(3)

2

PEOPLE'S REPUBLIC OF BANGLADESH

Ministry of Irrigation, Water Development and Flood Control

Bangladesh Water Development Board

CYCLONE PROTECTION PROJECT II - FAP 7
FEASIBILITY AND DESIGN STUDIES

DRAFT PROJECT PREPARATION REPORT
APPENDIX H - AFFORESTATION

February 1992

Joint Venture of
KAMPSAX INTERNATIONAL A/S,
BCEOM
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD

Financed by European Community - Project No. ALA/87/05

PEOPLE'S REPUBLIC OF BANGLADESH

Ministry of Irrigation, Water Development and Flood Control

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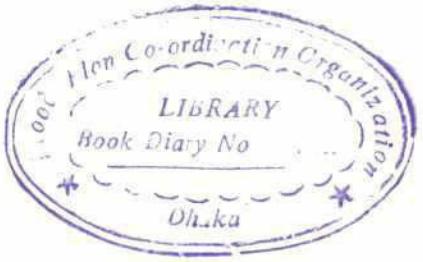

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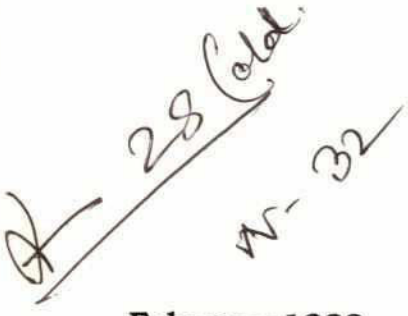

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REPORT VOLUMES

The present Report Volume is part of the

CYCLONE PROTECTION PROJECT II - FAP 7
FEASIBILITY AND DESIGN STUDIES
BWDB COMPONENT
DRAFT PROJECT PREPARATION REPORT

Consisting of the following Volumes :

Volume 1	-	Main Report
Volume 2	-	Annexes I - XI
Volume 3	-	Annex XII - Polder Data
Appendix A	-	Hydraulic Studies
Appendix B	-	Field Surveys and Soil Investigations
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1. INTRODUCTION

The current Cyclone Protection Project II comprises strengthening and improving the sea facing and similarly exposed embankments in the coastal districts. It has been learned that afforestation of the foreland and fore shore areas as well as on the seaward slope of the embankments provide a very efficient protection against damage by high tidal waves and cyclonic surges.

In this project, the effects of the afforestation on the embankments as well as the foreshore and seaward slope to protect the embankments are to be studied and reported.

2. CLIMATE OF THE COASTAL AREA

The coastal area of Bangladesh is within the tropical zone between 21 and 23 degrees north latitude. Like the climate of the country as a whole, there are four distinct seasonal weather patterns governed mostly by two monsoons namely the south-west monsoon and the north east monsoon. These are categorized as follows (a) The dry winter season from December to February. Rainfall is infrequent under the influence of the dry air circulation of land origin from the north east monsoon. Little low temperature during the day and night are common in this season. (b) The transition period from March to May - This period is termed the pre-monsoon season and is characterised by short duration thunder storms of land origin often associated with violent winds. The climate of May is characterised by severe cyclonic storms originating from the Bay of Bengal. (c) The monsoon season from June to September - This season is characterised by heavy rainfall under the influence of south west monsoon with 75 percent of the total annual rainfall occurring this period. (d) The second transition period is termed post monsoon since it follows the monsoon season. This season is characterized by violent tropical cyclonic storms and more than 75 percent of the cyclonic storms which strike the coastal area. The storms of this season are more severe and destructive than those which occur in May.

3. SOILS OF THE COAST

More than 85 percent of the area of Bangladesh is flat alluvial plain traversed by an intricate system of rivers and their innumerable tributaries and distributions. 6.5 percent of the total area of Bangladesh is responsible for the deposition of silts on the alluvial soil during the rainy season. This increases the soil fertility. In the coastal area, this is offset by saline intrusion and cyclonic storms. Coastal soils primarily consist of fine sands, silts, silty sands, sandy silts and clayey silts. The soil characterical of the regions are as follows :-

(a) Khulna - Soils are developed in alluvial sediments laid down by the River Ganges. Most ridge soils are loamy to clayey in texture. Soils of low ridges of the tidal flood plain are silty clay loam to silty clay. The general soil types are calcarious alluvium, calcarious grey to dark grey flood plain soil and have acid sulphate and peat.

(b) Barisal and Patuakhali - Soils are developed in alluvial sediments. Almost all the soils are silty to clayey in texture. Old tidal deposits occupying about two thirds of the regions are mainly clay to silty clay loam. Top soils are neutral to slightly acid in reaction. Sub soils are mainly neutral to moderately alkaline. The general soil types are calcarious and no calcarious alluvium and non calcarious grey flood plain soil.

(c) Noakhali - Soils are developed in young alluvial sediments. Most ridge soils are silty and clays occur in the basin. The southern part is severely affected by salts. The salt appears mainly to have been derived from sea water flooding during storm surges accompanying cyclones in recent years. The main general soil types are calcarious alluvium and in few cases to noncalcartous grey flood plain soil.

(d) Chittagong - Most of the soils of the area are formed of recent and subrecent alluvial sediments of tidal and river flood plain. They are dominantly silty and comprise silt loam to silty clay loams on ridges and slightly clayey soils in the basin. They are slightly to moderately saline along the coast. The general soil types are mostly non calcarious alluvium to grey flood plain soil except Sandwip and which have calcarious alluvium soil.

Table -1 and Map 3A show the coastal soil salinity situation.

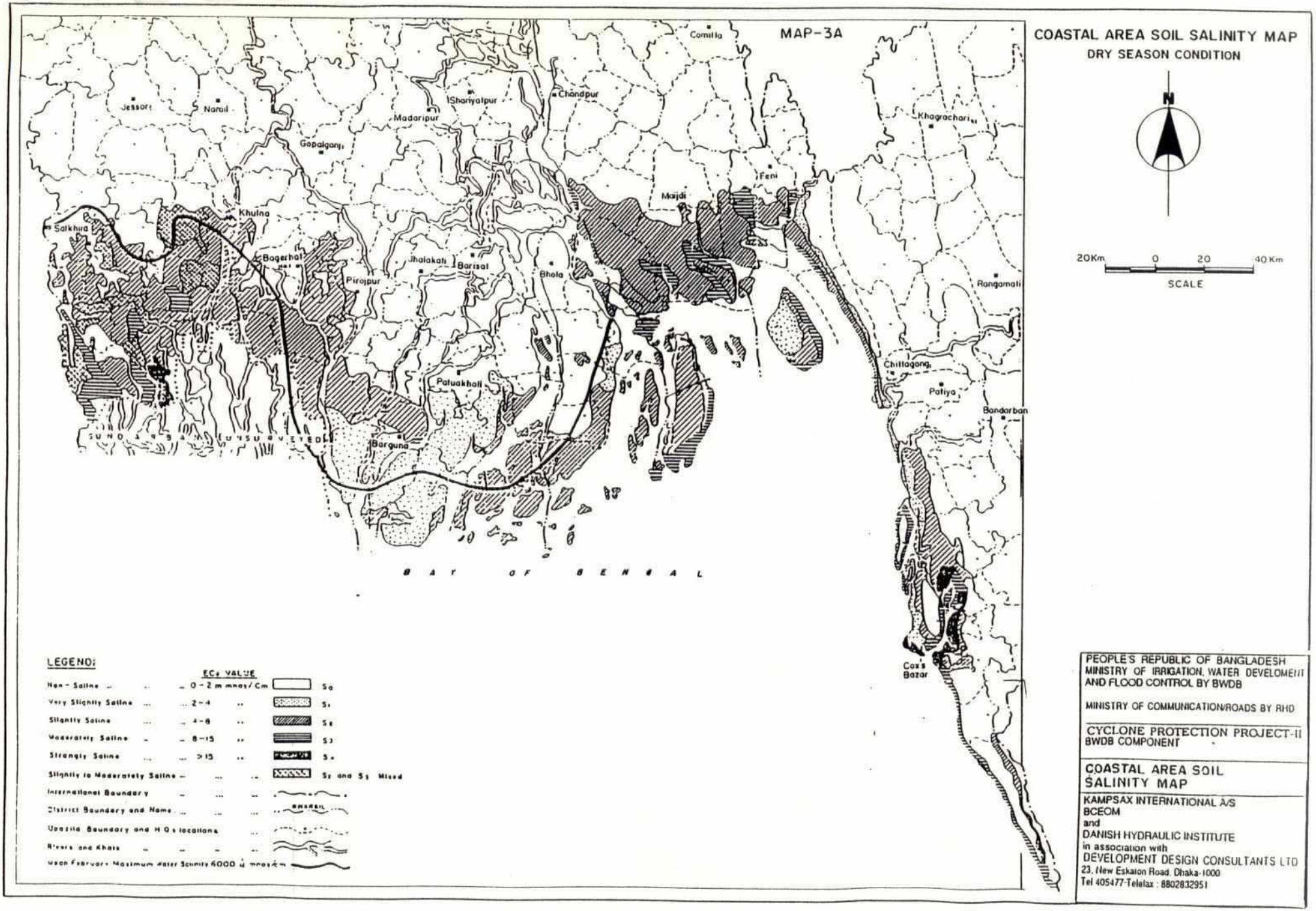

MAP-3A
COASTAL AREA SOIL SALINITY MAP
DRY SEASON CONDITION
N
20Km 0 20 40Km
SCALE
Comilla
Chandpur
Shariyatpur
Madaripur
Jessore
Narail
Gopalganj
Khagrachari
Feni
Majdi
Khulna
Satkhira
Bagerhat
Jhalakati
Barisal
Pirojpur
Bhola
Rangamati
Chittagong
Patiya
Bandarban
Patuakhali
Barguna
SUNDARBAN UNSURVEYED
BAY OF BENGAL
Cox's Bazar
LEGEND:
EC₄ VALUE
Non-Saline .. 0-2 mmos/Cm So
Very Slightly Saline .. 2-4 .. S1
Slightly Saline .. 4-8 .. S2
Moderately Saline .. 8-15 .. S3
Strongly Saline .. >15 .. S4
Slightly to Moderately Saline .. .. S2 and S3 Mixed
International Boundary
District Boundary and Name
Upazila Boundary and H.Q.s locations
Rivers and Khals
Mean February Maximum Water Salinity 6000 µ mos/cm
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
COASTAL AREA SOIL SALINITY MAP
KAMPSAX INTERNATIONAL A/S
BCEOM
and
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD
23, New Eskaton Road, Dhaka-1000
Tel 405477-Telefax : 8802832951

TABLE - 1

DISTRIBUTION AND EXTENT OF DIFFERENT CATEGORIES OF SOILS SALINITY OF POLDERS IN THE COASTAL REGIONS WHICH ARE UNDER THE CYCLONE PROTECTION PROJECT II

Sl. No.	Circle	Polder No.	Upazila	Salinity Catagories				
				S1	S2	S3	S4	1,000 ha
	Khulna	5	Kaligonj	2.20	16.30	4.90	2.60	26.00
		7/1	Asasuni	1.80	24.60	6.48	3.10	35.98
		7/2						
		10-12	Paikgacha	2.60	23.10	2.10	2.60	30.40
		14/1						
		14/2	Koyra	0.00	17.84	3.70	2.30	23.84
		15	Shamnagar	0.00	18.10	15.27	5.20	38.57
		31						
		32	Decope	0.00	17.60	3.40	2.10	23.10
		35/1	Sarankhola	0.00	12.28	0.00	0.00	12.28
			Total :	6.60	129.82	35.85	17.90	190.17
	Barisal Circle	40/1	Pathargata	19.66	0.90	0.00	0.00	20.56
		40/2						
		45						
		46	Borguna	25.60	1.60	0.00	0.00	27.20
		48	Kalapara	31.40	4.10	0.00	0.00	35.50
		54	Galachipa	25.10	39.90	0.00	0.00	65.00
		56/57	Charfassion	2.14	4.61	0.00	0.00	6.75
		"	Daulatkhan	0.00	3.60	0.00	0.00	3.60
		"	Lalmihan	2.14	4.62	0.00	0.00	6.76
		"	Manpura	0.00	12.08	0.00	0.00	12.08
		"	Tazimuddin	5.24	5.90	0.00	0.00	11.14
			Total :	111.28	77.31	0.00	0.00	188.59
	Noakhali Circle	59/2	Ramgati	8.80	6.50	1.30	0.00	16.60
		59/3B	Sudharam	3.40	5.20	1.60	0.00	10.20
		59/3C	Companiganj	1.30	1.30	0.80	0.00	3.40
		60	Sonagazi	0.30	4.10	0.40	0.00	4.80
		73/2B	Hatiya	0.00	33.40	1.0	0.00	34.40
			Total :	13.80	50.50	5.10	0.00	69.40

Cont. Table - 1

Sl. No.	Circle	Polder No.	Upazila	Salinity Catagories				
				S1	S2	S3	S4	1,000 ha
	Chitta-gong Circle	61/1	Sitakunda	2.30	1.00	1.50	0.00	4.80
		62	Patenga	0.50	0.30	0.00	0.00	0.80
		63/1A	Anwara	0.00	1.90	0.00	0.00	1.90
		64/1A	Banskhali	0.60	4.10	0.00	1.30	6.00
		64/2B	Chakaria	3.10	7.50	8.00	5.70	24.30
		66/1	Ramu	0.50	1.00	0.00	0.00	1.50
		66/3	Cox's Bazar	0.50	3.60	0.80	2.60	7.50
		68	Teknaf	1.80	1.00	2.30	3.10	8.20
		69	Maheshkhali	0.80	2.10	3.40	2.60	8.90
		70	Matherbari					
		71	Kutubdia	0.00	1.00	1.80	0.00	2.80
		72	Sandwip	9.80	4.40	4.00		
			Total :	19.90	27.90	21.80	17.90	87.50

NOTE :

Salinity Class	Salinity level micro-mhos/cm
S0 (Non Saline)	0 - 2,000
S1 (Slightly saline)	2,000 - 4,000
S2 (Moderately saline)	4,000 - 8,000
S3 (Saline)	8,000 - 15,000
S4 (Highly saline)	> 15,000

Source : Salinity Problems and Crop intensification in the coastal regions of Bangladesh. by Z. Karim, S.G. Hossain and M.Ahmed.

Soils and Irrigation Division, Bangladesh Agricultural Research Council, BARC, Soils Publication No - 33. 1990.

4. COASTAL AFFORESTATION

It is the practice in Bangladesh that as soon as a new formation rises and ecological succession starts with grass coming up as the first colonizer, the new land is taken over by people and cattle start grazing. The cattle not only loosen the soil but also browse all successor vegetation that have colonized the new land. Ecological succession is thereby retarded. If there had not been this retardation in the ecological succession, grass would eventually be replaced by deep rooted shrubs and trees which would have consolidated the newly formed land. This can not happen in coastal Bangladesh.

So afforestation and protection in certain areas of the new coastal formations have been attempted. In some of the areas like Patherghata in Patuakhali South Hatiya in Noakhali and Kukri-muki in Barisal, stable formations are fast appearing around the forest plantations. Massive efforts in afforestation in these newly formed lands may help to develop more such areas. By realizing the importance of coastal afforestation for the consolidation of newly accreted land, the Bangladesh Forestry Department has undertaken extensive afforestation projects with mangrove species in the coastal districts of Bangladesh. Areas of plantations in the coastal districts raised up to 1990 and proposed plantation up to 1992 are given below in Table.2.

TABLE - 2

COASTAL AREA FOR AFFORESTATION IN BANGLADESH

HECTAR

Year	Chittagong Division	Noakhali Division	Barisal Division	Patuakhali Division	TOTAL
1965-1970	1056	637	1580	-	3273
1970-1975	1110	1000	669	493	3272
1975-1980	8649	9650	5539	5145	28983
1980-1985	9389	14609	10855	5544	40397
1985-1990	8585	12748	6390	4654	32377
Grand Total :	28,789	38,644	25,033	15,836	108,302
1991	830	2023	809	404	4066
1992	830	2023	809	404	4066

5. STABILIZATION OF NEWLY ACCRETED LAND

Some form of vegetation usually algae or salt tolerant grasses is the first macroscopic plant life to colonise newly emergent delta sediments. The algae or grasses increase the resistance of the sediments to reworking by binding the superficial sediments and providing a protective barrier between the sediment and any passing currants. The algae can provide a continuous cover over the sediment with a low friction coefficient and thus protect the sediment from resuspension. These plants can also trap some additional sediment but their main contribution to new land accretion is through the protection from erosion they provide for the sediments beneath them. So a grass or algae cover over say 50% or more of a sediment surface would be a good indicator that stability was sufficient to justify planting if other site conditions were favourable.

Mangroves are the next plant species to colonise an area after the grass or algae. They are not as good at binding sediments as the grasses and algae because they don't provide the high vegetation cover near the sediment/water interface, but they provide excellent check or baffles (particularly species with well developed pneumatophore or stilt root systems) which reduce the flow velocity of any sediment laden current passing through them. The baffle effect provided by mangroves can be readily observed by watching the decrease in the rate of movement of floating leaves as a rising tidal current flows into a mangrove forest. As a result of the decrease in flow velocity in a mangrove forest it should be expected that the rate of sediment accretion will be substantially greater than in a similar but unforested area, in some areas of the Bangladesh delta complex deposition of up to 1 m of new sediment per year in young mangrove forest has been noted. The elevated rates of sediments accretion in mangrove plantations may in some areas result in the total or partial burial of some seedlings but as the mean sediment surface rises, relative to the mean water level sediment accretion rates will decline. Thus given that one of the objection of the mangrove afforestation project is the reclamation of new land, it may be desirable in areas where high sedimentation rates are likely to plan an initial sacrificial planting to accelerate accretion and to follow this 12-24 months later with a second planting of the intended crop. The burial of an initial plantation should be viewed as a success in working with natural processes to create new land rather than a failure in relation to the loss of an initial batch of seedlings.

So in the Brahmaputra - Megna delta there are continually forming tidal and subtidal shoals but these are not colonized by any plant or plant community because they generally remain under water. The island that occasionally emerges is occupied by neighbouring farmer for growing one or two crops of paddy after which the island disappears as a

result of soil erosion. In the late 1960's and early 1970's satellite sensing revealed large scale land accretion in the estuaries of Brahmaputra, Meghna and to a limited extent Ganges river. It was then estimated that about 5000 sq.km of such new land were in the process of formation. As the newly accreted land masse are extremely fragile and unstable, the Government of Bangladesh decided to stabilize and consolidate the new accretions through afforestation. The objectives set for coastal afforestation are to :-

(a) Accelerate the process of siltation and the stabilization of soil

(b) Create forest shelterbelts to protect embankments, life and property inland from tidal bores

(c) Create an urgently needed resource to add to the national wealth
(d) Create job opportunities for the rural communities.

(e) Create an environment for wild life, fishes and other estuaries and marine fauna.

Afforestation in the coastal area commenced on a model scale in 1965 with the planting of seedlings on the slopes of the embankments of the Water Development Board. The access of these plantation led to a bold coastal afforestation programme. World Bank assistance has been available from 1980 to extend the coastal afforestation programme. Species used in coastal afforestation are:

Acacia arabica(Babla tree), Acacia catechu (Khair tree) in higher land along the slopes of embankments and Sonneratia apatala (Keora), Avicinea officinalis (Baen), Bruguiera gymnorhiza (Kankra) and Nypa fruiticans (Gulpata) in new accretions and lower areas of embankments.

6. MANGROVE FOREST

The coastal area of Bangladesh extend along the Bay of Bengal from the mouth of the Teknaf River in the south east to the mouth of the Raimangal River in the south west. A natural mangrove ecosystem occurs in this belt up to a width upstream to which saline water (PH-7.5 and above) from the sea intrudes with tide. This area comprises climate, salinity, fresh water supply, siltation erosion, substrate and nutrients each of which influences the flora and fauna which in turn act on the environment. The mangrove forests of Bangladesh are both natural and man made. There are two natural mangrove forest in the country such as (a) The chakaria Sunderban Cox's Bazar and (b) Khulna Sundarban.

A. The Chakaria Sunderban, Cox's Bazar

The chakaria sunderban is located in the eastern part of the coast and situated within the Cox's Bazar district is the small patch of about 7500 hectares of forest known as the chakaria Sunderban. In this forest there are a large number of low lying islands which are mostly submerged at high tide and the water remains brackish throughout the year. Salinity increase during the dry season. The vegetation consists of salt water halophytes. There are about 20 species of trees and none attains a height of 12 m. This forest was reserved in 1903 to provide protection to human settlements following damage caused by a cyclone in 1882. Management practices involved restricted exploitation based on minimum diameter limits of trees of different species and limited grazing. The depletion of the chakaria Sunderban mangroves has accelerated since the late 1970's as a result of the conversion of forests into shrimp cultivation pond. So far 3061 hectares have been allotted to private individuals for shrimp cultivation. The investors got a good harvest of shrimp and at the same time they extracted the mangrove forest and sold the tree and made a good profit and ultimately half of the mangrove forests are almost destroyed. Moreover the mangrove forests were much over worked in the past and illicit felling was very common. As a result the condition of the forest has deteriorated to such an extent that the forest should be given complete rest from any forestry operation for a certain period.

So the UNESCO mission to Bangladesh made recommendation in 1986 regarding the Chakaria Sunderban. According to that recommendation it was agreed that (a) the whole chakaria sunderban forests should be closed from any forest operation for the next ten years. (b) a system of rotation grazing on the basis of five years cycle should be adopted. (c) It is necessary that artificial plantation should be tried to accelerate the restocking of

the area and (d) the desirability of cancelling leases for shrimp culture previously issued should be examined very seriously.

B. The Sunderbans, Khulna

West of the Brahmaputra - Meghna delta lies the most important mangrove forest, the Sunderbans. This is the largest mangrove forest in the world in one patch and extends contiguously towards the west beyond the international boundary with India. The Sunderban reserved forest has a total land area of 401,600 hectares, 395,500 ha. is occupied by forest and 6100 ha is scrub jungle, grassland or bare ground. Topographically, the Sundarbans are a delaic swamp. The land surface is essentially flat. The Sunderbans receive large volumes of fresh water from inland rivers flowing from the north and saline water from tidal incursions from the sea. The fresh water is charged with alluvium which contains plant nutrients and this together with the salinity of the tidal water, is a major factor affecting the forest ecosystem.

The numerous rivers and streams which dissect the Sunderbans in a north- south direction are distributaries of the Ganges. These rivers partially combine to form the five main estuaries which provide the major points ingress for saline intrusion.

The natural vegetation of the Sunderbans is composed of halophytic tree species. The forest canopy is seldom more than 10 m above the ground level and is more or less open, permitting some directs unlight to reach the forest floor.
Some parts of the forest have two storied and attaining a height up to 20 m. Stem diameters are generally less than 20 cm at breast height. One or two species attain much bigger diameters. Due to salinity of which the vegetation has to be adopted, the forest flora are not rich in species. There are about 25 other species which are common but considerably less frequence in their occurrence.

Three ecological zones within the Sunderbans have been recognized which are differentiated according to salinity and species composition. These are (a) The fresh water zone consist of Heritiera forest (b) The moderately salt water zone is characterized by a predominance of Excoecaria agallocha species and (c) the forest in the salt water zone is typically a more or less closed understorey of Ceriops decandra species etc.
The Sunderbans have been under some form of management since 1875 and most of the forests were declared reserved forests in 1879 up to 1985 there were a total of seven working plans or revision of working plans. The present working plan prescribes a 20 year cutting cycle for the main species and a number of miscellaneous prescriptions

covering the exploitation of ceriops fuelwood and polders, nipa palm leaves, honey and a range of other minor forest produce.

The common mangrove species of Chokoria Sunderban Cox's Bazar and Sunderban at Khulna are listed in Table - 3.

TABLE - 3

LIST OF COMMON PLANTS IN THE SUNDARBAN FORESTS

Scientific Name	Family	Vernacular Name	Type of Plant
Acrostichum aurcum	Pteridiaceae	Hodo tiger fern	Gregarious fern
Aegialitis rotundifolia	Plumbarinaceae	Dhalchaka	Small tree
Avicennia officinalis	Avicenniaceae	Baen	Tree
Bruguiera gymnorhiza	Rhizophoraceae	Kanhta	Tree
Ceriops decandra	Rhizophuraceae	Goran	Shrub or small tree, usually coppice
Dalbergia spinosa	Leguminosae	Chanda Katta	Scandent, armed shrub
Excoecaria agallocha	Euphorbiaceae	Gewa	Tree
Heritiera fomes	Sterculiaceae	Sundri	Tree
Myriostachya wightiana	Gramineae	Dhanshi	Grass, common on new accretions
Nypa fruticans	Palmae	Golpatta	Palm with underground stem
Phoenix paludosa	Palmae	Hental	Thorny plam
Sonneratia apatala	Sonneratiaceae	Keora	Tree
Xylocarpus mekongensis	Meliaceae	Passur	Tree

7. DESCRIPTION OF POLDERS REGARDING AFFORESTATION

Field studies were made in the polders included in the Mid Term Programme to assess the type of afforestation on and in front of sea facing embankments and to assess the requirements for new afforestation. Reconnaissance and condition surveys were made in the polders listed in Table - 4 and shown on the base Map of which the majority are included in the Mid Term Programme. In the following is presented a description of the existing and proposed new afforestation of each polder together with the related polder maps.

The descriptions also contain some observations on the condition of the embankments which should be seen in the overall context of the embankment condition survey and the project rationale

During the survey of the polders the existing afforestations on the slopes of the embankments as well as on the forelands were found to be discontinuous and scattered. The existing babla trees were mostly planted during the early stages have become matured and need to be replaced. The available mangrove trees in the fore land have become thinned out creating large gaps between the trees which need to be filled up by immediate planting of new seedlings.

POLDER -5

This polder belongs to upazila Kaligonj and Shamnagar under Satkhira district and Khulna circle. About 35 kilometers of embankment were surveyed for the mid term plan and is shown in Map 4. Scattered trees of 15-20 years old Babla trees were found to be growing on the slope of the embankment. On the foreland there are about 500 meters area available and most of the area is used by the shrimp cultivator and also some scattered patches of mangrove species and gulpata are growing. Some part of the embankment is completely barrel and not a single tree is present except few local bushes and grass cover. The soil of the embankment is silty clay and where the Babla (Acacia arabica) trees are growing, looked very healthy and luxuriant in growth.

This part of the embankment is sorrounded by Kalinda river where the India border has started just the other sides of the river. This part of the embankment has not been much affected by wave action and did not need any protective work. While coming through the Charkuni khal through the Dumkoll khal , the chainage from 69.76 to 74.80 kelometers, the embankment is found to be damaged in several places by the wave action. In this

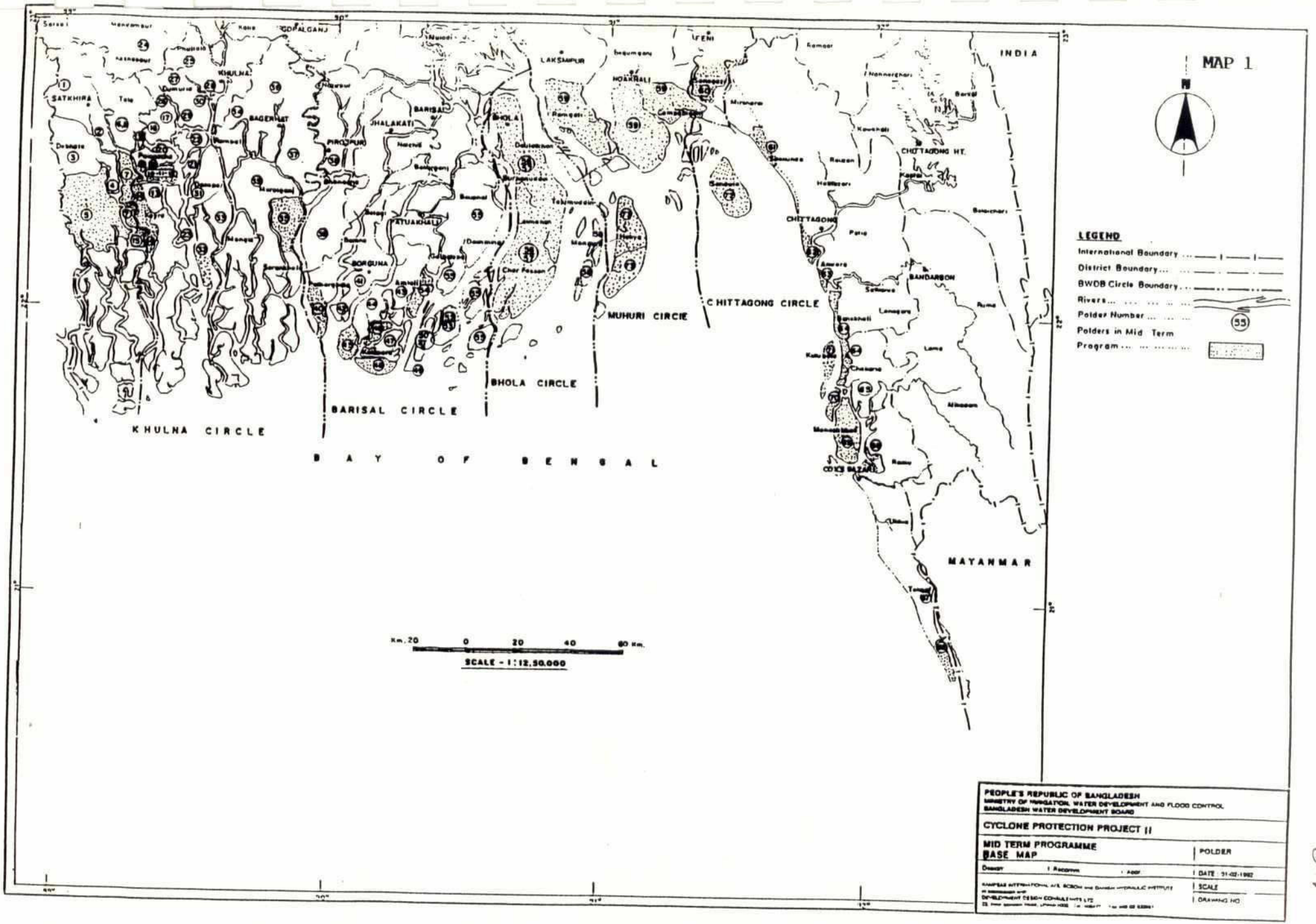
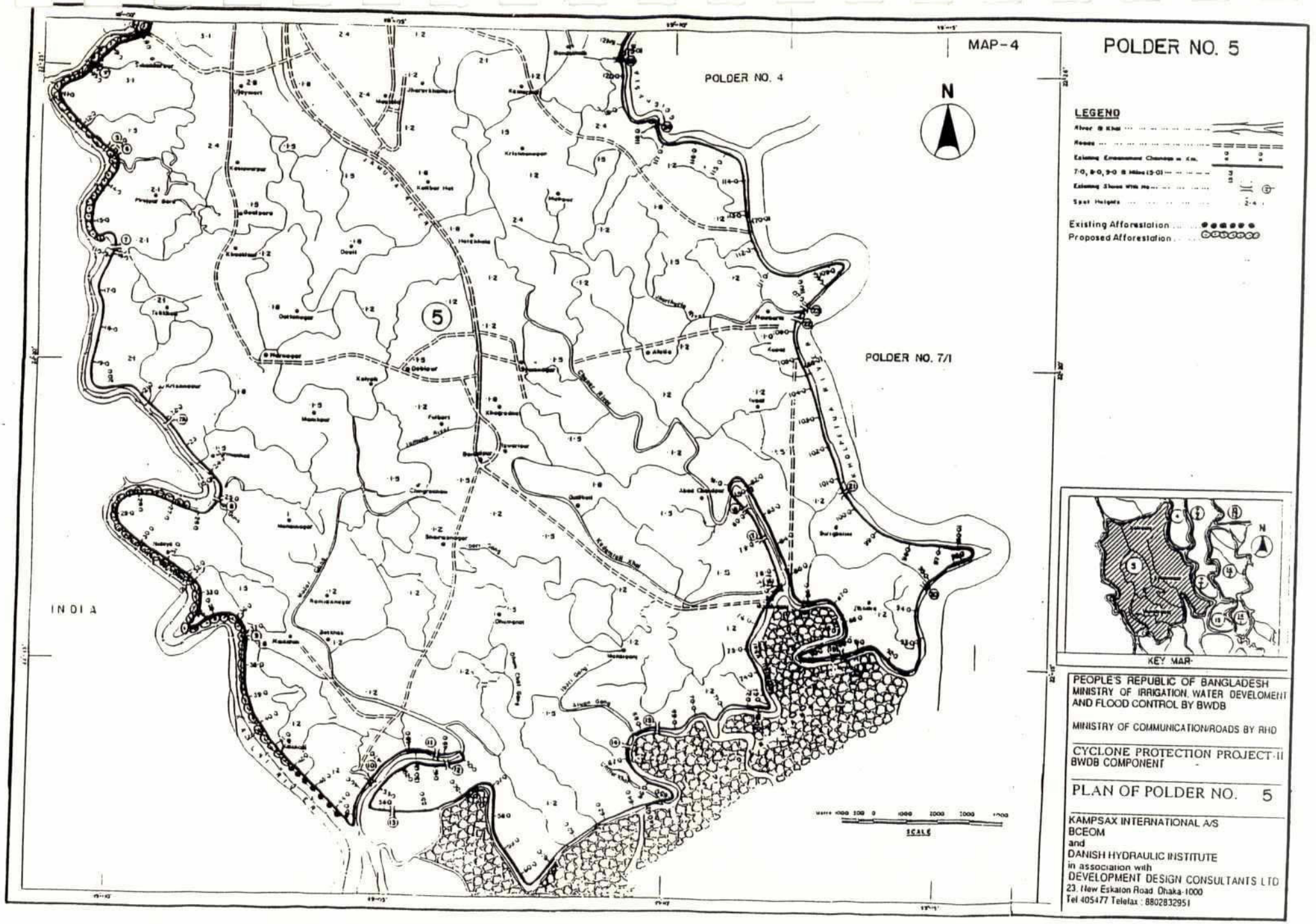

MAP 1
N
INDIA
MAYANMAR
BAY OF BENGAL
KHULNA CIRCLE
BARISAL CIRCLE
BHOLA CIRCLE
MUHURI CIRCIE
CHITTAGONG CIRCLE
SATKHIRA
KHULNA
GOPALGANJ
BARISAL
JHALAKATI
PIROJPUR
BAGERHAT
BHOLA
LAKSHMIPUR
NOAKHALI
FENI
CHITTAGONG
CHITTAGONG HT.
BANDARBON
COX'S BAZAR
PATUAKHALI
BORGUNA
LEGEND
International Boundary
District Boundary
BWDB Circle Boundary
Rivers
Polder Number
Polders in Mid Term Program
Km. 20 0 20 40 60 Km.
SCALE - 1:12,50,000
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
CYCLONE PROTECTION PROJECT II
MID TERM PROGRAMME
BASE MAP
POLDER
DATE : 31-02-1982
SCALE
DRAWING NO

TABLE - 4

POLDERS SUBJECT TO FIELD SURVEYS OF AFFORESTATION

Sl. No.	Polder No.	Length of Embankment (Km)	Area surv-eyed (Km)	Name of Upazila	District	Circle
1	5	38	35.1	Kaligonj and Shymnagar	Satkhira	
2	7/1	32	31.0	Asasuni	"	
3	7/2	10	11.4	Asasuni "		
4	10-12	8	10.4	Paikgacha	Khulna	Khulna
5	14/1	11	11.8	Koyra	"	Circle
6	14/2	31	31.1	"	"	
7	15	27	27.1	Shamnagar	Satkhira	
8	31	5	1.6	Dacope	Khulna	
9	32	15	27.7	Dacope	"	
10	35/1	19	17.7	Sarankhola	Bagerhat	
11	40/1	16	16.0	Patharghata	Borguna	Barisal
12	40/2	15	4.4	Patharghata	Borguna	Circle
13	45	13	12.5	Borguna	Borguna	
	46	2	2.4			
14	48	19	16.2	Kalapara	Patuakhali	
15	54	12	12.0	Galachipa	Patuakhali	
16	56/57	91	110.7		Charfassion	
				Daulatkhan	Bhola	Bhola
				Burhanuddin		Circle
				Lalmohan		
				Tazimuddin		
17	59/2	10	10.2	Ramgati	Laxmipur	
18	59/3B	42	30.0	Sudharam	Noakhali	Muhuri
19	59/3C	27	42.0	Companiganj	Noakhali	Circle
20	60	21	22.0	Sonagazi	Feni	
21	73/2B	29	32.8	Hatiya	Noakhali	
22	61/1	20	19.0	Sitakunda	Chittagong	
23	62	16	21.6	Chittagong Patenga	Chittagong Circle	Chittagong
24	63/1A	15	19.1	Anwara	Chittagong	
25	64/1A	24	27.9	Bash Khali	Chittagong	
26	64/2B	8	8.3	Chokoria	Cox's Bazar	
27	66/1	7	7.0	Ramu	Cox's Bazar	
28	66/3	4	5.3	Cox's Bazar	Cox's Bazar	
29	68	17	14.4	Teknaf	"	
30	69	23	20.0	Moheskhali	"	
31	70	17	19.7	Matherbari	"	
32	71	25	23.6	Kutubdia	"	
33	72	67	63.4	Sandwip	Chittagong	


MAP-4
POLDER NO. 5
POLDER NO. 4
POLDER NO. 7/1
INDIA
N
LEGEND
Existing Afforestation
Proposed Afforestation
KEY MAP
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 5
KAMPSAX INTERNATIONAL A/S
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part , there is no tree on the slopes of the embankment and also any mangrove species in the foreland. Again from the chainage 85.92 to 132.8 kilometers, the embankments were damaged earlier and have been affected by heavy wave action. The whole foreland area need good plantation with mangrove species and good afforestation with suitable species on the slopes of the embankment. The existing and proposed afforestations on the slope of the embankment and on the foreland are shown in Map 4.

POLDER- 7 / 1 AND 7 / 2

These two polders belong to Assassuni Upazila under Satkhira district and Khulna circle. About 31.0. Kilometers of embankment for polder 7/1 and 12 kilometers of embankment for polder 7/2 were surveyed and are shown in Map 5. The river Kobadak passes through the eastern side, and River Kholpeta passes through the western side of the polders. During the monsoon, there is a great pressure on both the river and as a result, the embankment in both sides are much affected and damaged by the wave action. Very few tree except scattered date palm (phoenix dacty lifera) and palm trees Borassus flabellifer) were growing on the slopes of the embankment and with some local bushes and grass cover. On the foreland, few patches of mangrove species are growing.

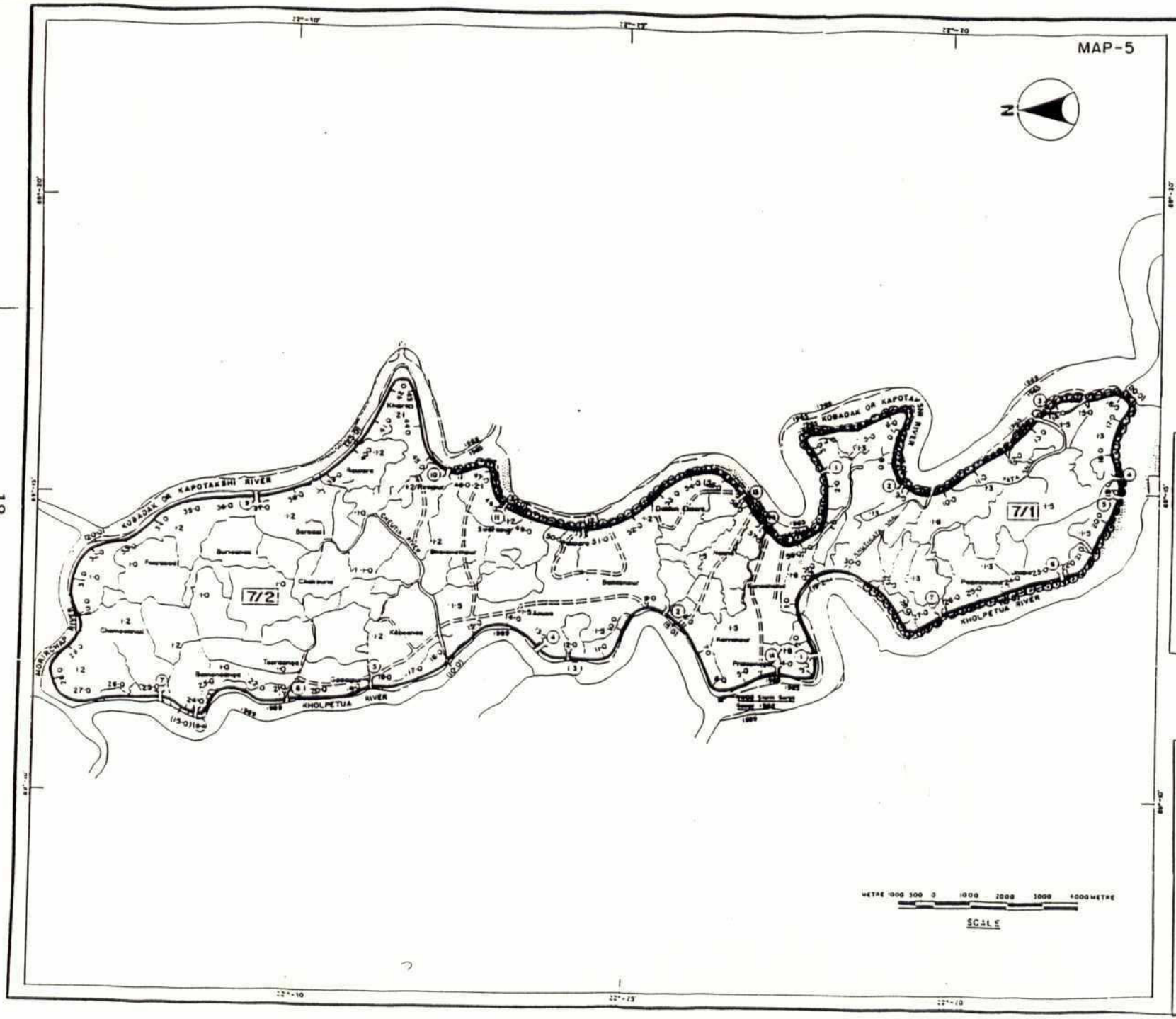
For polder 7/1, the chainage from 0.0 to 10.8 kilometers, there are some damaged area. On the western side, at the bank of the Kalpetua river, the embankment for both the polders are more or less affected by wave action. The tree species are also found to be growing scatteredly - here and there on the embankment. Very few mangrove afforestation are present in the fore land, but there are some good spaces available where mangrove afforestation can be established. Again for polder 7 /2, the chainage from 47.0 to 50.0 kilometers and 50.6 to 55.8 kilometers, the portions are damaged and need immediate protective work. So there is a good chance to raise plantation on the embankments as the soil is silty clay and suitable for any kind of good species. The existing and the proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 5.

POLDER, 10-12

This polder belongs to Paikgacha Upazila under Satkhira district and Khulna Circle. About 10 kilometers of embankment were surveyed for this mid term programme and is shown in Map 6. Some trees like date palm (Phoenex dacty lifera) Babla (Acacia arabica) Shil koroi (Albizzia lebek) Rain tree (Samanea saman) Coconut (Cocos nucifera) trees etc. are found to be growing on the slopes of the embankment and some

MAP-5

POLDER NO. 7/1 & 7/2

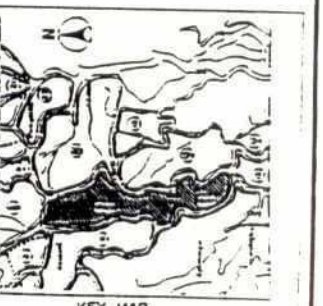


LEGEND

- River & Khal
- Roads
- Existing Embankment Chainage in Km. 23.0, 24.0, 25.0 And Mile (15.0)
- Proposed Embankment
- Existing Sluice with Number
- Proposed Sluice
- River Bank 1989
- River Bank 1965
- Spot Heights

Existing Afforestation

Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 7/1, 7/2

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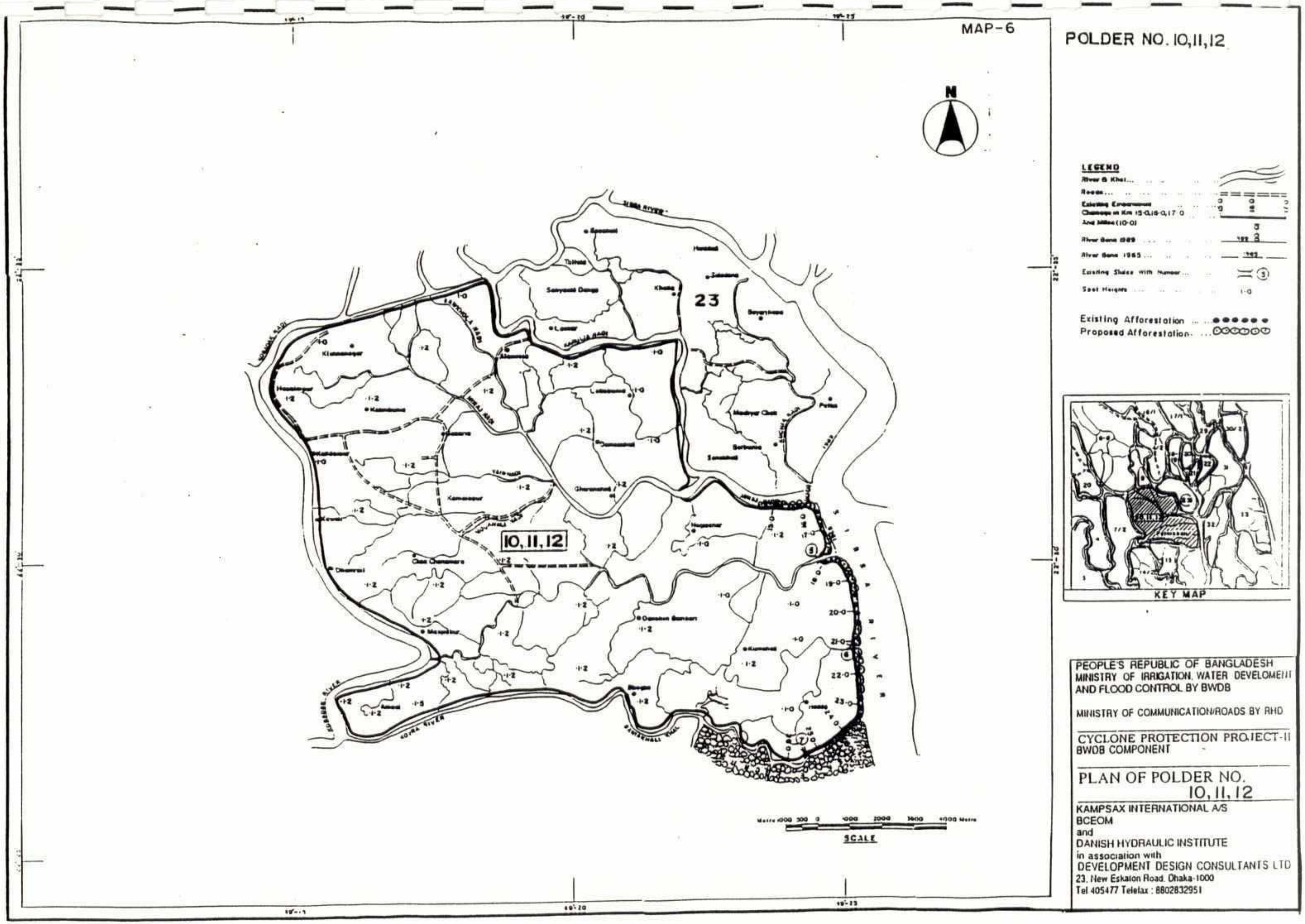
scattered mangrove trees were growing on the foreland. In some area, the whole embankment is almost empty, only few local bushes and grass cover are present. In some area there is no berm where mangrove species can be planted.

The soil of the embankment is silty clay and there is a chance to grow suitable species of good trees. The mangrove species need to be planted in order to protect the embankments. The section from chainage, 15.2 to 25.6 kilometers of embankment along the Sibsa River is very much affected by wave action. Specially from chainage 15.2 to 20.9 kilometers, the embankment has been damaged in few places. In the foreland, very few mangrove trees are present. There is a god space available in the foreland where mangrove species can be planted. The existing and proposed afforestation on the slopes of the embankment as well as on the foreland, are shown in Map 6.

POLDER 14 / 1 AND 14 / 2

These two polders belong to Koyra upazila under Khulna circle. About 12.0 kilometers of embankment for 14 /1 polder and 31.0 kilometers of embankment for polder 14 /2 were surveyed for the mid term programme and are shown in Map 7. While visiting the polder it was found that the most affected area of these polders are on the side of the Kobadak river . In polders 14 /1, the chainage from 0.0 to 1.50 kilometrers, the area is very affected and damaged by wave action in several places. Very few trees are found on the slopes of the embankment except few local bushes and grass cover. In some area, the grass cover is also absent, this may be due to the over grazzing by local live stock and some direct saline water action. In the fore land there are some scattered patches of mangrove stand which are preventing the embankment from direct wave action. There are good spaces where mangrove afforestation can be established.

In polder 14 /2, the Chainage from 3.21 to 6.43 kilometers, 13.27 to 21. 14 kilometers and 23.26 to 27. 53 kilometers, these portions are more or less seriously affected. Among the tree species, some trees of date palm (Phoenix dactylefera) Shil koroi (Albizzia lebbek) kul boroi (Zizyphus jujuba) and babla (Acacia arabica) trees are found to be growing scatteredly on the embankment. Again in some areas there were no trees except few local bushes and grass cover. On the fore land, some mangrove afforestation are present. There are some good spaces all along the embankment where mangrove afforestation can be established. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 7.


MAP-6
POLDER NO. 10,11,12
N
23
10,11,12
SIBSA RIVER
SCALE
LEGEND
Existing Afforestation
Proposed Afforestation
KEY MAP
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 10, 11, 12
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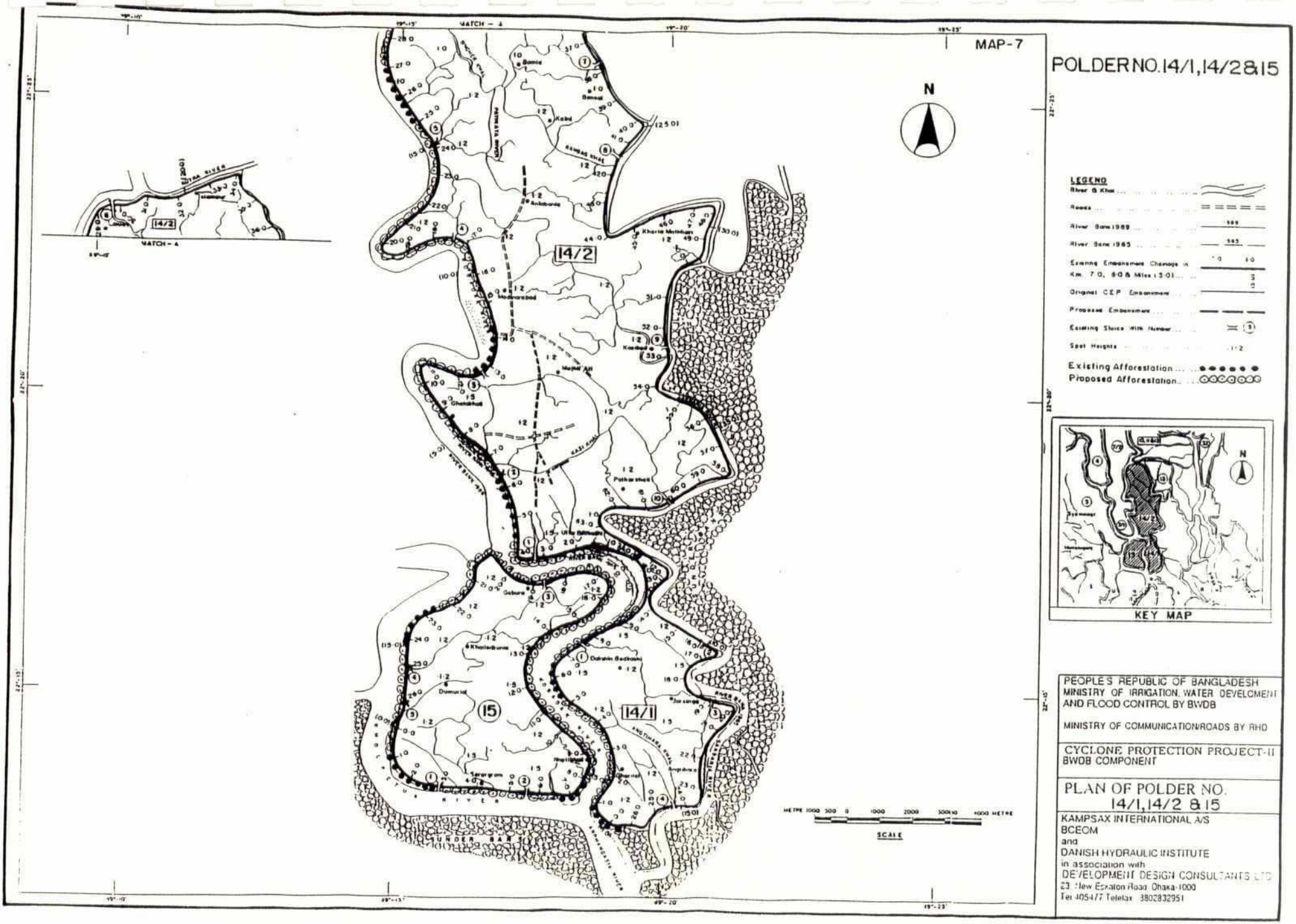
MAP-7
POLDER NO.14/1,14/2&15
N
LEGEND
River & Khal
Roads
River Bank 1989
River Bank 1965
Existing Embankment Chainage in Km. 7.0, 8.0 & Miles 5.01
Original CEP Embankment
Proposed Embankment
Existing Sluice With Number
Spot Heights
Existing Afforestation
Proposed Afforestation
KEY MAP
14/2
14/1
15
WATCH - A
SCALE
METRE 1000 500 0 1000 2000 3000 4000 METRE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 14/1,14/2 & 15
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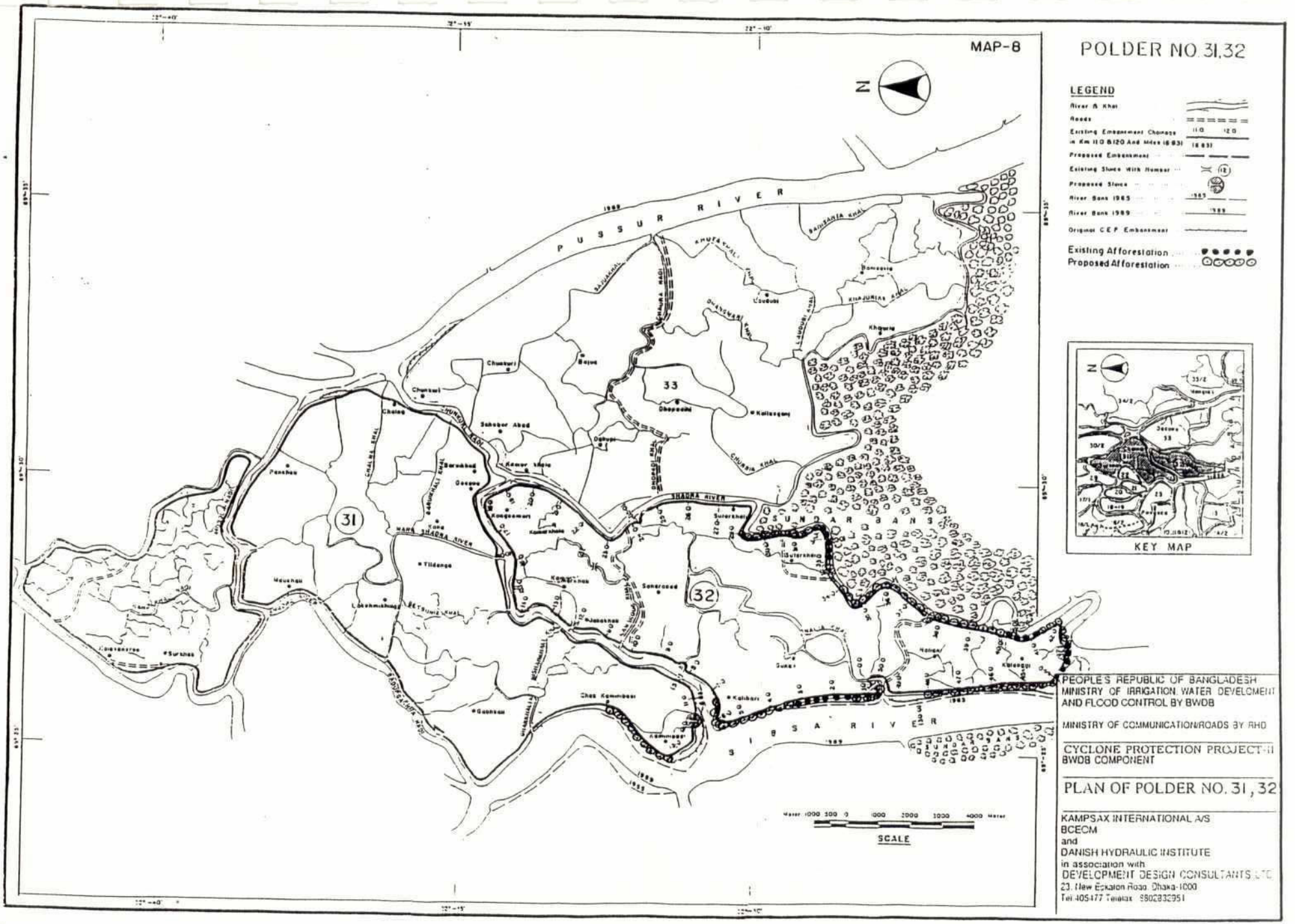
POLDER - 15

This polder belongs to shamnagar upazila under Khulna circle. About 27 kilometers of the embankment were surveyed for the mid term programme and is shown in Map 7. On the eastern side of the polder, the river Kobadak passes between the polders 14 and 15 and in the western side, the river Kholpetna passes between polders 5 and 15. Scattered trees of date palm (Phoenix dactylefera) coconut (Cocos nucifera) shil koroi (Albizzia lebbek) etc. were observed but most part of the embankment is empty without any trees except few local bushes and grass cover. On the fore land there are few patches of mangrove afforestation. About 500 meters of the land all around the embankment are available except few spots where mangrove afforestation can be easily established. From the chainage, 8.04 to 11.26 kilometers and 12.55 to 14.44 kilometers, these areas are seriously damaged and need immediate protective work. The soil of the embankment is silty clay and there is a chance to grow any of the suitable species. The existing and proposed afforestation for the slope of the embankment as well as for the fore land are shown in Map 7.

POLDER 31 AND 32

These polders belong to Dacop upazila under Khulna circle. About 30 kilometers of the embankment from the polders of 31 and 32 were surveyed and are shown in Map 8. Scattered trees of babla, (Acacia arabica) Mahagony (Swietenia Mahogony) shil Koroi (Albizzia procera) Rain trees (Samanea saman) Kul Boroi (Zizyphus jujuba) Neem (Melia azadirachta) date palm (Phoenix dactylifera) and coconut (Cocos nucifera) trees etc were found growing on the slopes of the embankment and in the foreland. Some scattered trees of mangrove species such as Sundari, (Heritiera fomes) Baen (Avicinnia officinalis) Keora, (Sonneratia apatala) Gulpata (Nypa fruiticans) and kankra (Bruguiera gymnarhiza) are growing along the embankment. It is found that gulpata is the most effective species for the protection of embankment for any kind of wave action. In some areas, the whole embankment was completely out of trees except some local bushes and grass cover. The sections from the chainage 28.0 to 28.5 kilometers and from 32.0 to 33.5 kilometers, are damaged due to high wave action.

There is a big breach of the embankment from the chainage 45.4 to 46.9 kilometers and as a result saline water entered the whole area and destroyed all the agricultural land. For the last few years, these lands could not be used for any kind of paddy and crop productions. In the foreland of this part, there is no mangrove afforestation but there is a space where mangrove afforestation can be established. The soil of the embankment is


MAP-8
POLDER NO. 31,32
LEGEND
River & Khal
Roads
Existing Embankment Chainage in Km 11.0 & 12.0 And Miles (6.83)
Proposed Embankment
Existing Sluice With Number
Proposed Sluice
River Bank 1965
River Bank 1989
Original C.E.P. Embankment
Existing Afforestation
Proposed Afforestation
N
PUSSUR RIVER
SHAGRA RIVER
SUNDARBANS
SIBSA RIVER
31
32
33
KEY MAP
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 31, 32
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silty clay and there should be planted more suitable forestry species in the slopes and mangrove afforestation in the foreland of the empty spaces all along the embankment. The existing and proposed afforestation for the slopes of the embankment as well as for the foreland are shown on Map 8.

POLDER 35 /1

This polder belongs to Sharankhola upazila under Bagherhat District and Khulna circle. About 18.0 kilometers of embankment were surveyed for the mid term plan and is shown in Map 9. Some tree species of babla (Acacia arabica) shil koroi (Albizzia lebbek) Ful koroi (Samanea saman) coconut (Cocos nucifera) date palm (Phoenix dactylifera) Mahogony (Swietenia Mahogony) and cotton (Bombax insigne) trees were found to be growing on the slope of the embankment and some scattered patches of mangrove on the fore land. These mangrove plantations are not continuous. It was found that where the mangrove afforestation is absent in the foreland of the embankment, the embankment is seriously affected by the wave action and cyclone surges. In the foreland there is little spaces where mangrove can be planted.

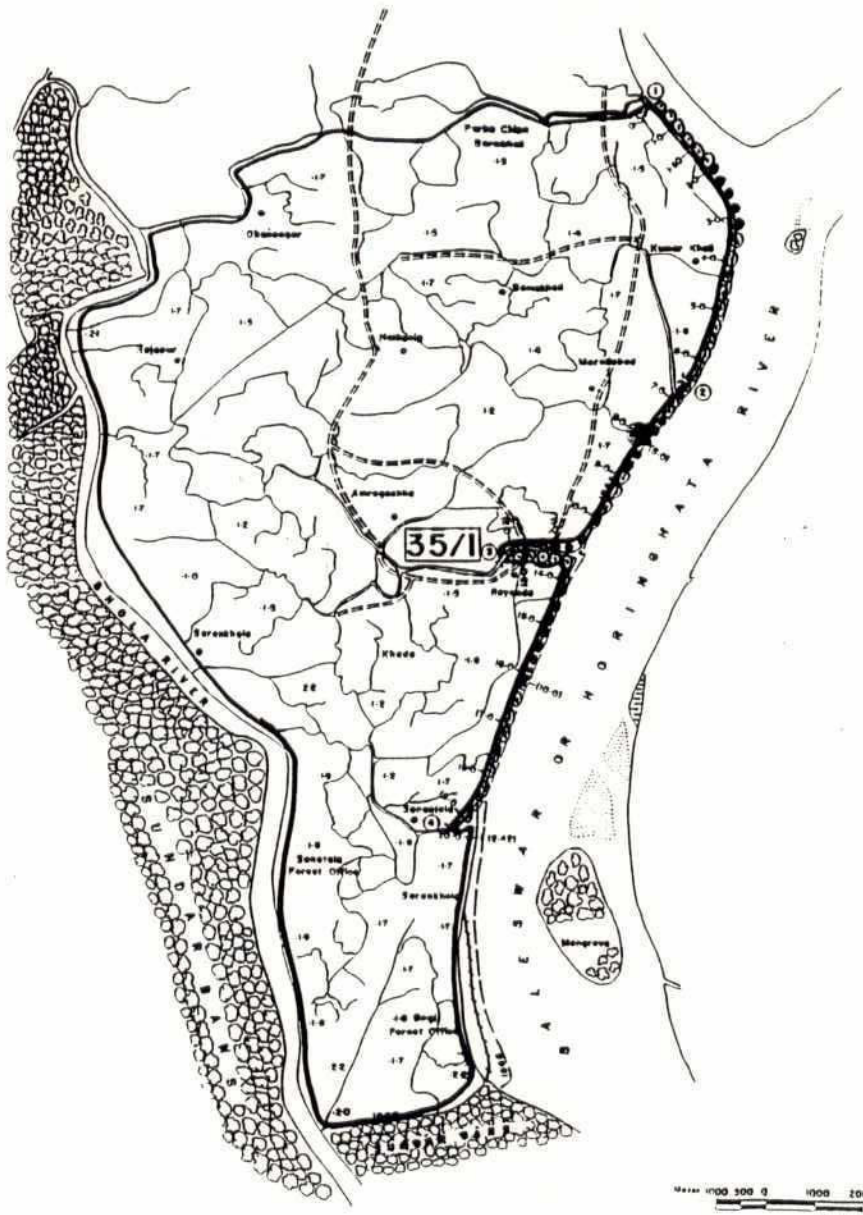
The water Development Board has already sent a proposal for retiring the embankment. This area is always getting damaged by the wave action. From the chainage 4.1 to 5.5 Kilometers, this portion had already some protective work and there are some mangrove trees on the fore land of this area and as a result the protective works are still in good condition. The existing and the proposed afforestation on the slope of the embankment as well as on the fore land are shown in Map 9.

POLDER 40 /1 AND 40 /2

These two polders belong to Pathargata upazila under Borguna district and Barisal circle. About 16.0 kilometers of embankment for polder 40 /1 and 5.0 kilometers for polder 40 /2 were surveyed for the mid term programme and are shown in Map 10. It was found that some scattered tees of Babla, (Acacia arabica) and date palm, (Phoenix dactylifera) coconut trees (Cocos nucifera) were growing in the slopes of the polder 40 /1 but there were not many mangrove trees on the foreland except a few scattered here and there. From chainage 2.5 to 2.8 kilometers, damaged portion was found and there were not any mangroves in front of that portion. After the damaged portion some protective work was found which was done earlier. Again from chainage 4.0 to 5.5 kilometers the embankment was retired but on the embankment there is no any trees and also no mangrove afforestation on the foreland.

MAP-9

POLDER NO. 35/1

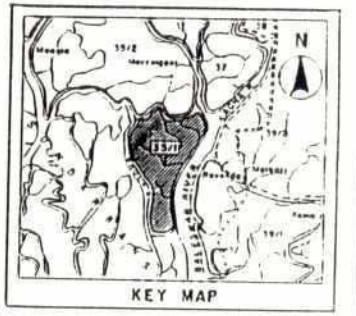


LEGEND

- River & Khal
- Roads
- Existing Embankment Chainage in Km. & Miles (5.01)
- Proposed Embankment
- Existing Sluice With Number
- Proposed Sluice
- Original C.E.P. Embankment
- River Sand 1969
- River Sand 1985
- Spot Heights

Existing Afforestation

Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 35/1

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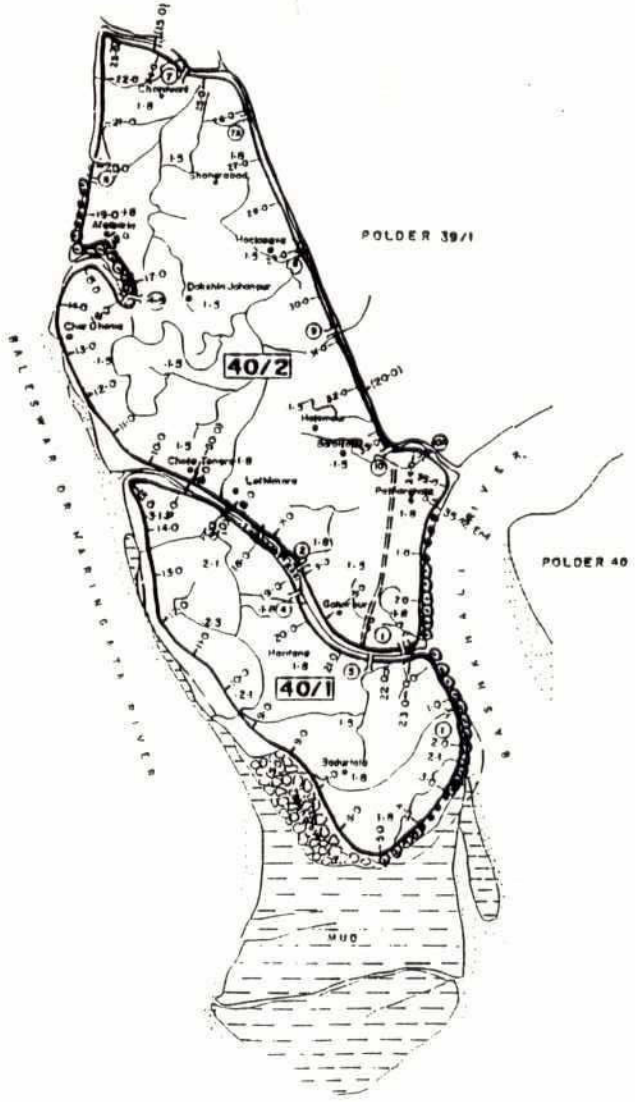
G4

MAP-10

POLDER NO. 40/1,40/2



N

LEGEND

- River & Khal
- Roads
- Existing Embankment Chainage in Km.&Q, 9-0, And Miles (5-0)
- River Bank 1989
- River Bank 1985
- Existing Sluice With Number
- Spot Heights
- Existing Afforestation
- Proposed Afforestation

KEY MAP

SCALE

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO.
40/1, 40/2

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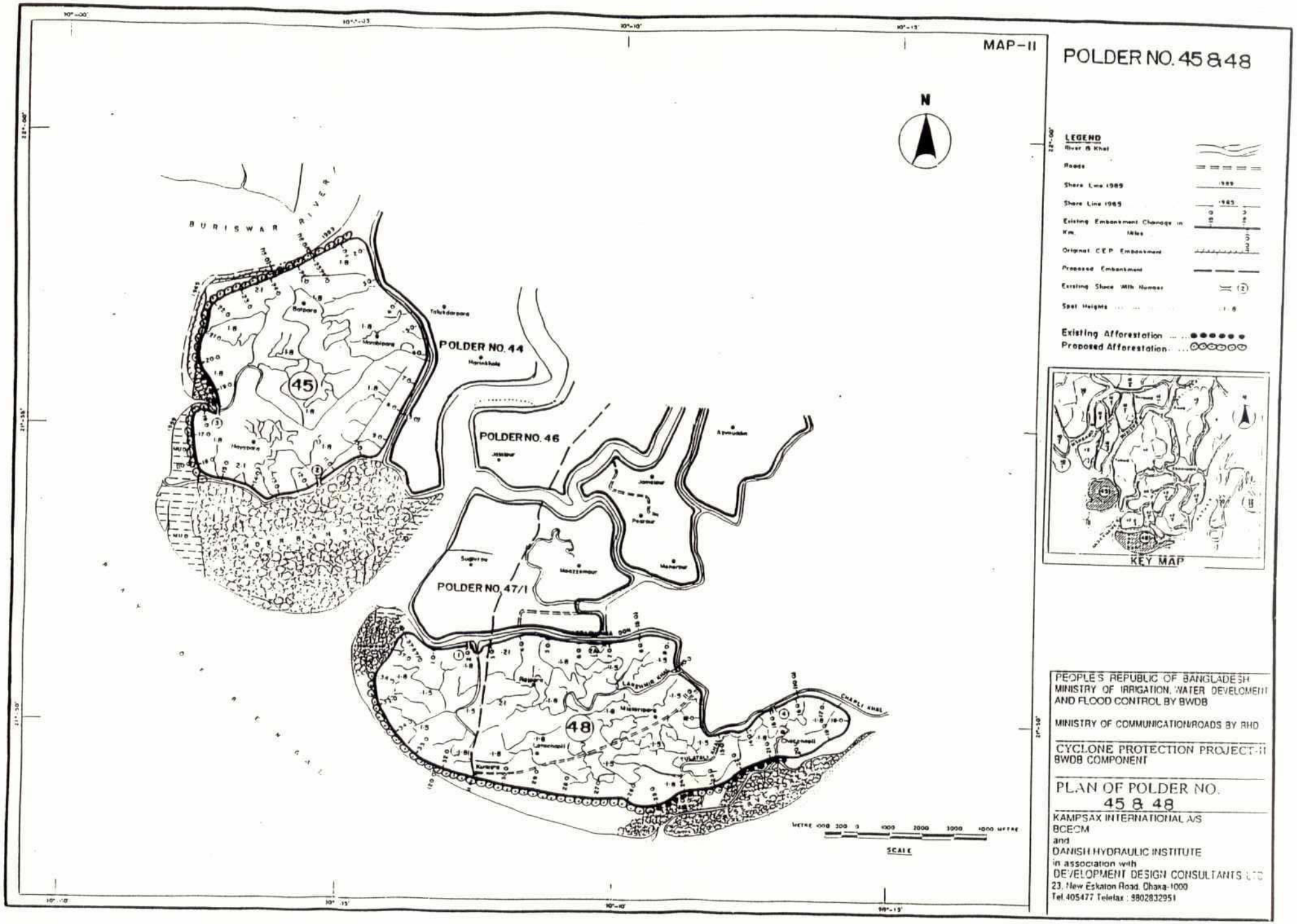
In polder 40/2 , few scattered trees of babla, shil koroi, date palm, trees etc. are growing on the slope of the embankment but also some scattered patches of mangrove afforestation is present in the foreland. From the chainage 17.6 to 22.0 kilometers, some portions are found to be damaged due to wave action but no afforestation is present in the foreland of this damaged portion. The forest department planted gulpata in the borrow pit all along the embankment from chainage 25.0 to 30.0 kilometers during 1980-82. These gulpata are growing very well and working as a good protective work for the embankment. There is a good accreted land where forest department planted mangrove species which are established very successfully. The soil of the embankment is silty clay. So there is a good chance to plant suitable forestry species on the slope of the embankment and mangrove on the fore land. The existing and proposed afforestation on the slope of the embankment as well as on theforeland are shown in Map 10.

POLDER 45

This polder belongs to upazila Barguna under the Barisal circle. About 13.0 kilometers of embankments were surveyed for the mid term programme and is shown in Map 11. Very good strands of 15 to 20 years old Babla (Acacia arabica) Khair (Acacia catechu) trees etc were found on the slopes of the embankment. On the fore land, there is a good mangrove plantation with gulpata on the borrow pit which was planted by the forest department during 1980-82. The plantation in growing very successfully and it is protecting the embankment very well. At the western part of the polder, the River Haringhata and River Buriswar joined together and during the monsoon it has become very active and creating a heavy wave action on the embankment. From the chainage 16.2 to 19.5 kilometers, the area became very much effected and was damaged on several portions. For some reason, the species gulpata could not be established in the fore land of this part and subsequently this part became very weak. There is a good chance to be established mangrove afforestation in these areas. At the southern part of the embankment, there is a good accreted land where forest department established a very nice mangrove afforestation. These are almost 10-15 years old. and the growth of the trees are very well.

Mangrove afforestation is growing in the foreland of the southern part of the polder and keeping the embankment well proted from any kind of wave action. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 11.


MAP-II
POLDER NO. 45 & 48
N
LEGEND
River & Khal
Roads
Shore Line 1989
Shore Line 1965
Existing Embankment Chainage in Km. Miles
Original CEP Embankment
Proposed Embankment
Existing Sluice With Number
Spot Heights
Existing Afforestation
Proposed Afforestation
BURISWAR RIVER
POLDER NO. 44
POLDER NO. 46
POLDER NO. 47/1
45
48
KEY MAP
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO.
45 & 48
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POLDER 46

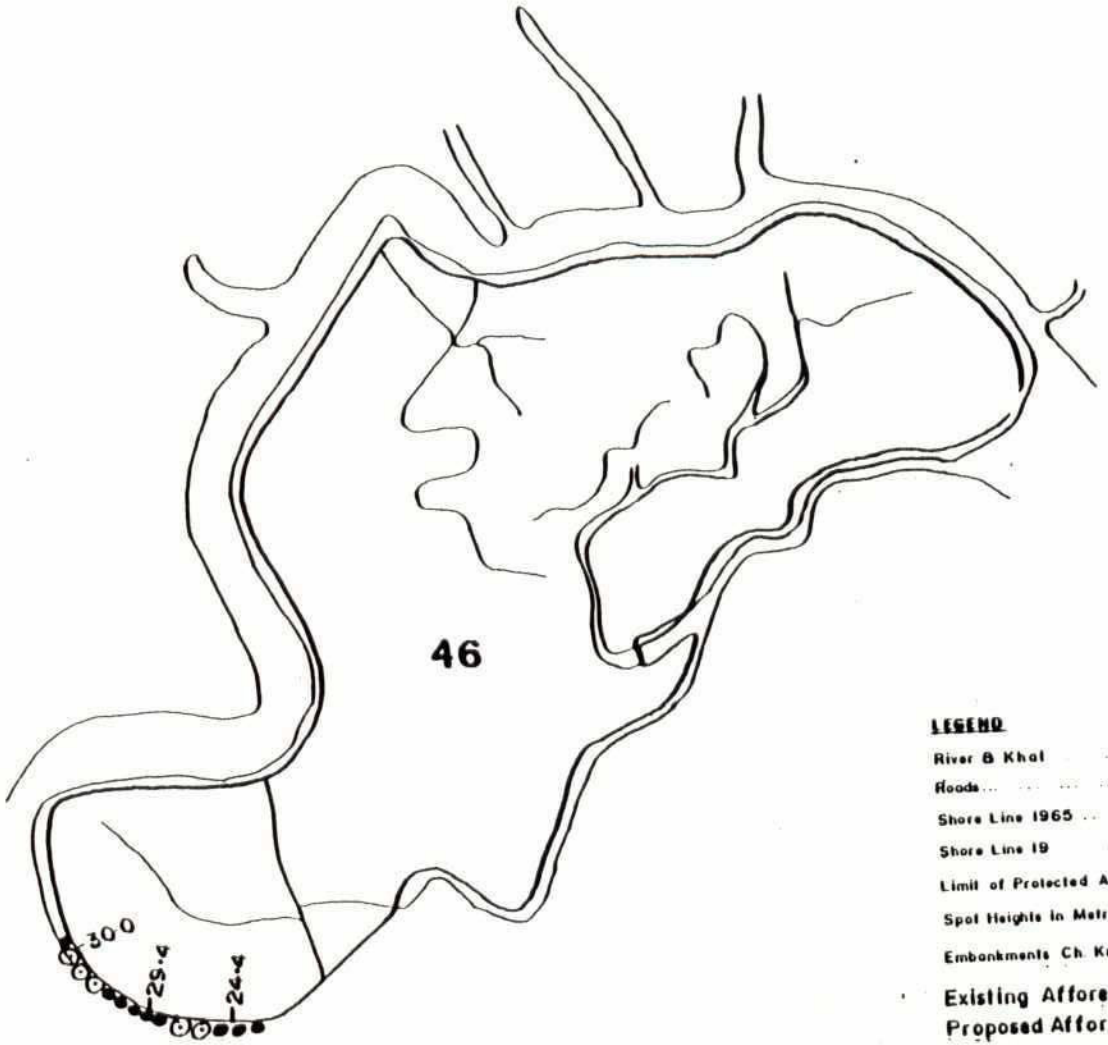
This polder belongs to Kalapara upazila under Barguna District and Barisal circle. About 2.4 kilometers of embankment were surveyed for this mid term programme and is shown in Map 12. Very good sized Babla (Acacia arabica) were found to be growing in most part of the embankment . Mangrove species like Keora and Baen grown to a very good height in the foreland were observed. Most parts of the embankment are still in good condition. The south western part of the polder has been much affected. From chainage 28.4 to 30.0 kilometers, this part is damaged. In the foreland of this part there is not any mangrove species growing and due to this, this part has become very much affected by wave action. The soil of the embankment is silty clay. Suitable species can be grown in the embankment . Some land will be available in front of the damaged part and mangrove afforestation can be established. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 12.

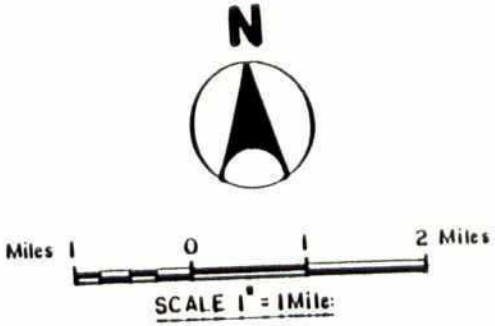
POLDER 48

This polder is situated at kuakata belongs to Kalapara upazila under Patuakhali district and Barisal circle. About 16.0 kilometers of embankment were surveyed for the mid term programme and is shown in Map 11. Species of Babla (Acacia arabica) Bat (Ficus bangalensis) khaya Babla tree (Pithecellubium dulce) Chalta (Dillenia indica) Date palm (Phoenix dactylifera) coconut (Cocos nucifera) bamboo (Bambusa tulda) etc. were found to be growing on the slopes of the embankment . The soil of the embankment is very sandy and the top soil is gradually eroding due to rain and some wave action . The top soil was covered with silty clay which was brought from other places to stabilize the sandy cover then it was turfed with dubra grass (Cynodon dactylon). Due to heavy rain, gradually the top soil became eroded and the sandy soil was exposed. It happened in few places. In the foreland of the embankment, there is almost more than 500 meters up to the sea shore, where coarse sand has been accumulated. In front of the embankment, there is a place where there is a good plantation of coconut (Cocos nucifera) tree 20-25 years old. About fifty per cent of the coconut tree died earlier but the existing trees are growing and fruiting very well.

There are also some cashewnut (Anacardium.occidentale) plant growing under the coconut (Cocos nucifera) trees. From chainage 30.6 to 35.2 kilometers, the area is badly damaged by direct wave action and the sandy embankment is gradually eroding. The embankment should be covered with silty clay soil and turfing with dubra grass. In the foreland of this area though there is a moving sandy soil, it could be stabilized by

POLDER NO. 46





LEGEND

- River & Khal
- Roads
- Shore Line 1965
- Shore Line 19
- Limit of Protected Area
- Spot Heights in Metre (P.W.D.) — 3.4
- Embankments Ch. Km 8.0/Mile(5.0) — 8.0
- Existing Afforestation
- Proposed Afforestation

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT II
BWDB COMPONENT

POLDER NO. 46

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DANISH HYDRAULIC INSTITUTE
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planting ipomea creeper then casuarina and tamarix species. As this area is directly situated on the sea shore, it can be developed as a recreation and picnic center for the tourist. From chainage 20.80 to 25.60 kilometers there is a large accereted land where forest department established a good mangrove afforestation which was planted during 1978 to 1980. The embankment in front of this afforestation is not affected at all by the wave action. Though the soil of the embankment is sandy still there is a good chance to raise suitable forestry species. The casuarina and tamarix species as well as more coconut and data palm trees on the foreland can be easily established. The existing and proposed afforestations on the slope of embankment as well as on the foreland are shown in Map 11.

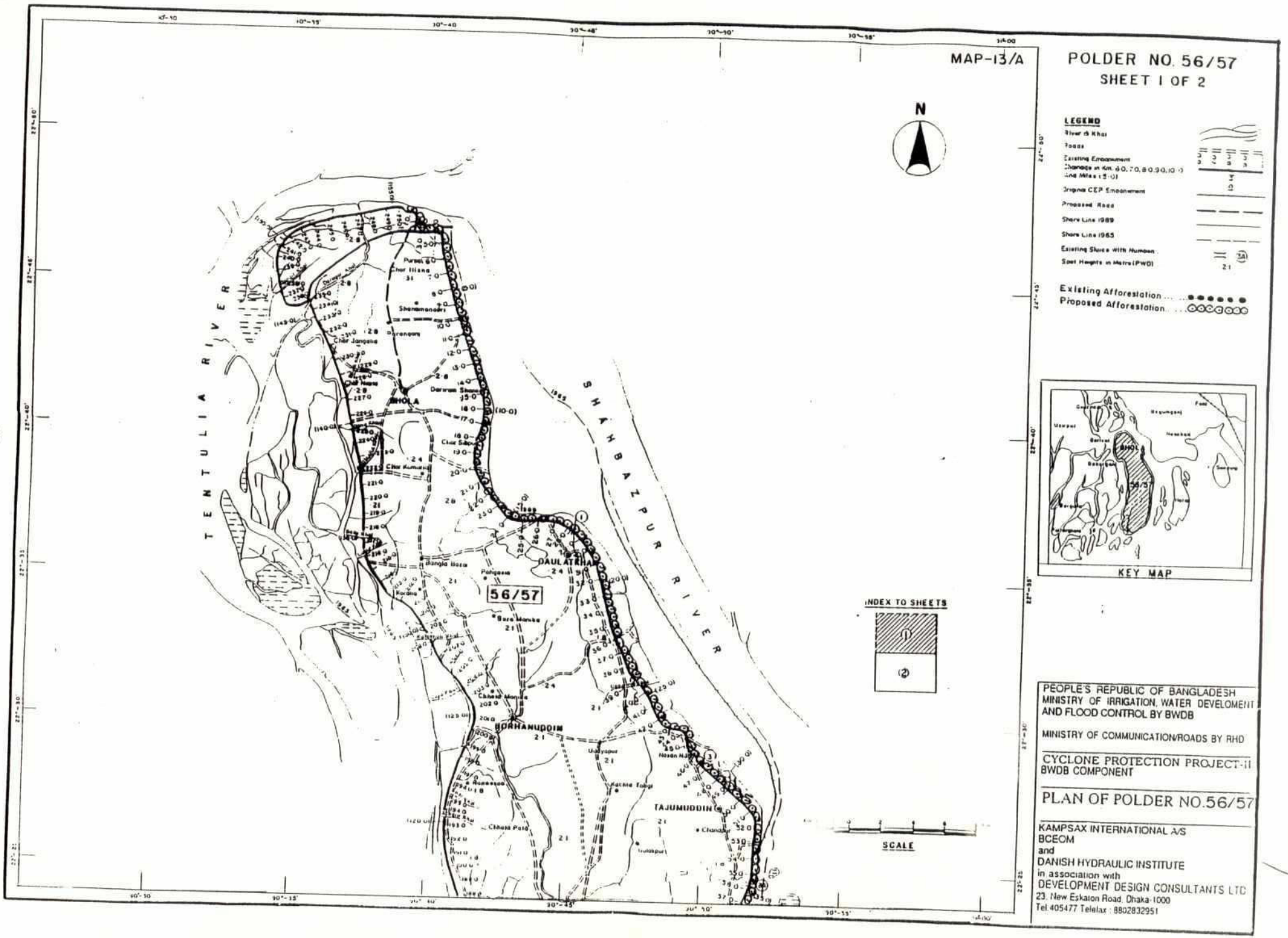
POLDER - 54

This polder belongs to Galachipa upazila under Patuakhali District and Barisal circle. About 12.0 kilometers of embankment were surveyed for mid term programme and is shown in Map -14. While visited the polder, few scattered trees of Babla (Acacia arabica) date palm (phoenix dactylifera) and in some areas, bannana (Musa paradisiaca) plants etc were found to be growing in the slopes of the embankment. Except some parts, most of the embankment is without trees and only covered with grass. Very few bush species are present on the embankment. The Galachipa and Patuakhali river are flowing on the side of the polder. The river is very wide and having always a high pressures of wave action during the monsoon. Very few scattered mangrove trees are found to be growing on the foreland.

Due to strong wave action during the monsoon, most part of this side of the embankment is under heavy pressure. There are already some protective work with brick blocks. It is observed that is some places the brick block is getting damaged. There is no mangrove trees in the foreland of these damaged portion. The soil of the embankment is silty clay and is very suitable for any kind of good afforestation species.In the foreland, there is a plenty of spaces just after the borrow pit and even in the borrow pit, the mangrove species can be established as there are already some mangrove trees in the foreland all along the embankment. The existing and proposed afforestation on the slopes of the embankment as well as on the fore land are shown in Map 14.

POLDER 56/57

This polder belongs to Bhola District Barisal Circle. About 100 Kilometres of embankment were surveyed for the mid term plan and is shown in Map-13. It was observed that from chainage 4.0 to 7.0 kilometres at Murad Shafiullah, at the northern


MAP-13/A
POLDER NO. 56/57
SHEET I OF 2
LEGEND
Existing Afforestation
Proposed Afforestation
N
TENTULIA RIVER
SHAHBAZPUR RIVER
BHOLA
DAULATKHAN
BORHANUDDIN
TAJUMUDDIN
56/57
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MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO.56/57
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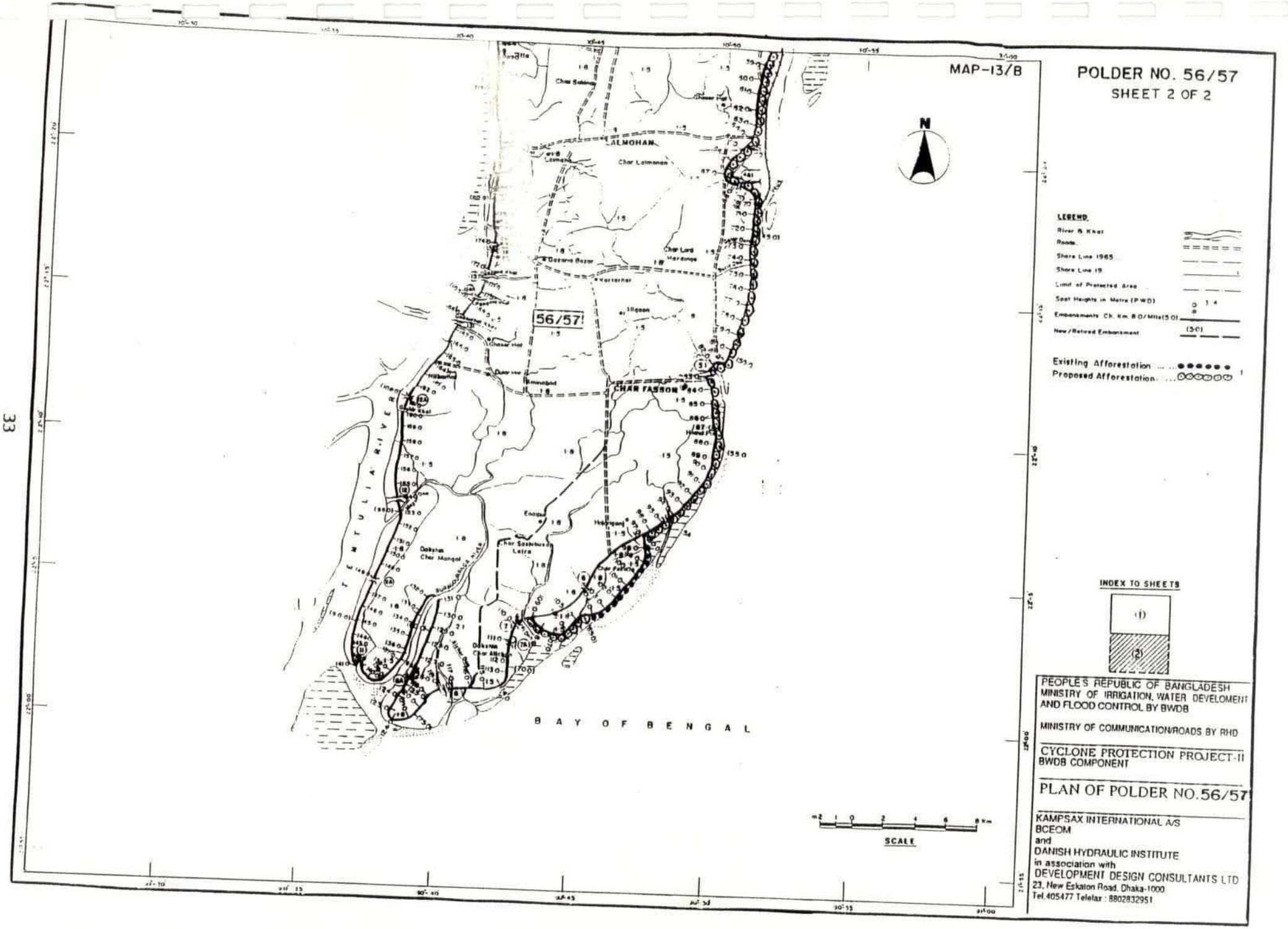
MAP-13/B
POLDER NO. 56/57
SHEET 2 OF 2
N
ALMOHAN
Char Lalmonan
Char Lord Hardinge
CHAR FASSON
56/57
TENTULIA RIVER
BAY OF BENGAL
LEGEND.
River & Khal
Roads
Shore Line 1965
Shore Line 19
Limit of Protected Area
Spot Heights in Metre (PWD)
Embankments Ch. Km. B.O/Mile(S.O)
New/Raised Embankment
Existing Afforestation
Proposed Afforestation
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SCALE
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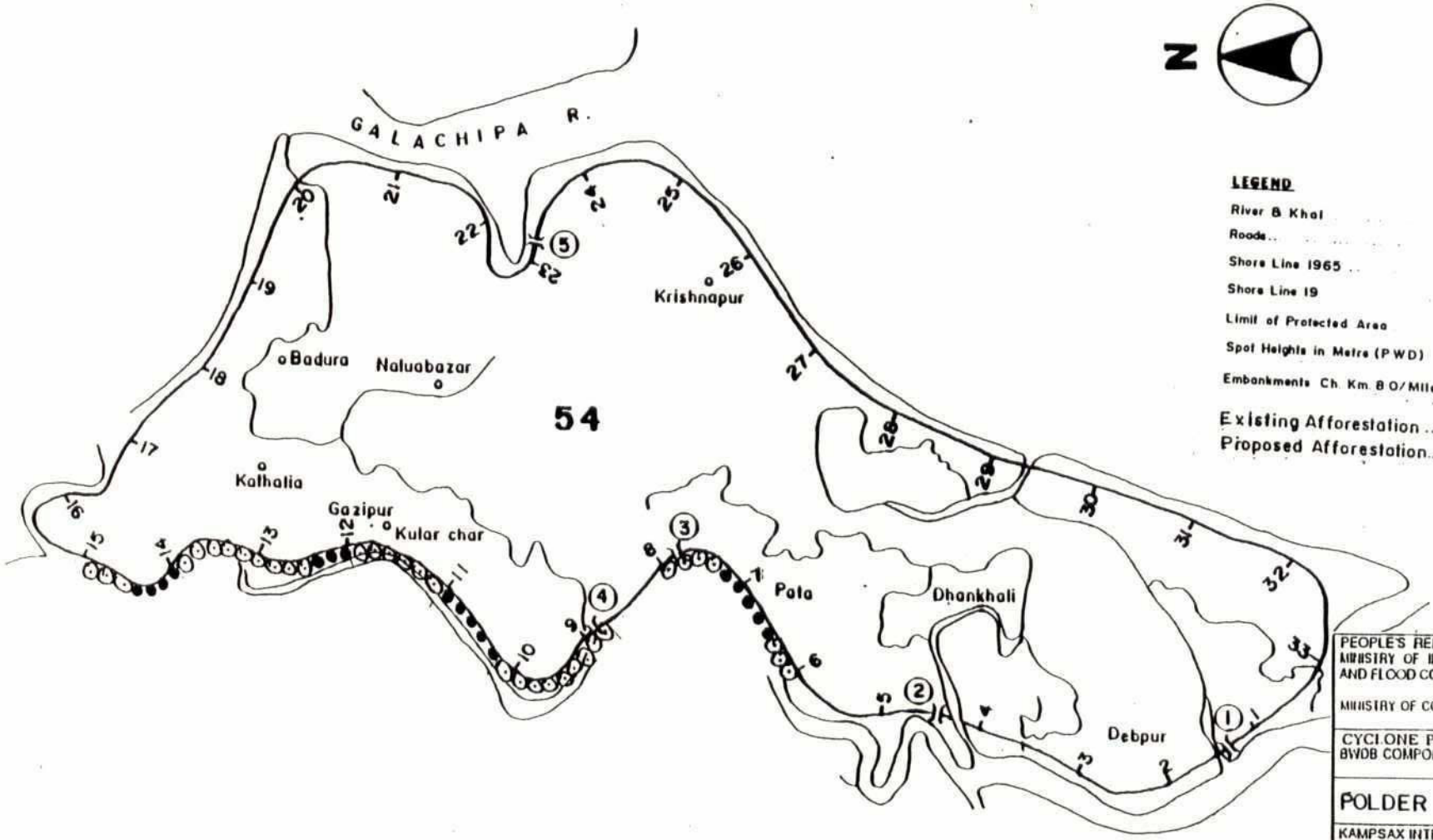
MAP-14

POLDER NO. 54



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MINISTRY OF COMMUNICATION-ROADS BY RHD

CYCLONE PROTECTION PROJECT II
BWDB COMPONENT

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part of Bhola, the embankment is very affected by the wave action. Moreover the soil of the embankment is more or less sandy in nature and it is gradually getting eroded and almost one third of the embankment is damaged. There is not any trees on the slope of the embankment as well as on the foreland. On the foreland, almost 500 meters of land under paddy cultivation. Few coconut, date palm and palm trees were present in the foreshore where once people used to live and later on compelled to shift elsewhere due to heavy wave action during the monsoon. There is a regular 7 to 10 meters wide borrow pit running all along the embankment just after the berm where 1 to 1.5 meters of water was found to be standing during the month of December and January.

From the chainage 16.0 to 30.0 kilometres at char Pata, the embankment was damaged by wave action and it was retired earlier through food programme. No trees are yet growing in the slopes except some bushes like Dhol Kalmi, and dubra grass as a ground cover. Even in some area, the top soil is completely exposed. There is no trees of mangrove present in the foreland. There is a space of more than 500 meters and the paddy crops are grown in these areas. From char Daulat Khan to Char Tajumuddin that is from chainage 31.0 to 60.0 kilometres, the old embankment still exist and the local landless people are settled on both slopes of the embankment. Tree species like some Babla, Shil Koroi, Ful Koroi, Madar, Coconut, date palm, and Banana are growing vigorously on the slopes but nothing is growing on the foreland. The borrow pits are running all along embankment. After the borrow pit till to the sea front, the peoples are growing paddy and other crops. There is a good opportunity of planting mangrove in the borrow pit which can at least resist the wave action during the monsoon period. From Char Tajumuddin to Char Fassion, the chainage from 61.0 to 90.0 Kilometres, the area is again highly affected by the wave action and got damaged in several places. These damaged potion were retired earlier. These new retired embankment are still vacant and in small areas cuttings of Madar trees (Ery -thrina) were planted and they are established very well. So the whole embankment should be covered with Madar tree immediately as well as turfing with dubra grasses.

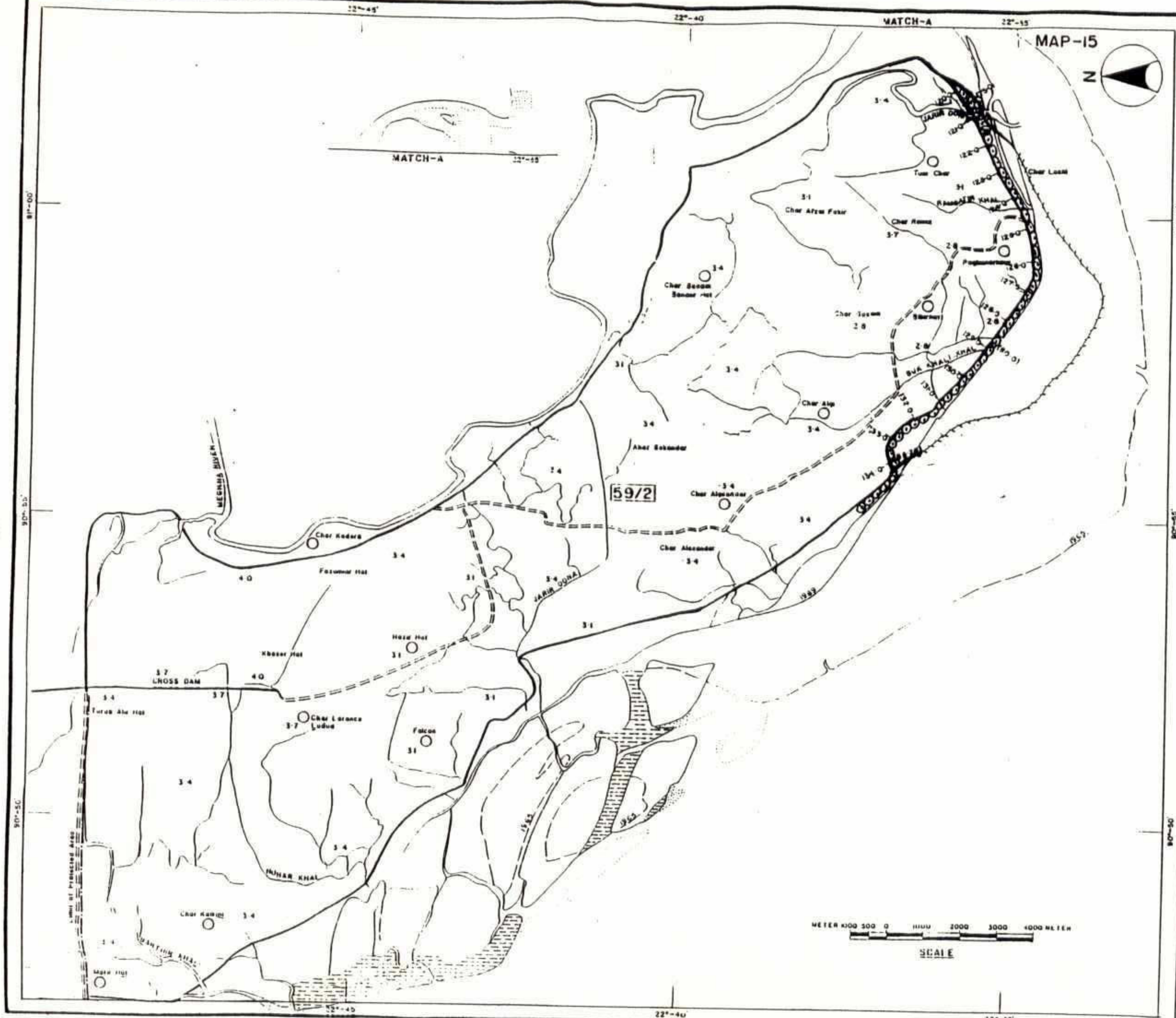
At Char Fakira, from the chainage 96.0 to 109.0 Kilometres, there was a good accretion land where new embankment was constructed in order to protect a few thousand hectares of accreted land for growing paddy and other crops. The forest department planted and established a good patch of mangrove species in these accreted land just after the embankment. Recently it was found that the embankment became very much affected and was damaged. It was repaired through the FFW programme. So on the embankment some suitable species should be planted on the slopes and further mangrove afforestation should be established. After Char Fakira the chainage from 110.0 to 124.0 Kilometres

the area is also affected but there is a little accretion on the foreland, so the damage is not as bad as other places. Some babla trees, madar, Coconut and date palm trees were found on the slope of the embankment. There is good opportunity to plant mangrove species on the foreland. At Lalmahan Upazila that is the western part of Bhola, the chainage from 172.0 to 183.0 Kilometres at debichar area just on the bank of the Tetulia river, the embankment is seriously affected and half portion of this is already damaged. Few scattered trees like Bamboo, Shil Koroi, Madar, date palm, Ful Koroi plant etc are growing on the slope of the country side. On the river side about 500 to 1000 meters area are available where now the farmers are cultivating paddy and other crops during the winter. Few patches of Hagla plant were seen on the berm of some portions and due to the presence of Hogla plants, the embankment is completely alright and no damage at all. So the embankment should be repaired and trees like madar, Babla and some bushes should be planted and on the berm area, Hogla pata can be planted and in the foreland up to the river, these area should be planted with mangrove species. So the existing and the proposed afforestation on the slope of the embankment as well as onthe foreland are as shown in Map 13A and 13B.

POLDER 59 / 2

This polder belongs to Ramgati Upazila under Lakkhipur district and Muhuri circle. About 10 kilometers of embankment were surveyed for the first year programme and is shown in Map-15. The embankment was found very high and from the chainage 123.88 km to 126.30 km. very few trees are present on the slope of the embankment and there is not any mangrove afforestation in the foreland. There is almost 1/2 km to 1 km accreted land where mangrove afforestation can be established. This part of the embankment is subjected to heavy wave action and had already good protective work. These protective work has already been damaged in some parts.

In the foreland there is still some coconut, (Cocos nucifera) date palm (Phoenix dactylefera)and palm trees (Borasus flabellifer) etc. remained there where once people used to live in those areas and the embankment was retired a few years back but the foreland has since been subject to erosion. As a result one office building has already been damaged by wave action. After this from chainage 126.0 km to 134.30 kilometer, about 8.0 kilometers, new retired embankment was constructed during 1989-1990 through FFW programme. There is a good opportunity to plant tree species on the slope of the embankment as well as mangrove afforestation in the borrow pot in the beginning stage then gradually it can be extended towards the river side. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 16.



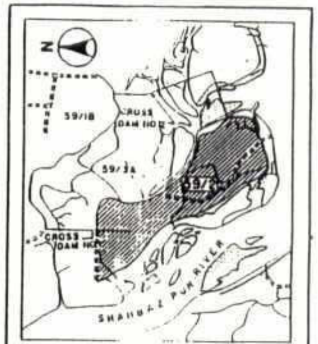
POLDER NO. 59/2

LEGEND

- River & Khal
- Roads
- Shore Line 1989
- Shore Line 1963
- Existing Embankment Chainage in Km.128·0,129·08 Miles (80·0)
- Original C.E.P. Embankment
- Proposed Embankment
- Existing Sluice with Number
- Proposed Sluice
- Cyclone Shelters
- Spot Heights in Metre (PWD)

Existing Afforestation

Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 59/2

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82

POLDER 59/3 B

This polder belongs to Sudharam upazila under Noakhali District and Muhuri circle. About 42.0 kilometers of embankment were surveyed for the first year programme and is shown in Map 16. Species like Babla (Acacia arabica) Rain tree (Samanea saman) Shil koroi (Albizzia Lebbek) Simul tula (Bombax insigne) and Bhadi (Lannea Grandis) etc. were found growing on the slopes of the embankment. In most of the embankment's slope, the local landless people are settled there for a long time. In that area the tree species like bannana plant (Musa paradisiaea) Shil koroi (Albizzia lebbek) Simul tula (Bambax insigne) Date palm (Phoenix dacty lifera) Kat Badam (Terminalia catappa) Bamboo (Bambusa tulda) Tetul (Tamarindus indiea) Neem (Meliazadirachta) Kalajam (Eugenia jambolina) coconut (Cocos nucifera) Betelnut (Areca catechu) khaya babla (Pithecellobium dulce) Mango (Magnifera indica) and Jack fruit (Artocarpus integrifolia) etc.are growing very well.

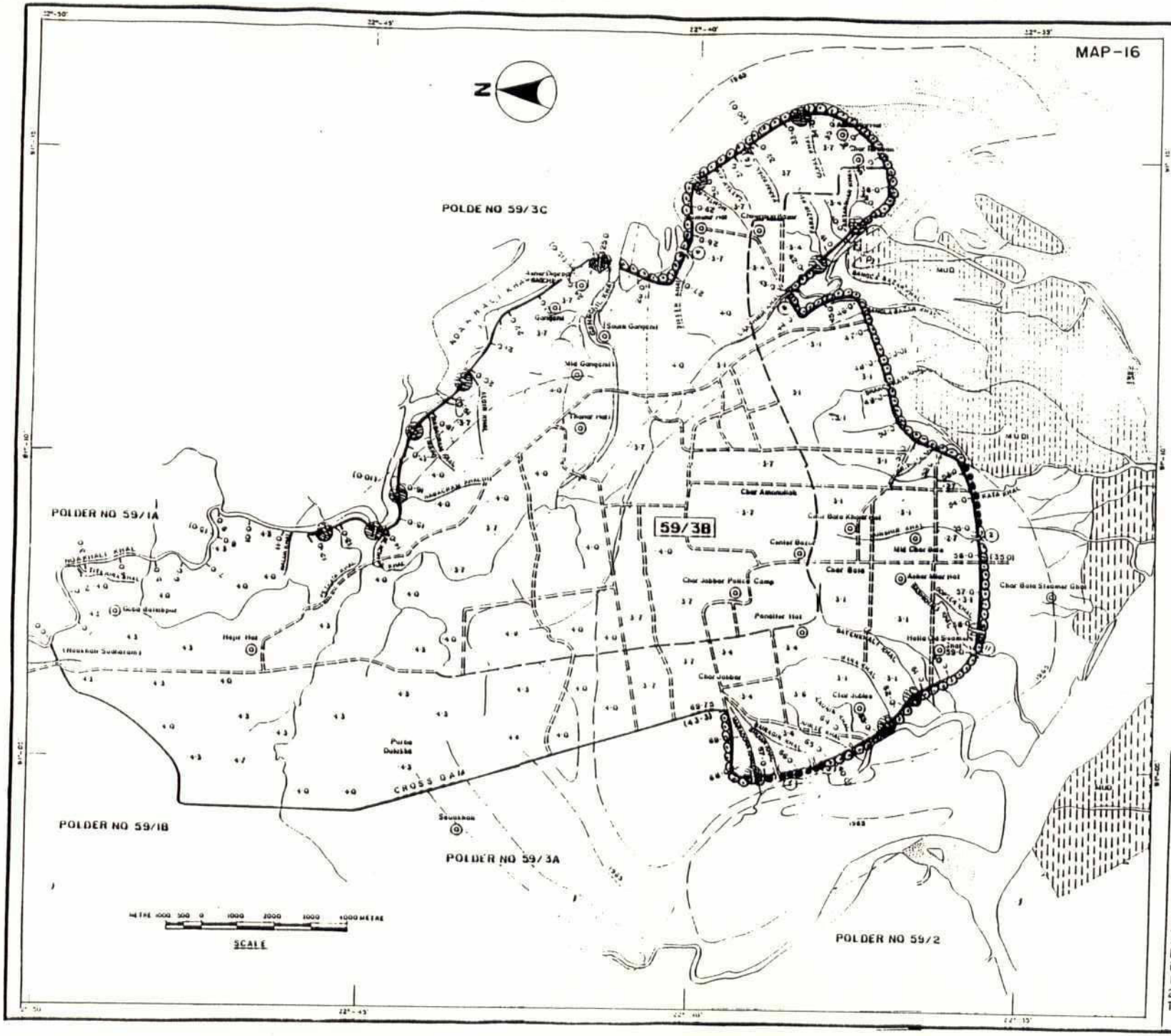
Due to this plantation on the embankment, it seemed to be well protected and the people are generally taking care of the embankments from any damage. In the foreland there is a vast area of accreted land. The forest department established very well growing mangrove afforestation. This mangrove afforestation is also acting as a good protection of the embankment from the direct wave action of the sea and during the cyclonic surges. From the chainage, 27.50 to 37.0 kilometers, this part of the embankment is seriously damaged by direct wave action and there is not any mangrove afforestation in the foreland. A good amount of area will be available in the foreland to establish mangrove afforestation. There are lots of area of the embankment needing good plantation with suitable trees species. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 16.

POLDER 59 / 3 C

This polder belongs to companiganj upazila under Noakhali district and Muhuri circle . About 45 kilometers of embankment were surveyed for the mid term programme and is shown in Map 17. The species of Babla (Acacia arabica) is found to be growing scattered on the slope of the embankment. The other species like date palm (Phoenix dactylefera) coconut (Cocos nucifera) Shil koroi (Albbizzia Lebbek) etc. are also growing here and there. But in some area there is no trees except few local bushes and grass cover. At char Langta, the embankment from chainage 16.10 to 17.8 kilometers, this area is damaged due to high wave action during the monsoon. On the foreland there is no mangrove

MAP-16

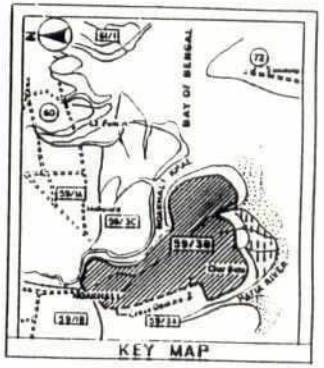
POLDER NO. 59/3B



LEGEND

- River & Khal
- Roads
- Railway Line
- Existing Embankment
  Chainage in Km 23.0, 24+0, 25.0
  and Miles (15.0)...
- Proposed Road
- Existing Sluice with Number
- Proposed Sluice
- Shore Line 1989
- Shore Line 1965
- Cyclone Shelters
- Spot Heights in Metre (PWD)

Existing Afforestation .....
Proposed Afforestation .....



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MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 59/3B

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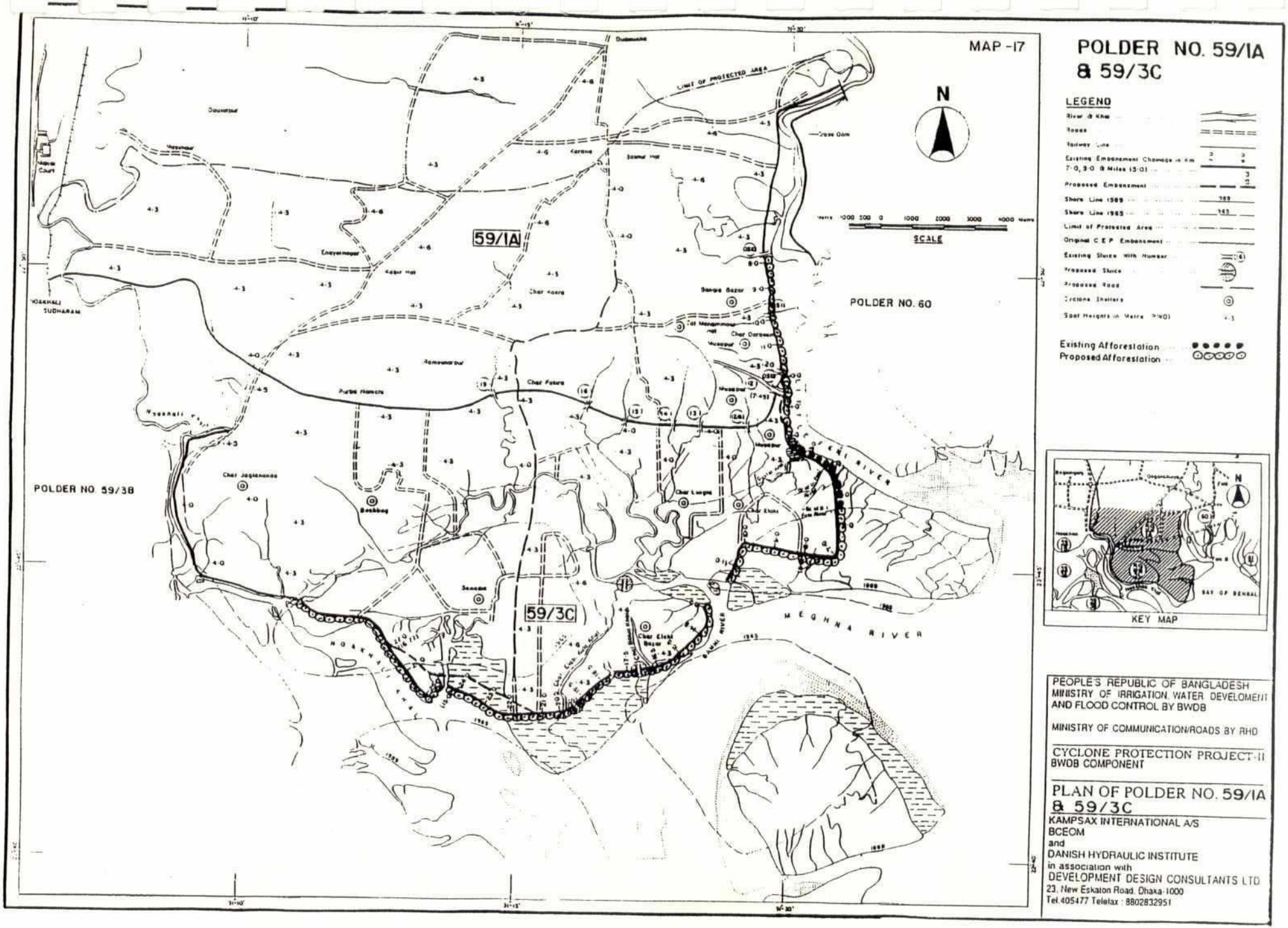
MAP -17
POLDER NO. 59/1A & 59/3C
LEGEND
Existing Embankment
Proposed Embankment
Shore Line 1989
Shore Line 1985
Limit of Protected Area
Original C E P Embankment
Existing Sluice With Number
Proposed Sluice
Proposed Road
Cyclone Shelters
Existing Afforestation
Proposed Afforestation
SCALE
N
59/1A
59/3C
POLDER NO. 60
POLDER NO 59/3B
MEGHNA RIVER
BAY OF BENGAL
KEY MAP
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
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PLAN OF POLDER NO. 59/1A & 59/3C
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afforestation but there is a space where mangrove can be established.There is a nice grass cover in some area of the embankment without any trees and bushes.

The soil is silty clay and there is a good opportunity to grow tree species. There is a river passing through the polders and there is no sluice yet. From 7.50 to 9.80 kilometers and 11.50 to 13.20 kilometers the embankmentis partly damaged. Afforestation on the embankment and mangroves on the foreland is needed to protect the embankment. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map 17.

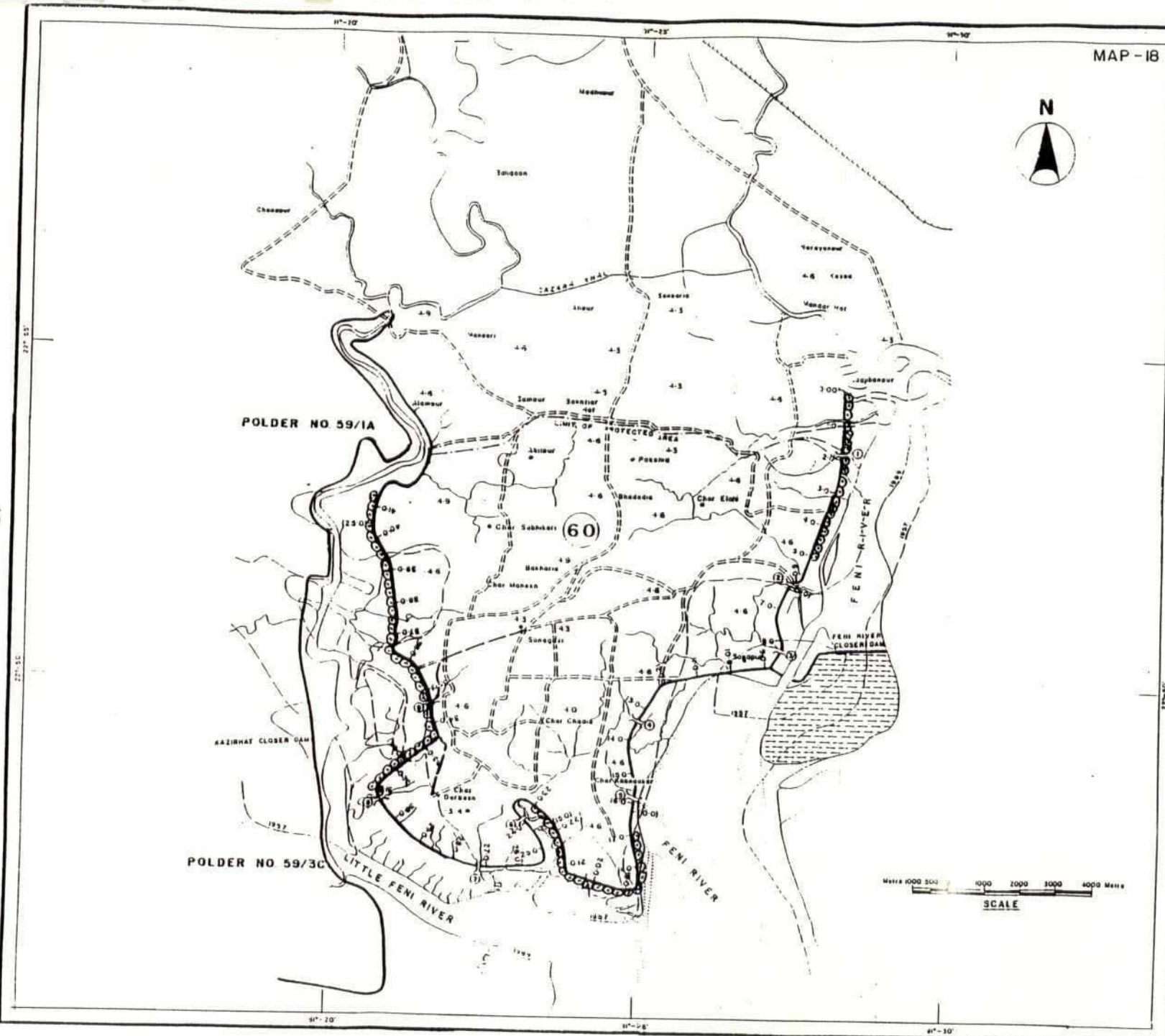
POLDER - 60

This polder belongs to Sonagazi upazila under Feni district and Muhuri circle. About 22.0 kilometers of embankment were surveyed and is shown in Map 18. Spcies of Babla (Acacia arabica) date palm (Phoenix dactylifera) Shil Koroi (Albizzia lebbek) Kul boroi (Zizyphus jujuba) Palm trees (Borassus flabellifer) etc. are growing all over the embankment . In the foreland there is a good accreted land. There is no mangrove afforestation. From the chainage 1.6 to 40.6 kilometers, most of the embankment is more or less found to be in good condition. In order to make the embankment more protected, mangrove plantation can be established in the borrow pits. But most of the borrow pits are already filled up and the soil become very hard and it will be very difficult to establish mangrove plantation. Casuarina (Casuarina equisetifolia) and Jarul (Lagerstroemia speciosa) species can be successfully planted in these berm and borrow pit areas.

Most parts of the embankment have been used as roads and some parts have already been paved. Suitable species like Babul (Acacia arabica) Khair (Acacia catechu) Shisam (Delbergia sissoo) and Shil Koroi (Albizzia lebbek) etc. can be planted on the slopes of the embankment . More over a vast area has been accreted in the foreland during the last few years where the peoples are already growing paddy and other crops. The existing and proposed afforestation on the slopes of the embankment as well as on the foreland are shown in Map 18.

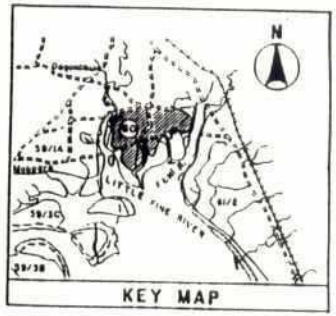
MAP-18

POLDER NO. 60



LEGEND

- River & Khal
- Roads
- Railway Line
- Shore Line 1989
- Shore Line 1957
- Existing Embankment Chainage in Km 3.0, 6.0, 7.0 And Miles (5.0)
- Original CEP Embankment
- Proposed Road
- Existing Sluice With Number
- Proposed sluice
- Cyclone Shelters
- Limit Of Protected Area
- Spot Heights in Metre (PWD)
- Existing Afforestation
- Proposed Afforestation



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MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 60

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POLDER 61/1

This polder is located from Kumira to Sita Kunda and belongs to Sitakunda Upazila under Chittagong circle. About 18.0 Kilometers of embankment were surveyed as shown in Map-19.

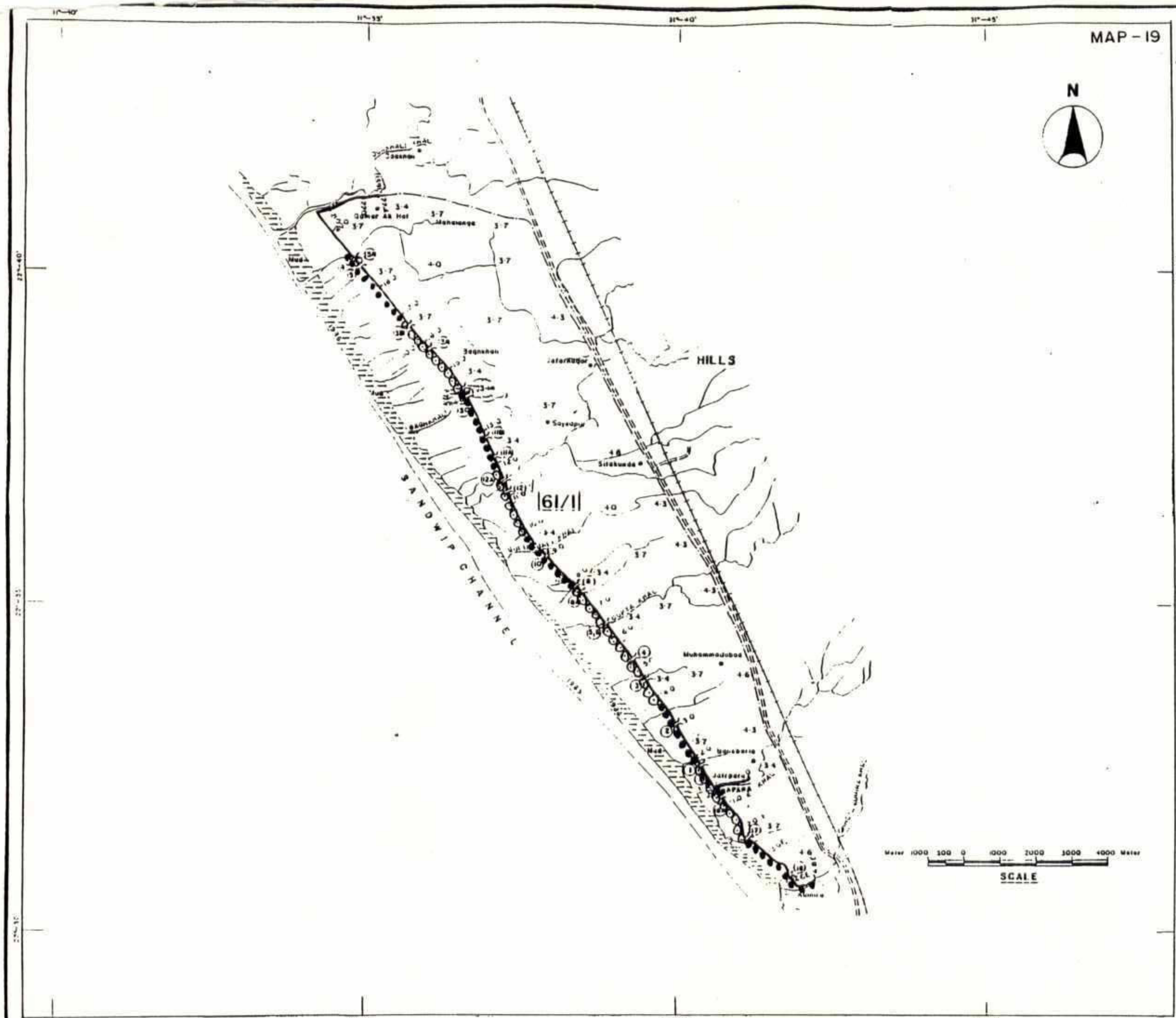
Scattered trees of Babla (Acacia arabia), Date palm (phoenix dactylifera), Shil Koroi (Albizzia procera), Rain tree (Samanea saman) etc were found on the slope of the embankment. Forest Department planted mangrove species in almost all the area of the foreland during 1980-1985. In some area the mangrove afforestation has been established very well and is growing very luxuriantly but in some area due to natural calamity i.e. the plantation being covered with heavy siltation and it could not be established. It was found that in those areas where there is no mangrove afforestation in the fore land, the embankment is greatly affected by wave action and cyclone surges. From 2.30 Km to 2.93 Kilometre and 3.15 Kilometres to 4.10 Kilometres, the embankment was completely breached out and on the foreland of this area, there is no afforestation.

Moreover, there were lots of area where embankments were damaged by wave action and had already brick block protective work. In some area of the embankment where the foreland is covered with heavy coarse sand it is very difficult to grow mangrove afforestation. But if the sand layer is thin and fine, a large size seedlings of mangrove species can be easily planted by making a deep hole, where the roots can touch the clay part. Mostly thick layers of coarse sand is found in the berm due to wave action. In these case the species of cauarina and tamamix plantation can be successfully established. It was seen that at this type of sea front, plantation of mangrove species needed to be repeatedat least three to four times to establish the afforestation. The existing and the proposed afforestation on the slope of the embankment as well as on the foreland of the sea side are shown in Map -19.

POLDER - 62

This polder belongs to Patenga Upazilla (Chittagong port area) under Chittagong circle. This embankment starts from the coastal sites of Chittagong airport area and extends up to the end of Uttar Halisahar. About 19.0 Kilometres of embankment were surveyed as shown in Map-20. Just from the beginning of the polder up to the naval office a good plantation of Babla (Acacia arabica) trees are found to be growing on both sides of the slope which were planted during 1968-1970. The trees are in good growth and the average height and girth were measured and found to be 12.0 meters and 35.0

MAP - 19

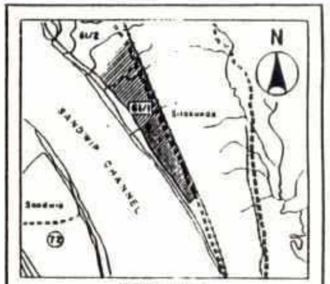


POLDER NO. 61/1

LEGEND

River & Khal
Roads
Railway Line
Existing Embankment Chainage in Km 0.30 and Miles (3.0)
Proposed Embankment
Existing Sluice with Number
Proposed Sluice
Shore Line 1986
Shore Line 1965
Limit of Protected Area
Spot Heights in Metre (PWD)

Existing Afforestation
Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

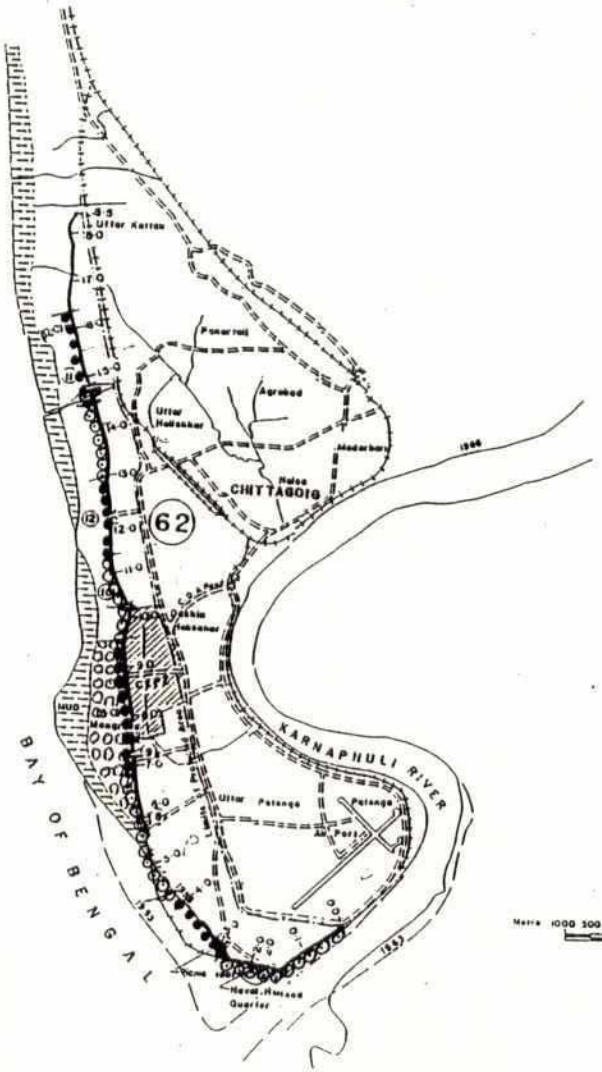
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 61/1

KAMPSAX INTERNATIONAL A/S
BCEOM
and
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD
23, New Eskaton Road, Dhaka-1000
Tel 405477 Telefax : 8802832951

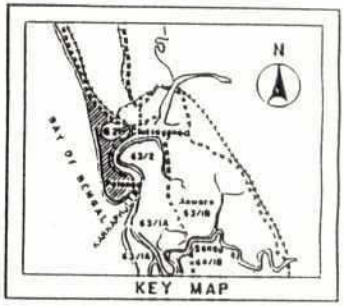
MAP - 20

POLDER NO 62



LEGEND

- River & Khal
- Roads
- Railway Line
- Existing Embankment Chainage in Km. 7·0, 8·0 & Miles (5·0)
- Proposed Embankment
- Shore Line 1986
- Shore Line 1963
- Limit of Protected Area
- Original C E P Embankment
- Existing Sluice With Number
- Proposed Sluice
- Existing Afforestation
- Proposed Afforestation



PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 62

KAMPSAX INTERNATIONAL A/S
BCECM
and
DANISH HYDRAULIC INSTITUTE
in association with
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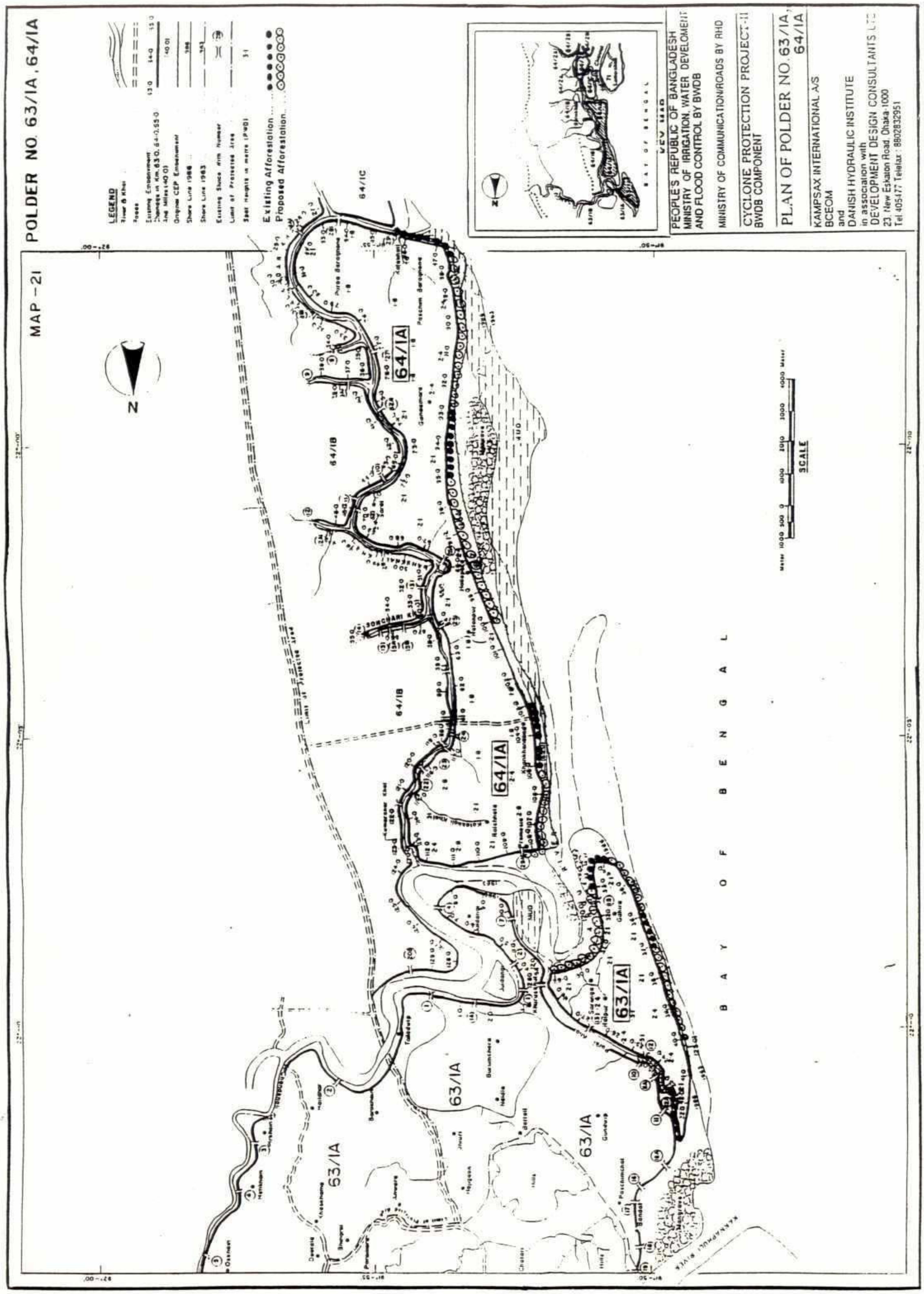
centimetres. Under the trees, the embankment was well covered with dubra grass (cynodon dactylon). After the naval office, the embankment has a sharp bend and then continues for a few Kilometres. This area is the most seriously affected area from the direct sea wave action and cyclone surges. On the embankment, few scattered date palm trees of height about 8-10 meters and local bushes are found on the slopes of the country side. The sea side has been protected by concrete and brick blocks as well as bolders against damage by high tidal waves and cyclonic surges.

The forest department planted mangrove species in the foreland several times earlier during 1975 to 1980 but the afforestation could not be established due to heavy wave action and repeated erosion. From the chainage 3.56 kilometres to 5.50 kilometres, the whole embankment was completely breached out. A new retired embankment was found to be under construction in this area. From chainage 7.0 kilometres to 9.9 kilometres the whole embankments are covered with good plantation of Babla (Acacia arabica) shil koroi (Albizzia Procora), Ipil-Ipil (Leuceana Leococephylla), Khoir tree (Acacia Catechu), Rain tree (Samanea Saman), date palm (Phoenix dactylifera) which are growing very well in both the slopes of the embankment. On the foreland, the forest department established a good mangrove afforestation with the species of Baen (Avicinea officinalis), Garan (Cereops decandra). Gulpata (Nypa fruitcans) Gewa (Exoecaria agallocha), Keora (Sonneratia apatala), Kankra (Bruguiera Gymnorhiza) etc during 1980-1985. But the Gulpata species was not established in this area. The mangrove species are growing very well. A portion of the mangrove afforestation was destroyed and felled out by the shrimp cultivator from this area. From the chainage 9.91 to 10.67 Kilometres, just opposite to the Export processing zone (EPZ), the embankment was retired few years back and the plantation on the embankment was not yet established. In the foreland, there is no mangrove afforestation although mangrove afforestation could be established here. After this the embankment is continued up to the beginning of the Dakkin Kattali. The whole area is covered with good plantations of Babla, Shilkoroi and Rain tree etc. and some scattered mangrove afforestation on the foreland. The existing and the proposed afforestation on the slope of the embankment as well as on the foreland of the seaside are shown in Map-20.

POLDER 63/1A

This polder is situated at Anwara Upazilla under Chittagong circle. About 15.0 Kilometres of embankment is included in the first year plan and the area is shown in Map-21. Some scattered trees of Babla (Acacia arabica), Date palm (phoenix dactylifera), Ful Koroi (Samanea saman), Shil Koroi (Albizzia proara) and Bamboo (Bambosa tulda)


POLDER NO. 63/IA, 64/IA
MAP - 21
LEGEND
River & Khal
Roads
Existing Embankment
Original CEP Embankment
Shore Line 1986
Shore Line 1983
Existing Sluice with Number
Limit of Protected Area
Spot Heights in metre (PWD)
Existing Afforestation
Proposed Afforestation
N
64/IC
64/IA
64/IB
63/IA
BAY OF BENGAL
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 63/IA, 64/IA
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etc were found mostly on the slope of the embankments in countryside. In some area of the embankment remained completely fallow that is without any trees except few local bushes and grass (cynodon dactylon) cover. Even in some area of the embankment the top soil remained completely exposed due to over grazing by the local live stocks. In the foreland, there was no any mangrove afforestation.

The forest department has not yet tried to make any afforestation in this part. The forest department managed to establish afforestation in the newly accreted land of the northern and south eastern part of the polder which was planted during 1980-1985. Most of the berm of the embankment has a heavy deposit of coarse sand and maybe due to this reason mangrove afforestation could not be established earlier. Recently a new accretion has been formed in the foreland of more than five hundred meters almost all along the embankment. In some places thin layers of fine sand were found to be deposited but in the bottom, a good layers of clay soil are available where tall seedlings of mangrove species can be planted by digging a little deep hole. On the berm and near areas where heavy sands are deposited, species of casuarina and tamarix can be planted to stabilize the moving sand . The existing and the proposed afforestation on the slope of the embankment and in the foreland of the sea side are shown in Map-21.

POLDER 64/1A

This polder belongs to Banskhali Upazilla under Chittagong circle. About 24 Kilometres of embankment were surveyed and the area is shown in Map-21. Few scattered trees of Babla (Acacia arabica), Date palm (phoenix dactylifera). Ful Koroi (Samanea saman). Shil Koroi (Albizzia procera), Kul boroi (Zizyphus jujuba) Palm tree (Borassus flabellifer) and Bamboo (Bambusa tulda) etc were found to be growing on the slopes of the embankment and some mangrove afforestation on the coastal sites. During 1980 to 1985, the forest department planted mangrove species on the foreland of the embankment in the newly accreted land. It was found that the planting of mangrove species on the accreted land increased the sedimentation rate. The sedimentation has increased to such an extent that the tree growth gradually slowed down significantly and in some area, the trees have been completely buried. Again in some area, mangrove seedlings were planted two to three times but unfortunately every times the seedlings were buried resulting in a the complete failure of the plantation. So the embankment on the river side became exposed and ultimately got damaged by strong waves and cyclone surges. From the chainage 86.0 to 86.7 Kilometres, 101.3 to 102.6 Kilometres and 107.2 to 107.8 Kilometres severe damages were observed There is no afforestation of mangrove species in front of these damaged area.

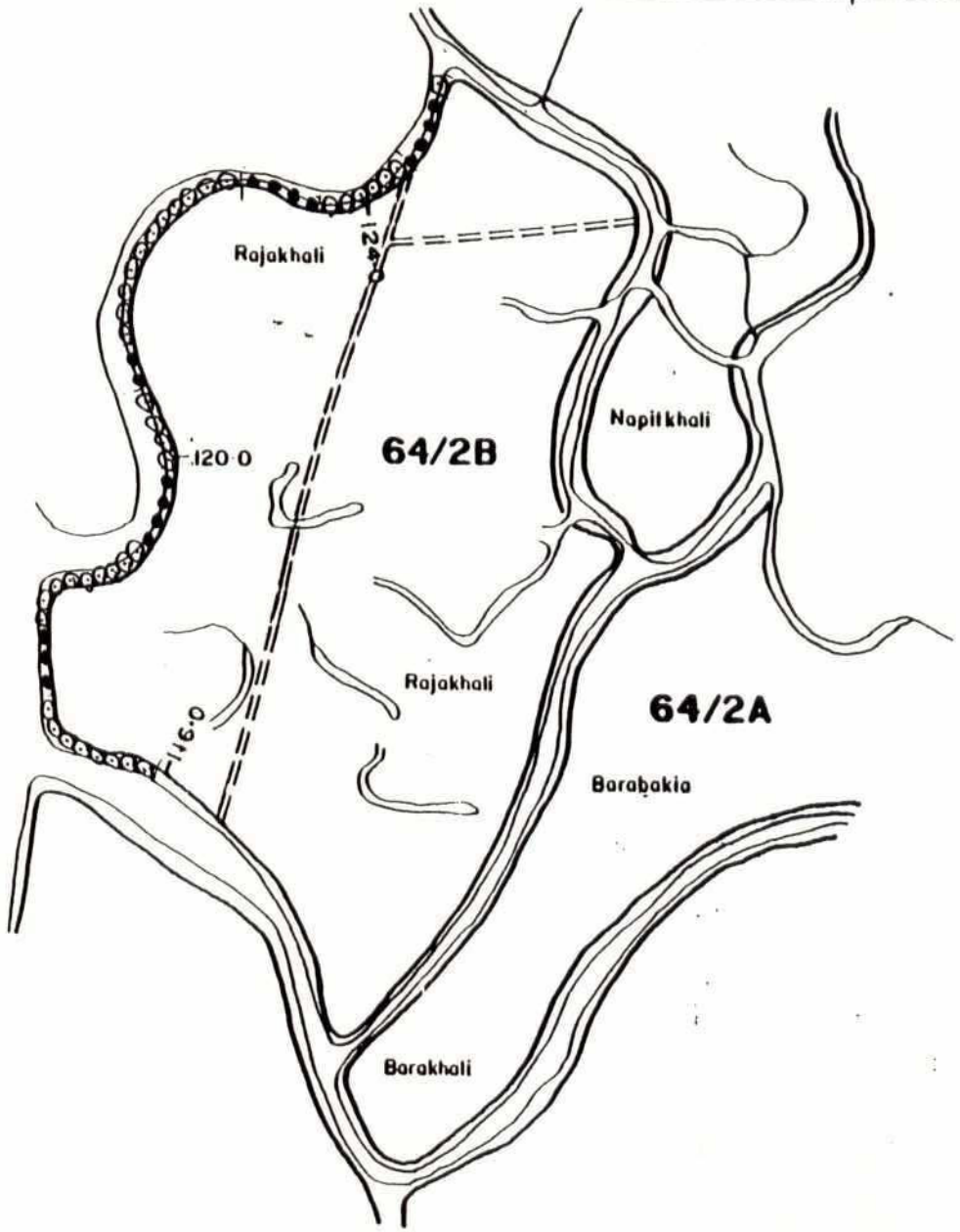
In the southern part of the polder, a good plantation was established on the slope of the embankment as well as with mangrove afforestation in the foreland by the forest department in an area of about one Kilometre. Both the plantations were found to be very healthy and highly protective for the embankments. All along the embankment there is need for immediate plantation with mangrove species in the foreland and suitable forestry species on the slopes of the embankment.

At the berm of the embankment almost all the area large volumes of sand are accumulated due to the fact that these sand were being removed from a sandy offshore char and transported to the beach by waves. Once the sand is on the beach, the cohesionless sand is redistributed by wind forming mobile dune systems which migrate both inland and along the beach in the direction of the prevailing winds. This moving sand is also prevented by the embankment from moving inland. It is a matter of fact that several species of mangrove can survive in some stable sandy substrate but they can not tolerate repeated burial and exposure if sand dunes move along the beach. Due to this reason the whole plantation established by the forest department during 1980 to 1985 was destroyed by the migrating sand dunes. There is a need for immediate plantation of forestry species on the slopes of the embankment and mangrove species on the foreland whatever area are available. The existing and the proposed afforestation on the slope of the embankment and in the foreland of the sea side are shown in Map-21.

POLDER 64/2B

This polder known as Magnama belongs to Chokoria upazilla under Cox's Bazar District and Chittagong circle. About 8.0 Kilometres of embankment were surveyed for the first year plan and the area is shown in Map-22. Some scattered Babla trees (Acacia arabica) were found in some portion of the embankment. In some area the whole embankment is completely barren and not even grasses present. It needs quick covering. This may be due to saline affect on the embankment and also over grazing by the local cattle and live stocks. Some bushes like Dhol Kalmi (Ipomea fistulosa). Shada Akanda(Calotropis procera) etc. were found in both the slopes of the embankment. Few scattered patches of mangrove afforestation are available in the foreland along the embankment. Mangrove afforestation exists on the foreland but most of the lower branches of the trees were cut down illegally by the local people for fuel wood and as a result these trees become ineffective from wave action. So the foreland should be replanted again with mangrove species and the embankment with good forestry species. In some areas there are already some protective works and again in some areas, the embankment became very much affected from strong wave actions and got damaged.

POLDER NO. 64/2B



N

LEGEND

- River & Khal
- Roads
- Shore Line 1965
- Shore Line 19
- Limit of Protected Area
- Spot Heights in Metre (PWD)
- Embankments Ch. Km. 8.0/Mile(5.0) 3·4 8.0
- Existing Afforestation
- Proposed Afforestation

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION-ROADS BY RHD

CYCLONE PROTECTION PROJECT II
BWDB COMPONENT

POLDER NO. 64/2B

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There is a plenty of land available all around the embankment where mangrove afforestation can be established. The existing and proposed afforestation on the slope of the embankment and in the foreland of the river side are shown in Map- 22.

POLDER 66/1

The polder belongs to Ramu upazilla under the Cox's Bazar district and Chittagong circle. About 7.0 Kilometres of embankment were surveyed and is shown in Map-23. Few scattered trees of Babla (Acacia arabica), Date palm (phoenix dactylifera), Ful Koroi (Samanea saman) and few local bush species were found to be growing on the slope of the embankment. On the foreland, scattered patches of mangrove afforestation are growing.

Some parts of the embankment are damaged due to strong wave action. These damaged portions are used for the anchoring of the local fisherman's boat. Hundreds of fishing boat anchor this area daily and due to this the mangrove afforestations planted by the forest department are seriously affected. There is a space of about two hundred meters all along the embankment where mangrove afforestation can be successfully established except for few small areas. The soils of the embankment is silty clay and there is a chance to grow all the suitable forestry species as required. The existing and the proposed afforestation in the slope of the embankment and in the foreland on the river side are shown in Map- 23.

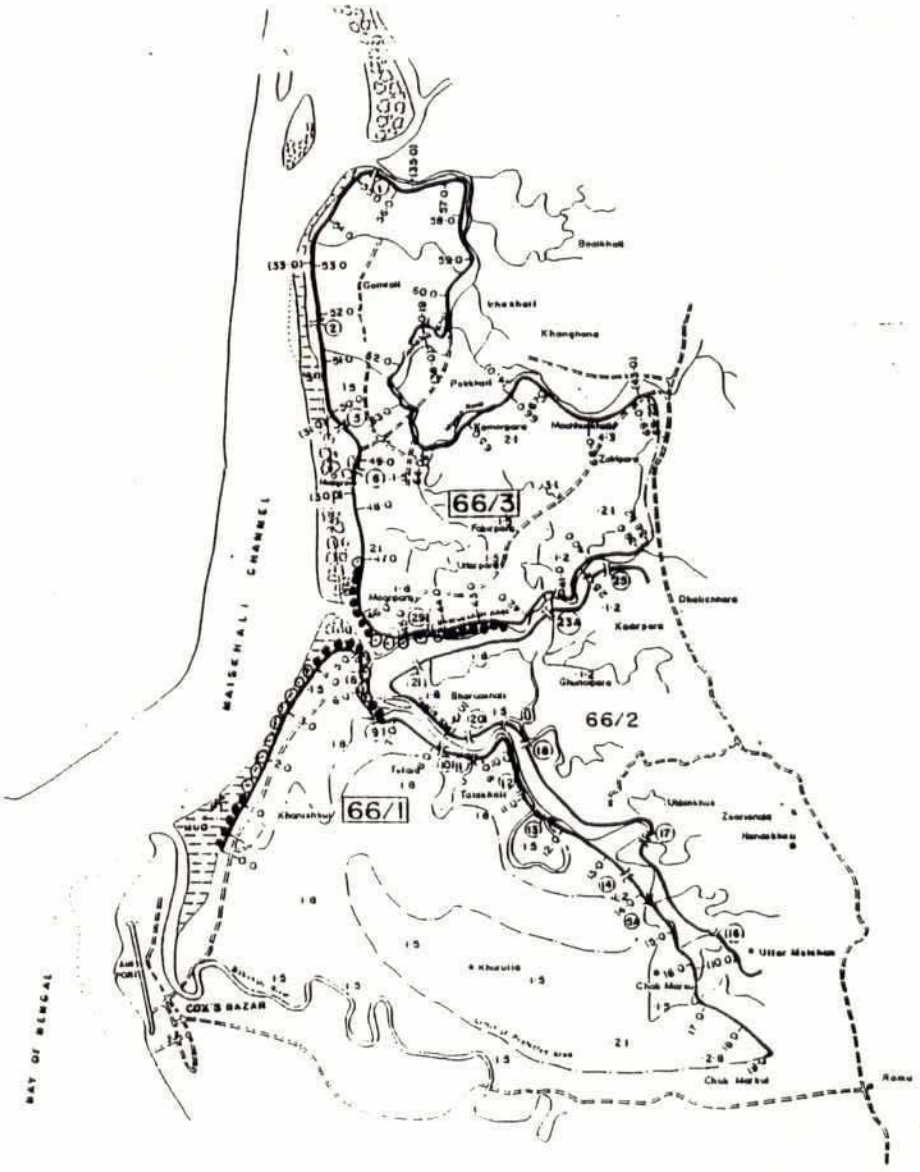
POLDER 66/3

This polder known as Kurushpur belongs to Cox's Bazar Upazilla under Cox's Bazar District and Chittagong circle. About 5.0 Kilometres of embankment were surveyed is shown in Map-23. During the field visit, it was observed that very few trees growing in the embankment except few local bushes and grass cover. In some parts of the embankment, the top soil is more or less exposed due to over grazing by the local cattles and livestocks. In the foreland there is some good mangrove afforestation.

The area where the embankment remained barren without any mangrove trees, is greatly damaged by the wave action. There are plenty of spaces almost 200 meters wide where mangrove afforestation can be established. The existing and the proposed afforestation on the slope of the embankment and on the foreland of the river side are shown in Map-23.

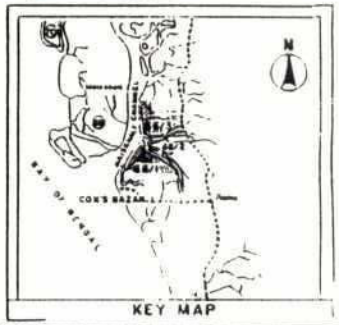
MAP-23

POLDER NO.66/1&66/3



LEGEND

- River & Khal
- Roads
- Shore Line 1986
- Shore Line 1963
- Existing Embankment Chainage in Km / Miles
- Proposed Embankment
- Existing Sluice With Number
- Proposed Sluice
- Cyclone Shelters
- Spot Heights in Metre (PWD)
- Existing Afforestation
- Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 66/1 & 66/3

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POLDER 68

The polder belongs to Teknaf upazilla under Cox's Bazar district and Chittagong circle. About 17 Kilometres of embankment were surveyed and is shown in Map-24. At Badar Mukam, the last southern part of the Teknaf, there is a area of two hundred hectares of accreted land where forest department made mangrove afforestation during 1983. The afforestation is now 7 to 8 years old and the growth of the trees are very well. The average height of the trees is almost 5 to 6 meters. The species are mostly Baen (Avicennia officinalis), Gewa (Excoecaria agallocha), Keora (Sonneratia apatala), Kankra (Bruguiera gymnohiza) and Gulpata (Nypa fruticans) etc. On the embankment, a good stand of Babla trees on both slopes of the embankment, Rain tree (Samnea saman), Shil Koroi (Albizzia procera) and Kul boroi (Zizyphus jujuba) were found. Some local bushes like Dhol Kalmi (Ipomea fistulosa) Sada Akanda (Catatropis procera), etc. were found to be growing very well on the embankments.

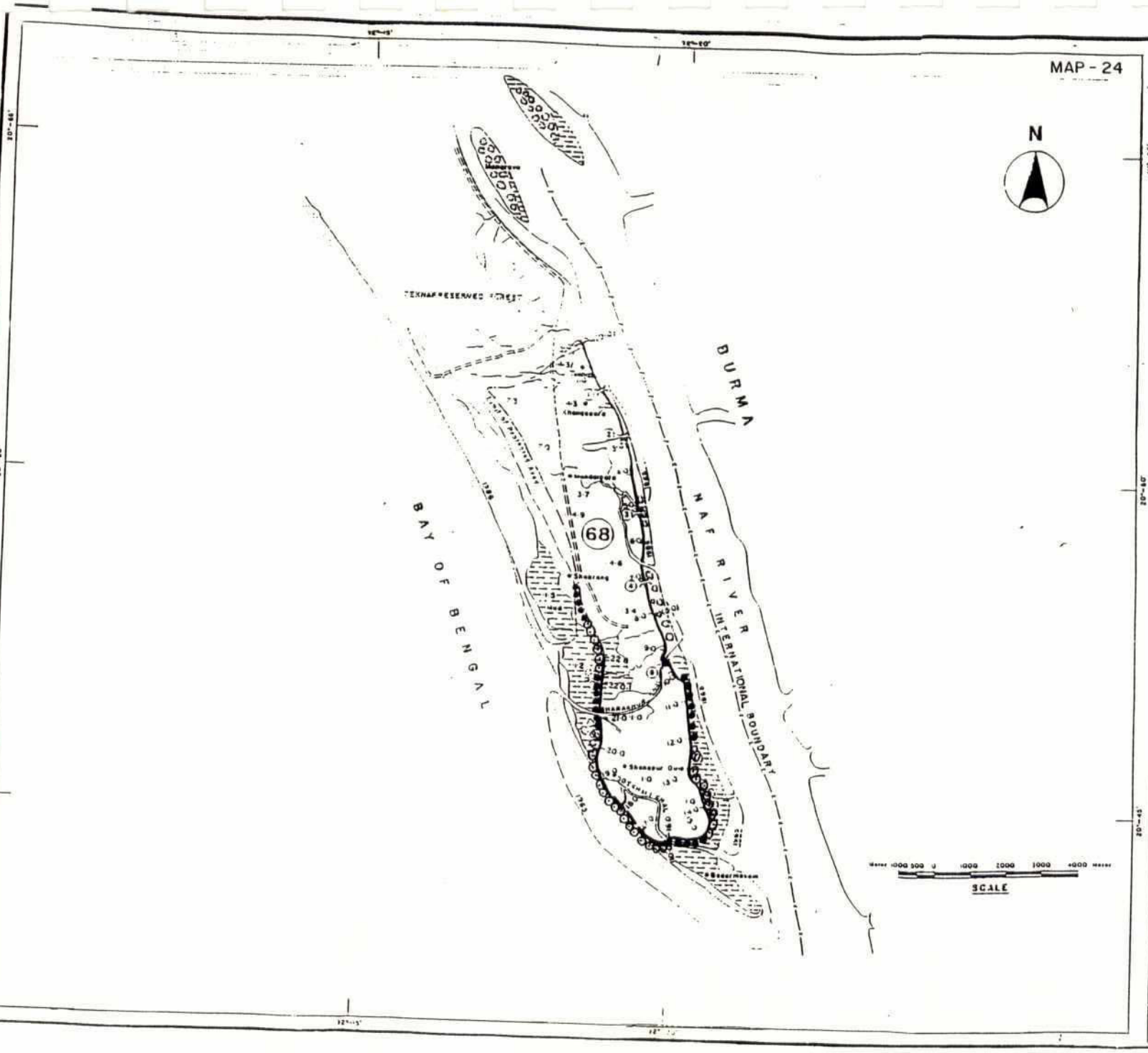
In the area where the mangrove afforestation is present on the foreland and trees on the embankment, the embankment was found to be unaffected by wave action. After Badar Mokam about few Kilometres area along the embankment, forest department also planted mangrove during 1989. The seedlings are still growing and not yet stabilized. From the chainage 18.2 to 20.3 Kilometres the embankment is badly damaged. It was damaged once before but repaired through the FFW programme. The whole embankment is completely barren, no trees even bushes are present. There is no grass cover on the damaged portion. The foreland is also empty. Once, the forest department planted mangrove species all around the embankment but due to some unseen reason, the plantation could not be established. From chainage 21.2 to 27.0 Kilometres the forest department established beautiful mangrove afforestation during 1980-1985. But the whole plantation has been felled and destroyed by the shrimp cultivator. There is still a good area available all along the embankment where mangrove afforestation can be established and on the embankment, suitable forestry species can be planted on the slopes. The existing and the proposed afforestation on the slope of the embankment and in the foreland on the sea side are shown in Map-24.

POLDER 69

This polder is located at Maheshkhali upazilla under Cox's Bazar District and Chittagong circle. About 21 Kilometres of embankment were surveyed for the first year plan and is shown in Map-25. Only few balda trees were observed on the slope of the embankment. Some bushes like Keya (Pandanus odoratissimus) which are growing very luxuriantly on

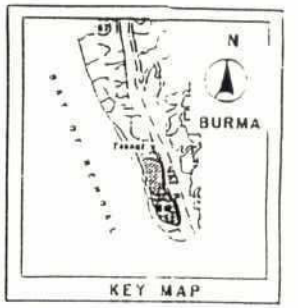
MAP - 24

POLDER NO. 68



LEGEND

- River & Khal
- Roads
- Existing Embankment Chainage in Km / Sea Wall
- Proposed Embankment
- Existing Sluice with Number
- Proposed Sluice
- Shore Line 1988
- Shore Line 1985
- International Boundary
- Limit of Protected Area
- Spot Heights in Metre (PWD)
- Existing Afforestation
- Proposed Afforestation



PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 68

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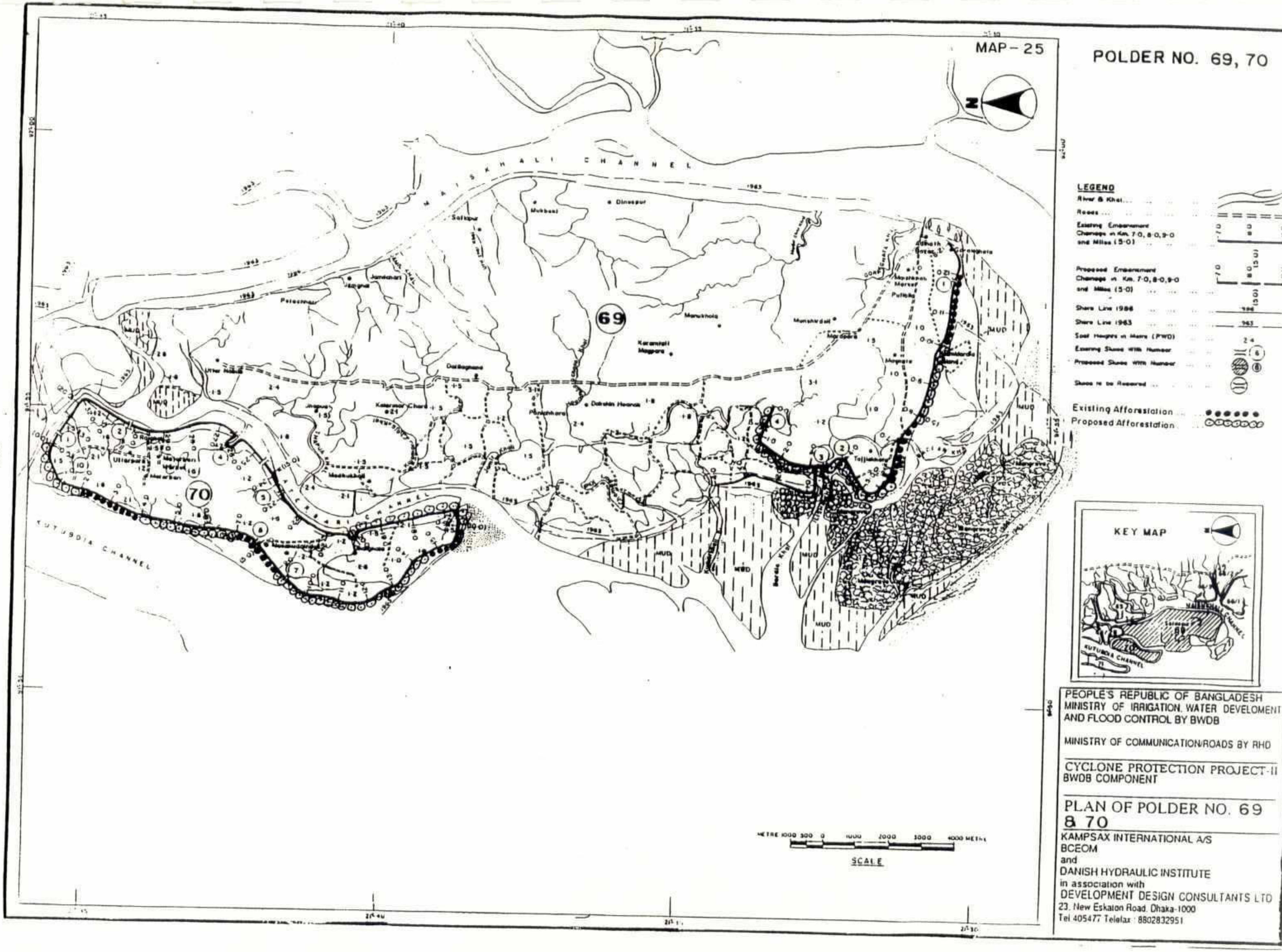
MAP - 25
POLDER NO. 69, 70
LEGEND
River & Khal
Roads
Existing Embankment Chainage in Km. 7·0, 8·0, 9·0 and Miles (5·0)
Proposed Embankment Chainage in Km. 7·0, 8·0, 9·0 and Miles (5·0)
Shore Line 1986
Shore Line 1963
Spot Heights in Metre (PWD)
Existing Sluice with Number
Proposed Sluice with Number
Sluice to be Repaired
Existing Afforestation
Proposed Afforestation
KEY MAP
MAISKHALI CHANNEL
KUTUBDIA CHANNEL
69
70
MUD
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 69 & 70
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both the slopes. From the chainage 5.6 Km to 6.5 Kilometres, the soil of the embankment is very coarse sand. This sand is very unstable and moving with the high wind due to lack of cohesion. But Keya bushes are growing very well in this part. There are some protective work by brick blocks which was done, earlier. Next to this part, creepers of Ipomea are growing on the top soil. The soil of this whole area of the embankment is silty sand.

In the foreland, the forest department established good plantations of mangroves which is about 15-20 years old. But in some parts, the shrimp cultivator felled and destroyed the mangrove trees and as a result the whole front became open and barrel and consequently this part become affected by sea wave action and the embankment which is sandy getting gradually erroded. The area where there is a presence of mangrove afforestation, the embankment is perfectly unaffected. Still there is plenty of spaces where mangrove afforestation can be established. But on the coastal area of the eastern side along the Mahesh Khali channel there is a good plantation of mangrove species. So on the slope of the embankment suitable species of forestry tree can be planted and on the foreland mangrove species should be used for plantation. The existing and the proposed afforestation on the slope of the embankment and in the foreland on the sea side are shown in Map-25.

POLDER 70

This polder belongs to Matarbari and Dhalghat under Mahesh Khali upazilla of the Cox's Bazar District. About 20 Kilometres of embankment were surveyed for the first year programme and is shown in Map-25. Only few scattered trees of Babla (Acacia arabica) trees was found in some areas of the embankment. Most of the embankment is out of trees except some bushes like Dhol Kalmi (Ipomea fistulosa) Sada Akanda (Calotropis procera) etc. and grass (Canodon dactylon) cover on the top of the soil. The dubra (Cynodon dactylon) grass has been keeping the top soil in a very stable condition and this grass cover acts as a protection from the mild wave action.

On the foreland there is a few patches of mangrove afforestation which were planted by the forest department lduring 1980-85. These plantations are not continuous and there is a large gap in between the plantations. So it was found that where the mangrove afforestation in the foreland is absent, the embankment is affected by the wave action. Some protective work was done in some areas previously. Some damaged areas were observed from the chainage 10.7 to 15.1 Kilometres and there is no mangrove afforestation in the foreland of these areas. Suitable forestry species should be planted on

the slopes of the embankments and mangrove species on the foreland. About 200 to 300 meters of land will be available all along the embankment. The existing and proposed afforestation on the slope of the embankment and on the foreland are shown in Map-25.

POLDER - 71

This polder belongs to Kutubdia upazilla under Cox's Bazar district and Chittagong circle. About 25 Kilometres of embankment were surveyed for the first year plan and is shown in Map-26. Only few babla (Acacia arabica) trees were found on the embankment but tree species like Rain tree (Samanea saman), Shil Koroi (Albizzia procera), Kul boroi (Zizyphus jujuba), Bambo (Bambusa tulda) and Bat tree (Ficus bangalensis) etc were growing on the slope of the country side. On the slope of the sea front, the whole embankment is more or less affected by direct sea waves. From chainage 24.5 to 28.7 Kilometres, the whole foreland is mostly sandy soil and mangrove species is not possible to establish. In this sandy soil, new attempt of establishing casuarina afforestation was tried before 2 to 3 years back. It was found that casuarina became estblished very well and had grown up to 3 to 4 meters within this time.

The forest department planted mangrove species earlier in this area but due to heavy siltation and strong wave action the plantation could not be established and they never attempted for the second time. But below the sandy soil, the soils are more or less silty clay in nature and about 300 to 400 meters of accreted land will be available for mangrove afforestation. In some places, the foreland is very narrow and it will be difficult to establish mangrove afforestation. In this area mangrove afforestation will not be possible to establish due to the soil condition. Strips of plantation with coconut and date palm can be done which is able to sustain salinity. This plantation may delay the erosion of the area in the future. Rain tree (Samanea saman) is found to be common tree in Kutubdia. Some tree grew very big and gigantic in size. Some bushes like Dhol Kalmi(Ipomea fistulosa), Sada Akanda (Calotropis procera) are growing very well even in the sea front side of the embankment. Dubra grass (Cognition dactylon) is growing as a soil cover all over the embankment but due to effect of direct salt water action on the sea front side, the grasses are unable to survive and there is no protection of the soil. Without cover, the soil become erroded. The slopes of the whole embankment should be planted with the suitable forestry species and in the foreland mangrove afforestation should be established. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in the Map-26.

MAP - 26

POLDER NO. 64/2B, 64/IC & 71

LEGEND

- River & Khal
- Roads
- Existing Embankment — Chainage in Km. 7 0 , 8 0 — And Miles (5 0)
- Original CEP Embankment
- Shore Line 1986
- Shor Line 1983
- Proposed Embankment
- Existing Sluice With Number
- Spot Heights in Metre (PWD)
- Existing Afforestation
- Proposed Afforestation

KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO.
64/2B, 64/IC & 71

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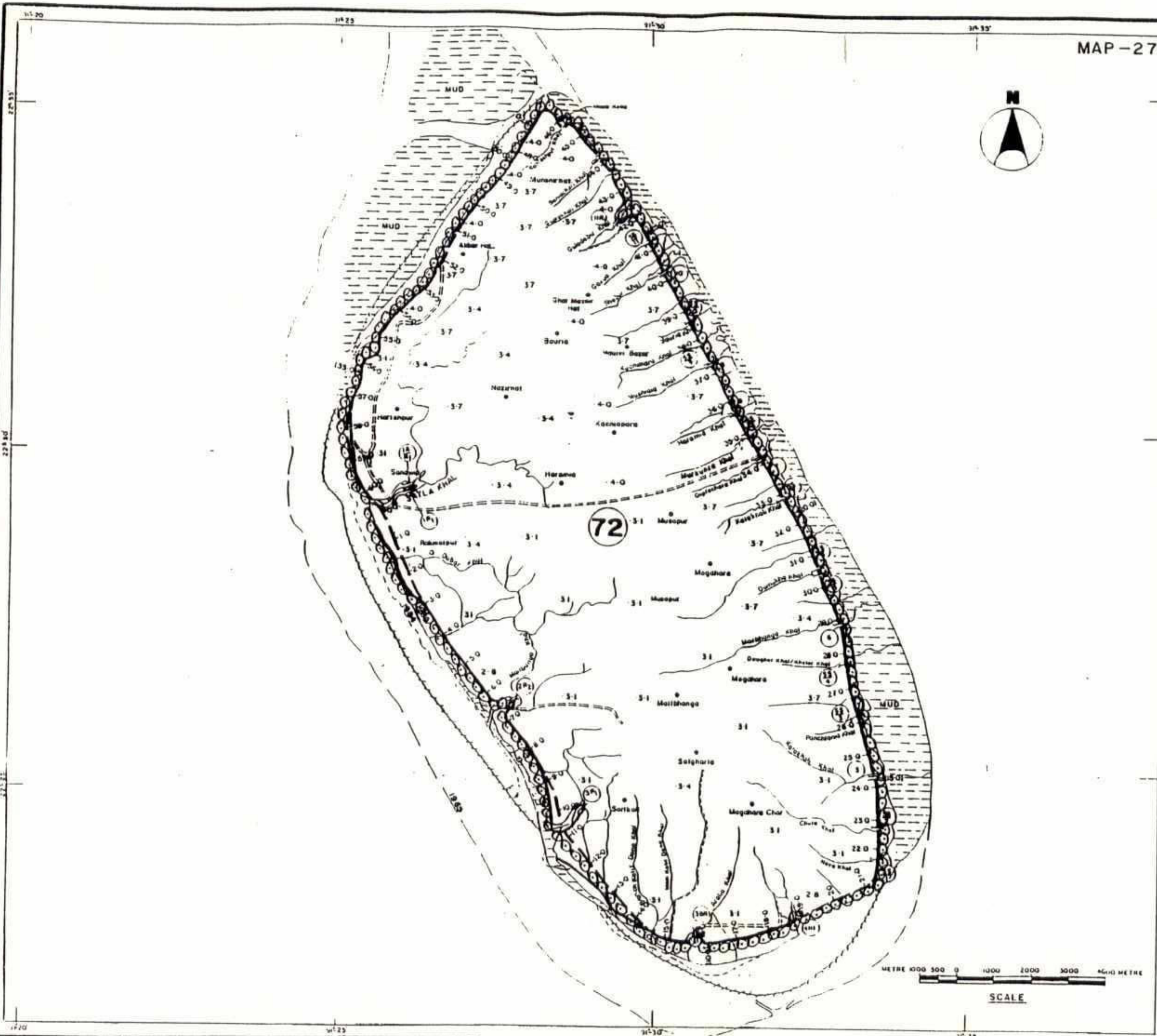
POLDER 72

This polder belongs to Sandwip upazila under Chittagong circle. About 64 kilometres of the embankment were surveyed and is shown in Map-27. From Sandwip Water Board Inspection Banglow towards south up to Azampur, the chainage from 0 to 4.28 kilometres, the embankment was completely damaged due to high erosion and strong sea waves during the monsoon. There were lots of coconut, date palm and palm trees, jack fruit, mango, beetal nut tree etc. are found to be growing on the sea shore but those are gradually going under water due to heavy erosion. The embankment has been retired and constructed through FFW programme. From 4.25 to 5.92 kilometres, the old embankment is still there and the local land less people are settled on the side of the embankment. The tree species like Banana(Musa paradisiaca), date palm(phoenix doctylifera), coconut (Cocos nucifera),mango(Magnifera indica), jack fruit (Artocarpus integrifolia),few babla(Acocia arobica) trees etc. are growing on the slope of the embankment but no mangrove trees were found on the foreland or on the sea front. There is not yet planted any trees or covered with grasses in the retired embankment which were constructed after the damage of the old embankment.

From the chainage 5.92 to 6.50 kilometres, the embankment is partially damaged by the wave action. There are some scattered trees growing on the embankment. From chainage 6.50 to 8.60 kilometres, the old embankment is in good condition and some trees are growing on the slope of the embankment but no trees one the foreland. Again from the chainage 9.9l to 20.24 kilometres, the whole embankment is completely and partially damaged except a small portion from 9.9l to l0.78 kilometres. The foreland of this area has an accretion but not yet planted or found to be growing any trees. From chainage 20.24 to 45.57 kilometres except in some small portions, the whole embankment is completely in good condition. Lots of local and landless people are settled on both sides of the embankments. Lots of good sized Babla (Acacia arabica) trees are growing on both the slopes of the embankment. The trees are almost 20 to 25 years old. Besides the babla trees, the peoples planted banana (Musa paraadisiaca) plant, date palm (Phoenix dactyliffer), coconut (Cocos nucifera) tree, Fulkoroi (Samarnea saman), shil koroi (Albizzia lebbek), mango(Magnifera indica),jack fruit (Artocarpus integrifolia), kulboroi (Zizyphus jujuba), simul tula (Salmalia malabaricum), Guava, dhaki jam (Syzygium grandis) etc. which are growing very well on the slopes of the embankment. From the chainage 45.47 to 48.39 kilometres, this part of the embankment is partially damaged but still there is some scattered trees on the embankment but there is no mangrove species in the foreland. The foreland of the whole area is about l to l.5 kilometres wide and paddy is grown all over the area.

POLDER NO. 72

MAP–27



LEGEND

River & Khal

Roads

Existing Embankment Chainage in Km 7.0, 8.0, 9.0 And Miles 15.01

Proposed Embankment

Original CEP Embankment

Shore Line 1989

Shore Line 1984

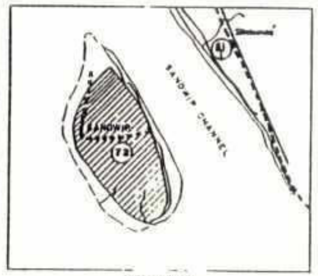
Shore Line 1965

Existing Sluice with Numbers: Drainage Sluice, Surface Sluice

Spot Heights in Metre (PWD)

Existing Afforestation

Proposed Afforestation



KEY MAP

PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB

MINISTRY OF COMMUNICATION/ROADS BY RHD

CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT

PLAN OF POLDER NO. 72

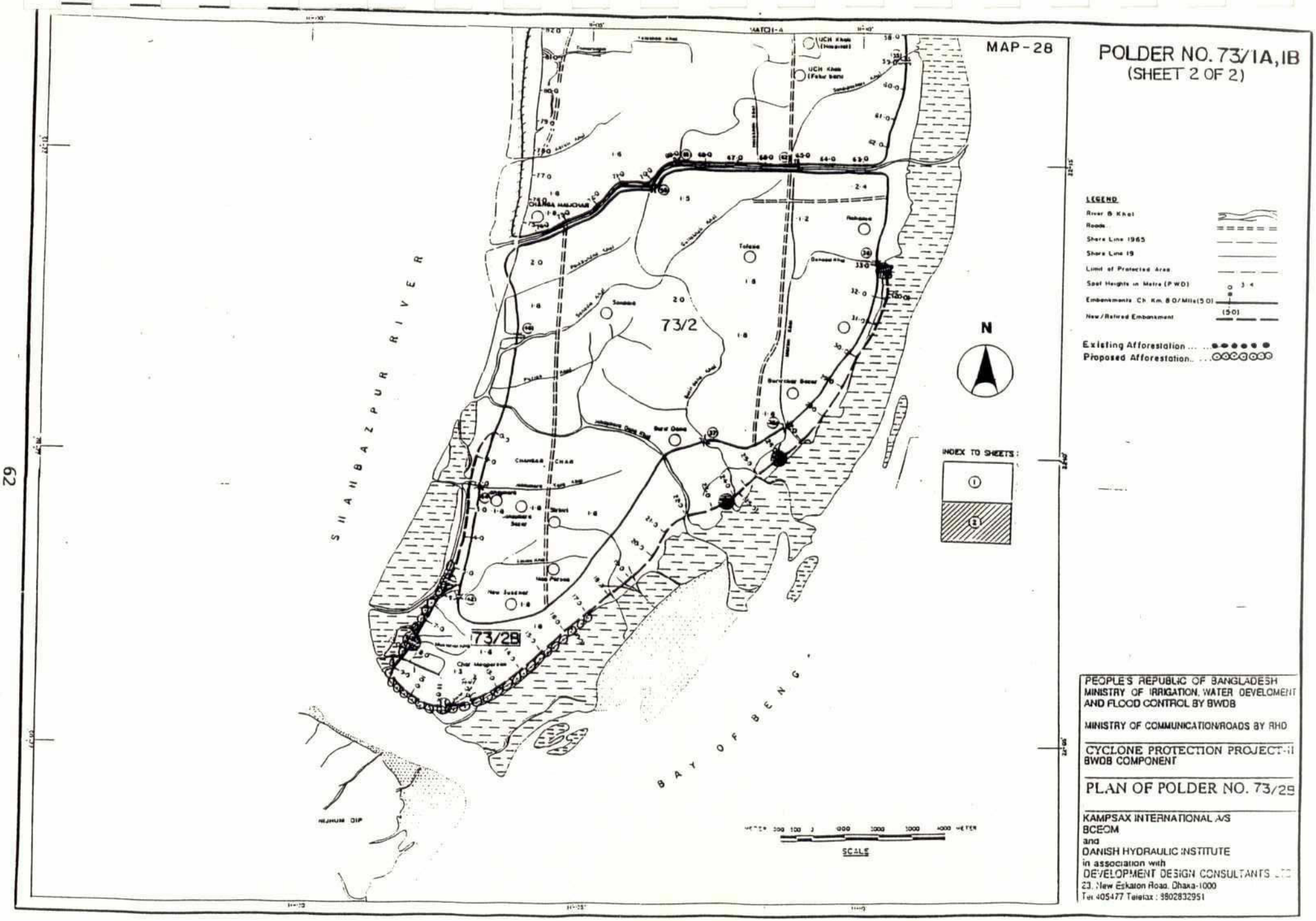
KAMPSAX INTERNATIONAL A/S
BCEOM
and
DANISH HYDRAULIC INSTITUTE
in association with
DEVELOPMENT DESIGN CONSULTANTS LTD
23, New Eskaton Road, Dhaka-1000
Tel 405477 Telefax : 8802832951

From chainage 48.50 to 60.5 kilometres, the whole embankment is almost without trees, only few bushes and grass cover were observed. In some areas the top soil was found to be completely exposed. This may be due to over grazing direct wave action and erosion due to heavy rainfall etc. On the foreland of this area there is a great accreted land where the farmers started growing paddy and raising cattles. The forest department is not yet permitted to establish mangrove afforestion in these accreted land. Lastly from the chainage 60.2 to 62.0 kilometres, the whole old emkbankment has been damaged by the wave action and new retired embankment has been constructed. the retired embankment is very low in height and constructed on temporary basis. There are no trees on the slope of the embankment but some coconut tree, date palm, palm tree etc. are found on the foreland of the sea front. These trees once belonged to household areas but due to erosion and repeated flooding during the monsoon, the people had to move elsewhere. Not a single patch of mangrove afforestation were noticed all around the embankment of the whole Sanwip area. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown in Map-27.

POLDER 73/2B

This polder belongs to Hatiya upazilla under Noakhali Circle. About 33 Kilometres embankment were surveyed and is shown in Map-28. In the southern part of Hatiya, a vast land area has been accreted. This accreted land has been stabilized and the peoples are already growing paddy crops and other agricultural crops but during the rainy season due to flooding, saline water enters this area and only one crop can be grown.

There is a good mangrove afforestation with almost 1/2 to 1 kilometre width which is established by the forest department during 1980-85. The plantation is well established. On both sides of the embankment the local landless people are settled. Tree species like Babla, Shil Koroi, Ful Koroi, Kat Badam, Simul tula, date palm and palm tree etc are growing very well. The existing and proposed afforestation on the slope of the embankment as well as on the foreland are shown on Map-28.


MAP-28
POLDER NO. 73/1A, 1B
(SHEET 2 OF 2)
LEGEND
River & Khal
Roads
Shore Line 1965
Shore Line 19
Limit of Protected Area
Spot Heights in Metre (P.W.D)
Embankments Ch. Km. & O/Mile(S.O)
New/Raised Embankment
Existing Afforestation
Proposed Afforestation
N
INDEX TO SHEETS :
1
2
73/2
73/2B
SHAHBAZPUR RIVER
BAY OF BENGAL
SCALE
PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF IRRIGATION, WATER DEVELOMENT AND FLOOD CONTROL BY BWDB
MINISTRY OF COMMUNICATION/ROADS BY RHD
CYCLONE PROTECTION PROJECT-II
BWDB COMPONENT
PLAN OF POLDER NO. 73/2B
KAMPSAX INTERNATIONAL A/S
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8. SELECTION OF SPECIES FOR EMBANKMENT AND FORESHORE PLANTATION

Planting of selected tree species on the embankment is very essential. This would help to stabilize the embankments and create also a wood resources for future use. Trials selection should seek to identify species with the following general characteristics such as (1) xerophytic, the species which are more or less drought resistant in nature. (2) Low transpiration water demand (3) Rapid growing (4) Extensive surface root system (5) Hardy, strong and non brittlesness species which can stand cyclone and high wind during the early monsoon period (6) Ability to regenerate through coppicing following cropping. Such type of species are ideally suited for cuttings for fire wood on a continuous demand basis. and (7) Species with multiple uses such as fuel wood, fodder, timber, windbreaks, food, soil stability and soil nutrition.

In the foreland and foreshore, the mangrove species are successfully growing. Mangroves are evergreen species or forests between the land and the sea occupying areas along sheltered coasts, estuaries and deltas where they are influenced by tides, salinity and rainfall. In the coastal zone always new accretion of land is developing and massive efforts for afforestation are going on by the Bangladesh forest department since 1980 to stabilize the lands. The forest department is planting the species of Baen (Avicennia officinalis), Goran (Ceriops decandra), Gulpata (Nypa fruitcans), Keora (Sonneratia apatala), and Kankra (Bruguiera gymnorhiza) etc all over the coastal regions but the species of Keora (Sonneratia apatala), Baen (Avicennia officinalis), Kankra (Bruguiera gynnorhiza) and gul pata (Nypa fruiticans) are the species successfully established all over the plantation areas of the coast.

While visiting the polders several tree species were found to be growing successfully on the slopes of the embankment. The species are (1) Babla (Acacia arabica), (2) Khaya Babla (Pithecellobium dulce), (3) Khair (Acacia Catechu), (4) Sil Koroi (Albizzia Lebbek), (5) Rain Tree (Samanea Saman), (6) Simul Tula (Salmalia Malabaricum), (7) Madar (Erythrina Indica), (8) Tetul (Tamarindus Indica), (9) Barta (Artocarpus Lacucha), (10) Bhadi (Garuga Pinnata), (11) Kat Badam (Terminalia Catappe), (12) Kadam (Authocephalus Cadamba), (13) Bamboo (Bambusa Vulgaris), (14) Sonalu (Cassia Fistula), (15) Coconut (Cocos nucifera), (16) Date Palm (Phoenix Dacty lifera), (17) Tal Tree (Borassus Flabellifer), (18) Mango (Magnifera Indica), (19) Jack Fruit (Artocarpus Integrifolia), (20) Betelnut (Areca Catechu), (21) Bannana (Musa Paradisiaca) etc. (22) Kul Boroi (Zizyphus Jujuba) etc.

Bush (Shrub) species

(1) Dhal Kalmi (Ipomoea fistulosa)
(2) Shada Akanda (Calotropis procera)
(3) Keya (Pandanus Odoratissimus)
(4) Hogla pata (Typha angustata).

These species are growing scatteredly and unmethodically

Soil cover (Grass)

1. Dubra grass (Cynodon dactylon)
2. Utuchan (Imperata cylinderica)

Recommended Tree Species for Embankments

1. Acacmoni (Acacia auriculiformis)
2. Babla (Acacia arabica)
3. Khaya Babla (Pithecellobium dulce)
4. Shisham (Delbergia sisso)
5. Sil Koroi (Albvizzia procera)
6. Rain tree (Samanea saman)
7. Mahogany (Swietenia microphylla)
8. Madar (Erythrina indica)
9. Ipil Ipil (Leucaena Leucocephala)
10. simul tula (Salmalia malabaricum)
11. Kadam (Anthocephorlus cadamba)
12. Coconut (Cocos nucifera)
13. Date palm (Phoenix dactylifera)
14. Tal tree (Borassus flabellifer)
15. Kul boroi (Zizyphus jujuba)
16. Tetul (Tamarindus indica)
17. Bamboo (Bambusa vulgaris)
18. Jack fruit tree (Arotcarpus integrifolia)
19. Eucalyptus (Eucalyptus camaldulensis)

Tree Spcies which can be used as fodder from leaves and fruits for animals during the rainy season and flood periods.

1. Babla (Acacia arabica)
2. Acacmoni (Acacia auriculiformis)
3. Tpil-Ipil (Leucaena Leucocephala)
4. Shisam (Delbergia sisso)
5. Sada Koroi (Albizzia procera)
6. Rain tree (Samanea saman)
7. Madar tree (Erythrina indica)

Shrub (Bush) Species

1. Dhol Kalmi (Ipomoea fistulosa)
2. Shada Akanda (Calotropis procera)
3. Keya (Pandarus odoratissimus)
4. Hogla pata (Typha angustata)

Soil Cover

1. Dubra grass (Cynodon dactylon)
2. Siratro (Macroptillium atropurpureum)
3. Centrosema (Centrocema pubescens)
4. Kudzu (Pueraria phaseoloides)

Mangrove Species

1. Keora (Sonneratia apatala)
2. Baen (Avicennia officiualis)
3. Kankra (Bruginera gymnorhiza)
4. Gulpata (Nypa fruiticans)

For the Sandy area on the sea shore

1. Jhau (Casuarina equisetifolia)
2. Tamarix (Tamarix gallicha)

9. PROPOSED AFFORESTATION PROGRAMME

On the basis of the information gathered during the field survey of the polders and the recommendations for afforestations in these polders an afforestation programme has been proposed for the surveyed polders comprising a total of 699 Km aforestation of foreland and 706 km afforestation of embankment. The details of this programme are presented in table-5.

TABLE - 5

AFFORESTATION PROGRAMMES FOR THE EMABNKMENTS AND THE FORELAND DURING MID TERM PLAN

Serial No.	Polder No.	Upazilla	Embankment			Fore Land		
			Chainage (km)	Length (km)	Total Length (km)	Chainage (km)	Length (km)	Total Length (km)
CHITTAGONG DIVISION - I & II								
1.	61	Sitakunda	0.5 - 4.5 5.5 - 15.0 16.0 - 19.5	4.0 9.5 3.5	17.0	0.0 - 4.0 6.0 - 13.0 15.0 - 20.0	4.0 7.0 5.0	16.0
2.	62	Patenga	0.5 - 6.0 6.5 - 16.0	5.5 10.5	16.0	2.0 - 6.0 9.0 - 18.0	4.0 9.0	13.0
3.	63/IA	Anwara	21.0 - 24.0 29.0 - 40.0	3.0 11.0	14.0	21.0 - 24.0 29.0 - 40.0	3.0 11.0	14.0
4.	64/IA	Banskhali	86.0 - 100.0 102.0 - 108.0	14.0 6.0	20.0	86.0 - 108.0	22.0	22.0
5.	72	Sandwip	0.0 - 25.0 26.0 - 60.0	25.0 32.0	57.0	0.0 - 25.0 26.0 - 60.0	25.0 34.0	59.0
COX'S BAZAR DIVISION								
6.	64/2B	Magnama	116.0 - 126.0	10.0	10.0	116.0 - 126.0	10.0	10.0
7.	66/1	Ramu	0.0 - 7.0	7.0	7.0	0.0 - 7.0	7.0	7.0
8.	66/3	Cox's Bazar	42.0 - 47.0	5.0	5.0	42.0 - 47.0	5.0	5.0
9.	68	Teknaf	10.5 - 25.5	15.0	15.0	10.0 - 26.0	16.0	16.0
10.	69	Mahesh Khali	5.0 - 13.0 0.0 - 12.0	8.0 12.0	20.0	6.0 - 14.0 0.0 - 12.0	8.0 12.0	20.0
11.	70	Matarbari	0.0 - 16.50 17.5 - 19.0	16.50 1.50	18.0	0.0 - 19.0	19.0	19.0
12.	71	Kutubdia	0.0 - 22.0	22.0	22.0	0.0 - 22.0	22.0	22.0

Cont. Table - 5

Serial No.	Polder No.	Upazilla	Embankment			Fore Land		
			Chainage (km)	Length (km)	Total Length (km)	Chainage (km)	Length (km)	Total Length (km)
NOAKHALI DIVISION								
13.	59/1A	Companiganj Begumganj	8.0 - 12.0	4.0	4.0	8.0 - 12.0	4.0	4.0
14.	59/2B	Ramgati	116.3-126.3 126.5-135.5	8.0 10.0	18.0	116.5-126.5 126.5-136.5	8.0 10.0	18.0
15.	59/3B	Sudaram	25.0-40.0 42.0-70.0	15.0 18.0	43.0	25.0-40.0 42.0-70.0	15.0 28.0	43.0
16.	59/3C	Companiganj Sudarampur	0.0-20.0 21.0-43.0	20.0 22.0	42.0	0.0-21.0 22.0-43.0	21.0 21.0	42.0
17.	60	Sonagazi	0.0-5.2 16.9-23.2 31.0-41.5	5.2 6.3 10.5	22.0	0.0-5.2 16.9-23.2 31.0-41.5	5.2 6.3 10.5	22.0
18.	73/2B	Hatiya	0.0-33.0	33.0	33.0	15.0-27.0	12.0	12.0
BHOLA DIVISION								
19.	56/57	Bhola	2.5-7.0 9.0-16.0 17.0-29.0 30.0-66.0 67.0-80.5 83.0-95.0 96.0-110.0	4.5 8.0 12.0 36.0 13.5 12.0 14.0	100.0	2.5-16.0 17.0-66.0 67.0-95.0 96.0-110.0	13.5 49.0 28.0 14.0	104.5
SATKHIRA DIVISION								
20.	5	Kaliganj Shamnagar	7.5-19.5 33.0-52.5	12.0 19.5	31.5	7.0-20.0 33.0-53.0	13.0 20.0	33.0
21.	7/1	Asasuni	0.0-31.0	31.0	31.0	0.0-31.0	31.0	31.0
22.	7/2	Asasuni	47.0-58.0	11.0	11.0	46.0-59.0	13.0	13.0
23.	14/1	Koyra	0.0-10.5 26.5-27.8	10.5 1.3	11.8	0.0-10.5 26.0-28.0	10.5 2.0	12.5
24.	14/2	Koyra	0.0-31.0	31.0	31.0	0.0-31.0	31.0	310.0
25.	15	Shamnagar	0.0-27.0	27.0	27.0	0.0-27.0	27.0	27.0

Cont. Table - 5

Serial No.	Polder No.	Upazilla	Embankment			Fore Land		
			Chainage (km)	Length (km)	Total Length (km)	Chainage (km)	Length (km)	Total Length (km)
BAGERHAT DIVISION								
26.	35/1	Saronkhola	1.5-9.5 9.6-19.6	8.0 10.0	18.0	1.0-10.0 10.5-19.0	19.0 9.5	18.5
KHULNA DIVISION								
27.	10-12	Paikgacha	15.0-25.0	10.0	10.0	15.0-25.0	10.0	10.0
28.	31	Dacop	11.0-12.5	1.5	1.5	11.0-12.5	1.5	1.5
29.	32	Dacop	0.0-7.0 28.0-48.0	7.0 20.7	27.0	0.0-7.0 28.0-480	7.0 20.0	27.0
BARGUNA DIVISION								
30.	40/2	Pathergata	17.5-22.5	5.0	5.0	17.0-23.0	6.0	6.0
31.	46	Kalapara	28.0-30.5	2.5	2.5	28.0-31.0	3.0	3.0
32.	48		17.0-33.0	16.0	16.0	17.0-33.0	16.0	16.0
TOTAL AREA					706.0			699.0

10. COST ESTIMATE FOR AFFORESTATION PROGRAMME

NUMBER OF SEEDLINGS PER KILOMETER

Seedlings for Embankment

Number of seedlings need per kelometer for the embankments.
Distance from seedlings to seedlings = 1.5 meters
Three lines for each slope and for both slopes need 6 lines.
Seedlings need for one kilometer = 1000 m / 1.5 m = 666 seedlings per line
For 6 lines, 666 x 6 = 3996 number of seedlings or 4000 number of seedlings need per kilometer

Mangrove Seedlings for foreland

Spacing between plants - 1.5 meter
Spacing between line to line - 1.5 meter
Area per plant 1.5 x 1.5 = 2.25 sq. meter
Total area per kilometer = 1000 meter x 200 meter = 200,000 sq meter
Seedlings need for 1 kilometer area = 200,000 / 2.25 = 88,890 number of seedlings.

COST OF RAISING 1000 SEEDLINGS FOR EMBANKMENT IN THE NURSERY BED

Type of Work	No. of Labour	Labour Rate (Tk.)	Cost (Tk.)
Clearing the area for nursery	5	40.00	200.00
Preparation of bed	4	40.00	160.00
Collection of soil for polythene bag	9	40.00	360.00
Mixing the soil	3	40.00	120.00
Filling up polythene bag	3	40.00	120.00
Fixing stake	1	40.00	40.00
Sowing seed	1	40.00	80.00
Transfer of seedlings from the bed to polythene bag	2	40.00	80.00
Irrigation	5	40.00	200.00
Weeding	4	40.00	160.00
Transfer of seedlings from original place and cutting the extra roots.	1	40.00	40.00
			1,520.00

Purchase of Materials

Prices of polythene bag	10 bags.	50.00 per bag	500.00
Chemical fertilizer	25 kg.	8.00 per kg.	200.00
Organic manure	100 kg.	2.00 per kg.	200.00
Collection of seed			150.00
		Total	1,050.00

Grand Total Tk. 1520.00 + 1050.00 = 2,570.00

COST OF PLANTATION ON THE SLOPES OF THE EMBANKMENT PER KILOMETER

Number of seedlings per kilometer = 4000

Cost of seedlings for raising 4000 seedlings	Tk. 10,288.00 Tk. 2570.00 per 1000 seedlings	10,288.00

Type of Work	No. of Labour	Labour Rate (Tk)	Cost (Tk.)
Survey and other related work in the land	2	40.00	80.00
Preparation of land	5	40.00	200.00
Fixing stake in the land accounting to the mark	25	40.00	1000.00
Digging hole for seedlings 1.5' x 1.5' x 1.5'	70	40.00	2800.00
Carrying seedlings in the field	32	40.00	1280.00
Planting seedlings	50	40.00	2000.00
Planting arhar seeds on the sides	10	40.00	400.00
Maintenance for 1st year	15	40.00	600.00
Gap fillings	30	40.00	1200.00
			9,560.00

Cost of Materials

Chemical fertilizer	500 kg.	Tk. 8.0 per kg.	4000.00
Organic manure	2000.0 kg.	Tk. 2.0 per kg.	4000.00
Arhar seeds			1000.00
		Total	5,400.00

Grand Total Tk. (10,2880 + 9,56.00 + 5,400.00) = 25,248.00

COST OF
RAISING MANGROVE SEEDLINGS IN THE
NURSERY BED

FOR 1000 SEEDLINGS

Type of Work		No. of Labour	Labour Rate (Tk)	Cost (Tk.)
Clearing and sorrounding the land		1	40.00	40.00
Preparation of bed and sowing seed (Bed size = 40" x 4')		1	40.00	40.00
Weeding		1	40.00	40.00
Cost of Materials				
Chemical fertilizer	5 kg.	Tk. 8.0 per kg.		40.00
Organic fertilizer	20 kg.	Tk. 2.0 per kg.		
Collection of seeds				80.00
				Tk. 280.00

COST OF PLANTATION OF MANGROVE SEEDLING
PER KILOMETER. (DURING FIRST YEAR)

NUMBER OF SEEDLINGS PER KILOMETER - 88,890

Cost for raising 88,890 seedlings	Tk. 24,890.00 Tk. 280.00 per 1000 seedlings		Tk. 24,890.00

Type of Work	No. of Labour	Labour Rate (Tk.)	Cost (Tk.)
Clearing the land for plantation	75	40.00	3000.00
Preparation of land for plantation	100	40.00	4000.00
Plantation of seedlings	150	40.00	6000.00
Carrying seedlings in the field	75	40.00	3000.00
Gap fillings	50	40.00	2000.00
Maintenance and weedings around the seedlings	50	40.00	2000.00
			Tk. 20,000.00
	Grand Total		Tk. 44,890.00

1. Salary for Forest Watchman

Tk. 1200,00 per month Tk. 1200.00 x 12 = 14,400.00 per year for 5 years = 14,400 x 5 = 72,000.00 A watch man for every 5 kilometers.	Tk. 72,000.00
2. Shed for Watchman	Tk. 25,000.00
(2 watchman in one shed)	
3. Bicycle for watchman	Tk. 5,000.00
Tk. 5,000.00 including maintenance (Bicycle - 3500.00) Maintenance	

	Tk. 102,000.00

Taka 102,000.00 for 5 years
Taka 20,400.00 for one year

TOTAL COST OF PLANTATION PER KILOMETER

1)	For Embankment -	Tk. 25,248.00
2)	For Foreland (Mangrove)	Tk. 44,890.00
3)	For watchman, shed and bicycles	Tk. 20,400.00

		Tk. 90,538.00

TOTAL COST FOR THE WHOLE PLANTATIONS

Embankment - 706.0 kilometers		
Cost of plantation for each kilometer	Tk.	25,248.00
706.0 x 25,248.0	Tk.	17,825,088.00
Fore land - 699.0 kilometers		
Cost of plantations for each kilometer	Tk.	44,890.00
699.0 x 44,890.0	Tk.	31,378,110.00
A watch man for every 4 kilometers		
$\frac{700.0}{4} = 175$ watch man		
Salary for each watchman in 5 years	Tk.	72,000.00
175 x 72,000.00	Tk.	12,600,000.00
One Bicycle for each watchman		
Cost of each Bicycle	Tk.	5,000.00
175 x 5,000.00	Tk.	875,000.00
Shed for watchman - 2 watchman in one shed		
One shed for every 8 kilometers		
$\frac{700}{8} = 87.5$ or 88 sheds.		
Construction cost for each shed	Tk.	25,000.00
88 x 25,000.00	Tk	2,200,000.00

<u>The Total Cost</u>

Cost of plantation on Embankment	Tk.	17,825,088.00
Cost of plantation on Foreland	Tk.	31,378,110.00
Salary of Watchman for five years	Tk.	12,600,000.00

Bicycle for Watchman	Tk.	875,000.00
Shed for Watchman	Tk.	2,200,000.00
Miscellaneous	Tk.	2,500,00.00
	Tk.	67,378,198.00
Contingecies 15%	Tk.	10,106,129
		77,484,927
Establishment Cost 15%	Tk.	11,622,739
		89,107,666
Price increase to price level of Januury 1992 12%	Tk.	10,692,920
Total cost for afforestation of 700 km foreland on embankment in one operation		99,800,586

Cost per km in one operation Tk. 142,500

It is however foreseen that the operation will have to repeated up to 3 times say 2 in average and the total average cost per km afforestation is therefore estimated at 2.0 x 142, 500 Tk. 285,000

11. RECOMMENDATIONS

From the field surveys and study of afforestations in the whole coastal areas of the sea facing embankments of Chittagong, Noakhali, Barisal, Patuakhali and Khulna, the following observations and recommendations are made :

1. Afforestations in the Cyclone Protection Project II is playing a very important role for strengthening and improving the sea facing and similarly exposed embankments in the coastal areas as protection against waves.

2. It has been observed that afforestation of the foreland and foreshore areas as well as on the sea ward slope of the embankments provide a very efficient protection against damage by high tidal waves and cyclonic surges. In areas where there is no afforestation the embankments as well as the costly protective works are very often damaged by monsoonl tidal waves.

3. It is essential that coordination between the water Development Board (BWDB) and the Forest Department be established for the implementation of afforestation schemes.

4. So far, afforestation by the Forestry Department in the coastal area since 1975 is mostly limited to newly accreted char land where extensive afforestation projects with mangrove species have been carried out in order to stabilize the newly accreted land. Through cooperation between the Water Development Board (BWDB) and the Forest Department, afforestation on the foreland with mangrove species and other tree species on the slopes of the embankments could be established more successfully to protect the embankments.

5. There are plenty of areas available outside the polders where mangrove afforestation can be established.

6. A 200 meter wide belt of mangrove afforestation will in most cases provide a good protection of sea facing coastal embankment against wave action. A few sections of afforestation suggested in the fore land of the embankment as shown in Figure 1A and 1B.

7. Planting of selected tree species on the embankment as well as on the fore land are very essential. This would help to stabilize the embankments and the newly accreted

land in the foreshore and would create also a wood resources for controlled future use. Trials selection should seek to identify the species with the required general characteristics like hardy and strong, deep and well spread root system, heavy branching, ever green and fast growing etc.

8. In the areas where salinity is less specially on the embankments, the species like Babla (Acacia arabica), Khair tree (Acacia catechu), Khaya Babla (Pithecellobiun dulce) etc are easy to grow from the direct seeding. These are the thorny species which will not be easily eaten or destroyed by animals. On the in land slopes of the embankment, the forestry trees like Sil koroi (Albizzia lebbek), Rain tree (Samanea saman), mahogany (Swietonia microphylla), Fruit trees like Date palm (Phoenix dactylifera), coconut (Cocos nucifera), Jack fruit tree (Arotocarpus integrifolia) and fodder trees like Ipil-Ipil (Leucaena leucocephala), Acacmoni (Acacia auriculiformis), Shisam (Delbergia sisso), and Madar tree (Erythrina indica) etc.

9. In areas where there are more salinity and regular high and low tides specially in front of the sea, the mangrove species like keora (Sanneratia apatala), Baen (Avicinea officinalis) Gewa (Exoecaria agallocha), Kankra (Bruguiera gymnorhiza) and Gulpata (Nypa fruiticans) etc can be successfully planted. In the borrow-pit, Gulpata (Nypa fruiticans) is the most suitable species to be established which stands for the best protection of the embankment.

10. The turfing of embankments with dubra grass (Cynodon dactylon) provide good protection against erosion by rain and moderate wave action. Grazing by animals should be stopped on the embankment and need regular maintenance of the grass cover.

11. Local bushes like Dhol Kalimi (Ipomea fistu losa), Shada Akanda (Calotropis procera), Keya (Pendenus odoratissima) etc can be grown on the slope of the embankments and Hogla pata (Typha angustata) in the berm also provide good protection of the embankment. These bushes can easily be reproduced by stem and root cuttings and are not eaten by livestock except hogla pata.

12. In areas exposed to wave attack and wave erosion with little or no foreshore, the embankment can be retired and the fore land thus made available can be used for afforestation.

13. In areas exposed to erosion from a strong currents, the erosion of the foreshore areas can be delayed and in some cases stopped by plantation on the foreland of fruit trees like coconut (cocos nucifera), Date palm (Phoenix dacty-lifera), Palm tree (Borassus flabellifer) etc which can grow well in the salinity affected area. The plantation should be established in belts per pendicular to the embankments to form a system of natural growing as shown in Figure 2. Different types of industries like coconut oil, mattresses, ropes etc may be established from the produced coconuts, and juices, molasses etc can be obtained from date palm and Tal palm tress.

14. The mangrove afforestation in the foreland would provide ideal food for shrimps from decomposed fallen leaves, which nurish and help the shrimps to quick growth.

15. In mangrove afforestation areas, shrimp cultivation in blocks along the embankments can be made by encircling areas in the foreland with small temporary embankments, refer figure 3A and 3B.

16. It will be very difficult to rehabilitate elsewhere the thousands of landless people who are settled on the slopes and near the embankments as are seen in Noakhali, Hatiya, Sandwip and Bhola. Different cooperative groups could be organized in each area who will be responsible for plantation, maintenance and production for a certain distance by their own group. The forest department will provide them seedlings and necessary technical assistance. Three different categories of plantation would be set up as i) short maturing tree species like Ipil-Ipil, Babla, Arhar, Eucalyptus, Acacia etc. for fuel, fodder etc ii) Fruit bearing trees like coconut, date palm, Tal trees Mango, Jack fruit Kulboroi etc and iii) Long maturing tree species for timber production like Mahogony, shil Koroi, Rain Tree, etc.

17. Local NGO's should be involved to organize different types of agro forestry projects for these peoples who are settled on the slopes and near the embankments in coordination with Water Development Board (BWDB) and the Forest Department.

18. In the foreland with existing mangrove afforestations it was found that the branches of the trees in the lower parts are pruned and cut by the local people for fuel wood. New seedlings should be planted in these plantations as gap fillings.

19. In most of the areas where babla (Acacia arabica) trees were planted during 1965-1970, these trees have now become over matured. They are very susceptible to

insect and pest attack as well as breaking by the strong winds. They should be felled and replaced by new seedlings.

20. In the berm and foreland of the sea shore where coarse and moving sand have been accumulated, only species of casuarina equisetifolia and Tamarix gallycha can be successfully established as was seen earlier in the cox's Bazar Beach and a small plantation at Kutubdia sea front. Both the species can resist more or less salinity and flood water for a short time during the high tides and monsoons.

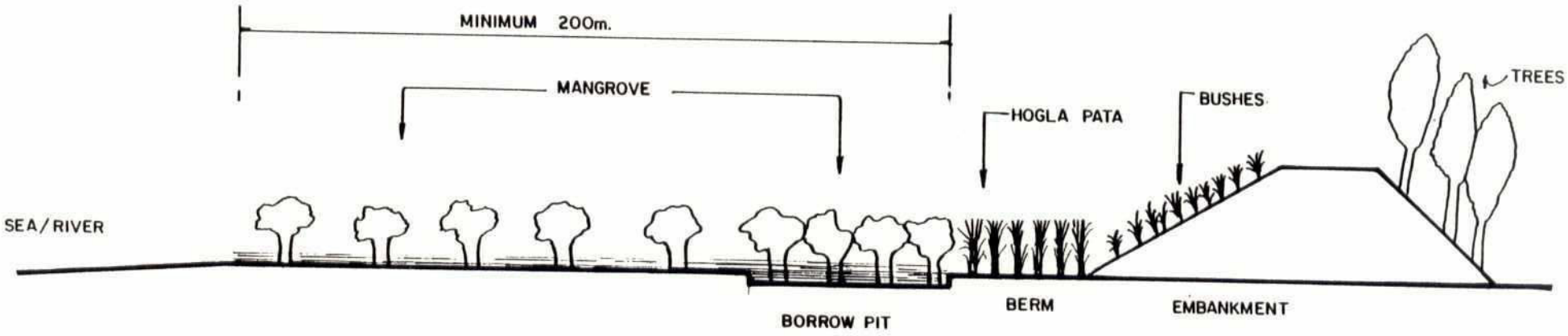
21. In the foreland where the sand is more or less stable and fine in texture, a longer seedlings of mangrove species can be planted by digging a deep hole where roots of the mangrove seedlings touches the clay beneath the snad.

22. Ideally afforestation should preceed construction of new embankment on newly accreted land. This way the embankment will be less affected by tidal waves due to the presence of established afforestation in the foreland.

23. Among all the trees and vegetations growing on the slopes of the embankments specially where peoples are settled, about 75-80% of vegetations are bannana (Musa Paradisiaca) plants. These bannana plants are detrimental for soil compaction due to the quick rottening of the roots which encourage the soil erosion and ultimately damage the embankment. So bannana plant should be discouraged for further plantation and must be replaced by suitable species.

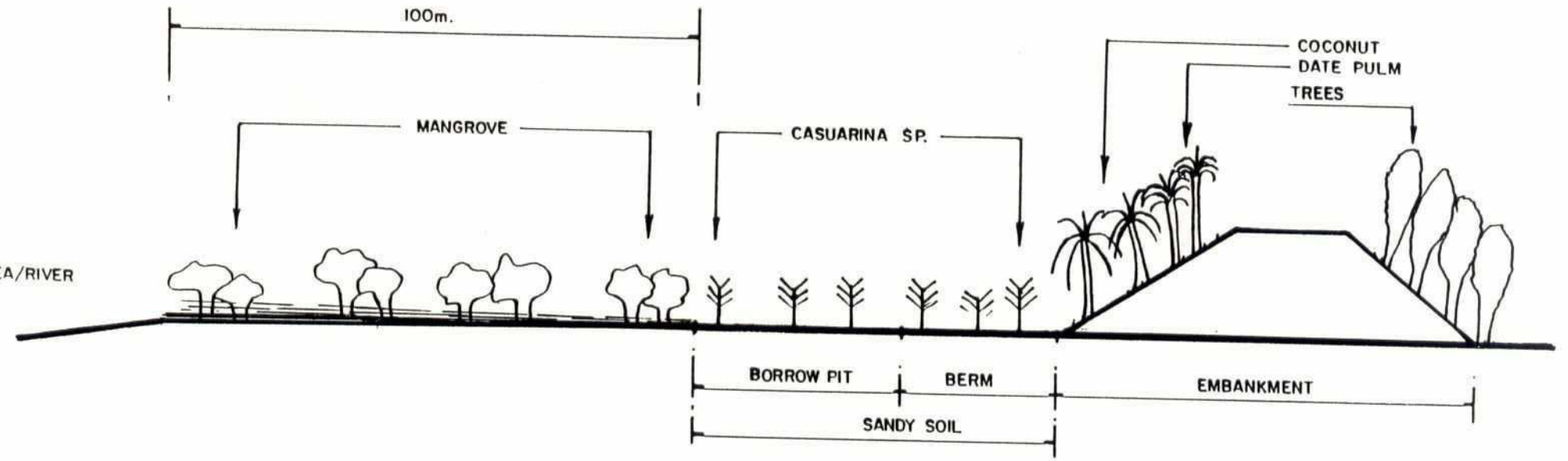
24. Afforestation in the coastal area specially in the newly accreted land, the foreland of the embankment as well as on the slopes of the embankment will not only provide protection of the coastal area and improve the environment, it will also provide large amount of timber, fuel wood, oil, fruits, fodden etc by making maximum use of the land. This will increase the forest area of the country which to day is only 15 per cent of the total area of Bangladesh.

25. Afforestation in the coastal area specially along the embankments will create job opportunities for the rural communities and also create on environment for wild life, fishs and other marine fauna.



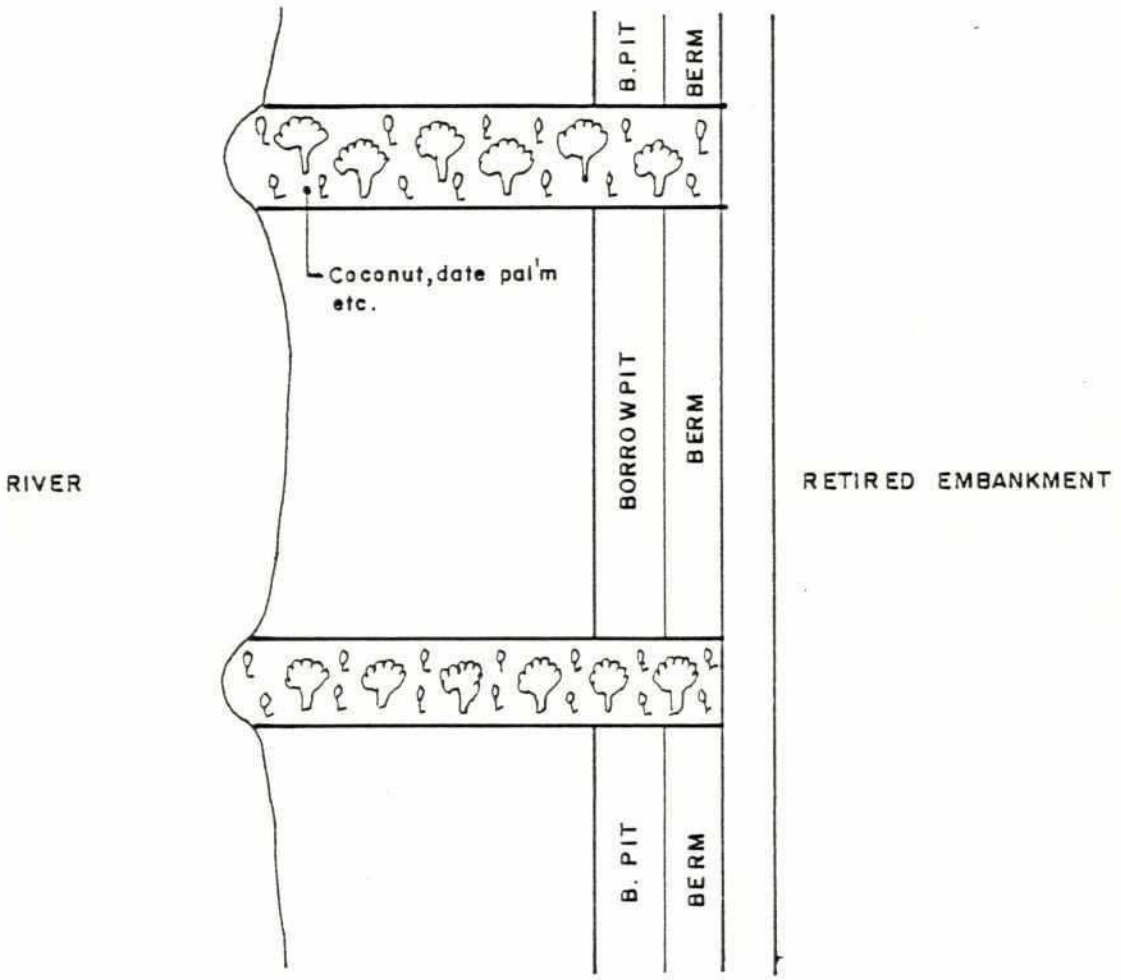
TYPICAL DESIGN OF AFFORESTATION (NORMAL CONDITION)

FIG - IA



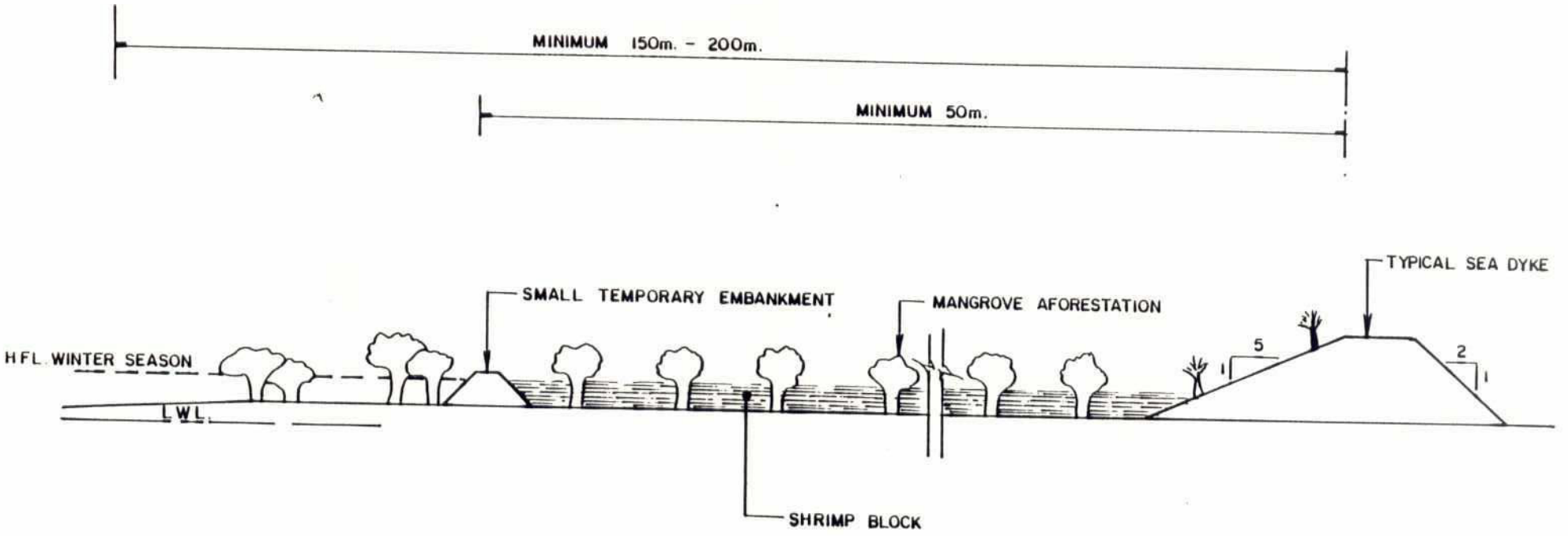
TYPICAL DESIGN OF AFFORESTATION (SANDY SOIL IN THE BERM AND FORELAND)

FIG. – 1B



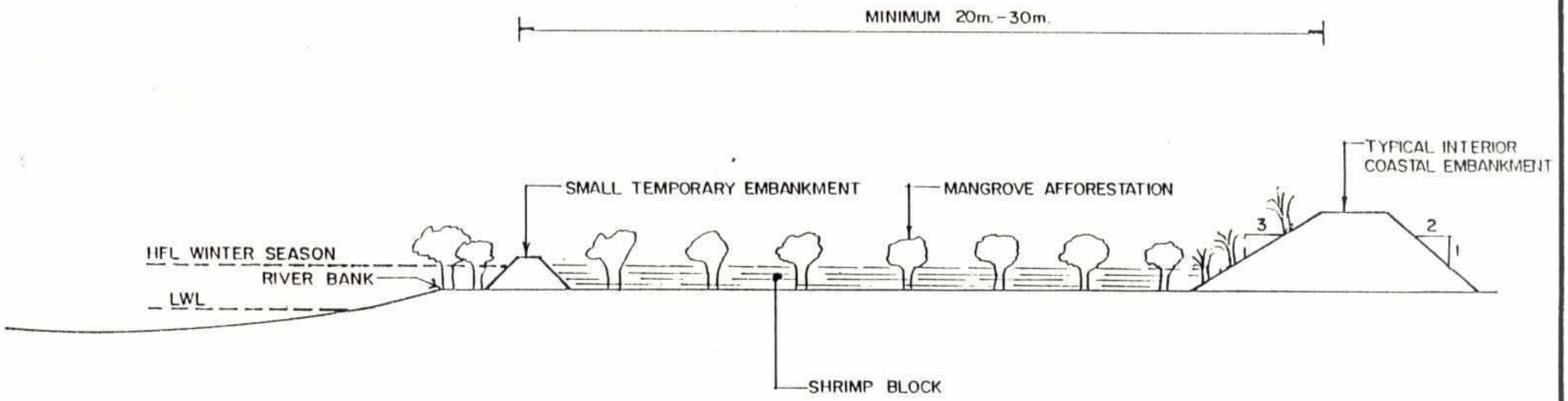
TYPICAL PLANTATIONS ON FORELAND AT ERRODED AREAS AFTER RETIREMENT OF EMBANKMENTS

FIG. 2



TYPICAL SHRIMP BLOCK IN THE FORELAND OF SEAFACING COASTAL EMBANKMENT, COX'S BAZAR AREA

FIG. 3A



TYPICAL SHRIMP BLOCK IN THE FORELAND OF
INTERIOR COASTAL EMBANKMENT, KHULNA AREA.

FIG. 3B

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