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MEGHNA ESTUARY STUDY

INCEPTION REPORT

(REVISED)

MAY 1997

DHV CONSULTANTS BV

in association with

KAMPSAX INTERNATIONAL
DANISH HYDRAULIC INSTITUTE
RESOURCE ANALYSIS

DEVELOPMENT DESIGN CONSULTANTS
SURFACE WATER MODELLING CENTRE
AQUA CONSULTANTS AND ASS. LTD.

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EXECUTIVE SUMMARY

1 INTRODUCTION

The Meghna Estuary Study (MES) is a component (FAP 5B) of the Flood Action Plan (FAP). The project is being implemented under a cooperation programme between the Governments of Bangladesh, The Netherlands and Denmark. The executing agency is the Bangladesh Water Development Board (BWDB). The coordination with other projects under the Flood Action Plan is to be maintained by the Flood Plan Coordination Organization (FPCO), now WARPO.

The Meghna Estuary Study can be considered as the follow-up of the "marine based" activities of the Land Reclamation Project. The main goals of the study are to retain and increase the operational knowledge of hydraulic and morphological processes in the Meghna Estuary and to develop appropriate approaches and techniques for efficient land reclamation as well as effective river bank protection measures. In the long term the physical safety and social security of the people living in the coastal areas and on the islands in the estuary should be improved.

The objective of this Inception Report is to elaborate the Terms of Reference for the Meghna Estuary Study, dated November 1992, as well as other documents annexed to the invitation to prepare a proposal for the execution of the Meghna Estuary Study Project - FAP 5B. The Inception Report includes a firm Project Implementation Plan for the 32 months project period as well as confirmation of the approach and methodology to be followed. Several changes in approach, planning aspects and project activities as given in the Terms of Reference are recommended in the Inception Report.

Prior to the Inception Report an Interim Inception Report was prepared and submitted to BWDB and the Royal Netherlands Embassy in December 1995.

2 BACKGROUND

The MES area covers the Lower Meghna River from Chandpur town (the downstream extent of FAP9B) to the Bay of Bengal. See also the following pages.

Figure 1 shows the location map of the Meghna Estuary Study area with the boundaries of the project, figure 2 shows the Meghna Estuary.

By spontaneous intervention of the local population or by specific action of government organizations, land has been reclaimed and embanked along the coast of Noakhali and some of the coastal islands, notably the activities under the Land Reclamation Project (LRP, 1977-1991) and the ongoing Char Development and Settlement Project (CDSP).
These activities indirectly include the intervention caused by Noakhali cross-dams and Aria Nadir cross-dams etc. The experience of these cross-dams would be taken into consideration when the study of pre-feasibility and/or feasibility would be taken up for such project.

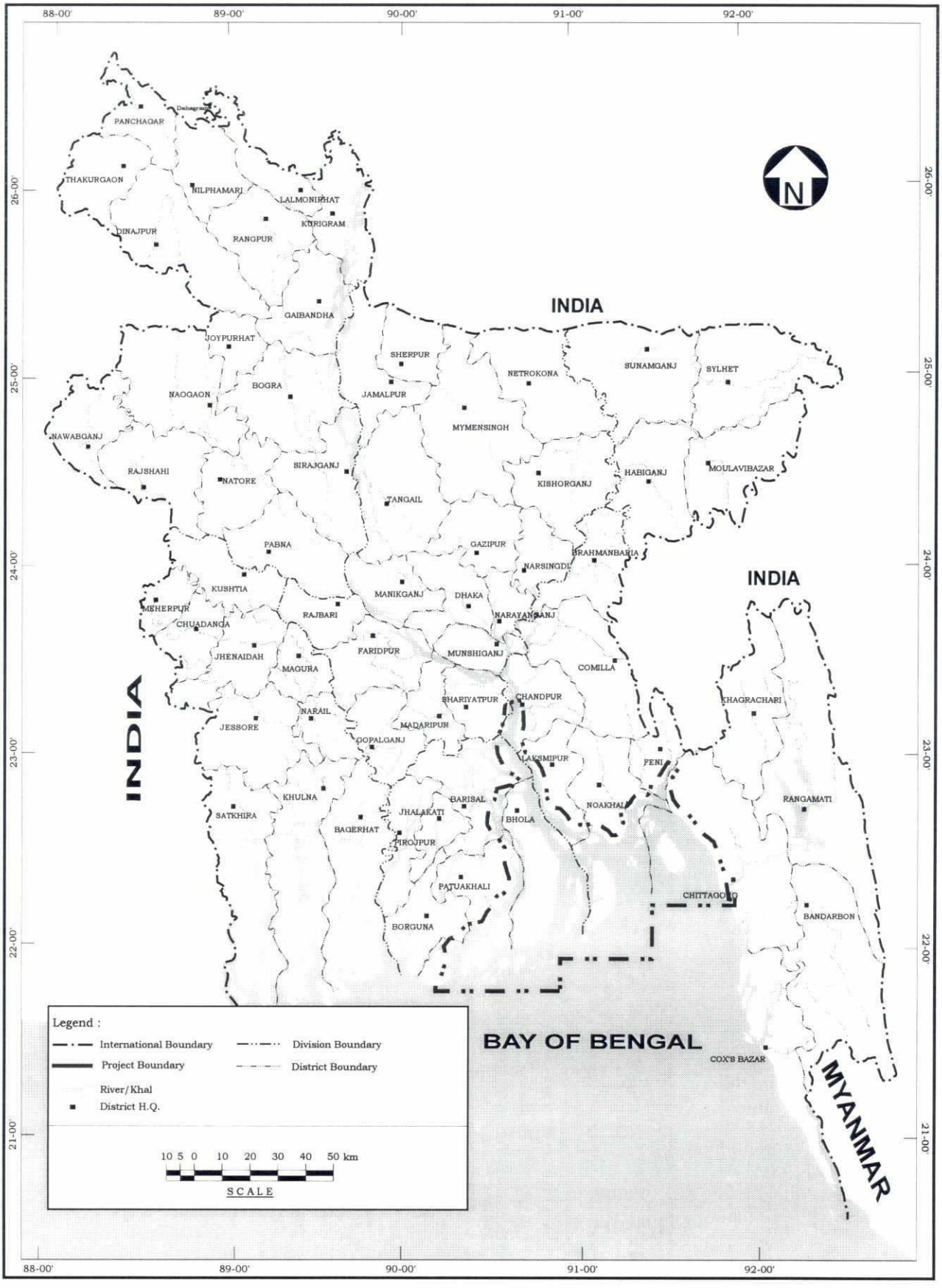
Drainage congestion and water logging are considered main obstacles for agricultural development of flood protected areas situated in the Meghna Estuary. Drainage congestion occurs when excessive rain water cannot be removed in time by a drainage system. Such a situation may be more pronounced in the estuary compared to other areas of Bangladesh due to the construction of protection embankments, sedimentation of the natural internal drainage system, land accretion near the outfall of drains, a higher rainfall, etc.

Another restriction for agricultural development in the Meghna Estuary is caused by soil salinity. The LRP studied in detail the soil salinity and concluded that the natural desalinization of accreted and protected land is a slow process. Favourable drainage conditions may accelerate this process. Previous experiences related to water management are very limited in the case of LRP. Nowadays,

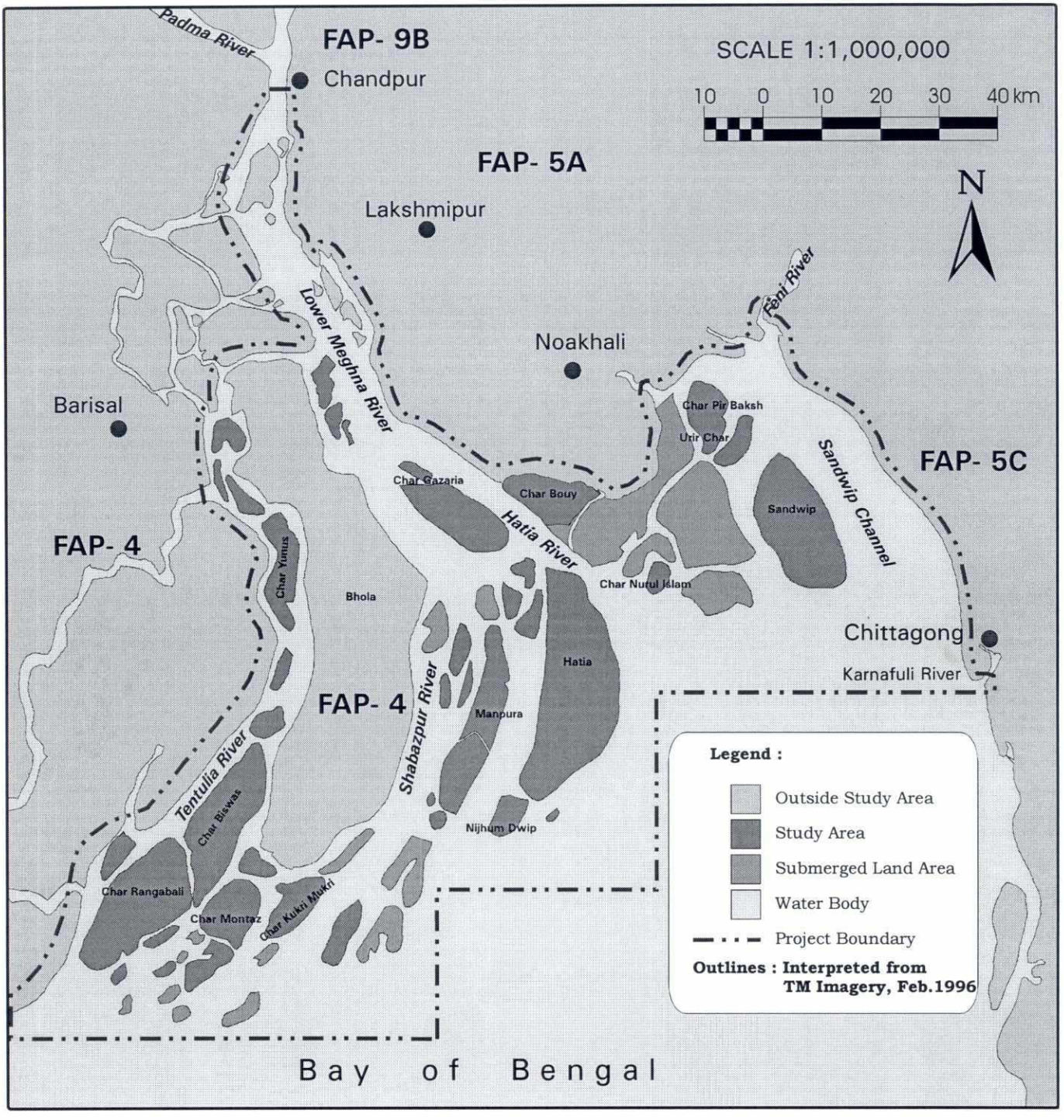
improved water management concepts and experiences are found with on-going BWDB projects such as CDSP, CPP and more in particular SRP. Salinity intrusion, tidal flooding, storm surge and vulnerability to cyclones are also notable features obstructing the development in the coastal area.

In order to fully justify the technical proposals for reclamation and protection arrangements it is necessary to create a linkage to the possibilities for settlement and rural development in the new and existing char islands, along with the provision of agriculture, livestock and fisheries for feasible settlements.

Location of Meghna Estuary Study Area



Map of the Project Area



3 PROJECT DESCRIPTION

The description follows the logical framework sequence of objectives-outputs-activities-inputs.

OBJECTIVES

The development objectives of the project are to increase the physical safety and social security of the inhabitants and promote sustainable development in the coastal areas and on the islands.

The immediate objectives are to enhance and strengthen operational knowledge of hydraulic and morphological processes in the Meghna Estuary, find suitable land reclamation and bank protection methods, increase the capacity of BWDB to reclaim new land and protect the eroding river banks and finally to prepare a plan with priority project and programmes for flood protection, agricultural and socio-economic development for early implementation.

OUTPUTS

The outputs to be expected from the Meghna Estuary Study are:

- modernized land-based and marine survey capabilities
- an up-to-date data base on hydro-morphology
- background data for rural development planning in the project area
- hydraulic and morphological studies
- impact assessment studies
- increased institutional capacity to retain and update the knowledge of the hydraulic and morphological processes in the estuary
- a Master Plan for the development of the estuary
- a Land and Water Development Plan, including a portfolio of rural development projects
- feasibility studies for priority projects and programmes
- pilot projects for establishing effective land reclamation and river bank protection works

ACTIVITIES

The activities required to be carried out during the execution of the study are summarized below.

- land based and marine surveys
  - procurement and installation of survey instruments and software
  - reconnaissance and installation of reference benchmarks and determination of x,y,z coordinates by DGPS
  - coast line and coast line gradient surveys
  - marine surveys, two monsoon seasons (flow, sediment transport and salinity) and two winter seasons (bathymetry, flow, sediment transport and salinity)
  - wave and tide recording at six locations throughout project area by special data logger and water level registration by existing instruments and staff gauges
  - sediment analysis, off-line data processing and survey data reporting
- hydraulic and morphological studies
  - collection and screening of data from BIWTA, BWDB, LRP, Meteorological Department, and other sources
  - analyses of meteorological, hydrodynamic and morphological conditions (states and processes) in the estuary
  - development of a valid reference for impact prediction and comparison
  - set-up and calibration of a nested (5400 - 200 m) grid numerical model for the estuary
  - simulation and evaluation of predicted hydraulic impact (flow, water level, etc.), and comparison with baseline conditions

- analysis of predicted morphological impact (accretion and erosion), and comparison with baseline conditions

- institutional development

  - assessing alternative institutional arrangements for sustainable data collection and processing linked to the planning process
  - assisting in development of (a cell in) WARPO to carry out its role as macro planning organization
  - assisting in development of (cells in) WARPO and BWDB to formulate and update land and water development plans
  - contributing to feasibility studies of priority projects by identifying what institutional arrangements are needed to ensure implementation of these projects in line with the long-term objectives of MES

- socio-economic studies

  - collection of socio-economic and general rural development data about the present situation, partly from existing documentation and partly through socio-economic surveys of selected chars
  - close liaison with CDSP and to some extent Adrasha Gram (Ideal Village) Project
  - liaison with Government institutions, involved in settlement and rural development
  - preparation of inputs for Development Plan

- development of reference scenarios

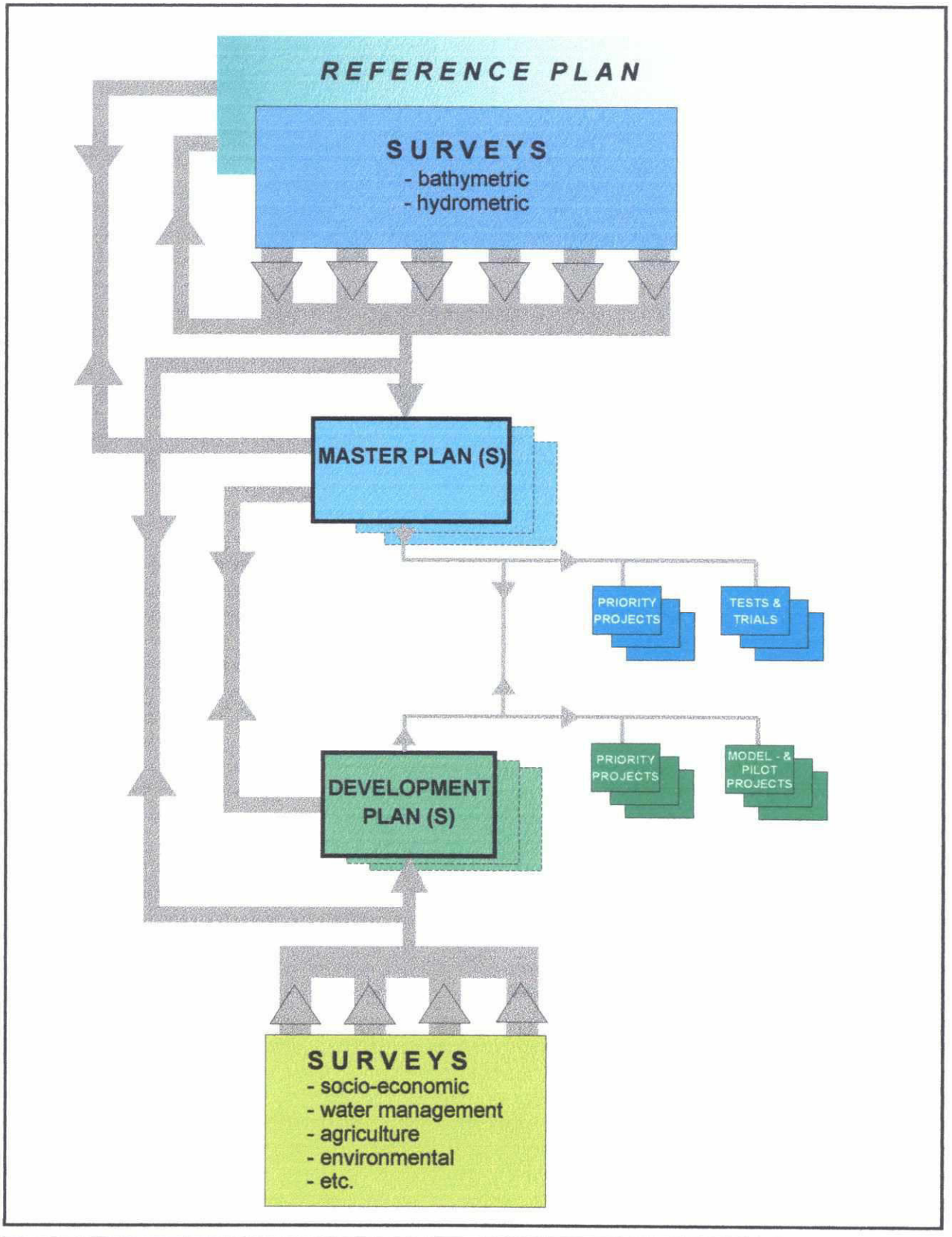
Especially in an environment that is as dynamic as that covered by the Meghna Estuary Study, developing realistic Reference Scenarios, is considered to be an essential first step in the master planning process, see Figure 3. Without those, the preparation of a Master Plan would soon become an exercise in the pursuit of individual preferences and avocations, without any linkages to physical realities and without necessarily taking full account of the potentials the area harbours and of the prevailing limitations.
The expected rise in average sea levels, resulting from global warming, will definitely be a physical reality that has to be linked to the Reference Scenarios.

In attempting to define, from several Reference Scenarios, a Reference Plan that could serve as a reference for any programme of actions planned for the near and medium term future, the following criteria are considered realistic and functional:

- safeguard the fresh water pocket that is available west of the Tetulia River
- make the length of the Lower Meghna to the sea as short as possible, so as to facilitate the discharge of flood waters and to minimize the cost of future works to stabilize the river course
- shorten the coastline of Bangladesh as much as possible, to reduce the cost of maintenance of coastal embankments and of any coastal defence works, thus enhancing the safety of the protected area
- optimize the utilization of the potentials for the reclamation of new land

- preparation of a Master Plan

  - The Master Plan to be prepared during the study will comprise a realistic picture of how the project area could look like after the completion of the Master Plan, that is 25 years from now
  - while covering a period of 25 years, a Master Plan would have to be flexible, requiring regular updating, on the basis of a check of actual conditions and the verification of the impact of interventions applied. This is a continuous process indeed, for which the tools, including the institutional capabilities, should be present. This planning process is shown in Figure 3.



REFERENCE PLAN

- preparation of a Development Plan

  Before preparation of a development plan, it is necessary to develop a realistic scenario as an essential first step in the planning process.
  The main approach to planning of the estuarine region should follow the principles adopted in other FAP regional studies. The planning components will include:

  - Primary Protection systems, including coastal embankments, conservation and development of the foreshore, coastal defence works
  - Secondary Protection systems including secondary embankments, cyclone shelters, protected fresh water ponds
  - Development of protected areas including settlement of new lands, water management systems and associated development of agriculture etc.
  - Non-structural and other systems, including flood/cyclone forecasting and disaster preparedness and management etc.

  The planning and design of these works require the inputs of the local population who will be duly consulted, in compliance with the relevant government guidelines.

- preparation of Priority Projects and Programmes:

  - three projects, including Nijhum Dwip that will be studied at feasibility level
  - three projects that will be analyzed at pre-feasibility level
  - a portfolio of rural development projects

- small scale interventions

  - accretion trials at promising locations
  - pilot scheme for bank protection
  - implementation of small cross dams

INPUTS

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The project inputs consist of the following components:

- technical assistance (2,125 lakh Taka)

  - provision of expatriate and local experts
  - provision of survey and office equipment
  - provision of operation and maintenance
  - provision of training

- financial assistance (200 lakh Taka)

  - accretion trials
  - bank protection pilot scheme
  - small cross dam construction

- contribution of the Government of Bangladesh (440 lakh Taka)

  - counterpart personnel
  - survey vessel "Anwesha" and tender boats
  - project personnel for "Anwesha", sediment laboratory and others
  - CDST & VAT

4 IMPLEMENTATION METHODOLOGIES

The methodologies adopted in the project are as follows:

- Data collection
  - bathymetric data collection will be based on the latest DGPS-RTK technology
  - Wave and Tide recording with a logger with a large data storage capacity
  - Acoustic Doppler Current Profiler for accurate measurement of flow velocities
  - S4 current meter for recording the tidal streams

- Geographic Information System
  - capability for in-house processing and storage of existing data
  - durable optical media data storage
  - color printing and plotting

- Planning techniques
  - logical framework for efficient management of the project
  - Gantt chart for day to day planning of project activities
  - problem tree to be used during meetings or workshops with the local population and local agencies to finalize problem analysis

- Feasibility studies
  - project screening
  - updating of project assessment guidelines
  - use of the Multi Criteria Analysis (MCA) for displaying project impacts

- Hydraulic and morphological modelling
  - A 1-D (Mike11) model, covering the main river system and the Meghna Estuary (the so-called SWSMP model)
  - A 2-D (Mike21) 5400 m grid model, covering the northern part of the Bay of Bengal is called Bay of Bengal model (see Figure 4)
  - A 2-D (Mike21) 1800 m grid model, covering the entire coast of Bangladesh and main river system with Meghna estuary
  - A 2-D (Mike21) model with 600 m/200 m grid, covering the main river system and the Meghna estuary which is called Meghna Estuary Model
  - morphological computations, sedimentation and erosion, sediment balance

The boundaries of the hydraulic and morphological modelling are indicated in Figure 4.

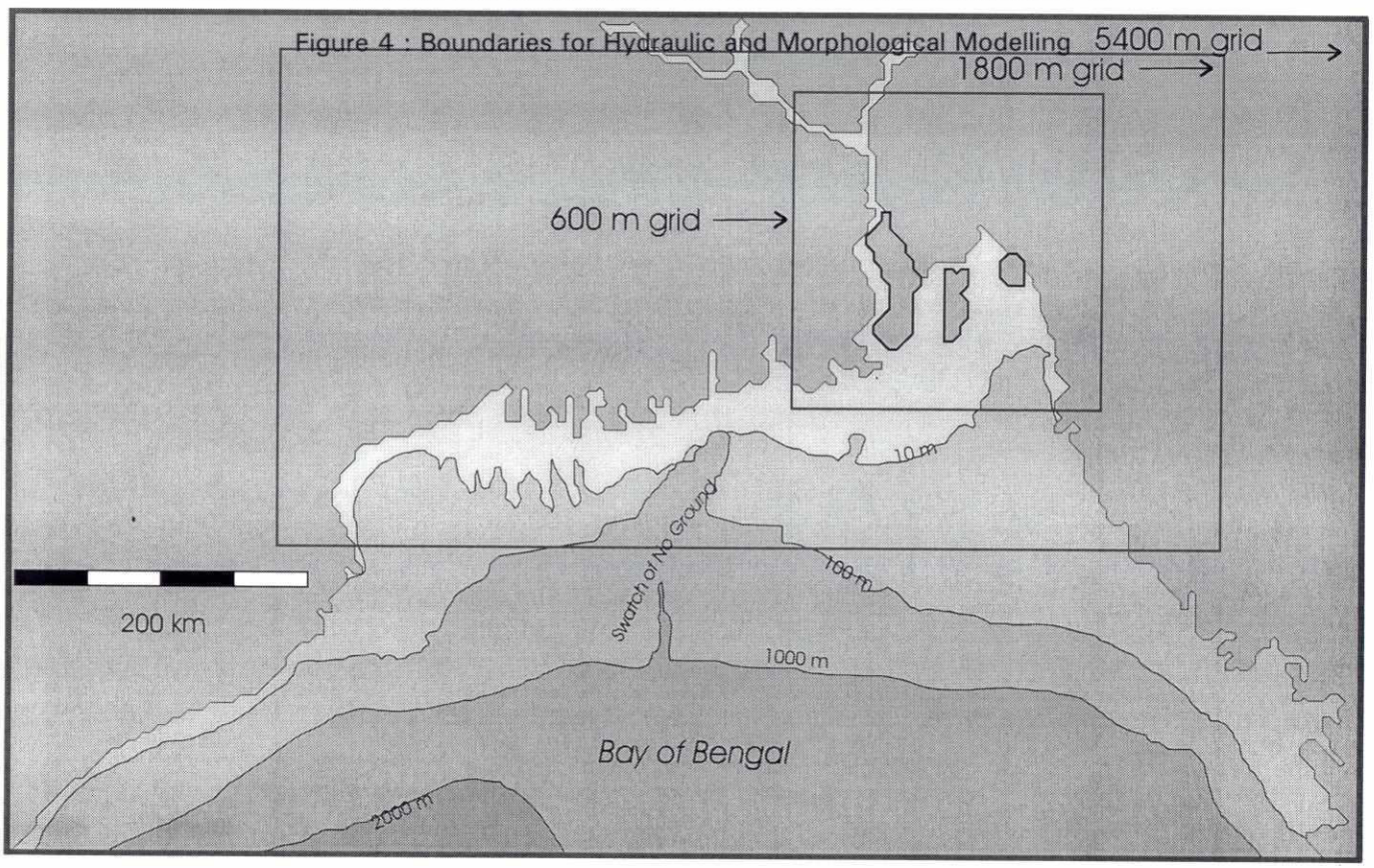

Figure 4 : Boundaries for Hydraulic and Morphological Modelling

5 ORGANIZATION FOR PROJECT IMPLEMENTATION

- Project staffing
  - 20 expatriate technical staff, total 126 manmonths
  - 20 local technical staff, total 340 manmonths
  - 10 surveyors and junior technical staff, total 150 manmonths
  - 20 office staff

- Office equipment
  - computers and printers.
  - photocopy machines
  - training equipment

- Survey equipment
  - Anwesha survey vessels, two tender boats and one rubber boat
  - positioning system and echosounders
  - current meters, including salinity and temperature measuring equipment
  - wave and tide recorders
  - sediment samplers and laboratory equipment for sediment analysis
  - computers, printers, hydro soft ware

6 PROJECT IMPLEMENTATION PLAN

The following Gantt charts have been provided for project implementation:

- Morphology and Hydraulics
- Civil Engineering and Reclamation
- Water Management and Drainage
- Rural Development and Socio-Economic Aspects
- Agricultural Aspects
- Livestock Aspects
- Fisheries Aspects
- Forestry Aspects
- Environmental Aspects
- Economic Aspects
- Remote Sensing and GIS
- Institutional Development
- Expatriate Technical Staff input
- Local Technical Staff input
- Reporting Schedule

7 REPORTING

The following reports are to be produced under this project:

- Interim Inception Report
- Inception Report
- Report on institutional strengthening of BWDB
- Proposals for Small Scale Interventions
- Interim Master Plan
- Interim Development Plan
- Proposals for phase II Surveys and Studies
- Feasibility Report on Reassessment of Nijhum Dwip Reclamation
- Draft priority Project/Programme Preparation Report(s)
- Priority Project/Programme Preparation Report(s)
- Draft Master Plan
- Draft Development Plan
- Master Plan
- Development Plan
- Technical reports, notes and working papers
- Quarterly reports

ABBREVIATIONS

ACQ	Name of Computer System for Data Acquisition
ADB	Asian Development Bank
ACL	Assistant Commissioner Land
ADC	Additional Deputy Commissioner
ADCP	Acoustic Doppler Current Profiler
AE	Assistant Engineer
AEZ	Agro-Ecological Zone
AFPM	Active Flood Plain Management
AHI	Assistant Health Inspector
AIT	Asian Institute of Technology
ASA	Association for Social Advancement
AST	Agriculture Sector Team(CIDA)
BADC	Bangladesh Agricultural Development Bank
BBS	Bangladesh Bureau of Statistics
BDRCS	Bangladesh Red Crescent Society
BIWTA	Bangladesh Inland Water Transport Authority
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
BS	Block Supervisor
BTM	Bangladesh Transverse Mercator
BUET	Bangladesh University of Engineering and Technology
BW	Black and White
BWDB	Bangladesh Water Development Board
CBD	Char Bagadona
CDSP	Char Development and Settlement Project
CDST	Custom Duty Sales Tax
CE	Chief Engineer
CEC	Commission of the European Community
CEP	Coastal Embankment Project
CERP	Coastal Embankment Rehabilitation Project
CFE	Cash Foreign Exchange
CHW	Community Health Worker
CIDA	Canadian International Agency
CIP	Chandpur Irrigation Project
CPP	Compartmentalisation Pilot Project
CSPS	Cyclone Shelter Preparatory Study
CTG	Chittagong
DAE	Department of Agriculture
DANIDA	Danish International Development Agency
DC	Deputy Commissioner
DCR	Duplicate Carbon Receipt
DDP	Delta Development Project
DEM	Digital Elevation Model
DGIS	Directorate General for International Cooperation, the Netherlands
DGPS	Differential Global Positioning System
DLS	Department of Livestock Services
DOE	Department of Environment
DOF	Department of Fisheries
DPHE	Department of Public Health Engineering
DTW	Deep Tubewell
EC	European Commission
EE	Executive Engineer
EGIS	Environmental and Geographical Information System
EIAR	Environmental Impact Assessment Report
EIP	Early Implementation Project

Abbreviations (continued)

EMG	Embankment Management Group
EMP	Environment Management Plan
EOL	End of Line
EPI	Expanded Programme on Immunization
ERD	Economic Relations Division
ERIM	Environmental Research Institute of Michigan
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agriculture Organisation
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FFDP	Farm Family Development Programme
FFW	Food for Work
FHH	Female Headed Household
FPCO	Flood Plan Coordination Organisation
FWA	Family Welfare Assistant
FWV	Family Welfare Visitor
FY	Financial Year
GIS	Geographical Information System
GK	Ganges Kobadak Irrigation Project
GOB	Government of Bangladesh
GON	Government of The Netherlands
GPS	Global Positioning System
HA	Health Assistant
HH	Head of Household
HI	Health Inspector
HRD	Human Resources Development
HRDP	Homestead Resources Development Programme
HYDRO	Name of a computer system for data acquisition
HYV	High yielding Variety
IBRD	International Bank of Reconstruction and Development(WB)
ID	Identification (code or number)
IDA	International Development Agency(WB)
IDP	Infrastructure Development Programme(LGED)
IEE	Initial Environmental Evaluation
IETC	Irrigation Extension Training Centre(BWDB)
IGA	Income Generating Activities
IGP	Income Generating Programmme
IHE	Institute of Hydraulic Engineering
ILO	International Labour Organisation
IO&M	Improved Operation and Maintenance
IPM	Integrated Pest Management
IRWP	Intensive Rural Works Prograsmme
ISP	Institutional Support Programme
ISS	Institute of Social Studies
JICA	Japan International Cooperation Agency
LAED	Land Accretion and Estuary Development
LCS	Labour Contracting Society
LGED	Local Government Engineering Department
LRP	Land Reclamation Project
MB	Mega Byte
MCA	Multicriteria Ananysis
MCC	Mennonite Central Committee
MES	Meghna Estuary Study
MO	Medical Officer

Abbreviations (continued)

MOA	Ministry of Agriculture
MOFA	Ministry of Foreign Affairs
MOL	Ministry of Land
MOWR	Ministry of Water Resources
MSS	Multi-spectral Scanner
NGO	Non-Governmental Organisation
NSC	National Steering Committee
O&M	Operation and Maintenance
ORS	Oral Rehydration Solution
PCP	Project Concept Paper
PIP	Project Implementation Plan
PMC	Project Management Committee
PP	Project Proforma
PRA	Project Rapid Appraisal
PWD	Public Works Department(also name of a reference level)
RRA	Rapid Rural Appraisal
RRI	River Research Institute
RSP	Rural Settlement Project
RTK	Real- Time Kinematic(DGPS)
SC	Steering Committee
SDE	Sub-divisional Engineer
SE	Superintending Engineer
SMG	Structure Management Group
SMO	Subject Matter Officer
SMS	Subject Matter Specialist
SOB	Survey of Bangaladesh
SOL	Start of Line
SPANS	A Software by ISPAN/EGIS
SPARRSO	Space Research and Remote Sensing Organisation
SPOT	French Satellite?
SRDI	Soil Resources and Development Institute
SRP	Systems Rehabilitation Project
SSD	Survey and Study Division
S/T	Salinity/Temperature(of sea water)
SWMC	Surface Water Modelling Centre
SWSMP	Surface Water Simulation Modelling Project
TFO	Thana Fishery Officer
THC	Thana Health Complex
TM	Thematic Mapper
TNO	Thana Nirbahi Officer
TOR	Terms of Reference
UNDP	United Nations Development Programme
UP	Union Parisad
WARPO	Water Resources Planning Organisation
WGS 84	World Geodetic System 1984 (a geodetic model of the earth)
WID	Women in Development
WUA	Water Users Association

GLOSSARY

Adarsha Gram	Literally ideal village (also the name of a government settlement program)
Aman	Rice produced during the Kharif I & II seasons
Aus	Rice produced during the Kharif II season
Bari	Homestead
Beel	A natural depression the bottom of which,if undrained, cannot be cultivated
Bishkatali	A plant used as pesticide
Boro	Irrigated rice produced during the Rabi season
Char	Alluvial land or land grown up from river
Chira	Beaten rice/flat rice
Chasi	A farmer
Churanta	Final
Deshi	Local/national
District	Administrative Unit in the charge of a Deputy Commissioner comprising a number opf Thanas
Jama	Deposit
Jamabandi	A stage in land settlement
Kabiraj	Ayurbedic practitioner
Kabuliat	Registration deed between the Government and the tenant
Kanungo	An official in the office of DC involved in the work of land settlement
Katcha	Unmetalled, Immature
Kharif I	Early summer (March through June)
Kharif II	Late summer (July through October)
Khal	Canal/Creek
Khas land	Government land
Khatian	The form in which the record of rights is prepared showing all the details relating to any particular "interest"
Khesari	A species of pulse
Monsoon	Period of rains starting in June and ending in October
Mouza	Village as per revenue unit(and not a village as per social unit)
Muri	Popped rice
Nadi	River
Polder	Land protected by embankment with water management system
Pourashava	Municipality
Pucca	Permanent, Metalled, Concrete, Pitched
Rabi	Winter season (November through February)
Samity	Society
Selami	Fee
Tahsilder	Revenue official in charge of tahsil
Thana	Administrative unit of the Local Government below the district
Union	Lowest self-government unit comprising several villages
Union Parisad	Elected council for adminstration and development activities at the union level
SPANS	A software by ISPAN/EGIS

1 INTRODUCTION

1.1 Objectives of the Inception Report

The Meghna Estuary Study, as described in the Terms of Reference, consists, like any project for that matter, of a judicious combination of inputs, which will allow to perform those activities that are needed to produce a specified output. It implies that one should have a clear understanding of the output to be delivered, in order to define the activities to be undertaken. In the case of MES this is not as easy as probably in most of the other FAP-projects. This applies in particular to the Master Plan to be delivered. The consultants would consider it preposterous to suggest that at this stage they are already in a position to give a full description of what the Master Plan could be.

The first priority of the consultants is to come to learn the characteristics of the area, to try to understand the forces and processes that govern physical developments, to discern patterns and tendencies, that will help them when trying to make a projection of possible developments in the near future. Efforts to develop the Master Plan will be guided by the gradually growing understanding of the dynamics of the project area.

This Inception Report reflects this understanding as the consultants have it at this moment. On the basis of that, a conceptual framework is developed, to structure thinking about the master planning exercise and to guide operations for the near future. So much is sure at this stage, that dedicated surveys, model- and other studies will be needed. These should, of course, never become a goal in themselves, but always be guided by the output they are to deliver.

While the preparation of the Development Plan for the coastal islands included in the project may be more straight forward, it certainly depends on the inputs from various other projects, in particular the Compartmentalisation Pilot Project (CPP, FAP20) and the Char Development and Settlement Project (CDSP). Working relationships with these two projects have been established meanwhile.

The primary objective of this report is to describe as far as possible at this stage, in clear and unambiguous terms the outputs that the project is expected to yield, the approach that the consultants intend to follow and the activities they propose to undertake in order to produce these outputs, and finally the inputs they propose to deploy to that end.

1.2 Brief overview of contents of the Inception Report

This Inception Report contains a summary and maps, a main report with tables and figures in Volume 1 and annexes in Volume 2 and Volume 3.

In Chapter 2 the background and context of the Meghna Estuary Study is given including an overview of the Land Reclamation Project as well as a summary of problems that have to be addressed by the Meghna Estuary Study

The description of the project in terms of objectives, outputs, activities and inputs is dealt with in Chapter 3. The main outputs of the MES are: institutional development, surveys, studies, a master plan and a land development plan.

The methodologies that will be used during the elaboration of the study are described in Chapter 4. In particular the use of a Geographic Information System and Remote Sensing data will be an integral part of the study. For planning purposes the log frame approach will be used.

The implementation of the project and a Project Implementation Plan (PIP) are dealt with in Chapters 5 and 6, respectively. The Project Implementation Plan contains the Gantt Charts for surveys and investigations, studies and hydraulic and morphological modelling.

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Chapter 7 provides a description of the reporting to be produced during the Meghna Estuary Study.

Volume 2 and Volume 3 of the Inception Report contain 15 annexes, these two volumes provide the contributions of the various disciplines of the Meghna Estuary Study. As agreed during the meeting of the Steering Committee, these volumes have not been revised after initial submission.

Special attention and effort have been given to the preparation of Annex 01 Logical Framework.

2 BACKGROUND

2.1 Preparation of the Meghna Estuary Study by GoB and Donors

The Meghna Estuary Study (FAP5B) is a component of the Flood Action Plan for the Government of Bangladesh (GOB), launched with assistance from the international donor community and coordinated by the World Bank. Most of the 26 components and supporting activities of the Flood Action Plan, which started in 1990, have been completed by now.

The project will be implemented under a cooperation programme between the Governments of Bangladesh, The Netherlands and Denmark. The administrative Agreements between the three governments was signed on 7 December 1995. The executing agency on the Bangladeshi side is the Bangladesh Water Development Board (BWDB). According to the Terms of Reference the coordination with other projects under the Flood Action Plan (FAP) is to be done by the Flood Plan Coordination Organization (FPCO).

MES area covers the Lower Meghna River from Chandpur town (the downstream extent of FAP9B) to the Bay of Bengal. The eastern boundary follows the left bank and the coast line to the mouth of the Karnafuli near Chittagong (the boundaries of FAP5 and FAP5C). The western boundary follows the right banks of the Lower Meghna and Tetulia Rivers and the coastline to the bay (partly the boundary of FAP4). The southern boundary, which covers the eastern area and the offshore islands, is not specifically defined. But the eastern side should cover the entrance to the Karnafuli River. The western boundary may be extended further to the west if it is considered necessary for the complete coverage of the mathematical model - See Figure 1.1.

Although Bhola island is in the project area, its internal area development and water management are covered by FAP4 South West regional Study, and will thus be outside the MES responsibility.

The area has been served by the Land Reclamation Project (LRP) from 1978 onwards with assistance from the Government of The Netherlands and by the end of the Project in July 1991, the two Governments, in recognition of the two distinct approaches, divided it into Char Development and Settlement Project (CDSP) and Meghna Estuary Study (MES). After the devastating cyclone in 1991, the Flood Action Plan gave priority to the area and thus the MES is designated as FAP5B.

The Terms of Reference for the project have been revised several times over the last four years; the study as it eventually has been formulated is rather complex, covering a number of components that have some degree of coherence. In addition it has connections with some other projects being carried out or completed earlier in the same area. The project also has an important institutional component.

Ultimately the various components have to be brought together in coherent overall plans, in the ToR referred to as the Master Plan for the total area and the Development Plan for the coastal islands included in the project area. This certainly is a complicated matter, which requires a well planned approach and the timely inputs of various experts and supporting tools and equipment, in order to produce eventually the outputs that satisfy the expectations of all participants in the exercise.

2.2 Description as per Terms of Reference of MES

1. Planning the development of the project area, giving due attention to:

   Surveys

   Carrying out a systematic programme of surveys to build up a reliable data base for assessing estuarine behaviour. Most of the hydrographic surveys will be carried out with the survey vessel "Anwesha" and its two tender boats.

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Data base

Carrying out a systematic data collection programme and setting-up a database including the establishment of a GIS data processing and presentation system that is compatible with GIS facilities of other institutions in Bangladesh

Studies

Carrying out a systematic programme of hydraulic and morphological modelling to assess the estuarine behaviour.

Master Plan

Enhancing the optimum exploitation of the potentials of the area in terms of land reclamation and land use, thus providing new land to landless people.
The masterplan is expected, in due course, to lead to an enhanced morphological stability and eventually to a shortened coastline. It thus aims at a safer environment for sustained human habitation.

Land and Water Use

Mitigating the destructive forces of storm surges (cyclones), thus providing a higher degree of safety to the population and property, and improving the productivity of the coastal islands by introducing better systems for drainage, salinity control and water management (development plan). This would include those areas which are at present not protected and which are not covered by FAP-7.

2. Enhancing understanding of the natural forces that shape the physical properties of the area and which largely determine the potential for settlement and development.
To the extent that information is available from other FAP studies about the possible impact of flood protection works along the major rivers on hydraulic and morphological conditions in the rivers, related consequences for the Meghna Estuary should be assessed.

3. An early start to implementation of priority projects and programmes which are compatible with the phased long term and/or development plan. Implementation of works beyond the stage of practical experiments is not included in MES.

4. Practical solutions for an effective continuation of surveys and studies, aimed at sustained and coordinated actions to update and progressively implement the long term plan.

5. Reinforce the capacity of the concerned institutions to survey investigate, plan, design and implement MES, its projects and long term plan.

2.3 Project area

Broadly speaking it includes the following water bodies: the Lower Meghna south of Chandpur, the Tetulia River in the west, the Shahbazpur River, as a direct continuation of the Lower Meghna, the Hatia River, being the area in between Hatia and Sandwip, the coastal waters to the north of these two islands, and finally the Sandwip Channel, in between Sandwip island and the Chittagong main land.

The land area comprises the three main islands of Manpura, Hatia and Sandwip; the shallows and tidal mudflats along the coast of Noakhali; and finally the many small islands lying within the indicated boundaries of the project area. Notably excluded from the project area are Bhola island and the landside areas of the Noakhali mainland.

The southern boundary of the project area is not precisely defined. The stepped line indicated in the map attached to the Terms of Reference is not to be taken too rigidly in this respect. The hydraulic models to be used require a more southern boundary.

In any case on the eastern side the mouth of the Karnafuli River is to be included as per the Terms of Reference; more to the west the potential areas for land accretion at the southern tips of Hatia and Bhola are to be included as well.

The hydraulic and morphological conditions within the project area vary significantly. Riverine processes dominate in the Lower Meghna and the Tetulia River, and presumably also in the Shahbazpur Channel, although little factual information is available on the latter river. Yet, because of tidal influences, in some reaches there could be distinct ebb and flood channels.

The tide, approaching the estuary from south-westerly direction, penetrates strongly into the Lower Meghna; except for periods with very high upland discharges, the vertical tide penetrates up to Chandpur in the monsoon season, and in the dry season even up to Sylhet in the east. While the tide is strong in the Shahbazpur River, it is relatively weak up the Tetulia.
Presumably the reason is that the outlet of the Tetulia into the Bay of Bengal is relatively shallow, which in turn is caused by the fact that the Tetulia carries a relatively low discharge, which is insufficient to keep the outlet open. This situation appears to be similar to adjacent river outlets to the west of Tetulia River.

This is a very fortunate situation indeed, because it implies that there is a very weak exchange between fresh water from upland flow and saline water brought in by the tide. This situation contrasts sharply, for instance, with the Pussur - Sibsa river systems in the western part of the South West region, where the tide is predominant and a very strong saline intrusion occurs. The fresh water pocket which, partly by the grace of the weak tidal penetration, extends from the Tetulia in westerly direction, is to be considered as a very precious resource worth preserving as much as possible. If not also for other reasons, this consideration in itself makes it worthwhile to preserve and whenever possible even to encourage the accretion apparently taking place at the southern end of Bhola island, which will tend to strengthen the formation of a bar separating the Tetulia from the sea.

By contrast in the Hatia Channel, the area in between Hatia and Sandwip and in the Sandwip Channel, tidal forces are predominant. The maximum tidal range may vary from about 3.50 m at the southern end of Hatia and Sandwip to about 7.50 m in the extreme north-eastern end, near the Feni Closure Dam.

Very strong tidal currents could occur, values up to 3.5-4 m/s have been recorded. As a result morphological developments could go very fast in this area. The persistent erosion which occurred along the northern end of Sandwip for several decades up to about 1990 and which is still ongoing at the northern end of Hatia, bear witness in this respect.

Most of the sediment being carried down the Lower Meghna, is washed out into the sea; the coastline of Bangladesh exhibits a remarkable degree of stability, as is evident when comparing the Rennel map of about two centuries ago with the present day situation; see also the map attached to the Terms of Reference. It seems as if about all the sediment brought in by upland flow, is lost to the deeper sea.

Yet the tidal flows entering into the Shahbazpur Channel and the area in between Hatia and Sandwip, are heavily laden with sediment, largely consisting of fine, more cohesive particles, washed back by the sea. This sediment will be deposited wherever conditions are favourable. The forces that govern the erosion in some places and siltation in others appear to be in a dynamic equilibrium, allowing hardly any net gain of land.

Since times immemorial man has tried to change his natural environment, so as to suit his requirements; the coastal area of Bangladesh is no exception in this respect. Due to the dynamic riverine and marine environment prevailing especially in the eastern part of the project area, only

the latest interventions left their traces. Those which are important for this study, include the following (for a more complete description of these interventions, reference is made to the related studies and reports):

Crossdams nr. 1 and 2

These dams were built in 1957 and 1963 respectively. They were constructed across the Bamni Channel, once apparently a major channel of the Lower Meghna. While the latter changed its course in accordance with the present day configuration, massive siltation occurred on both sides of the crossdams since then. This gives an indication of the potentials for land accretion that could prevail in the area.

Coastal embankments

In the 60's and 70's the Coastal Embankment Project has been implemented, extending also into the project area, as shown in Figure 3.1. The embankments, which originally have been designed to prevent flooding at high tidal levels, are not believed to have had an appreciable impact on the accretion of new land in the project area, apart from siltation in some of the drainage channels in the main land of Noakhali.

Closure of channels

In the course of the last decades a number of channels along the coast of main land Noakhali have been closed, the most significant of which are the Daria Nadi closure under the Land Reclamation Project (LRP) in 1982 and the Feni Closure Dam, constructed in 1985. In both cases siltation occurred along the seaward face of the dams. Especially in the case of the Feni Closure Dam the rate and extent of the siltation, known by the name of Muhuri Accretion, is spectacular, again giving an indication of the potentials for the reclamation of new land in the area.

Reclamation of new land

By spontaneous intervention of the local population or by specific action of government organizations, land has been reclaimed and embanked along the coast of Noakhali and some of the coastal islands. Notably the activities under the LRP and the ongoing Char Development and Settlement Project (CDSP) are relevant in this respect. In fact, as required by the Terms of Reference, the MES has to cooperate closely with CDSP.

2.4 Previous hydraulic surveys and model studies

The Land Reclamation Project

The Land Reclamation Project (LRP) (1977-91) comprised comprehensive field investigations and numerical hydraulic modelling, for providing a part of the planning basis of that project.
(In principle, the scope of the MES field programme is to supplement the data produced by the LRP and other previous studies. However, the rapid morphological changes in the estuary, in combination with the general need of simultaneous data, imply a need of a thorough continuation of the field survey activities).

A description of the LRP accomplishments is given in the LRP Final Report, August 1991. In brief, the field programme components were (i) coastline surveys, (ii) bathymetry surveys and transect geometries, (iii) sea level recordings, (iv) flow recordings, (v) wind recordings and salinity recordings (to a minor extent). A catalogue of collected data has been compiled by BWDB/SSD in the publication Inventory of available data and information, BWDB, May 1991.

Numerical hydraulic modelling within the LRP comprised 1-D hydrodynamic modelling (by the NETFLOW model), and 2-D hydrodynamic modelling (in a 1 km grid). Also, detailed 2-D hydrodynamic models were applied for selected areas. The numerical modelling was largely carried out in

the Netherlands.

The NETFLOW set-up has subsequently been incorporated in the SWSMP model, which is implemented at the SWMC. The SWSMP model in turn is the origin of the 1-D model that will be used in the present study.

The marine survey activities under LRP have been carried out by the `Anwesha' which was the main survey vessel of LRP stationed in Chittagong. Today, the vessel is operated by BWDB/SSD, it will also be used for the MES survey activities.

From May 1980 to 1991, 'Anwesha' was in operation for some 50 percent of the time, the remaining time being spent on bunkering, scheduled and unscheduled repair and maintenance, weather downtime, holidays, and unrelated activities. The vessel was docked once per year for routine inspection and maintenance, and also, on several occasions, for major repairs due to accidental damage to the hull or to the propulsion system. Typical reasons for such damage was hitting the seabed, and getting the propeller entangled with fishing nets (to which the vessel is reportedly particularly sensitive, 'LRP, Final Report', p. 32-34).

In 1990, an appraisal mission made the following observations on working conditions in the project area: (Westdijk and Mol, draft, undated):

- travelling distances are enormous
- accessibility is often difficult and sometimes impossible
- local currents are sometimes dangerous according to Dutch standards
- unpredictable and dangerous tidal bores occur in the area; on one occasion, a tidal bore caused the loss of one vessel

Other investigations in the Meghna Estuary

Apart from those under LRP, several other relevant marine investigations or study components have been carried out or are in progress in the coastal area of Bangladesh such as for example:

- National Water Plan Project
- South-West Regional Plan, supplement E, IECO (1980)
- Chittagong Harbour, small studies of siltation and dumping of dredging spoils (1977-78, 1983)
- 2nd Coastal Embankment Rehabilitation Project (CERP II) (BWDB) (1988-91)
- Pussur-Sibsa River and Karnafuli Entrance (Ministry of Shipping, GoB) (comprising marine field surveys, and numerical hydraulic modelling) (1989-92)
- Numerical simulation of tides and saline water intrusion in the Meghna Delta, IFCDR, BUET (1989)
- Cyclone Protection Project II (BWDB) (comprising topographic field surveys, and numerical hydraulic modelling) (1990-91)
- SW Area Water Resources Management Project (FAP4) (FPCO) (comprising numerical hydraulic modelling) (1991-93)
- Cyclone Shelter Preparatory Study (Local Government Engineering Department) (comprising topographic and marine field surveys, and numerical hydraulic modelling) (in

progress, November 1995 - August 96)

As indicated, some of these investigations have comprised small or comprehensive field surveys, and numerical hydraulic simulation programmes.

Geographically adjoining FAP projects are FAP4 (SW Area Regional Study), FAP5 (SE Regional Study), FAP5C (S Regional Study) (not yet initiated), and FAP9B (Meghna Left Bank Strengthening). The River Survey Project (FAP24) does not cover the Lower Meghna.

A new phase of the Coastal Embankment Rehabilitation Project (CERP) is scheduled for implementation in 1996, and for that purpose a GIS project in the area is under preparation, founded by the EC.

In connection with the Surface Water Simulation Modelling Programme (SWSMP), the Surface Water Modelling Centre (SWMC) has set up, calibrated and applied a suite of hydraulic models for the Meghna River estuary.

These models have been used for previous studies in the area, such as the Southwest Area Regional Study (FAP4), the Pussur-Sibsa and Karnafuli entrance study, and the Cyclone Protection Project (FAP7). A 2 km grid 2-D model is presently being updated for the purpose of the Cyclone Shelter Preparatory Study (November 1995 - August 1996).

Further, SWMC operates a data base for data storage, and a GIS system for data presentation and impact analysis.

2.5 Drainage and water management

Introduction

Drainage congestion and water logging are considered main obstacles for agricultural development of flood protected areas situated in the Meghna Estuary. Drainage congestion occurs when excessive rainfall cannot be removed in time by a drainage system.
Such a situation may be more pronounced in the estuary compared to other areas of Bangladesh due to, a) the construction of protection embankments, b) sedimentation of a natural, internal drainage system, tides and land accretion near the outfall of drains and c) a higher rainfall.

Another restriction for agricultural development in the Meghna Estuary is formed by soil salinity. LRP studied in detail soil salinity and concluded that desalinisation of accreted and protected land is a natural, but slow process. Favourable drainage conditions may accelerate this process.
Previous experiences related to water management are very limited in the case of LRP. Nowadays, improved water management concepts and experiences are found with on-going BWDB projects such as CDSP, CPP and more in particular SRP.

Drainage congestion

Drainage congestion and water logging result in reduced yields and restriction of crops that can be grown throughout the year. High rainfall occurs in the months of July and August. Flooding of Aman rice plots occurs and may submerge recently transplanted rice for several days resulting in considerable yield reductions. LRP and research institutes such as BARI found that farmers who were hampered by water logging had to delay the cultivation of Rabi crops. Fields are still too wet in December and late rains may damage Rabi crops in case of an inadequate surface drainage system. Besides, if planting is delayed, Rabi crops have to cope with an increasing soil salinity and a decreasing available soil moisture later in the dry season.

In general, problems with drainage congestion worsen after the construction of protection embankments, despite the fact that sufficient drainage sluices have been provided. Drainage congestion is caused by an inadequate internal drainage system and in the coastal area this

situation may be aggravated by sedimentation of the drainage system and drainage outfalls combined with relatively high rainfall.

The internal drainage of a coastal polder is realised through a natural network of smaller and larger waterways, named khals. These khals are formed during accretion of the land and convey tidal floods and excess rainfall. After construction of a protection embankment, main khals are connected to drainage sluices. The size of sluices depends on the catchment area of a particular sluice. Catchment areas are defined by hydrological boundaries. Natural topographical features such as ridges and depressions form hydrological boundaries, but so do human interventions such as roads, footpaths, crossdams and canals.

LRP developed criteria and a typical layout for a drainage network of main and minor drains. Surface water drainage criteria and a typical layout for a surface drainage system have been tested successfully in research plots of the LRP pilot polder. A main drainage system is formed by the existing khals, but a minor drainage canals has to be constructed in a rational way, followed by settlement or resettlement of the population.

LRP experiences related to settlement issues show that application at a larger scale of such a minor drainage system will be difficult. One of the main lessons learnt from LRP is that settlement policies and issues have to be addressed before accretions are stimulated since resettlement and redistribution of land of fully accreted land, when empoldering can start, is virtually impossible.

It means that newly protected lands may have been occupied for more than 10 to 15 years by the farmers, fishermen and herdsmen. In such a situation, there is little scope to plan a minor drainage network as it has been developed and tested by LRP and later on proposed in the feasibility study of the Sandwip Crossdam.

Other approaches may be tried to develop a required drainage network that meet acceptable drainage criteria in situations that may not differ much from already existing polders with drainage problems. These approaches should have in common that participation of the already settled population takes place in planning, construction as well as management of drainage networks.

The experience of SRP in Polder 55/1, and of EIP in Polder 43/2c and to some extent the drainage study carried out by LRP for the Southern Sudharam area reveal a number of causes for drainage congestion in areas that have been protected against floods. Causes for drainage congestion found so far are:

- Intensification of a road network, once the area is protected against flood. Roads act as hydrological boundaries, especially when no or insufficient culverts and bridges are provided.

- Roads are planned and constructed by LGED and under the Union Parishad. Co-ordination or planning between the Local Administration and BWDB is weak and funds allocated for culverts and bridges, if requested for, are insufficient.

- Properly designed sluices may have to drain out the water of an entirely different catchment area as a result of changing hydrological boundaries caused by crossdams and road construction.

- Little or no maintenance is carried out. Capacity of main drains may have been reduced due to sedimentation or excessive growth of aquatic plants. In most FCD projects, neither BWDB nor other agencies consider it as their task to maintain the internal drainage systems. BWDB is in principle only responsible for the constructed embankments and sluices. The area occupied by the drains is registered as Government land (Khas land) and falls under the Ministry of Land (MoL).

- Fishing practices may obstruct the free flow of water in drains. Fishermen install structures in cross sections of drains, such as bamboo constructions with fine netting or sometimes

even a temporarily or permanent crossdam. It also happens that fishermen make unauthorised use of drainage sluices to catch fish by opening and closing the sluice at moments favourable for fishing, but not necessarily favourable for drainage.

- The operation of drainage sluices is poor due to frequent absence of the BWDB sluice operator and a non-functioning of the sluice committee, established by BWDB.
- CDSP found that even the pilot polder of LRP formed no exception to this.

From what has been mentioned here, it can be concluded that involvement of the population as well as relevant agencies is necessary to solve and prevent drainage congestion and to establish a proper water management in polders.

A rather separate problem is sedimentation of outfalls. Examples of such outfalls are mentioned in the drainage study carried out by LRP of the Southern Sudharam Thana. Two main outfalls of this area, the Baggar Dona East Khal and the Noakhali Khal, cope with sedimentation problems. In the case of the Baggar Dona the problem is siltation of the upper reach while in the case of the Noakhali Khal sedimentation takes place at the downstream end of the khal where shoals have been formed. An eventual crossdam from the main land to Sandwip as proposed by LRP may further worsen the conditions at the outfall of the Noakhali Khal as a result of new accretions.

Several proposals were made by LRP, SRP and the South East Regional Study, FAP 5, to find a solution for the location of a new drainage outfall for Southern Sudharam Thana. Two sites, Chitalkhali (LRP and SRP) and another more south on the West Baggar Dona River close to Ramgati (FAP 5) were proposed. For a final decision on such a location, morphological and hydraulic studies are required (and will be conducted by MES) to improve predictions on the stability of such sites, whether rapid accretion may be expected or whether a considerable chance for erosion exists.

Salinity

Salt-tolerant, low yielding Aman varieties are cultivated during the monsoon on fully accreted but still unprotected land.

Farmers will continue cultivating such varieties on land that only recently has been protected by embankments. Cultivation of improved, higher yielding Aman varieties is only possible if desalinisation has progressed sufficiently. LRP found that south of Noakhali such favourable soil salinity levels can be reached within 4 to 5 years after empoldering the area. However, the slow process of desalinisation may delay the introduction of a second crop such as Rabi or an Aus rice by more than 10 years.

Desalinisation occurs only during the monsoon when saline groundwater is diluted with fresh rain water. In unprotected areas, resalinisation happens during tidal inundation, when standing saline water percolates into the soil and during the dry season by a capillary rise of saline groundwater. Once accretion has been completed a natural equilibrium between desalinisation and resalinisation may be reached that allows cultivation of salt-tolerant Aman rice varieties.
The construction of embankments will prevent periodically flooding with saline water but the capillary rise of saline groundwater will continue to occur. The most effective way to prevent a capillary rise of saline water is removing salts from the subsoil. This can be achieved through leaching. Leaching occurs when rain water can percolate through the sub soil and wash down salts to deeper groundwater layers. LRP salinity studies revealed that in soils south of Noakhali, deep drainage is the major agent for desalinisation.

LRP found that deep drainage takes place only during the monsoon and can be stimulated by keeping water levels in main khals low. A level of about one metre below field level was assumed possible and sufficient to stimulate percolation. Realisation of such water level during the monsoon may require re-excavation of main khals, in particular if khals have been exposed to strong sedimentation before empoldering was completed.

Speeding up desalinisation and thus stimulating deep drainage will allow a more rapid development of agricultural production in coastal areas. It means that, if also surface drainage criteria have been met, a timely introduction of HY Aman and Rabi varieties can be realised. Stimulation of desalinisation prevents unnecessary delays of planned benefits from costly interventions such the construction of a crossdam and the construction of embankments and sluices.

Although little is known so far, rates of desalinisation and resalinisation may differ from place to place in the estuary. Soil characteristics such as soil texture and soil profiles that are formed during sedimentation will influence these rates. Soil salinity levels may also differ due to different salinity levels of water that surrounds accretions. Field observations and study of existing soil and water data may provide a better insight in salinity levels and expected desalinisation rates for other areas of the estuary.

Water management

As mentioned earlier, drainage congestion is mainly the result of human interventions such as the construction of crossdams in drains, footpaths and roads without a sufficient number or size of culverts or bridges. Lack of maintenance of khals and outfalls, improper operation of sluices and a detrimental use, from a drainage point of view, of drains by fishermen combined with a rapid deterioration of flood protection and drainage infrastructure due to lack of maintenance contribute to drainage congestion.

The cooperative approach or growth-centre approach followed by LRP, focusing on integrated rural development, has so far been less effective to improve water management in LRP polders. To further pursue the development of polders, diversification of coordinating and planning organisations along different interests may be required. At present CDSP started to establish single-purpose Water Users Groups (WUGs) and tries to involve existing multi-purpose Sub-Polder Committees (SPC) in planning, implementation and supervision of O&M of former LRP polders.

Strategies to develop main and minor drainage and irrigation systems through people's participation have been developed and implemented by SRP. Pilot areas in Polder 55/1 provide an example of a step-wise approach to develop minor drainage and irrigation systems, starting with the organisation of water users in small command areas along hydrological boundaries. Water users in such areas have a common interest. A shared strong interest will help to solve for example drainage problems that those water users have in common, despite their social differences. Although promising experiences have come up, it is too early to draw final conclusions regarding application of such concepts at a larger scale.

Most projects and FAP studies, like FAP 13, the O&M study, seem to agree that organisation and participation of water users in FCDI schemes form a prerequisite for improving water management. They also agree that, although LGED has also a clear mandate to develop minor irrigation and drainage systems, BWDB is the most logical institute to develop the interior of its FCDI schemes. However, it has also been concluded that to be able to start with such an ambitious task, BWDB needs to be reoriented and reorganised. The provision of more O&M funds and additional O&M staff is not sufficient. Despite the establishment of an O&M section, BWDB remains basically a construction-oriented organisation rather than a water management-oriented organisation that tries to establish an effective communication with water users and other relevant organisations such as Fisheries, LGED, DAE, and Union Parishads.

According to SRP participation of water users in water management is only possible if those water users are organised. The organisation of water users, mainly farmers, should be done taking into account the hydrological boundaries, because the farmers in the same command or catchment area have a common interest to solve problems related to irrigation or drainage. At a lower scheme level this means the establishment of Water Users Groups (WUGs) for small command or catchment areas, who will be fully responsible for water management at that level. At medium and higher levels responsibility for water management will be shared between water users and BWDB.

For the Meghna Estuary Study it means that strategies and development plans for improvement of water management and drainage in protected areas, will take into account the above mentioned water management principles, which have been approved by BWDB and which are in line with FAP guidelines for People's Participation.

2.6 Summary of development issues

In order to fully justify the technical proposals for reclamation and protection arrangements it is necessary to create a linkage to the possibilities for settlement and rural development in new and existing char lands.
Without addressing settlement and rural development issues it may even be questionable to what extent traditional feasibility studies will provide background for proposing any major technical reclamation and protection measures.

The problem which has been faced by all khas land settlement schemes so far - including the reclaimed char areas - is that *the land has already been occupied at the time the settlement scheme has come to the point of implementation*. The actual settlers - in fact illegal settlers - are usually from the very poor strata of society but the de facto control of the areas is in the hand of people from the local power elite, which is often a mix of the local political and economic power. Absentee landlords living in Dhaka or other big cities are also seen as holding power over large areas of land. It is this situation that makes it difficult to undertake a planned settlement afterwards, and the land owner elite seems to constitute a social force strong enough to resist establishment of an efficient and transparent land allocation and formalization system.

The actual and illegal settlers do not have title deed to their plots, and they have often paid a high price to the landlord for the plot. Due to their non-formalized settlement situation their legal position is very weak.
A most crucial issue for the settlers is that they have access to income earning activities, either through agriculture and fishery or non-agricultural/fishery activities. At the outset there are no activities at all in new char areas, so naturally agriculture, livestock and fishery will be playing an important role. With soil salinity problems and possibly other soil deficiencies it is likely to take some years to develop agriculture to a point where yield reaches an expected level, and even in that case 2 acres (the size prescribed by Ministry of Land for khas land settlers) will normally not be sufficient to sustain a household. The household deficit has consequently to be supplied in other ways which may be fishery or other non-farm activities. The latter are not easily available in new char areas, and support to establishment of new income generating activities should therefore be given a high rating.

A general experience from rural development in Bangladesh is that many of the government agencies at local level lack capacity to reach out to the beneficiaries in the way that is intended. This situation is anticipated to be aggravated with increasing remoteness of the areas to be reached. Presumably the situation is even worse when moving to off-shore char areas which are not even administrative units with the normal thana set-up of administration and departments of line ministries.

Such issues need to be given special attention in the present project. Experience has been gained over the years and ongoing on these subjects, e.g. from Land Reclamation Project (DGIS funded) and Noakhali Rural Development Project (Danida funded) and experience is presently being gained in e.g. Char Development and Settlement Project (DGIS funded) and Adarsha Gram Project (EU funded). This experience supplemented by own field and institutional investigations shall be the information base for developing improved strategies and interventions in cooperation with government departments and local administrative authorities.

3 PROJECT DESCRIPTION

3.1 Objectives

3.1.1 Development objectives

The development objectives of the project are:

- To increase the physical safety of the population living in the South-Eastern coastal areas of Bangladesh
- To promote sustainable development in these areas.
- To increase the social security for the population in the coastal areas and on the islands.

The indicators to verify the achievement of this long term objective are that during floods and cyclones, comparable to similar events in the past, there will be:

- less casualties among the population living in the coastal areas and on the islands
- less damage and loss of property and livestock along the coastal zone and on the islands

3.1.2 Immediate objectives

- Enhanced operational knowledge of hydraulic and morphological processes in the Meghna Estuary established and institutional capacity to maintain and update the same knowledge strengthened.
- Suitable land reclamation and bank protection methods identified and increased capacity of BWDB to reclaim new land and to install river bank protection works.
- Development plan with priority project and programmes for flood protection, agricultural and socio-economic development prepared for early implementation.

The indicators to verify the achievement of the immediate objectives at the end of the project are:

- a detailed programme for surveys and studies in the Meghna Estuary and an efficient and reliable setup for continuation of the surveys and studies
- a set of bank protection and land reclamation methods applicable in the Meghna Estuary
- a portfolio of projects and programmes ready for early implementation

3.2 Outputs

3.2.1 Institutional development

The short-term outputs of the MES in relation to institutional development are to:

- increase the knowledge of the hydro/morphological processes in the Meghna Estuary;
- increase the institutional capacity to retain and update that knowledge;
- develop appropriate approaches for rapid and low-cost land reclamation;
- develop priority projects and programmes for early implementation.

In pursuit of these outputs, the project will:

- re-activate, direct, and make recommendations for effective continuation of the survey and study programmes aimed at sustaining coordinated actions to update and progressively implement a long-term Master Plan;
- establish a master planning process by developing a Master Plan for interventions aimed at increasing the land area and the physical safety in the Meghna Estuary;
- establish a development planning process within the framework of the Master Plan by formulating a Land and Water Development Plan for physical development of (parts of) the MES area, with ultimate benefits to the landless poor;
- establish the link between macro and micro planning by conducting feasibility studies in preparation of micro planning for priority projects and programmes in the development plan area(s), aimed to benefit the landless poor.

3.2.2 Surveys

Land based and marine surveys

These surveys aim at the following results:

- Upgrading of the survey spread of M/S Anwesha
- Establishment of a grid of geodetic reference points covering the project area
- Generation of competence within BWDB/SSD and SWMC to utilise the supplied data collection and data processing facilities
- Provision of hydraulic data, to serve as a part of the basis for design and impact evaluation within the project

The planned upgrading of the survey spread of M/S Anwesha and its tender boats comprises accurate positioning, state-of-the art survey instruments for bathymetry, flow and S/T measurements and sediment sampling, and computer hardware and software for high-capacity on-line data processing. Hereby, the vessel will have facilities that compare favourably with the best survey units in operation in Bangladesh today. With respect to positioning, which is crucial for the morphological monitoring, the vessel will be equipped with advanced so-called RTK-DGPS 3-dimensional satellite positioning.

As a basis for the surveys, a grid of geodetic reference points is required. Most of the country is already covered by a geodetic grid recently established by Survey of Bangladesh, but this grid does not cover the MES area. Therefore, a grid will be established for the purpose. At the same time, the grid will supply a link with the reference levels of the ongoing water level registrations, and the reference levels of the LRP bathymetry mapping, so that past, present and future data from different sources can be directly compared. The results of the activity will comprise the network itself, as established in the field, together with its BTM coordinates and PWD levels. Also, information will be provided about conversion from WGS84 coordinates.

Due to inherent range constrictions for the applied RTK system, a network of base stations will be applied. Of course, the same station will be retained for successive surveys in the same area. The stations have been selected during a separate activity that is not comprehensively described in the Inception Report. Wherever possible, they are located on the roof of cyclone shelters, and their coordinates and elevations have been determined by a high-accuracy geodetic DGPS survey relative to the national grid recently established by Survey of Bangladesh.

The marine survey work will be carried out by BWDB/SSD. Since the scope and facilities are highly extended as compared with for example the LRP, a comprehensive capability upgrading is required for the purpose.

This process will take place gradually in the course of the Study. Initially, the field work will be done under supervision and with full-time active participation by expatriate project staff, whereas

later on, the work can be done by BWDB/SSD staff with some occasional assistance (backstopping and trouble-shooting) by the foreign specialists. At the end of the project, it is intended that BWDB/SSD can plan and execute estuarine surveys (of the type in question) by own means.

The over-all objective of the surveys is to supply hydraulic data, as a supplement to the data already produced or being produced by BWDB, BIWTA, LRP, and others. The data will serve as an important part of the basis for design and impact evaluation within the project.
The anticipated volume of data to be produced within the MES is indicated in Table 3.1:

Registration	Data volume
Water level	120 station-months (by MES) + 120 station-months (by BIWTA)
Wind	96 station-months (by Meteorological Department)
Waves (6 stations)	120 station-months
Bathymetric surveys	10,000 km line, about 50 maps
Flow measurements (with current recordings)	80 transects
Salinity/Temperaure	500 profiles
Sediment transport	80 transects
Sediment settling velocity	160 samples
Bed material	500 samples
Data reports	24 reports

Table 3.1: Estimated data production

The field survey data are not to be considered solely as input for modelling and computer simulation on which design or impact assessment will be based. These data, after elaboration and compilation as mentioned in the Terms of Reference, and in combination with remote sensing data will also be a means for better understanding of the present estuarine environment.
The tabulated output may serve as an indication to potential data users of the possible extent of the data production.

Socio-economic surveys

The socio-economic survey will have the following output :

- Contribution to establish background data for rural development planning for the char settlers in the project area.
- Identification of a realistic approach to the planning process in the project area by enhancing the optimum exploration of the potentials of the project area in terms of land use and socio-economic activities.
- Identification of needs, formulation of ideas and proposal for activities in the rural development planning for the benefit of the settlers.
- Development, of an understanding of gender issues and women's participation in the planning and development process of the char land.

3.2.3 Studies

General

The objective of the studies is to provide a part of the basis for feasibility evaluation, design, and impact assessment of different schemes that will be considered in the course of the planning process. For this purpose, the studies must supply:

- a baseline description
- impact assessments (prediction of consequences of various schemes)
- indications on design modifications or corrective measures for mitigation of adverse consequences
- guidelines for impact monitoring (for validation of the predicted consequences).

Reference for impact assessment

The baseline description will be synthesised into a description of 'present conditions', serving as a reference for the impact evaluation. This reference will be simplified, but well-defined, and with a transparent validity, in order to make it suited for a detailed and consistent impact analysis. It will represent a typical dry season period and a typical monsoon period.

Hydraulic studies

The hydraulic impact is evaluated by predicting the hydraulic conditions after implementation of a given scheme, and by subsequent comparison with the reference conditions.

The following characteristics will be included in the hydraulic impact assessment to the extent that they are relevant from case to case:

- Water level
- Current velocity
- Tidal excursion
- River flow rates (i.e. flow distribution between channels)
- Salinity
- Wave height
- Sedimentation and erosion capacity

This analysis will be largely based on numerical modelling.

Morphological studies

Similarly, the morphological impact is evaluated by predicting the morphological conditions after implementation of a given scheme, and by subsequent comparison with the reference conditions. The analysis will be partly based on results of the hydraulic impact evaluation, which will establish the sediment transport and erosion capacity for the reference situation and after implementation of a given scheme. Hereby, the impact zones (of increased and reduced accretion and erosion) will be identified.

Reporting

For each case to be studied, results will be presented in maps that show baseline conditions, and predicted deviations from the baseline conditions. The maps will cover those areas where effects of a practical significance are indicated.

Findings will be reported in a series of impact assessment notes that will contain data summaries, outline of main physical processes, basic assumptions, descriptions of applied methodologies, maps, and discussion of the results. For selected development schemes, guidelines will be given on impact monitoring, and mitigation measures will be suggested as prompted by the findings.

3.2.4 Master Plan

For centuries accretion and erosion, both natural processes, take place in a highly dynamic Meghna Estuary. The Meghna Estuary Study focuses on an assessment of the potential for accretion and the formulation of priority projects in the area. Firstly the project has to enhance the institutional capacity of the WARPO/BWDB to apply appropriate land reclamation methods. Secondly, has to to ensure an early start of implementation of priority reclamation and settlement projects that favour the position of rural poor, landless and destitute women.

The Master Plan to be submitted at the end of the project period will comprise the following components:

- A realistic picture of how the Consultants believe the project area could look like twenty five years from now.
- An outline of the strategy to be followed for the implementation of the plan and an indication of how necessary adaptations of the plan could be defined and incorporated in order to keep the plan up-to-date and valid.
- A full description of the sequence and nature of successive interventions that are planned to bring about the envisaged changes. The interventions will comprise reclamation and protection works, embankments and development plans for reclaimed land.
- A description in outline of the projects to be implemented during the next five-year period, jointly with a justification of the anticipated phasing.
- Jointly with the Development Plan, a full feasibility study for three priority projects, scheduled for implementation during the first five years; three more projects in this category will be analysed at pre-feasibility level, including design criteria, an outline of the Terms of Reference for the next stage and, if appropriate, a suggestion for possible lumping of projects.
- An indication of additional measures that could be foreseen in case the planned sequence of successive Master Plans would be interrupted for some reason, in order to secure the sustainability of the outcome of this first phase Master Plan.
- An outline for the strategy for the periodical reformulation of the Master Plan.
- A description of procedures designed to maintain a realistic Reference Scenario, as a guide for subsequent master planning exercises.

3.2.5 Development Plan

The elaboration of a Land and Water Development Plan has to take place within the framework of a Master Plan. The Master Plan will define areas where accretion can be stimulated. The Master Plan will also define the stability of existing accretions for which priority projects are to be formulated. Stability, which means a low risk for future erosion will be an important factor in making the decision where to allocate the scarce resources for reclamation and settlement.

The Land and Water Development Plan will provide more insight and criteria for selection of priority project areas among the potential areas identified by the Master Plan.

The Development Plan will describe :

- the present process of land reclamation and settlement
- strategies and models for reclamation and settlement
- priority activities for early implementation
- a portfolio of selected projects and programmes in a format that will allow GOB to invite donor assistance for immediate implementation.

Whereas the Master Plan outlines the long term physical potentials and constraints, the Development Plan will outline the aspirations and potentialities of the population within the given physical framework. The Development Plan produced by MES will include physical reclamation and protection aspects as well as rural development aspects for support of the development objective

of increased physical and social security.

Regarding settlement and rural development, the Development Plan will focus on strategies and interventions to streamline and enhance the processes of formal land allocation and of selection of beneficiaries. There will be strong institutional linkages with the Ministry of Land, Deputy Commissioner with ADC Revenue, and the TNO with AC Land and other thana staff.

As the Development Plan is foreseen to include a portfolio of relevant projects, it is not unlikely that some of the proposed projects relate to land distribution and settlement.

The Development Plan will outline the rural development process as a whole for the MES area, and discuss in particular sectoral development. **Income generation**, including such sectors as agriculture, livestock, open water fishery and aquaculture will play a dominant role. In a more long term perspective non-farm and non-fishery related activities may be of great importance as well. Basically, it is a matter of establishing the foundation for economic activities which are sufficient for creating the necessary income in order to ensure proper living conditions for the settled population.

After identification of the needs and definition of proper institutional arrangements, the MES team will suggest a portfolio of rural development projects and allocate a priority. For some of these project the Development Plan will present just an outline and for other projects a feasibility study will be prepared. Some of the projects will be recommended for early implementation.

The MES team will prepare the Interim Development Plan in the period July - September 1997. MES will appraise the proposed projects in cooperation with government departments as well as thana and district authorities. The appraisal period is planned until February 1998; new data and information coming available during that period will be used for updating th projects and the Development Plan.

3.3 Activities

3.3.1 Institutional development

The Terms of Reference (Section 5.3.14) infer that the Consultants should not necessarily take for granted existing task allocations with respect to hydrographic surveys of the coastal waters of Bangladesh; this inference could probably be extrapolated to other aspects of MES as well. For the sake of the discussion the Consultants have endeavoured indeed to take a fresh look at the institutional dimension. Institutional development has to be based on the fact that the master planning process is a continuous effort; it always is, but certainly so if related to a physical environment as dynamic as the project area.

One can distinguish at least three aspects :

- developing the Master Plan
- continuous updating the Master Plan and maintaining links with other organisations that are in charge of preparing micro development plans and their implementation
- collecting basic data

The institutional development in support of these activities will consist of:

- assessing alternative institutional arrangements for sustainable data collection and processing linked to the planning process;
- assisting in development of (a cell in) WARPO to carry out its role as macro planning organization with the following tasks:
  - to coordinate training of counterpart staff;
  - to assist in the formulation of the mandate for planning and enforcement;

- to identify whether BWDB has the proper mandate and capability to plan/develop projects within the Master Plan, and recommend amendments if necessary;
- to specify the links between BWDB's planning process and WARPO's master planning.

- assisting in development of (cells in) WARPO and BWDB to formulate and update land and water development plans with the following tasks:
  - to coordinate training of counterpart staff in WARPO and BWDB;
  - to assist in the formulation of the mandate for planning and enforcement;
  - to identify institutional arrangements necessary for coordination of sectoral activities in the plan area;
  - to identify whether institutional arrangements for project implementation exist:
    - which institutions are responsible for implementation of different interventions/activities in the plan area?
    - what are these institutions' capabilities to plan/develop projects within the Land and Water Development Plan?
    - what are the links between the institutions' planning processes, master planning by WARPO, and major infrastructure development planning by BWDB?
  - to assess whether implementation can be in line with the long-term project objectives:
    - does legislation exist to enable transfer of land to the landless poor?
    - is there an institution responsible for enforcement of this legislation?
- contributing to feasibility studies of priority projects by identifying what institutional arrangements are needed to ensure implementation of these projects in line with the long-term objectives of MES:
  - for existing land: follow CDSP findings and approaches;
  - for new land:
    - does legislation exist to enable transfer of land to the landless poor?
    - is there an institution responsible for enforcement of this legislation?
    - do these arrangements work in practice, and if not, can they be improved?

3.3.2 Surveys

The activities for the field surveys are given in Table 3.2 and Table 3.3.

Special surveys in case of an exceptional floods have not been included in the planning.

Measuring during such events could be important as the sediment transport and the morphological changes would be more pronounced. It has, however, been the intent that such effects be described within the framework of the general survey plan, with comprehensive dry season surveys and concentrated flood season surveys.

One reason behind this strategy is purely practical, namely that a substantial weather downtime is anticipated in the monsoon season. However if the weather in the delta permits the survey to continue during maximum flood discharges in the river systems, the consultant will definitely do so.

No.	Activity/Period	Description
1	Detailed planning	Elaboration of scope, selection of survey procedures, identification of required instruments and software, procurement budget
2.1	Procurement of survey instruments	Procurement of survey instruments and software, testing, interfacing
2.2	Installation of survey instr-	Installation of equipment onboard Anwesha and its

	uments	tender boats, testing, finalisation of survey procedures
3	Surveys by Anwesha	2 monsoon season programmes and 2 dry season programmes
3.1	Monsoon season 96	Definition of transect runlines, measurements of flow, sediment transport, salinity
3.2	Dry season 96/97	Definition of bathymetry runlines, measurements of bathymetry, flow, sediment transport, salinity
3.3	Monsoon season 97	Measurements of flow, sediment transport, salinity
3.4	Dry season 97/98	Measurements of bathymetry, flow, sediment transport, salinity
4	Wave and water level registrations	Continuous registrations by self-recording instruments and staff gauges
5	Sediment analyses, off-line data processing, survey data reporting	Laboratory analyses of sediment properties, calculation of flow rates, preparation of bathymetry charts, other analyses (water level, waves, S/T), data reporting
5.1	Monsoon season 96	Analysis, off-line processing, data reporting, 1st survey
5.2	Dry season 96/97	Analysis, off-line processing, data reporting, 2nd survey
5.3	Monsoon season 97	Analysis, off-line processing, data reporting, 3rd survey
5.4	Dry season 97/98	Analysis, off-line processing, data reporting, 4th survey

Table 3.2 Summary of activities, estuarine surveys

No.	Activity/Period	Description
6	Installation and survey of reference bench marks	Reconnaissance, selection of grid point locations, positioning by DGPS
7	Survey of coastlines and coastline gradients, elevation contours of shallow areas	Reconnaissance, establishment of temporary (secondary) bench marks by DGPS, traditional (spot) levelling
7.1	1996/97 survey	1996/97 dry season geodetic survey
7.2	1997/98 survey	1997/98 dry season geodetic survey
8	Supplementary mapping of land elevations	Supplementary geodetic surveying

Table 3.3 Summary of activities, geodetic surveys

3.3.3 Studies

The following studies will be undertaken on behalf of the preparation of the Master Plan and the Land and Water Development Plan:

No.	Activity	
9	Detailed planning	Elaboration of scope, identification of data demand, identification of interfaces and constraints, selection of approach
10	Review of existing data	Screening and collection of data from BIWTA, BWDB, LRP, Meteorological Department, and other sources
11	Basic assessment of states and processes	Analysis of meteorological, hydrodynamic and morphological conditions (states and processes) in the estuary
12	Selection of baseline conditions	Development of a valid reference for impact prediction and comparison
13	Numerical model set-up	Set-up and calibration of a nested (5400 - 200 m) grid numerical model for the estuary
14.a	Hydraulic impact analysis	Simulation and evaluation of predicted hydraulic impact (flow, water level, etc.), and comparison with baseline conditions
14.b	Morphological impact analysis	Analysis of predicted morphological impact (accretion and erosion), and comparison with baseline conditions
15	Reporting	Contribution to progress reporting and project reports

Table 3.4 Summary of activities, hydraulic and morphological studies

- hydraulic and morphological studies

The activities, planned for the hydraulic and morphological studies, are:

- review of relevant hydraulic and morphologic data and reports to gain qualitative

and quantitative knowledge of the dominant hydraulic and morphologic processes
- setting up of a reliable data base for the data collected by MES and LRP
- analysis of data regarding water levels, flow velocities, cross sections, discharges, salinity profiles, sediment concentrations, bathymetry, coastline, waves and wind in order to:
  - establish the appropriate equilibrium relationships between the morphodynamic parameters
  - find the erosion and accretion rates in areas of interest
  - help identify the locations for small scale interventions and of potential land reclamation sites
- selection of periods for the calibration and verification of numerical hydrodynamic and morphologic models on regional and local scale for comparing the impacts of short and long term alternative development scenarios.

- water management and drainage studies

Drainage congestion and water logging are considered to be the main obstacles for agricultural development of flood protected areas situated in the Meghna Estuary. Studies and surveys related to water management and drainage are available from different sources.

A first step is to review the findings of completed and on going projects and studies particularly those implemented in the coastal area. For this purpose an inventory of all relevant projects and studies along with procurement are to be made. Collection of meteorological data, soil salinity and water salinity data are required.

- agricultural studies

The studies include the collection and review of LRP and FAP findings. Prepare a development plan for sub-projects within priority projects.
Works to be undertaken are reconnaissance visits, agro-economic survey, Rapid Rural Appraisal, household surveys, data processing, development of cropping patterns etc. for studies and evaluation. Further attention will be paid to impact and constraints assessment for agricultural development.

- fisheries studies

Fisheries have not been conceived as a separate discipline in the original TOR of the Meghna Estuary Study, however this discipline is included in the revised TOR.
The studies will involve assessment of fisheries potential in the lower Meghna and estuarine areas. Impact of land development on fisheries, both capture or culture fisheries will be studied. A plan for the development of fisheries as a priority project will be actively considered.

- forestry studies

Forestry has not been conceived as a separate discipline in the original TOR of the Meghna Estuary Study, however this discipline is included in the revised TOR.
The studies will involve assessment of forestry potential in the lower Meghna and estuarine areas. The impact of land development on forestry will be studied.
A plan for the development of forestry on newly accreted lands will be actively considered.

- livestock studies

Livestock has not been conceived as a separate discipline in the revised TOR.
However the consultant will assess the livestock potential in the lower Meghna and estuarine areas. The Impact of livestock development on agriculture and forestry will be

studied.

- socio-economic studies

The socio-economic studies will be undertaken to provide an indication of the present socio-economic situation and for the planning process of rural development. The activities are summarized as follows :

- collection of socio-economic and general rural development data about the present situation, partly from existing documentation and partly through socio-economic survey of selected chars.
- close liaison with CDSP and to some extent Adrasha Gram Project.
- liaison with Government institution which are involved in settlement and rural development.
- preparation of inputs for Development Plan.

- environmental impact studies

Study of relevant LRP and FAP documents and prepare a work programme for inception report. Reconnaissance visits, design and formulate field plan and field investigations. Report preparation for Master Plan, Development Plan, and feasibility studies.

- planning studies

Principal activities of MES will concentrate on measuring studying and macro planning in water sector with a long term objective - to increase physical safety and to promote sustainable development and economic activities in the Meghna Estuary Area.
Thus the MES's primary objective is to develop appropriate approaches for rapid and low cost land reclamation. The planning process will include identification, setting objectives, methodology suitable to complete the plan and the execution of the plan. The execution of the plan requires data collection, master plan, development plan and others including priority projects, implementation and operation, maintenance and monitoring.

In this connection the project (MES) will pay attention in creating a favorable circumstances/environment for micro-level intervention which should be planned and executed through co-ordination and participatory approaches at the field level.

Whether it will be possible to undertake significant (planning for) infrastructure projects within the frame-work of master plan, will depend on technical, financial/economic and institution feasibility. MES may help, undertake, provide co-operative support in the feasibility studies for priority projects and programmes (on a limited way in view of its workload and time constraint).

- institutional studies

The ideas behind institutional development are to enhance and strengthen the operational knowledge of hydraulic and morphological processes in the area, to study to find appropriate method for land reclamation, protect land from erosion, flood and cyclone and to settle people in those new lands - and support them for socio-economic activities.

Many organizations are involved such as:

- WARPO, responsible for macro-planning in water sector
- BWDB, responsible for micro-planning in development and implementation of priority development projects.
- SSD (BWDB), SWMC, RRI, BARC, Meteorological Department, SPARRSO and many others, responsible for data collection.
- Other line ministerial agencies (LGED, Agriculture, Fisheries, Forestry, Environment, Public Health, Union Council NGOs) involved in local development planning,

settlement and other economic and social activities.

- Within the framework of institutional development MES is to conduct an appraisal study on data collecting and other agencies.

3.3.4 Development of Reference Scenarios and Plans

Whereas the identification of a number of potential projects in the project area, both in the field of the reclamation of new land and the protection of existing land, as done in the past may not be too difficult a task, that should not be equated to having identified the ingredients for a Master Plan, as the Consultants have to present.

An overall plan is more than the summation of a number of individual projects. It requires an insight in the potentials of the area and of their limitations as well, and that in turn a basic understanding in the forces and processes that shape it. This applies in particular in this case, when preparing a Master Plan for the Meghna Estuary, where the physical conditions are subject to rather rapid and sometimes even dramatic changes.

The Terms of Reference acknowledge the very special conditions prevailing in the project area and state that the plan to be presented should be flexible. The Consultants' proposal characterises the Master Plan as some sort of a strategic plan, that is not to be considered as a blue print, but rather as a guidance for actions in the near and medium term and that as such is to be updated regularly, taking on board new developments.

Without harbouring any unrealistic views as to what extent it is possible to control or even to influence developments in an environment that is shaped by forces as formidable as are active in the project area, yet one should not lose sight of the fact that it is not a shortage of technical tools that set limits to what can be done with respect to reclamation and/or erosion protection, but rather the prevailing socio-economic realities. Technical measures as designed, for instance, for the Jamuna Bridge, the protection of Chandpur or of Sirajganj, could also be applied in the project area and there is no doubt that they would work there as well as for the places they have been designed for.

Undoubtedly at some point of time in future, it will be justified to apply such measures, to stabilize the course of the Lower Meghna, the Shahbazpur Channel and the Hatia Channel, or whatever channel configuration one might prefer at that time. It should be added immediately that such time is still far away, possibly a century or even longer.

Yet, however far away this time may be, if one would be able to define a future situation that under present conditions appears to be preferable over other possible options that could be envisaged at this moment, then now and in future (as long as the defined situation remains valid considering the changes that doubtlessly will take place) one should refrain from any measures that could block the preferred future situation to evolve.

The envisaged desired situation would thus serve as a Reference Scenario, against which the suitability of any planned intervention should be measured.

Especially in an environment that is as dynamic as that covered by the Meghna Estuary Study, developing a realistic Reference Scenario, is considered to be an essential first step in the master planning process.

Without having that, the preparation of a Master Plan would soon become an exercise in the pursuit of individual preferences and avocations, without any linkages to physical realities and without necessarily taking full account of the potentials the area harbours and of the prevailing limitations.

In the Interim Master Plan, covering a period of 25 years, several Reference Scenarios will be pres-

ented. During review of the Interim Master Plan, the Reference Scenarios will also be assessed in detail. While preparing the Draft Master Plan, the Consultants will organise a workshop on future development of the Meghna Estuary.

On the basis of the comments of the Government of Bangladesh and the Donors as well as the views and opinions expressed during the workshop and additional studies by Consultants' team; a Reference Scenario or Plan for the long term development of the Meghna Estuary will be presented in the (Draft) Master Plan.

The main virtue of a Reference Plan is that it provides a consistent framework that structures the master planning process.

In attempting to define a Reference Plan based on a desirable future situation, that could serve as a reference for any programme of actions planned for the near and medium term future, the following criteria are considered realistic and functional:

- Safeguard the fresh water pocket that is at present available west of the Tetulia.
- Make the length of the Lower Meghna and its extension into the sea (by whatever name it may be known) as short as possible, so as to facilitate the discharge of flood waters and to minimize the cost of future works to stabilise the river course.
- Shorten the coastline of Bangladesh as much as possible, to reduce the costs of maintenance of coastal embankments and of any coastal defence works, thus enhancing the safety of the protected area.
- Optimise the potential for the reclamation of new land.

The application of these considerations yields scenarios as presented in Figures 3.1, 3.2, 3.3 and 3.4. The vision of possible future developments that determine the Reference Plan to be presented together with the Master Plan, are believed to correspond well with the line of thinking underlying the Terms of Reference, which in Section 4.3.1 also envisages a shortening of the coastline of Bangladesh.

Since BIWTA maintains Class-I river routes in the Meghna Estuary, it goes without saying that navigational requirements will be take care of in the project study; subsequent implementation of projects shall hamper navigation in the area.

It should be emphasized once more that the scenarios presented in the figures are not to be interpreted as plans that the Consultants propose to be taken up for implementation.
The reference scenarios are to be considered as thoughts of what should be achieved in the very long term in obtaining more land and providing social security to the area.

No detailed studies guide the reference scenarios shown in Figures 3.1 - 3.4.
Adequate supporting analyses will be done before preparation of the Interim Master Plan.
One scenario may be the most desirable for the time being and again subject to change in future.
This scenario will be selected as a guide for master planning and will be called the reference plan.

MEGHNA ESTUARY

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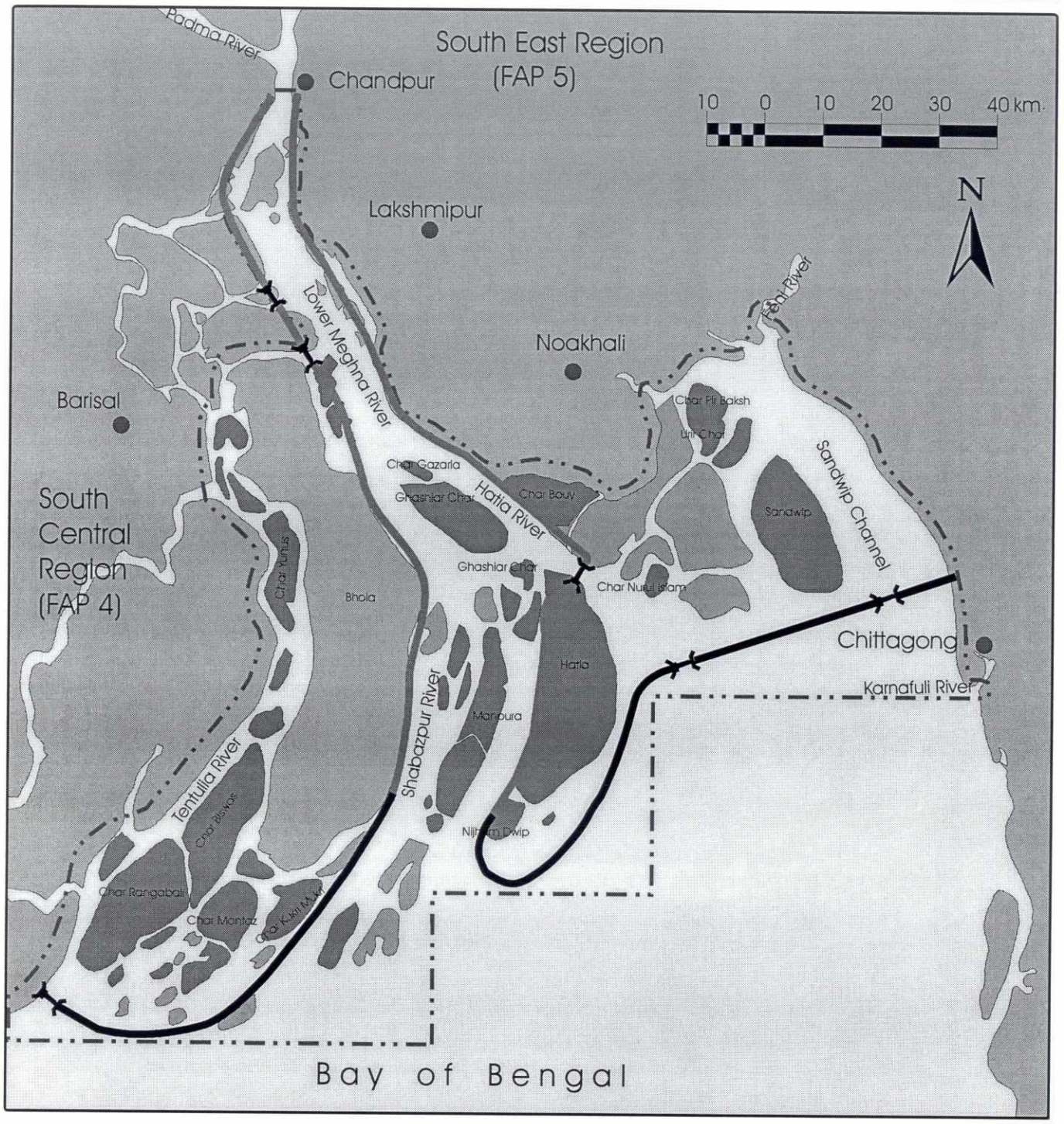
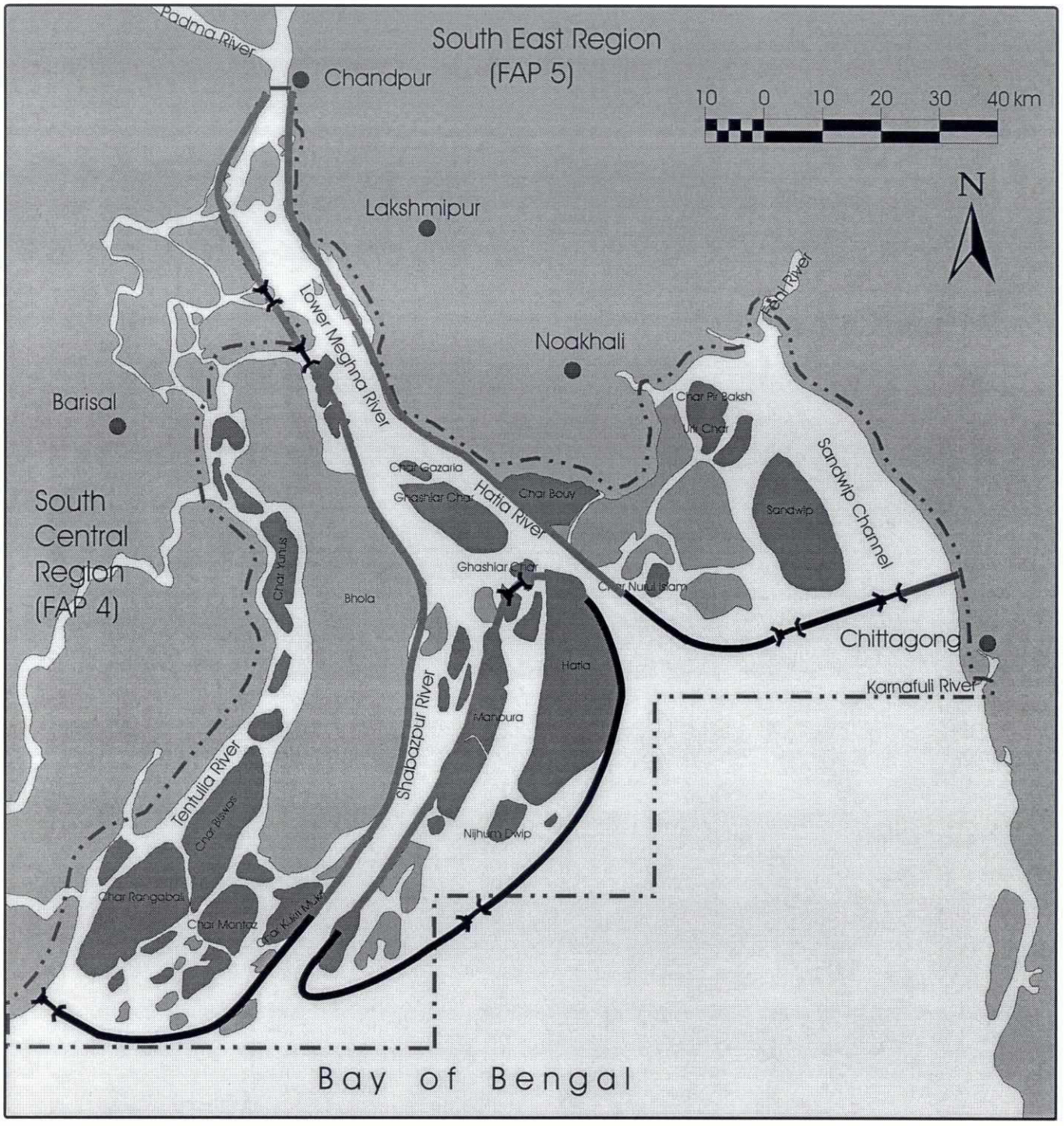


Legend :

- Outside Study Area
- Study Area
- Submerged Land Area
- Water Body
- River embankment + training works
- Coastal embankment
- Regulator - cum - lock
- Project Boundary

Outlines : Interpreted from TM Imagery, Feb.1996

Figure 3.1 : Reference Scenario A



Legend :

- Outside Study Area
- Study Area
- Submerged Land Area
- Water Body
- River embankment + training works
- Coastal embankment
- Regulator - cum - lock
- Project Boundary

Outlines : Interpreted from TM Imagery, Feb.1996

Figure 3.2 : Reference Scenario B

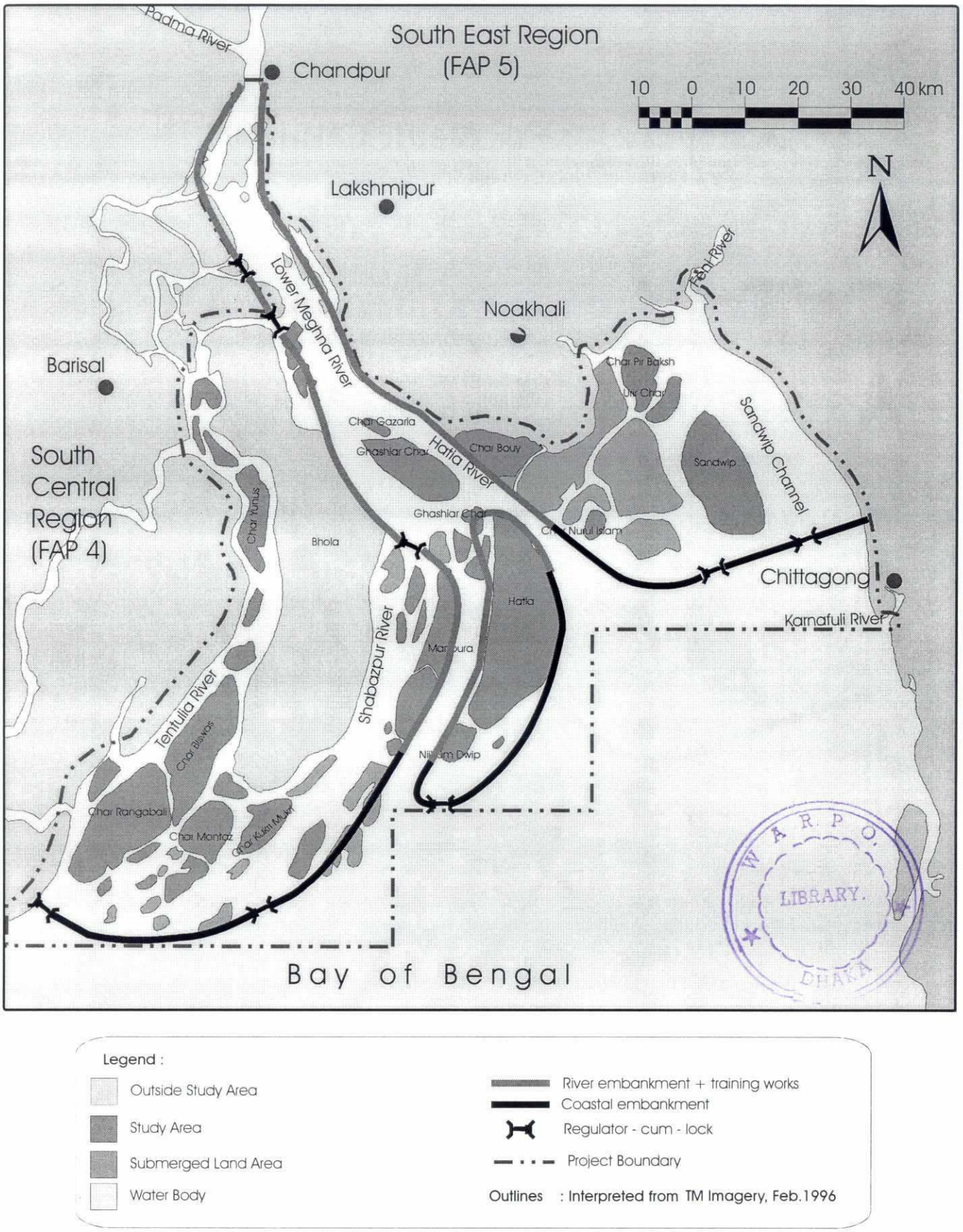
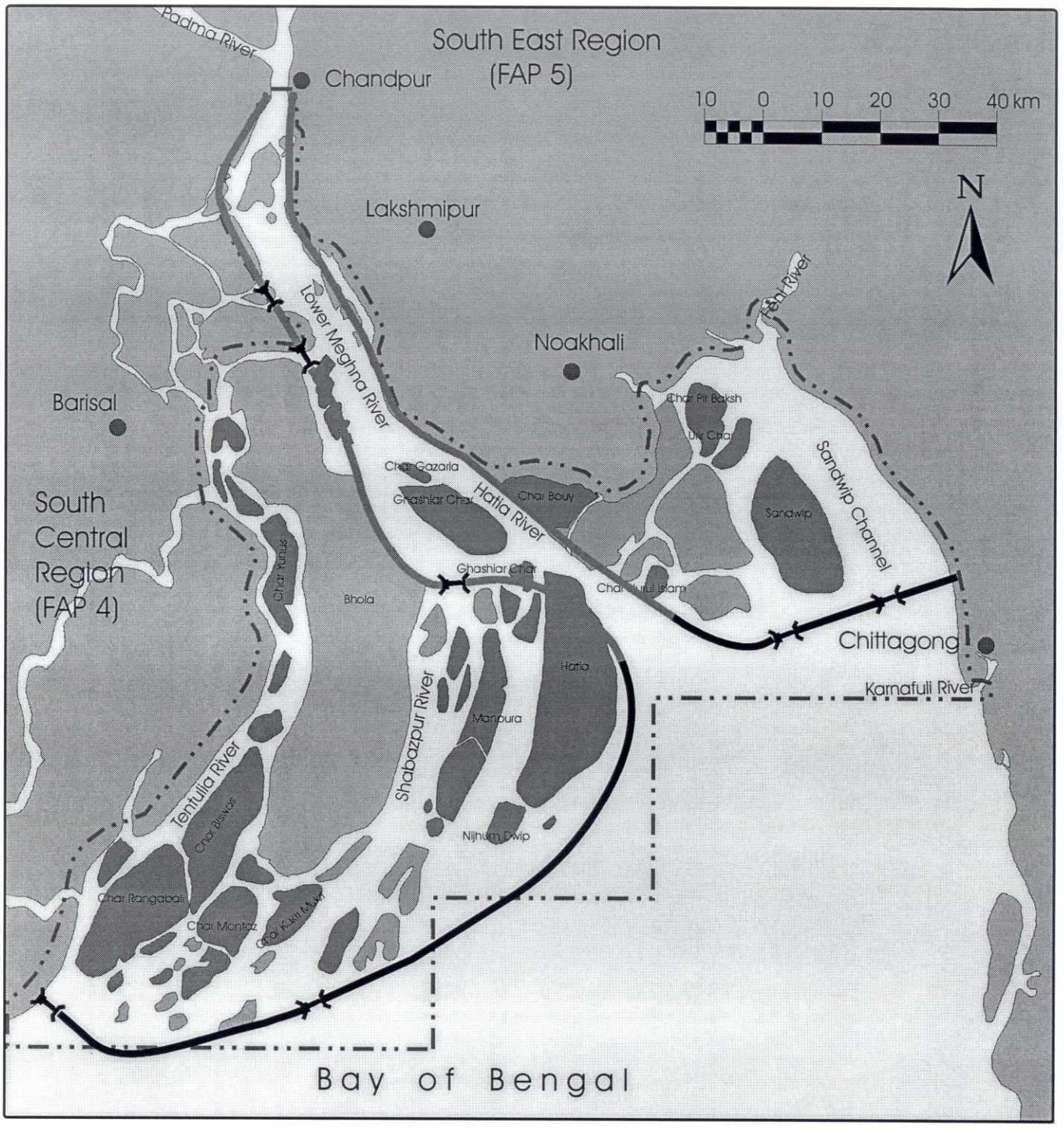


Figure 3.3 : Reference Scenario C



Legend :

- Outside Study Area
- Study Area
- Submerged Land Area
- Water Body
- River embankment + training works
- Coastal embankment
- Regulator - cum - lock
- Project Boundary

Outlines : Interpreted from TM Imagery, Feb.1996

Figure 3.4 : Reference Scenario D

3.3.5 Preparation of Master Plan

The recommended Reference Scenario will be a powerful tool for the preparation of a Master Plan, as required per Terms of Reference. If the Reference Scenario is acceptable as such, then the Master Plan the Consultants propose to prepare would be the first phase on the road that eventually should lead to the situation as envisaged by the Reference Scenario. In fact, the Reference Scenario would be realised via a continuously evoluting Master Plans with a planning horizon of about 25 years. Periodically, e.g. every ten years, the Master Plan as well as the Reference Plan will have to be updated and reformulated.

The name "Master Plan" for each of the stages is still very appropriate, because they are not just well defined successive phases; the environment the plan relates to is such that for each of the stages, while continuing from the foregoing, there still are too many uncertainties and variables left over. Planning under such conditions has to be based on new surveys, (model) studies; it is by nature a continuous and iterative process. Such iterative approach is precisely one of the characteristics of a master planning process.

Master planning has to be flexible, requiring regular updating, on the basis of a check of actual conditions and the verification of the impact of interventions applied. This is a continuous process indeed, for which the tools, including the institutional capabilities, should be present. One even could say that, unless such facilities are in place, preparation of a Master Plan would be a vain exercise.

Exactly as foreseen in the Terms of Reference (Section 4.3.2), each of the successive Master Plans will comprise a number of "Building Blocks"; these are defined as individual works or a programme of works, which fit in the future pattern, but which could stand alone for some time, for instance in case there would be a hiatus in the planned sequence of Master Plans

The potentials for the reclamation of new land and the problems associated with the protection of existing land are briefly reviewed in the following sections.

When trying to assess the potentials for the reclamation of new land, some basic considerations should be taken into account. Especially in riverine morphological processes, there often is a close relationship between on the one hand sedimentation and/or protection against erosion in one place and on the other hand actual erosion in another place. In other words, in rivers one should not consider measures to promote accretion or to prevent erosion in one place, without assessing at the same time potential effects in other places.

Therefore in general terms one is inclined to caution against efforts to reclaim land or to prevent erosion being pursued in isolation. These should preferably be part of an overall programme directed towards the management of the river bed over a larger length. This statement may be extended to any alluvial channel through which water is moving. Generally speaking siltation (and erosion prevention) and erosion are two sides of the same coin and should never be studied in isolation one from another.

However, a close relationship between siltation or erosion prevention on the one hand and erosion on the other, as described above, does not necessarily exist when considering reclamation from the sea, although one certainly would have to assess repercussions elsewhere if the possible impact of (tide or wave induced) currents dictate so.

When applying such considerations to the water bodies in the project area, the above implies that in general one should refrain from the reclamation of land in the Lower Meghna, the Shahbazpur River and the Tetulia without studying at the same time possible effects elsewhere. It might well be that opportunities for the reclamation of new land present themselves, but before actively promoting such tendencies, possible morphological responses should be studied carefully.
There also may be good opportunities to reclaim new land along the Hatia River adjacent to the Ramgati main land, but reclamation there could enhance the erosion of the northern end of Hatia and would therefore require very careful study. Similar considerations apply when considering

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interventions to stimulate the siltation at the northern end of Sandwip; while there could be opportunities to do so, this almost certainly would intensify ongoing erosion along the southern coastline of Char Pir Baksh to the north.

Generally speaking the reclamation of new land and the prevention of erosion of existing land in Bangladesh is of national importance for a number of reasons.
For a country as densely populated as Bangladesh, efforts to retain or even to expand the land area to accommodate the growing population is of critical importance indeed. However, when analysing the critical economic parameters, measures to prevent erosion usually score lower than land reclamation projects.

A number of relevant studies done under FAP (FAP1 and 9B) confirm the general conclusion that at the present stage of the socio-economic development of Bangladesh, works to protect agricultural land are not feasible from an economic point of view. Only if also urban centres would benefit from such works, or if there were other related benefits, the necessary investments could be justified. One may assume that this applies also for the coastal areas of the country. In fact this should not come as a surprise: the National Committee that studied the erosion of Bhola in 1988 came to the same conclusion.

There could be good reasons to reconsider this matter in future, in the light of the results of FAP21, under which tests are being carried out on low cost bank protection works along the Jamuna. They could lend support to the supposition that the protection of coastal islands may not be unfeasible in all cases.

The Consultants will study the feasibility to apply new methods and materials that could come up in the course of the study and that appear to have good potentials for application in the coastal zone of Bangladesh. In particular they will assess the effectiveness and practical installation of surface and/or bottom vanes (SBV) will be assessed.
Provided that the SBV can be considered as an attractive method of preventing bank erosion or for river training in certain locations, the Consultants will propose to install this type of protection as a small scale intervention that will be monitored during the project.

3.3.6 Preparation of the Development Plan

The Terms of Reference require a comprehensive plan to be prepared for flood protection and the improvement of the internal water management of the coastal islands included in the project area. In fact all inhabited islands with the exception of Bhola are to be included, notably Hatia and Sandwip (Section 3.3). Section 4.1.1 says that also those areas are to be included which are at present not protected and are not covered by FAP7.

One of the main objectives is to provide a higher degree of safety to the population and property against the forces of storm surges (cyclones). In addition, the productivity of the land is to be improved, through better systems for drainage, salinity control and water management (Section 4.1.1).

The link between the Development Plan and the Master Plan lies in the fact that, in conjunction with CDSP an attempt will be made to produce models for the development and settlement of new land that may have been gained as a result of efforts under the Master Plan (ToR, Section 3.3). Thus, in addition to development of the existing islands, also new land expected to be reclaimed as a result of MES is to be covered by the Development Plan.

Whereas the preparation of the Master Plan is largely driven by the physical potentials available in the project area, taking into account some limitations set by the environment, the preparation of the Development Plan will be driven primarily by the demands and aspirations of the population.

Another main difference is that for the preparation of the Development Plan experiences gained in other projects in Bangladesh and also elsewhere can be called on to a larger extent

Whereas in preparing the Master Plan the Consultants largely tread in unmapped areas, literally and figuratively speaking.

The greater part of the existing land has been provided with an embankment already, either under the original Coastal Embankment Project, or under some project in connection with cyclone protection, as for instance FAP7. In the coming dry season Phase II of this project is to start. In addition to that, in recent years and especially so since the cyclone of April 1991, a number of additional measures have been taken to enhance the safety of the people on the coastal islands.

Quite a number of cyclone shelters has been built; additional shelters are under construction, or are scheduled to be built. The systems for activating public awareness of impinging danger have been improved; also the road systems are being upgraded. All this will help to make the islands a safer place to live in.

Yet, cyclones are bound to re-occur. It should be realised that, after rehabilitation under the Cyclone Protection Project or any other project, the embankments are not preventing flooding in all cases, but are designed to remain stable even in the case of overtopping. Whether they actually are, depends not only on the design and the quality of construction, but to a large degree on the maintenance situation. In any case, important in this respect is that the risks of floods will continue to be there.

The Terms of Reference assume that the planning components will include Primary and Secondary Protection Systems.

Primary Protection Systems comprise:

Coastal embankments

Most of the islands have already been provided with embankments, either under the original Coastal Embankment Project or under the Cyclone Protection Project (FAP7); others will be constructed or rehabilitated under Phase II of the latter project. The Consultants will closely cooperate with ongoing projects in this field.

If within the project area more embankments are needed than provided for under any of the projects mentioned, they will be taken up in the Development Plan. The accepted design criteria will be followed, possibly with some minor adaptations. For instance, studies in The Netherlands have shown that trees have to be considered as foreign elements, which tend to weaken the structural strength of the embankment, when subjected to the action of waves.

However Consultants realise that the situation in Bangladesh is different. Outer slopes of coastal embankments are very gentle and therefore occupied by people, in particular landless farmers and destitute women, practicing agriculture and constructing their hutments on the outer slope.
Therefore it is more realistic to give advice which species of trees could be planted and which should not be planted on the slopes of the embankments. Moreover, a strip of land in front of the embankment should be planted with mangroves breaking the wave attack.

Conservation and development of the foreshore

Maintaining a sufficiently wide foreshore strengthens the performance of the embankment significantly. It should preferably consist of flat land with a proper vegetation cover, not intersected by borrow pits and the like. Trees help to absorb part of the energy of incoming waves. Afforestation programmes may be part of the Development Plan. The Forest Department is planting mangroves on chars as soon as these have accreted sufficiently.

The Consultants also caution against too optimistic expectations about the use of vegetation (trees, mangrove) as a measure to prevent or even delay erosion. At best it does temporarily, but vegetation as such does not have the capability to withstand persistent erosion.

Coastal defence works

These serve to prevent or delay the erosion of the foreshore and embankment. Although the Consultants will endeavor to identify and/or develop cost-effective measures, the options for this will probably be limited, because the cost to install and maintain structures to resist persistent riverine or coastal erosion is often prohibitive as experience shows.

The Consultants will include in the Development Plan a coherent programme of measures for effective primary protection systems, wherever opportune.

Secondary Protection Systems:

Secondary Protection Systems will be proposed under the Development Plan. These system aim essentially at containing the extent of floods once they should occur. One of the measures mentioned there is the provision of secondary embankments, subdividing the islands into smaller units, so that, if the primary embankment would fail at some point, not necessarily the entire island is flooded. This is elsewhere a quite common measure in areas that are prone to flooding and is, for instance, also applied in The Netherlands. It is anticipated that as far as possible existing infrastructure will be used for the establishment of the Secondary Defence System, such as old embankments, roads etc., in order to minimise the use of land.

Subdividing an island along whatever lines will almost certainly interfere with existing systems for water management, notably drainage. Adaptations of the existing systems will be necessary and in this respect the lessons learnt under the Compartmentalisation Pilot Project will be taken into account.

This includes technical aspects, also mathematical modelling. FAP20 is the Compartmentalisation Pilot Project, designed especially to serve as a model for other riverine areas. Under MES, it will be considered whether it is feasible and useful to try to select some typical area and to develop a model for coastal islands, which then could be duplicated in other areas with similar conditions.

But not only the physical dimensions of FAP20 will be useful for the preparation of the Development Plan. The other aspects, and notably those related to systems for the consultation of the population will be taken on board, in addition to components related to enhance the agricultural production. In this respect also the experiences gained in CDSP will be most valuable.

MES will also pursue cooperation with CDSP especially for the part of the Development Plan that is to deal with the development of new land. A wealth of experience is expected to be available with CDSP, the land-based inheritor of the former LRP, including matters related to the settlement of new land. All efforts will be made to maximize the benefits that can be drawn from the cooperation with CDSP, including those related to the chosen institutional set-up for that project.

CDSP has been created specifically to optimize the conditions of and the services provided to new settlers. MES staff have established effective relationships with the CDSP project management and have visited the CDSP project area several times. A fortunate circumstance is that CDSP and MES share the guidance of the same Project Director.

Jointly with CDSP the possibility will be studied to develop "model-approaches" for the creation and subsequent reclamation, settlement and development of new land, incorporating all relevant technical and non-technical components. At least two such models may be needed, one for new land adjacent to existing land, thus possibly influencing the drainage of the hinterland and transforming an existing sea-facing embankment into a "compartment-boundary", and another one relating to new land that has no connection with existing land and thus would be surrounded by open water, obviously entailing a higher degree of risk than the former one.

There are many factors that play a role when the issue of accretions and subsequent settling of new land comes up. Not just any tract of land that emerges at some point of time along the shores of the Bay of Bengal deserves to be reclaimed, settled and developed. The land should have

risen to a level sufficiently high to allow gravity drainage after reclamation; under LRP useful studies have been done in this respect.

Should the government, and for that matter BWDB, be held to provide some level of services whenever people decide to settle spontaneously on tracts of new land, however insecure this still may be? An important point is the durability of new land: investments (also for some provisional cyclone shelters?) will be justified only if it can be made plausible that the new land will enjoy a sufficiently long lifetime. It will be endeavoured to develop practical guidelines, in conjunction with CDSP.

Appraisal of the Land and Water Development Plan

In between the interim and the draft Land and Water Development Plan an appraisal process will be conducted for strategy, plan and project proposals. The appraisal process will be undertaken in cooperation with departmental staff at central level as well as at district and thana level, and if possible at union level also. In cases where NGOs are involved they have to participate as well. The procedure should roughly be as follows:

Presentation of the Interim Development Plan and initial discussion

Depending on the proposed plan it will be determined how much time has to be be allocated at central departmental level and how much at local level. Land issues, for instance, should be thoroughly discussed with the Ministry of Land to reach the full extent of commitment and cooperation. Sufficient time has to be spent at district and thana level to make a comprehensive presentation of the proposals and to have initial discussions. DC, TNO and relevant departmental officers will have to be consulted. The concerned union chairmen should also be approached at some stage in the process, but they may be involved through the Thana Coordination Committee meetings.

Time to respond

Officers at all levels should be given about one month to consider the proposals and give their comments.

Final discussions

A round of meetings will be held with the same departments and local level institutions as indicated under the paragraph "Presentation and initial discussion". Their final response shall be dscussed and a prioritization of the possible project proposals has to be made. New proposals may also be presented by the concerned authorities. If deemed appropriate for facilitation of the communication process workshops may be conducted. Appraisal of the projects in cooperation with the intended beneficiaries seems more difficult as there are no established procedures to follow and no institutions to approach at that level. It is anticipated that RRA/PRA techniques can be applied for this purpose, mostly applied at village level or a sub-group of the most interested villagers. If cooperatives or informal groups are in existence they could be the focus of communication as well. The approach and methodology for this has to be further developed during the third or fourth quarter of 1997, and the actual field work has to be conducted during fourth quarter of 1997 and first quarter of 1998.

In connection with preparation of the Development Plan - as well as before and after - a number of feasibility assessments will be undertaken, not only for settlement and rural development projects but also for major project options in relation to land reclamation and physical protection. Such interventions require proper feasibility studies, and it will be important to identify and quantify costs and benefits of socio-economic and human development nature in addition to the economic, financial and technical parameters of cost and benefit.

Once a decision has been made on the feasibility study methodology and actual subjects for study have been defined - probably during first quarter 1997 - the specific data input can be specified. It

is likely that socio-economic data from specific areas may be required in this context and two or three small surveys can be conducted in response to need; manpower has to be allocated accordingly. The survey methodology is expected to be adapted versions of the Rapid Rural Appraisal technique.

3.3.7 Preparation of Priority Projects and Programmes

The Terms of Reference mention a number of potential priority projects which should be studied; they have been referred to above. They appear in the lists of 18 potential projects, as prepared under the LRP in 1988. The complete list is given below; these projects will be discussed in more detail in Annex 04. See also Figure 3.5.

1	Six Polder Scheme	10	N.W. Hatia Cross-dam
2	Urir Char Polder	11	Manpura Polder
3	Sandwip Cross-dam	12	Gazaria Polder
4	S.E.Sandwip Polder	13	N.E. Bhola Bank Protection
5	Feni Polder	14	W. Bhola Protection
6	Char Boya Cross-dam	15	S. Bhola Cross-dams
7	Char Nurul Islam Polder	16	Ramgati Polder
8	South Hatia Cross-dam	17	Sudharam Drainage
9	Hatia Bank Protection	18	Ramdaspur Cross-dam

It seems that at the time the list was prepared, the projects included were studied in isolation. Possible impacts elsewhere may have been studied, but without placing the projects within the wider context of an overall Master Plan.

However, it would go against the philosophy and the essence of MES (ToR, Section 4.1.4) if the evaluation of the individual projects were continued to be pursued without considering them within the context of the basic considerations that underlie the preparation of the Reference Scenario and, which after all will be the basis for the Master Plan to be prepared.

Therefore, the priority projects that are included in the project area, will be reviewed in Annex 04, taking into account the basic considerations that govern the proposed Reference Scenario.

The Terms of Reference require projects suitable for immediate implementation to be identified and studied at pre-feasibility level at an early stage (Section 4.3.4). The list of projects will presumably include some of the listed projects, one or two in connection with the protection and/or development of existing land (Section 4.3.4) and in addition possibly some other projects as well, identified in the course of the study. For those projects which appear to have confirmed potentials, a feasibility study will be carried out (Section 4.3.4), including Nijhum Dwip (Section 5.3.11).

Without setting undue limitations on the possible outcome of the study, it is anticipated that in combination with the results of the Development Plan, three projects will be analysed at pre-feasibility level and in addition three more at feasibility level. The caution mentioned in the Terms of Reference (Section 4.3.2) with respect to the limited useful lifetime of feasibility studies of projects situated in this dynamic environment, will be taken at heart.

3.3.8 Preparation of Small Scale Interventions

The Terms of Reference make it clear that although a large part of the efforts under MES will have to be directed towards data collection and studies, of which the preparation of realistic Master and Development Plans will be the final result, the need for short term interventions should not be lost sight of. This will remind the Consultants of the expectations, notably on the side of Bangladesh, that the potentials for accretion of new land and the threat of loss of existing land due to erosion, get due and urgent attention.

The main contribution of MES in this respect will be to propose approaches and techniques for rapid and low-cost reclamation of new land, employing to the maximum extent local labour and materials (ToR, Section 4.2.5) and to make proposals for effective measures to protect existing land against erosion (Section 4.2.4).

The Terms of Reference are more specific with respect to the reclamation of new land than with respect to the protection of existing land. In general they caution against too high expectations: in Section 4.1.3 it is explained that the implementation of works beyond the stage of practical experiments is not included in MES, while Section 4.3.4 says that even under the first phase of the Master Plan, the interventions in the natural environment are expected to be moderate.

The philosophy of the Terms of Reference (Section 4.3.4) clearly is to gradually build up an understanding of the natural forces and processes at work in the area and not to move into over-ambitious projects and programmes, before having passed through a learning process, moving gradually from small scale interventions to gradually increasing more ambitious ones.

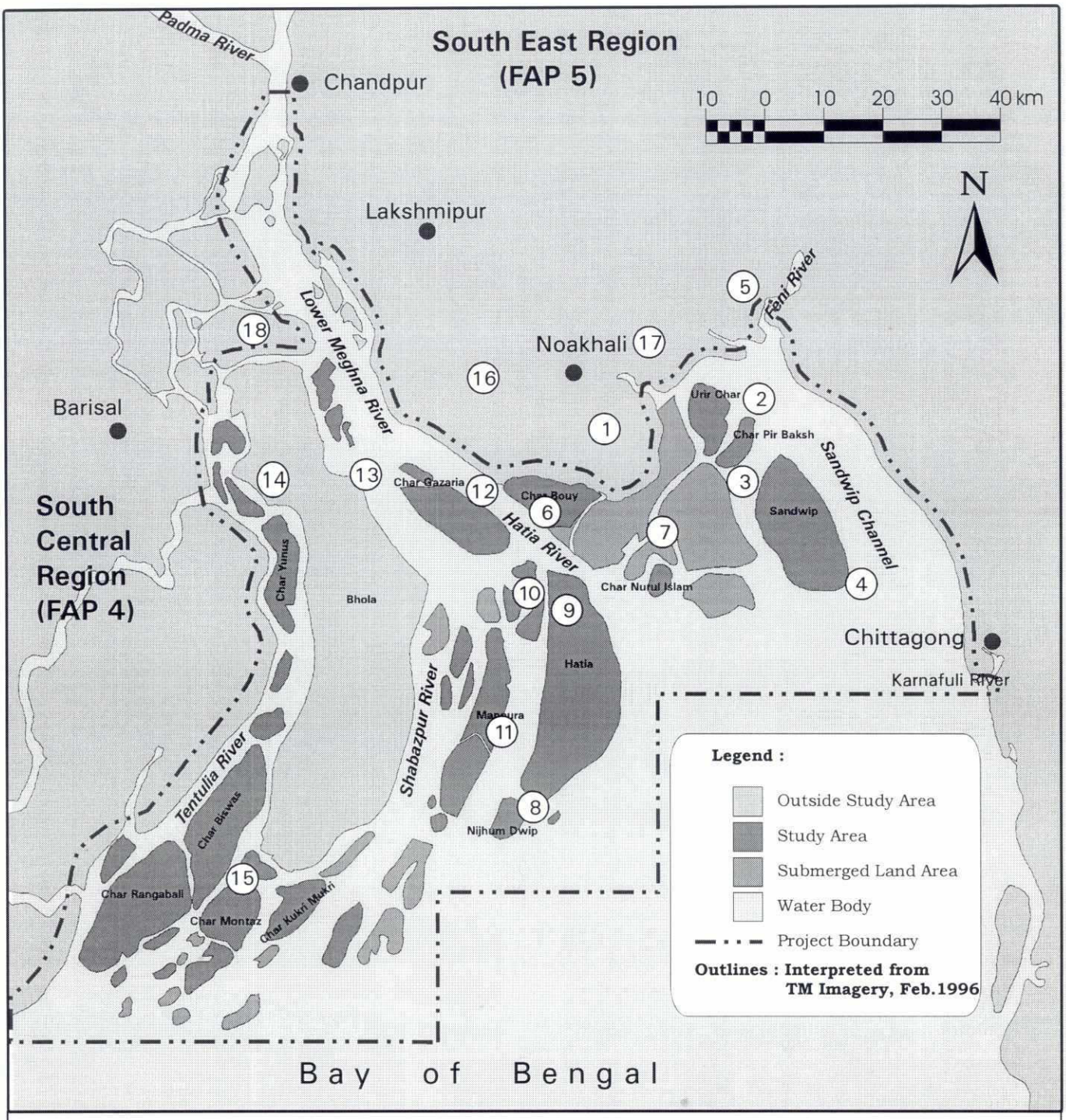
Two main considerations apply in particular in this respect:

- It is one thing to reclaim new land, which may be settled and made productive subsequently, it is quite another thing to ensure its sustainability and to protect this land against erosion if vagaries of nature would reverse chances.

- The potentials for the reclamation of land in Bangladesh should not continue to depend to a critical extent on foreign expertise: indigenous capabilities for the identification, preparation and implementation of suitable projects should be developed. This calls for a gradual building up of the size and complexities of interventions earmarked for implementation.

In the Terms of Reference the small cross-dams constructed by the people of Manpura Island, in the Shahbazpur River, with the help of BWDB (Section 5.3.10), are mentioned as an example of the interventions that are meant to be taken up under MES. The same type of approach is mentioned in connection with the reassessment of the feasibility study done under LRP, to reclaim land along Nijhum Dwip (Section 5.3.11), which the Consultants have to do.

Again emphasis is on low cost methods to close tidal channels. The implementation of the works should be within the capability of local contractors, possibly with some specialist inputs of an expatriate company. The input of expertise from abroad for the preparation of designs and implementation methodologies, for instance with respect to the techniques for the closure of the final gap in some cross-dam, would be one of the aspects of MES.



1. SIX POLDER SCHEME
2. URIR CHAR POLDER
3. SANDWIP CROSS-DAM
4. SOUTH EAST SANDWIP POLDER
5. FENI POLDER
6. CHAR BOYA CROSS-DAM
7. CHAR NURUL ISLAM POLDER
8. SOUTH HATIA CROSS-DAM
9. HATIA BANK PROTECTION
10. NORTH WEST HATIA CROSS-DAM
11. MANPURA POLDER
12. GAZARIA POLDER
13. NORTH EAST BHOLA BANK PROTECTION
14. WEST BHOLA BANK PROTECTION
15. SOUTH BOLA CROSS-DAMS
16. RAMGATI POLDER
17. SUDHARAM DRAINAGE
18. RAMDAPUR CROSS-DAM

Figure 3.5 : Location of priority projects (according to LRP)

Indigenous measures to influence the movement of sediment in channels have been applied in Bangladesh for many years already: the art of bandalling has been practiced along the Brahmaputra and other rivers for a long time, as an effort to maintain a navigation channel through shoaling river stretches. This objective is contrary to the one to be pursued under MES, where siltation is to be promoted.

Nevertheless the experience is available in the country with respect to influencing the movement of sediment will be of value. Also the desk study done under FAP22 will be very useful. MES will carry out experiments and studies to try to extrapolate experience under riverine conditions to tidal areas, where currents and sediments are essentially different.

In general sediment settles where currents are weak; this is the principle behind the installation of sedimentation fields, as for instance done under the Schlesswig Holstein (SH) method, applied along the German and Dutch coast of the North Sea. The fields are divided into compartments by means of spurs of piles and brushwood, which retain the silt-laden water for some time and give the sediment the opportunity to settle.

The method can be applied to promote siltation in areas where there is already a tendency for siltation; it is not a method to combat erosion. The method may not fully be adapted to the conditions along the coast of Bangladesh: the amounts of sediment moving around along the coast of Noakhali are so large that, if the SH method would appear to be successful, the construction would probably soon be buried under the accumulated sediment.

The basic elements of the SH method can presumably be applied with a good chance of success in tidal channels. Spurs, which need not be too high, could be put in rows across shallow channels with low currents velocities, e.g at tidal meeting points where they would tend to increase the hydraulic resistance and by that further slow down currents. Siltation could follow, which, once started, could be the beginning of a self-reinforcing process. Similarly rows of screens could be put across emerging mudflats, again creating resistance, reducing flow and inducing accelerated siltation.

Various types, dimensions and lay-outs of screens will be tested out, at various locations and, whenever necessary, adapted to the prevailing conditions. The Consultants will provide assistance for the siting and design of the works, which then will be implemented by a contractor under the responsibility of BWDB (Section 5.3.10). Due consultations will be held with the local population, explaining the proposed works (including the limitations of the proposed tests), seeking their support and participation.

In addition to studying the technical and economic feasibility of small scale interventions aiming at promoting accretion, the Consultants will also consider alternative methods for protection of existing land against erosion by the river. Further details are provided in Annex 04.

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3.4 Inputs

3.4.1 Technical Assistance

Table 3.5 shows the input in terms of funding by the donor agencies for Technical Assistance. Details about staffing, purchase of equipment, O & M and training are provided in Chapter 5.

Cost in Lakh Taka

	1995	1996		1997		1998		Total
Description	II	I	II	I	II	I	Ii	
Contract staff	53.7	295.7	215.0	407.4	170.7	399.5	44.2	1586.2
Purchase/Investments	1.3	277.8	5.0	2.5	0.0	0.0	0.0	286.6
Operational costs	4.0	43.2	50.0	37.0	39.5	44.7	12.4	230.8
Training and courses	0.0	0.0	10.0	17.5	12.5	12.5	0.0	52.5
Contingencies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	59.0	616.7	280.0	464.4	222.7	456.7	56.6	2156.1

Table 3.5 Technical Assistance Input

3.4.2 Financial Assistance

Table 3.6 shows the input in terms of funding by the donor agencies for Financial Assistance. Details about the small scale interventions to be financed from this budget are provided in Chapter 4 and Annex 04.

Cost in Lakh Taka

	1995	1996		1997		1998		Total
Description	II	I	II	I	II	I	II	
Accretion trial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank protection pilot scheme	0.0	0.0	0.0	10.0	40.0	50.0	0.0	100.0
Cross dams pilot scheme	0.0	0.0	0.0	10.0	40.0	50.0	0.0	100.0
Total	0.0	0.0	0.0	20.0	80.0	100.0	0.0	200.0

Table 3.6 Financial Assistance Input

3.4.3 Government of Bangladesh

Table 3.7 shows the input in terms of funding by the Government of Bangladesh. Details about Government of Bangladesh staffing and purchase of equipment are provided in Chapter 5.

Cost in Lakh Taka

	1995	1996		1997		1998		Total
Description	II	I	II	I	II	I	II	
Project personnel GOB	16.0	48.0	48.0	48.0	48.0	48.0	24.0	280.0
CDST & VAT	0.0	70.0	70.0	0.0	0.0	20.0	0.0	160.0
Total	16.0	118.0	118.0	48.0	48.0	68.0	24.0	440.0

Table 3.7 Government of Bangladesh Input

Note : The following has been assumed for the exchange rates between the Bangladshi Taka and the currencies of the donors as well as the US dollar:

1 Lakh Taka = NLG 4,000
1 Lakh Taka = DKK 14,000
1 Lakh Taka = USD 2,500

4 METHODOLOGIES

4.1 Data collection

4.1.1 Marine Surveys

Existing data

There are three main data sources covering the estuary:

- Ongoing monitoring programmes by national agencies
- The LRP
- Other specific studies, completed or in progress

Data from these sources have been, or are being screened and compiled for the purpose of the MES.

Ongoing monitoring activities

Monitoring of meteorological conditions is undertaken by the Meteorological Department, and tidal (sea level) registrations are carried out mainly by BIWTA, but also by BWDB and by CPA. BIWTA publishes annual Tide Tables with predicted tidal elevations for a number of stations in the estuary and in the Lower Meghna.

A continuous programme of bathymetric surveying is carried out under the Director of Hydrography. For each year, this programme covers a certain (minor) part of the large area used for navigation.

The Land Reclamation Project

The Land Reclamation Project (LRP) (1977-91) comprised comprehensive field investigations and numerical hydraulic modelling, for providing a part of the planning basis of that project.
In principle, the scope of the MES field programme is to supplement the data produced by the LRP and other previous studies. However, the rapid morphological changes in the estuary, in combination with the general need of simultaneous data, imply a need of a thorough continuation of the field survey activities.

A description of the LRP accomplishments is given in the *'LRP Final Report', August 1991.* In brief, the field programme components were (i) coastline surveys, (ii) bathymetry surveys and transect geometries, (iii) sea level recordings, (iv) flow recordings, (v) wind recordings and salinity recordings (to a minor extent). A catalogue of collected data has been compiled by BWDB/SSD in the publication *'Inventory of available data and information', BWDB, May 1991.*

Other investigations in the Meghna Estuary

Apart from the LRP surveys and studies, several other marine investigations or study components have been carried out or are in progress in the estuary, such as for example

- Chittagong Harbour, small studies of siltation and dumping of dredging spoils (1977-78, 1983)
- 2nd Coastal Embankment Rehabilitation Project (CERP II) (BWDB) (1988-91)
- Pussur-Sibsa River and Karnafuli Entrance (Ministry of Shipping, GoB) (comprising marine field surveys, numerical hydraulic modelling) (1989-92)
- Cyclone Protection Project II (BWDB) (comprising topographic field surveys, and numerical hydraulic modelling) (1990-91)
- SW Area Water Resources Management Project (FAP4) (FPCO) (comprising numerical hydraulic modelling) (1991-93)
- Cyclone Shelter Preparatory Study (Local Government Engineering Department)

(comprising topographic and marine field surveys, numerical hydraulic modelling) (in progress, November 1995 - August 96)

As indicated, some of these investigations have comprised small or comprehensive field surveys, and numerical hydraulic simulation programmes.

Geographically adjoining FAP projects are FAP4 (SW Area Regional Study), FAP5A (SE Area Regional Study), FAP5C (S Area Regional Study) (not yet initiated), and FAP9B (Meghna Left Bank Strengthening). The River Survey Project (FAP24) does not cover the Lower Meghna.

Meghna Estuary Study estuarine surveys

The estuarine surveys of the MES aim at producing data for:

- The general basis for the physical planning in the estuary
- Hydraulic design of specific land development schemes
- Baseline description of the environmental and morphological state and processes
- Hydrodynamic and morphological impact evaluation

The field measurements for these purposes can be divided into categories as follows:

- Water level registration by self-recording gauges and by staff gauges
- Wave recordings by self-recording gauges
- Bathymetric surveys
- Current and Salinity/Temperature (S/T) recordings by electromagnetic self-recording instrument
- Measurements of flow transects, flow profiles, and S/T profiles
- Collection of suspended sediment samples for determination of sediment concentration and settling velocity
- Collection of sea bed samples

The MES estuarine surveys comprise the following components:

- Establishment of a geodetic grid for reference stations
- Installation and operation of water level gauges and wave recorders
- Routine measurements from Anwesha: Bathymetric surveys, flow transects, sediment sampling, and S/T profiles
- Data processing and reporting

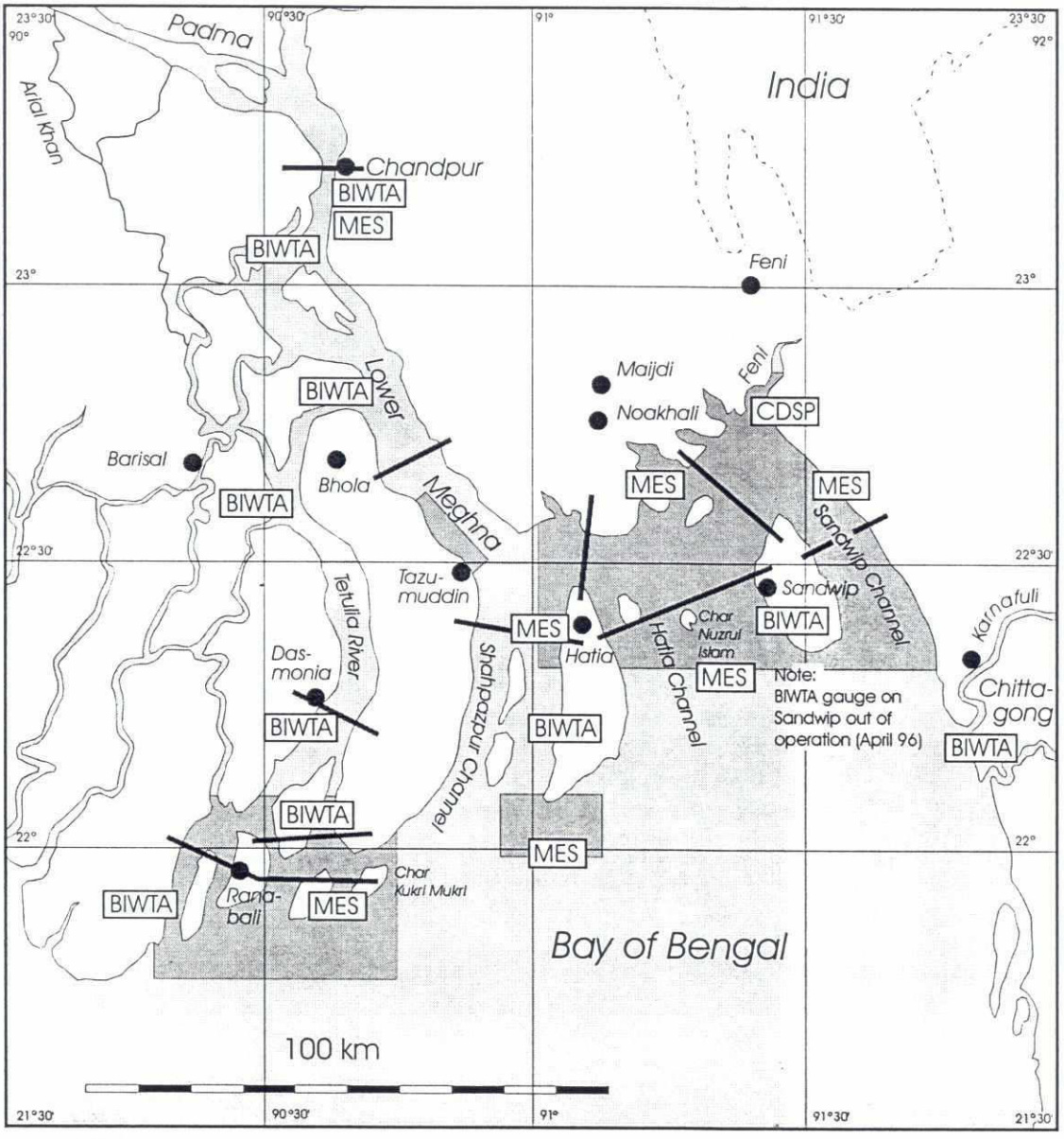
Following the initial mobilisation, this work comprises four campaigns:

- 2 monsoon season campaigns (flow, sediment sampling, and S/T profiles)
- 2 dry season campaigns (bathymetry, flow, sediment sampling, and S/T profiles)

Hereby, the programme has been compressed as compared with the programme presented in the Interim Inception Report, where a total of 5 campaigns was envisaged. This change was necessitated by the period of unavoidable circumstances in early 1996, which delayed the mobilisation. However, the number of effective vessel days remains unchanged.

The anticipated operation areas are indicated in Figure 4.1

The tentative programmes for the different categories of campaigns are indicated in Table 4.1.



MES bathymetry and flow gauging transect

MES priority study area and bathymetry area

BIWTA — BIWTA water level gauge - location shown in BIWTA Tide Tables

MES — MES wave and water level gauge, to be established

CDSP — CDSP wave and water level gauge, to be established

Figure 4.1: Location of survey areas

Activity	Monsoon survey	Dry season survey
		+
Bathymetry	+	+
Cross-section geometry and flow transects	+	+
Salinity/temperature profiles	+	+
Suspended sediment samples	+	+
Sea bed samples	+	+
Deployment and servicing of instruments	+	+
Transfer and stand-by		

Table 4.1 : Outline of survey activities

The field survey procedures are described in Annex 2, and an outline of the execution of the field programme is included in Annex 3.

4.1.2 Land-based Surveys

Existing topographic information

Information about topographic conditions is available from Survey of Bangladesh and from the Local Government Engineering Department, as well as from the LRP and certain specific studies. An inventory of topographic data from the LRP is included in the publication *'Inventory of available data and information', BWDB, May 1991.*

FAP18 has carried out a comprehensive geodetic mapping in the area, but the results have not yet been released.

A geodetic survey was planned to take place in early 1996 under the Cyclone Shelter Preparatory Study. However, the work was discontinued during the national political unrest and will not be completed until later on, or perhaps not at all.

A new phase of the Coastal Embankment Rehabilitation Project (CERP) is scheduled to start in 1996. It is anticipated that this project will comprise a certain land survey component.

MES land surveys

Topographic (land) surveys will be carried out by MES with the following objectives:

- To establish a grid of reference bench marks
- To map coastlines and coastline gradients
- To map elevation contours of shallow areas, as a basis for sedimentation/accretion monitoring and sediment budgets
- To carry out supplementary mapping of land elevations as a part of the design basis for priority study areas

The basic grid of reference bench marks is being established by stationary DGPS with an expected accuracy of 5-10 cm per 100 km, both horizontally and vertically. The grid will be linked with the national geodetic grid that has recently been established by Survey of Bangladesh and JICA, but which does not cover the MES area.

The subsequent detailed topographic survey work (as well as the estuarine surveys) will be made relative to this primary grid, which will also serve as a reference for interpretation of long-term water level recordings (by BIWTA and MES), as well as for past bathymetric surveys (by LRP). Hereby, a provision is made for a consistent comparison between data from the various past and present sources.

Socio-economic survey

Both quantitative and qualitative information of the survey areas will be obtained by the following methods :

- Secondary Sources documents that will provide an initial picture of the project area. Sources include national government agencies,(e.g. Thana administration) records and reports of BWDB, BBS, local government agencies, village records (village tax records) and area specific studies (feasibility studies).

- Household survey with pre-designed questionnaires to be administered to randomly selected household heads. Three survey areas will be purposively selected to ensure geographical representation. The sample villages in the survey areas will also be purposively chosen in view of easy accessibility.

- In-depth survey of social groups to get insight into people's perceptions, attitudes and behavior in the context of multi-stage process of dialogue between groups by participatory rapid appraisal approach. No formally structured questionnaires will be used. However a checklist of issues or guidelines will be held in mind or noted. This would help direct learning by the investigators from and with local people seeking diversity and differences on rural development planning.

4.2 Geographic Information Systems and Remote Sensing

4.2.1 Introduction

The MES project is anticipated to generate a lot of maps and spatially distributed data. The project will also require a large amount of input maps and other data. Within the project, a GIS database will be developed and maintained, which ensures a proper use and management of the geographical data.

GIS (Geographic Information Systems) is a set of computer programs especially designed for storage, analysis and retrieval of geographic data. The GIS stores the information in data layers or coverages, each containing data on a specific theme. GIS allows for referencing the coverages and updating and retrieving information in the coverages. It also allows for combination of coverages, so GIS can be used to analyse spatial combinations and spatial problems. GIS systems come with a powerful map plotting subsystem, which can be used to produce maps of any combination of the coverages in the database. In principle, these maps can be plotted at any scale desired, but attention should be paid to the fact that GIS cannot create accurate data on coverages that were surveyed on a very coarse scale. Data can be fed into the GIS using several methods:

- Interpolation of values of point measurements or model results;

- Digitizing contour lines or boundaries of objects from existing paper maps;

- Importing data already digitized for other purposes;

- Use Remote Sensing techniques to obtain accurate data on areas which are insufficiently surveyed.

Remote Sensing (RS) techniques make it possible to obtain information on objects and characteristics on the earth surface without being in direct contact with them. Thus, remote sensing can give information on an area to be studied before any field work is done. Especially when large areas are to be studied the reduction of the amount of fieldwork can be considerable. Traditionally, aerial photography is the most commonly used technique, but more recently other forms of remote sensing, notably satellite imagery, have become available. These images are relatively inexpensive and provide a great deal of information.

Starting with the Landsat MSS-images (Multi-Spectral Scanner images, resolution of ground details 80x80 meters) in 1973, enhanced sensors became available. At present, the most sophisticated satellite sensors are Landsat TM (Thematic Mapper, resolution of ground details approximately 30x30 m) and SPOT panchromatic (ground resolution 10x10 m).

Other satellite data, especially satellite radar data (from RADARSAT, ERS 1/2) could be used to examjne wave directions and wave heights and in the wider context coarse spatial resolution satellite imagery from AVHRR could be used to look at the mixing of sea and sediment-laden freshwater in the Bay of Bengal. However RADARSAT/ERS mapping, is beyond the resources available for the purpose of data collection within the MES project.
The hydrodynamic models (for currents and waves) are already extended widely beyond the project area, and available information about the off-shore wave climate will be a part of the basis for the wave calculations. In the large shallow and sheltered parts of the study area, the waves are expected to be predominantly determined by the local conditions.

In general, two types of satellite image products can be obtained: the black and white or color prints or photomaps, and the digital information on computer tape. Both the products have their own use with specific advantages and disadvantages. The photomaps are readily available for further visual interpretation, and with most of the photos the user does not have to worry about georeferencing and geocorrecting the photo. However, interpretation can only be done visually, while image enhancement and automatic image classification are only possible with digital images on computer tape.

Several studies have been executed to define the applicability of Remote Sensing techniques for the water sector in Bangladesh. The reports of these studies start to appear from around 1975 onward. The use of Remote Sensing in the water sector can be divided into two major groups of applications. The first group is the classification of landuse and cropping patterns, and the second group is the applications for coast line and river bank development.

SPARRSO and ERIM (Environmental Research Institute of Michigan) (SPARRSO and ERIM, 1981) conducted a study in 1981 using Landsat Digital Data for measuring the land accretion in the Coastal Zone of Bangladesh. Their main objectives were:

1) to determine whether a net gain or loss of land occurred along the coastline of Bangladesh between 1972 and 1979;
2) to provide some insight into the nature of the interrelationship between the processes of accretion, erosion and sediment transport in the Meghna estuary that are responsible for the changes observed;
3) to predict, on basis of the observations made, where it is likely new land will be formed in the future; and
4) to define the steps that should be taken to accelerate the process.

In the above study it is concluded that it was feasible in 1981 to monitor and measure changes in the Meghna delta since 1973. Present day remote sensing techniques provide a much longer record of images available. Moreover, the resolution and spatial characteristics of the modern sensors provide a more detailed insight and overview for the Meghna estuary. However, the primary objectives of the SPARRSO and ERIM study remain completely valid.

For the MES project, several applications of GIS and Remote Sensing are anticipated. For processing of GIS and Remote Sensing data, a PC based GIS/RS system will be installed at the

MES office. Since the capacity of this system is limited, some tasks will be allocated to other institutes.

The most important anticipated outputs of Remote Sensing in this study are:

- Mapping of the dynamics of the coastline and the ability to give an overview of the areas eroding and those that are accreting.
- Provision of data on land use and infrastructure where no other data is available.

Regarding the mapping of the dynamics of the coastline: This is essentially a dynamic view of the area, what is happening where, and could we identify possible causes of the phenomenon.

In order to accomplish this, the MES proposes a multitemporal approach, meaning we need RS images of the study area reflecting the situation at several moments in time. Each image gives a static description of the situation at that moment, and the stack of images together will uncover the dynamics of the system.

Regarding the mapping of land use and infrastructure data: As much of the land in the Meghna estuary is insufficiently mapped, there is a need throughout the project for (more) detailed information on the actual situation in the area. To help providing this information, a Remote Sensing Landsat TM image of the area has been obtained. Ideally, after processing this Remote Sensing image could provide information on land use, settlement patterns and infrastructure in the area, as well as information on currents and silt loads of the water bodies.

To obtain these results, the following processing steps need to be executed:

- georeferencing the image (make sure a known and correct coordinate system is attached to the image, so that we can match locations in the field to locations in the image);
- enhancing the image (contrast stretching etc);
- printing the image.

4.2.2 In-house applications

The in-house system will be used for digitizing existing paper maps, and the set up and maintenance of the database. Using ILWIS/ARCINFO as the main database platform, data exchange with other groups will be ensured. ArcView will be used for data display and map production.

The MES will in principle use the same software as EGIS. The ILWIS/ARCINFO package will be used which includes conversion facilities to many other software packages. Data management in relation to the stipulations of the Terms of Reference will aim at compatibility with existing data bases in Bangladesh.

4.2.3 Environment and GIS support Project EGIS

Modern remote sensing techniques have been applied to geographical research, flood monitoring and natural resources assessment in Bangladesh for more than two decades. The Government of Bangladesh has embraced the use of this technology by establishing the Bangladesh Space Research and Remote Sensing Organisation (SPARRSO).

The Flood Action Plan FAP has addressed principles of Remote Sensing for use in water resources planning and management under FAP-19 (the GIS project). FAP-19 was implemented through EGIS Environmental and GIS Support Project for Water Sector Planning.

FAP-19 was coordinated by FPCO and is currently funded by DGIS (Netherlands government). In addition to its main project focus within the FAP, the EGIS team has provided leadership in the development, application and institutionalization of GIS technology in Bangladesh. The processing and handling of the data from the Landsat TM image of 1996 is done by EGIS. EGIS produced the geocorrected mosaic of Landsat TM imagery, that is used in the MES project.

4.2.4 Surface Water Modelling Centre

The Surface Water Modelling Centre (SWMC) is the "centre of excellence" in the field of mathematical river modelling in Bangladesh.

SWMC was created in 1990 based on technology transfer carried out through the Surface Water Simulation Modelling Programme initiated in 1986 and supported by the World Bank and UNDP.

Since 1990, SWMC has been supported financially by DANIDA. SWMC forms and independent unit under the Ministry of Water Resources administered through the River Research Institute. The Danish Hydraulic Institute has provided the mathematic modelling technology and carried out the training of SWMC staff.

The large quantities of data required and generated by SWMC are stored in digital format in GIS. This GIS can also be linked to the simulation models to produce flood depth maps and impact assessment.

SWMC is assisting the MES project giving general GIS support and allowing the use of their equipment in the study. They are also involved in the mathematical modelling of the MES, and as such will cooperate in the incorporation of model results in the MES-GIS.
Surface Water Modelling Centre has implemented a GIS system that was developed for the Ministry of Water Resources by the Flood Management Project (FAP25). The system is based on ArcInfo software, like the GIS system used by EGIS.

The following data and information will be supplied by SWMC to the in-house GIS system of the MES:

- Topographic and bathymetric surveys carried out by MES
- Selected historical data, as applied under the project
- Model bathymetries and key results of the numerical model simulations

The data will be transferred in BTM grid and PWD datum.

4.3 Planning techniques

4.3.1 Logical framework

The logical framework is regarded by MES as a tool that will help to improve the management and thus the effectiveness of the project. The logical framework, or logframe, shows the development objectives, immediate objectives, expected output and main project activities in a logical sequence.
Indicators and verificators have been identified to keep track of progress made. Critical assumptions, which require to be monitored, are also mentioned in the logframe. The partially complete logical framework presented in the Draft Project Document (annex 3) has been used as a reference for the first logical framework presented in this document.
It is the intention of the Consultants to promote with the logframe approach the active

participation of decision-makers and planners (GoB, donors), implementing agencies (BWDB and Consultants), as well as the local population and agencies. Such participation may lead to major changes in the orientation of the project, and if decided to do so, these changes will be reflected in a modified logframe.

The logframe gives a breakdown of main activities into activities for the various project study components, further details are given in Gantt charts which can be found in the detailed Project Implementation Plan. In this way a direct link has been established between daily project activities and the objectives of the study. During implementation of the study activities of the various project components may be modified, as knowledge and insight will grow or due to changing circumstances. The purpose of such modifications is to increase the effectiveness, or, to improve the efficiency of the total of project activities through tuning and coordination. Annual up-dates of the logframe have to reflect such minor changes.

In the case of MES, which is a study that consists of various project components, it is considered useful to show the coherence of the components in the study. To make this possible, the overall logical framework is worked out in sub-logical frameworks for each component. In this way, the major activities of the overall logframe have become outputs for the components and in the logframe for each component sub-activities have been formulated. Figure 4.2 shows the principle of interlocking the project component logframes into the overall project logframe. Annex 01 of this Inception Report presents the detailed logframes for the various project components.

4.3.2 Gantt Chart

For day-to-day management of the project, Gantt charts have been prepared for each project component. Whereas the logframe identifies the activities, the Gantt chart describes the detailed activities for each component including starting date and duration. The relative position of the Gantt bar shows which activity is before and after, as well as overlap between activities. Gantt charts are used to present the detailed project implementation plan and will be used to keep track of progress of each project component.

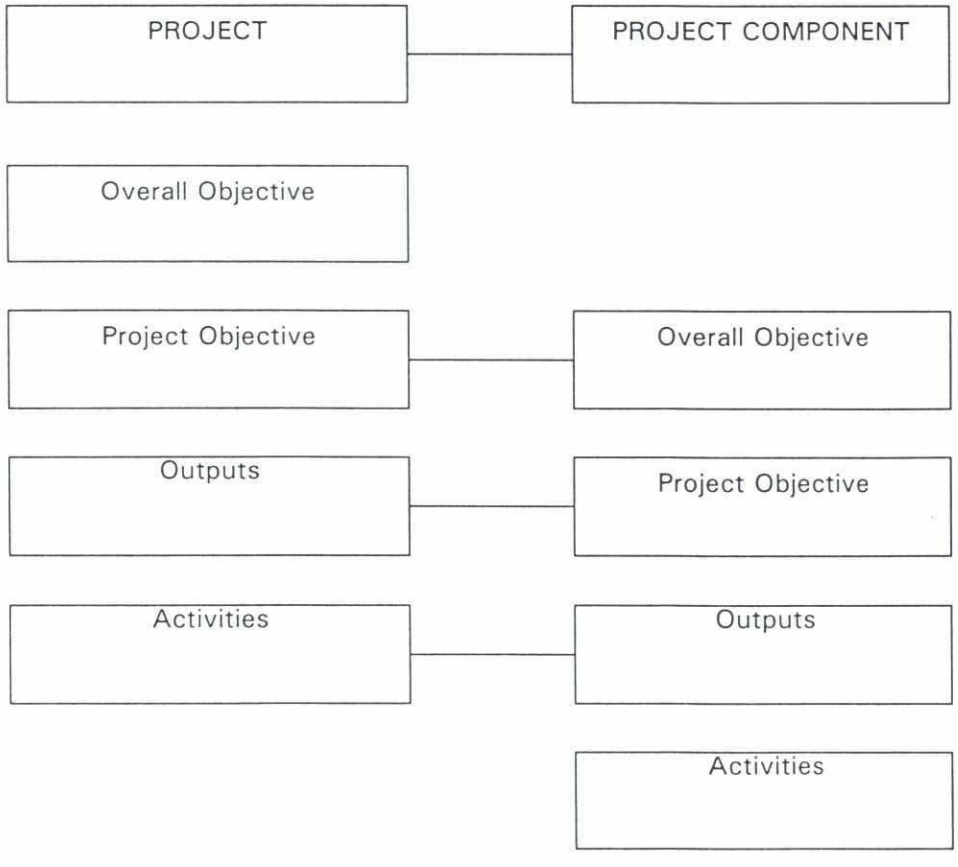


Figure 4.2 : Relation between the Project Log Frame and Log Frame different components of the Project.

4.3.3 Problem tree

The logframe is more than a table with logical interventions, indicators, verificators and critical assumptions. Using the logframe approach in a broader sense will help to shape and tailor priority projects in particular to address problems and needs of the local population and agencies. Problems and needs related to issues such as flood protection, drainage, settlement and agriculture are being identified in the early stages of the study through rural household surveys, rapid rural appraisal, walk-throughs, individual and group interviews with the local population and consultation with local agencies.

Participation of local population and agencies in the early formulation of priority projects can be stimulated by the use of so-called problem trees. Problem trees reflect a logical hierarchy of causes and effects in a diagram for a particular problem that is considered a main bottle-neck.

An example of a problem tree is given in Figure 4.3. In this figure, the main bottle-neck is drainage congestion. The cause-effect relations given is this example may differ from place to place and have been generalised in this example.

The purpose of the use of problem trees in meetings or workshops with the local population and local agencies is to finalise a problem analysis of a major bottle-neck and to discuss the objectives of future priority projects and to some extent the programme of activities of these projects. In such a way, a first outline of a logframe for each priority project can be obtained.

Figure 4.3 : Example of a problem tree for drainage congestion

4.4 Hydraulic and Morphological Modelling

4.4.1 Objectives

Modelling activities will lead to improved understanding of the natural processes of accretion and erosion and of the effects of human interventions, both on the main rivers discharging their water and sediment in the area and on the coastal area itself. This will enable the preparation of a phased long term plan for the estuary. Therefore, the main objectives of the hydraulic modelling are:

- To check the water movement through the different channel as well as the Bay of Bengal of MES area,

- To provide a tool for a detailed and consistent hydraulic impact evaluation of various land development schemes and planning scenarios, relative to a well-defined common reference.

As with all computer programmes, the quality of the results of computations (2-D model in our case) depends to a very large extent on the quality of the input data. For getting quality data extensive surveys and studies will be needed to determine the basic characteristics of tides, current, waves, bathymetry as well as the condition of water management.

4.4.2 Approach

Previous Model Studies

Hydraulic modelling has been carried out in connection with several previous studies and projects in the area, and is in progress as one component of the ongoing Cyclone Shelter Preparatory Study (CSPS, 1995-1996).

Numerical hydraulic modelling within the Land Reclamation Project (LRP) comprised 1-D (one dimensional) hydrodynamic modelling (by the NETFLOW model), and 2-D (two dimensional) hydrodynamic modelling (in a 1 Km grid).
Also, detailed 2-D hydrodynamic models were applied for selected areas. The numerical modelling of LRP was largely carried out in the Netherlands. The hydraulic model was constructed on the basis of the data collected by the LRP.
The model played an important role in the pre-feasibility studies on measures to protect Sandwip island and Hatia island against erosion and in the feasibility study on the Sandwip crossdam development scheme. The model was used to see impact of the proposed Sandwhip crossdam on the siltation of Chittagong port and erosion along the North East coast of Bhola.
Furthermore, the model was used to study the possibility of simulating cyclone-induced storm surges in the delta. Land reclamation on south Hatia and South Bhola were also studied through these models.

Apart from the LRP, several other relevant marine investigations of study components have been carried out or are in progress in the coastal area of Bangladesh such as for example

- Chittagong Harbour, small studies of siltation and dumping of dredging spoils(1977-78,1983)

- Report of the National Committee on erosion of Bhola, Dhaka, April, 1988

- Pussur-Sibsa River and Karnafuli Entrance (Ministry of Shipping, GoB) (comprising marine field surveys, and numerical hydraulic modelling) (1989-91)

- Cyclone Protection Project II (BWDB)(comprising topographic field surveys, and numerical hydraulic modelling (1990-91)

- SW Area Water Resources Management Project(FAP4) (FPCO) (comprising numerical hydraulic modelling) (1991-93)

- Cyclone Shelter Preparatory Study (Local Government Engineering Department) (comprising topographic and marine field surveys, and numerical hydraulic modelling (in progress, November 1995- August 1996)

As indicated, some of these investigations have comprised small or comprehensive field surveys, and numerical hydraulic simulation programmes.

Geographically adjoining FAP projects are FAP4 (SW Area Regional Study), FAP5 (SE Regional Study), FAP5C (S Regional Study) (not yet initiated), and FAP9B (Meghna Left Bank Strengthening). The River Survey Project (FAP24) does not cover the Lower Meghna.

A new phase of the Coastal Embankment Rehabilitation Project (CERP) is scheduled for implementation in 1996, and for that purpose a GIS project in the area is under preparation, funded by the CEC.

The Surface Water Modelling Centre

In connection with the Surface Water Simulation Modelling Programme (SWSMP), the Surface Water Modelling Centre (SWMC) has set up, calibrated and applied a suite of hydraulic models for the Meghna River Estuary.:

- A 1-D (Mike11) model, covering the main river system and the Meghna Estuary (the so-called SWSMP model)

- A 2-D (Mike21) 5400 m grid model, covering the northern part of the Bay of Bengal, which is called 5400 m grid Bay of Bengal model.

- A 2-D (Mike21) 1800 m grid model, covering the entire coast of Bangladesh and main river system with Meghna estuary, which is called 1800 m grid intermediate model.

- A 2-D (Mike21) model with 600 m grid, covering the main river system and the Meghna estuary, which is called 600 m grid Meghna Estuary Model.

- A 2-D (Mike21) model, covering the whole area (stated above) using all 3 models when combined as one nested grid model.

- A 2-D (Mike21) model with 200 m grid, covering small area within the Meghna Estuary Study(MES) area, which is called local model.

The three first-mentioned models have been used for previous studies in the area, such as the Southwest Area Regional Study (FAP4),the Pussur-Sibsa and Karnafuli entrance study (taking 2 km grid and 6 km grid). At present the Cyclone Protection Project (FAP7) has been working by taking 1800 m grid instead of 2000 m grid and 5400 m grid instead of 6000 m grid. The 1.8 km grid and 5.4 km grid 2-D models is presently being upgraded for the purpose of the Cyclone Shelter Preparatory Study (November 1995- August 1996).

Further, SWMC operates a data base for data storage, and a GIS system for data presentation and impact analysis.

Model studies by MES

The modeling tools are based on numerical models that have been used in the past, as briefly described below.

The following data are required as input in the models (refer to Figure 4.4).

- coast contours
- bathymetrics and transect geometries
- hydrodynamic boundary values
- wind field

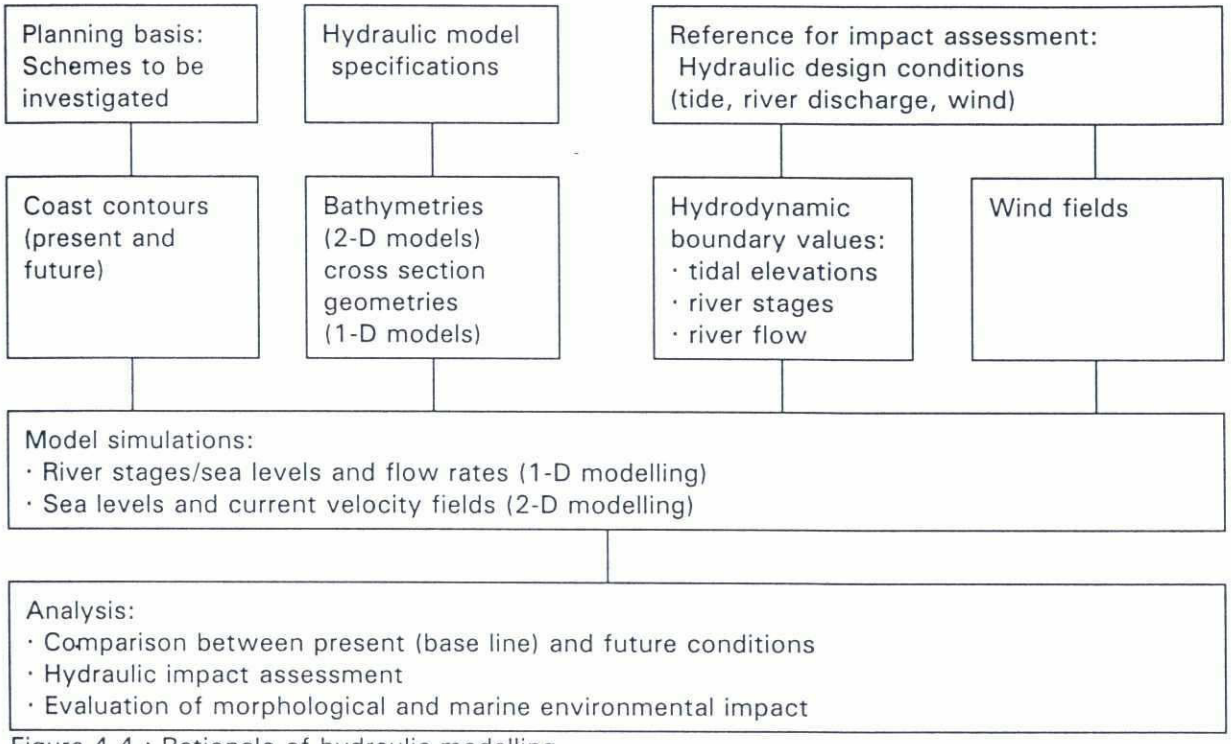


Figure 4.4 : Rationale of hydraulic modelling

The input data, in particular the bathymetry of the entire area, could initially have been taken from past surveys and monitoring programmes, basically from LRP and other projects in the estuary, BIWTA, and Meteorological Department.

However, the satellite mosaic (from early 1996) presented in the Inception Report shows that adjustments of coast contours and depths are required, due to significant changes as compared with available survey results, notably in the area at the mouth of the Meghna River. Therefore, and because of the need of simultaneous data for the sake of consistency, additional field data are a necessity in relation to the model.

The existing data will serve as a reference for the validity of the simulation periods (and will be applied in the analysis of the historical morphological development of the estuary.)
A compilation is in progress of all data from the Land Reclamation Project, all available bathymetric data, and comprehensive extracts of available water level registrations and meteorological data.

As one component of the ongoing CSPS study (1995-1996), 2-D numerical hydraulic models have been developed in a very good form. These model used tabulated tidal elevations in the open part of Bay of Bengal as boundary values, and wind recordings and BIWTA water level data as the basis for calibration. It would have been possible to use these models initially for the Meghna Estuary Study, however the morphlogical changes in the estuary are such that the results can not be meaningful.

Therefore it has been decided that first the data base will be updated by results of the MES field surveys executed during the 1996/1997 winter season as well as by data from the other ongoing marine surveys and from the Meteorological Department.

The 2-D models will be adjusted and calibrated with the most recent information available. The results of the simulations will be used for impact predictions included in the Interim Master Plan.

Selected critical areas will be successively revised on the basis of the subsequent MES bathymetry surveys, in order to upgrade the quality of the impact prediction prior to final recommendations of the MES project.

For the overall coverage of the estuary area a 2-D model is expected to be adequate.
A 1-D model for the upper part of the Meghna river as well as the western branch channels of the Meghna Estuary may be required to establish proper boundary conditions for the 2-D model.

The methodology which can be used for hydraulic model study, comprises the following stages:

- Selection of the model area, which should contain all locations of interest and whose boundary is located far from these locations
- Specification of numerical constants: grid size, time step etc.
- Schematization of the bathymetry using the most recent maps or data.
- Elaboration of the data collected to provide boundary conditions for the model.
- The model (Mike 21) is to be calibrated using field data which were collected earlier, requiring an extensive data reduction.
- Finally the model can be applied to predict the effect of proposed future works.

Hydraulic design basis for impact assessment

In general, the hydrodynamic impact, the morphological impact, and the marine environmental impact of a given scheme do not necessarily occur under the same oceanographic or meteorological conditions. For example, a morphological impact may occur under high flow and strong winds, whereas a marine environmental impact (such as an increased salinity) of the same scheme may occur under low flow and calm conditions.

Therefore, a critical activity of the miscellaneous impact evaluations is to develop an appropriate hydraulic design basis. This implies a selection of representative 'adverse', 'normal', or 'critical' conditions that have an adequate validity in relation to a specific impact of a given potential scheme.

Approach, 1-D hydrodynamic modelling

The scope of the 1-D modelling is to examine the hydrodynamic impact in the Bangladeshi rivers (if any) of potential MES schemes, or, in other words, the impact outside the study area of changes within the study area.

For this purpose, the SWSMP model will be used, or rather a part of it, namely the part upstream of the 2-D model boundary.

Approach, 2-D hydrodynamic modelling

The scope of the 2-D modelling is to examine the local and regional hydrodynamic impact of potential schemes within the MES, and also to provide part of the basis for the morphological and marine environmental impact assessment. The 2-D modelling will supply summary informa-

tion about the wave climate, which will be calculated for average NE monsoon and average SW monsoon wind conditions. In addition, the modelling will serve as a support for analysis of the satellite imagery.

For the purpose, an adaptation will be made of the most recent 2-D model of the Meghna Estuary available with the SWMC. Hereby, the model area will be extended to cover the entire MES area, and the grid size will be reduced. The model will be of the so-called nested grid type, with three levels of coupled models, the basic level being SWMC's Bay of Bengal model, which covers an area of 850 km by 600 km with a grid size of 5400 m.
The nested grid approach is required because the outer boundary conditions must be unaffected by the impact to be described by different simulation. Therefore, a regional model of 600 m grid which covers the entire MES area will be set up in this case.

In addition, local fine grid (200 m) models will be set up for examination of MES priority areas. The grids and reference level of all models will be BTM (Horizontal grid) and PWD (Reference level) respectively, in order to conform with the bathymetry surveys, other field measurements, and satellite imagery. The tentative model specification is shown in Table 4.2.
A preliminary simulation programme is given in Table 4.3. The final number of simulations depends on the extent of the impacts of the different schemes: In cases where the impacts is 'regional', rather than 'local', both the regional and the local models must be applied for a valid description, because the impact will penetrate beyond the boundary of the local model.

5400 m grid Bay of Bengal model					
easting BTM	northing BTM	Area	Water area	Time step	CPU time per simulation day 1)
-50 - 800 (850 km)	100 - 700 (600 km)	510,000 km²	40 percent	60 s	3 min
1800 m grid intermediate model					
easting BTM	northing BTM	Area	Water area	Time step	CPU time per simulation day 1)
180 - 750 (570 km)	300 - 620 (320 km)	182,000 km²	37 percent	60 s	7 min
600 m grid Meghna Estuary model					
easting BTM	northing BTM	Area	Water area	Time step	CPU time per simulation day 1)
500 - 720 (220 km)	360 - 600 (240 km)	53,000 km²	43-70 percent 2)	60 s	31 min
The above 3 models when combined as one nested grid model					
				Time step	CPU time per simulation day 1)
				60 s	38 min
200 m grid local sub-model for detailed analysis					
		Area	Water area	Time step	CPU time per simulation day 1)
		100,000 km²	50 percent	60 s	63 min
All 4 models when combined as one nested grid model					
				Time step	CPU time per simulation day
				60 s	114 min

1): The CPU time depends on the computer capacity.
Values in the table are given for SWMC's DEC-Alfa 250 4/266 work station

2): This area includes land area exposed to occasional flooding

Table 4.2 : Tentative specifications for 2-D hydrodynamic models

Calibration and validation	4 simulations
Baseline description	2 simulations (dry season and monsoon season)
Impact analysis	8 x 2 simulations

A duration of each simulation of 14 days has been assumed

The extent indicated is preliminary. The simulations for impact analysis may be organised as a larger number of simulations with a shorter duration, or a combination

Table 4.3: Tentative 2-D hydrodynamic simulation programme

Approach other modelling

Depending on the implications of the schemes to be investigated in the course of the project, a need may arise for additional, supplementary model simulations with a different scope and by application of different models than the ones described above.

Examples of such potential model analyses are simulations of wave fields, and modelling of littoral processes, as a support for the morphological impact analysis.

Such modelling will be of a minor extent and will be selected only in cases where work can be saved, or an improved quality can obtained within a given resource allocation, as compared with alternative methods.

Data presentation and storage

Depending on the scope of each particular simulation, the results can comprise for example

- Fields of calculated, characteristic instantaneous current velocities
- Fields of calculated, characteristic neap and spring tidal ranges and tidal stream velocity amplitudes
- Fields of calculated speed differences between 'present' (baseline) and 'future' situation, as well as time series at selected locations
- Longitudinal transects of calculated set-up from the 1-D modelling (as applicable), by comparison between a 'present' (baseline) and a 'future' situation, as well as time series at selected locations

All 2-D model data (input and output) will be given or produced in the same fixed grid as the one used for the bathymetric and topographic mapping.

4.4.3 Morphological modelling approach

Most of the numerical models used in the hydraulic and morphological field are characterized by the flow chart in Figure 4.5.

They contain modules for tides, (if necessary) waves, currents and sediment transport, and a sediment balance module. In many model systems, this is the final result, which is translated into morphological evolutions by expert interpretation. Some other systems contain a time loop mechanism in order to simulate morphological evolutions. These model systems, however, are still in their research phase, and applications are usually restricted to short-term evolutions, e.g. due to one or a few storms or neap-spring tide period.

The hydraulic and morphological models to be discussed in the Meghna Estuary Study belong to the former type, called "initial models".

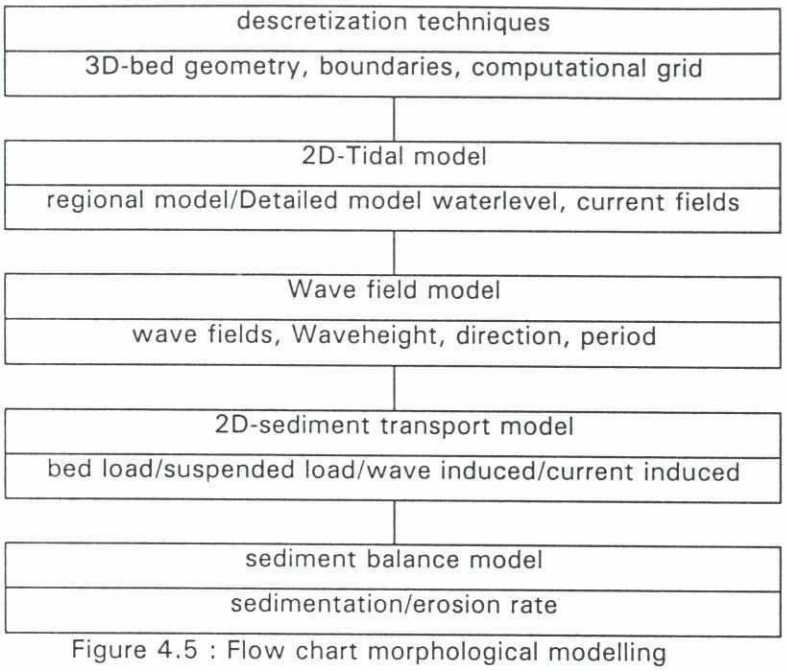


Figure 4.5 : Flow chart morphological modelling

For simulation of hydraulic and morphological characteristics in the Meghna Estuary area, it is necessary to identify the relevant physical processes and the primary driving mechanism behind sediment motion. Preliminary analysis of physical processes in the Meghna Estuary led to the following composition of constituent models:

- 2-D tidal model.
  This should solve the complete shallow water equations, including the tide, the river discharge and wind stress as driving forces. At the present state, wave-driven currents are assumed to be of minor importance in the Meghna estuary. Of course, the model should include a flooding and drying mechanism for large shallow areas (such as North-Sandwip, Urir Char, North Hatia). The model will be established as a structure of nested models with a grid size down to 200m.

- Wave field model.
  This should include 2D-propagation, generation by wind input, and dissipation by bottom friction and breaking. To avoid focusing and tunnelling of wave energy, a refraction model (bottom and current refraction) taking into account the directional spread of the wave field seemed to be the best solution for the time being. The MIKE-21 program package includes these effects. The wave models will be used for representative wind directions.

- Sediment transport model.
  This should apply to a wave/current environment, and take account of relaxation effects (specially in the case of fine sediments) in the suspended load concentration. For the time being a dedicated model will be used, consisting of a transport formula and a pick-up/advection/deposition model for the suspended sediment. The morphological model will take care of different size fractions of non-cohesive sediments. It cannot take into account the influence of salinity on flocculation and salinity induced density currents.

- Sediment balance.
  This module should determine the sedimentation/erosion rate from the divergence of the transport field.

The model components could be linked at the software-level through the MIKE-21 program system, providing steering facilities, interfaces between the constituent models and a range of utility programs, and easy access to pre- and post processing facilities.

However the data base generated by the Meghna Estuary Study will not be adequate to produce reliable results of the sediment transport and sediment balance, therefore the sediment transport and morphological computations will be performed separately from the hydro-dynamic calculations with Mike-21.

4.5 Feasibility Studies

4.5.1 Economic aspects - project screening, assessment and preparation

Specification of the objectives for the economic inputs in MES is considered to be a prerequisite for embarking on any study activity - choice of methodology, data collection and analysis. As per FAP 5B TOR, p. 8-9, the economic inputs in MES are particularly required in relation to the following outputs:

- identification and selection of projects for inclusion in the Master Plan (economic level of analysis not specified) for the study area,
- identification and selection of projects for inclusion in a phased Development Plan (pre-feasibility level analysis) for the study area,
- feasibility level analysis for priority projects, and
- preparation of the priority projects for immediate implementation.

For guidance on policy makers objectives and how to perform the project preparation and assessment processes, the FAP 5B TOR, p. 13, refers to:

- the general approach for FAP project preparation (listing at the same time only a selection of general project preparation criteria) , and
- the specific project supporting activities of FAP, namely the FPCO Guidelines for Project Assessment, March 1992.

The TOR is thus not specific with regard to a clearly defined set of objectives for the Development Plan or for individual project screenings and assessments either at pre-feasibility or feasibility levels.

4.5.2 The Need for Project Assessment Guidelines

The Guidelines for Project Assessment for FAP projects have been developed to (Guidelines p.4):

- provide a consistent basis for evaluation of benefits and costs of projects (micro planning purposes), and
- provide a sound basis for decision-makers in choosing between alternative possible resource strategies and investments macro planning (macro planning purposes; regional and inter-regional planning).

The guidelines are built on the assumption that any intervention with human and natural environment gives rise to multidimensional impacts and externalities (indirect impacts) many of which can not be quantified or even foreseen and internalized. As such, selection of projects

can not be done on economic considerations alone. Assessment of projects under FAP involves economic analysis, financial analysis and considerations of other potential effects, including social and environmental impacts, and institutional implications. The Guidelines require that special attention be given to data collection and analysis of potential impacts on fisheries, non-agricultural activities, different social groups and the bio-physical environment.

Environmental Impact Assessment (EIA) is an integrated study process in FAP aiming at predicting environmental consequences of a proposed project and to delineate any environmental management measures which must be integrated into the plan to ensure that the project will be acceptable.

Two types of information - summary of positive and negative impacts as well as costing of the Environmental Management Plan to address the impact of each proposed development - are the outputs of the EIA that enter into the analysis. Finally, a framework for Multi-Criteria Analysis (MCA) has been set up in order to facilitate the integration of all considerations into a common format for decision making emphasizing (ref. Guidelines p. 4):

- the FAP scope of work as a comprehensive approach towards water management and not only physical flood control, and

- the need to bring regional plans to a common standard, and to study the cumulative effects both within and between regions.

The MES economists have reviewed the Guidelines for Project Assessment (May 1992 issue) and find it conceptionally very interesting and technically in line with standard and widely accepted approaches for project evaluation and appraisal. The Guidelines alert the user to problems and issues specially relevant to water management projects in Bangladesh.

It is felt, however, that the Guidelines need to be updated (latest copies are from 1992) and methodologically clarified and operationalised on a number of key issues before these can be directly applied for the MES activities.

Some of these issues are:

- the Guidelines are not explicit with regard to the project selection criteria - e.g, which criteria should be used when identifying and screening potentially interesting projects for MES (Master as well as Development Plan). Furthermore, the project selection criteria need not be the same at identification and feasibility levels.

- the Guidelines are not explicit when it comes to the appropriate steps and depth of the screening activities and feasibility analysis. It is not specified which analytical steps to take and what level of information is required in order to perform satisfactorily:
  - project identification and screening (Master as well as Development Plan level),
  - pre-feasibility analysis,
  - feasibility analysis,and
  - project preparation activities.

- forecasting techniques and procedures for future with (W) and without (WO) project scenarios are not clear. Net incremental differences between the W and the WO scenarios distinguish the impact of the proposed interventions. These impacts will occur against trends and events in society and the natural world that have to be identified, discussed and eventually agreed upon. MES - like other FAP programmes - needs a consistent and precise framework for defining future scenarios in relation to e.g. level of population, economic activity and frequency of flood hazards. That the MES projects are long term investments only supports the need for operational guidelines for producing realistic project scenarios - (more than "care" is needed, ref. Guidelines p.7),

- which components or dimensions (and their operationalisation) should be included in the analysis of total project benefits and costs,

- how to assess quantifiable benefits and costs for main impact areas - social aspects, environment, agriculture, fisheries, general flood damage etc. The methodology for including environmental impacts and possible externalities in the analysis should be expanded and brought in line with the latest international developments.

- how to assess qualitative benefits and costs which are not amenable to quantification and evaluation,

- the Multi-Criteria Analysis (MCA) provides a framework for displaying calculated and estimated project impacts in a concise, standardized and comparable way, but is not dealing with a procedure to be used for ranking MES or FAP project alternatives, or alternatives related to regional water management resource strategies and investments (ref. Guidelines p. 18).

It has not (yet) been possible for the MES economists to consult with the economist of WARPO /FPCO or to consult with colleagues on other FAP projects in order to discuss and learn from their practical experience with the FPCO Guidelines. The economists intend to do so during the preparation of the Interim master Plan as part of their activities for developing a set of MES Guidelines for Project Assessment using the FPCO Guideline structure as the basis when addressing the above mentioned need for methodological clarification. Additional inputs from the donors with regard to project selection and assessment criteria will be most welcome in this process.

4.6 Institutional setting

4.6.1 Project objectives

The main objective of institutional development in MES is to identify and develop conditions conducive to sustaining and continuing the project activities. These activities are aimed at:

- increasing the operational knowledge of the hydro/morphological processes in the Meghna Estuary;

- increasing the institutional capacity to retain and update that knowledge;

- developing appropriate approaches for rapid and low-cost land reclamation.

From these project objectives, it is clear that the main thrust of the project is establishing and nurturing a planning process, together with data collection and processing in support of that process, in the counterpart organization. A project with such an objective would rightly be called an institutional development project. This impression is reinforced by the fact that, even in addressing tangible interventions to be planned within the framework set by the Master Plan, the objective is to develop appropriate approaches and not specific engineering artifacts *per se*.

4.6.2 The Terms of Reference

However, the TOR for MES, while stressing the need for sustaining the activities after completion of the project, do not entirely bear out this process orientation. The TOR are most specific on the "hard/ technical" side, where they address the tangible outputs of the process, i.e. the products: data collected, a Master Plan developed, a Land and Water Development Plan formulated, and (an unspecified number of) feasibility studies of priority projects and programmes conducted. In addition, the project would identify and support implementation of (an unspecified

number of) small-scale interventions. While the "soft"/sustainability side is explicitly addressed, the TOR are somewhat contradictory on this subject.

On the one hand, they require a detailed institutional assessment of the Survey and Studies Division of the BWDB, together with proposals for continuing these activities in the future. On the other hand, the job description for the institutional development specialist (in the TOR from DANIDA) is purely stated in terms of assessing past and possible future roles of Thana and Union Councils, Farmers Cooperatives, and different organizations related with the actual development of the study area.

4.6.3 The nature of MES

There is no doubt as to principal orientation toward planning of MES, in particular macro planning. However, the inclusion of the work for the priority projects and programmes, and the institutional development focused on local level implementation, would give the impression that MES attempts to be all things to all people.

It would thus go the same route as the preceding LRP. However, LRP implementation has shown this all encompassing approach to be too difficult in practice. In fact, the land and water-based activities of (master) planning and development have been separated into the two sister projects CDSP and MES for that very reason. It is revealing to note in this regard, that CDSP is termed a project (with specific tangible development objectives), while MES is a study, with the corollary objective to establish the planning process in the counterpart organization.

4.6.4 Institutional development in MES

Institutional development activities in MES must take heed of the process orientation and planning nature of the project, and of the fact that CDSP is developing approaches to actual settlement. Hence it is proposed that institutional development in MES focus on re-activating the data collection and processing activities, and establishing/strengthening the macro-planning capability in the counterpart organization.

As such, institutional development would be oriented toward identifying suitable *modi* for continuing these activities after conclusion of the project in an effective and efficient manner. In pursuing this goal, the MES must take due account of institutional changes that may be imminent in the GoB organization with respect to water resources development and management (along the lines presented at the Fourth Conference on FAP held in December, 1995: combining the activities of RRI, SWMC, and BWDB Hydrology Directorates into one organization).

In light of these considerations, it is proposed that MES not deal with grassroots institutional development for people's participation at the project level, as this is far removed from the core planning activity within MES. MES should deal with this aspect at a higher level of abstraction insofar as it is relevant for planning, i.e. by determining whether appropriate legislation and arrangements for enforcement exist to make implementation possible.
In doing this, MES would not try to re-invent the wheel but adopt the findings of approaches developed in CDSP. If the nature or scale of interventions suggested by MES requires institutional arrangements beyond those developed in CDSP, MES would identify the relevant institutional gap or overlap and suggest improvements. However, such suggestions would have to be worked out in detail by the project(s) to be formulated for the implementation of such interventions.

An issue related to sustainability of the planning process but not addressed in the TOR is the absence of an institutional framework for coastal zone management. Yet, without appropriate legislation and an organization to enforce it, all planning will come to naught if it is not clear where the responsibility lies for deciding what activities or interventions can be carried out along the coast of Bangladesh. Since this issue as such transcends the scope of the project (it per-

tains to more than just the MES plan area), the development of relevant institutional arrangements can indeed not be part of MES. However, it is strongly recommended to resolve this issue in the near future.

4.6.5 Sustaining project activities

In seeking ways to sustain the core project activities after conclusion of MES, institutional development in MES must focus on different organizations:

- WARPO is now responsible for macro planning, and will also coordinate FAP activities after the merger with FPCO. The project must establish a close working relationship with WARPO if it is to be successful in transferring its macro planning process to that organization.

- BWDB will continue to be responsible for micro planning, design, implementation, and coordination and supervision of O&M (for large-scale projects on/in the water and on land; LGED is responsible for small-scale projects on land). For subsidiary development of arrangements to align BWDB's micro planning procedures with the macro planning process, the relevant counterpart for MES is the Directorate for Land Accretion and Development (LAED).

- LAED's Surveys and Studies Division in Chittagong is responsible for data collection and processing. This activity has partly been dormant in the past five years and must now be re-activated.

- SWMC under the River Research Institute does surface water modelling.

Despite the fact that all these organizations are relevant for MES, the TOR mention only one counterpart organization, the LAED of the BWDB. However, with its micro planning and implementation orientation BWDB would play its most important role after the core (macro) planning process. Thus, it would appear that BWDB's role in MES is significantly overstated in the TOR.

4.6.6 Issues to be settled

In light of the above observations, a number of important issues need to be settled in detail for MES to be able to carry on convincingly:

- Project ownership
  As demonstrated above, the proper counterpart for the project would be WARPO. However, policy control and coordination of MES activities rest with the BWDB, which also controls the counterpart budget. Especially the latter may have a major impact on GoB support to be provided to the project. Therefore appropriate arrangements will have to be made to ensure that WARPO has access to adequate means to participate in and support MES in planning and establishing the planning process.

- Counterpart staff for training
  Establishing, nurturing, and sustaining the (macro) planning process requires a small number of staff assigned to MES on a nearly full-time basis to participate in the day-to-day work developing the Master Plan and the Land and Water Development Plan. They would thus become not only fully knowledgeable on these plans but also able to continually update them after project end. Since BWDB is not responsible for macro planning, establishing this process there would by definition be unsustainable.
  Therefore, the counterpart staff should come from WARPO. Agreement should be reached with WARPO and BWDB (and possibly also with the donors) on selection and secondment of the staff involved, and on the budget needed for their participation and training.

- Process vs. product
  The plans to be developed in MES are not expected to be definitive but must be continually updated in the on-going planning process to be established. According to the spirit of the TOR, the main thrust of the project is establishing and nurturing this process. However, the letter of the TOR bespeaks an end-product orientation, which is amplified by the inclusion of feasibility studies and small-scale interventions.
  Agreement should be reached on the process nature of MES and on how success or failure will be determined.

- Focus institutional development on the process
  The proposed emphasis on the planning process does not imply that MES should assume responsibility for institutional development of WARPO as a whole.
  Rather, arrangements should be made to closely coordinate MES activities with upcoming efforts to that purpose, supported by the World Bank. If those efforts are not to start within the next few months, MES would have to remain limited to training a small number of WARPO counterpart staff and developing procedural links between the macro and micro planning processes.

- Defer to CDSP for people's participation
  Since people's participation becomes particularly relevant during micro planning and implementation, institutional development in the context of feasibility studies will defer to approaches (to be) developed in CDSP.
  It should be agreed that MES will not become involved in institutional development at the field level, and will consider institutional aspects of implementation only insofar as relevant for planning purposes.

- Sustainability of data collection and processing
  The TOR prescribe an assessment and planning for development of the SSD in Chittagong. However, there is also reference to alternatives outside SSD in this regard.
  Hence, it may be agreed that the report on institutional development for data collection and processing will not exclusively focus on the SSD, but will include alternative options for continuing routine surveys and studies after conclusion of MES.
- Coastal zone management
  Proper arrangements for coastal zone management (legislation, enforcement) are of the highest importance for MES-developed plans to be effective in practice.
  However, because the relevance of this issue transcends the scope of MES, it may be agreed that the development of such arrangements is not a proper objective for MES. The project can, however, outline specific criteria for such arrangements from the perspective of the MES Master Plan.

5 ORGANISATION FOR IMPLEMENTATION

5.1 Project Organisation

The tender of consultancy services for the Meghna Estuary Study in Bangladesh was issued by the Directorate General (DGIS) of the Netherlands' Ministry of Foreign Affairs in April 1995.

The consultancy services have been awarded to the following group of Consultants:

DHV Consultants, Amersfoort, the Netherlands (lead consultant)
Kampsax International S/A, Copenhagen, Denmark
Danish Hydraulic Institute, Copenhagen, Denmark
Resource Analysis, Delft, the Netherlands
Development Design Consultants Ltd., Dhaka
Surface Water Modelling Centre, Dhaka and
Aqua Consultants and Associates Ltd., Dhaka

The Main Agreement was signed on 10 December 1995, the starting date of the services was agreed to be 1 November 1995.

The project will be implemented under a cooperation programme between the Governments of Bangladesh, The Netherlands and Denmark. The administrative agreement between the three governments was signed on 7 December 1995.

The executing agency on the Bangladeshi side is the Bangladesh Water Development Board (BWDB). According to the Terms of Reference (TOR) the coordination with the other projects under the Flood Action Plan (FAP) is to be done by the Flood Plan Coordination Organisation (FPCO) presently merged with Water Resources Planning Organization and known as WARPO.

The organigram for the Meghna Estuary Study project is shown in Figure 5.1

ORGANIGRAM FOR MES PROJECT

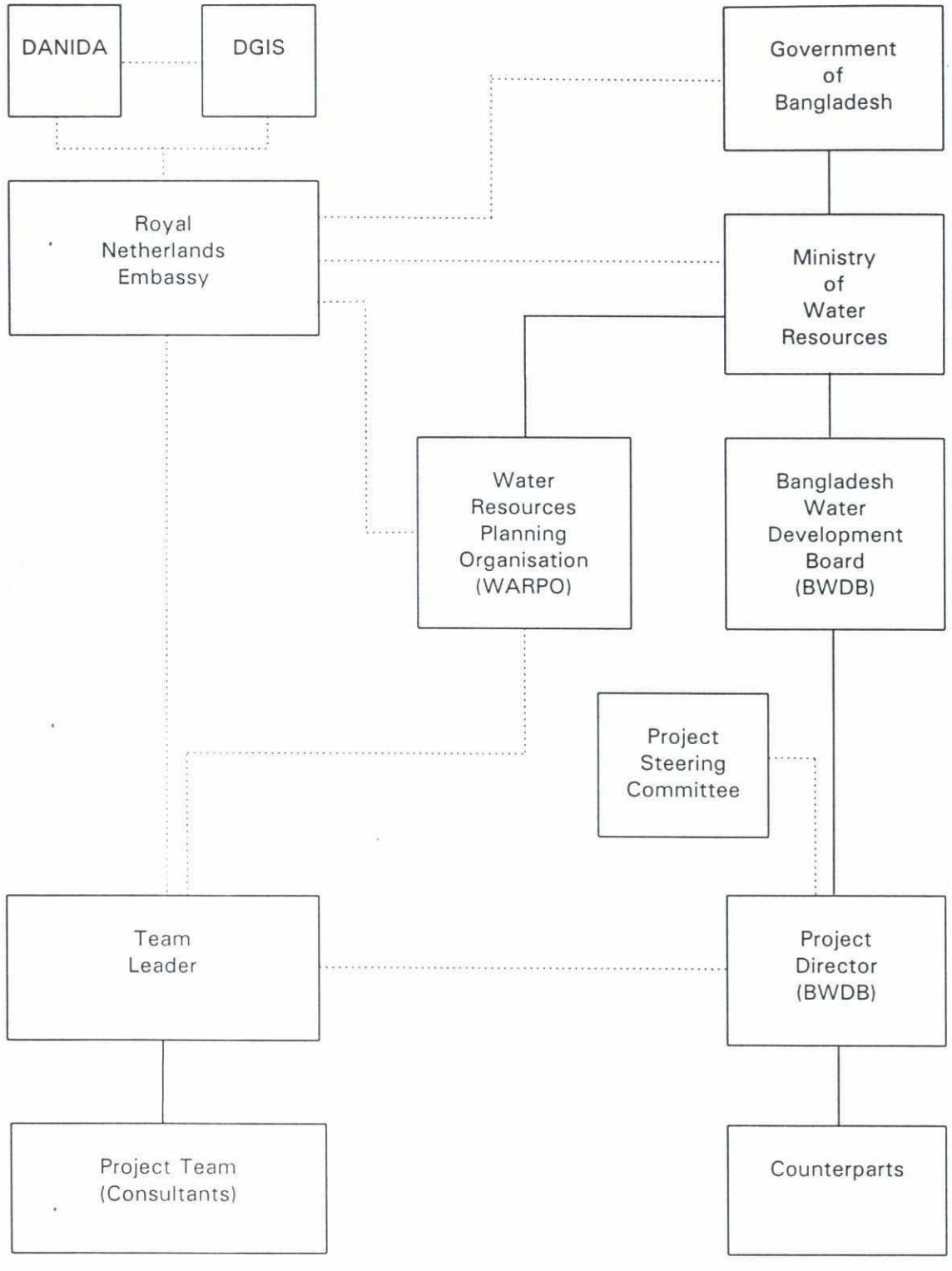


Figure 5.1 : Organigram Meghna Estuary Study

5.2 Project Staffing from BWDB

The following tables show the list of BWDB personnel on behalf of Government of Bangladesh:

A.	Directorate of Land accretion and Estuary Development, Dhaka		
Sl. No.	Description	TAPP Number	Actual [1] Number
1.	Superintending Engineer	1	1
2.	Executive Engineer	1	1
3.	Deputy Director(Absorbed)	1	
4.	Sub-divisional Engineer	2	2
5.	Accounts Officer	1	1
6.	Sub-Assistant Engineer	2	2
7.	Head Assistant	1	1
8.	Draftsman	1	1
9.	Stenographer	1	
10.	U.D.A.	1	1
11.	S.A.A.	2	1
12.	L.D.A.	2	2
13.	Typist	2	1
14.	Driver	1	1
15.	Gestetner Operator	1	1
16.	Guard	2	2
17.	M.L.S.S.	4	4
18.	Sweeper	1	1
	Sub-total of A	27	23

Note [1] Actual number as received from the office of the Project Director, LAED/MES

Table 5.1 Staffing Directorate of Land accretion and Estuary Development, Dhaka:

B.	Survey and Study Division, BWDB, Chittagong		
Sl. No.	Description	TAPP Number	Actual [2] Number
1.	Executive Engineer	1	1
2.	Deputy Director(Absorbed)	4	4
3.	Assistant Engineer	2	
4.	Divisional Accountant	1	
5.	Draftsman Grade I	1	1
6.	Sub-Assistant Engineer	1	
7.	Head clerk	1	1
8.	S.A.A.	2	1
9.	Steno-Typist	1	
10.	Clerk-cum-Typist	4	4
11.	Accounts Assistant	2	1
12.	Driver	3	2
13.	Store Keeper	1	1
14.	Blue Printer/Machine Oper.	1	
15.	Record Supplier	1	
16.	Guard	3	
17.	M.L.S.S/Peon	4	2
18.	Sweeper	1	1
19.	Orderly Peon	1	1
20.	Office Chowkider	1	
21.	Gardener	1	
	Sub-total of B	37	20

Note [2] Actual number as received from the office of the Executive Engineer, SSD/BWDB

Table 5.2 Staffing Survey and Study Division, BWDB, Chittagong

C.	Survey Vessel		
Sl. No.	Description	TAPP Number	Actual [2] Number
1.	Skipper	1	
2.	Engineer Grade "A"	1	
3.	Engineer Grade "B"	1	1
4.	Skipper Grade-II	1	
5.	Sub-Assistant Engineer	1	
6.	Sailor	6	4
7.	Greaser	2	1
8.	Daughter Vessel Driver	2	
9.	Cook (Cook-B)	1	1
10.	Lasker	2	1
11.	Jetty Guard	3	
12.	Assistant Cook	1	1
	Sub-total of C	22	9

Note [2] Actual number as received from the office of the Executive Engineer, SSD/BWDB

Table 5.3 Staffing Survey Vessel

D.	Measurement Sub-division		
Sl. No.	Description	TAPP Number	Actual [2] Number
1.	Sub-divisional Engineer	1	1
2.	Junior River Surveyor	8	3
3.	Clerk-Cum-Typist	1	
4.	Gauge Reader	4	1
5.	Survey Khalashi	4	3
6.	M.L.S.S/Peon	1	
7.	Guard	1	
	Sub-total of D	20	8

Note [2] Actual number as received from the office of the Executive Engineer, SSD/BWDB

Table 5.4 Staffing Measurement Sub-division

E.	Processing Sub-division		
Sl. No.	Description	TAPP Number	Actual [2] Number
1.	Sub-divisional Engineer	1	1
2.	Assistant Director	1	
3.	Tracer	1	
4.	Draftsman Grade-II	1	
5.	Clerk-cumTypist	1	
6.	M.L.S.S/Peon	1	
7.	Sweeper	1	1
	Sub-total of E	7	2

Note [2] Actual number as received from the office of the Executive Engineer, SSD/BWDB

Table 5.5 Staffing Processing Sub-division

F.	Laboratory Section		
Sl. No.	Description	TAPP Number	Actual [2] Number
1.	Assistant Director	1	
2.	Lab. Technician/Soil Tech.(Grade-C)	2	2
3.	M.L.S.S/Peon Sub-divisional Engineer	1	
	Sub-total of F	4	2

Note [2] Actual number as received from the office of the Executive Engineer, SSD/BWDB

Table 5.6 Staffing Laboratory Section

5.3 Staff mobilization Consultants

STATEMENT SHOWING THE LIST OF Consultants STAFF FOR MES PROJECT

A.	Expatriate Consultants of MES Project		
Sl. No.	Description	TAPP Man-months	Actual Man-months
1.	Project Director		
2.	Team Leader	30	28
3.	Hydraulic Engineer (Estuaries)	12	9
4.	Hydraulic Engineer (Reclamation/Closures)	10	6
5.	Coast/River Morphologist	14	9
6.	Chief Hydrographer	12	10
7.	Economist	10	8
8.	Water Management/Drainage Engr.	10	9
9.	Civil Engineer	18	7
10.	Rural Dev./Social Specialist	12	9
11.	Environmentalist	12	8
12.	Agronomist	7	5
12a.	Fisheries Specialist	3	3
12b.	Forestry Specialist	5	5
13.	Modelling Specialist	7	5
14.	Institutional Specialist	7	6
15.	Remote Sensing Specialist	[3]	2
16.	Special Adviser (as required)	3	2
17.	Instrument Specialist	[3]	3
	Sub-total of A	175	134

Note [3] These specialists have not been included in the TAPP and the TOR, however the Consultants included them in their Technical Proposal in order to be able to cover remote sensing as well as the use of hi-tech equipment for the survey operations.

Table 5.7 Staffing Expatriate Consultants of MES Project

B.	Local Consultants of MES Project		
Sl. No.	Description	TAPP Man-months	Actual Man-months
1.	Co-team Leader	32	32
2.	Hydraulic Engineer (Estuaries)	32	30
3.	Hydraulic Engineer (Reclamation/Closures)	32	30
4.	Morphologist	32	30
5.	Chief Hydrographer	24	22
6.	Economist	20	20
7.	Water Management/Drainage Engr.	32	28
8.	Civil Engineer	32	28
9.	Rural Dev./Social Specialist	25	27
10.	Environmentalist	14	14
11.	Agronomist	22	21
11a.	Fisheries Specialist	6	6
11b.	Forestry Specialist	12	12
12.	Modelling Specialist	22	28
13.	Institutional Specialist	12	12
14.	Remote Sensing Specialist	[4]	12
15.	Special Adviser (as required)	6	6
16.	Surveyors & Junior Specialists	150	150
	Sub-total of B	520	520

Note [4] These specialists have not been included in the TAPP and the TOR, however the Consultants included them in their Technical Proposal in order to be able to cover remote sensing.

Table 5.8 Staffing Local Consultants of MES Project

C.	Local contracts of MES Project [5]		
Sl. No.	Description	TAPP Man-months	Actual Man-months
1.	GIS specialist		30
2.	GIS/computer operator		27
3.	Skipper "Anwesha" (temporary contract)		6
4.	Survey crews		40
5.	EGIS (elaboration of existing map/satellite data)		7
	Sub-total of C		110

Note [5] These specialists/personnel have not been included in the TAPP and the TOR, however the Consultants included them during the Inception Phase of the project for various reasons.

Table 5.9 Staffing Local Contracts of MES Project

5.4 Office staff

The office of the Consultants is established at "AFROZA" House No.34, Road No. 25, Gulshan, Dhaka 1212. The office will be self sufficient and properly staffed. Table 5.10 showS the staff that has been recruited for the operation and maintenance of the office.

Office staff of MES Project			
Sl. No.	Description	TAPP Number	Actual Number
1.	Office Manger/Administrative Officer	1	1
2.	Accountant	1	1
3.	Secretary		1
4.	Typist/Word Processor	2	1
5.	Librarian/Word processor	6)	1
6.	Driver	3	3
7.	Messenger/peon	4	2
8.	Photocopy operator	6)	1
9.	Kitchen Assistant	6)	1
10.	Guard	6)	3
11.	Gardener	6)	1
	Sub-total of B	11	16

W A R. P. O. LIBRARY. DHAKA

Note [6] This office staff has not been included in the TAPP and the TOR, however the Consultants included them during the Inception Phase of the project for various reasons.

Table 5.10 Staffing Office of MES Project

5.5 Office facilities and vehicles

An office for the Consultants has been hired in Gulshan. It is a two storied building with floor area of about 500 m^2. This has been furnished with appropriate furniture.

The following facilities will be available in the office of the Consultants:

- telephone/fax
- computers and printers
- GIS hardware and software
- photocopy machine
- library/conference room
- map storage
- computer data storage
- training equipment

The details of the office equipment are shown in Table 5.11

Sl. No.	Type of Equipment	Number	Remarks
1	Computers	1	Office BWDB Dhaka
		1	Office BWDB/SSD Chittagong
		6	Office consultant Dhaka
2	Laser printer	1	Office BWDB Dhaka
		1	Office BWDB/SSD Chittagong
		2	Office consultant Dhaka
3	Color printer	1	Office consultant Dhaka
4	Plotter	1	Office BWDB/SSD Chittagong
5	Photocopier	1	Office BWDB Dhaka
		1	Office BWDB/SSD Chittagong
		2	Office consultant Dhaka
6	Air conditioners	1	Office BWDB Dhaka
		11	Office consultant Dhaka
7	Fax	1	Office Consultant Dhaka
8	Telephone set	6	Office Consultant Dhaka
9	Fan	2	Office BWDB Dhaka
		2	Office consultant Dhaka
10	Stabilizer	2	Office BWDB Dhaka
		2	Office BWDB/SSD Chittagong
		5	Office consultant Dhaka
11	UPS	1	Office BWDB Dhaka
		1	Office BWDB/SSD Chittagong
		4	Office consultant Dhaka
12	Digitising table	1	Office consultant Dhaka
13	Optical media for data storage	1	Office consultant Dhaka

Table 5.11 : List of office equipment

The following vehicles were available for transportation of the Consultants in Dhaka and for field trips on 15 April 1996:

1. One Rocky Jeep - Borrowed from Royal Netherlands Embassy
2. One Nissan Landcruiser - Borrowed from Royal Netherlands Embassy
3. One Toyota Microbus - Leased for transport in Dhaka

As per approved TAPP the following vehicles will be imported for the project, only for these vehicles CDST will be paid by the Government:

1. Two Toyota Landcruisers – For BWDB Dhaka
2. Three Toyota Landcruisers – For the Consultants
3. One Toyota Pick-up – For BWDB Chittagong

As per Consultants' Main Agreement the transport requirements for the Project are as follows:

1. One sedan type car
2. Two minibus
3. Two jeeps

The Consultants proposed to import six vehicles, as specified in the TAPP, instead of the vehicles mentioned in the Main Agreement.

However the three 4WD vehicles, allocated to the Consultants, are not adequate to cover their transport requirements. Therefore one microbus has been leased already for the duration of the project and it has been agreed that the Rocky jeep of the Royal Netherlands Embassy can be borrowed until the end of the project.

5.6 ANWESHA and tender boats

The marine survey activities under LRP have been carried out by the `Anwesha' which was the main survey vessel of LRP stationed in Chittagong. Today, the vessel is operated by BWDB/SSD, it will also be used for the MES survey activities. The main specifications of the vessel are indicated in Table 5.12.

Anwesha	Built (Akerboom, Leiden, Holland)		1980
	Length		32 m
	Beam		7 m
	Draft (summer mark)		1.9 m
	Speed	Maximum	10 knots
		Steaming	8 knots
	Tank capacity	fresh water	22,000 l
		fuel	36,000 l
	Power Supply (2x85 kW + 20 kW)		440/220 V AC
	B.H.P.		720
Two tender boats	Length		7 m
	Draft		0.7 m
	Speed (maximum at delivery)		20 knots

Source: 'Holland Shipbuilding', May 1980, pp. 36 - 37

Table 5.12 Key specifications of 'Anwesha' and tender boats

From May 1980 to 1991, 'Anwesha' was in operation for some 50 percent of the time, the remaining time being spent on bunkering, scheduled and unscheduled repair and maintenance, weather downtime, holidays, and unrelated activities. The vessel was docked once per year for routine inspection and maintenance, and also, on several occasions, for major repairs due to accidental damage to the hull or to the propulsion system. Typical reasons for such damage was

hitting the seabed, and getting the propeller entangled with fishing nets (to which the vessel is reportedly particularly sensitive, 'LRP, Final Report', p. 32-34). In addition to the LRP field programme, which ended in 1991, the vessel has been used for minor surveys for FAP1 (1990-91) and FAP24 (1992).

In 1990, an appraisal mission made the following observations on working conditions in the project area: (Westdijk and Mol, draft, undated):

- travelling distances are enormous
- accessibility is often difficult and sometimes impossible
- local currents are sometimes dangerous according to Dutch standards
- unpredictable and dangerous tidal bores occur in the area
  On one occasion a tidal bore caused the loss of one tender boat

The Technical Assistance budget includes provisions Operation & Maintenance of the M.V. Aneshwa, Tender Boats and other small boats (Rubber boats) for the duration of the Meghna Estuary Study. These survey vessels will be equipped with new and sophisticated equipment as a part of the Technical Assistance program. The details of the new survey equipment is given in Section 5.7.

The vessels are presently (April 1996) at the dock yard in Naryanganj. The major overhaul was completed by Mid March 1996. After a successful trial run in the presence of the Adviser of the Royal Netherlands Embassy, the ship has been cleared survey work in the Estuary. The overhaul of the Tender boats is expected to be completed shortly.
A well for the ADCP has been installed in the ship after permission was obtained from the Loyds' agent.

The "Anwesha" will remain in Naryanganj until the new survey equipment has been installed on board the ship.

A proposal with cost estimates has been received from BWDB for lengthening of the jetty connecting the landing pontoon for "Anwesha" in Chittagong to the shore.
The adjustment of jetty is required because of shoaling along the river bank. In addition repairs and painting of the steel parts is required to prevent further deterioration of these facilities.

5.7 . Survey equipment

The survey equipment that has been purchased for the project is indicated in the following table:

Table 5.13 Detailed list of survey equipment

Type of equipment	Number units	Brief details	Remarks
Positioning equipment	4 4	Trimble RTK GOS receivers type 7400MSI, including antenna and cables.(3 mobiles & 1 reference station) UHF Radio link type Radtel including antenna and cable	This equipment is mobilized for the Anwesha,tender boats and reference station operation. The system includes the latest RTK-OTF technology.
Gyro/conpass	1	Gyro compass Tokimec GM 20, RGC signal interface (Anwesha)	Magnetic variations occur within the project area while the ship has unknown deviation in its magnetic compass. Therefore for the determination of true north at different sites in the area, assistance of a gyrocompass is essential.
Auto-pilot	1	Radio Zeeland Delta 510 and F.O stick Delta 600	The auto-pilot is required to keep the ship on course as accurately as possible
Echosounders	1 2	Echosounders duel frequency 30/200 khz,type Atlas Deso 15 or similar including transducers (M/V Anwesha) Echosounder single frequency 200 khz,type Atlas Deso 14 or similar,includingtransducers (tender boats)	A duel frequency echosounder has been included in the equipment list to obtain a proper signal where single frequency equipment fails for muddy conditions of the bed
M/V Anwesha Computer & navigation, datalogging hardware	3 1 2 1 2 Lot	PCs A3 plotter Helmsman display Tape streamer Printer Racks cables etc.	This equipment is required for on-line processing of data from the positioning system and the echosounder on the Anwesha
Tender boats Computer & Navigation, datalogging hardware	2 2 2 2 Lot	PC's portable Tape streamer Helmsman display Printer Racks, cables etc.	This equipment is required for on-line processing of data from the positioning system and the echosounder on the tender boats

Type of equipment	Number units	Brief details	Remarks
Rubber boat with out board engine	1 1 1	Sillinger 490 RIB PRO, V-shape, fibreglass, cloth 1660 DTX 60 HPMercury Water Jet Engine Steering Console and cables for remote control	An 8 - seater rubber boat suitable for use in the Meghna Estuary.
Software	1 1	Hydro software package incl.3 dongles (Anwesha and 2 tender boats) HydroACQ software (Anwesha)	This software is required for on-line processing of data from the position equipment, the gyro - compass and the echosounders
Acoustic Doppler Current Profiles:	1	ADCP, 600 Khz B.B.D.R (Anwesha)	The ADCP will measure the current velocities between the bottom of the ship and the bed of the river/bay
Communication equipment:	2 2	Safecom transceivers & PC/printers (Anwesha,Dhaka) VHF, radio SP ,25 Watt (tender boats)	The safecom system is required for reliable and undisturbed satellite communication between the Anwesha and Dhaka. The transceiver (VHF) will be installed in the office of BWDB/SSD in Chittagong
Power supply units (UPS)	1 2	Stabilized power unit including battery charger, inventer & batteries (Anwesha) Power supply units AC/DC convertor & batteries (tender boats)	The uninterrupted Power Supply (UPS) is required to avoid loss of data in computer when the A/C generator of the tender boats stops suddenly
Self Recording Current Meter	1	Current meter type InterOcean S4 P (including T,C,P and tilt sensors)	This propeller current meter will continuously record the changing tidal velocities. These data will be required as reference for the current measurements by ADCP

Table 5.13 Detailed list of survey equipment (continued)

Table 5.13 Detailed list of survey equipment (continued)

Type of equipment	Number units	Brief details	Remarks
Sediment equipment:	1 3 1	Owen samplers (SK110) Integrated bottle sampler Winch including Grundfos pump and umbilical	This equipment will replace the old equipment on board the "Anwesha"
Tide/Wave Recorders	7 3	Tide/Wave recorders, type Van Essen Air pressure recorders, type Van Essen Diver	The Tide/Wave gauge, electronics and battery (life 10 years) are integrated in a single Titanium housing. The recorder can be easily programmed and data can be read out directly into a standard portable computer.The Tide/Wave gauge will be installed below water level and sufficiently above the bed to avoid loss of equipment or data by deposition of sediment. Three 'Diver' units will be installed on land to record the changes in air pressure. These data wil be used to calculate the actual water level from the water pressure.
Temp./cond. P·ofiler	2	WTW T/C meter	This equipment will replace the old equipment on board the "Anwesha"
Sediment lab:	1 1 1 1 500 50 100 2	Drying killn and desiccator (already available) Sieving machine with sieves Balance Mettler AE200 Vacuum pump complete with hose Glassware & filters 0.5 liter bottles 25 l container for water samples 1 l bottles Andreasen settling tube	This equipment will replace the old equipment in the BWDB/SSD laboratory in Chittagong
Service tools & miscellaneous equipment:	2 lot lot	Tool set, incl. scopemeter, Fluke multim., hand tools etc. Service PC etc. Miscellaneous equipment	Required in the BWDB/SSD laboratory in Chittagong
Spare parts	lot		

2 DD

6 PROJECT IMPLEMENTATION PLAN

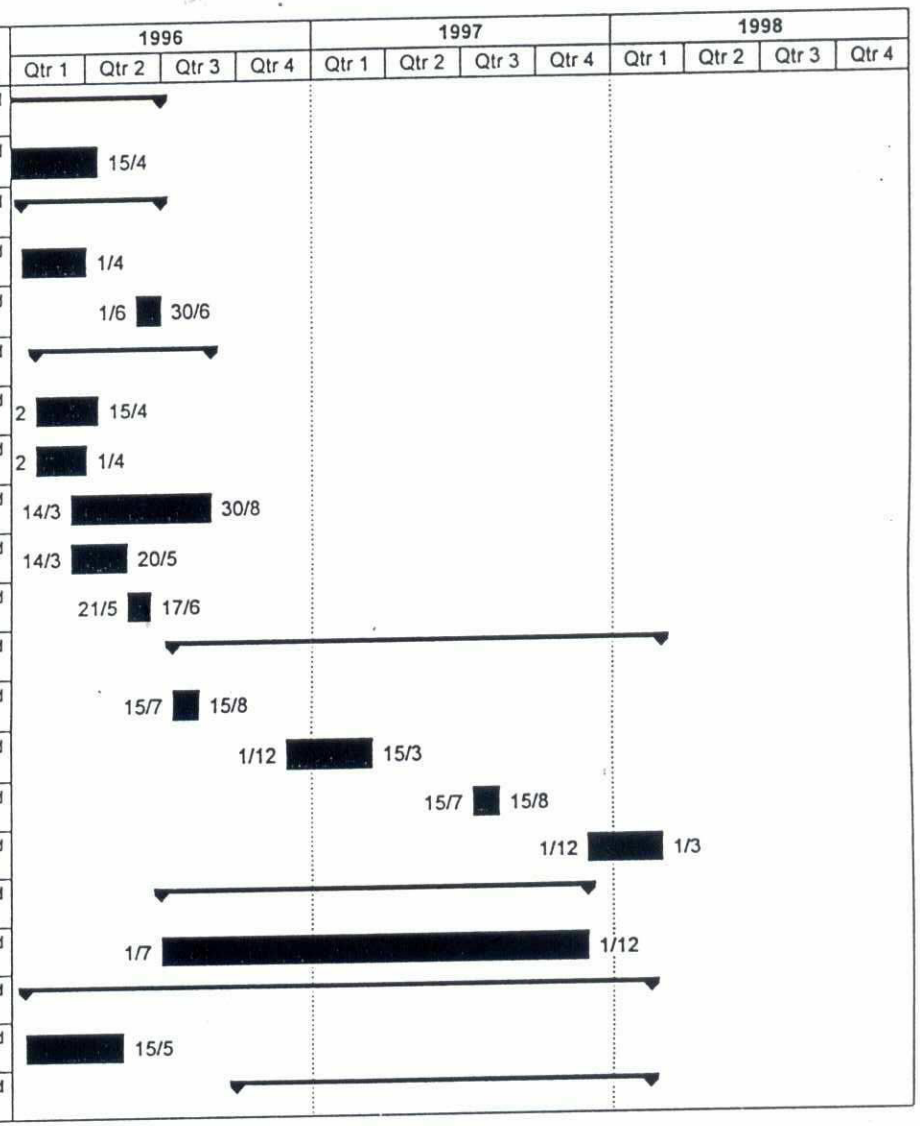
The Project Implementation Plan is provided in the form Gantt charts for the different disciplines that will contribute to the Meghna Estuary Study.
The Gantt charts will be used for day-to-day management of the implementation of the project and to keep track of progress of each project component.

The following Gantt charts have been prepared:

Chart 6.1 : Morphology and Hydraulics
Chart 6.2 : Civil Engineering and Reclamation
Chart 6.3 : Water Management and Drainage
Chart 6.4 : Rural Development and Socio-Economic Aspects
Chart 6.5 : Agricultural Aspects
Chart 6.6 : Fisheries Aspects
Chart 6.7 : Forestry Aspects
Chart 6.8 : Environmental Aspects
Chart 6.9 : Economic Aspects
Chart 6.10 : Remote Sensing and GIS
Chart 6.11 : Institutional Development
Chart.6.12 : Expatriate Technical Staff
Chart 6.13 : Local Technical Staff
Chart 6.14 : Reporting Schedule

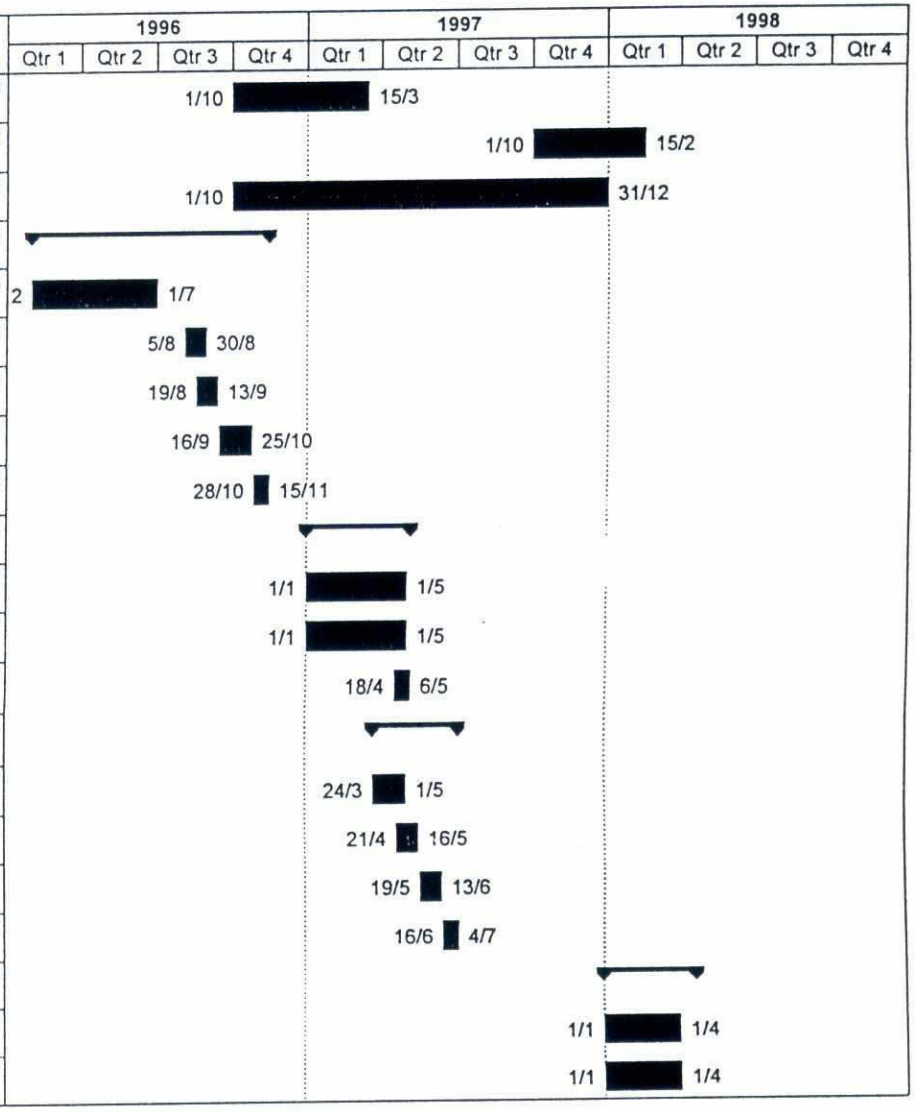
MEGHNA ESTUARY STUDY
Gantt Chart Estuary Hydrodynamics and Morphology

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	243d
2	1.1 Detailed planning of surveys and studies	167d
3	1.2 Procurement and installation of survey instruments	168d
4	1.2.1 Procurement of survey instruments	78d
5	1.2.2 Installation of survey instruments	30d
6	2 INVENTORY AND PREPARATION OF PRESENT DATA	212d
7	2.1 Inventory of available data	75d
8	2.2 Review of relevant morph. studies & reports	61d
9	2.3 Digitize bathymetric maps & shorelines	170d
10	2.4 Set-up of reliable datablase system & update	68d
11	2.5 Prepare data inventory report (as part of inventory report)	28d
12	3 SURVEYS BY ANWESHA	595d
13	3.1 Monsoon season 1996, survey 1	32d
14	3.2 Dry season 1996/1997, survey 2	105d
15	3.3 Monsoon season 1997, survey 3	32d
16	3.4 Dry season 1997/1998, survey 4	91d
17	4 WAVES AND WATER LEVELS	519d
18	4.1 Wave and water level registartions	519d
19	5 LAND BASED SURVEYS	759d
20	5.1 Reference bench marks	118d
21	5.2 Coastline and coastline gradients, elevantion contours of shallow areas	503d



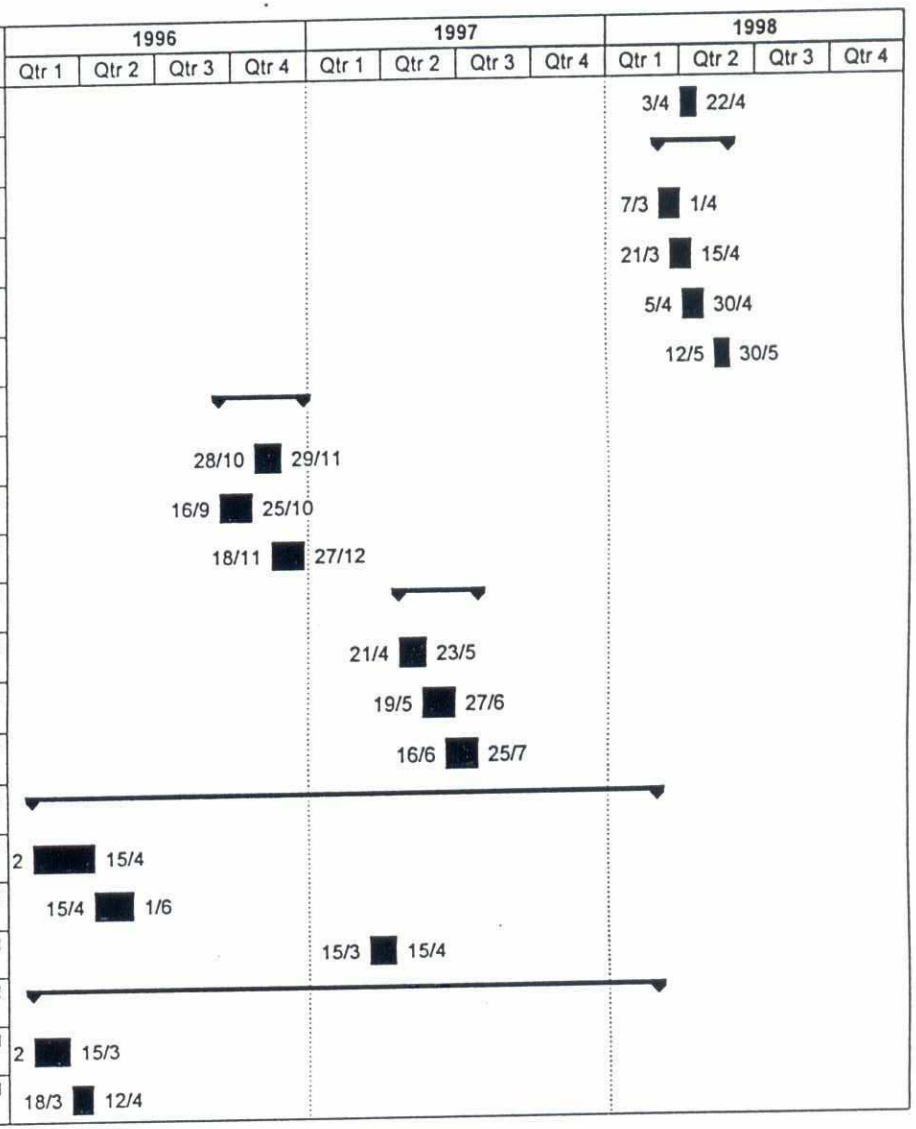
MEGHNA ESTUARY STUDY
Gantt Chart Estuary Hydrodynamics and Morphology

ID	Task Name	Duration
22	5.2.1 Survey of 1996/1997	166d
23	5.2.2 Survey of 1997/198	138d
24	5.3 Supplementary mapping of land elevantions	457d
25	6 DATA PROCESSING AND ANALYSIS OF HYDRO. AND MORPHOL. DATA	289d
26	6.1 Numerical model set-up	152d
27	6.2 selection & data processing of field data	26d
28	6.3 First results morphological changes of the shoreline	26d
29	6.4 Parametrisation of morphometric data	40d
30	6.5 Morphol. data at site specific areas	19d
31	7 FIELD SURVEY DATA AND DATABASE WITH DATA OF 1996/1997	126d
32	7.1 Digitize bathymetric data & remote sensing data field survey 1 and 2	121d
33	7.2 Updating of the database (field survey 1 and 2)	121d
34	7.3 Updating of inventory report (field survey 1 and 2)	19d
35	8 DATA PROCESSING AND ANALYSIS WITH DATA OF 1996/1997	103d
36	8.1 Update of selection and processing of field data, survey 1 and 2	39d
37	8.2 Update of the results morphological changes of the shoreline	26d
38	8.3 Update parametrisation of morphometric data	26d
39	8.4 Morph. data at site specific areas	19d
40	9 FIELD SURVEY DATA AND DATABASE WITH DATA OF 1997/1998	112d
41	9.1 Digitize bathymetric data & remote sensing data field survey 3 and 4	91d
42	9.2 Updating of the database (field survey 3 and 4)	91d



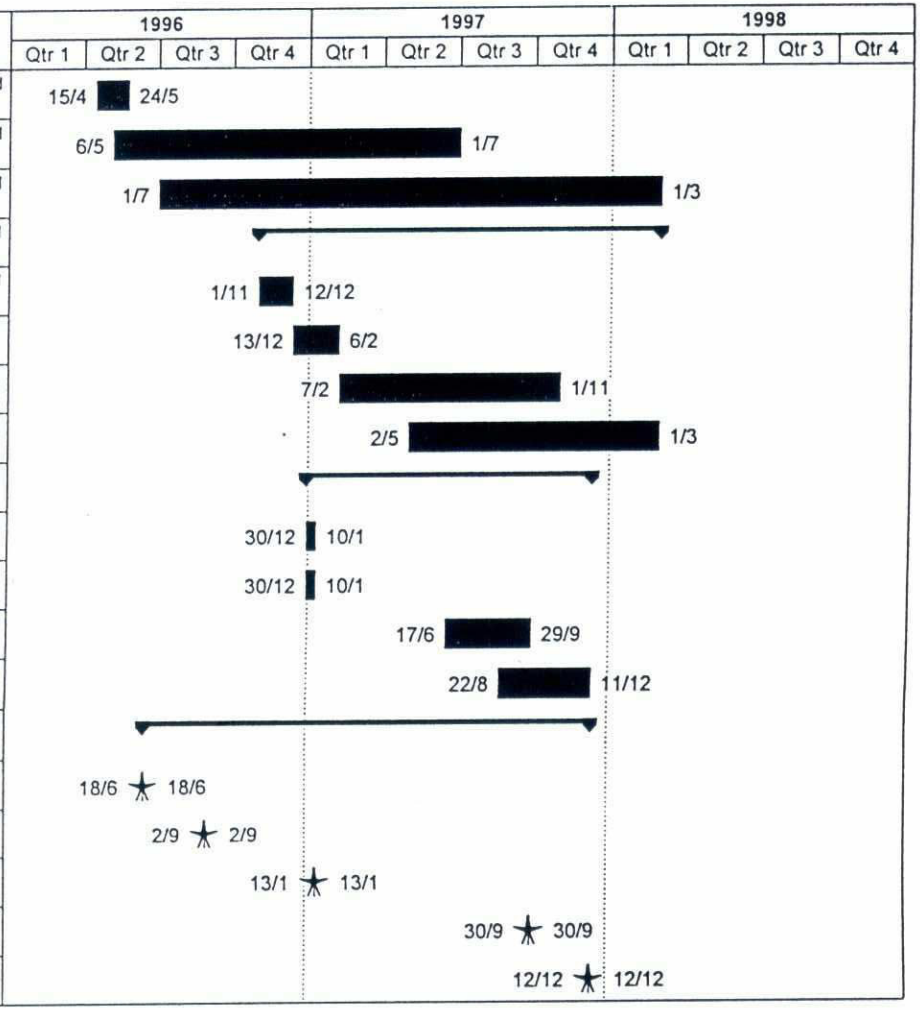
MEGHNA ESTUARY STUDY
Gantt Chart Estuary Hydrodynamics and Morphology

ID	Task Name	Duration
43	9.3 Updating of inventory report (field survey 3 and 4)	20d
44	10 DATA PROCESSING AND ANALYSIS WITH DATA OF 1997/1998	85d
45	10.1 Update of selection and process. of data, survey 3 and 4 incl. sediment analysis	26d
46	10.2 Update of the results morph. changes of the shoreline	26d
47	10.3 Update parametrisation of morphometric data	26d
48	10.4 Morpho. data at site specific areas	19d
49	11 EMPERICAL I/D RELATIONSHIPS AND MORPHOLOGICAL ADAPTION PROCESS	103d
50	11.1 Investigate & determine equil. relationships	33d
51	11.2 Investigate & determine the shoreline & channel stability	40d
52	11.3 Investigate & determine morph. response to input conditions	40d
53	12 UPDATE OF EMPERICAL I/O RELATIONSHIPS	96d
54	12.1 Investigate & determine equil. relationships	33d
55	12.2 Investigate & determine the shoreline & channel stability	40d
56	12.3 Investigate & determine morph. response to input conditions	40d
57	13 NUMERICAL MODELLING ON REGIONAL AND LOCAL SCALE	760d
58	13.1 Review of existing data	75d
59	13.2 Basic assessment of states and processes	48d
60	13.3 Selection of baseline conditions	32d
61	13.4 Numerical modelling on regional scale	760d
62	13.4.1 Hydraulic model set-up	44d
63	13.4.2 Selection & composition of model components	26d



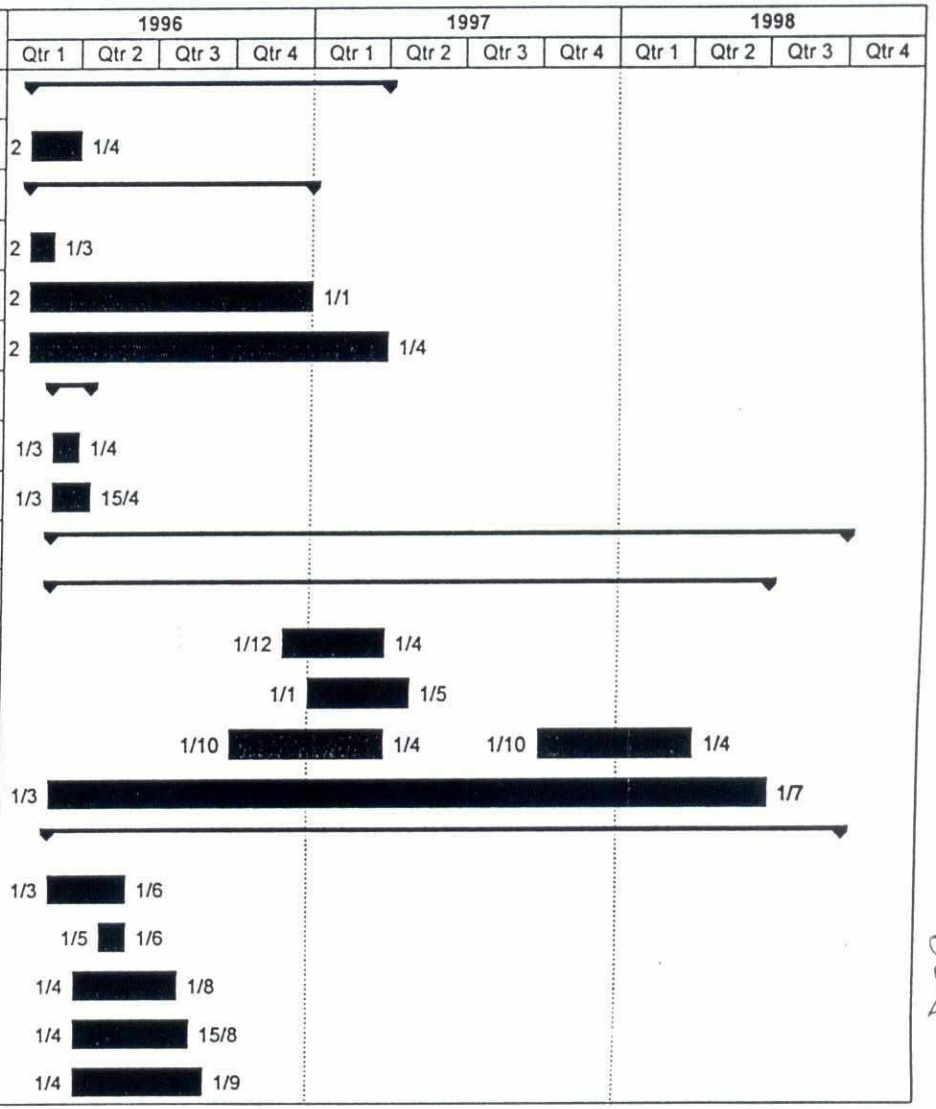
MEGHNA ESTUARY STUDY
Gantt Chart Estuary Hydrodynamics and Morphology

ID	Task Name	Duration
64	13.4.3 Model calibration	40d
65	13.4.4 Production of hydraulic & waves conditions	422d
66	13.4.5 Analysis of model results	609d
67	13.5 Numerical modelling on local scale	486d
68	13.5.1 Hydraulic model set-up	42d
69	13.5.2 Model calibration	56d
70	13.5.3 Production of hydraulic & waves conditions	268d
71	13.5.4 Analysis of model results	304d
72	14 MORPHOLOGICAL EVOLUTION AND POTENTIAL LAND RECLAMATION AREAS	347d
73	14.1 Identification of morph. changes & dominant phys. processes in Meghna estuary	12d
74	14.2 Identification & classification of potential land reclamation areas	12d
75	14.3 Morphological studies (feasibility studies)	105d
76	14.4 Prediction of morphological development	112d
77	15 RESULTS OF MORPHOLOGICAL IMPACT STUDIES	543d
78	15.1 An inventory of available and relevant morphological & hydrological data	1d
79	15.2 A reliable data system containing available and relevant morphol. & hydr. data	1d
80	15.3 Identification & priority ranking of potential land reclamation areas	1d
81	15.4 Identification of the morph. development and processes in feasibility studies	1d
82	15.5 An intial assessment of the overall morphological development	1d



MEGHNA ESTUARY STUDY
Gantt Chart Civil Engineering and Reclamation

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	426d
2	1.1 Review and assess existing reports, data, etc. from LRP and FAP	61d
3	1.2 Study relevant ongoing activities in Meghna Estuary and elsewhere	336d
4	1.2.1 Establish liaisons with CDSP and other relevant project (i.a. FAP)	30d
5	1.2.2 Examine, assess on-going and pipeline studies and projects	336d
6	1.3 Pay field visit to familliarise with project area and civil engineering aspects	426d
7	1.4 Contribute to Inception Report	46d
8	1.4.1 Prepare Project Implementation Plan	32d
9	1.4.2 Prepare contributions to Inception Report concerning civil eng. and reclamatio	46d
10	2 SURVEY AND STUDIES	945d
11	2.1 Study primary and secondary protection systems	853d
12	2.1.1 Carry out surveys and studies of existing protection systems	122d
13	2.1.2 Assess requirements for protection of pop., prop. and sustained agri. develop	121d
14	2.1.3 Carry out visual surveys of morophological changes	548d
17	2.1.4 Study, evaluate survey results, satellite imagery and other relevant information	853d
18	2.2 Small scale Intervention 1: Low cost measures enhancing accretion	944d
19	2.2.1 Study, evaluate such measures applied in Bangladesh and elsewhere	93d
20	2.2.2 Select low cost methods probably effective, adapt them to estuary conditions	32d
21	2.2.3 Locate areas for accretion enhancing trials	123d
22	2.2.4 Prepare outline designs, work methods, cost estimates for accretion works	137d
23	2.2.5 Discuss trials with BWDB and local authorities	154d



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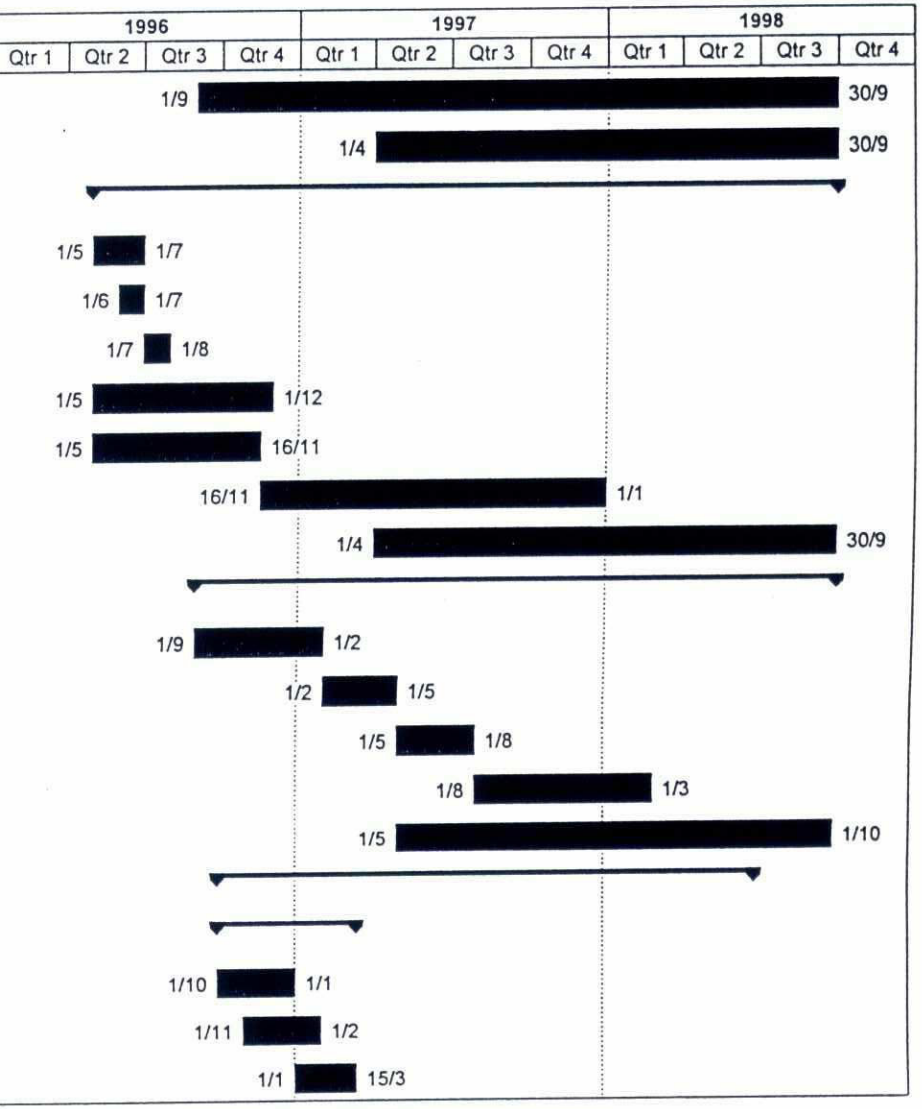
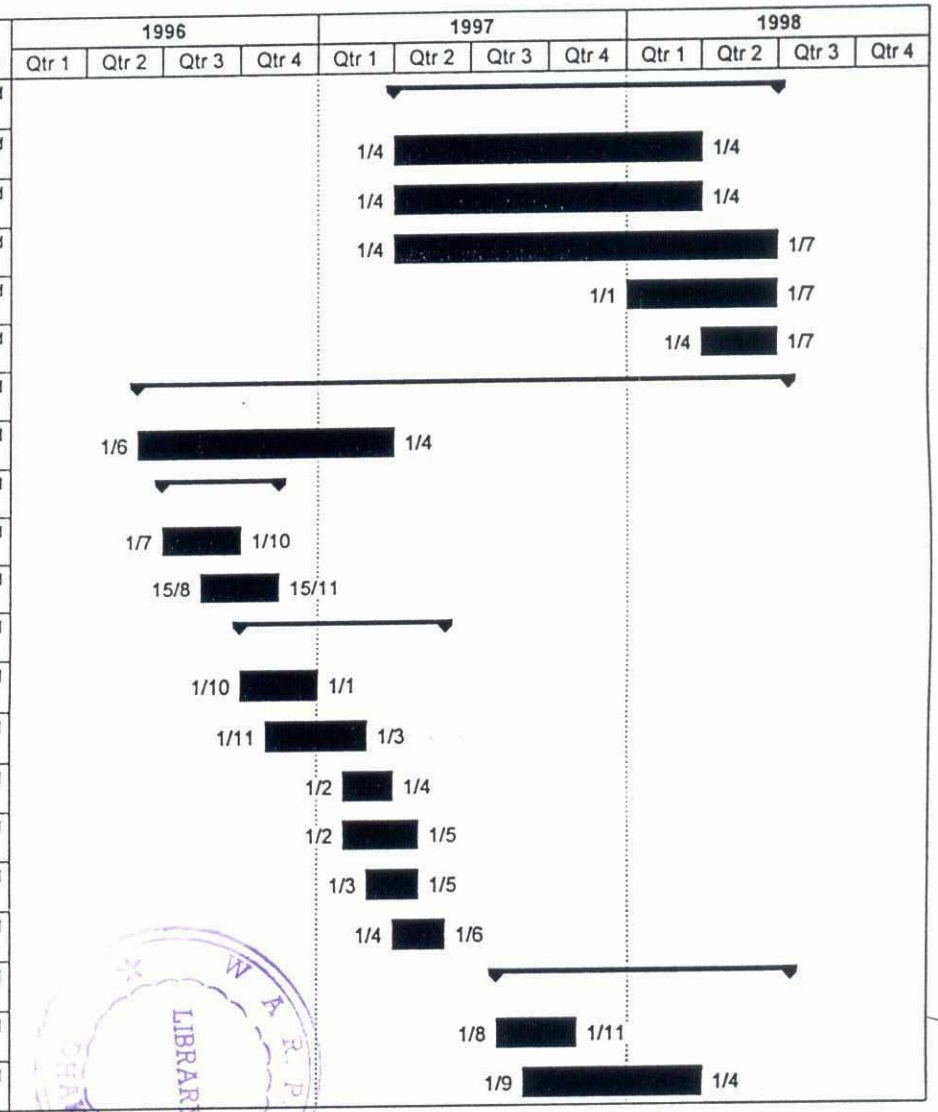
MEGHNA ESTUARY STUDY
Gantt Chart Civil Engineering and Reclamation

ID	Task Name	Duration
24	2.2.6 Advise BWDB during preparation, implementation & maintenance of works.	760d
25	2.2.7 Monitor effectiveness of accretion enhancement trails	548d
26	2.3 Small scale Interventions 2: Low cost measures to reduce or check erosion	883d
27	2.3.1 Study, evaluate such measures applied in Bangladesh and elsewhere	62d
28	2.3.2 Select low cost methods probably effective, adapt them to estuary conditions	31d
29	2.3.3 Locate areas for erosion reduction trials	32d
30	2.3.4 Prepare outline designs, work methods, cost estimates for erosion reduction w	215d
31	2.3.5 Discuss trials with BWDB and local atuhorities	200d
32	2.3.6 Advise BWDB during preparation & implementation of works	412d
33	2.3.7 Monitor effectiveness of erosion reduction trials	548d
34	2.4 Small scale Interventions 3: Low cost methods to build cross-dams	761d
35	2.4.1 Study, evaluate low cost methods to implement cross-dams	154d
36	2.4.2 Prepare designs, work methods, cost estimates for works	90d
37	2.4.3 Discuss methods with BWDB and local authorities	93d
38	2.4.4 Assist BWDB during implementation of works	213d
39	2.4.5 Monitor effectiveness of repair works	519d
40	3 MASTER PLAN ACTIVITIES	639d
41	3.1 Contribute to Interim Master Plan	166d
42	3.1.1 Study and establish potential measures for land protection	93d
43	3.1.2 Study and establish potential measures for reclamation	93d
44	3.1.3 Prepare planning criteria	74d



MEGHNA ESTUARY STUDY
Gantt Chart Civil Engineering and Reclamation

ID	Task Name	Duration
45	3.2 Contribute to preparation of Master Plan	457d
46	3.2.1 Study, evaluate processes of accretion and erosion	366d
47	3.2.2 Describe hydrological, hydraulic criteria for planning protection systems	366d
48	3.2.3 Study assess, describe methods and potential for land reclamation	457d
49	3.2.4 Study evaluate describe environmental effects on physical estuary developme	182d
50	3.2.5 Assist in preparation of long term plan for estuary	92d
51	4 DEVELOPMENT PLAN ACTIVITIES	775d
52	4.1 Collection data, carry out surveys to establish existing state of dev. on island	305d
53	4.2 Assess various strategies and options	138d
54	4.2.1 Assess various strategies and options for flood/cyclone protection	93d
55	4.2.2 Assess various strategies and options for reclamation, dev. of portected areas	93d
56	4.3 Contribute to Interim Development Plan	244d
57	4.3.1 Identification of projects and prelim. priorities for prim. and sec. protection syst	93d
58	4.3.2 Identification of projects and preliminary priorities for dev. of protected area	121d
59	4.3.3 Identification projects and preliminary priorities for non-structural systems	60d
60	4.3.4 Provisional assessment of economic and financial viability	90d
61	4.3.5 Provisional assessment of social and environmental impact	62d
62	4.3.6 Formulation of priority projects and programmes for feasibility stage	62d
63	4.4 Contribute to the Development Plan	349d
64	4.4.1 Review and discussions with concerned agencies	93d
65	4.4.2 Update etc. of relevant surveys and studies by other projects	213d



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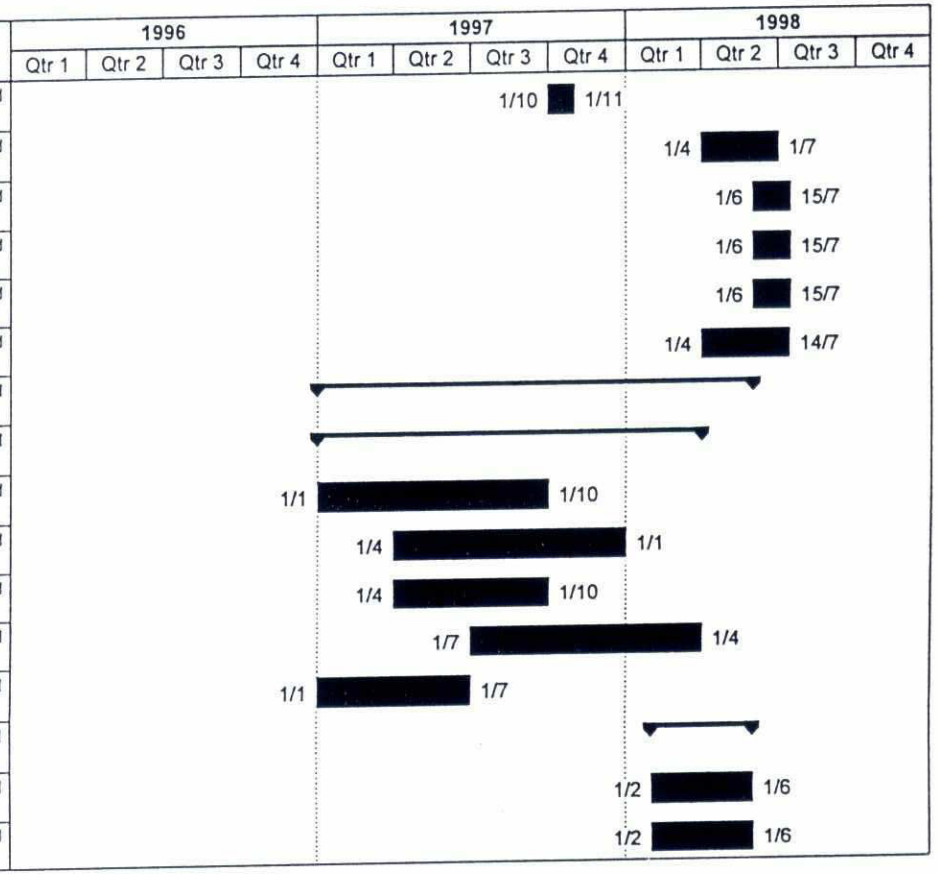
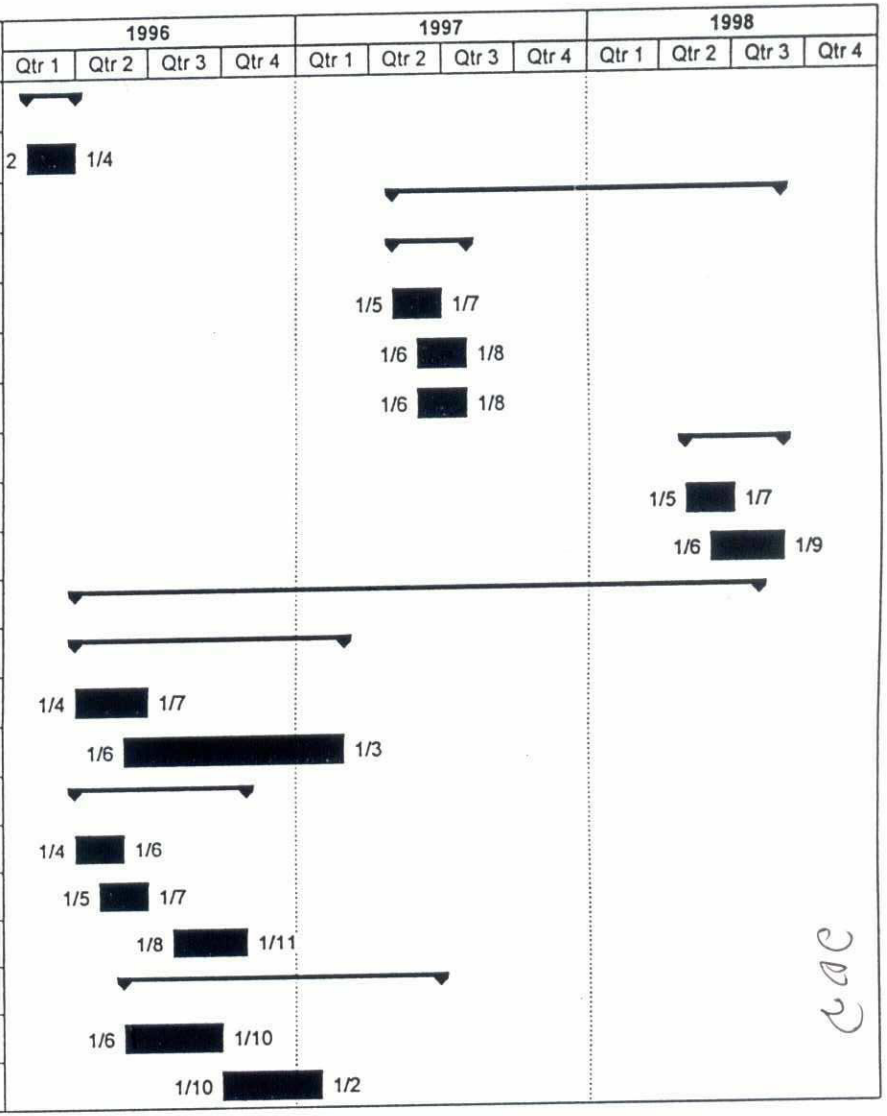
MEGHNA ESTUARY STUDY
Gantt Chart Civil Engineering and Reclamation

ID	Task Name	Duration
66	4.4.3 Confirmation, revision of IDP components	32d
67	4.4.4 Economic, social, environmental impact analyses at prefeasibility level	92d
68	4.4.5 Identification for first stage projects for Phased Development Plan	45d
69	4.4.6 Financial requirements for Phased Development Plan	45d
70	4.4.7 Institutional recommendations for Phased Development Plan	45d
71	4.4.8 Draft project formulations and TOR of first stage projects	105d
72	5 CONTRIBUTE TO PREPARATION OF PRIORITY PROJECTS	517d
73	5.1 Carry out Priority Project and Programme Preparation	456d
74	5.1.1 Reassessment of South Hatia/Nijum Dwip feasibility study	274d
75	5.1.2 Reassessment of Sandwip cross-dam feasibility study	276d
76	5.1.3 Pre-feasibility studies of possible priority projects	184d
77	5.1.4 Feasibility study of most potential priority projects	275d
78	5.2 Carry out programme preparation for non-structural measures	182d
79	5.3 Contribute to Project/programme report	121d
80	5.3.1 Prepare draft concept papers and project proformas	121d
81	5.3.2 Incorporate recommendations of Review Committee	121d



MEGHNA ESTUARY STUDY
Gantt Chart Water Management and Drainage

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	61d
2	1.1 Review and assess existing reports, data, etc. from LRP FAP	61d
3	2 MASTER PLAN	489d
4	2.1 Contribute to an Interim Master Plan	93d
5	2.1.1 Description of possible interventions related to drainage and water management	62d
6	2.1.2 Contribution to outlines of possible projects for the first 5 years after the study	62d
7	2.1.3 Participation in a pre-feasibility study	62d
8	2.2 Contribute to draft Master Plan	124d
9	2.2.1 Full description of interventions related to drainage and water management	62d
10	2.2.2 Comprehensive description of possible projects for the first 5 years after the study	93d
11	3 LAND AND WATR USE DEVELOPMENT PLAN	853d
12	3.1 Collect existing data of the study area	335d
13	3.1.1 Collection of existing data	92d
14	3.1.2 Make periodical visits to the estuary for orientation and collection of field data	274d
15	3.2 Review of water management and drainage projects and studies	215d
16	3.2.1 Inventory of relevant projects and studies	62d
17	3.2.2 Field visits of selected project such as CDSP, CPP and CRP	62d
18	3.2.3 Preparation of Technical Notes on relevant project and study findings	93d
19	3.3 Field Investigations and studies of protected and unprot. areas	395d
20	3.3.1 Design and preparation of field investigations and studies	123d
21	3.3.2 Field investigations to assess the existing situation	124d



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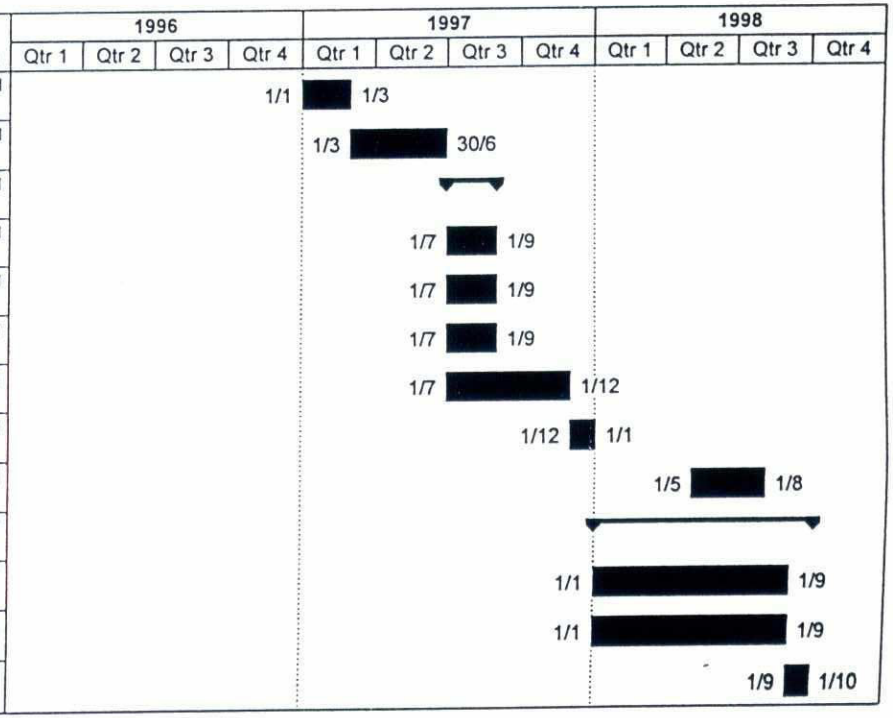
MEGHNA ESTUARY STUDY
Gantt Chart Water Management and Drainage

ID	Task Name	Duration
22	3.3.3 Preparation of Technical Notes on findings of investigations and studies	60d
23	3.3.4 Prep. of Tech. Reports on water management and drainage in the Est.	122d
24	3.4 Assess alternative strategies for development of protected areas	63d
25	3.4.1 Define scope and options for drainage improvement of protected area	63d
26	3.4.2 Define scope and options for improved water man. in protected area	63d
27	3.4.3 Contribute to specification of objectives and criteria for plan formulation	63d
28	3.5 Contribute to the development of models for protected areas	154d
29	3.6 Contribute to the preparation of an Interim Development Plan	32d
30	3.7 Contribute to draft Development Plan	93d
31	4 PRIORITY PROJECTS AND PROGRAMMES	274d
32	4.1 Contribute to project preparation at feasibility level	244d
33	4.2 Contribute to program preparation	244d
34	4.3 Contribute to draft Project and Program Preparation Report	31d



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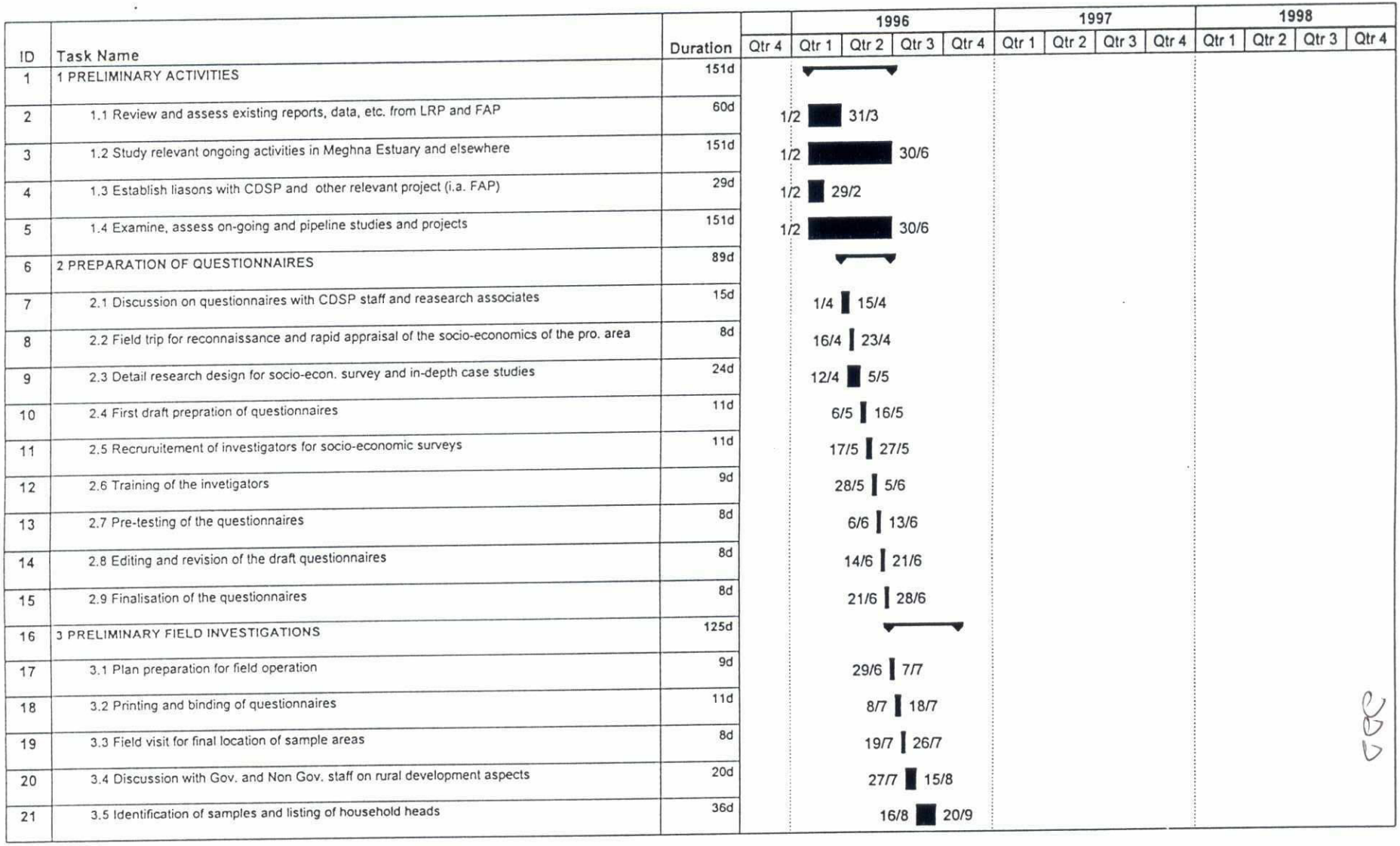
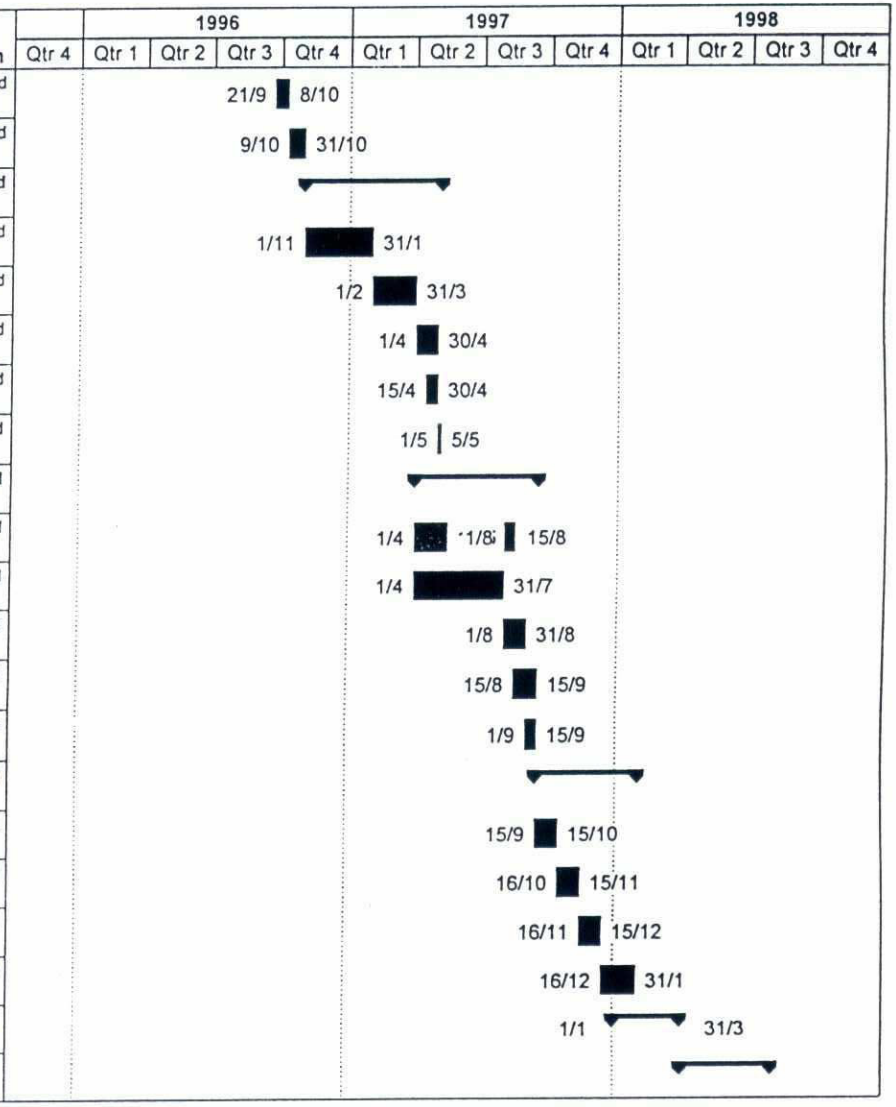
MEGHNA ESTUARY STUDY
Gantt Chart Rural Development and Socio-Economic Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	151d
2	1.1 Review and assess existing reports, data, etc. from LRP and FAP	60d
3	1.2 Study relevant ongoing activities in Meghna Estuary and elsewhere	151d
4	1.3 Establish liasons with CDSP and other relevant project (i.a. FAP)	29d
5	1.4 Examine, assess on-going and pipeline studies and projects	151d
6	2 PREPARATION OF QUESTIONNAIRES	89d
7	2.1 Discussion on questionnaires with CDSP staff and reasearch associates	15d
8	2.2 Field trip for reconnaissance and rapid appraisal of the socio-economics of the pro. area	8d
9	2.3 Detail research design for socio-econ. survey and in-depth case studies	24d
10	2.4 First draft prepration of questionnaires	11d
11	2.5 Recruruitement of investigators for socio-economic surveys	11d
12	2.6 Training of the invetigators	9d
13	2.7 Pre-testing of the questionnaires	8d
14	2.8 Editing and revision of the draft questionnaires	8d
15	2.9 Finalisation of the questionnaires	8d
16	3 PRELIMINARY FIELD INVESTIGATIONS	125d
17	3.1 Plan preparation for field operation	9d
18	3.2 Printing and binding of questionnaires	11d
19	3.3 Field visit for final location of sample areas	8d
20	3.4 Discussion with Gov. and Non Gov. staff on rural development aspects	20d
21	3.5 Identification of samples and listing of household heads	36d



MEGHNA ESTUARY STUDY
Gantt Chart Rural Development and Socio-Economic Aspects

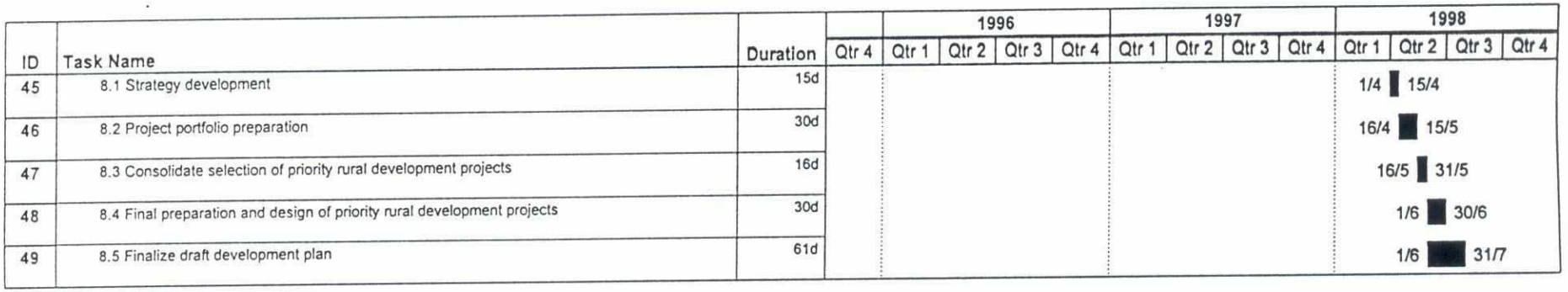
ID	Task Name	Duration
22	3.6 Visit to Adrasha gram projects to assess its status	18d
23	3.7 Secondary data gathering	23d
24	4 FIELD INVESTIGATIONS, SURVEY AND ANALYSIS	186d
25	4.1 Field survey and data collection	92d
26	4.2 Data coding, processing and tabulation	59d
27	4.3 Overall analysis and report prepration	30d
28	4.4 Socio-economic project apprisal	16d
29	4.5 Workshop on Rural Development Aspect	5d
30	5 INTERIM DEVELOPMENT PLAN PREPARATION	168d
31	5.1 Settlement and RD strategy formulation	137d
34	5.2 Project portfolio preparation: Settlement & rural development	122d
35	5.3 Selection of priority rural development projects	31d
36	5.4 Preparation and design of priority rural development projects	32d
37	5.5 Final write up of Intrim Development Plan	15d
38	6 APPRAISAL OF DEVELOPMENT PLAN AND PROJECTS	139d
39	6.1 Appraisal with concerned ministries	31d
40	6.2 Appraisal at district and thana level & NGOs	31d
41	6.3 Develop methodology for appraisal at beneficiary level	30d
42	6.4 Appraisal at beneficiary level	47d
43	7 UPDATING OF STRATEGY, DP AND PROJECT PROPOSALS WITH LATEST DATA	90d
44	8 DRAFT DEVELOPMENT PLAN PREPARATION	122d



MEGHNA ESTUARY STUDY

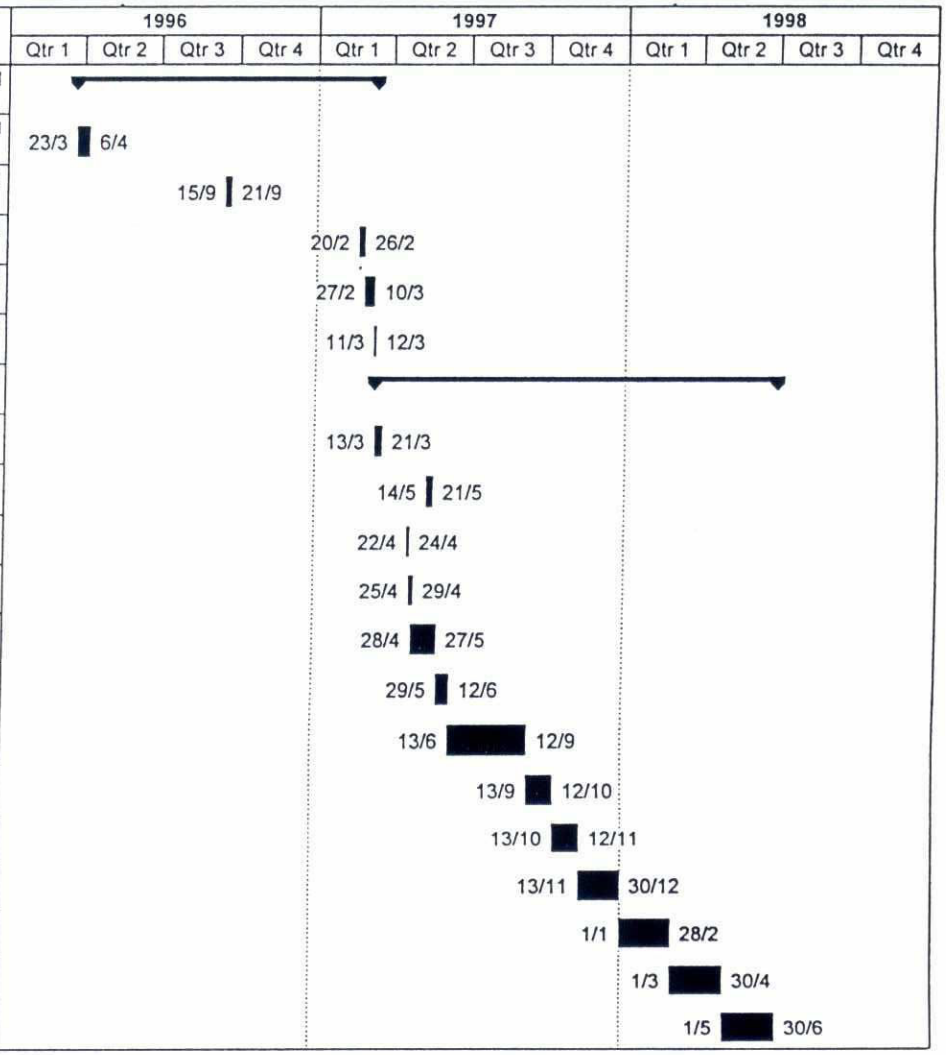
Gantt Chart Rural Development and Socio-Economic Aspects

ID	Task Name	Duration
45	8.1 Strategy development	15d
46	8.2 Project portfolio preparation	30d
47	8.3 Consolidate selection of priority rural development projects	16d
48	8.4 Final preparation and design of priority rural development projects	30d
49	8.5 Finalize draft development plan	61d



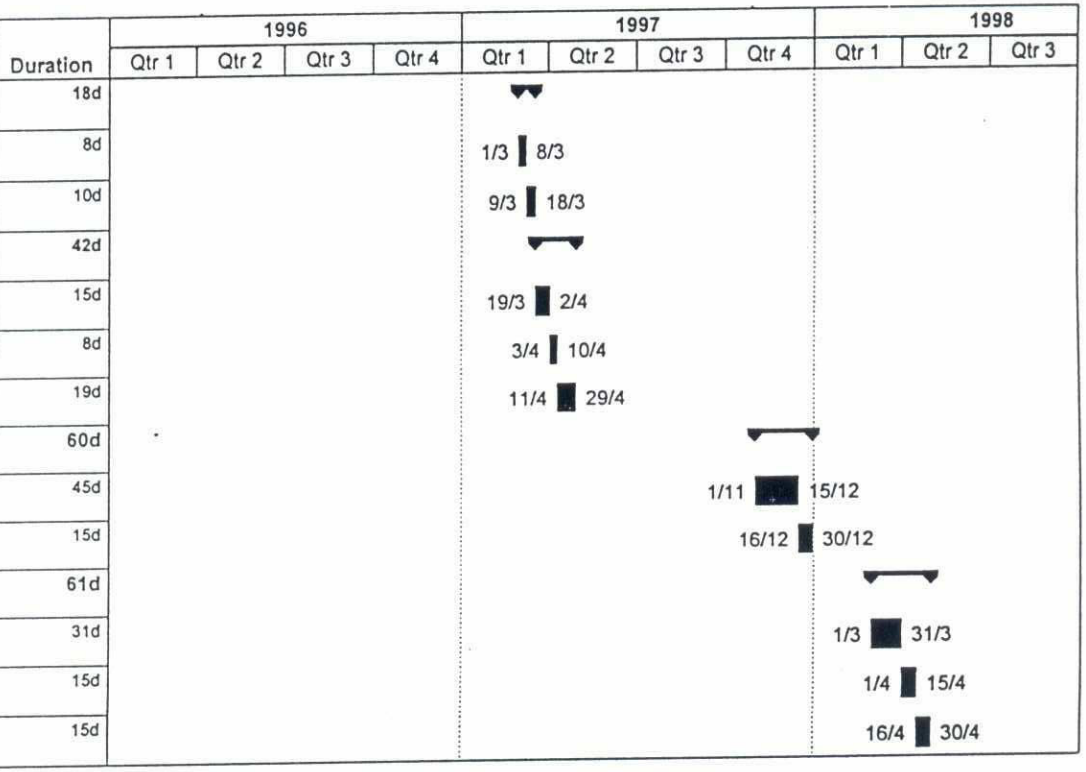
MEGHNA ESTUARY STUDY
Gantt Chart Agricultural Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	355d
2	1.1 Contribution to Inception	15d
3	1.2 Accretion trials	7d
4	1.3 Collection of soil resources and salinity data for SRDI	7d
5	1.4 Preparation of questionnaires for agricultural survey	12d
6	1.5 Training field investigators	2d
7	2 DEVELOPMENT PLAN	475d
8	2.1 Conduct households survey in Nijhum dwip and south Hatia	9d
9	2.2 Analysis and tabulation of field data	8d
10	2.3 Prepration of soil association map	3d
11	2.4 Preparation of land capability map	5d
12	2.5 Preparation of tables and writing detailed report	30d
13	2.6 Collection of soil water samples and testing them in lab.	15d
14	2.7 Collection of thana records and writing reports thanawise	92d
15	2.8 Need assessment of agricultural inputs in each thana	30d
16	2.9 Preparation of report for other char areas from socio-economic data	31d
17	2.10 Identification of major constraints in char lands	48d
18	2.11 Collection of data in other areas through checklist/qustionnaire	59d
19	2.12 Preparation of development plan for 25 years in phases in charlands	61d
20	2.13 Preparation of priority proejct reports for implementation	61d



MEGHNA ESTUARY STUDY
Gantt Chart Fisheries Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITES	18d
2	1.1 Collection, review of LRP reports	8d
3	1.2 Collection, review of Fisheries reports	10d
4	2 DEVELOPMENT PLAN - PHASE (I)	42d
5	2.1 Reconnaissance field visit and data collection	15d
6	2.2 Screening & selection of sub-project	8d
7	2.3 Data collection and processing	19d
8	3 DEVELOPMENT PLAN - PHASE (II)	60d
9	3.1 Data cllection (final) and field visit	45d
10	3.2 Data processing	15d
11	4 DEVELOPMENT PLAN - PHASE (III)	61d
12	4.1 Preparation of development plan	31d
13	4.2 Identification of contraints	15d
14	4.3 Preparation of reports	15d



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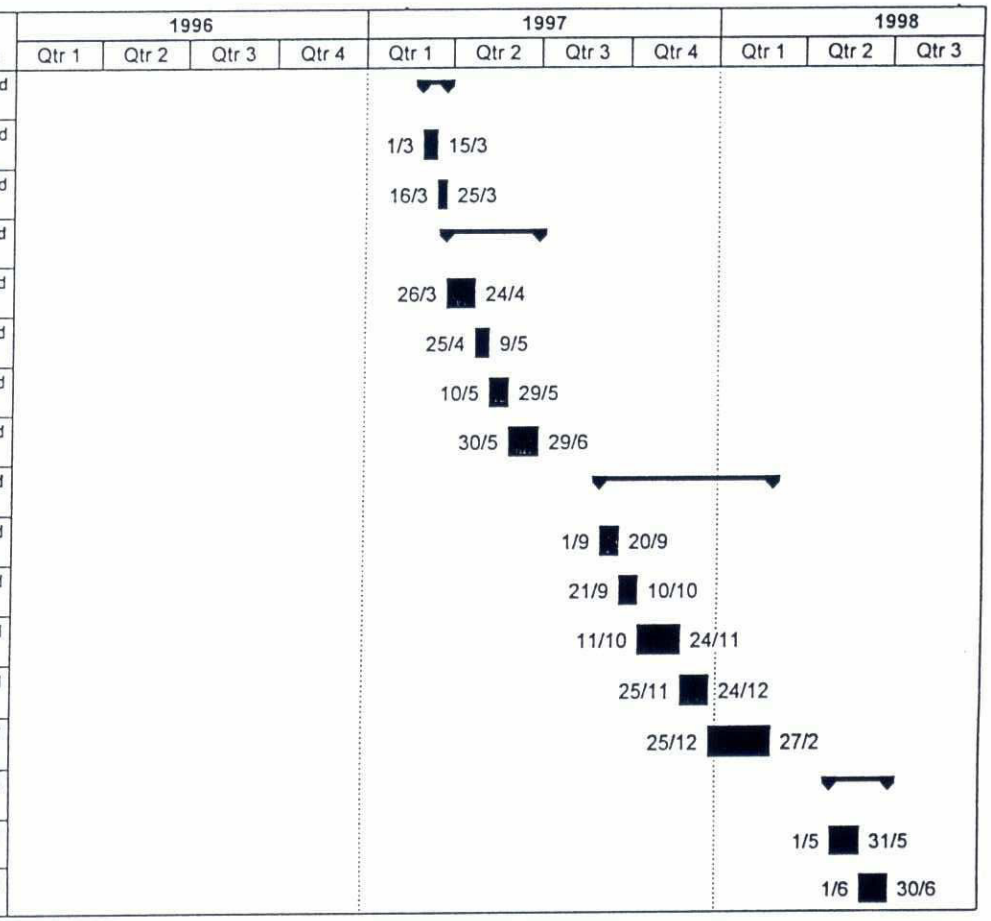
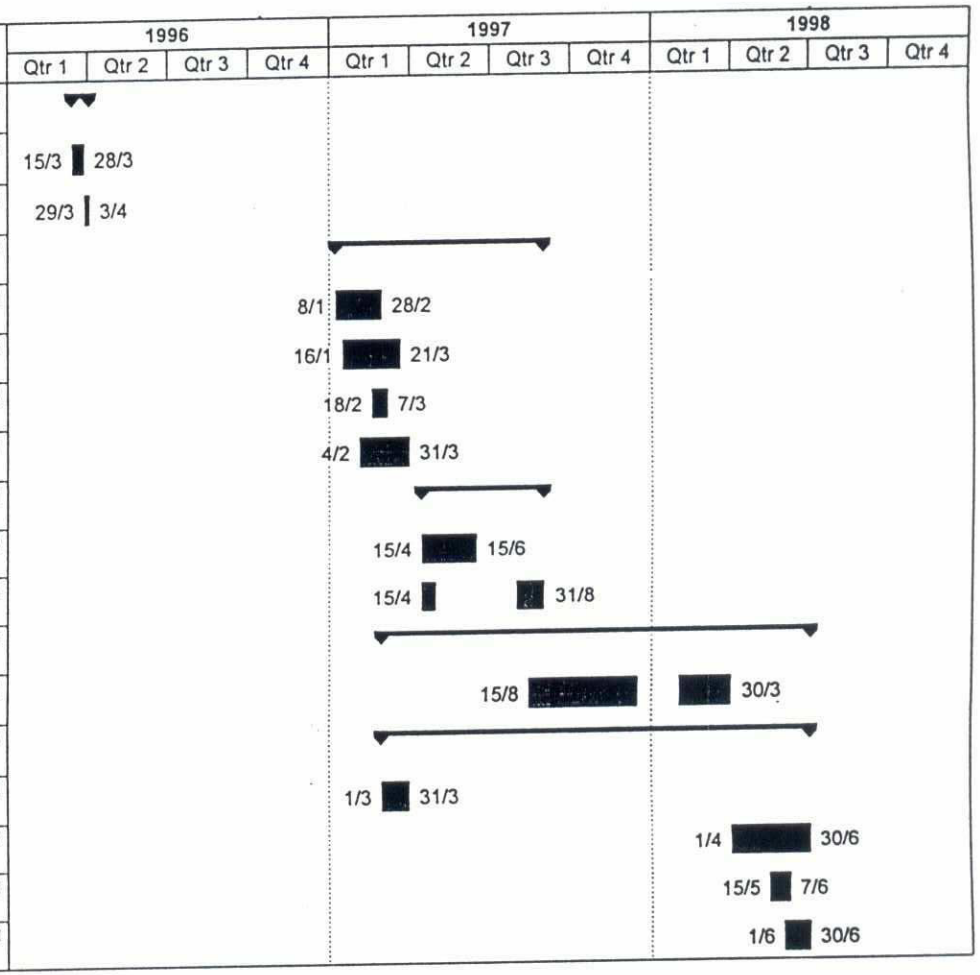
MEGHNA ESTUARY STUDY
Gantt Chart Forestry Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITES	25d
2	1.1 Study of LRP & FAP documents	15d
3	1.2 Preparation of work plan	10d
4	2 PHASE (I)	96d
5	2.1 Literature reivew and discussion	30d
6	2.2 Field visit	15d
7	2.3 Formulation of plan	20d
8	2.4 Field investigation	31d
9	3 PHASE (II)	180d
10	3.1 Further work plan	20d
11	3.2 Further field visit	20d
12	3.3 Field investigation	45d
13	3.4 Data processing	30d
14	3.5 Report preparation	65d
15	4 PHASE (III)	61d
16	4.1 Final draft report	31d
17	4.2 Final report	30d



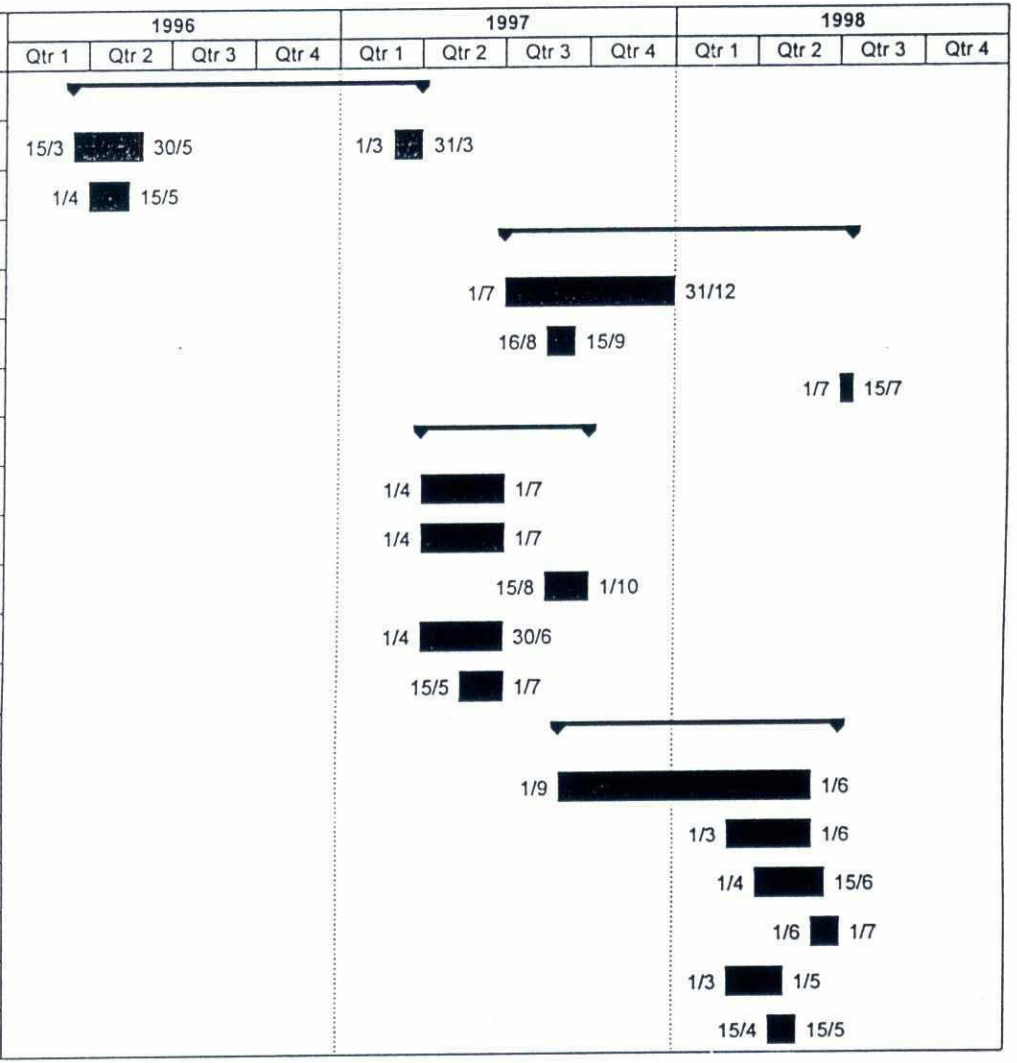
MEGHNA ESTUARY STUDY
Gantt Chart Environmental Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	20d
2	1.1 Study relevant LRP and FAP documents regarding environmental aspect	14d
3	1.2 Preparation of a work programme for inception report	6d
4	2 PHASE I	236d
5	2.1 Literature review and discussion	52d
6	2.2 Reconnaissance field visit	65d
7	2.3 Formulation and design of field plan	18d
8	2.4 Field investigations - Nijhum Dwip	56d
9	2.5 Report preparation	139d
10	2.5.1 IEE : Interim Master Plan	62d
11	2.5.2 IEE : Interim Development Plan	139d
14	3 PHASE II	487d
15	3.1 Field investigations	228d
18	3.2 Report preparation	487d
19	3.2.1 EIAR : Nijhum Dwip land accretion	31d
20	3.2.2 EIAR, Draft Project/Programme preparation report	91d
21	3.2.3 IEE : Draft Master Plan	24d
22	3.2.4 IEE : Draft Development Plan	30d



MEGHNA ESTUARY STUDY
Gantt Chart Economic Aspects

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	382d
2	1.1 Collection, review of LRP and FAP reports	382d
5	1.2 Study FCPO and other appraisal guidelines of relevant FAP projects	45d
6	2 MASTER PLAN	380d
7	2.1 Provide input in undertaing master socio-economic survey	184d
8	2.2 Ranking of possible projects listed in the Interim Master Plan	31d
9	2.3 Up-date ranking of projects listed in the Master Plan	15d
10	3 DEVELOPMENT PLAN	184d
11	3.1 Develop project assessment models	92d
12	3.2 Develop guidelines for input data reporting	92d
13	3.3 Develop operative screening models	48d
14	3.4 Review FCPO guidelines for project assessment	91d
15	3.5 Contact and discuss assessment aspects with FCPO economists	48d
16	4 PRIORITY PROJECTS AND PROGRAMME	304d
17	4.1 Recommend on an update of guidelines for project assessment	274d
18	4.2 Prepare proposals for project impact reporting	93d
19	4.3 Develop a format for presenting the multi criteria analysis	76d
20	4.4 Assess alternative project proposals in terms of their scoring	31d
21	4.5 Train the counterpart staff in project evaluation methodology	62d
22	4.6 Conduct workshop on proejct evaluation methodology	31d



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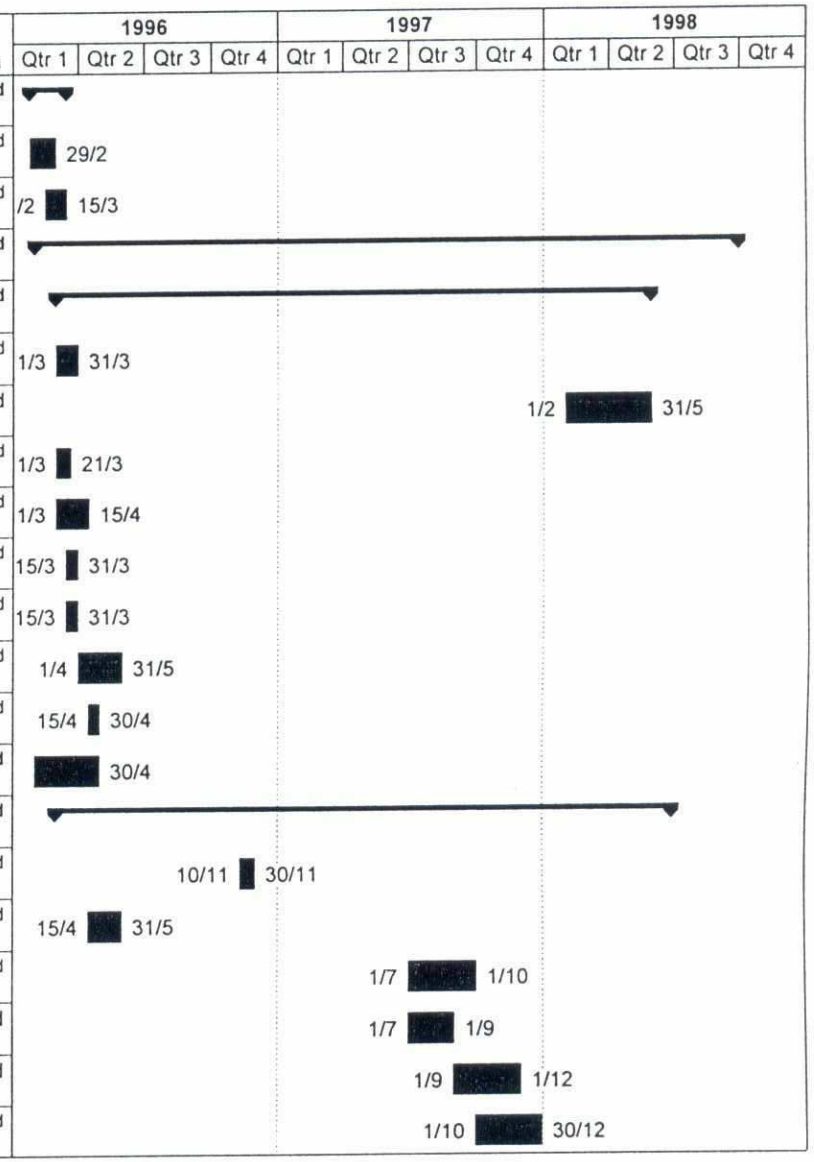
MEGHNA ESTUARY STUDY
Gantt Chart Remote Sensing and GIS

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	51d
2	1.1 Assessment of RS requirements by having group discussion with different sectors	36d
3	1.2 Collection of information from different institutions regarding maps and RS data	30d
4	2 ACTIVITIES SUPPORTING MASTER PLAN AND DEVELOPMENT PLAN	973d
5	2.1 Collection of reports and RS data from different institutions	822d
6	2.1.1 Procurement of Landsat TM image of 1996	31d
7	2.1.2 Procurement of Landsat TM image of 1998	120d
8	2.1.3 Procurement of soil reports and maps from SRDI	21d
9	2.1.4 Procurement of Landsat MSS data	46d
10	2.1.5 Procurement of 1:250,000 DHS map	17d
11	2.1.6 Procurement of Thana and District maps from LGED	17d
12	2.1.7 Procurement of SPOT bw prints	61d
13	2.1.8 Procurement of 1:50,000 scale fisheries Resources Survey System maps	16d
14	2.2 Inventory of historic maps and topo sheets	90d
15	2.3 Interpr. of Maps, Remote Sensing data and preparation of shoreline/bankline GIS maps	852d
16	2.3.1 Preparation of shoreline/bankline maps from Rennells map of 1779 and Landsat map	21d
17	2.3.2 Preparation of shoreline/bankline map from Landsat 1973 at 1:250,000 scale	47d
18	2.3.3 Preparation of GIS map at 1:250,000 scale from 2.3.2	93d
19	2.3.4 Preparation of GIS Forests Resources Map from 1996 imagery	63d
20	2.3.5 Preparation of GIS map on Forest coverage by each MES Thana	92d
21	2.3.6 Preparation of GIS map from FRSS maps of 1980 (1:50,000) at 1:250,000 scale	91d



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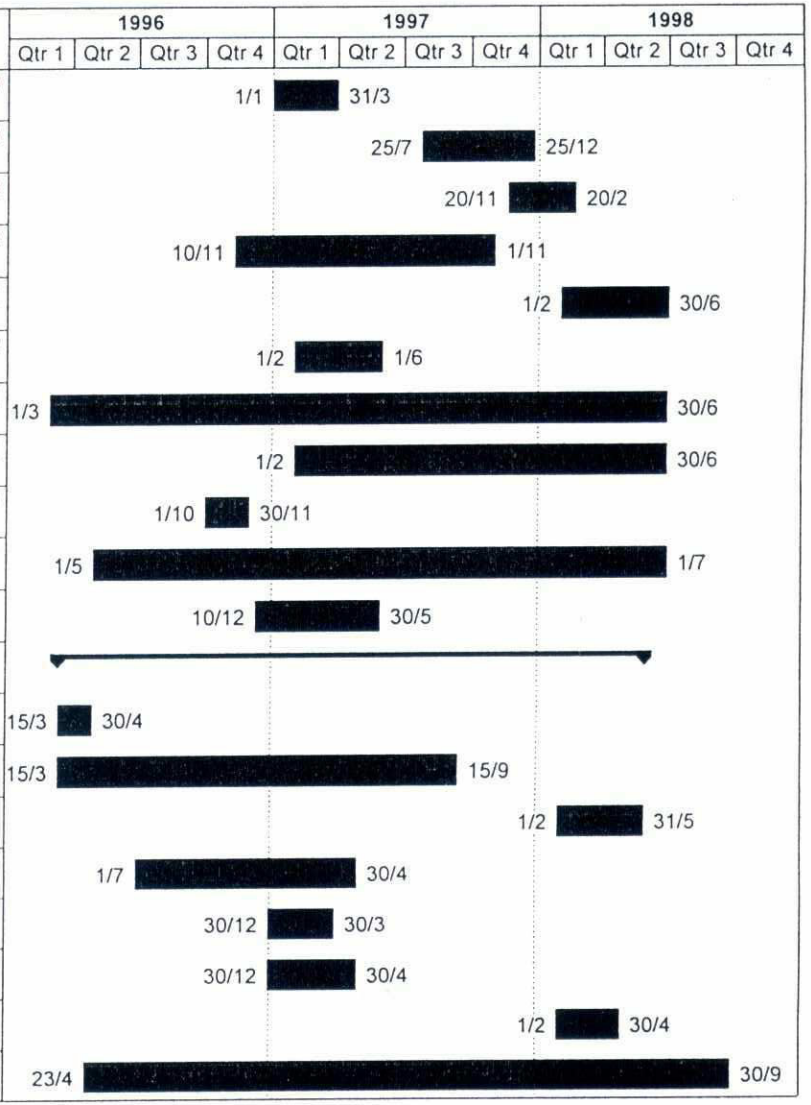
MEGHNA ESTUARY STUDY
Gantt Chart Remote Sensing and GIS

ID	Task Name	Duration
22	2.3.7 Preparation of GIS shoreline/bankline map from 1996 TM Imagery data at 1:250,000 s	90d
23	2.3.8 Preparation of GIS map from SPOT 1989 images from National GIS database at 1:25	154d
24	2.3.9 Preparation of GIS shoreline/bankline map from Landsat TM data of 1992 at 1:250,00	93d
25	2.3.10 Create GIS application for showing coastline from 1973-1996 images	357d
26	2.3.11 Create GIS application for showing coastline from 1998 image	150d
27	2.3.12 Preparation of Nijhum Dwip Intrevention /Study Map series	121d
28	2.3.13 Preparation of different Thematic Maps for MES sections	852d
29	2.4 Digitizing of bathymetric maps of areas of Interest, Approx. 20 nos of 1990-93 and then 60 no	515d
30	**2.5 Visual interpretation of one of the SPOT Images of 1989/1990 and prepare Landuse Ma**	61d
31	2.6 Preparation of CAD Design, Sketch,& Engineering Drawings for diff. MES sections	792d
32	**2.7 Preparation of MES basemap from LGED, SPARRSO 1996 Landsat Imagery**	172d
33	**2.8 Coordination with EGIS on analysis and processing of Landsat TM image and Maps**	808d
34	2.8.1 Procurement & processing, mosaiking and printing of sat. data (1996)	47d
35	2.8.2 Procurement, processing, mosaicking and printing of 1973,78,84,90,93,96 sat. data	550d
36	2.8.3 Procurement, processing, mosaicking and printing of 1998 sat. data	120d
37	2.8.4 Full resolution FCC maps of each year showing 6 landuse classes	304d
38	2.8.5 Overlay of consecutive years' shoreline map for erosion/ accretion	91d
39	2.8.6 Overlay of cumulative years' shoreline map for erosion / accretion	122d
40	2.8.7 Statistics and reports on the above activities and supply of datasets.	89d
41	**2.9 Preparation of reports and final GIS maps**	891d



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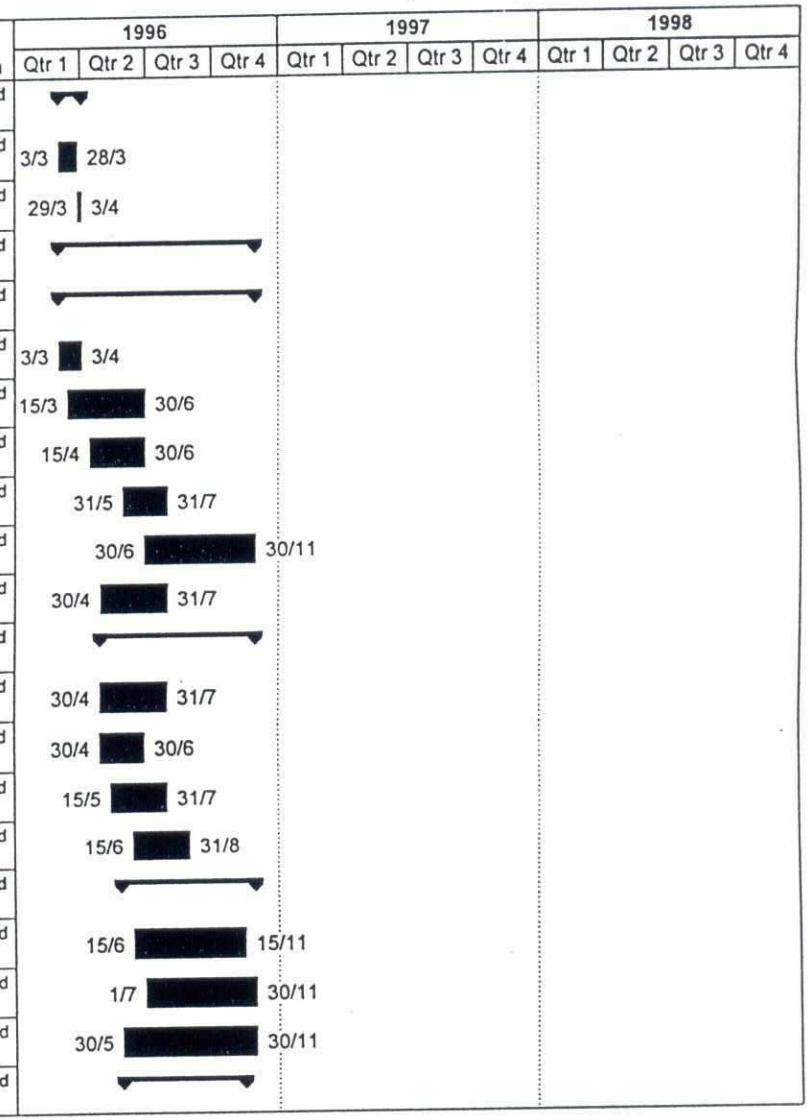
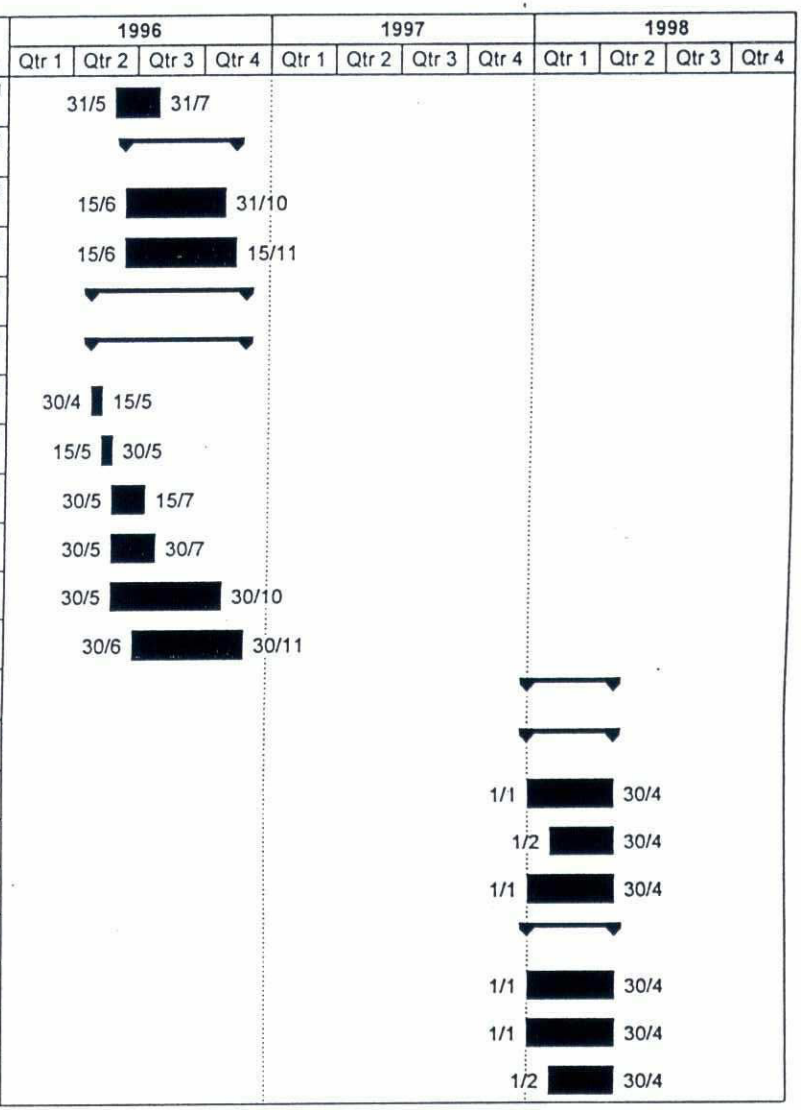
MEGHNA ESTUARY STUDY
Gantt Chart Institutional Development

ID	Task Name	Duration
1	1 PRELIMINARY ACTIVITIES	32d
2	1.1 Study relevant LRP and FAP document regarding institutional aspects	26d
3	1.2 Preparation of a work programme for inception report	6d
4	2 PHASE A	273d
5	2.1 Asses posibilities for sustained data collection and processing	273d
6	2.1.1 Review the activities to perform by SSD	32d
7	2.1.2 Assess past and current activities	108d
8	2.1.3 Future SSD activities	77d
9	2.1.4 Assessment of the existing institutional capabilities regarding hydrogr. surveying of coastal	62d
10	2.1.5 Recommend optimum institutional arrangements to continue routine surveys and studies	154d
11	2.1.6 Assessing alternative institutional arrangements for sustainable data collection and process	93d
12	2.2 Analyzing and Institutionallzing the planning process	215d
13	2.2.1 Identify and assess relationship between BWDB and WARPO in planning process	93d
14	2.2.2 Identify on-going plans and projects with impact on institutionalization of MES activities	62d
15	2.2.3 Identity development needs of WARPO and BWDB	78d
16	2.2.4 Specify the link between BWDB's planning process and WARPO's master planning	78d
17	2.2.5 Identify links between macro and micro planning org. active in MES plan area	185d
18	2.2.5.1 Identify organizations which are currently working in the sector-suggested imporve	154d
19	2.2.5.2 Recommend on links between these organizations planning and MES	153d
20	2.2.5.3 Assess role of LAED in the estuary planning process	185d
21	2.3 Institutional arrangement for implementation of infrastructure projects	169d



MEGHNA ESTUARY STUDY
Gantt Chart Institutional Development

ID	Task Name	Duration
22	2.3.1 Identify institutions responsible for implementation and interventions	62d
23	2.3.2 Assess whether planned implementation is in line with long term objective MES	154d
24	2.3.2.1 Assess legal basis for allocation of accreted or reclamied land	139d
25	2.3.2.2 Assess institutional arrangements for enforcement of land allocation based on law	154d
26	2.4 Training Assistance and Co-ordination	215d
27	2.4.1 Training Needs Assessment (TNA) of the inst. involved in MES planning process	215d
28	2.4.1.1 Develop proforma for TNA in trms of institutions building	16d
29	2.4.1.2 Assist in collecting information through TNA format	16d
30	2.4.1.3 Coordinate analysis of information /data so gathered	47d
31	2.4.1.4 Coordinate training needs assessment	62d
32	2.4.1.5 Coordinate training program preparation	154d
33	2.4.1.6 Coordinate implementation of training program and assist where required	154d
34	3 PHASE B	120d
35	3.1 Assess sustainability of arrangements for data collection and processing	120d
36	3.1.1 Review institutional strengthening of relevant organizations	120d
37	3.1.2 Assessment of the institutional capabilities on hydrographic surveying of coastal water	89d
38	3.1.3 Recommend adjustments to institutional arrangements to continue surveys and studies	120d
39	3.2 Follow-up in institutionallazing the planning process	120d
40	3.2.1 Review the relationship between BWDB and WAROP in planning process	120d
41	3.2.2 Indentify plans and projects with impact on institutionalzation of MES activities	120d
42	3.2.3 Review needs for continuing development of WARPO and BWDB	89d



MEGHNA ESTUARY STUDY
Gantt Chart Institutional Development

ID	Task Name	Duration
43	3.2.4 Review links established between BWDB's planning and WARPO's master planning	89d
44	3.2.5 Review links between marco and micro planning of orgainzatins activie in MES plan area	91d
45	**3.3 Follow-up for institutionla arrangemment for project implementation**	**120d**
46	3.3.1 Review institutions responsible for implementation and interventions	120d
47	3.3.2 Review institution's capabilities to plan, develop projects	59d
48	3.3.3 Assess whether planned implementation is in line with long term objectives of MES	61d
49	**3.4 Follow-up on training Assistance and Co-ordination**	**120d**
50	3.4.1 Coordinate training needs assessment	31d
51	3.4.2 Coordinate training program preparation	59d
52	3.4.3 Coordinate implementation of training program	120d

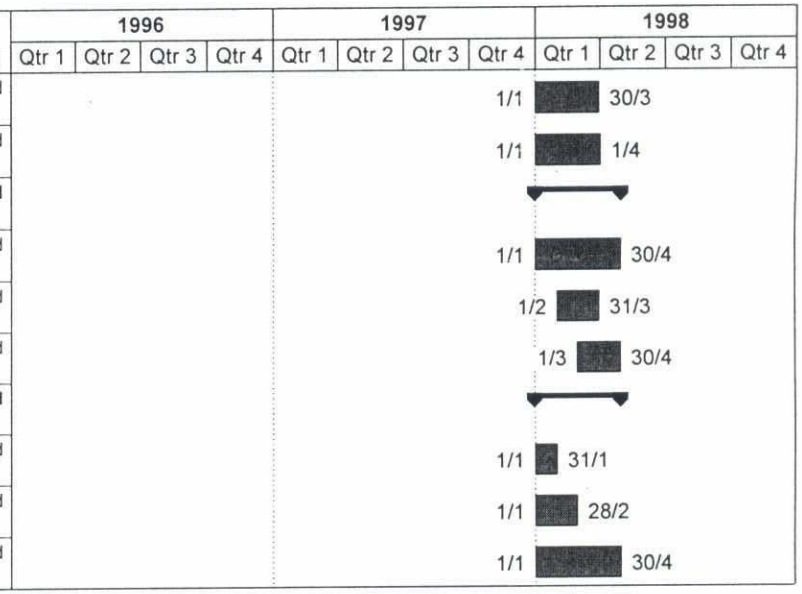


Chart 6.11: Institutional Development (continued)

MEGHNA ESTUARY STUDY
Gantt Chart Expatriate Staff

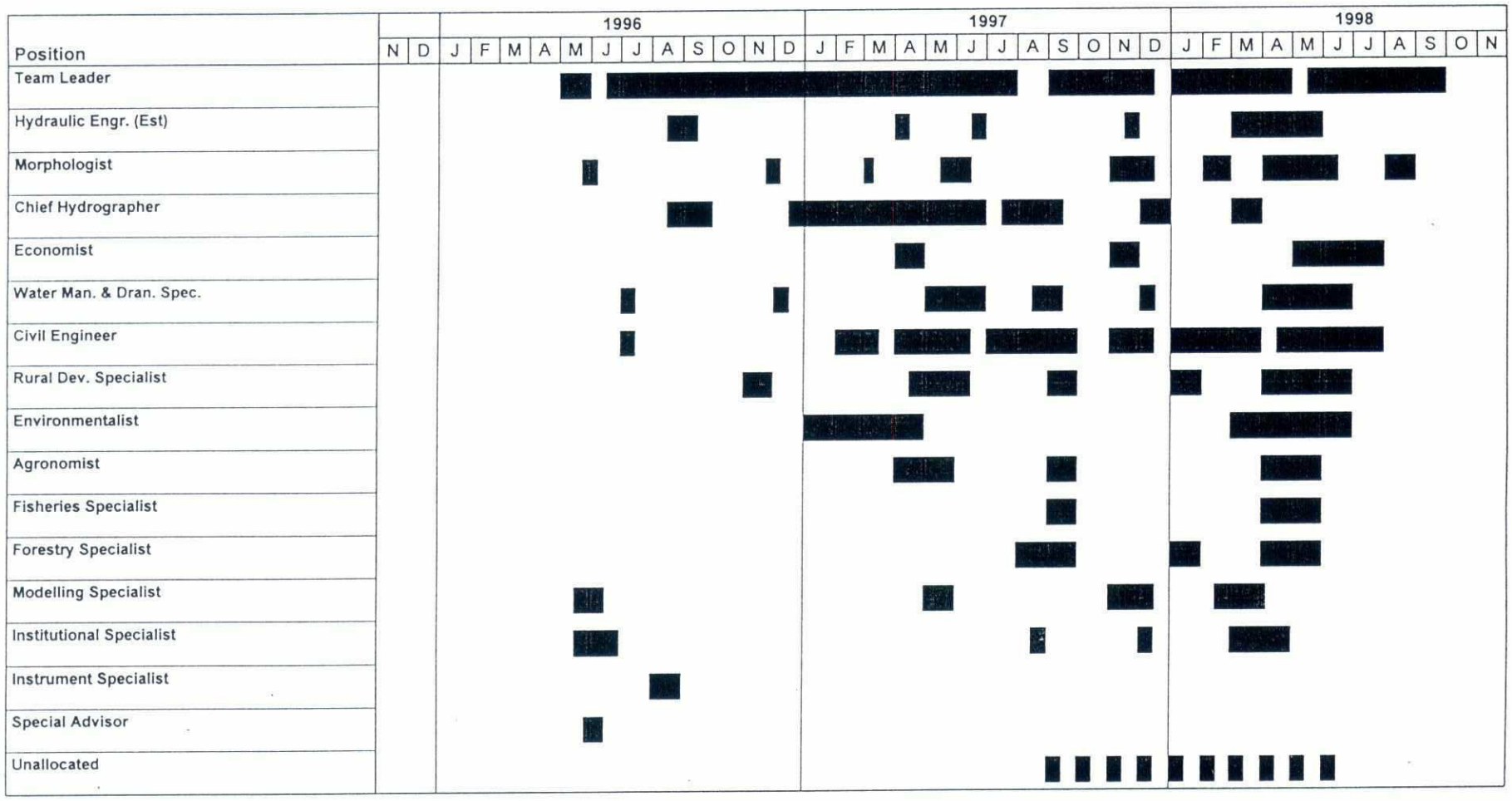


Chart 6.12 : Expatriate Technical Staff

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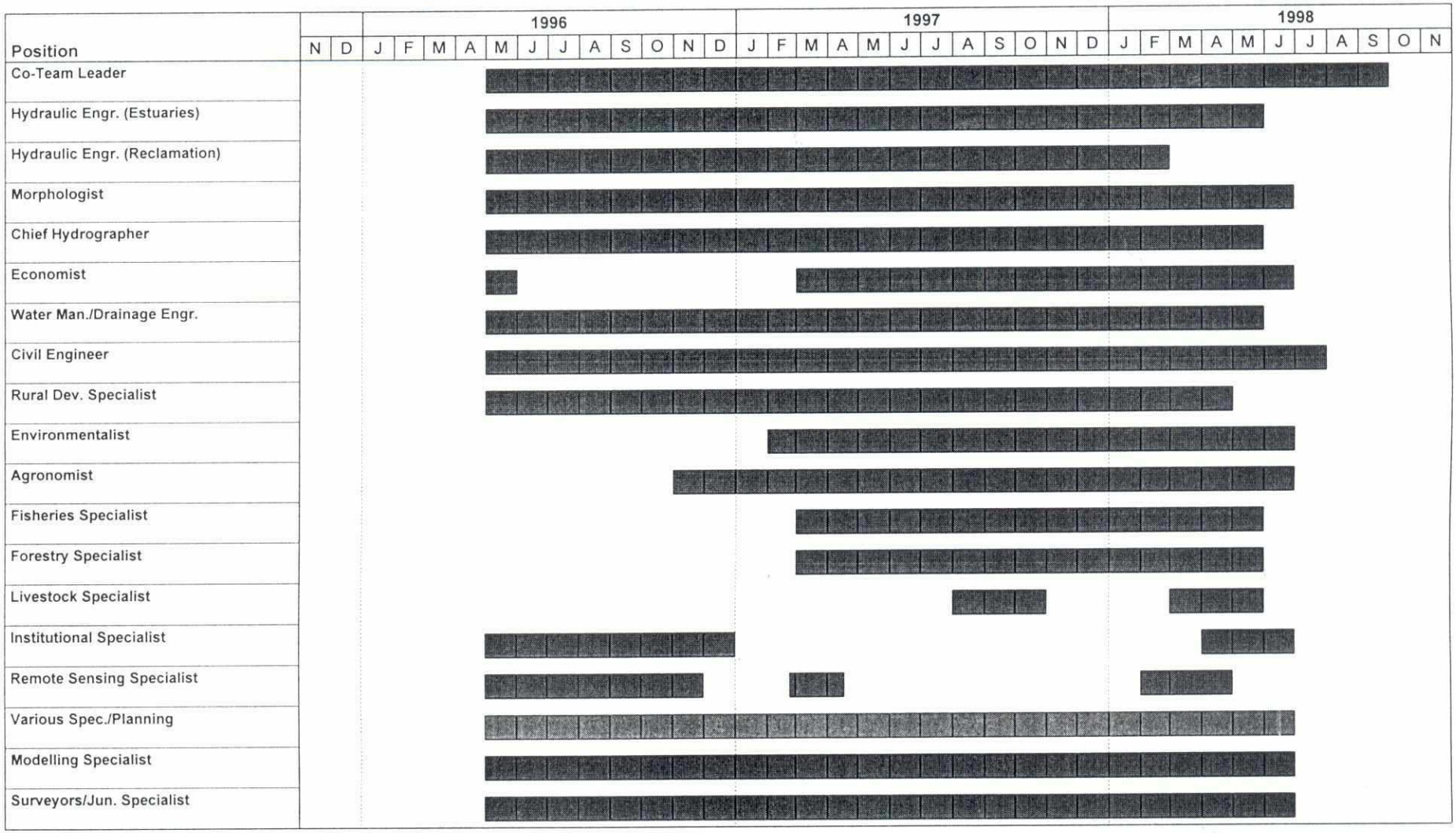
MEGHNA ESTUARY STUDY
Gantt Chart Local Staff



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MEGHNA ESTUARY STUDY
Gantt Chart Reporting Schedule

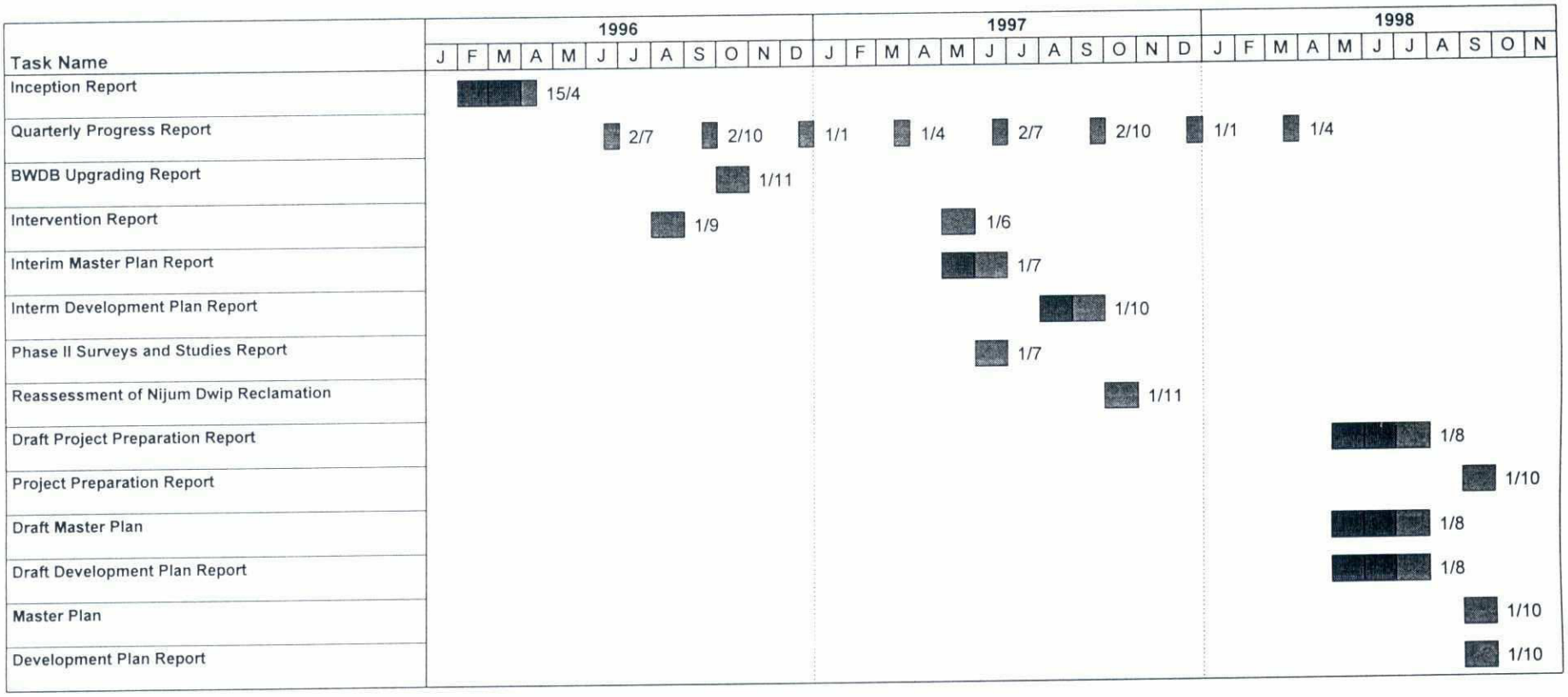

Chart 6.14 : Reporting Schedule

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7 REPORTING

7.1 General

Reporting requirements for this project is determined following the guide lines of the TOR. In addition, an interim inception report is prepared following the requirements of the additional TOR. The reports in general will be prepared as draft and submitted to the Project Director for comments. After incorporation of comments and corrections the final reports will be submitted in 30 copies to WARPO for circulation and necessary use.
The following reports will be produced for this project (See Chart 6.12, included in Chapter 6)

Month 2	Interim Inception Report.
Month 6	Inception Report.
Month 14	Proposals for small scale interventions to be implemented in the period February 1997 - May 1997
Month 18	Proposals for small scale interventions to be implemented in the period November 1997 - April 1998
Month 18	Feasibility Report on Reassessment of Nijum Deep Reclamation
Month 20	Interim Master Plan Report
Month 20	Proposals for continuation of Surveys and Studies in the Meghna Estuary including Institutional Arrangements
Month 22	Interim Development Plan Report
Month 31	Draft Project/Programme Preparation Report(s)
Month 33	Project/Programme Preparation Report(s)
Month 33	Draft Master Plan Report
Month 33	Draft Development Plan Report
Month 35	Master Plan Report
Month 35	Development Plan Report

Technical reports, notes and working papers will be produced during the course of the assignment as required together wilh quarterly reports after the submission of the Inception Report as shown in Chart 6.14.
If the Project Director desires the Consultants will submit the word processing, spread sheet and graphic files on diskette. The Consultants will submit two copies of the reports to each of the Donors.

7.2 Planning

7.2.1 Master Plan

A Master Plan with phased long term project activities will be prepared which will have the main characteristics as detailed below.

- A realistic picture of the project area after it is being implemented with newly accreted land and definite river channels etc.

- A full description of the sequence and nature of successive interventions to bring about the envisaged changes. The interventions will comply reclamation and protection works, embankments and development plans for reclaimed land.

- Full feasibility study for priority projects, scheduled for implementation during the first 5 years and pre-feasibility level study of projects, including design criteria, outlines for the Terms of Reference for next stage, if appropriate, suggesting for possible lumping of projects.

- Additional measures that could be foreseen in case the planned sequence of successive implementations would be interrupted for some reason, in order to secure the sustain-

ability of the out-come of this first phase plan.

- Outlines for the strategy for the preparation of the next Master plan, as a guide for subsequent master planning exercises.

The reports of the Interim Master Plan, Draft Master Plan and Master Plan will be prepared in the 20th, 33rd and 35th months of the project respectively.

7.2.2 Development Plan

A comprehensive plan to be prepared for flood protection and the improvement of the internal water management of the coastal islands included in the project area. In fact all inhabited islands are to be included, with the exception of Bhola. An initial phased development plan for submission in the Interim Development plan is to be prepared in month 22.
The process of planning will continue with the guidelines as shown in the Terms of Reference and the Draft Development Plan report is to be prepared and submitted for review and comments in month 33.
The Development Plan will be finalized and submitted in month 35 at the closing of the MES.

7.3 Feasibility Studies

7.3.1 Nijhum Dwip Reclamation

The feasibility of reclaiming land along Nijhum Dwip and along South Hatia as studied under LRP, will be reassessed by considering new parameters. The primary objective will be to test the measures of reclamation by means of timely applied low cost methods of closing tidal channels thus accelerating the accretion process.
A comprehensive report including the input of the Ministry of Lands; technical, socio-economic, environmental and institutional aspects will be prepared and submitted in month 20.

7.3.2 Priority Projects

The Land Reclamation Project indicated 18 priority areas where projects could be undertaken for land reclamation, water management and drainage. An initial review shows that one of these projects is outside the MES project area and two of them are found to be unsuitable for further studies, so 15 priority projects will be studied under MES.
Depending on the Interim Master Plan (month 20) and the Interim Development Plan (month 22) and on the agreement of the Steering Committee, a feasibility report for the Priority Projects will be prepared and submitted in month 33.

7.3.3 Priority Programmes

Priority Programmes for setting up early warning systems as well as activities with regard to disaster preparedness will be prepared and submitted in month 33.

7.4 Miscellaneous

7.4.1 Institutional Arrangements Marine Surveys

The bathymetric surveys in accordance with an agreed plan will be submitted to the Project Director BWDB. The survey plan will take account of similar surveys by other agencies (BIWTA, NAVY, Chittagong Port Authority). It will reflect the priorities determined by areas of observed intensive siltation and/or erosion and pollution by intended small scale interventions for the

preparation of the long term plan. The surveys will be designed to cover the entire area of MES at regular intervals and the proposal for bathymetric survey to be submitted to BWDB for approval at least 3 months before the start of the wet season.

7.4.2 Small Scale Interventions

These will comprise opportunities which are expected to arise during the project period in connection with the accretion/reclamation of new land. Small works using local technologies, labour and construction materials which can be rapidly implemented will be envisaged.
The Consultants will locate and design the works and monitor their effectiveness. The implementation of these interventions and the construction of the simple structures will be the responsibility of BWDB, with time to time advice from the Consultant.

DGD

BANGLADESH

ACTION PLAN FOR FLOOD CONTROL

FAP 5B

TERMS OF REFERENCE
(revised)

MEGHNA ESTUARY STUDY
(MES)

BANGLADESH WATER DEVELOPMENT BOARD
AND
WATER RESOURCES PLANNING ORGANIZATION

MINISTRY OF WATER RESOURCES

MAY 1997

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TOR (revised) FOR FAB5B MEGHNA ESTAURY STUDY

1. INTRODUCTION

1.1 The Flood Action Plan

Following the disastrous floods in 1987 and 1988, the Government of Bangladesh (GoB), with assistance from the international donor community, initiated a comprehensive Flood Action Plan (FAP). This plan, the first phase of which coincides with the Government's Fourth Five Year Plan (1990 -1995), is coordinated by the World Bank. It comprises water development studies in all the country's major regions, supporting studies and pilot projects to improve project design and implementation, and a number of non-structural measures to increase the flood resilience of the population and infrastructure. Most of the 26 components and supporting activities are well underway with technical and financial assistance to GoB from donor countries.

The Flood Coordination Organisation (FPCO) has been established as an arm of the Ministry of Irrigation, Water Development and Flood Control (MOIWDFC) to supervise and coordinate FAP activities.

Six regional studies cover most of the country's flood prone areas (see insert to Figure 1). The only areas not covered are the Meghna Estuary and the Chittagong coastal areas to the south and east of FAP-4 and FAP-5. FAP-4, the south West Regional Study funded by ADB/UNDP, covers the area bounded by the Ganges, Padma, Lower Meghna, Bay of Bengal and the Indian border. FAP-5,the South East Regional Study funded by the World Bank's IDA, covers the areas between the Noakhali coastline of the Meghna Estuary in the south and a line from Hasvinagar to Madhabpur in the north,and between the Meghna River in the west and the Indian border and the western boundary of the Muhuri Irrigation Project in the east. Also relevant to the south east estuarine and coastal areas are: FAP 9b, Meghna Left Bank Protection Project, funded by IDA, includes a study of the Meghna River from Bhairab Bazar to Chandpur and Fap 7, Cyclone Protection Project, which, with technical assistance from the European Community (EC) and financial assistance from IDA, is concerned with the rehabilitation of coastal protection works.

2. BACKGROUND

2.1 The Land Reclamation Project

In 1978 the Government of the Netherlands and Bangladesh started the Land Reclamation Project (LRP). The aim was to address the problems of floods and coastal erosion and to exploit the potentials for the reclamation and development of new lands along the coastal fringes from the mouth of the Lower Meghna in the west to the mouth of the Karnafuli River in the southeast. At the start of the project, the main emphasis was technical with implementation by the Bangladesh Water Development Board (BWDB) of MOIWDFC. The Consultants on the Netherlands side consisted mainly of engineers in water related subjects.

As the project progressed the initial emphasis shifted from the reclamation of new land to the consolidation of existing young land. A pilot polder taken up for demonstrating methods of improved agricultural development, became the focus for settling landless people. LRP developed into two distinct sets of activities: those related to the development of the polder, notably to the settlement of landless people and those related to the study of the processes of erosion and accretion.
Both components continued under the same project head,but over time lost their logical interrelationship. Further details of LRP and its achievements are given in Annex 1.

By the end of the project in July 1991, the two Governments, in recognition of the two distinct approaches, agreed that the project should proceed as two separate activities. These would be:

1. Char Development and Settlement Project (CDSP)
2. Meghna Estuary Project (MES)

CDSP, which would be land based, would be implemented by MOIWDFC with participation from the Ministry of Lands, Ministry of Local Government, Rural Development and Cooperatives, and others. The second, which would be largely concerned with the hydrological and morphological aspects, would continue with BWDB as the executing agency, but under the umbrella of FAP. Coordination between the two projects would be maintained, especially regarding matters of mutual interest. Them Government of the Netherlands has expressed interest in providing assistance to GoB in the execution of both projects, with the Government of Denmark also showing joint interest in MES.

Although the two components of the former LRP will be tendered separately and will possibly be executed by different consultants, it is important that proper liaison be maintained for the full; duration of the project to ensure full exchange of pertinent information. Mes is thus expected to acquire from CDSP, in particular, guidance in the fields of social impact of settlement and development of coastal lands, giving due attention to women. The consultant is also expected to acquaint himself with, and take due account of the institutional arrangements introduced in CDSP. The TOR of CDSP will be provided as information to the consultants.

2.2 Meghna Estuary Study

Although the Flood Action Plan gave priority to the areas vulnerable to flooding by the major rivers, it was recognised that eventually all flood-prone areas should be covered by FAP. The cyclone of 29/30 April 1991,which devastated the southeast coastal areas and coastal islands, has demonstrated the need to bring these areas to the same level of study as the other FAP regions. The Meghna Estuary Study affords the opportunity to cover the regional aspects of flood control and cyclone protection development, while at the same time continuing with the hydrological and morphological study of the estuary. The Chittagong coastal region, the remaining area extending from the Muhuri Irrigation Project to Cox's Bazar, would be a separate study.

It is proposed that the Meghna Estuary Study(MES) be designated as FAP 5b and that the Chittagong Coastal Regional Study (to be considered separately) be designated as FAP 5c.

The rationale for undertaking MES under FAP together with its relationship with FAP4 South West Regional Study, FAP5 (now FAP5a) South East Regional Study, FAP7 Cyclone Protection Project, FAP9b Meghna Left Bank Protection Project and other relevant FAP activities are discussed in the next section.

3. THE PROJECT AREA AND RATIONALE

3.1 General

The broad objective of FAP regional studies is to provide a sound basis for implementing structural and non-structural flood related projects and programmes through comprehensive planning. Pre-feasibility studies are being undertaken with advice and assistance from the supporting FAP activities. During the course of the regional, studies, high priority projects are identified, and provided that the regional development plans are not prejudiced, feasibility level studies of projects for early implementation are initiated.

MES would be expected to follow the same general pattern as the other regional studies. However the circumstances are different from those in the other regions; firstly because of its dynamic geomorphology and secondly because of major ongoing flood /cyclone protection activities.

Whereas the other FAP regional studies are aimed at the production of regional plans leading to phased implementation, MES will also include a major survey/study of the dynamic environment, an activity which will clearly extend beyond MES period in the same way that FAP 24 River Surveys will probably extend and develop into a long term study/research programme.

3.2 The Project Area

Figure 1 shows the general study area. It covers the Lower Meghna River from Chandpur Town (the downstream extent of FAP 9b) to the Bay of Bengal. The eastern boundary follows the left bank and the coastline to the mouth of the Karnafuli near Chittagong (the boundary of FAP5a and FAP5c). The western boundary follows the right bank of the Lower Meghna and Tentulia rivers and the coastline to the bay (partly the boundary of FAP4). The southern boundary, which covers the estuarine area and the off- shore islands, is not specifically defined, but on the eastern side should cover the entrance to the Karnafuli River. The western boundary may be extended further to the west if it is considered necessary for the complete coverage of the mathematical model. Although Bhola island is in the project area, its internal area development and water management is covered by FAP4 South West Regional Study, and will thus be outside the MES responsibility.

The area is subject to the forces of tides, river flows and tropical cyclones. Tides entering the area from a general southwesterly direction penetrate into the funnel - shaped area and increase their amplitude in the process, from about 2m at the Karnafuli mouth to about 6m at the mouth of the Feni River. Tidal currents may reach a velocity of 3-4 m/s and their devastating effects, in recent years, resulted in serious erosion of the north coasts of Sandwip and Hatia islands, rendering thousands of people homeless. Strong currents in the Lower Meghna regularly devour considerable areas of land, particularly on Bhola island in recent years.

Cyclones are a regular phenomenon in the coastal areas of Bangladesh and their effect can be extremely destructive. When the April 1991 Cyclone struck the coast of Chittagong and Noakhali, floodwaves swept across the coastal islands and plains, killing about 130,000 people and causing widespread damage to property and crops.

Population increase has resulted in serious pressure on land all over Bangladesh. The coastal areas and islands are no exception, and the population density has probably increased disproportionally because of erosion on the main islands, pushing people back onto remaining land. The population have come to expect the inherent risks in these areas. The pressure on land has reached a stage where newly accreted land, barely rising above spring tide level, is already occupied by settlers.

While there appear to be potentials to gain new land in the estuary of the Meghna, as shown in the accretion of about 900 sq. km due to the two cross-dams in Southern Noakhali, the natural increase during the last two centuries has been almost negligible. This is shown by comparing the Rennell map of 1779 with the present situation (see Figure 2). Even if some net accretion appears to have taken place over the last few years, this may represent a temporary stage of an essentially oscillating phenomenon. In the absence of any convincing evidence to the contrary, it must be assumed that, if the area is left unattended, the dynamic processes of erosion and accretion will continue without any net gain in land, that tidal waves and cyclones will continue to claim their regular toll and that the environment will be full of risks for human settlement and unattractive for investments which could induce economic growth.

3.3 Rationale

Apart from completing FAP coverage of flood-prone areas, the basic reason for bringing MES into the FAP is to benefit from consistency in approach and quality control that is being established through coordination and interaction with the plan's various components and supporting activities.
The concept of MES is shown in Figure 3. MES is clearly an extension of LRP, but with the additions and modifications required to make it a component of FAP. As mentioned earlier, there is the additional potential complication of the execution of complementary cyclone protection projects and programmes by agencies outside FAP.

MES essentially comprises two main components:

- Through surveys and studies, an understanding will be developed of the forces that condition the ever changing pattern of land and sea areas. From this a phased long term plan for the area will be prepared; this component referred to as the "master plan". Because of natural changes and changes induced by human interventions, the plan has to be flexible, giving an indication of the long term potentials. Consequently attention must be given to a continuation of surveys and monitoring beyond MES.

- The preparation of a comprehensive plan for flood protection and the improvement of the internal water management of the coastal islands included in the study area; this component referred to as the "development plan". In principle all inhabited islands in the area are included, notably Sandwip, Hatia. However Bhola is excluded from considerations of internal area development (see section 3.2).

The link between the two components lies in the consideration that, while the first will identify the potentials for the reclamation of new land, the second in conjunction with the on-going LRP, will produce models for the development and settlement of new land. Both components are expected to lead to the identification and subsequent implementation of priority projects.

The various relevant FAP and other activities, together with their interactions with MES, are indicated below:

- **FAP4 South West Regional Study:** Immediately to the west of MES, this area includes the Tetulia River which now would fit logically into MES. Close coordination will be necessary in defining conditions and planning development along the common Lower Meghna - Tetulia boundary. Bhola Island, however, is covered by FAP4.

- **FAP5 South East Regional Study (FAP5a).** Sharing a common boundary from Chandpur to the mouth of the Feni River, close coordination will be required for planning the development of the coastal strip and for designing drainage outfalls. One of the main problems to be studied is drainage congestion, related to continuing siltation along the south-east coast.

- **FAP5c Chittagong Coastal Area Study(proposed).** The main area for coordination will be the determination of tidal surge conditions and the effects of future morphological changes, particularly in the Sandwip Channel.

- **FAP7 Cyclone Protection Project.** Covering the design and construction / rehabilitation of coastal (seaward facing) embankments in the MES area, FAP7 is closely related to MES with respect to the letter's hydro-morphological studies and development planning for FAP7's design and programming respectively.

- **FAP9b Meghna Left Bank Strengthening.** Part of FAP's town protection studies, this component covers the hydraulic modelling of the Meghna, including the confluence with the Padma. FAP9b will provide information on the upstream boundary conditions for MES.

- **FAP10 Flood Forecasting and Warning.** The results of FAP10 will be incorporated in the operation of flood / cyclone preparation and management systems which will be form part of MES development plans.

- **FAP11 Disaster Preparedness.** This component will be an important element in the mitigation of the disasters which regularly strike the MES area. Close coordination will be required in the planning and design of operation and management systems.

- **FAP20 Compartmentalisation Pilot Project.** Although this project is situated inland, activities in relation to technical and institutional aspects of compartmentalisation and water management will be relevant to MES.

- **FAP21/22 Bank Protection and River Training (AFPM) Pilot Project.** The results of this pilot trials will have application to MES, even though the emphasis will be mainly on the Brahmaputra/Jamuna rivers.

- **FAP24 River Survey Programme.** The programme of hydraulic and morphological measurements and surveys with associated studies will be particularly important to MES in understanding the future flood regimes of the rivers discharging into the estuary, which will have impacts on the hydrological and morphological conditions in the estuary.

- **FAP25 Flood Modelling / Management Project.** This focus of all FAP modelling activities will be relevant to MES in that it overviews, advises and assists in the coordinated development of all regional models.

  Additionally FAP25 will be developing the Flood Management Model covering all the flood-prone areas of Bangladesh, which will include the MES area.

- **Social/Economic/Institutional and other Supporting Activities.** Coordination with the following FAP activities will be necessary to maintain a consistency in approach and to enhance MES planning process:

  - FAP12 FCD/I Agricultural Review
  - FAP13 O&M Study
  - FAP14 Flood Response Study
  - FAP15 Land Acquisition and Resettlement Study
  - FAP16 Environmental Study
  - FAP17 Fishery Study and Pilot Project
  - FAP18 Topographic Mapping
  - FAP19 Geographic Information System
  - FAP23 Flood Proofing Pilot Project
  - FAP26 Institutional Development Project

In addition to FAP, other initiatives are expected in the MES area; these will be cyclone related activities concerned mainly with rehabilitation and strengthening of existing infrastructure and the construction of new cyclone protection facilities. These projects, most of which still have to formulated, will include main and feeder roads, cyclone shelters, freshwater ponds, food godowns etc. The concerned agencies will include Local Government, Public Health, Education, Roads and Highways, Fisheries and Livestock, Environment and Forestry, Relief, etc.
It will be necessary for MES to coordinate closely with these agencies in the planning and project formulation processes.

4. SCOPE

4.1 Objectives

The objectives of the study are:

1. Planning the development of the project area, giving due attention to:

   - **Surveys.**
     Carrying out a systematic programme of surveys to build up a reliable data base for assessing estuarine behaviour.

- **Master plan.**
  Enhancing the optimum exploitation of the potentials of the area in terms of land reclamation and land use, thus providing new land to landless people.
  The master plan is expected, in due course, to lead to an enhanced morphological stability and eventually to a shortened coast line. It thus aims at a safer environment for sustained human habitation.

- **Land and water use.**
  Mitigating the destructive forces of storm surges(cyclones), thus providing a higher degree of safety to the population and property and improving the productivity of the coastal islands by introducing better systems for drainage,salinity control and water management(development plan). This would include those areas which are at present not protected and which are not covered by FAP 7.

2. Enhancing understanding of the natural forces that shape the physical properties of the area and which largely determine the potential for settlement and development. To the extent that information is available from other FAP studies, of the possible impact of flood protection works along the major rivers on hydraulic and morphological conditions in the rivers, related consequences for the Meghna Estuary should be assessed.

3. An early start to implementation of priority projects and programmes that are compatible with the phased long term and /or development plan. Implementation of works beyond the stage of practical experiments is not included in MES.

4. Practical solutions for an effective continuation of surveys and studies, aimed at sustained and coordinated actions to update and progressively implement the long term plan.

5. Reinforce the capacity of the concerned institutions to survey, investigate, plan, design and implement MES, its projects and long term plan.

4.2 Expected outputs

The expected outputs of the study are expected to include:

1. Plans to enhance the security of the population in the coastal area and on the islands.

2. Plans to strengthen the technical and institutional aspects of water/land management on the coastal islands.

3. Reports describing the hydraulic and morphological processes that shape the area and the changes expected as a result of FAP interventions.

4. Proposals for effective measures to protect existing land and potential reclamation areas against erosion.

5. Approaches and techniques for rapid and low-cost land reclamation, employing local labour and materials to the maximum extent.

6. Small scale interventions using locally available facilities.

7. A literature review of advanced and modern approaches and techniques for rapid land reclamation with associated technology.

8. An indicative master plan for the estuary aimed at a net sustainable gain in land, together with proposals for surveys and studies required for updating the plan.

9. Phased development plan for land and water use (pre-feasibility level), embodying the above approaches and proposals, which includes:

   - strategies for progressive implementation
   - portfolio of projects for implementation in the short to medium term which are expected to be economically. socially and environmentally sound
   - identification of priority activities for early implementation.

10. Preparation of projects and programmes to feasibility level and in a format that will allow GoB to invite donor assistance for immediate execution.

4.3 Approach

The study can be perceived as four distinct but interconnected activities;

- Surveys and studies of the estuaries hydrology, hydraulics and morphology(including small scale interventions).

- A phased long term plan for land reclamation and estuary control(Master plan).

- Comprehensive flood/cyclone protection and drainage plan for the inhabited coastal islands (Land and Water Use Development Plan).

- Priority project and programme formulation, resulting from both master and development plans.

1. Surveys and Studies

Extensive surveys and studies will be needed to determine the basic characteristics of tides, currents, waves, sediment movement etc. as well as of the conditions of water management. Through the survey systems, data collected, equipment, vessel(s) and trained staff, LRP has already provided the basis for these activities. Much information and many relevant data have been collected in the course of LRP. These will be made available to the consultants.

For the planning and design of interventions, two-dimensional mathematical models will probably be needed to describe the hydraulic and morphological processes necessary and to simulate the effects of interventions.

Alternative strategies will have to be tested, selecting eventually a limited number of realistic and practicable options. For the over all coverage of estuary, a one-dimensional model is expected to be adequate. A two -dimensional model of (the upper part of) the Bay of Bengal may be required to establish proper boundary conditions for the one-dimensional model.

The survey studies and modeling activities will lead to improved understanding of the natural processes of accretion and erosion and of the effect of human interventions, both on the main rivers discharging their water and sediment in the area and the coastal area itself. This will enable the preparation of a phased long term plan for the estuary.

The potentials for the reclamation will be identified and a strategy for a phased approach will be determined. The plan should lead to an enhancement of the morphological stability of the estuary and eventually yield possibilities of shortening the coastal line, thus rendering the area less vulnerable to the attacks of storm surges and currents, making it a safer place for sustained human habitation.
Measures to reclaim new land may include the construction of dams linking islands and/or shallow mud flats, thus accelerating colmatage (the process of siltation).
Once the new land is considered safe for permanent habitation, priority will be given to the settlement of landless people, in accordance with the practices already developed under the Land Reclamation Project and to be developed under the Char Development and Settlement Project.

2. Master Plan

Development would be phased so as to allow implementation in self contained stages which could be left to consolidate for some time before the next stage is taken up. The reclamation element of the plan will thus consist of a number of identified "building blocks" embracing technical works or a combination of works needed to bring about designed changes in the area.
Building blocks could consist of cross-dams linking some islands with each other or with the mainland; they could comprise large settling basins where new land is progressively created; and they could include coastal protection works, designed to stabilise the present situation.

Phased implementation of the estuarine region will involve large investments, each of the plan stages requiring considerable capital inputs.
It may take some time to mobilise the necessary resources, even for the first phase of the plan. If too much time were to elapse between project preparation and implementation, the design of the works would probably no longer be fully valid, considering the dynamic character of the area. Even the plan itself might be superseded by events if the anticipated interventions are not applied as planned.
It would therefore be important to identify and initiate preparation of priority projects during the preparation of the long term plan, allowing GoB to start securing finance for implementation. Although the potentials for reclamation of new land would be the main objectives for the preparation of a master plan for the estuary, there are other interests which either pose stringent boundary conditions or need to be made constituents in the plan from the beginning. the navigation route to Chittagong, both for sea-going and for coastal/ inland navigation, should be maintained or even improved, fisheries are an important economic activity and protection of the south-east coastal area should not lead to intensive loss of land through erosion elsewhere. The environmental impact of major interventions will have to be studied carefully.

Surveys and studies of the estuary will clearly be long term, probably permanent activities. Consultants will therefore make an assessment of the technical and institutional requirements beyond MES.

3. Land and Water Use Development Planning

The general approach to planning the development of the estuarine region should follow the principles adopted in the other FAP regional studies. Emanating from the Eleven Guiding Principles of the flood policy study(GoB/UNDP), these are:

- main structural and non-structural options to be identified,
- associated development of protected areas to be assessed,
- all options to be rigorously tested for technical, social, economic, environmental and institutional soundness,
- phased development plan to be evolved, with public participation, using appropriate consultative and selection processes,

- priority projects to be identified and selected including those unprotected areas not covered by FAP 7, on the basis of project impact analyses , which are to be performed in conformity with the FPCO Guidelines for Project Assessment, consideration to be given to the impact that projects,directly or indirectly, could have on the various population groups, in particular women; the special characteristics of the coastal environment shall be given due attention.

The planning components for MES will probably include:

a) Primary Protection Systems

- coastal embankments (including drainage outlets), designed functionally for appropriate tidal surge events and structurally to withstand the forces of cyclones,
- conservation and development of the foreshore,as a necessary measure to protect the embankment,
- coastal defence works, wherever possible and justified to prevent or delay the erosion of the foreshore and embankment.

b) Secondary Protection Systems

- secondary embankments (mainly feeder roads) to protect urban areas and to reduce the effect of flood in the case of primary protection overtopping or failure (compartmentalisation).
- cyclone shelters and raised platforms, as refuges in the case of floods,
- protected freshwater ponds, drinking water, sanitation, food godowns etc.

c) Reclamation

- cross dams and/ or empoldering, designed for effective colmatage systems
- settlements (part of Char Development and Settlement Project)

d) Development of Protected Areas

- water management systems (similar to FAP20), incorporating drainage channels and structures, internal embankments, O&M systems, public participation etc.
- associated development of agriculture, irrigation, communications, forestry, fisheries, livestock, salt pans etc.

e) Non-structural and other Systems

- flood/cyclone forecasting and warning
- disaster preparedness and management
- public health including drinking water
- flood proofing programmes and projects
- environmental mitigation/ enhancement programmes and projects.

Although some of the above components will be implemented outside MES and even outside FAP, they should be considered as part of a comprehensive approach to planning the future of the study area.

4. Priority Projects and Programme Formulation

The long term plan will be structured in such a way so that the magnitude of the interventions along with their investments, will increase gradually as experience is built up. The first phase of the plan will consist of projects that are suitable for immediate implementation.

The interventions in the natural environment are expected to be moderate. The projects expected to result in immediate reclamation of new land or the flood/cyclone protection and drainage of existing land will be subject to the usual financial-economic, social and environmental project assessment, carried out at pre-feasibility level.
It would be desirable to start feasibility studies of high priority projects during the course of preparing the development plan, as is being done in the other FAP regional studies. The general approach for FAP project preparation would apply, including:

- consultation on the project concept and design with beneficiaries, impacted groups, local government bodies and other concerned agencies,

- involvement of beneficiaries and disadvantaged groups, particularly the landless and women in the construction, operation and maintenance of the project,

- identification of environmental impacts and measures for mitigating negative impacts,

- provision of appropriate institutions for implementation and management,

- multi-criteria analyses.

Just as in a general planning, full use should be made of the criteria and guidelines which result from the supporting activities of FAP. The recent guidelines for project assessment(FPCO March 1992), covering economic, social and environmental analyses, will be followed.

In addition to the priority projects, which generally involve structural solutions, non-structural projects or programmmes will have an important part to play in the first year of the plan. Activities such as early warning systems and disaster preparedness require less preparation than the investment related structural projects.

4.4 Institutions and Coordination

From its start in 1978, LRP has been in the port-folio of the Ministry of Irrigation, Water Development and Flood Control. MES will continue under this Ministry, now called the Ministry of Water Resources (MOWR).

However it is recognised that many of the projects, particularly under secondary protection, may be designed and executed by other ministries and agencies. It is therefore essential that these organisations participate in the planning process. A list of organisations which may be concerned with MES is given in Annex 2.

BWDB has been the executing agency for LRP; it has been responsible for the operation of the survey vessels and the laboratory at Chittagong that have been used for the survey part of LRP.

FPCO was responsible of coordinating FAP and for supervising most of the components. WARPO (after the merger with FPCO) will maintain the FAP monitoring and evaluating role and ensure coordination with other FAP components with which the MES consultants have to liaise closely.

For reasons of continuity, BWDB has been assigned as Executing Agency for the Meghna Estuary Study (FAP-5B).

It is considered very important that close linkages be maintained between MES and CDSP throughout the duration of both projects. In order to formalize the coordination:

- the team leader of MES participates, as observer, in the Steering Committee meetings of the CDSP and ,vice versa;
- quarterly coordination meetings shall be held between the two projects and agreed minutes of meetings be forwarded to WARPO, BWDB and the two donors;
- informal meeting shall be held on technical levels as required;
- exchange of all relevant project reports between the two projects should take place as a matter of routine.

4.5 Continuation of surveys and studies

After twenty months the consultant shall submit a technical report with detailed recommendations regarding the institutional arrangements for a purposeful continuation of a programme of studies for the Meghna Estuary, complete with a description of the required facilities, equipment, instruments, staff (number and discipline) and estimate of the initial investments and annual operating cost.

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4.6 General Programme

The generalised programme for MES is shown on Figure 4.

5. TERMS OF REFERENCE

5.1 Introduction

The following terms of reference describe the services to be performed by the consultant. The list and descriptions are not necessarily complete or exhaustive. however the consultant shall perform all the activities needed to satisfy the objectives of the project and to realise the required outputs, as described in sections 4.1 and 4.2 In preparing the proposal for Consultancy Services, the consultant shall provide a detailed description of:

- programme of data collection, surveys and studies
- approach and methodology
- equipment, instruments, hardware and software
- staffing inputs (local and expatriate consultants)
- support staff requirements
- office accommodation and facilities
- vehicles, vessels, etc.

Approval of the above does not relieve the consultant from the responsibility to deliver the specified results. This implies that, if during the assignment, BWDB cannot be reasonably satisfied that the above will yield the required results, the consultant shall modify or replace them to BWDB's and the Donors' satisfaction.

5.2 Preliminary

5.2.1 Review and assess the reports, data, instruments, equipment, facilities and technical and support staff from LRP.

5.2.2 Examine and assess on-going and pipeline studies, projects and other activities, including FAP, which will be relevant to MES.

5.2.3 In conjunction with BWDB and WARPO, establish coordination links with relevant organisations. In order to avoid any duplications or omissions it will be particularly important to establish the roles of the following with respect to MES;

-	FAP4	South West Regional Study
-	FAP5(a)	South East Regional Study
-	FAP5c	Chittagong Coastal Regional Study
-	FAP7	Cyclone Protection Project
-	FAP24	River Surveys
-	FAP25	Flood Modeling/Management

5.2.4 At the end of month 4, submit an inception report which will confirm the approach and methodology and which will firm up the Project Implementation Plan.

5.3 Surveys and Studies

The paragraphs below refer to the items which largely constitute a continuation and development of LRP's activities.

5.3.1 Survey conditions on the coastal islands to establish the extent and causes of flooding and coastal erosion in recent years and to assess the requirements for safety of the population and property and for sustained agriculture-based development. The survey will cover the existing primary and secondary protection systems.

5.3.2 Collect water levels by means of an adequate network of gauges, to be set up and maintained in collaboration with other agencies (BWDB, BIWTA, Port of Chittagong). Wherever justified, automatic tide gauges should be used in conjunction with regularly read manual gauges. Gauges are to be erected where they are expected to have a sufficient lifetime.

If not already done, two concrete benchmarks will be erected next to each gauge. The zero-levels of all gauges are to be connected to PWD datum, either by second order levelling to the nearest Survey of Bangladesh (SOB) benchmark or by means of GPS, with and acceptable accuracy. In this respect, the Consultant will liaise closely with the mapping activities being carried out by Finnmap for BIWTA to avoid duplication.

5.3.3 Carry out velocity, discharge, salinity and sediment measurements at appropriate locations. In view of the tidal influences throughout the area, observation should extend over an adequate period, taking seasonal influences into account.

5.3.4 Measure wave characteristics by means of wave-riders of a type and number appropriate to the prevailing conditions.

5.3.5 Carry out bathymetric surveys in accordance with an agreed plan to be submitted for approval to BWDB at least 3 months before the start of the wet season.

The survey plan will take account of similar surveys by other agencies (BIWTA), will reflect the priorities determined by areas of observed intensive siltation and / or erosion and pollution by intended small scale interventions or by requirements for the preparation of the long term plan. The surveys will be designed to cover the entire area at regular intervals.

Use will be made of the vessels assigned to LRP, the Anwesha and two tenders, supplemented as necessary by boats to be provided by the Consultant.

The overall accuracy of the measurements will be in accordance with the purpose of the surveys. The vessels will be adequately equipped; it may be necessary to enhance the present position fixing equipment and by installing temporary local systems.

5.3.6 Carry out water sampling in the framework of the siltation studies, as well as to monitor water quality in the area. While salinity observations will be done on a routine basis, other water quality observations are not done yet.

However, in order to build up database for water quality in the area, a start will be made with such observations, in accordance with the mandate of BWDB. A comprehensive assessment and description of the present environmental assets of the estuary will be prepared. The Consultant shall carry out all necessary laboratory tests, using the existing facilities and equipment in Chittagong.

5.3.7 Provide systems for data processing, analysis and storage design for easy retrieval and dissemination, particularly for activities to be continued on a routine basis. When selecting and designing his data base and management system the Consultant should give full attention to other related activities in MOWR with a view to facilitating easy exchange of data and full compatibility of system(s) within the Ministry. In addition, basic data should be made available on request to accredited third parties. Bathymetric observations will be processed into conveniently scaled hydrographic charts.

5.3.8 Assess the morphological changes in the area, on a regular basis, to identify areas of apparent rapid siltation and erosion, using the results of the above surveys and relevant information from other sources such as satellite imageries.

5.3.9 Develop appropriate measures to accelerate accretion and decelerate erosion, by means of a low cost approach using indigenous materials and labour intensive methods.

5.3.10 Implement small scale interventions. These will comprise opportunities that are expected to arise during the project in connection with the reclamation of new land or protection of existing land.

In principle small works using local technologies, labour and construction materials which can be rapidly implemented are envisaged. However the use of new technologies and construction materials may be considered also particularly for small scale pilot schemes that are deemed essential for an assessment of the technical feasibility of large scale reclamation or bank protection works using the same technology.

As an example of the type of small scale interventions meant here, it may be recalled that in the past through local initiative and with the help of the local administration and the BWDB, the people of Manpura island have constructed a number of small cross-dams resulting in considerable acceleration of the sedimentation process. Similarly under LRP a cross-dam was constructed in the Daria Nadi resulting in a accretion of about 1000 ha of land. The Consultant will locate and design works of this type and monitor their effectiveness. Construction will be the responsibility of BWDB, with advice from the Consultant. A list of small scale interventions, supported by outline designs and cost estimates, will be provided in month 18 so that construction can be completed in the following dry season.

As an example of the type of new technology vanes or screens for controlling erosion and accretion may be considered; as novel construction material geotextiles[1] could be used. A small pilot scheme using new technology and materials a horizontal curtain made of strong permeable polytheen geotextile shall be installed in the channel between Hatia and Nijhum Dwip islands. The space below the curtain is expected to be filled with sand with a heigth of 1.0 - 1.5 m.
This system has been tested successfully in the Netherlands and elsewhere. The curtain will be installed around 15 March 1997. The performance of the system will be closely monitored. If successful, the screen can be used to build a sill across a channel by catching sand in a natural way under the screen. On top of the sill the cross dam can be build, the screen will provide protection against erosion during construction of the dam.

A pilot scheme for bank protection shall be installed along the banks of Bhola, near Khorki located at the Northeast part of the island. In the past years about 4 km of the island have been eroded and sofar other protective works have not been successful. The proposed bank protection shall consist of screens pointing upstream along the bank line and bottom vanes at some distance from the bank line that will deflect the sediment laden bottom layers towards the bank which will induce accretion along the bank and stop erosion.
For the manufacturing of the screens and vanes geotextile will be used, fabrication will be done on the spot.

The screen and vanes will be anchored in the river bed by anchor plates and chains to be jetted into the river bed prior to the installation of the screens/vanes and will be protected by horizontalcurtain provided with ballast. Installation of the anchor plates and chains as well as the vanes/screens shall start about 1 April 1997 and shall be completed two months later.

After installation, the performance and behaviour of the works will be monitored closely. In particular the accretion/erosion pattern will be surveyed frequently throughout the monsoon season by detailed and accurate echosounding.

5.3.11 The feasibility of reclaiming land along Nijhum Dwip at the southern end of Hatia Island as studies under LRP, will be reassessed. The primary objective will be to test the measures of reclamation by means of timely-applied, low cost methods of closing tidal channels thus accelerating the siltation process.
If there appears to be a good case for the early reclamation of substantial areas of new land, the input of the Ministry of Lands will be enlisted to in connection to the allocation of land to landless people, including appropriate selection procedures.

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[1] The following remarks have been made by BWDB/LAED:
Geotextile is a banned item. Permission has been given for Pilot Scheme in FAP-21 and FAP-22 which will expire on June 1997. The consultant may apply the modern technology if GoB agrees and the consultant can arrange geotextile during this working season. GoB also requires to pay CDST and VAT for this item which is not provided in TAPP. Two number Pilot Scheme s may be considered if GoB agrees to provide additional Tk. 10(ten) lakh for CDST and VAT as estimated by the consultant, otherwise small scale interventions should be implemented as provided in the original TOR.

The re-assessment should address all technical, socio-economic, environmental and institutional dimensions, of the project. Wherever appropriate, the guidance of CDSP will be sought; see also para 2.1. A report on the feasibility of Nijhum Dwip reclamation will be submitted in April 1997. The report will include an evaluation of the effectiveness of the horizontal curtain to catch sand about one month after installation.

Provided that the test is successful, the Nijhum Dwip cross dam shall be implemented as a small scale intervention. The works shall use local technologies, labour and construction materials in combination with new technologies and materials which can be rapidly implemented and will result in a low cost structure. The Consultant will locate and design the Nijhum Dwip cross dam and monitor the effects of the dam with regard to accretion and erosion. Construction of the cross dam will be the responsibility of BWDB, with advice from the Consultant.

The horizontal curtain with related protective works shall be installed in December 1997. The preparation for construction of the cross dam body shall start from 1 November 1997.
After filling below the curtain, the construction of the gunny bag cross dam body shall start about 15 January 1998. The cross dam shall be completed 1 April 1998.

5.3.12 Support to the CDSP for preparation of a feasibility study of the Muhuri accretion including establishment of its technical, social, economic and financial feasibility, the institutional setting and the long-term viability.

5.3.13 Use the existing one-dimensional model of the Lower Meghna Estuary, which has been set up and applied by the SWSMP-II under the SWMC to stimulate the hydraulic and morphological processes in the estuary and to predict the effects of interventions. In doing so the Consultant shall draw on all available experience from the NETFLOW model established under the LRP project.
With due recognition of already existing models, develop appropriate two-dimensional models as may be required for specific detailed studies or to establish boundary condition for the one-dimensional model.

5.3.14 Make an assessment of the available capabilities in the country with respect to hydrographic surveying of coastal waters of Bangladesh, and put forward proposals for optimum institutional arrangements for the continuation of a required routine programme of surveys and studies after the expiry of MES. Proposals should include the required facilities, equipment and staffing, together with an estimate of the initial investment and annual costs. A report on this matter should be issued in month 18.

5.3.15 Prepare technical reports and working papers on special aspects of the surveys and studies. These will be submitted periodically during the course of the assignment.

5.3.16 About twelve months before the end of the project, submit a report with proposals for the continuation of surveys and studies in phase 2 containing the following.

- status of surveys, studies and modelling
- status of vessels, equipment and facilities
- status of technical staff and training
- proposals for continued surveys, studies and modelling activities accompanied by requirements for staff, equipment and facilities, institutional arrangements and estimates.

5.4 Master Plan

5.4.1 Prepare a phased long term plan, the main characteristics of which are described above. Due attention to be given to the anticipated environmental impact of the main phases of the plan.

5.4.2 In month 18 submit an interim plan for the physical development of the estuary which will provide provisional criteria for planning protection systems and reclamation. These will be essentially for priority and short term development.

5.4.3 In month 33, submit a draft master Plan report of the physical development of the estuary, which will contain the following:

- description of the processes of accretion and erosion
- hydrological and hydraulic criteria for planning and designing protection systems
- assessment of the methods and potential for land reclamation
- initial environmental evaluation (IEE), covering the effects on navigation, fisheries and other environmental aspects
- provisional long term plan for the estuary, taking upstream developments into account

The report will be supported by descriptions of all the activities undertaken with the appropriate technical reports and working papers appended. The report will be accompanied by data volumes and map boxes. The data will also be submitted in disk form.

5.4.4 Following FAP review procedures, finalise the Master Plan Report.

5.5 Land and Water Development Plan

5.5.1 Collect data and carry out surveys to establish the existing state of development on the estuarine islands. The pre-feasibility level surveys will cover:

- geomorphology and soils (including new char lands)
- water and land management (including drainage and reclamation)
- agriculture (including irrigation)
- livestock and fisheries
- coastal afforestation
- salt pans and other rural activities
- social conditions (including land tenure) and settlements,
- institutions

- markets, roads, navigation, telecommunications, public health, education, etc.
- primary and secondary protection systems, together with disaster preparedness, forecasting and warning provisions.

5.5.2 Assess alternative strategies for flood/cyclone protection, reclamation and the development of protected areas, taking into account current policies, planning, pipeline projects and relevant criteria being developed under FAP supporting studies and pilot projects. The strategies to be examined should included non-structural elements, either as alternative or as complementary options. The strategy assessment process should include consultations with beneficiaries disadvantaged groups, government (inc. local), NGO's and other concerned bodies.

5.5.3 Develop and assess options for primary and secondary protection, reclamation, development of protected areas and non-structural systems as defined in section 3.3. The assessment, which will be carried out at pre-feasibility level of detail, will include:

- general arrangement / outline design, broad cost estimates and O&M provisions for structural interventions and non-structural programmes, including the improvement of existing facilities;
- provisions for the involvement and participation, at various project development stages, of beneficiaries, landless groups; women, fishermen and other affected groups;
- benefits to agriculture, forestry, fisheries (incl. shrimp cultivation), salt pans, betel nuts, etc.;
- generalised benefits to other aspects of the rural economy and infrastructure, including commerce, industries and communications
- social impacts in terms of safety, general security incl. settlements and property, rural together with the broad costs of measures to mitigate any negative impacts,
- IEE report describing environmental impacts together with the broad costs of measures to mitigate any negative impacts.

In carrying out the above assessments the consultant will follow the Guidelines for Project Assessment (FPCO) July 1991).

5.5.4 Prepare an initial phased development plan for submission in the interim development Plan Report in month 21. The preliminary plan for the MES area will comprise the following, with identification of projects and preliminary allocation of priorities:

- primary protection systems
- secondary protection systems
- development of protected areas
- non-structural systems,

together with a provisional assessment of:

- institutional requirements
- economic and financial viability
- social and environmental impacts.

5.5.5 Make recommendations in the Interim Development Plan Report for priority projects and programmes that can proceed to the project / programme preparation stage in advance of the finalisation of the overall development plan. Appropriate justification of early preparation and probable implementation should be given.

5.5.6 In month 33 submit the draft Development Plan Report. Preparation of the final plan will include the following processes and procedures:

- review and discussion with concerned agencies,
- updating, modifications and elaborations as a result of continued surveys and studies, and on-going development, eg:
    - estuarine hydrology, hydraulics, morphology and modelling with particular reference to reclamation methods and potential, impact of internal and external interventions, and results of small scale interventions
    - social, environmental and institutional studies in this project and in other FAP activities
    - project activities such as FAP7 Cyclone protection Project, other relevant FAP components and those of other ministries and organisations
    - feedback from the preparation of priority projects and programmes
    - feedback from the Char Development and Settlement Project
- in the light of the above, confirmation or revision of the component projects of the plan
- pre-feasibility level economic, social and environmental impact analyses
- preparation of the Development Plan, with phasing, identification of first stage projects, financial requirements and institutional recommendations.

5.5.7 Make recommendations in the draft Development Plan Report for projects that can proceed to project preparation at an early stage. The Report should include draft project formulations and terms of reference.

5.5.8 Following review and discussion with concerned parties, in accordance with the FAP review procedure, finalise the Development Plan Report.

5.6 Preparation of Priority Projects and Programmes

5.6.1 Depending on the Interim Master Plan (month 18) and the Interim Development Plan (month 21) and on the agreement of the FAP Review Committee and the Technical Committee, initiate preparation of priority projects and programmes. Project preparation is scheduled to start in month 22 and is scheduled to be completed by month 33 (see Figure 4), thus providing limits for the extent and scope of project preparation.

5.6.2 Project preparation will involve the following steps:

- consultation on the project concept and design with affected social groups in the project area, local government and other concerned agencies
- outline designs and cost estimates of works
- O&M requirements and estimates of recurrent and replacement costs
- arrangements for involvement and participation of beneficiaries and disadvantaged groups in the construction and O&M for the project
- institutional provisions for implementation and management, where possible with the involvement of local government
- social impact analysis
- cost estimates of measures to mitigate any adverse impacts
- economic and financial analyses
- environmental impact assessment report (EIA)

The above should be carried out at full feasibility study level and in accordance with the Guidelines for Project Assessment.

5.6.3 Carry out programme preparation. This would comprise non-structural activities implemented in advance of, or in parallel with, any structural interventions or as stand-alone programmes. The procedures for preparing programmes will follow the same principles as for project preparation.

5.6.4 By month 31, submit draft Project / Programme Preparation Reports for consideration by the Review Committee.

5.6.5 By month 33, submit the final Project / Programme Preparation Reports, embodying the recommendations of the Review Committee and including draft Concept Papers and Project Proformas (PP's). All these documents will be submitted, through the Review Committee, to the Technical Committee.

6. REPORTING

The following reports will be produced (see Figure 4):

Month 4	Inception Report
Month 14	Proposals for small scale interventions to be implemented in the period February 1997 - May 1997
Month 18	Proposals for small scale interventions to be implemented in the period November 1997 - April 1998
Month 18	Feasibility Report on Reassessment of Nijum Deep Reclamation
Month 20	Interim Master Plan Report
Month 20	Proposals for continuation of Surveys and Studies in the Meghna Estuary including Institutional Arrangements
Month 22	Interim Development Plan Report
Month 31	Draft Project/Programme Preparation Report(s)
Month 33	Project/Programme Preparation Report(s)
Month 33	Draft Master Plan Report
Month 33	Draft Development Plan Report
Month 35	Master Plan Report
Month 35	Development Plan Report

Technical reports, notes and working papers will be produced during the course of the assignment, together with monthly progress fact sheets and quarterly reports. Unless instructed otherwise, the Consultant will produce at least 50 copies of all reports and will submit the word processing, spreadsheet and graphics files on diskette.
All reports are to be submitted to WARPO who will take care of further distribution; two copies each are to be submitted to the donors.

7. PROJECT DURATION AND SCHEDULES

The duration of the Project is 35 months with start date 1 November 1995.
The schedule of activities shown in Figure 4 is provisional and will be firmed up after submission of the Inception Report. However, any changes proposed by the Consultant, should remain within the limits of the agreed budget and time schedule.

8. ORGANISATION AND STAFFING

8.1 Organisation

MES will form part of the flood Action Plan, with WARPO taking responsibility for overall coordination. The project will pass through the established procedures of coordination, reporting, review and approval as for all FAP components.
WARPO will take responsibility for the supervision of the planning and project preparation activities, and will appoint a Superintending Engineer/Principal Scientific Officer as coordinator for MES as well as the necessary counterpart staff particularly in planning and coastal morphology.

The executing agency for the project will be BWDB. BWDB will appoint a Project Director for day to day project supervision and assistance[2] .

A Steering (or Coordination and Advisory) Committee, with members form relevant GOB agencies and ministries, will provide guidance and supervision. The Committee will meet quarterly or more frequent if required. Members are:

- Chairman (from BWDB)
- WARPO Principal Scientific Officer (secretary)
- BWDB Project Director MES
- Co-opted members from BIWTA, WARPO (SWMC), RRI, Ministry of Land, Ministry of Relief, Ministry of Planning, Ministry of Agriculture, Ministry of Environment and Forests, Ministry of Local Government, Ministry of Fisheries and Livestock
- BWDB Project Director CDSP
- Consultant's team leaders as observer
- CDSP team leader as an observer

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[2] The BWDB/LAED remarked that the following sentence should be added here:
BWDB should continue to operate the survey vessels and the laboratory in Chittagong after completion of the project.

On the donor side, DGIS will act as the coordinating agency on behalf of the Danish and Dutch governments. Through their missions in Dhaka the donors will consult with WARPO on policy issues.

DGIS will be responsible for invitation of tenders and selection of the Consultant following procedures agreed with DANIDA.

The Consultant's team will undertake the necessary project activities and be responsible to WARPO for achieving the specified outputs.

The Consultant's team leader will cooperate closely with the Project Director.

The Consultant will associate with (a) local consultancy firm (s) and operate as a coherent team, jointly with the counterpart staff attached to the project.

The Consultant will maintain an office in Dhaka for planning and project preparation. The counterpart staff attached to the project will be accommodated in the Dhaka office The team leader of the Consultant will visit the Chittagong office regularly for discussions with the SSD staff[3] .

During the marine surveys with "Anwesha" the Consultant will liaise closely with the Executive Engineer of BWDB Surveys and Study Division in Chittagong.

The Consultant will appoint a laboratory engineer who will supervise the laboratory works and provide training and guidance to the laboratory staff.

8.2 Staffing

The study is expected to require a total of 695 man months of international and local consultants. A provisional staffing list is shown in figure 5 as an indication of the disciplines and numbers of personnel; however, the Consultant is expected to use his own judgement in formulating his staffing arrangement.

It is expected that about 520 staff months of the Consultants' input may be adequately and economically provided by the local consultants, a block provision of at least 150 staff months should be made for junior engineers to ensure on-the-job transfer of technology.

As this project would require major efforts in surveys and studies it is required that the local and international professional staff (not including the 150 staff months of junior engineers), have appropriate post graduate qualifications.

The Consultant's proposal will contain a complete list of disciplines and related staff.

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[3] BWDB/LAED made the following remarks:
As per decision taken in the meeting of Chief Engineer, Planning , BWDB on 6.10.96 (i) Survey and Study Division (SSD),BWDB, Chittagong would be the local office for conducting survey and data processing (ii) Right at this moment, survey and study Division would continue survey work and data collection, processing and storage etc. the consultant would set up offices at Chittagong for carrying out survey work, data processing and related work together with Laboratory works.

8.3 Training

8.3.1 The government staff presently attached to the survey and study component of LRP will be deputed to the project team as from the start of the project; their normal payroll costs will continue to be borne by GOB.
It is expected that by month 15 the full team of government staff, deemed necessary for the continuation of surveys and studies after expiry of the project, will be deputed to the project team under the same conditions.

8.3.2 Training will be an important project element, covering all activities of the project. Notwithstanding its project responsibility, the Consultant will delegate as much of the routine activities as possible to the counterpart staff.

The Consultant will be required to train counterparts in surveys and the operation of models suitable for handing over to the responsible Bangladeshi organisation after completion of the project.

The Consultant will carry out all the on-the-job and more formal training activities considered necessary for effective transfer of technology.

The budget includes a Provisional sum for formal and semi-formal training of local staff proposed jointly by the BWDB and the Consultants. The staff may be drawn from government and private organisations.

8.4 Vessels, equipment and Facilities

The existing survey vessels, the Anwesha and its two tenders will be handed over by the Owner to the Consultant for the duration of the project, including the regular crew. The Consultant is responsible for the proper operation of the vessels and shall bear all operation and maintenance cost, both regular and incidental. The cost of insurance for "Anwesha" and its two tenders as well as the cost of renewal of Lloyd's certificates will be born by the Government of Bangladesh.[4].

The responsibilities of both parties will be described in a Memorandum of Understanding between the Project Director Directorate of LAED, BWDB (MES) and the Team Leader Meghna Estuary Study regarding Operation and Maintenance survey vessel "Anwesha" during MES.

At the end of the project the vessels shall be handed back to the Owner in good running condition.

The laboratory of SSD/BWDB at Chittagong, including existing equipment and instruments, will be made available to the Consultant for the full duration of MES.

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[4] BWDB/LAED made the following remarks:
1. The vessel should exclusively be used for survey works.
2. The Anwesha and its two tenders are the property of BWDB. So these should be handed back to BWDB in good running condition.
3. The cost of insurance and renewal cost of Lloyd's certificate should be paid by the consultant during MES

The Consultant will be responsible for the operation and maintenance and will bear the related costs, and will hand back the same or identical facilities, in good working order, at the end of the project. While preparing his proposal, the Consultant shall ascertain the type, number and condition of the equipment, instruments and facilities that are to be made available, and shall make provision in his proposal for any addition or replacement he considers necessary.

Any additional equipment required for the purpose of the project shall be handed over to GOB upon completion of the project and the institutional capacity to operate and maintain such equipment shall be established by the Consultant during the course of the MES.

The survey approach to be proposed by the Consultant, both with respect to its scope and use of technology, shall be based on the requirement that the GOB[5] is able to sustain an identical programme beyond the duration of the MES.
Hence the selection of (advanced) survey equipment, which will be handed over to the GOB upon completion of the project, shall be carefully considered by the Consultant in view of future use.

The Consultant will procure 5 Nos. 4WD vehicles and 1 No. Pick-up for the purpose of the project; 3 Nos. 4WD vehicles will be used by the Consultants.

After completion of the project, GOB will take full responsibility for the operation and maintenance of all equipment, instruments and facilities, handed over by the Consultant, which are necessary for the continuation of surveys and studies.

9. RESPONSIBILITIES OF THE GOVERNMENT

9.1 Freedom from Taxation And Duties.

The Government / Executing Agency shall bear the cost of any taxes, duties, fees, levies and other impositions under the laws and regulations in effect in Bangladesh on the consultants and expatriate personnel in respect of:

- any payments made to the consultants or their personnel other than Bangladesh nationals, in connection with the carrying out of services;
- any materials, equipment and supplies brought into Bangladesh for the purpose of carrying out the services and which after having been brought to the country will be subsequently withdrawn therefrom;
- any equipment imported for the purpose of carrying out the services and paid out from the funds provided by the Government and which is treated as property of the Government.

Provided that :

(a) If the Consultant or any of the expatriate personnel shall follow the usual customs procedure of the Government in importing property into Bangladesh;

(b) If the consultant or any of the expatriate personnel does not withdraw, but disposes of any property in Bangladesh upon which custom duties and taxes have been exempted, the consultant shall bear such custom duties and taxes in conformity with the regulations of the Government.

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[5] BWDD/LAED made the following remark:
"GoB" should be replaced by BWDB as mentioned in original TOR

9.2 Other Privileges and Exemptions

The Government shall :

- provide the expatriate personnel with work permits and such other documents as shall be necessary to enable them to perform the services including privileges specified in the Government of the people's Republic of Bangladesh notification no/R 88-L/85/906/CUS dated 13th February, 1985 and no/RO 89-/85/907/CUS dated 13th February, 1985 (circular of 1988 is to be incorporated);

- arrange for the personnel and his authorised dependents to be provided promptly with all necessary exchange permit and travel documents required for their stay in Bangladesh;

- facilitate clearance through customs of any property required for the services and of the personal effects of the expatriate personnel and the prompt issue to the consultants expatriate personnel of Custom Pass Books;

- issue to the officials, agents and representatives of the Government all such instructions as may be necessary or implementation of the services;

- exempt the consultants and the personnel for the services from any requirement to register or obtain any permit to practice the profession of Engineer, Architect or other profession, or to establish himself either individually or as a corporate entity according to the laws of Bangladesh;

- arrange for duties or taxes on the imported equipment, vehicles and other materials relating to the project which and other materials relating to the project which will be retained in Bangladesh, to be paid by the implementing agency in Bangladesh.

9.3 Services, Facilities and Equipment

- The Government shall provide assistance to collect pertinent data, maps and information available for the performance of the Services under this Contract. Any cost incurred, except for direct reproduction cost, will be reimbursed by WARPO.
- The executing agency shall furnish the Consultant with such information relating to the Services and the Project as the Consultant may, from time to time, reasonably request.
- The Government shall, if available, provide accommodation in the Government Guest House at usual rate.
- Indemnify, save and hold harmless the Consultant and its personnel from and against all claims, demands or suits, that may be made or brought against the Consultants and the personnel arising directly from the performance of the services provided that, such claims, demands or suits are not the result of negligence or wilful acts of the Consultants and its personnel.

10. RESPONSIBILITIES OF THE CONSULTANT

10.1 Responsibility of Consultant

The Consultant shall carry out the services as detailed in "scope" and "Terms of Reference" in the best interest of the Government for the successful realisation of the project with all reasonable care, skill and diligence with sound engineering, administrative and financial practices and shall be responsible to Contracting Party and the Executing Agency for the discharge of responsibilities.

The consultant shall during the execution of the services appoint and designate a Team Leader to represent the Consultant in Bangladesh in all matters relating to the services.

The Consultant shall be responsible for the professional and technical competence of its employees and personnel's behavior and shall use its best efforts to select and employ for work in Bangladesh only on those persons who in its judgement will be the best and most likely to perform satisfactorily the terms of their employment.

The Consultant shall keep accurate and systematic records and accounts in respect of the services in such form and detail as is customary in the profession and shall be sufficient to accurately establish the costs and expenditures incurred for the services.

Except with the prior approval of the Netherlands Government and the Executing Agency the Consultant shall not at any time communicate to any persons or entity not connected with the services any confidential information, disclosed to them for the purpose of the services or disclosed by them in the course of their services, nor shall the Consultant or the Consultant's personnel make public any information relating to the services.

The Consultant shall be responsible in respect of life, health, accident, travel and other insurance which may be necessary for the Consultant's personnel for the purpose of the services.
All existing rules and regulations of the Government of Bangladesh related to the classification, custody and issue of restricted map, aerial photograph and other related data shall be maintained.

10.2 Information

The consultant shall furnish the Netherlands Government and the Executing Agency with such information relating to the services and project as the Executing Agency may from time to time reasonably request.

10.3 Assignment, Sub-contractors

Except with prior written approval of the Contracting Party and the concurrence of the Executing Agency, the Consultant shall not assign or transfer the contract or any part thereof nor engage any independent Consultant or Sub-Contractors to perform any part of the services other than nominated personnel listed in the contract.

The approval of the Contracting Party to the assignment of any part of the Contract or to the engagement by the Consultant of independent Consultants or sub-contractors to perform any part of the services shall not relieve the Consultant of any of his obligations under this contract.

10.4 Prohibition on Conflicting Activity

No member of the personnel assigned to this Project shall engage, directly or indirectly either in his name or through the Consultant any other business or professional activities in Bangladesh during the performance of his duties or assignment under this contract.

10.5 Laws and Regulations of Bangladesh

The Agreement on the Technical Cooperation between the Kingdom of the Netherlands and the People's Republic of Bangladesh signed in Dhaka on May 19, 1977 will be applicable.
The consultant shall respect and abide by all applicable laws and regulations in Bangladesh and shall use his best efforts to ensure that the Consultant's personnel and their dependents while in Bangladesh and local employees of the consultant shall respect and abide by all laws and regulations of Bangladesh.

10.6 Ownership of Drawings, Data and Reports

Article 5 of the Agreement on Technical Cooperation referred to in section 9.5 above, shall be applicable.

10.7 Reports and Communication

All reports, communications, recommendations and general correspondence from the Consultant to the Executing Agency under the Agreement shall be in English language.

10.8 Notice of Delay

In the event the Consultant delay in obtaining the required services or facilities set forth in this contract for the conduct of the services, or the occurrence of any event or condition that might delay or prevent completion of the services in accordance with the time schedule, the Consultant shall promptly notify the Contracting Party and the Executing Agency of such delay indicating what steps are being taken or suggested by the consultant to meet the situation and may request an appropriate extension of time for completion of the services.

11. FINANCIAL PROVISIONS

The budget cost of the project is US$ 7.180 million with price contingencies.

Technical assistance to an amount of US$5.385 net of duties and taxes but excluding price contingencies, will cover the following costs:

- internationally recruited consultancy (to a maximum of 175 staff months);
- local consultancies (approximately 520 manmonths);
- surveys, modeling and studies;
- instruments, equipment, transport;
- operational costs (including vessels and laboratory in Chittagong).

Financial Assistance to an amount of US$ 500,000 to cover the costs of small scale interventions.

A summary of the Technical and Financial Assistance costs is given below in 1,000 US$ (see also Annex 3) :

	Year 1 95/96	Year 2 96/97	Year 3 97/98	Year 4 98/99	Total
Technical Assistance	1,000	2,400	2,100	385	5,885
Financial Assistance[6]			P.M.	P.M.	P.M.
Sub Total	1,000	2,400	2,100	385	5,885
Price Contingencies	50	120	110	15	295
Total	1,050	2,520	2,210	400	6,180

The Government of Bangladesh will finance the remaining project costs approximately US$ 1.0 million, to include taxes and duties, land acquisition, relevant Government provisions for staffing and office accommodation.

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[6] BWDB/LAED made the following remark:
Diversion of US$ 0.5 million (F.A.) may be allowed if agreeable by GoB, in view of the proposed pilot project i.e. bank protection using geotextile screen & vanes & construction of cross-dam using geotextile curtain to adopt the new technology in Bangladesh as a new type of intervention for future deployment

A further amount will be made available to cover the taxes relief on imported personnel belongings etc., in accordance with the relevant Articles of Agreement on Technical Cooperation between the respective donors(Netherlands and Denmark) and the People's Republic of Bangladesh. The balance of GoB's contribution would be made available through annual budget appropriations in conformance with the project implementation schedule. The approval of the project Concept Paper would be a condition of the effectiveness of the provision of the foreign financial and technical assistance.

Annex - 1

LAND RECLAMATION PROJECT (LRP) 1977 - 1991

1. Introduction

1.1 General

In 1975, the Bangladesh Water Development Board (BWDB) proposed technical cooperation with the Netherlands in the fields of land reclamation and estuary control. Following the recommendations of an identification mission sent in the same year, an agreement, arranging technical cooperation between Bangladesh and the Netherlands, was signed in Dhaka on May 19, 1977. The administrative arrangement for the LRP was signed on October 29, 1979.

1.2 Project period 1977 - 1980

The LRP started in December 1977. Initially, the Plan of operations covered a period of three years until the end of 1980. The project area is located in the eastern delta of Bangladesh, comprising an area of approximately 6,000 km2 between the Tetulia River and the coast of the Chittagong mainland and from the Lower Meghna to the Bay of Bengal.

The objectives of the LRP were defined as follows:

1. to set up an organisation within the Bangladesh Water Development Board (BWDB) to carry out surveys and studies in order to develop a longterm policy for land accretion works in the south-eastern coastal area of Bangladesh;
2. to try out various methods to accelerate the accretion of land, in order to define those methods that are feasible in Bangladesh;
3. to implement an experimental test scheme with the purpose to promote a quicker and more effective use of newly gained land, so that food production is increased and conditions are viable for poor farmers.

In February 1978, a mission from the Netherlands visited Bangladesh and the scope of the work was defined in more detail. During the first year the project operated on a modest scale. The organisation (office, personnel) was built up, equipment was imported, a laboratory for analysing water and sediment samples was established and the training of personnel was started.

Emphasis was given to the preparation of survey activities. The BWDB made available the river-survey launch ML Ganges in order to enable an early start of the survey activities. In May 1980, the new survey vessel MV Anwesha, constructed in the Netherlands and especially designed to meet the LRP requirements, arrived in Bangladesh.

Trials were started to test land accretion methods with sedimentation fields at two locations north of Chittagong.

On Char Baggar Dona, situated between Ramgati and Char Jabbar in the Noakhali region, an area of about 1600 ha of reclaimed (khas) land was selected for the construction of the agricultural test scheme. Within this area for the future Pilot Polder, the construction of a 40 ha research plot was started. In this plot an agricultural research programme was planned.

Based on the results of the research programme, recommendations on water management, land use and cropping practices in the future Pilot Polder had to be formulated at a later stage. Then these recommendations were to be tested and evaluated under farmers' conditions in the Pilot Polder.

A logical step following the reclamation of new land is the settlement of farmers in the new areas. Land occupancy in Bangladesh is strongly governed by economic and political factors. Officially, khas lands are owned by the Bangladesh Government and will be distributed among landless farmers. However, the impression was obtained that in practice, a large part of the newly accreted lands, although Government property, falls in the hands of the rural elite of the area. The lands are then either worked by tractors and labourers or given out to share-croppers, who have no legal rights to the land and pay 50 to 75 percent of the yield to the landlord. The profits of the new land should go to the people who actually cultivate the land, being the landless farmers who lost their land because of floods or erosion. Land reclamation, an effective use of the new land and settlement on the land are strongly related. For that reason, it was recommended to start an experimental settlement project simultaneously with the development of the Pilot Polder. In a separate effort, although closely related to the LRP, the formation of cooperatives of landless people to be settled in the Pilot Polder was initiated with the help of the national non-governmental organisation Nijera Kori.

The project activities executed during the period 1977 - 1980 have been extensively reported upon in the Interim Report of January 1981.

1.3 Project Period 1981 - 1982

At the start of the project in 1977, it had been anticipated that planning and execution of land reclamation works is a matter of many years. Thus, at the end of the first project period, it was decided by the Governments of Bangladesh and the Netherlands that the project was to be extended. A project document (PC II) was prepared by the BWDB, covering the period from July 1980 till July 1984. This document was approved in February 1983 by the Government of Bangladesh, Ministry of Finance and Planning.
From the Netherlands side an extension of the project for 1981 and 1982 was formulated during the annual bilateral discussions in Bangladesh in 1981. The objectives of the project remained unchanged.

Considerable progress was made with respect to the collection of data on hydraulics, sedimentology and bathymetry of the estuary. In principle, the complete project area was sounded. Also, a topographic survey of Urir Char, an accreting Char north of the island of Sandwip, was carried out.

A start was made with the development of a mathematical model describing the tidal flow in the area between Bhola Island and the Chittagong coast.

Accretion trials were continued on the sedimentation fields at north Kattali and Sitakunda along the Chittagong coast. In 1982, in the Noakhali region, the Daria Nadi, a tidal channel north of Char Lakhi was closed. Since then, regular surveys have been executed to monitor the rate of accretion at the seaside of the closure. The main objective of this experimental closure was land reclamation. A drainage channel and a water control structure were included to drain excess surface water and to protect the drainage are from salt water intrusion.

On Char Baggar Dona the construction of the research plot was completed. The soil and agricultural studies and the first trials in the research plot were started. The processes were monitored, the data were collected and processed. Survey and preliminary design activities for the construction of the Pilot Polder were carried out.

Nijera Kori, a non-governmental organisation, was engaged to undertake the organising of cooperatives of landless farmers. A number of male and female groups were formed and applied for registration and for the allocation of government land.

At the end of 1982,an external evaluation took place by a mission appointed by the Governments of Bangladesh and the Netherlands. In their critical assessment of the project the mission put forward three important questions;

- is it possible to gain new land in the south-eastern part of the delta with means appropriate in the context of Bangladesh?
- what are the chances of settling genuinely landless families on the reclaimed land, and
- what are the chances to keep those families there ?

It was concluded that none of these questions could be answered at that time. The mission doubted whether the hydrographic surveys would lead to conclusions regarding reclamation activities on a scale that is feasible for Bangladesh. What the project was exploring with respect to the attempts to secure the land leases in the Pilot Polder for the settlement of landless people, going through the whole process of selection, claims and counter-claims, intimidation, inertia, etc., was considered of great value for possible future reclamation schemes. The project appeared to be highly relevant for the logterm policy on land reclamation in Bangladesh and also for the Netherlands development policy towards Bangladesh.

The project activities executed during 1981 and 1982 have been extensively reported upon in the Second Interim Report of December 1983.

1.4 Project period 1983 -1984

On the Bangladesh side the running PC II covered the continuation of the project up to mid 1984. From the Netherlands side the project was extended for another period of two years.
The objectives of the LRP remained unchanged. The activities for the period 1983 - 1984 were outlined in an updated plan of operations.

The data collection and hydrographic survey continued. Repeated soundings and coastline surveys were executed to monitor erosion and natural accretion in specific areas in the estuary. A start was made with the longterm planning of land reclamation works.

The development of the two-dimensional mathematical model on the water movement in the south-eastern estuary was completed.
A number of specific studies were carried out, such as a general morphological study of the estuary, a pre-feasibility study of erosion protection and land reclamation at Sandwip and Hatia islands and an evaluation of the applicability of the field method to accelerate sedimentation.

Monitoring of the accretion trials along the Chittagong coast and at the Daria Nadi closure were continued. Agronomic trials in he research, data collection for the design of the Pilot Polder, extension activities of Nijera Kori with respect to the formation and strengthening of the cooperatives were also continued. A great part of the perimeter embankment of the Pilot Polder was constructed.

Since mid 1983 progress and construction of the LRP was seriously hampered. Project activities, especially the activities related to the completion of the Pilot Polder, were delayed because of the numerous problems that were experienced with the allocation of the land of the Pilot Polder to the cooperatives. The mid - term review meeting between the Governments of Bangladesh and the Netherlands in September 1984 resulted in a more optimistic outlook for the future of the LRP. At the meeting it was concluded that the pre-feasibility study on erosion protection and land reclamation at Sandwip Island would be followed up by a fullfledged feasibility study on the construction of a crossdam between Sandwip Island and Noakhali mainland.

At the end of 1984, in an extraordinary issue of the official Bangladesh Gazette, it was stated in relation to all claims on the land in the Pilot Polder in the relevant part of Char Baggar Dona that "rent receipts and corresponding holdings have been found to be fraudulent, forged and fabricated and therefore declared henceforth too be inoperative in the eye of law". This important official statement paved the way for the actual allocation of the land in the Pilot Polder to the landless cooperatives.

1.5 Project Period 1985 -1986

At the Mid-term Review Meeting in September 1984, it was concluded that in order to fulfill the project objectives, a further extension of the project was required. The Bangladesh project document PC II, covering a period of three years up to July, 1987, was drafted. On the Netherlands side the Plan of Operations 1985 - 1986 was prepared.

During the previous phases of the project the attention had been focussed on the collection of hydrographic and hydrosedimentological data in order to study the general hydraulic and morphological conditions in the south-eastern delta. Methods that stimulate the natural accretion of land had been tested. Furthermore, data on land use and water management had been collected and the construction of Pilot Polder had been stated.

An experimental agricultural and land development scheme, aimed at optimum agricultural yields on newly accreted lands, had been started and experience was being gained with the planning and execution of land reclamation works and water management, including the legal and administrative procedures for cooperative land use.

These study aspects of the LRP were to be continued.In the meantime, the project had identified a number of specific projects in the field of erosion protection and land reclamation. It was decided that the future LRP would be more involved in project-related feasibility studies and the implementation of specific land reclamation projects. The LRP objectives were slightly modified in order to cover the wider scope of the project. One of the specific projects was the Sandwip Crossdam Project, for which a pre-feasibility study had been carried out in 1984. Early 1985, a full-scale feasibility study started on the Sandwip Crossdam Development Scheme. A separate study team was formed, LRP staff being a part of this team. Most of the activities executed in this project period were focussed on the Sandwip Crossdam feasibility study.

Mid 1986, the construction of the sluice, the perimeter embankment and a large part of the drainage system of the Pilot Polder were completed. The internal development of the polder was delayed because of again serious problems with the allocation of the land of the Pilot Polder to the landless cooperatives.It was not until June 29, 1986 that in a violent confrontation, a detachment of police supported by 1000 landless farmers expelled a force of several hundred representatives of land-grabbers from Char Baggar Dona and the cooperatives finally gained possession of the land.

1.6 Project period 1987 - 1989 (mid 1990)

At the mid-term review Meeting in Dhaka in July 1986, the project was extended for another three years up to end of 1989. A plan of operations was prepared. The Bangladesh authorities prepared the corresponding PC II for the period mid 1984 to mid 1990. The running project activities were continued.

The project intended to enter gradually into a phase that specific projects in the field of erosion protection and land reclamation were to be studied and implemented. Those projects should be part of a longterm development plan on land reclamation and estuary control in the south-eastern delta. Ample attention was given during this project period to the improvement of the planning methodology for land reclamation and estuary control, covering both technical and socio-economic aspects. Survey and research in this fields were continued for monitoring purposes and for the collection of required data for (pre-) feasibility studies in specific projects emerging from the planning exercise.

In view of the preparation for the large-scale land development schemes in the Sandwip Crossdam Development Scheme, it was planned that each year the construction of a new polder outside the coastal embankment in South Noakhali should be initiated, applying on a bigger scale the gained experience and know-how in the pilot polder. Just north of the pilot polder, a start was made with the construction of a similar polder; Pilot Polder - Phase II.

Two additional polders; Char Bhatir Tek and Char Majid, were prepared and a start was made with the construction of the perimeter embankment of the latter

As in South Noakhali drainage problems increase in the entire area, a study was started, aimed at the improvement of the drainage of the area surrounding and including the newly planned polders.

In the Pilot polder most infrastructural works, including cooperative villages, were completed. Only the planned market place was not yet developed. A plan was formulated to provide shelter against cyclones. The cyclone shelters also serve as community centres and godowns. Construction of the shelters started in 1990.

In March 1987, the final report on the Feasibility study on the Sandwip Crossdam Development Scheme was submitted. The Bangladesh and Netherlands governments consulted other donor countries on the subject of their participation in the implementation of the project. A video presentation was prepared to promote the Sandwip Crossdam Development Scheme. In April / May 1988 an independent review panel, appointed by four potential donor countries, visited Bangladesh to review the Sandwip Crossdam feasibility study. In their report of July 1988, the panel commented on the feasibility report. Critical comments were related to the land allocation and settlement issues, the economic feasibility and the limited technical data on which the design of the crossdam had been based. Since then the Sandwip Crossdam project has been postponed indefinitely and the LRP focussed its attention on smaller scale specific land reclamation projects in the South Hatia and South Bhola regions. Occasional bathymetric surveys were continued in the Sandwip - Urir Char area in order to monitor the morphological developments.

In February 1989, the LRP was evaluated by a joint Bangladesh - Netherlands evaluation team. It was concluded that broadly the project had achieved its objectives. A number of modifications and additions in project organisation and activities were formulated to be included in the recommended continuation of the project.

It was felt to be a major handicap in the organisational setup of the LRP that governmental agencies dealing with rural development and distribution of land were not represented within the project.

Discussions were started to adjust the LRP organisation in this respect. Pending these discussions the current plan of operations was provisionally extended to mid 1990, when also the current PC II expired.

1.7 Project period mid 1990 - mid 1991

In June 1990, a multi-disciplinary, joint Bangladesh - Netherlands formulation mission assessed the viability of the continuation of the LRP. In the meantime, it was decided to continue the on-going LRP activities till the end of 1990.

After the Formulation Mission, an Appraisal Mission visited Bangladesh in November 1990. It was concluded that the complexity of the problems faced by the present LRP, requires the formulation of a fresh approach in order to safeguard and promote the positive effects that the project had generated so far. A major change in the future will be that the LRP as such will cease to exist as from July 1, 1991. It was recommended that a new project be initiated; the Land Reclamation and Settlement Project, consisting of two components:

- the Char Development and Settlement Project, and
- the Meghna Estuary Study.

As the new project was not expected to be operational before mid 1991, it was decided to continue the on-going activities of the LRP till July 1, 1991. In April 1991, it was decided to shift the start of the new project to January 1992 and to continue the support to the land-based activities in Noakhali for an interim period of 6 months from July 1, 1991. The interim period was later extended to 12 months.

At the end of the project, on June 27, 1991, the LRP organised the workshop "Living with Cyclones", in this way contributing to the initiation of discussions in Bangladesh on the phenomenon of Cyclones and now to deal with them.

List of organisations which may be concerned with MES, FAP5B

1. Ministries

- Ministry of Water Resources
- Ministry of Land
- Ministry of Local Government, Rural Development and cooperatives
- Ministry of Agriculture
- Ministry of Health
- Ministry of Education

2. Government departments / organisations

- Water Resources Planning Organisation
- Bangladesh Water Development Board
- Local Government Engineering Bureau
- Bangladesh Rural Development Board
- Department of Agriculture Extension
- Bangladesh Inland Water Authority
- Department of Fisheries
- Department of Forests
- Department of Environment

3. Non governmental organisation

- Society for Economic and Basic Advancement
- Other suitable Societies or Organisations

Annex - 3

Cost estimate of Technical and financial assistance in 1000 US$

	Year 1 95/96	Year 2 96/97	Year 3 97/98	Year 4 98/99	Year 4 98/99
A. Technical Assistance					
Consultancy Services	700	1,250	1,250	1,020	1,020
Instruments and equipment	100	20	20	25	25
Operational costs	150	220	220	180	180
Training		50	50	30	30
Small Scale Interventions:		450	50		
· Nijhum Dwip trial					
Khorki bank protection pilot scheme					
Sub-total	1,050	1,990	1,590	1,255	1,255
Price contingencies (5% inflation)	50	120	105	12	12
Total A	1,050	2,520	2,205	252	252
B. Financial Assistance					
Small scale interventions (Provisional sum)	-	P.M.	P.M.	-	-
Price contingencies (5% inflation)	-	P.M.	P.M.	-	-
Total B	1,050	2,520	2,110	400	400
C. Total disbursement (A + B)	**1,050**	2,520	**2,110**	**400**	**400**

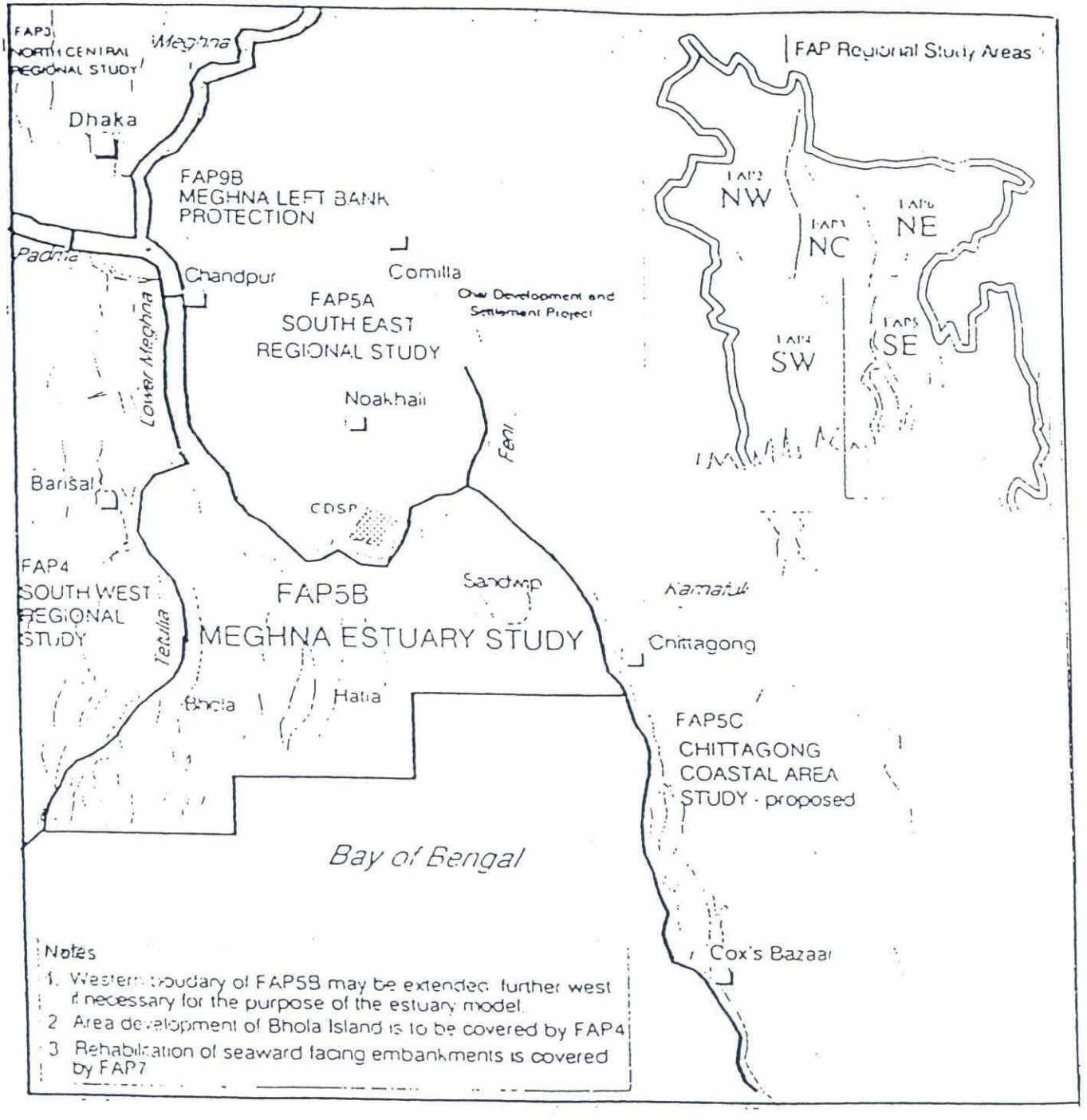

Figure 1 LOCATION OF STUDY AREAS

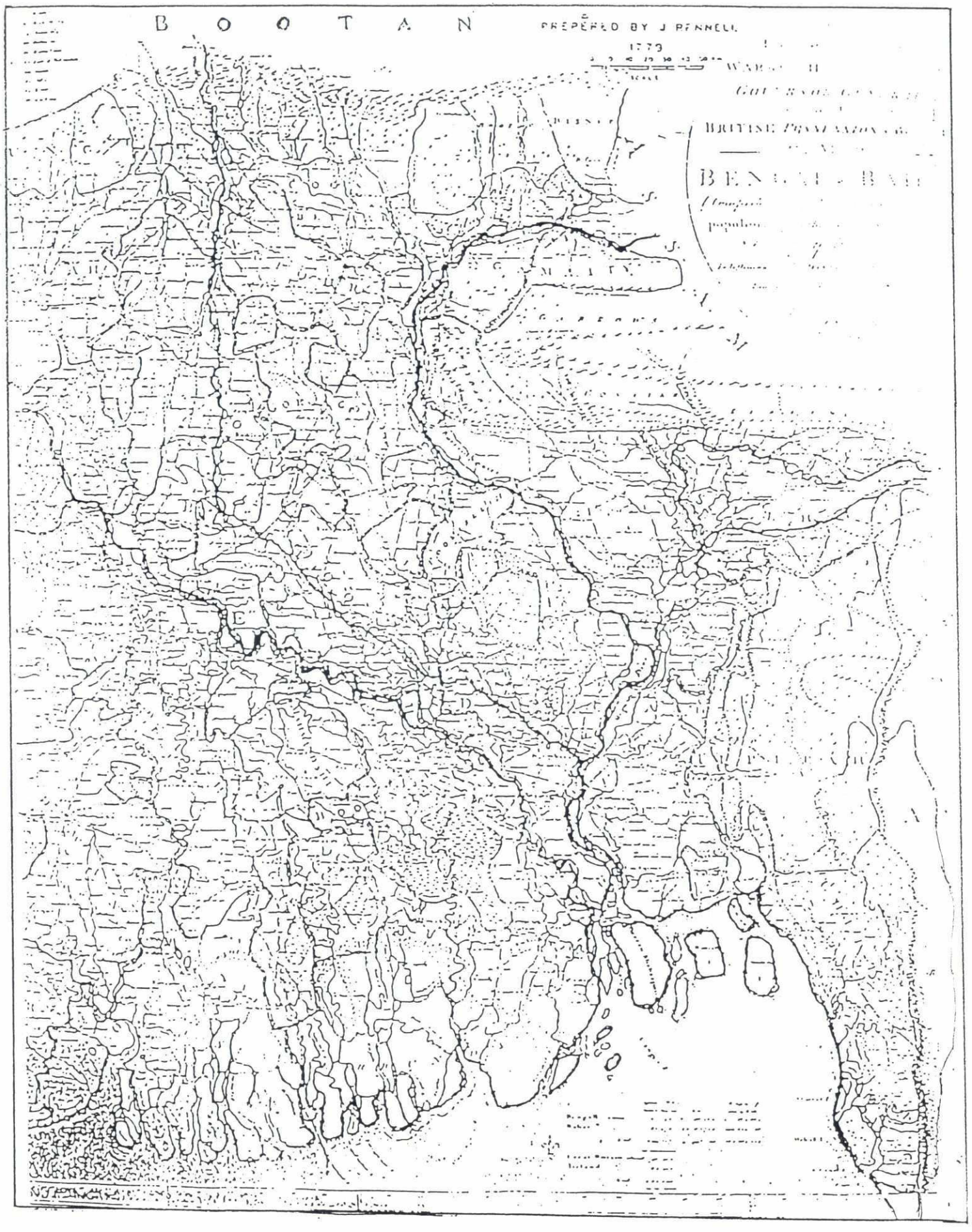

Figure 2 RENNELL'S MAP OF BENGAL

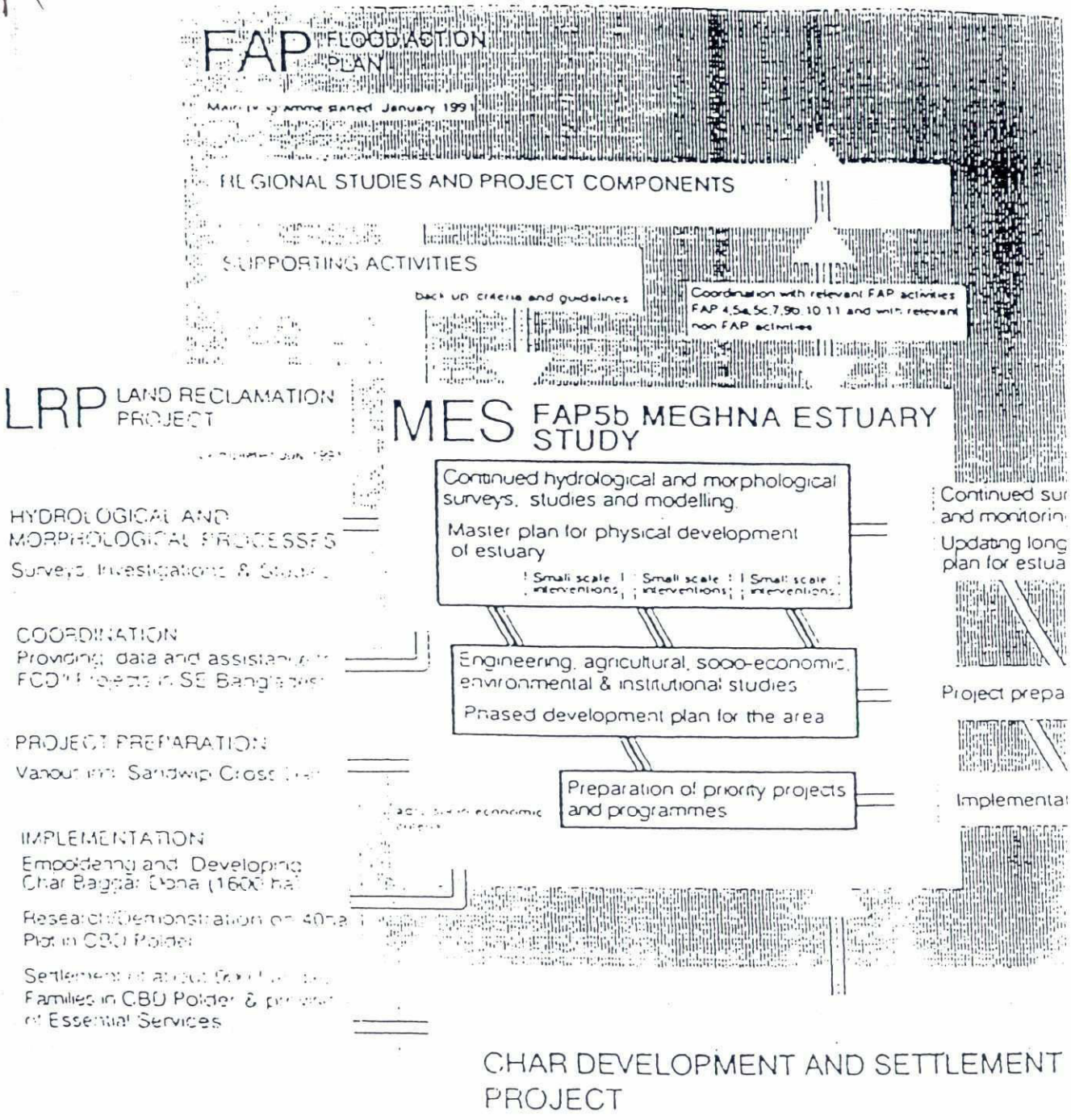

Figure 3 PROJECT CONCEPT

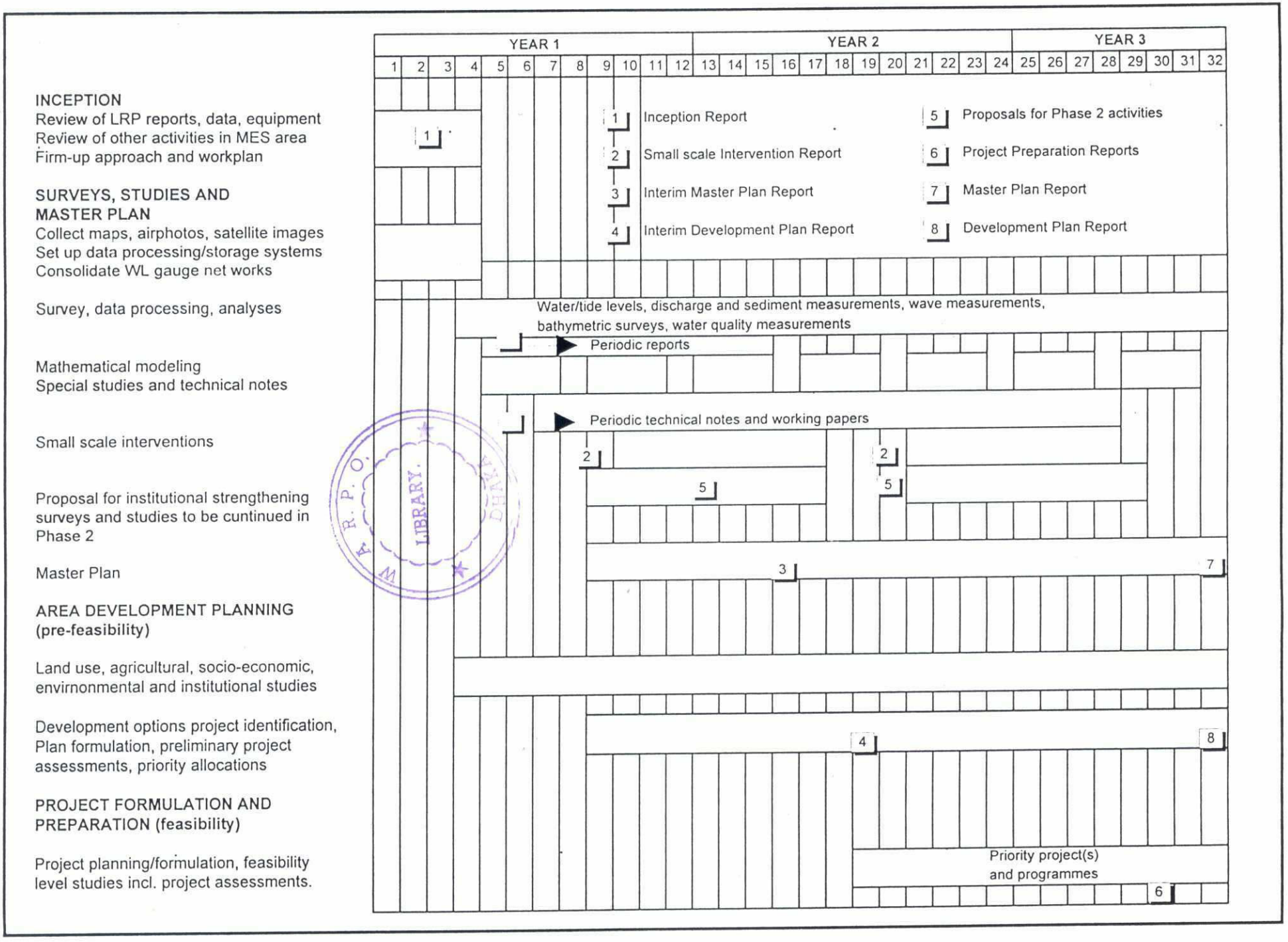

Figure 4: STUDY SCHEDULE

Post	Manmonth	
	Expatriate	Local
Team Leader (hydraulic / planning)	30	
Co-Team Leader		32
Hydraulic Engineer (estuaries)	12	32
Hydraulic Engineer (reclamation, closures)	10	32
Coast / River Morphologist	14	32
Chief Hydrographer	12	24
Economist	10	20
Water Management / Drainage Engineer	10	32
Civil Engineer (embankment, protection structures)	18	32
Rural Development/Social Specialist	12	28
Environmentalist	12	14
Agronomist	7	22
Fisheries Specialist	3	6
Forestry specialist	5	12
Modeling Specialist	7	22
Institutional Specialist	7	12
Specialist as required	6	18
Surveyors and Junior Professionals		150
Total	**175**	**520**

Figure 5 PROVISIONAL STAFFING ESTIMATE

SPECIFIED TERMS OF REFERENCE FOR THE IMPLEMENTATION OF THE MEGHNA ESTUARY STUDY (FAP 5B) BANGLADESH

1. General Information

For a description of the background of the project and of the Land Reclamation Project (LRP), the project which preceded this project, reference in made to the project document entitled "Meghna Estuary Study; Terms of Reference", dated November 9, 1992.

2. Description of the project

General
For a description of the project area and the rationale of the project, reference is made to the project document entitled "Meghna Estuary Study; Terms of Reference", dated November 9, 1992.

Duration of the project
The project has a duration of 35 months. The starting data is November 1, 1995.

Objective
The objectives of the project can be summarized as follows:

Long-term objective is to increase the physical safety of the population living in the south-eastern coastal areas of Bangladesh and to promote sustainable development in these areas.

Short-term objective:

- to increase the operational knowledge in the area of hydrological and morphological processes in the Meghna Estuary;

- to increase the institutional capacity to retain and update that knowledge;

to develop appropriate approaches and techniques for rapid and low-cost land reclamation.

For and overview of approach, activities, expected outputs and institutional set-up reference is made to the project document entitled "Meghna Estuary Study; Terms of Reference", dated November 9, 1992. In addition to the activities mentioned under para. 5.3, Survey and Studies, it is necessary to determine the grainsize composition of the bed sediment on specific locations an to do wind measurements (direction, velocity).

Special areas of attention
The following activities of the project deserve special attention:

- proper liaison needs to be maintained with the Char Development and Settlement Project (CDSP), which will provide information in the field of development of coastal lands and settlement of landless people and to which the MES will provide data and techniques on land reclamation and internal water management; institutional arrangements introduced in CDSP will be taken due account of (Terms of Reference for CDSP is enclosed);

- close interaction needs also to be maintained with other relevant FAP components, such as FAP-7, FAP-9b, FAP-10, FAP-11, FAP-24, and FAP-25, to which the MES will supply as well as receive relevant data; for a complete overview of related FAP-activities, reference is made to the project document entitled "Meghna Estuary Study; Terms of Reference", dated November 9, 1992;

- an important objective is to reinforce the capacity of the GOB to survey, investigate, plan, design and implement the MES; at the end of the project the institutes, which can independently undertake studies, collect data and update the gathered information, shall have been designated and their personnel shall have been trained;

- public participation, using appropriate consultative and selection processes, should form an integral and decisive part of drafting the Land and Water use Development Plan;

- the consultant will present an Interim Master Plan in month 20. The Interim Master Plan will include the terms of reference for an Environmental Impact Assessment of land and water development.

  The EIA will be subsequently prepared by the consultant in close consultation with beneficiaries, impacted groups and local government bodies; the results of this EIA will be presented together with the Draft Land and Water Development Plan in month 33;

- feasibility studies of high priority projects should be started during the course of preparing the development plan and should include; consultation on project concept and design with beneficiaries, impacted groups and local government bodies; involvement of beneficiaries and disadvantaged groups, particularly women and landless, in the construction, operation and maintenance of the project; identification of environmental impacts and measures for mitigating negative impacts; provision of appropriate institutions for implementation and management; and multi-criteria analyses.

3. Required Technical Assistance

Tasks
The tasks of the technical assistance component of the project can be summarized as follows:

- to ensure that the project methodology is being coherently guided and development;
- to provide advice to the BWDB and WARPO;
- to institutionally reinforce the GOB/WARPO/BWDB by, among others, setting up an operational research network and a comprehensive computerized data base with relevant LRP and MES data;
- to participate in the daily management of the project, including the relevant part of the financial implementation;
- to contribute to the monitoring of the project and to timely point out factors which can limit and / or harm the progress;
- to ensure that the quality of implemented small-scale interventions which are financed under the FA component is in conformity with BWDB standards;
- to contribute to the specific professional areas, as indicated in the job descriptions of the experts.

In preparing the proposal for consultancy services, the consultant shall provide, in close collaboration with BWDB staff, a detailed description of:

- programme for data collection, surveys and studies;
- approach and methodology, incl. proposed mechanisms for (institutional) coordination;
- equipment, instruments, hardware and software;
- staffing inputs;
- support staff requirements;
- office accommodation and facilities;
- transport.

Organisation
For the implementation of the project a Steering Committee will be formed with members from relevant GoB agencies and ministries which will provide guidance and supervision. The committee will meet quarterly or more frequent if required. Members are:

- Chairman (from BWDB)
- WARPO Principal Scientific Officer (secretary)
- BWDB Project Director MES
- Co-opted members from BIWTA, WARPO (SWMC), RRI, Ministry of Land, Ministry of Relief, Ministry of Planning, Ministry of Agriculture, ministry of Environment and Forests, Ministry of Local Government, Ministry of Fisheries and Livestock.
- BWDB Project Director CDSP
- Consultants's team leader as an observer
- CDSP teamleader as an observer

The Consultant's team will be responsible towards the WARPO and the donors for achieving the specified outputs. DGIS will act as the coordinating agency on behalf of the Danish and Dutch governments.

The consultant will associate will (a) local consultancy firm(s) and operate as a coherent team, jointly with the counterpart staff attached to the project.

The consultant will maintain an office in Dhaka for planning and project preparation. The counterpart staff attached to the project will be accommodated in the Dhaka office

The team leader of the Consultant will visit the Chittagong office regularly for discussions with the SSD staff. During the marine surveys with "Anwesha" the Consultant will liaise closely with the Executive Engineer of BWDB Surveys and Study Division in Chittagong. The Consultant will appoint a laboratory engineer who will supervise the laboratory works and provide training and guidance to the laboratory staff.

Personnel
The international personnel will consist of one long-term expert (team leader) with a background in hydraulics and planning, and several short term experts with backgrounds in estuary development, land reclamation, coast/river morphology, hydrography, economics, water management, protection structures, rural development, environment, agronomy, fisheries, forestry, modeling and institutional development.

The local consultants team will mainly consist of long-term experts. In total 175 person months have been reserved for expatriate expertise and 520 manmonths for local expertise.

A provisional staffing list is shown in figure 5 of the project document entitled "Meghna Estuary Study; Terms of Reference", dated November 9, 1992.

Reporting
For an overview of reports to be produced, reference is made to the project document entitled "Meghna Estuary study; Terms of Reference". dated November 9, 1992, including figure 4. Regular reporting by the consultant will take place according to DGIS guidelines and will consist of brief quarterly progress reports, planning and evaluation reports. The inception report will indicate what the approach will be of the project.

Before May 15, 1996, the project management will draft a detailed Plan of Operation.

Every three months the finances of the project will be accounted for. The project management will give insight in the progress on state of affairs of the finances any moment the Steering Committee desires to obtain this.

4. Finances and contribution of the Bangladesh Government

The total project budget financed by the Government of the Netherlands and Denmark amounts to US$ 6,180,000 while the total contributing of the Government of Bangladesh amounts to an equivalent of US$ 1 million. The contribution of GoB will cover taxes and duties, taxed relief on imported personal belongings, land acquisition, Government provisions for staffing and office accommodation.

Annex 1: Job description for the expatriate teamleader

Expert in hydraulics and planning with experience in the area of institutional development

Qualifications and experience

Master Degree in civil engineering, a minimum of ten years of recent experience in developing countries, of which five years in Asia, Experience with surveys and studies in the area of hydrology, coastal hydraulics and morphology, including small-scale interventions aimed at land reclamation. Experience with institutional strengthening of governmental orginasations at district level. Good coordination capacities. Knowledgeable about DGIS policies and procedures. Fluency in English. Knowledge of Bengali is recommended.

Specific Tasks

- Act as co-director of the project in close cooperation with the Bangladesh Project Director; co-responsible for the daily management of the project, including monitoring and financial management; participate in the Steering Committee of the Meghna Estuary Study and the Char Development and Settlement Project (CDSP); and, together with the Project Director and the CDSP project team, organise coordination meetings between both projects;

- Manage a consultants team and, in cooperation with the Project Director, report on project activities to the Netherlands authorities;

- Ensure a coherent approach and a systematic development of the project methodology; in close cooperation with the Project Director formulate a phased long term plan for land reclamation and estuary control and a comprehensive flood/cyclone protection and drainage plan for the inhabited coastal islands;

- Carry out Environmental Impact Assessments for every priority project which is proposed to be implemented within the framework of the MES; utilize the EIA's as analyzing framework on the basis of which choices between different interventions are made;

- To provide advice to all Bangladesh parties concerned.