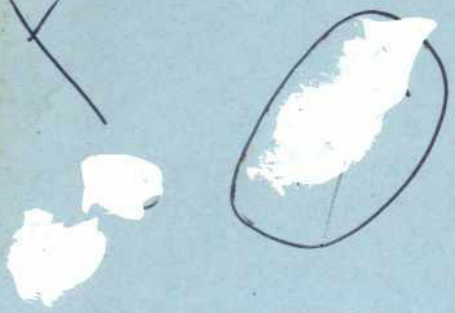
United Nations Development Programme
Government of the People's Republic of Bangladesh

Assistance to Ministry of Relief in Coordination of Cyclone Rehabilitation (BGD/91/021)



Final Report

Volume VI

CONCEPT PLAN FOR INTEGRATED COASTAL PROTECTION

Mott MacDonald International Ltd.
in association with
Asian Disaster Preparedness Centre
assisted by
House of Consultants Ltd.

December 1993

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ASSISTANCE TO MINISTRY OF RELIEF IN COORDINATION OF CYCLONE REHABILITATION (BGD/91/021)

The Final Report for the Project comprises the following volumes:

Volume I	:	Main Report
Volume II	:	Natural Disasters affecting Bangladesh (including Social and Gender Issues, Natural Resources and Environment)
Volume III	:	Organisation and Systems for Disaster Management in Bangladesh
Volume IV	:	Assessment of Damage Caused by Disaster (Agriculture, including Livestock and Fisheries, Forestry and Infrastructure)
Volume V	:	Disaster Management Training Strategy
Volume VI	**:**	**Concept Plan for Integrated Coastal Protection**

ASSISTANCE TO MINISTRY OF RELIEF IN COORDINATION OF CYCLONE REHABILITATION (BGD/91/021)

FINAL REPORT

VOLUME VI

CONCEPT PLAN FOR INTEGRATED COASTAL PROTECTION

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LIST OF ACRONYMS AND ABBREVIATIONS

ADAB	Association of Development Agencies in Bangladesh
ADB	Asian Development Bank
ADP	Annual Development Program
ADPC	Asian Disaster Preparedness Centre, Bangkok
AFD	Armed Forces Division
BBS	Bangladesh Bureau of Statistics
BDPC	Bangladesh Disaster Preparedness Centre
BDRCS	Bangladesh Red Crescent Society
BMD	Bangladesh Meteorological Department
BPDB	Bangladesh Power Development Board
BRDB	Bangladesh Rural Development Board
BWDB	Bangladesh Water Development Board
CDP	Community Development Programme (of BDRCS)
CDPC	Cranfield Disaster Preparedness Centre, Shrivenham, UK
CPP	Cyclone Preparedness Programme (of MOR/BDRCS)
CPPII	Cyclone Protection Project II
DAE	Department of Agricultural Extension
DC	Deputy Commissioner
DCMU	Disaster Coordination and Monitoring Unit
DHA	Department of Humanitarian Affairs of UN
DM	Disaster Management
DPHE	Department of Public Health Engineering
DPP	Disaster Preparedness Programme (of BDRCS)
DRR	Directorate of Relief and Rehabilitation
EC	European Community
ERD	Economic Relations Division
ESO	Emergency Standing Orders
FAO	Food and Agriculture Organization of the United Nations
FAP	Flood Action Plan
FFW	Food-for-Work
FPCO	Flood Plan Coordination Organization
FFWC	Flood Forecasting and Warning Centre (of BWDB)
GB	Grameen Bank
GoB	Government of Bangladesh
GR	Gratuitous Relief
IDNDR	International Decade for Natural Disaster Reduction
IFRC	International Federation of Red Cross and Red Crescent Societies (formerly the League, LRCS)
LGED	Local Government Engineering Department
MFL	Ministry of Fisheries and Livestock
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MoC	Ministry of Communication
MoF	Ministry of Food
MoH	Ministry of Health
MoR	Ministry of Relief
MoS	Ministry of Shipping

NGO	Non-governmental organization
MDMR	Ministry of Disaster Management and Relief
ODA	Overseas Development Administration (U.K.)
PC	Planning Commission
PIO	Project Implementation Officer
SDC	Swiss Development Co-operation
SIDA	Swedish International Development Authority
SPARRSO	Space Research & Remote Sensing Organization
SWC	Storm Warning Centre (of BMD)
TAO	Thana Agricultural Officer
Tk	Taka (Bangladesh currency unit)
TNO	Thana Nirbahi Officer
TOR	Terms of Reference
TR	Test Relief
T&T	Telegraph and Telephone Department
UNDP	United Nations Development Programme
UNDRO	UN Disaster Relief Co-ordinator Office
UNICEF	United Nations Childrens Fund
USAID	United States Agency for International Development
VGD	Vulnerable Group Development (Programme)
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organisation
ZRC	Zonal Relief Coordinator

CONCEPT PLAN FOR INTEGRATED COASTAL PROTECTION

CHAPTER 1

INTRODUCTION

1.1 Terms of Reference

This Volume has been prepared to address Immediate Objective 4 of the Terms of Reference included in the Contract concluded between the United Nations Office for Project Services (OPS) and Mott MacDonald Ltd on 27 May 1992.

The Objective and its related Output and Activities are reproduced below:

IMMEDIATE OBJECTIVE 4

In Conjunction with the Flood Action Plan, prepare a concept plan for integration measures to protect coastal areas from the effects of cyclones and tidal surges into the overall disaster preparedness system and into the Flood Action Plan.

Output 4.1

A concept plan which would outline an integrated approach to coastal protection and indicate how long-term measures can be implemented in a co-ordinated and consistent manner, taking due account of the need to emphasize priority investments.

Activities

4.1.1 In consultation with the current implementation agencies, establish the concept for an integrated approach to coastal protection which would cover normal tidal as well as cyclone events.

4.1.2 Prepare a structure for the programme which would group the various elements by function, phase and sector and establish the linkages.

4.1.3 Identify priorities and suggest the multi-sectoral responsibilities for implementation.

4.1.4 Review ongoing relevant Flood Action Plan activities and other relevant activities and determine the modifications, extensions or additions that may be required.

This paper includes all material published previously in Annex F of the project Inception Report (MM, 1992). It was presented to the Fifth Professional Panel Meeting on 4 October 1992. The minutes of that meeting, including the list of participants which included representatives from the Flood Plan Coordination Organisation, the Inland Water Transport Authority and Consultants from FAP 4 and FAP 7, are given in **Annex E.**

1.2 Integrated Coastal Planning Concept

The concept of integrated planning for the development of the coastal areas was highlighted by numerous speakers at the National Seminar held in Dhaka in connection with the Multipurpose Cyclone Shelter Master Plan on 30 and 31 January 1993. A brief outline of the findings of this study were presented at the Seminar.

1.3 Form of this Report

This report has five Chapters. Following brief introductory and background Chapters, the Plan Concept is discussed in **Chapter** 3 the Plan Components in Chapter 4 and the Integration of Component in **Chapter 5.**

There are five Annexes. **Annex A** gives details of existing infrastructure in the Coastal Areas, **Annex B** discusses telecommunications for disaster management, **Annex C** discusses the role of forestry in the coastal areas, **Annex D** outlines a proposal of groundwater investigation for the area and **Annex E** includes the notes of the Professional Panel meeting on 4 October when the Concept Plan was presented.

CHAPTER 2

BACKGROUND

2.1 General

Storm surges and hurricane force winds associated with tropical cyclones have affected the coastline of Bangladesh for centuries. Since the 1960s, the Coastal Embankment Project (CEP) has created polders in the coastal area to protect the deltaic lands from tidal flooding and to provide inter-tidal surface water drainage. This has enabled agricultural production to increase to support the growing population, which has been expanded by landless migrants from elsewhere

Three major cyclones have struck the Bangladesh coast in the last 25 years in 1970, 1985 and 1991. Following the 1970 cyclone, a programme of cyclone shelter construction was initiated but various difficulties prevented it being completed. After the 1985 cyclone, the need to strengthen the sea-facing embankments was recognized. However , preparatory studies were delayed by the devastating river floods of 1987 and 1988 and they had not been completed by the time the 1991 cyclone struck. The studies were then extended to take account of the damage from this cyclone and were finally completed in early 1992.

Following the 1991 cyclone, a Multipurpose Cyclone Shelter Programme study was undertaken. This was substantially completed in August 1992 and recommended a construction programme of schools-cum-shelters to supplement the shelters being constructed by NGOs and the 'pucca' buildings that exist or will come up.

As a result of the 1987 and 1988 river floods, GOB embarked on a major programme of studies, as the first phase of the Flood Action Plan, to determine development priorities and to enable the country to cope more effectively with major floods in the future. The need for an equivalent approach to cope with cyclones was recognized and led to the present study.

2.2 The Study

The purpose of the this study was to prepare a concept plan outlining an integrated approach to protection of the coastal area and its population. It considers the measures required throughout the coastal area, those being implemented and presently planned, taking account of the ongoing Flood Action Plan activities and priorities, and identifies gaps in present planning.

The methodology of plan preparation involved :

- meeting with concerned government officials and non-government agency staff
- collection and study of reports
- field visits to the cyclone affected areas of Chittagong and Cox's Bazar

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- identifying the infrastructural components required to protect the area
- preparation of a map showing the location and distribution of the existing and proposed elements of infrastructure

Field visits were made to Chittagong, Banshkhali, Cox's Bazar, Moheshkhali, Badarkhali, Ujantia, Moghnama, Dalghata, Matarbari and Kutubdia. Embankment repair and breach closure work, afforestation, roads, power lines, jetties, relief godowns, storm signalling and wireless equipment has been seen in the cyclone affected areas as listed above.

Figure 5.1 shows the programmes of committed and anticipated studies and project implementation that have been identified and includes issues for consideration under FAP-5B (Meghna Estuary Study) and under an expanded FAP-5C (Khulna/Chittagong Coastal Area Study).

2.3 Related FAP Activities

A list of Flood Action Plan projects is given in **Table 2.1.** The projects which are directly related to the coastal area are FAP-7 for the sea-facing embankments, which has been completed, (following which CPP-II is now under implementation), FAP-4 and FAP:5A which are underway, and FAP-5B which is due to start shortly. Supporting studies which are particularly relevant are FAPs 10, 13, 15, 16, 17, 18, 19, 23 and 26.

Associated with CPP-II will be studies relating to the completion of the internal works, the Minor Works Programme, required to enable the full benefits of the embankment rehabilitation to be realised from the polders concerned. The achievement of full benefits will also depend on the completion of planned rehabilitation works to non sea-facing embankments in certain affected polders under the on going BWDB System Rehabilitation Project.

2.4 Other Activities

A number of related projects have been identified at both planning and implementation stages. These are :

Coastal Area Resource Management: a preliminary study by a US team for integrated development in the coastal area

Integrated Development for the Sundarbans: an environmental management programme for the promotion of improved management of forestry, forest products, fisheries and wild life conservation

Second Coastal Project: a drainage and development study for an area north of Khulna

TABLE 2.1
Flood Action Plan Projects

FAP	Description
1.	Brahmaputra Right Embankment Strengthening
2.	North West Regional Study
3.	North Central Regional Study
3.1	Jamalpur Priority Project
4.	South West Area Water Management Study
5A.	South East Regional Study
5B.	Meghna Estuary Study
5C.	Chittagong Coastal Area Study
6.	North East Regional Study
7.	Cyclone Protection Project
8A.	Greater Dhaka Protection Project
8B.	Dhaka Integrated Flood Protection Project
9A.	Secondary Towns Protection Project
9B.	Meghna Left Bank Protection Project
10.	Flood Forecasting and Early Warning Project
11.	Disaster Preparedness Programme
12.	FCD/I Agricultural Review
13.	O&M Study
14.	Flood Response Study
15.	Land Acquisition and Resettelement
16.	Environmental Study
17.	Fisheries Study and Pilot Project
18.	Topographic Mapping
19.	Geograpical Information System (GIS)
20.	Compartmentalization Pilot Project
21.	Bank Protection Pilot Project
22.	River Training and Active Flood Plain Management Pilot Project
23.	Flood Proofing Pilot Project
24.	River Survey Programme
25.	Flood Modeling/Management Project
26.	Institutional Development Programme

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BWDB Systems Rehabilitation Project: mentioned above, a project comprising a number of water development sub-projects being taken from feasibility through to tender document and construction stages. The sub-projects in the coastal area are mostly polders. Some of them are associated with CPP-II, sea-facing embankments

Multipurpose Cyclone Shelter Programme: mentioned above, completed in August 1992 which proposes the provision of schools-cum-cyclone shelters in the High Risk cyclone surge area.

Bangladesh Building Code: a commission to review existing building codes and prepare a National Building Code i.a. to cover cyclone resistant buildings

Assistance to the Flood Warning Centre: (BGD/88/013) activities to strengthen the capability of the BWDB Flood Forecasting and Warning Centre including the provision of technical assistance, equipment to receive and process flood information and to communicate national flood warnings

The Coastal Area Resource Management study has a similar objective to the present study, namely to promote the coordination of projects for sustainable and protected development in the coastal area. The Sundarbans Project aims to address the special problems associated with the Sundarbans, namely the control of exploitation of the mangroves, wild life and other natural resources. The Second Coastal and Systems Rehabilitation Projects are aimed at increasing agricultural production of coastal polders through improved protection and drainage/irrigation facilities. The Multipurpose Cyclone Shelter Programme (MCSP) study recommends the construction of 2500 schools-cum-shelters. The Bangladesh Building Code will propose technical standards, developed in the MCSP study. BGD/88/013 is associated with the FAP programme and will prepare TOR for the proposed follow-on FAP:10 project.

CHAPTER 3

PLAN CONCEPT

3.1 Introduction

As stated in the Terms of Reference, the purpose of the Plan is to outline an integrated approach to coastal protection and to indicate how long term measures can be implemented in a coordinated and consistent manner taking due account of the need to prioritise investments.

3.2 Policy Objectives

The following policy objectives have been adopted for the concept plan:

- the prevention of loss of human life
- the protection of standing crops, livestock, and agricultural land
- the protection of industrial areas including the Export Processing Zone (EPZ), Patenga and the EPZ development area
- the protection of infrastructure including roads, buildings, electricity distribution, telecommunications
- the protection of fisheries and shrimp culture
- the preservation of mangrove forests and plantations

3.3 Coastal Protection Measures

Socio-economic studies following natural disasters indicate that it is the disadvantaged members of the community that are most adversely affected by disasters. This leads on directly to the conclusion that all development activities aimed at improving the general economic situation within disaster-prone areas would tend to reduce overall disruption by enabling the inhabitants themselves to undertake measures to protect themselves and their livelihood (e.g. building 'pucca' houses).

The coastal areas are comparatively underdeveloped even by Bangladesh standards ('pucca' road/households, children/school, tubewell/hand etc). Hence, general development funds should be directed towards the area to redress the balance and encourage economic uplift.

The particular measures required to actually protect the coastal areas and its inhabitants can be considered under two main headings :-

i)	Non-structural measures	:	warning dissemination and systems, training, community mobilisation etc.
ii)	Structural measures	:	embankments and related structures, forestry, shelters, roads and transport system, water supplies.

Specific measures under each heading are discussed in more detail in **Chapter 4.**

3.4 Coordination and Prioritisation of Development

The measures that are required to improve the overall situation in the coastal, both for a general economic viewpoint and from a more narrowly focused 'protection' viewpoint involve almost all the ministries and agencies of GOB. Particular responsibilities are given in **Table 3.1.**

It is apparent that if any coordinated development is to take place the important activities would be :-

i) preparation of general development guidelines;

ii) funding must be secured in principle for all activities covered by the guidelines;

iii) individual agencies should prepare their development plans in accordance with the guidelines;

iv) actual funding should be secured for the plans; and

v) phased implementation initiated.

In order to coordinate these processes the role of the Planning Commission is clear.

The establishment of a Coastal Area Development Committee within the Planning Commission umbrella might be considered to coordinate activities more effectively. Such a Committee might find it convenient to divide the Coastal Area into a number of Development Units in order to focus activities in priority areas and evolve an overall coastal Area Development Plan/Programme.

The first priority might be to bring all areas up to a certain agreed standard of development as given in the Guidelines (measured by persons/tubewell, pucca road/population, public telephones/population etc). Thereafter, the area as a whole should be uplifted.

Care should be taken to ensure that implementation by the individual agencies is coordinated. As a general rule, roads and communication facilities might be developed first, then shelters and embankments. However the priorities in each area would be different. Development priorities might be determined initially at the thana level through the Thana Development Committees under the TNO. These priorities should be linked to local level planning carried out by the Thana Engineer.

TABLE 3.1

GOB Agency Responsibilities

Responsibility		Agency
1.	**Overall Coordination**	CabD/PC
2.	**Preparedness**	
	- Coordination	?
	- Standing Orders (SO)	MoR
	- Distribution of SO	MoR
	- Shelters	MoE/LGED/PWD/BDRCS
	- Raised platforms	LGED/BDRCS
	- Training	?
	- Warnings (National/Local)	
	Floods	BWDB (FFWC)
	Cyclone	BMD/CPP
3.	**Employment/Income Opportunities**	
	- Coordination	DistAd
	- Agriculture	MoA
	- Fisheries	MoFL
	- Livestock	MoFL
	- Forestry	MoEF
	- Credit	BKB/GB
4.	**Physical Infrastructure**	
	- Coordination	PC/DistAd
	- Roads	RHD/LGED
	- Clinics/Hospitals	MoH
	- Water Supply/Sanitation	Municipality/DPHE
	- Education facilities	MoE
	- Buildings	MoW/LGED
	- Irrigation	BWDB/BADC
	- Embankments	BWDB/LGED
	- Channels	BIWTA/BWDB/LGED
	- Electricity	BPDB/REB
	- Telecommunications	T&T
	- Railways	MoC
	- Ports and Harbours	MoS

CHAPTER 4

PLAN COMPONENTS

4.1 Introduction

The Plan components consist of various non-structural and structural measures to improve cyclone warnings, to protect the area, to enhance preparedness and response and to encourage overall development of the coastal area. Maps showing selected existing and proposed elements of the Plan are included in a pocket at the back of this Volume. Data on existing infrastructure are given in **Table 4.1.**

The components of the Plan include :

Warning Systems
- Cyclone Tracking, Forecasting and Warning
- Telecommunications
- Benchmarks and Sea Level Monitoring
- Cyclone surge tracking
- Long term sea level rise

Security and Damage Reduction
- Shelters and killas
- Embankments
- Afforestation
- Erosion Control
- Surge suppressors

Rescue and Transport Facilities
- Rescue Vessels
- Helipads, landing strips/drop zones
- Roads
- Inland and coastal waterways
- Harbours, Jetties and IWTA terminals
- Rail Network

Relief Measures
- Medical Centres
- Flood Stores
- Agricultural support

Rehabilitation and Development
- Growth Centres
- Cluster Villages
- House Strengthening
- Water Supply
- Roads

TABLE 4.1

Population, Cyclone Shelters in High Risk Areas

District	Thana (Upazila)	Estimated Population in year 2002	Population Sheltered in Buildings to be Constructed by 2002	Total Building and Shelters			Population per Shelter/Building			Additional Killas	
				Existing	Under Construction	Proposed by MCSP and others	Existing	Under Construction	Proposed	Proposed with MCSP Shelters	Required
		(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)
Sathkhira	Shymnagar	52,549	3,428	1	1	28	52,549	26,275	1,752	27	0
Khulna	Dacope	48,514	3,026	3	1	25	16,171	12,129	1,673	25	0
Khulna	Koyra	37,497	2,875	4	1	16	9,374	7,499	1,786	16	0
Khulna	Sarankhola	41,323	2,366	17	0	19	2,431	2,431	1,148	16	0
Khulna	Monglaport	26,943	1,647	4	2	13	6,736	4,491	1,418	11	0
Barguna	Pathargata	164,933	10,646	37	3	77	4,458	4,123	1,410	74	1
Barguna	Barguna Sdr	162,688	10,535	10	1	84	16,269	14,790	1,713	82	5
Barguna	Amtali	98,993	6,749	14	1	50	7,071	6,600	1,523	43	6
Barguna	Betagi	46,657	3,333	4	0	23	11,664	11,664	1,728	23	0
Patuakhali	Bauphal	133,212	8,661	15	0	64	8,881	8,881	1,686	64	0
Patuakhali	Galachipa	260,225	15,511	86	3	99	3,026	2,924	1,384	92	9
Patuakhali	Dashmina	100,024	6,402	33	0	39	3,031	3,031	1,389	36	0
Patuakhali	Kalapara	224,539	14,228	61	3	100	3,681	3,508	1,369	85	10
Perojpur	Mathbaria	87,195	5,660	5	0	44	17,439	17,439	1,779	44	0
Bhola	Bhola Sdr	225,268	14,663	11	1	112	20,479	18,772	1,817	112	0
Bhola	Burhanuddin	131,283	9,563	3	0	67	43,761	43,761	1,875	67	0
Bhola	Lalmohan	224,881	14,744	19	0	108	11,836	11,836	1,771	95	0
Bhola	Char Fasson	397,694	24,385	85	8	174	4,679	4,276	1,489	160	1
Bhola	Manpura	65,477	4,273	31	13	15	2,112	1,488	1,110	11	8
Bhola	Tazumuddin	138,799	8,540	37	0	60	3,751	3,751	1,431	48	0
Bhola	Daulatkhan	169,084	12,253	31	0	73	5,454	5,454	1,626	61	1
Barisal	Bakerganj	17,303	865	1	0	9	17,303	17,303	1,730	9	0
Barisal	Barisal Sdr	15,072	1,254	1	0	7	15,072	15,072	1,884	7	0
Lakshmipur	Ramgati	399,504	23,974	43	0	200	9,291	9,291	1,644	195	0
Lakshmipur	Raipur	92,505	5,625	6	0	47	15,418	15,418	1,745	47	0

TABLE 4.1 (Continued)

Population, Cyclone Shelters in High Risk Areas

District	Thana (Upazila)	Estimated Population in year 2002	Population Sheltered in Buildings to be Constructed by 2002	Total Building and Shelters			Population per Shelter/Building			Additional Killas	
				Existing	Under Construction	Proposed by MCSP and others	Existing	Under Construction	Proposed	Proposed with MCSP Shelters	Required
		(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)	(nr)
Lakshmipur	Lakshmipur	93,572	5,678	6	0	47	15,595	15,595	1,766	47	0
Noakhali	Hatiya	371,464	22,573	71	18	155	5,232	4,174	1,522	139	0
Noakhali	Noakhali Sdr	167,496	11,374	20	0	80	8,375	8,375	1,675	72	0
Noakhali	Companigonj	56,193	4,309	25	0	22	2,361	2,361	1,256	16	4
Feni	Sonagazi	140,416	8,521	31	0	67	4,530	4,530	1,433	62	0
Chittagong	Sandwip	332,847	23,740	68	0	145	4,902	4,902	1,565	99	4
Chittagong	Mirsarai	78,321	5,717	13	7	31	6,025	3,916	1,536	29	5
Chittagong	Sitakunda	194,422	13,522	48	13	72	4,050	3,187	1,462	72	0
Chittagong	Patiya	162,833	10,942	50	1	48	3,330	3,265	1,682	48	7
Chittagong	Anwara	141,248	9,164	38	14	55	3,717	2,716	1,320	40	2
Chittagong	Banshkhali	292,826	20,142	47	25	121	6,230	4,067	1,517	99	20
Chittagong	Bandar			2		2					
Cox's Bazar	Kutubdia	126,902	8,645	50	9	55	3,099	2,626	1,359	4	25
Cox's Bazar	Chakaria	353,645	22,283	52	26	151	6,801	4,534	1,544	121	8
Cox's Bazar	Moheshkhali	165,329	10,767	56	22	60	2,952	2,120	1,198	51	1
Cox's Bazar	Cox's Bazar	140,837	8,841	77	17	45	2,174	1,780	1,204	38	13
Cox's Bazar	Ramu	27,250	2,363	1	4	10	27,253	5,451	1,817	7	1
Cox's Bazar	Ukhia	34,292	2,215	3	2	16	11,431	6,858	1,633	11	0
Cox's Bazar	Teknaf	111,705	6,385	31	7	32	3,603	2,940	1,596	26	0
Totals		**6,353,760**	**412,387**	**1,251**	**203**	**2,767**				**2,431**	**131**

Sources: Multipurpose Cyclone Shelter Project (July 1992) and Government Records

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- Water Transport
- Power generation and distribution
- Mangrove conservation

4.2 Warning Systems

a) Cyclone Tracking, Forecasting and Warning

BMD is the GOB agency responsible for cyclone tracking, forecasting and the issue of warnings at the national level.

When cyclones are in the process of formation in the southern Bay of Bengal relevant data are received through the WMO World Weather Watch network, mainly from the New Delhi Regional Telecommunication Hub (RTH). Data from the US:NOAA satellite are received directly by BMD and information from the Japanese Geostationary Satellite is received via SPARRSO. As cyclones travel up the Bay, they come within the 400 km range of radar tracking stations at Kalapara and Cox's Bazar and, eventually, Dhaka.

BMD uses ten different methods to forecast the tracks of incoming cyclones and this in part explains why it take time to make predictions. BMD is proud of its recent record and despite hearsay reports to the contrary it appears to have only issued 10 cyclone warning (Signals 8, 9 and 10) in the last twenty years, all of which struck the coast.

Having made their predictions BMD pass their warnings to Bangladesh Radio and TV, to the CPP and to many other agencies for dissemination and follow up action.

While more sophisticated equipment is continually being developed to assist cyclone tracking and forecasting, BMD facilities appears adequate at least by the results they have given. It is in the warning dissemination area that improvements are required.

Specific improvements are required in the following areas :

i) There is no facility for the reception of video data in Dhaka from the two weather radar stations at Cox's Bazar and Khepupara. Action in this regard is being taken under the Japanese aid programme;

ii) Dissemination of Storm Warning bulletins through the GENTEX teleprinter network is inadequate. The possibility of utilising the Police communication systems and the fax systems of T&T as soon as they become reliable for the dissemination of these bulletins should be explored;

iii) Telecommunications links between BMD National Meteorological Communications Centre (NMCC) and the Flood Forecasting & Warning Centre, consisting of leased teleprinter circuits is inadequate and should be supplemented by a reliable data link as early as possible; and

iv) Telex and fax communications services should be introduced at the BMD: NMCC for more efficient communications with other agencies both within and outside

Bangladesh.

Until January 1991, a UNDP/WMO Technical Support Unit under the Tropical Cyclone Project was based in Dhaka. A follow on phase has been prepared and is being considered by UNDP. Such a project would in part enable BMD to keep abreast of that latest relevant developments worldwide.

b) Telecommunications

Investigations have revealed that numerous agencies have telecommunications facilities within the coastal area. However, almost without exception, these were disputed for a period following the 1991 cyclone strike.

The Bangladesh Telephone and Telegraph Board (T&T) provide the country's public telecommunications network and T&T has an extensive network extending to almost all thana HQs. The greatest weakness of the network is that there are no alternate paths for its major trunk routes. When the Chittagong microwave terminal antenna tower collapsed during the April 1991 cyclone, communications were disrupted for many days. Due to disruption of the Dhaka-Chittagong service, the Bethbunia Earth Communication Station was cut off from the rest of the country, which resulted in the complete disruption of international communications for more than two weeks. T&T is now planning additional microwave links which would provide alternate communications paths.

The World Bank has agreed to finance a new Earth Communications Station near Mohakhali, Dhaka. This will replace the existing Bethbunia Station at Chittagong. Dhaka is preferred as it is generally free from cyclonic storms. Japanese consultants, financed by a Japanese grant, are carrying out the study for the project. Tenders should be floated by the end of 1992 and the earth station commissioned by early 1994.

T&T has plans to convert the present analog telephone exchanges in the major cities to digital exchanges. The present microwave and UHF network will be further extended to cover all the thanas and many of the offshore islands. Telex and fax services are also be extended.

T&T is required to operate commercially and therefore it is unlikely that it will be able to provide services to all parts of the coastal areas in the foreseeable future. Hence, unless GOB provides subsidies for T&T operation in the affected areas, there will be a continuing need to provide emergency facilities through other agencies.

Following the devastating 1970 cyclone, the Bangladesh Red Crescent Society in cooperation with GOB established the Cyclone Preparedness Programme (CPP). CPP has an extensive network of radiotelephone facilities consisting of HF and VHF radio systems. CPP communications extend to many of the offshore islands. Performance during the April 1991 cyclone was generally good. All stations are equipped with batteries and battery chargers for the operation of radio equipment when commercial power supply failure. Some of the stations are equipped with solar cells and battery chargers for operation without any commercial power supply requirement.

CPP has a good maintenance workshop in Dhaka and plans to set up two more workshops to improve services in future.

During the cyclone of 1991, antenna masts and antennas were damaged and communications were disrupted at a few stations. Such disruptions could be overcome if spare antenna were kept in stock in the field or if antenna could be taken down immediately prior to a cyclone strike.

Bangladesh Police communications extend to all thanas in the country and some smaller Police outposts. The system comprises HF and VHF radiotelephones. Leased teleprinter services are also operated. The Police service is quite reliable and works round the clock. They have their own reliable maintenance support. With the addition of fax services between a number of their stations, the Police system is the largest in Bangladesh.

The Multipurpose Cyclone Shelter Programme - MCSP (BUET, 1992) reviewed the telecommunications needs of the coastal area before, during and after cyclones and made proposals for improved facilities including the means by which they could be integrated into the shelter design. Different types of telecommunications systems which could be provided were discussed and a VHF/UHF Cellular radio system recommended.

The Cellular system is based on the concept of a fixed network of VHF/UHF radio stations. Each station caters for a cell area covering a thana and would serve about 100 cyclone shelters which would act as subscriber terminals. A frequency band of 450-500 Mhz was proposed. The subscriber terminals could be either fixed or mobile.

Each base station would have an 'omni' antenna linking it with all subscriber stations and a directional antenna linking it with zonal stations. There would be about 50 thana base stations. Since within the cell (or thana) all the subscribers would have radio terminals, local cable distribution networks would not be necessary.

The system would have five zonal stations at Khulna, Barisal, Noakhali, Chittagong and Cox's Bazar. Each zonal station would be linked to 10 thana stations. Each zonal station would provide an interface with the national telecommunications grid, which would enable any telephone subscriber from outside the network to communicate with any Cellular subscriber.

The estimated cost for such a system were given as :

		US$ million
i)	5-Zonal stations with links to 50-thana stations, complete with channel accessories	2.0
ii)	50-thana stations equipment having 100-subscribers terminals in each thana, complete with switching equipment and solar power supplies	38.0

The system would cover the whole of the coastal area. The implementation and operation of such a project would require an organisation like the T&T Board.

The Draft Final Report was submitted in August 1992 and is being considered by GOB. It is not clear whether finance for the installation and operation of such a system could be secured.

The Police should be seen as the Emergency service and until such time as GOB can finance a scheme similar to that described above there would seem to be merit in reinforcing the Police network to cover as much of the area as possible.

The senior Police officer at each station should be charged with passing warning messages to CPP volunteers and others for wider dissemination. They should also be responsible for passing damage and needs assessment messages for the civil adminstration, when required to do so. Radio operators should be responsible for ensuring that their masts and aerials were taken down in due time when a cyclone is forecast.

Additional information on telecommunications in the coastal area is given in **Annex B**.

c) Signal Masts, Flags, Lights, Sirens

The IWTA and shipping authorities operate storm signal systems using hoisted cones during day time and lights at night at the approaches to harbours and IWTA terminals.

Sirens and flags are used by the CPP to alert people to warnings. The system of signals is readily understood and consideration should be given to extending it to provide continuous coverage of coastal centres and villages.

The need to extend the present system of one to three flags to possibly five flags should also be considered. While three flags are sufficient to warn inland waterways vessels to take shelter, the safety of land based activities and property becomes limiting only at much higher wind speeds. There is therefore a case for providing further warnings for people in the coastal area to indicate approaching winds of hurricane force.

The possibilities of installing signal flag masts at one kilometre intervals, at benchmark positions, along all sea-facing embankments during the course of construction should be investigated. The BWDB officer responsible for each particular reach of the embankment should also be responsible for ensuring that the correct signal flags were flown in the event of a cyclone alert.

d) Benchmarks and Sea Level Monitoring

Uncertainties concerning the Survey of Bangladesh (SoB), the Public Works Department (PWD), and Mean Sea Level (MSL) datums are being investigated by FAP-18. A difference of 0.2 m has been reported between levels on the left and right banks of the River Jamuna. A difference of 0.2 m in the crest level of a sea facing embankment would have a significant effect on the degree of protection provided. A reliable network of level benchmarks is a prerequisite for achieving the intended standards of surge protection under CPP II (sea-facing embankments).

At present, there is no reliable means of recording actual surge heights. IWTA tide gauges, require frequent replacement due to problems of erosion and siltation. The linking of the national level benchmark network with tide gauges at IWTA terminals is to be carried out under FAP-18. There are proposals to replace, as well as install additional, tide gauges under FAP-5B.

It is difficult to establish permanent installations which continue to register throughout extreme cyclonic surge conditions. It has been suggested by IWTA that submerged gauges should be installed at ten selected locations.

e) Surge Tracking

Facilities for the early detection and tracking of the cyclonic surges have been suggested (IDNDR 1990). These would consist of a series of buoys anchored to the sea bed, terrestrial reference stations and global positioning system (GPS) satellite communications, to detect the wave trajectory of the surge. Such a system might facilitate improved predictions and earlier warnings.

f) Long Term Sea Level Rise

Although the assessment of rise in sea level due to global warning and its related consequences are outside the scope of the present study, a project for the assessment of such effects on Bangladesh due to the greenhouse affect and climatic change is in progress (BUP/CRU, 1990).

Account needs to be taken of future sea level rise, as far as is economically feasible, when considering rehabilitation criteria. This has direct implications for the management of the sea-facing embankments (CPP II). It is recommended that they be maintained in such a condition as to allow them to be modified and raised if and when necessary.

4.3 Security and Damage Reduction

a) Shelters and 'Killas'

Following the 1970 cyclone, 238 shelters and 156 'killas' were constructed throughout the coastal areas under the IDA Coastal Area Rehabilitation and Cyclone Protection Project. For various reasons, the project objectives were only partly achieved (World Bank, 1984). A further 79 shelters, including five with associated 'killas', were constructed by NGOs.

Following the 1985 cyclone, GOB set up a Cyclone Preparedness Committee, which identified inadequacies in the provision and condition of existing shelters and 'killas'. The multi-purpose use of shelters and the construction of a further 400 shelters, each able to accommodate 500 persons, were recommended.

Following the 1991 cyclone, an Inter-ministerial Task Force (IMTF) was set up to review the situation in the affected area and to make proposals for the future. One recommendation was that an MPCS programme should be initiated. The first stage of the programme was completed in August 1992 with the issue of the Draft Final Study Report (BUET, 1992) as

discussed above.

The six month study provided an overall plan and criteria for the continuing provision, repair and maintenance of shelters and 'killas'. Particular emphasis was laid on the multipurpose use, which would be mainly as schools, so that in normal times the buildings would have an essential function. An important issue also addressed was the association of shelters with 'killas' to provide both for people and livestock.

In the meantime, additional shelters are under construction in areas hit by the 1991 cyclone. Two hundred schools-cum-shelters are being financed by the Saudi Government and others are being funded by non-governmental organizations. All involve designs previously approved by the Public Works Department. A comprehensive statement of shelters completed and planned to 30 June 1996 is shown in **Table 4.2.**

It is noteworthy that few if any 'pucca' buildings were reported to have been significantly damaged during the 1991 cyclone. It is therefore concluded that the various building codes used (if any) were sufficient for cyclone prone areas in spite of there being no unified national building code. A Bangladesh Building Code is now under preparation and is scheduled for completion in 1993. It has been suggested that all government/public buildings in the cyclone-prone areas should be built with a concrete frame and be of at least two storeys in height, in order to be able to serve as shelters.

There is a need for the integration of fish ponds, 'killas' and associated cyclone proof community buildings. The MCSP recommends providing multipurpose shelters on top of 'killas'. The opportunity could be taken to provide basement storage beneath such buildings. This would economise on earth fill and, provided the construction could be watertight, would provide valuable space for storing relief supplies and potable water.

b) Embankments

In 1958, the Government of East Pakistan initiated a programme of embankment construction in an effort to increase rice production. Initially, the embankments were constructed along river banks or around beels or low lying cultivable areas so that during floods water would not inundate the crops. Early success lead the East Pakistan Water and Power Development Authority (EPWAPDA) to engage International Engineering Company (IECO) to undertake engineering feasibility studies. IECO recommended the construction of 4,500 km of perimeter dykes and 5,200 m of pipe sluices to provide protection from saline intrusion in the coastal area (IECO 1960). In 1962, EPWAPDA engaged Leedstill-De-Leuw Engineers (LDL) to prepare detailed designs for the project. The majority of the present embankments in the coastal areas were constructed between 1962 to 1971 under the Coastal Embankment Project (CEP).

CEPs extend from Satkhira (the Raymongal estuary) on the borders of India to Cox's Bazar. In all 92 polders are enclosed by a total of 4,000 km (2,500 miles) of embankment. The primary purpose of the project was to increase agricultural production by protecting some 14,000 km2 (3.5 million acres). Three types of embankments were formed (See **Table 4.3).** The embankments were not designed to prevent overtopping due to surges associated with cyclones.

TABLE 4.2
Shelter Construction Programme

Agency Responsible	Funded by	Shelters likely to be available by 30 June					
		1991	1992	1993	1994	1995	1996
PWD (CCC)	?	132	132	132	132	132	132
PWD	IDA	226	226	226	226	226	226
BDCRS	Various	62	102	142	182	217	217
CARITAS	Various	12	35	72	113	154	154
LGEB	Japan	0	0	20	40	40	40
LGEB	IFAD	0	0	0	10	10	10
MOE	?	24	24	24	24	24	24
MOE	Saudi Fund	0	183	306	306	306	306
MOE	IDB	0	0	20	49	49	49
MOE	Japan	0	0	20	40	60	60
MOE	EC	0	0	64	128	200	200
CCDB	Various	0	5	15	55	55	55
Grameen Bank	Self ?	0	1	10	20	20	20
BRAC	Self ?	0	9	16	16	16	16
Save the Children	ODA?	0	8	8	8	8	8
Other NGOs	Various	12	22	42	62	82	103
Total		**468**	**747**	**1117**	**1411**	**1599**	**1620**

Sources: MCSP(1992) and Agencies

a:\ik-4\Tab4-2.wk1

TABLE 4.3

Dimensions of Coastal Embankments

Type of Embankment	Slope		Crest Width (m)	Minimum Freeboard (m)	Set back (m)
	Country Side	Water Side			
Sea	2:1	7:1	4.5	1.9	85
Interior	2:1	3:1	4.5	1.2	60
Marginal	2:1	2:1	2.8	1.0	40

Sea dykes were provided where the embankment was exposed to the Bay of Bengal or major rivers, the interior dykes where embankments were exposed to rivers and the marginal dykes along river banks in interior areas to prevent the intrusion of saline water in the polder areas.

The height of the embankments was fixed relative to the highest spring tide to which a freeboard of 3 to 5 ft was added. No consideration was given to wave action. In recent years, sea dykes at some vulnerable areas have been protected by concrete blocks.

The sea-facing embankments, together with coastal afforestation where it exists are the first line of defense against cyclonic surges although as noted they were not originally designed to resist surges. Prior to 1985, maintenance to sea-facing embankments was inadequate. Following the 1985 cyclone, medium and long term plans were prepared by BWDB to cater for existing coastal embankments and newly accreted lands (Kampsax, 1992).

A mid-term programme for the strengthening of the existing embankments has since been prepared under the Cyclone Protection Project II (CPP II). These are indicated as **Figure 4.1.** Criteria have been developed for Phase I : Emergency Cyclone Protection Project. For all sea facing embankments, except Polder 67 Patenga, the criteria are :-

'Normal' Monsoon Storm

- 1 in 5 year storm monsoon design conditions. No overtopping defined as only 13% of waves should overtop the embankment crest.

Cyclonic Storm

- 1 in 20 year design condition : flooding due to waves overtopping the crest of the embankment should result in an average water depth in the polder not exceeding 1.0 m.

- 1 in 40 year design condition : still water level should not exceed the crest level of the embankment.

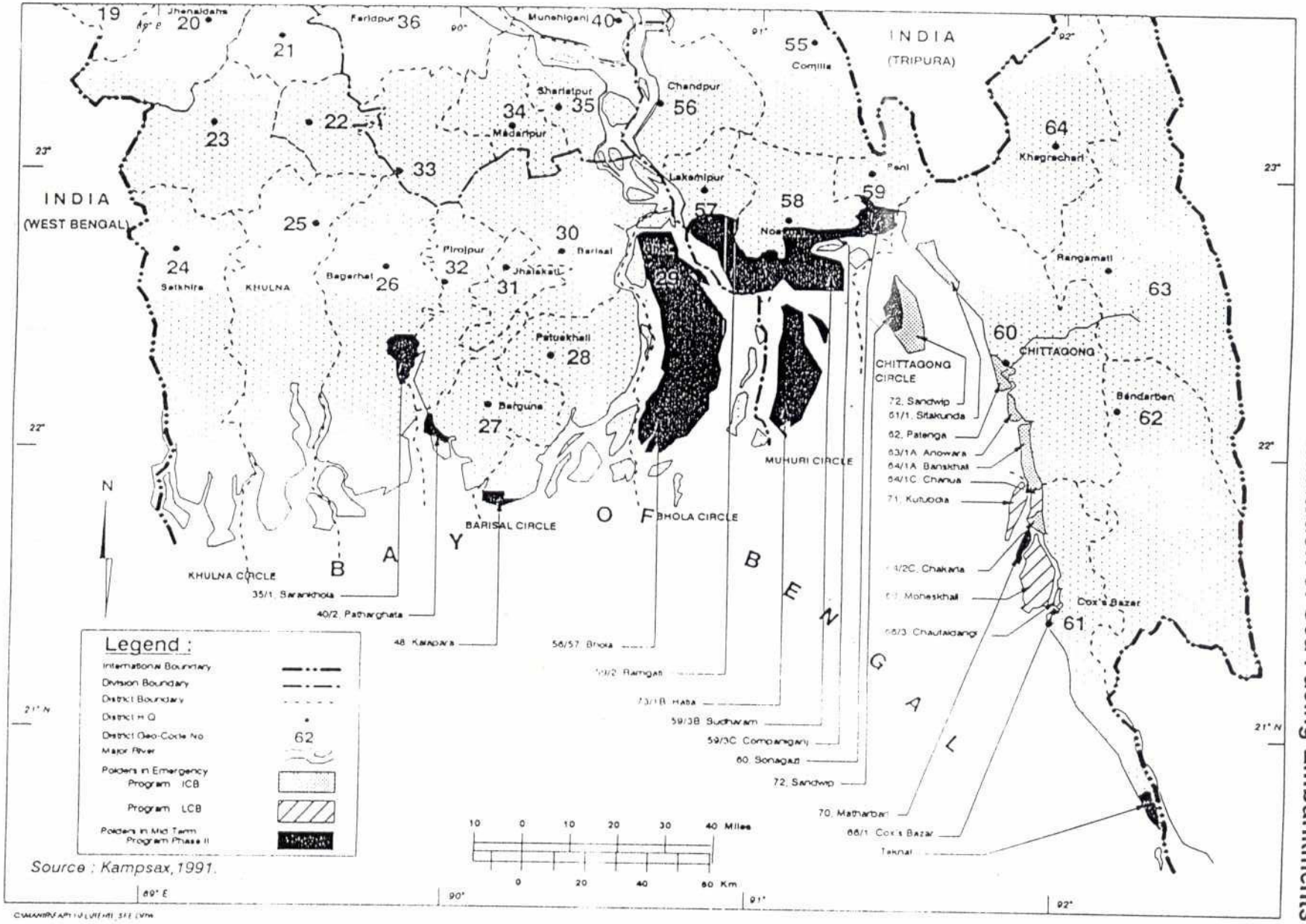

Figure 4.1
Rehabilitation of Sea Facing Embankments

Tender designs have been prepared and construction of the Phase I : Emergency CPP is due to start in FY 1992. Designs and tender documents for the mid term Phase 2 programme are to be prepared for the remaining works. All works in the Phase II programme are due to be completed by mid 1995.

Surveys carried out during CPP II studies found that much of the damage caused by the April 1991 cyclone would not have occurred had the existing embankments been better maintained. They also found that embankments shielded by foreshore afforestation were less damaged than those without. Key CPP II recommendations include that beneficiaries should be involved in embankment maintenance and that afforestation of the foreland and the embankments should be established (Kampsax, 1992).

Further studies have been recommended to refine the modelling of cyclonic storms to obtain better agreement with historical data. This would result in more appropriate design criteria for future work, with the chance of construction cost savings.

Indications of the conflicting interests in land use and the resulting impact on cyclone protection were noted especially private development of newly accreted and previous agricultural and forest areas for salt and shrimp production and buffalo grazing. The apparent absence of planning controls and the low level of protection led to the exposure of these islands and mainland coastal polder areas and resulted in major losses of life and damage during the April 1991 cyclone.

CPP II is confined to existing sea facing embankments protecting agricultural areas. Some of these areas have been converted to shrimp/salt production (Chakaria, Moheshkhali) and these areas come under the IDA Shrimp Culture Project which includes both polders for shrimp culture and hatcheries. In addition, there are private enterprise low-technology interventions comprising embankments and water control structures which generally appear to have no regard for appropriate engineering standards. Sea-facing foreshore land available for afforestation is now severely limited and, in places, there is pressure for its use for livestock grazing. There is therefore a compelling need to reconcile the relative demands on land use in these areas to enable protective measures to be properly coordinated.

The BWDB Systems Rehabilitation Project (SRP) under which non-seafacing polder embankments throughout the 'cyclone' affected coastal areas are being rehabilitated has been in progress for some time. The works are based largely on criteria which pre-date the surge and tidal assessments of CPP-II. The BWDB Minor Works Programme is being implemented to ensure that agricultural land in the coastal polders, is provided with both protection and water control measures. The opportunity should be taken to harmonize the cyclone protection design standards of CPP:II with SRP and the proposed Minor Works Programme, allowing for the decrease of surge height with distance from the coastline.

The land use of embankment crests and side slopes needs to be managed to preserve the strength and integrity of the embankment. The early establishment of a scour resistant vegetative mat (grass turf) is considered essential for achieving this. Methods such as mulching and spraying-on selected seed mixes have proved to be very successful in areas of tropical rainfall where mechanized construction methods are adopted. They should be introduced to Bangladesh (if not already) and field tested under CPP II.

Quality control problems of construction in dispersed and remote locations are well known and generally acknowledged. The damage in 1991 was caused by :

i) overtopping and suction force at the time of backflow;

ii) overtopping by surge water resulting in erosion of the country side slope leading to breach in the embankment;

iii) poor quality of earthwork, without proper compaction; and

iv) use of inappropriate fill material.

Sea-facing and non-seafacing embankment construction requires particular care in supervision to achieve the required standards of compaction to avoid failure at the time of a cyclonic surge. No evidence of such care was seen during site visits to the Moheshkhali and Chakaria polders in April/May 1992.

There is no annual independent assessment of the condition of the coastal embankments. An annual 'condition audit' with inspection, monitoring and recording involving beneficiaries and BWDB is needed. The survey records of embankments prepared during FAP:7 shows the relative condition of the protective system. With fore knowledge of the least prepared lengths of embankment, contingency plans for targeting emergency repair materials and supplies should be made as part of the 'normal' time preparedness activities.

c) Afforestation

In the 1960s, technical reports on mangroves and tidal area afforestation were limited and available data were not sufficiently detailed to give sufficient evidence to support a capital investment programme. However, using the information available, afforestation of the forelands and sea facing exposed land was tried out on an experimental basis.

Artificial afforestation to protect new coastal formations has been attempted and good results have been obtained. Stable formations are fast appearing around the plantations. The most successful areas are Patharghata in Patuakhali, South Hatiya in Noakhali and Char Kukrimukri in Barisal. The realisation of the importance of coastal afforestation in the consolidation of newly accreted land, led the Department of Forests (DoF) to undertake extensive afforestation projects with mangrove and tidal species in the coastal districts. the area of coastal plantations to 1990 and projected to 1992 are given in **Table 4.4.**

It is planned to develop forests along the forelands of the sea-facing embankments wherever they are set back and where they are to be re-sectioned, the only exception is where there is existing forest. Both World Bank and ADB are trying to ensure that this work is implemented in parallel with the embankment construction work. This would involve local voluntary participation. Such an approach has already been initiated by the CPP in the Cox's Bazar area. In addition, BWDB are introducing forest plantations on the foreland of Polder 67 (Teknaf) under deposit works arrangements. These approaches should be coordinated to devise the most appropriate methods of establishing sustainable protective forest plantations.

TABLE 4.4

Coastal Area Plantations (ha)

Year	Area by Division				
	Chittagong	Noakhali	Barisal	Patuakhali	Total
1965-70	1 056	637	1 580	-	3 273
1970-75	1 110	1 000	669	493	3 273
1975-80	8 649	9 650	5 539	5 145	28 983
1980-85	9 389	14 609	10 855	5 544	40 397
1985-90	8 585	12 748	6 390	4 654	32 377
Sub Total	28 789	38 644	25 033	15 836	108 302
Projection					
1991	830	2 023	809	404	4 066
1992	830	2 023	809	404	4 066
Total	**30 449**	**42 690**	**26 651**	**16 644**	**116 434**

Different opinions exist concerning the benefits and risks associated with establishing trees on the side slopes of the embankments themselves. A thorough examination and review of experience in countries which have a long history of polder development, such as in the Netherlands, is required. In such countries, as in Bangladesh, pressures on land have to be balanced against long term safety.

The association of forestry development with multi-purpose shelters, 'killas' and other community building works is proposed in the Multi-Purpose Shelter Programme master plan.

Annex C discusses the above issues in more detail.

d) Erosion Control

There are particular problems of developing sustainable forests on foreshores where erosion is taking place. Such action is affecting Sandwip and other offshore islands,. Low cost measures could be used to help stabilize such coastlines. Flexible mats of artificial seaweed might be used to promote sedimentation and the self growth of groynes. They have been shown to induce the formation of sand deposits and to withstand sub-sea scour conditions in the North Sea at a fraction of the cost of equivalent 'hard surface' defences (King, 1992). Such measures deserve consideration and should be reviewed under FAP:5B.

e) Surge Suppressors

At present, the full force of the storm surge is spent at the coastline. The embankments resist the pressure of the sea rise and some of the kinetic energy is absorbed by the frictional

resistance of any local forests. Where embankments are insufficiently high, the residual surge overtops and spreads over the countryside gradually dissipating itself against the frictional resistance of the features of the land surface.

Although the detailed nature of the surge wave is not fully understood, its general form and behaviour can be modelled. It has been suggested that an arrangement of sea brakes could be constructed on the shore to reduce the force of the incident surge wave before it reaches the coastline (IDNDR, 1980). Proven techniques of construction, including dredging and sea bed protection, could be considered. Such measures could be associated with the acceleration of near-shore accretion, where conditions are favourable.

4.4 Rescue and Transport Facilities

a) Rescue Vessels

For a considerable time following a cyclonic surge, high winds and rough seas tend to persist making rescue operations and access for immediate relief supplies to offshore islands and polders extremely difficult without suitable vessels. No such vessels are available, except perhaps with the Armed Forces. Consideration should be given to the procurement of suitable vessels which could be used in normal times for ferry purposes and be available for rescue and relief duties following disasters.

b) Helipads, Drop Zones and Landing Strips

The effectiveness of helicopters in assisting immediate damage assessments and with the distribution of relief supplies following the 1991 cyclone, is generally recognized. Short take-off and landing (STOL) aircraft could also be employed, where landing strips were available. The location of helipads, drop zones and landing strips requires to be full detailed on maps as part of an integrated disaster relief transport system.

c) Roads

In addition to sea-facing embankments, designs and tender documents for a programme of road construction and rehabilitation in cyclone affected areas were prepared under FAP:7 (later CPP II). Following the April 1991 cyclone, the programme was modified and a revised programme developed. There is a need for this revised programme to be reconciled with shelters planned under the MSCP and other projects. There is also a need for further identification of priority feeder roads in the area.

The condition of the trunk and feeder road network needs to be kept under annual review to enable the direction of relief transport in the most effective way. One of the chief shortcomings immediately after the 1991 cyclone is reported to have been lack of usable roads. Trunk and feeder roads need to be part of an integrated disaster relief transport system.

At present, many roads are aligned parallel to the shore. These tend to be badly damaged by surges and more roads at right angles should be constructed. Many existing jetties and lending places are not connected into the all-weather road network. It is interesting to note

that many people in the cyclone-prone areas considered raised road embankments a higher priority than 'killas'. This should be further investigated.

d) Inland and Coastal Waterways

Waterways form one of the most used transport arteries for people and goods in the coastal area. There is a continuing need to monitor the silting and scour of the network of tidal channels and to be aware of routes available for use by vessels of differing capacity and draft i.a. for the distribution of relief. A register of vessels should be prepared and the routes they can operate normally and in emergencies should be maintained and reviewed annually.

e) Harbours, Jetties and IWTA Terminals

Harbours, jetties and safe anchorages provide facilities both for the safety of vessels during cyclones and for the distribution of relief afterwards. In normal times, they are an essential link in the transport system.

Apart from Chittagong, and to a lesser extent Cox's Bazar and Chandpur, there appear to be no significant harbours along the eastern coastline, in the Meghna Estuary, or along the western coastline. Inland waterway vessels, however, appear to find shelter without great difficulty away from the coastline and major boundary rivers.

Vessels sank in the port of Chittagong during the April 1991 cyclone. Although in the coastal area, Mongla is inland. Inspite of this, however, vessels are reported to have sunk during a previous cyclone. The District ports of Barguna and Patuakhali, which are further inland, did not report any sinkings.

Sheltered landing sites on islands and in tidal estuaries where the water is silty are normally subject to siltation and require jetties for low tide berthings. In the Cox's Bazar District, a permanent jetty has been recently constructed at Moheshkhali. This jetty survived the April 1991 cyclone with only superficial damage. There is only a temporary wooden jetty at Cox's Bazar itself.

The need for more permanent jetties have been expressed by BWDB and CPP officials. Expressed needs are for jetties at Cox's Bazar, Badarkhali, Ujantia, Moghnama, Dalaghata, Matarbari and Kutubdia. The LGED has initiated a design programme for six jetties as listed in **Table A.1 in Annex A.** This table also shows jetty sites recommended in the MSCP Report (July 1992).

Further investigations are required to confirm these sites and to determine additional locations. Feasibility and detailed design studies for the jetties and other anchorage facilities would then be required. Such facilities need to be planned for use in normal times and to be available as part of the relief transport system.

f) Rail Network

Large quantities of supplies can be moved between major distribution centres by the railway network. Hence, it could play an important part in relief work. The main food stores are

served by railway sidings for the purpose. Railways should be included in the overall transport system which should cater mainly for normal times but should form part of integrated relief transport system.

4.5 Relief Measures

a) Health Centres

Hospitals, dispensaries and stores containing relief medical supplies, all form part of the disaster preparedness and response system. The distribution of these facilities in cyclone resistant buildings located strategically throughout the cyclone prone areas, and in relation to community groups of shelters, should be reviewed and existing gaps identified. There are significant variations in the number of medical centres in different thanas and per head of population. These can be seen on the map and indicate a need for more coordinated planning.

b) Food Stores

Apart from the food storage facilities in thana LSD (local storage depots) there have been efforts to provide small scale food storage at union level. Preliminary studies indicate that there are only two locations within the High Risk Area (HRA) where 10 tone VGD stores have been established. Outside the HRA, there are more VGD stores but distribution is very uneven. There have been proposals for the construction of 20 tonne stores but it appears that none have been built. Such small scale stores could be used in normal times in conjunction with growth centre development. They would then be available at times of disaster.

c) Agricultural support

Following a cyclonic surge, areas of farm land are temporarily covered in sea water and the restoration of the land for agricultural use requires support. Power pumps, seed and fertilizer need to be held in reserve. Sources of supply and contingency plans for the rapid procurement and deployment of hand operated power tillers, need to be developed and be ready for implementation.

4.6 Rehabilitation and Development

a) Growth Centres

Government have designated certain important villages as Growth Centres, usually three or four in each thana. These centres should be the first to be protected under any programme of coordinated local level cyclone protection schemes (c f flood proofing).

b) Cluster Villages

Following the 1985 cyclone, and largely in response to the loss of life and devastation in newly settled 'chars', the concept of nucleus housing was used in re-establishing villages on Urir Char. In this concept, individual cyclone-proof family houses were constructed in groups around fish ponds. About 260 such units were built, however their cost was high.

Various proposals for low cost cyclone resistant housing units and shelters have been put forward by the Ministry of Works Committee on Cyclone Shelters (IMTF 1991, LGEB 1991)

c) House 'Strengthening'

Large quantities of C.I. sheet, distributed following the April 1991 cyclone, have been used for the roofing of both small houses of simple construction and also larger buildings, including schools. Experience shows that roofing sheets get blown about in cyclonic winds with very dangerous consequences to people moving from homes to shelters. Small houses may not have substantial structural frames or foundations. Roofing sheets are often not anchored adequately to the supporting purlins and trusses which in turn may be insubstantial or not adequately incorporated into the building structure.

There is a need to provide for the strengthening of village buildings at least to the extent that they fail safely and with minimum danger to third parties during damaging cyclones. The ideal of making loans available for the strengthening of buildings to make them cyclone resistant has been suggested and needs to be followed up.

The provision of loans to enable people to build two storied 'pucca' houses has also been suggested. The recipients of such loans would be expected to provide emergency shelter facilities for others.

d) Water Supply

The most urgent requirement immediately following inundation due to a storm surge is for the re-establishment of potable water supplies. At sites visited and shelters seen under construction in May 1992, hand pump tubewells had been installed to a depth of typically 650 feet to produce sweet water. At one well established site, a hand pump had been replaced by an electric pump. The hand pumps was reinstalled on the day after the 1991 cyclone as, in the absence of power, the electric pumps could not work, Such contingency arrangements should not be overlooked as development progresses in cyclone prone areas.

Approval has been given by ECNEC for the construction of five thousand deep tubewells in the cyclone-affected areas (Bangladesh Observer 14.05.92). Although DANIDA are assisting DPHE with investigations for potable water in the coastal area, it understood that there has been no thorough investigation of the extent and yield of deep aquifers in the area. **Annex D** outlines the scope, terms of reference and methodology for such an investigation.

e) Roads

Plans for the repair and rehabilitation of the coastal area road network to improve access for rescue and relief have been proposed (FAP:7). Detailed engineering and implementation is scheduled to start shortly. Further general needs for road network extensions have been identified in association with the provision of schools-cum-shelters (BUET, 1992). There is a need to coordinate the road network with the water and rail transport system and also to link roads to IWTA Terminal and other jetties.

f) Water Transport

IWTA terminal buildings are frequently under-utilized due to lack of link roads. Terminals have been lost due to erosion. Others have been silted up and abandoned. IWTA appear to have no plans to replace or extend their existing cyclone-proof terminal buildings. This should be reviewed and addressed as part of a coordinated transport development plan.

g) Power Generation and Distribution

The relative cyclone resistance of the precast concrete 11 kV distribution poles was very evident during the field visits. On the other hand, tall lattice pylons were blown down at the major waterway crossing near Badarkhali. Plans and standards for power distribution facilities should be included in the integrated plans for the coastal areas and appropriate design criteria adopted consistently.

h) Mangrove Conservation

The protective value of coastal forests has already been mentioned. Its value as a sustainable resource for fisheries and forest products is also recognized. The need to preserve wildlife is generally accepted. The problem of management and control is currently being addressed by the UNDP/FAO Team for the Integrated Development of the Sunderbans.

CHAPTER 5

INTEGRATION OF COMPONENTS

5.1 Mapping and Geographical Information System

Selected components of the Plan have been mapped within the designated High Risk Area (MSCP 1992). Copies of two working maps showing infrastructure and telecommunications accompany this Working Paper and are intended as aids to planning for integrated rehabilitation and development in the coastal area. Existing and proposed elements are also shown. The map serves to show the value of a Geographical Information System and it is recommended that a computerized system be developed to plan and coordinate the integrated protection and development of the coastal area.

5.2 Integrated Coastal Area Development

An integrated system of measures for coastal protection requires coordinated planning and management as outlined in **Chapter 3**. This necessitates supra-ministerial policies and decision making on plans drawn up jointly by the authorities responsible for the development of the coastal districts. A Coastal Area Development Programme could be conceived as a rolling programme of coordinated development projects with the aims of cyclone protection, resource management, and sustained economic growth.

Recommendations for integrated coastal area development have come from many sources (ESCAP, 1987; Moudud et al, 1988; NEMAR, 1991; Mokammel Haque, 1991; Clark et al, 1991; Kampsax et al, 1992) and most recently in January 1993 at the National Seminar to discuss the MCSP. These recommendations need to be reviewed and the institutional requirements and an implementation framework established, with coordination at the highest level. As previously suggested this coordination might best be provided by a Coastal Area Development Committee within the Planning Commission with members representing agriculture, water development, fisheries, environment and forests, local government, tourism etc. This would provide an umbrella under which all activities could be planned and monitored.

There are many aspects that require the attention of such a Committee many of which were highlighted during the presentation of this Concept Plan on 4 October 1992. They include:

- location of multi-purpose and other shelters
- shelter design criteria
- relationship between sea-facing embankment and shelter design criteria
- trees on side slopes of sea-facing embankments
- encouragement of coconut and palm tree forests
- groundwater surveys
- protection of shrimp cultivation areas
- improvement of IWTA facilities
- storage facilities
- the need for accurate records of tides, surge heights etc.

5.3 Tourism Development

Consultants, engaged by the World Tourism Organisation, with assistance from UNDP (BGD/85/119) published a Tourism Action Plan in January 1990 (PKF, 1990).

This Plan highlighted the tourism potential of the following in the coastal areas: Cox's Bazar and its beach, the historic mosque-city of Bagerhat and the Sundarbans.

In developing the Concept Plan further these aspects should be fully considered.

5.4 Costs

Costs for the components of the Plan either being implemented or planned have been taken from the relevant study reports where available. These costs are presented in **Table 5.1**. Costs of shelters (ongoing and planned by Agencies) are based on CARITAS information. Systems Rehabilitation Project costs are tentative and will depend on feasibility studies presently underway or in the pipeline. Donor budget provisions are shown for the Coastal Afforestation, Green Belt and Sundarbans Development projects. The road rehabilitation costs are based on information given in the MCSP. Jetty budget costs were provided by LGED. Costs of telecommunications equipment are taken from Volume III and allowances have been provided for the replacement of IWTA Terminals and the provision of rescue vessels.

The costs have been distributed as indicated by available planning reports (MCSP, FAP-7, SRP). The remaining costs are spread in relation to priority and inter-linkage with other components. The total cost of the resulting financial programme reflects the consequence of uncoordinated planning. There is a need to examine the rate at which a coordinated programme of protection works and coastal area development could be implemented, in light of manpower and funding constraints.

5.5 Investment Levels

The value of the works proposed under the MCSP amount to some Tk 12 500 million ($313 M) allowing for physical contingencies but excluding financial contingencies. **Table 5.2** shows this amount in the perspective of the current Five Year Plan (1990-95) and includes the costs of Sea-facing Embankment Project. Even though the shelter programme is spread over six rather than five years it would amount to some 3% of the Public Sector development budget allocation and require a 90% increase over the country average in expenditure per head on the population of the High Risk Area.

If the full costs as indicated on **Table 5.1** were incurred, this would represent some 9% of the public sector development budget and require an expenditure per head of more than 200% above the national average.

5.6 Further Studies

The Concept Plan has revealed a range of coastal protection activities both at the planning and implementation stages. It has also revealed needs, gaps, inconsistencies and an

TABLE 5.1

Cost Streams for Outline Concept Plan

Description	Unit	Qty	Rate US$ '000	Base Cost US$ Million	Yearly Base Costs 92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	15% Eng & Admin	15% Phys Contg	Totals US$ Million
Shelters under Construction	Nr	200	56.5	11.30	11.30								1.70	1.70	14.69
Shelters Planned by Agencies	Nr	467	56.5	26.39		17.59	8.80						3.96	3.96	34.30
Multipurpose Cyclone Shelter Programme															
Repair Cyclone Shelters	Nr	226	10.6	2.40		2.40							0.36	0.36	3.11
Repair Killas	Nr	146	1.4	0.20		0.20							0.03	0.03	0.27
Shelters on Killas	Nr	1500	84.0	126.00			11.45	22.91	22.91	22.91	22.91	22.91	18.90	18.90	163.80
Shelters on Stilts	Nr	1000	110.0	110.00			10.00	20.00	20.00	20.00	20.00	20.00	16.50	16.50	143.00
Killas (incl addl 131)	Nr	2631	20.0	52.62			4.78	9.57	9.57	9.57	9.57	9.57	7.89	7.89	68.41
Sea-facing Embankments (FAP-7)															
Priority Works (LCB)				13.85	13.85								2.08	2.08	18.01
Priority Works (ICB)	km	126	270.0	34.02	34.02								5.10	5.10	44.23
Phase 2 Works (ICB)	km	206	270.0	55.62		27.81	27.81						8.34	8.34	72.31
Afforestation (Shore/Slopes)				4.35			1.45	1.45	1.45				0.65	0.65	5.66
Minor Works Programme (Say)				10.00			5.00	5.00					1.50	1.50	13.00
Systems Rehabilitation Project (Say)				20.00	4.00	4.00	4.00	4.00	4.00				3.00	3.00	26.00
Coastal Afforestation	ha	33000	1.1	36.30		7.26	7.26	7.26	7.26	7.26			5.45	5.45	47.19
Green Belt Project	km	700	6.0	4.20			1.4	1.4	1.4				0.63	0.63	5.46
Shrimp Culture Project				1.86	1.86								0.28	0.28	2.42
Sundarbans Integrated Resource Development				2.72	0.91	0.91	0.91						0.41	0.41	3.54
Cyclone Damaged Road Reconstruction															
Priority 1	km	308	90.8	27.97		13.98	13.98						4.19	4.19	36.36
Priority 2	km	362	90.8	32.87			16.43	16.43					4.93	4.93	42.73
Coastal Road System Rehabilitation (MCSP)															
Road Repairs	km	80	90.8	7.26	7.26								1.09	1.09	9.44
Roads Rehab (MCSP Grp 1)	km	189	90.8	17.16				17.16					2.57	2.57	22.31
Roads Rehab (MCSP Grp 2)	km	216	90.8	19.61					19.61				2.94	2.94	25.50
Roads Rehab (MCSP Grp 3)	km	384	90.8	34.87						17.43	17.43		5.23	5.23	45.33
IWTA Link roads	km	88	90.8	7.99	7.99								1.20	1.20	10.39
Jetties (MSCP/LGEB/IWTA)	Nr	16	25.0	0.40	0.13	0.27							0.06	0.06	0.52
Replacement Terminals (IWTA)	Nr	5	50.0	0.25		0.25							0.04	0.04	0.33
Telecommunications	Thana	50	800.0	40.00		10.00	10.00	10.00	10.00				6.00	6.00	52.00
Rescue Vessels	Nr	10	200.0	2.00		2.00							0.30	0.30	2.60
Engineering & Administration (15%)				105.33	12.20	13.00	18.49	17.28	14.43	11.58	10.49	7.87			
Physical Contingencies (15%)				105.33	12.20	13.00	18.49	17.28	14.43	11.58	10.49	7.87			
Totals (US$ Million)				912.87	105.72	112.67	160.26	149.74	125.06	100.32	90.88	68.22	105.33	105.33	912.87
Totals (Tk Crore)				3651.48	422.89	450.67	641.05	598.95	500.24	401.28	363.53	272.88	421.32	421.32	3651.48

TABLE 5.2

Investment Levels

Investment	Total Investment (Tk M)	Area 0.144 Msq.Km (Tk/sqkm)	Population 115 m (1992) (Tk/head)
BANGLADESH			
- Agriculture, Water Resources	110,210	765,347	958
- Rural Development			
- Industry	41,800	290,278	363
- Electricity, Oil, Gas	88,500	614,583	770
- Transport & Communication	74,730	518,958	650
- Physical Planning Housing & Water Supply	12,410	86,181	108
- Education & Religious Affairs	24,010	166,736	209
- Health	10,670	74,097	93
- Population Control & Family Planning	17,100	118,750	149
- Socio-Economic Infrastructure	5,850	40,625	51
- Miscellaneous	34,020	236,250	296
Total	419,300	2,911,806	3,646

	(Tk M)	Area 0.0105 Msq.Km (Tk/sqkm)	Population 5.2 m (1992) (Tk/head)
HIGH RISK AREA			
- MCSP Shelters (incl 10%)	12,500	1,190,476	2,404
- Sea-facing Embankments	5,000	476,190	962
Total	17,500	1,666,667	3,365

Source: MCSP-BUET, 1992; Fourth Five Year Plan.

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underlying need for coordination of the various components. Where appropriate , identified needs and recommendations have been included as additional items to be included in the CPP II : Sea-facing Embankment project and forthcoming FAP:5B Meghna Estuary Study (**Figure 3.1)**

To cover the remaining range of activities, a Khulna-Chittagong Coastal Area Master Plan Study is recommended. This would replace the presently proposed FAP:5C Chittagong Coastal Area Study and enable all the issues to be considered as part of a coherent Coastal Area Development Plan. Further, it would encourage the establishment of a Coastal Area Development Committee (CADC) with the Planning Commission to coordinate implementation.

The scope of the study is outlined below and shown in **Figure 5.1.**

- Development criteria need to be considered, including economic investment per capita and equity of facilities.

- Water resources and flood studies are needed for regional development in the Chittagong Coastal Area (original FAP-5C concept), including water management, upland flash-floods and cyclone surge protection.

- Offshore fisheries in the Bay of Bengal need to be reviewed and development opportunities identified.

- Specific environmental issues need to be addressed in relation to sea-facing embankments including mangrove conservation, the impact of shrimp culture and salt production activities on polder soils and the siltation of tidal channels, which in turn impact on channel capacity to pass upland flash flood flows.

- The coordination of the various telecommunications systems and their optimum utilization for disaster management should be reviewed. The key systems should be identified and strengthened. The expansion of CPP into new areas will require support.

- The improvement of cyclone warning by linking the services of the Bangladesh Meteorological Department and Bangladesh Television should be considered.

- The use of emergency radios and installation of high frequency networks to areas presently without stations.

- A transportation study should be undertaken for the High Risk Area to coordinate the rehabilitation and extension of trunk and feeder roads with inland and coastal waterways and the railways.

- Priorities should be set for new jetties and IWTA terminals with link roads and the provision of rescue vessels and landing strips, helipads and drop zones should be considered.

- Groundwater resources should be investigated to determine sustainable yields throughout the coastal area. The provision of potable water and sanitation should be reviewed.

- Design criteria for power distribution HT/LT lines and towers should be reviewed. The protection of power generation and grid stations should be considered.

- Social and relief systems need to be developed to enable rapid provisions of low lift pumps, power tillers, seed and fertilizers. The development of the Bangladesh Red Crescent Society and Disaster Preparedness Programme need to be considered.

- The provision of medical centres and of a system of union level food stores should be reviewed.

- Review tourism potential of the coastal areas.

It is understood that, as a follow on to the Multi Purpose Cyclone Shelter Programme the EC and the World Bank are likely to fund project preparation activities. Such work should be undertaken within the framework of a Coastal Area Development Plan. Further studies under the UNDP Coastal Area Resource Management Project and the UNDP/FAO Integrated Development for the Sundarbans should also be carried out within such a framework.

Committed Studies and Activities

PROJECTS	REF	AGENCY	FUND
SW Area Water Resources Management Study	FAP-4	MOI/FPCO	ADB/UNDP
SE Regional Study	FAP-5A	MOI/BWDB	IDA/UNDP
Cyclone Protection Project II (including Water Management)	FAP-7	MOI/BWDB	EC
O & M Study	FAP-13	MOI/FPCO	ODA/JICA
Land Aquisition and Resettlement	FAP-15	MOI/FPCO	SIDA
Environmental Study	FAP-16	MOI/FPCO	USA
Fisheries Study and Pilot Project	FAP-17	MOFL/FPCO	ODA
Topographic Mapping	FAP-18	MOI/FPCO	FIN,FR
Geographic Information System	FAP-19	MOI/FPCO	USA
Institutional Development Programme	FAP-26	MOI/FPCO	UNDP
Coastal Area Resource Management	US Team	PC	UNDP
Chittagong Master Plan	Binnie	CDA	UNCHS
Integrated Development for the Sundarbans	UNDP Tea	MOEF	UNDP/FAO
Second Coastal Project	Haskoning	MOI/BWDB	ADB
Systems Rehabilitation Project (Preparation)	Halcrow	MOI/BWDB	EC
Systems Rehabilitation Project (Advisory)	Dutch Tea	MOI/BWDB	NL
Multi-purpose Cyclone Shelter Programme	BGD/91/02	PC	UNDP
Bangladesh Building Code	DDC	PC	GOB
Assistance in Cyclone Rehabilitation (including Coastal Protection Concept Plan)	BGD/91/02	MOR	UNDP
Assistance to the Flood Warning Centre	BGD/88/01	MOI/BWDB	UNDP

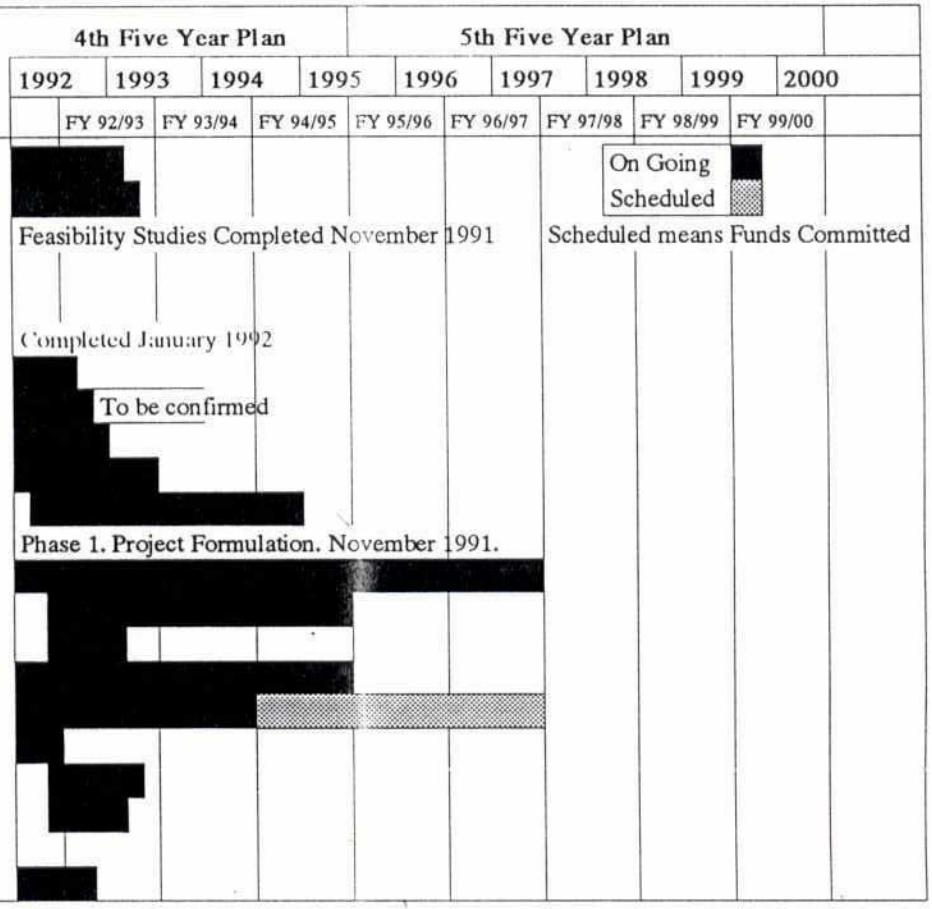
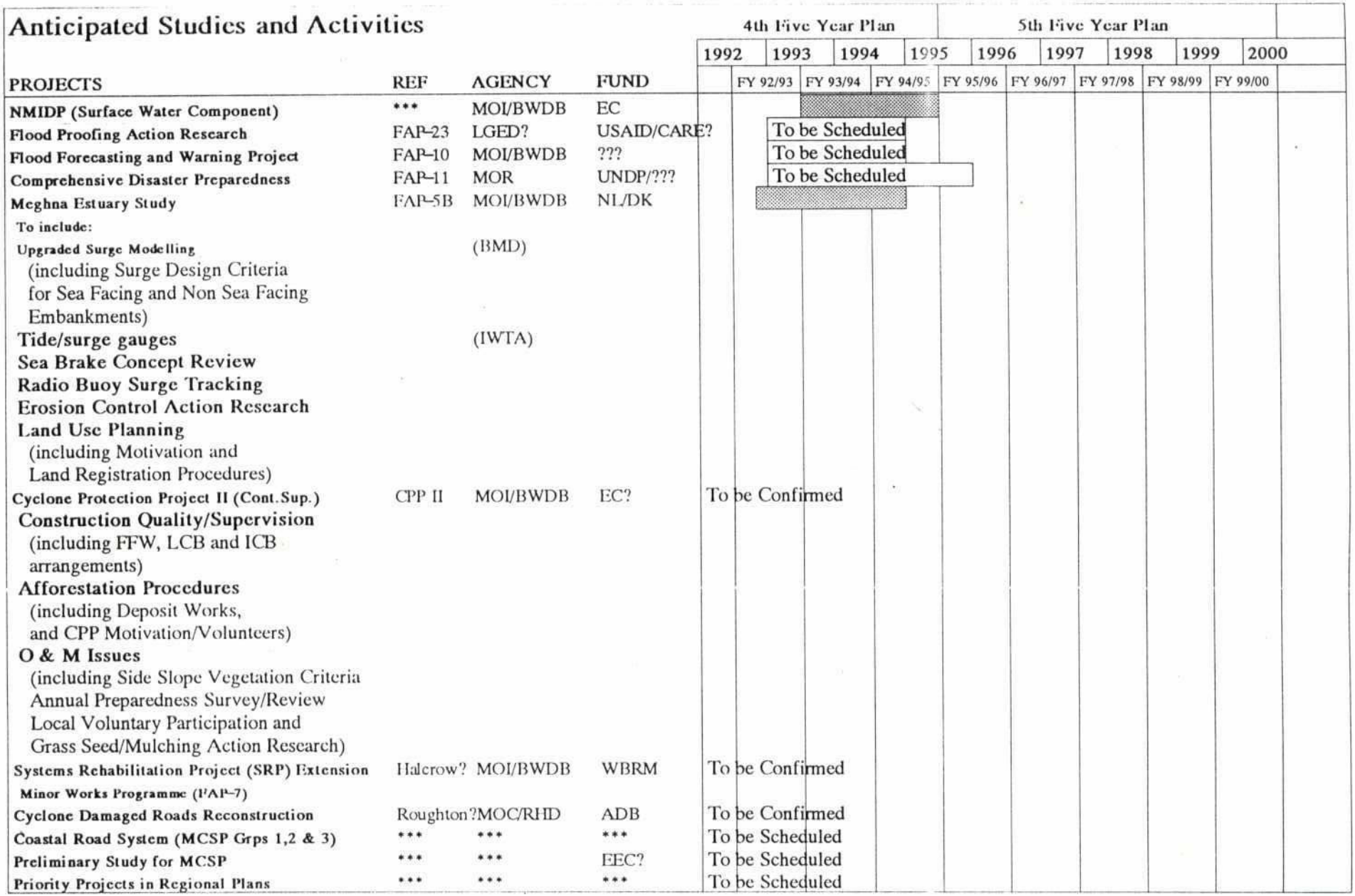


Figure 5.1
Outline Programme

Anticipated Studies and Activities



PROJECTS	REF	AGENCY	FUND
NMIDP (Surface Water Component)	***	MOI/BWDB	EC
Flood Proofing Action Research	FAP-23	LGED?	USAID/CARE?
Flood Forecasting and Warning Project	FAP-10	MOI/BWDB	???
Comprehensive Disaster Preparedness	FAP-11	MOR	UNDP/???
Meghna Estuary Study	FAP-5B	MOI/BWDB	NL/DK
To include:			
Upgraded Surge Modelling (including Surge Design Criteria for Sea Facing and Non Sea Facing Embankments)		(BMD)	
Tide/surge gauges		(IWTA)	
Sea Brake Concept Review			
Radio Buoy Surge Tracking			
Erosion Control Action Research			
Land Use Planning (including Motivation and Land Registration Procedures)			
Cyclone Protection Project II (Cont.Sup.)	CPP II	MOI/BWDB	EC?
Construction Quality/Supervision (including FFW, LCB and ICB arrangements)			
Afforestation Procedures (including Deposit Works, and CPP Motivation/Volunteers)			
O & M Issues (including Side Slope Vegetation Criteria Annual Preparedness Survey/Review Local Voluntary Participation and Grass Seed/Mulching Action Research)			
Systems Rehabilitation Project (SRP) Extension	Halcrow?	MOI/BWDB	WBRM
Minor Works Programme (FAP-7)			
Cyclone Damaged Roads Reconstruction	Roughton?	MOC/RHD	ADB
Coastal Road System (MCSP Grps 1,2 & 3)	***	***	***
Preliminary Study for MCSP	***	***	EEC?
Priority Projects in Regional Plans	***	***	***

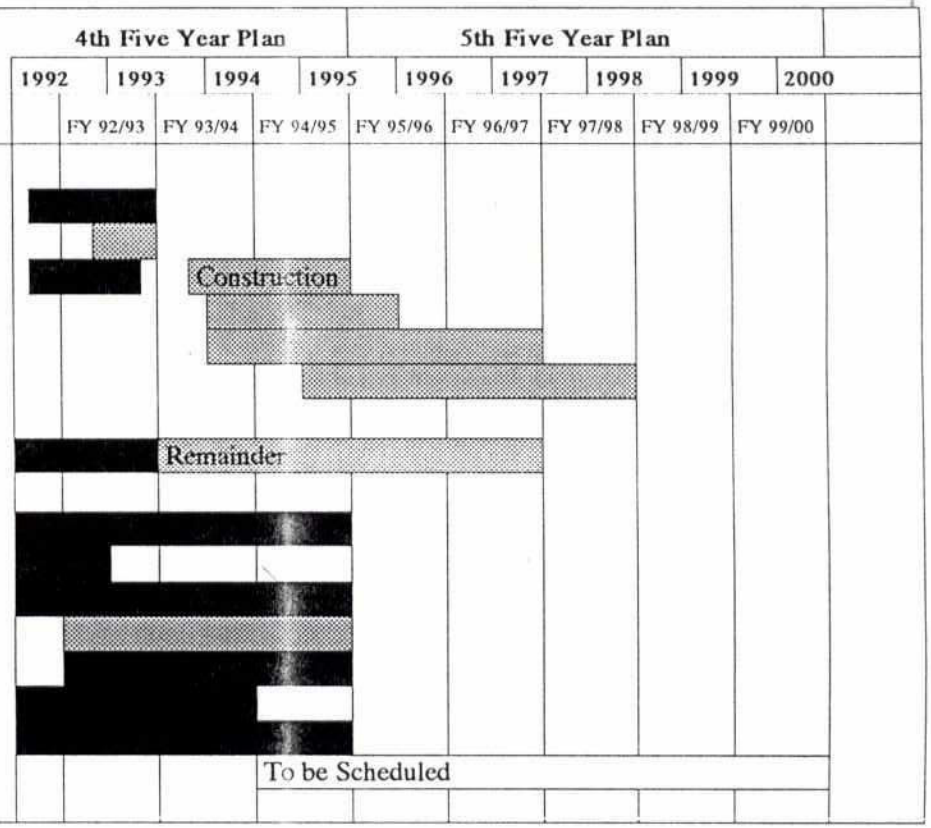
Figure 5.1 (Continued)
Outline Programme

Proposed Studies and Activities

PROJECTS	REF	AGENCY	FUND	4th Five Year Plan				5th Five Year Plan				
				1992	1993	1994	1995	1996	1997	1998	1999	2000
					FY 92/93	FY 93/94	FY 94/95	FY 95/96	FY 96/97	FY 97/98	FY 98/99	FY 99/00
Khulna–Chittagong Coastal Area Master Plan	FAP-5C	MOI/FPCO	***	To be Scheduled								
Development Criteria (including economics,investment per capita and equity of facilities)												
Protection of Agric/Shrimp/Salt Areas (Water Management, Upland Flash Flood and Cyclone Surge Protection)		(MOEF)										
Coastal Fisheries												
Environmental Issues (including Mangrove Conservation, Shrimp/Salt areas Soils, Channel Siltation, and Sand Dune Stabilization)												
Telecoms/Warning Systems												
CPP Development												
BMD/BTV Link												
Telecommunications in High Risk Areas (including Emergency Radios and High Freqency Networks)												
Additional Microwave Routes												
Transport Systems												
Transportation Study in High Risk Areas (including Trunk/Feeder Roads, Bridges, Shipping/Harbours/Jetties, Helipads/STOL strips/Drop zones, Rail Network, and Rescue/Relief Vessels/Craft)												
Utilities/Services												
Groundwater Investigations												
Potable Water/Sanitation												
Power Distribution System												
Social/Relief Systems												
Agricultural Rehabilitation (including BADC pumps, Power Tillers, Seed and Fertilizers etc.)												
Social Issues (including Womens Issues and BDRCS/DPP Development)												
Relief Storage Systems												
Medical Facilities												
Institutional Development												
Consideration of Coastal Area Development Committee (CADC)												

Figure 5.1 (Continued
Outline Programme

Project Implementation



PROJECTS	REF	AGENCY	FUND
Sea Facing Embankments/Structures (CPP II)			
Priority Works (LCB)		MOI/BWDB	IDA
Priority Works (ICB)		MOI/BWDB	IDA
Phase 2 Works		MOI/BWDB	IDA
Afforestation Trials		MOI/BWDB	IDA
Foreshore Afforestation		MOI/BWDB	IDA
Embankment Afforestation		MOI/BWDB	IDA
Non Sea Facing Embankments/Structures			
Systems Rehabilitation Project (SRP)		MOI/BWDB	IDA/EC
Shelter Facilities			
BDRCS Programme (217)		BDRCS	(Various)
Saudi Grant Programme (306)		MOE	Saudi
CARITAS (154)		CARITAS	(Various)
EC (Schools/shelters) (200)		MOE	EC
JAPAN (100)		LGED/MOE	JICA
CCDB (55)		CCDB	(Various)
Others (119)		Various	Various
MCSP Shelters and Killas (2500)		MOE?	IDA?

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Figure 5.1 (Continu
Outline Program

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ANNEXES

ANNEX A

Existing Infrastructure in the Coastal Areas

TABLE A.1
Tubewells, Stores and Medical Centres in High Risk Areas

District	Thana (Upazila)	Existing Tubewell STW (nr)	Existing Tubewell DTW (nr)	Population/ Existing Tubewell (nr)	Stores VGD (10t) (nr)	Stores LSD (nr)	Stores Capacity (tonnes)	Medical Centres (nr)
Sathkhira	Shymnagar	548	1	96		4	4,000	9
Khulna	Dacope	348	3	138		1	1,000	
Khulna	Koyra	248	12	144		1	250	1
Khulna	Sarankhola	560	0	74		1	1,000	2
Khulna	Monglaport	50	2	518		1	2,000	7
Barguna	Pathargata	119	190	534		3	5,000	5
Barguna	Barguna Sdr	0	584	279		2	4,000	5
Barguna	Amtali	1	559	177		3	6,500	7
Barguna	Betagi	0	323	144		1	2,500	4
Patuakhali	Bauphal	0	791	168		4	7,000	9
Patuakhali	Galachipa					6	9,000	7
Patuakhali	Dashmina	0	266	376		2	2,000	4
Patuakhali	Kalapara					4	6,500	5
Perojpur	Mathbaria	765	4	113		3	4,500	7
Bhola	Bhola Sdr	771	0	292		2	3,750	7
Bhola	Burhanuddin	259	0	507		3	4,750	6
Bhola	Lalmohan	155	394	410		4	5,750	3
Bhola	Char Fasson	2	565	701		4	7,250	7
Bhola	Manpura	0	139	471		1	1,000	
Bhola	Tazumuddin					2	3,000	2
Bhola	Daulatkhan	67	284	482		1	1,000	
Barisal	Bakerganj					2	2,000	5
Barisal	Barisal Sdr					1	2,665	10
Lakshmipur	Ramgati					3	4,000	5
Lakshmipur	Raipur	2,382	26	38		1	1,500	3
Lakshmipur	Lakshmipur	3,880	40	24		1	1,000	4
Noakhali	Hatiya	808	489	286	2	3	4,000	1
Noakhali	Noakhali Sdr	3,551	333	43		2	7,500	10
Noakhali	Companigonj	1,305	67	41		1	1,500	3
Feni	Sonagazi	2,080	25	67		1	1,750	6
Chittagong	Sandwip	2,043	64	158	2	1	4,500	3
Chittagong	Mirsarai	2,626	63	29		2	3,000	10
Chittagong	Sitakunda	586	21	320		1	1,000	7
Chittagong	Patiya	360	663	159		1	3,500	20
Chittagong	Anwara	850	304	122		1	1,000	5
Chittagong	Banshkhali	688	515	243		1	1,000	3
Chittagong	Bandar							
Cox's Bazar	Kutubdia	300	16	402		1	1,000	2
Cox's Bazar	Chakaria	2,174	450	135		2	3,500	6
Cox's Bazar	Moheshkhali	1,322	87	117		2	2,500	4
Cox's Bazar	Cox's Bazar	920	253	120		2	10,500	2
Cox's Bazar	Ramu					1	2,000	4
Cox's Bazar	Ukhia					1	1,500	3
Cox's Bazar	Teknaf	927	25	177		1	1,000	3
Totals		**30,695**	**7,558**		**4**	**85**	**143,665**	**216**

Sources: Multipurpose Cyclone Shelter Project (July 1992) and Government Records

TABLE A.2

Transport Terminals, Weather Radar and Power Stations in High Risk Area

District	Thana (Upazila)	Place Name	Jetties Existing E Proposed P MCSP M LGED L	Landings Airport A Strip S Helipad H Raised R	IWTA Existing E Terminal Requires R Replace	Weather Radar	Power Station P Grid Stn G Future F	Fuel Store
Bagerhat	Morrelganj			1 HR				
Bagerhat		Bagerhat					1 G	
Bagerhat	Sarankhola							
Bagerhat	Monglaport						1 G	
Sathkhira		Sathkira					1 GF	
Sathkhira	Shymnagar							
Sathkhira		Hirons Point						
Khulna	Dacope							
Khulna	Koyra							
Khulna	Mongla	Chandpai		1 H				
Khulna	Khulna	Goalpara					1 P	
Khulna		Central					1 G	
Khulna		South					1 GF	
Barguna	Pathargata							
Barguna	Barguna							
Barguna	Amtali			1 H				
Barguna	Betagi							
Patuakhali	Patuakhali			1 S?	1 E		1 G	
Patuakhali	Bauphal							
Patuakhali	Galachipa	Galachipa			1 E			
Patuakhali	Galachipa	Rangabali			1			
Patuakhali	Galachipa	Bora Baisdia			1 E			
Patuakhali	Dashmina							
Patuakhali	Dashmina	Char Kazal			1 E			
Patuakhali	Dashmina	Char Momtaz			1 E			
Patuakhali	Kalapara				1 E	1		
Patuakhali	Kalapara	Tiakhali		1 H				
Perojpur	Mathbaria							
Perojpur	Kaukhali							
Bhola	Bhola Sadar			1 H	1 E		1 P	
Bhola	Bhola Sadar	Ilshaghat			1 E			
Bhola	Burhanuddin			1 HR				
Bhola	Lalmohan			1 H	1 E			
Bhola	Char Fasson			1 HR				
Bhola	Char Fasson	Char Madras			1 E			
Bhola	Char Fasson	Ghosherhat			1 E			
Bhola	Manpura		1 MP	1 H	1 E			
Bhola	Tazumuddin			1 H	1 R			
Bhola	Daulatkhan		1 MP	1 HR				
Barisal	Bakerganj			1 HR				
Barisal	Barisal Sadar			1 H			1 PG	
Barisal	Hizla			1 HR				
Barisal	Mehendiganj			1 HR				
Lakshmipur	Ramgati							
Lakshmipur	Raipur							
Lakshmipur	Lakshmipur							
Lakshmipur	Lakshmipur	Chital Khal			1 R			
Noakhali	Hatiya	Hatia	1 MP		1 R		1 P	
Noakhali	Hatiya	Tamaruddin			1 E			
Noakhali	Hatiya	Jahaz Mara			1 E			
Noakhali	Noakhali Sadar							
Noakhali	Noakhali Sadar	Char Jabbar			1 E			
Noakhali	Companigonj							
Noakhali	Noakhali	Maijdi Court		1 H				
Feni	Sonagazi							
Feni	Feni			1 S			1 G	
Chittagong	Sadar	Sikalbaha					1 PG	
Chittagong	Bandar			1 A				
Chittagong	Sandwip	Sandwip	2 MP				1 P	
Chittagong	Sandwip	Harishpur						
Chittagong	Sandwip	Gupta Char			1 E			

TABLE A.2 (Contd.)

Transport Terminals, Weather Radar and Power Stations in High Risk Area

District	Thana (Upazila)	Place Name	Jetties Existing / Proposed / MCSP / LGED		Landings Airport / Strip / Helipad / Raised		IWTA Existing Terminal Requires Replace		Weather Radar	Power Station Grid Stn Future		Fuel Store
				E P M L		A S H R		E R			P G F	
Chittagong	Sandwip	Shatal Khal					1	R				
Chittagong	Mirsarai											
Chittagong	Sitakunda											
Chittagong	Sitakunda	Kumira	1	MP			1	R				
Chittagong	Patiya											
Chittagong	Anwara											
Chittagong	Banshkhali	Chanua			1	H	1	E				
Chittagong	Banshkhali	Khankhanabad			1	H						
Chittagong		Halishahar								1	G	
Chittagong		Dohazari								1	G	
Chittagong		Hat Haari								1	G	
Chittagong		Modanhat								1	G	
Chittagong		Bara Awalia								1	G	
Chittagong		Chandra Ghona								1	G	
Chittagong		Kulshi								1	G	
Chittagong		Bakulia								1	GF	
Chittagong		Noapara								1	GF	
Chittagong	Banshkhali	Saral			1	H						
Chittagong	Kumira											
Chittagong	Rangunia	Kaptai								1	PG	
Chittagong	Boalkhali											
Cox's Bazar	Kutubdia		1	MP			1	E		1	P	
Cox's Bazar	Kutubdia	Bagerhop	1	LP	1	H						
Cox's Bazar	Kutubdia	Sateruddin					1	E				
Cox's Bazar	Chakaria											
Cox's Bazar	Chakaria	Lakhyar Char			1	H						
Cox's Bazar	Chakaria	Magnama	1	LP								
Cox's Bazar		Ujantia	1	P								
Cox's Bazar		Dalghata	1	P								
Cox's Bazar	Chakaria	Badarkhali					1	E				
Cox's Bazar	Chakaria	Bhola Ghat					1	E				
Cox's Bazar	Moheshkhali		1	E								
Cox's Bazar	Moheshkhali	Gorak Ghata					1	E				
Cox's Bazar	Moheshkhali	Jemghata					1	E				
Cox's Bazar	Cox's Bazar		1	P	1	A	1	E	1	1	G	
Cox's Bazar	Cox's Bazar	Chaufaldan	1	LP								
Cox's Bazar	Ramu											
Cox's Bazar	Ukhia											
Cox's Bazar	Teknaf		1	LP								
Cox's Bazar	Teknaf	St Martin I	1	LP								
Chittagong	Chandanaish											
Khulna	Dublar Char											
Other Locations												
	Totals		**16**		**25**		**30**		**2**	**25**		

Sources: Government Agencies

A:\ik-4\Tab3-3w9

TABLE A.3

Stores, Godowns and Medical Centres Outside High Risk Area

District	Thana (Upazila)	Stores VGD −10t	Stores LSD	Capacity	Medical Centres
		(nr)	(nr)	Ton	(nr)
Bagerhat	Bagerhat Sdr	4	1	3,000	6
Bagerhat	Mollarhat	7	1	1,500	5
Bagerhat	Rampal		2	3,000	8
Bagerhat	Morrelganj		1	2,000	11
Bagerhat	Kachua	4	1	2,000	4
Bagerhat	Fakirhat	1	1	1,500	
Bagerhat	Chitalmari	3	1	n/a	3
Bagerhat	Sarankhola		1	1,000	2
Bagerhat	Monglaport		1	2,000	7
Sathkhira	Satkhira Sdr		1	4,500	9
Sathkhira	Kalaroa	9	1	1,500	9
Sathkhira	Assasuni	5	2	2,500	8
Sathkhira	Kaliganj		1	1,000	7
Sathkhira	Debhata		1	1,000	2
Sathkhira	Tala		1	2,000	9
Khulna	Paikgacha	4	1	1,000	5
Khulna	Batiaghata	5	1	500	3
Khulna	Daulatpur				3
Khulna	Dumuria	7	1	2,000	7
Khulna	Tarokhada	3	1	1,500	1
Khulna	Fultola		1	1,000	2
Khulna	Rupsha		1	250	3
Barguna	Bamna		2	1,500	3
Patuakhali	Patuakhali Sdr		2	5,000	12
Patuakhali	Mirzaganj		2	2,000	5
Perojpur	Perojpur Sdr		2	2,500	6
Perojpur	Kawkhali		1	3,000	3
Perojpur	Nazirpur		1	2,500	5
Perojpur	Swarupkati		1	1,250	7
Perojpur	Bhandaria		1	2,000	9
Jalakhati	Jalkhati Sdr		1	4,500	9
Jalakhati	Kathalia		1	1,500	4
Jalakhati	Nalchity		1	1,000	9
Jalakhati	Rajapur		1	1,000	5
Barisal	Gowranadi		1	1,500	3
Barisal	Babuganj		1	1,000	3
Barisal	Ujirpur	4	1	1,000	3
Barisal	Hizla		1	1,000	5
Barisal	Mehediganj		1	1,000	7
Barisal	Muladi	5	1	1,000	3
Barisal	Agoiljhara	5	1	500	1
Barisal	Banaripara		1	1,250	2
Lakshmipur	Ramganj		1	2,500	2
Noakhali	Begumganj		3	8,500	11
Noakhali	Senbagh		1	1,500	4
Noakhali	Chatkhil		1	1,500	7
Feni	Feni Sadar		1	3,500	8
Feni	Chagalnaiya		2	4,000	2
Feni	Parshuram		1	1,500	2
Feni	Dagonbhuiyan		1	1,000	6
Chittagong	Fatichari		1	1,500	5
Chittagong	Hathazari		2	1,500	9
Chittagong	Rangunia		1	4,000	9
Chittagong	Rawzan		1	1,000	6
Chittagong	Satkania		1	2,000	11
Chittagong	Boalkhali		1	1,000	7
Chittagong	Lohagora		1	500	4
Total		**66**	**66**	**106,250**	**311**

ANNEX B

ANNEX B

TELECOMMUNICATIONS FOR DISASTER MANAGEMENT

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LIST OF APPENDICES

ANNEX B

TELECOMMUNICATIONS FOR DISASTER MANAGEMENT

B.1 INTRODUCTION

This report was prepared during the course of UNDP Project BGD/91/021: Assistance to the Ministry of Relief in the Coordination of Cyclone Rehabilitation. This Project formally commenced on 19 March 1992 and is due to terminate ten months later.

This report summarises the findings of the Telecommunications Consultant whose Terms of Reference are given in **Appendix 1.**. His input covered a period of two and a half months commencing in mid May 1992. His initial findings were reported in **Annex E** to the Inception Report (MM, 1992) which was published in June 1992.

Section B.2 sets the scene, highlighting the need for reliable telecommunications at the time of disasters.

Section B.3 describes the existing systems which appear in most cases to be used exclusively by their 'owner' agencies.

Section B.4 discusses communications requirements, present deficiencies and plans to overcome them, while **Section B.5** outlines a concept plan for the development of effective telecommunications in the future.

B.2 BACKGROUND

Because of her geographical position, Bangladesh is extremely vulnerable to natural disasters, as demonstrated by many occurrences in the past and recently by the floods of 1987 and 1988 and by the cyclone of April 1991.

Major objectives of UNDP Project BGD/91/021 was to assist the Ministry of Relief in co-ordinating efforts to repair and rehabilitate the areas affected by the cyclone of April 1991 and to strengthen the Ministry by setting up a Disaster Co-ordination and Monitoring Unit (DCMU) which would be capable of effective monitoring, evaluation and reporting, together with co-ordination of, and assistance to, agencies involved in disaster-related activities. The Project would pave the way for a longer term Disaster Management Project.

Reliable communications are an essential requirement for effective disaster management. Following the April 1991 cyclone, international telecommunications were interrupted due to the collapse of vital microwave tower at Chittagong, which provided the only link to the Bethbunia Satellite Earth Communications Station. The microwave tower was blown down and Bangladesh was cut-off from the rest of the world for several days, before services could be partially restored.

Immediately after the cyclone, the Bangladesh Red Crescent Society (BDRCS) radio network appears to have been the only means of communication to and from the affected areas as the other communication systems were inoperable following the devastating cyclone.

Some external agencies, which came forward with offers of assistance in the aftermath of the cyclone, wished to operate emergency communication systems to facilitate their own activities and those of others. The strict Government regulations governing the use of radio communications and the importation of such equipment, were enforced, preventing the use of such equipment and severely handicapping the operational efficiency of those assistance programmes.

B.3 EXISTING TELECOMMUNICATION SYSTEMS

B.3.1 Investigations

In order to determine the details of existing telecommunication networks in the country, visits were made to various organisations. Discussions were held with the concerned officials concerning their facilities and performance, especially during the cyclone of April 1991.

The following organisations/offices were visited in Dhaka:

i) Telegraph & Telephone Board
ii) Bangladesh Meteorological Department (BMD)
iii) BMD: National Meteorological Communication Centre, Dhaka
iv) Meteorological Office, Zia International Airport
v) Civil Aviation Authority of Bangladesh (CAAB)
vi) Space Research and Remote Sensing Organization (SPARRSO)
vii) Ministry of Relief, Control Room
viii) Flood Forecasting & Warning Centre, BWDB
ix) Fire Service & Civil Defence Organization
x) Cyclone Preparedness Programme, Bangladesh Red Crescent Society
xi) Bangladesh Amateur Radio League
xii) Inspector General of Police
xiii) Bangladesh Police Telecommunications
xiv) Bangladesh Railway
xv) Bangladesh Power Development Board
xvi) Bangladesh Navy
xvii) Bangladesh Air Force
xviii) Bangladesh Army
xix) Bangladesh Inland Water Transport Authority
xx) Bangladesh Inland Water Transport Corporation
xxi) Bangladesh Rifles

Some of the organizations mentioned above had to be visited many times to collect complete informations about their telecommunications networks.

Initially, there were difficulties in contacting officials of some of the organizations, but these were overcome with the assistance of MOR. It was particularly difficult to contact officials of T & T as they were 'too busy' much of the time.

Visits were also made to Cox's Bazar, Moheshkhal and Khurushkul to see the actual telecommunication system in the field conditions.

B.3.2 Bangladesh Telegraph and Telephone Board

Bangladesh Telegraph and Telephone Board (T&T), operates an extensive network of telecommunications systems in the country. These consist of landlines, VHF, UHF, microwave and satellite communications services. T&T is the only agency of GOB

authorised to provide public telephone, telegraph, telex, fax and other allied services to subscribers for communications both within the country and with the outside world.

T&T also provides leased telegraph, telephone, telex and data circuits to other agencies on a commercial basis. It is solely responsible to the GOB for the control and regulation of all telecommunications services within the country.

T&T communications network extends to all thanas, except a few such as Fultala, Companyganj and Debir Duar. A map showing the extent of the network is given in **Appendix 2.**

During the cyclone of April 1991, the microwave link between Dhaka and Chittagong was disrupted due to the collapse of 85 metre microwave antenna tower at its terminal at Chittagong. This resulted in the complete disruption of communications between Dhaka and Chittagong and between the southeast Bangladesh and the rest of the country. Also, due to breakdown of the main telecommunications link between Dhaka and Chittagong, Bethbunia Satellite Earth Communication Station was cut off from the rest of the country, which resulted in the complete breakdown of international communications from Bangladesh for more than 15 days.

This disruption occurred because the Dhaka-Chittagong microwave link is the only connection as there is no alternative microwave path between the two cities. T&T is now planning to strengthen its microwave network by constructing additional paths linking Chittagong with Barisal via Bhola and between Rangpur and Sylhet via Mymensingh. When these additional links are established, Dhaka-Chittagong telecommunications could be rerouted via Khulna, Barisal and Bhola if the main link between Dhaka and Chittagong failed. These proposals are presently under active consideration of GOB.

T&T provides leased telegraph or telephone circuits to outside agencies subject to their availability. However, in some cases, the quality of these leased services are not satisfactory.

BMD with Japanese aid will be provided with microwave equipment to carry weather radar images from Cox's Bazar and Khepupara to the NMCC in Dhaka. The installation under this project will be carried out in association with T&T and their existing antenna towers, equipment and buildings will be fully utilised . T&T will be responsible for the maintenance of the equipment after its installation, under agreement with the BMD. The system is expected to be commissioned in 1994.

T&T operates GENTEX, a private teleprinter network, primarily for their own internal communications, between telegraph offices within the country. More than 120 telegraph offices (TO) are connected to this network, with the main exchange of the network being located at the Central Telegraph Office (CTO), Dhaka. Telegrams or cables received from the public are also accepted at the TOs and transmitted through the GENTEX network for onward deliveries to their respective addressee. BMD: NMCC and Bangladesh Railways are the only agencies outside T&T, connected to the GENTEX network. (See **B.3.3** and **B.3.13** below).

To operate radio communication equipment in Bangladesh, a licence must first be obtained (See **Appendix 2**). The procedure for obtaining a licence is quite lengthy. When an application for a licence is received, Bangladesh Wireless Board, which is a part of T&T Board, consults other GOB organisations, national security and military authorities in the matter. If these organisations have no objection, the licence may be issued and set frequencies are allocated and authorised for use. The process takes several months. In this connection, efforts were made to obtain a copy of the legislation, containing the Rules governing the operation of radio communication equipment to find out why such delays occur, but a copy could not be obtained as it was considered to be a 'classified' document.

During the cyclone emergency of 1991, some foreign agencies failed to obtain operating licences and frequency clearance for their radio equipment. The delay reduced the effectiveness of their activities. Such delay in the issue of licences is not desirable and efforts should be made to simplify the procedures.

One way to solve the problem would be to allocate some frequencies to MOR in advance, both in the HF and VHF Bands. These could be temporarily authorised for use by any bonafide agency willing to use their communication radio during emergencies. DCMU might act as a co-ordinating agency for this purpose.

The present allocation of HF frequencies to MOR is given in **Appendix 18**.

MOR has had 12 frequencies in the HF Band since July 1976. As all these frequencies cannot be utilised by MOR, some might be earmarked for temporary use during emergencies. MOR does not have any VHF frequencies. A few frequencies in the VHF Band might also be requested for use in future emergencies.

In addition to an operating licence, an Import Licence from the Chief Controller of Imports and Exports for importation of radio communication equipment in Bangladesh must be obtained. Some agencies, such as UN organisations and other diplomatic agencies, may be exempted from these requirements.

For issue of Import Licence, T&T Board normally reviews such applications, who recommends for issue of Licence to the Chief Controller of Import and Exports through Ministry of T&T and Ministry of Commerce. This process also takes a long time and requires simplification.

Communication using INMERSAT satellite operated at 4 GHZ down link and 6 GHZ up link can apparently be utilised for international communications without the need for permission of the T&T as present regulations do not cover this type of communications. The US military, while assisting relief operations during the last cyclone in 1991 in the coastal areas, were reported to have been using such communications for direct communication with their base station. Also certain frequencies such as international distress frequencies in the maritime radio band 500 kHz, 2182 kHz and 156 MHz may be used for communications without the prior permission from T&T.

B.3.3 Bangladesh Meteorological Department

Bangladesh Meteorological Department (BMD) has its own network of radio telephone communications between its headquarters in Dhaka and 25 meteorological stations throughout the country. HF/SSB radiotelephone equipment operates on frequencies of 2324, 2505, 3563 and 8814 kHz.

The stations connected to this network are: Barisal, Bhola, Bogra, Chittagong, Comilla, Cox's Bazar, Dhaka, Dinajpur, Faridpur, Feni, Ishwardi, Jessore, Khepupara, Khulna, Kutubdia, Maizdi, Mymensingh, Rajshahi, Rangamati, Rangpur, Satkhira, Sitakunda, Srimangal, Sylhet, Tangail and Teknaf.

This communication network is used mainly to transmit meteorological data from the various meteorological stations to the Forecasting Office in Dhaka. Data are transmitted to Dhaka every three hours from each station. Data may also be transmitted more frequently, if necessary, as these stations operate on a 24-hrs basis. All stations in the network are equipped with HF/SSB transceivers operating from mains electric supply and/or battery supply. The network is generally adequate to meet the communications requirements of BMD, although, at times, communications using HF radio is difficult due to atmospheric noise etc.

In addition to the above, BMD has leased the following teleprinter circuits from the Telegraph and Telephone Board (T&T):

Chittagong - Cox's Bazar

Dhaka - Bogra, Chittagong #1, Chittagong #2, Dhaka (Zia International) Airport, BWDB Flood Forecasting Centre, Ishwardi, Radio Bangladesh, Sylhet, Tejgaon/Jessore and New Delhi.

These teleprinter circuits are operated on a 24-hr. basis for exchange of meteorological data between the stations.

The following links are also operated by BMD from its National Meteorological Communication Centre (NMCC), in Dhaka to disseminate storm warning bulletins to various agencies in Dhaka:

Dhaka Meteorological Office
- Radio Bangladesh
- Bangladesh Television
- Ministry of Relief (Control Room)
- Bangladesh Red Crescent Society
- Cyclone Preparedness Programme

These links are either on telephone, teleprinter or telegraph services through T&T network.

As required by the MOR Emergency Standing Orders for Cyclone (SOC), BMD issues storm warning bulletins from its NMCC, located at BMD HQ. These bulletins are passed to addressees listed under code names in the SOC. These addressees under codes

"WHIRLWIND", "HURRICANE" and "TYPHOON" are distributed throughout the country. BMD does not have its own communication system to handle these bulletins and therefore it transmits them through a private teleprinter network, GENTEX operated by the T&T. There is a GENTEX machine is installed in the NMCC, which is manned round the clock by an operator from the T&T.

The BMD Storm Warning Centre (SWC) prepares the bulletins for the coded addressees and passes them to the T&T operator, who transmits them through the GENTEX network to the appropriate CTOs or TOs according to the address/codes indicated. To access the appropriate CTO or TO, the operator has only to dial a number like a telephone subscriber's number, which is unique to a particular CTO or TO.

The text of these bulletins are written in plain language but the 'priorities' and 'addressees' etc are coded, and the T&T operators are expected to interpret them correctly.

When the bulletins are received at the CTOs or TOs, they are delivered according to the distribution list, related to their address codes. These bulletins are passed on by telephone or by messengers like a telegram or cable. In most cases, in larger cities, the distributions are made within a reasonable time but, in some cases, the bulletins are sent by ordinary post where there is no other means of communications. There are no data available to ascertain how efficiently these bulletins are being received. Even the BMD who originates the bulletins, does not know how quickly they are delivered to their addressees by the T&T.

A partial listing of the GENTEX network, which is utilised by BMD to disseminate the bulletins is shown in **Appendix 3**, also shown is comprehensive information on the leased teleprinter circuits and data circuits being operated by BMD.

All categories of bulletins are sent to Radio Bangladesh for broadcasting in the 'news'. The BMD uses an exclusive teleprinter circuit with Radio Bangladesh to pass these bulletins. These are also followed up with telephone messages. For Bangladesh TV, the bulletins are sent by telephone, which are followed by a telegram sent through the GENTEX network. All categories of bulletins for BRCS: CPP and Ministry of Relief are sent by telephone, followed by telegrams through the GENTEX system.

At present, it is not possible to receive video data in Dhaka from the two weather radar stations at Cox's Bazar and Khepupara. Negotiations are going on with Japanese aid to provide microwave links between Dhaka and these two stations to enable data to be received in NMCC. Under the proposed arrangements, the microwave links would be maintained by T&T, who would lease out the video channels to BMD.

BMD also has a direct data link (2400 Bauds) between NMCC in Dhaka and New Delhi for the exchange of WMO meteorological data. This link, which is working very satisfactorily, is leased from the T&T.

B.3.4 Meteorological Office, Zia International Airport, Dhaka

Zia International Airport Meteorological Office (AMO) is responsible for the dissemination of weather forecasts to aircraft and aviation agencies to ensure the safe and efficient operation of aircraft in the region and for the general benefit of civil aviation.

The AMO does not, have its own telecommunications network. It makes use of the Civil Aviation Authority of Bangladesh's (CAAB) communication channels to exchange messages relating to meteorological data between aeronautical stations in the region. The messages received or transmitted are written in a special bulletin format suitable for use in aviation. The AMO usually exchanges messages between Dhaka, Bangkok, Calcutta and New Delhi (via Calcutta) utilising the following civil aviation communications network.

Circuits	Mode of Operation	Hours of Operation	Remarks
Dhaka-Bangkok	Leased teleprinter circuit	H-24	Very reliable
Dhaka-Calcutta	HF radio teleprinter	H-24	Fairly reliable
Dhaka-Chittagong	Leased teleprinter circuit	Operating hours of airport	Rather unreliable

The Dhaka-Chittagong leased teleprinter circuit is often disrupted because of cable faults between the microwave terminal at Chittagong and Chittagong Airport. During the cyclone in April 1991, the circuit was out of operation for several days due to breakdown in Dhaka-Chittagong microwave link.

Some delays are experienced by the AMO in exchange of messages between Dhaka and Calcutta, due to propagation conditions and equipment failures at the Calcutta end. The CAAB is cooperating with Calcutta to improve this circuit.

As well as the above circuits, AMO has a very reliable leased landline teleprinter circuit between its airport unit and the BMD/NMCC at Sher-e-Bangla Nagar.

B.3.5 Civil Aviation Authority of Bangladesh (CAAB)

CAAB operates its own network of telecommunications linking Zia International Airport Dhaka with all airports in Bangladesh and airports in the region outside Bangladesh, primarily for exchange of messages relating to the movement of aircraft but, as stated above, meteorological data are also exchanged. Civil Aviation Authority telecommunication network may be seen in **Appendix 4.**

All airports within Bangladesh are presently linked to Dhaka airport by a HF/SSB radio telephone circuits, operated in a network with frequencies of 6826 and 3660 kHz. The airports linked to Dhaka in the network are Chittagong, Cox's Bazar, Jessore, Rajshahi, Saidpur and Sylhet. Communications from Dhaka to Chittagong and Cox's Bazar are usually

disrupted, following cyclones, due to damage to the HF antenna at Chittagong and Cox's Bazar. CAAB has good maintenance support at each airport and, in most cases, communication facilities are repaired and the services restored within a day or two.

Dhaka is also linked to Calcutta Airport by a voice circuit through a leased microwave line, which operates round the clock. This is a very reliable communication circuit. Dhaka airport is also linked to Chittagong, Bangkok and Calcutta by direct teleprinter circuits. (See para **B.3.4** above).

Dhaka-Calcutta HF radioteleprinter circuit is operated on a 24-hrs basis. The operation of this circuit is generally satisfactory, but at times, communications become difficult due to radio propagation conditions and equipment problems at Calcutta. CAAB is trying to improve this circuit in cooperation with Calcutta.

The most reliable communications circuit at Dhaka is the teleprinter link to Bangkok which is based on a leased satellite circuit. The reliability of this circuit has been of the order of 99%, although it was established after the April 1991 cyclone.

CAAB also operates VHF ground/air communication services for direct voice communications between Air Traffic Controllers and aircraft in flight or on the ground. These are very reliable facilities. All airports outside Dhaka are provided with modern VHF transceivers and in case of failure, standby equipment provides the services without any break. Both Chittagong and Cox's Bazar are equipped with equipment, which might provide reliable services even after cyclonic storms.

B.3.6 Space Research & Remote Sensing Organisation

The Space Research and Remote Sensing Organisation (SPARRSO) receives satellite pictures from the Japanese Geostationary Meteorological Satellite (GMS-4) once every hour. These photographs show clearly, atmospheric conditions at higher altitudes and are very useful in the prediction of weather, storms and cyclones in the region. The time of landfall approaching cyclones and their intensity may also be estimated from these photographs.

SPARRSO sends these photographs regularly by messenger to the BMD to assist with their weather forecasting. They also supply the pictures to other GOB agencies, if required.

SPARRSO does not have own communications network and the satellite pictures are therefore sent by them by hand to all agencies. However, they have plans to transmit them by fax.

SPARRSO also obtains satellite pictures from the orbiting satellite US: NOAA-11, which overflys Bangladesh once every 12 hours. These pictures are also used to assist weather forecasting.

B.3.7 Ministry of Relief, Control Room

Ministry of Relief operates an aging telephone network linking its Control Room at the Bangladesh Secretariat Building Nr 4 to 20 District HQs, by leased telephone circuits. A telephone exchange, integrating these leased circuits, is located in the Control Room. The

Control Room is also linked to 54-District HQs by a HF/SSB radiotelephone network, operated on frequencies of 3900 and 7400 kHz. The details of the stations that are linked to Dhaka with leased circuits and HF/SSB radio networks and their hours of operation are given in **Appendix 7**. At the District level, the equipment is operated by staff from the office of the District Relief and Rehabilitation Officers of the Directorate General of Relief and Rehabilitation. Their offices are generally located within the District Deputy Commissioners' office complex.

The operation of the leased telephone circuits is not always satisfactory. Some of the circuits are badly affected during rains due to poor local underground cable distribution arrangements. During the cyclone in 1991, all the leased telephone circuits to Chittagong/Cox's Bazar area were out of action due to the collapse of the microwave link between Dhaka and Chittagong.

The condition of the HF/SSB radiotelephone network linking Dhaka with 54 District HQs is not very satisfactory and the equipment at the outstations is also reported to be in a poor condition. During the cyclone of 1991, installations at Cox's Bazar, Chittagong, Khagrachari and Bandarban were blown down which disrupted the communications with these stations.

Stocks of spares for radio equipment are dwindling and they are no longer available from their manufacturers due to obsolescence. Maintenance staff attached to the MOR Control Room are ineffective due to the lack of spares and the non-availability of test and measuring equipment and workshop facilities. In the absence of such facilities, the maintenance of all radio equipment is being carried out by technicians from T&T Board under a contract between MOR and T&T. The technical staff of the MOR remain unutilised.

B.3.8 BWDB: Flood Forecasting & Warning Centre, Dhaka

BWDB's Flood Forecasting & Warning Centre, (FFWC) is located in the WAPDA HQ, Dhaka, and operates an HF/SSB radiotelephone network, which links Dhaka with all BWDB hydrological and rainfall stations in the country. The radio network operates on the frequencies of 5089, 8157 and 8188 kHz, and is utilised to call each station daily to obtain hydrological and rainfall data. The network is reported to be working satisfactorily.

Between 1 May and 30 September each year, Flood Forecasting Bulletins are prepared daily and distributed and disseminated to a large number of GOB and non-GOB organizations. They are sent either by hand or post. This system of delivery is rather very slow and it would be more appropriate if they could be transmitted by telex/fax machines. The hydrological and rainfall stations are detailed in the **Appendix 5**.

A leased teleprinter circuit between FFWC and the BMD/NMCC at Sher-e-Bangla Nagar is also operating satisfactorily. A data link with the BMD HQ, leased from T&T Board, does not work at all. A microwave link, installed over the WAPDA building, to provide a data link with the Meteorological HQ is also not operational. It could not be ascertained who is actually responsible for the maintenance of this link.

B.3.9 Fire Service and Civil Defence Organisation

The Fire Service and Civil Defence Organisation (FS & CD) HQ at Dhaka has its own HF/SSB radiotelephone network linking Dhaka to its Fire Service and Civil Defence stations at key District HQs including Rajshahi, Khulna, Patuakhali, Barisal, Maizdi, Chittagong, Satkhira, Cox's Bazar and Bhola. The network was brought into operation recently, after the April 1991 cyclone. At present, 12 stations, including Dhaka, are connected to this network. The network is used regularly for co-ordination with all the field offices. FS & CD plans to expand its communications network in the near future and bring more of its field stations into its communications network.

The FS & CD in Dhaka and Chittagong have their own VHF/FM mobile radio networks for direct voice communication between fire vehicles operating in the field and their base stations in Dhaka or Chittagong. Frequencies of 81.0 and 81.1 MHz are utilised. The facilities operated by FS & CD are given in the **Appendix 8.**

B.3.10 Cyclone Preparedness Programme, Bangladesh Red Crescent Society

The Cyclone Preparedness Programme (CPP) of the Bangladesh Red Crescent Society (BRCS) operates an extensive HF/SSB radio telephone network which links its Dhaka HQ office with about 30 HF stations which include 24 thana HQs in the southern part of Bangladesh. Each of these stations are manned by an officer of the CPP. The network operates on the frequencies of 3798, 6991.5 and 7003 kHz, and is normally activated twice a day but more frequently at times of disaster.

The HF stations are connected to many distant Union offices and off-shore islands by VHF/FM radio links. Many of the HF stations are linked to a group of two or three VHF stations operating to their assigned frequencies, to ensure reliable and efficient communication between the CPP Control Room in Dhaka and all the stations connected to the network. In this case, the HF station operates as a relay station for communications between the Control Room and the distant Union stations or the off-shore islands. Four VHF frequencies, 86.850, 86.875, 86.900 and 86.925 MHz are used in the VHF network. The frequencies are distributed among the group of VHF stations to avoid radio interference. In this way, about 17 HF stations are linked to about 30 VHF stations.

The combined, HF and VHF network provides good communication between Dhaka and all stations in the network throughout the year. During the cyclone in April 1991, except for one or two stations, the network operated satisfactorily.

CPP is expanding its radio communications network with assistance from the International Federation of Red Cross and Red Crescent Societies. Equipment worth about US$ 525,000, donated by IFRC members to carry out this expansion and modernisation programme, has been lying with the Zia International Airport Customs since March 1992. The Customs Authorities have imposed high import duties, which the Ministry of Relief considers not applicable to relief goods. The case is under active consideration by the Ministry of Finance.

Radio maintenance is presently undertaken in Dhaka where there is a maintenance workshop. Whenever a radio becomes inoperative, it is returned to Dhaka for repair. It is later sent

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back to the field station when repaired. CPP has a plan to expand its maintenance activities and open workshops at Chittagong and Barisal.

About 90% of CPP's communications stations are equipped with batteries and battery chargers. Seven VHF stations in the network have been equipped with solar cells and battery chargers within the last two years. These are working very satisfactorily. The stations with solar cells are completely independent of commercial power supply or standby generators.

Seven more thanas will be included under the expansion programme and all stations will be modernised with battery chargers and batteries. Solar cells will also be supplied to many other stations.

A well written Wireless Operation Manual has been prepared giving details of the radio communications facilities and the procedures to be followed by the Wireless Operators.

The radiotelephone network operated by CPP is detailed in **Appendix 6.**

B.3.11 Bangladesh Amateur Radio League

Bangladesh Amateur Radio League (BARL) was formed in 1979 to promote the cause of amateur radio in Bangladesh and to liaise with relevant GoB agencies. It has 25 members, mainly in Dhaka, but some are in Chittagong area.

At a meeting of the Bangladesh Wireless Board in May 1983, the issue of radio operating licenses to BARL members was approved. However, before any license could be issued, the approval was revoked. On further representation by BARL, the Wireless Board again approved the issuing of licenses in August 1991, however due to various technicalities no licenses could actually be issued to members (up to mid 1993).

During the cyclone of April 1991, BARL requested GoB to allow operation of amateur radio and let its members set up emergency communication links to help in the post-cyclone relief operations. The proposal was accepted by the Ministry of Telecommunications and sent for approval to relevant Ministries. Before the "file" had passed through the various bureaucratic levels, the need for emergency communications had passed.

The country would be benefitted by the introduction of amateur radio, one of the most important services being backup communications at the time of disasters. ITU Resolution Nr. 640 formally recognizes the value of such resources. In many countries, while the military and other Government communications systems are effective during "normal" times, at times of disaster emergencies, the volume of communications required is such these systems cannot cope. Spot frequencies in the HF and VHF frequency bands are exclusively allotted worldwide, by the ITU, to facilitate the activities of amateur radio enthusiasts.

During the Gulf War, when all communications from Kuwait with the outside would were cut, it is reported that some Bangladesh nationals residing in Kuwait were able to send messages to Bangladesh using amateur radio transceivers.

Once their activities are permitted, BARL plans to set up emergency communications stations at each coastal Thana. Science colleges and schools are targeted as club stations. Each station would have simple, inexpensive, HF communications transceivers. BARL is confident of being able to mobilize funds from international bodies such as International Amateur Radio Union (IARU). BARL is now a full member of IARU Region 3, which comprises of the countries of the Asia-Pacific Region.

In early 1993, the International Federation of Amateur Radio Services made strong representations to GoB through the Bangladesh Embassy in Washington for the promotion of amateur radio activities in Bangladesh. As a result, GoB has now issued a few amateur radio operating licenses to Bangladesh nationals, who already held valid radio operating licenses issued in other countries.

CARE, an NGO working inn Bangladesh, organized a training course for radio operators in Dhaka in early 1993, to which qualified instructors were invited. Some trainees successfully completed the course. They are now qualified and become eligible to obtain licenses from the T&T Board. At present, there are no training facilities in Bangladesh where people can study to obtain a amateur radio operator's license. The Training Division of T&T Board is expected to finalize its examination criteria, which intending amateur radio operators will have to pass before they are eligible for a license. Until then, licenses will only be issued to those who already have a valid license from a foreign country.

B.3.12 Bangladesh Police

The Bangladesh Police Department operates an extensive network of radio communications throughout the country. The Control Station at Dhaka is located at Razarbagh Police Lines. Dhaka is linked to all 64 District HQs by an HF/SSB radio network and the district HQs are linked by VHF/FM radio telephone links to all the Police Stations under their control. In this way, all the Police Stations in the country are linked by radio. In some cases, where the distances between the two VHF stations are large, repeater stations are provided for effective communications between the stations.

The network operates round the clock. During interviews with the Police Department, it was stated that any GOB agency could send a message to any place within their network, through the Duty Officer, Police Communications at Razarbagh. During emergencies, this service was available to all agencies GOB or non-GOB. At the district level, requests have to be passed through the local Superintendent of Police.

When cyclonic storms are forecast the Police Department obtains weather bulletins from BMD and takes appropriate action to warn people to take precautions.

The operating frequencies of these radio links could not be accurately ascertained for security reasons. However, it appears that the Police are using some spot frequencies in the 2-10 MHz HF and 148-172 Mhz VHF band.

The Police Department has a separate radio network for its nine battalions of Special Police Force, whose HQ is located at Uttara, Dhaka.

As stated earlier, the Police radio network links all the thana HQs and in some cases some outposts below thanas are also linked. In future, it is planned to link in all Police outposts to the radio network.

During the cyclone in April 1991, except for a few stations in the affected areas, the network operated satisfactorily. The stations affected during the cyclone were repaired by maintenance crews from their base stations and were brought back into normal operation within a few days.

At present, each of the four Police Divisional HQs have maintenance facilities to handle the repair of Police radio equipment. Whenever equipment becomes unserviceable, it is withdrawn and replacement serviceable equipment sent to the station. This causes minimum disruption to the service. Dhaka Maintenance Workshop is the central facility where major repairs and overhauling is undertaken. The central workshop is well equipped with test gear and adequate manpower to carry out its responsibilities and there is little backlog of work.

The Police Department has recently linked a number of its District HQs and some operationally important positions with facsimile service. Under this scheme, 30 stations have already been connected with fax machines and 9 more are planned for the future. T&T telephone lines are being utilised for the operation of their fax services. It is gathered, that, due to high level of noise on the telephone lines, their operation are not very satisfactory. T&T Board does not normally allow connecting fax equipment except on International Direct Dialling telephone lines but for Police Department some special arrangements exist.

Bangladesh Police has a leased teleprinter link with INTERPOL, Paris, to exchange of information relating to international crimes. There is also a TELETEXT service with Tokyo to receive INTERPOL information. The telecommunications network, operated by Bangladesh Police is detailed in the **Appendix 9**. The frequencies and names of the stations in the network involved are not available for security reasons.

Bangladesh Police plans to extend their communications network in the coastal areas and these plans are under the active consideration of GOB.

B.3.13 Bangladesh Railways

Bangladesh Railways (BR) have an extensive network of telecommunications facilities, comprising their own microwave system, HF/SSB radio telephone circuits, and leased telephone circuits to communicate between selected important railway stations. BR are also connected to the T&T GENTEX network for teleprinter communications between some of their establishments.

The BR HQ is located at Chittagong and its four Regional HQs are located at Chittagong, Dhaka, Lalmonirhat and Paksey. Total railway track in the country is 2800 km and 80% of this length has fibre optic cables laid underground, along the railway track. There are two networks, one in the eastern part of the country and the other in the western part. The networks are inter connected by two microwave links, owned and maintained by the BR at Sarishabari-Sirajganj and Dewanganj Bari-Bonapara. These cable networks link all the railway stations in the country through a private digital telephone network through which it

is possible to communicate from one station to another, independently, without going through the T&T network.

This 'private' telephone network is controlled from nine telephone exchanges located at Akhaura, Chittagong, Dhaka and Mymensingh in the eastern region and Khulna, Lalmonirhat, Paksey, Parbatipur, Rajshahi and Shantahar in the western region. BR Dhaka is linked to the Railway Division in the Secretariat building by a 100-pair cable, laid underground. Hence, it is possible to communicate with any railway station in the country directly from the Secretariat.

Although the network is presently being utilised for telephone communications and train movement control system only, BR has a plan to utilise its cable network to send teleprinter and fax messages of its own.

Following the cyclone in April 1991, BR communications between Dhaka and Chittagong continued for about 24-hours and then failed due to the failure of its battery system at Chittagong terminal. This happened because there was no commercial power available at Chittagong, immediately after the cyclone, and the Chittagong BR terminal was not equipped with a standby generator. Such a long power supply failure was not visualised and therefore provision of a standby generator had not been made. After this experience, a generator has now been provided and communications are expected to be more reliable in future.

After cyclone, when T&T's Dhaka-Chittagong telecommunications network failed, BR provided emergency communications between Dhaka and Chittagong, through their fibre optic cable communications network for the following:

- Prime Minister
- Minister for Communications
- Minister for Telecommunications
- General Manager, Dhaka Telecommunications Region
- Circuit House, Chittagong
- Army Divisional HQs, Chittagong

The BR fibre optic cable system is the most modern network in Bangladesh and possibilities may be explored to interconnect the DCMU with the Railway communications through the 100 pair cable already available from the Secretariat building to the BR communications centre at Dhaka. The BR network of communications may be seen in the **Appendix 10.**

B.3.14 Power Development Board

Bangladesh Power Development Board (BPDB) operates its own microwave telecommunications system using the national power grid. The system links all power houses and grid stations. The main communications centre and control room is located at Siddhirganj Power Station, Siddhirganj.

The communications system utilised by BPDB is known as SCADA (Supervisory Control And Data Acquisition). SCADA is primarily designed to provide voice communications between various units of BPDB and for carrying data relating to transmission of power

through the national grid. Detection and location of faults on transmission lines could also be carried out through SCADA, such that, any fault on the line would be reported to the control room instantaneously.

At present, SCADA is only utilised for voice communications between various power stations, grid stations and senior management of BPDB. The system is planned to be upgraded in future to include other functions such as fault location, etc. on the transmission line and g rid stations.

Besides field units, the following senior management staff of BPDB are connected to SCADA voice communications network for direct telephone conversation between various units:

- Chairman, BPDB, WAPDA Building, Dhaka
- Member, Transmission, WAPDA Building, Dhaka
- Member, Generation, WAPDA Building, Dhaka
- Chief Engineer, WAPDA Building, Dhaka
- Superintendent Engineer, BPDB, Dhaka
- Superintendent Engineer, BPDB, Chittagong
- Superintendent Engineer, BPDB, Khulna
- Superintendent Engineer, BPDB, Ishwardi

During April 1991 cyclone, the electricity supply system of BPDB sustained severe damage. The Chittagong area was completely cut off from the national grid and the power supply in the affected areas was totally disrupted. The SCADA communications system was extensively damaged due to collapse of a number of transmission towers in the affected areas. Power supplies to the essential areas were restored within 4/5 days after repair.

A new SCADA system is planned for the Greater Dhaka Power Distribution System for which tenders will be floated shortly. The SCADA system for Greater Dhaka Power Distribution System is expected to be commissioned by the end of 1993.

B.3.15 Bangladesh Navy

The Bangladesh Navy telecommunications network is limited to its HQs at Dhaka and Naval bases at Chittagong and Khulna. The Main Communications Centre is located at the Naval HQs, Dhaka. The details of Navy's telecommunications network are shown in **Appendix 11.**

Dhaka-Chittagong and Dhaka-Khulna HF communications circuits are operated in Morse Code as well as Radio Tele-Typewriter (RTT) mode to exchange messages between the stations. Operation frequencies of these HF circuits could not be obtained for security reasons.

The Navy also operates leased telephone circuits on the Dhaka-Chittagong and Dhaka-Khulna routes for direct voice communications between Dhaka and Chittagong and Dhaka and Khulna. Leased teleprinter circuits, Dhaka-Chittagong and Dhaka-Khulna are also operated by the Navy to exchange operational messages between these stations.

Facsimile equipment has been installed recently at Naval HQs, Dhaka and the bases at Chittagong and Khulna. They are directly connected to the public telephone lines from the T&T. Dhaka-Chittagong fax service is reported to be functioning unsatisfactorily, because of 'noise' on telephone lines. The Dhaka-Khulna fax service is operating satisfactorily, because of the good quality telephone lines available in this sector.

Naval ships, frigates and gunboats with base stations at Chittagong and Khulna are equipped with HF two way radio communications.

During the April 1991 cyclone, Chittagong Naval base was badly affected and communications with Dhaka have severed. There was no commercial power supply at the base and the standby generator was inoperative as flood water entered the power house.

The Communications Centre at Chittagong was inundated with water and the telephone exchange was damaged as flood water entered into the exchange equipment. Some communications equipment were also damaged due to flood water. Communications with Naval HQs at Dhaka was maintained, during this period, through Naval frigates anchored at Chittagong port, using HF radio.

B.3.16 Bangladesh Air Force

Bangladesh Air Force (BAF) operates its own HF Radio-Telephone network between Air Force bases at Dhaka, Chittagong and Jessore using voice communication. The operating hours for the network are limited to normal working hours of these stations. Recently, Cox's Bazar BAF has also been brought into the network. BAF circuits also use Morse Code to exchange of messages.

BAF is operates leased telephone circuits for voice communications between Dhaka and Chittagong and Dhaka and Jessore. Leased teleprinter circuits between Dhaka and Chittagong and Dhaka and Jessore are operated for exchange of written messages. These circuits are operated round the clock. The circuits presently used by BAF are shown in **Appendix 12.**

BAF has been operating Facsimile equipment on public telephone lines at Dhaka, Chittagong and Jessore but these are presently discontinued due to equipment problems and noise on the lines.

During April 1991 cyclone, leased telephone and teleprinter circuits were inoperative for days and HF communications facilities with Chittagong were disrupted due to severe damage to the Chittagong base and its radio installations. Normal operations were restored after repair.

B.3.17 Bangladesh Army

During peace time, the Bangladesh Army operates leased telephone circuits between its Army Divisional HQs at Dhaka, Chittagong, Bogra, Comilla, Rajshahi, Khulna and the Army HQ at Dhaka Cantonment, for voice communications between these stations. Leased teleprinter circuits are also operated between these stations to exchange written operational and other messages. These circuits are operate for 24 hrs a day and are working satisfactorily.

Each Divisional HQ is linked to the units under its command, using leased telephone circuits for voice communications. Divisional HQ at Chittagong has a leased teleprinter network to exchange messages HQ with its Units. No other Division HQ has a teleprinter network.

Army Units utilise HF/SSB radio communications facilities at field level for operational purposes. During emergencies, such as cyclones, government and (approved) Non-government organisations are allowed to utilise the army facilities to pass messages. These field radio communications are entirely operated for voice communications only. The details of the Army network are shown **Appendix 13.**

During the April 1991 cyclone, Army telecommunications with Chittagong area were severed because of breakdown of T&T microwave link to Chittagong. However, they were able to restore telecommunications with Chittagong through Bangladesh Railway fibre optic cable communications network within seven days. Difficulties were faced in interconnecting the two systems as the fibre optic system works on the principles of light pulses, and the T&T system works on the principles of electronic pulses. Special interface equipment had to be installed to interconnect the two systems. Hence, there was a considerable delay in the restoration of the communications service with Chittagong. However, once communications with Chittagong were restored, the Army was able to continue its normal service, as a direct telephone service was established between Dhaka HQ with the Divisional HQ in Chittagong through the BR system. (See **B.3.13** above).

Facsimile equipment are also used by the Army for communication between some of the Army Divisional HQs. The equipment is directly connected to T&T Board telephone lines. They generally work satisfactorily, but on some of the sectors the telephone lines are not of good quality.

B.3.18 Bangladesh Inland Water Transport Authority (BIWTA)

BIWTA operates HF/SSB radiotelephone network for direct radio communications from its HQ in Dhaka to its river ports and ferry ghats throughout the country. The communications facilities operation during the day time only, to exchange messages relating to movement of IWTA vessels.

IWTA also has a direct mobile communication service with its dredger fleet operating in the rivers of Bangladesh from the dredger base located at Narayanganj. All the BIWTA dredgers are equipped with two way HF/SSB radio equipment for this purpose. The details of telecommunications network operated by BIWTA is given in **Appendix 14.**

Apart from Dhaka and Chittagong, where the telecommunications installations are located in their office buildings the other installations are located at their terminals.

BIWTA has a well equipped maintenance workshop in Dhaka to maintain and repair their equipment. All field installations are provided with battery chargers and batteries to ensure uninterrupted operation of radio equipment during power outages.

During the April 1991 cyclone, BIWTA radio communications with its terminals in the affected areas were severed due to damage in their installations. They were repaired and restored normal operation with maintenance support from Dhaka within a couple of weeks.

BIWTA also operates a DECCA radio navigation service for all river craft. The service provides complete coverage of all the rivers in Bangladesh. The system consists of a DECCA Master station located at Chandpur and three Slave stations at Dohazari, Monirampur and Rupchandpur with a Monitoring Station at Narayanganj. The system operates on a low frequency band of 72-126 kHz.

BIWTA plans to modernise its HF/SSB system with new equipment with assistance from World Bank in the near future. The matter is being considered by GOB.

B.3.19 Bangladesh Inland Water Transport Corporation (BIWTC)

Bangladesh Inland Water Transport Corporation (BIWTC) is operates large fleet of steamers and other vessels covering an existing network of inland water transport services. These vessels ply the major river routes, providing regular river transport facilities to and from inland ports of Dhaka, Barisal, Patuakhali, Chittagong, Sandwip etc. carrying passengers and cargo between these cities. BIWTC is also operates regular ferry services at Aricha Ghat, Nagarbari Ghat, Sirajganj Ghat across the rivers Padma, Meghna, Jamuna carrying passengers and vehicles across the rivers. Many of these vessels and most of the river ports are provided with two way radio telephone equipment, by BIWTC, for voice communications between the stations round the clock.

BIWTC operates its own HF/SSB radio telephone network, linking its Dhaka Control Room, located at BIWTC HQs, with most of the river port jetties, where they operate. The telecommunications network is utilised to exchange information relating to the movement of BIWTC vessels and for other purposes as well, to ensure the safe, efficient and orderly movement of traffic. The details of BIWTC telecommunications network is given in **Appendix 15.**

All the ferries operating at Aricha Ghat, Nagarbari Ghat, and Sirajganj Ghat are linked to this network, so that their movements are known to the Control Room at all times.

BIWTC presently operates a fleet of about 300 vessels, of which about 60 are equipped with two way radio facilities, to communicate with the base stations.

BIWTC has its own maintenance workshop for repair of their radio equipment. All their installations, including those at out stations are equipped with battery chargers and batteries for uninterrupted operation of equipment during power outages.

During the April 1991 cyclone there was only minor damage to BIWTC telecommunications facilities and the operation of their network remained unaffected.

BIWTC plans to modernise their HF/SSB equipment with assistance from World Bank. The matter is under the active consideration GOB.

B.3.20 Bangladesh Rifles (BDR)

Bangladesh Rifles (BDR) are responsible for keeping watch along the border areas with India and Mayanmar for any illegal cross-border traffic of persons or materials. BDR is also required to assist the civil administration in maintaining law and order in the country, whenever called upon to do so.

BDR operates an extensive telecommunications network and keeps in contact round the clock with the Sector HQs, Battalion HQs and the Border Outposts, HF/SSB radio telephone circuits are utilised. For communications between Dhaka and the Sector Battalion HQs. For short distance communications between the Battalion HQs and the Border Outposts, VHF/FM radiotelephone circuits, both fixed and mobile are utilised. A VHF/FM radio network linking Cox's Bazar to Teknaf, Moheshkhali, Sapurer Dwip, St.Martin Islands etc. are also being operated keep a close watch on the Bangladesh-Mayanmar border. BDR communications are along the border areas and there are hardly any within cyclone affected areas or the coastal areas of Bangladesh.

BDR uses leased telephone circuits for round-the-clock direct telephonic communications between Dhaka and all their Sector HQs, Digital telephone exchanges are available at each of the Sector HQs for fast communications.

These communication circuits are all operating very satisfactorily. The details of the network is given in **Appendix 16.**

BDR also has a Facsimile network linking their Sector HQs with Dhaka. These Faxes are directly connected on the public telephone lines but their operation and is variable. Wherever good, noise-free telephone lines are available, their operations are quite satisfactory.

BDR is well equipped with a base maintenance workshop in Dhaka to carry out their maintenance. The base maintenance workshop is well equipped with Test Equipment and Tools, and has adequate manpower to undertake maintenance, repair and overhaul of all their radio equipment in operation in the field.

During 1991 cyclone, BDR communications with their field stations in the cyclone-affected areas, including Chittagong, remained uneffected.

B.3.21 Field Investigations

a) Cox's Bazar

At Cox's Bazar, direct HF/SSB radiotelephone communication is available with Ministry of Relief, Control Room, Dhaka. The equipment, installed in the office of the District Relief & Rehabilitation Officer (DRRO), is quite old having been commissioned in 1972 and it requires replacement. Interference from other unidentified radio stations is also regularly experienced. There is no battery or battery charger available for backup when the commercial power supply fails. During the April 1991 cyclone, the HF antenna was blown down and damaged and there was no radio communications with the Control Room in Dhaka

commercial power supply fails. During the April 1991 cyclone, the HF antenna was blown down and damaged and there was no radio communications with the Control Room in Dhaka for more than a week until the antenna was repaired. The Police and CPP networks were utilised to pass messages to Dhaka and elsewhere during this period.

DRRO, Cox's Bazar, has no communications with his Project Implementation Officers at thana level, except through public telephones, which at times are not satisfactory. Telephones were also unserviceable after the cyclone in April, 1991 for many days. The need for radio communications with those thanas, which are affected by cyclones, with Cox's Bazar is felt strongly. Radio communications with Kutubdia, Moheshkhali, Chokoria and Teknaf would be particularly useful.

The Office of Deputy Commissioner, Cox's Bazar district, has a telex, as do all DCs, for communication with Dhaka and other district HQs.

The Police at Cox's Bazar have HF/SSB and VHF radiotelephone links with Dhaka HQ, the latter via repeater stations at Chokoria, Chittagong, Comilla, Noakhali etc. The HF/SSB Police communications were inoperable following the 1991 cyclone, as the antenna at Cox's Bazar was blown down. This VHF circuit operated during and after the cyclone in April 1991 and it was the only link to Dhaka during that period. Cox's Bazar Police have direct VHF network communications with all seven thanas under their jurisdiction including St. Martin Island. During the cyclone in April 1991, VHF antennas at Moheshkhali and Kutubdia Police Stations were blown down. Communication facilities at both the stations were only restored with some difficulty.

All radio equipment at Cox's Bazar Police station is operated from 220 volts AC mains supply which is backed up with batteries and battery chargers for uninterrupted operation during commercial power failures.

The Cyclone Preparedness Programme at Cox's Bazar has one HF/SSB and one VHF transceiver for communications with the stations under its control. They are Teknaf, Ukhia, Moheshkhali, Chokoria, Kutubdia and Khurushkul. Battery chargers and batteries are available at the station for operation of the equipment during power supply failure. There was no damage during the cyclone of 1991 to its equipment, and the station continued to operate and communications links were maintained. However, Kutubdia was badly affected and its radio installation was inoperative. A CPP Zonal Officer is responsible for the operation of Cox's Bazar station and the seven other stations within the Cox's Bazar Zone.

Besides direct HF/SSB radio communication with its Dhaka office to communicate data, the BMD Cox's Bazar has a leased teleprinter circuit with BMD Chittagong for the exchange of meteorological data.

BMD Cox's Bazar also receives fax messages from New Delhi, Tokyo and Bangkok. These are received through an HF fax receiver installed at the station. Receiving frequencies at Cox's Bazar from New Delhi are 4993.5, 7403.0, 18225.0, 18227.0 and 14842.0 kHz, from Tokyo 9970, 18220 and 22770 Khz and from Bangkok 6765, 7395 and 17520 Khz. Similar receivers are also installed at BMD Dhaka, Dhaka airport, Chittagong, Sylhet, Ishwardi and

Bogra. Through fax receivers, charts indicating weather information are directly printed on paper in the form of weather maps.

Cox's Bazar Airport, operated by CAAB, has an HF/SSB radio transceiver for direct radio communication with Dhaka International Airport. During the 1991 cyclone, its HF antenna was blown down but it was repaired and replaced within one day. After the cyclone of 1991, there was no commercial power supply at the airport for about 15 days but airport operations were not affected, since it is equipped with standby generators. The public telephones installed at the airport were affected by the cyclone and remained inoperative for a month before they were restored to normal operation by T&T.

The Fire Service & Civil Defence Organization at Cox's Bazar operates an HF/SSB communications transceiver which was installed at the station after the last cyclone in 1991. The radio equipment is utilised for direct communication with the Dhaka HQ of Fire Service and other Fire Service stations at Chittagong, Khulna and Rajshahi. The operating frequencies are 7350 and 9905 Khz.

b) Moheshkhali

CPP installations at Moheshkhali consist of an HF/SSB transceiver for direct communications with Cox's Bazar and the Control Room at Dhaka and a VHF transceiver for communications within the zone to stations such as Cox's Bazar, Sonadia, Dhal Ghata, Khurushkul and Chokoria. Both HF and VHF communications operate satisfactorily. The station has a commercial power supply which is supported by a battery charger and batteries for operation during power supply failures. The HF communications equipment comprises an Edystone Model 5000 Series and the VHF is a YAESU Model FLT-1001 transceiver. The VHF transceiver operates from a 12 volt DC directly from the battery and battery charger. During the 1991 cyclone, the HF antenna was blown down but this was repaired fairly quickly. The VHF communication was not damaged and operated normally throughout the period.

Police radio communications at Moheshkhali consist of a VHF transceiver for communications with Cox's Bazar Police Station. During the cyclone in April 1991, the antenna was badly damaged. The mast has been repaired but with a reduced height which has affected its range. However, this has not had any serious effect on the operation as the station maintains contact primarily with Cox's Bazar Police Station and over this range the transceiver operates satisfactorily.

c) Khurushkul

During 1991 cyclone, CPP's Khurushkul VHF radio installation was badly affected. The antenna mast collapsed and the antenna was damaged. The facility was brought into normal operation after one month, following limited repairs. The VHF transceiver is primarily used for direct communications with CPP, Cox's Bazar and is operating satisfactorily, except that the range has been reduced considerably, due to the damage in the antenna, during the last cyclone. This, however, does not seriously affected the normal operation at the station. The station which is located in a school building does not have commercial power supply. To operate the radio equipment, the Wireless Operator, takes the batteries to his residence for charging, once every fortnight, which adequately meets the requirements of the station.

B.4 COMMUNICATIONS REQUIREMENTS AND PRESENT DEFICIENCIES

B.4.1 Multipurpose Cyclone Shelter Programme Recommendations

The Multipurpose Cyclone Shelter Programme - MCSP (BUET, 1992) reviewed the telecommunications needs of the coastal area before, during and after cyclones and made proposals for improved facilities including the means by which they could be integrated into the shelter design. Different types of telecommunications systems which could be provided were discussed and a VHF/UHF Cellular radio system recommended.

The Cellular system is based on the concept of a fixed network of VHF/UHF radio stations. Each station caters for a cell area covering a thana and would serve about 100 cyclone shelters which would act as subscriber terminals. A frequency band of 450-500 Mhz was proposed. The subscriber terminals could be either fixed or mobile.

Each base station would have an 'omni' antenna linking it with all subscriber stations and a directional antenna linking it with zonal stations. There would be about 50 thana base stations. Since within the cell (or thana) all the subscribers would have radio terminals, local cable distribution networks would not be necessary.

The system would have five zonal stations at Khulna, Barisal, Noakhali, Chittagong and Cox's Bazar. Each zonal station would be linked to 10 thana stations. Each zonal station would provide an interface with the national telecommunications grid, which would enable any telephone subscriber from outside the network to communicate with any Cellular subscriber.

The estimated cost for such a system were given as :

		US$ million
i)	5-Zonal stations with links to 50-thana stations, complete with channel accessories	2.0
ii)	50-thana stations equipment having 100-subscribers terminals in each thana, complete with switching equipment and solar power supplies	38.0

The system would cover the whole of the coastal area. The implementation and operation of such a project would require an organisation like the T&T Board.

The Draft Final Report was submitted in August 1992 and is being considered by GOB. It is not clear whether finance for the installation and operation of such a system could be secured.

B.4.2 World Bank

The World Bank has agreed to finance the T&T project to establish a new Satellite Earth Communications Station near Mohakhali, Dhaka. This will replace the existing Bethbunia Satellite Earth Communications Station at Chittagong. The site at Dhaka is preferred over

Chittagong, as Dhaka is generally free from severe cyclonic storms, unlike Chittagong where severe storms are experienced frequently.

Japanese consultants, financed by a Japanese grant, are to carry out a feasibility study and prepare specifications for the project shortly. According to the present schedule, tenders for the project will be floated by the end of 1992 and the earth station commissioned by early 1994. With the completion of this project, the reliability of international telecommunications with Bangladesh will improve greatly.

B.4.3 Telegraph and Telephone Board

T&T has an extensive network of telecommunications facilities extending to almost all thana HQs and plans to extend their network further.

The greatest weakness of the T&T microwave network is that there are no alternate paths for its major trunk routes. When the Chittagong microwave terminal antenna tower collapsed during the April 1991 cyclone, communications between Dhaka and Chittagong area were disrupted for many days. Due to disruption of Dhaka-Chittagong service, Bethbunia Earth Communication Station was cut off from the rest of the country, which resulted in the complete disruption of international communications for more than two weeks. If there had been an alternate communications path between Dhaka and Chittagong, this disruption could have been avoided. T&T is now planning additional microwave links which would serve as alternate communications paths.

B.4.4 Bangladesh Meteorological Department (BMD)

BMD has adequate communications facilities to transmit basic meteorological data from its various stations within Bangladesh utilising its HF/SSB radiotelephone network. Its telecommunications link with India has been improved considerably, with the introduction of a new leased data circuit with New Delhi, primarily for the reception of WMO regional meteorological data and other meteorological information from Indian stations, through the New Delhi Regional Meteorological Centre.

However, deficiencies exist in certain areas:

i) There is no facility for the reception of video data in Dhaka from the two weather radar stations at Cox's Bazar and Khepupara. Action in this regard is already being taken to provide microwave links under the Japanese aid programme;

ii) Dissemination of Storm Warning bulletins through the GENTEX teleprinter network is inadequate. The possibility of utilising the Police and Railways communication system for the dissemination of these bulletins might be explored;

iii) Telecommunications links between BMD National Meteorological Communications Centre (NMCC) and the Flood Forecasting & Warning Centre, consisting of a leased teleprinter circuit is inadequate and this should

be supplemented with a reliable data link as early as possible for more efficient flow of meteorological data between the two centres; and

iv) Telex and fax communications services should be introduced at the BMD: NMCC for more efficient communications with other agencies within and outside Bangladesh, which are not connected to its telecommunications network.

B.4.5 Civil Aviation

The aeronautical communications network, operated by CAAB is primarily for the benefit of aircraft operation in the region but is also used for the exchange of meteorological messages relating to aviation. The communications network operated by the CAAB is generally satisfactory.

However the following improvements are suggested:

i) Dhaka-Chittagong HF/SSB radiotelephone circuit should be converted to a leased telephone circuit for more reliable and efficient operation;

ii) The performance of the Dhaka-Calcutta radio teleprinter circuit should be improved in co-ordination with Calcutta airport; and

iii) Telex and fax communication services may be introduced at Dhaka airport communications centre, for more efficient communications with other agencies both within and outside the country, where aeronautical communications facilities are not available.

B.4.6 Ministry of Relief

Ministry of Relief telecommunications facilities consist of leased telephone lines linking 20 District HQs, integrated into an aging PBX, and a HF/SSB radio telephone network linking 54 out of 64 District HQs. The PBX has been in operation for more than 20 years and requires early replacement. The HF/SSB radio telephone transceivers located at the Control Room and at outstation District HQs, have been in operation since 1972, and their present performance is far from satisfactory. Spares for these equipment are no longer available and repairs are being carried out by cannibalisation. They should be replaced with new equipment as early as possible.

The MOR Control Room has adequate maintenance staff but they are not utilised since they have no workshop facilities. As a result, maintenance work of all radio equipment is presently being undertaken by technicians from T&T Board, under a contract with the MOR.

The details of manpower now available with the Ministry of Relief Control Room are as follows:

- Officer-in-Charge 3
- Engineering Superviser 1

-	Radio Technician	3
-	Draftsman	1
-	U.D.Assistant	2
-	L.D.Assistant	4
-	Typist	3
-	Telephone Operator	2
-	Peon	3

The PBX with the MOR Control Room should be replaced with a digital PABX, having adequate line capacity to meet future demands. The HF/SSB transceivers operating at the Control Room and at the District HQs should also be replaced. A workshop with adequate Test Equipment and Tools might be set up to enable the maintenance staff to carry out maintenance of equipment installed in Dhaka and elsewhere, without the need for assistance from outside agencies.

The HF/SSB radio network is operated on the frequencies of 3900 and 7400 kHz. These frequencies are quite different from those allocated and authorised by the Bangladesh Wireless Board of the T&T. The frequencies allocated to MOR are:

2 - 5 MHz Band	3180,	3349,	4571,	4833 kHz
5 - 7 MHz Band	5247,	5379,	6806,	6942 kHz
8 - 12 MHz Band	8128,	9118,	10118,	11521 kHz

The details of HF radio frequencies allocated to the MOR by the T&T may be seen in **Appendix 18.** It is imperative that actions are taken to change over the operating frequencies to conform with the authorised frequencies at an early date.

B.4.7 BWDB : Flood Forecasting and Warning Centre (FFWC)

The BWDB FFWC has an adequate communications network for daily collection of water level and rainfall data from its various stations in Bangladesh. However, its communications link with the BMD:NMCC based on a leased teleprinter circuit, should be further supplemented by a reliable data link for rapid flow of information.

Dissemination of Flood Warning Bulletins are presently carried out through messengers in Dhaka, and by ordinary post to addresses outside Dhaka. Provision of telex and fax services would greatly improve the present dissemination arrangements. Consideration might also be given to the utilisation of Bangladesh Railway's communication network for the dissemination of flood warning bulletins.

B.4.8 Cyclone Preparedness Programme (CPP)

CPP has an extensive network of radiotelephone facilities consisting of HF and VHF radio communications systems. CPP communications extend to many of the offshore islands in the coastal area. Performance during the April 1991 cyclone was generally good. All stations are equipped with batteries and battery chargers for the operation of radio equipment

when commercial power supply failures. Some of the stations are equipped with solar cells and battery chargers for operation without any requirement for commercial power supply.

CPP has a good maintenance workshop at Dhaka and has a plan to set up two more maintenance workshops to improve services in future.

During the cyclone of 1991, antenna masts and antennas were damaged and communications were disrupted at a few stations. In some cases, considerable time was taken to repair and restore of the facilities. Such disruptions could be overcome if spare antenna were kept in stock in the field. In future, the new antenna should have sufficient strength to withstand the cyclonic winds experienced in the coastal areas of Bangladesh.

CPP Communication Centre, Dhaka should be provided with telex and fax services for more efficient communications with other agencies, both within and outside the country.

B.4.9 Police

Bangladesh Police communications extend to all the Thanas in the country and some of the Police outposts. The system comprises of HF and VHF radiotelephone service within the country. Extensive leased teleprinter service, for exchange of messages between stations are also being operated by the Police Department. The Police telecommunications service are quite reliable and are working satisfactorily, round the clock. They also have a very good maintenance support of their own, for their equipment. With the addition of fax services between a number of their stations, Police telecommunications is one of the largest of its kind in Bangladesh. Possibilities should therefore be explored, to make use of Police telecommunications for dissemination of Storm Warning Bulletins issued by the NMCC.

B.4.10 Bangladesh Railways

Railways communications networks use fibre optic cables, laid underground, along 80% of its total track length. All stations are connected to this network to ensure efficient communications between the stations. Besides telephone communications, the network is also utilised for train movement control. These networks have spare capacity which might be utilised by the DCMU. The possibility of linking the DCMU telephone PBX with the Railways Network for faster communications during natural disasters might be explored. The possibility of using the BR network to disseminate Storm Warning Bulletins which are now being disseminated through the GENTEX network might also be explored. Flood Forecasting & Warning Centre could also take the advantage of the BR network for the dissemination of flood warning bulletins.

B.4.11 Bangladesh Power Development Board

BPDB with assistance from the Asian Development Bank are known to be planning to extend their SCADA systems.

B.4.12 Armed Forces and Bangladesh Rifles

The Armed Forces and Bangladesh Rifles appear to have adequate telecommunication systems to support their operations. It is likely that as more advanced technology becomes cheaper, they will improve their systems.

One suggestion to improve communications following a disaster is to 'drop' fully operational military telecommunications units. This may be necessary in exceptional circumstances to establish communications with particularly isolated areas and/or while other means of telecommunications are being restorated, but cannot be relied on for more general use. Armed Forces personnel may have a role in helping to repair damaged antennas and other equipment.

B.5 FUTURE DEVELOPMENT

B.5.1 Introduction

While these studies have focused upon telecommunications at the time of disasters, an overall consensus has developed which considers that the way to improve disaster time communications is to improve normal communications. Hence, large sums of money should not be spent in improving systems which are really only needed when disaster strikes rather use any funds to make 'normal' communications more disaster proof.

This view was strongly endorsed at the meeting of the Professional Panel on 4 October 1992 at which the findings of this report were presented(See **Annex B** to this Volume).

B.5.2 T&T System

The Bangladesh Telephone and Telegraph Board (T&T) provide the country's public telecommunications network and T&T has an extensive network extending to almost all thana HQs. The greatest weakness of the network is that there are no alternate paths for its major trunk routes. When the Chittagong microwave terminal antenna tower collapsed during the April 1991 cyclone, communications were disrupted for many days. Due to disruption of the Dhaka-Chittagong service, the Bethbunia Earth Communication Station was cut off from the rest of the country, which resulted in the complete disruption of international communications for more than two weeks. T&T is now planning additional microwave links which would provide alternate communications paths.

The World Bank has agreed to finance a new Earth Communications Station near Mohakhali, Dhaka. This will replace the existing Bethbunia Station at Chittagong. Dhaka is preferred as it is generally free from cyclonic storms. Japanese consultants, financed by a Japanese grant, are carrying out the study for the project. Tenders should be floated by the end of 1992 and the earth station commissioned by early 1994.

T&T has plans to convert the present analog telephone exchanges in the major cities to digital exchanges. The present microwave and UHF network will be further extended to cover all the thanas and many of the offshore islands. Telex and fax services are also to be extended.

All agencies involved in disaster management are likely to be greatly benefitted by the above developments. They should, therefore follow the developments, take advantage of the improvements and plan their own future telecommunications systems accordingly.

T&T is required to operate commercially and, therefore, is unlikely to be able on willing to provide services to all parts of the coastal areas in the foreseeable future. Hence, unless GOB provides subsidies for T&T operations in those highly disaster-prone areas, there will be a continuing need to provide emergency facilities through other agencies.

B.5.3 'Disaster time' Communications

Investigations revealed that numerous agencies have telecommunications facilities within the coastal area. However, almost without exception, these were disrupted for a period following the 1991 cyclone strike. **Table B.1** summarises their performance.

TABLE B.1

Reliability of Existing Telecommunications

Sl. No.	Agency	Reliability of the Telecommunication System		
		Most Reliability	'Normally' Satisfactory	Poor
1.	Telegraph and Telephone Board		√	
2.	Civil Aviation Authority		√	
3.	Bangladesh Meteorological Department		√	
4.	Water Development Board		√	
5.	Flood Forecasting and Warning Centre			√
6.	Cyclone Preparedness Programme		√	
7.	Ministry of Relief			√
8.	Fire Services and Civil Defense		√	
9.	Police	√		
10.	Bangladesh Railway	√		
11.	Navy			√
12.	Air Force		√	
13.	Army		√	
14.	Bangladesh Inland Water Transport Authority		√	
15.	Bangladesh Inland Water Transport Corporation		√	
16.	Bangladesh Rifles	√		

Following the devastating 1970 cyclone, the Bangladesh Red Crescent Society with international assistance from the Federation of Red Cross and Red Crescent Societies, and in cooperation with GOB established the Cyclone Preparedness Programme (CPP). CPP has an extensive network of radiotelephone facilities consisting of HF and VHF radio systems. CPP communications extend to many of the offshore islands. Performance during the April 1991 cyclone was generally good. All stations are equipped with batteries and battery chargers to operate the radio equipment when the commercial power supply fails. Some of the stations are equipped with solar cells and battery chargers to allow operation without the need for any commercial power supply.

CPP has a good maintenance workshop in Dhaka and plans to set up two more to improve services. Substantial assistance in upgrading equipment is expected from the international Red Cross movement.

Although operations were generally satisfactory during the cyclone of 1991, some antenna masts and antennas were damaged and a few communications links were disrupted. Such disruption could be overcome if spare antenna were held in stock in the field, or if antenna could be taken down immediately prior to a cyclone strike and re-erected afterwards.

Bangladesh Police communications extend to all thanas in the country and some smaller Police outposts. The system comprises HF and VHF radiotelephones. Leased teleprinter services are also operated. The Police system is quite reliable and works round the clock. They have their own reliable maintenance support. With the addition of fax services between a number of their stations, the Police system is the largest in Bangladesh.

The Multipurpose Cyclone Shelter Programme - MCSP (BUET, 1992) - reviewed the telecommunications needs of the coastal area before, during and after cyclones and made proposals for improved facilities including the means by which they could be integrated into the shelter design. Different types of telecommunications systems were discussed and VHF/UHF cellular radio system recommended.

The estimated cost of such a system covering the whole of the coastal area would be $40 million. The implementation and operation of such a project would require an organisation like the T&T Board. The Draft Final Report was submitted in August 1992 and is being considered by GOB. It is not clear whether finance for the installation and operation of such a system could be secured.

The Police system is already widely used in emergencies to support the civil administration, might be seen as the Emergency service. Until such time as GOB could finance a cellular scheme as described above, there would seem to be merit in reinforcing the existing Police network to cover as much of the area as possible.

The senior Police officer at each station should be charged with passing warning messages to CPP volunteers and others for wider dissemination. They should also be responsible for passing damage and needs assessment messages for the civil administration, when required.

Radio operators should be responsible for ensuring that their masts and aerials were taken down in due time when a cyclone is approaching and windspeeds exceed a specified level.

The role of the AFD telecommunication, especially those of the Army, at times of disasters needs to be futher considered.

Appendix 20 reproduces IDNDR Newsletter Nr 10 of November/December 1992 which was a special issue on the vulnerability of telecommunications at times of disasters.

B.5.4 Ministry of Relief

It is proposed to establish a Disaster Management Bureau (DMB) as a part of the Ministry of Relief in the context of the FAP:11 project which will follow on from the present assignment. The DCMU would be subsumed into the DMB, which would serve as a national Emergency Operations Centre (EOC) at the time of emergency. **Figure B.5.1** shows the proposed organisation of the DMB, which includes a Logistics and Communication Cell. The DMB would be located outside the secretariat, i.e. physically separate from the present MOR.

With the establishment of DMB, the telecommunications requirements of the Ministry would change and in part its requirements would depend upon the physical location of DMB. As the location of the DMB has yet to be decided, it is not possible to make firm proposals regarding the procurement of telecommunications equipment. The suggestions which follow provide only a general indication of what might be required. They are based on upgrading the existing Relief Control Room **(which the Consultants do not recommend).** They should be re-examined and finalised as soon as the establishment of the DMB and its location are finally agreed.

At present, a small cell within the Ministry, the Relief Control Room (RCR), provides telecommunications between the MOR and the District Administrations. The DMB would require efficient communications to maintain links with various Ministries, Government Departments and Non-Government organisations throughout the country. The present RCR facilities are not adequate for such proposes.

In the absence of an efficient public telephone system, there is no alternative but to retain an HF network for at least the next 10 to 15 years. The existing RCR HF radio communications equipment has been in use for more than 20 years and has exceeded its useful life. The operational frequencies of the equipment are not those allocated to MOR by the T&T. The existing equipment should be replaced with new equipment, using frequencies approved by the T&T Board.

The existing PBX installed in RCR is also in a very poor condition and requires replacement with a digital PABX. This should have adequate line capacities to meet the future requirements of the DMB.

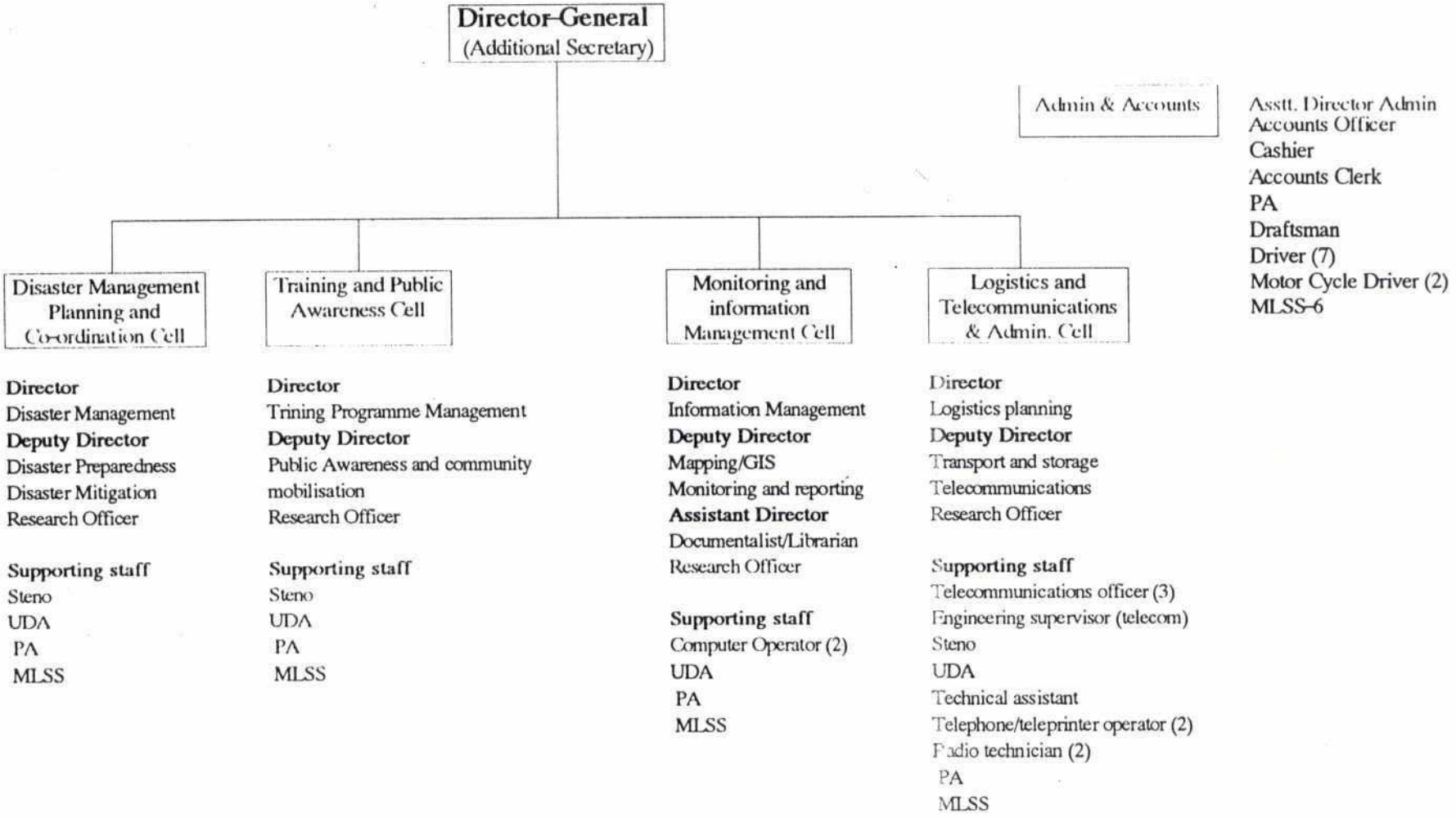
Experience shows that radio telecommunication equipment functions more efficiently if it is utilised frequently. The RCR communications network is utilised only intermittently during normal times and, therefore, is not very reliable when it is needed more frequently during emergencies. The overall utilisation is poor and does not justify further expansion. It would be more appropriate to modernise and strengthen the existing system, replacing the present equipment and providing more reliable battery operated power supplies at each station.

At present, DRROs utilise the public telephone system to communicate with Project Implementation Officers at thana level. This is adequate during normal times, and generally meets needs. In emergencies, DRROs seek the assistance of the CPP or the Police who have more reliable and extensive communications networks in the coastal areas. To facilitate co-ordination with the CPP, especially during emergencies, some selected MOR/DMB stations

Figure B.5.1

Core Structure for the Disaster Management Bureau

(Operational structure during normal times)



in Dhaka, Chittagong, Cox's Bazar, Barisal and Khulna should be provided with additional systhesised HF/SSB transceivers, so that they can also operate on CPP frequencies, whenever required. They may, in this manner, directly communicate with any CPP HF/SSB radio station. However, this facility should be used in emergencies only.

For emergency field communications, hand-held VHF/FM transceivers (Walkie-Talkie) should be provided to the DMB. New frequencies would be required from the T&T Board prior to procurement from abroad.

In addition to the above facilities, facsimile equipment should be provided within the DMB and to DRROs at four district HQs at Barisal, Chittagong, Cox's Bazar and Khulna. Facsimile equipment may be connected directly to existing telephone lines. A number of Government agencies including the Police, Military and LGED are using facsimile for their inter-office communications. To ensure better co-ordination during emergencies, the DMB, some Ministries and agencies, as listed below, should have facsimile equipment (if they do not have it already):

- Cabinet Division
- Principal Staff Officer, PM Office
- Armed Forces Division
- Ministry of Post & Telecommunications
- Ministry of Information
- Ministry of Local Government, Rural Development and Cooperatives
- Ministry of Health
- Ministry of Foreign Affairs
- Ministry of Food
- Ministry of Finance (Economic Relation Division)
- Bangladesh Meteorological Department
- Space Research & Remote Sensing Organisation
- BWDB Flood Forecasting & Warning Centre
- BDRCS
- CPP
- ADAB
- VHSS

Technical specifications for the procurement under the present project (BGD/91/021) of one PABX and HF/SSB transceivers have been prepared and these are given in **Table B.5.2**.

B.5.5 Operational Frequencies and Disaster Operation

The frequencies of operation of the Ministry of Relief HF/SSB communications network, as given by the Officer-in-Charge, Control Room, were 3900 and 7400 kHz. Discussions with the Bangladesh Wireless Board (T&T) revealed that these frequencies were not those authorised for Ministry of Relief use. It appears that the frequencies being operated by MOR have used since 1972, when the HF/SSB transceivers were first brought into the country. Although Bangladesh Wireless Board allocated a different set of frequencies in 1976, MOR did not change to the new frequencies. In fact 3900 kHz is allocated to CAAB so there is a danger of interference with civil aviation communication.

TABLE B.5.2

Telecommunication Equipment Proposed for DMB

Sl. No.	Description	Unit Cost ($)	Unit (Nr)	Total Cost ($)
i)	Digital PABX, equipped for 4 T&T lines and 30 extension lines, expandable to 8 T&T lines an d72 extension lines with accessories	12,000	1	12,000
ii)	HF/SSB transceivers, complete with antennas and accessories for 14 stations	5,000	14	70,000
iii)	Batteries and battery chargers with accessories	200	8	1,500
iv)	Fax equipment with autodialling, relay broadcast, multiple broadcast facility with accessories and spares.	1,500	15	22,500
v)	Electronic teleprinter, telex version with auto-dialling, multiple address transmission and VDU display unit, complete with accessories and spares.	4,500	1	4,500
			Total	**110,600.00**

On 29 November 1993 at a meeting held in DMB the question of MoR/DMB frequencies was discussed. The decisions of the meeting together with he frequencies proposed for official allocation are listed below:

"i) MoR should have 14 frequencies allocated for disaster communications:

2-5 MHz Band 3180, 3349, 3880, 4571, 4833 kHz
2-7 MHz Band 5247, 5379, 6806, 6942 kHz
7-9 MHz Band 7400, 8128 kHz
9-12 MHz Band 9118, 10118, 11521 kHz

ii) In the event of a major disaster the DMB would be in a position to allocate one or more of the above frequencies to organisations engaged in disaster relief work. It should be noticed that DMB will have the power to allocate frequencies to bonafide relief agencies at the time of disaster."

B.5.6 Legal Issues

The Terms of Reference required that, if considered necessary, proposals for changes in legislation to liberalise the use of telecommunications equipment particularly at time of disaster should be made. It proved impossible to obtain copies of any current laws relating to the operation of telecommunications equipment. Hence, no proposals for modifications can be put forward.

Present customary practise requires that any organisation wishing to operate telecommunications equipment within Bangladesh should apply on a standard form (See **Appendix 2**) to the Bangladesh Wireless Board (BWB) through the T&T.

These applications are sent to all BWB members for their concurrence. BWB members include the various GOB organisations who are major telecommunication operators such as Radio Bangladesh, Civil Aviation, Meteorological Department, Army, Navy, Air Force, Police, BDR and National Security Intelligence. If no organisation has any objection, an operating licensing is issued and frequencies are allocated and registered in the name of the applicant. The process may take many months.

B.5.7 Detailed Studies Required

Further studies are required in connection with the establishment of the DMB as the Disaster Management Communications hub:

- to liaise further with the Police, AFD, and other agencies with the aim of evolving Standing Orders to cover full interagency cooperation at the time of disasters;

- to determine in more detail the telecommunications requirements of DMB, its requirements vis a vis District HQs and other line ministries and agencies, and to assess future communications requirements between District HQs and thana offices and the offshore islands in the coastal areas;

- to consider the technical manpower required for the maintenance and repair of telecommunications equipment and, if necessary, to prepare an equipment plan and

technical specifications for providing test equipment and tools for development of a base maintenance workshop for MOR;

- to review further dissemination arrangements for Storm and Flood Warning Bulletins, utilising GENTEX teleprinter networks and explore the possibilities of utilisation of Police, Railways and other telecommunications networks for more efficient dissemination of the bulletins;

- to lobby GOB through the Interministerial Disaster Management Coordination Committee to adopt a more sympathetic attitude towards amateur radio enthusiasts and to simplify regulations relating to radio communications operating licensing.

APPENDIX 1

TERMS OF REFERENCE FOR TELECOMMUNICATIONS CONSULTANT

APPENDIX 1

TERMS OF REFERENCE FOR TELECOMMUNICATIONS CONSULTANT

The Telecommunication Consultant will carry out the following tasks:

a) Make contact with all relevant on-going and proposed projects including:

- Bangladesh Red Crescent Society: Cyclone Preparedness project
- UNDP/World Bank: Multipurpose Cyclone Project
- Japan/Meteorological Dept: Microwave links from weather Radar stations at Cox's Bazar and Khepupara with Dhaka
- Ministry of Relief: Control Room communications modernisation programme

b) Prepare detailed account of telecommunications facilities available with various Govt. agencies for communications within Bangladesh and with outside world.

c) Comment on the reliability and usefulness of the above communications systems, specially at the time of national emergencies keeping in view the 1991 cyclone as an example.

d) Assess the communications requirements of the Ministry of Relief as the focal point in co-ordinating and monitoring disaster relief and rehabilitation.

e) Review Govt. Legislation regulating the use and operation of telecommunications equipment in Bangladesh.

f) Review the mode of communications between Indian data gathering stations and the appropriate Bangladesh Organisations.

g) Based upon the findings of the above investigations prepare outline proposals for providing:

- Reliable communications for effective disaster management at times of cyclones, floods and other emergencies, at the international, national, regional and local levels.
- Appropriate communications for the Ministry of Relief
- Draft legislations covering the operation of telecommunications equipment at the time of national emergencies

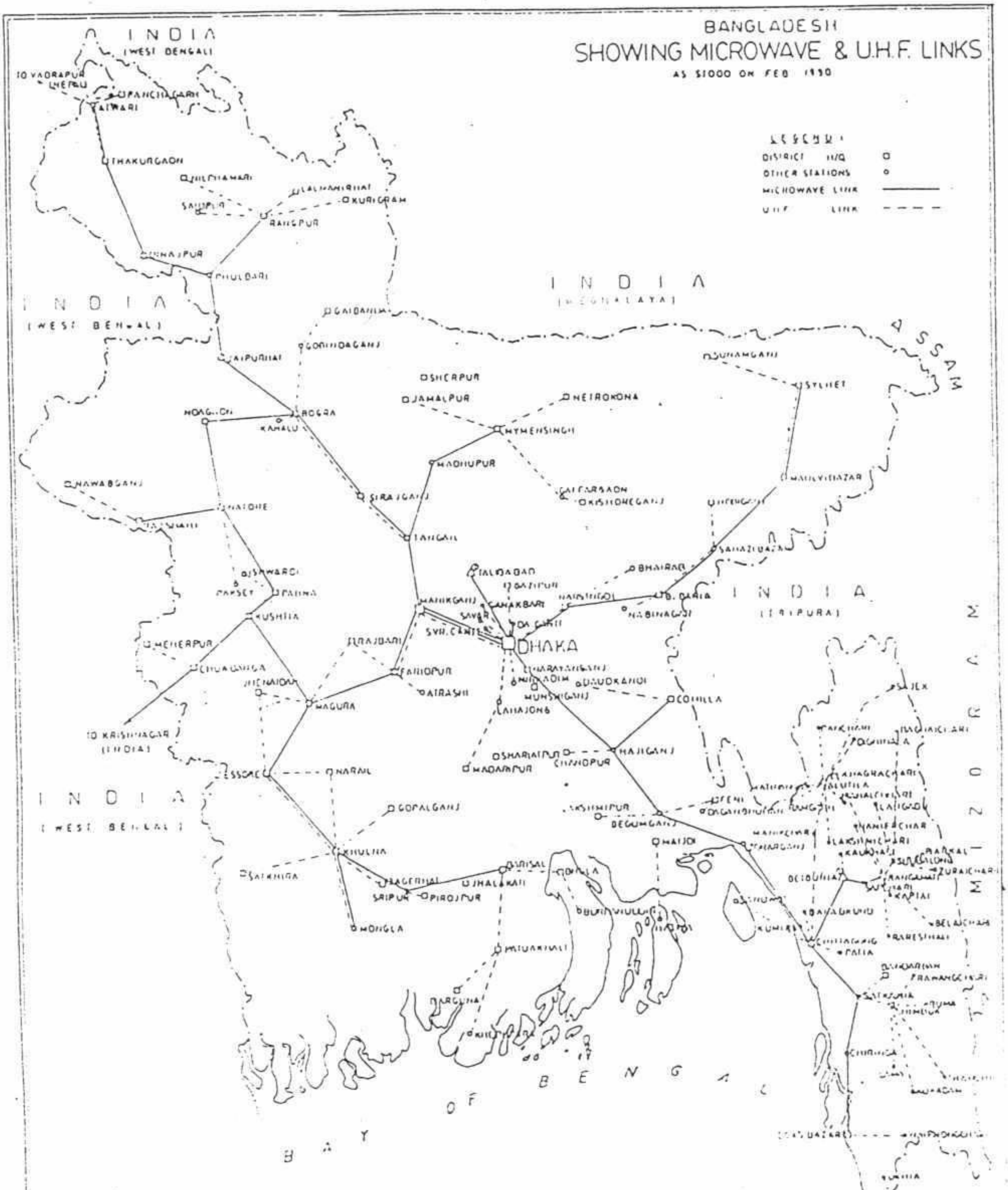
h) Preparation of list of equipment, with detailed technical specifications, for Ministry of Relief to be procured under BGD/91/021, the budget being US$ 125,000.

i) Preparation of Terms and Reference for further studies and associated technical assistance inputs for Flood Action Plan, FAP-11 project.

APPENDIX 2

BANGLADESH T&T BOARD
MICROWAVE & UHF TELECOMMUNICATIONS NETWORK
AND BWD APPLICATION FORM FOR A FIXED/LAND
MOBILE STATION LICENCE

APPENDIX 2



DRAWN BY M. A. MATIN

APPLICATION FORM FOR A FIXED/LAND MOBILE STATION LICENCE.

Application from Bangladesh State subject for licence to establish maintain and work wiereless Telegraphs/Telephones in Bangladesh.

1. Name of the Application(in block letters): .

   Address: .....

   Age: ..... Occupation: .....

2. Nationality: .....

3. Father's Name and Home Address: .....

   .....

4. Scientific qualifications(if any) of applicant:

   .....

5. Particualrs of any experience in working wireless Telegraphs/Telephone transmitting apparatus: .....

   .....

6. Particualrs of certificates of competency as wireless Operator held by the applicant: .....

7. Speed at which applicant can send and receive in the morse code:

   .....

8. Particulars of apparatus to be used, the trade name of the set in the case of standard set bearing a recognised trade name(Diagrams to be furnished and attached to this form unless a standard set bearing a recognised trade name is to be employed):

   a) Transmitting : .....

   b) Receiving : .....

   c) Antenna(including sketch and dimentions & menas of support) :

   .....

9. Power in watts to be used for transmission(A) :

   a) Source of power supply

   b) Measured at input (c) Volts

   c) D/C or A/C

   d) Cycle pur second(A/C)

   e) Maximum watts at input to aerial

   f) Power out of transmitting

If more than one station is desired details must be given for each station separately.(a) Power is defined as the power taken from the terminals of the main generators or equivalent point. (b) if batteries are used, state kind, if dianamo, state maximum power available and if supply main, state voltage(whether direct or alternating and periodically)

The term wireless telegraphs includes Wireless telephone.

Cont'd ...P/2.

10. Particulars of station:

Exact location of Tx with Postal Address:	Type of Station	Class of stations.	Remarks.

.....

Note(a) State full postal address at which the station is to be created if the station is to be moveable, state place in which it will normally be located and area over which if is desired to move.

(b) For 'Type'and class see table on page-1 of the pamphlet instructions governing licences for wireless telegraphs in Bangladesh.

11. Wave length is desired to use.
Transmitting normal: .....
Additional :
Receiving:
Additional:

12. Range of wave over which apparatus is capable of being adjusted
Transmitting
Receiving:

13. Station with which it is desired to communicate:

14. Type of message desired to be exchanged :

15. Hourse of working desired :
Transmitting: Hours:
Receiving: Hours :

16. If the applicant proposes to employ operators to work the transmitting apparatus, give names, addresses, qualifications of operators with particulars of their certificates of competency as wireless operator.
.....
.....
.....

If more than one station is desired, details must be given for each station separately .

Cont'd ...../3.

APPLICATION FORM FOR A FIXED/LAND MOBILE STATION LICENCE.

Application from Bangladesh State subject for licence to establish maintain and work wiereless Telegraphs/Telephones in Bangladesh.

1. Name of the Application(in block letters): .....

   Address: .....

   Age: ..... Occupation: .....

2. Nationality: .....

3. Father's Name and Home Address: .....

   .....

4. Scientific qualifications(if any) of applicant:

   .....

5. Particualrs of any experience in working wireless Telegraphs/Telephone transmitting apparatus: .....

   .....

6. Particualrs of certificates of competency as wireless Operator held by the applicant: .....

7. Speed at which applicant can send and receive in the morse code:

   .....

8. Particulars of apparatus to be used, the trade name of the set in the case of standard set bearing a recognised trade name(Diagrams to be furnished and attached to this form unless a standard set bearing a recognised trade name is to be employed):

   a) Transmitting : .....

   b) Receiving : .....

   c) Antenna(including sketch and dimentions & menas of support) :

   .....

9. Power in watts to be used for transmission(A) :

   a) Source of power supply

   b) Measured at input (c) Volts

   c) D/C or A/C

   d) Cycle pur second(A/C)

   e) Maximum watts at input to aerial

   f) Power out of transmitting

If more than one station is desired details must be given for each station separately.(a) Power is defined as the power taken from the terminals of the main generators or equivalent point. (b) if batteries are used, state kind, if dianamo, state maximum power available and if supply main, state voltage(whether direct or alternating and periodically)

The term wireless telegraphs includes Wireless telephone.

Cont'd ...P/2.

5.08

D E C L E A R A T I O N

I undertake of observe the conditions o: licence and herebt certify that the apparatus herein described ca.t and will be worke' in accordance with the provisions of the licen:e. I further decla:: that if the apparatus is licenced for the tran:mission of message only operators holding approved certificate of competency shall be employed to work the tranami.ting apparatus.

Signature of the .pplicant.....

Date.....

Seal(if an.)

" FORM-A "

BANGLADESH WIRELESS BOARD

SITE CLEARANCE

Details required to be submitted with application for sitting of a Wireless Station.

1. Name of Station :

2. Longitude and Latitude of Station :

3. If to be used for transmitting or receiving or both

4. Power output of transmitter :

5. Type of transmitting Antenna :

6. Over all height of transmitting antenna (indicate whether from ground or roof top)

7. Type of receiving antenna :

8. Height of receiving antenna :

9. In case the wireless station falls within 10 nautical miles of the nearest aerodrom, the bearing and distance of the station from the aerodrom.

10. Transmitting Frequencies :

11. Receiving Frequencies :

12. Frequency control VFO or Crystal :

13. Type of Emission :

14. Portable date of Installation :

15. Name of other stations already installed

16. Whether equipment is available or is to be imported from abroad

17. Period for which wireless system is required.

REMARKS :

HAPUN/

307

" FORM " B "

BANGLADESH WIRELESS BOARD
(FREQUENCY CLEARANCE)

Details required to be submitted for approval of frequency.

Notifying body

Assigned frequency

Date of putting into use

Name of transmitting station

Longitude and Latitude of
Transmitting Station.

Point of receiption

Length of circuit

Class of station and
nature of service

Type of emission with bandwidth

Power in KW

Transmitting Antenna Characteristics
Azimuth of maximum radiation
Angular width of main lobe
Antenna gain in db.

Maximum hour of operation

Supplymentary information

Remarks:

গণ প্রজাতন্ত্রী বাংলাদেশ সরকার
বাংলাদেশ তার ও টেলিফোন বোর্ড
টেলিযোগাযোগ ভবন, ৩৬/১, ময়মনসিংহ রোড, ঢাকা।

নং বি-ডাব্লিউ ঃ _____ তারিখ -- _____

বিষয় ঃ-বেতার যন্ত্রের তরংগ (ফ্রিকোয়েন্সি) বরাদ্দের ছাড়পত্র।

১। আবেদনকারী সংস্থার নাম ও ঠিকানা ঃ (ক) স্থায়ী _____
_____
(খ) বর্তমান _____
_____
_____

২। সরবরাহকারী স্থানীয় এজেন্টের নাম ও ঠিকানা। ঃ _____
_____
_____

৩। প্রার্থীত তরংগ (স্পট ফ্রিকোয়েন্সি) ঃ _____
_____
_____

৪। বেতার যন্ত্র ট্রান্সসিভার অথবা প্রেরক ও গ্রাহক যন্ত্র পৃথক কিনা (ফ্রিকোয়েন্সি রেঞ্জ সহ)। ঃ _____
_____
_____

৫। প্রেরন যন্ত্রের পাওয়ার আউটপুট ঃ _____

৬। এ্যান্টেনার প্রকারভেদ ও উচ্চতা ঃ _____

৭। পাওয়ারের উৎস (এসি / ডিসি) ঃ _____

৮। ষ্টেশন সমূহের অবস্থান ঃ _____
_____

৯। ষ্টেশন সমূহের প্রকারভেদ (স্থির/ভ্রাম্যমান) ঃ _____

১০। এমিশনের শ্রেণীভেদ ঃ _____

১১। ষ্টেশন সমূহের উদ্দেশ্য ঃ _____

১২। বেতার যন্ত্রের অপারেশন (সিমপ্লেক্স/ডুপ্লেক্স) ও চ্যানেল সংখ্যা। ঃ _____

১৩। বেতার যন্ত্রের তরংগ নিয়ন্ত্রন পদ্ধতি (সিনথেসাইজড/ক্রিস্টাল কন্ট্রোল)। ঃ _____

১৪। আমদানীর জন্য প্রার্থীত বেতার যন্ত্রের সংখ্যা। ঃ _____

পাতা (২) দ্রষ্টব্য -

১৫। বেতার যন্ত্র ব্যবহারের সময়সীমা ও পুনঃরপ্তানীযোগ্য কিনা(বিদেশী সংস্থার জন্য প্রযোজ্য) । : ----------

১৬। বেতার যন্ত্রের সহিত কোন কোডিং/ সাইফার যন্ত্র ব্যবহার হইবে কিনা। : ----------

১৭। বেইজ/রিপিটার ষ্টেশন ব্যবহৃত হইবে কিনা । : ----------

১৮। পর্বে কোন বেতার যন্ত্রের জন্য লাইসেন্স প্রাপ্ত কিনা। হইয়া থাকিলে ব্যবহৃত তরংগ, পাওয়ার আউটপুট ও সেটের সংখ্যা (সচল /অচল) । : ----------

১৯। বেতার যন্ত্র সমূহ বাংলাদেশী নাগরিক (অপারেটর) দ্বারা পরিচালিত হইবে কিনা । : ----------

২০। আবেদনকৃত বেতার যন্ত্রের পাওয়ার আউটপুট, তরংগ ও বেতার বোর্ডের কোন নীতিমালার আওতাভুক্ত । : ----------

২১। বাংলাদেশ টি এন্ড টি বোর্ডের মন্তব্য : ----------

বিভাগীয় প্রকৌশলী(তরংগ ও বেতার)
ফোন নম্বর - ৮৩ ৪২ ৪১ ।

নং বি-ডাব্লিউ:_____ তারিখ ----------

নিম্নে বর্ণিত বাংলাদেশ তরংগ ও বেতার বোর্ড সদস্য মহোদয়গনকে উল্লেখিত তরংগ সমূহের ছাড়পত্র প্রদান করার জন্য অনুরোধ করা যাইতেছে। উল্লেখ্য যে, এই পত্র প্রাপ্তির ১৫(পনর) দিনের মধ্যে কোন মতামত না পাওয়া গেলে ১২তম বেতার বোর্ড মিটিংয়ের এজেন্ডা ১৩-বি এর সিদ্ধান্ত অনুযায়ী তরংগ বরাদ্দের ব্যাপারে কোন আপত্তি নাই বলিয়া গণ্য করা হইবে ।

১।

২।

৩।

৪।

৫।

বিভাগীয় প্রকৌশলী(তরংগ ও বেতার)
ফোন নম্বর - ৮৩ ৪২ ৪১ ।

১মাহমুদ২

APPENDIX 3

BANGLADESH METEOROLOGICAL DEPARTMENT
TELECOMMUNICATIONS NETWORK
WEATHER FORECAST AND WEATHER DISSEMINATION SYSTEM

BANGLADESH METEOROLOGICAL DEPARTMENT
Telecommunications Network
(May 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communication Network**				
	Dhaka – Barisal, Bhola, Bogra, Chittagong, Comilla, Cox's Bazar, Dinajpur, Faridpur, Feni, Ishurdi, Jessore, Khepupara, Khulna, Kutubdia, Maizdi, Mymensingh, Rajshahi, Rangamati, Rangpur, Satkhira, Sitakunda, Srimangal, Sylhet, Tangail, Teknaf.	HF/SSB Radio Telephony	24 Hrs	2324, 2505, 3363, 8814 kHz	Operated once in ever 3 Hrs for collecting MET data from al stations
02.	**Leased Teleprinter Circuits**				
	a) Dhaka – Chittagong	Leased Teleprinter Circuit	24 Hrs		Exchange of MET messages
	b) Chittagong – Cox's Bazar	Leased Teleprinter Circuit	24 Hrs		Exchange of MET messages
03.	**Cyclone Warning Bulletins**				
	MET Office Dhaka – Radio Bangladesh, BTV, Cyclone Preparedness Programme, Ministry of Relief, Deputy Commissioners, Shipping Authorities, Newspaper Offices, Zia Int'l Airport, etc.				During cyclone seaso cyclone warning ar transmitted by teleph teleprinter, telegraph utilising T&T Boar Communication Facil
04.	**Future Plans**				
	a) Dhaka – Cox's Bazar	Leased Microwave Circuit	24 Hrs		Japanese aid program Target : 1994
	b) Dhaka – Khepupara	Leased Microwave Circuit	24 Hrs		Japanese aid program Target : 1994

BANGLADESH METEOROLOGICAL DEPARTMENT
STORM WARNING CENTRE
Weather Forecast & Warning Dissemination System
Telecommunications Network
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**Gentex Communications Network**				
	MET Com Centre – Chandpur, Chittagong, Chittagong CTO, Chuadanga, Dhaka CTO, Dinajpur Faridpur, Feni, Hatia, Khulna, Kushtia, Madaripur Court, Maizdi, Mangla, Patuakhali, Rajshahi, Rangpur, Sylhet.	Gentex Network	24 Hrs		
02.	**Leased Teleprinter Circuits**				
	MET COM Centre – Bogra, Chittagong #1, Chittagong #2 New Delhi MET Centre, Dhaka CTO, Dhaka Airport, Flood Forecasting Centre, Ishurdi, Radio Bangladesh, Sylhet, Tejgaon, Jessore.	Leased Circuit	24 Hrs		
03.	**Leased Data Circuit**				
	Dhaka MET Centre – New Delhi MET Centre	Leased Data Circuit 2400 Bauds	24 Hrs		Under test operation

APPENDIX 4

CIVIL AVIATION AUTHORITY COMMUNICATIONS

APPENDIX 4

CIVIL AVIATION AUTHORITY OF BANGLADESH

Telecommunications Facilities
(May 1992)

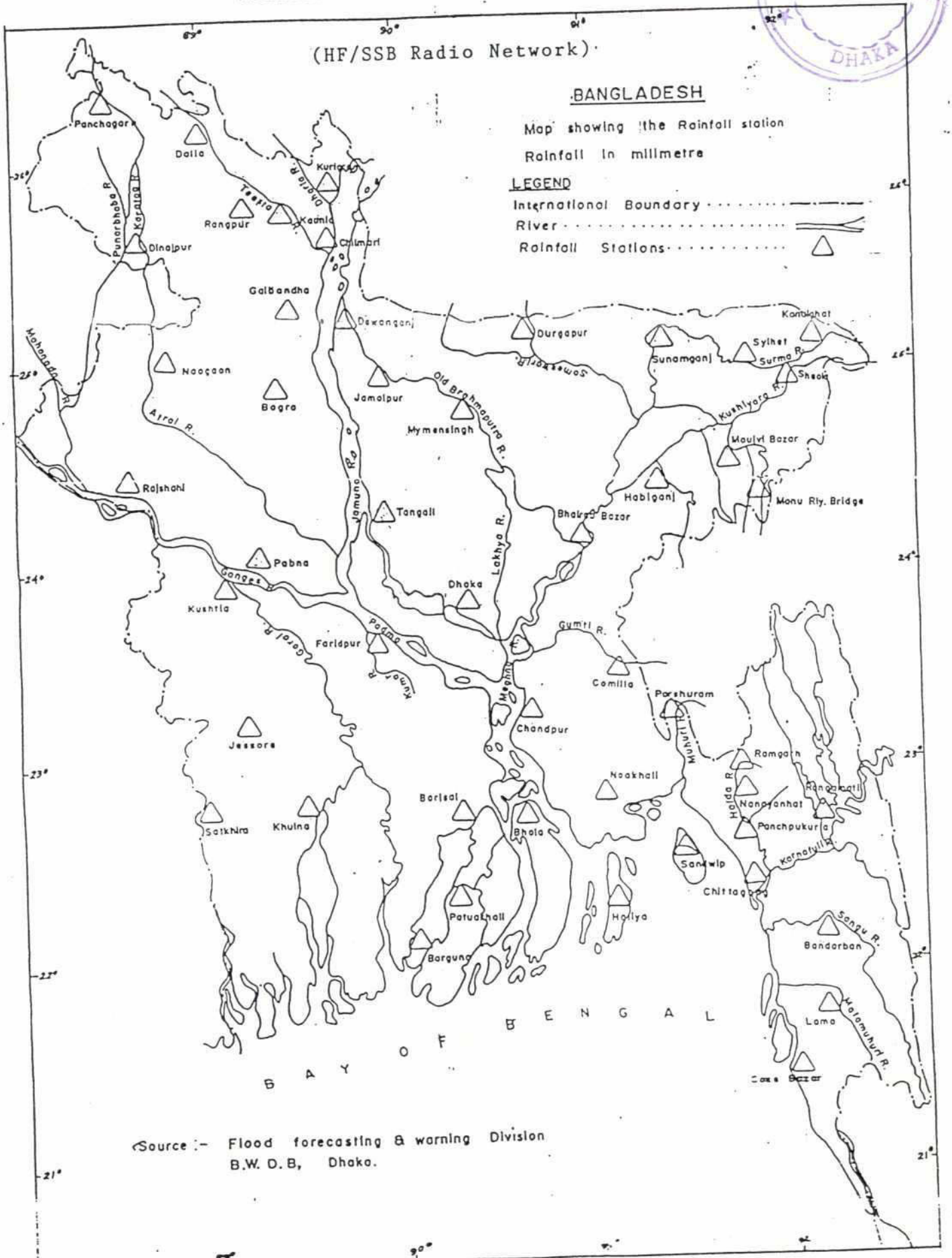
Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communication Network**				
	Dhaka – Chittagong, Cox's Bazar, Jessore, Rajshahi, Saidpur, Sylhet.	HF/SSB Radio Telephony	Opert.hrs of Airport	6826, 3660, kHz	For Co-ordination of Air Traffic
02.	**Leased Voice Circuits**				
	Dhaka – Calcutta	Leased Microwave Circuit	24 Hrs		For Air Traffic Co-ordination between Dhaka and Calcutta.
03.	**Leased Teleprinter Circuits**				
	a) Dhaka – Bangkok	Leased Satellite Circuit	24 Hrs		For exchange of messages relating to Air Traffic
	b) Dhaka – Chittagong	Leased Microwave Circuit	Opert.hrs of Airport		For exchange of messages relating to Aviation
04.	**HF Radioteleprinter Circuit**				
	Dhaka – Calcutta	HF Radio Teletype	24 Hrs		For exchange of messages relating to Civil Aviation
05.	**VHF Air–Ground Radiotelephone Communications**				
	a) Dhaka –	VHF/AM	24 Hrs	118.3,121.3 121.8,125.7 126.7 MHz	For direct ground-to-Air Voice communicatio with Aircraft
	b) Chittagong –	VHF/AM		118.7,121.8 MHz	For limited hours
	c) Cox's Bazar, Ishurdi, Jessore, Rajshahi, Saidpur, Sylhet.	VHF/AM		122.9 MHz	For limited hours

APPENDIX 5

BANGLADESH WATER DEVELOPMENT BOARD

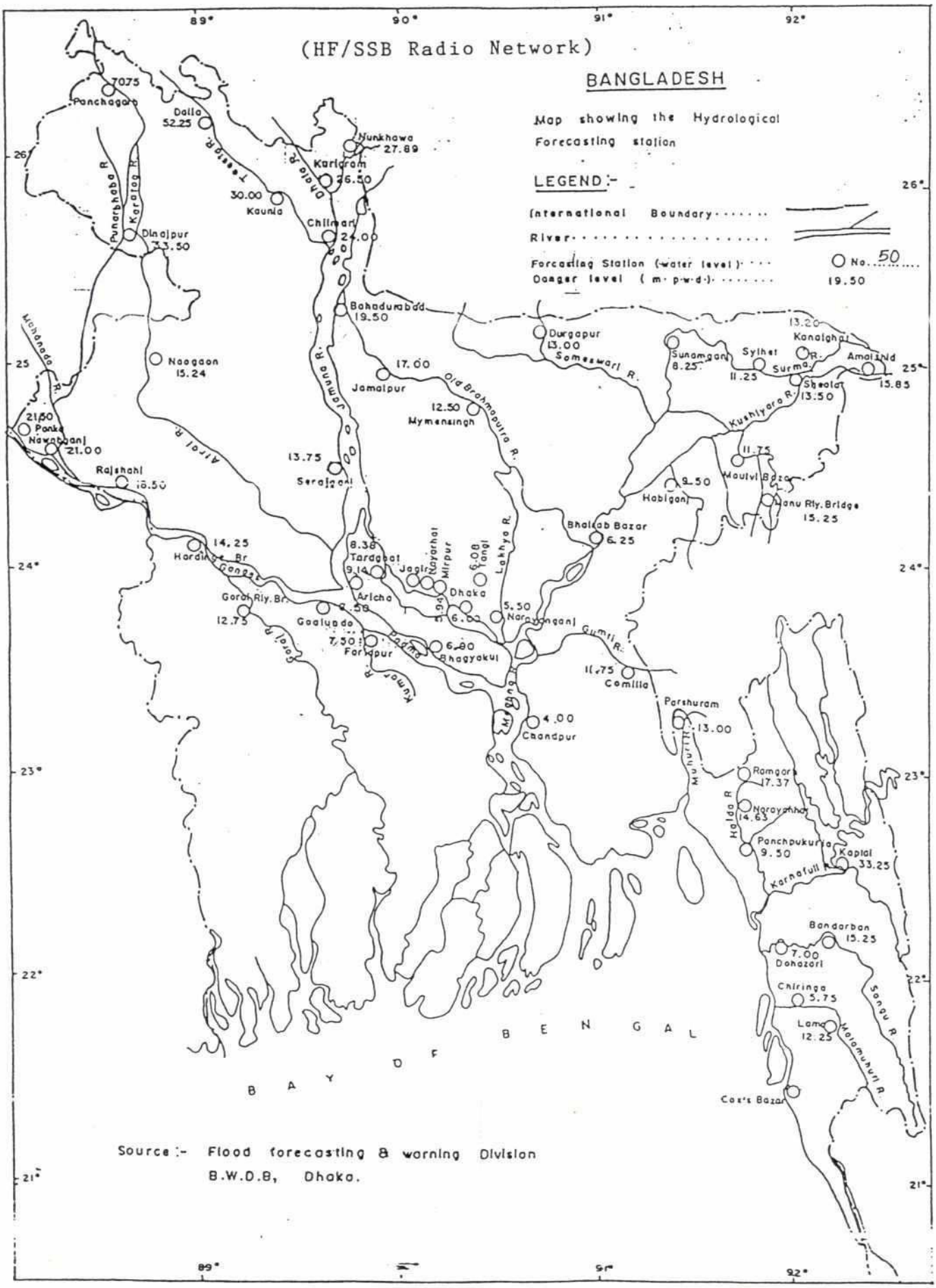
BANGLADESH WATER DEVEOPMRNT BOARD
Flood Forecasting & Warning Division
Rainfall Data Collection Stations

(HF/SSB Radio Network)



Source :- Flood forecasting & warning Division
B.W.D.B, Dhaka.

BANGLADESH WATER DEVELOPMENT BOARD
Flood Forecasting & Warning Division
Hydrological Forecasting Stations



Source :- Flood forecasting & warning Division
B.W.D.B, Dhaka.

APPENDIX 5

FLOOD FORECASTING & WARNING CENTRE
WAPDA BUILIDNG, DHAKA
Telecommunications Network
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	HF/SSB Voice Communication Network				
	Dhaka – Amolshid, Aricha, Bahadurabad, Bandarban, Bhagyakul, Bhairab Bazar, Chandpur, Chilmari, Chiringa, Comilla, Cox's Bazar, Dalla, Dinajpur, Dohazari, Durgapur, Faridpur, Goalundo, Gorai Railway Station, Habiganj, Hardinge Bridge, Jagir, Jamalpur, Kanaighat, Kaptai, Kaunia, Kurigram, Lama, Mirpur, Monu Rly. Bridge, Moulvi Bazar, Mymensingh, Naogaon, Narayanganj, Narayanhat, Nawabganj, Nayarthal, Nunkhawa Panchagarh, Panchpukur, Panka, Parshuram, Rajshahi, Ramgarh, Serajganj, Shaola, Sunamganj, Sylhet, Taragoat, Tongi.	HF/SSB Radio Telephony		5089,8157 8188 kHz	Rainfall & water data collection once a day
02.	Leased Teleprinter Circuits				
	WAPDA Building – MET Hqs	Leased Teleprinter Circuit	24 Hrs		

APPENDIX 6

CYCLONE PREPAREDNESS PROGRAMME COMMUNICATIONS

CYCLONE PREPAREDNESS PROGRAMME
Teleocmmunications Network

APPENDIX 6

BANGLADESH RED CRESCENT SOCIETY
CYCLONE PREPAREDNESS PROGRAMME
Telecommunications Network
(June 1992)

Sl. No.	Network Details			Mode of Operation	Hours of Operation	Frequencies (kHz/MHz)	Remarks
01.	**HF/SSB Voice Communication Network**						
	Dhaka	–	Amtali, Barguna, Barisal, Char-Fesson, Chittagong, Chokoria, Companiganj, Cox's Bazar, Dashmina, Daulatkhan, Galachipa Hatia, Kalapara, Kutubdia, Lalmohan, Mirsarai, Moiscal, Monpura, Noakhali, Patherghata, Ramgati, Sandwip, Sitakunda, Sonagazi, Sudharam (Char Bata), Tajmuddin, Teknaf.	HF/SSB Radio Telephony	1000–1030 1430–1500 1500–1530 Hrs	6991.5, 3796, 7003 kHz	
02.	**VHF/FM Communications Network**					(MHz)	
	a) Amtali	–	Atharo Gashia, Bara Bagi	VHF/FM Radio Telephony	11.50–12.10	86.850	
	b) Baraguna	–	Baliatoli, Naltona	VHF/FM Radio Telephony	11.50–12.10	86.875	
	c) Chakoria	–	Magnama, Rajakhali	VHF/FM Radio Telephony	10.50–11.10	86.850	
	d) Charfesson	–	Char Kukri Mukri, Char Motahar, Dhal Char,	VHF/FM Radio Telephony	11.30–11.50	86.850	
	e) Companyganj	–	Gangchil Kalmi, Musapur	VHF/FM Radio Telephony	11.10–11.30	86.850	
	f) Cox's Bazar	–	Jaliapalang (Ukhia), Khurushkul	VHF/FM Radio Telephony	10.30–10.50	86.875	
	g) Galachipa	–	Barabaizdia I, Barabaizdia II, Char Kazal (Char Siba) Rangabli (Char Montaz)	VHF/FM Radio Telephony	11.30–11.50	86.875	
	h) Hatia	–	Char Clerk, Nijhumdwip	VHF/FM Radio Telephony	10.50–11.10	86.900	
	i) Kalapara	–	Lalua (Nishan Baia) Latachapli (Khajura)	VHF/FM Radio Telephony	11.30–11.50	86.900	
	j) Moiscal	–	Dhal Ghata, Sonadia	VHF/FM Radio Telephony	10.30–10.50	86.900	
	k) Monpura	–	Char Nizam, Shakuchia (Koralia)	VHF/FM Radio Telephony	11.10–11.30	86.875	
	l) Patherghata	–	Kakchar	VHF/FM Radio Telephony	11.50–12.10	86.900	
	m) Sandwip	–	Urir Char	VHF/FM Radio Telephony	11.50–11.10	86.875	
	n) Tajumuddin	–	Char Zahiruddin	VHF/FM Radio Telephony	11.10–11.30	86.900	
	o) Teknaf	–	Bahar Chara, St.Matin Island	VHF/FM Radio Telephony	11.30–10.50	86.850	

APPENDIX 7

MINISTRY OF RELIEF : CONTROL ROOM COMMUNICATIONS

MINISTRY OF RELIEF, CONTROL ROOM
Telecommunications Network
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**Leasd Telephone Network**				
	Dhaka – Brahman Baria, Chittagong, Comilla, Cox's Bazar, Feni, Gaibanda, Jessore, Kishoreganj, Magura, Mymensingh, Naogaon, Narail, Natore, Noakhali Patuakhali, Rangpur, Sylhet, Tangail.	Leased Tehephone Circuit	As required		
02.	**HF/SSB Voice Communication Network**				
	Dhaka – Bagerhat, Bandarban, Barguna, Barisal, Bhola, Bogra, Chandpur, Chittagong, Chuadanga, Cox's Bazar, Dinajpur, Faridpur, Feni, Gaibanda, Gazipur, Gopalganj, Habiganj, Jaipurhat, Jamalpur, Jhalakati, Jhenaidah,Khagrachari, Khulna, Kishoreganj, Kurigram, Kushtia, Lakshmipur Lalmanirhat, Madaripur, Manikganj, Meherpur, Maulvibazar,Munshiganj,Naogaon, Narail, Natore, Nawabganj, Netrakona, Nilphamari,Noakhali,Pabna, Panchagarh, Patuakhali, Perozpur, Rajbari, Rajshahi, Rangamati, Satkhira, Shariatpur, Sherpur, Serajganj, Sunamganj, Sylhet, Thakurgaon.	HF/SSB Radio Telephony	10.30–12.30 15.30–17.30	7400, 3900 kHz	

APPENDIX 8

FIRE SERVICE AND CIVIL DEFENCE COMMUNICATIONS

APPENDIX 8

FIRE SERVICE & CIVIL DEFENCE, DHAKA

Telecommunications Facilities
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communications Network**				
	Dhaka – Bhola, Chittagong, Cox's Bazar, Khulna, Maizdi, Patuakhali, Rajshahi.	HF/SSB Radio Telephony	10.00, 14.00 16.00, 20.00	3570, 4530 7350, 9905 kHz	
02.	**VHF/FM Mobile Voice Communication Network**				
a)	Dhaka Hqs – o 12 Fire Statins in Dhaka City, o 3 Fire Stations at Narayanganj, o 1 Fire Station at Demra, o 1 Fire Station at Tongi, o All fire vehicles	VHF/FM Radio Telephony	24 Hrs	81.0,81.1 MHz	
b)	Chittagong – o 9 Fire Stations at Chitagong City, o All fire vehicles	VHF/FM Radio Telephony	24 Hrs	81.0,81.1 MHz	
c)	Khulna – o 5 Fire Stations at Khulna City o All fire vehicles	VHF/FM Radio Telephony	24 Hrs	81.0,81.1 MHz	
d)	Rajshahi – o 2 Fire Stations at Rajshahi City o All fire vehicles	VHF/FM Radio Telephony			

APPENDIX 9

BANGLADESH POLICE TELECOMMUNICATIONS NETWORK

BANGLADESH POLICE
Police Telecommunications Network
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Remarks
01.	**HF/SSB Voice Communication Network**			
	a) Dhaka Hqs – 64 District Hqs	HF/SSB Radio Telephony	24 Hrs	
	b) Battalion Hqs – 9 Battalions Uttara, Dhaka	HF/SSB Radio Telephony	24 Hrs	
02.	**VHF/FM Voice Communication Network**			
	a) Dhaka – 64 District Hqs	VHF/FM Radio Telephony	24 Hrs	Operating through repeater stations
	b) 64 District Hq – 512 Police Station	VHF/FM Radio Telephony	24 Hrs	
	c) Selected Than – Selected Police Outposts	VHF/FM Radio Telephony	24 Hrs	
03.	**Leased Telecommunication Circuits**			
	a) Dhaka – 18 District Hqs	Leased Teleprinter Circuit	24 Hrs	
	b) Dhaka – Paris	Leased Teleprinter Circuit	24 Hrs	Communications wit Interpol, Paris
	c) Dhaka – Tokyo	Teletext Service	24 Hrs	International Police Informations.

APPENDIX 10

BANGLADESH RAILWAYS TELECOMMUNICATIONS NETWORK

APPENDIX 10

BANGLADESH RAILWAYS, KAMALAPUR, DHAKA
Telecommunications Network
(June 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communication Network**				
	Dhaka – Akhaura, Chittagong, Lalmanirhat, Mymensigh, Paksey, Railway Ministry, Rajshahi, Sylhet.	HF/SSB Radio Telephony	24 Hrs	2775, 4065 7600, 8120 kHz	
02.	**Leased Voice Circuit**				
	Dhaka – Chittagong, Lalmanirhat, Paksey, Rajshahi.	Leased Telephone Circuit	24 Hrs		
03.	**GENTEX Communications Network (Partial)**				
	Dhaka – Chittagong, Lalmanirhat, Paksey, Rajshahi	GENTEX Telecom Network	24 Hrs		
04.	**Digital Telephone Network**				
	Dhaka – All Railway Stations in Bangladesh	Private Fibre Optic Cable Network	24 Hrs		Fully Operational

APPENDIX 11

BANGLADESH NAVY TELECOMMUNICATIONS NETWORK

APPENDIX 11

BANGLADESH NAVY
Telecommunications Network
(September 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Remarks
01.	**HF Radio Teletypewriter Circuits**			
	a) Dhaka – Chittagong	Radio Teletypewriter	24 Hrs	Also operated on Morse Code
	b) Dhaka – Khulna	Radio Teletypewriter	24 Hrs	Also operated on Morse Code
02.	**Leased Teleprinter Circuits**			
	a) Dhaka – Chittagong	Leased Teleprinter Circuit	24 Hrs	
	b) Dhaka – Khulna	Leased Teleprinter Circuit	24 Hrs	
03.	**Leased Telephone Circuits**			
	a) Dhaka – Chittagong	Leased Telephone Circuit	24 Hrs	
	b) Dhaka – Khulna	Leased Telephone Circuit	24 Hrs	
04.	**Facsimile Service**			
	Dhaka, Chittagong, Khulna	Facsimile	24 Hrs	Operated on Public Telephone Lines

APPENDIX 12

BANGLADESH AIR FORCE TELECOMMUNICATIONS NETWORK

APPENDIX 12

BANGLADESH AIR FORCE
Telecommunications Network
(September 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Remarks
01.	**HF Radio Teletypewritr Circuits**			
	a) Dhaka – Chittagong	Radio Telephony	Operating Hours	Also operated on Morse Code
	b) Dhaka – Jessore	Radio Telephony	Operating Hours	Also operated on Morse Code
	c) Dhaka – Cox's Bazar	Radio Telephoney	Operating Hours	Also operated on Morse Code
02.	**Leased Voice Circuits**			
	a) Dhaka – Chittagong	Leased Telephone	24 Hrs	
	b) Dhaka – Jessore	Leased Telephone	24 Hrs	
03.	**Leased Teleprinter Circuits**			
	a) Dhaka – Chittagong	Leased Teleprinter	24 Hrs	
	b) Dhaka – Jessore	Leased Teleprinter	24 Hrs	

APPENDIX 13

BANGLADESH ARMY TELECOMMUNICATIONS NETWORK

APPENDIX 13

BANGLADESH ARMY
Telecommunications Network
(September 1992)

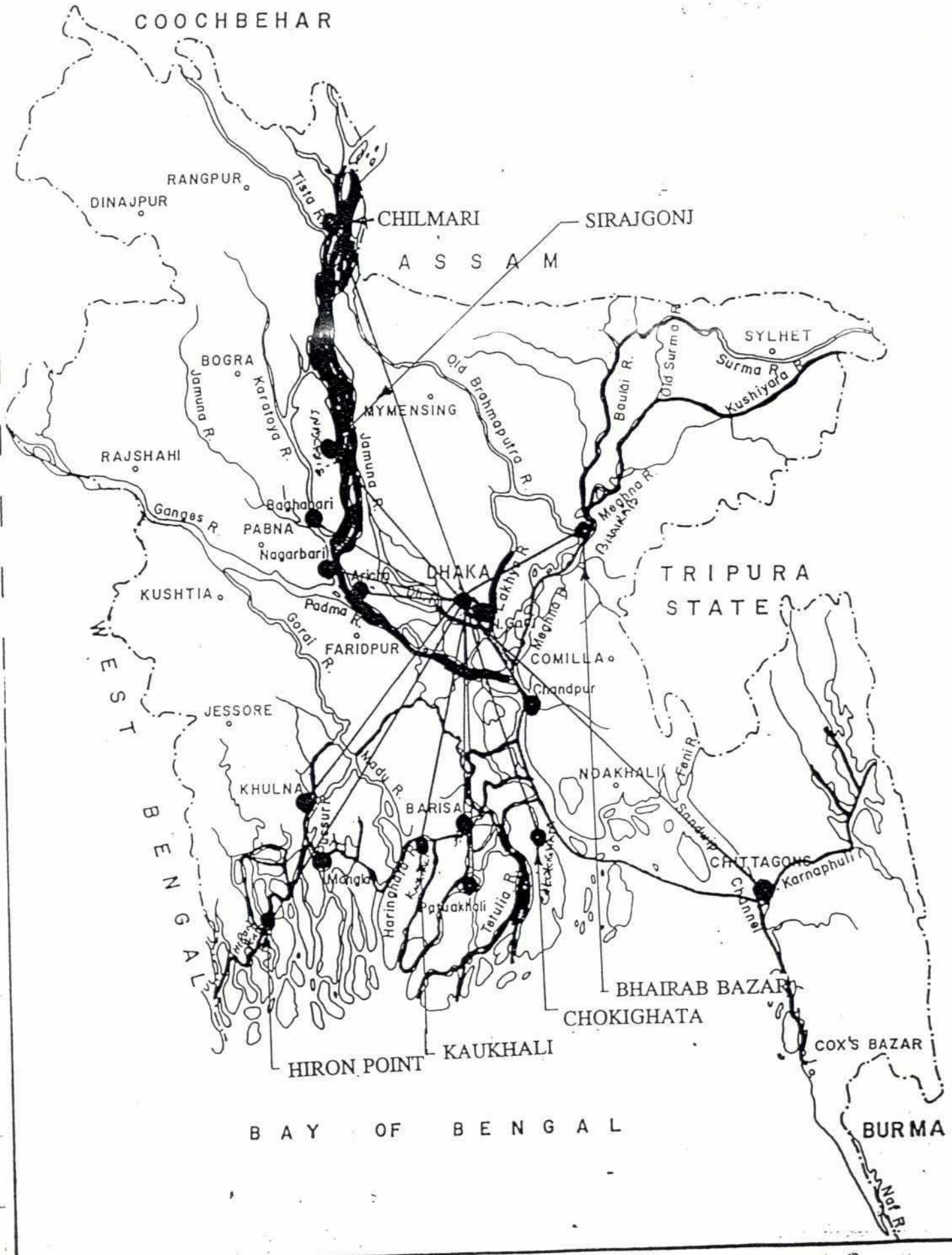
Sl. No.	Network Details	Mode of Operation	Hours of Operation	Remarks
01.	**Leased Telephone Network**			
	a) Army Hqs – All Divisional Hqs	Leased Telephony	24 Hrs	
	b) All Divn.Hqs – Army Units	Leased Telephony	24 Hrs	
02.	**Leased Teleprinter Network**			
	a) Army Hqs – All Divisional Hqs	Leased Teleprinter	24 Hrs	
	b) Ctg.Divn.Hqs – Army Units	Leased Teleprinter	24 Hrs	
03.	**HF/SSB Radio-Telephone Network**			
	Anywhere in Bangladesh wherever necessary	HF/SSB Radio Telephony	As required	For field operations

APPENDIX 14

BANGLADESH INLAND WATER TRANSPORT AUTHORITY (BIWTA) TELECOMMUNICATIONS NETWORK

BANGLADESH

IWTA Telecommunication Network



APPENDIX 14

BANGLADESH INLAND WATER TRANSPORT AUTHORITY (BIWTA)
Telecommunications Network
(October 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communication Network**				
	Dhaka – Aricha, Barisal, Bhairab Bazar, Chandpur, Chilmari, Chittagong, Chokighata, Dredger Base (Narayanganj) Kakulia, Khulna, Nagrarbari, Narayanganj, Sheikh Baria, Sirajganj.	HF/SSB	0800 – 0930 1230 – 1200 1300 – 1430 1600 – 1630 1900 – 1930	2153, 2182, 4576, 4824 6479, 8327 kHz	
02.	**HF/SSB Mobile Voice Communication Network**				
	Dredger Base, Narayanganj – IWTA Agra Bahak, IWTA Agra Jat, IWTA Agra Pathik, IWTA Agrani, IWTA Dishari, IWTA Dredger 135, IWTA Dredger 136, IWTA Dredger 137, IWTA Dredger 138, IWTA Dredger 139, IWTA Hamza, IWTA Investigation, IWTA Path Finder, IWTA Rustom, IWTA Sandhani, IWTA Teesta, IWTA Titas, IWTA Turag,	HF/SSB	As required	2153, 2182 4576, 4824 6479, 8327 kHz	

APPENDIX 15

BANGLADESH INLAND WATER TRANSPORT CORPORATION (BIWTC) TELECOMMUNICATIONS NETWORK

BANGLADESH INLAND WATER TRANSPORT CORPORATION (BIWTC)
Telecommunications Network
(October 1992)

Sl. No.	Network Details	Mode of Operation	Hours of Operation	Frequencies (kHz)	Remarks
01.	**HF/SSB Voice Communication Network**				
	Dhaka – Aricha, Barisal, Chandpur, Chittagong, Huller Hat, Khulna, Mongla, Morolganj, Narayanganj, Narayanganj Dockyard, Patti, Sandwip, Sirajganj.	HF/SSB Radio Telephony	24 hrs	2125, 2189, 4824, 5940 6204, 6245 8670 kHz	
02.	**HF/SSB Mobile Voice Communication Network**				
	a) Dhaka – Aricha Ferry, Bhuapur Ferry, Daulatdia Ferry, Mawa Ferry, Nagarbari Ferry, Shirajganj Ferry	HF/SSB Radio Telephony	24 hrs	2125, 2189, 4824, 5940, 6204, 6245 8670, kHz	
	b) Dhaka – 60 River going vessels of IWTC	HF/SSB Radio Telephony	24 hrs	2125, 2189, 4824, 5940, 6204, 6245 8670, kHz	

APPENDIX 16

BANGLADESH RIFLES TELECOMMUNICATIONS NETWORK

APPENDIX 16

BANGLADESH RIFLES
Telecommunications Network
(October 1992)

Sl. No.	Network Details			Mode of Operation	Hours of Operation	Remarks
01.	**HF/SSB Voice Communication Network**					
	a) Dhaka	–	Chittagong, Comilla, Dinajpur, Khagrachari, Khulna, Kushtia, Mymensingh, Rajshahi, Rangamati, Rangpur, Sylhet Sector Hqs.	HF/SSB Radio Telephony	24 hrs	
	b) Dhaka	–	All Battalion Hqs	HF/SSB Radio Telephony	24 hrs	
02.	**VHF/FM Radiotelephone Network**					
	a) Sector Hqs	–	Battalion Hqs	VHF/FM Radio Telephony	24 hrs	
	b) Battalion Hqs	–	Border Outposts	VHF/FM Radio Telephony	24 hrs	
	c) Cox's Bazar	–	Moheshkhali Sapurer Dwip, St. Martin Island, Teknaf	VHF/FM Radio Telephony	24 hrs	
03.	**Leased Telephone Circuits**					
	Dhaka	–	Chittagong, Dinajpur, Khagrachari, Khulna, Kushtia, Mymensingh, Rajshahi, Rangamati, Rangpur, Sylhet Sector Hqs. & Training Centre.	Leased Telephone	24 hrs	
04.	**Facsimile Network**					
	Dhaka	–	Chittagong, Comilla, Dinajpur, Khagrachari, Khulna, Kushtia, Mymensingh, Rajshahi, Rangamati, Rangpur, Sylhet.	Facsimile	24 hrs	Operation satisfactory only when telephone lines are noise free

APPENDIX 17

TECHNICAL SPECIFICATIONS

APPENDIX 17

DIGITAL PABX/INTERCOM SYSTEM
Technical Specifications

Sl. No.	Description	Qty.	Estimated Price US$
01.	Digital PABX 4+30, equipped for 4 T&T lines and 30 extension lines, expandable to 8–T&T lines and upto 72 extension lines, fully electronic, digital swithcing, speed call,call forward,pick up,all page, privacy, class of service, toll service restrictions etc. complete with Operator's Console, mike/headset. Installation and commissioning.	1 set	5,500
02.	Telephone sets for operation sets for operation with item No.1 above and spare telephone set	33	3,300
03.	Installation at telephone subscribers premises for 30 positions, including cabling etc.	--	1,500
		Sub–Total US $:	**10,300**
		Estimated Air Freight US $:	1,700
		Total US $:	**12,000**

Source :

i. Gulf Bangladesh Associates, RAJUK Annex Building, Dilkusha Commercial Area, Dhaka–1000

ii. Any other supplier

APPENDIX 17

HF/SSB COMMUNICATIONS TRANSCEIVERS AND ACCESSORIES

Technical Specifications for Items No. (ii) and (iv)

Sl/No.	Description of Items	Qty	Estimated Price US$
1.	HF/SSB Transceivers	14	56,000

Freq range : 2-16 MHz, continuous coverage, in steps of 100 kHz

No. of Channels : 4 (Four) Pre-programmed channels selectable from front panel selector switch

Operating Frequencies : Programmable through internal adjustments in the equipment Operating freq will be notified later,

Mode of Operating : A3J/USB, Press-to-talk, Simplex.

Antenna Impedance : 50 Ohms

Operating Environment : -30°C to +50°

Relative Humidity : 95%

Power Supply : 220 v AC 50 Hz, 12 VDC negative ground

Accessories : Microphone, built-in loudspeaker, wideband antennas, cables & connectors and technical manual in English

Transmitter

Power Output : 100 watts PEP

Antenna Mismatch : Protected against antenna mismatch

Carrier Suppression : -63 dB at 1000 Hz

Audio Input : 150 Ohms

Metering : Relative RF output, VSWR

Antenna Tuners : As required

Receivers

Sensitivity : 0.3 μV for 10 dB S+N/N

Selectivity : 300-2700 Hz at -6 dB

Image Rejection : Better than 80 dB

Intermodulation : 85 dB

Audio Output : 2 watts nominal

Metering : DC supply voltages

HF Antennas

Wideband Dipole HF antenna, 50 Ohms complete with baluns, co-axial cables (30 M each) Connectors etc.

2.	Spares for item No. 1 sufficient for 3 years consumption	1-lot	7,000
	Total:		63,000
	Estimated Air Freight:		6,000
	Grant Total:		US$ 69,000

APPENDIX 18

ALLOCATION OF RADIO FREQUENCIES TO MINISTRY OF RELIEF

APPENDIX 18

MINISTRY OF COMMUNICATION
T&T DIVISION

Ref. No.T&T/1P-2/76 Dated, Dacca the 16th July, 1976.

Mr. Rasheed Ahmed
Joint Secretary
Ministry of Relief & Rehabilitation
Dacca.

Sub:- **Allocation of frequencies for Wireless sets of your Ministry.**

Ref: Your D.O. letter No.RCR-28/76/4551 dt.10.7.76 addressed to the Additional Secretary of this Division.

We have gone through the above and it appears that you actually are asking for allocation of four frequencies in each of the three specific bands mentioned in your letter. Accordingly, in consultation with the Bangladesh Wireless Board, we are listing below the available frequencies.

Band		Frequencies	
A.	3-5 MHz	i) 3.180	MHz
		ii) 3.349	,,
		iii) 4.571	,,
		iv) 4.833	,,
B.	5-7 MHz	i) 5.247	MHz
		ii) 5.379	,,
		iii) 6.806	,,
		iv) 6.942	,,
C.	8-12 MHz	i) 8.128	MHz
		ii) 9.118	,,
		iii) 10.118	,,
		iv) 11.521	,,

2. In the meantime we would request you to please arrange to complete the necessary formalities in the matter as required by Bangladesh Wireless Board.

Sd/
(Manzur Murshed)
Director (T&T)
Tele: 257532.

No. T&T/1P-2/76 Dated, Dacca the 16th July, 1976

Copy for information to Mr. Mohammed Abdul Aziz, Divisional Engineer, frequencies Wireless Board, Telephone Exchange Building, Sher-e-Bangla Nagar, Dacca. As Telephonically discussed with him, he is requested to note down the frequencies shown above and assume the same to be temporarily allocated to the Ministry of Relief and Rehabilitation, pending completion of other necessary formalities.

Sd/
(Manzur Murshed)
Director (T&T)

APPENDIX 19

LIST OF OFFICIALS CONTACTED

Assistance to Ministry of Relief
Co-ordination of Cyclone Rehabilitation
(BGD/91/021)

List of Officials Contacted

Date 1992	Name of Organisation Visited	Officials Contacted
May 26	Multipurpose Cyclone Shelter Programme Dhaka	Dr. J.R. Choudhury Team Leader
May 27	World Bank, Dhaka	Dr. Reazul Karim Programme Officer (Industry)
May 28	Meteorological Department Dhaka	Mir Fakrul Quayum Deputy Director Ashraf Ali Howlader Senior Communication Engineer
May 28	Space Research & Remote Sensing Organisation (SPARRSO) Dhaka	Dr. A.M.Choudhury Director
May 30	Civil Aviation Authority Dhaka	Majibor Rahman Deputy Director Nurul Amin Senior Communication Officer
May 30	Meteorological Office Dhaka Int '1 Airport	Shah Mohammad Noor Assistant Director
May 31	Ministry of Relief, Secretariat Building Dhaka	A.Z.M. Hossain Khan Joint Secretary
May 31	Relief Control Room, Secretariat Bldg. Dhaka	Daliluddin Duty Officer
June 01	Flood Forecasting & Warning Project WAPDA Building, Dhaka	James Dent Advisor WMO Sharifuddin Ahmed Assistant Director
June 02	Fire Service & Civil Defence Dhaka	Brig.(Rtd) Nurul Islam Laskar Director General
June 02	T&T Board, Dhaka	Abdus Salim, Chairman
June 02	Red Crescent Society, Dhaka	Emdad Hossain, Director
June 03	Cyclone Preparedness Programme Bangladesh Red Crescent Society	Emdad Hossain Director
June 04	Gulf Bangladesh Associates	Md. Rafique Uddin Engineer-in-Charge
June 04	Bangladesh Amateur Radio League	Saif D. Shahid President, BARL
June 04	Civil Aviation Authority	Wali Ahmed Deputy Director Communications
June 06	General Electric Company, Bangladesh	A.R.Mamun Assistant Manager
June 06	Multipurpose Cyclone Shelter Programme	Prof. Saiful Islam BUET Dr. Mohiuddin Ahmed Associate Professor, BUET
June 06	T&T Board	A.M. Mohiuddin Ahmed, Director Planning & Development
June 07	Inspector General of Police	Azizul Huq. Additional Inspector General of Police

Date 1992	Name of Organisation Visited	Officials Contacted
June 07	T&T Board, Dhaka	Fazlur Rahman Director International (T&T) Mohamad Ismail Divisional Engineer (T&T)
June 14	Bangladesh Amateur Radio League	Saif D. Shahid President, BARL
June 15	Fire Service & Civil Defence Dhaka	Major (Rtd) F.M. Kaikobad Director Operations & Maintenance Mohiuddin Ahmed Assistant Communication Engineer
June 15	National Meteorological Communication Centre	Mortaza Bhuiyan Senior Communication Engineer
June 16	Bangladesh Police Telecommunication Head Quarters, Dhaka	Mohammad Sanaul Huq Asstt. Inspector General (Telecom) Abdur Rouf Asstt.Superintendent of Police A.K.M. Enamul Huq Asstt. Superintendent of Police
June 17	Cyclone Relief Project	Informal Workshop on Cyclone Relief
June 23	Gulf Bangladesh Associates	Md. Rafique Uddin Engineer-in Charge
June 23	T&T Board Dhaka	Golam Mowla General Manager Planning A.M.Mohiuddin Ahmed Director Planning & Development
June 24	Cyclone Relief Project	Info. Exchange on Cyclone Relief
June 25	Central Telegraph Office, T&T Board, Dhaka	Abdul Mannan Miah Director Telegraph Mohammad Hossain Shift Superintendent, CTO
June 28	Relief Control Room Secretariat Building, Dhaka	Kazi Badruddoza Officer-in-Charge, Control Room
July 01	Cyclone Preparedness Programme Bangladesh Red Crescent Society	Emdad Hossain Director George Seppala Development Delegate International Federation of Red Cross
July 01	Bangladesh Railways Dhaka	Syed Lutfar Rahman Divisional Signals & Telecom.Engineer Adbul Jabbar Pathan Divisional Signals & Telecom.Engineer
July 06	Deputy Commissioner's Office Cox's Bazar	Haradhan Sil Dist Relief & Rehabilitation Officer Biplob Biswas Radio Operator
July 06	Police Station Cox's Bazar	Dinebandhu Paul Officer-in-charge Police Telecom
July 07	Cyclone Preparedness Programme Moheshkhal	Tajul Islam Development Officer
July 07	Police Station Moheshkhal	Mohammad Sirajdoula Officer-in-Charge
July 07	Civil Aviation Authority Cox's Bazar	Mohammad Abul Kashem Airport Manager
July 07	Fire Service & Civil Defence Cox's Bazar	Kazi Taibur Rahman Station Officer
July 08	Cyclone Preparedness Programme Khurushkul	Hafez Ahmed Union Team Leader Majibul Haq Choudhury Wireless Operator

Date 1992		Name of Organisation Visited	Officials Contacted
July	08	Cyclone Preparedness Programme Cox's Bazar	Abul Kashem Sarkar Zonal Officer, CPP
July	08	Deputy Commissioner's Office Cox's Bazar	Haradhan Sil District Relief & Rehabilitation Officer
July	09	Meteorological Office Cox's Bazar	Mohammad Manzurul Huq Khan Meteorologist Saiful Islam Khan Asstt Meteorologist
July	15	T&T Board Dhaka	Mohammad Ismail Divisional Engineer
Sept	07	Power Development Board, Dhaka	Iskander Azam Director, Programme
Sept	08	T&T Board, Dhaka	Mohammad Ismail Divisional Engineer
Sept	13	Bangladesh Police Telecommunications Headquarters, Dhaka	Mohammad Sanaul Haq Asstt. Inspector General (Telecom)
Sept	17	Ministry of Relief Bangladesh Secretariat, Dhaka	A.Z.M. Hossain Khan Joint Secretary Abul Kalam Azad Executive Engineer Monirul Haq Asstt. Engineer Ali Akbar Bhuiyan Officer-in-Charge, Control Room
Sept	19	Inspector General of Police	Khitish Chandra Mollick Asstt.Inspector General (Eqpt)
Sept	22	Naval Headquarter, Banani, Dhaka	Lt. M.Belayet Hossain Staff Officer, Signals
Sept	26	Air Headquarters, BAF, Dhaka	Grp.Capt.Mahboob Director of Signals Wing Comd. Khalilur Rahman Wing Comd. Mohammed Ishaq
Sept	27	Army Headquarters, Dhaka	Brig. Khalid A Karim Director of Signals Brig. Ibrahim Director of Operations
Oct	05	Bangladesh Inland Water Transport Authority (BIWTA)	M. Shamser Ali Senior Director Hafizur Rahman Deputy Director (Echosounder) Mortaza Kabir Ahmed Asstt. Director (Telecom)
Oct	07	Bangladesh Inland Water Transport Corporation (BIWTC)	Towfiq Ahmed Rahman Chief Marine Construction A K M Rashid Asstt Manager Commercial
Oct	20	Bangladesh Rifles Dhaka	Col. Kazi Haider Ali Director Communications Col. M Shamsujahan Choudhury Director Operations Lt.Col. Yunus Khan Sector Commander Signal Lt. Col. Nazmul Huq General Staff Officer, Grade-I Major Nisar Sector Second in Command

APPENDIX 20

IDNDR NEWSLETTER Nr 10
VULNERABILITY OF COMMUNICATION SYSTEMS DURING DISASTERS

Strategies to Reduce the Vulnerability of Communication Systems During Disasters

Guest Editorial by
Väinö O. Kelhä & Veli Santomaa
Technical Research Centre of Finland

Natural disasters have killed millions of people over the past twenty years alone and caused massive financial ($800 billion) and other damage to people, property and environment. Such disasters will continue to occur around the globe, with particularly devastating consequences in the developing countries. The Conference on Disaster Communications held at Tampere, Finland in May 1991 (see column), declared that there is an urgent need to improve international co-operation in communications and enhance national communications capabilities in order to reduce loss of life, damage to property and livelihood. and damage to the environment caused by disasters.

A disaster may damage cables, radio links or exchanges of the public communication network as well as other technical installations and equipment. Besides being out of order, the switched public network may suffer from excessive congestion in catastrophe situations. This risk can be avoided using separate leased lines. Besides being very expensive, a potential cable fault may block these separate lines as well as the adjoining dial-up lines. A conclusion therefore is that connections based on terrestrial networks are not always suitable for data communication of a disaster management system. When a disaster strikes. there is an urgency to establish effective and comprehensive communication links at the disaster site, between the site and the national systems dealing with disaster response, and with the concerned international community.

Therefore new strategies should be sought to reduce the vulnerability of communication systems during disasters. Terrestrial mobile and satellite communications, including established international satellite networks and remote-sensing technologies, will play a major role in reducing the devastating effects of disasters by dramatically improving hazard identification and risk assessment, disaster preparedness, monitoring. early warning and relief operations. The mobile networks cover only a few vulnerable conditions in terms of potential damage i.e. measuring points of mobile telemetric data, base stations. mobile exchanges and the respective cabling or radio links. To avoid these shortcomings of the public mobile networks, private mobile networks for example. based on digital trunking technology is to be recommended. In addition. separate mobile connections for collection and distribution of environmental data, can be set up by using radio modems and satellite links. The collected data is used to improve preparedness against disaster. The mobile measuring stations offer much more freedom in choosing the locations compared with links based on the wired network.

Satellite connections are a good choice for trunk connections between a central or a regional location and the field stations. Satellite techniques themselves also provide many ways to reduce the vulnerability of communication systems:

- they can be utilized not only in daily operational use but also in prediction. monitoring and early warning;

INDICATIONS FOR AN INTERNATIONAL CONVENTION ON DISASTER COMMUNICATION

22 May 1991, Tampere, Finland

(extract from...)

Present limitations to disaster communications include:

(a) Organizational barriers which impede the flow of information among the various elements of the international disaster response network.

(b) Uncertainty over the availability and location of communications equipment which could be made accessible for disaster use.

(c) Regulatory barriers which slow down the importation and operation of communications equipment.

(d) High costs which inhibit the effective use of communications equipment during disasters.

In order to overcome these barriers a Convention on Disaster Communications should, at a minimum:

(a) Establish an effective framework for co-operation between and among State parties, intergovernmental and regional groupings and entities, and non-governmental bodies, including international terrestrial and satellite telecommunications operating organizations and relevant commercial sector organizations.

(b) Further improve the co-ordination of international disaster management.

(c) Ensure the utilization to the maximum extent of existing global, regional and national terrestrial and satellite communications networks; encourage the immediate availability at national, regional and international centres

of communications equipment; and encourage the development of the amateur radio services and their application to disaster communications.

(d) Encourage national authorities to establish an inventory and/or data base of their own communications equipment and resources relevant to disaster relief, national regulations to ensure access to them, and an appropriate national preparedness plan for their effective use.

(e) Encourage UNDRO, within the framework of the International Decade for Natural Disaster Reduction, to maintain an international inventory of communications equipment and resources and to invite national governments, intergovernmental organizations, non-governmental organizations and other relevant entities to make their own communications equipment and resources information available.

(f) Encourage improved and enhanced national and international training programmes to develop the necessary expertise in the rapidly-evolving field of disaster communications, and the further consideration of the communications issue in disaster management training programmes.

(g) Facilitate the rapid dissemination and effective use of communications equipment and resources by limiting, reducing and, where possible, removing, regulatory barriers including:

- Customs clearance procedures and duties
- Restrictions on possession and use
- Inappropriate restrictions on the dissemination of existing and new technical information
- The need for type-approval procedures and operating licences, including simplification
- National rules concerning the temporary assignment of appropriate radio frequencies.

(h) Establish appropriate further rules relating to matters such as:

- Entry, exit and transit for personnel, equipment and property
- Direction and control of assistance
- Confidentiality of information

- they provide an effective way to increase the redundancy of existing communication networks;
- satellite links can quickly replace the damaged connections in the disaster area, and they can even play an important role in distress and emergency communications.

If the data is to be collected over a large geographical area, the satellite systems remote sensing and communications are superior to terrestrial means, which are often not available.

An automatic satellite system based on a measurement platform can be a compact and low-cost terminal powered by a solar panel or a wind generator. The measured environmental data is transmitted via satellite to the central station, where it is received, processed and archived into a database. For this kind of low-rate data collection there are many systems available e.g.ARGOS. METEOSAT DCS, Inmarsat C, and PRODAT (ESA). The key feature in all these systems is that the terminal is reliable and is able to transmit low-rate data to the central station according to the planned time schedule or instantly in case of alert. The processed data can be further disseminated to the authorities of the at-risk communities if there is damage to the terrestrial networks by using Very Small Aperture Terminal-VSAT- satellite communication systems.

Reduction of vulnerability of existing networks can also be made by means of redundancy. Satellite networks can serve as efficient back-up links for the terrestrial networks. For this task many global, regional and national satellite communication systems are available. In order to reduce the risk the common parts of the networks should be minimized. The connection point may locate on different hierarchy levels of the networks. When VSAT-networks are utilized the satellite terminal can be installed even on the premises of an end-user. The satellite networks are less vulnerable due to the fact that there are less critical points in the system if for example the disaster has violated the earth terminal itself and caused a breakdown of communication. In the planning of a new communication network the redundancy dimensioning should take into account the possibility of natural or man-made disasters. A vulnerability assessment should be a standard procedure and reassessment should be carried out for the existing networks to identify the possible need for redundancy improvements.

Satellite communications are of great assistance in post-disaster relief operations. Satellite links provide a rapid and flexible way to first facilitate emergency communications and then to replace the damaged links. In emergency, portable terminals such as Inmarsat A and C, and Intelsat services are available. Inmarsat E-service can also be extended for land applications. Accurate positioning is also essential in disaster areas. In this task the Global Positioning System (GPS) is invaluable.

Unfortunately, these above mentioned facilities are not universally accessible, particularly in developing countries where such disasters most frequently occur. Far from respecting political boundaries, remote sensing and satellite communications are used to gather and distribute information most frequently on a regional scale and more often on a global scale in order to assist in the protection of the environment or to avoid natural disasters. Nevertheless, the collected data can be used not only for disasters but also for commercial or military purposes. This fact lends a strong incentive to international co-operation. On the other hand it raises questions as to whether the sensing entity's freedoms are unlimited, most particularly in regard to the interests of States whose territories are "sensed". The UN has adopted in 1986 a resolution "Principles relating to Remote Sensing", according to which the "sensed" State shall have

access to raw and processed data concerning the territory under its jurisdiction on a non-discriminatory basis and on reasonable cost terms, once the data is produced. The needs and interests of the developing countries shall be taken into particular account. Special obligations are further imposed on States having high technology and sensing capabilities where information would assist to avoid natural disasters.

International collaboration between space agencies (e.g. NASA, Russian Space Agency, ESA, NASDA) and communication organizations (e.g. Intelsat, Inmarsat) is far from satisfactory from the point of view of natural disasters. Our common target in IDNDR should be to improve this collaboration. When member states of the UN are able to collaborate in UN peacekeeping efforts, it should be possible for this same cooperation with communication systems during natural disasters, thus creating a firm basis for the strategies to reduce the vulnerability of communication systems.

- Privileges, immunities and facilities
- Claims and compensation.

(i) Establish the basis for an appropriate tariff structure for domestic and international communications carriers, including waiver of charges where appropriate, and the necessary philosophy and approach to payment for communications services required in disaster relief efforts.

Reducing the Vulnerability of Communications Systems when Disaster Strikes

by Lawrence K. Grossman

Hurricane Andrew, which smashed into Florida and Louisiana in the southeast United States last August, has been called the most destructive storm in the nation's history. Despite Andrew's ferocity, with winds that hit over 160 miles per hour, and the enormity of its devastation of land and property, surprisingly few lives were lost and physical injuries suffered. By comparison with similar natural disasters of earlier times, the fact that so few perished is nothing short of a miracle. In 1900, for example, the hurricane that hit Galveston, Texas, killed more than 6,000 people and injured at least 6,000 more, even though its wind velocity never exceeded 120 miles per hour.

In recent years, in the United States at least, such miracles have been the rule rather than the exception. In 1989, Hurricane Hugo, which struck the Carolinas, and the Loma Prieta earthquake in the San Francisco area, and in 1980, the Mt. St. Helens volcano eruption in Washington, caused fewer than 100 deaths among them.

The reduced human toll from hurricanes and volcanic eruptions in the U.S. has been due in large part to timely warning systems that enable experts to predict where and when disasters will hit. The ability to forecast nature's ravages accurately, however, is of little use without the capacity to communicate the information instantaneously to people in the endangered areas so they can evacuate, protect themselves, or take other appropriate measures before a storm hits or a volcano erupts.

In the United States and other highly developed countries,telephone, television and radio reach into every nook and cranny of the land, covering virtually 100 percent of the population. But even here, serious vulnerabilities remain in our communications systems. Often, the more sophisticated they are, the more likely our communications systems are to fail during storms, floods, or other severe natural eruptions. Take the simple telephone, which once operated independently of electric power lines. Today's telephones come equipped with increasing numbers of bells and whistles, features that enable them to transmit faxes and data, automatically record and deliver messages, amplify sound, conduct conference calls and operate without wire cords. All these require telephones to be plugged into electrical outlets in order to work. As a result, whenever the electricity fails, much of the phone system fails to function as well.

Similarly, cable television, which is transmitted by landlines, is more vulnerable in a storm than old-fashioned over-the -air broadcasting. And over-the-air television is more vulnerable than radio. So, as people increasingly rely on television rather than radio whenever a crisis hits, they run the risk of losing their main electronic communications link to the outside world should a natural disaster strike their area. Simple portable transistor radios with spare batteries should be standard equipment in every home and workplace for use during emergencies.

New Opportunities

With today's satellite communications technology, inexpensive and effective methods exist to equip even the most remote homes and villages in disaster-prone areas with dependable instant alerts so that all residents can receive essential warnings at any time of the day or night. If disaster should strike suddenly, especially in the middle of the night when most people are asleep and radios and television sets are turned off, such passive systems can serve to awaken them to imminent danger. In addition, the increasing use of cellular phones proved enormously useful during Hurricane Andrew, both before and after the storm. They are communications assets to be encouraged in disaster prone areas.

Interpreting an earthquake's Richter scale, a volcano's potential for eruption, or a hurricane's intensity now requires knowledge of complicated scientific terminology that few can understand or quickly grasp. To improve the effectiveness of disaster warnings, a set of standard international graphic symbols and codes should be developed and promoted, comparable to today's universal traffic signs. No matter what the country or the language, everyone can recognize the standard "Stop" signs by their universal shape and colour. Similarly, easy-to-understand pictographs and codes could instantly identify the nature of pending disasters, their degrees of danger, the time they are expected to strike, and what action should be taken.

Finally, more attention must be paid to what is likely to happen to communication systems in vulnerable areas after disaster strikes. Local emergency management officials, working with representatives of local media and the communications industry, should establish in advance a set of priorities to restore radio stations, television stations and newspapers. Media that increasingly depend on word processors, computers and modems rather than on manual typewriters, voice telephones and old fashioned legwork by reporters on the street, may find themselves increasingly handicapped when the electricity goes out, as it usually does at times of severe storms or floods.

Before the next disaster hits, a system should be put in place to provide the media with timely and reliable information during the duration of a crisis so that the general public can quickly be told what roads are open, what shelter is available, what medical care can be obtained, where food and potable water can be found, what is the extent of damage in the area, what forms of transportation are accessible, and what community services will be restored, when.

None of this is terribly complicated, sophisticated or costly to prepare. But some elemental emergency planning for essential communications services before, during and after the "Big One" strikes can do much to avoid panic, minimize confusion, overcome despair, provide help and reassurance, and speed the recovery process. If people know they can count on accurate dependable and timely information in a crisis, they will cope with even the worst emergency far better than if they are left frightened, ignorant and feeling alone and helpless in the dark.

Lawrence Grossman, former President of the NBC News can be contacted c/o RLL, National Research Council, Board on Natural Disasters, 2101 Constitution Avenue, N.W.; HA 466 Washington DC 20418. Tel.: 1-202-334.1964; fax 1-202-334.3362.

STOP DISASTERS - mailing lists

Disks with multiple names and addresses for addition to the mailing lists may be sent to the IDNDR Secretariat. They should be saved in TEXT FORMAT.

These may include members of organisations and institutions and the lists of delegates to symposiums and conferences.

Our distribution lists continue to increase day by day. This is a most encouraging sign to the Osservatorio Vesuviano and the IDNDR Secretariat, indicating that the Newsletter is reaching a wider and wider audience.

As the No. 10 issue is about to be published we have arranged to increase the number of printed copies to 9000. These are distributed to 176 countries!

Communications: the International Amateur Radio Network - IARN

by Robert Bruce
DJOXC Region 1
Co-ordinator for IARN.

The International Radio Network (IARN) provides low-cost disaster mitigation through the use of existing communications resources to replace failed and saturated communications links. With only a reasonable amount of preparation ahead of a disaster, backup communication systems can be provided.

The use of Amateur Radio Operators, who have their own equipment and are licensed in most countries as volunteer communications assistants, has proved in the past to be a useful low-cost resource for establishing immediate post-disaster replacement for saturated or severed telephone and telex links.

During the first few days of a disaster, their unique ability to set up radio equipment and antennas is extremely valuable for establishing the only link with the outside world. They can quickly establish a network for transmitting life-saving messages to disaster-assistance organisations, reporting the extent of the disaster and the most urgent requirements.

If the Amateur Radio Operators are properly trained, prepared and equipped, links can be set up before storms arrive or in the case of earthquakes, quickly after the event. These include voice (SSB), written message (AMTOR/Sitor-B) links using low power 12 Volt 100 Watt transceivers and wire antennas.

We recommend that such SSB transceivers be installed ahead of time at a disaster command post with charged-up 12V/100 Amp Hour batteries so that a non-AC-mains operation can begin immediately the radio operator arrives. Also 2 meter transceivers capable of operating on a variety of 2M band frequencies should be installed at command centres and in mobile command posts beforehand.

In-Country communications (VHF) portable and mobile

From disaster command posts to: • hospitals, • emergency shelters. • ambulance and fire dispatchers. • red cross co-ordinators. • other agencies.

In-country communications using battery powered HF-SSB

From disaster command posts to: • Airport control towers in the disaster area for co-ordination. • Disaster agency control centres. • Government agencies. • disaster scene area.

Communications with the outside world by HF-SSB and HF-AMTOR links

• provide communications for authorized Red Cross/ Red Crescent workers to their base stations in Geneva, Germany etc. on Red Crescent frequencies. • exchange traffic on 14.275 MHz the International Amateur Radio Disaster Frequency to pass traffic to any agency as well as health + welfare tfc. • check in on 14.268 MHz United Nations New York amateur radio frequency for UN/UNDRO traffic.

Other AMTOR links can be set up on request and AMTOR mailboxes are presently set up and waiting on several frequencies including 14.075 MHz.

Such communications proved very valuable during the earthquakes in Armenia, Mexico City, Northern Iran, San Francisco, Eastern Turkey and during the hurricanes in Jamaica, St Croix, Puerto Rico, Miami and also during the recent events in Kurdistan and Sarajevo. This type of Amateur Radio Disaster communications is specifically authorized by ITU Regulation 640. However these back-up communications were missing in Bangladesh and Honduras during their flood/tsunami disasters and also in Georgia between the epicentre area and Tibilisi.

Get together with the Amateur Radio Clubs in your country and plan with them for a possible disaster so that you will be prepared. Without this proper preparation our experience has shown that delays of several days can occur and unreliable or incorrect information may be transmitted.

For more information and assistance contact IARN: Glenn Baxter, IARN Manager, Belgrade Lakes Me. 04918 USA. Tel: (207)495-2215 Fax. (207)495-2069

International Amateur Radio Network providing volunteer worldwide Amateur Radio Disaster Communications with 3,500 members in 60 countries. IARN works with UNDRO, German Red Cross, FEMA, American Red Cross and many other agencies.

IARN has "Jump-Teams" who can leave on short notice with their own radio equipment and antennas to assist with communications set-up and operation in disaster areas. When you get your system set-up, IARN will be glad to make a test of the HF-SSB system with you.

Communication systems during disasters in Japan

by Mitsutoshi Kikuchi
Deputy Director, Telecommunications Office, Disaster Prevention Bureau, National Land Agency, Government of Japan

Owing to its unfavourable meteorological and geographical conditions, Japan is subject to natural disasters caused by typhoons, earthquakes, heavy snowfalls, heavy rains and volcanic eruptions. For the purpose of saving lives and protecting property, and for guarding public health and safety from such disasters, the central government, local governments and public corporations have been taking various disaster prevention measures.

National Land Agency (NLA) is in charge of he overall co-ordination of the different disaster prevention measures, in cooperation with the designated administrative organs and public corporations.

TELECOMMUNICATION SYSTEMS

It is essential to ensure rapid and proper exchange of information among the organs/bodies concerned during disasters. So far, this has been the function of the telephone cable networks. However, natural disasters have often destroyed the telephone lines or, if this has not occurred, a disaster will create an overloading of the telephone lines beyond the capacity of the networks.

Thus, the organs/bodies concerned with disasters have developed disaster-proof telecommunication systems individually or jointly. Disaster Prevention Radio Communication System (DPRC) by NLA, Fire-defence Radio Communication Network by Fire-defence Agency, and Radio Communication Networks by local governments play major roles not only during disasters, but in preparedness stages before disasters. This enables the headquarters for disaster countermeasures to react quickly and smoothly at the time of disaster. A description of the DPRC is reviewed here.

- **DISASTER PREVENTION RADIO COMMUNICATION SYSTEM (DPRC)**

During disasters the DPRC system should provide hot-lines which connect the NLA headquarters with the disaster organisations, to implement urgent and necessary countermeasures for reducing damage. The system is also used for promoting preparedness against disaster by disseminating necessary information. The DPRC system consists of four systems:

a. Fixed Communication System

The administrative organs and public corporations designated by the Disaster Countermeasures Basic Acts are linked together with a radio wave transmission network. The network covers 53 Governmental organisations as well. It enables the headquarters to broadcast urgent information to all the organs/bodies at once. Communication is made mainly by telephones and facsimiles. The frequency bands of the radio waves allotted to the system are 40Ghz, 2Ghz, 12Ghz, and 400Mhz.

b. Mobile Communication System

Anybody with portable wireless telephones or transceivers can erect a mobile communication station. The telephone should be the duplex type. Each mobile station can communicate not only with a communication centre placed at NLA, but also with other stations through transmitters equipped at the centre. Any governmental survey missions in disaster-damaged areas should be transmitted equipped with the system. Whenever the fixed system breaks down, it is possible to switch to the mobile one. The frequency bands of 400Mhz and 150Mhz are allocated for transmission.

c. Satellite Communication System

As satellite orbiting is not affected by disasters and can be accessed from any site, the NLA has incorporated satellite communication into the DPRC system, using the Communication Satellite 3(CS-3). At present, 3 earth stations are installed and one transportable earth station is ready to be dispatched to any damaged site. Telephone contact, facsimiles and TV images can be so that direct communication is possible between the centre ant other organizations concerned. Whenever the fixed system is partially damaged during disaster, the satellite system will replace it. 20Ghz and 30Ghz radio waves are used for transmission.

d. Video Trasmission System

In order to provide the headquarters with live images of damaged areas during disasters, automobiles equipped with video-cameras and radio-wave transmitters are dispatched to these areas. The centre receives the images and transmits them to the headquarters. They will help to simplify decision making for prompt and appropriate implementation measures. 15Ghz radio wave is used for transmission.

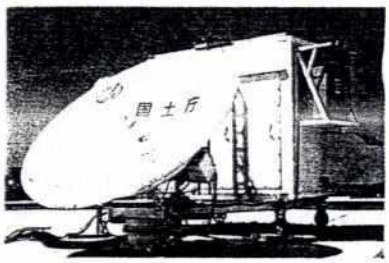
- FUTURE ISSUES

Such advanced technologies as the Integrated Services Digital Network (ISDN). are being utilized to communicate information for disaster management. The ISDN will enable us to use more convenient communication terminals like digital multi-functioned telephones and G4 facsimiles. We will be able to send moving images quickly and more efficiently.

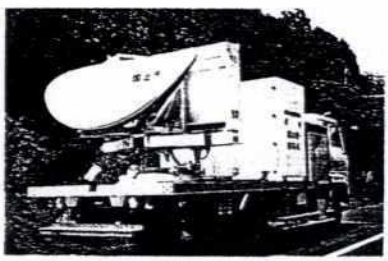
In addition to telephones and facsimiles, we will continue to search for new communication media. Faster and more efficient communication of information at the time of disaster will be required for future disaster management. At the National Land Agency, we will continue to seek a better communication network to respond to this requirement.

Outline of NLA's DPRC System

SATELLITE COMMUNICATION SYSTEM



earth station



transportable earth station

HEADQUARTERS FOR DISASTER COUNTERMEASURES

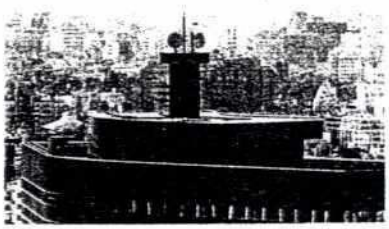
MOBILE COMMUNICATION SYSTEM

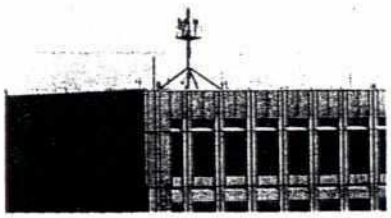
land mobile station (duplex system)

VIDEO TRANSMISSION SYSTEM

video transmission station

FIXED COMMUNICATION SYSTEM





portable station (duplex system)

INTELSAT and Disaster Management

Thanks to Gail P. Yamazaki of INTELSAT for providing the information for this article.

Disasters can strike without warning at any time of the day or night, anywhere in the world. In such emergencies, satellite communication systems with networks of earth stations located throughout the world are usually one of the first lines of assistance in the aftermath. In a crisis, the use of satellites can be critical to providing immediate emergency services for rescue and relief personnel, as well as for the victims. From relaying data or video images from a disaster site - through the use of rapidly deployed VSAT systems (very small aperture terminals), to longer-term relief and telephony restoration services provided by somewhat larger transportable antennas, satellites are one of the most vital keys to direct assistance.

Time is of the essence in establishing a disaster telecommunication network. Use of existing gateway earth stations to establish disaster telecommunication links is usually the fastest way to provide service, as long as the earth station and the terrestrial links to them are intact. In an emergency these gateway earth stations, which in most cases are located near a country's capital, can provide either direct service or serve as the hub for VSAT networks which might be required to reach remote regions.

Preparation for emergencies is the key both to minimizing damage to existing facilities and to providing service in the immediate aftermath. There are a number of fairly simple steps that can be taken in advance which may assist in mitigating damage. Taking these precautionary measures can mean the difference between an earth station that is prepared to provide support in a crisis, or an earth station that is non-functional.

Basic procedures for reducing the vulnerability of earth station equipment and facilities in advance of a disaster include the following:

1. Self-Sufficiency: International gateway facilities should be designed to enable at least limited operation, independent of other national facilities such as transit switching centres, terrestrial lines, offsite power,etc.
2. Redundancy: Any possible single point failure that could disable operation should be eliminated.
3. Alternate International Facilities: Provision should be made for the efficient installation of smaller temporary earth stations capable of supporting at least limited international traffic if the primary gateway antennas are damaged.
4. Alternate Internal Facilities: Arrangements should be made to have available, small transportable (VSAT) earth stations - VSAT's which could be used in conjunction with the primary international gateway antenna to form an emergency domestic thin route network for restoration of critical internal communications, independent of the normal terrestrial facilities.

In the event that prevention and redundancy are not sufficient, then having emergency contingency plans and conducting drills can also shorten the time required for implementation of a disaster communications network. These plans should show how to set up the telecommunication links under different scenarios, identify where the best sites are for transportable terminals, and which earth stations and satellite capacity could be used. Planners should also understand any regulatory mechanisms which could slow down the importation and operation of communication equipment and even go so far as to have agreements with neighboring countries or other nations to include possible support of that country's infrastructure.

The following three case studies show how satellites have been involved in past disaster situations.

Telephone Services for Iranian Earthquake

In June 1990, Iran suffered a devastating earthquake, severely disrupting communications between the stricken northwest regions and the rest of the country. Immediately following the earthquake, communications links were partially restored. But, as is often the case, the disaster area comprised a number of villages in a remote and very mountainous region located far from the Shaheed Dr. Ghandi (SDG) international gateway earth station, and all links between the affected area and the SDG gateway had been incapacitated. A portable communication system that could link the earth-stricken villages to Iran's public switched telephone network was the obvious solution.

A "fly-away" portable earth station was loaned to the Telecommunications Company of Iran (TCI) by INTELSAT and a communication system consisting of two parts was set up: a hub station and a remote or fly-away station, providing one full duplex voice or data circuit. The hub, consisting of a CFM/SCPC transmitter and receiver, requires at least a Standard B antenna (measuring 10 - 13 meters and not part of the fly-away), which is usually housed at an existing earth station. The remote station is the mobile part of the fly-away and can be easily moved and operated from any site from which the satellite is "visible". The remote station consists of a 1.8 meter antenna and a CFM/SCPC transmitter and receiver.

Medical Assistance to the Armenian Earthquake Victims

For several months in 1989, INTELSAT and its U.S. Signatory, COMSAT, joined NASA in a satellite medical assistance demonstration project, designed to make U.S. medical expertise available to victims of the December 1988 Armenian

earthquake. The space segment was provided 4 hours per day, 5 days per week. INTELSAT provided free space segment for this "telemedic spacebridge" project, which connected specialized medical facilities around the USA with the Diagnostic Centre in Yerevan, Armenia. This made possible live consultation between medical experts in the two countries on the medical treatment of earthquake victims with long-term physical and psychological trauma.

Natural Disaster in Bangladesh

The cyclone and tidal bore in Bangladesh in 1991, proved yet again that in many instances the terrestrial links to the earth station are the weak points in most disasters. At Betbunia, the cyclone did not interrupt service to the earth station itself, but was responsible for destroying the microwave tower in nearby Chittagong, which links this major communication gateway facility to all adjoining areas of the country. Within 24 hours, 13 telephony circuits had been made available on a temporary basis on the INTELSAT 60° E satellite for emergency restoration services. A task force was quickly established to assist with the restoration of the Bangladesh telecommunication network and a portable earth station was offered until regular communication links were restored. Just 5 days after the disaster, domestic and international trunk and telex services were reintroduced.

The INTELSAT Connection

Adequate redundancy and well-conceived emergency preparations to protect the existing infrastructure, coupled with the availability of alternate, transportable VSAT earth stations which can immediately access systems from a remote site, are the vital keys to re-establishing communications in a disaster situation.

Communications for disaster management entering the 21st century space age

by David E. Sterling and Peter A. Swan

"As the cyclone's 200 kilometer per hour winds bent the palm trees almost to the ground and the raging surf tossed the village boats like match sticks, the village chief wondered if this would be the storm which would destroy his village and its way of life. Although it would be four hours until the storm abated, this was the first disaster in which he did not feel alone or isolated. The chief was able to keep in constant contact via a new emergency satellite radio/telephone with disaster response agencies within his country and around the world. Just last year, the Office of the Disaster Relief Coordinator (UNDRO) had given him this new type of battery powered radio able to communicate directly to low orbiting satellites. The chief was very grateful that his village would directly benefit from this space age technology".

Although the above scenario is in the realm of science fiction today, it is quickly becoming science fact.

During March 1990, UNDRO marked the start of the International Decade for Natural Disaster Reduction (IDNDR) (1990-2000) with a conference attended by 83 participants from 54 organizations around the world. One of the significant achievements was to codify a list of requirements for disaster communications systems (pag. 12). These communications needs can be summarized to three major characteristics: readily available communications capability, self-sufficient infrastructures, and essential service quality.

Readily available. Communication assets must be at critical locations in-country for the local leaders to use for warning and preparation, during the disaster, and immediately following. The equipment must be useable without specialized training. The system must be affordable: both the unit cost and the on-air cost.

Self sufficient. The telecommunications network must have its own power, must be self-contained (optimum is pocket phone size), independent from the local telephone structure yet connect to both the world's telecommunications networks and other mobile phones in the area.

Essential service. The disaster communications devices must provide reliable, clear voice service capable of "voice recognition quality", fax and data capabilities (for supply ordering), and optional secure capability for sensitive reporting.

Responding to these needs, communications providers are increasing their support to disaster mitigation. Todays radio networks are effective when available; the VITASATs and amateur radio satellites are supportive; the C-band and A terminal option of the INMARSAT mobile satellite service are excellent when available; and, two-way police/safety/fire radios are becoming more and more important as they become more pervasive around the world. However, no one technology seemed to fulfill all of UNDRO's requirements simultaneously until the development of Low Earth Orbit (LEO) Mobile Satellite Service (MSS) systems.

In February 1992, the World Administrative Radio Conference (WARC-92) established a global radio frequency allocation to permit LEO MSS systems to offer personal communications from anywhere to anywhere on the Earth. In response to this new allocation, the competition is becoming intense among the major communications development corporations to establish this "Global Mobile" personal communications service. The Motorola Iridium™ is a major example of this coming capability.

It is planned to be fully operational in 1998 and it is intended to make first class digital communications available to over a million users where only unreliable or nonexistent telephone service is available today. It will be possible to make and receive calls anywhere in the world with a pocket-sized unit transmitting only 7 watts (peak) through a 10 centimeter antenna directly to satellites in space. Both voice and 2.4 kilobyte per second digital data services will be available to support many disaster response needs. Gateway Earth stations complete the operational portion of the system by providing the interface to the terrestrial telephone systems to communicate with normal wire telephones or cellular telephones.

UNDRO'S REQUIREMENTS

- Ready availability of equipment
- Conformity of equipment to worldwide standards
- Rapid customs clearance for equipment
- Ease of deployment
- Self-sufficiency and independence of equipment from national communication systems
- Interconnection with international networks
- Clear reliable communications
- Security of communications
- Moderate costs
- Early warning and preventive capabilities

(Source: UNDRO, 1990)

LEO satellites will be designed to provide a clear, robust communication channel to the users. In the case of Iridium™ sixty-six satellites will travel in 6 polar orbits of 11 satellites each at an altitude of 780 kilometers. Each satellite projects a pattern of contiguous terrestrial cells upon the earth using phased array antennas. Each satellite is connected to adjoining satellites through intersatellite linkage to form a global communication network. Once the user's signal arrives at the satellite, the message can travel one of three places: • *To a gateway Earth station to interface to the terrestrial telephone network;* • *Through an intersatellite crosslink to another satellite to a gateway Earth station or another mobile user;* • *Directly to another mobile user within the footprint of the same satellite*

LEO MSS systems hold great promise to provide communications during the critical time during and after a disaster strikes. Gone is the need for large satellite antenna dishes which are a liability during many disasters; gone is the reliance on local utility electric power; gone is the need for cumbersome radio equipment; gone is the marginal transmission quality of current systems; gone is the cumbersome connectivity to the worldwide telephone grid. In its place will be a battery-powered, pocket-sized radio/telephone which operates anywhere in the world during any weather conditions providing essential communications to anywhere in the world, at all times.

Critical communications must get through to the victims before, during and after a disaster. Prior to a disaster striking, alert warning can be passed to remote villages allowing people to prepare. During the disaster, national command centres can have assured connectivity to the total population to assess the extent of the damage and prepare to respond. To enhance the response, authorities can collect information about the effects of the disaster and inform the response agencies of the specific help needed. No longer will the wrong supplies be sent to the wrong locations through lack of information. Providing clear communication for voice, facsimile, and computer networks will significantly shorten the response time and result in the saving of many lives.

The world's disaster response community has shown an extraordinary ability to adapt commercially available communications systems to save lives and mitigate the suffering following emergencies. The community must act now to prepare to utilize the full capabilities of LEO MSS systems. A transition plan is essential which starts with today's capabilities of INMARSAT C and A terminals, incorporates the enhanced amateur radio networks, VITASAT for store-and-forward capability, ORBCOM for short messaging, and, in the near future, systems like the Iridium™ constellation. The future looks bright for pocket-sized, battery powered, Iridium™ telephones coupled with palm-top computers to meet UNDRO's stringent requirements and take communications for disaster relief operations into the 21st century space age.

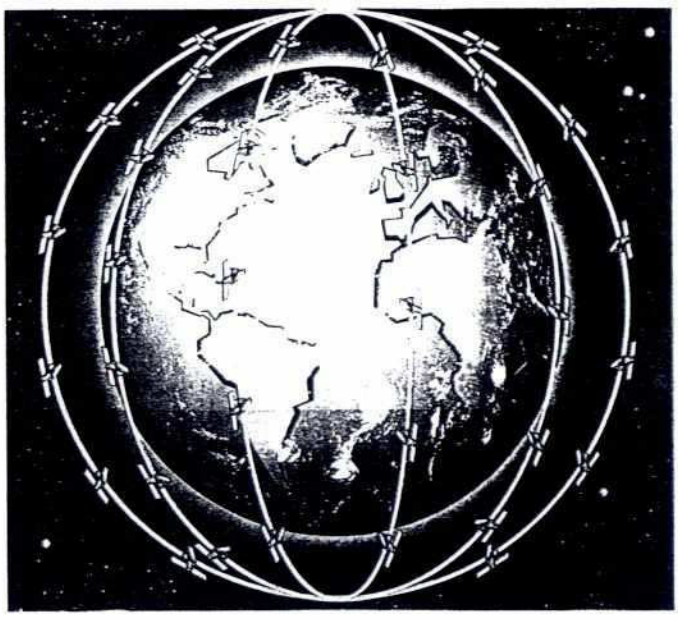


Illustration by Motorola Iridium™

Contact: Mr. Louis Walter, Assistant Director for Science, NASA, Goddard Space Flight Centre, Earth Sciences Directorate, USA. Tel. 1-301-286.2538; fax 1-301-286.3884

ANNEX C

Afforestation in the Coastal Areas

ANNEX C

COASTAL AFFORESTATION

LIST OF CONTENTS

ANNEX C

COASTAL AFFORESTATION

C.1 REVIEW OF THE AFFORESTATION PROGRAMME

C.1.1 Background

During the late 1960s and early 1970s satellite imagery interpretation revealed that about 5,000 sq.km of new lands were being accreted in the estuaries of the rivers Brahmaputra, Meghna and Ganges. These new lands were highly susceptible to erosion. GOB decided to undertake an extensive mangrove afforestation programme to stabilise the soil and consolidate the accreted lands.

The specific objectives of the programme were :-

i) to accelerate the process of siltation and stabilisation of the soil;

ii) to create shelterbelts to protect life and property in the lee of the belt, from tidal bores and storms;

iii) to create a resource to add to the national wealth of mangrove origin; timber, firewood, fish wildlife; and

iv) to create an environment in which to increase biomass.

The general development objectives were :-

i) to improve the standard of living of the people;

ii) to create job opportunities, and arrest migration of people to the cities;

iii) to stabilize the environmental regime, mangrove in this case, and encourage maximum production of biomass;

iv) to improve the balance of payment situation for the country; and

v) to create a landbank for the future.

C.1.2 Progress

DoF commenced coastal embankment afforestation on an experimental scale in the 1960s. The species used was Acacia (Babla) and it was planted on the slopes of embankment constructed by BWDB. The reason for selecting Babla is not clear, but is appears probable that isolated groups of Babla plants were found in very inhospitable sites. Moreover, its deep and penetrating root system make it sufficiently storm hardy without at the same time making the embankments loose and friable. Some 3,992 ha of such plantations had been raised on the slopes of embankments by 1973. It has been estimated that the average width of the plantation was 10m, and the total length 3,992 km.

After 1973, the focus of plantation moved to the coastal forelands. The work was undertaken mainly by the DoF. Babla was again selected due to its suitability in a wide range of soils, especially those found in the coastal areas and its simple regeneration technique through the dribbling of bare seeds. Young Babla plants are armed with stipulate spines, which provide natural protection against grazing.

It is reported that date palms were also planted on a limited scale on coastal embankments by DoF. Selection of this species was on grounds similar to that for Babla, adaptability, ease of raising plantations and natural protection against browsing and grazing.

Generally, the plantations were an outstanding success and led on to a more extensive coastal afforestation programme. World Bank assistance was secured from 1980.

According to DoF, 115,277 ha of plantation had been established by 1991-1992. The distribution is spread over coastal afforestation divisions of Chittagong, Bhola, Noakhali and Patuakhali. The organisational set-up of coastal divisions (**Figure C.1**. Further details of the divisions and index maps are given in **Appendix 1**.

DoF afforestation activities in the coastal areas were monitored by SPARRSO. The total area raised in the period 1966-79 as reported by DoF was 35,549 ha. 1981 aerial photographs confirmed the existence of 34,407 ha (SPARRSO 1987). DoF plantations in the period 1981 to 1985 were reported as 40,397 ha, of this 77.6% (30,530 ha) was confirmed by SPARRSO. The data are given in **Table C.1.**

TABLE C.1

Coastal Area Plantations (ha)

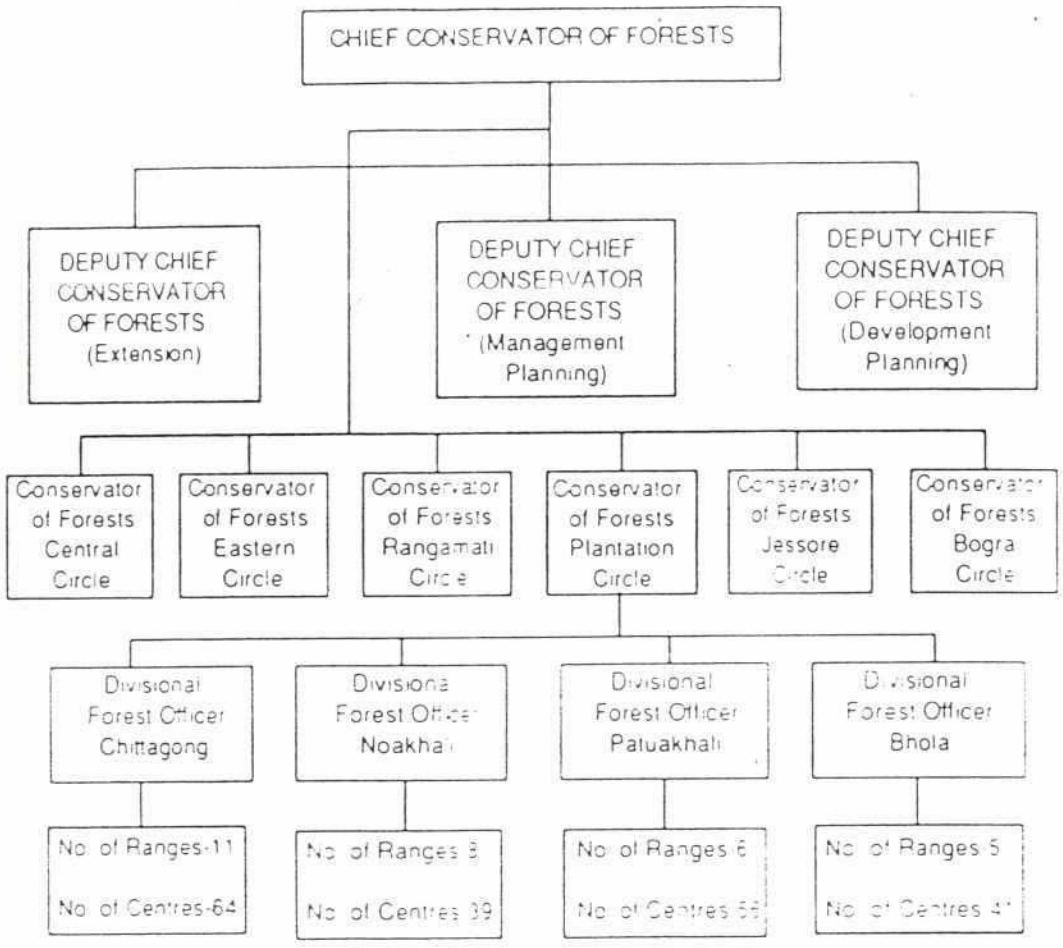
Period	Divisions				
	Chittagong	Noakhali	Bhola	Patuakhali	Total
1965/66 to 1972/73	1,340	778	1,823	000	3,941
1973/74 to 1979/80	9,477	10,526	5,966	5,639	31,608
1980/81 to 1984/85	9,389	14,609	10,855	5,544	40,397
1985/86 to 1989/90	8,586	12,748	6,390	4,654	32,378
1990/92	1,692	2,954	1,214	1,093	6,953
Total	**30,484**	**41,615**	**26,248**	**16,930**	**115,277**

Source : DoF Planning Cell

DoF has recently established a Resource Information Management System (RIMS). This organisation has started to inventory the coastal plantations and update the coastal maps prepared by SPARRSO on the basis of most recent information. Data have been collected from the field regarding the area of plantations established, the present area of plantation, areas that failed, were encroached or were eroded **(Tables C.2 - C.6).**

There are discrepancies between the Planning Cell and RIMS data. The Planning Cell figure is based on budget allocations whereas that of RIMS is based on information received from the field. The RIMS inventory takes account of plantations on coastal forelands, but in most cases does not take account of those on embankments. As RIMS data are based on field survey, they do not include any double counting where plantations were established two times

Figure C.1
Organisational set up of Forest Department
Showing Coastal Divisions



Notes: Name of ranges and centres are given in annexure Appendix 54 A

Source: Dalmacio et al. 1995

TABLE C.2
Status of Coastal Afforestation

Division	Established	Existing		Plantation Status Eroded		Encroached		Failed or Damaged	
	(ha)	(ha)	%	(ha)	%	(ha)	%	(ha)	%
Patuakhali	16,535	10,730	66.0	2,156	13.0	210	1.0	3,079	19.0
Bhola	21,268	10,218	48.0	6,467	30.0	930	4.0	3,351	16.0
Noakhali	34,241	24,140	70.5	4,368	12.8	14	0.0	5,719	16.7
Chittagong	30,684	11,941	39.0	4,523	14.7	2,621	8.5	11,599	37.8
Total	**102,728**	**57,029**	**55.5**	**17,514**	**17.0**	**3,775**	**3.7**	**23,748**	**23.1**

Source : DoF, RIMS, 1992

Note: Success is the highest in Noakhali and the lowest in Chittagong. It is found that 13%, 30% 12.8% and 14.7% of plantations in Patuakhali, Bhola Noakhali and Chittagong divisions were eroded respectively.

TABLE C.3
Status of Coastal Plantations in Patuakhali

Name of Range	Plantation (ha)					Dominant Species	Stem/ha (nr)	Remarks
	Established	Existing	Failed	Eroded	Encroached			
Patharghata	4,290	3,196	628	445	20	Keora	**	Includes 856 ha Natural Keora Forest
Golachipa	5,451	3,872	676	794	26	Keora	**	No reason has been given for non-existance of 83 ha Plantation
Char Momotaj	4,835	2,739	1,130	649	40	Keora	**	No reason has been given for non-existance of 270 ha plantation
Mohipur	910	265	426	95	124	Mangrove 50% (Mostly Keora) Non-Mangrove 50% (Mostly Koroi)	**	
Amtali	942	551	219	172	0	Keora	**	
Dashmina	107	107	0	0	0	Keora	**	
Total	**16,535**	**10,730 (65%)**	**3,079 (19%)**	**2,155 (13%)**	**210 (1%)**			

Source : DoF, RIMS

** Data not available

( ) Figures in parentheses indicate percentage of "Raised" area

TABLE C.4
Status of Coastal Plantations in Noakhali

Name of Range	Plantation (ha)					Dominant Species	Stem/ha	Remarks
	Established	Existing	Failed	Eroded	Encroached		(nr.)	
Char Bata	5,516.00	4,208.00	1,255.00	53.00	0.00	Keora, Baen & Babla	**	
Jahajmara	6,723.00	4,687.00	710.00	1,325.00	1.00	Mostly Keora	**	
Char Alauddin	1683	1,144.00	240.00	0.00	0.00	Mostly Keora with Baen and Gewa	**	
Char Habibia	3,426.00	2,930.00	20.50	462.50	13.00	Keora, Baen	**	
Nalchira (Hatiya)	5,758.00	4,424.00	60.00	1,274.00	0.00	Keora	**	
Sagaria (Hatiya)	2,473.00	1,293.00	167.00	1,013.00	0.00	Keora	**	
Companiganj	2,489.00	779.00	1,710.00	0.00	0.00	Baen and Keora	**	
Alexander	6,173.00	4,675.00	1,498.00	0.00	0.00	Mostly Keora with Baen & Gewa	**	
Total	**34,241.00**	**24,140.00 (70.5%)**	**5,660.50 (16.7%)**	**4,127.50 (12.8%)**	**14.00**			

Source : DoF, RIMS

** Data not available

TABLE C.5
Status of Coastal Plantations in Bhola

Name of Range	Plantation (ha)					Dominant Species	Stem/ha (nr.)	Remarks
	Established	Existing	Failed	Eroded	Encroached			
Kukri–Mukri	7,112.10	4,095.12	1,855.98	445.00	1,151.10	Mostly Keora Gopata 4 ha non–mangrove 2 ha	1,830	
Majherchar	956.15	285.05	355.47	141.70	161.93	Keora – 143 ha, Goilpata 20 ha, Kankra – 95 ha, Baen – 31 ha, Non Mangrove 20.24 ha, Karamja – 16.19 ha.	1,155	
Manpura	7,545.43	3,029.63	3,515.57	323.88	677.21	Mostly Keora with Golpata, Gewa & Karamja(Less than 5%)	1,516	
Char Fasson	3,124.10	1,453.16	507.72	424.54	628.68	Keora	1,200	
Daulatkhan	2,530.20	1,353.89	111.00	30.36	791.95	Keora	2,207	243 ha of Planted Area has been cleared and handed over to Revenue Department
Total	**21,267.98**	**10,216.85 (48%)**	**6,345.74 (30%)**	**1,365.48 (4%)**	**3,410.87 (16%)**			

Source : DoF, RIMS

TABLE C.6
Status of Coastal Plantations in Chittagong

Name of Range	Plantation (ha)					Dominant Species	Stem/ha (nr.)	Remarks
	Established	Existing	Failed	Eroded	Encroached			
Mirsarai	4,953.49	4,430.00	344.46	0.00	0.00	Kapra, Baen	3,741	
Sitakunda	2,229.00	1,124.00	1,030.00	75.00	0.00	Keora, Baen	**	
Headquarter	2,002.00	495.00	2,214.00	170.00	230.00	Keora, Baen and Gewa	4,542	1 includes 44.5 ha of leased lands, includes 393 ha of plantation damaged during cyclone 1991
Bangshkhali	2,250.00	197.00	1,901.00	0.00	152.00	Baen	**	
Kutubdia	491.00	149.00	256.00	26.00	60.00	Baen	1,464	1 includes 70 ha of plantation damaged during cyclne 1991
Gorakghata	5,313.00	1,539.00	506.00	0.00	1,268.00	Baen	4,000	1 includes 1179 ha of leased lands 2 includes 509 ha of plantation damaged during cyclone 1991
Teknaf	1,338.00	57.00	955.00	2.00	324.00	Baen	1,023	
Sandwip	1,811.72	753.04	528.95	529.73	0.00	Keora, Gewa and Baen	1,764	
Charandwip	703.49	160.91	158.07	97.05	297.36	Keora	3,144	
Urirchar	8,998.00	2,968.30	4,191.00	3,633.20	290.00	Keora, Gewa	2,228	
Channa	694.00	68.02	626.31	0.00	0.00	Baen	3,473	
Total	**30,783.70**	**11,941.27 (39%)**	**12,710.79 (37.8%)**	**4,532.98 (14.7%)**	**2,621.36 (8.5%)**			

Source : DoF, RIMS

** Data not available

A:\IK - 20\TabC- 7FR

(i.e. plantation re-established due to failure of earlier plantation). The data provided by the Planning Cell take no account of unspent funds at the end of the financial year. Hence Planning Cell data are of limited importance in measuring the success of the coastal afforestation programme (See **Appendix 2**).

The area of successful plantations is highest in Noakhali and lowest in Chittagong. The reason for the variation in success is due to erosion, instability of the soil, crop failure or damage to plantation. Failure or damage is largely due to wrong site selection, rapid accretion, sand smothering or sediment winnowing. Considerable damage is caused by grazing buffaloes. Budgetary constraints, lack of experience and knowledge of plantation establishment and management are other factors. However, it is the first time that coastal plantations with sensitive species was tried in Bangladesh and the overall level of success was considered satisfactory (McConchie 1980).

Species selection is the most important aspect in any plantation. The suitability of the plant species to the planting site determines the success or failure of the plantation. Sonneratia opetala (Keora) is the dominant species in the coastal afforestation programme. This is followed by Avicenia officinalis (Baen) which can tolerate overhead shade. Most plantations comprise about 80% Keora, 15% Baen with the remainder being Gewa, Kankra, Passur, Koroi, Babla or Golpata.

Efforts to determine stocking densities were inconclusive. Average stock density varied widely from centre to centre, probably due to defects in the recording systems. Data on stock density from Noakhali and Patuakhali were not available, while the density in Chittagong varied between 4,000 to 1,000 plants per ha.

C.1.3 Effectiveness Against Cyclonic Surges

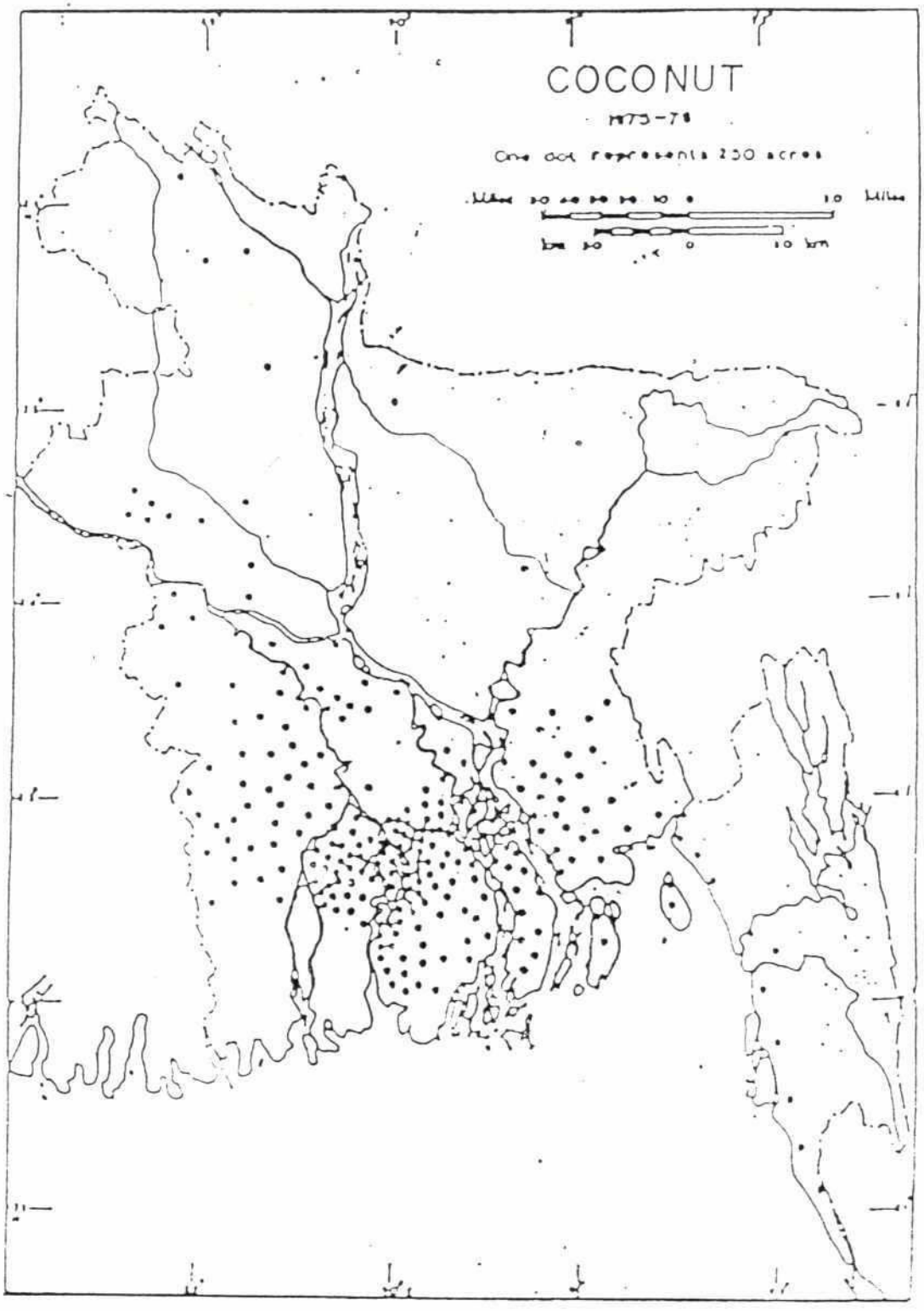
During the last 100 years more than 80 cyclones struck the coastal areas, however, only two caused damage to Greater Khulna (including Bagerhat and Satkhira). The concept of raising coastal plantations, arose from the fact that during the mid 1960s the people of Khulna were protected from the effects of cyclones and tidal surges by the Sundarbans.

It was reported that casualties during the cyclone were very high in the Chokoria Region, where there used to be a mangrove forest named Chokoria Sundarbans. This natural barrier was cut down and converted to shrimp farms during the 1980s. Foresters opposed the deforestation of the area but their advice fell on deaf ears until the cyclone caused such damage. It is recommended that the land be converted back to mangrove forest.

The effectiveness of Babla and Jhau (Casuarina) against tidal surge and cyclones has been questioned following its performance in 1991. In many areas, Babla on embankments were more than 20 years old and formed a dense canopy when the 1991 cyclone struck. Most were either uprooted or broken, except where they were protected by plantations on the foreland. In some places, Babla were washed away together with the embankment. DoF officials confirmed the mass uprooting of both species following field visits. However, they also noted that, despite the uprooting, there had been no damage to the associated embankments. At the same time, no tree species were seen to be totally safe from winds of cyclone intensity (See **Appendix 3**).

Pruning of coastal forests to reduce crown width would reduce the uprooting but the effectiveness of such 'pruned' trees in protecting the embankments would be reduced. The intensity of damage to trees depends on several factors, including :-

Figure C.5
Geographical Distribution of coconut (Ohisson, 1984)



- direction of wind
- depth of surge
- crown size
- age of the tree

Damage was substantially higher where trees were hit by surges of greater depth. Trees with smaller crowns suffered less. Smaller trees are less affected by surges and cyclonic storms. This is true not only in the case of Babla and Causarina but also for other species.

It may be concluded that a well established plantation of small crown width and low height will be effective as a shelterbelt against cyclonic storms and surges irrespective of species. Hence, any tree species which can grow well in the coastal areas should be allowed to grow.

According to one study afforestation of the coastal areas is of paramount importance in minimising cyclone damage (Haider et al, 1991).

C.1.4 Shelterbelts and their Management

Shelterbelts are forests which may be artificially raised or grown naturally. The purpose of shelterbelts is primarily to reduce the effects of high winds. Several types of shelterbelts are recognised for different purposes. These are :-

- **Angular** - where the vegetation starts at an acute angle and rises up to the natural height of the dominant trees.

- **Blow through** - is a pattern of trees in one or more lines.

- **Complex** - is generally a natural formation of considerable width, capable of blocking wind up to a considerable distance.

Investigations (Champion, 1968) have established that:

i) the sheltered distance on the leeward side extends to approximately 30 times the height of the belt;

ii) a dense belt provides greater shelter close to the leeward side but the sheltered distance in less, a moderately penetrable belt is best;

iii) the sheltering affect is mainly a function of height and penetrability, width influences the general microclimate most but not the reduction in wind velocity;

iv) a shelterbelt which both rises and falls abruptly on windward and leeward is said to be the most effective, smaller trees and shrubs should occupy the interspace between the full trees;

v) in a vertical direction, the influence on wind velocity extends to more than four times the height of the tree;

vi) in respect of soil blowing and wind erosion, the protective effect extends to about 30 times the height;

vii) shelterbelts reduce the temperature range, increase the humidity and cause a greater dew fall. The influence on evaporation extends to about 10 times the height.

Natural shelterbelts have nearly all disappeared in recent times and more commonly shelterbelts are artificially raised. Such artificial formations naturally assume a rectangular form (**Figures C.2 and C.3**). This shows a shelterbelt for a sea facing coastal embankment, and is appropriate for all purposes, including killas.

Figure C.4 represents a typical design mix of palms and trees on embankments and killas. Care should be taken in selecting the species for the slopes of embankments. Medium sized trees should be planted on slopes on the seaward side of the seafacing embankments where the slope ranges between 1:7 to 1:5, shrubs, small sized trees and palms should be planted on the steeper slopes on the country side and also on slopes of big rivers and channels. Medium sized trees should be allowed to grow only on the lower slopes of the embankment.

The shelterbelts should be harvested such that no permanent gap is created. Seedlings should be planted at a spacing of 2m x 2m. After five years, mechanical thinning i.e. removal of alternate plants should be carried out. At year 10-12, all tree species should be harvested in phases. Date palms and coconuts should be maintained as permanent shelterbelts. After felling of the 10-12 year old trees species with good growing power might be retained as standards for 2 to 3 rotations. Gaps after harvesting of 10-12 years trees should be replanted with suitable species.

Figure C.2
Schematic Diagram of Afforestation on Seafacing Coastal Embankments

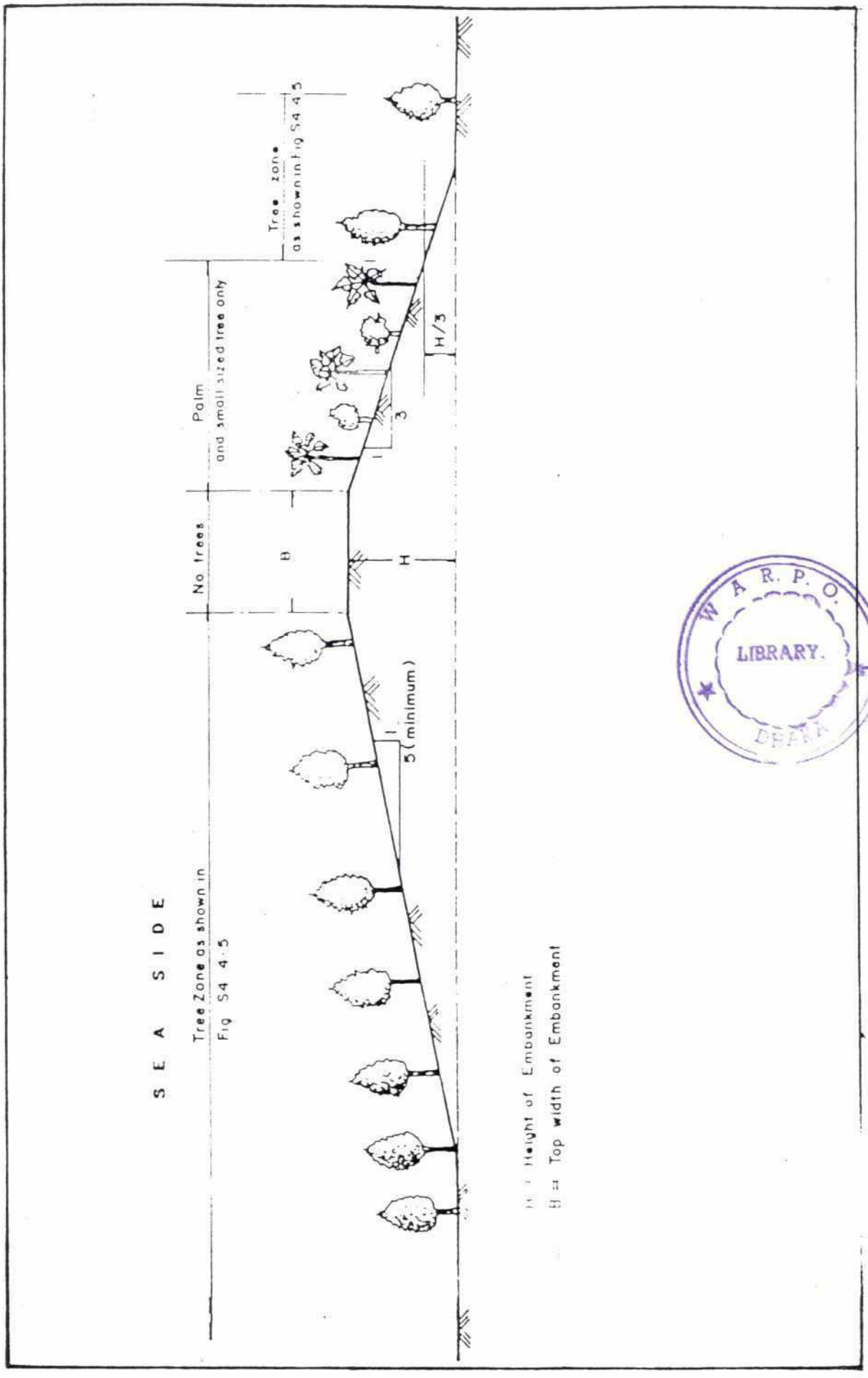


Figure C.3
Schematic Diagram for Afforestation in Killas

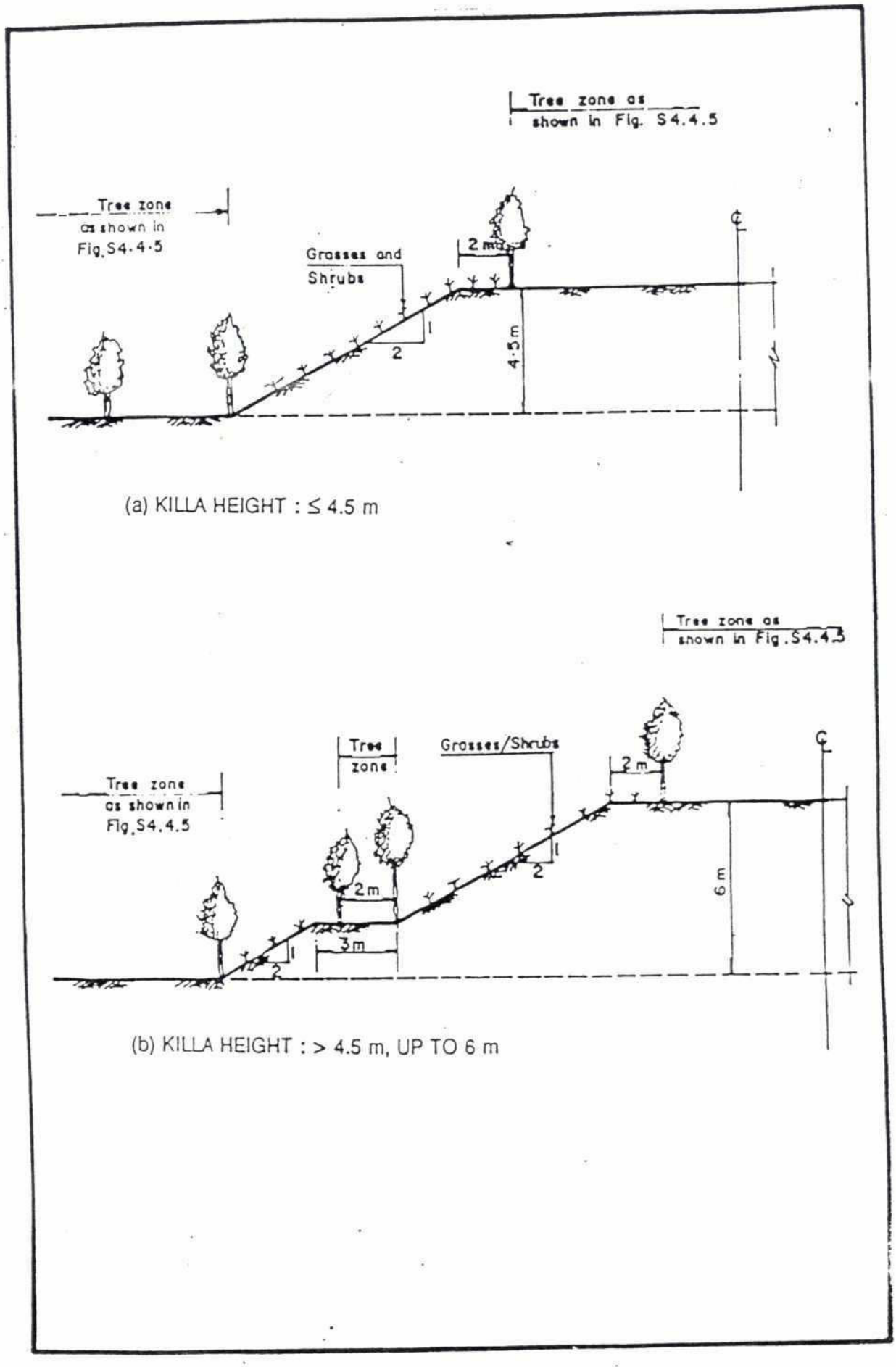
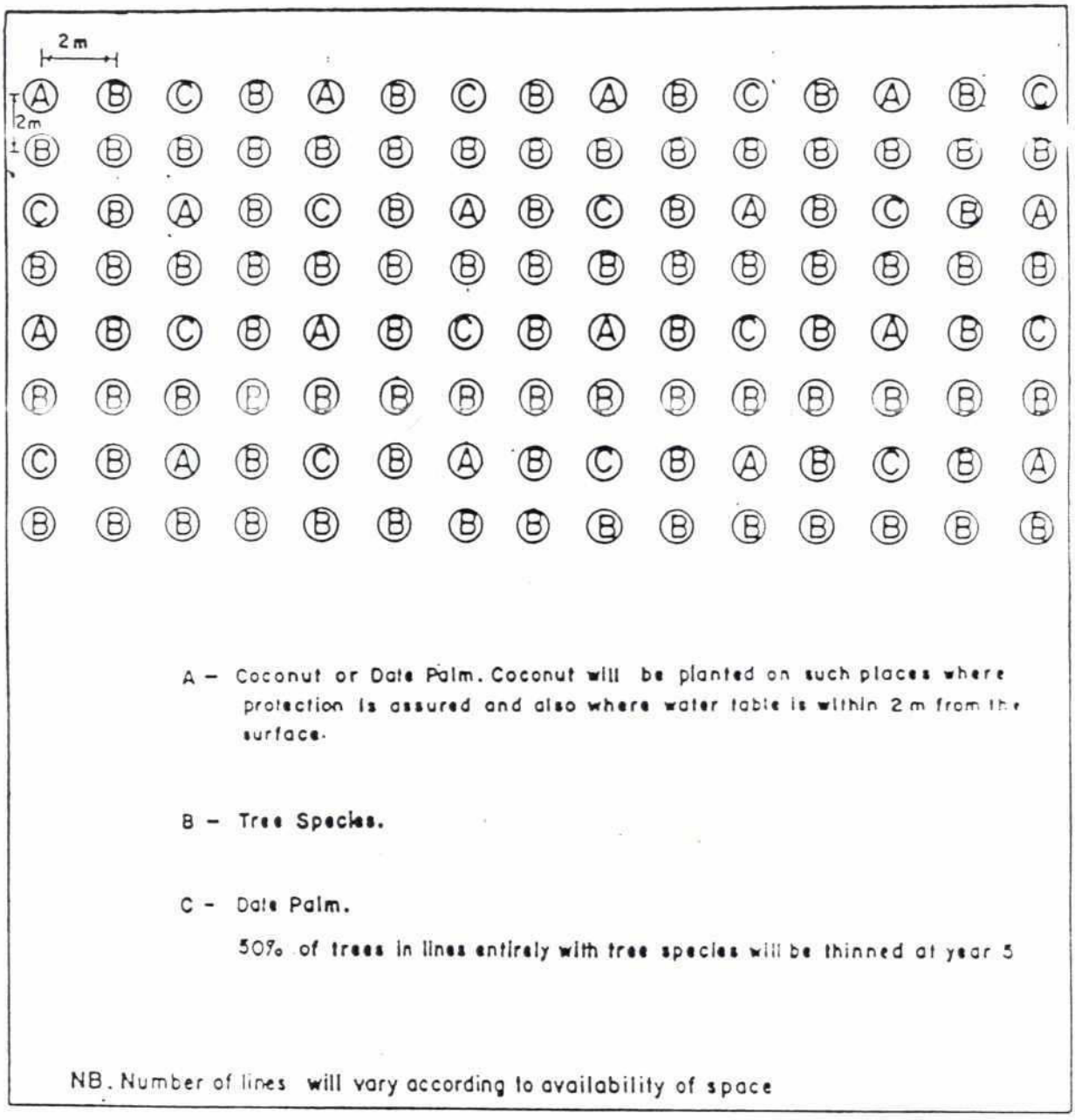


Figure C.4
Typical design of species mix of palms and trees on Embanments and Killas



C.2 THE MANGROVE ECOSYSTEM

C.2.1 Introduction

Mangrove ecosystems are receiving increasing world wide attention because of their immediate protective functions against cyclones and their longer term socio-economic importance. The coastal districts of Bangladesh have been seriously damaged thirty five times during the last 200 years by tropical cyclones and the damage has been considerably greater in Barisal, Noakhali and Chittagong districts, while in Khulna, which is protected by mangroves, it has been minimal.

C.2.2 General Description

It is important to clarify precisely what is meant by the mangrove ecosystem, how it forms, grows and survives. Mangrove is a floral and faunal association which develops naturally on the mudflats of large rivers at the sea interface provided the mudflats are substantially undisturbd. There is an identifiable succession starting from salt tolerant grass through wild rice, first colonizer tree species Keora, second colonizer Gewa, to facultative halophytes, Sundari, Passur and Baen. Each species differs in its capacity to withstand the inundation of forest floor by brackish and saline water due to high and low tides. Sundari, Kankra Passur and Baen are sensitive to salt and require regular flushing of the forest floor by fresh water. During the monsoon period the large volumes of fresh water brought down by the large rivers counterbalance the salinity introduced during the low flow period. The mangrove species grow best in the north-eastern Sundarbans, through which the large rivers, including the Sipsha, Passur, Sela and Baleswars, flow.

As salinity increases, the height and diameter of Sundari, Passur and Baen start to decline . This is followed by a decrease in population density and an increase in the population of Gewa and Goran. With further increases in salinity, Sundari gives way more and more to Gewa. With even higher salinity, some species of the Rhizophoraceae family e.g. Goran, Garjan, Kakra, Rohinia (Kandelia Rheedii), and probably also Kripa (Carallia Lucida) together with tiger fern take control.

An intermediate type of vegetation is apparent in the middle and midwestern region of the Sundarbans bounded by the river Passur on the east and river Sipsha on the west i.e. Khulna Range. The stunted Gewa, Goran and Garjan forests, which are substantially open in canopy, occur in the western and south western regions of the Sundarbans i.e. Burigaolini Range, now in Satkhira district.

Physiognomically, the mangrove plant association forms a continuum at one end of which is pure Sundari and at the other is scrub to open forest of stunted Gewa, Goran and Kripa. The whole area is the mangrove proper which survives, grows and regenerates so long as the land and vegetation is not substantially disturbed by edaphic and biotic factors.

In this complex association every unit of life form, vegetation, wildlife and microflora, influences the environment and is also influenced by the adjoining life forms and biota in a number of nutrition chains. For example, the organic matter on the forest floor is decomposed directly by deer and wildboar, which in turn feed man and tigers, two end-users. In a separate cycle, the organic matter is acted upon by zooplankton, and phytoplankton which are rich in nitrogen compounds, proteins and aminoacids. These micro-organisms are the feed of various fish mollusces and crustacea, again man is the major end-user.

These nutrition cycles explain the existence of the abundant wildlife and aquatic life in the mangrove forests and also the existence of three fish spawning grounds in the Bay of Bengal.

Strictly speaking, unlike other forests, the nutrition cycle in the mangrove ecosystem of the Sundarbans is open ended, with substantial amounts of nutrition being delivered upstream as diluted sewerage. This acts upon the ecosystem to enrich it and takes away the bye-products of the chain to enrich the spawning grounds in the Bay of Bengal. Within limits of disturbance by biotic and edaphic factors, the mangrove ecosystem is a subclimax and fairly stable.

C.2.3 Management of Mangrove Ecosystem

During the region of Emperor Akbar, a severe cyclone in 1584 destroyed the Bakla Pargana, which is now greater Barisal district, and its mangrove forest. The British disforested nearly 800 sq.miles of Sundarbans in Barisal and Khulna districts during the late 1800s and early 1900s.

Incipient erosion of growing stock, through overfelling and theft have reduced stock densities by 40% to 45% over the last 30 to 40 years. The die back from top downward due to disease is taking a heavy toll and continues unabated. The Farakka barrage in India has caused salinity to increase from 20 to 40 ppm to 2 000 ppm. This is bound to have affected the nutrition cycles, physiology and general health of the forest.

If this retrogression is allowed to continue, the population densities of the major species will fall below the critical level and regeneration and growth will not be possible. Important trees like Sundari, Gewa, Passur and Baen together with wildlife, fish and honey will disappear leaving Hijal and Boruna scattered over economically unproductive rice fields.

Cyclones cause much damage in such areas as is evident from the damage to Chokoria Sundarbans and Gorki by the 1991 cyclone, where the Sundarbans had been felled and the land converted into shrimp farms.

The 1958 forest inventory of Sundarbans estimated that the growing stock of Sundari and Gewa was 13.04 and 3.3 million cubic meters respectively while the the 1985 inventory revealed growing stocks of 7.87 and 1.82 respectively. This means that in 27 years of scientific management, Sundari stock had been reduced by nearly half.

The mangrove is an integral part of a process of change leading from tidal to high forest vegetation. It is possible to make recommendation for appropriate plantation species in the tidal and mangrove zone if this continuum is recognised. However, tidal and mangrove terminologies are often used in a mutually exclusive manner which does not appear appropriate.

C.3 SPECIES SELECTION

C.3.1 Introduction

The success achieved by plantations depends on the correct choice of species for the sites, on inundation frequency, depth, duration and level of salinity.

The selection of species is a complex task. Generally, importance is given to endemic species and these are expected to grow well. However, often this does not happen. In coastal areas, the predominant species are the mangroves which reduce in density and biomass and ultimately disappear until the stable high forest composition in reached. Consequently, recommending the existing vegetation may not always be appropriate. Research is necessary to determine what is required for each class of site.

C.3.2 Ecological Zones

Based on the agroecological zones of FAO (1988), eleven dendroecological zones (DEZ) were identified in Bangladesh (Richard et al, 1989). Most the coastal area is under one DEZ namely Estuarine Floodplain Soils, where the soils are either neutral or slightly alkaline in reaction. Coastal areas south of Chittagong City are in the Non-Gangetic Floodplain Soil DEZ, where soils are generally strongly acidic.

C.3.3 Mangrove Species

Mangrove and tidal species suitable for the coastal areas with their general site requirements are :-

Keura	:	new alluvial formations with low salinity and high tide every day.
Baen	:	new alluvial formations, can accommodate high tides and high salinity.
Gewa and	:	new alluvial formations with moderate salinity and normal high side
Kankra		to spring high tide, prefers partial shade.
Goran	:	new alluvial formations with moderate to strong salinity.
Golpata	:	river banks supplied with fresh water.

More detailed information is given in **Table C.7** while **Table C.8** gives mangrove species that were identified by Prain (1903) and Watson (1928) together with details of the dominant species based upon inundation characteristics.

C.3.4 Non-Mangrove Species

a) General

In general, species selected should be tolerant of wet and dry conditions and also salinity. Various growth limiting factors for 65 individual tree species, 26 industrial, 17 fuelwood and 22 horticultural have been listed (Richards et al, 1989). **(Table C.10)**.

TABLE C.7
Mangrove Species of Interest

Local Name	Scientific Name	Mature Form height	Flowering Time	Seed Collection	Establishment Method	Spacing (m)	Uses
Keora	Sonneratia apetala	Unbuttressed tall tree attaining a height of 20m	April–May	August–September	Bare–root planting of 5 to 8 months old seedings which attain a height of 45 cm to 50 cm	1.2 x 1.2 or 1.0 x 2.5–3	Furniture, Panelling, Boat parts. Anchor logs. Packing Boxes
Baen	Avicennia officinalis	Usually a tree or shub in favourable condition may grow upto a height of 10–12m	May–June	August–September	Planting 1–2 months old, seedings raised om 5" x 4" polybags	1.2 x 1.2 or 1.0 x 2.5–3	Fuelwood, Anchor logs, Resin from bark used as contraceptive, leaves
Gewa	Excoecania Aqallacha	A moderate size tree attaining of height of 10m to 13m	April–May	July–August	Sewing of 2 to 3 pregerminated seeds or planting of one year old wild seedings with a ball of earth	1.2 x 1.2 or 1.0 x 2.5–3	Pulpwood, Inferior quality fuelwood. Packing boxes Latex to kill fishes.
Kenkraq	Bruquiera gymnonhiza	A tall buttresed tree which may atain a height of 35m	April–May	July–August	Viviparous seeds sticked to the ground	1.2 x 1.2 or 1.0 x 2.5–3	Good timber used for heavy construction as beams, rafters and also for making furniture
Goran	Cenops decandra	Shrub or small tree	March–April	May–July	Sewing of germinated seeds	1.2 x 1.2 or 1.0 x 2.5–3	Good quality fuelwood for burning of bricks, for making of quality charcoal, House posts. Tanning from bank. Fencing material
Golpata	Nypa fruticans	A trunkless palm with tall erect fronds	August – September	January – February	Planting of two month old seeding	3.0 x 3.0	Nypa leaves used as thatching material

Source : Dalmacio et.al, 1991

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TABLE C.8

Dominant Species by Type of Inundation

Class	Description	Dominant Species Associations
I	Inundated by all high tides	Soneratia apetala, Avicennia alba
II	Inundation by medium high tides	Avicenia Sp. S. Apetala Rhizophora mucronata R. apiculata, R. stylosa, Bruguiera parviflora.
III	Inundated by normal high tides	R. mucronata, R. apiculata, R. stylosa Ceriops Roxburghiana, Bruguiera spp. Xyloiarpus moluccensis, Excaecaria agallocha.
IV	Inundated by high spring tides	Brugiera Sp. Zmoluccen-sis.Lumnitzera Sp. E.agallocha.
V	Inundated by equinoctial or other exceptional tides	Heriticra fomes, Heritiera littoralis, Hibiscus tilliaceous, Lummitzera Spp. Sonneratia caseolaris.

Source: Prain, 1903 and Watson, 1928.

Notes : The name of plants might have changed since identified more than sixty years ago.

: Same species might appear under two names due to identification difficulties on account of varying growth conditions.

TABLE 9

Limiting Growth Factors for Industrial Tree Species

Species	Growth Limitation Factors
Karoi	Moderate limitations on sandy and weakly saline soils, and those which are flooded intermittently
Raintree	Moderate limitations on weakly saline soils
Sissoo	Moderate limitations on soils with moderate moisture holding capacity, and severe limitations on weakly saline those and soils which are flooded intermittently
Simul	Moderate limitations on soils with moderate moisture holding capacity, on saline soils and on those soils which flooded intermittently
Jarul	Severe limitations on weakly saline soil
Kadam	Severe limitations on weakly saline soils

TABLE C.10

Species used in Site Capability Assessment

S.No.	Common Name	Botanical Name
Industrial Wood Species		
01.	Champa	Michelia champaca
02.	Chapalish	Artocarpus chaplasha
03.	Chikrassi	Chukrasia velutina
04.	Dhakijam	Syzygium grande
05.	Sal	Shorea robusta
06.	Toon	Toona ciliata
07.	Minjiri	Cassia siamea
08.	Gamar	Gmelina arborea
09.	Telsur	Hopea odorata
10.	Narkeli	Pterygota alata
11.	Teak	Tectona grandis
12.	*Koroi	Albizia spp.
13.	*Raintree	Samanea saman
14.	Sisso	Dalbergia sissoo
15.	*Shimul	Bambax ceiba
16.	Dewdaru	Polyaltha longifolia
17.	*Chatina	Alstonia scholaris
18.	Jarul	Lagerstroemia speciosa
19.	Kadam	Anthocephalus chinensis
20.	Garjan	Dipterocarpus spp.
21.	Mahogany	Swietenia spp.
22.	Pynkado	Xylia Kerrii
23.	Poplar (rainfed)	Populus spp.
24.	Poplar (irrigated)	Populus spp.
25.	Malakana	Paraserianthes falcataria
26.	Pine	Pinus caribaea
Fuelwood Species		
27.	Jhau	Casuarina equisetifolia
28.	*Ipilipil	Leucaena leucocephala
29.	*Mangium	Acacia mangium
30.	*Austrilia acacia	A. auriculiformis
31.	*Khayer	A. catechu
32.	Babul, Babla	A. nilotica spp. indica
33.	*Neem	Azadirachta indica
34.	*Amlaki	Emblica officinalis

Sl.No.	Common Name	Botanical Name
35.	*Bakphul	Sesbania grandiflora
36.	*Chalmugra	Hydnocarpus kurzii
37.	Sonalu	Cassia fistula
38.	Hinjal	Barringtonia acutangula
39.	*Mandar	Erythrina spp.
40.	Pitali	Trewis nudiflora
41.	*Gab	Diospyros spp.
42.	*Goranim	Melis azadirach
43.	*Eucalypt	Eucalyptus camaldulensis
44.	*Jam	Syzyglum cumini
45.	*Am (mango)	Mangifera indica
46.	Kul (Indian Plum)	Ziziphus mauritlana
47.	*Tetul (tamarind)	Tamarindus indica
48.	Litchu (litchi)	Litchi chinensis
49.	Jambura (pumelo)	Citrus grandis
50.	Payara (guava)	Psidium guajava
51.	Kamranga (Chinese gooseberry)	Averrhoa carambola
52.	Chalta (elephant apple)	Dillenia indica
53.	*Bel (wood apple)	Aegle marmelos
54.	*Amra (hog plum)	Spondias pinnata
55.	Lebu (Lemon)	Citrus spp.
56.	Supari (betal nut)	Areca catechu
57.	Tal (toddy palm)	Borassus flabellifer
58.	*Narkel (coconut)	Cocos nucifera
59.	Khejur (date palm)	Phoenix sylvestris
60.	Bamboo	Bambuses spp. Dend. spp.
61.	*Dumur (fig)	Ficus spp.
62.	*Bhadi	Lannea coromandilica
63.	*Kanthal (Jackfruit)	Artocarpus heterophyllus
64.	Jalpai (Indian olive)	Elaeocarpus floribundus
65.	Rubber	Hevea brasiliensis

Source: Richards et al, 1989.

* Indicates Multipurpose Tree Species (MPTS)

b) Industrial Trees

Table C.9 lists industrial tree species whose growth is only slightly limited in wet/dry and saline conditions. None of the species can grow without any limitation on coastal soils with the limiting factor being soil salinity. Species having severe growth limitations on saline soils are omitted, the industrial tree species suitable for the coastal are Koroi, Raintree and Simul. Again, where soils are non-saline or very weakly saline, all six species mentioned are suitable.

These species grow well on both acid and neutral soils, and can be grown in both DEZs. This accords with previous field observations.

In addition to these species, one additional species Sonboloi (Thespesia populnea) grows well in coastal areas. Mahogany also grows well on Estuarine Floodplain soils. Sonboloi and Mahogany can adapt themselves to a range of edaplic variations.

c) Fuelwood Trees

Table C.11 lists fuelwood species whose growth is not limited or only slightly limited in wet dry and saline conditions.

Akashmoni, Khair, Babla and Jham are suitable for some sites. Ipil-Ipil would be suitable for all sites except where soils acidic. This species should not be tried in the Chittagong Coastal Tidal Floodplain areas located south of Chittagong. Gab and Encaluyplus should not be tried in soils with low moisture holding capacity. Gab is also unsuitable for forest plantation because of its low value. Babla and Khaiya Babla grow well in coastal zone on the slopes of embankments. The calorific value of Hijal and Mandar are low making them of limited value.

d) Horticultural Species and Palms

A number of horticultural species are suitable for coastal area an important species is Anacardium occidentale, although strictly speaking it is not a mangrove. Its importance lies in the fact that it forms a good understory below coconut. A layered structure to a shelterbelt provides maximum protection against cyclones. Kathal, Jalpai and Umber not suitable due to the likelihood of inundation. There may be a moderate limitation on the growth of Litchi and Jambura due to soil salinity.

Cashewnut is well known all over this world. Attempts were made to introduce it to Chittagong and Chittagong Hill Tract region, but the results were near failure because of poor quality of seeds. It still deserves a fair trial as an understory using seeds from South America or India, where it grows well.

Among shrubs Hogla (Triraphis) and Sada Akond are found extensively along the canal banks in Bhola, Patuakhali, Noakhali and elsewhere. However, the best climber is Dhol-Kolmi, this grows almost anywhere and is difficult to eradicate. During the cyclone of 1991, which was the only species which remained unaffected.

Dholkalmi and other herbs and shrubs, grown on the slopes of embankments and killas, can protect them from the scouring action of waves. These plants have other uses, which have not been fully investigated.

TABLE C.11
Limiting Edaptic Factors for Fuelwood Species

Species	Limiting Edaptic Factors
Casuarina	No limitations
Ipil Ipil	Severe limitations under acid conditions
A. Mangium	Moderate limitations on moderately moist soils.
Babla	Slight/No limitations
Khair	Slight/No limitations
Akashmoni	Slight/No limitations
Gab	Moderate limitations with moderate moisture
Encatyptus	Moderate limitations on soils with moderate moisture holding capacity.
Bokphul Sonali, Hijal & Mander	Moderately limited in weakly saline soils.

The palms Narikel (Coconut) and Supari are common . Supari grows throughout the country while Narikel is largely concentrated in Jessore, Khulna, Bagerhat, Bhola, Patuakhali, Pirojpur and Noakhali (**Figure C.5**). Previously Supari was eaten as a nut with pan and Narikel was used primarily as a drink, for oil and as an ingredient in cakes. During the cyclone of 1991, its ability to withstand winds of cyclonic intensity was apparent. This suggested the possibility of using both species as the overwood in a shelterbelt on the inner side of the embankments and around houses.

About 14 varieties of Narikel have been identified each with different fruit size, color, taste of kernel water, amount of and oil content of copra. During 1987-88, the total area under coconut was estimated at 79,900 acres (32,335 ha) while the production was about 86,600 metric tons (BBS, 1990). Each tree produces about 60 to 80 nuts per year. There are individual trees and elite stands which may yield as many as 150 to 200 nuts per year.

Coconut requires porous moist soil, typically deep fertile sandy loams. Its roots can and it accommodate saline water, which does not effect its biocycle or physiology. It requires liming once a year and grows best in soils pH range of 5.2 to 8.

Coconut is intolerant of shade. Root system is lateral and it makes a massive anchorage capable of withstanding cyclonic winds. Seeds should be collected from seed bearers and germinated in a nursery. The nursery beds should be kept moist but not saturated. Seeds germinate in about 12 to 18 months. Planting is generally in line at a distance of 10m. If a dense plantation is desired, the matrix should be as close as possible to 10m x 10m, but should never be denser than 6m x 6m.

The young plants are usually shaded and are kept watered in dry weather. Weeding, shallow ploughing manuring (compost) is advisable throughout the life of the plantation.

Another important palm is Khejur (Date palm). Khejur was planted on embankments in the 1970s. Its natural protection due to spines, and extreme windhardyness make it a very

popular species in a shelterbelt. The tree yields juice for about four months each year. About 120 trees provide employment to one person for four months. The juice is collected and concentrated into sugar known as 'pataligur'. Occasionally, the juice is malted and concentrated to vinegar (sirka). However, the wind resistance of Khejur is less than that of Narikel. Date palms grow well in Jessore, Kushtia, Faridpur, Pirojpur, Patuakhali and Bhola (**Figure C.6**). The fruit has a large seed with a tasteless rind. Regeneration with bare seed dibbled in the ground is straightforward but the growth rate is very slow. The only advantage is that the plant is windfirm and yields sweet tasteful juice, provided the crown is kept clean during September and October every year. The annual production from 120 to 150 trees should be about 1200 to 1400 kg of molasses, valued at Tk. 20,000.

e) Species for Homesteads and Public Places

The growing of trees in homesteads is a common practice in Bangladesh and the coastal areas are no exception. The number of trees per homestead in coastal areas is more than in the interior of the country. Popular species are Coconut, Date palm, Tal, Supari, Amra, Mango, Bhadi, Shimul, Mandar, Tamarind, Jam, Raintree and Koroi. These trees provided shelter to many people in coastal areas during the 1991 cyclone, although all species were badly damaged.

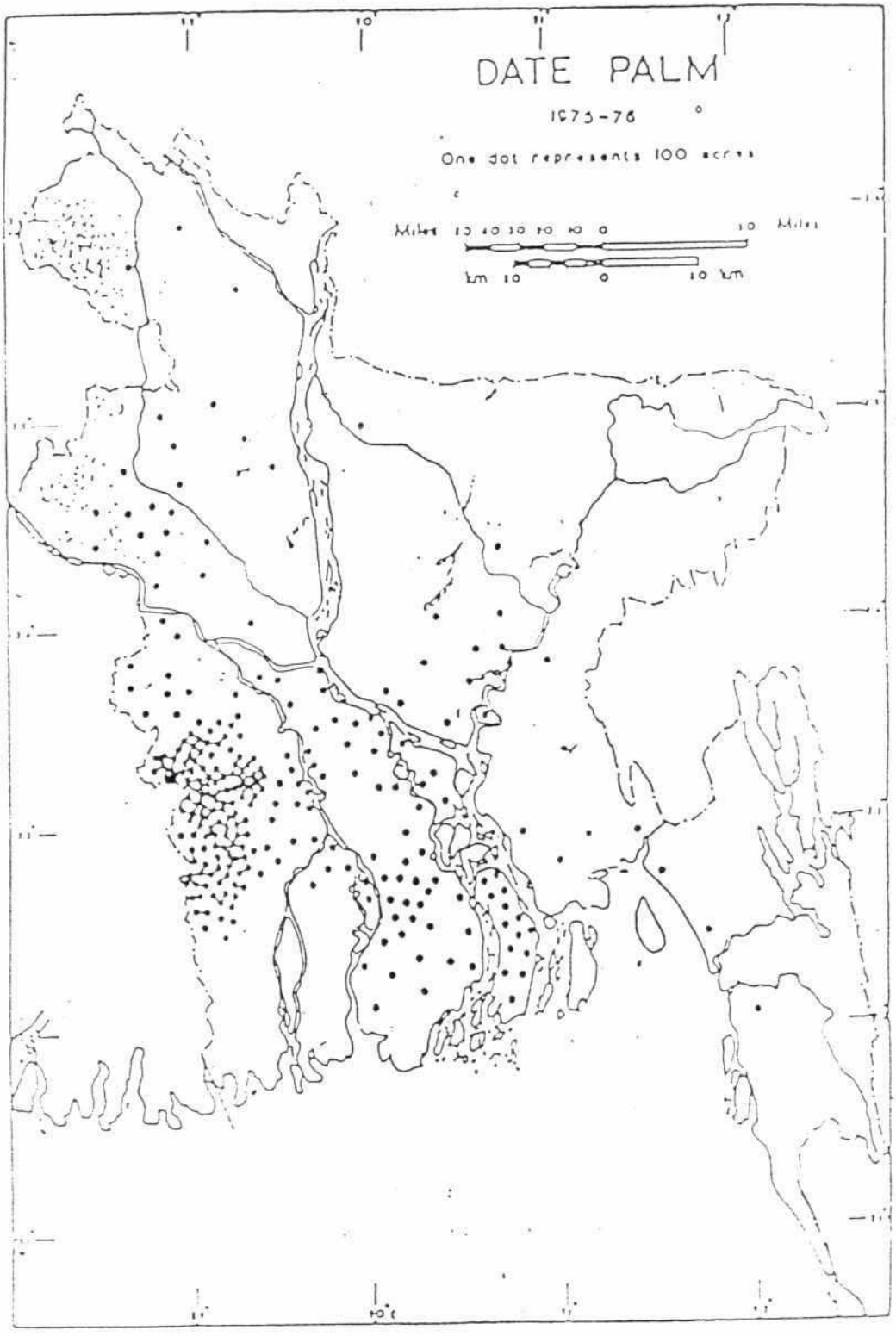
On the basis of their performance during the 1991 cyclone, the most storm hardy species, in order of strength were :

Dispyros	(Gab)
Hijal	
Areca Catechu	(Supari)
Avicennia officinatis	(Bean)
Azidrachta indica	(Neem)
Borassus flabellifer	(Tal)
Cassia siamea	(Minjeri)
Cocas nucifera	(Narikel)
Dipterocarpus Spp.	(Garjan)
Ficus Spp.	(Bot and related species)
Melia azedrach	(Ghora neem)
Michelia champaca	(Champa)
Sweitenia mahoganii	(Mahojany)
Phonix sylvestris	(Khejur)
Syzygium cummini	(Kalojam)
Syzygium grandis	(Dhakijam)
Tamarindus indica	(Tetul)

Raintree is the most common species in village areas and homesteads. Although damaged by high winds, they grow fast. Their disadvantage is that in open areas their crowns become wide which results in breakages. Systematic pruning reduces bole size and top heaviness and hence the damage by storms is considerably reduced. Generally, Raintree, Albizzia, and Simul are planted for protection and the plantations should be aligned at right angles to th strongest winds, generally west-north-east.

It was reported that coconut is the fastest growing of all the palms and provides cocount water and copra after a disaster and may provide extra food.

Figure C.6
Geographical Distribution of
Date Palm (Ohisson, 1984)



C.4 INSTITUTIONAL AND SOCIAL ASPECTS

C.4.1 Coastal Accretions

It is difficult to forecast potential sites for the establishment of coastal plantations. Recent data on coastal accretion are not available. According to 1984 satellite imagery, SPARRSO estimated that the total recent accretion amounted to 91,041 ha of which 50 000 ha were considered stable and suitable for afforestation (See **Table C.12**).

Between 1985/86 and 1991/92 DoF established 39,331 ha of plantations in the coastal areas. If all these plantations were raised on newly accreted land, only 11,500 ha of such land would be available for further plantations.

TABLE C.12

Land Accretion

	Extent of Accretion (ha)			
Division	Stable	Mudflats	Sandbank	Total Area
Chittagong	13,895.96	16,180.16	2,090.61	32,166.73
Noakhali	24,118.16	13,984.65	243.00	38,345.81
Barisal	8,849.66	6,551.69	391.97	15,793.32
Patuakhali	3,984.80	334.94	388.87	4,708.61
Total	**50,848.58**	**37,051.44**	**311.45**	**91,014.47**

Source : SPARRSO Technical Report 1987.

C.4.2 Legal Status of Accreted Lands

Under the Law, all newly accreted land and charlands belong to the Government. Their allocation is the responsibility of the GOB through the Ministry of Land (MoL). MoL transferred 497 975 ha of newly formed coastal accreted land to DoF in 1976 for a period of 10 years thereafter it was to revert to MoL. **Table C.13** gives the location of the land transferred.

Vague location, weak administration and lack of interdepartmental cooperation made it difficult for DoF to take possession of the land. On the contrary, some of the land had already been leased out and some were under the illegal possession of people from the mainland. DoF raised plantations where they could. However, from the start, DoF was considered to be an undesirable intruder by the local people. It was an important issue which shall requires discussion and solution. DoF personnel have pointed out that the maximum loss of life and property occurs when DoF activity is lowest. This is a political question which requires a political solution.

On August 14, 1985 a meeting was held under the chairmanship of the Minister of Land Administration and Land Reform (MLALR) which resolved that 40 486 ha of newly accreted would be transferred to DoF for 20 years for afforestation under the Mangrove Coastal Afforestation Project, supported by the World Bank. To demarcate the area and ensure speedy and smooth transfer, a Committee was formed in each of the coastal districts comprising:

TABLE C.13

Accreted Lands Transferred to the DoF in 1976

Districts	Area (ha)	Location	
		Longitude	Latitude
Chittagong	78 947	22°45'N 20°30'N	91°15'E 92°30'E
Noakhali	182 186	22°00'N 21°30'N	91°00'E 91°30'E
Barisal (Bhola)	145 749	22°30'N 21°30'N	90°30'E 91°00'E
Patuakhali	91 093	22°'00N 21°'00N	89°00'E 90°40'E

Source : DoF

-	Deputy Commissioner	Chairman
-	Superintendent of Police	Member
-	Deputy Director, Agriculture Extension	Member
-	Divisional Forest Officer (DFO)	Member Secretary

A National Committee was also formed to develop policy and policy instruments, rules and regulations in connection with coastal afforestation. This Committee comprises :-

-	Minister of Agriculture	Chairman
-	Secretary, Ministry of Agriculture	Member
-	Secretary, MLALB	Member
-	Secretary, Ministry of Finance	Member
-	Secretary, Ministry of LGRD & Coop	Member
-	Secretary, Ministry of Irrigation, WD and FC	Member
-	Chief Conservator of Forests	Member Secretary

In accordance with the policies formulated, the DFO should request the Deputy Commissioner to transfer any charland selected for afforestation to DoF. The request should be supported by a map. Once the transfer has been approved, afforestation activities can start.

Coastal lands were first 'leased' to DoF for 10 years, this was followed by further period of 10 years. Since plantations started in 1974, some are scheduled to be returned to MoL in 1994. In such a land hungry country, people are waiting to see how this will transfer take place and the ultimate fate of the land. Some policy guidelines need to be formulated immediately well before 1994, which is less than two years away.

C.4.3 Embankments

Although DoF achieved initial successes in raising Babla plantations on coastal embankments, the situation has changed drastically over the last 15 to 20 years. Pressure on land has increased and DoF is considered to be outsiders by the local people. There would be considerable difficulties for DoF to develop a plantation programme on the embankments alone.

In order to overcome these difficulties, local people's participation in the afforestation programme is essential. NGOs are being encouraged to come forward with definite proposals involving local people. As NGOs have limited or no forestry experience, they should use DoF expertise in raising the plantations. Alternatively, DoF might establish the plantations and maintain them for a initial period and then hand them over to local people through local Government bodies or NGOs for care and maintenance.

In mainland Noakhali, Hatiya, Sandwip and Bhola thanas, landless people have settled of the slopes of embankments. NGOs could take responsibility for organising the people in an afforestation programme on a benefit/share basis. Landless people could raise the plantations protect and maintain them and in return receive a share of the produce. BRAC and PROSHIKA have implemented successful participatory forestry schemes along roadsides with the assistance of DoF under Food for Work. NGOs should be invited to develop an appropriate methodology to involve the people settled on the embankments.

NGOs might organise social forestry groups with the assistance of WFP and MoEF. Group members would be drawn from the disadvantaged strata of the population. All beneficiaries of the scheme should be members of social forestry groups or cooperatives. A land-use right agreement would be prepared and signed by all parties, landowner (Government), implementing agency/NGO and beneficiaries. This agreement should be registered. WFP would assist the workers according to their scale for such works. The land-use right agreement should be for a tenure of not less than seven years. Where BWDB is constructing new embankments with WFP assistance on lands donated by private persons, the afforestation programme should be integrated with embankment construction. Local DoF personnel would provide technical advice and planting stock.

Where people take part in afforestation work under FFW, they should be responsible for protecting the plantation. In return, the produce should be shared between the workers, NGOs, BWDB and DoF.

Where BWDB is constructing embankments with assistance from donors other than FFW, the projects should also include forestry. Technical advice should again be obtained from DoF. Alternatively, BWDB could place afforestation funds at the disposal of DoF which would implement the programme and hand over the mature plantations to BWDB. Similarly, programmes could be worked out with the Union Parishads which could raise the plantations and protect them until maturity.

C.4.4 Afforestation versus Shrimp Culture

The World Bank started to finance the afforestation programme in 1980-81. At the same time, shrimp farming became a major threat to the programme. There was large scale felling of mangrove to form shrimp farms. As shrimp products had a ready international market, farming activities flourished under the patronage of MoFL, which in turn had support from Government itself.

Chokoria Sundarban was cut down following public pressure and converted to shrimp farms.

This area suffered high losses to life and property during the 1991 cyclone. Shrimp farming is good for the economy of the country but not at the cost of human lives.

The value of the mangrove ecosystem has been appreciated in many recent studies. Mangrove forests export significant amounts of organic matter and nitrogenous compounds as plant detritus which support coastal food webs through the food chain. In the process of breakdown of organic and other matter a large number of bacteria, plankton and phytoplanktons act upon the host material. These micro-organisms contain a high concentration of protein, which link up the food chain of shrimps, fish and animals. Man is the end user.

The inter-tidal ecosystem is a spawning ground for a number of shrimp species and a feeding ground for juveniles. The dependence of many species on mangrove estuaries have been demonstrated in a number of studies, consequently the loss of mangrove vegetation will undoubtedly reduce shrimp production.

To ensure sustainable development of shrimp farming and coastal afforestation, MoEF and MoFL should work together to develop projects which integrate shrimp farming with coastal afforestation. Both Ministries should insist that shrimp farms retain 40% of the farm under mangrove. To achieve this objective, District Committees should co-opt the District Fisheries Officer as a member. Similarly, the National Committee should be reconstituted under the chairmanship of the Minister of Environment and Forests and include the Secretaries of both MoEF and MoFL as members to develop appropriate policies and related policy instruments for coastal and mainland afforestation.

C.5 REHABILITATION AND NEW PLANTATIONS

C.5.1 Background

The cyclone of April 29-30, 1991 and previous ones yielded important information regarding the relationship between the intensity of damage and survival of vegetation, particularly large trees. Trees at vantage points saved lives and property, while areas devoid of trees and vegetation were badly damaged with the loss of many lives. Empirical observations revealed that houses encircled by trees were well protected, with consequently little loss of life and damage to property.

Due to the observed protective functions of trees, a persistent demand for large scale plantation in offshore islands, coastal embankments foreshore land and individual houses has developed. The aim is to provide a shelterbelt and hence reduce the damage and loss of life and property.

C.5.2 Rehabilitation of Cyclone damaged Forest and Creation of Green Belt

GOB has prepared a plan for the rehabilitation of cyclone damaged forests and the simultaneous creation of a 'green belt' along the coast. The physical work involves the following activities :-

- rehabilitation of 9,600 ac of hill forest
- raising 676 nurseries in 69 thanas along the coast
- replanting 600 acres of casurina plantations on the sea beach of Cox's Bazar
- raising 229.60 lac coconut seedlings and 112.35 lacs other seedlings, and their distribution to houses in 7 884 villages
- plantating of forest trees on the slopes of 1 000 miles of embankment
- reconstruction of buildings on roads and highways and rehabilitation of other infrastructure

The plan has been sponsored by MoEF and it is assumed that the activities will be mainly in damage prone areas along the coast.

Where the trees have been uprooted and the embankments are now unprotected, efforts should be made to replant in a systematic and scientific manner. This would substantially reduce the potential for damage from cyclonic storms and surges. However, if the embankment is damaged, rehabilitation of the embankment is of primary importance. It would be best to integrate plantation work with embanment rehabilitation work. It would not be correct to raise plantations on temporarily rehabilitated embankkments, because future embankment construction would damage them.

Major components and expenditure are :-

	(Tk. lac)
- Construction	2 778
- Manpower	1 765
- Vehicles	227
- Office equipment	34
- Land	338
- Rehabilitation of damaged forests and maintenance (10 100 acre)	798
- Nursery for 224.69 lac coconut and 112.35 lac other seedlings	7 190

- Afforestation of 1 000 miles of embankments	456
- Local training	17
- Miscellaneous	93
- Price escalation	1 172
Total	**14 867**

On completion after three years, the annual expenditure will be some Tk 900 lac of which personnel are likely to cost Tk. 735 lac. The project will generate employment for 69 professionals and 2 035 workers.

As the project is basically to protect life and property, the other benefits were not quantified and B/C, NPV and other economic indices were not calculated. **Table C.14** gives the programme for the period 1992/93 - 1998/99.

TABLE C.14

Resources Management Plan

Coastal Afforestation Division (CAFD)	Area established (ha)							
	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	Total
Noakhali	2,500	2,500	1,500	1,500	1,500	1,500	1,500	**12,500**
Chittagong	1,600	1,700	1,200	1,200	1,200	1,200	1,200	**9,300**
Patuakhali	900	900	500	500	500	500	500	**4,300**
Bhola	1,400	1,400	800	800	800	800	800	**6,800**
Total	**6,400**	**6,500**	**4,000**	**4,000**	**4,000**	**4,000**	**4,000**	**32,900**

Source : DoF

C.5.3 IDA Third Forestry Project

DoF plans to establish 24,000 ha of new plantations in stable newly accreted lands between 1992/93 and 1998/1999 under the World Bank funded Third Forestry Project. In addition, 8,900 ha of cyclone damaged plantations will be replanted. Consequently, unless there has been large scale accretion or conversion of unstable accreted lands into stable land since 1981, no potential area will be left for the establishment of additional plantation following implementation of the Third Forest Project.

Initially, DoF should concentrate on raising 200 m wide forest belts along the 700 km of sea facing and exposed embankments, as suggested by CPP-II (see below) under the Third Forestry Project.

C.5.4 Cyclone Protection Project II (FAP:7)

The feasibility and design studies for the Cyclone Protection Project II (FAP-7) propose that afforestation on the coastal embankment should play an important role in strengthening and improving the sea facing and similarly exposed embankments as wave protection. The study also recognised that afforestation of the foreland and foreshore areas as well as on the seaward slope of the embankments should provide efficient protection against damage by high tidal waves and cyclonic surges. In areas where there was no afforestation, the embankments and costly protective works were often damaged by monsoonal tide waves (Kampsax et al, 1992).

It is very difficult to estimate the length of embankment requiring afforestation. Cyclone Projection Project II (FAP 7) found that there are some 700 km of sea-facing and similarly exposed embankkments, which require plantations. Short term plans should be prepared to raise plantations on these embankments immediately to guard them against high tide waves and cyclonic surges. The length of embankments requiring afforestation is given in **Table C.15.** CPP-II also suggested raising forest belts of 200m width, mostly with mangrove species, on the seaward side of the 700 km of sea facing and similarly exposed coastal embankment.

TABLE C.15

Embankments requiring Afforestation

Districts	Polder Nr.	Thana	Length(km)
Chittagong	61	Sitakunda	17.0
	62	Patenga	16.0
	63/1A	Anwara	14.0
	64/1A	Banshkhaali	20.0
	72	Sandwip	57.0
Cox's Bazar	64/2B	Chakaria	10.0
	66/1	Ramu	7.0
	66/3	Cox's Bazar	5.0
	68	Teknaf	15.0
	69	Moheshkhali	20.0
	70	Matarbari	18.0
	71	Kutubdia	22.0
Noakhali Laxmipur & Feni	59/1A	Companiganj	4.0
	59/2B	Begumganj	
	59/3B	Ramgati	18.0
	59/3C	Sudharam	43.0
	60	Companiganj	42.0
	73/2B	Sudharampur	
		Sonagazi	22.0
		Hatiya	33.0
Bhola	56/57		100.0
Satkhira	5	Kaliganj Shyamnagar	31.5
	7/1	Asasuni	31.0
	7/2	Asasuni	11.0
	14/1	Koyra	11.8
	1/2	koyra	31.0
	15	Shyamnagar	27.0
Bagerhat	35/1	Sarankhila	18.0
Khulna	10/12	Paikgacha	10.0
	31	Dacope	1.5
	32	Dacope	27.0
Barguna	40/2	Patharghata	5.0
	46	Kalapara	2.5
	48	Kalapara	16.0
		Total	**706.0**

Source : Kampsax et al, 1992

Mid and long term plans should also be prepared to raise plantations on embanments facing large rivers and channels. The length of such embankments will be significantly more than that of the sea facing and similarly exposed embankments.

C.5.5 ADB Coastal Afforestation Study

The Asian Development Bank is assisting GOB to conduct a study to establish a 'green belt' along the coast with coconut, palm and other tree plantations. According to the TAPP prepared for the purpose, the study will :-

i) survey the total coastal area, both edaphically and ecologically, to ascertain the potential for growing coconut, other palm and tree species of mainland and mangrove origin;

ii) identify areas suitable for coconut palm;

iii) select site specific coconut varieties including dwarf coconut. If dwarf and deep rooted varieties are selected, seed source, support method and planting technique should be specified. This is the most complicated part of the specification. This could amount to identification of various races, populations and genetic varieties which have the desired characteristics. The performance of an adaptability test is a complicated exercise in applied statistics and may require selection and observations over several generations. The test should include :-

- the identification of total needs for coconut and other tree seeds and their source;
- role of NGOs and private enterpreneurs in raising such plantations;
- proposals for loan assistance necessary to raise coconut plantations by private enterpreneurs, which should be collectively large bu individually small, embracing the concept o family holding;
- the development of plantation models;
- recommendations of mechanisms for raising plantations, including the degree of involvement of local people, NGOs etc;
- the calculation of economics of account, other palm and tree plantations; and
- the examination of the concept of an umbrella government organisation, jointly with foreign and local private sector, having background and know how about coconut and palm oil plantation.

The study will involve 16 man-months of staff time costing US$ 250,000, which will be provided by an ADB grant.

Palm trees, coconut, palmyra, date and areca (supari), can effectively resist the effects cyclonic storms and surges due to the concentration of their mechanical tissues at the periphery of their columnar stems which give their stems extraordinary strength. Palsm have a sound rooting system which anchor them solidly into the soil and the trees are not usually uprooted. Palm trees were the trees least effected by the 1991 cyclone (Haider et al, 1991).

It should be noted that date palm is not susceptible to grazing damage but is slow growing. It is naturally storm hardy because of its root system. On the other hand, coconut is susceptible to browsing and its growth rate is very slow.

Coconut can be protected by brick gabions or barbed wire fencing. However, such protective measures are expensive. MCSP (see below) did not recommend large scale plantation of coconut on public land unless protection was ensured.

It is considered that despite its slow growth and possibility of grazing, coconut should be extensively planted because it is a source of good drinking water, the copra is edible and it yields good quality oil for soap.

C.5.6 Multi Purpose Cyclone Shelter Programme (MPCSP)

The MPCSP Mster Plan reviewed the progress of the coastal afforestation programme and made various proposals. MCSP recommended increased coastal afforestation and also appropriate plant species, which were storm hardy and stable in cyclonic and sub-cyclonic winds. In particular, the MCSP proposed :-

i) the critical examination of ground conditions in the coastal regions from maps and by physical observation and the delineation of the existing forests in coastal areas, including offshore islands;

ii) a review of the existing afforestation programme and an assessment of its effectiveness i.e., examine the success/failure of the previous strategy;

iii) programmes of afforestation along the coastal embankments, mangrove mudflats, shelter belts and offshore islands;

iv) appropriate species of plants in an arboricultural mix of anti cyclone/storm usefulness; and

v) the improvement of various institutional aspects of afforestation and tree plantation as the existing system is not considered appropriate.

vi) Recommendations for plantations around human settlements were classed as:

homestead
roads
canals
education and religious institutions
cyclone shelters
killas

Planting programmes were suggested for each class after field visits, wherever possible by a team.

MCSP made their various proposals following field visits and on examination of existing methodology. The suggestions appear sound, but would require much time and costly study to obtain reliable information on which to base such a major programme.

The field inspection were undertaken in April and May 1991 by MCSP to :-

Baraitali, Pekua, Mognama, Chittagong

Kutubdia Island, Moheshkhali, Chittagong
Khurushkul (Cox's Bazar)
Fouzdarhat, Kattali & Halishahar, Chittagong
Char Fasson, Char Manika, Bhola

These visits indicated that :-

i) **Palms:** Coconut, date-palm, Areca catechu (supari) were storm hardy;

ii) **Son boloi:** Thespesia, populnea (an endemic species) was fast growing and storm hardy in mangrove forests. It was also sustainable in mangrove formations;

iii) **Dhol Kalmi:** Ipomea fistulosa, a hardy shrub, is was suited for planting on foreshore, as ground vegetation;

iv) **Babla:** was suitable for planting on the slope of embankment;

v) All strata of society in the coastal areas considered that afforestation was a must for saving life and property;

vi) It was not possible for the DoF to carry out an afforestation programme on embankments unless peoples participation was ensured.

vii) According to Forest Officers, local people often do not respect DoF. They consider DoF personnel outsiders who encroach on local lands. However, the truth is that afforestation in coastal forelands is a must. This may deprive people of some immediate benefit, but in the long run these forests in coastal forelands save life and property.

The MCSP study recommended the planting of date palms because of their natural protection qualities and their employment generation capabilities through the collection of juice. Coconut was not recommended as they required much protection in their early growth stages. Areca nut was not recommended on the grounds of disease borne by tidal surge. (Talukder, 1975).

C.6 RECOMMENDATIONS

C.6.1 Introduction

It should be clearly understood that afforestation involves the following :-

- obtaining of planting stock
- planting
- protection of the plantation
- weeding and fertilization
- growth till maturity.

If any of the above stages is not properly carried out, the results may be disappointing, as has happened at many sites.

C.6.2 Homesteads

The growing of trees in homesteads is an age-old custom in Bangladesh. However, the limiting factor is the availability of planting stock. Scarcities can be eliminated by government assistance in the supply of seeds and cuttings and through publicity regarding the usefulness of nursery raising and planting economic plants. Recently DoF produced 8m to 9m seedlings, many of which could not be disposed of while unconfirmed reports quote the availability of required seedlings from existing nurseries as only 10% of demand. The situation needs to be addressed by NGOs engaged in forestry activities through motivation and the raising small private nurseries and training.

Selection of species for homestead plantation should focus on horticulture, fuelwood and windfirm species.

C.6.3 Cyclone Shelters and Killas

Most of the existing cyclone shelters and killas are devoid of vegetation. Efforts should be made to create 'green belts' around all such shelters and killas. An afforestation programme should be an integral part of the construction and rehabilitation of shelters and killas. Managing committees of each shelter and killa should be assigned specific responsibility for the raising, maintaining and protection of the trees.

Most of the proposed cyclone shelters will be primary schools during 'normal' times. All school children should be trained in nursery practices and tree planting. Children should assist their respective school-cum-cyclone shelter in raising, maintaining and protecting 'green belts' under the guidance of their teachers. Elements of nursery practice and plantation activities should be included in school curricula. Technical inputs should be provided by DoF and DAE personnel.

C.6.4 Accreted Land, Embankments and Forelands

As stabilisation is a natural process, it cannot be assumed that the land will stabilise within 20 years. It may take place in less than 10 year or it may take more than 50 years, although afforestation would tend to accelerate the process.

Coastal land cannot be considered stable while mangroves are its natural vegetation. When the land becomes stable, the mangrove species gradually disappear making room for high land species. The disappearance of mangrove is a continual process over a long period of time. For example in the Sundarbans, Sundari held its ground for several hundred years, now

it is being replaced by Kankra Brugiera gymnorhiza. This species will dominate until it is replaced by some other more salt tolerant species.

If coastal forelands are not suitable for mangrove species due to the level of the land, other species are required to form the shelterbelt to protect life and property of the people of the hinterland and to protect the embankments. This land should not be released for other purposes. A shelterbelt of considerable width (200m to 700m) should be maintained on the coastal forelands of all sea-facing and similarly exposed embankments.

C.6.5 Summary Proposals

i) Coastal plantations have an important role to play in minimizing the scale of damage caused by cyclones and surges. A 'green belt' should be created in the coastal area to reduce losses to life and property;

ii) DoF should continue with their afforestation work in coastal forelands and accreted areas;

iii) Clearing mangrove forests and coastal plantations for shrimp culture should be stopped. The Chokoria Sundarbans should be restored to its original mangrove status, MoEF and MoFL should jointly develop sustainable shrimp farming methods;

iv) DoF should hand over accreted stable lands to MoL provided such lands are not acting as sheltersbelts. A shelterbelt of considerable width (200m to 700m) should be maintained along coastal forelands;

v) All seafacing and similarly exposed embankments should be afforested. Mid and long term plans should be prepared to establish plantations on embankments facing large rivers and channels in the coastal area. All seafacing and exposed embankments should also be protected by a shelterbelt of considerable width on the seaside. Care should be taken in choosing species for the slopes of embankments. Medium sized trees should be planted on gentle slopes, whereas shrubs (Dhol Kolmi) and palms should be planted in steep slopes;

vi) All new construction or rehabilitation of coastal embankments should incorporate forestry as an integral part. Local people, local government bodies and NGOs should be involved in raising, maintaining and protecting these plantations with advice from DoF;

vii) Coconut and date palms should be planted extensively in the coastal areas, Coconut should be planted on sites, where protection is assured. Coastal accretions should be planted with mangrove species e.g., Keora, Kakra, Gewa and Baen Babla. Casuarina, Akashmani and other tree species should be planted on embankments. Raintree and fruit trees should be planted in homesteads, together with Koroi, Simul and other species. To prevent uprooting, all trees in shelter belts should be pruned at regular intervals so that their tops do not become too heavy;

viii) No rotation should be fixed for mangrove species. Natural death and replacement by other species indicates maturity and stability of soils. However, Keora plantations on embankments should be felled under shelter wood system and replanted;

ix) Private nurseries should be encouraged in coastal areas to satisfy local demand. Forestry and agricultural extension services should be strengthened to train local people in nursery raising. NGOs should take the lead in organising local people in nursery raising.

x) 'Green belts' should be established around cyclone shelters, killas, religious and academic institutions constructed in coastal areas. The management committee of each shelter and killa should be responsible for raising, maintaining and protecting the 'green belts' with technical inputs from the local DoF and DAE officers. School children should be 'tree minded' through training in nursery and plantation raising around their respective institutions.

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APPENDICES

APPENDIX 1
Ranges and Centres of Coastal Afforestation

Appendix 1

RANGES AND CENTRES OF COASTAL AFFORESTATION

Name of Range	Nr.	Name of Centre	Name of Range	Nr.	Name of Centre
Division : Bhola					
Kukri Mukri	1	Kukri Mukri	Manpur	4	Char Chiringa
	2	Patkar Char		5	Char Majumdar
	3	Char Jamir		6	Sonar Char
	4	Char Shafi		7	Char Lincon
	5	Char Dhal		8	Natun Char (Badar Char)
	6	Char Alim		9	Kalkini (Nizam)
	7	Char Patia			
	8	Char Hakim			
	9	Char Roushan	Char Fashon	1	Char Chandni
	10	Char Mukta		2	Char Hasan
	11	Char Baikal		3	Char Islam
	12	Char Nirala		4	Kachua Khal
	13	Char Dighal		5	Char Fakira
				6	Karchir Char
Majher Char	1	Majher Char		7	Jahanpur
	2	Tushkhali		8	Mohammadpur
	3	Bholmara		9	Kachabia
	4	Char Zahirul Islam		10	Manika
	5	Char Mizan		11	Bak Char
Manpura	1	Char Patila	Daulatkhan	1	Char Zahiruddin
	2	Char Pail		2	Char Uril
	3	Urir Char		3	Sulakshmi
Division : Chittagong					
Mirsarai	1	Dhumkhali	Teknaf	1	Teknaf
	2	Mogadia		2	Shahparidwip
				3	Hnilla
				4	Katabunia
Sitakunda	1	Mansoari	Urir Char	1	Urir Char
	2	Bagkhali			
	3	Baghachattar			
Head Quarter	1	Patenga	Sandwip	1	Dhupirkhil
	2	Halishahar		2	Katakhali
	3	Bandar		3	Guptachara
	4	Kattali		4	Maitbhanga
				5	Bhuiyarhat
				6	Izzatpur
				7	Harishpur

Appendix 1 – Continued

RANGES AND CENTRES OF COASTAL AFFORESTATION

Name of Range	Nr.	Name of Centre	Name of Range	Nr.	Name of Centre
Division : Chittagong					
Banshkhali	1	Chhanua	Sandwip	9	Sonadia
	2	Khankhanabad		10	Baradia
	3	Gandamara		11	Matarbari
	4	Ratanpur		12	Jahpua
	5	Khatkhali		13	Hamidkhali
	6	Premasia (Gohira)		14	Amabashya Khali
	7	Char Mizan		15	Malakhali
Kutubdia	1	Khudiartek	Charandwip	1	Charandwip
	2	Mognama		2	Rampur
	3	Ujantia		3	Silkhali
	4	Dhurung		4	Ichaphariadwip
	5	Baraghope		5	Muhuri Ghona
	6	Ali Akbar Deil			
Gorakghata	1	Bagkhali			
	2	Kalatali			
	3	Puk Khali			
	4	Gorakghata			
	5	Baruakhali			
	6	Khuruskul			
	7	Tataya			
Division : Noakhali					
Char Bata	1	Dakshin Char	Nalchira (Hatia)	1	Dhal Char
	2	Char Nangulia		2	Telir Char
	3	Char Lakshmi		3	Char Wahed
	4	Char Majid		4	Ghasir Char
	5	Banskhali		5	Char Nurul Islam
				8	Char Piaya
Jahajmara	1	Char Yunus	Sogoria (Hatia)	1	Char Alim
	2	Char Osman		2	Char Awal
	3	Kamlar Char			
	4	Char Klam	Companiganj	1	South Masumpur (Musap)
	5	Rowshan		2	Char Balua (Diara Balua)
	6	Rahaudddin		3	Char Mallick
	7	Rehania		4	Cachhapia
				5	Char Balua
Char Alauddin	1	Bonani	Alexander	1	Char Gajaria
	2	Char Alauddin		2	Gajon
	3	Char Lakshmi			
Habibia	1	South Toom Char			
	2	Char Mohiuddin			
	3	Ziauddin			
	4	Srijoni (Boyrachar)			
	5	Banskhali (West)			
	6	Banskhali Khal			

Appendix 1 – Continued

RANGES AND CENTRES OF COASTAL AFFORESTATION

Name of Range	Nr.	Name of Centre	Name of Range	Nr.	Name of Centre
Division : Patuakhali					
Patharghata	1	Hatimabria	Mohipur	1	Char Habib
	2	Lathimara		2	Khajura
	3	Ruhita		3	Gangamati
	4	Tengra		4	Kuakata
	5	Babuganj		5	Baliatali
	6	Badurtola		6	Dhulasahar
	7	Kumirmara		7	Hajipur
	8	Laldia		8	Shibbaria
	9	Padma		9	Latachapli
				10	Kawa Char
				11	Sonatola
Galachipa	1	Char Tufania	Amtali	1	Ashar Char
	2	Char Kashem		2	Nidrar Char
	3	Char Hare		3	Tengragiri (Sakhina)
	4	Char Talukdar		4	Bara Nishanoaria
	5	Char Bogla		5	Char Rowshan
	6	Agunmukha		6	New para
	7	Char Bangla		7	Andermanik
	8	Char Bangla		8	Kajikhola
	9	Bastin		9	Kumiramara
	10	Jamuna		10	Fatra
	11	Gungipara		11	Khottor Char
	12	Banani		12	Baliatali
	13	Lakshmi			
	14	Rustom			
	15	Ashabasria			
	16	Ghasir Char			
Char Montaj	1	Sonar Char	Dashmina	1	Char Hadi (Kachuakhali)
	2	Nayar Char		2	Shahalal
	3	Char Kabir			
	4	Char Taposhi			
	5	Ander Char			
	6	Char Montaj			

Source : Dalmacio et al, 1991

No	Name of Range	No	Name of Centre
1	Patharghata	1	Hambria
		2	Lathimara
		3	Ruhita
		4	Tengra
		5	Babuganj
		6	Badurtola
		7	Kumirmara
		8	Laldia
		9	Padma
2	Golachipa	1	Char Tufania
		2	Char Kashem
		3	Char Hare
		4	Char Talukdar
		5	Char Bogla
		6	Agunmukha
		7	Char Bangla
		8	Kankanipara
		9	Bastin
		10	Jamuna
		11	Gungipara
		12	Banani
		13	Lakshmi
		14	Rustom
		15	Ashabaria
		16	Ghasir Char
3	Char Montaj	1	Sonar Char
		2	Nayar Char (Montaj)
		3	Char Kabir
		4	Char Taposhi
		5	Ander Char
		6	Montaj
4	Mohipur	1	Char Habib
		2	Khajura
		3	Gangamati
		4	Kuakata
		5	Baliatali
		6	Dhulasahar
		7	Hajipur
		8	Shibbaria
		9	Latachapli
		10	Kawarchar
		11	Sonatola
5	Amtali	1	Ashar Char
		2	Nidrar Char
		3	Tengragiri (Sakhina)
		4	Bara Nishanbaria
		5	Char Roushan
		6	New Para
		7	Andermanik
		8	Kajikhola
		9	Kumirmara
		10	Fatra
		11	Khottor Char
		12	Baliatali
6	Dasmina	1	Char Hadi (Kachuakhali)
		2	Shahjalal

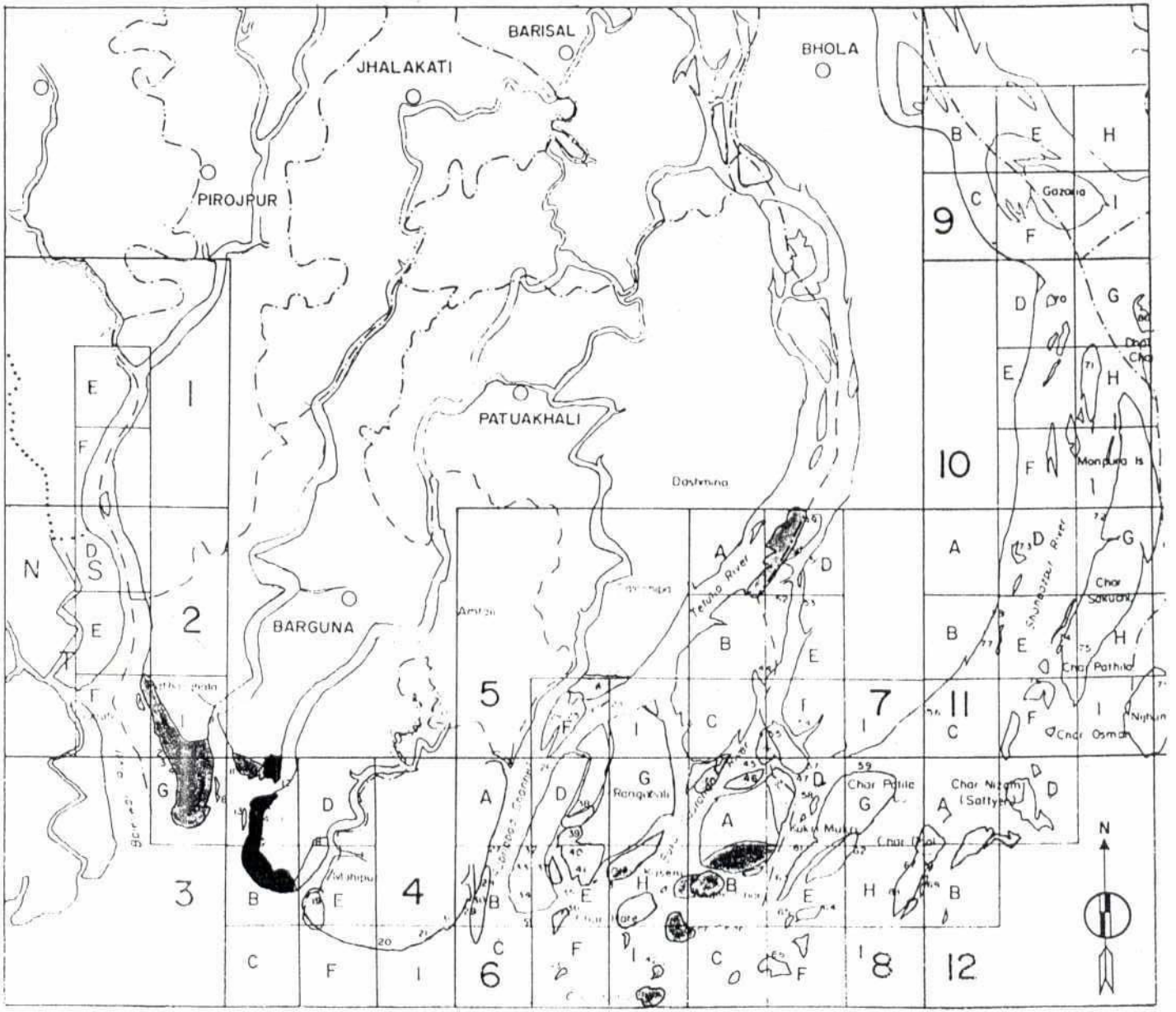


Figure 1.1
Index Map of Coastal Afforestation - Patuakhali Division

No	Name of Range	No	Name of Centre
1	Kukri Mukri	1	Kukri Mukri
		2	Patkar Char
		3	Char Jamir
		4	Char Shafi
		5	Char Dhal
		6	Char Alim
		7	Char Patila
		8	Char Hakim
		9	Char Roushan
		10	Char Mukta
		11	Char Baikal
		12	Char Nirala
		13	Char Dighal
2	Majher Char	1	Majher Char
		2	Tushkhali
		3	Bholmara
		4	Char Zahirul Islam
		5	Char Mizan
3	Monpura	1	Char Patila
		2	Char Pial
		3	Urir Char
		4	Char Chiringa
		5	Char Majumdar
		6	Sonar Char
		7	Char Lincon
		8	Natun Char (Badnar Char)
		9	Kalkini (Nizam)
4	Char Fashon	1	Char Chandni
		2	Char Hasan
		3	Char Islam
		4	Kachua Khal
		5	Char Fakira
		6	Karchir Char
		7	Jahanpur
		8	Mohammadpur
		9	Kachabia
		10	Manika
		11	Bak Char
5	Daulatkhal	1	Char Zahiruddin
		2	Char Uril
		3	Sulakshmi

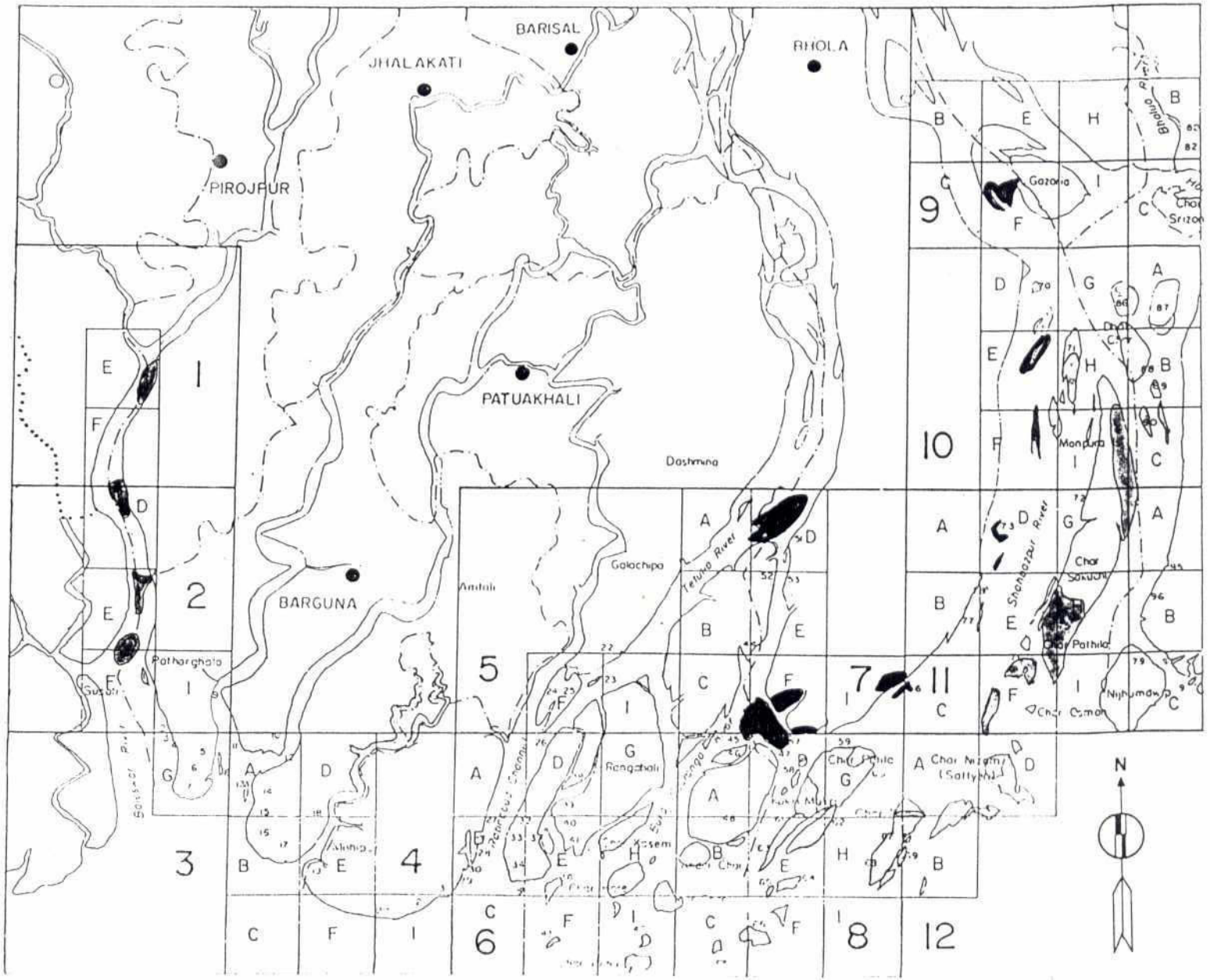
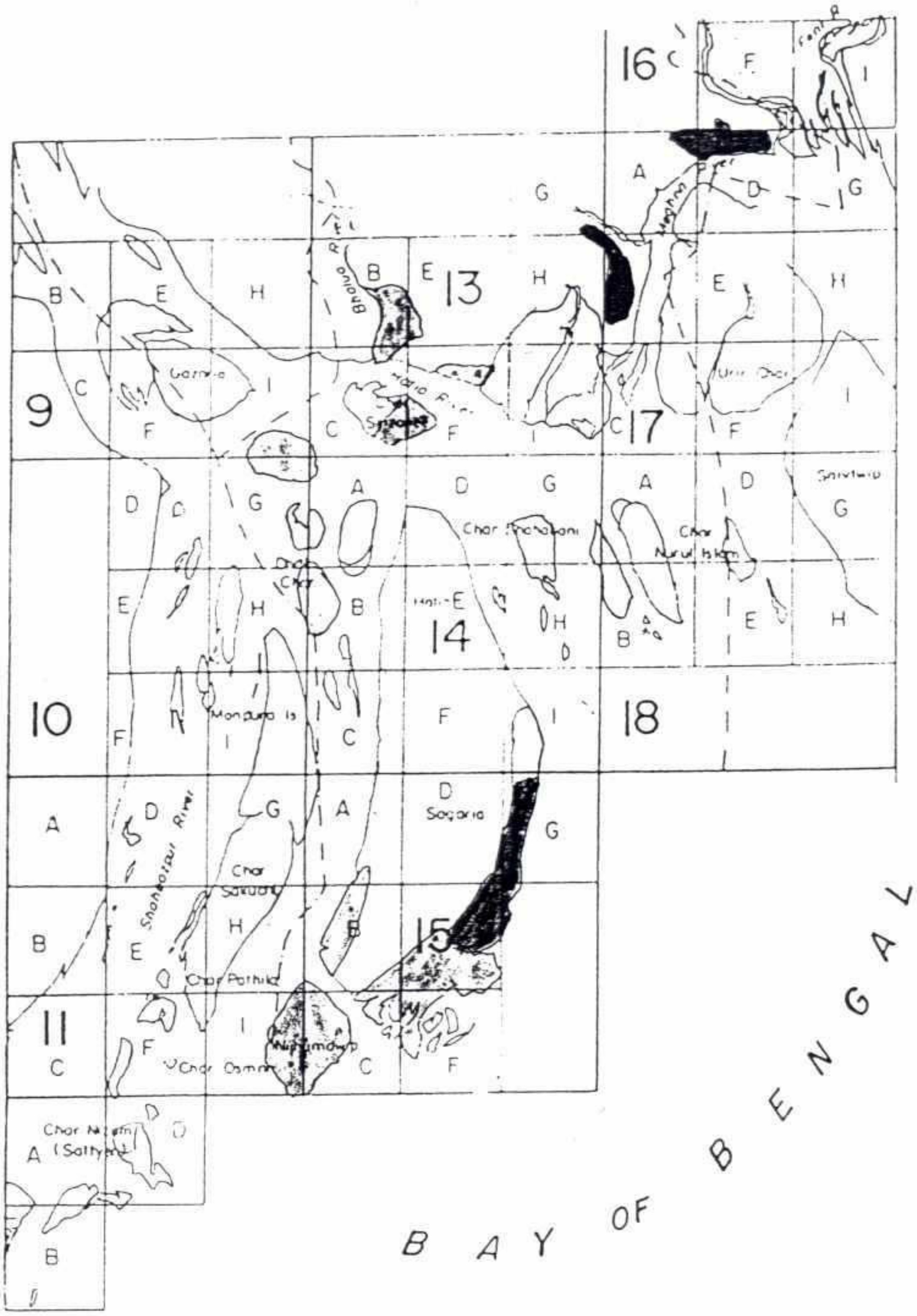


Figure 1.2
Index Map of Coastal Afforestation - Bhola Division

Figure 1.3
Index Map of Coastal Afforestation - Noakhali Division



No.	Name of Range	No	Name of Centre	No	Name of Range	No	Name of Centre
1	Char Bata	1	Dakshin Char Clarke	5	Nalchira (Hatia)	1	Dhal Char
		2	Char Nangulia			2	Telir Char
		3	Char Lakahmi			3	Char Wahed
		4	Char Majid			4	Ghasir Char
		5	Banskhali			5	Char Parvez
						6	Char Sahabani
2	Jahaj Mara	1	Char Yunus			7	Char Baten
		2	Char Osman			8	Oskhali
		3	Kamlar Char			9	Char Nurul Islam
		4	Char Kalam			10	Char Piya
		5	Roushan				
		6	Bahauddin	6	Sagoria (Hatia)	1	Char Alim
						2	Char Awal
3	Char Alauddin	1	Bonani			3	Rehania
		2	Char Alauddin				
		3	Char Lakshmi	7	Companigonj	1	South Masumpur (Musapur)
						2	Char Balua (Diara Balua)
4	Habibia	1	South Toom Char			3	Char Mallick
		2	Char Mohiuddin			4	Kachhapia
		3	Ziauddin			5	Char Balua
		4	Srijoni (Boyrachar)				
		5	Banskhali (West) & Banskhali (Khal)	8	Alexander	1	Char Gazaria
						2	Srijoni

Figure 1.4
Index Map of Coastal Afforestation - Chittagong Division

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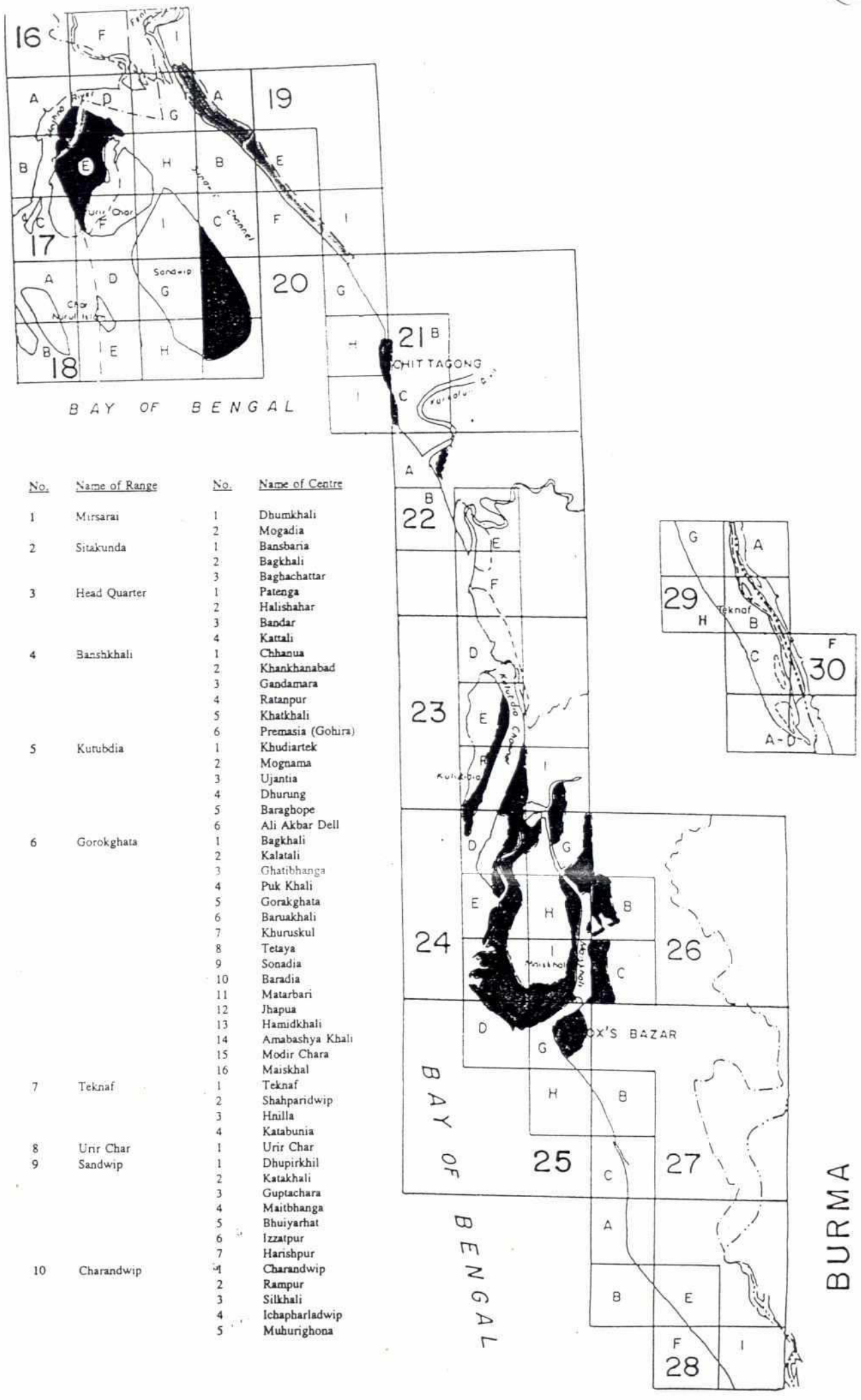

No.	Name of Range	No.	Name of Centre
1	Mirsarai	1	Dhumkhali
		2	Mogadia
2	Sitakunda	1	Bansbaria
		2	Bagkhali
		3	Baghachattar
3	Head Quarter	1	Patenga
		2	Halishahar
		3	Bandar
		4	Kattali
4	Banshkhali	1	Chhanua
		2	Khankhanabad
		3	Gandamara
		4	Ratanpur
		5	Khatkhali
		6	Premasia (Gohira)
5	Kutubdia	1	Khudiartek
		2	Mognama
		3	Ujantia
		4	Dhurung
		5	Baraghope
		6	Ali Akbar Dell
6	Gorokghata	1	Bagkhali
		2	Kalatali
		3	Ghatibhanga
		4	Puk Khali
		5	Gorakghata
		6	Baruakhali
		7	Khuruskul
		8	Tetaya
		9	Sonadia
		10	Baradia
		11	Matarbari
		12	Jhapua
		13	Hamidkhali
		14	Amabashya Khali
		15	Modir Chara
		16	Maiskhal
7	Teknaf	1	Teknaf
		2	Shahparidwip
		3	Hnilla
		4	Katabunia
8	Urir Char	1	Urir Char
9	Sandwip	1	Dhupirkhil
		2	Katakhali
		3	Guptachara
		4	Maitbhanga
		5	Bhuiyarhat
		6	Izzatpur
		7	Harishpur
10	Charandwip	1	Charandwip
		2	Rampur
		3	Silkhali
		4	Ichapharladwip
		5	Muhurighona

APPENDIX 2
Coastal Plantations

Appendix 2

COASTAL PLANTATIONS (acre)

Year	Chittagong	Noakhali	Barisal	Patuakhali	Total
1965-66	28	0	30	0	58
1966-67	146	26	800	0	972
1967-68	1,270	700	1,050	0	3,020
1968-69	816	682	1,100	0	2,598
1969-70	350	167	925	0	1,442
1970-71	400	179	300	0	879
1971-72	200	118	200	0	518
1972-73	100	50	100	0	250
Subtotal	**3,310**	**1,922**	**4,505**	**0**	**9,737**
1973-74	655	925	0	0	1,580
1974-75	1,390	1,200	1,055	1,220	4,865
1975-76	4,200	2,740	2,072	2,922	11,934
1976-77	6,000	5,420	2,536	2,165	16,121
1977-78	3,150	5,500	2,100	1,250	12,000
1978-79	4,225	4,575	3,809	3,290	15,899
1979-80	3,798	5,650	3,170	3,088	15,706
Subtotal	**23,418**	**26,010**	**14,742**	**13,935**	**78,105**
1980-81	3,500	5,000	4,024	2,500	15,024
1981-82	3,500	5,100	4,000	2,500	15,100
1982-83	4,900	7,000	5,000	3,100	20,000
1983-84	5,500	9,500	7,500	2,500	25,000
1984-85	5,800	9,500	6,300	3,100	24,700
Subtotal	**23,200**	**36,100**	**26,824**	**13,700**	**99,824**
1985-86	5,000	10,000	2,050	3,000	20,050
1986-87	6,000	8,000	3,000	3,000	20,000
1987-88	4,510	7,000	6,240	2,500	20,250
1988-89	3,505	2,500	2,000	1,400	9,405
1989-90	2,200	4,000	2,500	1,600	10,300
Subtotal	**21,215**	**31,500**	**15,790**	**11,500**	**80,005**
1991-92	2,130	2,300	1,000	1,700	7,130
1992-93	2,050	5,000	2,000	1,000	10,050
Subtotal	**4,180**	**7,300**	**3,000**	**2,700**	**17,180**
Total	**75,323**	**102,832**	**64,861**	**41,835**	**284,851**

Source : Planning Cell, DoF.

APPENDIX 3
Impact of 1991 Cyclone on Vegetation

Appendix 3

IMPACT OF 1991 CYCLONE ON VEGETATION

Plant Speces	Nature and percentage of overall damage	Additional observations
1. Acacia auriculifomis	Damage to branchlets and leaves (20%)	In Chunati plantations
2. A. Mangium	Branchlets broken (20%)	Damage in Chunati plantation
3. Alangium salviffolium (Ankura)	Branches broken, no leaf damage (15%)	Mostly at Chittagong
4. Albizia chinensis	Mostly defoliated, uprooted (60%)	
5. A. lebbeck (Siris)	Defoliated, now with new leaves (10%)	
6. A. lucida (Sil Koroi)	Negligible damage to stems (6%)	Greater damage in Banshkhali
7. A.l procera (Sil Koroi)	Negligible damage to stems (6%)	
8. Anogeissus lanceolata (Hingori)	Uproote,d damage to branches (10%)	
9. Anthocephalus chinensis (Kadam)	Mostly uprooted, branches torn (50%)	
10. Areca catechu (Supari)	Leaves scorched at the end (5%)	Stem damage in Moheshkhali and Banskhali
11. Artocarpus heterophyllus (Kanthal)	Excepting fruits, all parts damaged (40%)	
12. A. lakoocha (Deophal)	Some damage to stems,and branches (30%)	
13. Avicennia spp. (Baen)	Leaves scorched but stems intact (5%)	Stands on Sonadia island
14. Azadirachta indica (Neem)	Negligible damage (5%)	
15. Bambusa sp. (Bans)	Columns prostrate (50%)	Mostly in Moheskhali
16. Barringtonia acutangala (Hijal)	Least damage (1%)	
17. Bambax ceiba (Simul)	Stem intact, top branches broken (20%)	
18. Borassus flabellifer (Tal)	Slight scorching at the end of leaves (3%)	Nests of weaver birds
19. Bursera serrata (Gutgutiya)	Some damage to branches and leaves (15%)	
20. Carica papaya (pepe)	Tops blown off, stems prostrate (40%)	At Moheskhali
21. Cassia fistula (Sonalu)	Leaves scorched, damage to branches (10%)	
22. C. siamea (Minkiri)	Damage negligible (5%)	
23. Casuarina equisetifolia (Jhau)	Uprooted, branch damage (25%)	Sea beach, Cox's Bazar
24. Clinogyne dichotoma (Patipata)	Least damage (1%)	At Banskhali
25. Cocos ncifera (Narikel)	Damage negligible (3%)	More damage in Banskhali
26. Dalbergia sissoo (Sishoo)	Leaves and stems least affected (5%)	
27. Diospyros peregrina (Gab)	Very little damage (1%)	
28. Delonix regia (Krishnachura)	Much damage to branches (40%)	
29. Dipterocarpus alatus (Garjan)	Slight damage to leaves (3%)	
30. D. costatus (garjan)	Stems unaffected (3%)	
31. D. turbinatus (Garjan)	Stems unaffected (3%)	
32. Erythrina ovalifolia (Mandar)	A few trees uprooted (40%)	Mostly damage in Banskhali
33. Eucalyptus spp.	Uprooted, much branch damage (60%)	On Chunati-Cox's Bazar road
34. Ficus bengalensis (Bot)	Slight damage to branches (5%)	
35. F. religiosa (Asshoth)	Slight damage to branches (5%)	
36. F. rumphii (Gaya asshoth)	Slight damage to branches (5%)	
37. Garuga pinnata (Bhadi)	Stems intact, branches broken (15%)	
38. Gmelina arborea (Gamanri)	Uprooted, stems broken (20%)	
39. Grewia sp.	Least affected (2%)	Mostly in Moheskhali
40. Hevea brasiliensis (Para rubber tree)	Damage to branches (20%)	In Ramu plantation
41. Impomoeafistulosa (Dhol Kalmi)	Completely unaffected (0%)	Thriving in all environments
42. Lagerstroemia speciosa (Jarul)	One of the worst affected (40%)	Most damage to branches

IMPACT OF 1991 CYCLONE ON VEGETATION

Plant Species	Nature and percentage of overall damage	Additional observations
43. Lannea coromandelica (Jika)	Branch damage, leaves fallen (15)	
44. Litsaea sp.	Uprooted, branches broken, leaves scorched (40%)	
45. Mangifera indica (Aam)	Some branch damage (5%)	
46. Melia azadirachta (Gora neem)	Some branch damage (5%)	
47. Michelia champaca (Champa)	Damage to branchlets only (2%)	
48. Momordica charantia (Kerela)	Complete destruction (90%)	Near Sitakunda and Chittagong
49. Musa paradislaca spp. saplentum (Kola)	Severe damage to clumps (60%)	Most damage in Chakora
50. Oryza sativa (Dhan)	Crops perished, havested grain washed away (100%)	
51. Peltophorum pterocarpum (Halud Krishnachura)	Damage to branches and leaves (40%)	
52. Phoensix sylvestris (Khejur)	Some scorched effect on leaves (5%)	Little damage to stems
53. Piper betel (Pan)	Extensive damage to plantations (80)	From Sitakund-Chittagong
54. Polyalthla longifoiia (Debdaru)	Branches broken, no leaf damage (35%)	
55. Psidium guajava (Pyara)	Leaves and fruits show scorched effects (40%)	
56. Pterocarpus indicus (PadouK)	Damage to branches and leaves (7%)	
57. Saccharum officinarum (ikkhu)	Damage negligible (3%)	From Sitakunda-Chittagong
58. Samanea saman (Raintree)	Defoliation, damage to branches (50%)	Uprooted in banshkhali
59. Streblus asper (Asshoura)	Canopy with unilateral damage (15%)	
60. Swietenia macrophylla (Mahogani)	Stems intact, leaves scorched (10%)	{Mostly at Chittagong
61. S. mahagoni (Mahogani)	Stems intact, leaves scorched (10%)	{and Cox.s Bazar
62. Syzygium cumini (Kalojam)	Damage negligible (2%)	
63. S. grande (Dhakijam)	Damage negligible (2%)	
64. Tamarindus indica (Tetul)	Least damage (2%)	
65. Tectona grandis (Shegun)	Uprooted, branches and leaves damaged (75%)	Great damage in forest plantations
66. Terminalia arjuina (Arjun)	Occasional damage to branches (10%)	
67. T. catappa (kat badam)	Trees decapitated, no leaf damage	
68. Trewia polycarpa (Petali)	Mostly unaffected (10%)	
69. Zanthoxylum rhetsa (Bajna)	Mostly uprooted (60%)	

Source : Dr. Salar Khan, Impact on Vegetation BCAS Field Report, May 1991 (Haider at al. 1991).

ANNEX D

Evaluation of the Groundwater Resources of the Coastal Area

ANNEX D

EVALUATION OF THE GROUNDWATER RESOURCES OF THE COASTAL AREA

LIST OF CONTENTS

ANNEX D

EVALUATION OF THE GROUNDWATER RESOURCES OF THE COASTAL AREA

D.1 Overview

WHO statistics show that 80% of illnesses in Bangladesh, and 20% of child mortality, are linked to water related diseases. Reliable sources of fresh water are an essential pre-requisite for good health and, perhaps, the principal engine of growth in rural (i.e. agricultural) areas. In the coastal region, some 40-45% of the population drink contaminated water from rivers, ponds and dug wells although fresh groundwater is available in most of the area. This is either in the form of rather fragile fresh water lenses a few tens of metres below the surface, or from deep confined aquifers at depths of between 150 and 350 metres. The shallow and deep groundwater sources are normally separated by other aquifers containing brackish groundwater.

No comprehensive evaluation of the available groundwater resources has yet been attempted. The proposed National Minor Irrigation Development Project (NMIDP) has explicitly excluded the coastal zone from its promotional activities precisely because of the lack of information on the development potential of the coastal zone, and the attendant unquantified risk of salinisation.

D.2 Proposed Study

The principal objectives of the proposed study would be :

- to evaluate the sustainability of drinking water supplies, by thana, and develop management strategies to ensure both the quality and quantity of the resource for present and projected populations; and

- to identify areas in which there is groundwater in excess of the requirements for drinking water, quantify these resources, and develop an integrated plan for their development (by industry or agriculture) on a sustainable basis, and in a way that gives priority to the preservation of safe and adequate potable supplies, locally and regionally.

The 'coastal area' is not clearly defined, but the boundary shown in **Figure D.1** serves as a first approximation. To date, there has been little exploitation of groundwater for irrigation in the area. Groundwater has been developed locally for industrial purposes, especially at Chittagong and Khulna; but, in general, and in the absence of supporting studies, groundwater has been preserved for potable supply.

It is obvious that in any strategy for the development of deep aquifers in the coastal zone, the highest priority would be given to the sustainability of drinking water supplies, and in the past relatively little attention has been given to the quantification of these resources, a situation which has amounted to a virtual veto on their development for other purposes. The justification for such an approach is that if the resource cannot sustain drinking water requirements then it of no use for any other purpose. The hidden cost is a lost opportunity to support the growth of agriculture or industry. A further point is that, if the resource

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cannot sustain the drinking water needs of the present or projected populations, the sooner this is known the better.

The factors discussed in the preceding paragraph may be viewed as the theoretical arguments in favour of the proposed evaluation. There are, however, practical reasons for proceeding with some form of assessment as a matter of some urgency, because these deep aquifers are already being developed for irrigation. In the Noakhali North area, at least, strong demand from farmers has lead BADC in the last three years to sinking some 45 DTWs in areas which the MPO and FAP:5[1] had previously identified an insignificant number of tubewells and had both classified the as area as unsuitable for tubewell development because of salinity constraints. A survey of 33 operating DTWs by BADC in April 1992 found that only two had EC's above 2,000 μS/cm (maximum 2500 μS/cm) and 21 had EC's of less than 1,000 μS/cm. This new evidence renders the previous assessments invalid, there clearly being some significant potential. On the other hand, these developments are also of concern (abstraction takes place from beneath brackish water) since it is unplanned, without consideration of the potential resource, and without an adequate monitoring system. It is also worth noting that the resource potential models (as developed by the MPO) currently in use all depend on quantifying direct vertical recharge, and as such are totally inappropriate to these conditions.

The study would take account of surface water resources because these represent potential alternative sources for both drinking and irrigation water. The planning process for groundwater management should give the highest priority to drinking water supplies in areas where surface water is not a viable alternative.

D.3 Existing Data

DANIDA has compiled most data on groundwater conditions in the area based on the results from the DPHE/UNICEF rural water supply programmes. The most useful data included are the numbers and depth of the tubewells, and the chloride concentrations of the water. These allow a basic definition of the aquifer distribution, in particular the location of important shallow aquifers. Little information exists on deeper aquifers, the presence of deep fresh water tubewells demonstrates the presence of a deep, fresh water aquifer, but their absence does not disprove it. Even in the first case there is uncertainty about the thickness of the deep aquifer, and in all cases there is no information about the permeability of the aquifers. Nevertheless, while these reservations are noted, there is no doubt that the size and extent of the DANIDA database make it the ideal starting point for planning quantitative resource investigations.

Detailed local hydrogeological studies concerning municipal supplies have been undertaken in Khulna and Noakhali. Summaries of these studies are given in **Appendices I and II.** Both of these studies establish the existence of deep, fresh water aquifers at depths below 120 to 150 metres, of sufficient thickness to support wells of moderate to high capacity. The remarkable similarity of the resistivity logs in the two areas supports the view that deep, fresh water aquifers are regionally continuous.

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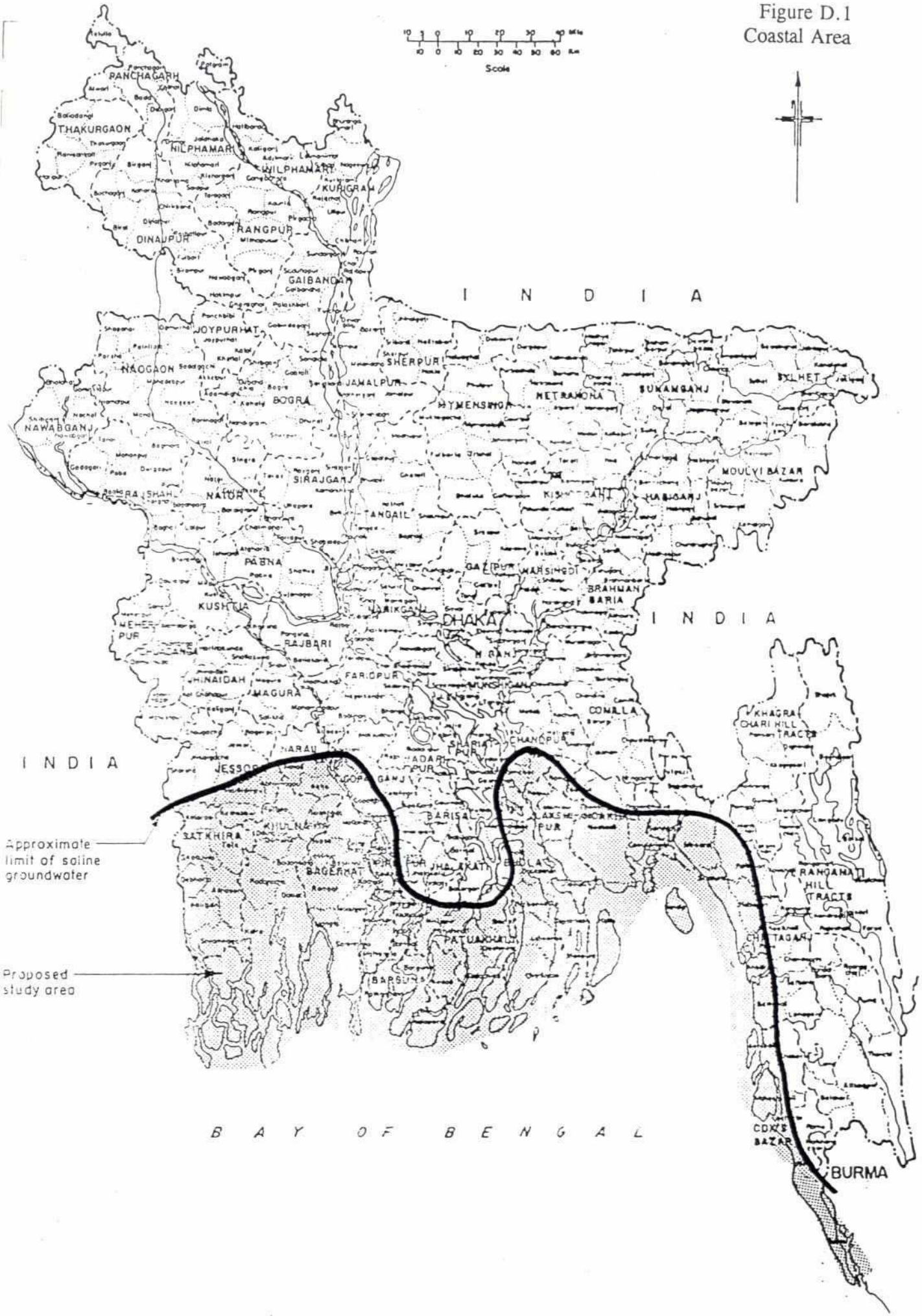
1 FAP:5, the Southeast Regional Study, is currently taking note of these changes, but is not able to make an evaluation of this aquifer within its present terms of reference.

Figure D.1
Coastal Area



D.4 Origin of Inland Salinity

An issue of fundamental importance to quantifying the groundwater resources of coastal areas, and yet frequently given insufficient attention, is that of water use criteria. In Bangladesh, as with most regions of the world, fresh water is not found to be overlying water with the same salinity as sea water, separated by a narrow transition zone (as implied by most text books). In reality, there is very little highly saline water, but there are enormous volumes of brackish groundwater. Thus, contamination of a fresh water aquifer is liable to be a gradual progressive deterioration rather than a sudden change to water of unacceptable quality.

This was illustrated very clearly in the modelling studies for Khulna City water supply (**Appendix II**) which showed setting the limit for chloride at 400 mg/l as opposed to 150 mg/l[2] results in five fold increase in the exploitable resource. Similar considerations arise with the criteria for irrigation water with values of 750 μS/cm and 2,000 μS/cm being recommended by different authorities in Bangladesh. It should be recognised that most standards for the salinity of both irrigation and drinking water are somewhat arbitrary. It is important that Bangladesh does not blindly adopt international standards. There should be accompanying research to ensure that the standards adopted are consistent the social values and agricultural practices of the country.

A common reaction, even among professional scientists and engineers, when they learn of the presence of saline groundwater in an area is to assume it is the result of sea water intrusion in response to over-pumping. However, this is frequently not the case.

In a natural state, under the climatic conditions of Bangladesh, shallow fresh groundwater should discharge out to sea, with a wedge of salt water dipping inland very close to the coast. Theoretically, the thickness of the fresh water layer would be forty times the elevation (above mean sea level) of the water table[3]. With the possible exception of the urban centres of Khulna and Chittagong, there is insufficient pumping of groundwater to induce significant intrusion of sea water. This would in any case only move inland at rates of perhaps 1 to 5 metres per year, and therefore could not possibly account for saline water many kilometres inland.

The aquifer system is evidently not in equilibrium. Evidence of this dis-equilibrium was provided by the Deep Tubewell II Project, which investigated the origin of groundwater salinity in Comilla and Brahmanbaria districts, far from the sea. It was concluded that large volumes of brackish water which occurred between thirty and a hundred metres below ground were residual estuarine waters trapped during the world wide transgression that followed the last glacial maximum 18,000 years ago. These waters are currently (but very slowly) being flushed by natural processes. These processes are particularly active in areas such as Noakhali where the delta has advanced seawards in the last few hundred years. The fact that the saline groundwater is a finite body of water and not connected to the sea is of considerable practical importance because it restricts the potential for its migration.

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2 Bangladesh currently uses a guideline value of 250 mg/l.

3 The well known Ghyben-Herzberg principle, as described in any standard text books.

D.5 Approach and Methodology

The key elements of a project to evaluate the groundwater resources of the coastal area are set out in **Figures D.2 and D.3.** The programme would require two years, and could divided into two, more or less distinct, phases - a field investigation and data collection phase lasting eighteen months, followed by an evaluation and planning phase of six months. Evaluation of both the deep and shallow aquifers would be included.

During desk study stage, data on existing wells, their depth, pumping test details and water quality would be compiled into a series of databases. All relevant data on groundwater and surface water would be collected from the BWDB and DPHE. A preliminary analysis would produce a zoning of the coastal area based on probable deep and shallow aquifer potential, and an attempt would be made to define conceptual models of the aquifer system.

From the desk study, areas of data deficiency on which to base an exploratory drilling programme would be identified. The drilling programme would be in two parts. In the first, two contracts would be let for 'slim hole' drilling which would identify the lithology, conduct geophysical (electrical resistivity and natural gamma) logging, collect water samples, and carry out a simple yield test on a select aquifer zone. Around twenty sites would be a reasonable compromise between data gathered on the one hand, and time and cost on the other.

In the second stage, test production wells would be constructed and test pumped at four or five of the 'slim hole' sites. Chemical analyses would be required to define water use criteria, and to define the aquifer units. Isotopic analyses would determine the age of the groundwater and enable a better understanding of the flow mechanisms in the aquifers. Age dating of selected wood fragments (or other organic matter) might also be carried out in order to understand the origin and field relations of the saline water.

Field investigations would include pumping tests at existing wells, and measuring the piezometric pressures at flowing artesian wells that exist in the coastal zone and off-shore islands. Measurement of water levels, probably on a monthly basis, would be a critical part of the programme, and pre-requisite for groundwater modelling in the evaluation and planning phase.

The depth of the exploratory boreholes would be limited by the available technologies, and would not exceed 300 to 400 metres. DPHE investigations at Khulna demonstrated the importance of conditions beneath the pumped aquifer in determining the sustainability of the water supply sources. The study demonstrated that surface electrical resistivity soundings could extend the depth of investigation to 600 to 900 metres. The same procedure would be followed at each of the twenty drilling sites.

Upon completion of the field investigation phase, the results would be integrated into a revised and more detailed conceptual model of the hydrogeology of the coastal area, which would define the detailed scope of work for the planning and evaluation phase. A variety of numerical groundwater models to a variety of scales would be required to evaluate the results of the programme. Modelling would be undertaken mainly with three dimensional flow models with a coarse grid to evalaute the regional flow pattern. There would be combined with two dimensional (vertical plane) solute transport and flow models for selected areas to investigate the long term migration of saline groundwater.

Figure D.2
Coastal Aquifers Evaluation

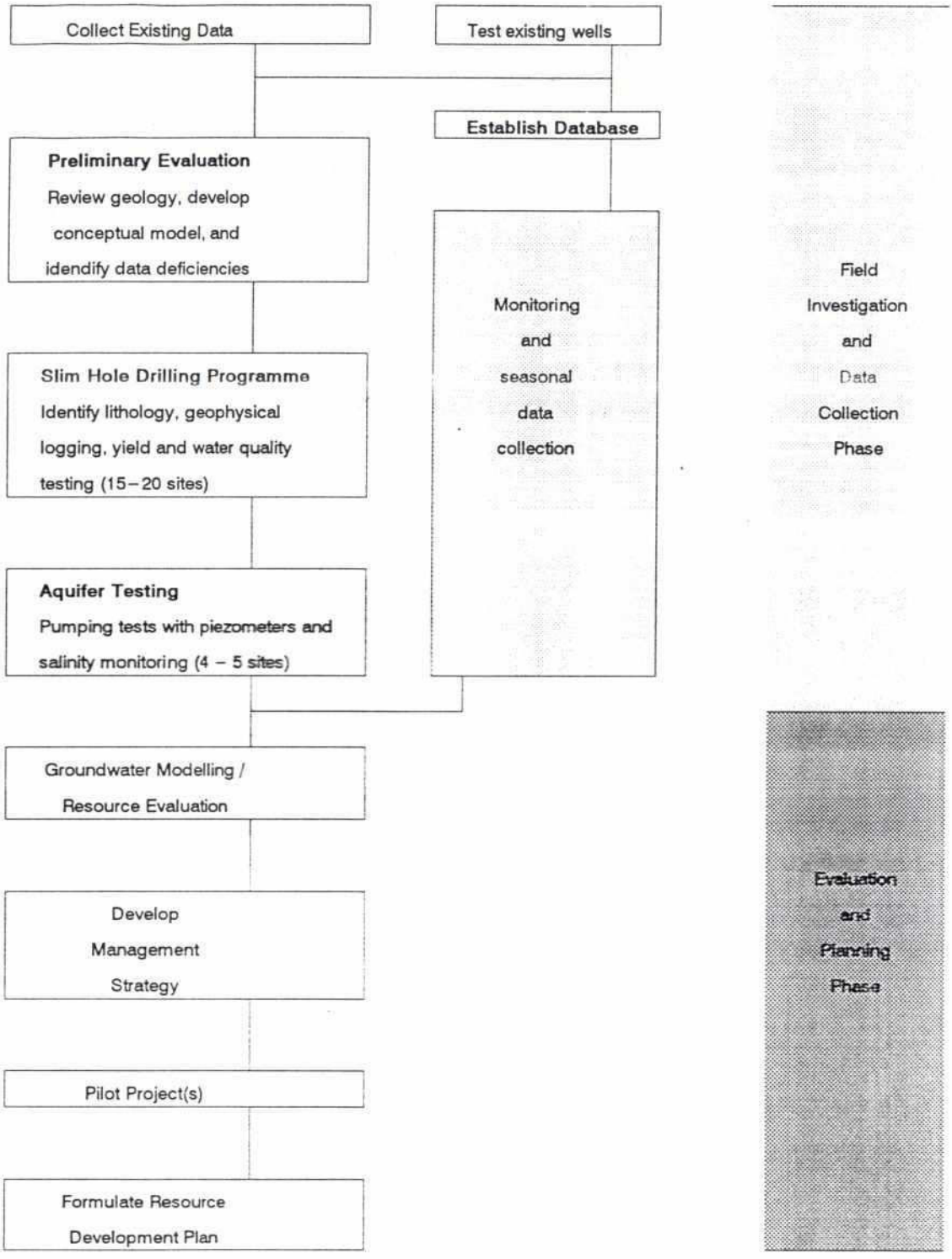

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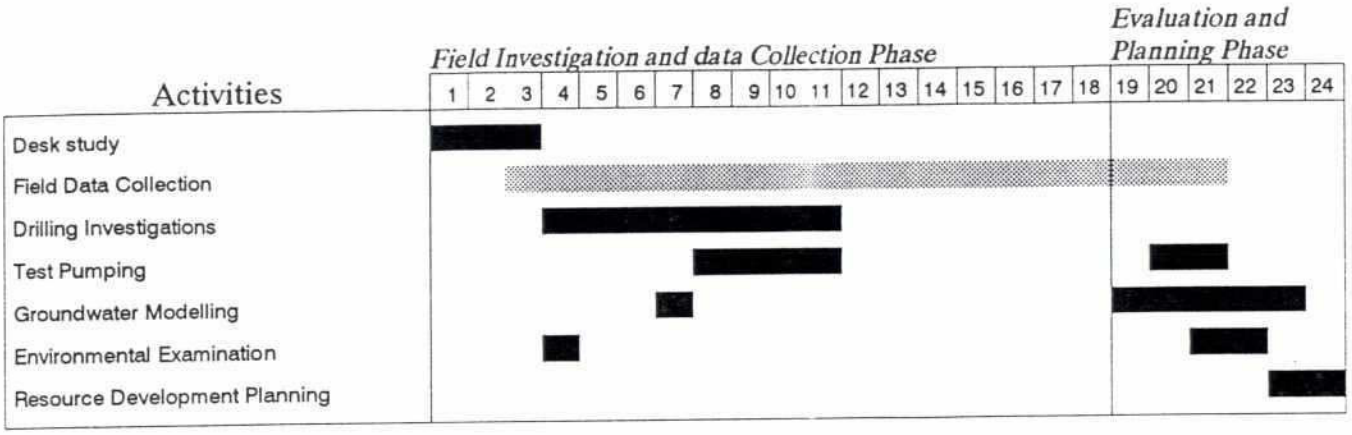
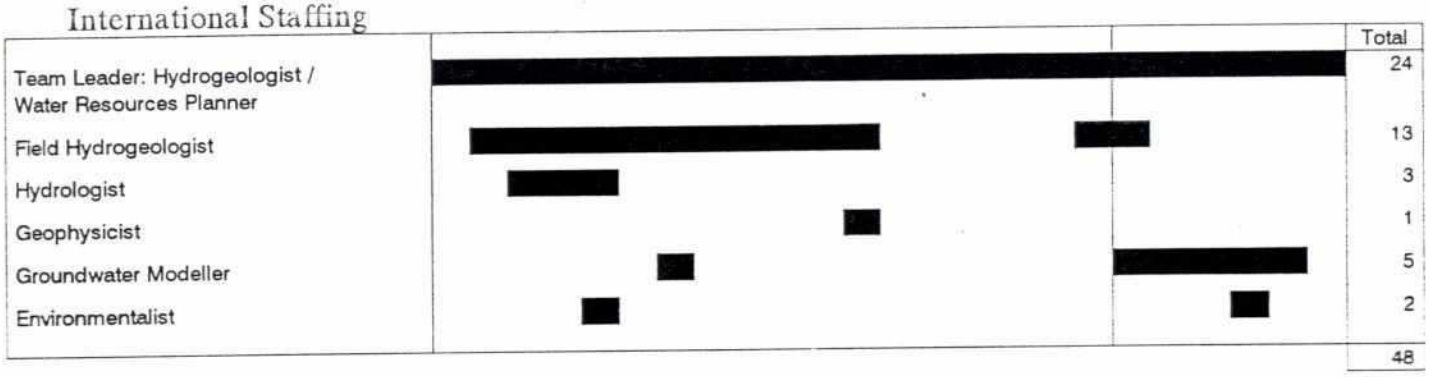
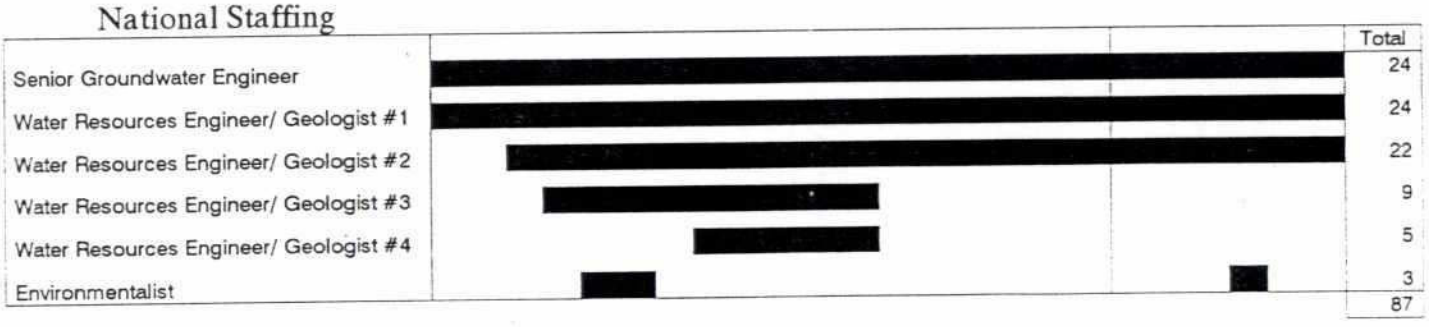
Figure D.3
Coastal Aquifer Investigations



International Staffing



National Staffing



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Output from the groundwater models would feed into a series of thana based planning models, which would examine the possible allocation of the surface water, and shallow and deep groundwater resources to the population based on the 1991 census data, for a range of development scenarios. The models would also take account of the tubewell technologies required in each thana, and their economic costs.

D.6 Institutional Framework

The project might be executed by the Ministry of Agriculture, through BADC and be linked to the NMIDP rather like the study area investigations carried out during the IDA/ODA Deep Tubewell II Project.

However, it might also be undertaken by the Ministry of Local Government, Rural Development and Cooperatives through either DPHE or LGED. The latter might be most appropriate because it would provide a linkage to more general development at thana level and provide an important input to local level planning.

APPENDIX I

SUMMARY OF EXISTING GROUNDWATER INVESTIGATIONS IN THE COASTAL AREA - 1:

Geohydrological Investigation in Khulna
DPHE - Water Supply & Sanitation Projects
Netherlands - Bangladesh Development Cooperation Programme
February 1985

The study, one of the most detailed of its kind in Bangladesh, was carried out as part of on-going Dutch assistance to the DPHE programme of providing municipal water supplies to the district towns. In 1984, the municipality abstracted about 25,000 m^3/d of water with chloride concentrations of 50 to 500 mg/l (EC of 1,000 to 2,000 $\mu S/cm$) from a deep aquifer between 150 and 250 metres. Private wells also draw water from this aquifer and a thin shallow aquifer. The two aquifers are separated by brackish water. The objectives of the study were to quantify the resources available for the municipality and locate new well fields.

The scope of works included thirty exploratory boreholes including down-hole resistivity logging. Surface electrical resistivity soundings were carried out to estimate salinity at depths below the boreholes. Pumping tests were conducted, water samples collected for chemical and isotopic analysis, and water levels monitored for extended periods. The final analyses of the data were integrated into a two dimensional (in a vertical plane) solute transport and groundwater flow model in order to predict the long term trends in salinity.

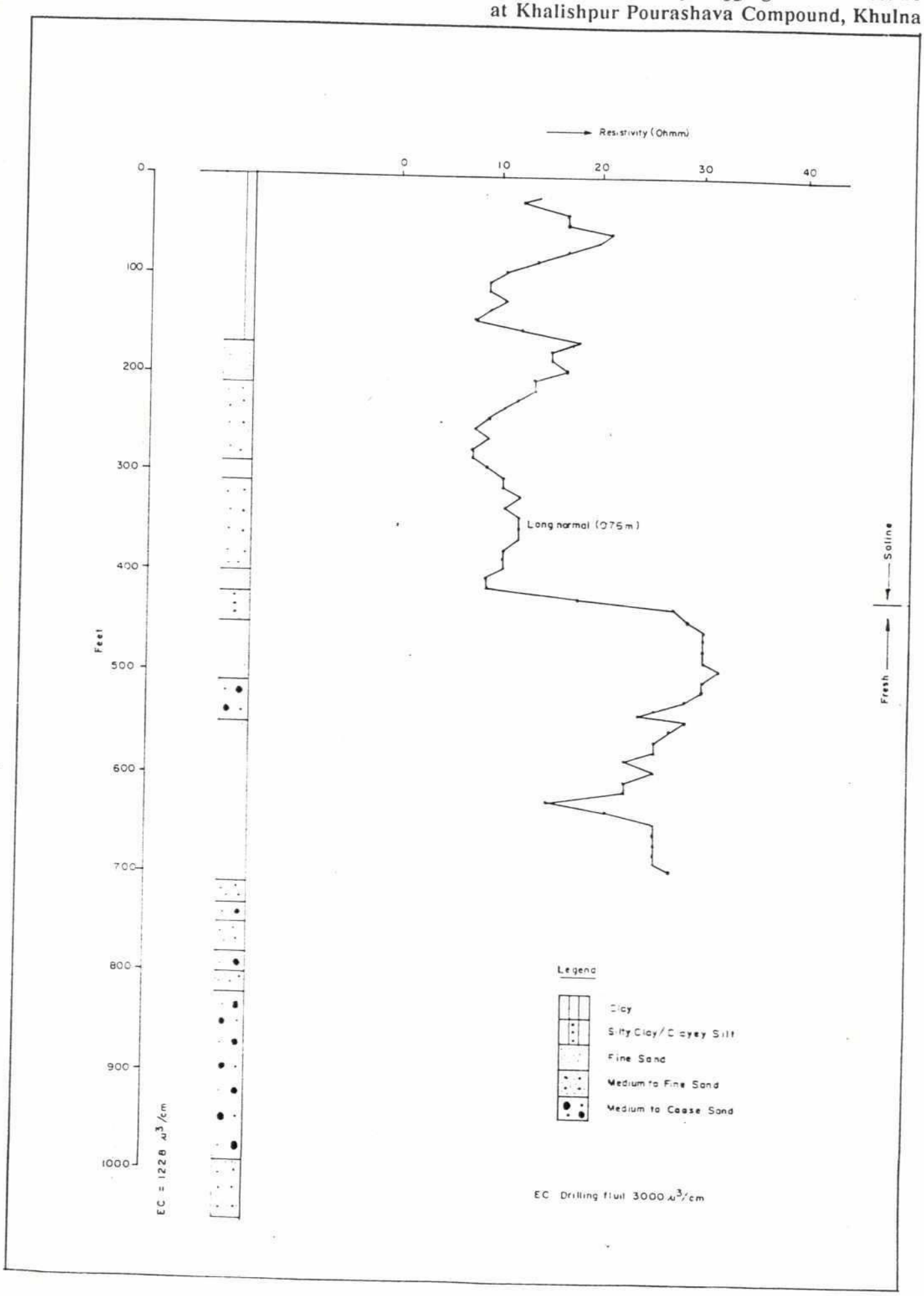
Groundwater age dating showed that water in the pumped aquifer is around 10,000 years old. There was considered to be very limited potential for recharge from above, but it is recharged from below as part of a regional flow system. A clay layer separates the fresh and brackish aquifer in most of the area. In the modelling, recharge was considered to be so small (in relation to the intensive municipal abstractions) that it could be neglected. This assumption is not strictly correct, but does represent a (safe) worst case analysis for evaluating the long term integrity of the supply. Indeed modelling showed that the permeability of the strata beneath the deep aquifer had a major influence on estimating the available resources.

The study concluded the exploitable groundwater resource to be 59,000 m^3/d with a salinity not exceeding 250 mg/l for the 30 year planning period. Modelling also drew attention to the critical influence of water quality criteria on the quantity of water available. In terms of the total volume of exploitable water (over 30 years), the study shows that at a limit of 150 mg/l of chloride the exploitable reserve is 300 million cubic metres, while with a limit of 400 mg/l the exploitable reserve would be 1,500 million cubic metres.

Figure I.1 shows an example of resistivity logging and a lithological profile from the Khulna investigations. The sharp increase in resistivity, which indicates a fresh water aquifer, beneath a prominent clay layer at a depth of 120 metres is particularly striking and is characteristic of wells in the area.

Figure I.1

Resistivity Logging Testwell P.S. 26
at Khalishpur Pourashava Compound, Khulna



APPENDIX II

SUMMARY OF EXISTING GROUNDWATER INVESTIGATIONS IN THE COASTAL AREA - 2:

Ground Water Investigation Reports:
1. Lakshmipur Pourashava, March 1989
2. Choumohani Pourashava, March 1989
3. Maijdee Pourashava, November 1989
DANIDA / Aqua Consult

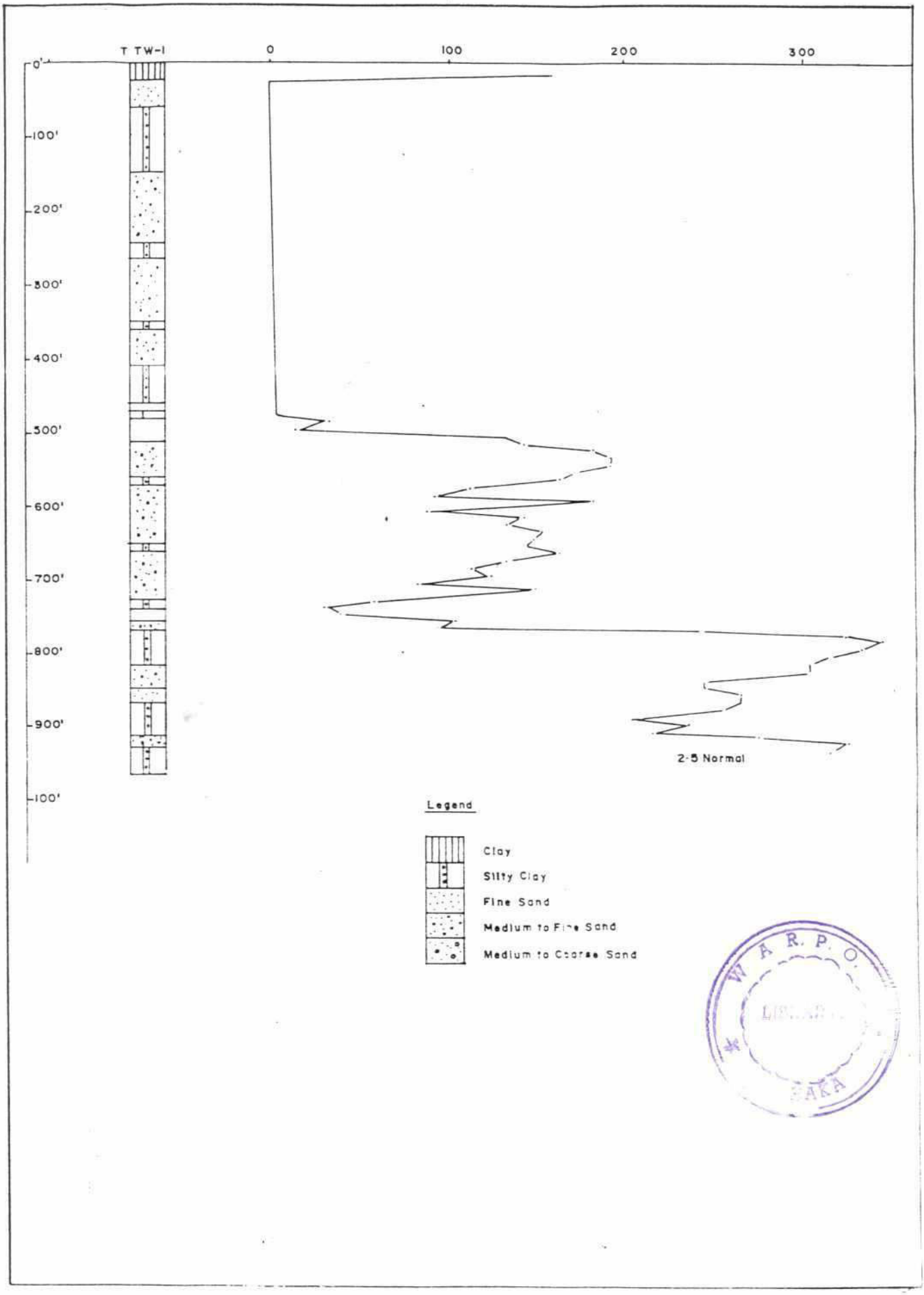
These investigations were carried out as an extension of DANIDA's long term involvement in the Noakhali area, and comprised a preliminary appraisal of the of the hydrogeological conditions at the district centres in Noakhali, Lakshmipur and Feni. Each of these reports has a similar format and describes a similar scope of work. Existing deep well records were compiled, and where possible the wells were test pumped. About four test wells were drilled and down-hole resistivity logs run. Water samples from all wells were analysed for chloride and iron. Basic interpretations of the data, in terms of plotting geological sections and profiles of chloride versus depth, are presented but no attempt to quantify the groundwater resources is made.

Although more limited in scope than the study of Khulna, these reports constitute an extremely valuable source of information on groundwater conditions under the southern part of the Meghna Floodplain. They establish beyond doubt the existence of a fresh water aquifer between 150 and (at least) 200 metres, and apparently capable of supporting wells of moderate to high capacity. **Figure II.1** shows lithological and resistivity logs from a typical well in Lakshmipur. There is a sharp increase in resistivity (indicating fresh water) beneath a clay layer at 150 metres that strongly resembles that at Khulna (**Figure I.1**).

The similarity of the resistivity profiles at so many wells in the Greater Noakhali and Khulna areas is so striking as to suggest a major regional phenomenon (perhaps related to the lowest Pleistocene sea level of 130 metres below present sea level that occurred 18,000 years ago).

Figure II.1

Resistivity Logging Testwell TWI
at Shahid Shriti School, Lakshmipur



ANNEX E

Minutes of 5th Meeting of the Professional Panel

Assistance to
Ministry of Relief
in Coordination of
Cyclone Rehabilitation
BGD/91/021

Disaster Coordination and
Monitoring Unit
House 38, Road 11
Dhanmondi R/A, Dhaka-1209

Minutes of the 5th Meeting of the Professional Panel : 4 October 1992

1. The meeting, held at DCMU began at 1100 hours under the Chairmanship of Mr. Mohammad Siddiquer Rahman, Chairman of the Professional Panel.

2. There were two Agenda items

   i) Concept Plan for Integrated Coastal Protection : presentation by Mr. Mark Brett, Hydraulic and Coastal Engineering Specialist assisted by Mr. Nasir Uddin, Telecommunications Consultant.

   ii) Issues associated with FAP:11 : discussion of paper prepared by Mr. Ron Ockwell.

3. The attendance list for the first Agenda item is attached, the attendees who were not Professional Panel or DCMU staff generally left the meeting after the first item had been discussed.

4. **Presentation of Concept Plan for Integrated Coastal Protection by Mr. Mark Brett.**

   - The attached papers were distributed and Mr. Brett made the presentation with extensive reference to a large 1/250 000 wall map showing actual and proposed infrastructure.

Key points that emerged from Mr. Brett's paper included the following :-

- the large number of agencies that had or were planning to have development activities in the Coastal Area;

- using estimates prepared by the agencies themselves investments of $ 912 M during the period upto 2000 were envisaged;

- given such a large investment, there is a need to prioritise the development projects

- various aspects of development need were required to be reviewed;

  - Funds allocated under the ongoing IDA funded Shrimp Cultivation project will be insufficient to complete the works;

- IWTA appear to have no plan to rehabilitate their damaged terminal facilities or to extend their systems.

- Groundwater resources in the coastal area have not been systematically inventoried.

- There are few "VGD" stores at Union level in the high risk coastal belt (only in two thanas).

- The coverage of basic support infrastructure (e.g. medical centres) is very uneven.

- Road development is again patchy and needs careful planning and accelerated implementation to ensure that key facilities are connected. More jetties are also needed in the coastal areas and offshore islands.

- Landing strips would be important in the more isolated areas, details are yet to be obtained.

- There are no good records of surge heights; special tide gauges are needed.

- there was an urgent need for an 'agency' to take over the Concept Plan and develop it.

5. **Question and Answer Session**

Chairman Panel of Experts FPCO (Mr. Nurul Huda)

- expressed concern that the consultants may have exceeded their brief, their focus should be disaster preparedness.

- are the developments proposed sustainable and do they rely on appropriate technology?

- considered that the costs were very high.

- wondered if any ideas for inter-agency coordination had been developed.

Mr. Brett and Mr. Gillham confirmed that the TOR were indeed as broad as the studies that had been carried out.

The developments proposed appear sustainable provided embankment O&M can be ensured this extensive forestry plantations are planned. Little high technology, apart from telecommunication equipment, is required to implement the 'Plan'. The costs were generally those provided by the agencies concerned.

Regarding coordination mechanisms it would seem that the main role should be played by the Planning Commission. A Coastal Area Development Committee chaired by the PC might be considered.

Planning Adviser (Mr. M. Mokammel Haque)

He made the following observations :-

- the paper had been well presented and that a lot of work had gone into it.
- it should be complimentary to the FAP and that there was a need to consider the effect of floods and cyclones together, the concerns are broader than those of the Flood Action Plan.
- the cost of the projects were a little frightening.
- a Coastal Region agency was required as there was indeed little coordination of development, the Planning Commission might be an appropriate location.
- following the cyclone the PC had very rapidly had to vet 131 projects, it was difficult for them to be objective in the aftermath of the disaster, particularly in the absence of any overall Plan.
- FAP:5B study in the Meghna Estuary will be vital.
- care is needed to ensure that buildings in the coastal area are not overdesigned, he had seen only three destroyed 'pucca' buildings as a result of the 1991 cyclone.
- considered that <u>all</u> new (GOB) buildings in the country should be two storied to cater for floods and sotrm surges; relevant building codes are needed.
- care was needed to ensure proper construction and maintenance of the sea facing embankments.

Team Leader Cyclone Protection Project II (Mr. B. Mathiesen)

He raised the following points

- specifications for coastal embanment construction includes compaction of the surface, but this is not always done. On ICB contracts the consultants were going to make special efforts to ensure compaction is to standard.
- BWDB staff are mostly concerned with river embankkments and not always familiar with the particular problems of (sea) waves. Staff were being constantly transferred which meant that knowledgable people were 'lost' to the area.

- perhaps BWDB needed a Coastal Management Unit for the sea facing embankments.

- the design criteria now established for sea facing embankments envisage the following :-

    - a 20 year cyclone, the average water depths within the polders would be no more than 1.00 m.

    - a 40 year cyclone, the sea level would not overflow the embankments, although much water would enter by wave action.

- in general discussion, the value of coconut trees was raised, these were less abundant now than in the past along the coastal fringe.

Team Leader Multipurpose Cyclone Shelter Project
(Prof. Dr. J. R. Chowdhury)

He thanked Mr. Brett for his interesting paper and noted the following :-

- reference might be made to the recently completed Tourism Master Plan;

- confirmed that the Bangladesh Building Code was being funded by GOB;

- some comment was needed on the Dutch funded Land Reclamation Project and their experience of river closures and cross dams;

- 626 double storied buildings were identified in the high risk zone, perhaps 500 000 people took shelter in them; the study has proposed the strengthening of existing buildings with stairs to provide access to roofs;

- in the long term the aim should be for all families to have at least one cyclone-proof room;

- killas are required but must be combined with shelter, not to be separate.

- housing credit schemes also might come up.

Coastal Fisheries Adviser (Dr. A. L. Sarker)

Considered that

- fisheries had not been fully considered;

- hatcheries should be shown on the map;

- fisheries suffer much loss at the time of cyclones.

Procedures Consultant (A.B. Chowdhury)

supported Mr. Sarker in his contention that fisheries were very important.

- raised the question of shelters that were portable;
- believed that the rich did not always accommodate their poorer neighbours;
- emphasised the need for pure drinking water and the value of coconut milk;

Training and Public Participation Adviser (Mr. Azizul Haq)

He emphasized the importance of evaluating the economic potential of alternative uses of land, for farming, fishery, forestry [this is being done by the regional FAPs], and of controlling the exploitation of new char land.

The Chairman of the meeting in his concluding remarks conveyed thanks and appreciation to Mr. Mark Brett for the excellent presentation and the laborious work done in bringing together so much information on the subject.

Taking care from the discussions he laid great emphasis on the need for making immediate institutional arrangements for coordination of the various development projects/programmes undertaken or proposed to be undertaken by the various agencies so that the common objectives were fulfilled and planned development could be undertaken and incoperance amongst the various projects/activities could be avoided.

He suggested that this matter should be immediately brought to the notice of the Govt. (Planning Commission/MOR) without waiting for a final report of the present project so that a cell in the Planning Commission could deal with the processing of projects of different Ministries dealing with coastal protection/reconstruction/development and also some organisation like a Coastal Reconstruction Board may be set up to coordinate and monitor the implementation of such projects (in the pattern of Cyclone Reconstruction Board set up after 1970 cyclone).

6. Presentation on Telecommunication facilities for Disaster Management by **Mr. Nasiruddin, Telecommunications Consultant**

Key points raised included the following :-

- a large number of organisations had radio systems but they were generally unreliable at times of disaster i.e. when they were needed);
- the most wide spread radio system was that of the Police to every district and thana and to some smaller outposts; it is manned round-the-clock (24 hours).
- where they are established, the CPP radio system is also extensive reaching to many Unions. But the coverage was still limited;

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- BMD maintains hourly contacts with the stations;

- the MOR radio system is used only intermittently and is unreliable; the sets are old and MOR has no maintenance facilities; [radio systems that are not in constant use cannot be relied on];

- T&T system was the major telephone network and must be further developed but, being 'commercial', there were problems of forcing them into coastal areas where operations might not be economic;

- the widespread railway network using fibre optic cables was mentioned, but it is not possible to make direct connections between this system and the normal telephone system;

- it is presently proposed to replace the MOR sets, but not to expand the system; fax and additional telex systems may be provided;

- there is need for additional VHF communications at local level;

7. Question and Answer Session

Military Adviser (Lt.Col. (Retd.) M. Mokhlesur Rahman

considered that DCMU needed a reliable radio system of its own.

MPCSP (Prof. Dr. Chowdhury)

noted that they had proposed that selected cyclone shelters should have (radio) telephone facilities which could be used as public telephone facilities in normal time. There were, in the risk zone, 47 thanas and 303 unions.

Disaster Management Specialist (Ron Ockwell)

suggested that :

- there should be a designated emergency frequencyand in the long-term, all agencies operating radios should have sets that can be turned to that frequency as well as their own, . Strict rules would be needed for the use of the frequency.

- radio operators should be advised to dismantle antennas (and protect generators) when a cyclone is approaching and the wind reaches a certain speed, and re-erect them as soon as the storm passes - rather than allowing antennas to be damaged.

- masts should be such that when a cyclone is approaching they can be taken down and re-erected.

The general feeling was that 'normal' time communications should be improved to assist 'disaster time' communications.

The need for coordination and cooperation of communications in emergencies was recognised and FAP:11 should consider measures to facilitate this.

The Chairman of the meeting emphasised the infortance of establishing dependable communication system so that the DCMU/Control Room of the MOR gets unhampered information from the affected areas (villages/towns) through the thana and District Administration and Zonal/Divisional HQ and can also communicate messages/instructions to the field through the same channel. There was also need for coordination of the communication facilities existing or being developed by various agencies. He also observed that there was need for standby arrangements so that these could be put into operations in case there was a void.

Issues associated with FAP:11

Ron Ockwell, Disaster Management Specialist, introduced the discussion paper explaining that:

(i) Drafts for FAP:11 had been prepared in '88, '89, and '90: an extract of the last, prepared by David Oakley, had been circulated to Panel members and some had commented. The discussion paper takes account of these previous ideas and comments.

(ii) The proposals are expressed as possible "outputs", i.e. what should be achieved/in place by the end of the 3-year FAP:11 project.

(iii) It is envisaged that FAP:11 should concentrate on cyclone and flood risks; several Panel members had suggested that river bank erosion should also be included from the outset; other hazards would be incorporated later.

(iv) The 13 "core" outputs proposed for FAP:11 could be complemented by a range of other projects as indicated in the second list.

Each of the 13 proposals was discussed in turn. All were generally agreed to be relevant and appropriate. The following specific points/clarifications were noted:

Title: The title of FAP:11 should be *Comprehensive Disaster Management*, not "preparedness".

Scope: River Bank erosion should be included from the outset; it was suggested by Dr J R Choudhury that earthquakes should also be included.

#1 The office/unit should be referred to as a "co-ordination unit", not a focal point: a dozen ministries had to be involved and would be responsible for many of the actual activities. Information management/processing capability should be emphasized.

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#2 A resource capability is needed, not necessarily a new "centre": an initial step would be to survey existing institutions and facilities to assess their capacities to provide training and develop materials (in relation to disaster management).

#3 Policy and legislation: important.

#4 "Refined" (rather than "new") Standing Orders must be clear and concise. The links between cyclone warning signals, and the various "stages" of action must be clarified. Separate books should be prepared for each distinct group. Guidelines/procedures should be provided covering rescue and other practical aspects of emergency relief and rehabilitation.

#5 Public awareness must be based on local possibilities including the need for and availability of flood shelter facilities (on existing infrastructure to be used or for the purpose or new facilities to be created).

#6 District and thana authorities must be convinced of the importance of drills/exercises, and motivated to organize them themselves: local-level exercises must not be dependent on special resources being provided. Exercises must be monitored and reported on; their effectiveness must be evaluated.

#7 Simulation games may be used in training organised groups. A few special courses/workshops would also be required.

#8 Inclusion of disaster-related material in the secondary school curriculum might be more effective than in primary schools (primary school children too young).

#11 Arrangements should be envisaged to mobilize personnel through professional associations as well as from government service (using the model of the Register of Disaster Engineers in UK). The difficulties of keeping any roster up to date should not be underestimated.

#12 There is need for a master plan for the development of communications.

#13 Specify liaison with "NGOs", not just other bodies.

Add: Compilation of documentation, and preparation of summary annual reports, on disasters in the country.

The importance of developing flood shelter sites, and other facilities/activities of the listed "possible complementary projects/studies", was emphasized.

The meeting ended with a vote of thanks from the chair.

Mohammad Siddiquer Rahman
Institutions Adviser and
Chairman, Professional Panel

PLATE Nr. 1

Coastal Area Plan
(Scale 1:250,000 to follow)