis	C
Bhuban cheel	Periah kite	Milvus migrans	C
Boro bok	Great egret	Bubulcus ibis	C
Bulbul	Red-vented bulbul	Pycnonotus jacosus	C
Cheuya pakhi			
Chonkho cheel	Brahminy kite	Haliaster indus	C
Chorui	House sparrow	Passer domesticus	C
Dahuk	Water hen	Gallicrex cinerea	C
Darkak	Jungle crow	Corvus macrorynchos	C
Doyal	Magpie robin	Copsychus saularis	C
Finga	Black drongo	Dicrurus macrocercus	C
Go salik	Pied myna	Sturnus contra	C
Holdey Pakhi	Blackheaded oriole	Oriolus xanthomus	UC
Hot titi	Red-wattled lapwing	Vanellus indicus	C
Jhuti salik	Jungle myna	Acridotheres fuscus	C
Kabutor	Pigeon		
Kali bok	Black bittern	Ixobrychus flavicollis	C
Kalo pipi	Coot	Fulica atra	C
Kani bok	Pond heron	Ardeola grayii	C
Kokil	Koel	Eudynamys scolopacea	C
Kura	Grey-headed fishing eagle	Icyhthophaga ichthydetus	R
Lal bok	Cinnamon bittern	Ixobrychus cinnanmeocus	C
Machranga	White-throated kingfisher	Halcyon pileata	C

Bangla Name	English Name	Scientific Name	Remarks
Mala gugu	Ring dove	Streptopeliatranquebarica	UC
Mautushi	Purple sunbird	Nectarinia asiatica	C
Nishi bok	Night heron	Nycticorax nycticorax	UC
Nishichor	Nightijar	Caprimulgus macrunus	UC
Nol bok	Grey heron	Ardea cinerea	C
Pancowri	Little cormorant	Phalacrocorax carto	UC
Papya	Pied grested cuckoo	Clamator jacobinus	UC
Patikak	House crow	Corvus splendens	C
Sada bok	Little egret	Egretta garzetta	C
Sada cheel	Black - wing kite	Elanus cacruleus	C
Satbhai	Common babbler	Turdoides striatus	C
Showkoon	White - backed Vulture	Gyps bengalensis	UC
Suichora	Common bee eater	Merops leschenaulti	C
Teya	Perakeet	Psittacula krameri	C
Tuntune	Tailor bird	Orthotomus sutorius	C
Utala pakhi			
MAMMALS			
Badur	False vampire bat	Megaderma lyra	C
Banar/ Bandar	Monkeys	Macaca mulatta	I
Bege	Mongoose	Herpestes edwardsi	C
Chika / Suchey	House shrew	Suncus murinus	C
Chitra Harin	Spotted deer	Axis axis	I
Indur	Rat	Bandicota bengalensis	C
Kathbiraly	Squirrel	Callosciurus pygerythrus	UC
Khargosh	Rabbit	Caprolagus hispidus	UC
Sehsu, Chuchum	Gangetic dolphin	Platanista gangetica	C (SW)
Uud	Otter	Lutra perspicillata	IT

Note: C = Common, UC = Uncommon, R = Rare, IT = Internationally Threatened,
I = Recently Introduced

Source : Checklist of FAP16 Bhola EIA and Thompson 1996. Field Interviews, March/April 1997.

Table I.5 : Fish species listings by habitat and area

Bengali name	English name	Scientific name	Remarks	
			Status	Habitat
Achila/Tiktiki machh	Greater lizard fish	*Saurida tumbil*	F	OS
Air		*Mystus aor*	F	RC
Baga champa Chingri	Shrimp	*Penaeus merguensis*	C	OS
Bagatara Chingri	Shrimp	*Penaeus semisalcus*	F	IS
Bagatara Chingri	Shrimp	*Penaeus semisulcatus*	C	OS
Bagda Chingri	Shrimp	*Penaeus monodon*	C	IS
Bagda Chingri	Shrimp	*Penaeus monodon*	C	OS
Baim	Spiny eel	*Mastacembelus armatug*	C	VWB
Batashi		*Pseuttotropius atheronoides*	C	VWB
Bele		*Glossogobius giuris*	C	R,C,CR
Berguni	Therapon perch	*Therapon jarbua*	F	OS
Bhetki/koral mach	Giant sea perch	*Lates calcarifer*	F	IS
Bhetki/Koral mach	Giant sea perch	*Lates calcarifer*	F	OS
Bom maittya	Eastern little tuna	*Euthynmus affinis*	C	OS
Catla	Carp	*Catla catla*	C	P
Chaga Chingri	Shrimp	*Penaeus indicus*	C	OS
Champa	Indian mackeral	*Rastrelliger kanagurta*	C	OS
Chan chanda	Moon fish	*Mene maculata*	C	OS
Chhuri machh	Ribbon fish	*Lepturacanthus sęvala*	F	OS
Chingri	Tiger shrimp	*Penaeus monodon*	F	F.C.
Darkuta	Forsteis barrawda	*Sphyraena forsteri*	C	OS
Dom mach	Silver- biddies	*Gerres filamentosus*	F	OS
Dora kata Chingri	Shrimp	*Penaeus japanicus*	C	OS
Dorakata Chingri	Shrimp	*Penaeus japanicus*	F	IS
Folichanda	Silver pomfret	*Pampus argentens*	C	OS
Gajar	Snakehead	*Canna marulius*	R	P
Gang Tengra	Cat fish	*Gangata viridescens*	F	C
Ghhoa Icha	Lobster	*Panulirus polyphagus*	F	OS
Golda Chingri	Prawn	*Macrobrachium rosenbergi*	F	IS
Goti poa	Croaker	*Otolithes macuptus*	F	OS
Gura Icha	Shrimp	*Nematopalaemon tenuipes*	F	IS
Hail chanda	Black pomfret	*Parastromateus niger*	C	OS
Hatir kann	Spade fish	*Ephippus orbis*	C	OS
Haturi Hanger	Hammer-hedded shark	*Sphyma blochii*	F	OS
Haush/Sankush	Sting ray	*Himanture uarnak*	C	OS
Hichiri machh	White sardine	*Escualosa thoracata*	F	OS
Hilsha	Hilsha shad	*Hilsha ilisha*	C	IS, OS
Horine Chingri	Shrimp	*Metapenaeus monoceros*	C	OS
Hundra machh	Laddy fish	*Sillago domina*	F	OS
Jagri	Silver- biddies	*Pentaprion longmanus*	F	OS
Kala poa	Spotted croaker	*Protonibea diacanthis*	C	OS
Kalabaus	Carp	*Labeo calbasu*	C	P
Kamat/Hangar	Milk shark	*Scoliodon walbeehmii*	C	OS
Kata mach	Cat fish	*Arius* s.p	C	IS
Kata mach	Cat fish	*Arius* s.p	F	OS
Khorul	Mullet	*Liga subvirdis*	F	OS
Kukurjib	Long tongue sole	*Cynoglossus lingua*	C	OS
Laita	Bombay duck	*Herpodon nehereus*	F	IS
Lakhua	Indian salmon	*Polynemus indicus*	C	OS
Lal chewa		*Odontamblyopus rubicundus*	C	IS, OS

Bengali name	English name	Scientific name	Remarks	
			Status	Habitat
Lal datina	Longspine sea bream	*Argyrops spinifer*	C	OS
Lal poa	Silver pennah croaker	*Johnius argentatus*	C	OS
Loittya mach	Bombay duck	*Harpodon nehereus*	C	OS
Moori	Djeddaba crevalle	*Alepes djeddaba*	C	OS
Mrigal	Carp	*Cirrhinus mrigola*	C	P
Murbailla	Flat head fish	*Platycephalus indicus*	F	OS
Nuilla	Squid	*Loligo* s.p	F	OS
Nunatengra/Guilla	Bagrid catfish	*Mystus gulio*	F	OS
Nune Cheai	Cuttle fish	*Sepia* s.p	F	OS
Octopus	Common octopus	*Octopus vulgaris*	C	OS
Olua	Pointed tail anchovy	*Collia dussumieri*	R	OS
Pangas	Cat fish	*Pangasius pangasius*	R	C
Pangas	Fatty cat fish	*Pangasius pangasius*	R	IS
Pangas	Fatty cat fish	*Pangasius pangasius*	R	OS
Pann mach	Sickle fish	*Derepane longimanna*	C	OS
Pari machh	Purple spotted (big eye)	*Pariacanthus tayenus*	R	OS
Phasa	Moustached thryssa	*Thryssa mystax*	F	OS
Phase	Moustached thrysa	*Thrysa mystax*	F	IS
Pitabri	Skate	*Rhycholbatus djeddensis*	F	OS
Poa	Croaker	*Otolithes cuviert*	C	IS
Poa	Croker	*Otolithes cuviert*	C	OS
Ranga choukya	Red snapper	*Lutjanus johni*	F	OS
Ruda Chingri	Shrimp	*Parapenaeopsis scuptilis*	C	OS
Rui	Carp	*Labeo rohita*	C	P
Rupban	Bream	*Nemipterus japanicus*	F	OS
Rupchanda	Chinese pomfret	*Pampus chinensis*	C	OS
Sada datine	Lined silver grunter	*Pomadasys hasta*	F	OS
Sadha mach	Falsh trevally	*Lactarius lactarius*	C	OS
Samudra serboti	Indian halibut	*Psettodes erumei*	R	OS
Shada chewa		*Tryauchen vagina*	C	C
Shada chewa		*Tryanchen vagina*	C	IS
Shingi	Catfish	*Heteropneustes fossilis*	C	CR,C,P
Shol	Snakehead	*Channa striatus*	R	P
Sila / Gool kakra	Mud crub	*Scylla serrata*	C	IS
Sonali bata	Goat fish	*Upeneus sulphurens*	F	OS
Surma machh	Mackerel	*Scomberomorus commerson*	C	OS
Taka chanda	Shortnose pouy fish	*Leiognathus brevirostris*	C	OS
Tapsi	Paradisethread fin	*Polynemus paradiscus*	C	IS
Teilla phasa	Harifin anchory	*Setipinnae taty*	F	OS
Thailla	Four finger threod fin	*Eleutheronema terradoctylum*	C	OS
Zazi kakra	Blue swimmer carb	*Neptune pelagicus*	C	IS

Codes :

Habitat: R = River, C = Canal, P = Pond, F = Flood plain, IS = Inshore, OS = Offshore, VWB = Various Water Bodies, CR = Creeks

Status : C = Common, R = Rare, F = Fairly Common.

Source : Field Survey and Thana Fisheries Office, Patuakhali, Bhola 1997-1998.

Table I.6: Selected Socio-Economic Survey Outputs for South Bhola

Table I.6a: Household Land Ownership by Group

LOCATION		FUNCTIONALL LANDLESS 0-0.02ha	MARGINAL 0.021-0.20ha	SMALL 0.21-1.00ha	MEDIUM 1.01-3.03ha	LARGE over 3.03ha	TOTAL
CHAR MONTAZ	HOUSEHOLDS	33	23	20	22	12	110
	PROPORTION	30%	21%	18%	20%	11%	100%
KUKRI-MUKRI	HOUSEHOLDS	11	12	12	10	5	50
	PROPORTION	22%	24%	24%	20%	10%	100%

Source: MES Household Socio-Economic Survey 1998

Table I.6b: Reasons for Settlement in the Area

LOCATION		LANDLESSNES	IVER EROSION DISPLACEE	INHERITANCE	OTHER	TOTAL
CHAR MONTAZ	HOUSEHOLDS	47	13	21	29	110
	PROPORTION	43%	12%	19%	26%	100%
KUKRI-MUKRI	HOUSEHOLDS	11	2	30	7	50
	PROPORTION	22%	4%	60%	14%	100%

Source: MES Household Socio-Economic Survey 1998

Table I.6c: Main Occupation of Household Heads

OCCUPATION	HAR MONTAZ		KUKRI-MUKRI	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
AGRICULTUR	41	37	21	42
AG. LABOUR	10	9	3	6
BUSINESS	9	8	5	10
FISHING	20	18	6	12
BOAT LABOU	21	19	3	6
SERVICE	3	3	1	2
OTHERS	6	5	11	22
TOTAL	110	100	50	100

Source: MES Socio-Economic Survey 1998

Table I.6d: Main Occupations of Household Members

OCCUPATION	CHAR MONTAZ				KUKRI-MUKRI			
	NUMBER MALE	PERCENTAGE MALE	NUMBER FEMALE	PERCENTAGE FEMALE	NUMBER MALE	ERCENTAG MALE	NUMBER FEMALE	PERCENTAGE FEMALE
AGRICULTUR	22	9	0	0	9	8	0	0
AG. LABOUR	11	5	2	1	2	2	0	0
BUSINESS	14	6	0	0	7	6	0	0
FISHING	16	7	1	0	10	8	0	0
BOATMAN	36	15	4	1	9	8	0	0
SERVICE	5	2	0	0	5	4	0	0
STUDENT	63	27	56	16	40	33	25	18
HOUSEWIFE	0	0	152	45	0	0	63	46
DEPENDENT	64	27	124	36	32	27	47	35
OTHERS	3	1	1	0	6	5	1	1
TOTAL	234	100	340	100	120	100	136	100

Source: MES Socio-Economic Survey 1998

Table I.6e: Household Income per Annum

LOCATION	CHAR MONTAZ			KUKRI-MUKRI		
CROPS	MEAN HH PRODUCTION kg	MEAN HH DIRECT CONSUMPTION kg	MEAN CASH INCOME (TK)	MEAN HH PRODUCTION kg	AN HH DIRE NSUMPTION	MEAN CASH INCOME (TK)
PADDY	1437	629	3883	1461	695	4603
WHEAT	0	0	0	0	0	0
PULSES/OILS	80	17	717	20	6	124
POTATO	0	39	36	9	5	1
ONION/CHILLI	7	4	39	1	1	0
FRUITS ETC	20	9	184	16	6	186
TOTAL CROPS	1544	698	4859	1507	713	4914

	NUMBER	NUMBER	TK	NUMBER	NUMBER	TK
COW/BULLOCK	3	0	1009	3		912
BUFFALO	1	0	587	1		820
SHEEP/GOAT	1	0	54	1		92
POULTRY	27	2	379	16		255
HORSE	0	0	0	0		0
EGGS	48	70	37	6		6
TOTAL			2066			2085

OPEN WATER	TK	TK	TK	TK	TK	TK
FISH			10043			7420
POND FISH			120			20
TOTAL			10163			7440
GRAND TOTAL			17088			#REF!

Source: MES Household Socio-Economic Survey 1998

Table I.7: Reported disease incidence data for Galachipa thana 1992-1996

Thana	YEAR	MONTH	DIARRHOEAL DISEASE	WORMS	PEPTIC ULCER	ARTI	SKIN DISEASES	POOR NUTRITION	ANEMIA	ASTMA	EYE DISEASE	EAR DISEASE	DENTAL DISEASE	OBS & GYNE
Galachipa	1992	January	194	152	82	87	19	265	75	4	4	3	1	2
Galachipa	1992	February	265	175	84	94	26	260	87	0	4	6	2	3
Galachipa	1992	March	239	152	22	81	19	237	68	0	7	5	2	3
Galachipa	1992	April	120	108	32	42	7	109	42	0	3	2	1	4
Galachipa	1992	May	244	152	72	81	19	220	69	0	7	4	2	4
Galachipa	1992	June	316	262	110	177	34	358	122	6	3	3	3	4
Galachipa	1992	July												
Galachipa	1992	August												
Galachipa	1992	September	823	807	518	302	233	343	484	62	233	71	124	18
Galachipa	1992	October	1451	1644	840	514	313	302	686	81	244	127	175	60
Galachipa	1992	November												
Galachipa	1992	December												
Total 1992			3652	3452	1760	1378	670	2094	1633	153	505	221	310	98
Monthly mean 1992			457	432	220	172	84	262	204	19	63	28	39	12
Galachipa	1993	January	216	139	60	10	30	86	121	25	9	3	4	1
Galachipa	1993	February	396	208	114	16	67	72	86	68	8	10	12	3
Galachipa	1993	March	335	144	141	15	33	78	84	34	19	26	16	17
Galachipa	1993	April	189	125	136	18	51	43	114	21	15	30	10	2
Galachipa	1993	May	244	137	169	18	90	78	107	25	38	25	28	9
Galachipa	1993	June	209	67	108	6	81	20	54	23	20	16	6	5
Galachipa	1993	July	253	131	155	29	128	57	46	32	53	21	11	6
Galachipa	1993	August	216	177	132	16	98	38	77	34	57	26	7	4
Galachipa	1993	September	202	251	116	31	118	23	37	35	33	19	5	13
Galachipa	1993	October	233	206	206	23	63	23	51	36	38	41	10	6
Galachipa	1993	November	236	418	215	31	109	58	62	26	34	26	6	40
Galachipa	1993	December	118	183	111	12	93	9	47	29	33	13	11	5
Total 1993			2847	2186	1663	225	961	585	886	388	357	256	126	111
Monthly mean 1993			237	182	139	19	80	49	74	32	30	21	11	9
Galachipa	1994	January	648	715	785	75	402	183	456	149	180	120	140	24
Galachipa	1994	February	514	386	490	182	234	118	206	107	105	64	7	98
Galachipa	1994	March	348	430	503	148	205	130	221	78	128	57	105	42
Galachipa	1994	April	1032	633	498	256	290	196	398	150	124	82	114	36
Galachipa	1994	May	578	535	548	144	244	125	263	7	91	57	83	12
Galachipa	1994	June	550	447	499	192	240	130	249	104	147	58	94	9
Galachipa	1994	July	586	414	251	164	178	144	233	70	141	51	79	13
Galachipa	1994	August	411	326	322	159	150	62	165	59	88	45	74	22
Galachipa	1994	September	703	353	302	752	173	292	267	159	115	44	65	18
Galachipa	1994	October	736	469	507	269	254	170	291	105	166	50	84	14
Galachipa	1994	November	381	342	391	134	272	102	233	47	128	61	77	77
Galachipa	1994	December	168	277	212	99	82	31	146	26	84	53	45	28
Total 1994			6655	5327	5308	2574	2724	1683	3128	1061	1497	742	967	393
Monthly mean 1994			555	444	442	215	227	140	261	88	125	62	81	33
Galachipa	1995	January	565	886	383	172	185	224	415	51	110	118	128	42
Galachipa	1995	February	436	325	367	256	254	109	363	62	163	100	161	10
Galachipa	1995	March	398	359	368	180	195	175	295	57	140	73	112	19
Galachipa	1995	April												
Galachipa	1995	May	135	210	280	265	130	130	270	125	160	205	115	110
Galachipa	1995	June	105	190	250	245	130	115	262	115	150	170	105	100
Galachipa	1995	July	80	140	210	210	120	110	230	100	150	160	95	130
Galachipa	1995	August	80	155	215	225	135	120	240	110	170	190	135	135
Galachipa	1995	September	57	250	260	400	200	230	210	175	255	290	200	210
Galachipa	1995	October	57	200	235	325	180	200	275	130	205	210	230	190
Galachipa	1995	November	60	190	200	280	170	205	280	110	205	210	200	170
Galachipa	1995	December	64	170	200	260	150	200	280	100	190	190	200	165
Total 1995			2037	3075	2968	2818	1849	1818	3120	1135	1898	1916	1681	1281
Monthly mean 1995			185	280	270	256	168	165	284	103	173	174	153	116
Galachipa	1996	January	87	184	200	240	130	195	290	90	185	190	185	170
Galachipa	1996	February	60	220	250	270	150	200	310	135	190	200	200	190
Galachipa	1996	March	60	200	230	250	170	225	318	135	220	200	210	220
Galachipa	1996	April	35	210	250	280	200	245	330	150	300	230	250	280
Galachipa	1996	May	30	220	270	270	175	270	335	155	290	230	260	270
Galachipa	1996	June	24	210	270	270	175	285	325	150	270	225	260	285
Galachipa	1996	July	143	329	617	0	278	291	318	119	29	26	31	281
Galachipa	1996	August	141	893	0	0	615	0	0	0	0	0	0	399
Galachipa	1996	September	24	260	370	380	240	350	445	165	330	265	321	350
Galachipa	1996	October	1331	1477	823	425	300	251	537	100	235	116	182	60
Galachipa	1996	November	989	1176	867	939	334	231	648	79	203	137	179	66
Galachipa	1996	December	471	528	312	246	168	236	301	89	117	60	106	13
Total 1996			3395	5907	4459	3570	2935	2779	4157	1367	2369	1879	2184	2584
Monthly mean 1996			283	492	372	298	245	232	346	114	197	157	182	215
GRAND TOTAL			**18586**	**19947**	**16158**	**10565**	**9139**	**8959**	**12924**	**4104**	**6626**	**5014**	**5268**	**4467**
ANNUAL MEAN 1992/1996			4055	4352	3525	2305	1994	1955	2820	895	1446	1094	1149	975
MONTHLY MEAN 1992/1996			338	363	294	192	166	163	235	75	120	91	96	81

Source: Galachipa Thana Health Complex 1997

Table I.8: Summary of reported disease incedence data for Galachipa thana 1992-1996

THANA	YEAR	MONTH	DIARRHOEAL DISEASE	WORMS	PEPTIC ULCER	ARTI	SKIN DISEASES	POOR NUTRITIO	ANEMIA	ASTMA	EYE DISEASE	EAR DISEASE	DENTAL DISEASE	OBS & GYNE
MONTHLY MEAN 1992 (pro rata)			457	432	220	172	84	262	204	19	63	28	39	12
MONTHLY MEAN 1993			237	182	139	19	80	49	74	32	30	21	11	9
MONTHLY MEAN 1994			555	444	442	215	227	140	261	88	125	62	81	33
MONTHLY MEAN 1995 (pro rata)			185	280	270	256	168	165	284	103	173	174	153	116
MONTHLY MEAN 1996			283	492	372	298	245	232	346	114	197	157	182	215
MONTHLY MEAN 1992/1996			338	363	294	192	166	163	235	75	120	91	96	81
TOTAL 1992			3652	3452	1760	1378	670	2094	1633	153	505	221	310	98
TOTAL 1993			2847	2186	1663	225	961	585	886	388	357	256	126	111
TOTAL 1994			6655	5327	5308	2574	2724	1683	3128	1061	1497	742	967	393
TOTAL 1995			2037	3075	2968	2818	1849	1818	3120	1135	1898	1916	1681	1281
TOTAL 1996			3395	5907	4459	3570	2935	2779	4157	1367	2369	1879	2184	2584
ANNUAL MEAN 1992/1996			4055	4352	3525	2305	1994	1955	2820	895	1446	1094	1149	975
GRAND TOTAL			**18586**	**19947**	**16158**	**10565**	**9139**	**8959**	**12924**	**4104**	**6626**	**5014**	**5268**	**4467**

Source: Galachipa Thana Health Complex 1997

Table I.9: Fever and Malaria Survery Data Summary

HH No.	Location	Land Holding	HH with Fever case in last year	No. of Attacks in last year	Month of Attack	Malaria identified Yes/No	Riggors Occurred Yes/No	Consulted date Yes/No	Treatment taken Yes/No
1	2	3	4	5	6	7	8	9	10
1	Char Montaz	Landless	1	1	11	0	1	1	1
2	"	Landless	1	2	6, 9	0	0	1	1
3	"	Landless	1	3	6, 6, 6	0	1	1	1
4	"	Marginal	1	1	5	0	1	0	0
5	"	Marginal	1	3	7, 7, 12	0	0	1	1
6	"	Small	1	5	5, 5, 8, 9, 12	0	1	1	1
7	"	Small	1	3	6, 10, 11	0	0	0	0
8	"	Small	1	8	6, 6, 7, 7, 3, 10, 11, 11	0	0	1	1
9	"	Medium	1	1	10	0	0	1	1
10	"	Medium	1	1	11	1	1	1	1
11	Char Lakshmi	Landless	1	2	5, 7	0	1	1	1
12	"	Landless	1	1	11	0	0	0	0
13	"	Landless	1	4	7, 10, 1, 3	0	1	1	1
14	"	Marginal	1	2	1, 3	0	0	0	0
15	"	Marginal	1	1	6	0	0	0	0
16	"	Small	1	2	8, 12	0	0	0	0
17	"	Small	1	3	11, 12, 2	0	1	1	1
18	"	Small	1	1	12	0	1	0	0
19	"	Medium	1	2	7, 3	0	0	1	1
20	"	Medium	1	1	3	0	0	0	0
21	Char Bastin	Landless	1	2	12, 12	0	0	0	0
22	"	Landless	1	3	1, 1, 1	0	1	0	0
23	"	Landless	1	3	4, 5, 11	0	1	1	1
24	"	Marginal	1	2	6, 3	0	0	0	0
25	"	Marginal	1	1	3	0	0	0	0
26	"	Small	1	2	3, 6	0	0	1	1
27	"	Small	1	1	10	0	1	1	1
28	"	Small	1	3	6, 7, 11	0	0	0	0
29	"	Medium	1	1	5,	0	0	0	0
30	"	Medium	1	2	5, 11	0	0	1	1
31	Char Kukri Mukri	Landless	1	2	6, 11	0	0	1	1
32	"	Landless	1	1	7	0	0	0	0
33	"	Landless	1	3	3, 5, 9	0	1	1	1
34	"	Marginal	1	2	2, 7	0	0	1	1
35	"	Marginal	1	1	2	0	0	1	1
36	"	Small	1	1	5	0	0	0	0
37	"	Small	1	2	6, 9	0	1	1	1
38	"	Small	1	1	3	0	0	1	1
39	"	Medium	1	3	4, 5, 10	0	1	1	1
40	"	Medium	1	1	11	0	0	0	0
Total			40	84	84	1	15	23	23

Source: Field Survey, March 1998

Note: Yes = 1, No = 0

Table I.10: Nutrition Survey Data Summary

HH No.	Location	Land Holding	No. of meals eaten per day	No. of times the following food stuffs have been eaten in the last 7 days							
				Rice	Pulses	Fish	Meat	Vege.	Fruit	Milk	Others
1	2	3	4	5	6	7	8	9	10	11	12
1	Char Montaz	Landless	3	21	-	18	-	6	6	-	-
2	"	Landless	3	21	3	15	3	-	2	2	-
3	"	Landless	2	14	-	5	-	14	-	-	7
4	"	Marginal	2	14	-	8	-	14	-	7	-
5	"	Marginal	3	21	-	15	-	14	1	7	-
6	"	Small	3	21	1	16	2	2	7	7	1
7	"	Small	3	21	-	12	-	16	3	6	-
8	"	Small	3	21	4	7	-	21	4	-	-
9	"	Medium	3	21	-	3	2	16	2	7	-
10	"	Medium	3	21	3	10	-	18	2	7	-
11	Char Lakshmi	Landless	3	21	-	10	-	15	-	1	-
12	"	Landless	3	17	-	12	-	10	-	-	4
13	"	Landless	3	21	1	15	-	12	-	-	-
14	"	Marginal	3	21	-	21	-	10	-	7	-
15	"	Marginal	3	21	1	16	-	12	-	-	-
16	"	Small	3	21	2	12	1	10	-	5	-
17	"	Small	3	21	-	14	1	6	-	7	-
18	"	Small	3	21	-	7	-	10	1	7	-
19	"	Medium	3	21	1	11	1	8	-	7	-
20	"	Medium	3	21	15	5	1	12	3	7	-
21	Char Bastin	Landless	3	21	-	12	-	10	-	-	-
22	"	Landless	3	21	1	15	-	12	-	1	-
23	"	Landless	3	21	-	10	-	11	-	-	-
24	"	Marginal	3	21	1	16	1	12	1	7	-
25	"	Marginal	3	21	-	12	1	15	-	5	-
26	"	Small	3	21	1	10	-	10	1	7	-
27	"	Small	3	21	-	12	1	13	-	7	-
28	"	Small	3	21	2	10	2	12	-	7	-
29	"	Medium	3	21	1	8	-	8	1	7	-
30	"	Medium	3	21	3	14	1	7	1	7	-
31	Char Kukri Mukri	Landless	3	21	3	12	-	9	1	7	-
32	"	Landless	3	21	-	15	-	10	-	-	-
33	"	Landless	3	21	-	10	-	12	-	-	-
34	"	Marginal	3	21	1	12	-	15	-	-	-
35	"	Marginal	3	21	10	12	1	10	-	7	-
36	"	Small	3	21	5	10	2	8	-	7	-
37	"	Small	3	21	4	15	1	6	1	-	-
38	"	Small	3	21	1	10	-	8	1	7	-
39	"	Medium	3	21	4	12	2	7	1	7	-
40	"	Medium	3	21	5	8	1	7	1	7	-
Mean			2.95	20.5	1.8	11.7	0.6	10.7	0.8	4.4	0.3

Source: Field Survey, March 1998

Table I.11: Needs 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 fishermen		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

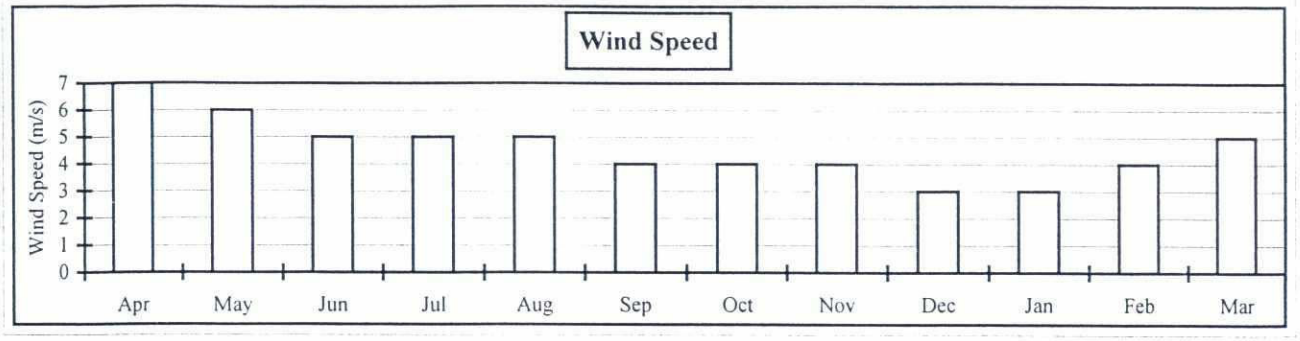
Table I.12: Land accretion areas with and without the proposed cross-dams to different levels in hectares

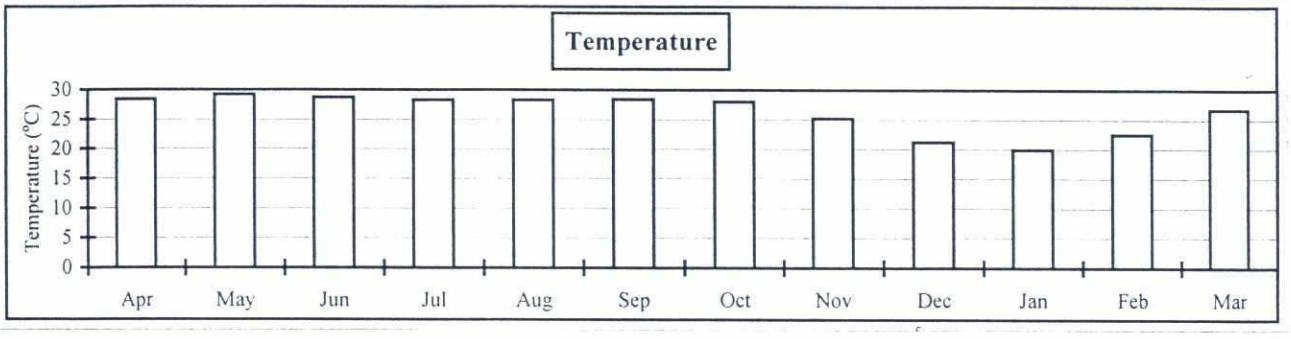
	OPTION 1 FUTURE WITH NO CROSS DAMS			OPTION 2 FUTURE WITH CROSS DAMS A2 TO A6			OPTION 3 FUTURE WITH CROSS DAMS A2 TO A8			OPTION 4 FUTURE WITH CROSS DAMS A1 TO A8			DIFFERENCE DUE TO CROSS DAMS A2 to A6	DIFFERENCE DUE TO CROSS DAMS A2 to A8	DIFFERENCE DUE TO CROSS DAMS A1 to A	ADDITIONAL AREA CROSS DAMS A7+A	ADDITIONAL AREA CROSS DAM A1
YEAR	+0.7m	+1.2m	+1.5m	+0.7m	+1.2m	+1.5m	+0.7m	+1.2m	+1.5m	+0.7m	+1.2m	+1.5m	+1.5m	+1.5m	+1.5m	+1.5m	+1.5m
0	3000	1500	0	3000	1500	0	3000	1500	0	3000	1500	0	0	0	0	0	0
1	3100	1600	100	3100	1600	100	3100	1600	100	3100	1600	100	0	0	0	0	0
2	3200	1700	200	3200	1700	200	3200	1700	200	3200	1700	200	0	0	0	0	0
3	3300	1800	300	3300	1800	300	3300	1800	300	3300	1800	300	0	0	0	0	0
4	3400	1900	400	3801	2287	760	3801	2287	760	3801	2287	760	360	360	360	0	0
5	3500	2000	500	4302	2774	1220	4881	3383	1672	4881	3383	1672	720	1172	1172	452	0
6	3600	2100	600	4803	3261	1680	5961	4479	2584	5961	4479	2584	1080	1984	1984	904	0
7	3700	2200	700	5304	3748	2140	7041	5575	3496	7041	5575	3496	1440	2796	2796	1356	0
8	3800	2300	800	5803	4233	2600	8119	6669	4408	8119	6669	4408	1800	3608	3608	1808	0
9	3900	2400	900	5917	4359	2745	8810	7405	5004	8810	7405	5004	1845	4104	4104	2259	0
10	4000	2500	1000	6031	4485	2890	9098	7719	5348	9098	7719	5348	1890	4348	4348	2458	0
11	4100	2600	1100	6145	4611	3035	9386	8033	5692	9977	8603	6106	1935	4592	5006	2657	414
12	4200	2700	1200	6259	4737	3180	9674	8347	6036	10856	9487	6864	1980	4836	5664	2856	828
13	4300	2800	1300	6373	4861	3327	9962	8659	6382	11735	10369	7624	2027	5082	6324	3055	1242
14	4400	2900	1400	6461	4951	3422	10224	8939	6674	12588	11219	8330	2022	5274	6930	3252	1656
15	4500	3000	1500	6549	5041	3517	10351	9085	6848	13306	11933	8919	2017	5348	7419	3331	2071
16	4600	3100	1600	6637	5131	3612	10478	9231	7022	13795	12416	9386	2012	5422	7786	3410	2364
17	4700	3200	1700	6725	5221	3707	10605	9377	7196	14284	12899	9853	2007	5496	8153	3489	2657
18	4800	3300	1800	6812	5311	3804	10731	9523	7372	14772	13382	10322	2004	5572	8522	3568	2950
19	4900	3400	1900	6898	5397	3892	10858	9666	7540	15261	13862	10783	1992	5640	8883	3648	3243
20	5000	3500	2000	6984	5483	3980	10938	9757	7651	15704	14288	11187	1980	5651	9187	3671	3536
21	5100	3600	2100	7070	5569	4068	11018	9848	7762	15998	14593	11501	1968	5662	9401	3694	3739
22	5200	3700	2200	7156	5655	4156	11098	9939	7873	16000	14898	11815	1956	5673	9615	3717	3942
23	5300	3800	2300	7243	5743	4242	11179	10032	7982	16000	15205	12127	1942	5682	9827	3740	4145
24	5400	3900	2400	7329	5829	4328	11261	10123	8089	16000	15510	12437	1928	5689	10037	3761	4348
25	5500	4000	2500	7415	5915	4414	11326	10194	8171	16000	15795	12723	1914	5671	10223	3757	4552
26	5600	4100	2600	7501	6001	4501	11391	10265	8254	16000	15995	12942	1901	5654	10342	3753	4688
27	5700	4200	2700	7587	6087	4587	11456	10336	8336	16000	16000	13160	1887	5636	10460	3749	4824
28	5800	4300	2800	7673	6173	4673	11521	10407	8418	16000	16000	13378	1873	5618	10578	3745	4960
29	5900	4400	2900	7759	6259	4759	11588	10477	8500	16000	16000	13596	1859	5600	10696	3741	5096
30	6000	4500	3000	7845	6345	4845	11653	10548	8582	16000	16000	13815	1845	5582	10815	3737	5233
31	6100	4600	3100	7931	6431	4931	11718	10619	8664	16000	16000	14033	1831	5564	10933	3733	5369
32	6200	4700	3200	8017	6517	5017	11783	10690	8746	16000	16000	14251	1817	5546	11051	3729	5505
33	6300	4800	3300	8103	6603	5103	11848	10761	8828	16000	16000	14469	1803	5528	11169	3725	5641

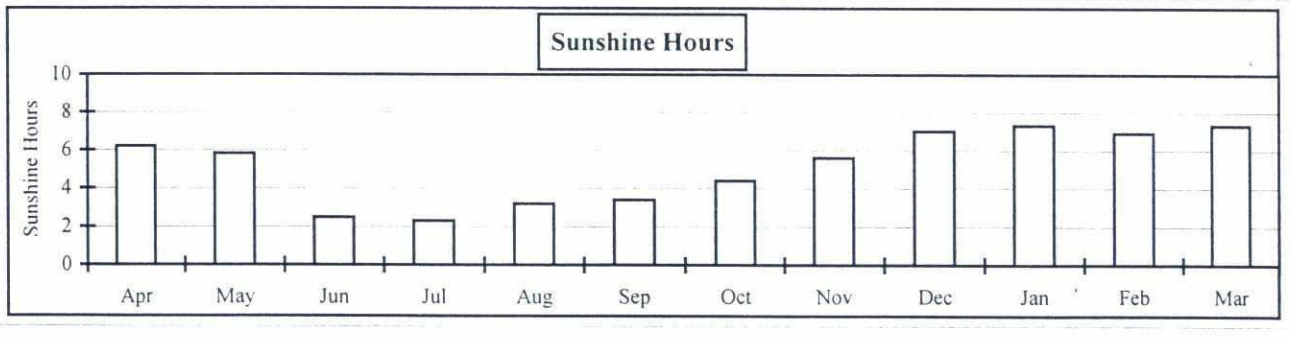
Source: MES Sedimentation modelling 1998

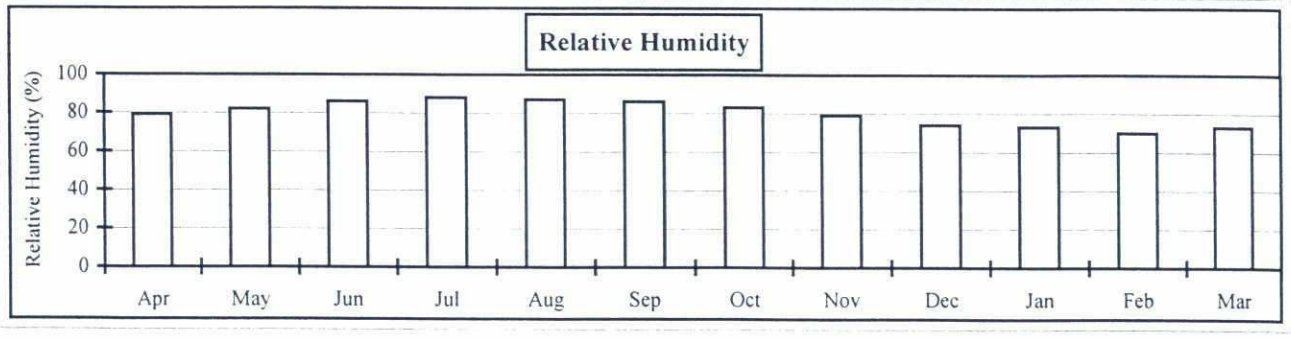
LIST OF FIGURES

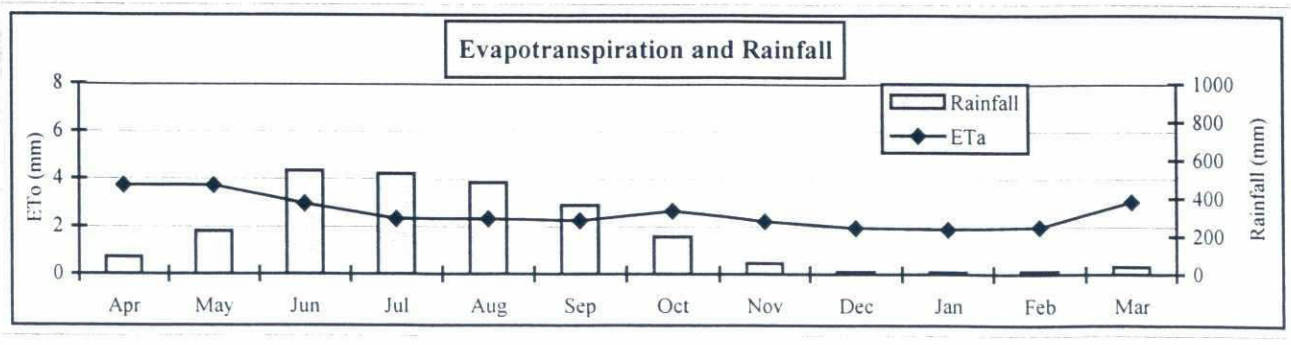
Figure II.1: Climatic norms at Patuakhali (1962-1989)



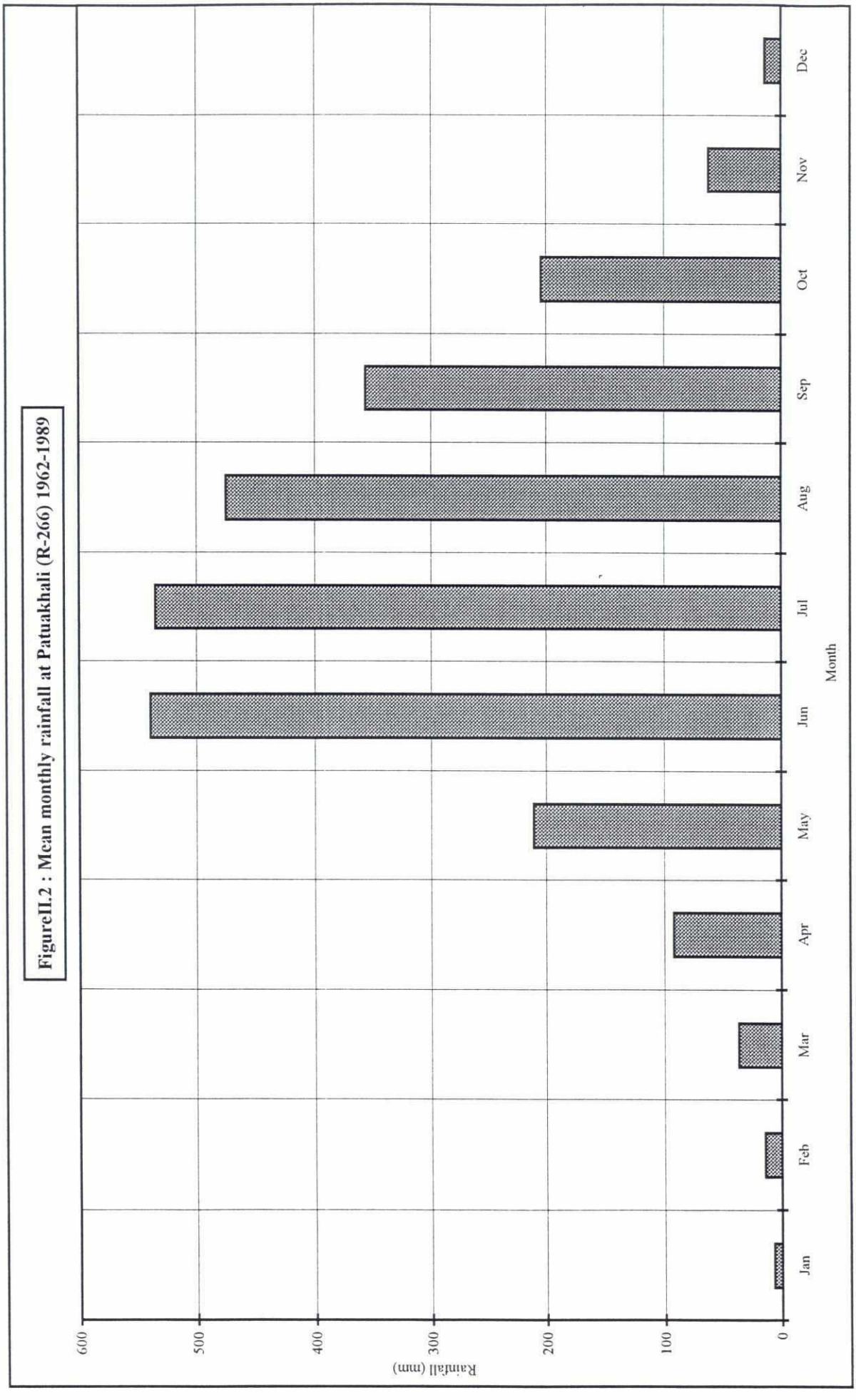








Source : Bangladesh Meteorological Department (BMD).



FigureII.2 : Mean monthly rainfall at Patuakhali (R-266) 1962-1989

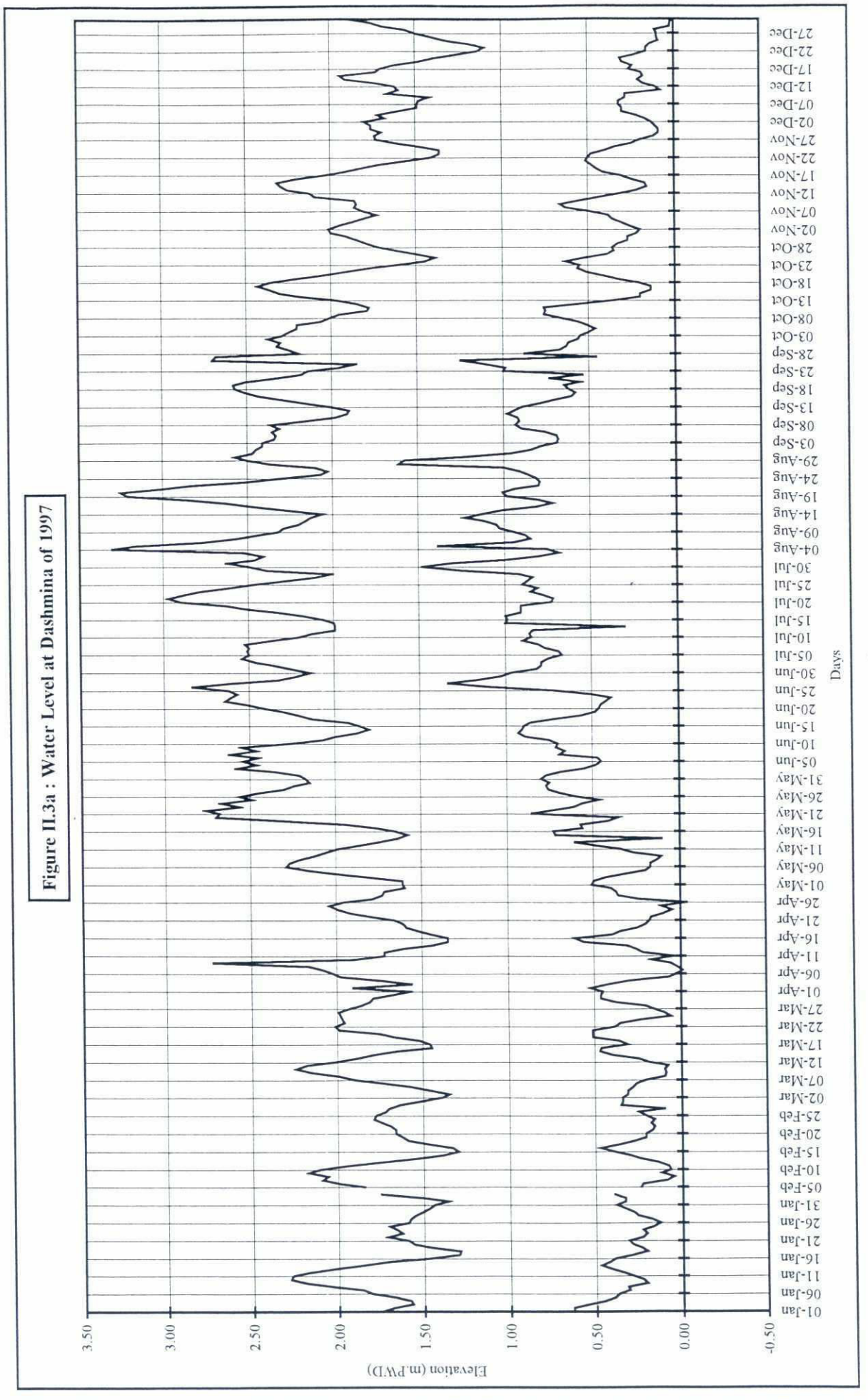


Figure II.3a : Water Level at Dashmina of 1997

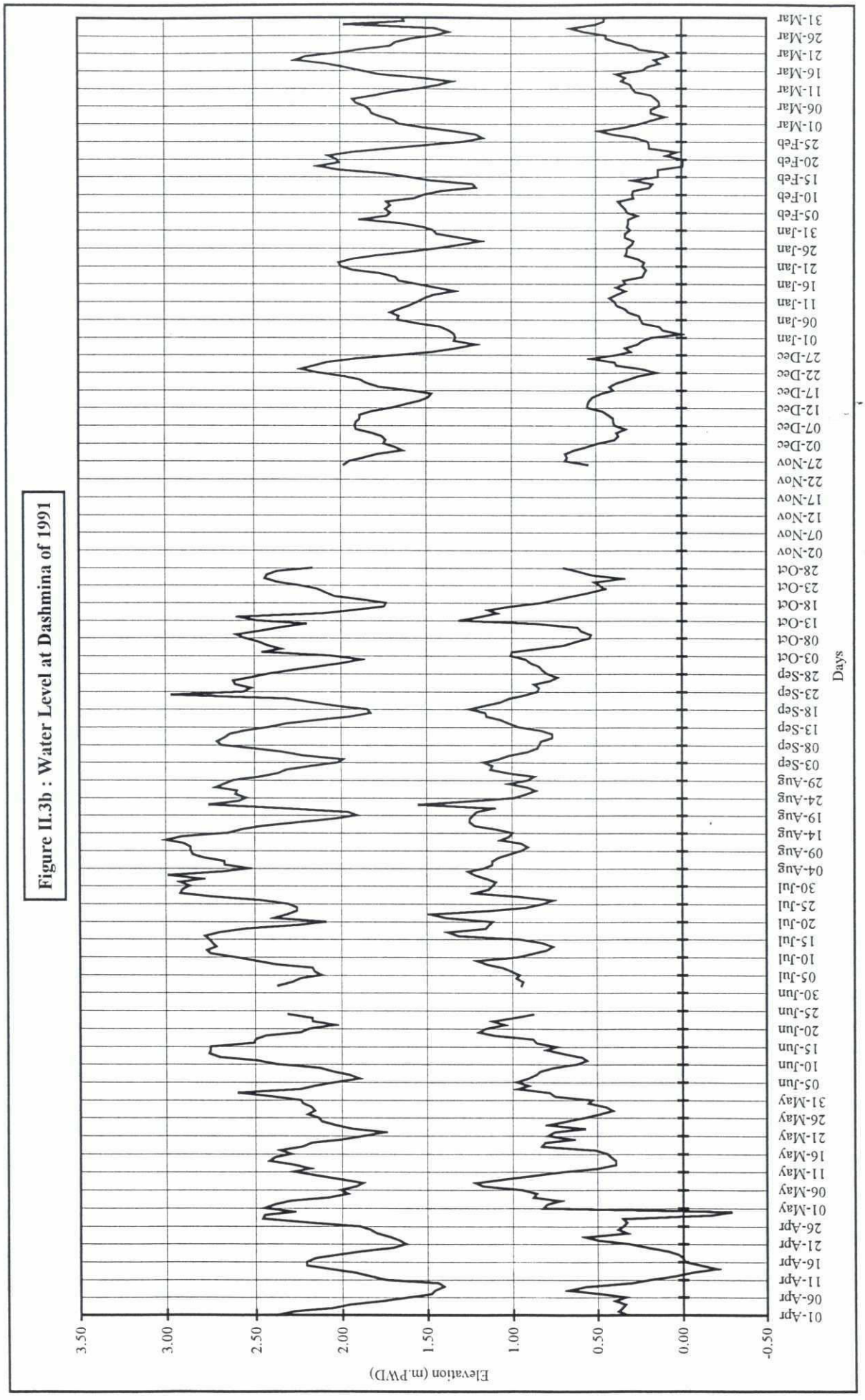


Figure II.3b : Water Level at Dashmina of 1991

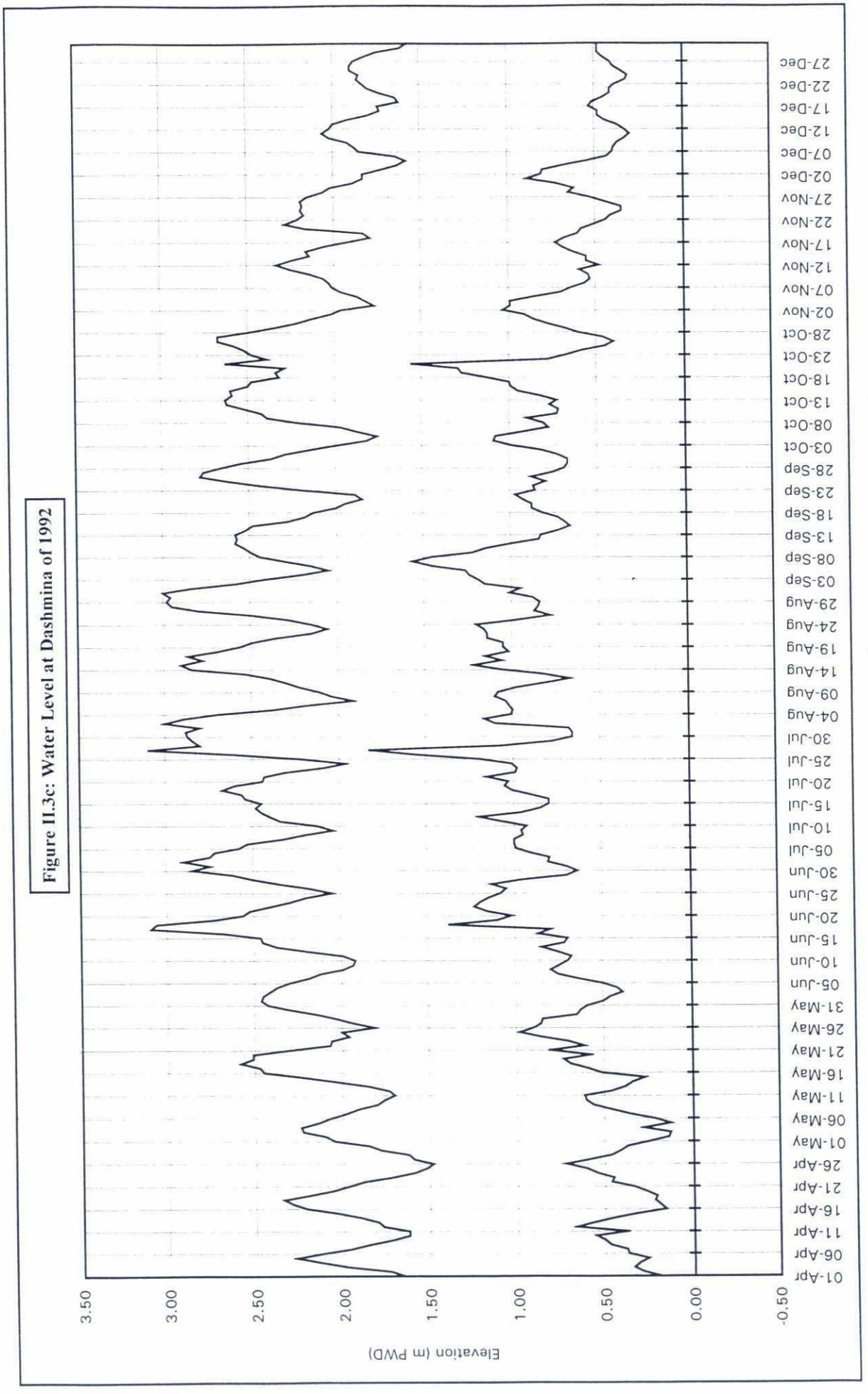


Figure II.3c: Water Level at Dashmina of 1992

ENVIRONMENTAL CONTACTS AND LIAISON

Considerable liaison with other studies, projects and organisations has taken place during the course of the MES and also prior to this by study staff working on related programmes. The following people and organisations have been contacted with specific reference to environmental aspects in the Study Area:

Water Resources Planning Organisation (WARPO)
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Zahir Uddin Ahmad, Programme Officer, Royal Netherlands Embassy
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European Commission
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Adarsha Gram Project Review
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EC Cyclone Shelter Review
Ian Tod

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Thana Health Complex, Hatia

Ministry of Education

Ministry of Social Welfare

Ministry of Establishment
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Water Resources Planning Organisation
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Bangladesh Water Development Board (BWDB), Hatia
Mohammad Ali, SDE, Hatia

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Ian Tod, ex Team Leader FAP 23, Flood Proofing
Paul Thompson, ex Team Leader, FAP 16 Meghna Charland Inventory

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FAP 4 South West Regional Study
Malcolm Wallace

South West Area Water Resources Development Project
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Frank Cooper, Senior Engineer
Syed Latif, Environmentalist

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S Hussain, Agro-Economist
K Mitra, Sociologist/Participation Specialist

FAP 20 Compartmentalisation Pilot Programme (CPP)
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Jean Louis Leterme, former Sociologist/Participation Specialist

FAP 6 North East Regional Study
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Mustafizur Rahman, Director
S.M.Shaheed, Ex Director
Abdul Wadud, Chief Scientific Officer
Majibur Rahman, Senior Scientific Officer
Mainuddin Ahmed, Senior Scientific Officer

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Md.Sirajul Islam, Scientist and Head Environmental Microbiology Laboratory
Md Jahangir Alam, Senior Research Officer

International Union for the Conservation of Nature and Natural Resources (IUCN)
Nargis Banu Joardar, Ecologist

International Center for Living Aquatic Resources Management (ICLARM)
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Bangladesh University of Engineering and Technology (BUET)
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Nazrul Islam, Professor of Botany

Jahangirnagar University
Anwarul Islam, Professor of Zoology

Bangladesh Agricultural University, Mymensingh
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Dr M Shahisul Haque, Professor, Department of Food Technology and Rural Industries

Bangladesh National Herbarium
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Md Oliur Rahman, Research Officer

Norwegian Embassy
Ryder Kvam, Country Boats Improvement Project

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Ian Tod, Flood Proofing Specialist

CONCERN
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Pradip Sanyal, Programme Manager
Donna Mooney, Technical Support Officer, Environmental Health

International Federation of Red Cross and Red Crescent Societies
Bob Storey, DPP Development Delegate

Centre for Women and Child Development
Azam Ali, Public Health Specialist
Afsana Wahab, Women and Child Development Specialist

CAPRe (Research Foundation assessing NGO Performance)
Jorge Barenstein

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Olena Reza, Research Officer

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Syed Akter Hussain, Managing Director
Alam, Laboratory Chief

Coastal Area Resource Development and Management Association (CARDMA)
Hasna Moudud, President

BIRTAN, Noakhali
Golam Kibria, Accountant
Abu Taher, Field Assistant

Remote Island Development Project
Shafiqual Alam, Project Co-ordinator, Char Montaz
Md Mahtaluddin, Field Worker, Char Montaz
Md Nasiruddin

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Mike Dapplyn, formerly Team Leader for FAP 12
Parvin Saltana, formerly Co-Team Leader for FAP 12
Paul Thompson, formerly Team Leader for FAP 13

ELECTED REPRESENTATIVES:

Sahid Talukder, Chairman, Char Montaz
Bibuti Bhusham Babu, Union Parishad Chairman, Kukri Mukri
Abdulqader, Union Parishad Secretary, Kukri Mukri
Wahab Khaliba, Trader, Char Bastin, Char Montaz
Atiqual Islam, Farmer, Char Laksmi
Md Zahidul, Fish Trader, Char Montaz
Md Salem, Bagda Fry Trader, Char Montaz
Abdul Roub Mocedah, Kukri Mukuri

Plus 112 people interviewed for the needs assessment and 990 people in 160 households interviewed for the socio-economic surveys

CONSTRUCTION IMPACT CHECKLIST FOR EMBANKMENT WORKS IN BANGLADESH

This checklist was drawn-up following an environmental audit of the Coastal Embankment Rehabilitation Project whilst it was under construction in September 1993. It can easily be adapted for other locations and types of construction programmes in Bangladesh.

1. Background Information:

Phase Number:
Section Name:
Construction Contract No
Name of Main Contractor:

2. Nature of the Works:

Total Length of Embankment in Contract:
Length to be Re-sectioned:
Length to be Retired:
Length to be Revetment:

Numbers of Households to be Resettled on each:

Number of Structures to be Built/Rebuilt:

3. Details of the Contract:

Total Contract Duration and Times:

Work Programme/Phasing: (mark locations up on map), Phased/Staggered?

Critical Programme Operations:
- -Priority Works
- -Seasonal Constraints (include monsoon flood risk)

Land Access Needs - areas and phasing:
- -Degree of Simultaneous Working

Nature and Degree of Supervising Engineers Control over the Contractor:

Existing Health and Safety Legislation:
- - Adequate? Appropriate? Enforceable? Enforced?

4. Construction Operations:

Land Access requirements/arrangements to site:
- -for site investigations
- -construction
  - -mobilisation date
  - -permanent works

-temporary works (e.g.borrow areas, workshop areas)
Negotiation/leasing Arrangements for Land:
Specific Difficulties Incurred:

Excavation/Stripping:
-Depths and areas:
-Plant/Techniques Used
-Manual Labour
-Bulldozer/Scraper
-Plough
-Tree/Scrub Removal: (problems with Forestry Department Cover?)

Fill:
-Materials
-Quantities
-Sources

Structures:
-Types
-Sizes
-Materials Required

Construction Technology:
-Labour Intensive, Mechanised or both

5. Construction Labour:

Maximum Number of Labourers to be Employed:
Skills Required:
Source of Labour:
Living Accommodation Arrangements:
Water Supply and Sanitation Arrangements:
Labour Health Checks:
-Infectious/transmitted diseases
Electricity Supply:
- Generators or mains?
Accident Emergency Facilities:
-First Aid Facilities
-Radio/Telephone Contact
-Emergency Medical Arrangements

6. Construction Plant and Machinery:

Types and Numbers of Plant to be used for what operations:
-Excavation - Excavators, Bulldozers, Scrapers, Tractors, Ploughs
-Fill Placement - Trucks, Tippers, Front-end Loaders, Graders
-Fill Compaction - Water Bowsers, Rollers
-Other Materials Transportation - Trucks, tippers, Low Loaders
-Materials Crushing Plants
-Concrete Batching Plants and Mixers
-Cranes
-Dewatering Pumps

Experience and Skills of operators:
Driver Training and Safety Awareness:
Workshops - Central Provision and/or Field Sites
Fabrication Yards - Location/Access, Materials, Equipment
Workshop, Stores and Fabrication Yards
-Pollution and Material Storage Hazards
Laboratories - locations, machinery, chemical storage/handling

7. Construction Materials and Sources:

Transportation Issues: volumes, distance, type of transport,
-Road -tipper trucks, size/volumes, routes, speeds, road access, bridge weight loadings, loading and unloading requirements
-Rail
-Boat

Fill Materials: -Specification, suitable sources
-Embankments -borrow pit strategy, locations, depths, extents, land acquisition and compensation arrangements, permanent or temporary acquisition? reinstatement? reuse as aquaculture ponds?
General Principals- all fill as far as possible from river side of embankment, distances, routes

Protection/Pitching:
-stone, sources, crushing and grading, where and how?
-concrete, what aggregate to be used? Where mixed/batched?
-aggregate, sources, types, sizes, volumes. Where Crushed
-gravel/shingle, sources, transport, handling, washing, grading, stockpiling
-sand, sources, handling, stockpiling, drying
-cement, sources, handling, bulk or bagged? silos?
-brick requirement- minimise as much as possible, problem of fuel wood requirement of this, however labour requirements for hand crushing have overall social and economic benefits

Geo-textiles: Use of local materials, imported geo-textiles now officially banned

Steel: Quality and Quantity Requirements, Types- Plate, bars etc
Sources, Transport/Handling, Fabrication, Erection

Formwork - materials used, reusable? Standard sizes
Gates - Fabrication/Erection- practices and procedures

8. Other Issues:

-Noise and dust pollution. Siting of crushing plants, prevailing wind direction, generator siting and operation
-Days and hours of work, night-time work, Friday work.
-Disturbance to residents
-Disruption of existing communications routes
-Demolition of old structures
-Reinstatement/Turfing after construction
-Dredging will require special consideration

9. Open Comments:

Supervising Engineers:

Contractors:

Local People:

10. Summary of Main Issues: