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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MEGHNA ESTUARY STUDY

DRAFT DEVELOPMENT PLAN

VOLUME 3 : PART 2
ENVIRONMENTAL IMPACT ASSESSMENT
NIJHUM DWIP INTEGRATED DEVELOPMENT PROJECT

September 1998

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
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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
AFPM	-	Active Flood Plain Management
ARTI	-	Acute Respiratory Tract Infection
BARC	-	Bangladesh Agricultural Research Council
BARI	-	Bangladesh Agricultural Research Institute
BBS	-	Bangladesh Bureau of Statistics
BCAS	-	Bangladesh Centre for Advanced Studies
Beel	-	Area of permanent or seasonal water away from a river (Bangla)
Bigha	-	Bengali unit of land area equal to 0.33 acre or 0.134ha
BIWTA	-	Bangladesh Inland Water Transport Authority
BRAC	-	Bangladesh Rural Advancement Committee, a national NGO
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
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)
DUS	-	Dwip Unnayan Songstha, an NGO working on Hatia island, literally translates as Island Development Organisation
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)
ICDDR,B	-	International Centre for Diarrhoeal Disease Research, Bangladesh
ICID	-	International Commission for Irrigation and Drainage
ICLARM	-	International Centre for Living Aquatic Resources Management
IEC's	-	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	-	metre
mm	-	millimetre
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
NRDP	-	Noakhali Rural Development Programme
NWMP	-	National Water Management Plan
PWD	-	Public Works Department
RAS	-	Research and Advisory Services, a research NGO
RDP	-	Rural Development Programme
RRA	-	Rapid Rural Appraisal
Sadar	-	Government Administrative designation for a town centre headquarters
SOB	-	Survey of Bangladesh
SRDI	-	Soil Resources Development Institute
SRP	-	Systems Rehabilitation Project
SWMC	-	Surface Water Modelling Centre, previously FAP 25
mt	-	metric tonne
Tk	-	Taka
Thana	-	Government administration unit between a Union and Zila, has been known in the past as an Upazila (Bangla word)
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
Zila	-	A government administration unit equivalent to a District which is above a Thana but below a Division.

SUMMARY

Aim and objectives of the environmental impact assessment (EIA)

The Nijhum Dwip 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 the Nijhum Dwip Feasibility Study.

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 overall 30 year intervention programme has been carried out. A detailed EIA has been carried out for the construction of one cross dam and an associated integrated rural development programme, assessing the likely impacts over a 15 year period.

Interventions

An outline of the proposed set of interventions is given in Section 2. The derived intervention philosophy is to construct just the one cross dam and then closely monitor the impacts for a five year period, before taking a decision about construction of a second cross dam. An integrated development programme has been drawn up which aims to use the newly accreted land in a sustainable manner.

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.

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. Using this information an appropriate set of interventions could be drawn up for the area, and also used for assessing impacts in with and without intervention conditions. The baseline data provides the framework to identify likely impacts due to the proposed intervention, assess their importance and then set up data collection programmes to allow quantification, valuation and also monitoring of Important Environmental Components (IEC's) and variables.

The main processes that have been identified are erosion and accretion patterns, with the primary risks and constraints being cyclones (causing loss of life and 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 no 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, but the area has one of the most favourable rural energy balances in the country.

A simple needs assessment was carried out in four different parts of the intervention area and including five social groups. A major conclusion is that by far the majority of people interviewed feel that creation of new land is the highest priority intervention. The major exceptions are land owning farmers who desire embankment construction for preventing saline inflow as a highest priority and land accretion as the second. There was also a significant request for the provision of income generation activities for women.

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 intervention have been identified using a comparative matrix technique as outlined in Section 5 and shown in Figures 20 and 21.

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

- accelerated land accretion
- the additional accreted land allows embankments to be built which will protect human life and allow more intensive agricultural land use.
- 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, especially on a per household basis. The quantification of impacts is given in Table V.9 and valuation of these, where possible, in Table V.10.

CONCLUSIONS

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 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.

The needs assessment indicates that accelerated land accretion is considered to be the highest priority intervention for all residents except for existing land holders in Southern Nijhum Dwip and the embanked part of South Hatia. The land holders group requested construction of an embankment to prevent saline water inflow as a first priority (despite the fact that one already exists in Southern Hatia, the problem is that in the recent past it has not been effective) and land accretion as a second priority.

For the proposed cross dam the main conclusion is:

- the main predicted benefit is land accretion, the rate due to the cross dam being over double 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 75,500 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 one cross dam these are not considered to be serious enough to prevent such a trial type of intervention being tested. However monitoring of these negative impacts would be required to allow quantification and valuation to take place and feed this information into the assessment of possible construction of a second cross dam at year five.

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 the channel 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 on Nijhum Dwip 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 the existing fisheries ghat on South Hatia;

- possible changes in human nutrition patterns and the risk of malaria;

- the disruption to the existing waterborne navigation through the channel;

- the improved access to Nijhum Dwip from Hatia using the cross dam 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 one cross dam and the associated integrated development project. A full appraisal of its impacts five years after construction should be carried out before consideration is given to constructing a second cross dam. 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 US$ 12 million for direct construction costs), that the first phase cross dam 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 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 negotiated arrangement for relocation of the fisheries ghat
- an evaluation of the impacts of the project on household livelihoods five years after the construction of the cross dam
- 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 and is given as Figure V.24.

1. PROJECT SETTING

1.1 Background

The Nijhum Dwip 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 V.1), with a planning horizon of 25 years and a phased intervention programme. In addition a Draft Development Plan for the immediate 0 to 5 and 5 to 10 year period will also be produced, which will identify the three 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 a Feasibility Study for the South Hatia Cross dams, in 1990 (Ref: Land Reclamation Project, 1990). 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 Nijhum Dwip 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 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.

A 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 (see Figure V.2 for its location and Plates 3 and 4). 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 intervention at Nijhum Dwip would appear to fall into Category D (Red) under item number 66 (Flood Control Dam, Polder, Dike 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 the Nijhum Dwip cross dam was drafted in May 1997, (prior to the Environmental Rules being made public), as the project was at that stage expected to be implemented as a priority trial under the MES. However it was eventually decided not to implement such a trial and the IEE was not submitted. In view of the recent changes in the legislation and following the WARPO EIA Procedures it has now been decided to produce a full EIA. This has used the May 1997 IEE as a basis, but with additional field data and sedimentation model outputs, along with more detailed knowledge of what the proposed intervention will actually entail.

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 and cross dam at Nijhum Dwip 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 advised.

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 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 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 Act 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 this 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.

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 partial 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.

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 area, working to a final reporting deadline of the end of June 1998. It was possible to collect data sets in September 1997 and December 1997 but none during the height of the dry season. Whilst it would have been desirable to have more dry season data for water and soil quality assessment, the lack of this has not been an impediment for selection of Important Environmental Components (IEC's) and impact analysis.

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 4.

2. THE PROPOSED INTERVENTION

2.1 Regional planning framework

The MES area forms the sixth regional study started under the Flood Action Plan. The area interfaces with the South West Regional Study (FAP 4) and the South East Regional Study (FAP 5), the boundaries of which are shown in Figure V.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.

The analysis of the erosion and accretion mapping indicates that the Nijhum Dwip area is one of the most consistent areas of continual accretion and displays a wide range of ages and stability of accreting land types. As such it would seem an ideal site for an accretion promotion trial and also the wider context of economic use of newly accreted land.

2.2 Previous studies

The LRP had already identified the possibilities for cross dam construction at Nijhum Dwip and carried out a Feasibility Study (Ref: Land Reclamation Project, December 1990). A major

conclusion 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 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 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.

The proposed intervention attempts to take the 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 justified.

2.3 Trial interventions

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 (by over 50 per cent in the case of a cross dam for accretion promotion) and hence make such interventions more cost effective.

The Nijhum Dwip area is a best case type situation where the natural accretion processes are well established and the proposed intervention reinforces these. It thus stands a higher chance of success than implementing such a trail in an area of less natural accretion or mixed accretion and erosion. Conversely it may be the case that accretion would have happened naturally without any intervention, but over a longer period. In such a situation the intervention may be harder to justify as you would be paying for a process that would have occurred naturally, although over a longer period of time. As part of the test area selection and location process it has been established that the low flow channel between Hatia and Nijhum Dwip (see Figure V.19) would never close up in the foreseeable future without some form of human intervention. The present low flow channel appears to bring in sediment from the west side of Hatia eastwards through the channel and then south down the east side of Nijhum Dwip Island. The channel itself has a stable cross-section area but could move location within the area between the islands.

An important preliminary conclusion justifying this type of trial is that the channel would not close up naturally and the sedimentation that is predicted to occur without intervention would be unstable as the low flow channel could move. This conclusion has implications for replicating such an intervention in other locations within the MES area.

2.4 Alternatives

The previous 1990 Feasibility Study looked at two cross dams to be built together. The presently proposed intervention is to build only the first cross dam between Hatia and Nijhum Dwip in year zero at the location shown in Figure V.2.1a. The second cross dam would only be built following detailed evaluation of the first dam five years after its construction. The EIA looks at the difference in accretion rates between a with and without intervention situation as a basis for environmental analysis, so that the benefits attributable to the intervention can be separated from those which would have occurred naturally.

The proposed intervention at Nijhum Dwip can also be seen as a trial for integrated land management on newly accreted areas.

Figure V.1: Location Map

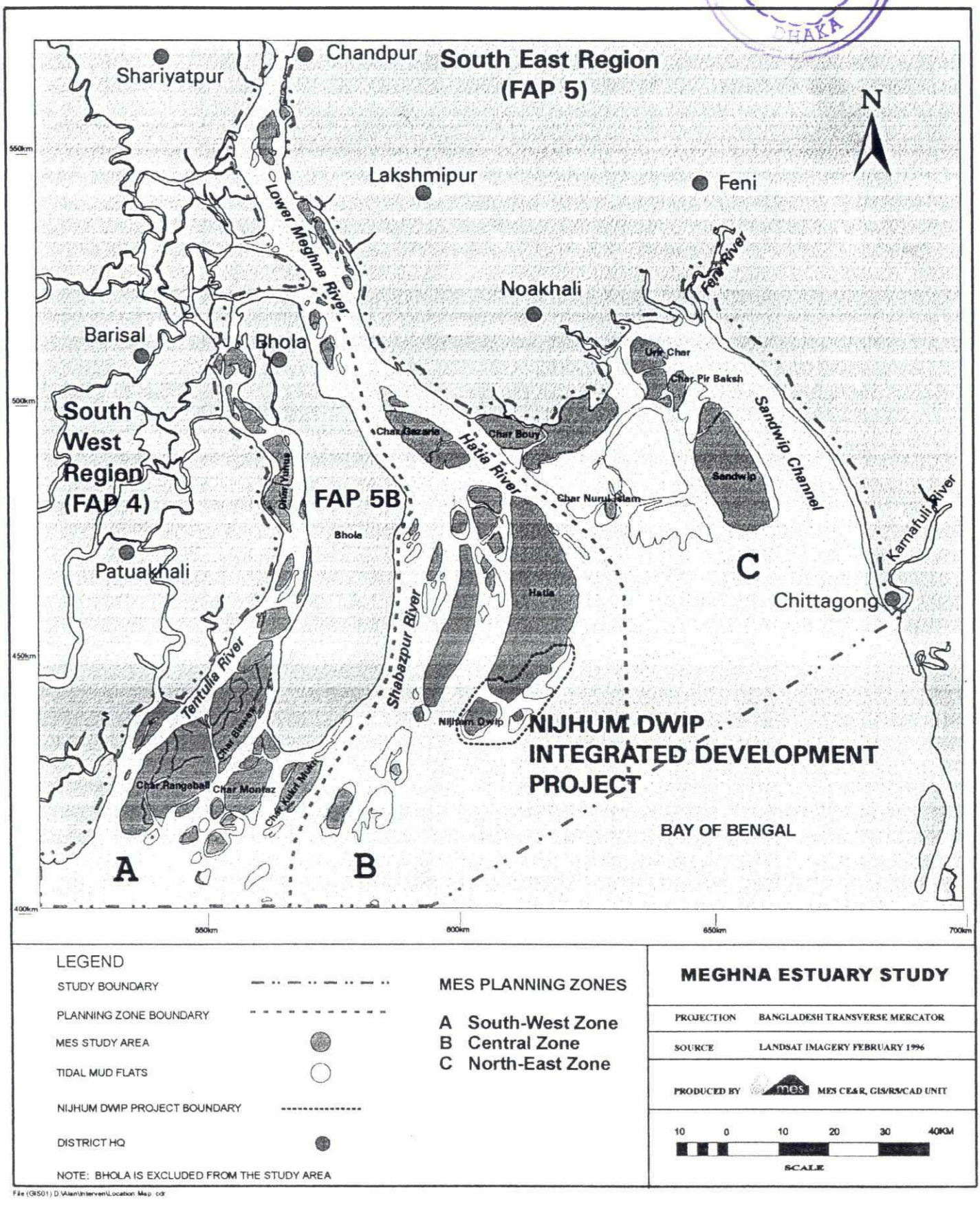
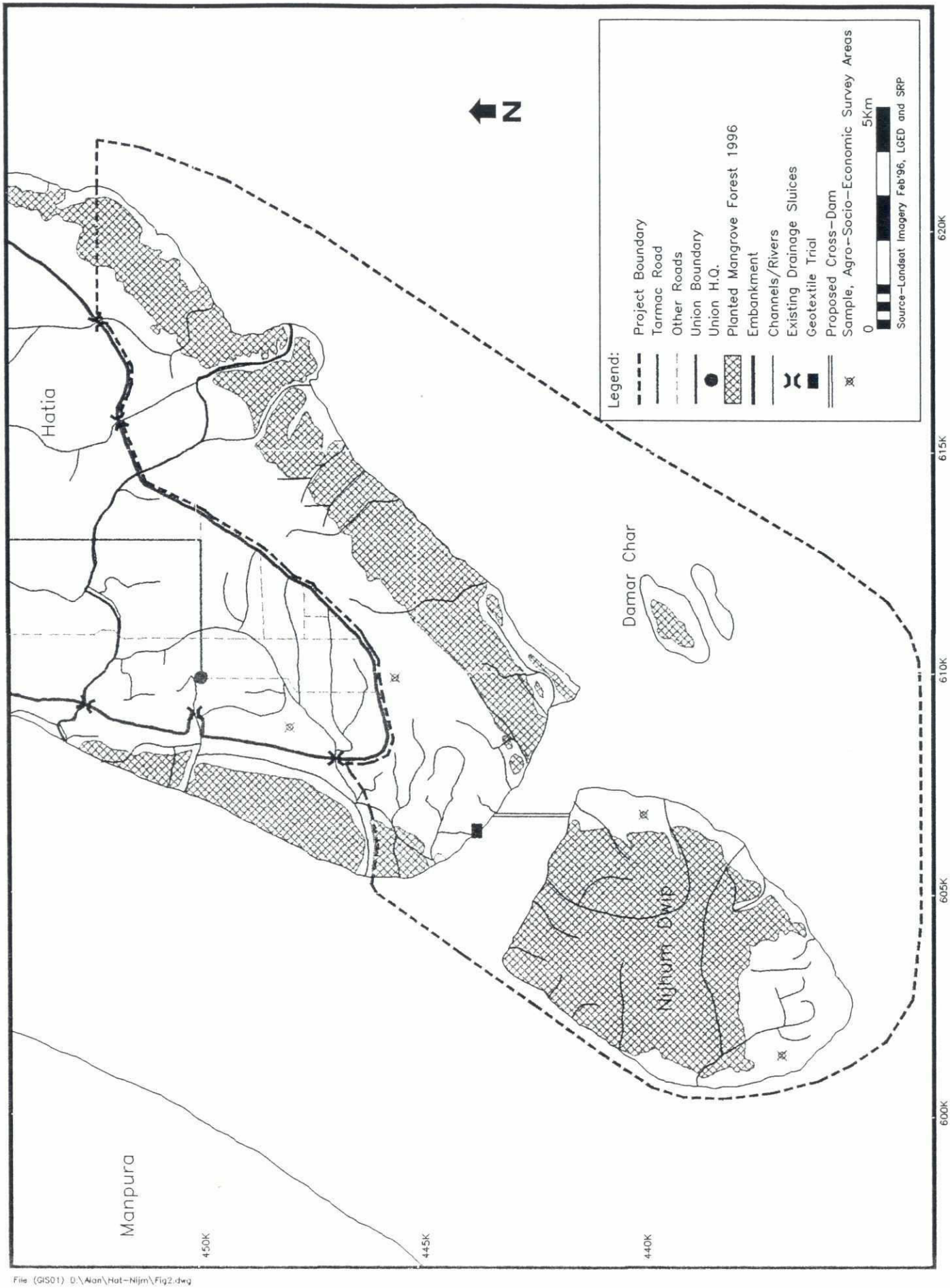


Figure V.2: Project Area Map



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2.5 The proposed intervention

The proposed set of interventions has been drawn up bearing in mind the results of the needs assessment for the area which sampled people's views by four different locations in the area and also by various social groups. The results of the needs assessment are given in Tables 17 and 18. Environmental considerations have also been incorporated into project design to minimise possible negative impacts and reduce the need for specific mitigation programmes. The nature and locations of the interventions are given in a series of maps in Figure V.2.1, also illustrating the implied land use that could be instigated, following the development philosophy for newly accreted land outlined in the MES Draft Master Plan. Option 1 is the without project situation, the present land configuration being given in Figure V.2 and the predicted future situation shown in Figure V.19. The situation for the initial incremental intervention of one cross dam constructed in year 0 is shown at year 5 in Figure V.2.1a, year 15 in Figure V.2.1b and year 30 in Figure V.2.1c. The situation of constructing a further cross dam in year 5, identified as Option 3, is given for year 15 in Figure V.2.1d and year 30 in Figure V.2.1e.

The range of incremental interventions that have been considered are:

Option 2, construction of one cross dam:

2a. Construction of a cross dam between South Hatia and Nijhum Dwip using 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 channel between the two islands.

2b. Construction of sea facing embankments (using design criteria from the CPP II project), on land that has reached an appropriate level (2.2m PWD) for all year farming, along with appropriate drainage infrastructure (drain excavation and water control structure construction, management and operation). The embankments would total 48.9 km in length and also act as multipurpose roads and possibly sites for linear settlements and social forestry activities. A further 12.5 km of other roads could be constructed.

2c. The implementation of an integrated management programme which puts the newly accreted land under productive economic use, based upon its level and location. This approach includes:

- The planting and sustainable management of forestry in areas outside embankments on land above 1.5m, with a minimum band of tree cover on the seaward side of any embankment of 1 km. The area available for planting would be 2,260 ha by year 15, 1,579 ha of which is attributable to the cross dam intervention. Cutting of forestry which is over 15 years old on land that has accreted to over 2.0m in order to turn the it 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 settlement of an additional 450 households in year 6/7, (over and above predicted without project human population increase), in 15 cluster settlements with the appropriate infrastructure (house construction, water supply, sanitation, school, aquaculture pond etc.). The programme would later be expanded to 780 households.

- 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 207 ha for fish and 27 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.

Table V.1 : Needs assessment of south Hatia and Nijhum Dwip Ranked by location

Positive intervention	Nijhum Dwip South Char Osman	Nijhum Dwip North-East Char Tila	South Hatia outside embankment	South Hatia inside embankment	Overall intervention ranking
A. Construction of a cyclone shelter	6	3	7	9	5
B. Construction of livestock Killa	12	12	12	12	12
C. Creation of more accreted land	1	1	1	1	1
D. Reduction in coastal erosion	10	10	9	3	9
E. Planting of mangrove forestry	8	7	4	7	7
F. Construction of an embankment to	2	2	2	2	2
reduce saline water inflow					
G. Construction of a drainage system	11	11	11	8	11
to reduce monsoon flooding					
H. Build new cluster settlements	4	6	3	4	3
I. Build new access roads	7	8	5	5	8
J. Provide safe drinking water supplies	9	9	10	11	10
K. Provide sanitation facilities	5	5	6	10	6
L. Build schools	13	13	13	13	13
M. Build health centres	3	4	8	6	4
Other suggestions:					
Provide postal service	*				
Create employment for women		*	*		
Develop cottage industry		*		*	
Credit for fishing			*	*	
Cold storage for fish				*	
Cross-dam to link Nijham Dwip				*	

Source: MES Field Surveys March 1997, 112 people interviewed

Notes: Ranking is 1 for highest priority to 13 for the lowest

* Suggested intervention by area

Table V.2 : Needs assessment of South Hatia and Nijhum Dwip ranked by social group

Possible intervention	Land owning farmers	Share cropping farmers	Landless Labourers	Full time fishermen	Women	Boat Operators	Overall intervention ranking
A. Construction of a cyclone shelter	6	4	5	4	10	7	5
B. Construction of livestock Killa	12	12	12	13	13	12	12
C. Creation of more accreted land	2	2	1	1	1	1	1
D. Reduction in coastal erosion	9	9	8	8	8	5	9
E. Planting of mangrove forestry	5	7	7	6	8	10	7
F. Construction of an embankment to	1	1	2	2	2	2	2
reduce saline water inflow							
G. Construction of a drainage system	11	10	11	11	12	11	11
to reduce monsoon flooding							
H. Build new cluster settlements	7	5	3	3	5	3	3
I. Build new access roads	4	8	9	9	6	8	8
J. Provide safe drinking water supplies	10	11	10	10	7	9	10
K. Provide sanitation facilities	8	5	6	7	3	6	6
L. Build schools	13	13	13	12	11	13	13
M. Build health centres	3	3	4	5	3	4	4
Others suggestions:							
Provide postal service	*	*					
Create employment for women					*		
Develop cottage industry					*		
Credit for fishing				*			
Cold storage for fish	*						
Cross-dam to link Nijham Dwip	*						

Source: MES Field Surveys March 1997, 112 people interviewed

Notes: Ranking is 1 for highest priority to 13 for the lowest

* Suggested intervention by social group

Option 3, construction of option 2 followed by a second cross dam in year 5:

Option 3. Construction of a second cross dam between Southern Hatia and Damar Char (see Figure V.2.1d for the location). This possibility would be reviewed at year five, following monitoring and evaluation of the first cross dam, and subject to a new Feasibility Study. There would also be an associated integrated land development programme based upon sustainable use of the additional accreted land. The second cross dam option allows a second sea facing embankment to be built and forestry cleared as shown in Figures 3d and 3e.

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. These have been calculated for levels 1.5m (the level at which forestry can be planted), 2.0m (the level at which seasonal cultivation can take) and 2.2m, the level at which the construction of embankments can be considered. The outputs are shown in Table V.1.19 and cover the scenarios of no dam construction, one cross dam at year zero and construction of one cross dam at year zero followed by the second cross dam at year five. The analysis is given for a 30 year period and shown as a series of maps in Figure V.19. 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 (450 households at year 6/7 with a maximum of 780 households over the life of the project).

It is also envisaged that there will be NGO promotion of income generating activities for women and NGO's 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 V.17.

The delineated Project Area for the Feasibility Study is given in Figure V.2 and includes the unembanked parts of southern Hatia and the offshore island of Nijhum Dwip plus the surrounding tidal mud flats. The delineation of impact areas is given in Section 5.3 below.

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 V.2.2) that was available when the studies commenced. The most detailed satellite imagery available for the area is French SPOT panchromatic data of December 1988 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.

The existing topography and bathymetry of the area are given in Figure V.2.5 compiled from the latest sources available. 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. However these 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 SRP work (Ref: Halcrow 1994, Polder 73/2) produced surveyed sections of the existing embankments on southern Hatia as well as land levels for drainage design all taken during 1994. These cross-section levels show that land levels inside the embankment are lower than those outside it, an indication that the embankment was built too early, before natural accretion had sufficient time to take place to 1m above mean sea level. This also partly explains the difficulty in draining some of the areas inside the existing embankments.

The bathymetry for the channel between Nijhum Dwip and Hatia islands was charted by the LRP in 1990 and later in 1993. In addition the LRP chart includes the 2.2m contour line for southern Hatia. All this data has been compiled onto Figure V.2.5 using PWD datum which is based on a datum of 1.17m at the BWDB Char Chenga gauge 1992 mean sea level reading. This datum is also known as Hatia Char Datum and, like the Sandwip levelling is not, as yet, tied to the national mapping datum. The nature of the low flow channel area at high tide is given in Plate 1 and a view across the western end of the channel between the two islands in Plate 2. The MES data collection programme has re-surveyed the channel in 1997 and the data is currently being compiled.

There are also significant historical maps of the area, the oldest of which would appear to be the Rennall'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 southern Hatia. However an island named Hatia is shown but it lies well to the north of present Hatia island in what is now the Ramgati mainland area. It is not known if the island was misnamed or it moved southwards to its present position. The Noakhali District Gazetteer of 1977 (Ref: Government of the People's Republic of Bangladesh, 1977) contains a map of the area compiled between 1883 and 1898 with revisions in 1913 and 1916 followed by additions of 1931. This map is shown as an overlay to the February 1996 Landsat image in Figure V.10. The implications for erosion and accretion trends are discussed in Section 3.1.5 below.

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

Climatic data for the Noakhali area has been collected for a considerable period of time, over 100 years. The seasonal variation in mean data for the period 1962 to 1989 is summarised for Hatia in Figure V.4. The most important parameter is rainfall and the mean monthly rainfall data for Hatia is shown in more detail in Figure V.3 and Table V.1.1. However the variation from year to year can be considerable and the differences in daily rainfall are critical in assessment of the drainage conditions in the area. Study of the daily rainfall records for 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. 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 Hatia Island using the BWDB gauge at Char Chenga, half way up the western side of the Island. Year round plots of this data have been analysed for 1988, 1991, 1994, 1995 and 1997 and sample outputs are given in Figures 8a-8c. These 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 monsoonal 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. The "normal" high tide would seem to reach a level of 2.0m PWD but peak tides of 3.0m PWD occur in many years during the months of March to June and September to October. However the highest peak levels are up to 3.5m in July/August when upstream river levels are highest.

Figure V.3 : Mean monthly rainfall at Hatia rainfall station (R-361) 1962-1996

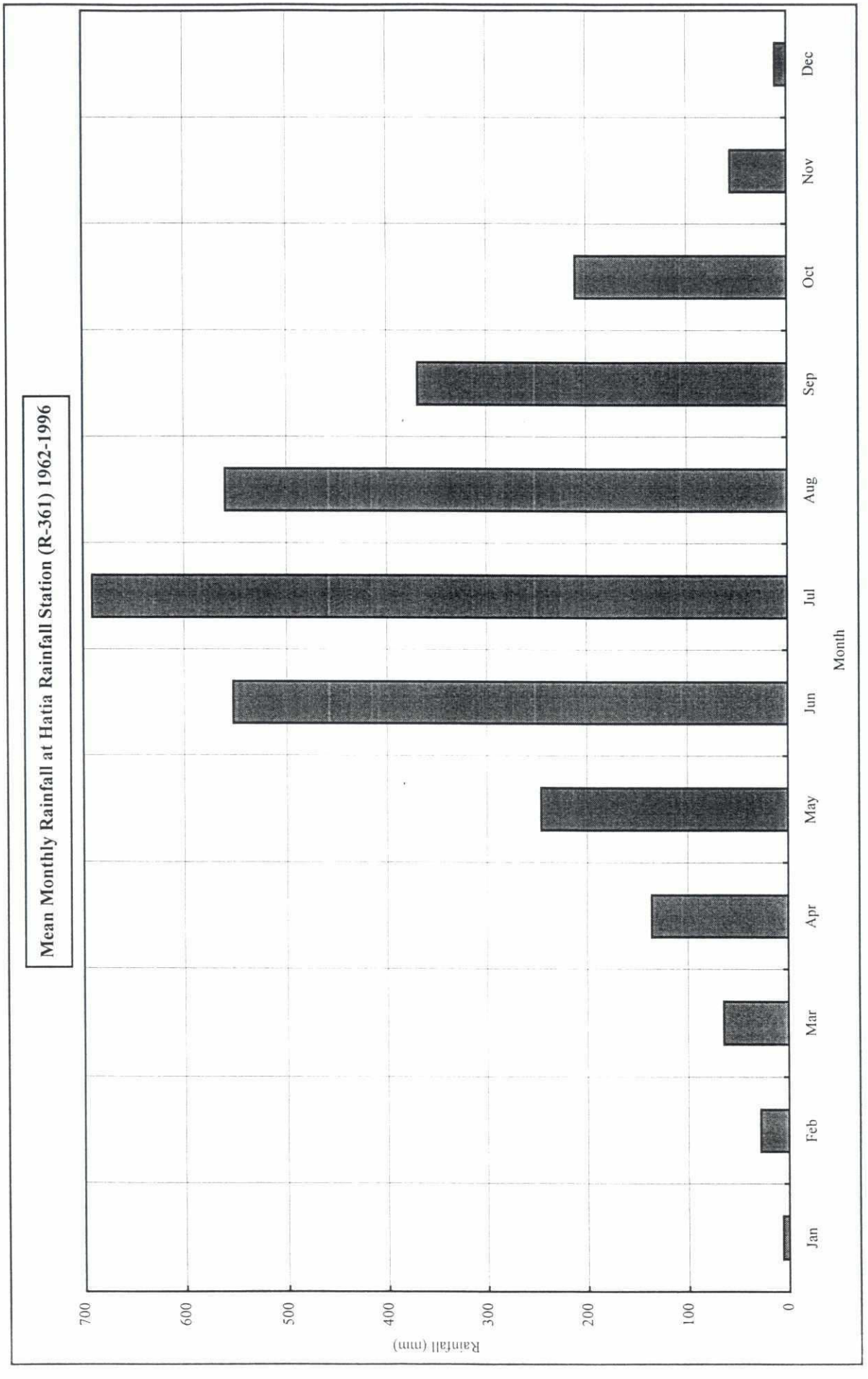
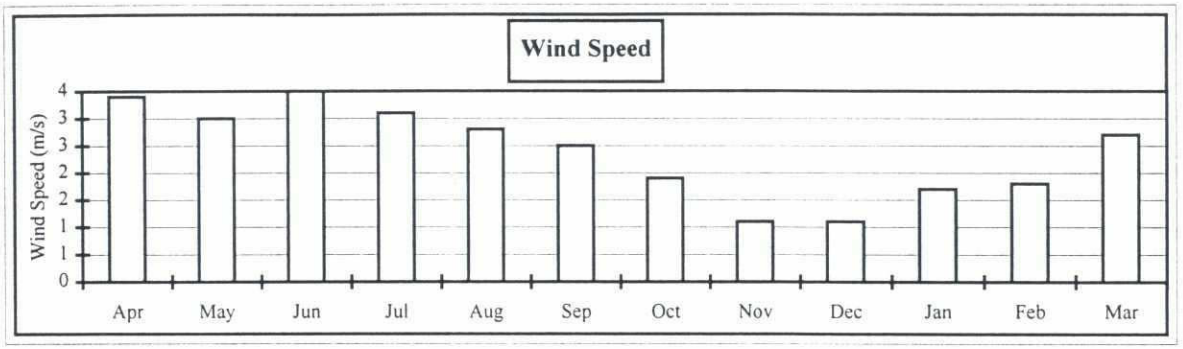
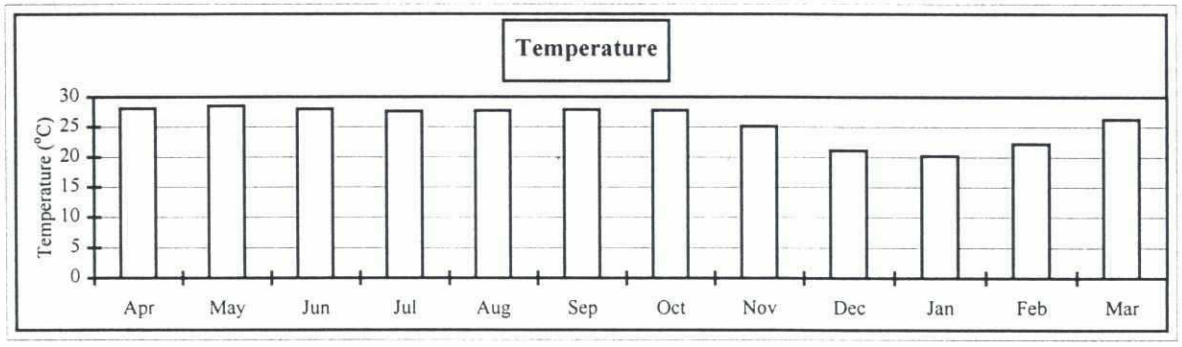
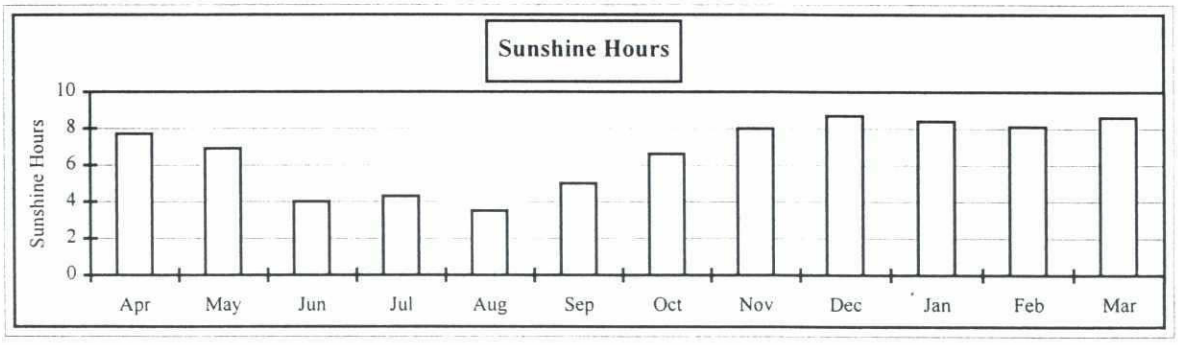
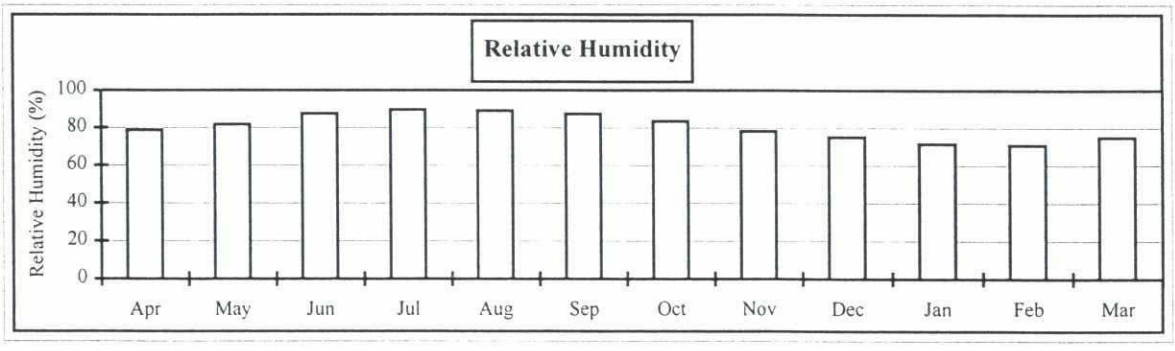


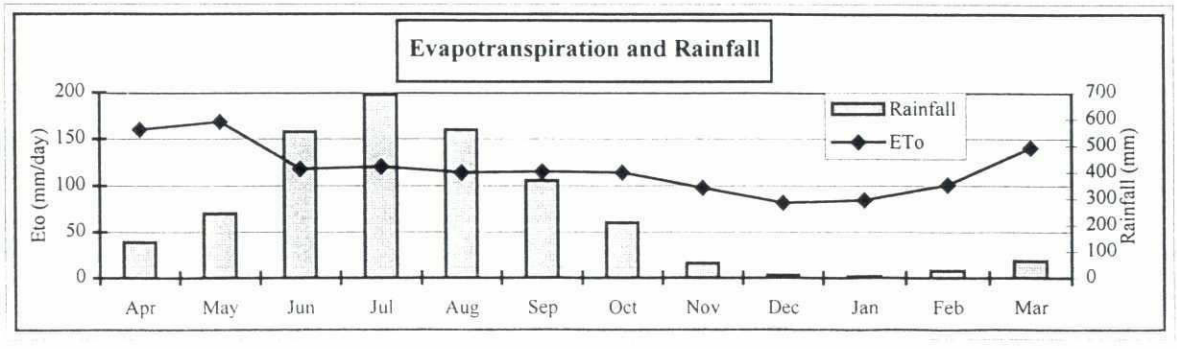
Figure V.4 : Climatic Norms at Hatia 1962-1989











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. The 18th May 1995 produced a peak level of 4.1m as it occurred at the height of a spring tide. A peak of 3.95m was recorded on 27th September 1997, even though this was 10 days after a spring tide. If it had occurred 10 days earlier it would have been 1.3m higher. However both of these times were outside the seasonal peak time of July and August, although evidence of the cyclone season developing earlier in the autumn should be cause for concern.

As part of the MES two automatic water level recorders have been set up in the Nijhum Dwip channel with data being collected from 26th January 1998. Unfortunately it has not yet been possible to directly correlate the level data from Char Chenga with that from Nijhum Dwip, but 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. The recent rehabilitation of the Southern Hatia area under the Systems Rehabilitation Project may have solved this problem to a greater extent. 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 South Hatia 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 Nijhum Dwip area is required. As part of the study, water samples were collected on two occasions at 10 points between 10th-12th September 1997 and also on 31st December 1997. The sampling locations are shown in Figure V.2.5 and the results in Table V.1.2. The sites include open surface water inside and outside the existing embankments as well as ponds and ground water. In addition there were two points previously sampled by SRDI during April 1994 were also sampled by the study. Plate 14 shows the location of one of these on the outside of the Hatia embankment on the main drainage channel from Jahajmara, a Union headquarters town. The most important parameter measured was electrical conductivity as an indicator of salinity. Study of the water levels (see Figure V.2.4) shows that there were probably saline intrusions around 20th August 1997 and relatively high water levels around 19th September 1997.

The conclusions of the data are that ground water salinity is considerably higher than surface water for the same period, although in December 1997 the values are lower than for September 1997 inside the embankment but higher outside it. The salinity values for open surface water inside the embankment during September 1997 were significantly lower than outside it (there was fresh water rainfall run-off at this time and presumably the rehabilitated embankment and water control structure were effective following SRP rehabilitation). The salinity values for open surface water outside the embankment are nearly all higher in December 1997 than in September 1997.

Inside the embankment the open surface water salinity was marginally lower in December 1997 than in September 1997. Pond water salinity levels were lower than open surface water during December 1997 and lower inside the embankment than outside it. The main shortcoming of the data set is that there is no peak dry season data (March would appear to be the best month), when salinity levels may be highest irrespective of water levels. However this could be influenced further by sea water levels as there was a high level in late March 1994 for instance. It is thus imperative that the water quality sampling be continued after the MES finishes. The sampling needs to be carried out in the same locations and initially for four times a year as part of the proposed environmental monitoring programme and interpretation of the results needs daily rainfall records for the area and also continuous water levels.

There are two SRDI surface water quality sample sites that were tested for salinity in early April 1994. These are shown in Figure V.12 and were on the outlets of the drainage system. The results are given in Table V.1.2 and indicate high salinity levels, however these SRDI samples appear to have been taken very soon after abnormally high water levels around 30th March 1994 (see Figure V.2.4b) and may not be representative of dry season conditions.

The main conclusions are that ground water can not be considered for irrigated agriculture and should be reserved for domestic use and even then the salinity levels may be problematic. The newly rehabilitated embankment in southern Hatia would seem to have made some improvement in open surface water salinity levels, although it remains to be seen how sustainable this will be.

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 ground water for domestic use is relatively great when compared to other parts of Bangladesh. The water quality sampling has included two ground water points, one inside the embankment on south Hatia and the other in a non embanked situation on Nijhum Dwip. The conclusions of the data are that ground water salinity is considerably higher than surface water for the same period, although in December 1997 the values are lower than for September 1997 inside the embankment but higher outside it. The main conclusions are that ground water can not be considered for irrigated agriculture and should be reserved for domestic use and even then the salinity levels may be problematic.

3.1.5 Land resources

Erosion and accretion

The broad picture for land erosion and accretion for Hatia Island between 1883 and 1996 can be seen in Figure V.10. The detailed picture between 1973 and 1996 can be seen in Figure V.11 with the six yearly steps between this. The broad conclusions are that the Nijhum Dwip area has been subject to considerable natural accretion in the last 23 years and a small amount of erosion in the north west corner and south western tip of Nijhum Dwip Island. Much of the accretion occurred in the period 1979 to 1984 with consolidation of these sediments taking place between 1984 and 1993. A further area of accretion is developing on the north eastern side of Nijhum Dwip Island and recent satellite imagery (November 1997 and March 1998) shows this is increasing but has not as yet started to consolidate.

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 V.1.12 and mapped in Figure V.2.15. It is predicted that the rate of accretion will be approximately

90 ha a year up to level +1.5m. An important conclusion is that the low flow channel between the islands is in equilibrium and is unlikely to close in the near future under natural conditions. The cross section area of the low flow channel has been relatively constant and is expected to remain so, although it could move its location. An important second conclusion is that the second cross dam will close the channel between Damar Char and Nijhum Dwip, a process which will not happen under natural conditions or with just the construction of the first cross dam. The closing of the channel between Damar Char and Nijhum Dwip would allow a second sea facing embankment to be constructed enclosing a significant additional area for cultivation without the risk of saline intrusion.

Soil

There is a considerable amount of SRDI published data for the Hatia area (Ref: SRDI, March 1995) although this does not include Nijhum Dwip Island itself. The SRDI data has been mapped as Figure V.2.8 showing the location of the samples and the three soil units, the soil chemistry results being summarised in Table V.1.3a. Some 17 surface soil chemistry samples were taken in the area by SRDI in April 1988 and analysed for 13 parameters. A series of 13 maps, one for each parameter has been made from this data to study the spatial variation relative to their rating given in Table V.1.4. A further 7 salinity samples were taken by SRDI in April 1994, including 2 water samples and soil samples at three depths, and the results of this analysis are summarised in Table V.1.4. The interpretation of the results is given below in conjunction with the data collected for the MES Feasibility Study.

As part of the LRP Feasibility Study a special component looked at soil salinity conditions in the area (Ref: LRP, November 1990). Unfortunately the date of collection of the soil samples is not given in the report, although the water samples were collected in mid to late December 1989. 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. In addition the locations of the soil samples are not mapped and it is thus impossible to interpret them in a meaningful way. The only conclusion that can be drawn from the results that are given is that soil salinity generally increases with depth and this is confirmation of the problems of capillary rise which appear to affect all newly accreted coastal soils in Bangladesh and are documented by LRP and CDSP.

There is some generalised work on soil salinity done for coastal areas of Bangladesh by BARC (Ref: Bangladesh Agricultural Research Council, 1990?), but this is not specific enough to the study area.

After reviewing the above data it was decided to take an additional set of soil samples as part of the Feasibility Study, particularly data for Nijhum Dwip which was not covered by SRDI. The locations of these 20 samples taken in the field between 10th and 12th September 1997 are shown in Figure V.2.5 and the results of the analysis of the eight parameters measured are given in Table V.1.3b. Seven of the soil sample sites were taken at the same places as the original SRDI work, with considerable assistance in the field from staff of SRDI. In addition two of the SRDI water sample sites were also replicated.

The data was plotted onto the set of maps for each parameter and matched with the SRDI results. The broad conclusions are:

- The September 1997 soil salinity data indicates that Ec values are significantly lower inside the existing South Hatia embankment than outside it and the values inside are also lower than the SRDI inside samples taken in April 1994. The conclusion would seem to be that the rehabilitated embankment, drainage provision and water management under SRP is more effective than it was, bearing in mind that there was a significant high water level around 21st August 1997. However it would still be worthwhile having a data set in peak salinity time of March, as the SRDI April 1994 data set my be symptomatic of a high water level around 30th March 1994.

- The SRDI soil salinity data indicates increasing salinity with depth in April 1994, a finding confirmed by the LRP published data set of 1990.

- The highest pH values in the newly accreted land of Nijhum Dwip and in September 1997 these were found to above recommended levels for agriculture. The lowest pH values were inside the embankment, although the longer established land outside the embankment at the tip of South Hatia also had levels that are acceptable for agriculture.

- The levels of organic matter in soil are generally low and not surprisingly lowest on the newer accreted land of Nijhum Dwip. However there are often higher levels of organic matter outside the embankment than inside it, particularly on seasonally flooded land which is covered in grasses and used for livestock grazing.

- Sodium and zinc levels are very low in all areas with no obvious difference inside and outside embankments or age of land. Sodium levels are high in all areas whilst there is greater variation with phosphorus and boron. Boron levels are uniformly low in on Nijhum Dwip island and inside the South Hatia embankment but high on the more longer established non embanked land of South Hatia.

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 a set of soil data is collected in March and also regular Ec measurements are taken at the same locations four times a year for at least the next five years.

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 (principally the Forestry Department officers living at Nijhum Dwip) to produce a listing for the study area. This listing is given as Table V.1.5. There is considerable planted mangrove cover in the area, (see the habitat map given as Figure V.2.9 and Plates 10, 12 and 13), 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 for the area, 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 Southern Hatia and Nijhum Dwip is given as Table V.1.6 with the habitats mapped in Figure V.2.9. The main internationally threatened species is the Gangetic Dolphin, however it is relatively common in the channel 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 were artificially introduced to Nijhum Dwip island during the mangrove planting programme as part of a policy to establish a conservation area there. However the subsequent deliberate setting up of a cluster village settlement programme in the area, subsequent to the 1970 cyclone, has 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 area is well recognised for its water bird populations and is specifically mentioned in the Asian Wetlands Directory, (Ref: Asian Wetlands Bureau). In addition bird counts have been made in the area since 1989 (Ref: Thompson and Johnson, 1996). It would seem that tidal mud flats are a major habitat (see Plate 11), and these areas are expanding all of the time as accretion continues.

3.2.3 Fish

A definitive listing of fish species found in the area is given as Table V.1.7, 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).

In addition a separate listings of fish species, numbers, lengths and weights are given in Table V.1.7b and Table V.1.7c. These are for those sampled from the low flow channel on the proposed cross dam alignment from three hours before low tide to the low tide time and also samples of off-shore fish catches taken in April 1997. The work of the assessment is illustrated in Plate 6.

A significant surprise was 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 1970 cyclone killed all but one family living on Nijhum Dwip, although the number of people previously living there is not know as it was not dis-aggregated in the BBS census data. The 1991 cyclone killed a significant number of people in the area although again this can not be accurately given as there is contradictory data and the numbers are not dis-aggregated from the total deaths occurring in all of Hatia Island (Ref: Sener Ingenieria y Sistemas SA, June 1996, Thana Overview Report). The estimate of human deaths for the whole of Hatia range from 2,956 to 8,331 and livestock deaths from 1,703 to 62,640. 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).

The high risk cyclone times are October/November and March/April and maps of their past tracks are given in 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 based upon the landfall location of past tracks has also been analysed, and whilst it would appear that the study area lies in the 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 the area is not embanked and the settlement is on the seaward side of the planted mangrove vegetation. The cluster village programme was responsible for settling people on the most vulnerable part of Nijhum Dwip possible. This is the southern edge of Nijhum Dwip Island which has no protective vegetation cover between the open sea and the settlement area.

Since the 1991 cyclone an extensive programme of cyclone shelter construction has been carried out. There are now four large concrete shelters on Nijhum Dwip (see Plate 16) although the cost of provision of these is high at $150 per person. Raised platforms for livestock have also been constructed (known as "Killas", see Plate 16) often turning the borrow pit produced into a pond for aquaculture (see Plate 9). There is a significant policy issue as to if any human settlement should be encouraged in such a risky place, and if so then if all new settlement should be located

on or behind a coastal embankment and/or adequate cyclone shelter provision be made, despite its cost.

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 time of storm surges relative to daily and lunar tidal conditions as well as annual flood cycles is critical in determining the degree of intrusion. In the past regular intrusion occurred both on unembanked land and also through the 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. The recent rehabilitation of the South Hatia embankment and drainage system may have significantly reduced the amount of intrusion in the last year.

3.3.3 Monsoon rainfall flooding

As part of the farming survey carried out in 1997, 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 three meters 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. A main cause of flooding in the past would seem to be the fact that the land levels inside the embankment are lower than those outside it, due to the fact that the embankment in south Hatia was 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 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 0.27m 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 dis-benefits due to global warming. The biggest problem is likely to occur in areas that have already been embanked with inadequately high earthworks. However 0.27m 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 area lies in a medium level risk seismic area when compared to the rest of Bangladesh. 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.

3.3.5 Insect pest attack

During the needs assessment and the farming survey it transpired that farmers perceived insect pest attack on standing crops to be the most important source of lost crops. The data from this work is hampered by being a relatively small sample size due to the need to spread it over four different type locations. However broad analysis indicates that the losses due to pest attack are 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 V.14 based upon the LGED Thana map, as the BBS Small Area Atlas was inadequately detailed (Ref: BBS, 1986-1995). The area considered to be covered by the Feasibility Study is the unembanked part of the southern Union of Hatia Island (Jahajmara Union) which includes Nijhum Dwip island and on Hatia Island is bounded in the north by a natural drainage channel. There are eight Mauzas in this area plus one (Char Bibiri) which is totally inside the embankment but the data for which has been included for comparative purposes. Some of the Mauzas are divided into Paras but the boundaries of these are not shown on the available mapping nor is the data consistently separated in both the 1981 and 1991 BBS data sets. The land areas in each Mauza were calculated by digitising the LGED Mauza boundaries as an overlay to the February 1996 Landsat image as the BBS acreages were obviously inconsistent. The total land area of Nijhum Dwip Island is approximately 3,400 ha and the part of the Union on Hatia Island is approximately 7,600 ha making a total area of some 11,000 ha, although this must be recognised as being very dynamic. 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 V.3 and V.4. The densities were calculated using digitised areas from the Landsat image and LGED map. Predicted human populations are given in Table V.3 using two alternative techniques.

The key BBS parameters given in Tables V.3 and V.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 V.3. There are some obvious errors in this, but in general it cross checks well to the MES socio-economic household survey data taken for 160 households in Nijhum Dwip. Interpretation of the 1981 data indicates that the highest densities were inside the embankment on south Hatia with some 670 people per km^2. The lowest densities were outside the embankment on Hatia and Nijhum Dwip where some 100 per km^2 per living in the non forested areas. In the period 1981 to 1991 the average population density increased by 48 per cent, a significant proportion of this being in-migration to Char Osman in South Nijhum Dwip where the population increased six fold to 650 people per km2 when taking only the non-forested land area. The areas outside the embankment on south Hatia had greater increases than those inside it, with the exception of one Mauza. Overall the Union has a human population density of accessible land of 580 people per km^2.

There has been a slight reduction in mean household size over the ten year period, but this is not as great as the national average fall. The 1991 data indicates that mean household size was 5.4 people, however there is a significant obvious error in the data for one Mauza. The MES socio-economic household survey found the average household size in the sampled area to be larger than this, however this may be due to sampling and the fact that the location of the sample was restricted to Char Osman. The definition of a household is also inconsistent in the BBS data from 1981 to 1991 as the concept of a dwelling unit was used.

Table V.3 : **BBS demographic data 1981 and 1991 by Mauza**

District	Thana	Union	Mauza	BBS Code	Mapped area ha	Human population 1981	Population density 1981 per Km2	Human population 1991	Population density 1991 per Km2	Change in Pop density 1981-1991 %	Population growth 1981-1991 %	Estimated population 1996-note 3	Estimated population 1996-note 4	Households 1981	Mean households size 1981	Households 1991	Mean households size 1991	% Change in mean hh size 81-91
Noakhali	Hatiya	Jahajmara	Char Birbiri	7.54E+08	775	2363	305	4999	645	212	7.78	7271	6539	396	5.97	864	5.79	-3
Noakhali	Hatiya	Jahajmara	Char Hare	7.54E+08	297	1957	659	2283	769	17	1.55	2466	2986	346	5.66	416	5.49	-3
Noakhali	Hatiya	Jahajmara	Char Mcpharson	7.54E+08	799	2743	343	3535	442	29	2.57	4013	4624	514	5.34	763	4.63	-13
Noakhali	Hatiya	Jahajmara	Char Osman	7.54E+08	670	721	108	4372	653	605	19.75	10766	5719	99	7.28	855	5.11	-30
Noakhali	Hatiya	Jahajmara	Jahajmara	7.54E+08	953	6464	678	8008	840	24	2.17	8913	10475	1154	5.60	1444	5.55	-1
Noakhali	Hatiya	Jahajmara	Mohammadpur	7.54E+08	470	3194	680	4251	904	33	2.90	4904	5560	553	5.78	769	5.53	-4
Noakhali	Hatiya	Jahajmara	Muktaria	7.54E+08	257	181	70	295	115	64	5.01	377	386	10	18.10	79	3.73	-485
Noakhali	Hatiya	Jahajmara	Nutan Sukhchar	7.54E+08	687	1912	278	3030	441	59	4.71	3814	3963	388	4.93	533	5.68	15
Noakhali	Hatiya	Jahajmara	Purba Birbiri	7.54E+08	798	2857	358	2362	296	-17	-1.88	2148	3090	478	5.98	427	5.53	-8
Total		Jahajmara			5706	22392	392	33135	581	48	4.00	44672	43342	3938	5.69	6150	5.39	-5
Total project area					2706	7578	280	479	171	171	5.52	20601	16960	1322	5.73	2457	5.28	-8

Source: BBS 1985 and 1992

Notes:

1. Order and spelling are according to 1991 BBS Census
2. The area of Char Osman is the cleared and cultivated area, i.e. not including the forested area
3. Projection of population based on individual Mauza growth rates 1981-1991.
4. Projection of population based on average project area growth 1981-1991.
5. The Project Area comprises Char Osman, Muktaria, Nutan Sukhchar plus the unembanked parts of Char Mcpharson (30%), Mohammadpur (59%) and Purba Birbiri (72%)

3.4.3 Settlement pattern and history

The 1776 Rennall's map shows no land in existence in southern Hatia at this time. According to the 1883 map that was revised in 1913/14 and amended in 1931 there was no land in existence at Nijhum Dwip and the present Union headquarters area at Jahajmara was an island much like Nijhum Dwip is now (see Figure V.10). It would appear that major land accretion in the area occurred during the 1950's but this is not mapped. The accretion patterns from 1973 have already been outlined above. Land stabilisation appears to have been greatly enhanced by the mangrove planting programme under the Forest Department.

The area appears to have been settled by in-migrants from northern Hatia many of whom had lost their land due to main river erosion (see Table V.1.10b). It is recorded that everybody except one family were killed in the 1970 cyclone, however the number of people living there at that time is not known. A major planned settlement programme on Nijhum Dwip Island was initiated from 1977 onwards up to 1989. In-migrants (mainly selected freedom fighters who were also erosion displacees), were given 2 acre agricultural land allocations and a basic house in one of seven purpose built cluster settlements catering for 422 households (Ref: Ministry of Land, 1996). However it would appear that there has been significant follow-on in-migration resulting in some 33 per cent of the present households being functionally landless whereas the rest still have their 2 acre plots. This has resulted in an unusually stratified land holding pattern as shown in Table V.1.10a which has been compiled from the MES household socio-economic survey.

The present settlement pattern of the area is indicated in Figure V.2.11, with most homesteads being inside the embankment on south Hatia, with the exception of the seven square clusters on Nijhum Dwip at Char Osman. There are however large isolated single homestead clusters on South Hatia outside the embankment as shown in Plate 15.

A major issue is the procedure for land allocation, both for homesteads and agricultural land. The Ministry of Land is the statutory body responsible for land allocation, although this power is devolved 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 Nijhum Dwip area does not at present have the additional problems of unscrupulous land occupation by influential people found in the CDSP area.

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 four locations in the area. The conclusions of the needs assessment found significant differences in priorities between women and men. For women the need for better health service provision was a very high priority, along with the need to provide closer safe drinking water access and sanitation facilities. In addition there was a call from women for improving transport links with Hatia Island which presently requires a major boat journey. The reason for this would appear to be that many women originate from Northern Hatia and have been married out of their families with whom they wish to maintain close links. Conversely the construction of more cyclone shelters was rated as a low priority by the women respondents. Irrespective of these significant issues, the highest priority given by women was for provision of more agricultural land.

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 V.4. The overall level of provision has risen from 36 per cent of households in 1981 to 54 per cent in 1991. However there are areas where provision levels have fallen, mainly in areas of significant in-migration where provision has not kept pace with population growth.

Table V.4 : BBS key data for Mauzas in South Hatia

District	Thana	Union	Mauza	BBS Code	% hh owning land 1981	% DU owning land 1991	Change in % land owning 1981-1991	% POP age 10-29 in cultiv 1981	% POP over 10 in AG 1991	Change in % POP in AG 1981-1991	Literacy rate (7 yrs) 1981	Literacy rate (7 yrs) 1991	Change in literacy 1981-1991	% hh with POT water 1981	% DU safe drinking water 1991	Change in safe water 1981-1991	% DU with sanitation 1991
Noakhali	Hatiya	Jahajmara	Char Birbiri	753657142	51	49	-2	14	66	52	7	17	10	46	56	10	2
Noakhali	Hatiya	Jahajmara	Char Hare	753657227	32	17	-15	24	55	31	14	15	1	40	80	40	1
Noakhali	Hatiya	Jahajmara	Char Mcpharson	753657426	37	35	-2	20	42	22	6	17	11	65	59	-6	0
Noakhali	Hatiya	Jahajmara	Char Osman	753657430	36	46	10	13	66	53	22	8	-14	74	49	-25	0
Noakhali	Hatiya	Jahajmara	Jahajmara	753657682	40	37	-3	15	47	32	15	21	6	38	42	4	1
Noakhali	Hatiya	Jahajmara	Mohammadpur	753657761	39	37	-2	25	45	20	7	17	10	39	53	14	0
Noakhali	Hatiya	Jahajmara	Muktaria	753657767	60	5	-55	12	32	20	8	7	-1	0	18	18	0
Noakhali	Hatiya	Jahajmara	Nutan Sukhchar	753657909	11	26	15	15	37	22	3	8	5	9	79	70	1
Noakhali	Hatiya	Jahajmara	Purba Birbiri	753657928	42	38	-4	17	53	36	8	14	6	19	38	19	2
Total		**Jahajmara**			37	37	0	18	52	34	10	16	6	38	54	16	1

Source: BBS 1985 and 1992

Notes:
1. Order and spelling are according to 1991 BBS Census
2. The definition of a household and a dwelling unit is different!

This situation is particularly acute in Char Osman where the previously high level of provision provided by the settlement project has not been expanded and has actually declined in absolute terms as some of the hand pumps have failed. There seems to be uncertainty as to if the reason for this is mechanical failure of the pump or falling in artesian pressure which has rendered the pump unable to extract the deep tubewell aquifer. The result is that women are forced to walk long distances to obtain safe drinking water and in some cases human health is being severely 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 Hatia has been obtained for the period 1992 to December 1996, entered into a database and analysed. This is shown for 12 diseases in Table V.1.11 with a summary by year in Table V.5. The data is shown graphically for the six most important diseases over the full five year period in Figure V.16. Care has to be taken when interpreting this data as it is biased towards the urban location and records only those who visited the Health Centre. In many ways the unreported disease cases from remote areas are probably the most important! 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 followed by skin diseases and separate detailed graphs for the incidence of these over time are given in Figure V.17. However there are significant seasonal variations in diarrhoeal disease outbreaks with high levels in May of most years and a particularly severe one occurring in May 1995. This date correlates with high flooding patterns following a storm surge on the 17th May 1995. 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 October 1993 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. Like the diarrhoeal disease data, there is a marked increase in occurrence after the floods of mid May 1995.

The provision of sanitation facilities according to the 1991 BBS census is shown in Table V.4. The level of provision 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.

Field work at Nijhum Dwip indicated that malaria was being reported as a significant problem. A fever and malaria survey was carried out and the results are shown in Table V.1.10. 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 50 households sampled, 48 reported fever outbreaks in the previous year and 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 both in the wet period (August/September) and the dry (February/March). It could be the case that some of the fever is linked to dysentery. However there seems little doubt that malaria is prevalent in the area, probably vivax carried by culex mosquitoes as the nearby forest cover provides a suitable habitat. The incidence of fever is also probably related to flooding, the peak month being given as March when conditions are driest and disease vectors tend to be concentrated. hydrological data is needed before any correlation can be established.

Overall there is a feeling that the existing health service provision for the area is inadequate and the there were demands, particularly from women, for this to be improved as a very high priority, especially on Nijhum Dwip Island.

Table V.5 : Summary of reported disease incidence for Hatia thana 1992/1996

Year	Diarr	Worms	Peptec Ulcer	Arti	Skin disease	Poor nutrition	Anemia	Asthma	Eye disease	Ear disease	Dental disease	OBS & Gyne
Monthly Mean 1992	1553	1451	721	612	574	397	535	171	260	246	239	154
Monthly Mean 1993 (pro-rata)	1378	1098	704	638	1631	376	462	231	284	215	192	94
Monthly Mean 1994	1620	800	601	758	1840	294	503	224	301	180	191	77
Monthly Mean 1995	1631	755	428	715	1159	305	401	164	142	121	159	27
Monthly Mean 1996	1107	703	425	621	1004	278	425	218	166	153	147	28
Monthly Mean 1992/1996	1465	949	564	671	1206	326	465	199	226	180	185	74
Total 1992	18634	17411	8647	7342	6893	4761	6415	2046	3124	2949	2867	1850
Total 1993 (pro-rata)	16536	13176	8448	7656	19572	4512	5544	2772	3408	2580	2304	1128
Total 1994	19440	9596	7210	9091	22077	3526	6032	2690	3608	2163	2291	924
Total 1995	19577	9061	5140	8583	13912	3658	4817	1972	1700	1448	1911	322
Total 1996	13284	8434	5102	7449	12047	3338	5102	2610	1996	1840	1762	331
Mean Annual Total 1992/6	17583	11387	6770	8058	14476	3910	5585	2387	2710	2161	2221	891

Source: Hatia Thana Health Complex March 1997

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 V.1.8). The results of the nutrition survey are given in Table V.1.11 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 households have inadequate food intake, by far the majority eat regularly and have high intakes of protein from fish. The biggest constraint to the data is that it recorded the number of times people ate, not the actual quantity of food. Only a highly detailed specific nutrition survey can give this data and it would be required for an adequate sample size sampled every two months over a twelve month period.

The best consumption data that presently exists is from the fisheries assessment. The per capita consumption of fish in the area is estimated to be 66 grams per day, which compares well with a minimum protein requirement of 45 grams per day, and a consumption level of all protein of 40 grams per day in all Bangladesh, 27 grams per 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 higher 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 V.4. Overall the literacy rate increased from 10 per cent to 16 per cent in the ten year period. However this hides a decline in Char Osman from 22 per cent to 8 per cent probably brought about by the recent influx of poorly educated erosion victim in-migrants. The provision of school places has probably not kept pace with this in-migration. The overall literacy rates for the area are low, even by national standards. However recently targeted programmes at primary level appear to be successful and school entrance rates, particularly for girls have been increasing. 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. The real problem in provision lies in the lack of secondary education facilities and many students have to leave the area to find this, many of whom may never return.

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 area does have a very unique landscape. The name Nijhum Dwip in the Bangla language means quiet or silent place and this is certainly the case, a rare situation even in rural Bangladesh. Away from the cyclone periods the areas has a unique tranquillity as is aesthetically restful, as despite the land being flat the planted vegetation provides variety and orientation. Due to the very 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 a remote area and producing low levels of cash income the South Hatia area is not one of the poorer parts of Bangladesh. Its general socio-economic level is such that it is not identified as an area for inclusion in the IFADEP work and the Human Development Index (HDI) places Noakhali District at position 14 out of 60 (i.e. within the top 25 per cent of the country's Districts), although the data inevitably set hides severe inequality within the district. 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 of course 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 embankment on Hatia island. 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 produced a very favourable rural energy balance.

In addition there is widespread catching of "free good" fish. The sample survey work in Nijhum Dwip indicates that some 74 per cent of households catch open water fish at some time (a further 19 per cent are involved in aquaculture), of which 13 per cent catch only for direct self consumption. Of the remaining 61 per cent of the Nijhum Dwip sampled households 51 per cent are dependant upon fisheries as their main source of cash income and also directly consume fish that they catch. The remaining 10 per cent have catch fish for sale but have another economic activity which is more important than fishing. The abundant availability of "free good" fish is the major reason why levels of human nutrition are so good in the area.

3.5.2 Agriculture

According to the BBS census data (see Table V.4) some 37 per cent of the households in the area own agricultural land. This figure was the same in 1981 and 1991. However there is significant spatial variation in this figure, with one very low figure for 1981 in a Mauza which lies outside the embankment in South Hatia. The trend on Hatia between 1981 and 1991 is for the figure to fall slightly, with the exception of one Mauza outside the embankment where it has increased significantly. On Nijhum Dwip it has also risen significantly, perhaps as the settlement project land is subdivided and may be (illegally) sold as the allocated plot sizes are large in comparison to the normal size for Bangladesh. Traded land values in south Hatia are some 30 per cent to 40 per cent higher inside the embankment than outside it.

From the 1981 BBS data (see Table V.4), it can be seen that only 18 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. However by 1991 the proportion had risen to 52 per cent although there are considerable variations across the area, the lowest being 32 per cent outside the embankment on Hatia south where the professional offshore fishing communities are based. Some 24 per cent of the households sampled in the 1996/7 MES survey at Nijhum Dwip have agriculture as their primary economic occupation, this compares with 66 per cent of people over the age of 10 in the BBS data in 1991. However a significant additional 40 per cent of the Nijhum Dwip households recorded having agriculture as their second occupation in the MES survey at Nijhum Dwip. 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 Nijhum Dwip is surprisingly low, perhaps a reflection of the fact that there is little cash around and most households will use family labour rather than hiring in land.

The total agricultural production and the amount sold for cash as recorded in the 160 sample households in Nijhum Dwip is given in Table V.6a, split by the four different areas. A significant conclusion is that 79 per cent of crops by weight are directly consumed and only 21 per cent is sold for cash which brings in only Tk 3,019 per year. The conclusions split by location confirm the results of the Char Osman data collected from the detailed household survey, with the area having 81 per cent of its agricultural production directly consumed. Other places have lower proportions

of crops being directly consumed, the lowest being Bandar Tila at 52 per cent, although care needs to be taken with the data as the sample sizes were small. The differences in production split by land holding size are given in Table V.6b. From this data it can be seen that functionally landless families work significant land areas (either by renting or share cropping) and these are larger per household than marginal farming households. Similarly small farmers on average work larger land areas per household than medium sized agricultural land owners.

Data on crop losses by location, crop type and cause of loss were also collected and a significant conclusion is that loss due to insect pests is the most significant. A schematic cropping pattern for the area is given as Figure V.2.14, 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.

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 V.2 and the 1996 satellite image in Figure V.2.2. 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 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 dissipated 2m 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 2m 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 area have been measured:

- South West Hatia = 775 ha
- South East Hatia = 1,360 ha
- Nijhum Dwip Island = 2,340 ha.

However, this well intentioned planting programme 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 Nijhum Dwip 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 Nijhum Dwip have indicated that the required minimum land level to do this in the area is +1.5m, 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 or replanting at 16 years.

Table V.6a : Agricultural production by location 1996-97

Area	Mean gross cultivated area per farm hh (ha)	Mean net cropped area per farm hh (ha)	Mean crop production per farm hh (Kg)	Mean production consumed per farm hh (Kg)	Mean production sold out per farm hh (Kg)	Mean farm income per hh (Tk)
Char Osman	1.92	2.59	1457	1175 (81%)	363	1953
Bandartila	0.39	0.41	66	34 (52%)	32	490
Char Hare	1.85	3.24	2344	1835 (78%)	509	5134
Char Mcpharson	2.14	2.50	2050	1584 (77%)	467	3310
Total	1.82	2.54	1725	1357 (79%)	400	3019

Source: MES Field Surveys 1997, sample size 57 farming hh.

Note: Cropped area includes multiple cropping of the same land.

Table V.6b : Agricultural production by agricultural land holding size, 1996-97

Land holding category	Mean gross cultivated area per farm hh (ha)	Mean net cropped area per farm hh (ha)	Mean crop production per farm hh (Kg)	Mean production consumed per farm hh (Kg)	Mean production sold out per farm hh (Kg)	Mean farm income per hh (Tk)
Landless	1.58	2.35	1299	1049 (81%)	379	1485
Marginal	0.48	0.60	363	303 (84%)	60	1917
Small	2.10	2.90	2101	1539 (73%)	561	3556
Medium	1.81	2.45	1878	1634 (86%)	254	3105
Large	3.39	4.74	2938	2213 (75%)	725	7196
Total	1.82	2.54	1725	1357 (79%)	400	3019

Source: MES Field Surveys 1997

Note: Land holding size is area of agricultural land owned by each farm hh, grouped into UNDP classification.

Land areas included worked land not owned by the farming hh.

Cropped area includes multiple cropping of the same land.

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 +2.2m 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 1.5m is kept on its seaward side.

The practical implementation of such a strategy at different times is given in the series of maps in Figure V.2.1, along with numbered locations of specific areas for the first five year programme in Figure V.2.1a.

During the first five years up to 3,800 ha of land could be considered for forestry planting in the area. However to achieve this programme approximately 400 ha of mangrove that is past maturity would need to be cut in the stabilised centre of Nijhum Dwip so that it could be turned over to agriculture and allocated to households presently farming the vulnerable newly accreted land at the tip of the island which should then be planted. 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 dam in place. The phasing for the programme is given in Figure V.24 and for the period up to year five an indication given below as to the degree of dependency upon the proposed cross dam intervention:

- planting of areas 2 and 3 can be carried out immediately irrespective of the construction of the cross dam;

- planting of area 4 can be carried out irrespective of the cross dam and has a high priority as well as social and economic benefits, but areas 8 and 9 will need to be cut first to provide equivalent replacement agricultural land.

The forestry programme would be reviewed during the Feasibility Study for Cross Dam 2 during year five and suitably modified.

3.5.4 Livestock

The existing numbers of livestock in the area are high by Bangladesh standards, the 1991 estimates to Mauza level collected by the Cyclone Shelter Project give totals of 13,000 cattle and buffaloes and 9,400 goats and sheep for the southern union of Hatia. There is extensive free grazing land in the area, particularly in areas outside the embankment where only one crop a year is grown, although some of the grassland is of poor quality due to saline intrusion. 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 ground water sources. The returns at household level for livestock on Nijhum Dwip are given in Table V.1.8c. The mean household returns to livestock are similar to 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 Hatia Thana 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 Nijhum Dwip. 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 V.7 and the returns from fishing per household in Table V.1.8c. From this data it can be seen that marine fishing is by far the most important source of cash income in the area (roughly 70 per cent of all household cash income) and some 69 per cent of households list fishing as their main economic activity.

Table V.7a : Fisheries in Nijhum Dwip

Category	Annual Production (t)	Proportion of total production (%)
Aquaculture	136	0.7
Inland Capture	254	1.4
In-Shore Marine	8125	43.6
Off-Shore Marine	10125	54.3
Total	**18640**	**100**

Source: MES 1997

Table V.7b : Fishing households in Nijhum Dwip

Category	1984/85 DoF	1997 MES
Total Population	721	6035
Households	99	1181
Fishing Households	81	815
% Fishing Households	82%	69%

Source: MES 1997

There are however serious constraints to development, 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 at Nijhum Dwip, including the lack of storage facilities and credit which allows the trade to be dominated by exploitative traders who pay very low prices to producers. In economic and nutrition terms it would be better if most families ate all the fish they caught rather than sold it for cash to purchase rice.

There is a major fish ghat and drying centre for commercial sale at the southern end of Hatia Island shown in Plate 5. The sale of fish is shown in Plate 8 and the non commercial dry of fish at household level is shown in Plate 7.

3.5.6 Rural energy

As previously outlined in the common resources section above the area has one of the most favourable rural energy balances in 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. 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 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. During the needs assessment exercise there were calls from women for cottage industry employment opportunities to be set up. 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.

3.5.8 Industry

The only industrial operation in the area is commercial fish drying in the open air at the south end of Hatia and also on Nijhum Dwip. 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

Navigation

The main ferry route to Hatia is from Char Bata in south Noakhali which links to the ghat at the northern end of Hatia. However this service is problematic as the tidal window at Char Bata is very narrow (less than two hours in some cases) and timing of the ferry departure and arrival becomes critical, especially as it is considered dangerous to travel outside daylight.

There are no BIWTA registered routes in study area, although there is a twice weekly private trawler service on market days which can carry up to 125 passengers from South Hatia to Nijhum Dwip Bazar. There are also occasional services run from Char Chenga and boats can be chartered by the day for carrying cargo as required.

Road network

The road network on Hatia island is surprisingly good when compared to other parts of rural Bangladesh. There is a very good tarmac road from the Hatia north ferry ghat to southern Hatia which is regularly used by buses and baby taxis. Away from this there are brick paved and unpaved roads which are accessed by rickshaw or walking. However access to Nijhum Dwip is entirely by boat and once on the island walking is the main form of movement. The need for a direct road connection between Nijhum Dwip and South Hatia was considered a high priority by women in Nijhum Dwip due to their family links to northern Hatia.

3.6 Conclusions

The main natural environmental processes that have been identified 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 no 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 four different parts 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 8 per cent of all households. The results of this work are presented by location in Table V.1.18 and by social group in Table V.1.19. A major conclusion is that by far the majority of people interviewed feel that creation of new land is the highest priority intervention followed by embankment construction and then construction of cluster settlements and provision of a health centre. The desire for provision of cyclone shelters was surprisingly low, probably influenced by the fact that four exist and are highly visible although local people may not appreciate that their capacity is inadequate for the population. The lowest stated priority was for schooling, probably a reflection of the fact that primary provision now exists in the area and the secondary schooling is not greatly valued.

There were significant differences in response by location, cyclone shelter provision being given a higher priority on northeast Nijhum Dwip where there are no existing structures. The provision of road access to the settlements outside the embankments on south Hatia was a high priority, where as inside the embankment the call was for sorting out the drainage problems created by the construction of the embankment with inadequate operational drainage facilities.

The major differences by social group included both land owning farmers and share croppers who desired embankment construction for preventing saline inflow as a highest priority and land accretion as the second. Land owning farmers also placed improved roads as a higher priority than any other group. Women placed provision of sanitation and safe drinking water as much higher priorities than other groups, as well as improving road links to Hatia where many have their pre-marital family homes. There was also a significant request for the provision of income generation activities for women.

The agricultural and socio-economic survey also asked farmers to prioritise existing constraints to increasing agricultural production and asked for suggestions to overcome these. The most significant reason for crop loss was stated as pest attack followed by saline intrusion both inside and outside the existing embankment. The main requests were for embankment construction in places where there were none and to deepen the drainage system inside the existing embankment. However the real issue would seem to be one of water management, specifically the provision of water control structures at appropriate locations in the embankment and operation of these which fully utilises the allowable tidal range for drainage. These issues are being addressed as part of the

SRP programme for southern Hatia.

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 subsequent 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 V.24.

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 4.

4.3 NGO's

There is presently only one major local NGO (Dwip Unnayan Songstha) working in the area, which has its headquarters on Hatia. It was established in 1970 to give assistance to local people after the cyclone. At present it mainly works with erosion victims in northern Hatia, having a poverty alleviation agenda. It targets its activities at the household level and also vulnerable groups. Its present programme targets 9,300 households in 43 villages over 9 Unions on Hatia island. DUS has also worked with international NGO's who have been active in the area in the past, particularly in the wake of cyclones, including the Red Crescent. Other national NGO's who have worked in the area include BRAC who have carried out cyclone shelter construction and CARDMA. Discussions were also held with the Noakhali based NGO BIRTAN.

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 were too high to be justified by the predicted benefits. The present MES feasibility study addressed this problem by proposing more cost effective cross dam construction techniques using geotextiles. The LRP also commissioned an environmental scoping study for the 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 them inadvisable.

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 also others 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 The 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 V.1). The main outcome of the study was a 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, there is unlikely to be any impact or constraint in the Hatia - Nijhum Dwip area.

4.4.4 The FAP South East Regional Study (FAP 5)

The FAP 4 study area was to the east of Meghna and as shown in Figure V.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 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 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 regional study phased programme would appear to have no proposed interventions that directly impinge on the Hatia/Nijhum Dwip area.

4.4.5 Cyclone Protection Project (CPP; FAP 7) and Coastal Embankment Rehabilitation Project (CERP)

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 dissipated wave energy and was cost effective (Ref: Kampsax, 1992). In those places where there was no existing mangrove cover the damage to the embankment had been significantly worse than in those places were it existed. An Initial Environmental Examination of the project 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. CERP have been working on the north eastern edge of Hatia where the embankment has been eroded. The aim is to retire the embankment to prevent immediate erosion and hence the risk of flooding, not to try and prevent erosion of the existing embankment.

4.4.6 Cyclone shelters

Many shelters have been constructed in the coastal area since the 1991 cyclone. On Nijhum Dwip there are four structures (see Plate 16), one funded by the Red Crescent and a smaller one by BRAC. The Cyclone Shelter Preparatory Study aimed to set criteria for the 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 Nijhum Dwip area (see Section 3.3.1 above). The Cyclone Shelter Study targeted Hatia as a case study vulnerable area and carried out a detailed Thana assessment, including a loss of 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 combining the MES bathymetry data and digitisation of the FINMAP 1991 land levels. As part of the early stage of the Cyclone Shelter Study the need for an integrated coastal management plan was identified (Ref: Mott MacDonald, 1992). The conclusions of the Cyclone Shelter Study 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 South Hatia polder No 73/2 (the embanked part of south Hatia) was 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, 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.

4.4.8 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 non 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). The plan outlines a proposed planting programme for the area but still fails to address the issue of sustainability and the need to fund to programme from revenue. Forestry in the 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.

4.4.9 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 Nijhum Dwip 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 was their most desired intervention. The proposed Integrated Development Plan takes note of the other conclusions and where appropriate has incorporated other wishes as components in the intervention.

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 Nijhum Dwip and the main environmental constraints to development, identified from the conclusions of the baseline environmental description in Section 3.6 above, were borne in mind. The resulting scoping matrix is given as Figure V.2.16 with the second column identifying the priority issues on technical grounds.

5.1.2 Local people's priority issues

Column three of the scoping matrix gives local people's priority issues based upon the results of the needs assessment discussed in Section 4.5 above.

5.2 Identification of likely important environmental components

The scoping matrix given in Figure V.2.16 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. Three scenarios have been assessed:

- construction of one cross dam at year zero
- construction of one cross dam at year zero followed by a second at year five
- the without intervention situation at year 30 assuming present trends continue.

One of the conclusions from this analysis is that the additional benefits of the second cross dam are not likely to be as great as for one cross dam and are longer term and prediction is less reliable. However a significant benefit is that the second cross dam would produce full accretion between Damar Char and Nijhum Dwip, allowing a second sea facing embankment to be built to enclose additional land for agricultural use. It was thus decided that as part of the project implementation process, the need for a second cross dam should be re-evaluated at year five, following detailed monitoring of the results of the first cross dam.

The EIA work was then focused on the impacts of construction of one cross dam at year zero, followed by the integrated land development programme as outlined in Section 2.5 above. It was decided to use a time horizon of 15 years as this is a crucial time period in terms of land use, being the point at which decisions have to be taken concerning cutting of mangroves, building new embankments, turning over to agriculture or replanting forestry. A matrix extracting the Important Environmental Components (IEC's) for the impacts of one cross dam has been

constructed and is given as Table V.8. 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 V.1.12 and are mapped in Figure V.2.12. The model indicates that the impacts are likely to be in the mud-flats and inshore areas (defined as within 5 km of the coast) south of the northern limit of the defined Project Area. The Project Area boundary is shown in Figure V.2. 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.

Table V.8 : Important environmental components matrix for one cross dam at year 15/16

Important Environmental Components	Technical Priority	Local Priority Ranking	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	*	*5	0	0	0	0	0	0
Cyclones	*	*5	0	0	0	0	0	0
Hydrology								
Surface Water:								
Quantity:								
Rainfall flooding			0	-1	+1	+2	+1	+2
Tidal/Sea flooding	*	*5	0	0	+2	+2	+2	+2
Drainage		*11	0	-1	·0	+1	0	+1
Quality:								
Salinity	*	*2	0	-1	+1	+2	+1	+2
Erosion			0	-1	0	+1	0	+1
Sedimentation		*9	0	+1	+2	+1	+2	+1
Accretion	*	*1	0	+1	+2	+1	+2	+1
Groundwater:								
Availability:								
Domestic water supply	*	*10	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								
Terrestrial Habitats:								
Fauna	*		0	0	+1	+1	+1	+1
In-Shore Marine Habitats:								

Important Environmental Components	Technical Priority	Local Priority Ranking	NOW	Future Without Intervention	Future With Successful Intervention	Difference Due to Intervention	Future With Project With Mitigation	Residual Impact
Fauna	*		0	0	-1	-1	-1	-1
Fish	*		0	-1	-2	-1	-2	-1
Natural Risks and Hazards								
Storms/Cyclones	*	*5	0	-1	+1	+2	+1	+2
Rainfall Flooding		*11	0	-1	0	+1	0	+1
HUMAN ENVIRONMENT								
Social Environment								
Human Population	*	*3	0	+1	+2	+1	+2	+1
Gender Issues		*	0	0	+1	+1	+1	+1
Settlement Pattern and History	*	*3	0	+1	+2	+1	+2	+1
Land Holding and Tenure	*	*1	0	-1	+1	+2	+1	+2
Common Resource Rights:								
Fish	*		0	-1	-2	-1	-2	-1
Domestic Water Supply	*	*10	0	0	+1	+1	+1	+1
Sanitation	*	*6	0	-1	0	+1	+1	+1
Health								
Waterborne Disease	*	*4	0	-1	+1	+2	+1	+2
Insect-borne Disease	*	*4	0	-1	-1	0	-1	0
Nutrition			0	0	+/-	+/-	?	+/-
Education and Literacy	*		0	+1	+2	+1	+2	+1
Economic Environment								
Agriculture	*	*	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	+2	+1	+2	+1
Forestry	*	*7	0	+1	+2	+1	+2	+1
Fisheries		*	0	-1	-1.5	-0.5	-0.5	-0.5
Industry		*	0	0	0	0	0	0
Other Non-Farm Wage Paid Employment	*	*	0	0	0	0	0	0
Infrastructure and Communications								
Roads and Embankments	*	*8	0	0	+2	+2	+2	+2
Navigation			0	0	-1	-1	0	0

Important Environmental Components	Technical Priority	Local Priority Ranking	NOW	Future Without Intervention	Future With Successful Intervention	Difference Due to Intervention	Future With Project With Mitigation	Residual Impact
Social Risk and Hazards								
Storms/Cyclones	*	*5	0	0	+2	+2	+2	+2
Erosion			0	-1	0	+1	0	+1
Disease	*	*4	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

+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

? Unknown

+/- 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 15 for one cross dam constructed in year zero

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 Table V.8 allows the significant impacts (both positive and negative) of the proposed intervention of one cross dam to be identified. The analysis has been carried out using a comparison to a without project situation 15 years after construction of the cross dam. The analysis allows the impacts of the project to be 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, the impacts have been quantified and the amounts are given in Table V.9.

6.3 Identified positive impacts

6.3.1 Land accretion

From the morphological modelling it is estimated that land accretion is accelerated to the point where the area of land at level +2.2m PWD (2,044 ha) is reached by year 6 instead of year 30, as shown in Table V.1.12. The total area of land accreted to level +2.2m PWD after 30 years with one cross dam is almost twice that (4,465 ha) as in the without intervention situation. At year 15 it is predicted that there will be 4,243 ha of land above +1.5m PWD (the level at which forestry planting can commence), 2,880 ha of which are attributable to the intervention. In addition the low flow channel between the two islands will be closed by the cross dam, 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, together estimated to be 6,590 households by year 15), many of whom have no agricultural land, to be allocated a cultivable plot. In addition a further 450 households can be settled into the area by year 6/7, with both a house plot and an agricultural land allocation. The number of additional households who could be settled in this way could be increased to 780 by year 15.

6.3.3 Reduction in cyclone damage

The effects of cyclone surges will be reduced as waves are dissipated by the kilometre wide forestry belt and also by the seaward side run-up slope of the newly built embankments. Analysis carried out by the CPP project indicated that such planting can dissipate two 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.

Table V.9 : Qualification matrix for significant impacts for one cross dam at year 15/16

Impacts (benefits and disbenefits)	Year 15 without intervention	Year 15 with successful intervention	Difference due to intervention
Accreted Land Area 1.5m	1363ha	4243ha	2880ha
Accreted Land Area 2.0m	1246ha	3510ha	2264ha
Accreted Land Area 2.2m	1022ha	3237ha	2215ha
Human Settlement (hh)	5604	6590	986
Additional Human Settlement Programme (hh)	0	780	780
Land Available for Agricultural Development (ha)	409ha	1983ha	1574ha
Cleared Forest Land Available for Agriculture (ha) at year 16	0	1911ha	1911ha
Livestock - Large	9990	11747	1757
Livestock - Small	9078	10675	1597
Livestock - Poultry	109455	128705	19250
Forestry Planting Area (ha)	681ha	2260ha	1579ha
Forestry Clearing Area (ha) at year 16	0	1911ha	1911ha
Forestry Net Area (ha) at year 16	681ha	349ha	-332ha
Aquaculture Fish (ha and tonnes)	100ha 80t	207ha 414t	107ha 214t
Aquaculture Shrimps (ha and tonnes)	4ha 0.5t	27ha 10.8t	23ha 9.2t
In-Shore Fisheries (can not quantify)	-	--	-
Human Nutrition (can not quantify) 60% of hh depend on fish	+/-	+/-	+/-
Embankment with Road	0	48.9km	48.9km
Local Road	0	12.5km	12.5km

Source: MES 1998

Note: The analysis includes the option of clearing forest land at year 16

6.3.4 Reduction in rainfall flooding

Assuming that the constructed drainage system operates 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 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 new embankments will be reduced as saline intrusion will be prevented 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 small length of bank edge erosion that presently occurs on the north west corner of Nijhum Dwip could be slightly reduced as the inter-island channel accretes. The erosion may be pushed further downstream but is unlikely to be worse than it is at present.

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. In addition, some land which will be forested and by year 15 has accreted to a level over +2.0 m PWD and also lies more than 1 km from the sea (estimated to be up to 1,911 ha), 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 19,200 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 15 years growth would allow an additional 1,750 large livestock and 1,600 small livestock to be reared. 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 phased planting programme and a sustainable management system is estimated to be 2,260 ha by year 15, 1,579 ha of which are attributable to the project. A larger area than this would be available for planting by year 15, but in order to have a constant planting rate not all of this would be planted at that moment in time. The financial analysis of the project has assumed that the forestry component will be self funded by the Forest Department and thus no costs have been put into the project calculations. However the net benefits have been included in the economic analysis. At year 16 1,911 ha of this planting outside the new embankment could be progressively cleared and turned over to agriculture if so desired. Alternatively the area could be replanted. The overall result would be that an additional minimum 349 ha of forest cover would exist at year 16 than is there at present, but this would be 332 ha less than at year 16 with no cross dam, assuming 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 107 ha of ponds could be cultivated by year 15. In the with project situation it is estimated that 414 mt of fish would be produced, 214 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 Nijhum Dwip to Hatia. This would allow better marketing with secondary benefits to agricultural production. In addition there has been a strongly stated desire by women in Nijhum Dwip for improved access to northern Hatia as many are erosion victims from there who have close family relations still residing at that place. Whilst the reduction in social isolation that this creates can not be easily quantified, let alone valued, it is a significant benefit.

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 the cross dam and in particular movement through the channel between Nijhum Dwip and Hatia would cease. From the sedimentation analysis is also apparent that similar new habitats will appear further off-shore. 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 which the area is significant (Ref: Thompson P and Johnson D, 1996) and also Gangetic Dolphins. The Gangetic Dolphin is classified as threatened under the IUCN Red Book (the world-wide register of threatened and endangered species). However dolphins are relatively common in the Nijhum Dwip 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 Nijhum Dwip, which is likely to increase as a result of the proposed project, will put further stress on the Forest Department's attempts to manage the place as a conservation area. Such a policy (which has included the stocking of the area with deer, monkeys and pythons) has already been seriously undermined by the past establishment of the seven cluster villages on Nijhum Dwip. The overall conclusion is that since the establishment of the cluster villages, it is not now possible to manage Nijhum Dwip as a conservation area and such strategies would be best reserved for more important national designated areas like the Sundarbans, Hill Tracts and forest areas at Madhupur and 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 15. 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 dam is likely to cause a further change in fish habitat and an additional reduction in fisheries catch. Again it not possible to quantify this without a baseline catch assessment and monitoring but it would seem that the effect of one cross dam 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 the Nijhum Dwip channel and the need to relocate the fish landing station and drying operation.

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 estimated to be 66 grams per day compared with a minimum protein requirement of 45 grams per day and an average consumption of protein of 40 grams per day in all Bangladesh, 27 grams per day of which comes from fish). 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 Nijhum Dwip 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 Navigation

The closing of the navigable channel will obviously prevent waterborne navigation through it and also close the fish landing ghat. Discussions with local people indicate that the improved access offered by a direct road connection is considered superior to navigation. Negotiations would need to take place to arrange a suitable re-location site for the ghat that was seen to be an acceptable replacement. It is likely that a location on the western side of the island would be preferable as there is less risk of siltation impeding access at a later date.

6.4.7 Changes in access

Whilst the improved access to Nijhum Dwip from Hatia 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 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 linked to the collection and handling of construction materials. A checklist of these issues has been prepared and included as Appendix 5 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 Table V.9. The main problems are the lack of data on in-shore fisheries and the uncertainty of complex two way trends with human nutrition. The quantification is for year 15 but also show the effect of a forestry cutting programme at year 16, which would reduce the forested area but increase those for seasonal cultivation and livestock grazing.

6.7 Impact valuation

Impact valuation has been carried out where possible and is given in Table V.10. 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 agricultural benefits have also been expressed as a value per household. The valuation is purely in financial terms up to year 15/16, assuming thinning and cutting of forestry at year 15. 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 the livestock programme are greater per household than for agriculture inside the embankment at year 15. The returns to forestry are positive but low and it has not been included in the project economic and financial analysis, the assumption being that it will be carried out on a self-funding basis by the Forest Department.

The overall economic analysis indicated that the proposed project is not very attractive, the fundamental problem is that the costs of infrastructure construction are relatively high (at Tk 359 million, the embankments, roads, water control structures and drainage system are 73 per cent of project costs, although the actual cross dam is relatively inexpensive) and the returns to agriculture are long term, particularly because of the slow rate of soil salinity reduction even after construction of the embankments.

Table V.10 : Valuation matrix for significant impacts for one cross dam at year 15/16

Impacts	Year 15 Without Intervention	With Successful Intervention	Difference Due to Intervention	Total Valuation of Benefit Year 15 due to Intervention Thousand Taka
Accreted Land Area 1.5m (Note 1)	+	+ +	+	+
Accreted Land Area 2.0m (Note 1)	+	+ +	+	+
Accreted Land Area 2.2m (Note 1)	+	+ +	+	+
HH Net Agricultural Benefit Inside Embankment Tk/hh/yr	5700	11400	5700	781140
Agricultural Net Benefit Existing Land Outside Embankment Tk/ha/yr	5290	8524	3234	1332
Agricultural Net Benefit Existing Land Inside Embankment Tk/ha/yr	6427	13120	6693	316445
Agricultural Net Benefit New Land Outside Embankment Tk/ha/yr	3906	5956	2050	6936
Agricultural Net Benefit New Land Inside Embankment Tk/ha/yr	0	8170	8170	837277
Surplus Livestock - Large Thousand Tk	3278	9733	6455	6455
Surplus Livestock - Small Thousand Tk	3068	9918	6850	6850
Milk Production Thousand Tk	5395	9867	4472	4472
Egg Production Thousand Tk	6567	11583	5016	5016
HH Net Benefit From Livestock Improvement Tk/hh/yr	0	6240	6240	689832
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 at yr 16	5725	5725	extra area	29390
Aquaculture Fish Tk/ha/yr (Cultured Pond)	14144	47329	33185	53261
Aquaculture Shrimps Tk/ha/yr (Without intervention assumes disease)	8625	44484	35859	12371
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 (tradeable/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

The total capital costs of the project are estimated to be Tk 490 million (US$ 10.02 million). 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. Baud on population projection for year 15 with the project the capital costs amount to some Tk 74,000 per benefited household and 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.

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 planning unit of north Hatia, (presently being considered for a pre-feasibility study), would need to bear in mind possible induced impacts downstream on the Nijhum Dwip area. As such the construction of the Nijhum Dwip cross dam may pre-empt possible development options in Northern Hatia.

As discussed above, the outputs of the sedimentation analysis indicated that accretion of tidal mud flats is likely to occur to the east and south of Nijhum Dwip. 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 0.27 metre 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 one cross dam at year zero. However if this were to be just the first stage of a major intervention strategy for cross dam construction then there could be concerns as to likely compounded impacts. The situation would in any case be reviewed during the reassessment process for the second cross dam at year five.

8. ENVIRONMENTAL MANAGEMENT

8.1 Mitigation measures

The predicted effects of environmental mitigation programmes can be seen in the Table V.8 by deducting column six from column eight. Due to the fact that the interventions have been carefully designed, there is little need for specific targeted mitigation programmes. Those that would be required are indicated below:

8.1.1 Fish ghat relocation

It will be necessary to relocate the fish ghat presently found adjacent to the channel on southern Hatia. This could be done by careful negotiation with the affected parties to come to an acceptable equivalent location. It would seem best to have a new site on the main channel to the western side of the area, as this will not be subject to accretion. There are not expected to be any major costs associated with this relocation. However consideration could be given to establishing a boat centre at the new site 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, particularly to see 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 mudflats 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 such a programme has been established 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 in Nijhum Dwip 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 5. 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 Table V.8.

8.3 Compensation measures

The relocation of the fish ghat outlined 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 the cross dam. There is however a proposed agricultural land reallocation programme for the southern tip of Nijhum Dwip, centred upon the planting of a coastal protection zone of forestry to provide greater protection for the residents of the area. In order to achieve this protection, approximately 400 ha of existing forested land in the centre of Nijhum Dwip would need to be cleared to provide replacement equivalent replacement land. Overall a considerably larger area of forest would be planted under the forestry programme than is lost by the need to clear land to promote safety for local people.

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 as if this is not done then the full potential benefits of the proposed intervention are unlikely to be attained;

- 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 and should thus be seen as a trial with an underlying risk that it may not be successful.

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, which will indicate the effectiveness of the intervention and also any induced impacts on in-shore marine habitats and navigation and which will be crucial in assessing the viability of constructing a second cross dam at year five;
- water salinity and soil salinity using the same sample sites established during the feasibility

study, initially 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;
- incidence of malaria;
- human nutrition levels in relation to fish consumption;
- household socio-economics related to predicted project benefits;
- external issues, particularly induced accretion and any proposed upstream developments.

In addition monitoring of construction management issues should be carried out using the checklist given as Appendix 5 as a basis for data collection and analysis.

It would be necessary to re-run the feasibility of construction of the second cross dam after 5 years, based upon the observed benefits of the first dam and also the predicted benefits of construction of a second cross dam. A further review will be required at year 15/16 when a decision is required as to the cutting of forestry and possible construction of a second coastal embankment.

8.6 Quantified and costed EMP

A programme for project implementation has been given in Figure V.24 which includes the re-location of the fisheries ghat 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 Table V.8. 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 the construction of one cross dam and an associated integrated rural development programme, assessing the likely impacts over a 15 year period. The intervention philosophy is to construct just the one cross dam and then closely monitor the impacts for a five year period, before taking a decision about construction of a second cross dam.

Under the Department of 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 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 impacted area is relatively small by international standards.

The needs assessment indicates that accelerated land accretion is considered to be the highest priority intervention for all residents except for existing land holders in Southern Nijhum Dwip and the embanked part of South Hatia. The land holders group requested construction of an embankment to prevent saline water inflow as a first priority (despite the fact that one already exists in Southern Hatia, the problem is that in the recent past it has not been effective) and land accretion as a second priority.

For the proposed cross dam the main conclusion is:

- that the main predicted benefit is land accretion, the rate due to the cross dam being over double 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 75,500 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 one cross dam these are not considered to be serious enough to prevent such a trial type of intervention being tested. However monitoring of these negative impacts would be required to allow quantification and valuation to take place and feed this information into the assessment of possible construction of a second cross dam at year five.

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 the channel. 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 Nijhum Dwip. This can be minimised by not promoting any additional in-migration of new settlers and managing new development in a planned 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 the existing fisheries ghat on South Hatia. The ghat will require relocation but the financial costs will be minimal.

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

- the disruption to the existing waterborne navigation through the channel. This only effects local traffic, and overall access to Nijhum Dwip should be greatly improved by the project as continuous access will be possible by land along the cross dam.

- the improved access to Nijhum Dwip from Hatia using the cross dam 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 one cross dam and the associated integrated development project. A full appraisal of its impacts five years after construction should be carried out before consideration is given to constructing a second cross dam. 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 US$ 12 million for direct construction costs), that the first phase cross dam 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 5.
- a baseline human nutrition survey should be instigated prior to construction, which should be repeated five years after construction of the first cross dam;
- a negotiated arrangement for relocation of the fisheries ghat on south Hatia;
- 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 V.2.17.

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APPENDICES

Table V.1.1: Monthly rainfall at Hatia, 1962 - 1996

Year	Monthly Total Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1962	13	12	0		212	487	426	608	342	312	0	0	2412
1963	0	0	0	173	369	643	989	505	355	605	0	0	3639
1964	18	0	15	272	140	397	833	413	303	390	151	0	2932
1965				11	93	909	832	897	530	329	31	51	3683
1966	7	0	25	13	115	634	435	846	546	324	2	117	3064
1967	7	0	68	102	143	359	801	588	722	344	0	0	3134
1968	0	12	61	149	227	1091	1020	470	228	106	9	0	3373
1969	0	0	87	95	135	458	1027	819	542	144	0	0	3307
1970	0	15	2	61	128	460	818	628	530	390	6	0	3038
1971	2	0	0	152	342	614	678	839	306	246	47	0	3226
1972	0	6	0	139	266	649	456	730	266	117	15	0	2644
1973	2	0	152	55	549	478	644	346	414	137	304	50	3131
1974	4	0	308	40	232	417	1030	671	330	104	162	0	3298
1975	0	0	0	5	271	365	1198	477	329	520	334	0	3499
1976	0	24	0	145	334	714	841	781	392	284	49	0	3564
1977	25	119	0	602	453	671	650	471	384	77	28	6	3486
1978	0	0	42	96	574	882	391	443	409	103	0	0	2940
1979	0	11	0	28	81	550	522	617	316	56	16	24	2221
1980	0	28	146	20	466	357	893	734	322	352	0	0	3318
1981	72	0	173	482	368	618	839	592	292	32	0	29	3497
1982	0	36	16	308	0	643	538	738	256	17	13	3	2568
1983	32	46	148	113	247	545	589	909	542	293	54	21	3539
1984	13	0	0	246	270	438	560	544	395	200	0	0	2666
1985	3	2	72	125	322	523	685	467	171	32	52	2	2456
1986	2	0	3	197	120	564	651	378	418	67	312	0	2712
1987	0	0	11	27	12	59	105	66	40	5	4	1	330
1988	0	3	5	10	54	84	81	54	42	14	6	0	352
1989	0	1	3	145	124	402	601	235	292	440	0	0	2241
1990	0	2	54	305	204	400	790	424	423	339	55	44	3039
1991	4	88	3	146	359	895	549	545	477	363	22	15	3466
1992	0	75	0	0	212	335	789	486	564	197	3	18	2679
1993	2	27	283	95	390	726	672	691	456	76	10	0	3428
1994	0	13	121	116	205	871	586	559	240	116	18	0	2843
1995	2	30	47	28	328	545	970	458	379	27	221	0	3035
1996	0	420	375										795
Mean	6	29	65	136	245	552	691	560	369	211	57	11	2844

Table V.1.2 : Water Quality Data

Sample location	Type of water resources	Date		Time		Tide (L, H)		Temperature (oc)		Conductivity (mS/cm)		PH		Dissolved 02 (ppm)		CaCO3 (ppm)		CO2 (ppm)		Sediment (L.M.H)		Odor (Sus, nonsus)	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
1	SW	31.12.97	12.09.97	12.36	8.35	L	H	22.5	28.5	4.36	1.74	8.1	8.5	12.8	10.9	110	55.0	Nil	3.0	M	M	ns	ns
2	SW	31.12.97	10.09.97	11.40	10.40	-	-	21.0	33.5	1.19	1.33	8.5	8.4	13.7	8.9	62	120.0	15.57	10.0	M	L	ns	ns
3	GW	01.01.98	10.09.97	11.00	16.34	-	-	27.0	27.5	0.90	5.30	7.5	7.9	7.0	10.9	74	102.5	15.57	11.0	-	-	-	ns
4	PO	01.01.98	10.09.97	10.42	15.54	-	-	22.5	34.0	1.58	1.98	8.8	8.8	13.5	8.9	76	90.0	Nil	3.0	L	L	s	ns
5	SW	31.12.97	12.09.97	13.23	9.30	H	H	22.5	28.5	4.30	2.37	8.2	8.5	13.0	10.9	106	62.5	Nil	2.5	M	M	ns	ns
6	SW	31.12.97	12.09.97	13.56	10.01	H	H	23.0	28.5	6.58	2.10	8.3	8.3	12.3	10.7	128	62.5	Nil	4.0	M	M	ns	ns
7	GW	31.12.97	11.09.97	10.30	11.10	-	-	27.0	27.0	6.78	3.78	7.7	8.0	6.9	5.4	40	75.0	11.68	10.0	-	-	-	ns
8	SW	31.12.97	12.09.97	16.20	16.50	L	L	26.0	29.5	4.79	1.86	8.3	8.4	12.3	10.3	120	65.0	Nil	3.0	H	M	ns	s
9	PO	31.12.97	12.09.97	15.12	15.15	-	-	24.0	30.5	2.26	2.50	7.9	9.0	12.6	10.0	30	45.0	27.24	8.0	L	L	-	-
10	GW	31.12.97	12.09.97	15.04	15.00	-	-	27.5	29.5	7.55	5.80	8.3	8.0	8.0	7.0	30	42.5	8.56	6.0	-	-	-	s
11	SW	1-15.4.94	-	-	-	-	-	-	-	5.19	-	-	-	-	-	-	-	-	-	-	-	-	-
12	SW	7-15.4.94	-	-	-	-	-	-	-	5.58	-	-	-	-	-	-	-	-	-	-	-	-	-

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

L = Low, M = Medium, H = High , s = Suspended, ns = Non-suspended

Source: Field Survey, 1997
Sample from sites 11and 15- SRDI Thana Land and Soil Utilization Guide for Hatia, 1995.

Table V.1.3a : Surface soil analytical data (South Hatia)

SRDI Site No	Soil Mapping Zone	pH	Org. Matter %	Milli equivalent / 100 gm			Microgramme (PPM) / millilitre Soil							
				Ca	Mg	K	Amon-N	P	S	Bo	Cu	Fe	Mn	Zn
57	4	8.1	1.3	4.2	3.0	0.37	8	24	96	0.9	6	204	65	1.0
58	4	6.8	1.8	5.4	3.1	0.30	19	21	105	1.2	7	999	93	1.0
59	4	6.8	1.7	5.8	3.6	0.29	30	20	70	0.6	7	245	89	1.0
60	4	7.4	2.0	9.3	8.8	0.54	27	36	45	0.3	6	66	11	2.0
61	4	6.6	1.6	7.0	3.5	0.39	15	19	75	0.1	9	28	11	2.0
62	4	6.7	1.5	6.5	2.6	0.36	21	18	75	0.3	4	91	24	1.0
63	5	8.0	1.6	8.6	2.9	0.18	4	57	59	0.4	7	819	86	Trace
64	3	6.6	1.6	4.4	6.9	0.47	25	30	25	Trace	7	106	73	2.0
65	3	6.6	1.3	6.6	5.1	0.25	15	38	89	0.1	8	37	29	1.0
66	5	7.0	1.6	11.7	4.1	0.31	12	22	65	0.6	6	370	93	1.0
67	5	6.7	2.2	6.5	7.5	0.55	20	23	25	0.1	2	59	33	2.0
68	5	7.7	2.3	6.2	7.6	0.51	25	26	20	0.1	4	184	33	1.0
69	5	7.5	1.4	3.4	1.6	0.28	7	22	75	0.7	10	326	69	2.0
70	5	7.6	1.9	9.3	3.1	0.30	18	80	75	0.7	6	49	85	1.0
71	5	7.2	1.6	7.1	5.2	0.76	25	30	35	0.3	5	78	24	2.0
72	5	7.1	2.1	5.1	7.0	0.56	23	29	14	Trace	6	210	69	1.0
73	5	7.2	1.5	13.5	9.3	0.84	25	20	65	0.6	5	45	10	1.0

Source: SRDI Thana Land and Soil Utilisation Guide

Date of Surface Soil Sample Collection was 8th-12th April 1988. Salinity samples taken 7th-15th April 1994.

Table V.1.3b : Surface soil analytical data (South Hatia)

MES Site No.	SRDI Site No.	Air Photo Reference Point	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	62	59-050/4	0.75	0.12	1.85	1.82	0.4	0.33	0.73	6.7
2	67	59-052/1	1.09	0.15	2.49	0.96	0.4	1.20	1.52	7.4
3	-	59-052/3	1.65	0.07	1.51	5.52	0.8	0.83	5.58	7.9
4	11	59-050/2	-	-	-	-	-	-	1.33	-
5	64	59-050/3	0.64	0.09	1.69	1.15	0.4	0.03	0.59	7.3
6	65	59-050/1	0.86	0.11	1.62	2.87	0.6	0.04	0.66	6.8
7	68	59-050/5	0.80	0.07	1.59	1.21	0.4	0.48	1.09	7.4
8	73	59-050/10	2.10	0.06	1.40	4.85	0.4	1.93	6.91	8.1
9	-	59-050/11	1.80	0.10	2.00	7.56	0.6	1.19	5.89	7.7
10	71	59-050/6	0.93	0.10	2.06	2.55	0.8	0.68	1.07	5.9
11	-	59-050/7	1.23	0.07	1.34	4.08	0.6	0.15	1.42	8.1
12	-	59-050/8	1.02	0.08	1.37	3.53	0.4	0.54	1.29	7.4
13	15	59-050/9	-	-	-	-	-	-	3.56	-
14	-	59-050	0.78	0.07	1.13	2.83	0.4	0.03	0.78	8.1
15	-	MES-EN-15	1.53	0.12	1.07	4.36	0.4	0.03	2.08	7.9
16	-	MES-EN-16	1.09	0.10	1.02	3.96	0.4	0.05	1.34	8.0
17	-	MES-EN-17	1.39	0.08	1.18	4.22	0.4	0.05	1.97	7.9
18	-	MES-EN-18	0.64	0.08	1.37	5.95	0.8	0.04	0.84	8.1
19	-	MES-EN-19	2.86	0.09	0.88	2.89	0.4	0.90	10.45	7.9
20	-	MES-EN-20	1.35	0.09	1.02	3.56	0.4	0.07	1.42	8.4

Note: Samples were collected during 10-12 September, 1997 and were analyzed in the SRDI laboratory, Dhaka.

Source: Field Survey, 1997

Table V.1.4 : 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)

pH Values for Agriculture 5.6-7.3

Soil classification descriptions

3 Inside embankment, lower clay content and higher available soil moisture than class 4
4 Inside embankment, higher clay content than class 3
5 Outside embankment and subject to regular saline water flooding

Source: SRDI Thana Land Soil Utilisation Guide for Hatia March 1995 (in Bangla)

Salinity data (Unit in mmhos/cm)

	Top soil	Medium	Lower	
Location	0.12-0.15m	0.15-0.25m	0.25-0.40m	Water
Site 7, Inside embankment	1.62	2.90	1.41	
Site 9, Inside embankment	2.34	1.78	0.80	
Site 11, Outside embankment and Groundwater	3.61	1.82	2.45	5.19
Site 12, Outside embankment	9.30	2.32	2.63	
Site 13, Outside embankment	6.25	3.88	1.23	
Site 14, Outside embankment	5.22	3.64	3.73	
Site 15, Outside embankment, Khal water				5.58

Source: SRDI Thana Land Soil Utilisation Guide for Hatia March 1995 (in Bangla)
Date of salinity sample collection was 7th - 15th April 1994.

Table V.1.5 : 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
Aegle marmelos	Rutaceae	Wood apple	Bel
Albizia procera	Leguminosae	White siris	Koroi
Albizia lebbeck	Leguminosae	Indian walnut	Sirish
Alocasia indica	Araceae	Glant taro, Arum	Mankachu
Alternanthera philoxeroides	Amaranthaceae		Helencha
Anthocephalus chinensis	Rubiaceae		Kadam
Areca catechu	Palmae	Betel nut	Supari
Artocarpus heterophyllus	Moraceae	Jackfruit	Kanthal
Azadirachta indica	Meliaceae	Margosa tree	Nim
Bambusa tulda	Gramineae	Bamboo	Jowa bans
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
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
Cucurbita maxima	Cucurbitaceae	Pumkin	Mistikumra
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
Enhydra fluctuans	Composiatae		Helencha
Eriocaulon sp	Eriocaulaceae		Ghaspata
Erythrina variegata	Leguminosae	Ceral tree	Mandar
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
Hibiscus tiliaceus	Malvaceae		Bhola

Scientific Name	Family	English Name	Local Name
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
Moringa oleifera	Moringaceae	Horse Raddish, ben oil tree	Sajna
Musa sapientum	Musaceae		Kola
Myriostachya wightiana	Gramineae		Dhanshi
Nymphaea nouchali	Nymphaeaceae	Water lily	Shapla
Oryza sativa	Gramineae	Paddy	Dhan
Pandanus foetidus	Pandanaceae		Kewakata
Phoenix sylvestris	Palmae	Date palm	Khejur
Phyllanthus amaras	Euphorbiaceae		Bhui amla
Polyalthia longifolia	Annonaceae		Debdaru, Saralgoch
Pongamia pinnata	Leguminosae	Indian beach	Karanja, Karamcha
Psidium guajava	Myrtaceae	Guava	Peyara
Ricinus communis	Euphorbiaceae	Castor oil plant	Veranda
Saccharum spontaneum	Gramineae	Thatch grass	Kash, Kaicha
Samanea saman	Leguminosae	Raintree	Raintree
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
Trichosanthes anguina	Cucurbitaceae	Snakegourd	Chichinga
Typha elephantina	Typhaceae	Elephant grass	Hoglapata
Vigna chinensis	Leguminosae	Cowpea	Barbati
Vigna mungo	Leguminosae	Black gram	Mash kalai
Vigna radiata	Leguminosae	Green gram	Moog
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.

Table V.1.6 : Fauna species list

Bangla Name	English Name	Scientific Name	Remarks
REPTILES			
Kochchop	Tortoise	Kachuga tecta	C
Tiktikee	Wall lizard	Hemidactylus	C
Tokkhok	Gecko	Gecko gecko	UC
Roktochosa	Garden lizard	Calotes sp.	UC
Kalo gui	Monitor lizard	Varanus bengalensis	IT
Atail kacho	Blind snake	Typlina porrectus	C
Darash sap	Rat snake	Ptyas mucosus	C
Gokhra sap	Cobra	Naja naja	UC
Kasim	Flap - shell turtle	Lissemys punctata	C
Dora sap	Checkered keelback	Xenochrophis piscator	C
Matia sap	Olive keelback	Enhydris enhydris	C
Jalbora	Dogfaced water snake	Cerberus phynchops	UC
Laldora	Rednecked keelback	Rhabdophis subminiata	C
Ajagar	Python	Python molurus	I
Anjila	Skink	Mabuya carinata	C
AMPHIBIANS			
Sona bang	Bullfrog	Rana tigrina	UC
Kotkoti bang	Skipper frog	Rana Cyanophlyctis	UC
Kuno bang	Toad	Bufo melanostictus	C
BIRDS			
Bhuban cheel	Periah kite	Milvus migrans	C
Sada cheel	Black - wing kite	Elanus cacruleus	C
Baz	Kestrel	Falco tinnunculus	C
Mala gugu	Ring dove	Streptopeliatranquebarica	UC
Teya	Perakeet	Psittacula krameri	C
Kokil	Koel	Eudynamys scolopacea	C
Suichora	Common bee eater	Merops leschenaulti	C
Ababil	Palm swift	Cypslurus pervus	C
Bulbul	Red-vented bulbul	Pycnonotus jacosus	C
Doyal	Magpie robin	Copsychus saularis	C
Tuntune	Tailor bird	Orthotomus sutorius	C
Finga	Black drongo	Dicrurus macrocercus	C
Patikak	House crow	Corvus splendens	C
Darkak	Jungle crow	Corvus macrorynchos	C
Bhatsalik	Common myna	Acridotheres tristis	C
Go salik	Pied myna	Sturnus contra	C
Jhuti salik	Jungle myna	Acridotheres fuscus	C
Chorui	House sparrow	Passer domesticus	C
Pancowri	Little cormorant	Phalacrocorax carto	UC
Boro bok	Great egret	Bubulcus ibis	C
Sada bok	Little egret	Egretta garzetta	C

Bangla Name	English Name	Scientific Name	Remarks
Kali bok	Black bittern	Ixobrychus flavicollis	C
Lal bok	Cinnamon bittern	Ixobrychus cinnanmeocus	C
Papya	Pied grested cuckoo	Clamator jacobinus	UC
Holdey Pakhi	Blackheaded oriole	Oriolus xanthomus	UC
Kani bok	Pond heron	Ardeola grayii	C
Nishi bok	Night heron	Nycticorax nycticorax	UC
Nol bok	Grey heron	Ardea cinerea	C
Chonkho cheel	Brahminy kite	Haliaster indus	C
Bali hans	Lesser whistling teal	Dendrocygna javanica	C
Dahuk	Water hen	Gallicrex cinerea	C
Kalo pipi	Coot	Fulica atra	C
Hot titi	Red-wattled lapwing	Vanellus indicus	C
Machranga	White-throated kingfisher	Halcyon pileata	C
Kabutor	Pigeon		
Cheuya pakhi			
Utala pakhi			
MAMMALS			
Badur	False vampire bat	Megaderma lyra	C
Bege	Mongoose	Herpestes edwardsi	C
Khargosh	Rabbit	Caprolagus hispidus	UC
Kathbiraly	Squirrel	Callosciurus pygerythrus	UC
Indur	Rat	Bandicota bengalensis	C
Chika / Suchey	House shrew	Suncus murinus	C
Sehsu, Chuchum	Gangetic dolphin	Platanista gangetica	C (SW)
Uud	Otter	Lutra perspicillata	IT
Chitra Harin	Spotted deer	Axis axis	I
Banar/ Bandar	Monkeys	Macaca mulatta	I

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 V.1.7 : Fish species listings by habitat and area

A. Inland fish fauna (pond, khal/river, flood plain)

Sl.No	Bengali name	English name	Scientific name	Remarks	
				Status	Habitat
1	Rui	Carp	Labeo rohita	C	P
2	Catla	Carp	Catla catla	C	P
3	Mrigal	Carp	Cirrhinus mrigola	C	P
4	Gang Tengra	Cat fish	Gangata viridescens	F	C
5	Lal chewa		Odontamblyopus rubicundus	C	C
6	Pangas	Cat fish	Pangasius pangasius	R	C
7	Kalabaus	Carp	Labeo calbasu	C	P
8	Chingri	Tiger shrimp	Penaeus monodon	F	F.C.
9	Shada chewa		Tryauchen vagina	C	C

B. Inshore fish fauna (within 5 km. of land):

Sl.No	Bengali name	English name	Scientific name	Remarks	
				Status	Habitat
1	Bagda Chingri	Shrimp	Penaeus monodon	C	IS
2	Bagatara Chingri	Shrimp	Penaeus semisalcus	F	IS
3	Dorakata Chingri	Shrimp	Penaeus japanicus	F	IS
4	Golda Chingri	Prawn	Macrobrachium rosenbergi	F	IS
5	Gura Icha	Shrimp	Nematopalaemon tenuipes	F	IS
6	Sila / Gool kakra	Mud crub	Scylla serrata	C	IS
7	Zazi kakra	Blue swimmer carb	Neptune pelagicus	C	IS
8	Kata mach	Cat fish	Arius s.p	C	IS
9	Bhetki/koral mach	Giant sea perch	Lates calcarifer	F	IS
10	Pangas	Fatty cat fish	Pangasius pangasius	R	IS
11	Tapsi	Paradisethread fin	Polynemus paradiscus	C	IS
12	Poa	Croaker	Otolithes cuviert	C	IS
13	Phase	Moustached thrysa	Thrysa mystax	F	IS
14	Hilsha	Hilsha shad	Hilsha ilisha	C	IS
15	Lal chewa		Odontamblyopus rubicundus	C	IS
16	Shada chewa		Tryanchen vagina	C	IS
17	Laita	Bombay duck	Herpodon nehereus	F	IS

Codes :

Habitat: R = River, C = Canal, P = Pond, F = Flood plain, IS = Inshore

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

C. Offshore fish fauna (more than 5 km.from shore).

Sl.No	Bengali name	English name	Scientific name	Remarks	
				Status	Habitat
1	Bagda Chingri	Shrimp	Penaeus monodon	C	OS
2	Bagatara Chingri	Shrimp	Penaeus semisulcatus	C	OS
3	Dora kata Chingri	Shrimp	Penaeus japanicus	C	OS
4	Baga champa Chingri	Shrimp	Penaeus merguensis	C	OS
5	Chaga Chingri	Shrimp	Penaeus indicus	C	OS
6	Horine Chingri	Shrimp	Metapenaeus monoceros	C	OS
7	Ruda Chingri	Shrimp	Parapenaeopsis scuptilis	C	OS
8	Ghhoa Icha	Lobster	Panulirus polyphagus	F	OS
9	Nune Cheai	Cuttle fish	Sepia s.p	F	OS
10	Nuilla	Squid	Loligo s.p	F	OS
11	Octopus	Common octopus	Octopus vulgaris	C	OS
12	Kata mach	Cat fish	Arius s.p	F	OS
13	Nunatengra/Guilla	Bagrid catfish	Mystus gulio	F	OS
14	Bhetki/Koral mach	Giant sea perch	Lates calcarifer	F	OS
15	Kukurjib	Long tongue sole	Cynoglossus lingua	C	OS
16	Pann mach	Sickle fish	Derepane longimanna	C	OS
17	Hatir kann	Spade fish	Ephippus orbis	C	OS
18	Dom mach	Silver- biddies	Gerres filamentosus	F	OS
19	Jagri	Silver- biddies	Pentaprion longmanus	F	OS
20	Loittya mach	Bombay duck	Harpodon nehereus	C	OS
21	Sadha mach	Falsh trevally	Lactarius lactarius	C	OS
22	Ranga choukya	Red snapper	Lutjanus johni	F	OS
23	Taka chanda	Shortnose pouy fish	Leiognathus brevirostris	C	OS
24	Chan chanda	Moon fish	Mene maculata	C	OS
25	Sonali bata	Goat fish	Upeneus sulphurens	F	OS
26	Khorul	Mullet	Liga subvirdis	F	OS
27	Rupban	Bream	Nemipterus japanicus	F	OS
28	Pangas	Fatty cat fish	Pangasius pangasius	R	OS
29	Sada datine	Lined silver grunter	Pomadasys hasta	F	OS
30	Lakhua	Indian salmon	Polynemus indicus	C	OS
31	Thailla	Four finger threod fin	Eleutheronema terradoctylum	C	OS
32	Murbailla	Flat head fish	Platycephalus indicus	F	OS
33	Pari machh	Purple spotted (big eye)	Pariacanthus tayenus	R	OS
34	Samudra serboti	Indian halibut	Psettodes erumei	R	OS
35	Achila/Tiktiki machh	Greater lizard fish	Saurida tumbil	F	OS
36	Hundra machh	Laddy fish	Sillago domina	F	OS
37	Goti poa	Croaker	Otolithes macuptus	F	OS
38	Poa	Croker	Otolithes cuviert	C	OS
39	Kala poa	Spotted croaker	Protonibea diacanthis	C	OS
40	Lal poa	Silver pennah croaker	Johnius argentatus	C	OS
41	Lal datina	Longspine sea bream	Argyrops spinifer	C	OS
42	Darkuta	Forsteis barrawda	Sphyraena forsteri	C	OS
43	Rupchanda	Chinese pomfret	Pampus chinensis	C	OS
44	Folichanda	Silver pomfret	Pampus argentens	C	OS
45	Chhuri machh	Ribbon fish	Lepturacanthus sevala	F	OS
46	Berguni	Therapon perch	Therapon jarbua	F	OS
47	Teilla phasa	Harifin anchory	Setipinnae taty	F	OS
48	Phasa	Moustached thryssa	Thryssa mystax	F	OS
49	Olua	Pointed tail anchovy	Collia dussumieri	R	OS
50	Hichiri machh	White sardine	Escualosa thoracata	F	OS
51	Ilish/Hilsha	Hilsha shad	Hilsha ilisha	C	OS
52	Hail chanda	Black pomfret	Parastromateus niger	C	OS

Sl.No	Bengali name	English name	Scientific name	Remarks	
				Status	Habitat
53	Moori	Djeddaba crevalle	Alepes djeddaba	C	OS
54	Bom maittya	Eastern little tuna	Euthynmus affinis	C	OS
55	Surma machh	Mackerel	Scomberomorus commerson	C	OS
56	Champa	Indian mackeral	Rastrelliger kanagurta	C	OS
57	Kamat/Hangar	Milk shark	Scoliodon walbeehmii	C	OS
58	Haush/Sankush	Sting ray	Himanture uarnak	C	OS
59	Pitabri	Skate	Rhycholbatus djeddensis	F	OS
60	Haturi Hanger	Hammer-hedded shark	Sphyma blochii	F	OS

Codes :
Habitat : Offshore = OS
Status : C = Common, R = rare, F = Fairly common

Source : MES Field survey, 1997-1998.

Table V.1.7a : Fisheries catch assessment results - Nijhum Dwip channels 12th April 1997

Species No	Bengali Name	English Name	Scientific Name	Number Caught	Mean Length (cm)	Maximum Length (cm)	Minimum Length (cm)	Mean Weight (gm)	Maximum Weight (gm)	Minimum Weight (gm)
1	Jatka Ilish	Hilsha	Hilsha Ilisha	10	8.0	9.0	7.0	4.7	5.0	4.0
2	Chiring	Gobies	Apocryptes Bato (Hamilton)	7	8.1	9.0	7.0	4.9	5.5	4.5
3	Boal	Catfish	Wallago Atle	2	62.0	64.0	59.0	950.0	1100.0	800.0
4	Gulla	Catfish	Mystus Gulio	20	13.6	17.0	11.0	32.0	70.0	14.5
5	Bata	Goatfish	Upeneus Sulphureus	20	17.8	20.0	15.0	58.3	60.0	55.0
6	Pangash	Fatty Catfish	Pangasious	5	34.1	41.0	28.5	320.6	500.0	200.0
7	Poa	Croaker	Otolithes Cuvieri	10	15.4	21.0	10.0	34.4	90.0	19.5
8	Chewa	Gobies	Odontamblyopus Rubicundus	20	19.4	28.0	14.0	21.1	50.0	10.0
Total				94	17.0			65.5		

Notes:
All fish were caught in a three hour period prior to low tide in the low flow channel between Hatia and Nijhum Dwip on 12th April 1997

Table V.1.7b : Fisheries catch assessment results - 5Km offshore from Nijhum Dwip

Species No	Bengali Name	English Name	Scientific Name	Number Caught	Mean Length (cm)	Maximum Length (cm)	Minimum Length (cm)	Mean Weight (gm)	Maximum Weight (gm)	Minimum Weight (gm)
1	Phaisa	Mustached Thryssa	Thryssa Mystax	7	11.6	12	11	5.5	6	4.9
2	Loilla Icha	Tiger Shrimp	Metapenaeus Monoceros	10	8.2	9	7.5	5.2	6	4.8
3	Tier Icha	Tiger Shrimp	Penacus Monodon	6	11.3	11.5	11	5.1	5.2	5
4	Laitta	Bombay Duck	Harpodon Nehereus	12	12.3	12.6	12	8.4	8.6	8
5	Ilish	Hilsha (Shad)	Hilsha Ilisha	7	24.7	28	18	152.8	180	100
6	Toposhi	Catfish	Polynemus Paradiscus	6	13.6	14.2	13	14.8	15	14
7	Kukurjib	Long Tongue Sole	Cynoglosus Lingua	8	13.5	14.5	12	6.5	7.2	6
8	Ghagra	Sea Catfish	Arius Gagora	7	31.4	34	27	437	520	330
Total				63	15.3			71.3		

Notes:
Fish were collected from the landing station at South Hatia in mixed baskets

Table V.1.8a : Socio-economic survey outputs for Nijhum Dwip

	Functionally landless 0-0.02ha	Marginal 0.021-0.20ha	Small 0.21-1.00ha	Medium 1.01-3.03ha	Large over 3.03ha	Total
Households	53	3	100	3	1	160
Proportion	33%	2%	62%	2%	1%	

Source: MES Household Socio-Economic Survey 1996

Table V.1.8b : Reasons for settlement in the area

	Landlessness	River erosion displace	Inheritance	Other
Households	51	92	2	15
Proportion	32%	58%	1%	9%

Source: MES Household Socio-Economic Survey 1996

Table V.1.8c : Main occupation of household heads

Occupation	Number	Percentage
Agriculture	38	24
Agriculture Labour	2	1
Business	12	8
Fishing	81	51
Boat Labour	3	2
Service	10	6
Others	14	9
Total	160	

Source: MES Socio-Economic Survey 1996

Table V.1.8d : Main occupations of household members

Occupation	Number male	Percentage male	Number female	Percentage female
Agriculture	12	3	2	0
Agriculture Labour	7	2	0	0
Business	3	1	0	0
Fishing	84	18	2	0
Boatman	0	0	0	0
Service	10	2	5	1
Student	171	38	140	26
Housewife	0	0	206	38
Dependent	154	34	185	34
Others	13	3	4	1
Total	454		544	

Source: MES Socio-Economic Survey 1996

Table V.1.8e : Household income per annum

	Mean households Production (Kg)	Mean household direct consumption (Kg)	Mean cash income (Tk.)
Paddy	1731	1312	2436
Wheat	0	0	0
Pulse/oil	11	3	71
Potato	232	152	119
Onion/chilli	19	16	150
Fruits etc.	1	0	3
Total crops	1994	1483	2779

	Number	Number	TK
Cow/bullock	3	0	448
Buffalo	0	0	137
Sheep/Goat	3	0	218
Poultry	31	2	134
Horse	0	0	0
Eggs	292	70	1204
Total	329	72	2141

Open water	Tk	Tk	Tk
Fish	20913	3825	17088
Pond fish	482	206	173
Total	21395	4031	17261

Remited			
Income			1892
Grand total			24073

Source: MES Household Socio-Economic Survey 1996

Table V.1.9 : Reported disease incidence data for Hatia thana 1992-1996

Thana	Year	Month	Diarr	Worms	Peptec Ulcer	Arti	Skin disease	Poor nutrition	Anemia	Asthma	Eye disease	Ear disease	Dental disease	OBS & Gyne
HATIA	1992	JAN	1614	1475	797	645	600	452	514	174	276	264	225	103
HATIA	1992	FEB	1125	1220	557	449	514	377	799	99	19	185	269	110
HATIA	1992	MAR	1238	1170	340	446	369	302	404	106	259	200	187	102
HATIA	1992	APRIL	1159	1215	555	451	504	369	789	101	21	196	278	121
HATIA	1992	MAY	1562	1408	768	515	582	448	514	232	274	186	219	108
HATIA	1992	JUNE	1529	1427	779	615	500	455	514	175	280	198	221	100
HATIA	1992	JULY	1766	1610	819	688	612	273	528	181	332	273	230	285
HATIA	1992	AUG	1806	1639	826	816	645	297	542	199	356	298	254	301
HATIA	1992	SEPT	1649	1506	797	655	624	468	524	191	333	275	250	116
HATIA	1992	OCT	1974	1869	815	801	742	395	613	241	415	343	281	283
HATIA	1992	NOV	1614	1475	797	645	592	452	494	174	276	264	227	103
HATIA	1992	DEC	1598	1397	797	616	609	473	180	173	283	267	226	118
TOTAL 1992			18634	17411	8647	7342	6893	4761	6415	2046	3124	2949	2867	1850
MONTHLY MEAN 1992			1553	1451	721	612	574	397	535	171	260	246	239	154
HATIA	1993	JAN												
HATIA	1993	FEB	1530	1363	792	552	604	492	207	189	278	261	225	142
HATIA	1993	MAR												
HATIA	1993	APRIL												
HATIA	1993	MAY												
HATIA	1993	JUNE												
HATIA	1993	JULY	1347	1363	792	552	604	492	207	189	278	261	223	136
HATIA	1993	AUG	1132	796	535	440	1152	315	530	173	275	171	198	61
HATIA	1993	SEPT	1183	960	420	320	1143	217	409	136	281	133	148	70
HATIA	1993	OCT	1651	1511	1103	920	3234	382	687	450	437	234	277	144
HATIA	1993	NOV	1802	974	724	1056	2798	395	625	284	251	262	182	65
HATIA	1993	DEC	1004	718	561	623	1880	342	566	199	190	184	93	40
MONTHLY MEAN 1993			1378	1098	704	638	1631	376	462	231	284	215	192	94
HATIA	1994	JAN	1234	700	640	715	1825	475	447	315	444	261	326	295
HATIA	1994	FEB	1106	637	583	663	2825	211	438	198	203	149	207	41
HATIA	1994	MAR	1114	697	670	650	2196	289	414	167	252	114	153	40
HATIA	1994	APRIL	2069	550	640	793	2228	207	567	221	263	233	260	70
HATIA	1994	MAY	2347	949	524	653	1538	235	454	219	177	168	212	54
HATIA	1994	JUNE	1923	1004	578	793	1078	352	545	169	223	157	129	39
HATIA	1994	JULY	2113	1165	683	755	1237	487	644	208	311	128	202	80
HATIA	1994	AUG	1567	802	594	668	2567	352	407	226	336	192	169	43
HATIA	1994	SEPT	1414	928	518	777	1889	280	511	152	347	167	196	102
HATIA	1994	OCT	1425	1255	546	818	1157	221	605	369	483	250	120	62
HATIA	1994	NOV	1717	486	791	1013	1595	209	570	236	331	221	184	38
HATIA	1994	DEC	1411	423	443	793	1942	208	430	210	238	123	133	60
TOTAL 1994			19440	9596	7210	9091	22077	3526	6032	2690	3608	2163	2291	924
MONTHLY MEAN 1994			1620	800	601	758	1840	294	503	224	301	180	191	77
HATIA	1995	JAN	1208	388	356	430	883	282	491	104	114	92	185	32
HATIA	1995	FEB	1213	405	362	413	863	284	498	97	120	113	177	29
HATIA	1995	MAR	1369	781	559	522	1003	134	362	146	74	98	125	32
HATIA	1995	APRIL	1564	789	500	820	1618	323	424	244	208	141	176	
HATIA	1995	MAY	5525	861	445	761	975	158	355	131	89	116	109	38
HATIA	1995	JUNE	1967	802	594	668	2567	352	407	226	336	192	169	43
HATIA	1995	JULY	1801	751	521	677	1087	315	293	109	94	110	139	40
HATIA	1995	AUG	1375	756	521	677	1079	314	292	112	94	106	132	40
HATIA	1995	SEPT	500	756	523	680	1083	315	289	105	98	105	135	
HATIA	1995	OCT	1176	948	354	1319	790	238	403	221	221	149	180	42
HATIA	1995	NOV	1047	1201	245	1037	1135	497	463	288	171	85	183	17
HATIA	1995	DEC	832	623	160	579	829	446	540	189	81	141	201	9
TOTAL 1995			19577	9061	5140	8583	13912	3658	4817	1972	1700	1448	1911	322
MONTHLY MEAN 1995			1631	755	428	715	1159	305	401	164	142	121	159	27
HATIA	1996	JAN	810	621	155	563	805	447	535	189	80	162	201	10
HATIA	1996	FEB	1000	788	173	687	786	205	377	131	65	114	169	8
HATIA	1996	MAR	987	781	559	520	1003	134	143	368	74	98	125	32
HATIA	1996	APRIL	1316	548	402	659	1290	413	458	370	298	236	186	94
HATIA	1996	MAY	813	419	443	793	1934	208	430	210	238	130		50
HATIA	1996	JUNE	1456	684	492	568	1704	351	401	216	337	191	167	40
HATIA	1996	JULY	1059	786	435	602	643	216	325	173	126	182	173	30
HATIA	1996	AUG	665	384	248	347	372	182	368	136	115	102	118	22
HATIA	1996	SEPT	1315	684	419	605	776	274	500	213	196	134	177	31
HATIA	1996	OCT	1188	864	554	625	832	279	547	129	213	184	107	3
HATIA	1996	NOV	1184	898	609	671	936	251	442	242	150	132	94	6
HATIA	1996	DEC	1491	977	613	809	966	378	576	233	104	175	245	5
TOTAL 1996			13284	8434	5102	7449	12047	3338	5102	2610	1996	1840	1762	331
MONTHLY MEAN 1996			1107	703	425	621	1004	278	425	218	166	153	147	28
GRAND TOTAL			80584	52187	31026	36928	66344	17918	25597	10938	12418	9906	10177	4085
ANNUAL MEAN 1992/1996			17583	11387	6770	8058	14476	3910	5585	2387	2710	2161	2221	891
MONTHLY MEAN 1992/1996			1465	949	564	671	1206	326	465	199	226	180	185	74

Source: Hatia Thana Health Complex March 1997

Table V.1.10 : Fever and malaria survey data summary

HH No.	Location	Land holding	Household with fever case in last year	Number of attacks in last year	Monthly of attack*	Malaria identified	Riggors occoured	Consulted doctor	Treatment taken
1	Char Osman	Landless	1	2	3,3	0	0	0	0
2	Char Osman	Landless	1	3	3,8,9,10	0	0	1	1
3	Char Osman	Landless	0	0	0	0	0	0	0
4	Char Osman	Landless	1	2	2,12	1	1	1	1
5	Char Osman	Landless	1	2	2,8	0	0	1	1
6	Char Osman	Landless	1	1	10	0	0	0	0
7	Char Osman	Marginal	1	1	9	1	1	1	1
8	Char Osman	Small	1	1	3	0	0	1	1
9	Char Osman	Small	1	2	2,10	1	1	1	1
10	Char Osman	Small	1	1	10	0	0	0	0
11	Char Osman	Small	1	2	3,7	0	0	1	1
12	Char Osman	Small	1	1	4	0	0	0	0
13	Char Osman	Small	1	2	2,7	1	1	1	1
14	Char Osman	Small	1	1	8	0	0	0	0
15	Char Osman	Small	1	3	3,7,9	1	1	1	1
16	Char Osman	Small	1	1	10	0	0	0	0
17	Char Osman	Small	1	2	8,12	0	0	1	1
18	Char Osman	Small	1	1	11	0	0	0	0
19	Char Osman	Small	1	1	12	0	0	0	0
20	Char Osman	Medium	1	2	8,10	0	0	1	1
26	Char Hare	Landless	1	1	8	1	1	0	0
27	Char Hare	Landless	1	7*	?	1	1	1	1
28	Char Hare	Landless	1	2	2,8	1	1	1	1
29	Char Hare	Marginal	0	0	0	0	0	0	0
30	Char Hare	Marginal	1	2	4,9	0	0	0	0
31	Char Hare	Small	1	2	2,7	1	1	0	0
32	Char Hare	Medium	1	1	3	0	0	0	0
33	Char Hare	Medium	1	2	4,12	1	1	1	1
34	Char Hare	Medium	1	3	3,9,12	1	1	1	1
35	Char Hare	Medium	1	4	3,5,8,11	1	1	1	1
36	Char Hare	Medium	1	1	8	0	0	0	0
37	Char Hare	Large	1	6	?	1	1	1	1
38	Char Hare	Large	1	2	2,8	1	1	0	0
39	Char Hare	Large	1	3	2,4,7	1	1	1	1
40	Char Hare	Large	1	2	7,12	0	0	0	0
41	Char McPharson	Landless	1	2	?	0	0	0	0
42	Char McPharson	Landless	1	2	3,9	0	0	0	0
43	Char McPharson	Landless	1	2	3,9	1	1	1	1
44	Char McPharson	Marginal	1	2	4,9	T	0	1	1
45	Char McPharson	Marginal	1	2	9,11	1	1	1	1
46	Char McPharson	Small	1	2	3,8	1	1	1	1
47	Char McPharson	Small	1	3	2,5,12	1	1	1	1
48	Char McPharson	Small	1	2	4,10	1	1	1	1
49	Char McPharson	Small	1	3	3,9,12	1	1	1	1
50	Char McPharson	Small	1	3	3,7,11	1	1	1	1
51	Char McPharson	Medium	1	3	?	1	1	1	1
52	Char McPharson	Medium	1	2	?	0	0	0	0
53	Char McPharson	Medium	1	3	2,7,9	0	0	0	0
54	Char McPharson	Medium	1	2	7,12	0	0	1	1
55	Char McPharson	Medium	1	4	?	1	1	1	1
Total			48 OUT OF 50	106	83	24	24	29	29

Source: MES Field Survey 11th-13th April 1997

Note: * Month 1 = January

T = Conformed typhoid case

Cases by month:

Month	Cases	Rank
Jan	0	11
Feb	10	4
March	14	1
April	6	8
May	2	10
June	0	11
July	9	5
Aug	11	2
Sept	11	2
Oct	7	7
Nov	4	9
Dec	9	5
TOTAL	83	

Summary:

1. 48 households of the 50 interviewed reported cases of fever in the last 12 months
2. The 48 households reporting fever had 106 fever attacks during the 12 month period
3. Of the 48 households reporting fever 24 identified at least one of the attacks to be malaria
4. The fever incidence shows concentration during the wet period (August/September) and the dry period (February/March).
5. Of the 48 households reporting fever, 29 consulted a doctor, normally a local traditional doctor.
6. The 29 households who consulted a doctor were given treatment for the fever but not for the malaria which may have caused it.

Table V.1.11 : Nutrition survey data summary

HH No.	Location	Land holding	Number of Meals eaten per day	Number of times the following food stuffs have been eaten in the last 7 days							
				Rice	Pulses	Fish	Meat	Vegetables	Fruits	Milk	Others
1	Char Osman	Landless	3	21	2	21	0	2	2	0	0
2	Char Osman	Landless	3	21	0	20	2	3	6	8	0
3	Char Osman	Landless	3	21	1	21	1	3	5	3	0
4	Char Osman	Landless	3	21	0	21	0	7	5	4	0
5	Char Osman	Landless	2	15	0	15	2	12	8	7	0
6	Char Osman	Landless	1	7	0	7	0	3	0	0	0
7	Char Osman	Marginal	3	21	4	21	6	8	4	18	0
8	Char Osman	Small	3	21	0	21	1	2	2	2	0
9	Char Osman	Small	3	21	0	21	2	10	2	4	0
10	Char Osman	Small	3	21	2	20	3	4	3	2	0
11	Char Osman	Small	3	21	1	21	0	6	2	1	0
12	Char Osman	Small	3	21	3	21	1	7	4	0	0
13	Char Osman	Small	3	21	5	21	2	8	3	1	0
14	Char Osman	Small	3	21	6	21	3	10	4	2	0
15	Char Osman	Small	3	21	4	20	2	12	2	2	0
16	Char Osman	Small	3	21	6	21	0	14	6	4	0
17	Char Osman	Small	3	21	6	20	3	12	2	0	0
18	Char Osman	Small	3	21	0	21	2	14	6	4	0
19	Char Osman	Small	3	21	3	21	2	10	3	1	0
20	Char Osman	Medium	3	21	3	21	1	2	1	3	0
26	Char Hare	Landless	3	21	2	10	0	21	0	0	0
27	Char Hare	Landless	3	21	0	21	0	15	0	0	0
28	Char Hare	Landless	3	21	0	21	0	10	0	0	0
29	Char Hare	Marginal	2	14	0	14	2	12	7	0	0
30	Char Hare	Marginal	3	21	0	21	0	16	4	0	0
31	Char Hare	Small	3	21	8	21	3	18	5	0	0
32	Char Hare	Medium	3	21	2	21	0	15	0	0	0

HH No.	Location	Land holding	Number of Meals eaten per day	Number of times the following food stuffs have been eaten in the last 7 days							
				Rice	Pulses	Fish	Meat	Vegetables	Fruits	Milk	Others
33	Char Hare	Medium	3	21	1	18	1	13	2	0	0
34	Char Hare	Medium	3	21	2	21	3	16	6	2	0
35	Char Hare	Medium	3	21	4	21	0	12	4	0	0
36	Char Hare	Medium	3	21	0	21	0	16	2	0	0
37	Char Hare	Large	3	21	0	4	1	16	5	1	Eggs
38	Char Hare	Large	3	21	3	21	2	14	6	2	0
39	Char Hare	Large	3	21	7	21	4	18	9	4	0
40	Char Hare	Large	3	21	6	21	3	16	6	2	0
41	Char McPharson	Landless	1.5	8.5	0	6	0	7	0	0	0
42	Char McPharson	Landless	1.5	10	9	0	0	21	0	0	0
43	Char McPharson	Landless	1.5	9	1	2	0	21	0	0	0
44	Char McPharson	Marginal	2	16	12	3	0	12	0	0	0
45	Char McPharson	Marginal	2	17	6	4	0	4	0	0	0
46	Char McPharson	Small	3	21	0	10	0	14	0	0	0
47	Char McPharson	Small	3	21	0	12	0	10	0	0	0
48	Char McPharson	Small	3	21	4	18	0	12	0	0	0
49	Char McPharson	Small	3	21	2	16	0	116	0	0	0
50	Char McPharson	Small	3	21	0	14	0	10	0	0	0
51	Char McPharson	Medium	3	21	0	21	3	16	8	7	0
52	Char McPharson	Medium	3	21	4	21	4	14	3	6	0
53	Char McPharson	Medium	3	21	6	16	2	16	8	0	0
54	Char McPharson	Medium	3	21	3	21	0	18	6	4	0
55	Char McPharson	Medium	3	21	6	21	0	14	7	6	0
Total			139.5	978.5	134	858	61	682	158	100	0
MEAN FOR 7 DAY PERIOD			19.5	19.6	2.7	17.2	1.2	13.6	3.2	2.0	0.0
MEAN PER DAY			2.8	2.80	0.38	2.45	0.17	1.95	0.45	0.29	0.00

Source: MES Field Survey 11th-13th April 1997

Table V.1.12 : Land accretion areas with and without the proposed cross-dams to different levels in hectares

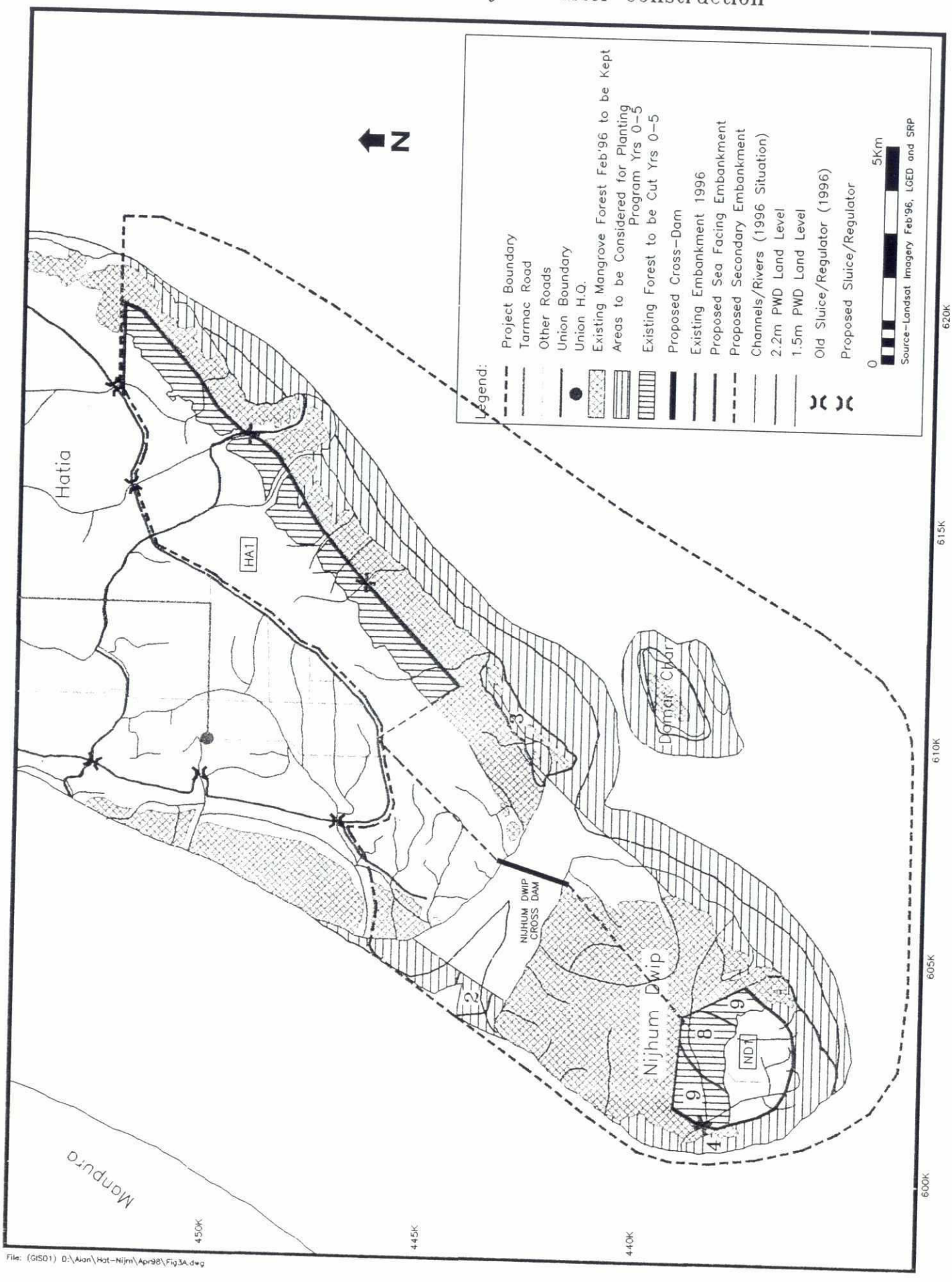
	OPTION 1			OPTION 2			OPTION 3			OPTION 2 - 1			OPTION 3 - 1			OPTION 3 - 2		
	Future with no cross dam			Future with one cross dam			Future with two cross dam			Difference due to dam one only			Difference due to two dams			Additional area of dam 2 over dam 1		
Year	+1.5m	+2.0m	+2.2m	+1.5m	+2.0m	+2.2m	+1.5m	+2.0m	+2.2m	+1.5m	+2.0m	+2.2m	+1.5m	+2.0m	+2.2m	+1.5m	+2.0m	+2.2m
1	91	83	68	520	434	397	520	434	397	429	351	329	429	351	329	0	0	0
2	181	166	136	1040	867	793	1040	867	793	859	701	657	859	701	657	0	0	0
3	272	249	204	1561	1301	1190	1561	1301	1190	1289	1052	986	1289	1052	986	0	0	0
4	363	332	272	2081	1734	1586	2081	1734	1586	1718	1402	1314	1718	1402	1314	0	0	0
5	455	416	341	2601	2168	1983	2601	2168	1983	2146	1752	1642	2146	1752	1642	0	0	0
6	545	499	409	2783	2322	2131	2973	2451	2239	2238	1823	1722	2428	1952	1830	190	129	108
7	636	582	477	2965	2477	2278	3344	2734	2494	2329	1895	1801	2708	2152	2017	379	257	216
8	727	665	545	3146	2631	2426	3716	3018	2750	2419	1966	1881	2989	2353	2205	570	387	324
9	817	748	613	3328	2786	2573	4087	3301	3005	2511	2038	1960	3270	2553	2392	759	515	432
10	908	830	681	3510	2940	2721	4459	3584	3261	2602	2110	2040	3551	2754	2580	949	644	540
11	999	913	749	3657	3054	2824	4738	3799	3453	2658	2141	2075	3739	2886	2704	1081	745	629
12	1089	996	817	3803	3168	2927	5018	4015	3644	2714	2172	2110	3929	3019	2827	1215	847	717
13	1180	1079	885	3950	3282	3031	5297	4230	3836	2770	2203	2146	4117	3151	2951	1347	948	805
14	1271	1162	953	4096	3396	3134	5577	4446	4027	2825	2234	2181	4306	3284	3074	1481	1050	893
15	1363	1246	1022	4243	3510	3237	5856	4661	4219	2880	2264	2215	4493	3415	3197	1613	1151	982
16	1453	1329	1090	4371	3610	3326	6074	4840	4380	2918	2281	2236	4621	3511	3290	1703	1230	1054
17	1544	1412	1158	4499	3710	3415	6291	5019	4541	2955	2298	2257	4747	3607	3383	1792	1309	1126
18	1635	1495	1226	4627	3810	3505	6509	5197	4702	2992	2315	2279	4874	3702	3476	1882	1387	1197
19	1725	1578	1294	4755	3910	3594	6726	5376	4863	3030	2332	2300	5001	3798	3569	1971	1466	1269
20	1817	1662	1363	4883	4010	3683	6944	5555	5024	3066	2348	2320	5127	3893	3661	2061	1545	1341
21	1908	1745	1431	4996	4101	3764	7114	5706	5163	3088	2356	2333	5206	3961	3732	2118	1605	1399
22	1999	1828	1499	5109	4192	3845	7285	5857	5302	3110	2364	2346	5286	4029	3803	2176	1665	1457
23	2089	1911	1567	5221	4283	3927	7455	6009	5440	3132	2372	2360	5366	4098	3873	2234	1726	1513
24	2180	1994	1635	5334	4374	4008	7626	6160	5579	3154	2380	2373	5446	4166	3944	2292	1786	1571
25	2272	2078	1704	5447	4465	4089	7796	6311	5718	3175	2387	2385	5524	4233	4014	2349	1846	1629
26	2363	2161	1772	5546	4549	4164	7929	6439	5839	3183	2388	2392	5566	4278	4067	2383	1890	1675
27	2453	2244	1840	5646	4632	4239	8062	6567	5960	3193	2388	2399	5609	4323	4120	2416	1935	1721
28	2544	2327	1908	5745	4716	4315	8196	6696	6080	3201	2389	2407	5652	4369	4172	2451	1980	1765
29	2635	2410	1976	5845	4799	4390	8329	6824	6201	3210	2389	2414	5694	4414	4225	2484	2025	1811
30	2725	2493	2044	5944	4883	4465	8462	6952	6322	3219	2390	2421	5737	4459	4278	2518	2069	1857

Source: MES Sedimentation modelling 1998

APPENDIX 2

LIST OF FIGURES

Figure V.2.1a: Option 2, 1Cross-Dam 5 years after Construction



Figire V.2.1b: Option 2, 1Cross-Dam 15 years after Construction

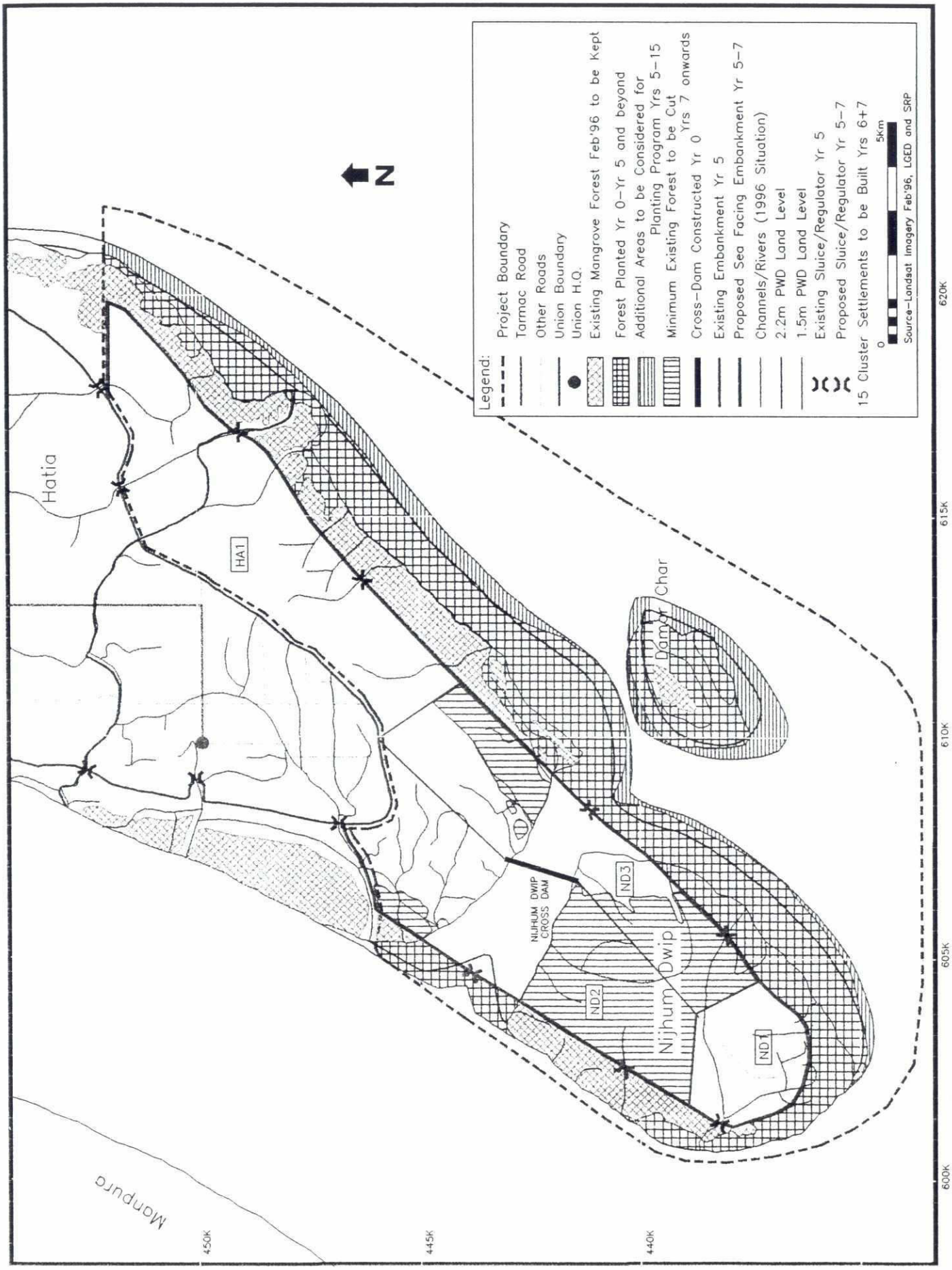


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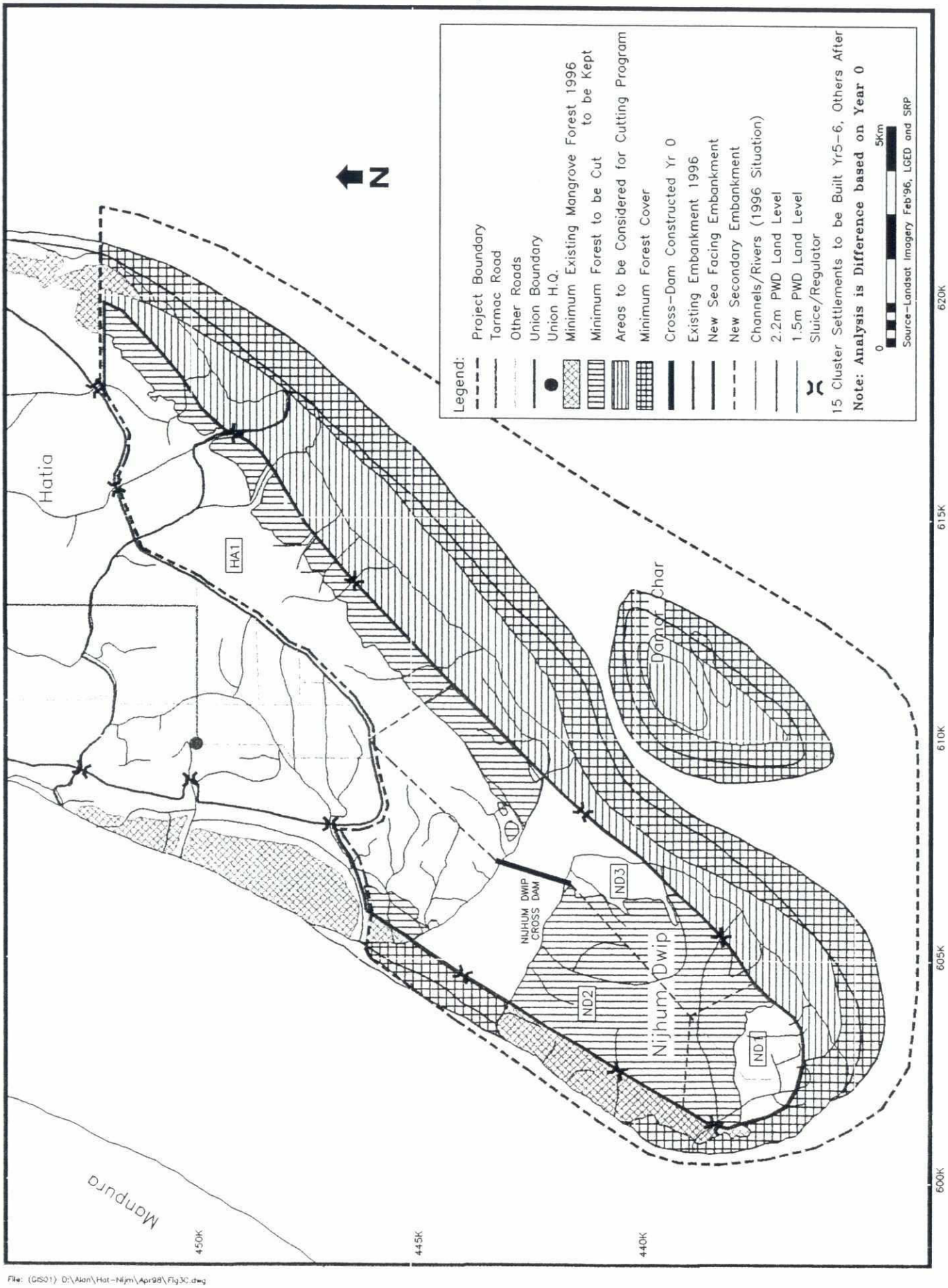
Figure V.2.1c: Option 2, 1Cross-Dam 30 years after Construction



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3DD

Figure V.2.1d: Option 3, 2Cross-Dams at Year 15

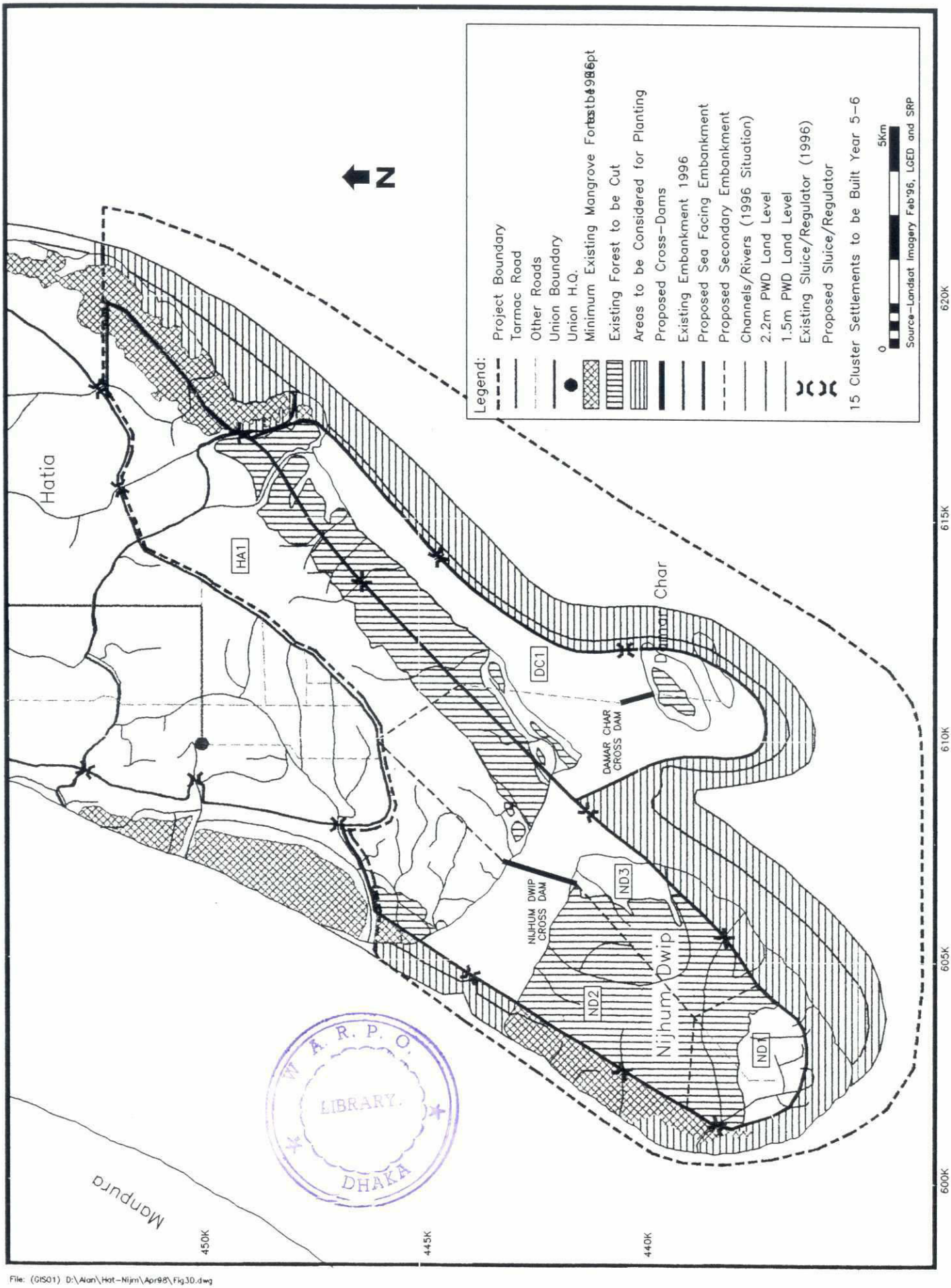

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Figure V.2.1e: Option 3, 2Cross-Dams at Year 30

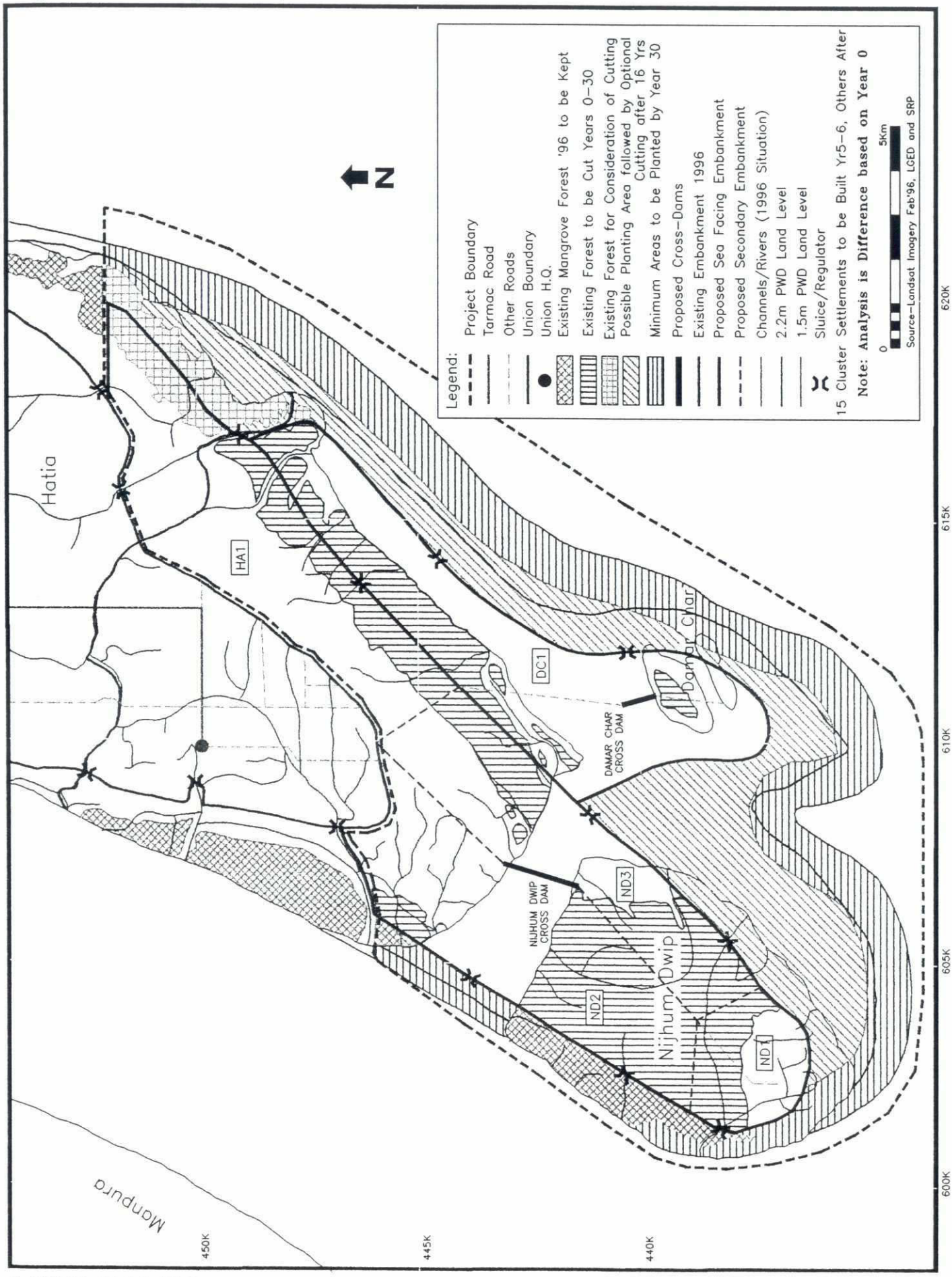

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Figure V.2.2 : Landsat Image of February 1996

Figure V.2.3: Topography and Bathymetry.

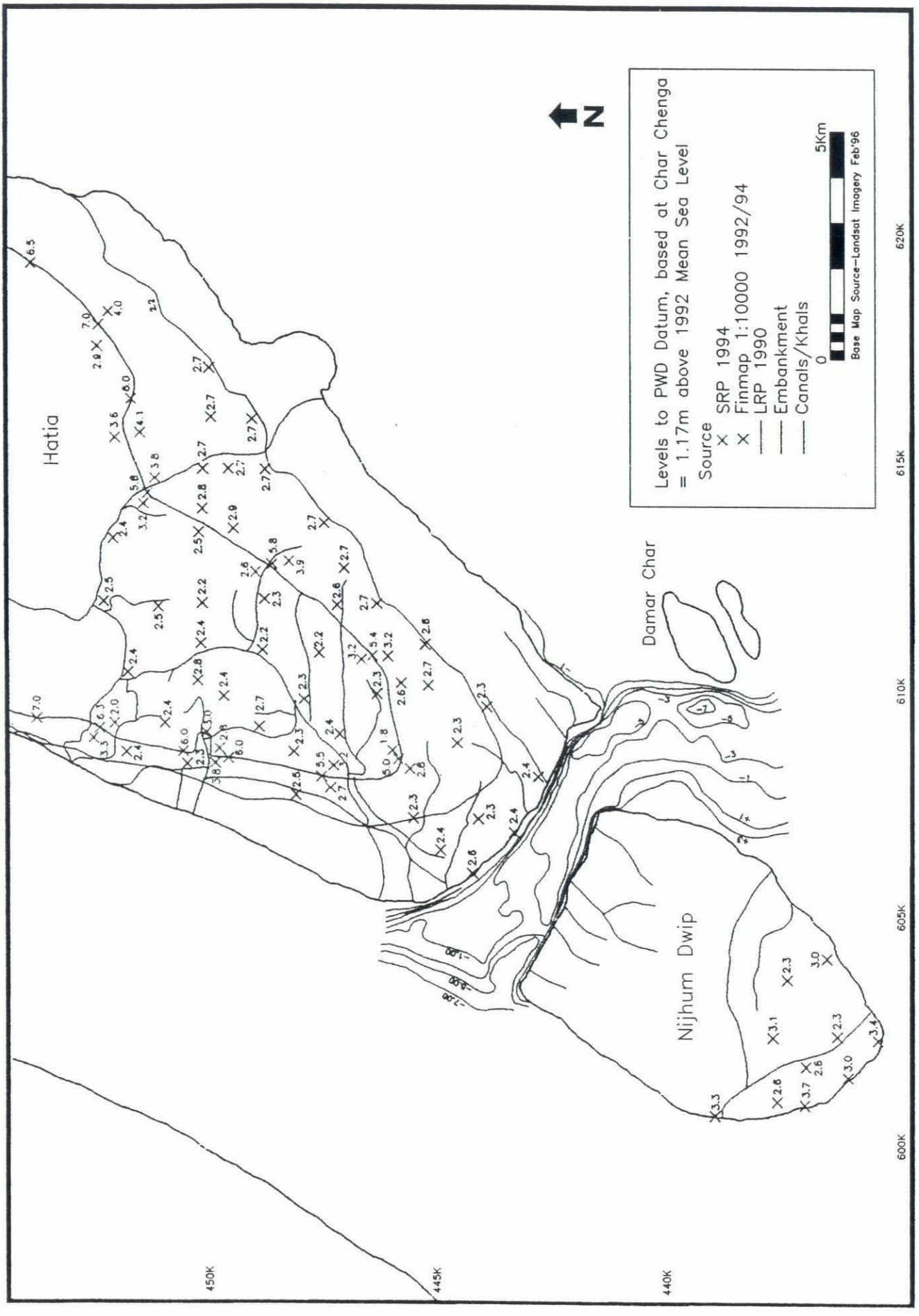


Figure V.2.4a : Water levels at Char Chenga, Hatia of 1997

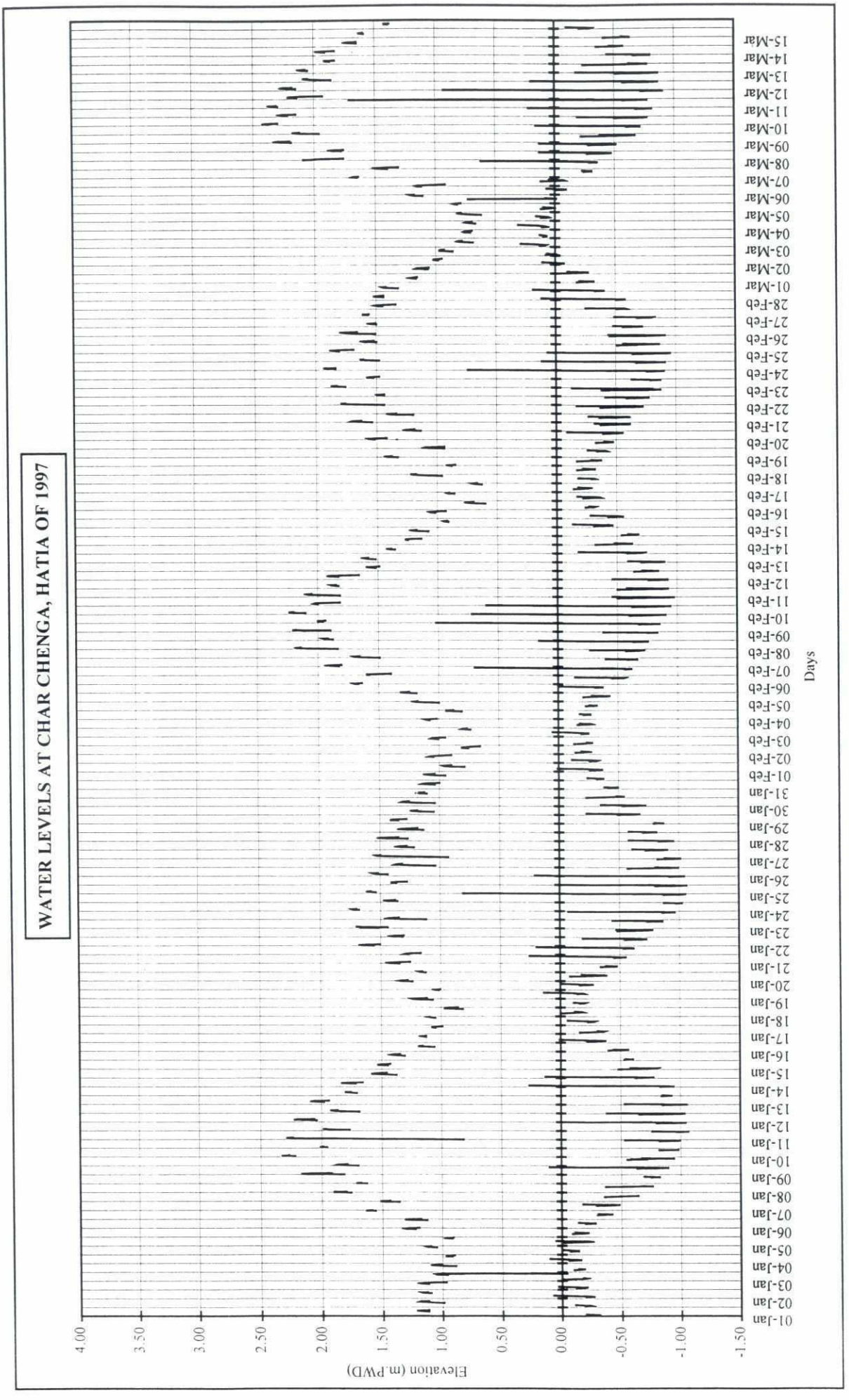


Figure V.2.4a : Water levels at Char Chenga, Hatia of 1997

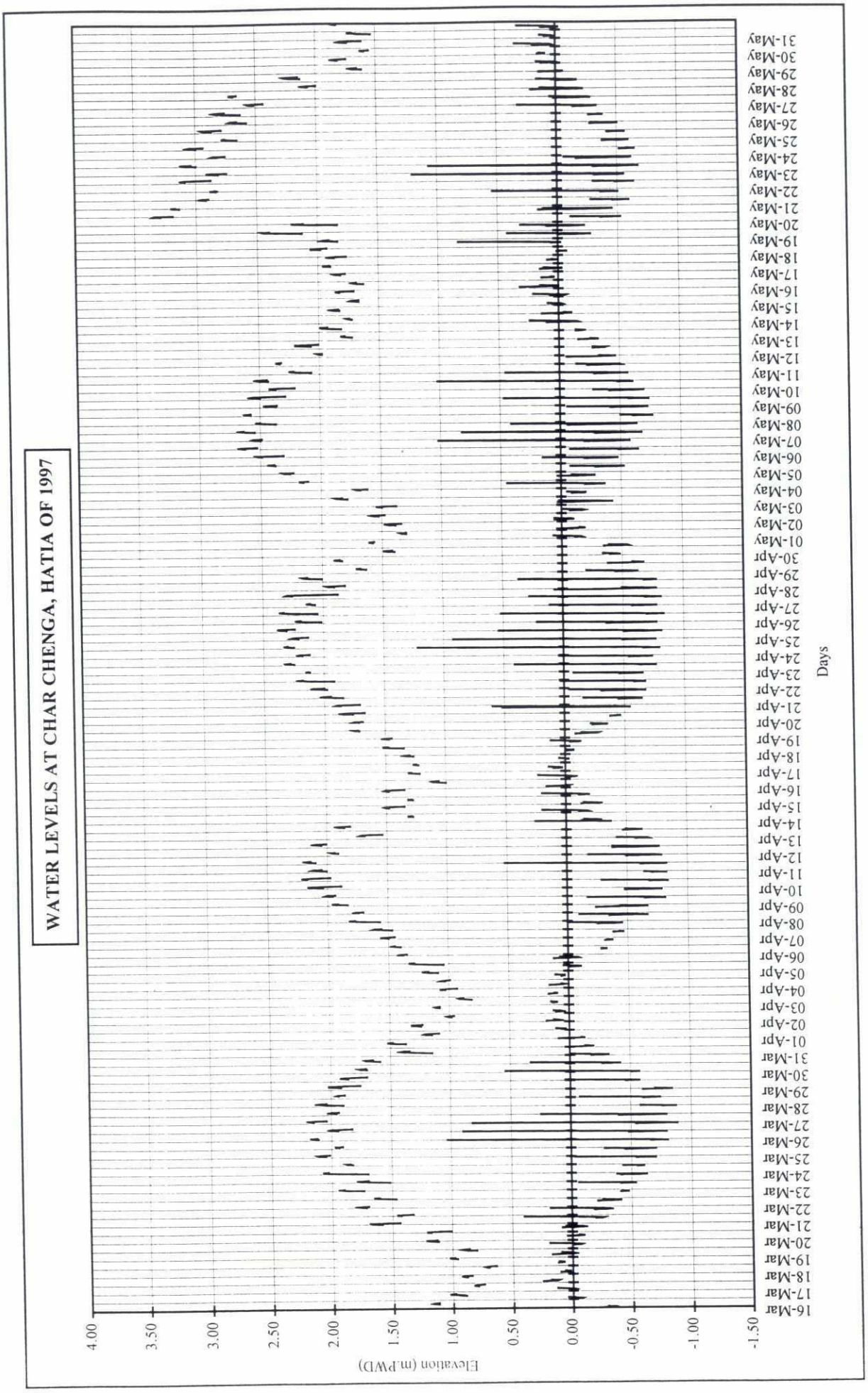


Figure V.2.4a : Water levels at Char Chenga, Hatia of 1997

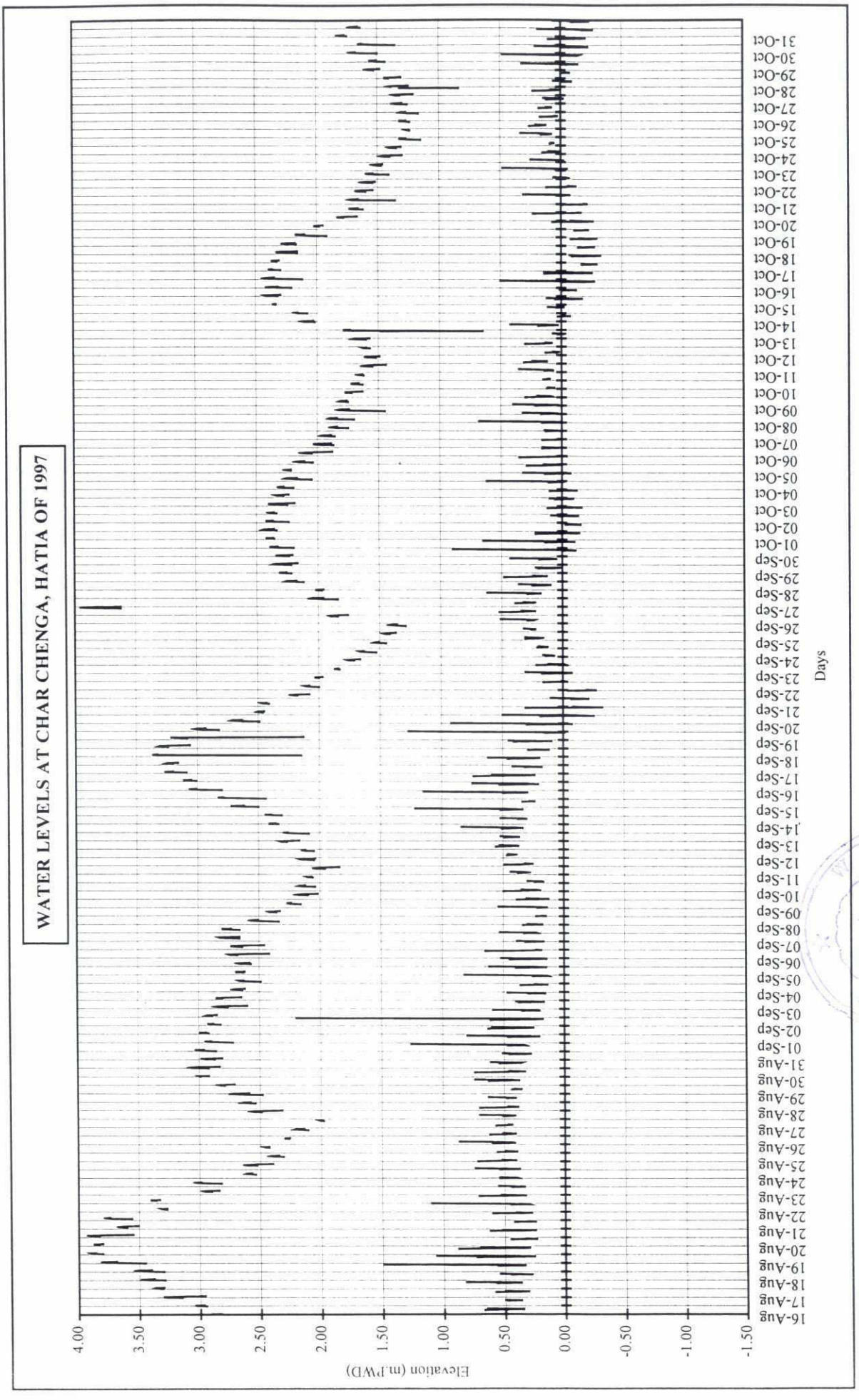


Figure V.2.4a : Water levels at Char Chenga, Hatia of 1997

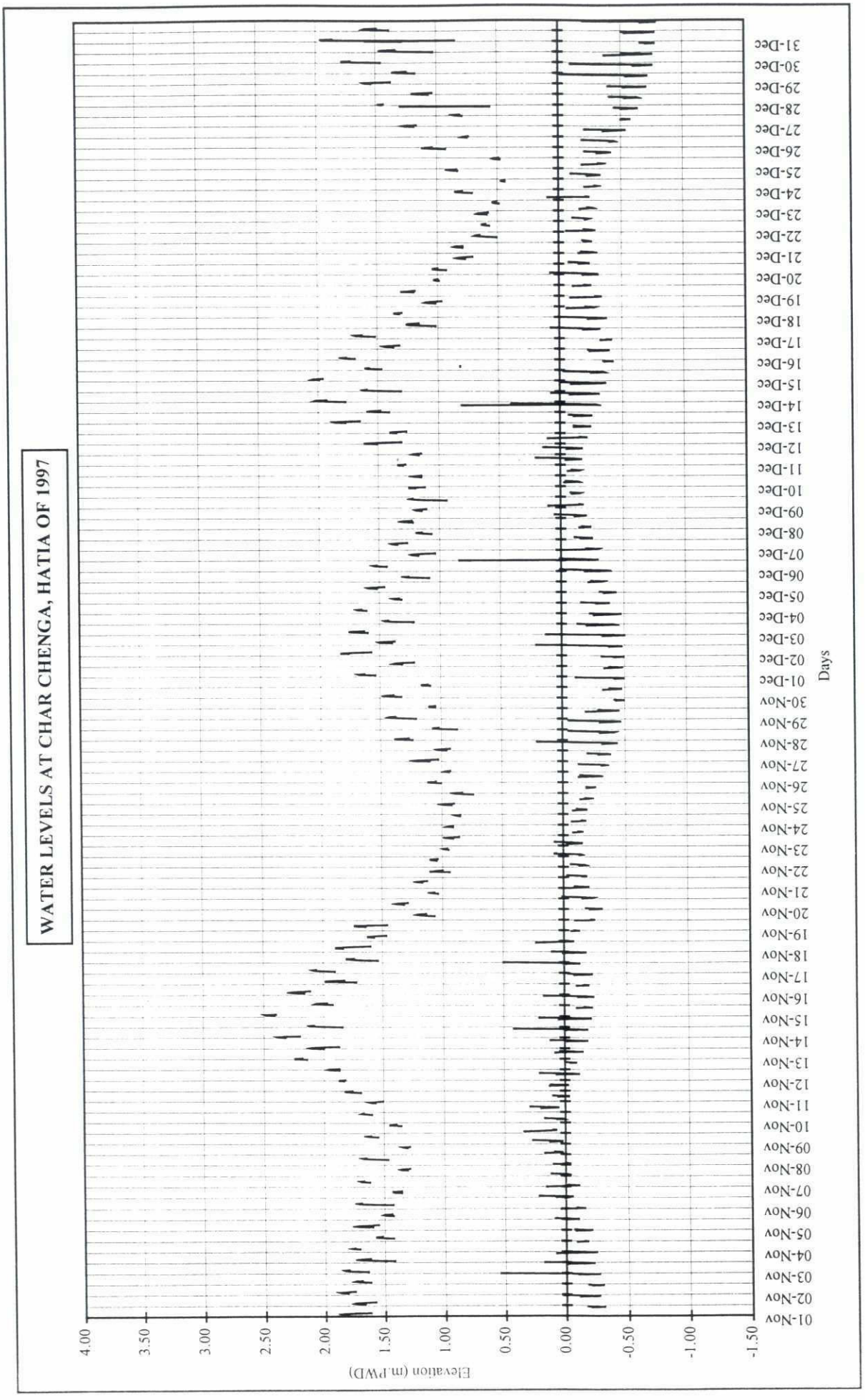


Figure V.2.4b : Water levels at Char Chenga, Hatia of 1994

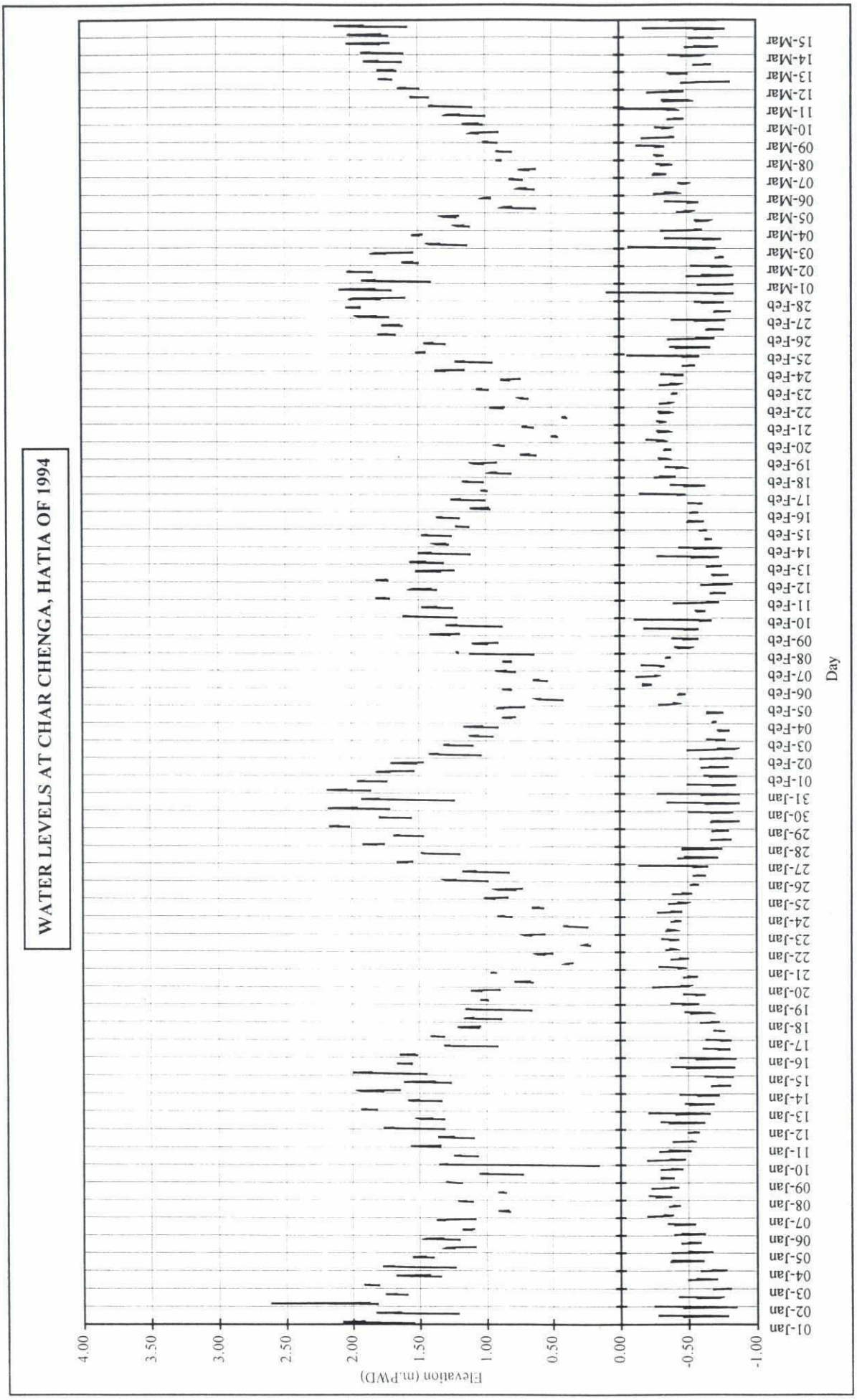


Figure V.2.4b : Water levels at Char Chenga, Hatia of 1994

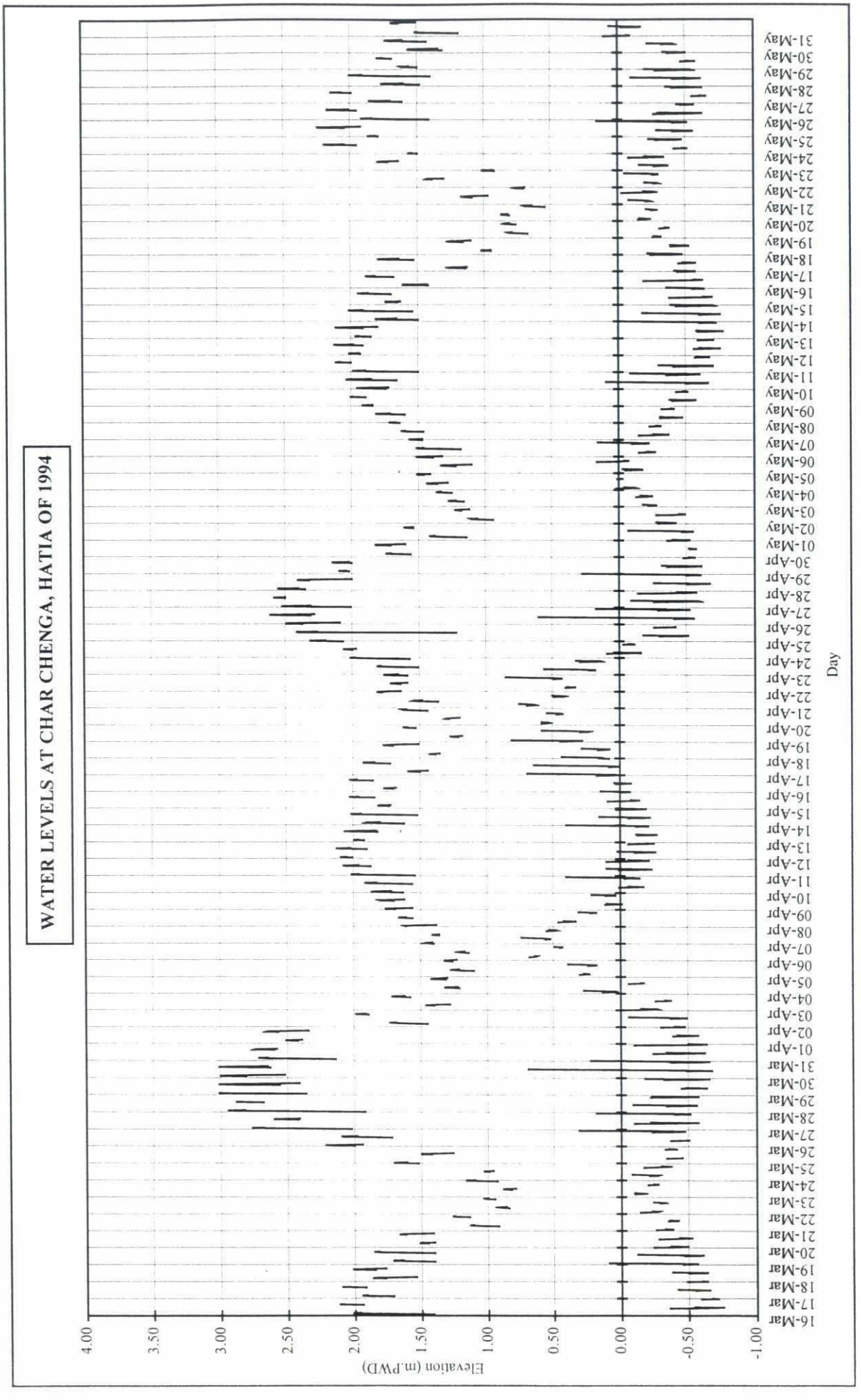


Figure V.2.4b : Water levels at Char Chenga, Hatia of 1994

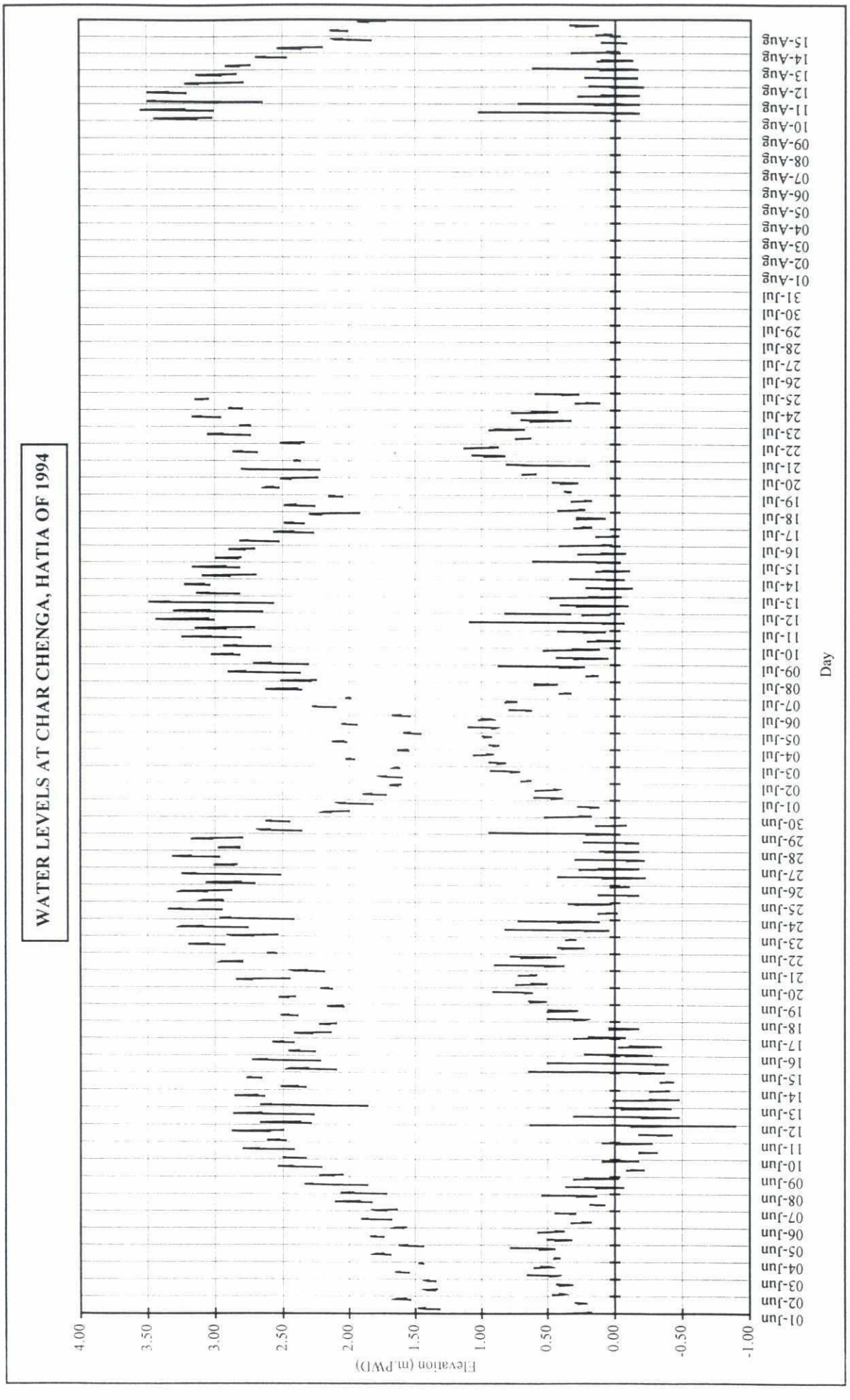


Figure V.2.4b : Water levels at Char Chenga, Hatia of 1994

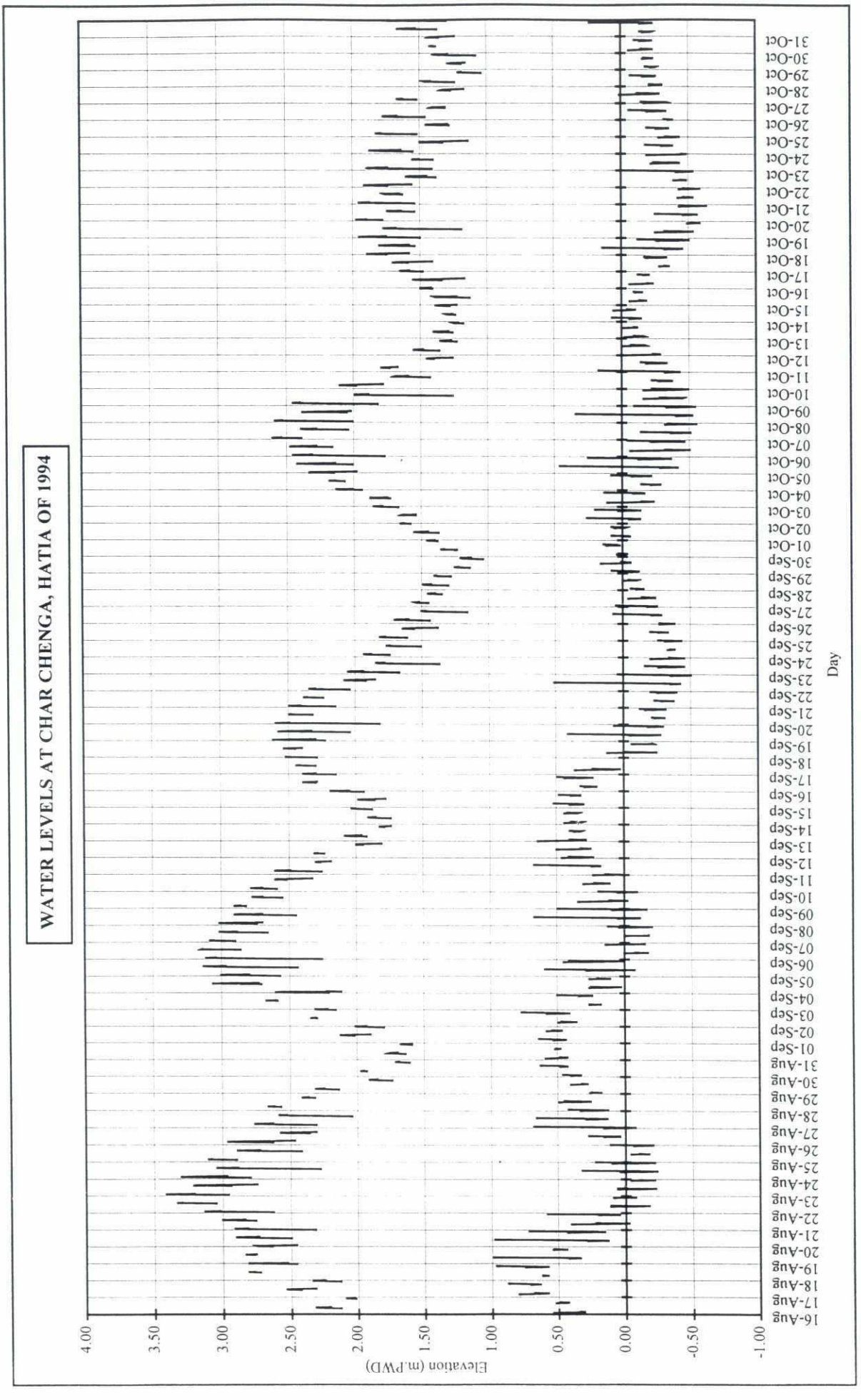


Figure V.2.4b : Water levels at Char Chenga, Hatia of 1994

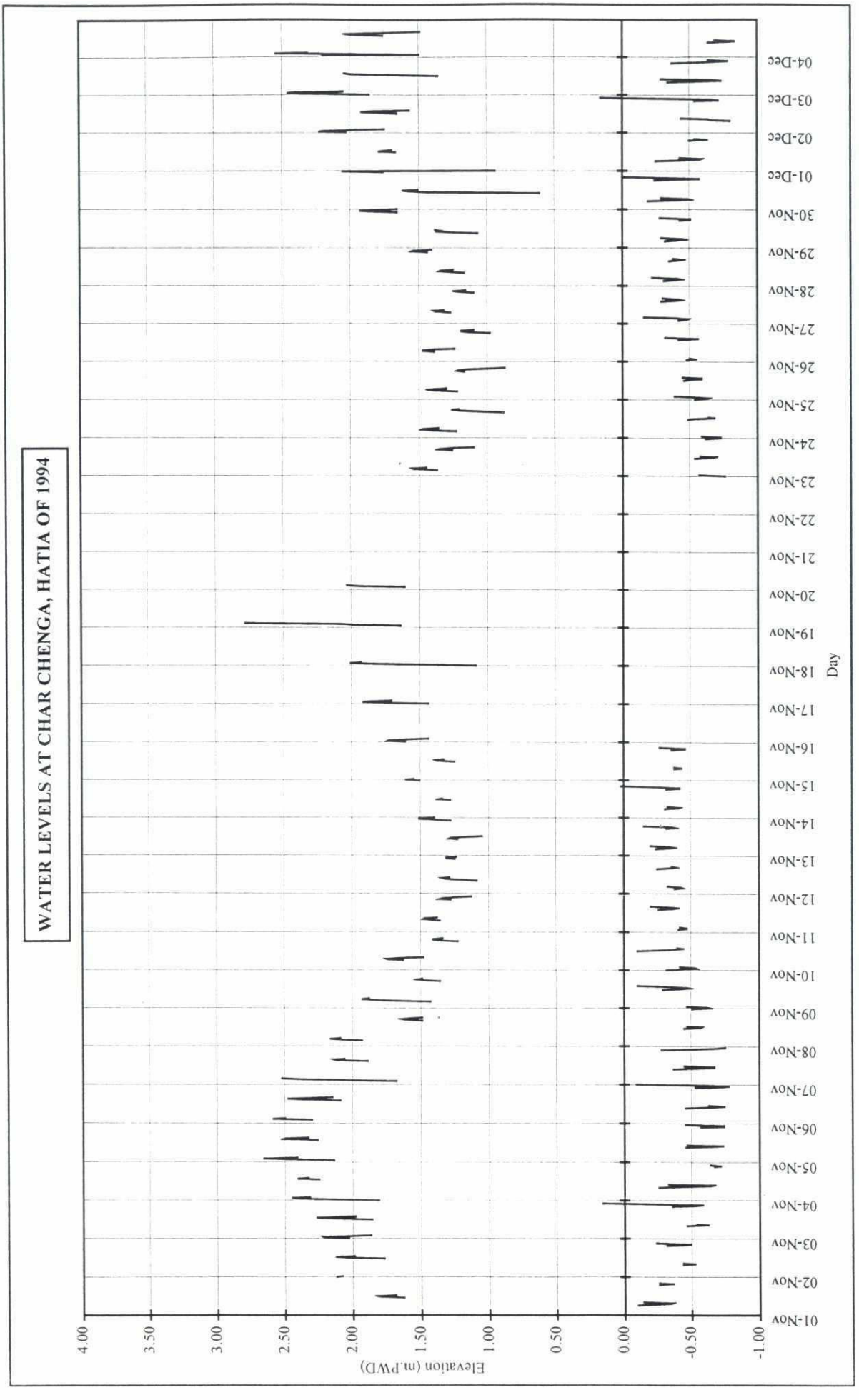


Figure V.2.4c : Water levels at Char Chenga, Hatia of 1995

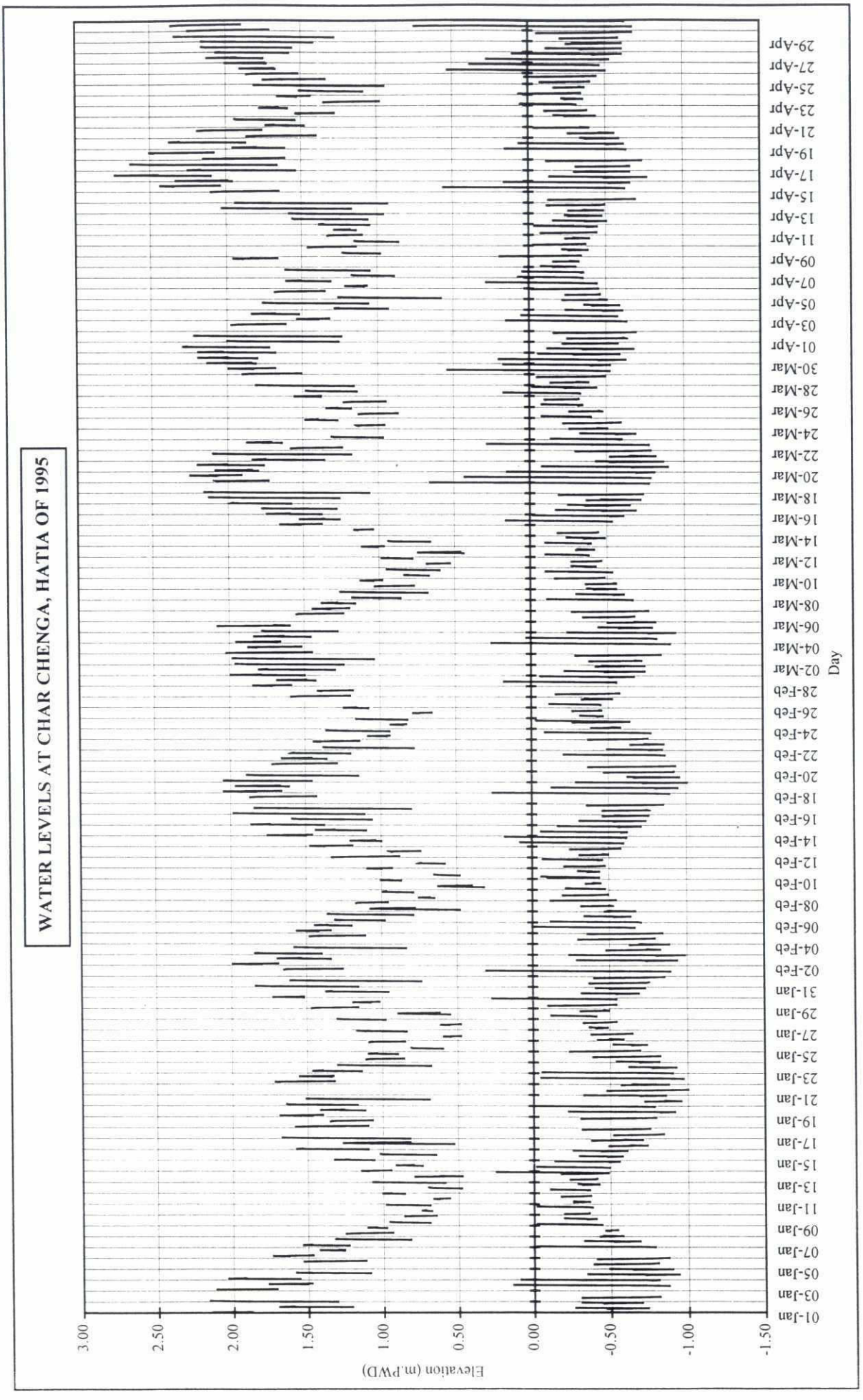


Figure V.2.4c : Water levels at Char Chenga, Hatia of 1995

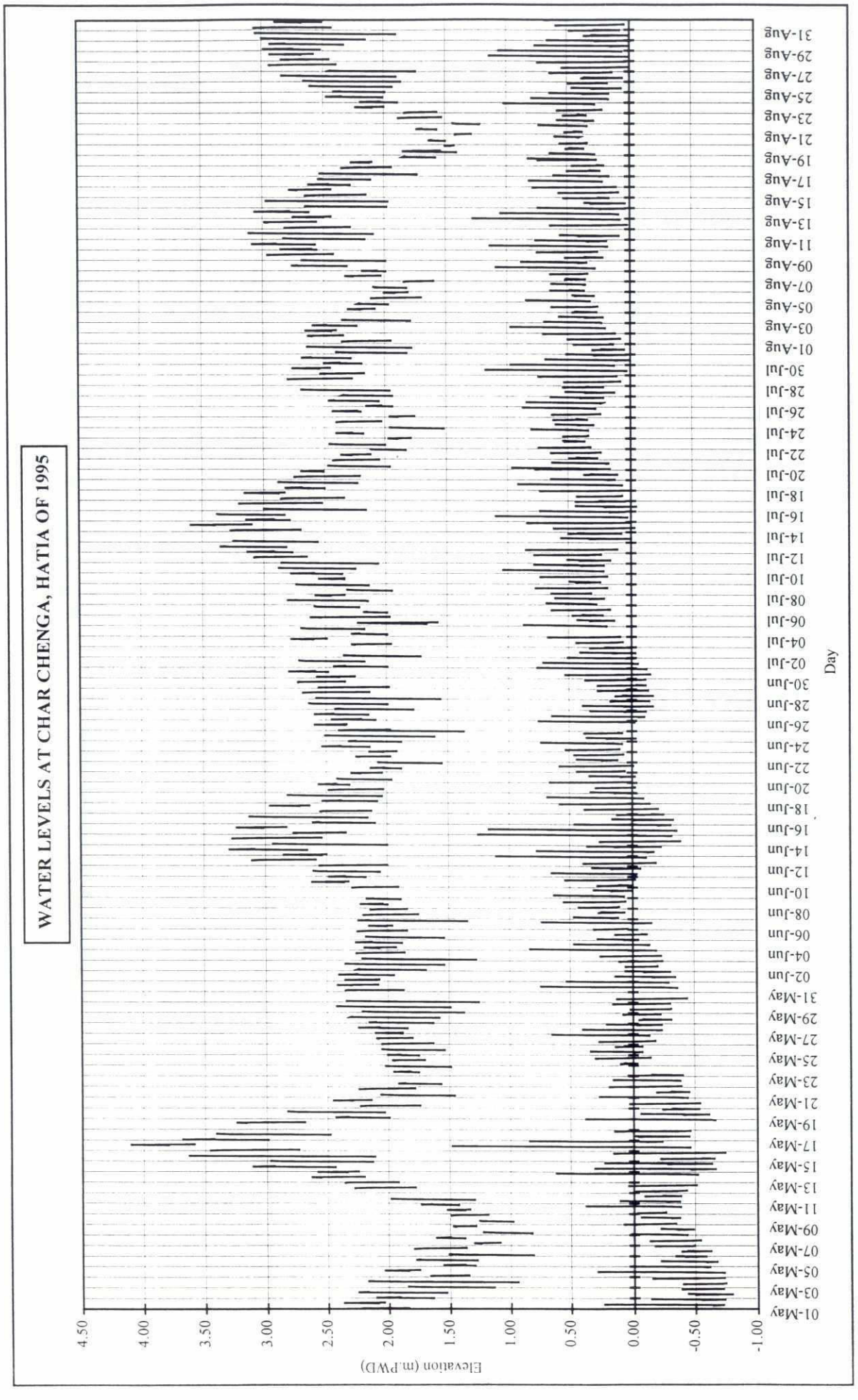


Figure V.2.4c : Water levels at Char Chenga, Hatia of 1995

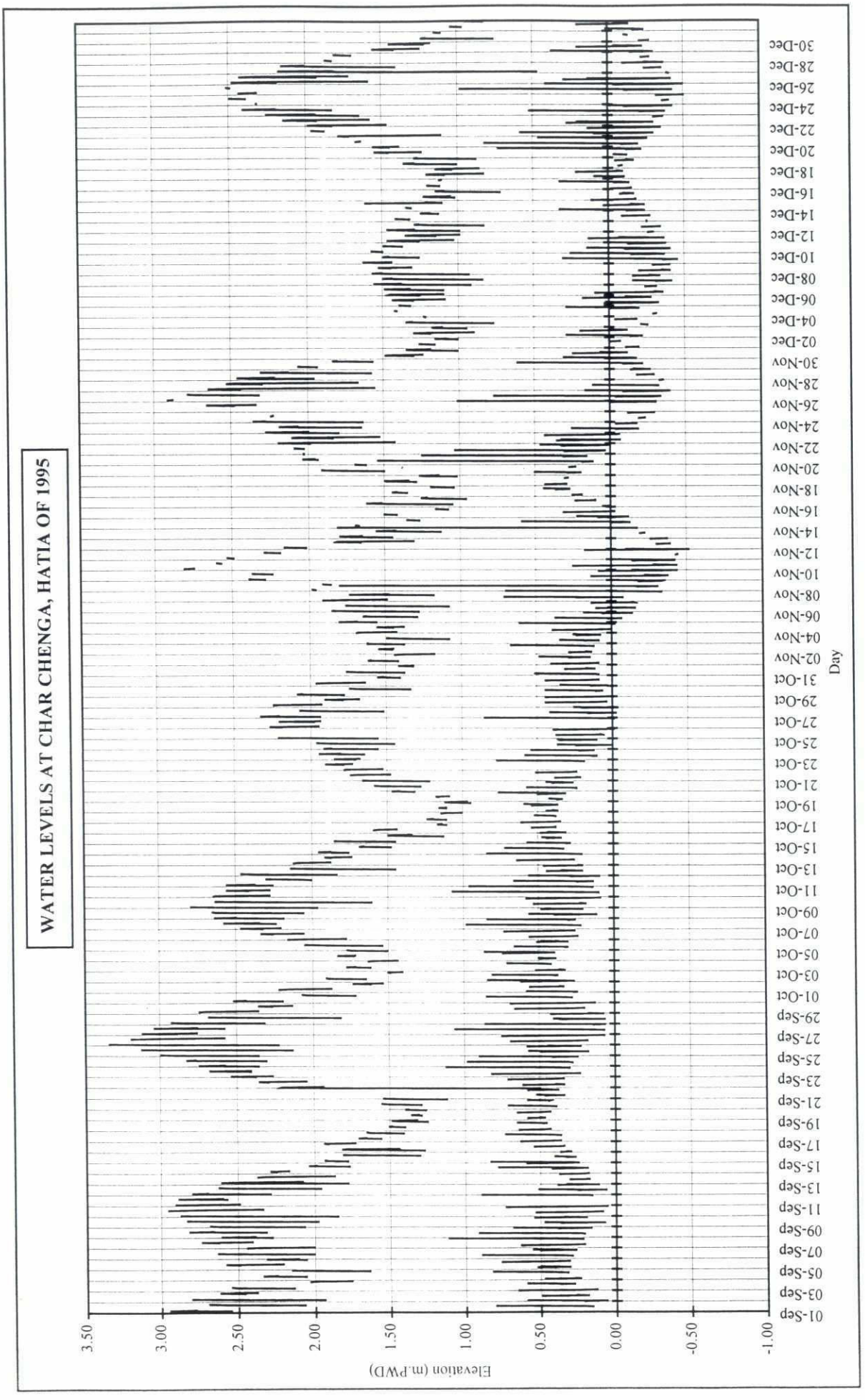
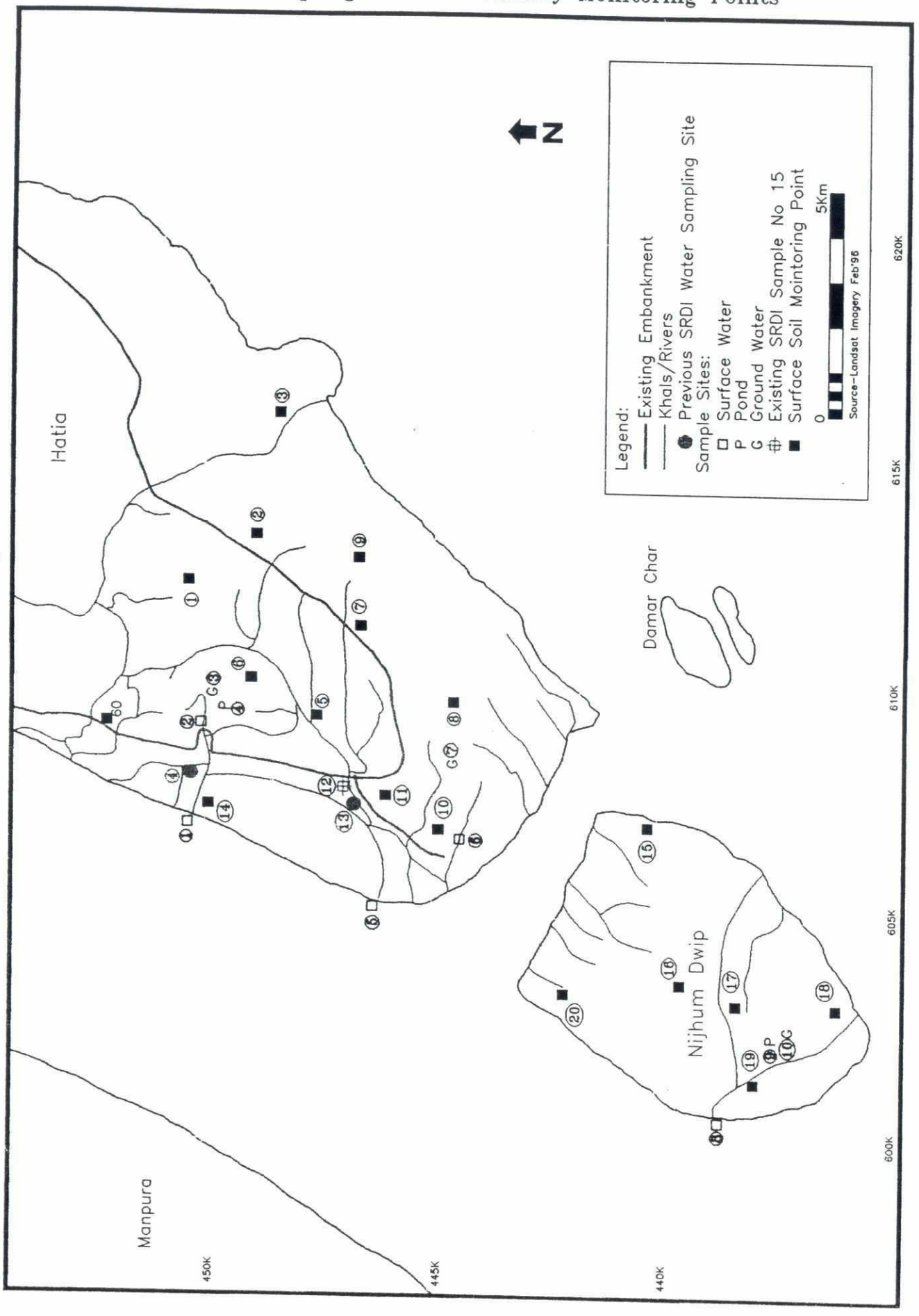


Figure V.2.5: Water Sampling and Soil Salinity Monitoring Points



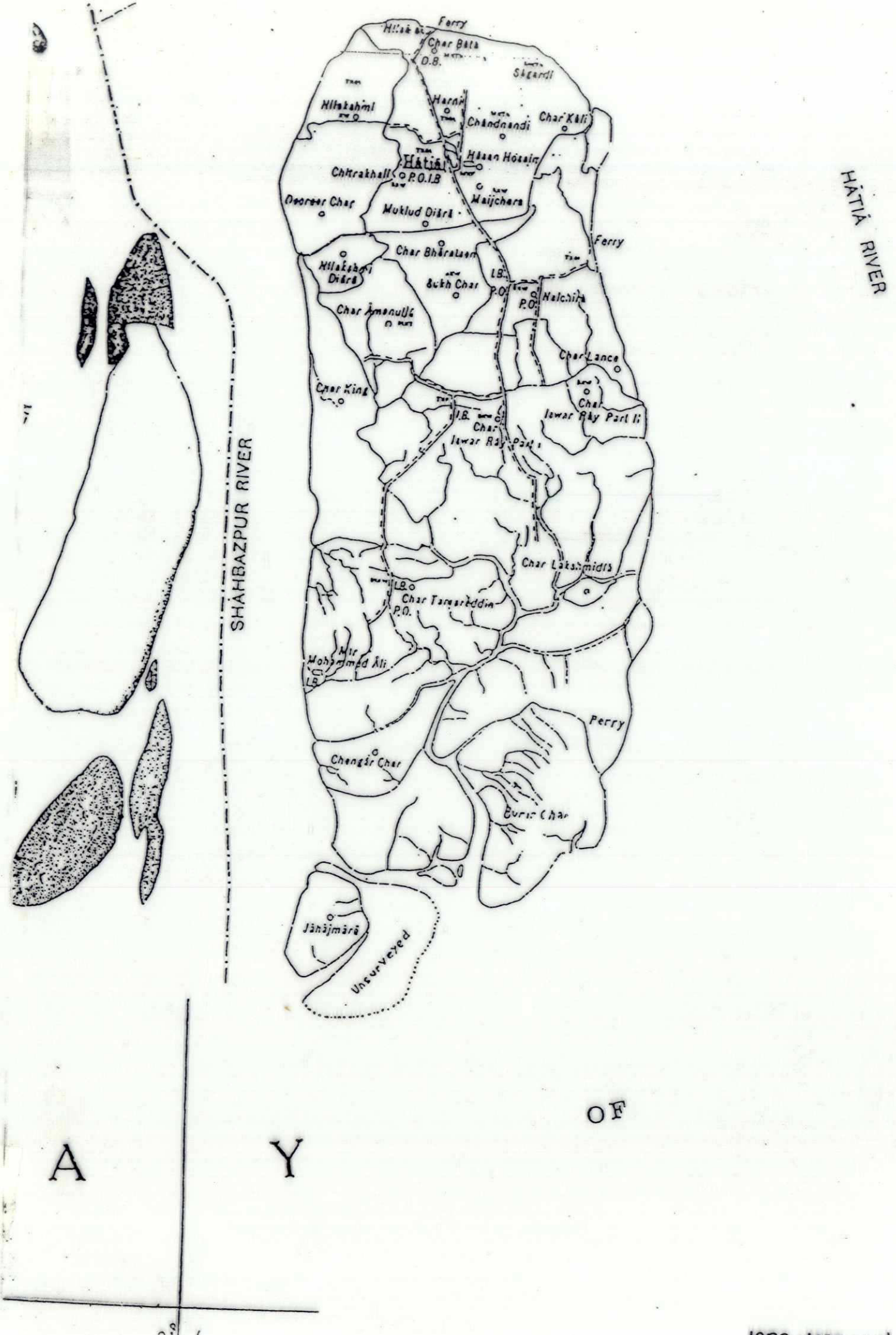
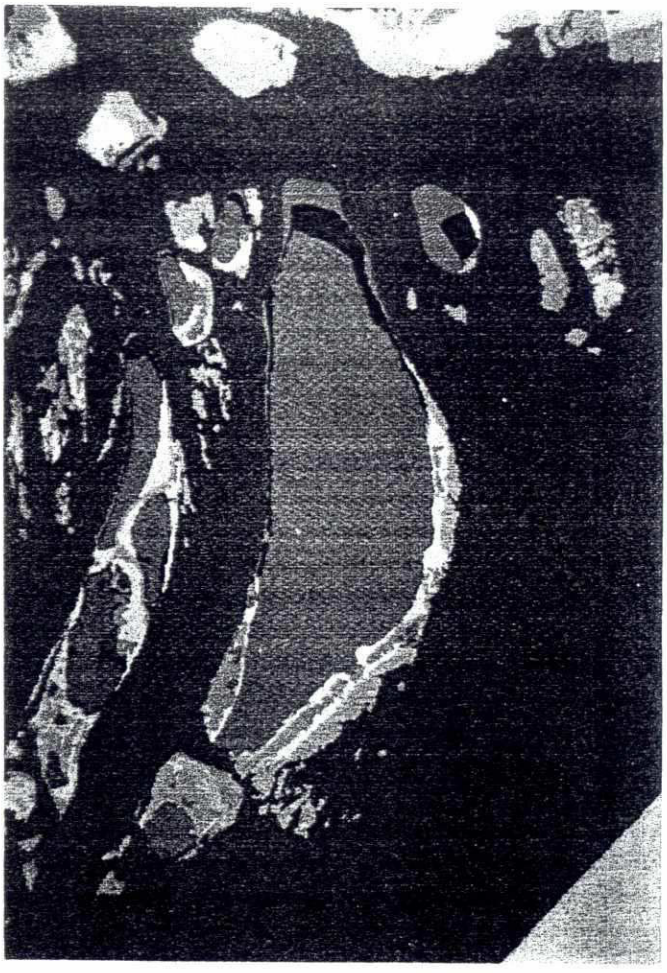

HÀTIÀ RIVER
SHÀHBAZPUR RIVER
Ferry
Char Bata
D.B.
Sagardi
Hilsakhali
Harnia
Chandnandi
Char Kali
Hatia
Hasan Hosain
Chitrakhali
P.O.I.B
Muklud Dihri
Maijchara
Char Bharatkhali
Ferry
Hilsakhali Dihri
Bukh Char
L.B.
P.O.
Nalchira
Char Amanulla
Char Lance
Char King
Char Iswar Roy Part II
Char Iswar Roy Part I
Char Laksmidia
Char Tamaruddin
P.O.
Mir Mohammad Ali
L.B.
Ferry
Chengar Char
Jahajmara
Unsurveyed
OF
A
Y
1883-1888 revised

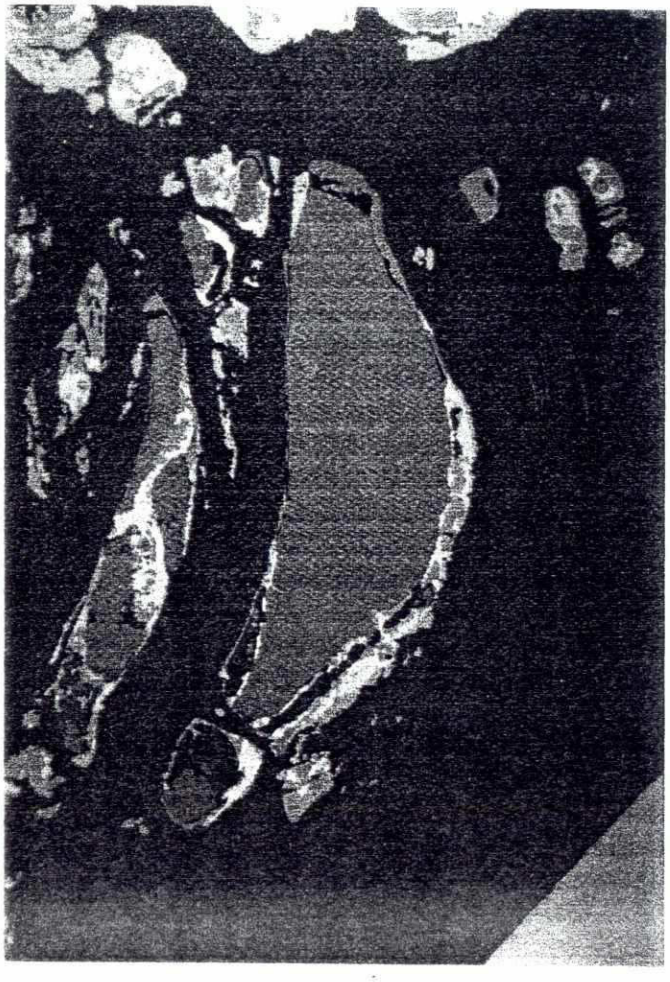
Figure V.2.6 Change in Hatia Island Extent 1883 to 1996

Figure V.2.7 : Erosion and accretion patterns Hatia island 1973-1996

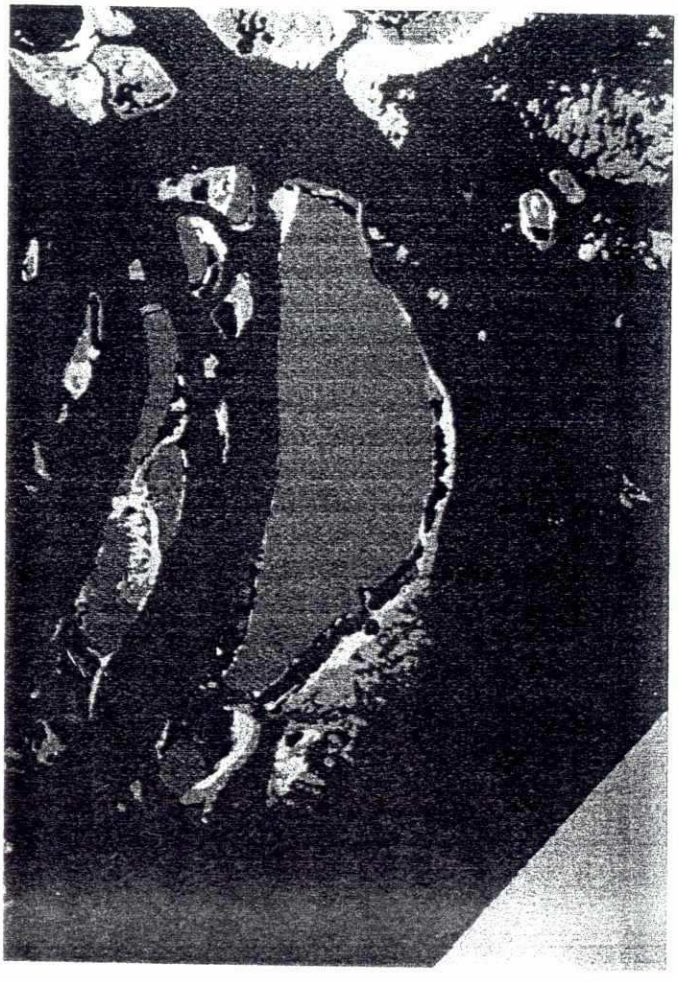
1974-1979



1979-1984

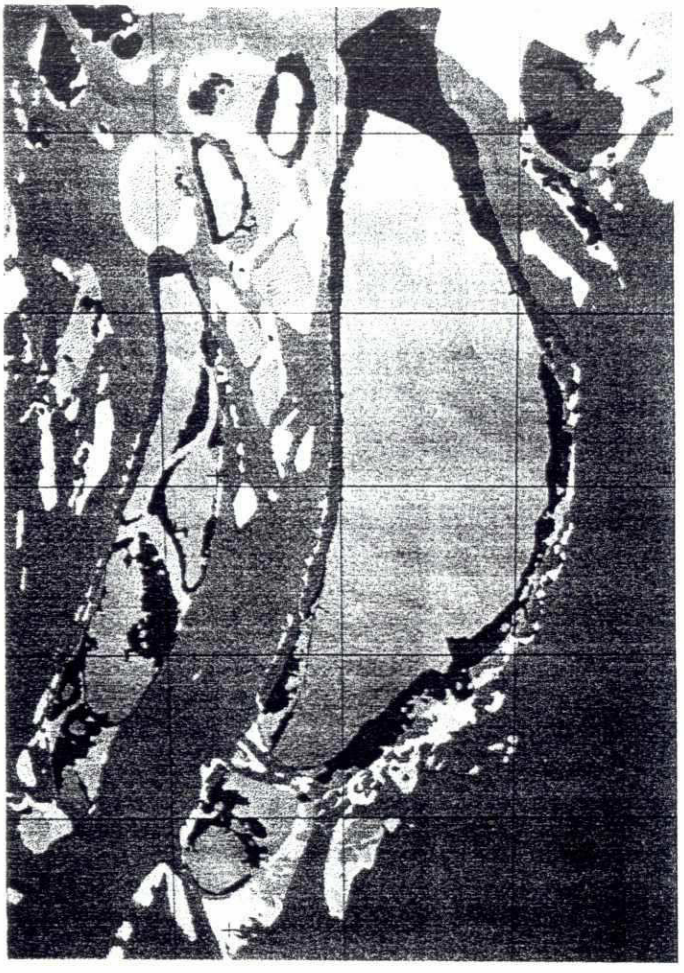


1984-1990

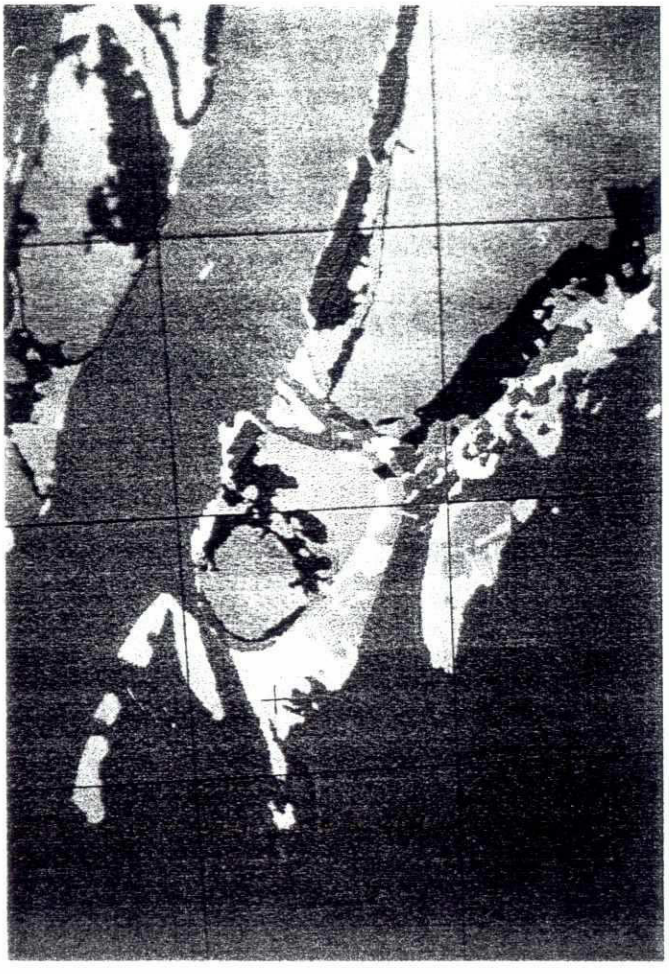


1990-1993

1993-1996



1973-1996



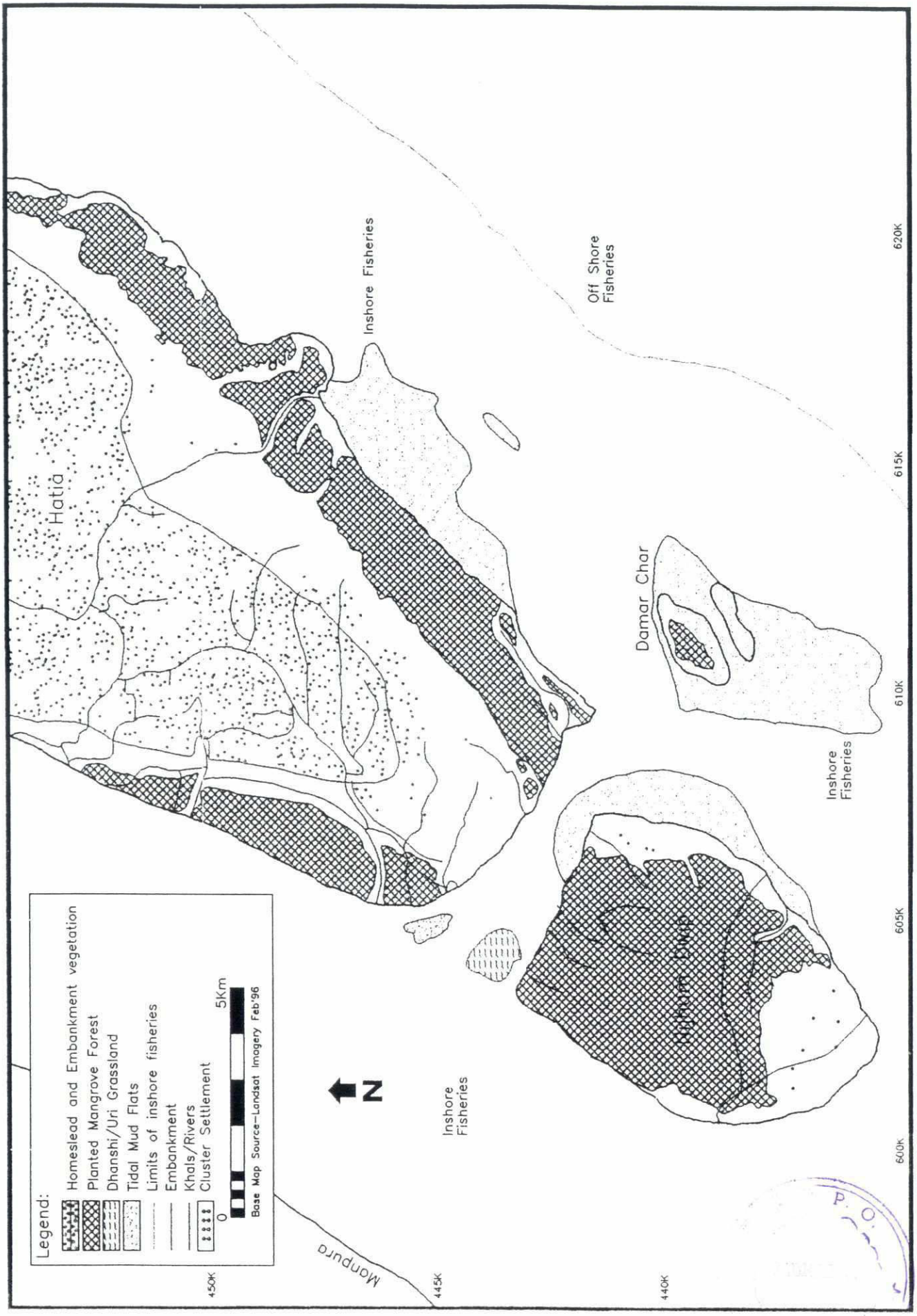
Nijhum Dwip 1973-1996

LEGEND

- 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

Figure V.2.8: SRDI Soil Chemistry Sample Locations

Figure V.2.9: Flora, Fauna and Fish Habitats



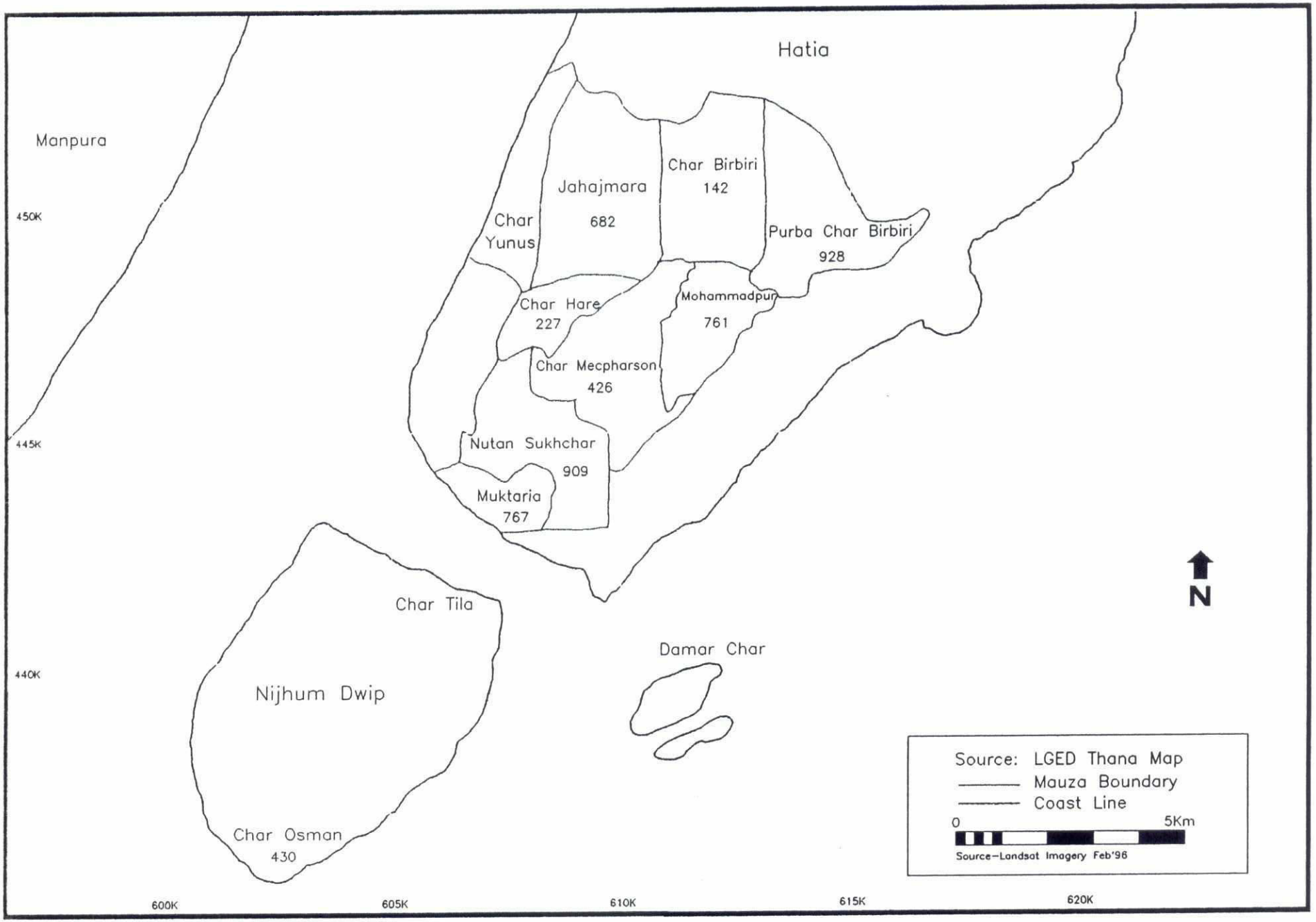


Figure V.2.10: Administration Boundaries

Figure V.2.11: Settlement Pattern

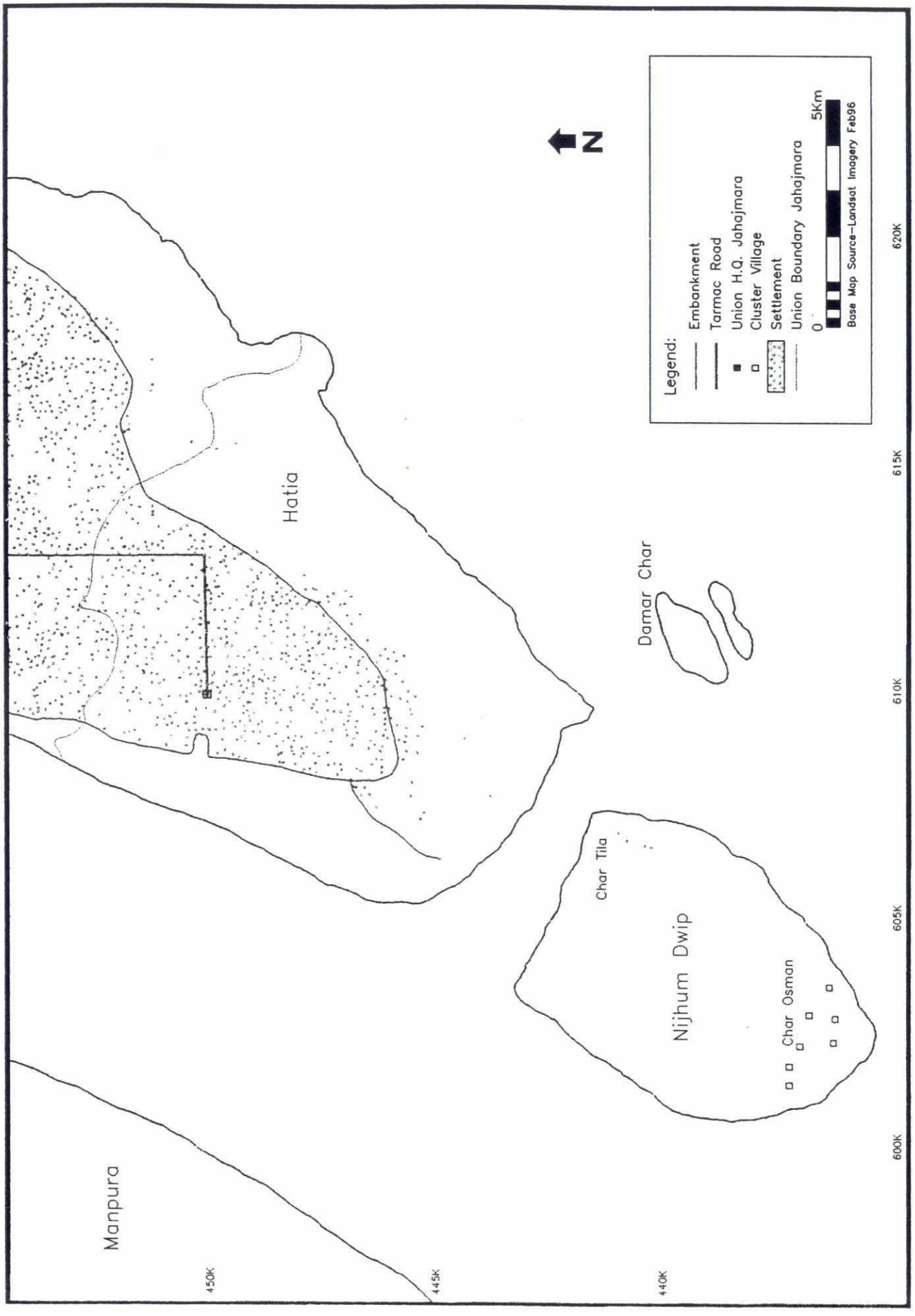


Figure V.2.12 : Monthly recorded disease cases at Hatia 1992-1996

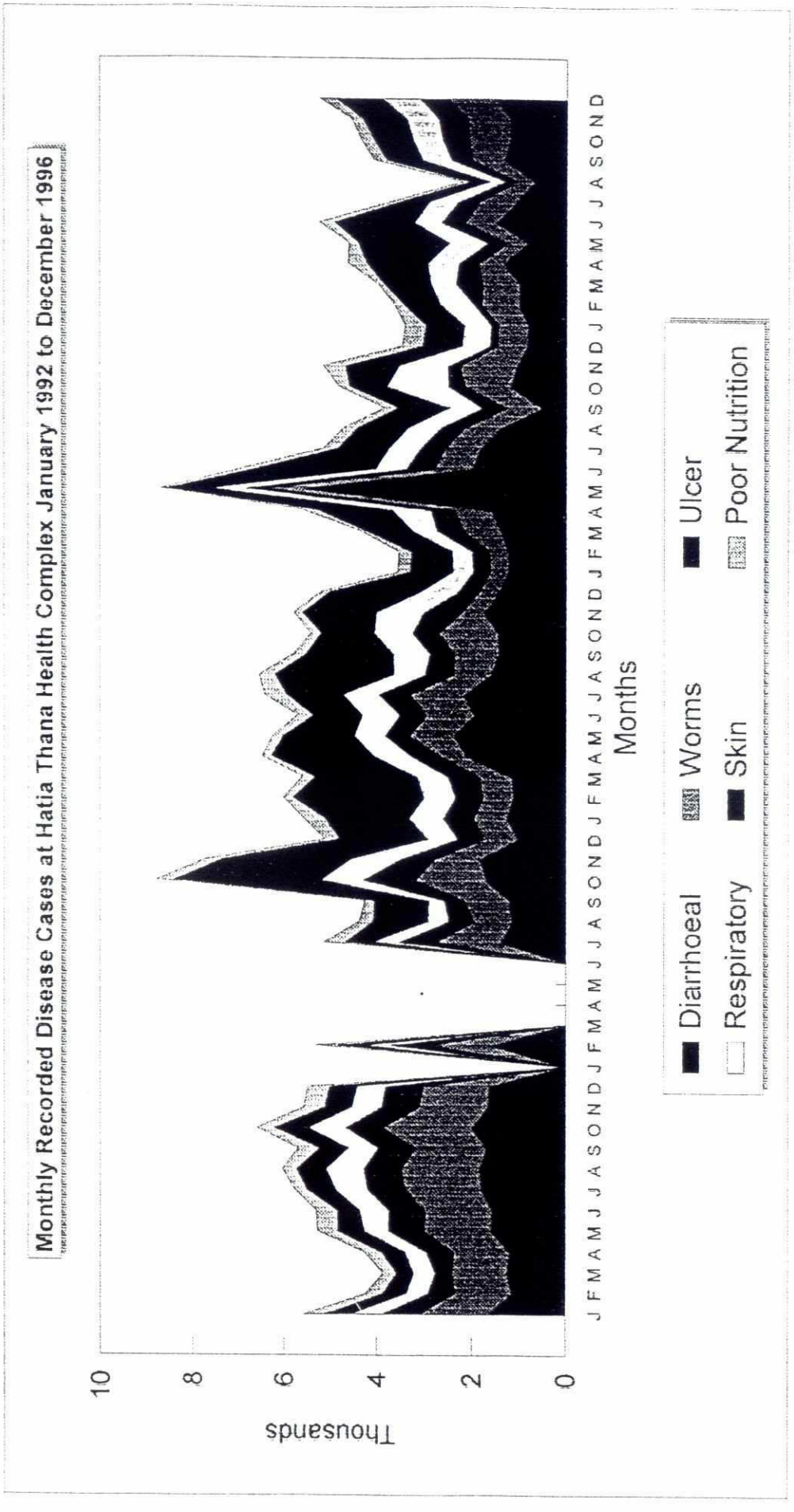


Figure V.2.13 : Diarrhoea and skin diseases for Hatia 1992-1996

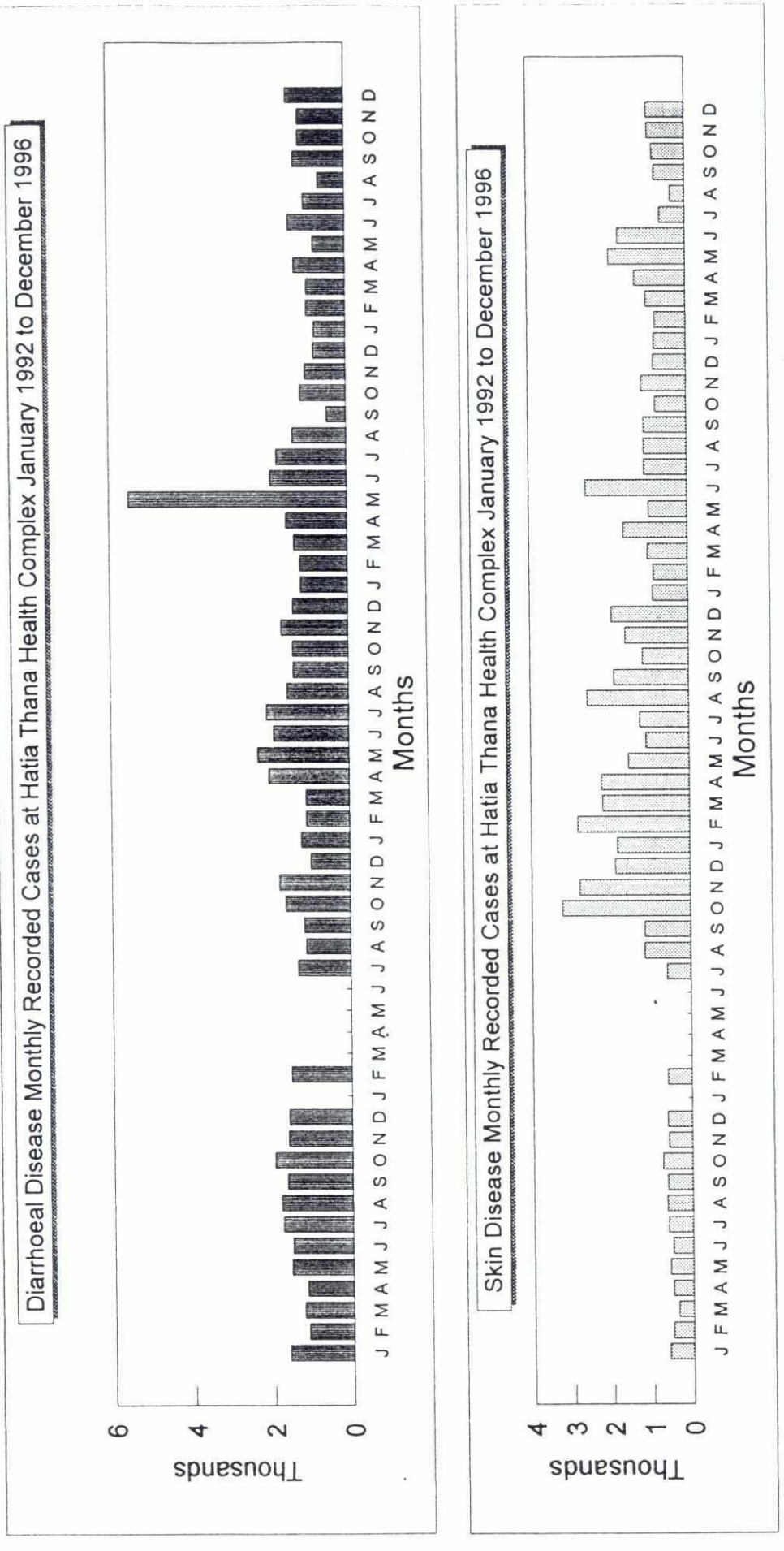
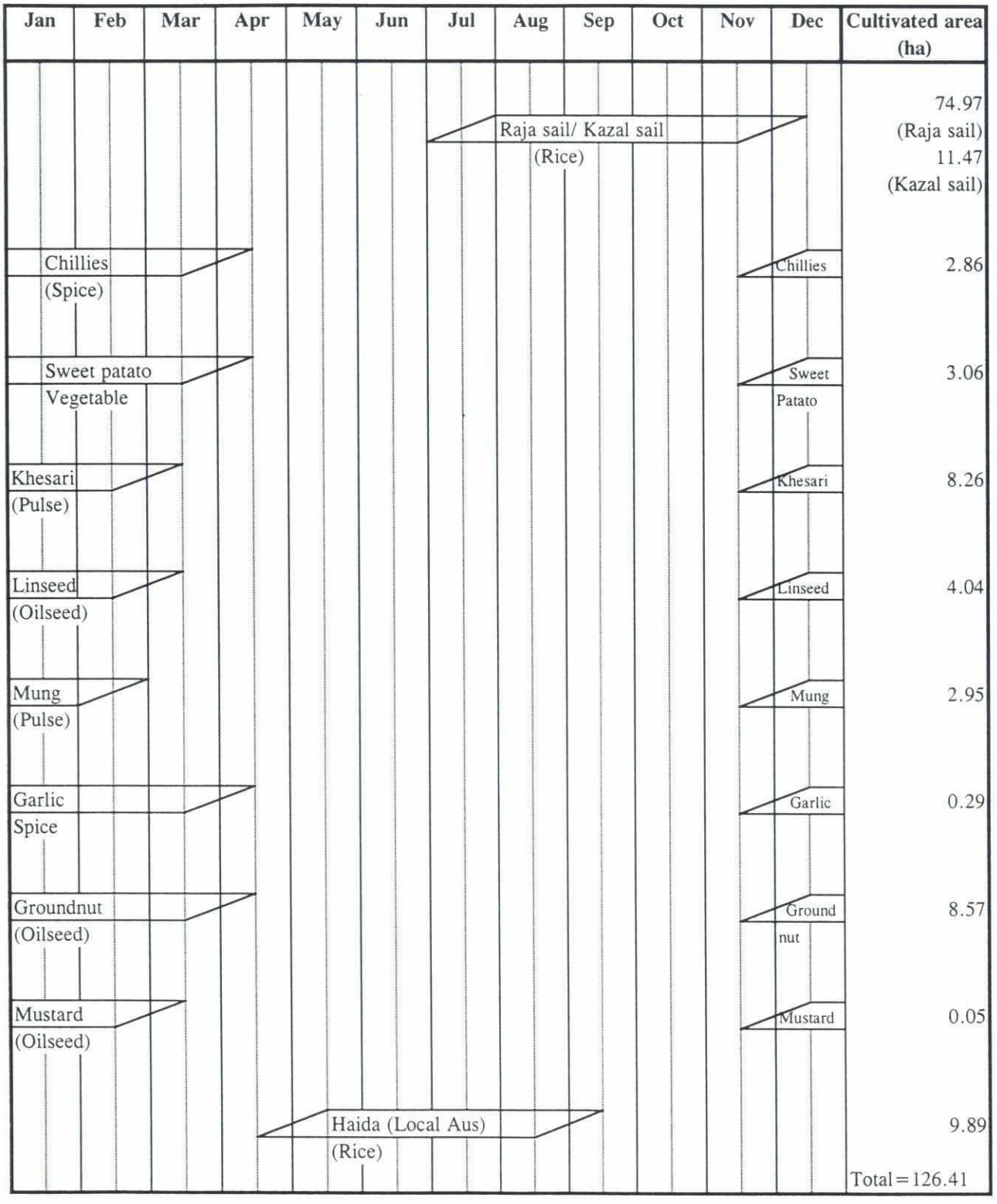


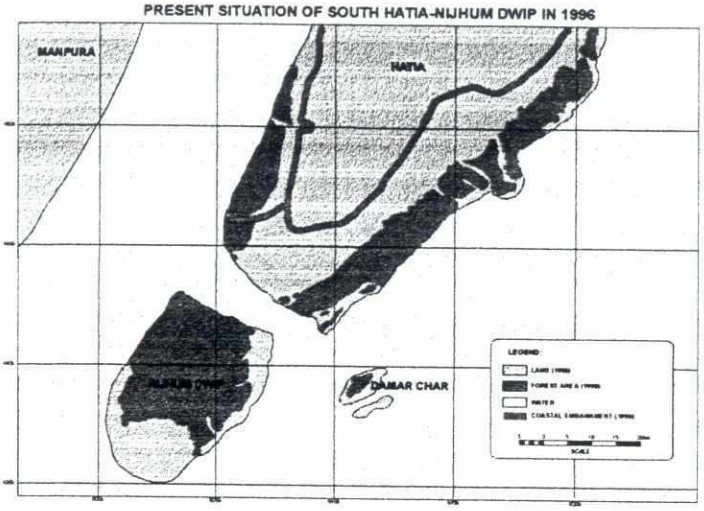
Figure V.2.14 : Cropping Pattern Diagram



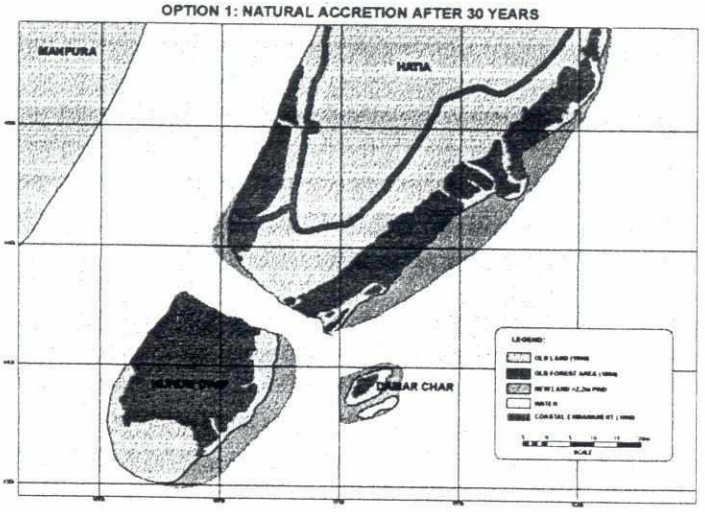
Source:
Field Survey: South Hatia and Nijhum Dwip, March 1997

Figure V.2.15: Land Accretion Predictions With and Without Interventions

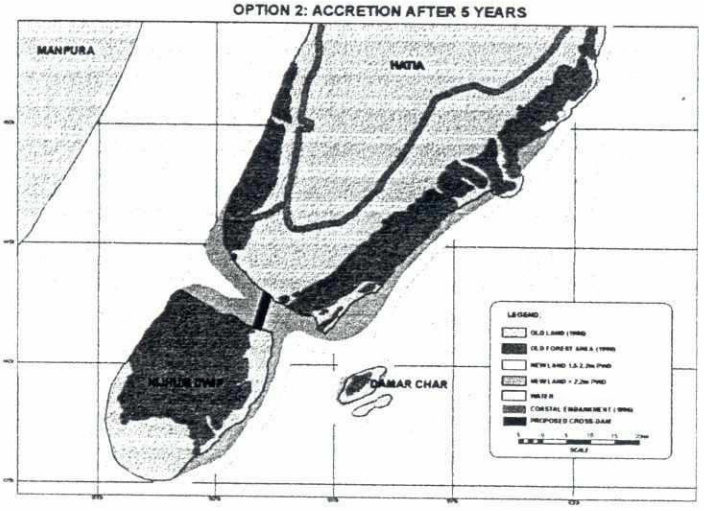
PRESENT SITUATION OF SOUTH HATIA-NIJHUM DWIP IN 1996



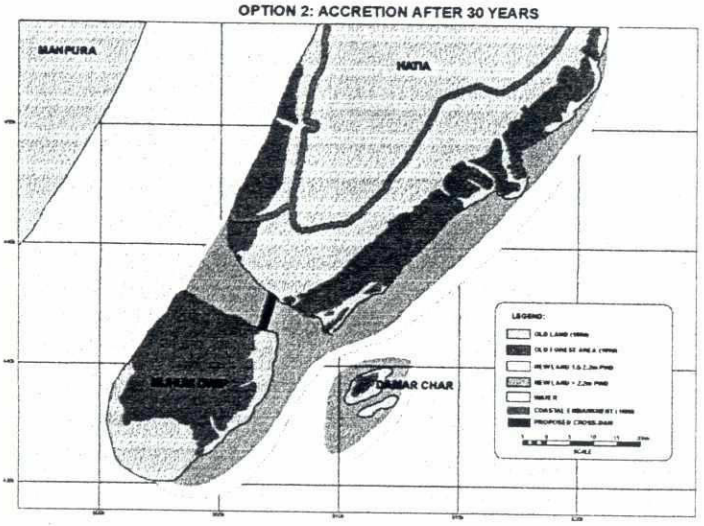
OPTION 1: NATURAL ACCRETION AFTER 30 YEARS



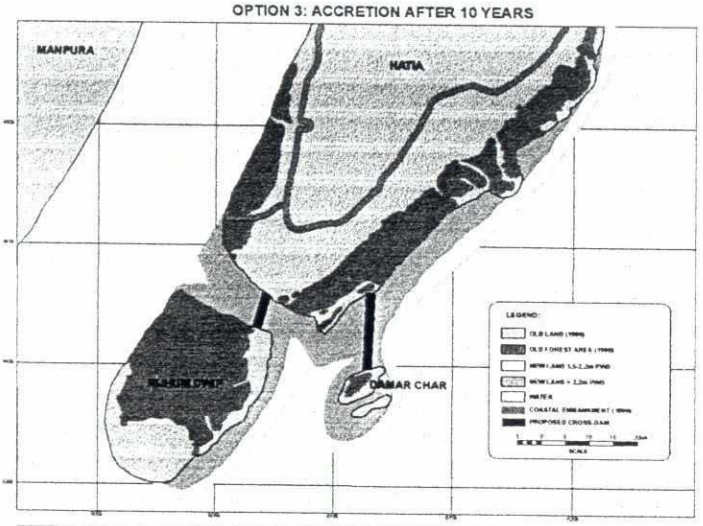
OPTION 2: ACCRETION AFTER 5 YEARS



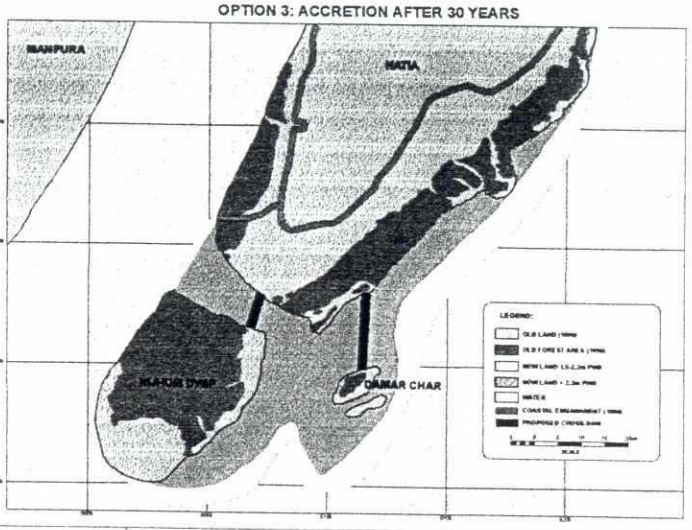
OPTION 2: ACCRETION AFTER 30 YEARS



OPTION 3: ACCRETION AFTER 10 YEARS



OPTION 3: ACCRETION AFTER 30 YEARS



Option 1 = No Intervention
Option 2 = One Cross Dam at Year 0
Option 3 = One Cross Dam at Year 0, Second Cross Dam at Year 5

Source : MES 1998.

MEGHNA ESTUARY STUDY

Land Accretion Predictions With & Without Interventions

PROJECTION	BANGLADESH TRANSVERSE MERCATOR
SOURCE	LANDSAT IMAGERY FEBRUARY 1996

mes

PRODUCED BY
GIS/RS/CAD UNIT
Meghna Estuary Study

Figure V.2.16 : Scoping matrix of important environmental components

	Technical Priority	Local Priority	Now	Year 30 Without Project	Year 30 With One Cross-Dam	Year 30 With Two Cross-Dams
NATURAL ENVIRONMENT						
Natural Physical Environment						
Climate:						
Rainfall			0	0	0	0
High Tides			0	0	0	0
Storm Surges	*	*	0	0	0	0
Cyclones	*	*	0	0	0	0
Hydrology:						
Surface Water:						
Quantity:						
Rainfall flooding			0	-1	+1	+1
Tidal/Sea flooding	*	*	0	0	+2	+2
Drainage		*	0	-1	0	0
Irrigation			0	0	+1	+1
Quality:						
Salinity	*	*	0	-1	+1	+1
Irrigation water supply			0	-1	+1	+1
Erosion		*	0	-1	0	0
Sedimentation			0	+1	+2	+3
Accretion	*	*	0	+1	+2	+3
Groundwater:						
Availability:						
Domestic water supply	*	*	0	-1	0	0
Quality:						
Salinity			0	0	0	0
Land:						
Topography			0	+1	+2	+3
Land Type			0	+1	+3	+3
Soil:						
Type			0	0	+1	+1
Quality						
Chemistry	*		0	0	+1	+1
Waterlogging			0	-1	+1	+1
Erosion			0	0	+1	+1
Capability	*		0	0	+1	+1
Natural Biological Environment						
Terrestrial Habitats:						
Flora			0	+1	+2	+3
Fauna	*		0	+1	+1	+1
Freshwater Habitats:						
Flora			0	+1	+2	+3
Fauna			0	+1	+2	+3
Fish			0	+1	0	0
In-Shore Marine Habitats:						
Flora			0	+1	-1	-1
Fauna	*		0	0	-1	-2
Fish	*		0	-1	-2	-3
Off-Shore Marine Habitats:						
Flora			0	0	0	0
Fauna			0	0	0	0
Fish			0	-1	-2	-2
Bio-Diversity and Conservation			0	+1	+1	0
Sensitive Areas			0	0	0	0

	Technical Priority	Local Priority	Now	Year 30 Without Project	Year 30 With One Cross-Dam	Year 30 With Two Cross-Dams
Natural Risk and Hazards						
Storms and Cyclones	*	*	0	-1	+1	+2
Rainfall Flooding		*	0	-1	0	0
Seismic Activity			0	0	0	0
HUMAN ENVIRONMENT						
Social Environment						
Political and Institutional Administration			0	0	+1	+2
Human Population	*	*	0	+1	+2	+3
Gender Issues		*	0	0	+1	+2
Settlement Pattern and History	*	*	0	+1	+2	+3
Land Holding and Tenure	*	*	0	-1	+1	+1
Common Resource Rights:						
Fish	*		0	-1	-2	-3
Fuelwood			0	0	+1	+1
Grazing			0	+1	+1	+1
Fodder			0	+1	+2	+2
Domestic Energy and Fuel			0	+1	-1	-1
Domestic Water Supply	*	*	0	0	+1	+1
Sanitation	*	*	0	-1	0	0
Health:						
Waterborne Disease	*	*	0	-1	+1	+1
Insect-borne Disease	*	*	0	-1	-1	-1
Mental Health			0	0	+1	+1
Nutrition			0	0	+/-	+/-
Education and Literacy	*		0	+1	+2	+2
Archaeological and Cultural Sites			0	0	0	0
Landscape Aesthetics			0	0	0	0
Economic Environment						
Agriculture	*	*	0	+1	+2	+3
Agricultural Wage Paid Labour			0	0	0	0
Homestead Production			0	+1	+2	+3
Livestock			0	+2	+2	+1
Forestry	*	*	0	+1	+2	+2
Fisheries		*	0	-1	-2	-3
Industry		*	0	0	0	0
Other Non-Farm Wage Paid Employme	*	*	0	0	0	0
Infrastructure and Communications:						
Roads and Embankments	*	*	0	0	+2	+3
Navigation	*		0	0	-1	-2
Energy and Power			0	0	+1	+1
Telecommunications			0	0	+1	+1
Social Risk and Hazards						
Storms/Cyclones	*	*	0	0	+2	+2
Rainfall Flooding			0	-1	+2	+2
Erosion		*	0	-1	0	0
Earthquakes			0	0	0	0
Famine			0	0	+1	+1
Disease	*	*	0	-1	-1	-1
Crop Pest Attack	*	*	0	-1	0	0
Pollution			0	0	0	0
Social Instability/Conflict			0	0	0	0
Economic Instability			0	0	+1	+1
EXTERNAL FACTORS						

	Technical Priority	Local Priority	Now	Year 30 Without Project	Year 30 With One Cross-Dam	Year 30 With Two Cross-Dams
Upstream Constraints			0	0?	0?	0?
Upstream Impacts			0	0	0?	0?
Downstram Constraints			0	0	0	0
Downstram Impacts			0	0	(+/-)?	(+/-)?
DIRECT CONSTRUCTION IMPACTS						
Land Acquisition			0	0	0	0
Compensation			0	0	0	0
Resettlement			0	0	0	0
Construction Operations (with management)			0	0	+0.5	+0.5
Construction Employment			0	0	+1	+2

LEGEND:

* Identified significant component/issue

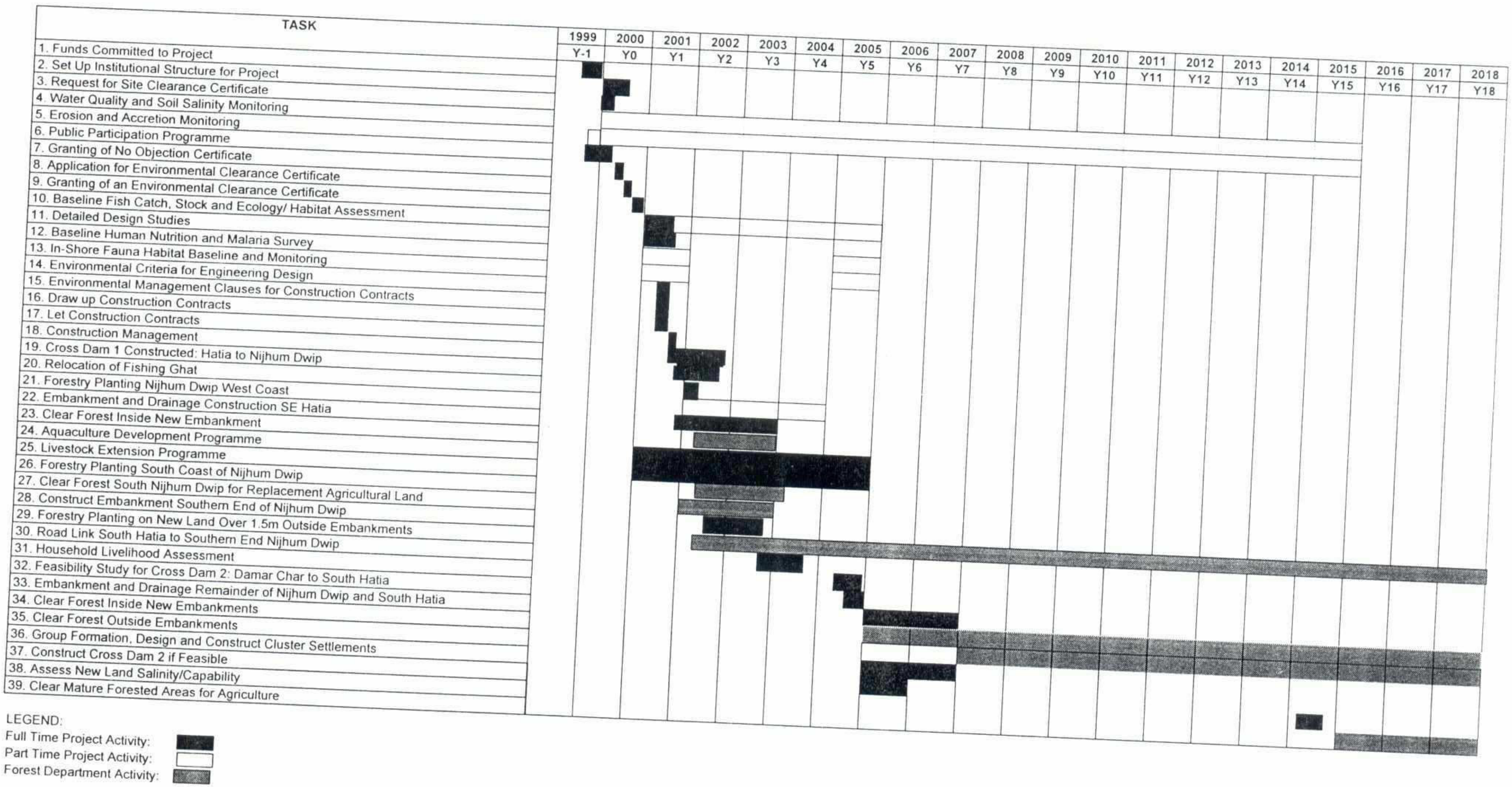
RATING OF IMPACTS:

+3 Significant positive trend/impact
+2 Moderate positive 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
+/- Simultaneous positive and negative trend/impact

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.

Figure V.2.17 : Implementation schedule and environmental management programme



LIST OF PHOTOGRAPHIC PLATES IN APPENDIX 3

Plate 1: Nijhum Dwip Channel Looking East Along South Edge of Hatia, February 1997.

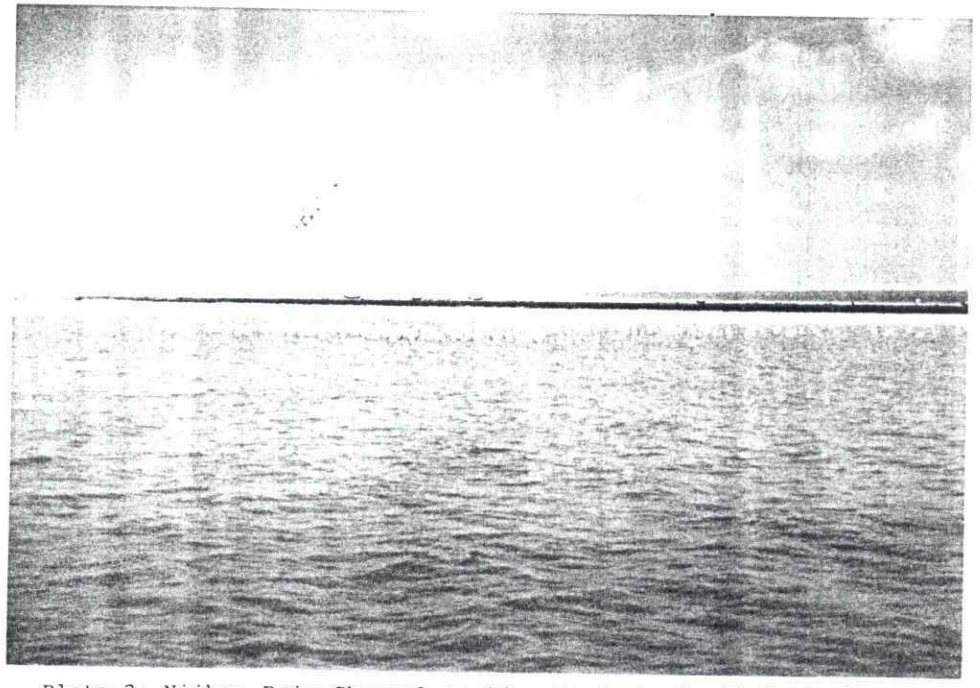


Plate 2: Nijhum Dwip Channel Looking North to South Hatia from North West Tip of Nijhum Dwip Island, Falling Tide, February 1997

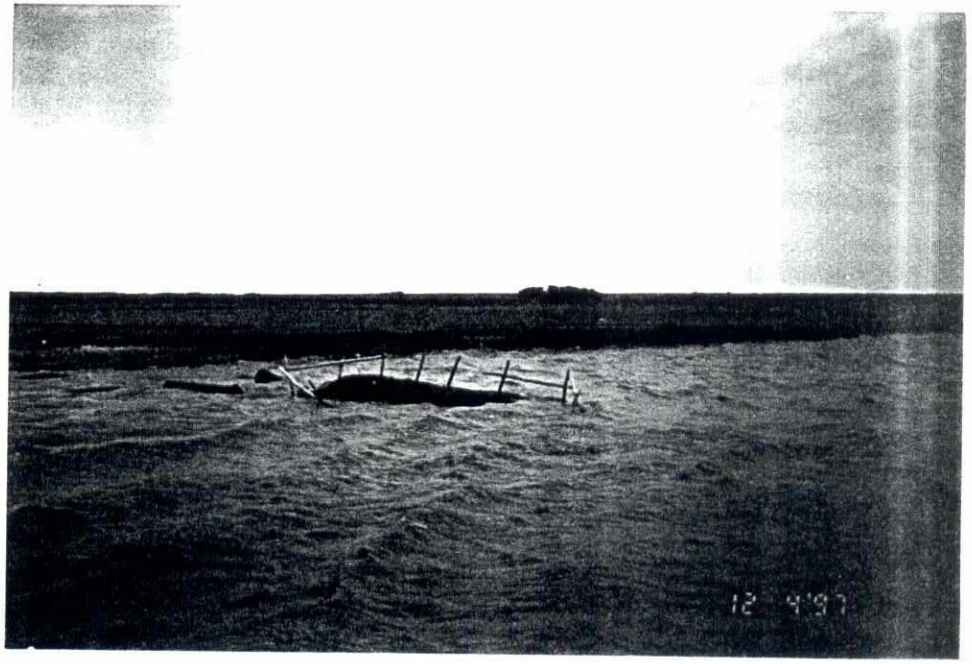


Plate 3: Trial Geo-textile Curtain in Place at South Hatia, High Tide, April 1997.

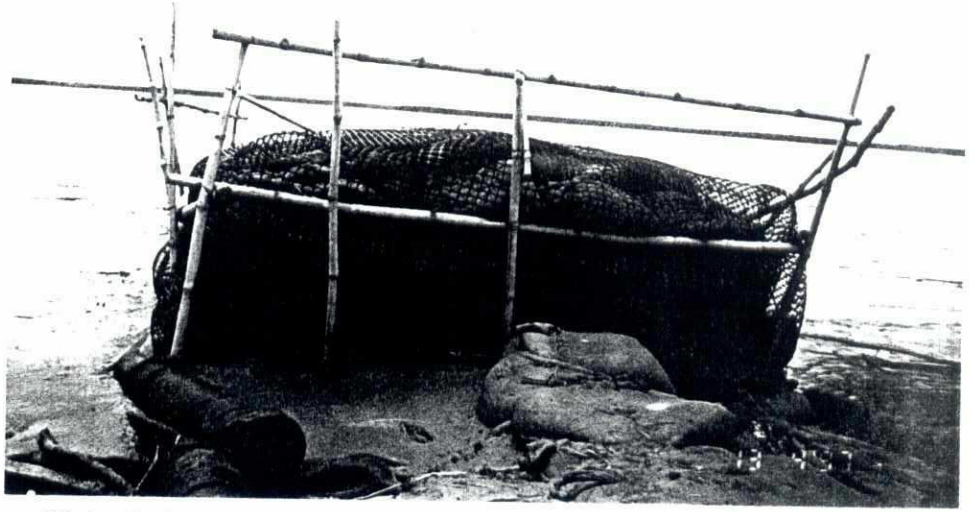


Plate 4: Geo-textile Trial at South Hatia, Low Tide, April 1997.

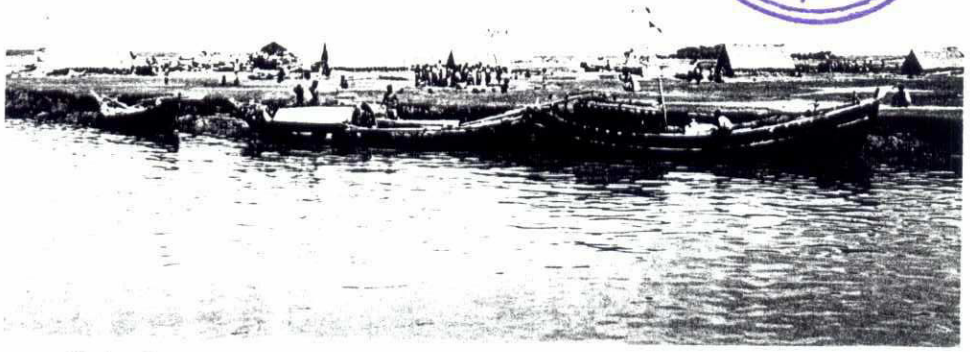


Plate 5: Fish Ghat/Market on North Side of Channel, February 1997

Plate 6: Fish Catch Assessment, Nijhum Dwip Market, April 1997.

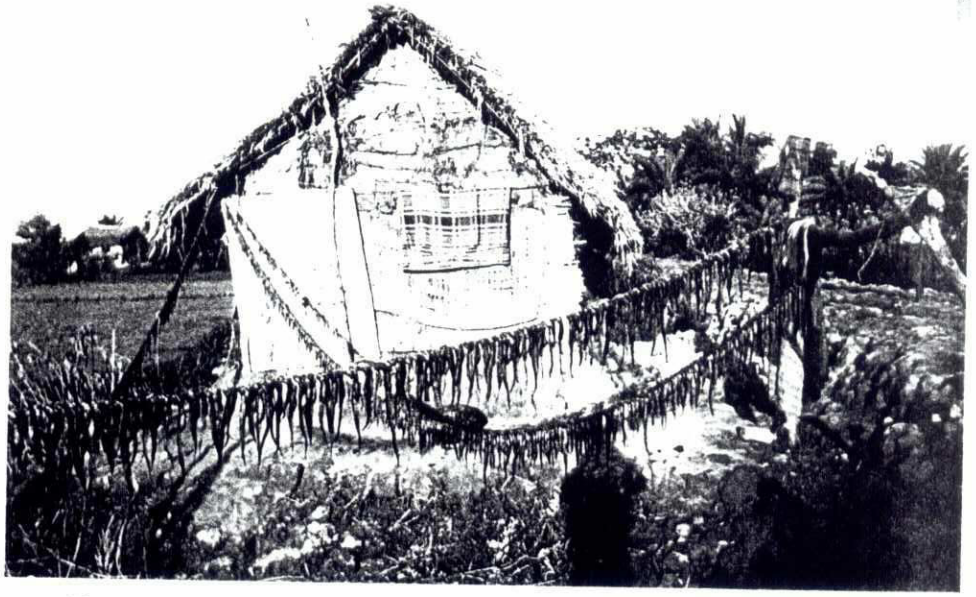


Plate 7: Domestic Fish Drying, Nijhum Dwip, April 1997.

Plate 8: Selling Fish (Chewa) Nijhum Dwip Market, April 1997.

Plate 9: Clearing Fish Pond, Nijhum Dwip, February 1997

Plate 10: Mangrove, South Side Nijhum Dwip Channel, February 1997

Plate 11: Foreshore Exposed at Low Tide, West Side of Nijhum Dwip Island, Falling Tide February 1997.

Plate 12: Children Collecting Domestic Fuelwood, West Side of Nijhum Dwip, February 1997.

Plate 13: Planted Mangrove, West Side of Southern Hatia, February 1997, Falling Tide.

Plate 14: South West Hatia Between the Mangrove Belt and Embankment, February 1997.

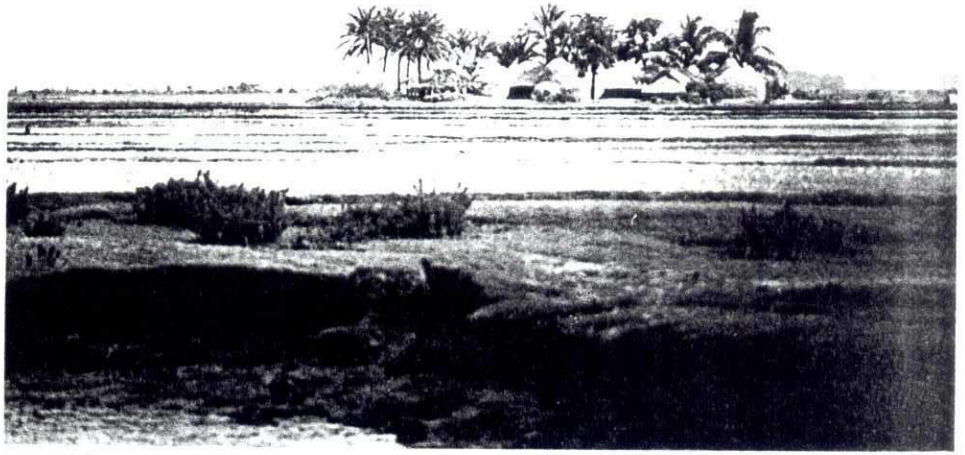


Plate 15: Isolated Homestead, Southern Hatia Outside the Embankment, February 1997.

Plate 16: Cyclone Shelter and Raised Livestock Refuge (Killa), Nijhum Dwip, February 1997.

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:

Char Development and Settlement Project (CDSP) Mission
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Md Jahangir Alam, Senior Research Officer

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Alam, Laboratory Chief

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Hasna Moudud

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

Dwip Unnayan Songstha (Hatia based NGO)
Matt Griffiths
Md. Rafiq Alam

Individuals:
Don Brown, formerly Team Leader for FAP 3
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:
Abul Kalam, Chairman, Jahajmara Union Parishad, Jahajmara, Hatia
Jamal Uddin Mohammad, Union Parishad Member, Jahajmara, Hatia
Mohiuddin Mohammad, Union Parishad Member, Jahajmara, Hatia
Khabirul Haq Belal, Union Parishad Member, Jahajmara, Hatia
Abul Kalam Azad, Union Parishad Member, Char Macpherson Mauza, Jahajmara Union, Hatia
Abdul Jalil, Union Parishad Member, Char Hare Mauza, Jahajmara Union, Hatia

APPENDIX 5

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: