United Nations Development Programme
World Bank
Bangladesh Water Development Board
Ministry of Irrigation, Water Development and Flood Control
Government of the People's Republic of Bangladesh

South East Region
Water Resources Development Programme
BGD/86/037

(FAP 5)

Regional Plan Report
Volume 1
Part 1 - Existing Situation

August, 1993

Sir M MacDonald and Partners Limited, UK
in association with
Nippon Koei Company Limited
Resources Development Consultants Limited
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South East Region Water Resources Development Program

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August 30, 1993 Our ref: 5109/1/R5/1062

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SWANTEX Court
9/I, Motijheel Commercial Area
Dhaka

Subject: South East Region Water Resources Development Programme (BGD/86/037) - Regional Plan Report

Dear Mr. Azhar Ali,

We now have pleasure in enclosing thirty copies of the above final report in five volumes as described below:

Volume 1	Regional Water Resources Plan Part 1 - Existing Situation
Volume 2	Regional Water Resources Plan Part 2 - The Regional Water Plan
Volume 3	Annexes I to IV
Volume 4	Annexes V and VI
Volume 5	Annexes VII to XIII

This report has been revised to include the results of the Noakhali North and Gumti Phase II feasibility studies which were recently completed in accordance with the comments and replies arising from the review of the draft report in July, 1992.

Please note that in addition to the thirty copies sent to you herewith we have also sent, by copy of this letter, additional copies to the World Bank, UNDP and to FPCO as described below.

We are most grateful to the Bangladesh Water Development Board for their support and cooperation during the study and we look forward to being of service to you again in the future.

Yours sincerely,

M J Politzer
Team Leader

cc:
1) Mr. Saeed A. Rana, Head of Agriculture, World Bank, Dhaka - 3 copies
2) Mr. Khondker A. Hafiz, Asstt. Resident Representative, UNDP, Dhaka - 3 copies
3) Mr. M. Nurul Huda, Chairman, Local Panel of Expert, FPCO, Dhaka - 2 copies.

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THIS REPORT CONSISTS OF THE FOLLOWING SEPARATE VOLUMES

Volume 1	Regional Water Resources Plan Part 1 - Existing Situation		
Volume 2	Regional Water Resources Plan Part 2 - The Regional Water Plan		
Volume 3	Annex I	-	Soils
	Annex II	-	Agriculture
	Annex III	-	Sociology
	Annex IV	-	Environment
Volume 4	Annex V	-	Hydrogeology
	Annex VI	-	Hydrology and Water Modelling
Volume 5	Annex VII	-	Fisheries
	Annex VIII	-	Financial and Economic Analyses
	Annex IX	-	Estimate of Costs of Minor Irrigation
	Annex X	-	Engineering Costs
	Annex XI	-	Comments, Replies and Actions on Draft Regional Plan Report
	Annex XII	-	Terms of Reference and Amendments
	Annex XIII	-	Dakatia/Little Feni Transfer Draft TOR

PART 1 - EXISTING SITUATION

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GLOSSARY OF TERMS AND ABBREVIATIONS

REFERENCES

CHAPTER 1

INTRODUCTION

1.1 General

The South East Region Water Resources Development Programme is a study financed by UNDP and executed by the World Bank as a component of the Flood Action Plan. The study is described in Project Document Number BGD/86/037/A/01/42 which was signed by UNDP and the Government of Bangladesh (GOB) on 17th October 1990. The Consultants' Contract was finalised on 22nd October 1990. The Consultants consist of a joint venture of the following firms:

Sir M MacDonald & Partners Ltd.	U.K. (lead)
Nippon Koei Co. Ltd.	Japan
Resources Development Consultants Ltd.	Sri Lanka
House of Consultants Ltd.	Bangladesh
Desh Upodesh Ltd.	Bangladesh

The total budget for the study is US$ 2.2m, of which $2 001 254 is for consultancy services and the balance for purchase of vehicles, computers, photocopiers, etc. by UNDP. The whole of the funding is supplied by UNDP but the GOB is to supply staff to the project at an estimated cost of Taka 46.3 lakh (Taka 4.63 million). The project commenced on 29 October 1990.

In August 1992 a proposal for revision of the project budget was prepared to allow for additional scope of studies at the feasibility level. The budget for consultancy services was increased to US$ 2,245,184 and a contract addendum was signed in May 1993.

1.2 Objectives

The objectives of the study as described in the Project Document are given below :

"The study will produce a regional development plan, and will identify specific investment programmes for addressing constraints to agricultural production in the region, particularly related to water resources. One or more of those investment programmes and the Muhuri Trans-basin augmentation programme will be studied to the feasibility level. This will lead to a series of investment activities in the region which will:

(a) significantly reduce flood damage to agricultural production, including crops, livestock and fisheries as well as damage to human life and settlement and other physical infrastructure such as roads,

(b) alleviate drainage congestion, thereby providing conditions for a major shift from presently cropped areas under local varieties to improved varieties and the early planting of rabi crops, and

(c) increase boro cultivation as primary irrigation supplies will be ensured.

In addition the proposed study will:

(a) assist in updating the data base, (topographical, hydrological, and socio-economic),

(b) provide a medium for recalibration of the surface water simulation model of the South East region, if proven necessary and useful, and improving the analytical techniques available at the Master Plan Organisation (MPO),

(c) develop a methodology for involving beneficiaries during the planning and implementation phases of the project,

(d) identify opportunities for landless persons and particularly women to participate in construction and maintenance activities,

(e) improve the capability of Bangladesh Water Development Board, (BWDB), and local consultant staff attached to the project team in water resources planning, utilization of models and analytical techniques, project management, coordination between public and private sector organizations, and

(f) develop a model integrating environmental concerns in the design of development programmes.

The overall objective of the project is to increase food production. This, presumably, will benefit all the inhabitants of the Project area. However, because of the diversity of the socio-economic status of the people in the region, it is assumed that project implementation will affect different segments of the population in different ways. Recognizing this reality the study includes a detailed description and analysis of the different socio-economic strata in the project area. This will provide the necessary information to:

(i) identify the target population most affected in each area of project implementation; and

(ii) involve the participants in the process of modifying objectives and implementation strategies so as to maximize the positive and minimize the negative.

The following benefits are expected from the project :

(a) improved opportunities for intensified agricultural, fish and livestock production for rural households;

(b) increased employment opportunities for the landless in the construction and maintenance of the new or rehabilitated infrastructures, and in the spin-off to agriculture related activities such as rice mills, trade, pump mechanics, and so forth;

(c) improved production environment and a safer environment for the whole population in the area".

During the negotiations with the Consultants' prior to signature of the contract for consultancy services, the requirement to study one feasibility study area plus the Meghna-Muhuri transfer was modified, so that only one feasibility study is now included in the study.

After preparation of the draft regional plan and its review it was agreed that the Noakhali North Drainage and Irrigation Project should be studied at Feasibility level and that this should be done in parallel with a feasibility study of the Gumti Phase II area. Since these two areas comprise over 31% of the whole region it was agreed that the final regional plan report should be delayed and should be prepared at the end of the project so as to incorporate the results of these studies. This final Regional Plan Report includes the feasibility study summaries.

1.3 Flood Action Plan

In the post liberation period until the floods of 1987 and 1988, the government has depended on donor agencies for aid for water resources development. While achieving some agricultural benefits, the selected projects had some serious adverse effects e.g.

- BWDB planning became primarily project oriented,
- Projects were developed individually, and no plan was developed to ensure co-ordination and to guide priorities,
- Other agencies such as the Roads and Highways Department developed infrastructure without considering effects on flood control and drainage,
- Implementation periods have been very long,
- Benefits have not reached their full potential,

Following the disastrous floods of 1987, the government undertook a comprehensive review of flood policy. A number of studies were carried out and, in June 1989, the government requested the World Bank to develop and co-ordinate a five year Flood Action Plan (1990-1995) based on eleven guiding principles (Table 1.1). This was endorsed at the G7 Summit held in Paris in July 1989.

The Flood Action Plan was prepared by the World Bank in close co-operation with the Government of Bangladesh and donor representatives in London, in December 1989.

The Action Plan aims at the identification, planning, design and construction of projects within the framework of the overall strategy which are technically, economically, environmentally and socially feasible. Such projects are proposed in Part II of this report, for the South-East Region of Bangladesh.

1.4 The Study Area

The study area covers approximately 9 000 sq km and is shown in Figure 1.1. It comprises the whole of the administrative districts of Brahmanbaria, Comilla, Chandpur, Lakshmipur and Noakhali (apart from Hatiya island) plus parts of Feni District and part of Madhabpur thana in Habiganj District. Apart from Habiganj District the area is within the BWDB South-eastern Zone. It should be noted that Ashuganj is part of the Brahmanbaria Sadar thana, but for many purposes separate data have been prepared for Ashuganj for the purposes of this study, and therefore it is regarded as a separate entity.

For the Regional Plan the study area has been divided into 13 Planning Units as shown in Figure 1.2. The study has used data from a variety of sources and the boundaries used for data collection have not been consistent; e.g. the Water Resources Planning Organisation (WRPO) data is based upon thana, Planning Area or Catchment whilst population statistics are based upon the old district boundaries. Therefore in some parts of this report data has more conveniently been summarised by Planning Unit.

1.5 Structure of the Report

The main report is split into two parts, Part I and Part II. Part I deals with the existing situation in the region and Part II is concerned with future development potential comprising the Regional Plan itself. There are various annexes as shown in the Contents List. These are bound separately and relate to both the existing situation and the Regional Plan.

Figure 1.1
South-East Region, Bangladesh

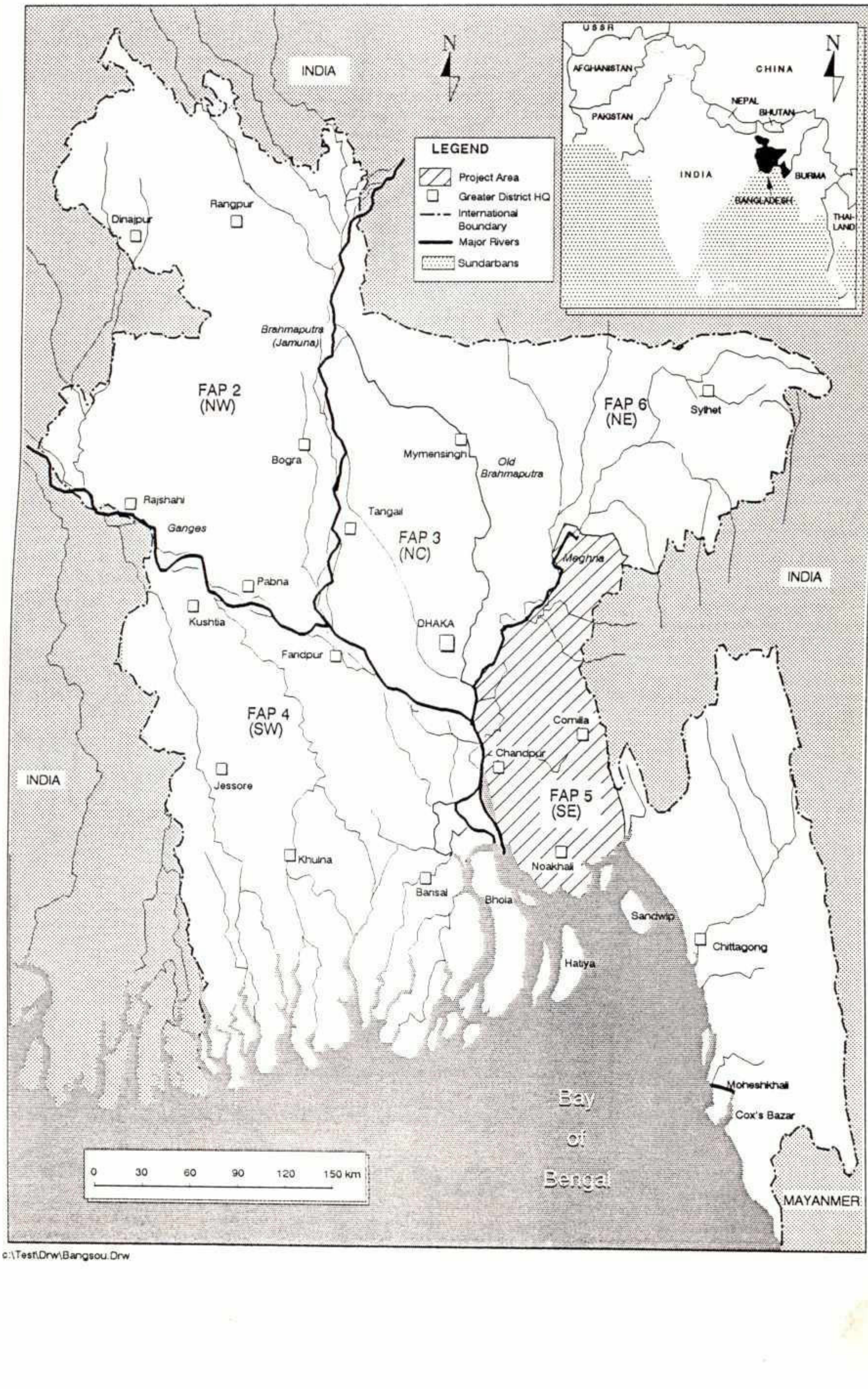

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Figure 1.2
Planning Units

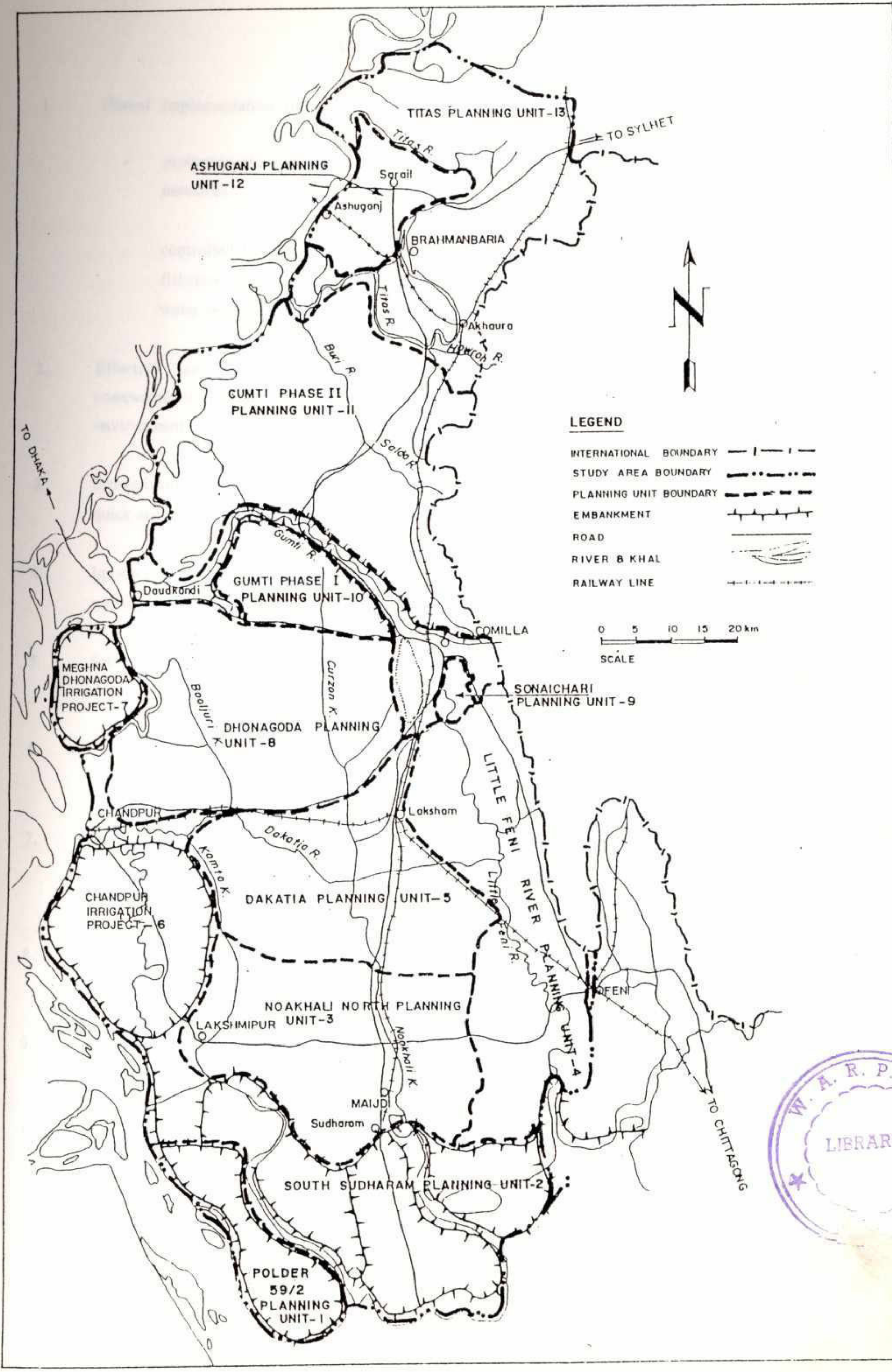

TABLE 1.1

Eleven Guiding Principles

1. Phased implementation of a comprehensive flood plan aimed at:

   - protection of urban, rural, commercial, industrial and public utility centres and communication networks,

   - controlled flooding, wherever possible and appropriate, to meet the needs of agriculture, fisheries, navigation, urban flushing, soil productivity and recharging the surface water/ground water resource with minimum dislocation of the environment.

2. Effective land and water management of protected and unprotected areas, involving compartmentalisation, drainage, irrigation, drainage decongestion, land use, cropping patterns, environment, ecology, erosion/sedimentation control, etc.

3. Strengthening and equipping the disaster management machinery including building infrastructure for quick and effective communication and transmission during disasters.

4. Improvement of the flood forecasting system and establishment of a reliable and comprehensive flood warning system with adequate lead times and at the same time evolving techniques for dissemination.

5. Safe conveyance of the large cross-boundary flow to the Bay of Bengal by channelling it through the major rivers with the help of embankments on both sides.

6. Effective river training works for the protection of embankments, infrastructure and population centres, linked wherever possible with the reclamation of land in the active river flood plain.

7. Reduction or distribution of load on the main rivers through diversion of flows into major distributaries or interception of local runoff/local rivers by channelling through major tributaries or special diversions.

8. Improvement of the conveyance capacity of the river networks to ensure efficient drainage through appropriate channel improvements and ancillary structures to provide regulation and conservation.

9. Development of flood plain zoning as a flexible instrument to accommodate necessary engineering measures and allocate space for habitation patterns, economic activities and environmental assets.

10. Co-ordinated planning and construction of all rural roads, highways and railway embankments with provision for unimpeded drainage.

11. Encouraging maximum possible popular participation by beneficiaries in the planning, implementation, operation and maintenance of flood protection infrastructure and facilities.

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CHAPTER 2

THE PHYSICAL SETTING

2.1 Climate and Hydrometeorology

2.1.1 General

The hydrometeorology of the study area has been described to some degree in several publications, the most note worthy of which are "The Agro-Climatic Survey of Bangladesh" (Manalo, Ref. 1), and "Net irrigation Requirement of Rice and Evapotranspiration of Wheat and Potato for Different Locations in Bangladesh" (Karim and Akland, Ref. 2). For completeness of the present study, some further analysis of climatic conditions of particular relevance to the project area has been carried out. In the case of rainfall, more extensive analysis has been carried out than in previous studies, utilising records up to the 1989-90 water year. The analysis of basic climatic data has been based on the readily available published data for stations in the project area, generally covering the period 1965-80.

The monsoonal climate which affects the South East Region, and indeed the whole of Bangladesh, is part of a system which affects the whole of Indian Sub-continent. There are three main seasons:

i) the south-west monsoon: lasting approximately from May to October, and producing the main rainy season; almost 90% of the annual rainfall total in the study area occurs during this period, when both temperatures and relative humidity are high;

ii) the north-east monsoon: extending from November through to March, establishes the cool dry season of winter; only occasional rainfall occurs, associated with weak cyclonic disturbances;

iii) a short hot season: this preceded the south-west monsoon and can extend from late March through till May; the highest maximum daily temperatures can occur at this time, and the season is associated with variable convective storm activity which can occasionally develop into severe cyclonic storms; during this season, flash flooding from the rivers draining the Tripura hills to the east of the region can be a problem.

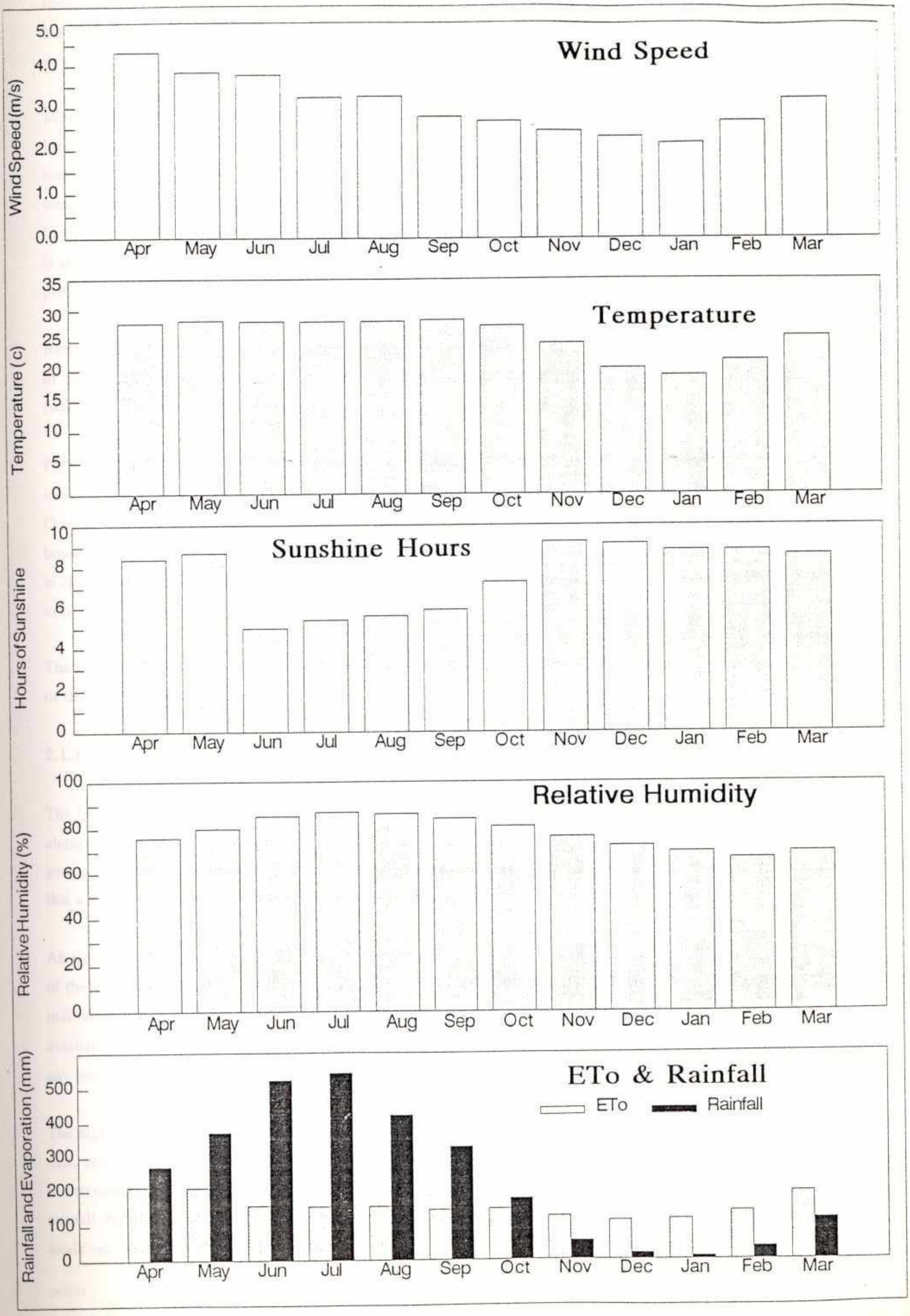
The region is affected by severe tropical cyclones which develop in the Bay of Bengal. Cyclones most commonly occur in the periods before and after the main monsoon season in the months of May and October. In recent times, severe cyclones have affected the region in 1970, 1985 and 1991. Tropical cyclones are generally accompanied by very strong winds, high rainfall, and storm surge, which in coincidence with high tides can have disastrous consequences in coastal regions.

2.1.2 Climatic Norms

The climate stations of relevance to the study are at Comilla, Chandpur, and Noakhali. Data at each station date from 1965, although there is some variability in the parameters recorded, and the completeness of record. The key parameters of temperature, relative humidity and wind speed are recorded at each of the climate stations. Climatic norms for Chandpur are summarised in Figure 2.1 and for all 3 stations in Table 2.1. From

Figure 2.1

Climatic Norms at Comilla



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these, the general characteristics in climate described in the introduction above are obvious. Wind speeds are lowest in the north-east monsoon period, but then pick up during the pre-monsoon hot season when Nor' westers and localised storm activity can occur. Wind speeds tend to level off during the south-west monsoon.

Mean daily temperatures in the region are fairly constant between the months of April and September, and show little variation across the region, being of the order of 28°C. From October, temperatures begin to decline, and mean daily temperatures reach a minimum of about 19-19.5°C in January. In April, maximum daily temperatures in the region can often exceed 35°C, while in January, minimum daily values can be below 10°C. Increased cloud cover during the south-west monsoon period prevents extremes of temperature when the sun is at its maximum declination. There is a dramatic fall in the hours of bright sunshine during the main monsoon period.

Relative humidity is high throughout the year. Maximum values occur in July, when the mean is of the order of 87.5% throughout the region. February generally produces the lowest values of 71% at Chandpur and Noakhali, and about 67% at Comilla.

Potential evapotranspiration has been calculated using the modified Penman Method, and these estimates are included in Table 2.1. In an average year, potential evapotranspiration exceeds rainfall between the months of October and March throughout the region. Rainfall in the early and late monsoon periods is highly variable however, and the average conditions do not give a representative indication of requirements for irrigation. It is clear from Figure 2.1 that there is a requirement for irrigation between the months of November and April, even under average rainfall conditions.

The peak rainfall months in the region are June, July and August. During these three months, about 55-60% of the annual rainfall total can be expected.

2.1.3 Regional Rainfall

The locations of raingauges of relevance to the study, and the availability of data are discussed in Annex VI, along with overall data reliability. There are some 40 stations of relevance to the study area, with records generally dating from 1964/65. Data quality is on the whole good, although recommendations have been made that a number of specific stations be excluded from analysis.

An isohyetal map of mean annual rainfall is presented in Figure 2.2. The map has been prepared on the basis of the available data at 40 stations in the region for the 1962-89 period. Infilling of missing years of data at individual stations has not been carried out, but this does not limit the usefulness of the map as the general data availability is good. It should be noted that the isohyets do not represent a homogeneous pattern, and that in any particular year, the regional distribution of rainfall may be quite different to that shown.

The highest rainfalls occur in the south of the region. Mean annual rainfall at Noakhali is of the order of 3200 mm, and decreases northwards to about 200 mm at Comilla. Moving north from Comilla, annual totals start to increase again towards the Sylhet depression, reaching about 2500 mm by Nasirpur. The pattern of annual rainfall distribution at 80 per cent exceedence probability is similar to that for the mean condition, and annual totals are generally about 500 mm lower.

Figure 2.2

Isohyets of Mean Annual Rainfall

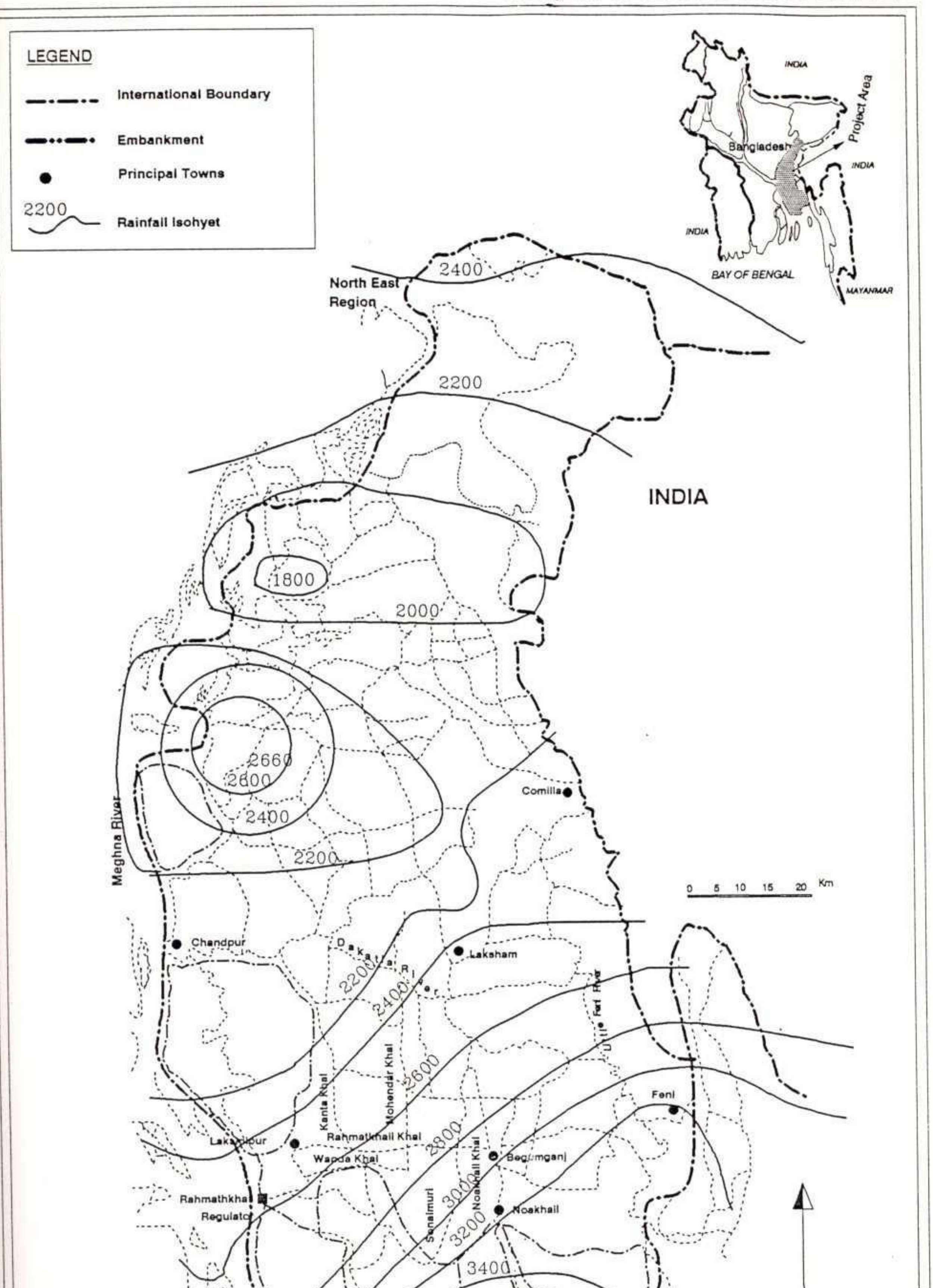


TABLE 2.1

CLIMATIC NORMS

Climatic Norms at Comilla

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Parameter												
Mean Temperature (C)	27.9	28.3	28.2	28.1	28.1	28.3	27.3	24.4	20.2	19.0	21.6	25.6
Relative Humidity %	76.1	80.1	85.3	87.1	86.4	84.3	80.9	76.4	72.4	69.6	66.8	69.7
Windspeed (m/s)	4.3	3.8	3.8	3.2	3.3	2.8	2.7	2.4	2.3	2.2	2.7	2.2
Sunshine (hrs/d)	8.4	8.7	5.0	5.4	5.6	5.9	7.3	9.2	9.1	8.8	8.8	8.6
Penman Eto (mm/d)	7.05	6.76	5.22	5.02	4.99	4.82	4.74	4.20	3.66	3.77	4.98	6.30
Rainfall (mm)	272.0	372.0	524.0	543.0	422.0	327.0	177.0	53.0	18.0	9.0	35.0	118.0

Climatic Norms at Chandpur

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Parameter												
Mean Temperature (C)	28.5	28.8	28.5	28.4	28.6	28.7	27.7	24.5	20.4	19.3	21.9	25.7
Relative Humidity %	74.1	78.3	86.2	87.4	86.7	86.5	82.9	79.2	77.6	73.8	71.0	70.7
Windspeed (m/s)	3.0	2.5	2.1	2.1	1.9	2.1	1.8	1.3	1.2	1.3	1.4	3.0
Sunshine (hrs/d)	8.4	8.7	5.0	5.4	5.6	5.9	7.3	8.8	9.1	8.8	8.8	8.6
Penman Eto (mm/d)	6.61	6.32	4.65	4.68	4.61	4.47	4.31	3.22	3.02	3.22	4.10	5.62
Rainfall (mm)	152.0	257.0	387.0	358.0	343.0	237.0	126.0	7.0	12.0	7.0	18.0	66.0

Climatic Norms at Noakhali

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Parameter												
Mean Temperature (C)	27.9	28.5	27.8	27.6	27.4	28.1	27.4	24.1	20.4	19.5	21.6	25.5
Relative Humidity %	76.6	80.4	85.6	87.5	87.2	85.0	82.3	76.7	74.9	71.0	71.5	71.3
Windspeed (m/s)	2.5	2.0	2.0	2.2	1.8	1.9	1.4	0.9	1.2	1.3	1.9	2.0
Sunshine (hrs/d)	9.6	8.5	4.7	5.1	5.8	5.9	7.4	9.3	9.1	9.0	9.1	8.6
Penman Eto (mm/d)	6.10	5.91	4.49	4.52	4.51	4.46	4.24	3.61	3.10	3.31	4.39	5.45
Rainfall (mm)	161.0	306.0	614.0	700.0	648.0	439.0	186.0	49.0	13.0	6.0	19.0	53.0

2.1.4 Drainage Design Rainfalls

Frequency analyses have been carried out on all daily rainfall stations in the project area, with the exception of the four stations identified as being unreliable. The objective has been provided the basic data for drainage design purposes. EV1 (Gumbel) distributions have been fitted to the annual maximum series rainfalls of the following durations:

- 1 day;
- 2 day;
- 3 day;
- 4 day;
- 5 day;
- 7 day;
- 10 day.

The seasonality of rainfall extremes is also important and forms part of the drainage design process. In accordance with practice in Bangladesh, rainfall extremes have been evaluated at each of the above durations for the following periods:

- pre-monsoon (April to June inclusive);
- mid-monsoon (July and August);
- post-monsoon(September and October).

Summary results for a sample station (Sarail R-131) at return periods of 2, 10, 20 and 50 years are presented in Table 2.2, full results are presented in Annex VI. These gives a good indication of how conditions vary across the region. The rainfall extremes are high by world standards.

2.2 Flood and Drainage Problems

2.2.1 General

A general map of the drainage system on the project area is presented in Figure 2.3. The entire region is bounded to the west by the River Meghna, and it is this that dominates drainage of the greater part of the region. At Bhairab Bazar in the north west of the project area, the River Meghna has a catchment area of 64,500 km^2. The mean annual flow at Bhairab Bazar is of the order of 4600 m^3/s, but seasonally the discharge varies between a mean monthly minimum of 260 m^3/s in February and a mean monthly maximum of 12,400 m^3/s in August. The Meghna is joined by the Padma about 100 km downstream of Bhairab Bazar. The Padma carries the combined discharges of the Ganges and Jamuna (Brahmaputra) Rivers, and has a total catchment area of some 1,639,300 km^2 at its confluence with the Meghna. Mean annual runoff in the Padma is of the order of 30,000 m^3/s, and on average varies between 75,000 m^3/s in August and 6,000 m^3/s in February. The annual rainfall on the South East Region, in volume terms, is less than 2% of the annual runoff in the lower Meghna, and contributes little to the runoff in the latter. The coincidence of seasonal rainfall with peak flood discharges in the Meghna does, however, exacerbate internal drainage problems. The basic parameters of the internal drainage problem of the region, are the same as those for the country as a whole.

Figure 2.3

The Drainage System

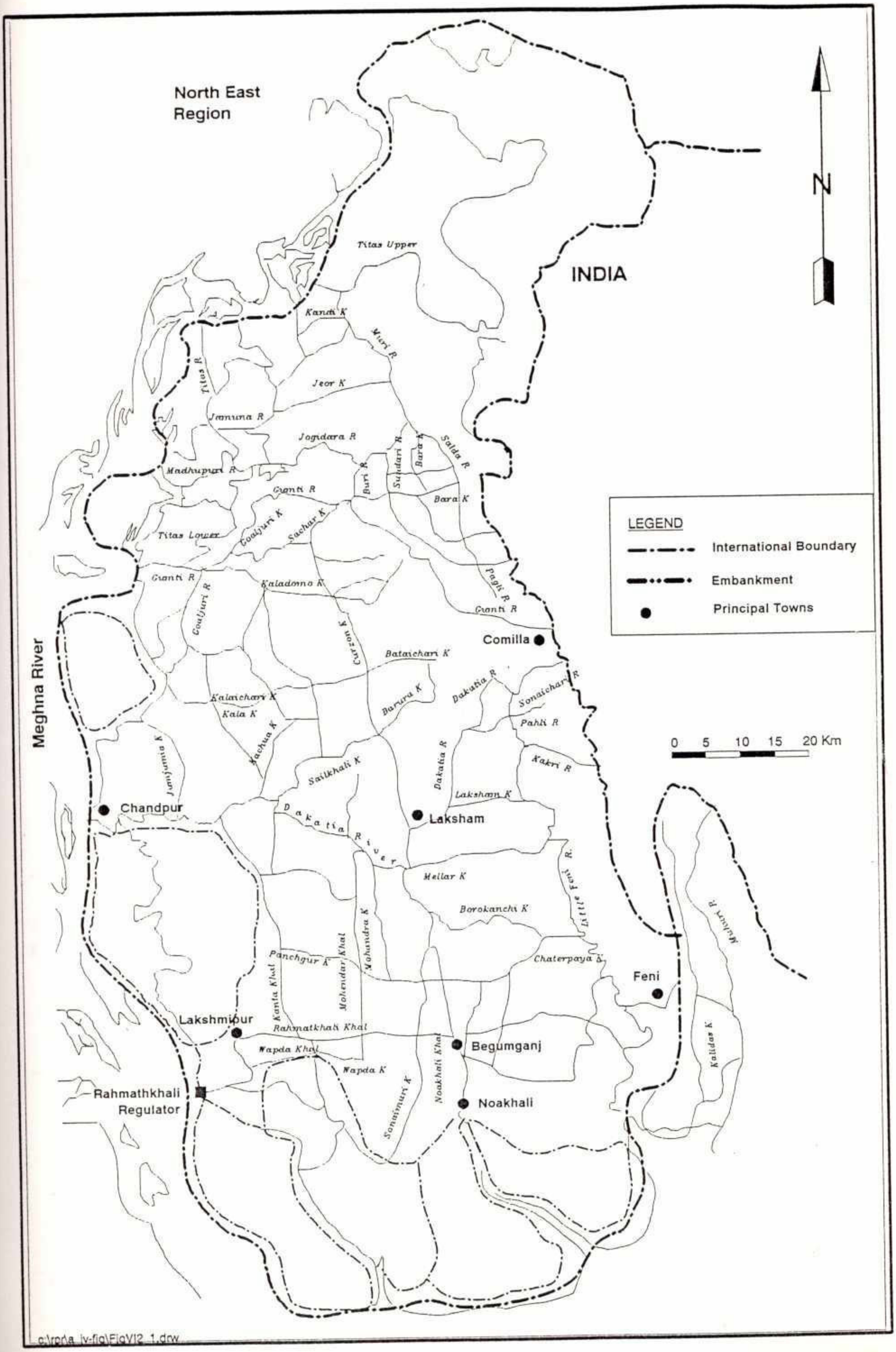


TABLE 2.2

Annual Maximum Rainfall Frequencies, Station R-321, Sarail

Annual Maximum Pre-Monsoon Rainfall
R-131, Sarail, Daily Rainfall (mm)

Duration Days	Return Period (years)				
	2	5	10	20	50
1	117	155	179	203	234
2	156	205	237	268	308
3	188	253	296	337	390
4	220	300	353	404	471
5	236	323	380	435	506
7	271	367	430	491	570
10	329	434	503	570	656

Annual Maximum Mid-Monsoon Rainfall
R-131, Sarail, Daily Rainfall (mm)

Duration Days	Return Period (years)				
	2	5	10	20	50
1	107	163	201	237	283
2	145	212	257	292	355
3	172	250	302	352	417
4	188	269	323	375	441
5	202	287	343	397	467
7	232	324	385	444	520
10	261	353	415	474	550

Annual Maximum Post-Monsoon Rainfall
R-131, Sarail, Daily Rainfall (mm)

Duration Days	Return Period (years)				
	2	5	10	20	50
1	77	102	119	136	157
2	100	137	161	185	215
3	113	152	177	201	233
4	123	168	198	226	263
5	134	179	209	237	274
7	146	192	223	252	289
10	172	227	263	297	342

The Meghna is the outfall water level control on drainage ,or almost the entire region. The seasonal range in Meghna water levels reduces in a southerly direction towards the Bay of Bengal. Seasonal water surface profiles between Bhairab Bazar and Daulat Khan are shown in Figure 2.4. The profiles shown are for 1981, but the chosen year is of no significance. At Bhairab Bazar, the seasonal range of water levels is of the order of three metres, and there is very little tidal influence in the dry season. At Chandpur the seasonal range in water levels is of the order of 1.5 - 2.0 m, with a tidal range in the monsoon season of the order of 0.6 m. At Daulat Khan towards the south of the region, and close to the outfall of Rahmatkhali Khal, the tidal range is much larger, of the order of two metres, and the difference is seasonal water levels much lower, being of the order of 0.5 metres. This variability in the range of Meghna water levels across the region does result in different drainage problems in different parts of the region. These are discussed further in section 2.2.2.

The internal drainage of the region may be considered under the general areas:

i) the area north of the railway line at Brahmanbaria

ii) the area between the Gumti River and the railway line at Brahmanbaria

iii) the area of the south of the Gumti River.

To the north of the railway at Brahmanbaria, there is an area of deep flooding, known as the Habiganj depression, lying in an old meander loop of the Meghna. Drainage through this area is by the Titas River.

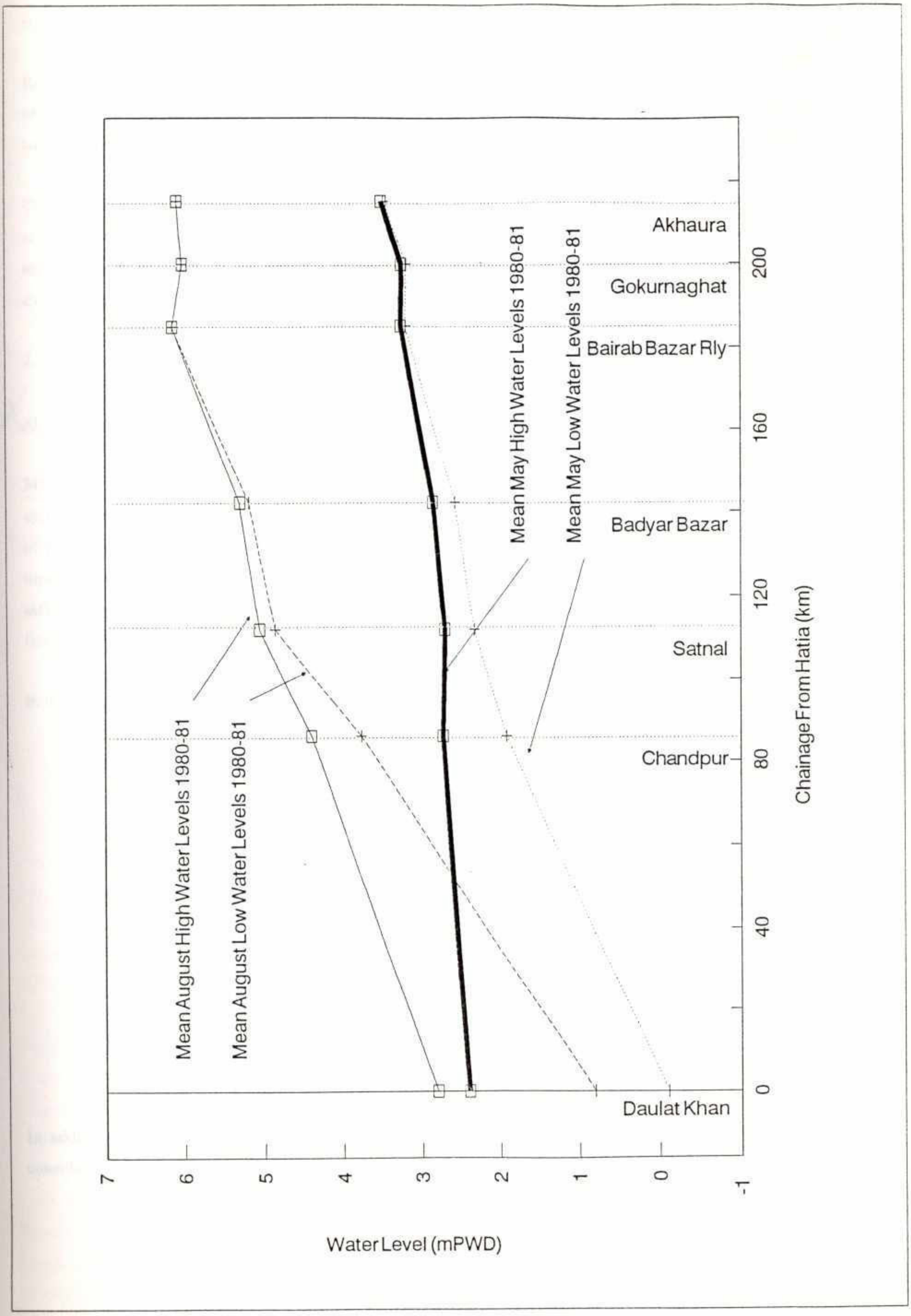
There are also areas of relatively deep flooding between the railway at Brahmanbaria and the Gumti River. The most deeply flooded areas are close to the Meghna. Drainage in this area is complex, with a series of interconnected channels and remnants of former main river courses. It is difficult to identify any singularly important main rivers, other than perhaps the Howra which flows into the Buri and Titas rivers, and the Salda River. Some of the channels in the area had formerly been fed by spills from the Gumti River, prior to completion of embankments and the construction of a regulator at the head of the Buri Nadi River. The area does receive inflows from a number of rivers draining the western slopes of the Tripura Hills. About 50% of the drainage through this area is generated in external catchments. During the pre-monsoon season, flash floods in these rivers can cause serious damage.

The Gumti River is the largest drainage feature in the South East Region. At Comilla it has a catchment area of 2173 km^2. The Gumti is embanked from upstream of Comilla, almost to its confluence with the Meghna. The annual maximum mean daily flood in the Meghna at Comilla is 500 m^3/s. During times of flood, water levels in the Gumti are significantly higher than the surrounding land.

Immediately south of the Gumti River, the Daudkandi to Comilla road and Gumti Phase I project embankments isolate a significant area, from which drainage in mainly west to the lower Gumti and Meghna. The area south of the Daudkandi to Comilla road has three principal drainage features. These are the Dakatia River, the Rahmatkhali Khal, and the Little Feni River. These rivers are in fact interconnected by a complex system of channels, but they do provide primary drainage routes. The Dakatia River has it source with the Sonaichari river which drains a small catchment in the Tripura Hills, but mainly drains areas in Bangladesh. The Little Feni collects drainage from a number of catchments in the Tripura Hills, but these are all significantly smaller

Figure 2.4

Meghna Water Surface Profiles



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than those north of the Gutmi. These catchments, although small, do bring in significant sediment loads to the river system, and also cause flash floods. Unfortunately none are gauged.

Rahmatkhali Khal forms the principal drainage route in the south of the region. Formerly, before completion of the coastal embankments and polders, it is believed that Noakhali Khal was more important. However, with land accretion in the south, the primary drainage route from the Noakhali area is now to the west.

The general drainage system is a complex network of interconnected channels, in which flow directions often reverse. Almost the entire system is inter-linked, and changes to one part of the system have an impact elsewhere. The evaluation of project impacts on flood levels thus requires the use of sophisticated hydrodynamic modelling techniques.

2.2.2 The Present Flood Problems

a) Seasonal Flood Characteristics

Much of the land in the project area is regularly flooded. On the basis of the MPO flood phase classification system, only 8.5% of the net cultivable area north of the Gumti is flood free and 5.9% of the area to the south of the Gumti. The flood problem cannot be considered in terms of depth of flooding alone, however. The timing, rate of rise, and duration of flooding are, in addition to the flood peak attained, very important factors influencing agricultural damage and cropping patterns and indeed general disruption caused. Seasonality of flooding is therefore a key variable.

In terms of seasonality, the flood problems are:

pre-monsoon	April-June	rapid rise in water level before boro crops are harvested, and kharif I crops planted; loss of young crops and seedlings;
monsoon	July-August	the rate of rise of flood levels exceeding the rate of growth of rice; peak main river levels and prolonged flooding partly through backing up from the main rivers and reduced gradients for local rainfall; duration of flood inundation is important, and whether flood water is clear or sediment laden;
post-monsoon	Sept.-Oct.	drainage at too slow a rate to permit timely planting of certain crops;

In addition to the above flood periods, the general categories under which flooding in the region can be considered are:

- monsoon floods from the River Meghna and Lower Meghna;
- flash floods from those rivers rising in the Tripura Hills to the east of the region;
- localised flooding as a result of heavy and intense rainfall;
- floods resulting from storm surges in the Bay of Bengal.

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b) **Sub-Regional Flood Characteristics**

The above categories of flooding affect different parts of the region to different degrees, as has been introduced in section 2.2.1. Following from the introduction, it is apparent that for the purposes of flood assessment, and for the definition of design approaches, the study area might best be considered under five zones:

i) north of the railway at Brahmanbaria;

ii) between the railway and the Gumti River;

iii) the area between the Gumti and the Dakatia rivers;

iv) the Little Feni catchment;

v) the area south of the Dakatia river.

The area to the north of the railway is very deeply flooded, and the primary control is in fact the Meghna River. Closer to the Tripura Hills, flash flooding can be a problem in the pre-monsoon season, and of course throughout the area the rate of rise of Meghna water levels is of importance in determining potential damage to crops on low lying land. This area requires consideration with the North East Region, as it has no natural northern boundary, and any works that might be undertaken would influence, and be influenced by, other works outside the project area.

The area between the railway and the Gumti River is well defined, and although linked to the north by cross drainage beneath the railway, and also linked to the Gumti River with a regulator near Companiganj on the Buri Nadi, the area has fixed physical boundaries. Problems of drainage within the area are very similar to those experienced to the north of Brahmanbaria, and the areas close to the Meghna are particularly susceptible to deep flooding. The flood problems of this area have been considered is some detail at feasibility level as part of the Gumti Phase II feasibility studies. During the main monsoon season, the Meghna dominates flood extent in the area, and in the norther part of the area, there is very little east to west gradient. From the elevation area characteristics published for MPO planning area 29 and 31, and water level records, it is apparent that the Meghna is the primary source of prolonged monsoon flooding.

South of the Gumti to the Dakatia river, the flood problems are less directly associated with inundation from the Meghna, than with impediment to the drainage of local rainfall caused by high outfall water levels in the Meghna. It has been noted by some observers that flood waters are relatively clear in this area, indicating their main origin to be local rainfall rather than the Meghna. It is, however, the Meghna which ultimately does form the control on the potential drainage of the area. There are areas of deep flooding to the east of the Meghna Dhonagoda project area, but there is less susceptibility to flash flooding than in the areas to the north of the Gumti, or in the Little Feni catchment. A number of roads also form natural drainage barriers in the region. These include the road from Matlab Bazar to Chandpur and Eliotganj, and the Chandpur to Comilla road. These roads apparently have adequate cross drainage provision, but they do impede floodplain flow. The Dakatia River forms the main arterial drainage for the area, discharging westwards to the Meghna at Chandpur. There is, however, a very complex interconnected network of channels.

The Little Feni River drains to the south from Comilla, collecting drainage laterally from the Tripura Hills, and from its own catchment area in Bangladesh. The hill catchments draining in to the Little Feni have a total area of 309 km^2. The catchment area of the Little Feni in Bangladesh is some 570 km^2. There are flash flooding problems from the Tripura Hill catchments, some of which (notably the Kakri) carry substantial sediment loads. Sediment deposition can result in further drainage problems. The Little Feni is regulated at its lower end by Kazirhat regulator. This problems the ingress of saline tidal water during the dry season, and provides a reservoir for irrigation. During the monsoon the regulator is kept open, but problems can occur in the pre-monsoon season as estuarine silts deposited downstream of the regulator during the dry season require excavation before the tidal flaps can be operated. There are numerous drainage connections from the Little Feni system to the Dakatia system, and to the Noakhali area, although the primary drainage is southwards through the main channel.

In the area to the south of the Dakatia River, the drainage is provided primarily by the WAPDA Khal and the Rahmatkhali Khal. This area is generally considered to suffer from congested drainage, and one of the most notable features is the Begumganj depression which is seasonally flooded. It is though that there may have been some deterioration in drainage of the area following the completion of the coastal embankment and polder projects.

The nature of the drainage system throughout the region is such that specific areas cannot be considered in isolation. Although division into zones is useful in the definition of primary flood mechanisms and design requirements, the holistic view of the system and its seasonal flood response is essential.

2.2.3 Data Availability

Water level and discharge measurement stations in the region are shown in Table 2.3. Data availability for these, and for the main river stations is discussed in Annex VI. No additional field data were collected as part of the regional study.

There are very few relevant discharge measurement stations in the region. Although up to 10 stations have existed they are in fact of limited value to the regional study, suffering from backwater influences from the Meghna. The flow record at Comilla (110) is almost complete from 1965, and is free from any backwater influences from the main rivers. This is an important station, being representative of Tripura Hill catchments. The Gumti is also gauged at Jibanpur, as is the Buri Nadi River (114). Flows to the Buri Nadi River are controlled, however, and the record is thus of limited value. The Little Feni River is gauged at Gunabati Railway Bridge, but in effect there is only one year of monsoon discharge data at this station. The stations at Kaliachari (84.1) and Parshuram (212) are in the Muhuri catchment. They are indicative of runoff conditions from Tripura Hill catchments, and are also of direct relevance to investigations of Muhuri Reservoir. The majority of inflows from the Tripura Hills are ungauged.

Water level data in the study area is generally more widely available than streamflow as indicated in Table 2.3. For the South East Region, many of the data are tidal, however, and usual practice is to record daily maximum and minimum levels.

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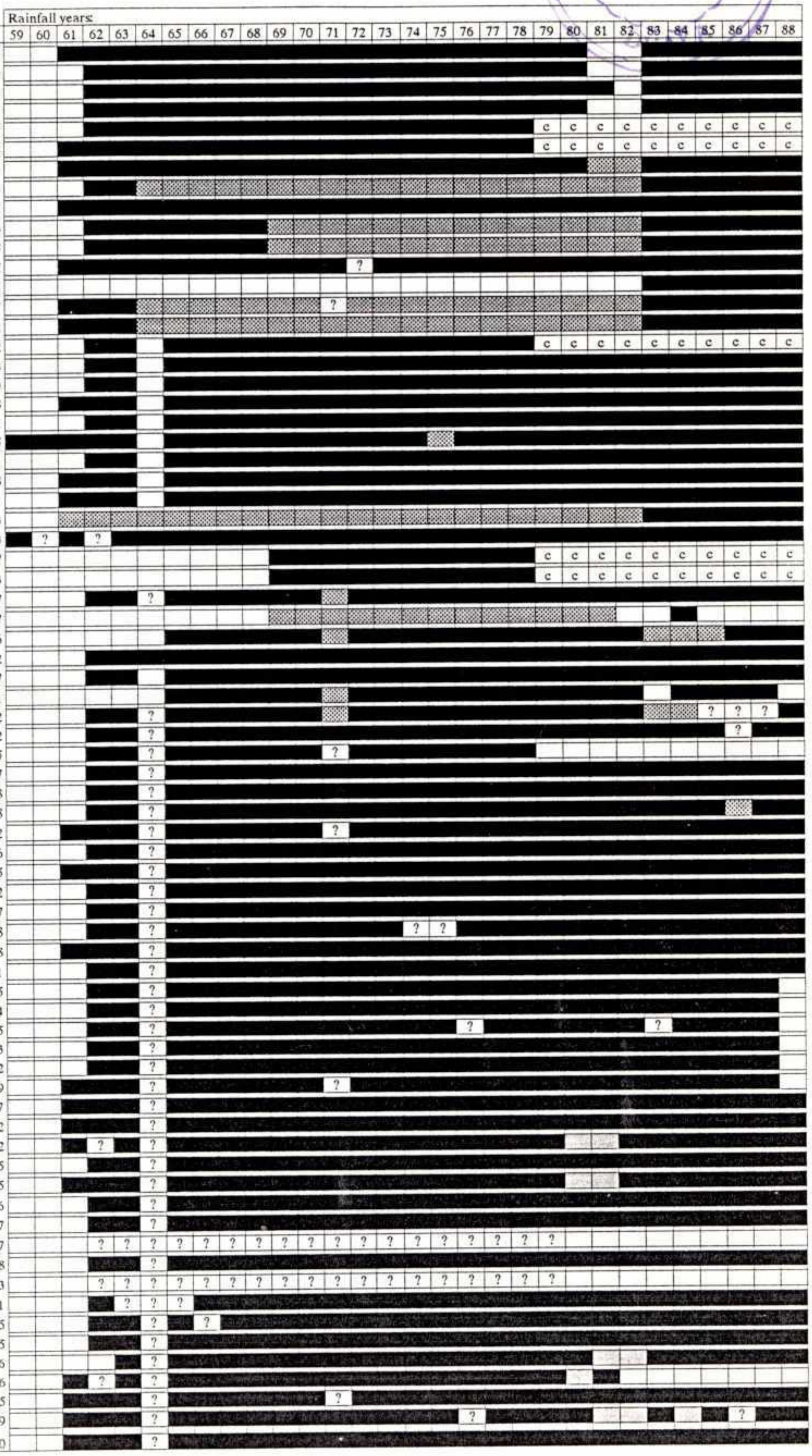
TABLE 2.3

Availability of Rainfall Data

Mean Daily Rainfall Data Availability for South East Region

Station	Latitude		Longitude	
R-017	24	9	90	25
R-031	24	5	90	10
R-031	23	49	90	18
R-037	24	11.7	90	29
R-069	23	55.3	90	35
R-070	24	7	90	36
R-076	23	57.3	90	42
R-101	24	2.7	90	59.3
R-103	23	58.7	97	7
R-105	24	7.92	91	29.06
R-110	24	22	91	25.5
R-111	24	8.14	91	22.97
R-126	24	18.2	91	44
R-131	24	4.3	91	7
R-132	24	11.8	91	12
R-251	22	56.5	90	33.2
R-252	22	32.7	90	20.4
R-254	22	47	90	10
R-255	22	25.1	90	33.8
R-257	22	29.9	90	43.1
R-258	22	42	90	22.5
R-260	22	41	90	39.1
R-261	22	37	90	46.8
R-263	22	58.4	90	14.1
R-264	22	39	90	11.3
R-266	22	22.3	90	21.3
R-268	22	11	90	48.7
R-270	22	7.6	90	39.3
R-301	22	44.5	91	45.7
R-304	22	44.2	92	22.7
R-308	23	15	92	1.86
R-311	22	39.64	91	50.62
R-315	22	29.8	92	13.7
R-318	22	55.93	92	1.41
R-319	22	50.5	91	48.2
R-320	22	46.71	91	49.22
R-321	22	47	91	43.5
R-323	22	55.07	91	53.67
R-324	22	38	91	47.8
R-327	23	1.29	91	48.28
R-330	22	28	92	4.2
R-334	22	36.86	91	42.66
R-351	23	44.5	90	47.5
R-352	23	21.43	91	4.2
R-353	22	52.3	91	16.7
R-354	23	14.3	90	49.8
R-355	23	2.5	91	32.8
R-356	23	27.5	91	11
R-357	23	31.7	90	44.5
R-358	23	1	91	24
R-359	23	5.8	91	17.5
R-360	23	15.2	90	52.3
R-361	22	29.14	91	25.72
R-362	23	45.4	91	8.9
R-363	23	14.3	91	7
R-364	22	56.2	90	50.2
R-365	23	33.1	90	32.2
R-366	23	42.6	90	56.5
R-367	23	53.5	90	58.5
R-369	22	50.3	91	6
R-370	23	12.8	91	27
R-371	23	32	90	47
R-372	23	2.5	90	45.8
R-373	23	43	90	53.3
R-375	22	34	91	1
R-376	22	59.2	91	14.5
R-377	23	1.9	91	6.5
R-402	23	31	90	16
R-408	23	38.57	90	29.06
R-410	23	12.57	90	11.5
R-412	23	38	90	9
R-413	23	15	90	20



Legend : [c] – station closed [?] – availability uncertain [■] – full record [□] – Incomplete record

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The water level data base is adequate to give an indication of historical flood problems over the region, although there are notable gaps in the data coverage, however, particularly in the area to the south of the Gumti River. There area generally fewer problems associated with water level data than river flow data, although problems have been noted with gauge datums at a number of locations, notably Daulat Khan. Such problems stem from difficulties in transferring bench marks across large expanses of water, and of course from the usual problems of gauge settlement or gauge re-establishment following damage.

Sediment deposition from rivers rising in the Tripura Hills is a problem in several areas. There are, however, very few sediment data available for the region. There is no routine sediment or water quality sampling at any location in the region. Some data have been collected by the Surface Water Modelling Centre, on the Gumti at Comilla and on the Buri Nadi at Jibanpur. Sediment data were also collected as part of the "Hydrological and Morphological Studies of the Gumti-Titas and Atrai Basins". Sampling points included the Gumti at Comilla and the Howra at Ganga Sagar.

2.2.4 Analysis of Available Data

The analysis of flood conditions within the project area has been largely based on computational hydraulic modelling, i view of the complexities of the system. These aspects are discussed in more detail in section 2.3. The extent of more traditional forms of flood hydrology, has therefore been at a fairly general level, and is discussed in the following sections.

Analyses have been made of all primary streamflow and water level data relevant to the project area. The focus has been on water level data, which is most widely available and which for the flood alleviation aspects of the project, is perhaps of most relevance. Some analysis has also been carried out of the water levels and discharges on the main river systems in order to help put the recent floods into perspective, to assist in defining appropriate distributions for regional multi-station analysis, and to test the data for non-stationarity. This analysis is presented in Annex VI.

a) Analysis of Water Levels in the South East Region

Analysis showed that application of Extreme Value Type I distributions provided good fits to the main station data on the Meghna. The distribution has been used for an assessment of water level extremes in the region. The fitted distribution to the series of annual maximum daily water levels at Chandpur is shown in Figure 2.5. The EV1 distribution apparently fits the data well, and for the purposes of regional analysis it has been considered appropriate to adopt this. Tabulated values of estimated water levels at locations on the Meghna are presented in Table 2.4. It is of particular interest to note the range of variability in levels at different locations. At Chandpur, the 50 year flood level is only 0.61 m above the 2 year flood level, while at Baidyer Bazar, the 50 year flood level is 1.18 m above the 2 year flood level. The northern parts of the region are therefore expected to be more susceptible to the influences of major river flooding than the southern parts of the region.

Figure 2.5

Annual Maximum Water Level Frequencies at Chandpur

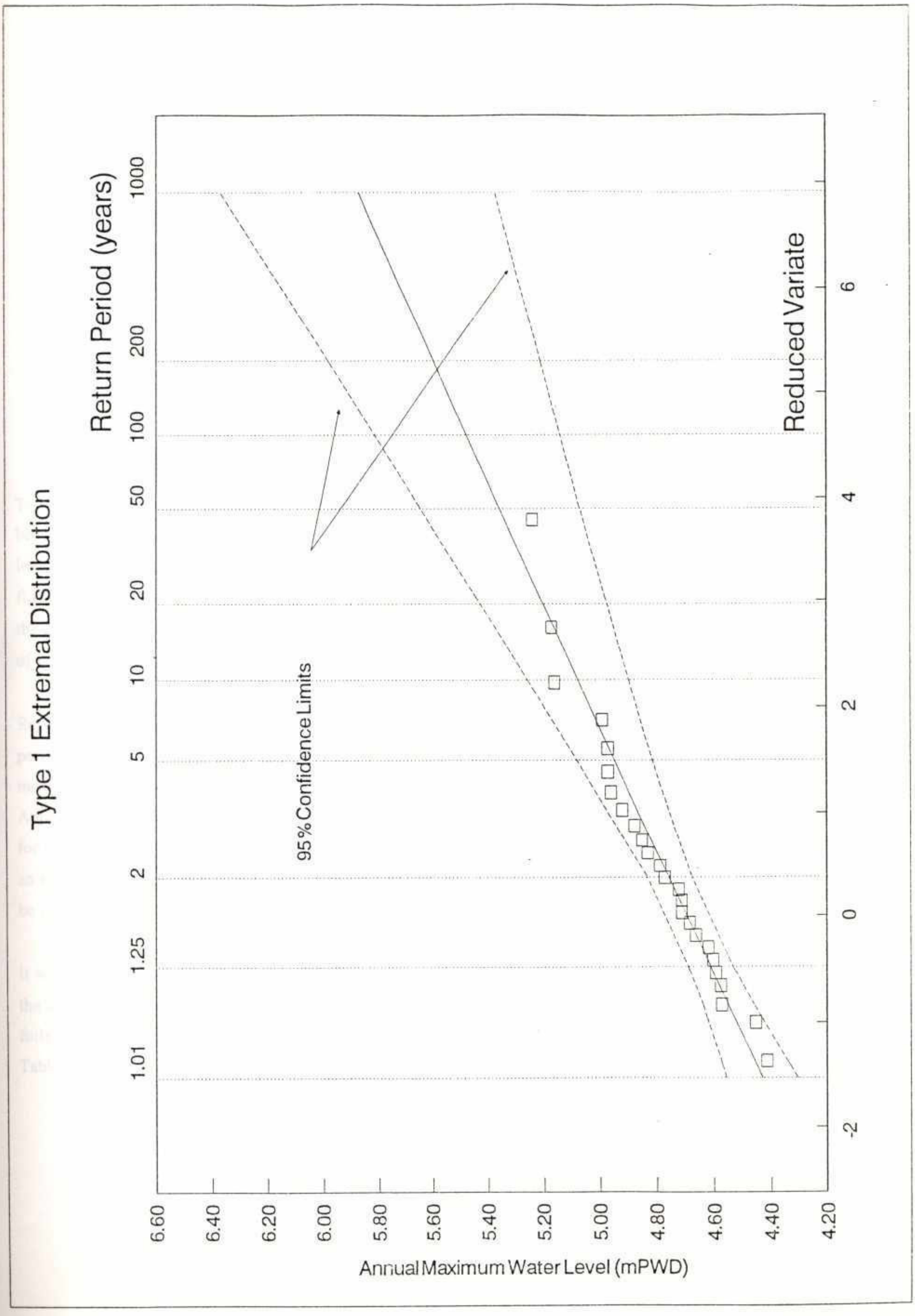

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TABLE 2.4

Annual Maximum Water Levels

Return Period (years)	Annual Max. Water Level (mPWD) Chandpur	Satnal	Baidyer Bazar
1.01	4.42	5.64	4.85
1.25	4.61	4.94	5.21
2	4.78	5.18	5.49
5	4.96	5.47	5.83
10	5.1	5.7	6.12
20	5.22	5.88	6.32
50	5.39	6.13	6.67

Typical mean high and low water surface profiles for the Meghna between Daulat Khan and Bhairab Bazar have been shown in Figure 2.4, for the months of May and August. These give an indication of the range in water levels that can be expected in different parts of the region. It is to be expected that the seasonal variation in flooded areas in the north of the region will be much greater than in the areas south of the Gumti. Similarly, the impact of flood extremes could be greater in the northern areas, subject of course to the overall distribution of land levels relative to flood levels.

Regionally, frequency analysis has been carried out on all available records of 10 day water levels. For the period April to October, frequency distributions have been fitted to each 10 day period, resulting in a series of independent seasonal water level frequency estimates. The full results of the analysis are presented in Appendix VII to Annex VI. The analysis provides a preliminary basis for the evaluation of embankment design for both full polder and submersible embankments. In conjunction with local topographic data it will also give an indication of flood risk on different land types. The seasonal presentation of results permits flood levels to be related directly to cropping conditions.

It was also considered important to prepare flood level frequency duration tables, from which an indication of the duration of inundation to certain flood depths could be obtained. The results of the analysis are presented fully in Annex VI. A summary of the results for selected flood durations and return periods is presented in Table 2.5, and serves to give an indication of variability across the Region.

W

TABLE 2.5

Summary of Flood Level Duration Frequencies

Duration Return Period	20 Days			40 Days			60 Days		
	2	5	10	2	5	10	2	5	10
Station									
W-110	10.34	11.01	11.45	9.84	10.49	10.91	9.42	9.95	10.29
W-113	7.69	8.25	8.62	7.27	7.80	8.16	6.80	7.38	7.76
W-114	6.81	7.05	7.21	6.45	6.75	6.95	6.27	6.55	6.73
W-123	5.84	6.24	6.50	5.57	5.84	6.02	5.47	5.75	5.94
W-157	21.59	22.42	22.97	20.95	21.49	21.48	20.65	21.16	21.50
W-158	15.48	16.07	16.45	14.63	15.18	15.54	14.36	14.78	15.05
W-3A	6.36	6.82	7.12	6.01	6.32	6.53	5.87	6.22	6.45
T-79	4.75	4.98	5.12	4.58	4.81	4.95	4.45	4.62	4.74
T-115	5.11	5.48	5.73	4.90	5.22	5.44	4.79	5.10	5.30
T-230	6.44	6.86	7.14	6.03	6.40	6.65	5.87	6.30	6.58
T-240	3.45	3.88	4.17	3.37	3.78	4.06	3.21	3.65	3.94
T-275	5.20	5.61	5.88	4.96	5.22	5.39	4.81	5.09	5.27
T-276	4.86	5.16	5.36	4.67	4.93	5.10	4.51	4.74	4.88
T-277	4.43	4.64	4.78	4.31	4.49	4.60	4.23	4.38	4.48
T-296	6.38	6.85	7.16	6.03	6.38	6.62	5.89	6.27	6.51
T-298	6.05	6.44	6.69	5.73	6.01	6.19	5.61	5.91	6.10

Frequency analysis based on historic water levels are of value in identifying appropriate design events, or preliminary outline design criteria. The statistical analysis of the historic record cannot however, be used as any form of predictor for flood levels that might be expected under future embanked river or polder conditions. The evaluation of such situations requires the use of hydrodynamic modelling techniques.

b) Analysis of Discharge Data

The analysis of discharge data has effectively been limited to that of the Gumti at Comilla, for reasons of data availability and quality. For the purposes of the regional study, the main objective of analysing the Gumti record has been to gain some understanding of the likely flood response of those rivers draining from the Tripura Hills into the project area. The Gumti records at Comilla have been tested for trend and persistence. Both mean annual runoff and annual maximum flood discharges have been evaluated. There is no evidence of persistence or trend in either the mean annual runoffs or annual maximum flood discharges in the Gumti. The situation with regard to mean annual runoff may change with future developments upstream, but it is unlikely that there will be any significant change in the flood response of the catchment.

The Gumti is a flashy type of river, and its' response is likely to be typical of many of the other smaller rivers draining from the Tripura Hills. Figure 2.6 shows a typical annual hydrograph for the Gumti at Comilla. This is quite different to those of the main rivers, exhibiting direct rainfall response. Frequency analysis has been carried out on the annual maximum series of mean daily flows on the Gumti. The results are summarised in Table 2.6. Discussion on regional flood frequency analysis is given in Annex VI. Flood synthesis for the cross boundary rivers is also discussed, and a methodology presented.

TABLE 2.6

Flood Frequencies, Gumti at Comilla

Return Period (years)	Estimated Maxima (m^3/s)	Q/Q_{mean}
2	468	0.94
5	630	1.27
10	738	1.48
20	842	1.69
50	975	1.96

c) **Sediment Discharges**

The availability of sediment discharge data for the region is quite limited. Work on the Hydrological and Morphological Study of the Gumti, Titas and Atrai Basins, has however, given some general figures on typical size fractions and annual sediment yields, and these are considered to be appropriate for outline planning purposes in the region. The annual sediment yield from the Gumti was estimated to be 770 tonnes/km^2/year, which compared well with a previous estimate for a catchment in north-east India of 700 tonneskm^2/year. As a part of the present study, a review has been made of sediment yield estimates from various parts of the world. It would appear that the estimate for the Gumti of 770 tonnes/km^2/year is reasonable.

The composition of Gumti sediment was 700 tonnes/km^2/year of silt, and 70 tonnes/km^2/year of sand. Morphological modelling runs carried out on the Gumti adopted a sand size of 0.2mm, and a silt size of 0.03mm.

2.3 The South East Regional Model

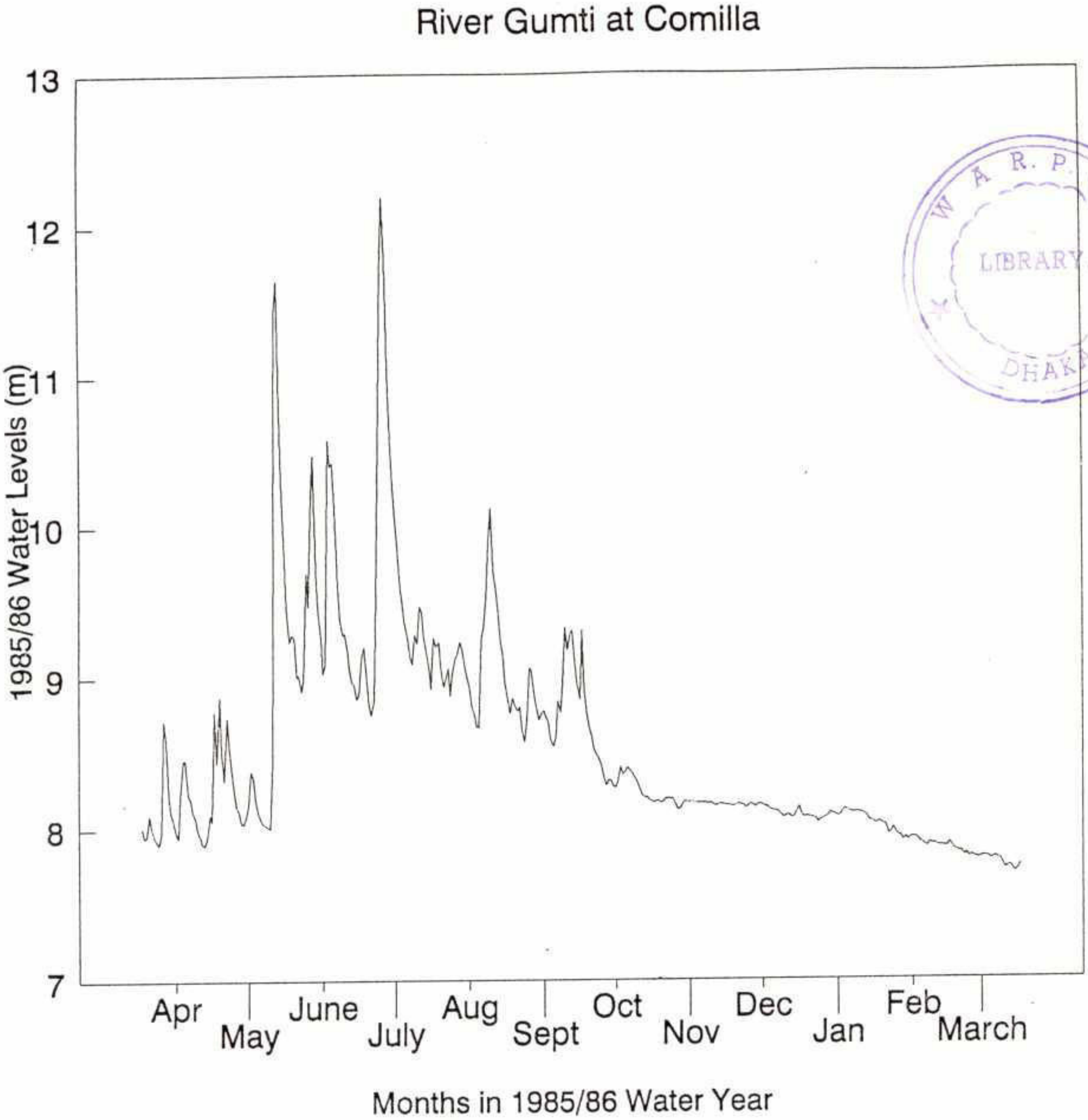
2.3.1 Introduction

The Surface Water Simulation Modelling Programme (SWSMP) in Bangladesh commenced in 1986, following a report commissioned by the Master Plan Organisation (MPO), which recommended that mathematical models be applied to analyse the hydrological and hydraulic process of the river systems. The objectives of the programme were:

"to develop a fully operational model of the South East Region; and to develop a structure approach

Figure 2.6

Typical Annual Hydrograph



For the purpose of the South East Regional Study, both the General Model and the South East Regional Model (SERM), were of particular importance. The General Model can be used to evaluate the response of the main river system to regional development programmes, and hence to the impact of such developments on main river levels forming regional boundaries. The regional model utilises these in the evaluation of internal conditions in the region.

The south-east regional model covers the area bounded in the west be the Meghna River, in the east by the Indian border, in the north by the Bhairab to Comilla railway line, and in the south by the Bay of Bengal. Almost all of the South East Region is covered.

The model was initially set up using the NAM hydrological model to provide the local rainfall runoff response, and the System 11 hydrodynamic model developed by the Danish Hydraulic Institute. The catchment delineation used in the NAM model is shown in Figure 2.7. A total of 24 catchments have been defined within the SERM. Calibration of the NAM model was primarily against observed groundwater levels in view of the lack of discharge observation stations and the degree of inter-connection between catchments through the river system. Calibration was found to be sensitive to surface detention storage capacity, overland runoff coefficients and thresholds for this and groundwater recharge. A full description of NAM and of the preliminary calibration is given in the SWSMP Phase I report. The NAM calibration has made the best possible use of available data in the region, but the lack of calibration of discharges could be a limitation for some applications, and this should be borne in mind. Sensitivity analysis will be required at feasibility and design studies in order to evaluate the possible impacts of inaccuracies in either model calibration or structure.

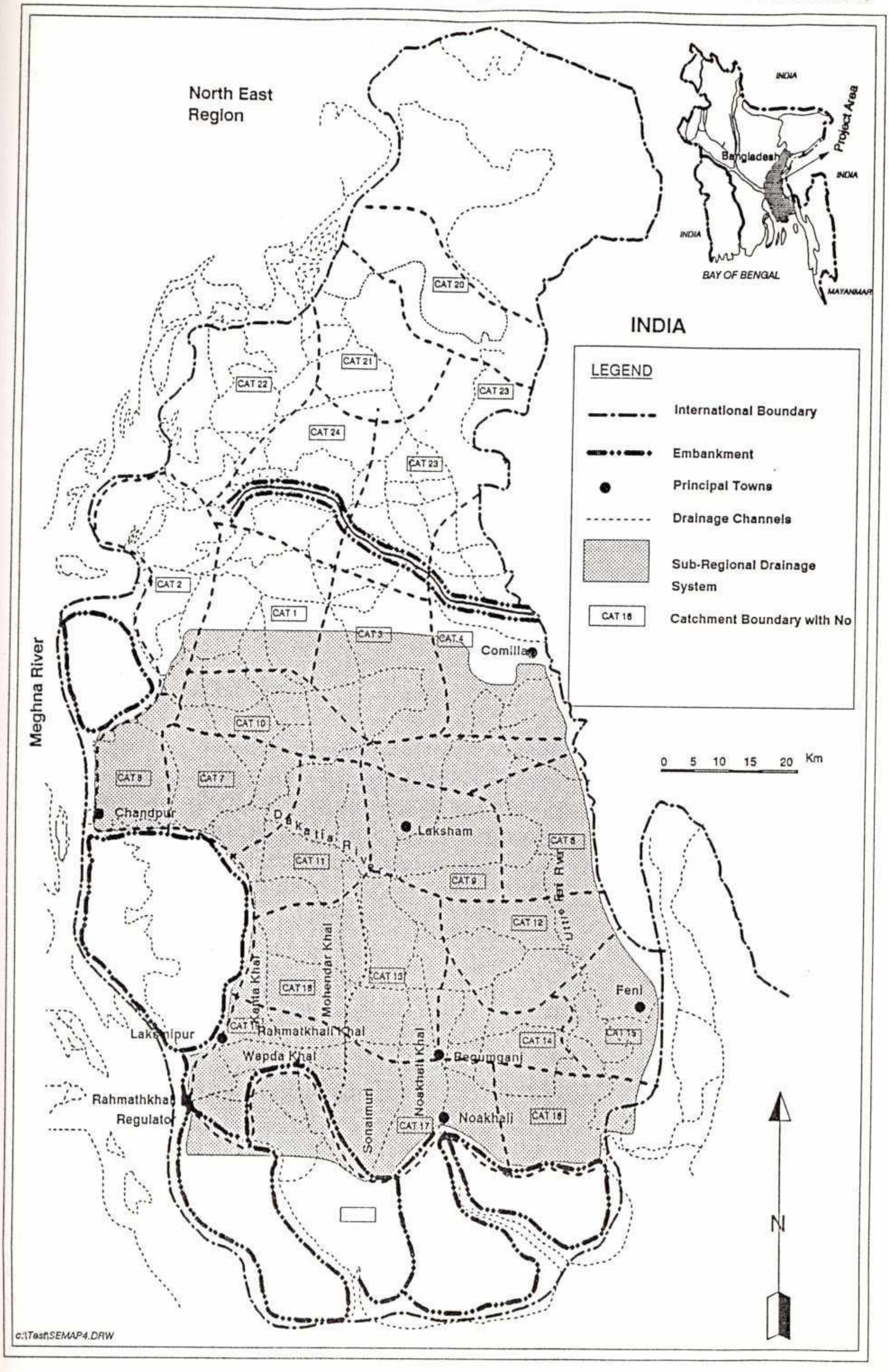
The System 11 model was set up with 175 channel reaches and 100 nodes. The model was set up in two parts, effectively divided by the Daudkandi to Comilla road. The road does form a natural divide, and water level stations were set up by the SWMC in order to provide control on the model. The System 11 model included 12 discharge and 12 water level boundaries. In the southern part of the modelled area, the boundaries were in fact set upstream of the existing regulator structures at Kazirhat and Rahmatkhali. This proved necessary in view of the uncertain operation of the structures, and the necessity of very short time steps had they been incorporated. The calibration results achieved with the System11 model were, on the whole, extremely good. Discrepancies in the simulation that were observed ar most likely to have been related to inaccuracies in the physical definition of certain floodplain features or their measurement, rather than any problem with the model itself.

Under Phase II of the SWMP, the models were transferred from System11 and Mike11. Mike11 comprises the same basic hydro-dynamic model as System11, but includes better user interface and data management facilities. In the South East Region, the SWMC has carried out full verification of the model on transfer to the Mike 11 system. Under the Mike11 system, further refinement of calibration and verification was carried out using data for the 1988/89 hydrometric year.

Models were transferred from the DOS operating system to a UNIX environment in 1992. This removes the memory limitations on the size of model that can be run, and permits the SERM to be run as a single model, rather than in two parts as was required at the time of the regional study. This facility has been utilised in subsequent feasibility level studies.

Figure 2.7

South East Region NAM Model Sub-Catchments



2.3.2 Model Outputs

The outputs from Mike11 are time serious of water levels ad discharges for each reach and node in the network. These may viewed as hydrographs, or printed as water surface profiles. These outputs are useful in determining in a qualitative manner the effectiveness of different flood mitigation options, but or full project evaluation further processing of the model outputs in relation to surrounding land levels has been required. The approach adopted has been to relate flood levels output from Mike11 to a simplified terrain model built up of 1' grid squares. This has permitted assessments to be made of t he aerial distribution of flood depths.

Each 4" to 1 mile map sheet covers as area of 5' longitude by 5' latitude, divided into 25.1' squares. In each 1' map square there are on average 80 to 90 spot heights, thus giving an excellent indication of micro-relief, or at least the micro-relief at the time of survey. This data was utilised to permit elevation area characteristics to be prepared on a 1' grid square basis for a large part of the study area. Using the Mike11 model network and floodplain allocation diagrams, 1' grid squares were attributed to each model node, thereby permitting flood depth area characteristics to be evaluated from model results on a local basis. Each model node was therefore considered to be representative of flood levels over a selected area. For planning area analysis, aggregations of 1' squares could be made in any configuration of planning or project boundaries. The elevation area characteristics of each of the planning unit are presented in an Appendix of Annex VI. A very small change in water level can result in a very significant change in the area of possible inundation. There are obvious implications for model accuracy, and for the sensitivity and accuracy of t he evaluations of model results. Errors in water levels within normal modelling tolerances can make a substantial difference in the simulated area of flooding.

2.2.3 System Sensitivity

A number of sensitivity runs have been carried out in order to determine the relative importance of rainfall and main river levels in producing floods in the southern part of the region. The model runs were carried out with main river boundary conditions for 1988 and 1986, and rainfall and inflows for 1986 and 1987. In terms of main river levels, the highest annual maxima occurred in 1988, and the lowest in 1986. In terms of regional rainfall, 1986 was very dry, and 1987 had the wettest mid monsoon period in record. The combinations carried out were:

1.	1988 main river water levels		High
	a)	1986 rainfall and local runoff	Low
	b)	1987 rainfall and local runoff	High
2.	1986 main river water levels		Low
	a)	1986 rainfall and local runoff	Low
	b)	1987 rainfall and local runoff	High

The runs carried out therefore reflect extreme conditions.

The results of the model sensitivity are presented in terms of maximum water surface profiles in Figures 2.8 to 2.10 for the Dakatia River, the Little Feni River, and Rahmatkhali Khal. These are fairly representative of the sub-regions of the project area.

Figure 2.8

System Sensitivity, Dakatia River

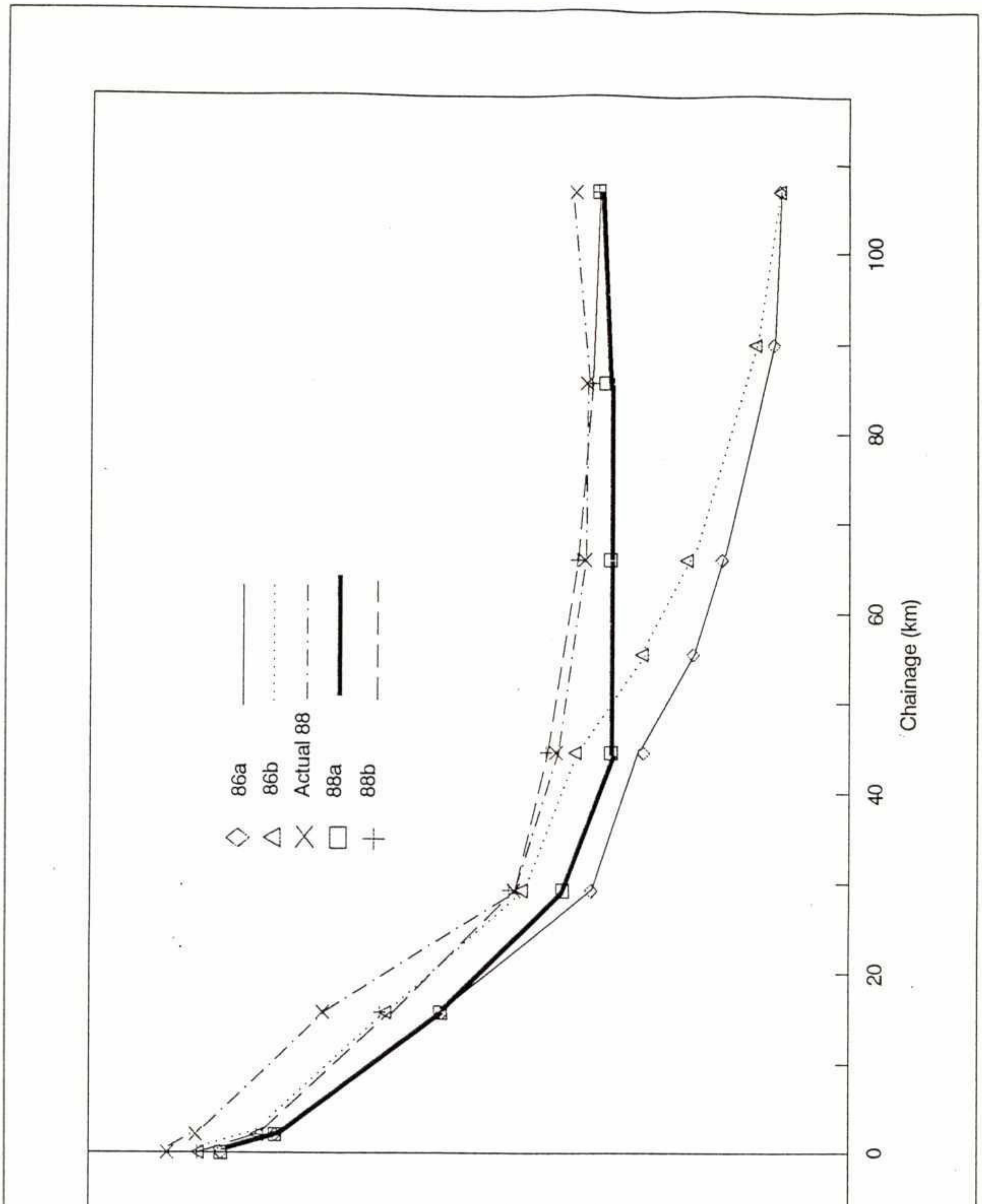


Figure 2.9

System Sensitivity, Little Feni River

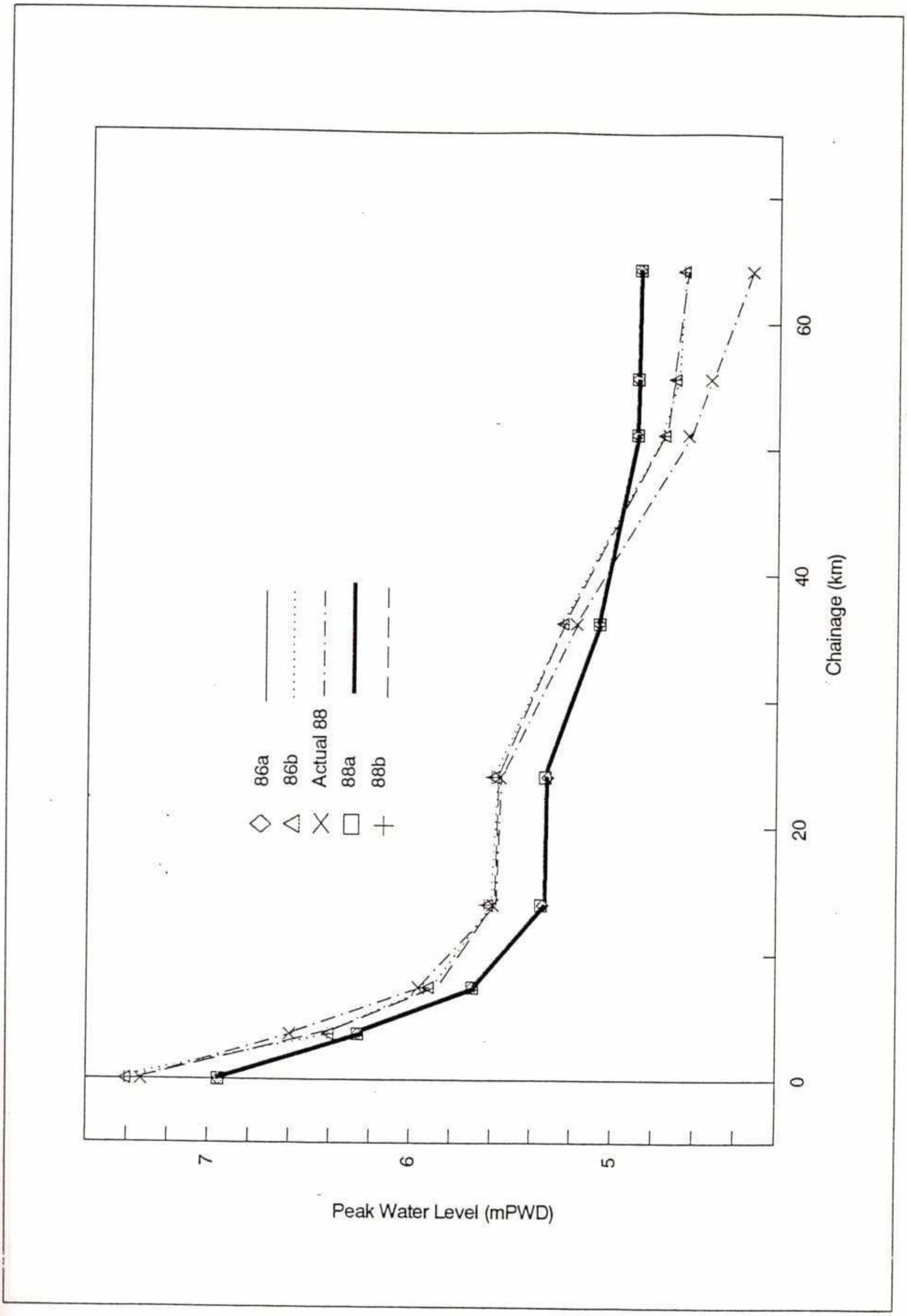
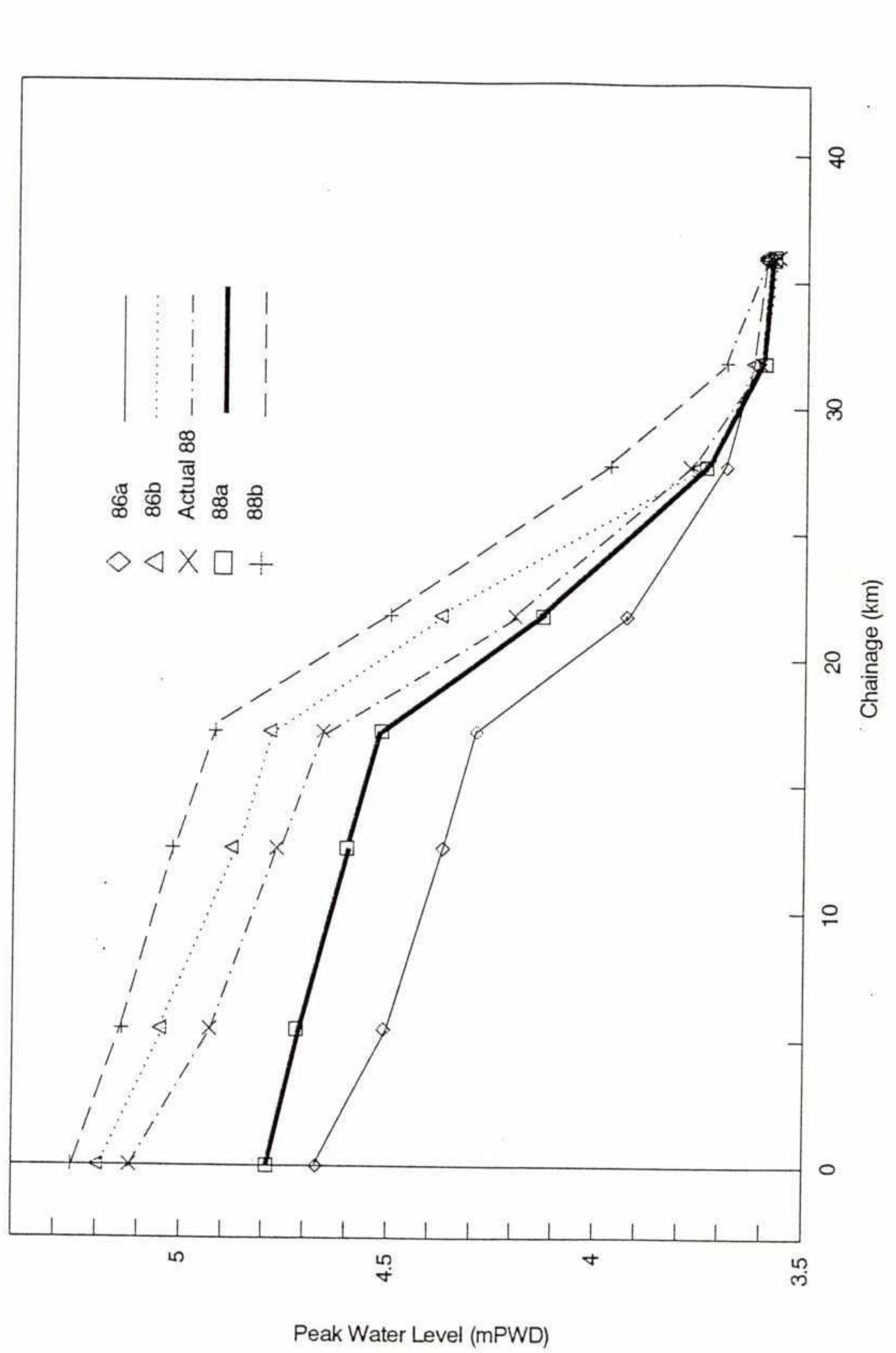


Figure 2.10

System Sensitivity, Rahmatkhali Khal



a) Dakatia River

It is clear that between chainages 40 and 100 on the Dakatia, the dominant influence on flooding is main river levels. Local rainfall adds about 0.2m to flood levels at chainage 50, and for design purposes, there would be little point of going to great lengths to try and refine water level estimates. The combination of extreme rainfall and extreme water level results in only a small overestimate in flood levels.

b) Little Feni River

The Little Feni River is effectively unaffected by assumptions about main river boundary conditions, and local rainfall dominants the flood response throughout most of the system. The operation of Kazirhat regulator is dominant over the last 20 km, and obviously influences the flood response. It is of interest to note that throughout most of the system, the difference in peak water levels between the rainfall extremes is only of the order of 0.3m in the centre of the region.

c) Rahmatkhali Khal

The Rahmatkhali Khal and Begumganj depression areas show most sensitivity to the chosen combination of main river boundaries and local rainfall. This is probably the result of the combined influences of the Dakatia and the Little Feni River spills on the area. This said, however, the dominant influence is apparently local rainfall, and the maximum influence of Meghna levels is only 0,20m.

d) Planning Unit Analysis

Similar sensitivity analysis to that discussed above has been carried out on a planning unit basis, giving an indication of how flood depth area characteristics respond to deferent boundary conditions. This is discussed fully in Annex VI. In the Dhonagoda planning unit, the dominant influence is Meghna water levels, but rainfall is important. A relatively small change in water level can result in a significant change in flooded area. In the Dakatia planning unit, the influence of main river levels on flooding is less pronounced, and rainfall is apparently more dominant. Main river levels are thus apparently still important, but less so than rainfall. In the Noakhali-North planning unit rainfall is the dominant influence, and main river levels have much less of an influence than in the Dakatia area, although the influence of the Meghna is still apparent. In the Little Feni planning unit, the Meghna has no influence on flood levels at all, and the predominant influence is apparently rainfall alone.

2.4 Soils

The soils of the region are fully described in Annex I.

There are 34 physiographic units and 30 Agro-Ecological Regions and Sub-Regions in Bangladesh, differentiated into soils, and/or land levels influencing climate, hydrological conditions and soils. These Agro-Ecological Regions and Sub-Regions have been described as Agro-Ecological Zones (AEZs) in the Land Resources Appraisal of Bangladesh for Agricultural Development, Report 2, Agro-Ecological Regions of Bangladesh (FAO, 1988). The information in this chapter is designed to assist the assessment of agricultural potential, cropping system, cropping pattern and crop production.

Of the 30 major Agro-Ecological Zones (AEZs) in the country, there are 8 AEZs represented within the study area as shown in Figure 2.11. The land area and estimated percentage distribution according to flood phases (as defined below) of the respective AEZs are shown in Table 2.7. The first four AEZs (AEZ-16, 17, 18 and 19) cover the greater part of the area, constituting the Meghna River and Estuarine floodplains. AEZ-21 is mainly a depressed area which is an extension of the haor area of the north-east region. The medium highland and medium lowland areas of AEZ-17, 18 and 19 are dominant and are good for crop production. Soils of these areas are mostly of alluvial silt loam, silt clay loam, silt clay, clay and clay loam in texture (Table 11 of the Annex). In the south in AEZ-18, soil salinity is a problem in the short term until leached, but apart from that the soils in all the AEZs are suitable for growing a variety of crops like rice of all types, wheat, jute, potato, sugar cane, oilseeds, pulses, and vegetables under both irrigated and non-irrigated conditions.

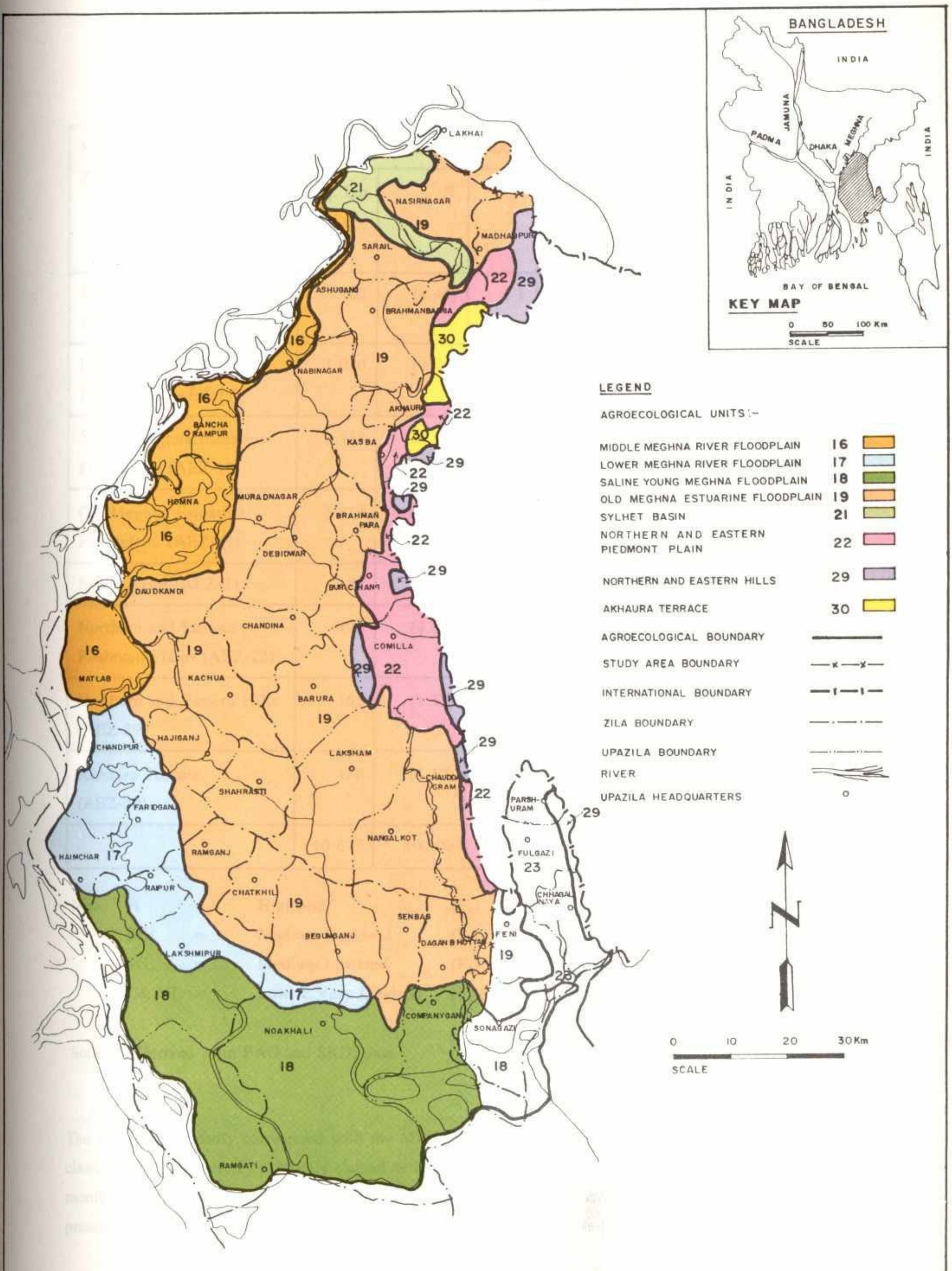
The Young Meghna Estuarine floodplain is almost all accreted land called char land covering the southern parts of Lakshmipur, Noakhali and Feni districts. Since the groundwater is saline, the scope for development of tubewell irrigation is very limited. Surface water is the only alternative to increase the acreage of dry season HYV crops (mainly boro).

A total of 101 soil associations in the study area, with 74 major soil series, have been shown in the soil association map in the separate Album of Drawings.

Based on depths of flooding, the land has been classified as follows:

Land Type	**MPO Flood Phase**	**Description**
Highland (H)	F_0	Land normally inundated <0.3 m deep
Medium Highland (MH)	F_1	Land normally inundated upto 0.3-0.9 m deep
Medium Lowland (ML)	F_2	Land normally inudated upto 0.9-1.9 m deep
Lowland (L)	F_3	Land normally inundated >1.8 m-2.0 m deep
Very Lowland (VL)	F_4	Land normally inundated deeper than 3.0 m.

Figure 2.11
Agroecological Units of the Study Area



SOURCE : LAND RESOURCES APPRAISAL OF BANGLADESH
MAP SHEET OF REPORT 2 :
AGROECOLOGICAL REGIONS OF BANGLADESH.

TABLE 2.7

Agro-Ecological Zones Showing Land Area and Percentage Distribution

Name of Agro-Ecologicl Zones	AEZ-wise area		Distribution of land in different flood phases %				
	sq. km	%	H	MH	ML	L & VL	Homestead & Waterbody
Middle Meghna River Floodplain (AEZ-16)	107	(8.49)	1	8	29	35	27
Lower Meghna River Floodplain (AEZ-17)	1 040	(9.75)	11	31	31	0	27
Young Meghna Estuarine Floodplain (AEZ-18)	1 938	(18.15)	0	41	10	0	49
Old Meghna Estuarine Floodplain (AEZ-19)	5 819	(54.50)	1	22	31	28	18
Sylhet Basin (AEZ-21)	189	(1.77)	0	4	25	57	14
Northern and Eastern Piedmont Plains (AEZ-22)	493	(4.62)	29	29	17	14	11
Northern and Eastern Hills (AEZ-29)	162	(1.53)	85	5	1	0	0
Akhaura Terrace (AEZ-30)	128	(1.19)	55	11	10	18	6
	10 677	100.00					

Note: H = Highland (F_0)
MH = Medium Highland (F_1)
ML = Medium Lowland (F_2)
L& VL = Low & Very Lowland (F_3+F_4)

Source: Derived from FAO and SRDI data.

The land types broadly correspond with the MPO (WRPO) classification now in use, as indicated. In this classification however, F_3 is strictly classed as land flooded to a depth of more than 1.8 m for less than nine months and F_4 land is land flooded to a depth of more than 1.8 m for more than nine months of the year. For present purposes Lowland and Very Lowland (F_3 and F_4) have in any case been lumped together.

The land capability has been broadly grouped into five classes as follows:

Class I - Very good agricultural land:	Soils in this class have no limitations for crop production throughout the year and the widest range of agricultural use.
Class II - Good agricultural land:	Soils have no limitations for crop during most of the year.
Class III - Moderate agricultural land:	Soils have moderate limitations (droughtiness, seasonal flooding, irregular relief or moderate erosion) for crop production throughout the year.
Class IV - Poor agricultural land:	Soils have severe limitations for crop production throughout the year.
Class V - Non-agricultural land:	Soils have severe limitations making crop production impossible.

In total 48 land capability associations have been recognized in the study area (see separate Album of Drawings) and these have been grouped into nine broad combinations as shown in Figure 2.12.

Group 9 (Class V) mainly falls in the char lands in the south, Polders 59/3A, 59/3B and 59/3C, with a small pocket in Kasba thana, and the Lalmai Hills. There are small isolated areas in group 8 (Classes IV and V) on the Indian border and in Bancharampur. The northern branch of the Titas, and Polders 59/3A, 59/3B and 59/3C contain group 7 lands (Class IV) whilst group 6 (Class III and IV) lands are restricted to the edges of the study area, apart from the Salda river and Buri Nadi channels. Group 5 (Class II and IV) land occurs only in a very small area south of Brahmanbaria. In general the majority of the area consists of land of Class I to Class III, with comparatively small areas of Class IV and V land. The exception to this is the southern char land, where major parts of Polders 39/3A, 59/3B and 59/3C contain Class IV or Class V land, i.e. poor agricultural land or land which is classed as non-agricultural, although much of it is farmed at least in the monsoon season. Apart from in the southern char land, soils should not be a determining factor in the development of the regional plan.

2.5 Geology

2.5.1 Structure and Tectonics

The study area lies in the folded belt of the Bengal Foredeep within the Bengal Basin and constitutes the western extension of the Tripura-Chittagong folded belt, a continuation of the Indo-Burma ranges. In the light of the currently accepted plate tectonics theory, the area is situated in the eastern margin of the Indian plate and has been formed by the collision of the Indian and Burmese Plate. The present relative plate motion between the Indian and Eurasian plates is apparently in north-east and south-west direction that is causing under-thrusting of the Indian plate under the Burmese plate in the east and has been responsible for the development of east-west compression in the region. The Burmese plate, being overridden by the Indian plate, has served as the main pushing force for the compression of the Tertiary sediments to produce folds. Detailed structural analyses of the folded belt in Bangladesh (Hoque, 1982; Hossain, 1985) and a study on similar structures of the Tripura hills (Mitra, 1966) indicate that the fold belt of the Chittagong - Tripura area, including the study area, has developed both by the horizontal east-west compression and by differential vertical crustal movement.

2.5.2 Stratigraphy

The area is covered by a sequence of fining upward deltaic and flood plain deposits of the Quaternary age. In the context of the present study concerning the hydrogeology of the water bearing sediments, the focus is on the Dupitilla formation which is immediately below the allumonium and the Tipam sandstone which is a massive, coarse grained unit with seismic homogeneity which is easily contrasted with the banded reflectors and overlying Dupitilla sandstone. The Dupatilla formation and, to a lesser extent the Tipam, each thin over anticlinal crests, indicating that they were contemporaneous with folding.

Lithologically both the Tipam and the Dupitilla formations are arenaceous with subordinate shale but the Dupitilla sandstones are fine grained, less indurated and more shaly. The Tripura folded belt and its adjoining western extension in Bangladesh experience fluvial sedimentation resulting in thick and extensive sheets of fining upward coarse sand - medium sand - fine sand - clay sequences. The Tipam sandstone is regarded as bed-load dominated (braided) river deposit and the fine-grained Dupitilla formations mixed load (meandering) river deposits.

The maximum penetration of the Tipam - Dupitilla section in Begumganj is about 1 400 m but in Titas and Bakhrabad it varies from 250 to 500 m.

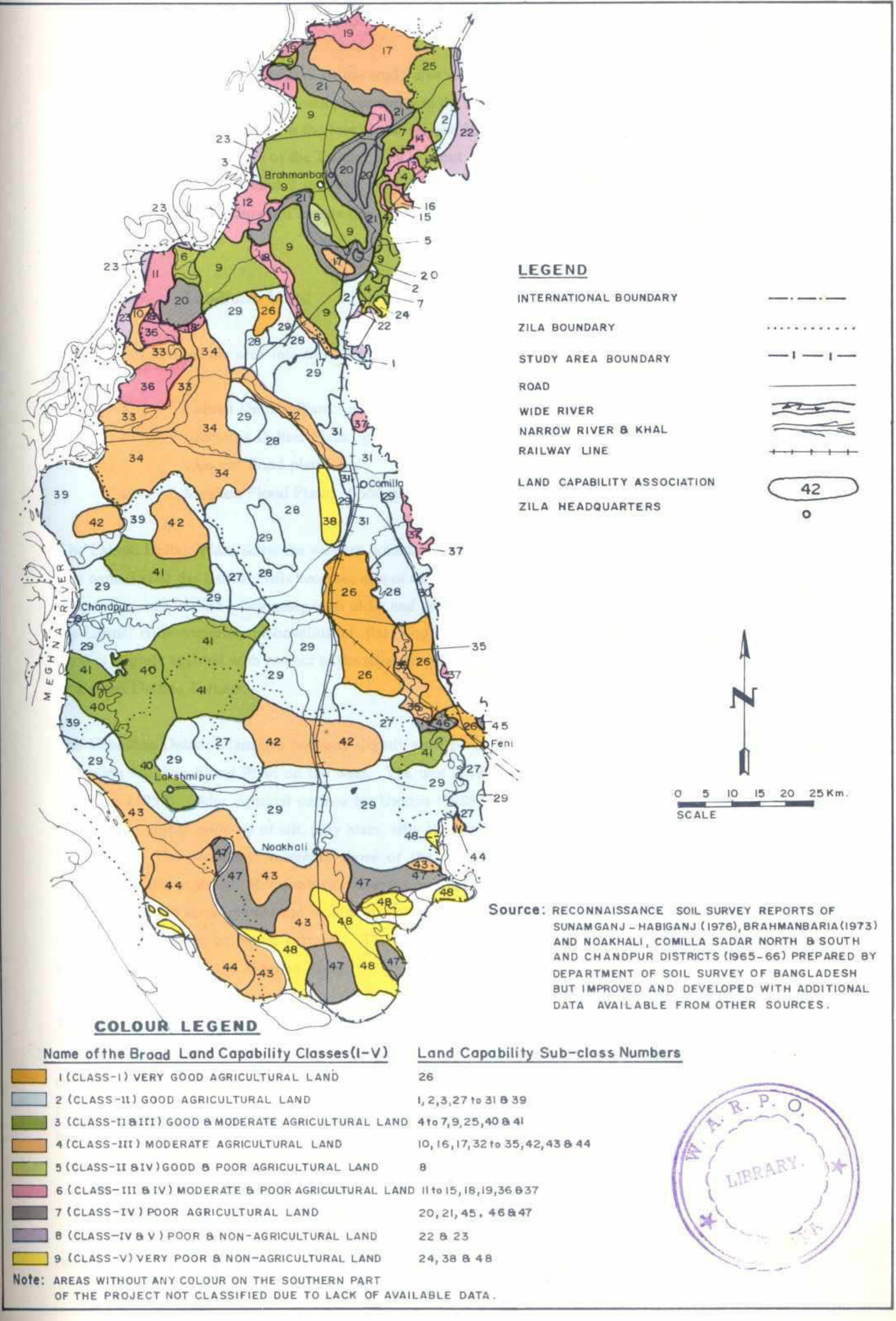
The litho-stratigraphic units analysed include:

a) Dupitilla Formation
b) Madhupur Clay Formation (see next section)
c) Chandina Deltaic Deposit (see next section)
d) Meghna Flood Plain Deposit (see next section)

The Dupitilla formation includes a sand member and silt member representing a fluvial meandering product. The Madhupur Clay is divisible into lower sandy and upper clay units. The Dupitilla sandstone and lower Madhupur Clay sand unit from the principal aquifer of the area. The Madhupur clay with high percentages of illite and halloysite overlies unconformable the Dupitilla formation. After the deposition of this unit, tectonic activity raised the Lalmai Hills which have been eroded and dissected giving rise to a fragmentary terrace. Consequently, a topographical unconformity had been formed. As a consequence, the drainage system then changed resulting in deposition of the Chandina deltaic flood plain deposit or Chandina formation, a sequence of grey silt, clayey silt and clay with high percentages of illite and kaolinite, which has built up the Chandina Deltaic Plain. The landform unit was also uplifted giving rise to a terrace surface called the Tipperah surface. The formation of the Chandina deltaic plain is reminiscent of two Holocene sub-stages which are the Atlantic and the sub-boreal. The Meghna Flood Plain is then ascribed to the sub-Atlantic age as a younger formation.

Figure 2.12

Land Capability Association Map



2.5.3 Relief and Topography

The dominant topographical feature of the study area is representative by a vast expanse of deltaic plain with the Lalmai hills elongated north-south prominently in the landscape as an outlier, a remnant of older sediments. The terrain slopes westward from the foot of the Tripura Hills up to the main channel of the Meghna river. The average elevation of the base of the Tripura hills is about 10 metres, and that of the western margin at the bank of the river Meghna is around 2 metres. Across the Bangladesh-Indian border, the Tripura Hills forming a series of north-south tending hill ranges rise in elevation from 65 metres to 130 metres. Further east they rise to 600 metres.

2.5.4 Landform Units

Bakr (1976) divided the area into three landform units (Figure 2.13):

a) Lalmai Deltaic Plain: skirting the Tripura Hills and sloping to the west;
b) Chandina Deltaic Plain: generally level land, occurring at a slightly higher elevation than the adjacent flood plain; and
c) Meghna Flood Plain: flood plain of the Meghna river and its tributaries.

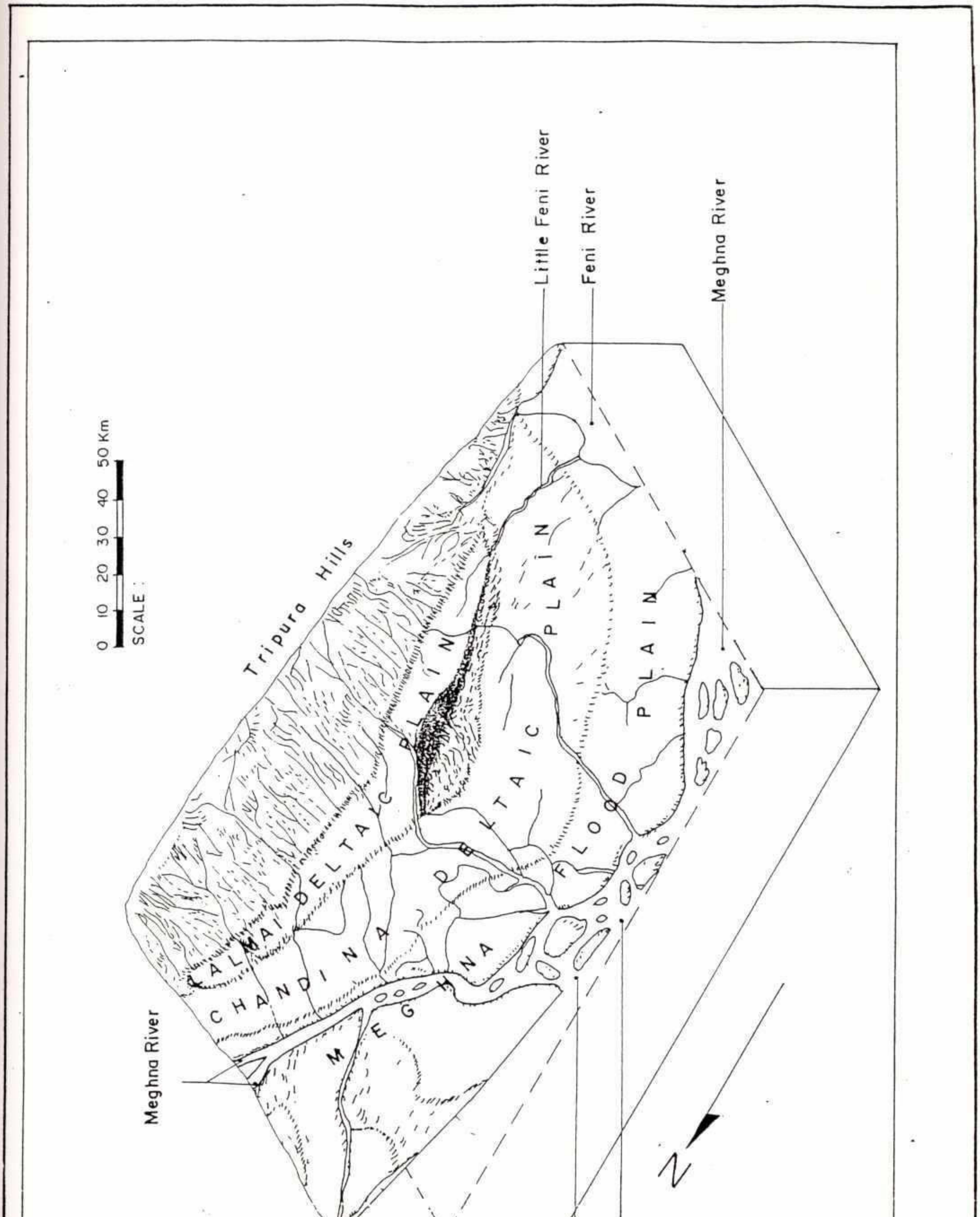
The Lalmai Deltaic Plain skirts the western boundary of the Tripura Hills the plain gradually slopes westward. It is named after the Lalmai Hills because, east of the Meghna, this is one of the few areas where the Madhupur Clay is exposed and its relationship with older and younger formations can be studied. The sediments capping the Lalmai Hills comprise unconsolidated, flat lying reddish brown and yellowish brown clay and sandy clay. As it is slightly uplifted with respect to the adjacent plains it is also referred to as Lalmai uplifted Deltaic Plain or Lalmai Deltaic Terrace.

The Chandina Deltaic Plain lies between slightly uplifted Lalmai Deltaic Plain on the east and comparatively low lying Meghna Flood Plain on the west. The unit is referred to as the Tipperah surface by Morgan and McIntyre (1959), Older Alluvial surface by Umitsu (1985) and Old Meghna Estuarine Surface by Brammer (1971). The unit is made up of silt, silty loam, silty clay and greyish clay and has been named as the Chandina Formation. The sediments resemble those of the Recent Meghna Flood Plain, but are more compact, decomposed and oxidized. Remnants of numerous meander scars, meander scrolls, old levees and ox-bow lakes can be detected in aerial photos and satellite imagery. The drainage developed in this unit is rectangular, partly due to the man-made irrigation network. The unit is uplifted to the south-east a few metres higher than the adjacent floodplain of the Meghna River.

The third landform unit in the study area is the Meghna floodplain. It is the least elevated and comprises the eastern bank of the river Meghna. The Meghna floodplain has been built up by the present day sediments carried by the Meghna river which is generally meandering in character but in places braided, resulting in a vast plain criss-crossed by numerous small streams, merging and branching, and building out channel bars, meander bars and levees. The sediments are mainly composed of sands, silts and clays.

Figure 2.13

Block Diagram of the Area Showing Land Form Units



2.5.5 Major Faults

The Upper Meghna river follows the Major Meghna Fault zone, but at the confluence with the Padma river the Lower Meghna River flows south whilst the Major Meghna Fault zone continues in the south south-west direction towards Barisal, so that the Lower Meghna river no longer follows the Fault Zone. The Jamuna river and Arial Khan also follow the Madhupur Fault which ends when it meets the Major Meghna Fault Zone near to Barisal, and the Padma follows the minor Padma fault which peters out just south-east of Chandpur. Fault lines are significant since rivers often tend to follow them even though the fault line may be deeply buried.

2.5.6 Seismicity

The study area lies at the juncture of three tectonic plates and is one of the seismically active areas of the world. In the vicinity of Bangladesh there have been 11 earthquakes with a magnitude greater than 7 on the Richter scale since 1895, including four which have been felt over an area of more than two million sq km. More details are given in Annex V. The effects of earthquakes have to be considered in the design of major hydraulic structures and embankments, particularly with regard to possible liquefaction of the latter.

2.5.7 Aquifer Characteristics

The main and composite aquifers, which range in thickness from less than 20 m to over 60 m, have good to excellent water transmission properties in the north central part of the study area. Their development potential is constraint by occurrences of saline groundwater.

The top of the aquifer unit, referred to as the composite aquifer, is composed of very fine to fine sand, and sometimes medium sand, and constitutes the uppermost water bearing zone. It varies in thickness from less than 20 m in the east to over 60 m in the west and north-west. Almost all the STW in the study area tap their groundwater from this aquifer.

Below the uppermost water bearing zone lies a series of medium to fine or medium to coarse sands with interlayers of clay. This zone, sometimes separated by a clay layer from the composite aquifer, is known as the main aquifer because it is the principal water bearing horizone for high capacity irrigation wells all over the country. The maximum depth to the top of the main aquifer ranges from less than 40 m to 60-80 m in the area except in the south-west, west and north central portions, where it is over 80 m. The thickness of the exploited aquifer ranges from 20 m to 60 m over much of the area except in the southern part.

2.5.8 Chemical Characteristics

There are isolated areas where groundwater is tainted by iron but the major problem is salinity. The chemical characteristics of groundwater are fully explained in Annex V and calculation of the effects is given in Chapter 3 of this Report.

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2.6 Environment

2.6.1 Climate

A description of the climatic norms for the region is given in Annex VI. Three other conditions of climate have to be noted in the impact assessment:

- Above average events which exceed the design criteria, but do not lead to structural damage.

- Extreme and catastrophic events that will need emergency measures and consideration of both structural and non-structural contingency plans

- Changing global climate patterns that will affect the base conditions of the existing situation, and on which the design criteria for projects have been based.

The events which exceed the design criteria will impinge on the viability and design of the engineering structures proposed, lead to a resumption of damage within the project areas, perhaps increase damage outside them and could significantly increase the costs for maintenance and rehabilitation. The most serious problems are from extreme events in the coastal areas when major damage to embankments could lead to a loss of a number of years of protection while rehabilitation work is organised. Overtopping of embankments, if the existing khals are closed, could lead to salt water standing on reclaimed land for longer than if the embankments were not there. Various contingency methods must be considered to allow for the rapid evacuation of sea water.

The analysis of historic data series on global climatic change does appear to indicate evidence of a current phase of global warming. Whether this will continue is still not fully understood, neither are its implications. However, the present widely discussed opinion, which is also based on analysis of previous global warming and cooling cycles in the planet's history, suggests that rising sea levels could be expected within the long-term planning horizone. Figure 2.14 gives indications of the coastal areas which would be flooded by a sea rise of one metre if this scenario does unfold. These factors have been analysed in some detail in "Effect of Climatic Change and Sea Rise on Bangladesh" (Dr. F. Mahtab/Commonwealth Secretariat, 1989).

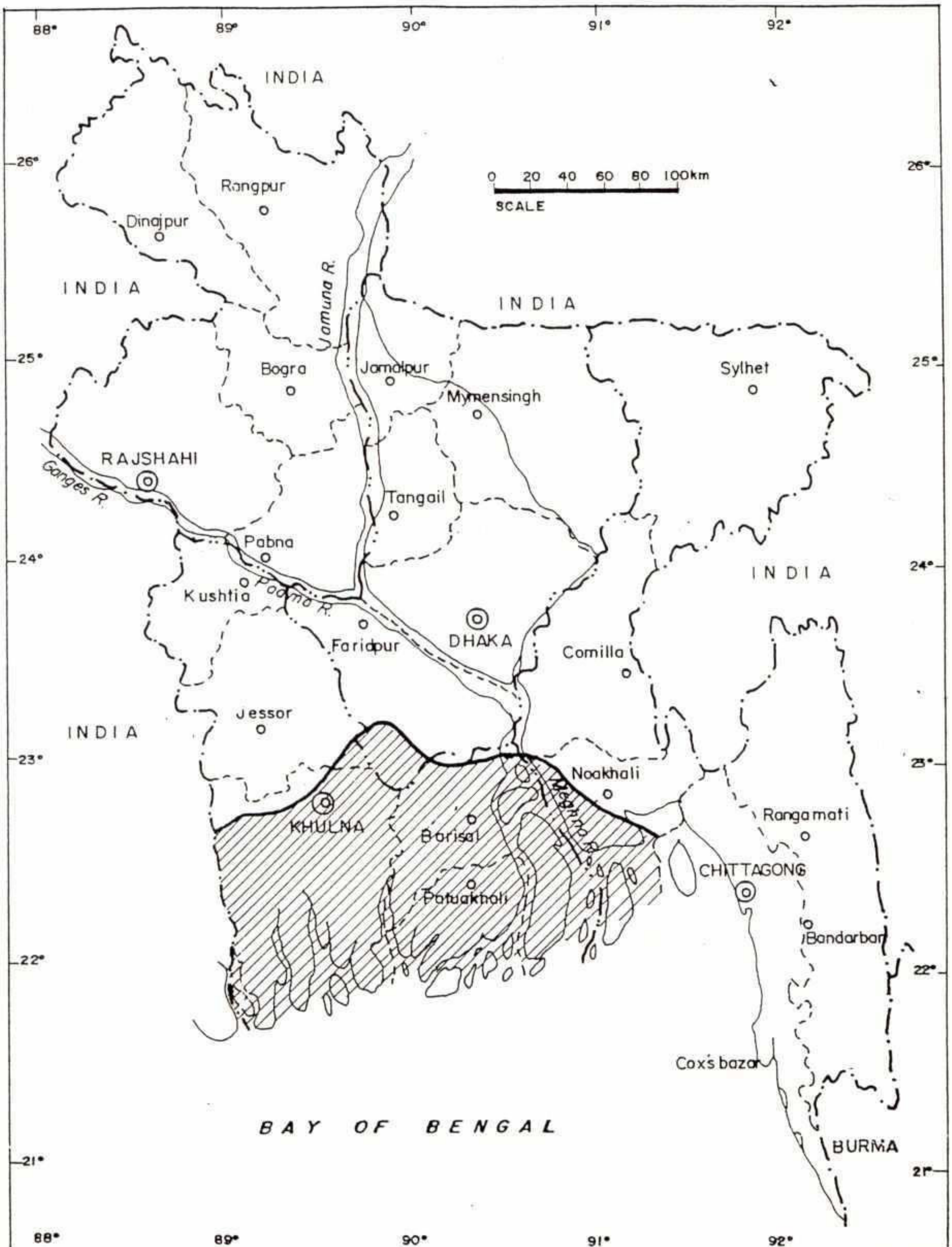
2.6.2 Soil Types, Potential and Problems

The basic soil types and their physical and chemical properties are described in Annex I. They have all been found suitable for rice cultivation with only minor potential limiting factors. The major factors of concern are the means by which soil fertility can be maintained under intensive use. Micro-nutrient and nutrient deficiencies and organic mater deficiencies are all of potential note in particular areas. There are also some physical characteristics which can lead to pans and impeded drainage if not managed properly.

There are isolated pockets of soils, high in organic matter, associated with old marshes. These affect tubewell water supplies when installation and abstraction interacts with marsh gas pockets. Where these deposits lie close to the surface and would be dried out by FCD, oxidation could lead to the gradual removal of organic matter and result in some minor subsidence of land levels. This is unlikely to be an issue of any concern. These areas are however of more concern for embankment construction as these soils are quite unsuitable as a construction material.

Figure 2.14

Area Likely to be Inundated Due to Sea Level Change by One Metre



2.6.3 Landscape Value

In the last few centuries the landscape as a whole has been dramatically transformed into intensive human use for settlement and food production as population has grown. Previously there were always areas where intensive use of natural resources took place around the settlement areas. The difference today is the complete degree to which this exploitation has taken place at the expense of natural and undisturbed habitats. The variety of habitats which exist are vital to sustaining the diverse range of survival strategies which are employed and which are continuing to evolve in the contemporary monetary era. Thus, the landscape has tremendous productive and economic value which needs to be taken into account in the transformations which FCDI interventions will impose.

2.6.4 Biological Environment

a) Habitat Types and Importance

The ecology of the region (discussed below) involves the inter-action between a large number of faunal and floral species and a range of different habitat types. the habitats include both aquatic and terrestrial environments ranging across the altitudes and landscapes described above. The main types of habitats found are mapped in general terms in Figure 2.15 and include the sites discussed below. Figure 2.16 shows the main general locations of bird and fishery uses.

b) Coastal and Estuarine

The coastal habitats bounding the region are very recently formed and still active. They are characterised by active mud flats and unstable low islands with high levels of seasonal silt accretion and erosion which lead to seasonally turbid waters. These areas are found to be very low in species diversity.1 The mud flats are important sites for birds of both resident and migratory species. Shrimp spawning zones have been identified but these are generally of less significance than those found to the west in the Sundarbans or along the Chittagong coastline. The coastal zone is generally too active to support extensive areas of mangrove. Attempts at afforestation to stabilise the coastline have had mixed results for a number of ecological, social and administrative reasons.

c) Char lands

Both actively forming, recently reclaimed and old char land are the main feature of the southern Noakhali area. Each of the types of char land have distinct differences in the succession of natural and managed vegetation, settlement patterns and land use that are to be found in these habitats. Actively forming char lands are mainly under natural forms of floral and faunal primary colonisation systems. As they stabilise, colonisation and acquisition of land rights takes place. Management is initially based on systems of livestock grazing and temporary settlement. This is followed by land reclamation, cropping and planting systems which have to deal with problems of saline intrusion. This is followed by full settlement, homesteading and non-saline land and crop management, as full reclamation is achieved (often behind polders and with water regulation). The continued accretion of land has extended the coastline by up to 40 km since the 1950s.

Figure 2.15

Main Habitat Types

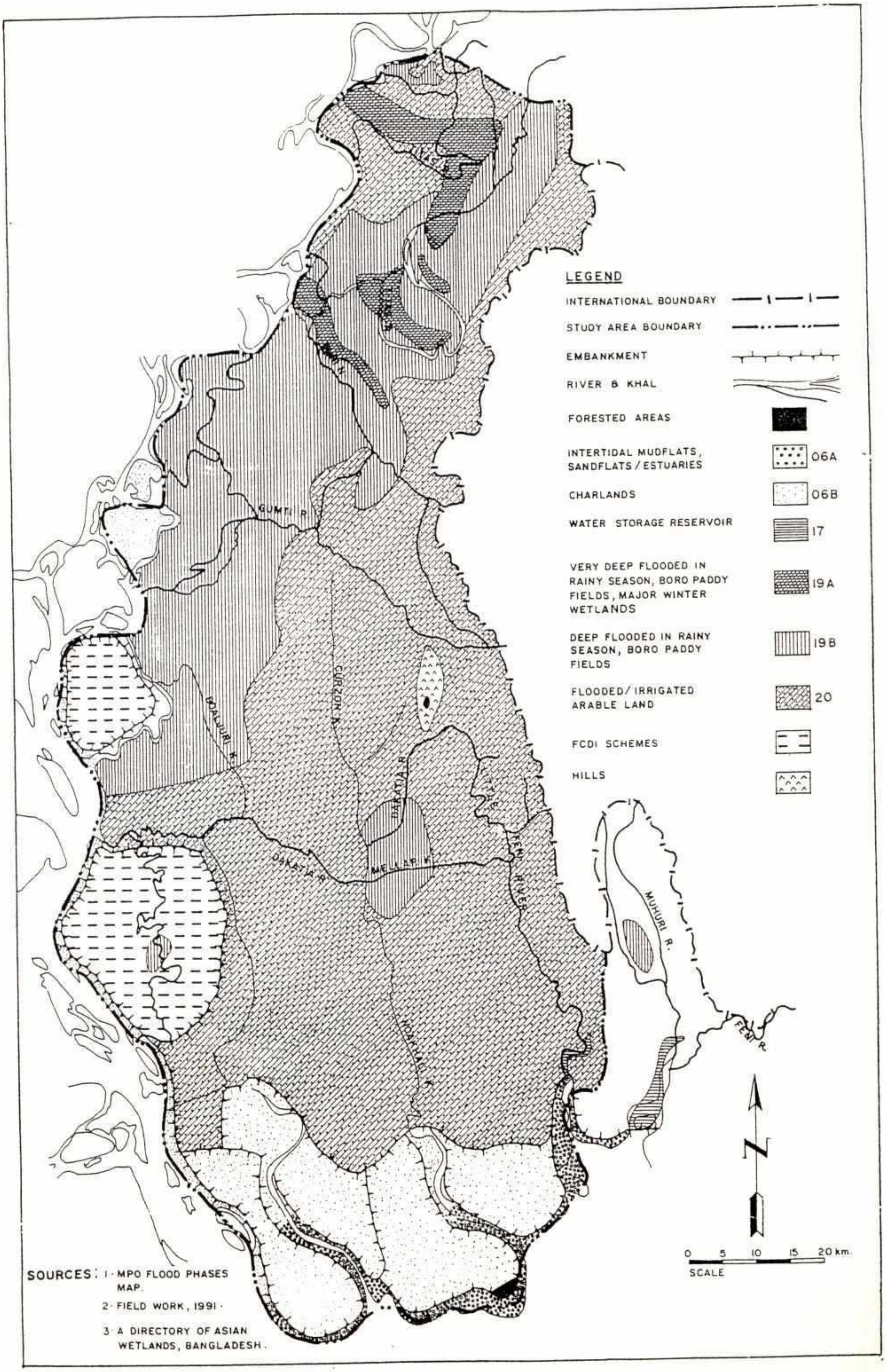
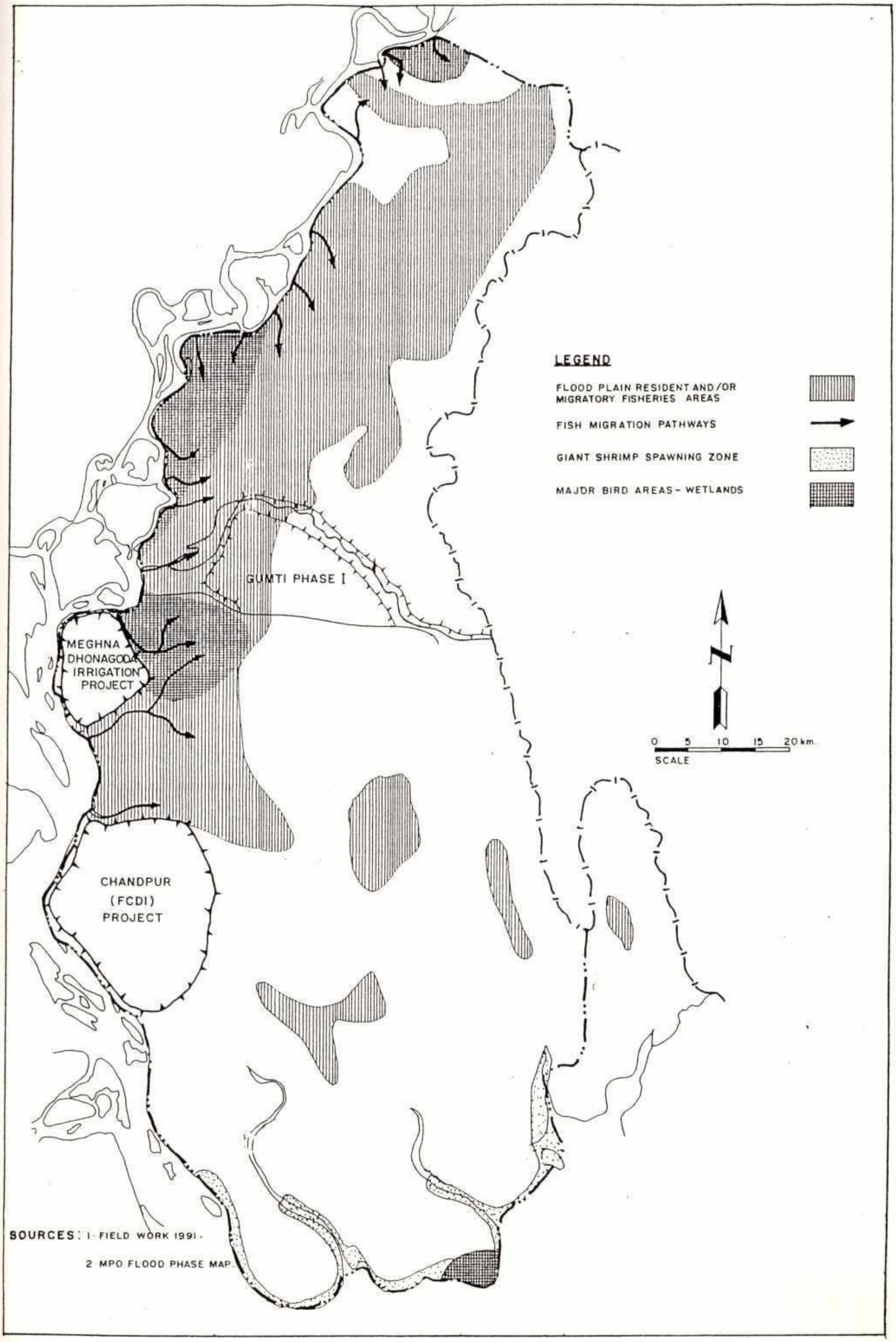


Figure 2.16

General Location of Birds and Fisheries Areas



d) **Homesteads**

Throughout the region there is a distinct habitat type which can be found in the immediate vicinity of homesteads. This is a managed agro-forestry and pond environment. For small homesteads these are the primary economic, ecological and social environment, mainly under the management of women. Where larger scale planting of coconut or betel nut occurs these are more the domain of men. Homesteads are of particular environmental importance as they provide the home and the main environment for children, livestock, minor nutritional and medicinal crops (including green leaf vegetables which are crucial sources of vitamins) and tree crops (which provide women's and family income, nutrition, shade and cover for other fauna). The habitat provides nesting, breeding and feeding sites for a host of locally important insects, birds, and small fauna, some of which have direct linkages to the health and productivity of the field ecology which surrounds the homestead. The homestead environment is thus a vital link in the social, economic and ecological systems which bind the whole landscape, ecology, economy and society together. It is a microcosm of multi-purpose production units that have been distinctly under-valued, under-rated, under-studied and ignored in most development planning to date. There are a number of key impacts which FAP projects could have on these systems which should be given careful consideration.

e) **Wetlands, Lowlands and Water Bodies**

The whole planning area of concern to FAP falls under this category. They form a vital link in the chain of landscape formation, maintenance of species diversity, cycling of nutrients and sustenance of the food chain, and in the control of pollution. The aquatic and seasonal terrestrial flora and fauna which they support are the basis of the survival strategies of many people. Adverse impacts on the poorest and minority groups dependant on these habitats are significant issues to be addressed by planning. The wetlands contain important habitats for migratory birds and also provide the habitats for a number of potentially threatened or endangered species.

The linkages between the lowlands, wetlands and water bodies are vital for the reasons described above. Understanding how they work and the services they provide is the key to appreciating the environmental management plan outlined in Chapter 5 of Annex IV.

f) **Fields and open country**

The main agricultural areas virtually coincide with the wetland and lowland areas described above. Some higher dry land systems do exist above these levels and would be directly affected by FAP projects. The flooded fields seasonally become part of the aquatic drainage and ecology system linking wetlands and homesteads. Even when drained, or on dry land, the linkages between different areas are also significant and poorly researched. The primary areas of interest are the linkages between different areas are also significant and poorly researched. The primary areas of interest are the linkages between the habitats for rice (and other crops), pests and predators int he fields, int he wetlands, in the water bodies and in the homesteads. There are basic relationships of feeding patterns, predation and maintenance of habitats and processes on which the productivity of the agricultural system depends. This not only affects pest and disease relationships, but also soil fertility and pollution levels. At present, the management of the system is ad hoc and simply the outcome of a whole range of unplanned and uncoordinated human activities in the urban and rural areas. Whether it can afford to remain that way, uninfluenced, is the subject of discussion in Chapter 5 of Annex IV.

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g) **Forested Areas**

The region once was covered in a dense network of dry land and wetland forest and swampy vegetation of which little now remains. The last sites of forestry are a small area (about 10 ha) of Sal forest near Comilla.

2.6.5 Flora and Faunal Ecology

bio-geographically Bangladesh lies at the juncture of the Indian Peninsula, Himalayan and South East Asian systems and thus has had a rich diversity of species. It has been the loss of habitat through increasing human settlement and population which has led to a decline in the biological resources.

In the region the vast majority of the winter wetland areas along the Meghna, Titas and Gumti rivers have been taken over for cultivation, replacing or significantly adapting the natural flora and fauna. Similarly, the adoption of HYV varieties has led to a decrease in the numbers of local rice varieties. The numbers of local varieties are not accurately known, but some estimates have put the figure at 10 000. The numbers remaining are not known. Efforts to create germ plasm banks have acquired around 4 500 varieties which can only be maintained for a period of 15 years, unless seed bulking programmes are carried out.

Due to the combined effects of loss of habitat and hunting (for sport, food and skins), the once rich wildlife status of the area has been severely impacted. This has affected birds, reptiles, amphibians, fish and mammals alike. This process started in centuries past and has accelerated in the last 200 years. The most dramatic losses have been of large mammals and ungulates, birds of prey, water fowl and certain reptiles and amphibians.

Further details of endangered species thought to inhabit area are given in Annex IV. The study was not able to carry out any original field work for the regional plan to confirm the current local situation.

a) **Flora**

The region can be divided into four major and three minor zones in terms of dominant vegetation and cover. In most of the region mixed areas of homestead and field vegetation exist which do not show variations in species composition which can be easily mapped without detailed field surveys. At the more detailed scale of mapping there are important variations in habitats where differences in species composition are important. The most important distinction would be between the aquatic and terrestrial species as indicated in Appendix G of Annex IV.

It is not known out of the 5 000 species in Bangladesh how many are to be found in the region, or the full ecological and economic significance of the diversity of the remaining natural flora. Whether there are any endangered species which could be affected by the FAP projects is not clear until detailed field work can be carried out. Provisions for this should be made in the feasibility stage but have not yet been allowed for.

The main focus of attention in planning is the inter-relationships which exist between these different areas in providing habitats suitable for pests and diseases.

b) Birds

The bird life of Bangladesh occupies a very important position int he worldwide avifaunal distribution, and particularly in that of South and Central Asia. The 660 species recently definitely recorded in Bangladesh represent about 50 % of the South Asian species and just more than 7 % of the globally known species. Of these there are some 220 which are migratory and 170 which are associated with wetlands. Over 70 of the water fowl species are now rare or rarely seen in Bangladesh. There are 71 resident and migratory species which have been definitely record in the SER. Of these, four are internationally important as the numbers are significant only in Bangladesh.

The wetland and coastal habitats are of importance for migratory birds, particularly of northern Asian origin. These include two types; those that over-winter in Bangladesh, and those in passage on routes to the Malayan Peninsular, the Indonesian Archipelago and the Australian sub-continent, and to the south and west to India and Sri Lanka. Another group of migrants comes seasonally from the Himalayan and Burmese hill and mountain ranges. The Typical habitats for these winter migrants are the seasonally flooded agricultural lands, the winter wetlands, forest remnant areas, the lower reaches and chars of large rivers and the coastal zone, particularly the offshore islands and mud flats. The main important habitat areas are shown in Figure 5.10.

Of the four significant international species the lesser Adjutant is dependent on the wetland habitats, while the Spoon-billed Sand Piper, the Green Shank and the Asian Dowitcher are found in the coastal habitats.

From the total number, 32 species might be affected by loss of habitat due to FAP projects. The significance of birds in planning is their diverse range of feeding habits and species. While some are pests and consume grain and food crops, many are insect and sediment feeders which consume considerable amounts of biological material. This plays a large part in the control of population numbers and preventing imbalances in the food chain.

c) Mammals

Records suggest that from over 200 species of mammal that were once common in Bangladesh over half have now disappeared or are seldom found. The primary impacts were seen in the floodplains in the last century and through to the 1970s. The loss of habitats has been so significant that little can now be done to restore the balance.

The few mammals which remain in the region are mainly small mammals adaptable to the new habitats created by human disturbance. The planning significance of mammals relates to their position near the top of the food chain, their role as predators on a range of smaller animals, and their feeding on crops in the field and in storage.

d) Amphibians and Reptiles

19 species of amphibian have been recorded in the country including ten species of frogs and toads. These have regularly been exploited. In recent years the problems of export of frog legs has led to a ban on trade in some species. Frogs and toads play and important role as predators on field pests. Research in BRRI has found this

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to be economically and ecologically significant. When taken together with the role of other fish and insect predators, the biological pest controls possible form the basis of an integrated pest management programme. This provides the major alternative to the agro-chemical approach to contemporary farming. This is the main avenue whereby pollution problems and wider loss of bio-diversity can be avoided. Many of these biological predators can also form productive sale assets in their own right, making the system a multi-purpose farming system.

Snakes are believed to have been the major causes of death amongst those who died during the floods of 1987/88. This was due to snakes and people alike heading for the high ground. It is reported that, in the last decade, there has been a considerable decline in the snake population in FCDI schemes. The cause of this is not known but is most likely to have been a combination of factors involving loss of habitats, agro-chemical pollution or disease induced by environmental stress in a rapidly changing environment.

e) Fish

There are 260 freshwater species which utilise the nation's rivers and floodplain and ponds. In addition there are 475 marine species which depend upon the inter-action between the land drainage system, the estuarine ecology and the marine nutrient and habitats systems. There have been 13 exotic species of freshwater fish introduced. Around 70 freshwater species are known to be marketed in the SER.

The wide diversity of fish species also reflects a wide range of habitats and feeding requirements from bottom feeders, herbivores, carnivores, omnivores. Fish in ecological terms sit at the top of the aquatic food chain. Their various feeding patterns also lead to controls on aquatic weeds, secondary disease vectors and crop pests. They are a vital link in the food chain and maintain the integrity of the floodplain and river habitats for other species and for human use. In the food chain they provide humans with a concentrated form of protein, oils and vitamins. Int he context of free access to a common property resource, poor people and fishing families depend on these sources for survival strategies, both in terms of nutrition and income. Many of these dis-advantaged groups also utilise the minor species which have less commercial value. Any loss of access to these free resources would be virtually impossible for FAP projects to effectively mitigate for the reasons which have been clearly identified under FAP 12 and previous evaluations.

Fish, as well as crustaceans are sensitive to contamination of their environment, and are thus good indicators. The outbreak of Epizootic Ulcerative Disease since 1988 has not been definitively researched or understood, but it is believed to have been imported from another country. The disease has been particularly prevalent in Thailand in recent years.

f) Insects and Fungi

There is very little information available on the diversity and role of insects and fungi, other than data on field pests available from BRRI and BARC. elsewhere, it is known that there are notable symbiotic relations involving fungi and bacteria which have economic significance in tree and field cropping. Fungi play a crucial link in decomposition, and the formulation of plant nutrients and a healthy soil environment. These are areas of vital research which are severely lacking in the floodplain and wetland circumstances of Bangladesh. This makes environmental assessment very difficult at this stage.

The key aspect for planning is the recognition that the linkages between the various aquatic and terrestrial habitats, and species of all kinds, have great value in the issues of pollution, bio-diversity, pest and disease control and maintenance of soil fertility, amongst others.

g) Micro Flora and Fauna

The primary basis of the flood chain and nutrient cycling is controlled by micro-organisms, in both the aquatic and terrestrial environments. All human activity is thus directly dependent on them. The role of micro-fauna and micro-flora in aquatic ecology in wetlands, beels, ponds, stream, and flood deposits from upper catchments is very poorly researched, given its key significance. The major external contribution of nutrients, apart from atmospheric sources, are brought into the floodplains by the annual floodwater. It is the organic matter and biological species from upstream which the waters carry that are of most significance to the planning process. There is no data to assess these processes and the impact which FCDI will have in preventing their entry into the floodplains and breaking the seasonal pattern of the natural regimes. the quantities of biological material will probably have key seasonal peaks which are of significance. the role of this material in the flood chain, nitrogen fixation and dynamic soil process has been alluded to in both the work of Brammer and BRRI/IRRI research. This has implications for the disease-pest-predator-population relations affecting crop and human health conditions. the floods also act as a biological control mechanism limiting habitat conditions and nutrient/pollution build up. This not only determines the nature of the micro-organisms in ecology, but also the habitats and population dynamics of larger animals like rats, mosquitos and insects.

Recent international research is also identifying the importance of nematodes. While nematodes have long been recognised as a source of potential crop damage, it is now apparent that there may be more nematode species worldwide than insects. They also are known to play a most important role in the breakdown of soil and benthic pollutants. Some research suggests that species diversity in contaminated soils can be higher than in unpolluted soils as a result of the response of nematodes.

2.6.6 Social and Cultural Environment

a) Historical Background and Settlement

The first historical accounts derive from the fourth century B.C. and the main archaeological remains start to arise from the 7th century A.D. onwards' although Palaeolithic fossil stone tools have been identified in the Lalmai Hills. A large number of archaeological sites have been discovered associated with the old regional kingdom of Samatata and its succession of religious affinities. These and other notable sites are listed in Appendix H of Annex IV. It is difficult to say definitively as to whether there will be any loss of important sites of national heritage as result of FAP projects. Based on the available information and type of development this is not believed likely to be an important issue, but should be reviewed in greater detail at the feasibility stage.

2.6.7 Quality of Life - Nutrition and Health

The health problems of the region are generated mainly by the poor socio-economic status of the population. The lack of access to income and employment are major benefits which are hoped to be associated with FCDI interventions. In an area so dominated by water, it is perhaps surprising to some that water-based diseases are

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not more of a problem. the main reason for this is the biological controls which the floods exert on limiting habitats and population levels of diseases and disease vectors. Nevertheless, the main water-related disease problems, of which diarrhoea is the most prevalent, are influenced considerably by both the hydrological regime and by poor sanitation and public health. These can only be effectively dealt with through careful detailed design and management of FCD schemes, closely coordinated with complementary programmes in the water supply and health sectors. While malaria is not a serious problem at present, cases are regularly recorded every year in the SER. It is endemic in the Chittagong area and in the Tripura Hills across the border in India.

The problems of poor nutrition are widespread. It is a complex area of research which the environmentalists have had no resources and insufficient time to appraise properly at this stage. The current access to common property resources, particularly fish, and the diversity of food and tree crop types, have been identified as important dietary implications which ought to be integrated into agricultural planning. These features of the current system all provide the basic nutritional complements to the main dietary consumption of rice. The diversity of protein, minor nutrients and vitamins provided from these other sources are essential to conserve under FAP planning if the basic minimum levels of nutrition are to be maintained at current levels, and if there is to be any hope of providing the minimum basic needs to all members of society in the future. This fundamental need cannot be adequately represented in the economic analysis of projects, or necessarily in the planning considerations of agriculturalists, given their background, training and planning perspectives. These limitations need to be considered carefully in the next stage of FAP planning. It is recommended that both public health and nutrition are given specific specialist inputs at the feasibility stage.

2.7 River Morphology

2.7.1 Introduction

The morphology of the left bank of the Upper Meghna is dealt with by FAP 6 and is therefore not covered in this report. The following are the major drainage channels starting from the Meghna-Padma confluence up to the Feni estuary which are tidal in nature and have some sedimentation problems:

- The Dakatia (new).
- the Rahmatkhali Khal WAPDA Khal,
- The Bagger Dona Khal
- The Noakhali Khal
- The Little Feni River and
- The Feni River.

Hydro-morphological conditions int he above channels are greatly influenced by the Lower Meghna and its estuary. These are therefore described first. It should be noted that river morphology in Bangladesh is in the research phase and in the absence of adequate data the findings are indicative, this chapter relies heavily on the reports of FAP 9B, the Meghna Right Bank, Short term study (Haskoning et al) and the Land Reclamation Project (LRP). The area is going to be studied further in FAP 5B the Meghna Estuary Study due to commence shortly. The Lower Meghna and its estuaries may be divided into the following reaches depending on their hydro-morphological conditions:

- The Padma-Meghna confluence,
- Chandpur to Haimchar,
- Haimchar to Motirhat,
- Motirhat to Boyer Char
- Boyer Char to Char Lakshmi
- Char Pir Baksh and adjoining areas
- The channel between Char Pir Baksh and Char Balua : from the outfall of Noakhali khal to the Sandwip channel (east of Sandwip).

2.7.2 The Lower Meghna & its Estuary (Figure 2.17)

a) The Padma-Meghna Confluence

The morphological condition at the Padma-Meghna Confluence has been elaborately studied under the Meghna River Bank Protection study (FAP 9B). They have rightly pointed out that a big char immediately upstream of the confluence (Figure 2.18) influences the morphological conditions at the confluence and further downstream significantly. The chars move progressively downstream in the Padma, as these chars reach the confluence with the Meghna the eastern or downstream tip is progressively eroded so that the char eventually disappears. However these chars in the Padma appear to form alternately near the right bank or the left bank of the Padma.

When the char nearest the confluence is near to the left bank of the Padma, the major flow in the Padma passes to the right of the char, i.e. to the north, in this case the Padma flow directly attacks Eklashpur. As that char moves downstream it is eroded. The next char is generally nearer to the north bank so that the major channel is near to the south bank, in this case the Padma attacks Chandpur town and the attack on Eklashpur diminishes. This cycle appears to repeat itself over a period of about 15 years. The ideal condition could probably b e to maintain both channels so that the intensity of erosion is less near both Eklashpur and Chandpur, but this may not be practicable with the present state of knowledge on river morphology.

The 1983 aerial photos indicate that the southern channel, which had disappeared by 1980 (Meghna river Bank Protection study FAP 9B), reappeared in 1983. The channel takes a definite shape as visible in the 1989 SPOT imagery. The channel appears to have further widened in the 1990 aerial photos. On the other had the width of the northern channel decreased from 1 750 m in 1989 to about 1 500 m in 1990. In spite of the decrease in the size of the northern channel, the entire left bank of the Lower Meghna up to Chandpur has shifted towards the east, Erosion at Eklashpur form 1989 to 1990 was about 50m. Mean annual erosion between 1980 to 1990 as per FAP 9B was 200m. The decreasing size of the northern channel has reduced the intensity of erosion near Eklashpur, while enlargement of the southern channel has increased erosion in Chandpur as predicted by FAP 9B.

The 1990 aerial photos show further char formation upstream of the major char on the Padma. This is likely to close the northern channel further during the next few years. The consultants for FAP 9B estimate that erosion at Eklashpur will start to increase by 1989 and erode a further 700 by 2004. The western bank of the Lower Meghna below the Padma char has shifted by about 900 m in 1989-90 towards the east.

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Figure 2.17

Morphological Changes in the Meghna Estuary

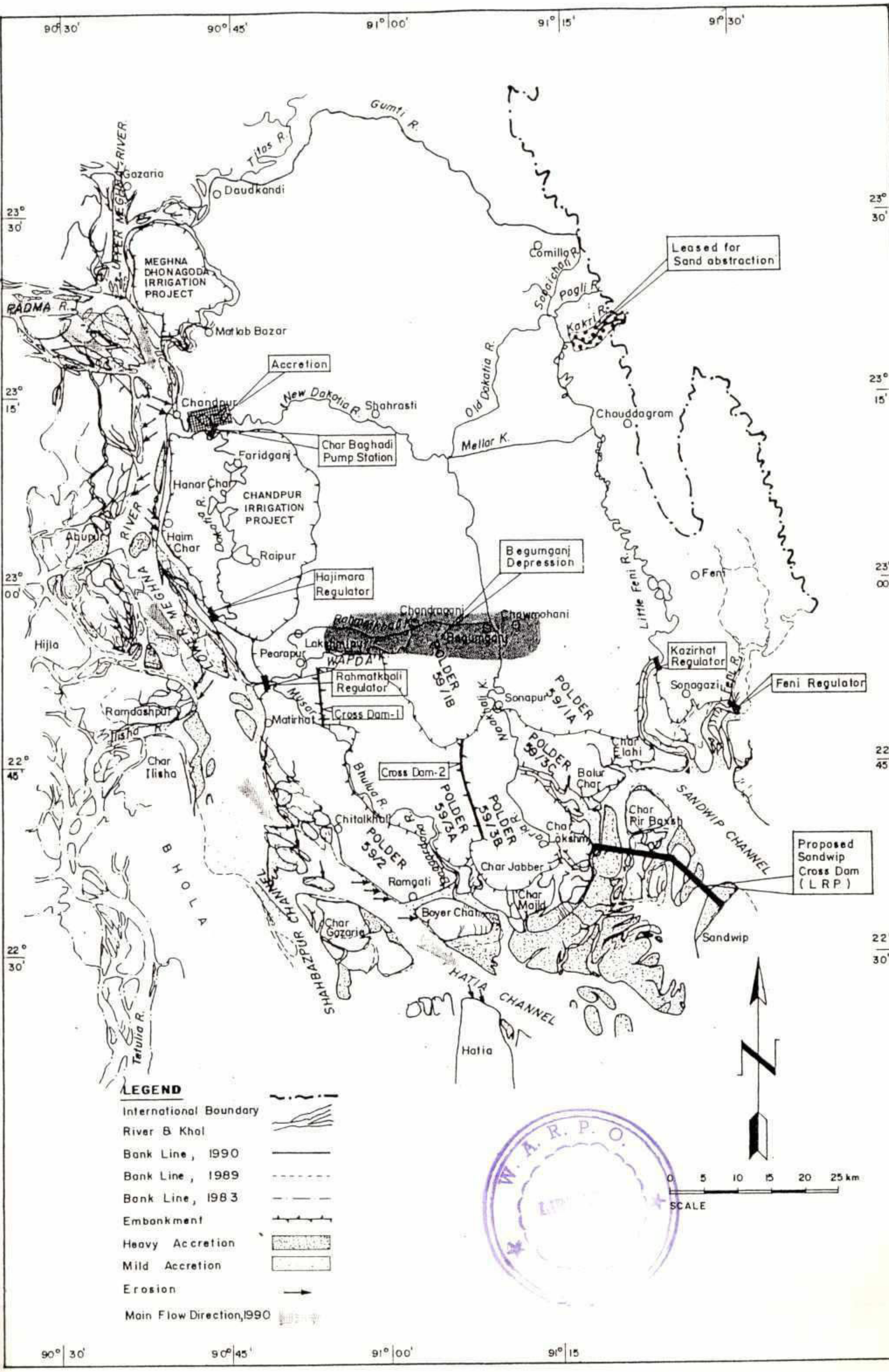
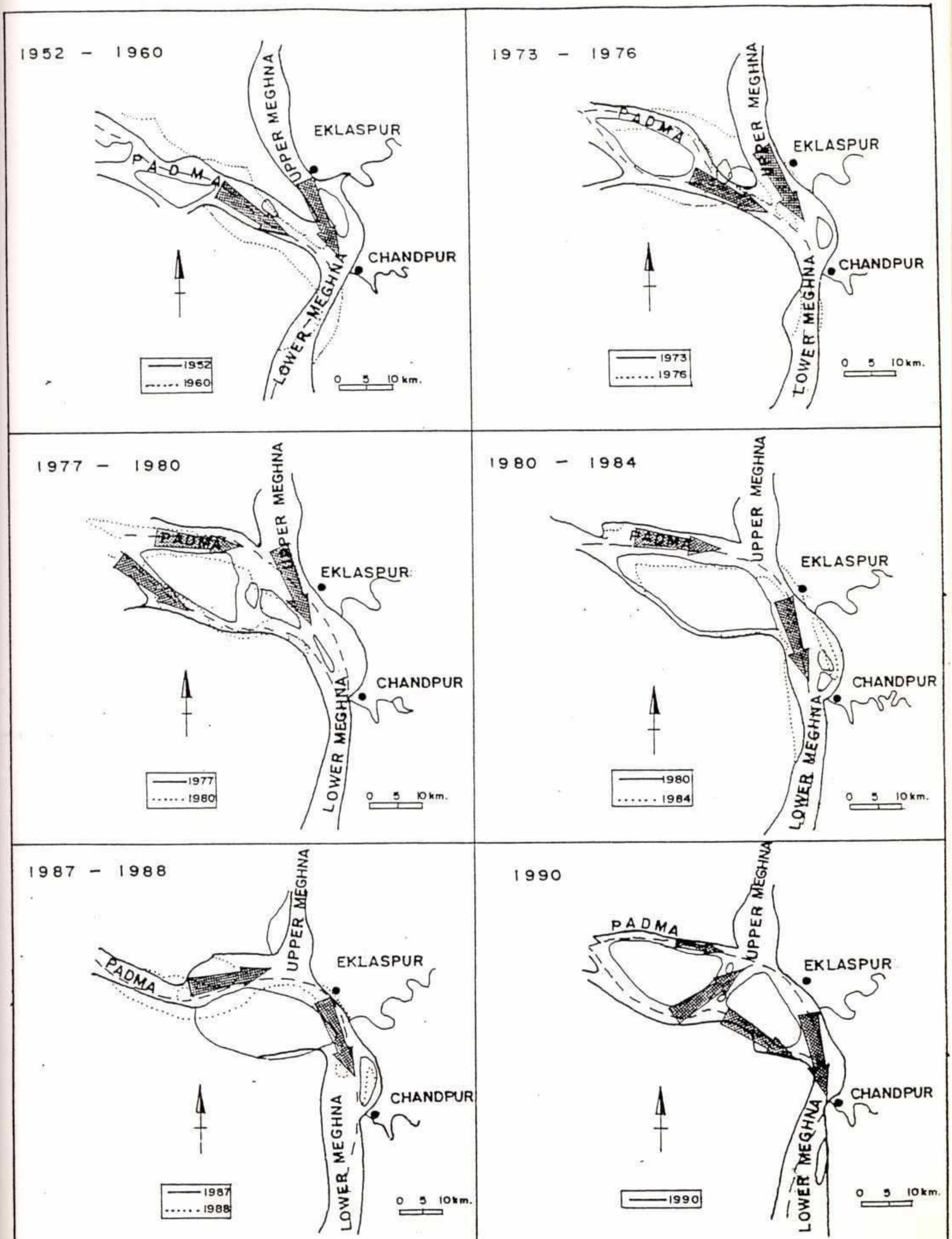


Figure 2.18

Confluence Padma - Upper Meghna - Lower Meghna, 1952-1990



Source: FAP 9B

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b) **Chandpur to Haimchar**

In this reach there is erosion on both the banks, however, erosion on the right bank appears to be more extensive. The 1989 SPOT imagery shows a long and narrow char formation along the left bank downstream of Chandpur. The char appears to be more prominent in the 1990 aerial photos. The 1989 SPOT imagery and 1990 aerial photos give a definite shape of the channel showing a gentle turn towards, the west and the forming of a bend at Abupur on the right bank where the river takes a turn towards the east. The 1989 SPOT imagery shows char formation near the bend which becomes more prominent in the 1990 photos. Formation of this char and the narrow and long char described above may decrease or stop erosion on the left bank in the reach but may aggravate erosion on the right bank near Abupur. Near Hanarchar at the inner bend (opposite to Abupur) no erosion was observed in 1989 and 1990, on the contrary in 1991 the bank at Hanarchar, just north of Haimchar was eroded confirming that Haimchar no longer appears to be critical. The erosion at Hanarchar is being tackled under the Systems Rehabilitation Project which is retiring the embankment, the reason for erosion at this location is difficult to explain, it obviously occurs at high water level when the river flows over the protecting char.

c) **Haimchar to Motirhat**

The channel took a turn towards the east in 1974 after cutting off Mear Char and the main land on the Hajiganj side (Figure 2.19) Mear char, visible even in the 1983 aerial photos, gradually disappeared leaving a triangular part near the west bank (SPOT imagery 1989 and aerial photos 1990 Figure 2.17. The east banks of the char, the Hijla island and the Ramdashpur island, form a smooth bend of the river except for a slight projection of Ramdashpur island which is now in the process of mild erosion possibly to further smoothen the curve.

In the past there was serious erosion on the eastern bank along Hajimara, Rahmatkhali and Motirhat (Ref. LRP reports). The 1989 SPOT imagery and the 1990 photos show char formation in the area. The river takes a straight line towards Motirhat and consequently does not erode the left bank which is in the the form of a bay, for this reason there is no char formation.

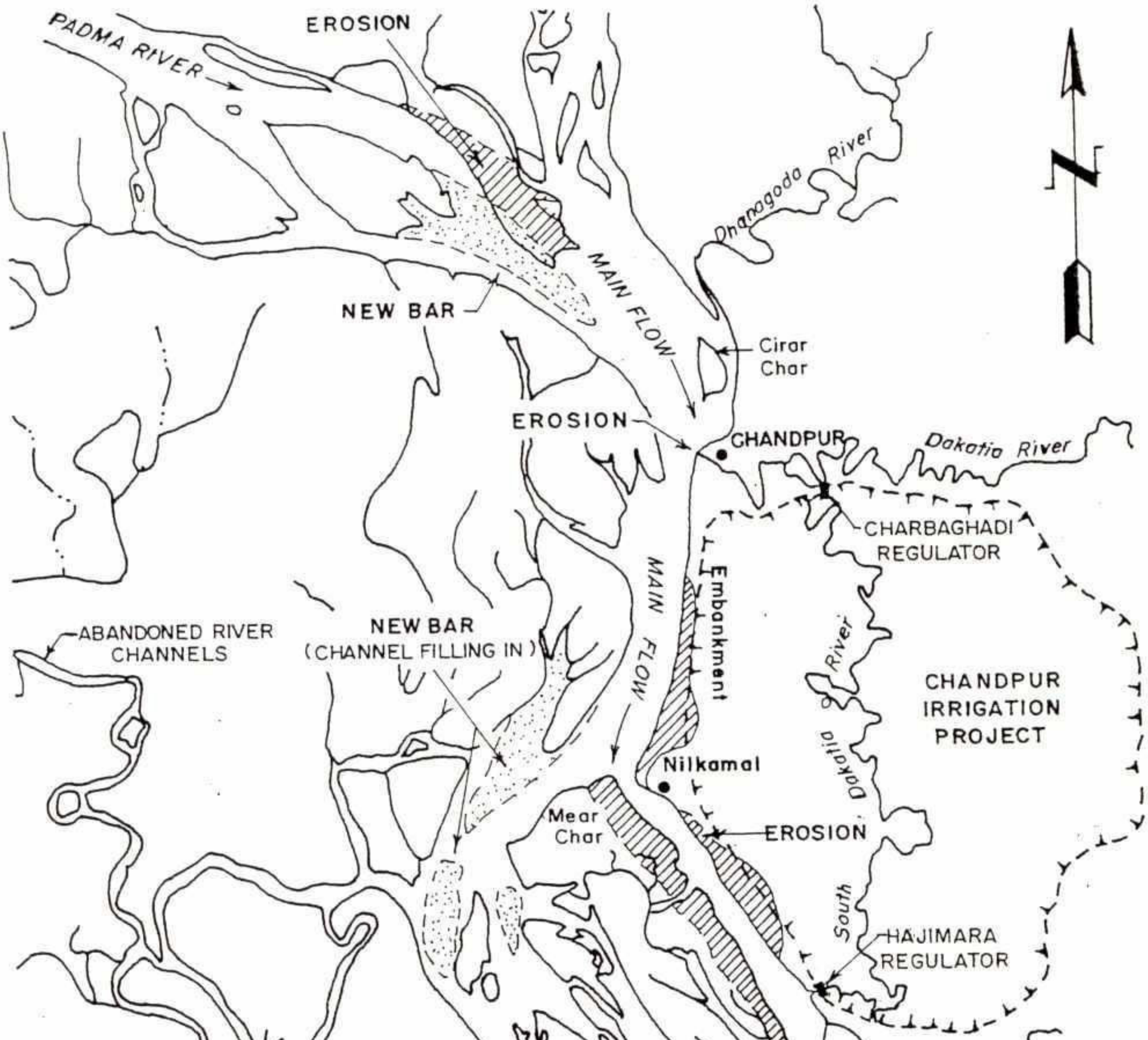
d) **Motirhat to Boyer char**

The west bank, on the northern side of Bhola island, has been under severe erosion for a long time. The 1989 SPOT imagery and the 1989 aerial photos indicate some recent tendency to accretion.

Downstream of this point, on the north of the Gazaria island, there are two small islands. Significant char formation is in process on the western side of the northern char decreasing the cross-section of the channel between the island and Bhola. The flow is therefore diverted through the other channel along Polder 59/2. This in turn causes erosion of both sides of the channel. It is likely that the channel will become prominent, aggravating erosion all along the bank of Polder 59/2 and the islands on the right bank. Currently there is minor bank erosion for a length of about 400 m at Matirhat, the effects of this may be avoided by very short retirement of the embankment.

Figure 2.19

Major Changes in Meghna River Due to 1974 Flood (GALA 1980)



Source: FAP 9B

e) Boyer Char to Char Lakshmi

This reach covers the southern coast of Ramgati, Boyer char, the Hatia channel (north of Hatia island), Baggar Dona outfall, and newly accreted land on the south of Char Jabbar up to the Char Lakshmi.

Meghna water spreads out after passing Polder 59/2, but the current is still strong on the north-west corner of Boyer char. The char is submerged during the high tides; the overland flow causes sheet erosion on the north western part of the Boyer char; however there is subsequent deposition towards the east and south-east. Erosion on the south of Polder 59/2 as described in the LRP reports (page 19, Main Report) is no longer visible in the 1990 aerial photos or in the field. The channel between Polder 59/2 and the Boyer char which was visible even int he 1989 SPOT imagery is hardly visible on the 1990 aerial photos. The 1990 aerial photos also show a tendency to accretion at the outfall of the Baggar Dona. There is extensive land accretion on the south of Polder 59/3B which continues up to Char Pir Baksh in the east.

Haita channel passing north of Hatia island, appears to be quite active in the 1990 aerial photos, though there is accretion on the northern side of the channel. The channel may become further active if the siltation in the channel east of Bhola island continues and more water is diverted through the eastern channel by Polder 59/2. The northern bank of Hatia will be further eroded. this may also erode the western bank of Boyer char. However there is likely to be further deposition on the east and south-eastern side of the char, as the increased flow from the Meghna will carry more sediment. Afforestation of the char may accelerate the deposition and minimise erosion.

f) Char Pir Baksh and adjoining areas

Rapid and extensive land accretion activities are going on in this area. Without going in to the long period changes a comparison of the short period changes in 1989 SPOT imagery and the 1990 aerial photos, indicate the following:

- There is extensive land accretion south and east of Polder 59/3B,
- The isolated chars between Char Lakshmi and Char Pir Baksh are now part of the mainland though the level of the accreted land is still low,
- All the four separate chars of Char Pir Baksh are now joined together,
- there is an extensive land accretion south and south-west of Char Pir Baksh,
- Intensity of accretion decreases towards the east and to the north as the distance from the major source of sediment, the Meghna, increases.

g) Noakhali Khal outfall to the Channel

The channel is still deep except the part north-west of Char Pir Baksh. In the case of the channels on the west and east of char Pir Baksh the main source of sediment from the Meghna has silted up, the sedimentation rate in the area will decrease even though LRP in their Feasibility Study on the Sandwip Cross-dam Development Scheme, 1987 (page D.13 and D.17) indicate that the amount of suspended sediment available from the Sandwip channel is more than the requirement. Nevertheless, even if there is extensive land accretion, a channel will remain here to drain the adjoining areas.

Land accretion is quite active in the area north of the line connecting the south Polder 59/3C width the Chittagong coast. The accretion process initially started after the closure of the Little Feni river during 1967/68 and accelerated subsequently after the closure of the Feni river in 1986. However a comparison of the 1989 SPOT imagery with the aerial photos of 1990 shows that the rate of accretion has decreased; there was virtually no new accretion south of the east west line referred to above; the present tendency is to stabilise the already accreted land in the north. Ultimately the entire area is likely to be silted up leaving only the outfall channels for the Little Feni and the Feni Rivers. Land accretion in the south has slowed partly due to the existence of a deep channel and partly due to the less suspended sediment in the water.

2.7.3 Rivers in the Study Area

a) The Dakatia River

Apart from a short reach at its outfall the Dakatia river appears to have decreased its width during the period 1983 to 1989. This is noticeable for the few kilometres upstream of the intake channel of the CIP pump station at Char Bagadi. There is practically no change in the width upstream but bed levels appear to have been raised at many places. However, it is difficult to measure the extent of siltation without reference cross sections.

Siltation downstream in the vicinity of the Chandpur Irrigation Project (CIP) pump station may be due to the decrease in the volume of tidal flow after the closure of the South Dakatia (main channel of the CIP) in 1980; but probably this has been stabilised. Siltation upstream may be mainly due to the sediment carried from the Lalmai Hills. Other sources of sediment are the Tippera Hills through the Sonaichari, Kakri and other flashy channels, however the rate of siltation may not be significant, maintenance every ten years would be adequate. However any dredging to improve the channel should not be very deep otherwise the frequency of O&M may increase, intensive dredging may induce bank failure. The extent of deepening the channel may be analysed at the time of detailed study and bank stability should also be considered.

b) Drainage Channels in the South

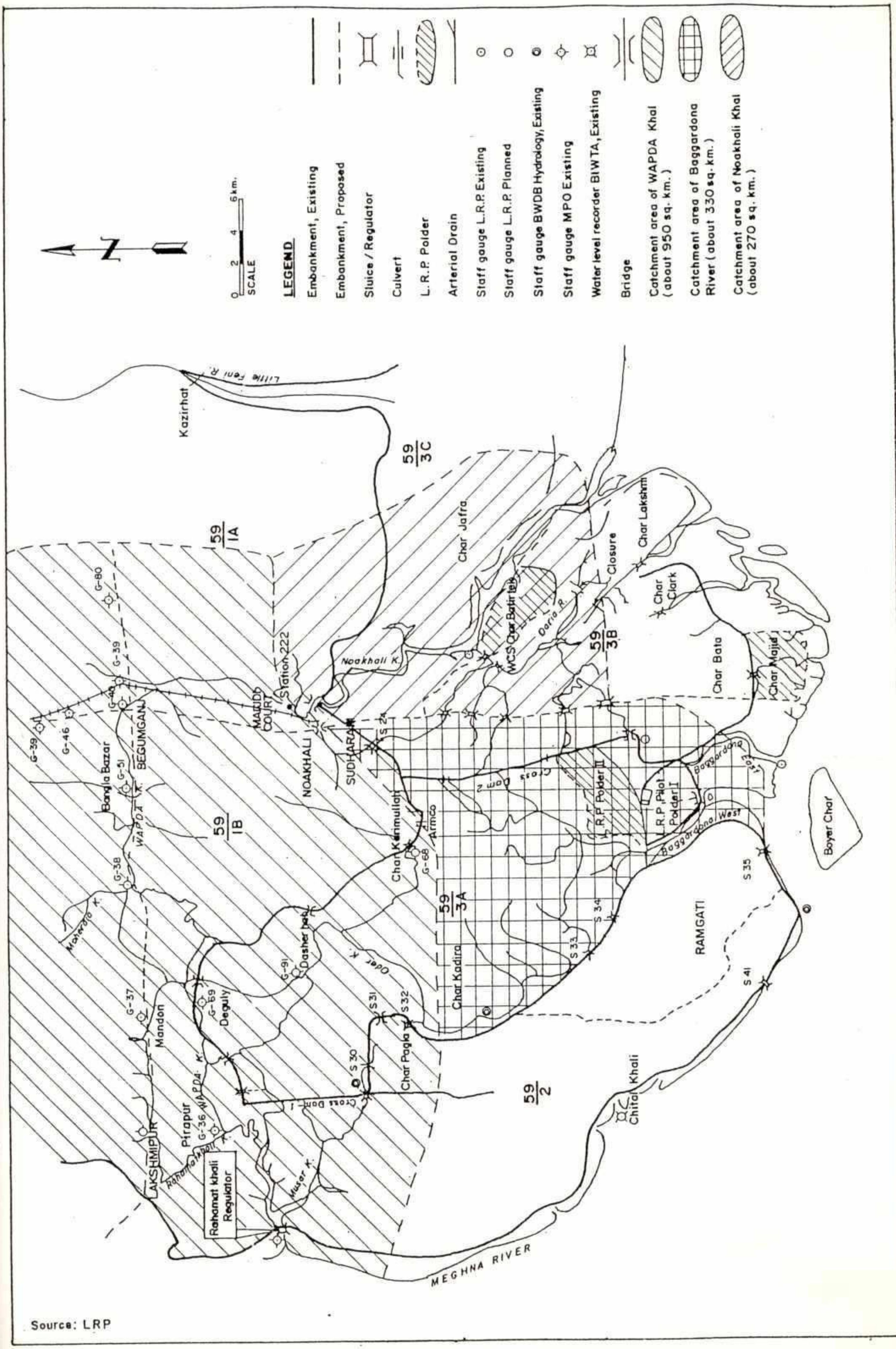
The Rahmatkahli kahl/WAPDa khal, the Baggar Dona khal and the Noakhali khal are the major drainage systems covering the area bounded by the Dakatia river in the north, the Little Feni River in the east, the Bay of Bengal in the south and the Polder 59/2 in the west. The total gross drainage area is as follows:

Rahmatkhali/WAPDA Khal		95 000 ha
Baggar Dona Khal		33 000 ha
Noakhali Khal		27 000 ha
	Total	155 000 ha

The catchment for each of the khals varies seasonally. The area shown above and in Figure 2.20 is for the late monsoon. Extensive analysis on each of the drainage channels have been done in the LRP reports. These are not repeated here. Only the important and new findings are dealt with.

Figure 2.20

Catchment Areas During Late Monsoon



Source: LRP

c) **Rahmatkhali/WAPDA Khal**

The Rahmatkhali Khal along with the WAPDA khal and the Rahmatkhali Regulator was constructed in 1975 under the Noakhali Comprehensive Drainage Scheme. The khal and the structure were originally planned to serve a much smaller area. At that time the Noakhali khal was still active and was the major drainage channel of the area. This will be discussed subsequently. According to the LRP report the existing capacity of the Rahmatkhali Regulator was just adequate for an area about 44 000 ha using a drainage co-efficient of 30 mm/day (less that half of the present area). After construction of the Meghna Cross-dam 1 (1956-57) and the Cross-dam 2 (1963-64) there was extensive land accretion towards the sea shifting the coast line by about 30 km, this is still in progress. The process has silted up the main drainage channel, the Noakhali Khal, at its outfall, its slope decreased significantly and the land in the south was raised up to the high tidal level (4.m PWD). On the other hand there was practically no deposition in the upper catchment of the Noakhali Khal, the Begumganj area, as the tidal effect did not reach there. The above processes created drainage congestion in the Begumganj area and raised the water level about one metre forming an artificial depression. At present part of the Noakhali Khal, from 6 km downstream of Sonapur, is drained back though the Rahmatkhali Khal increasing the catchment area to 95 000 ha and more during the pre-monsoon period.

Though the catchment area has been increased significantly the outflow through the Rahmatkhali/WAPDA khal has not been increased accordingly due to the restricted channel section and the capacity of the existing Rahmatkhali Regulator. In spite of that, both the channels and regulators are overloaded. High discharge and rain cuts have caused bank sliding in the khal which has consequently raised bed levels in the Begumganj to Chandraganj reach by about a metre or more. An attempt was made to re-excavate this channel under FFW programme in 1983-84 but was not completed fully Erosion is prominent in the reach from Piarapur to the Rahmatkhali/Regulator because of a steep water slope. Deep scour is observed immediately downstream of the regulator stilling basin indicating excessive flows through the structure. Deep scouring is also observed immediately upstream of the structure possibly due to the informal arrangement for taking irrigation water through the structure for which it was not designed.

Erosion of the Meghna bank at the outfall as discussed earlier, these almost stopped and may not be a major problem in the near future.

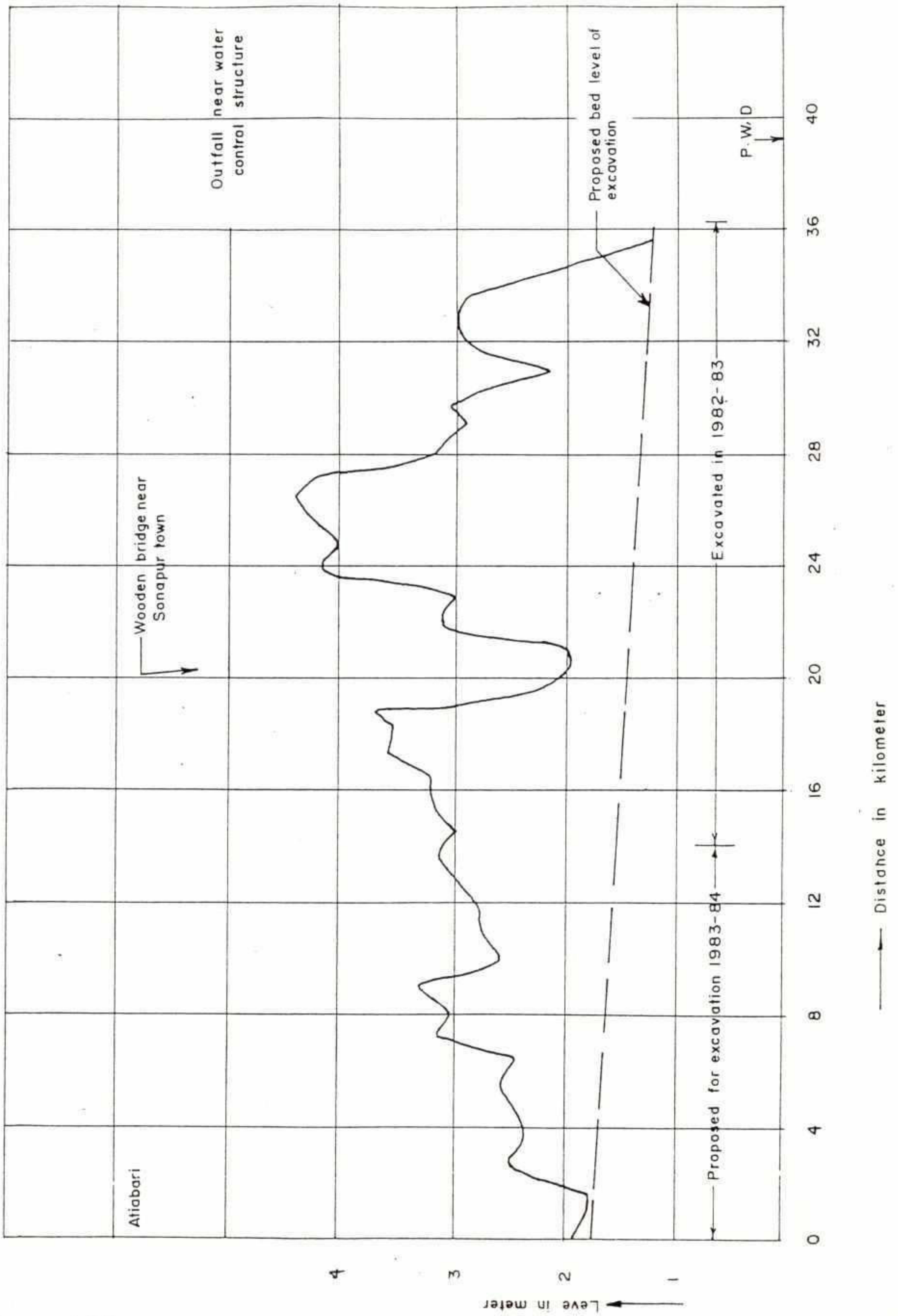
d) **Noakhali Khal**

The Noakhali khal was the main drainage channel for the area prior to 1955, falling into the Meghna river near Sonapur, and extending 30 km downstream near Char Lakshmi after the construction of the Cross-dam 1 and Cross-dam 2. The channel underwent many changes whilst shifting its outfall. The longitudinal slope has decreased and the cross-section has also decreased due to the decrease of tidal prism. From Figure 2.21 it appears that a negative slope has developed at km 28, six kilometres downstream of the bridge at Sonapur due to the formation of a bar up to an elevation of 4.2 m PWD and extending for a distance of about 3.5 km. The channel and the bar were re-excavated more than once in that part, but have quickly silted up.

It is therefore prudent to close the channel somewhere near the bar or downstream and divide the catchment into two. Drainage upstream of the closure may be diverted either through the Rahmatkhali or through a new drain out falling at Chitalkhali or Baggardona whichever is more feasible. The bank at Chitalkhali is no longer accreting or eroding. Therefore, contrary to the prediction of LRP, this location may be suitable for siting an outfall structure.

Figure 2.21

Long Section of Noakhali Khal Surveyed in 1981-82



Source: LRP

The channel section downstream of the proposed closure will continue to decrease in consequence of the decrease of the tidal prism but it will continue to extend eastward through the channel north of char Pir Baksh to meet the local drainage requirements.

After the closure, siltation in the upstream will be mainly stopped and normal maintenance will be required for any siltation.

e) **Bhulua/Baggar Dona Khal**

The Bhulua/Baggar Dona khal drains about 33 000 ha, 62% of Polder 59/3A and 33% of Polder 59/3B. Like Noakhali khal, this channel has also silted up after the construction of the Meghna Cross-dam 1 and Cross-dam 2.

The channel was re-excavated in 1988 at the critical reaches but did not work (Figure 2.22) The figure indicates that the outfall of the channel was still deep in October 1989. But a comparison of the SPOT imagery 1989 and the aerial photos 1990 shows further siltation in the area. Therefore it may not be desirable to maintain the channel for any major drainage. A supplementary report of LRP, March, 1990, also considers that the Baggar Dona is a dying river. Accretion is still occurring and for this reason Polder 59/3A has not been completely empoldered, and it should not be empoldered until accretion has slowed down.

f) **The Old Dakatia/Little Feni River**

The drainage basin of the Old Dakatia/Little feni River is bordered by the Tippera Hills, and the Feni Sonagazi Road, by the Gumti River and a natural ridge on the western boundary as shown in Figure 2.23. The total area is about 500 sq. km. The upper reach above the Gunabati Railway Bridge is called the Old Dakatia and the southern part is the Little Feni. The channel was developed by cutting the loops and re-excavation during the late fifties, seventies and eighties and constructing a regulator across the channel at Kazirhat. drainage congestion is still a problem partly due to heavy siltation at the outfall of the Kakri river (discussed below) and partly due to the tidal deposition downstream of the regulator. The coast line which was 12 km from the structure had moved to 20 km away by 1990. The active length of the channel downstream of the structure is silted up and every year about four km is excavated at a of about Tk. 3.5 million. Even then it takes between four and six weeks for the channel to be completely cleared in the early monsoon flood.

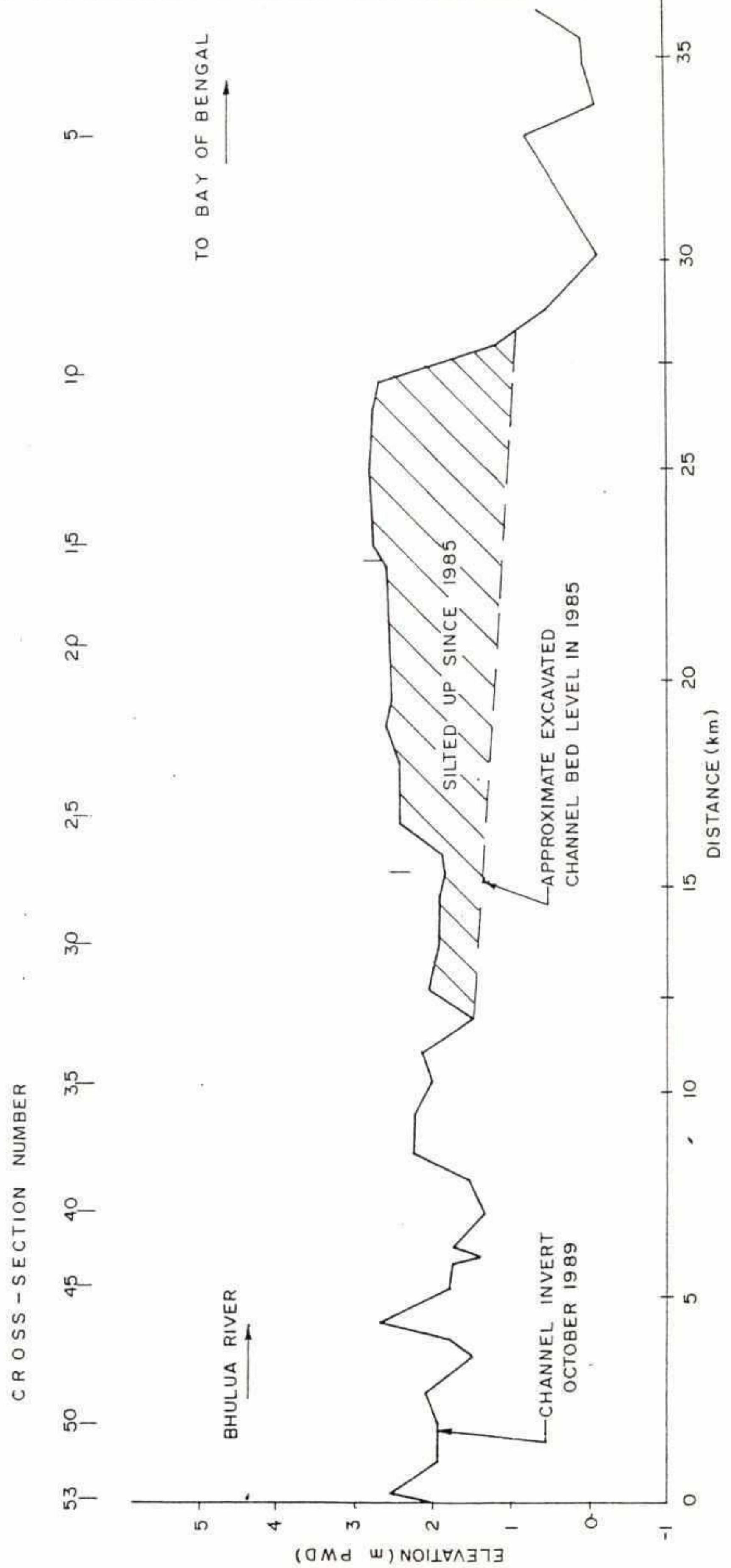
Although the siltation within the channel is heavy, a comparison of the recent SPOT imagery (1989) and aerial photos (1990), shows that the rate of accretion at the outfall has decreased. Therefore, a second regulator at a suitable location in the downstream may minimise the present siltation problem.

g) **The Feni Estuary**

The Feni River was brought under control in 1986 by the construction of a regulator and a cross-dam at the outfall. This resulted an extensive land accretion in the estuary covering an area of about 5 000 ha. The accreted land has almost extended up to the Little Feni outfall. but, as stated above, the rate of horizontal expansion has decreased in the recent years, possibly due to the existence of high water levels. However, it appears that the already accreted land is in the process of consolidation, and settlement will be considered in the proposed Settlement and Rural Development Project which is planned to commence this year.

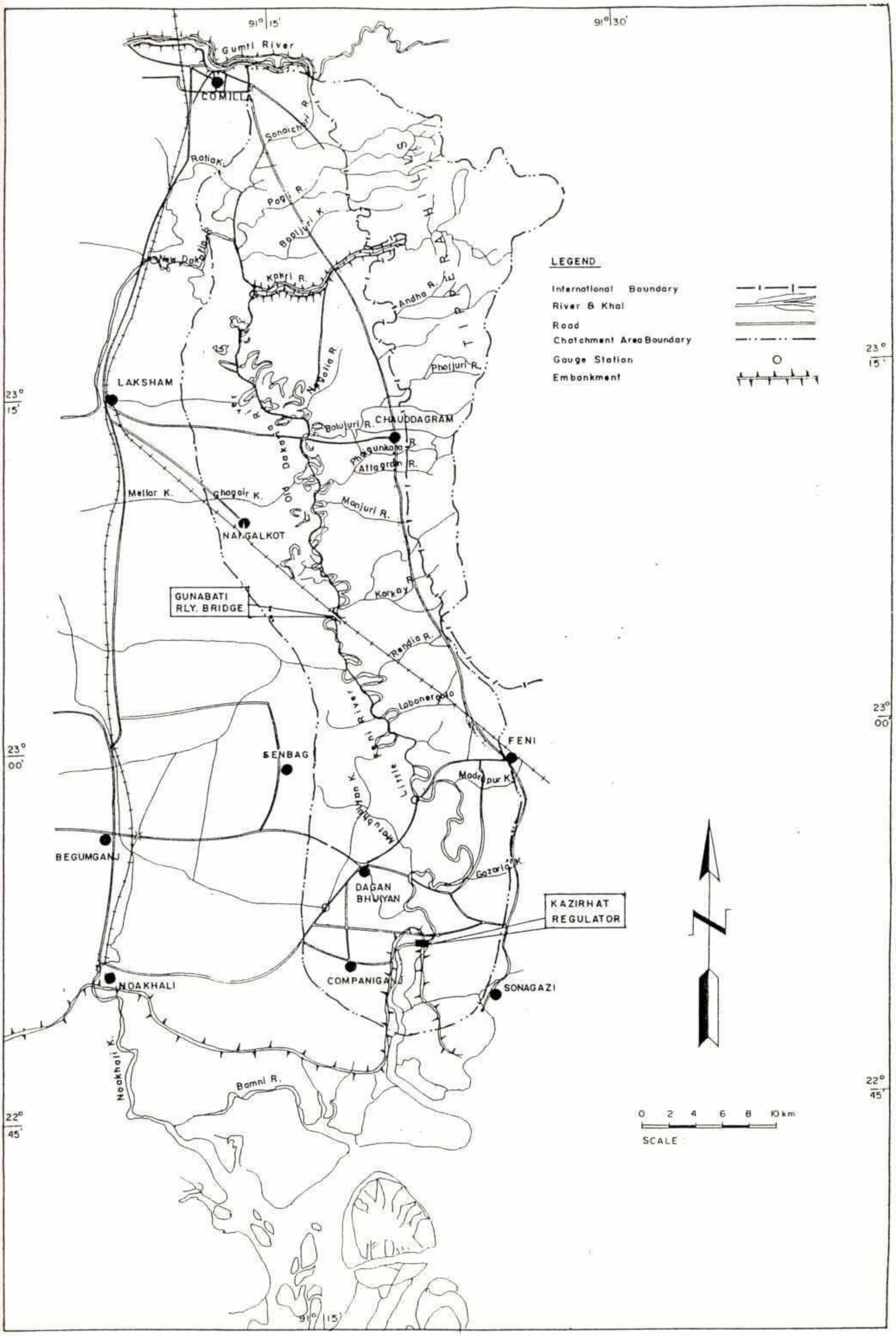
Figure 2.22

Bhulua River Profile



Source: LRP

Figure 2.23
Little Feni River Catchment Area



h) **The Eastern Flashy Rivers**

All of the flashy channels coming across the Indian border from the Tippera Hills carry heavy sediment load along with flood water. These are coarse sand to fine silt. In some areas these are beneficial for land development specially in the northern areas in the Titas flood plain. In some other areas these have serious adverse effects. Notable among these is the Kakri River in the Chauddagram thana. The River Kakri carries about 60% of the total flood water from the eastern rivers between the Gumti river and Feni town. The sediment load is proportional to the discharge and chokes up the channels and affects the agricultural land seriously. However the sand being coarse in size has commercial value for use as a building material. Every year the government leases out the river stretching from the bridge under the Dhaka Chittagong highway up to the Indian border (upstream), for extracting sand for commercial use. It is reported that the average annual extraction is about 30 000 cubic metres with a net commercial value of about Taka one million (gross Tk 2.0 million). Much of the sediment carried downstream of the highway are of finer quality and do not have any commercial value. However this does not appear to cause any serious siltation problems on the Kakri river possibly because of its high velocity, but this creates serious problem in the outfall channels (Old dakatia and Little Feni) where the gradient is very small. Consequently a stretch of 10 km to the south and 4 km to the north of he outfall of the Kakri river is silted up. There is no reliable data on the volume of siltation but it is reported that silt clearance after every five years may be adequate for effective maintenance of the channels. A comprehensive data collection programme is required to evaluate these problems before a definite solution can be identified and costed.

Silt carried out by the Boaljuri river is not significant and may be effectively used for reclaiming the beel areas near its outfall as long as this is found to be environmentally sound; there could be a conflict with fisheries. Siltation problems in other rivers in this area are not significant.

i) **Small Barrage Project on Three Minor Rivers**

The Hawrah river in the north, is another flashy channel coming form the Tippera hills and falling into the Titas. The average maximum discharge of the river is about 160 m^3/sec according to the Inception Report, Small Barrage Projects on three Minor Rivers, while the average minimum discharge is only 3m^3/sec. Data on the silt load is not available but it is reported to carry a large quantity of silt which is deposited low lying areas in the downstream and is beneficial for land development. Local people have constructed dwarf embankments on both banks of this channel from the Indian border up to Gangasagar Railway bridge very close to the channel. consequently these are breached almost every year. During the dry season the farmers build a number of earthen dams across the channel and divert the water for irrigation. Inlet sluices have been built in the embankment for such diversions. The earthen dams area worked out during the following flood season.

In consideration of the public interest the government decided to construct a small barriage across the river. Accordingly a Feasibility Study for the project was started in May 1990, but it was postponed after submission of the Inception Report (June, 1990) due to the proposed commencement of the South-East Regional Water Resources Development Programme. It now form part of Planning Unit 13 - Titas.

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CHAPTER 3

WATER RESOURCES

3.1 Surface Water Resources

3.1.1 Introduction

The seasonality in surface water resource availability in Bangladesh is extreme. In considering the surface water resources available to the South East Region, and planning their utilisation, the following distinctions must be made:

- the internal resources comprising locally generated rivers and khals, and the larger Titas, Gumti and Muhuri rivers which have significant catchment areas in India;
- the resources of the Meghna.

The indications of previous investigations have been that the internal surface water resources of the region are effectively fully utilised, and that any future surface water irrigation would be dependant upon transfers from the Meghna. There is competition for Meghna resources from potential projects in other parts of the country, and this, coupled with the potential impacts of saline intrusion and morphological change induced by such development, requires careful consideration at the national level. This is a function of the WRPO. Issues such as this have been addressed in the National Water Plan Phase I and Phase II, but effectively the Meghna is the only surface water resource available to the region.

3.1.2 Internal Resources

The inter-linkages in the drainage system of the region have been outlined in Chapter 2. The system is complex, and in terms of surface water resources development and evaluation, a holistic view is required. Developments in one area are likely to impact on water users in another. Further complications relate to the nature of the hydrological system, the extent of existing water use and irrigation, and the lack of long term reliable streamflow records in the region. It must be said, however, that even were such records available, the dynamic nature of the river systems, and of changing irrigation demands and practices, would have made their analysis particularly difficult.

Evaluation of the internal surface water resources of the region has been based on the results of the water balance model, as recently updated by the MPO (Ref 2). The water balance model was originally developed in 1982 for water balance studies of the northern regions of the country, and extended to cover the southern regions in 1985 under the MPO. In Phase II of the National Water Plan, the model was updated to include hydrological data up to the 1988/89 water year, and the calibration verified with more recent data which included higher levels of water use. The results of the water balance model, as related to the South East Region are presented and discussed in Annex VI. They indicate no internal dry season resource availability.

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3.1.3 Major River Sources

The river system comprising the Jamuna, Ganges, and Meghna, provide an average annual fresh water outflow to the Bay of Bengal of approximately 800000 Mm^3. Any analysis of the availability of water in the Meghna to meet potential requirements in the south-east region would be beyond the scope of the present study. Potential availability and constraints have, however been defined by the MPO under the NWP Phase II study (Ref 2).

In general, the potential availability from major rivers is constrained to a greater or lesser degree by salinity levels, which increase during January through to March as fresh water inflows reduce. Salinity levels to the south of the Ganges and west of the Lower Meghna have worsened, whilst salinity levels in the Lower Meghna generally remain low due to its high inflows, even during March. It was found by the MPO (Ref 5.1) that the 80 per cent reliability flow in the Lower Meghna during March, over and above that required to maintain salinity within desired limits, is approximately 3500 m^3/s. Future anticipated development diversions in the Lower Meghna will reduce this figure to 1500 m^3/s.

3.1.4 The Water Resources of the Muhuri Irrigation Project

The Muhuri Irrigation Project (MIP) is strictly speaking not within the study area of the South East Region Water Resources Development Programme. It lies just outside its south-eastern boundary. However, the Terms of Reference require the Consultants to 'make an operational study of the reservoir for the existing cropping pattern and the post-project recommended cropping pattern to determine the augmentation requirements of the reservoir for the original command area of 20 000 ha, the additional area that could be taken up above the project boundaries and for flushing requirements to keep the outfall canal free of silt to facilitate operation of the regulator gates at the onset of the monsoons'. This need for augmentation is based upon the assertion that 'irrigation withdrawals by riparians above the Muhuri Irrigation Project boundaries and the dry season discharge requirements for flushing of tidal silts led to inadequate water in the reservoir during February/March to command the irrigable area of 20 000 ha'. These topics are addressed through an evaluation of the water resources of the Muhuri/Feni basin within Bangladesh and their need for augmentation. Development options are considered in Chapter 5 of Part 2 of the Main Report. A full assessment of the water resources potential is presented in Annex VI.

Muhuri reservoir has an active storage capacity of 25.7 million m^3, and a surface area at full supply level of about 21 km^2. The range of operating levels is only 1.2m.

The concerns raised about the operation of Muhuri Reservoir, may be summarised as follows:

i) loss of active storage within the reservoir through siltation;

ii) increased abstraction by low lift pumps from the river system upstream of the reservoir, thereby potentially reducing inflows;

iii) the instability of the outfall channel downstream of the regulator and the dynamic nature in which this is changing and land accreting;

iv) the requirement for gate opening to control siltation immediately downstream of the reservoir during the dry season;

v) through the above, the potential loss of irrigation command from the reservoir.

Hydrological reservoir operation studies have been carried out in order to address some of the above issues, and hence to determine more precisely the total area which may be irrigated by existing surface water resources.

Reservoir siltation has been investigated. It is estimated that the live storage of the reservoir will be halved over a period of 50 years. The gross storage of the Muhuri reservoir at full supply level is only about 60 million m^3, whilst mean annual inflow is of the order of 3 800 million m^3. The trap efficiency during the main monsoon season should not therefore be high. The greatest sediment inflows will occur during the months of June to September. Irrigation demand in these months is low, and operational policy should be to keep reservoir levels as low as possible during these months, thereby minimising loss of active storage. Such a policy is obviously also advantageous from a flood control point of view, although it is understood that some fisheries interests may be affected. Reservoir simulation studies indicate that if the reservoir is filled in October, suitable levels of reliability in supply can be maintained.

The objective of the reservoir operation studies was to assess the reliable yields from the reservoir for irrigation supply. Over 50% of the Muhuri Reservoir catchment area lies in India. Inflows on the Muhuri River are gauged at Parsuram, with records dating from 1965. The Feni River is gauged at Kaliachari, and records data from 1975. Records at stations were extended and infilled using a combination of correlation and stochastic techniques. Runoff generated from the catchment in Bangladesh was simulated using the Water Balance Model.

A simulation of the reservoir operation has been carried out using a time series of monthly inflows and rainfall (1964-89), and specified monthly evaporation and releases. The reservoir model has been used to assess:

i) Whether full wet season drawdown is feasible.

ii) What additional releases are possible from the reservoir, while maintaining 80% reliability of supply in each month of the irrigation season.

It has been found that the reservoir can be kept at its lower operation level of 8.5 (2.59m) feet during the months of June to September, and will fill reliably in October. Although model results have indicated that the reservoir will remain full through November, the variability in October flows is such that any delay in filling beyond the end of September is not recommended.

The results of the simulation are summarised in Table 3.1. The prescribed minimum monthly releases have been set on the basis of:

- a gate flushing allowance of 3.0 m^3/s (see Section (d) below)

- irrigation water requirements for an additional 6 000 ha of irrigated area, on the basis of the irrigation duty implicit in the water balance model (0.75 l/s/ha).

TABLE 3.1

Simulation of Muhuri Reservoir Operation
Minimum Release in March For Gate Flushing and Additional Irrigation
7.5 m3/s. Minimum Dry Season Operating Level 8.5 feet (2.59 m) Above SOB Datum.

Gross Capacity 57.9 Million Cubic Metres

Units-million cubic metres unless stated

	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Prescribed minimum	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	month-end storage
Prescribed minimum	27.2	16.11	296.01	339.21	339.21	296.0	10.7	11.7	16.1	16.1	16.9	20.1	monthly release
Monthly evaporation(mm)	183.0	183.0	135.0	140.0	140.0	134.0	131.0	108.0	96.0	103.0	123.0	169.0	
Monthly rainfall(mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Assumed monthly seepage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Full Inflow Sequence

Year	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1965/66	34.2	87.0	462.9	932.9	1224.8	499.5	264.4	103.7	40.7	39.6	19.4	8.8	3718.0
1966/67	16.8	92.7	411.4	497.4	1084.2	623.4	333.7	110.7	95.6	58.4	25.9	33.7	3384.4
1967/68	57.0	176.8	347.1	763.6	695.3	507.3	311.2	73.1	22.2	25.2	12.8	22.5	3014.1
1968/69	59.6	369.4	1153.4	1276.8	668.5	377.9	161.5	79.1	23.8	28.1	14.5	15.3	4227.9
1969/70	129.9	90.3	675.0	883.6	1151.4	482.6	176.2	84.8	27.3	29.5	14.5	6.2	3751.2
1970/71	49.8	139.8	415.2	1065.7	735.2	355.1	396.7	134.8	41.5	37.2	17.2	3.53	392.2
1971/72	93.8	292.5	531.6	961.8	880.7	466.8	270.5	106.0	35.6	31.1	16.8	16.6	3703.8
1972/73	45.4	109.3	403.3	467.6	1009.5	204.0	135.3	53.1	11.2	16.9	6.3	9.9	2471.8
1973/74	49.8	712.2	682.5	719.7	590.1	362.9	191.8	234.6	91.9	52.5	18.4	15.3	3721.4
1974/75	66.6	318.2	702.4	1752.7	1072.2	723.4	608.5	168.7	74.7	58.7	36.3	24.1	5606.6
1975/76	11.7	72.6	167.4	1021.0	419.7	430.8	552.3	219.5	71.0	46.9	19.5	29.2	3061.6
1976/77	25.9	136.1	813.6	734.7	618.7	267.5	150.0	76.5	28.4	23.8	15.7	4.8	2895.7
1977/78	410.1	428.8	916.8	923.0	673.3	361.6	233.6	91.8	22.0	31.3	15.2	7.0	4114.4
1978/79	20.7	637.2	988.1	731.5	424.0	611.2	195.8	78.0	29.5	25.7	14.3	6.4	3762.3
1979/80	30.6	66.2	280.7	1258.3	857.6	515.5	207.8	116.1	51.7	31.9	16.0	29.5	3462.0
1980/81	10.1	371.8	311.8	437.9	753.7	464.5	293.8	73.9	3.2	6.4	10.2	18.5	2755.8
1981/82	261.5	341.2	498.7	2035.6	711.7	257.1	112.2	39.7	1.3	8.8	8.2	-4.8	4271.3
1982/83	43.3	35.9	593.0	317.4	3106.7	994.3	164.7	77.2	26.2	30.5	33.1	60.8	5483.3
1983/84	293.7	763.3	289.5	1019.1	1454.9	296.3	464.2	99.3	57.6	55.2	25.6	1.6	4820.2
1984/85	10.1	666.4	460.1	1452.2	597.0	553.1	290.1	75.4	31.1	30.5	19.8	19.8	4205.7
1985/86	87.9	285.0	712.8	771.1	754.5	273.2	105.3	52.6	14.7	21.4	8.0	-3.5	083.0
1986/87	127.3	132.0	269.0	774.9	417.6	433.4	433.9	284.6	45.0	40.7	14.3	38.6	3011.2
1987/88	260.2	89.7	336.2	1130.0	1359.0	804.6	229.3	113.3	35.1	25.4	15.3	51.2	4449.3
1988/89	43.8	688.3	727.1	1624.2	792.5	700.9	505.4	129.6	60.5	47.4	26.1	10.7	5356.6
Mean	93.3	295.9	547.9	981.4	918.9	482.0	282.8	111.5	39.2	33.5	17.7	17.7	3821.8
CV	1.13	0.80	0.46	0.43	0.59	0.39	0.50	0.54	0.65	0.43	0.42	0.92	0.23
Skew	1.8	0.8	0.7	0.8	3.0	0.9	0.9	1.6	0.8	0.2	0.9	1.1	0.7

Values Equalled or exceeded 80% of the time (Not an homogeneous sequence)

	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
X(I)	21.9	89.83	17.37	22.36	01.93	09.51	62.27	4.2	22.02	4.1	13.1	5.1	3024.8

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TABLE 3.1 (Contd)

Month-end Storage
Million Cubic metres

Year	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1965/66	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	57.7	43.9	577.9
1966/67	32.2	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	57.9	57.9	566.3
1967/68	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	51.7	53.6	581.5
1968/69	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	52.9	46.9	576.0
1969/70	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	53.9	38.4	568.5
1970/71	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	56.5	36.4	569.1
1971/72	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	55.5	48.5	580.3
1972/73	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	51.1	50.0	37.5	32.2	531.2
1973/74	53.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	56.8	50.8	579.8
1974/75	57.9	57.9	32.2	57.9	32.2	32.2	57.9	57.9	57.9	57.9	57.9	57.9	617.7
1975/76	40.2	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	57.9	57.9	574.3
1976/77	54.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	55.9	37.1	566.3
1977/78	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	53.7	37.7	567.6
1978/79	32.2	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	52.8	35.7	539.0
1979/80	35.7	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	55.2	57.9	567.1
1980/81	38.1	57.9	32.2	32.2	32.2	32.2	57.9	57.9	43.0	32.2	32.2	32.2	480.3
1981/82	57.9	57.9	32.2	57.9	32.2	32.2	57.9	57.9	41.4	32.2	32.2	32.2	524.1
1982/83	50.6	57.9	32.2	32.2	57.9	32.2	57.9	57.9	57.9	57.9	57.9	57.9	610.4
1983/84	57.9	57.9	32.2	32.2	57.9	32.2	57.9	57.9	57.9	57.9	57.9	35.9	595.7
1984/85	32.2	57.9	32.2	57.9	32.2	32.2	57.9	57.9	57.9	57.9	57.9	55.6	589.7
1985/86	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	54.5	57.9	46.4	32.2	551.4
1986/87	57.9	57.9	32.2	32.2	32.2	32.2	57.9	57.9	57.9	57.9	52.7	57.9	586.8
1987/88	57.9	57.9	32.2	32.2	57.9	32.2	57.9	57.9	57.9	57.9	54.3	57.9	614.1
1988/89	57.9	57.9	32.2	57.9	32.2	32.2	57.9	57.9	57.9	57.9	57.9	45.2	605.0
Mean	51.6	57.9	32.2	36.5	35.4	32.2	57.9	57.9	56.2	55.4	52.6	45.8	571.7
CV	0.1	90.0	00.0	00.2	70.2	50.0	00.0	00.0	00.0	80.1	30.1	50.2	20.05
Skew	-1.2	-1.1	-1.1	1.9	2.4	-1.1	-1.1	-1.1	-2.8	-3.0	-2.0	0.0	-1.1

Nr of months in the sequence 288
Nr of months the reservoir spilled 149
Nr of months the reservoir emptied 100

Nr of years in the sequence 24
Nr of years the reservoir spilled 24
Nr of years the reservoir emptied 24

Average monthly inflow 318
Average monthly losses-2.(-0.7%)

Average monthly outflow 321
Average monthly spill 72 (22.6%)

TABLE 3.1 (Contd)

Total Reservoir Outflow

million cubic metres

Year	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1965/66	30.6	85.2	498.4	946.3	1237.2	504.6	240.2	102.4	39.3	37.9	16.9	20.1	3759.2
1966/67	25.3	66.5	445.8	502.41	100.5	629.5	310.1	109.3	96.1	56.5	23.3	32.1	3397.5
1967/68	56.8	177.7	378.0	775.2	704.3	515.5	286.8	70.8	20.2	23.0	16.9	20.1	3045.4
1968/69	54.7	374.7	1198.2	1288.1	674.9	381.0	133.7	76.9	21.8	26.0	16.9	20.1	4267.1
1969/70	121.8	88.2	714.3	895.7	1166.2	486.1	148.5	82.6	25.3	27.7	16.9	20.1	3793.4
1970/71	29.6	140.6	447.3	1078.5	742.5	356.8	375.5	134.5	39.5	35.1	16.9	20.1	3416.9
1971/72	72.8	293.5	564.1	969.9	888.8	468.4	244.3	106.2	33.6	28.9	16.9	20.1	3707.7
1972/73	34.7	109.6	435.4	471.8	1020.4	202.5	109.7	50.9	16.1	16.1	16.9	14.0	2498.0
1973/74	27.2	718.3	719.5	727.0	592.5	367.2	165.1	237.1	91.6	50.4	16.9	20.1	3732.9
1974/75	59.1	322.6	735.5	1749.1	1103.8	727.6	585.8	167.3	72.7	56.5	34.0	20.6	5634.6
1975/76	27.2	53.9	195.0	1035.1	421.7	434.6	532.6	220.2	69.0	45.2	17.3	26.1	3077.8
1976/77	27.2	134.5	855.3	741.8	629.0	269.5	125.1	74.3	26.4	21.9	16.9	20.1	2941.9
1977/78	399.6	434.0	952.4	933.4	678.4	362.9	207.4	90.7	20.0	29.2	16.9	20.1	4145.0
1978/79	24.9	619.4	1022.0	739.0	428.3	617.6	169.5	75.8	27.4	23.5	16.9	20.1	3784.4
1979/80	27.2	44.0	313.9	1270.6	870.3	517.2	181.0	115.8	50.2	29.7	16.9	24.3	3461.3
1980/81	27.2	360.4	339.5	442.2	760.7	467.8	270.9	71.6	16.1	16.0	8.1	16.3	2796.8
1981/82	240.1	347.2	530.7	2025.9	742.4	258.5	83.9	37.4	16.1	15.9	5.9	0.0	4304.0
1982/83	27.2	27.2	629.5	322.9	3092.9	1024.6	136.6	75.6	24.3	28.9	31.8	59.4	5480.9
1983/84	300.1	771.2	319.1	1031.0	1442.7	324.2	443.4	97.5	56.6	53.2	23.0	20.1	4882.1
1984/85	11.5	652.7	491.5	1446.0	627.6	556.6	265.0	73.2	29.7	28.4	17.6	20.1	4220.0
1985/86	84.9	288.9	747.7	779.4	764.9	275.3	77.4	50.51	6.1	16.1	16.9	7.2	3125.4
1986/87	106.6	132.8	298.1	784.4	422.1	437.7	409.2	285.4	43.0	38.6	16.9	32.0	3006.8
1987/88	265.0	88.73	65.4	1143.9	1345.3	836.3	202.0	111.5	33.3	23.3	16.9	45.2	4476.8
1988/89	44.0	698.7	757.7	1612.0	823.8	707.3	479.5	129.2	58.5	45.2	24.1	20.1	5400.1
Mean	88.6	292.9	581.4	988.0	928.4	488.7	257.6	110.3	39.3	32.2	18.3	22.4	3848.2
CV	1.1	70.8	20.4	40.4	20.5	80.4	00.5	60.5	50.6	00.4	00.3	20.5	10.22
Skew	1.9	0.8	0.7	0.8	3.0	1.0	0.9	1.6	1.2	0.6	0.9	1.5	0.7

Values Equalled or Exceeded 80 percent of the time (Not an Homogeneous Sequence)

X(I)	27.2	85.9	345.3	729.7	627.9	331.6	134.4	72.0	20.0	22.2	16.9	20.1	3052.7

Percent of time p. the specified value of X is equalled or exceeded

X(I)	27.2	16.1	1296.0	1339.2	1339.2	1296.0	10.7	11.7	16.1	16.1	16.9	20.1	5405.2
P(I)	85.1	100.0	0.3	17.7	11.1	-3.4	100.0	100.0	100.0	89.2	89.2	80.9	10.6

The minimum release for the critical month of March is 7.5 m^3/s (20.1 million cubic metres). It was found that this release can be achieved with 80.9% reliability, based upon the inflow data for 1965/66 to 1988/89.

The reservoir has a substantial dead storage capacity, and if it were possible to utilise the storage down to 6.5 feet (1.98 m) rather than 8.5 feet (2.59 m), the dependable releases may be increased. A revised analysis on this basis showed that 8.5 m^3/s (22.8 million cubic metres) could then be released in March, with 80.9% reliability. Allowing 3.0 m^3/s for gate flushing the balance of 5.5 m^3/s is sufficient to irrigate some 7 300 ha.

The total area irrigable from existing surface water resources is between 18 150 ha and 19 450 ha. This compares with existing surface water irrigation of 20 292 ha. Examination of the water level records for recent years indicates that the reservoir is almost always maintained at or near 12.5 feet (3.81 m) elevation throughout the irrigation season. It is therefore concluded that existing surface water resources are sufficient for the irrigation of the existing 20 292 ha, but there is no significant additional potential.

3.2 Groundwater Resources

3.2.1 Hydrogeology

A working correlation has been established between the stratigraphy described in Chapter 2 and the conceptual aquifer model ('upper clay - composite - main aquifer) as used by the UNDP (1982) and in the MPO's National Water Plan. The correlation is not perfect, and it must be recognised that individual wells may encounter quite different conditions, however, it gives a valuable approximation for most of the southeast region. The upper clay is mostly formed of the top part of the Chandina Formation, and is of Holocene age. Its vertical permeability (typically 2 - 5 mm/d) is higher than on the Pleistocene terraces. The Chandina Formation (at depth) in fact consists mainly of sand and forms the composite aquifer in most places. The Chandina Formation contains much organic material, and sometimes contains connate water remaining from the time it was deposited in an estuarine environment. The permeability of the Chandina Formation is not known. The important difference to the MPO model is that the lower part of the Chandina Formation is locally a thick silty aquitard containing saline water. The main aquifer is mostly formed by the Dupi Tila Formation. In the northern part of the study area, the Dupi Tila (main) aquifer has not been explored below about 120 metres (there being no incentive to do this). However, in Noakhali and Laksmipur Districts the main aquifer is saline in the depth range (50-100 m) which is the range exploited further north, but recently BADC has successfully developed DTWs in the average depth range of 125 to 150 metres. The permeability of the main aquifer averages about 25 m/d.

The main and composite aquifers, which range in thickness from less than 20 m to over 60 m, have good to excellent water transmission properties in the north central part of the study area. The development potential of the main aquifer is locally constrained by occurrences of saline groundwater.

The top of the aquifer unit, referred to as the composite aquifer, is composed of fine sand, and sometimes medium sand, and constitutes the uppermost water bearing zone. It varies in thickness from less than 20 m in the east to over 60 m in the west and north-west. Most STWs in the study area draw water from this aquifer.

Below the uppermost water bearing zone lies a series of medium to coarse sands with occasional interlayers of clay. This zone, sometimes separated by a clay layer from the composite aquifer, is known as the main aquifer because it is the principal water bearing horizon for high capacity irrigation wells over most of the country. The maximum depth to the top of the main aquifer ranges from less than 40 m to 60-80 m in the area except in the south-west, west and north central portions, where it is over 80 m. The thickness of the exploited aquifer ranges from 20 m to 60 m over much of the area except in the southern part.

3.2.2 Groundwater Development Constraints

a) Salinity

Based on international standards, principally FAO Irrigation and Drainage Paper 24, which have also been accepted by SRDI and MPO, plus the results of field investigations in the Comilla area by BARI and the DTW II Project, it is considered that the criteria given in Table 3.2 are appropriate for irrigation water in Bangladesh. Of these, given actual cropping patterns, the value of electrolytic conductivity (EC) of 2,000 μS/cm serves as the basic point of reference for groundwater studies.

There are extensive areas of brackish groundwater in the study area that are not the product of modern sea water intrusion. It is believed that most of the saline groundwater is connate water entrapped during the deposition of the Chandina Formation between the end of the last glacial maximum 18,000 years ago and the time when global sea level recovered to its present level around 7,000 years ago. Despite the very high rainfall in the area, the low horizontal hydraulic gradients have meant that the sediments have not yet been flushed. The aquifer is particularly saline where there are one or more deeper aquitards, which greatly retard the natural flushing processes.

TABLE 3.2

Guidelines for Irrigation Water Quality

Electrolytic Conductivity	Crop
< 1,000 μS/cm	vegetables and other sensitive crops
< 2,000 μS/cm	rice
2-3,000 μS/cm	wheat only

There is a marked stratification of salinity. The composite aquifer is always fresh except in the extreme south, where there is still a fresh water layer of at least 10 metres thickness. North of Noakhali and Laksmipur Districts, the main aquifer is fresh throughout its thickness except in pockets where there is a thick lower aquitard, such as in Muradnagar. Nevertheless, there are major differences between the piedmont area, where the water is extremely fresh (usually < 250 μS/cm) and the aquifer sequence is formed dominantly of the older Dupi Tila Formation; and the central band where the water from the main aquifer is often more than 1,000 μS/cm and the Chandina Formation is much thicker. In Noakhali and Laksmipur Districts, fresh groundwater is obtained from DTWs screened deeper in the Dupi Tila aquifer. This water is suspected to be part of a flow system established before the last glacial maximum.

Figure 3.1 shows the EC of water obtained from DTWs over the whole area, and hence is representative of the water that can be obtained from the main aquifer, although it disguises the increasing depth of well required in the southern part of the area. Although it has not been proven, most of the pockets of water with EC of more than 2,000 μS/cm. The pockets are brackish water are better defined because of the detailed mapping by the DTW II Project, such that more pockets of brackish water may exist in the south. However, despite its hydrogeological vagueness, the figure shows what quality of water can be obtained over the whole area. Even for the areas shown as saline on Figure 3.1, it is possible that fresh water can be obtained from two other horizons at the same site, either in the very shallow zone or below 120 metres.

b) Natural Gas Discharges

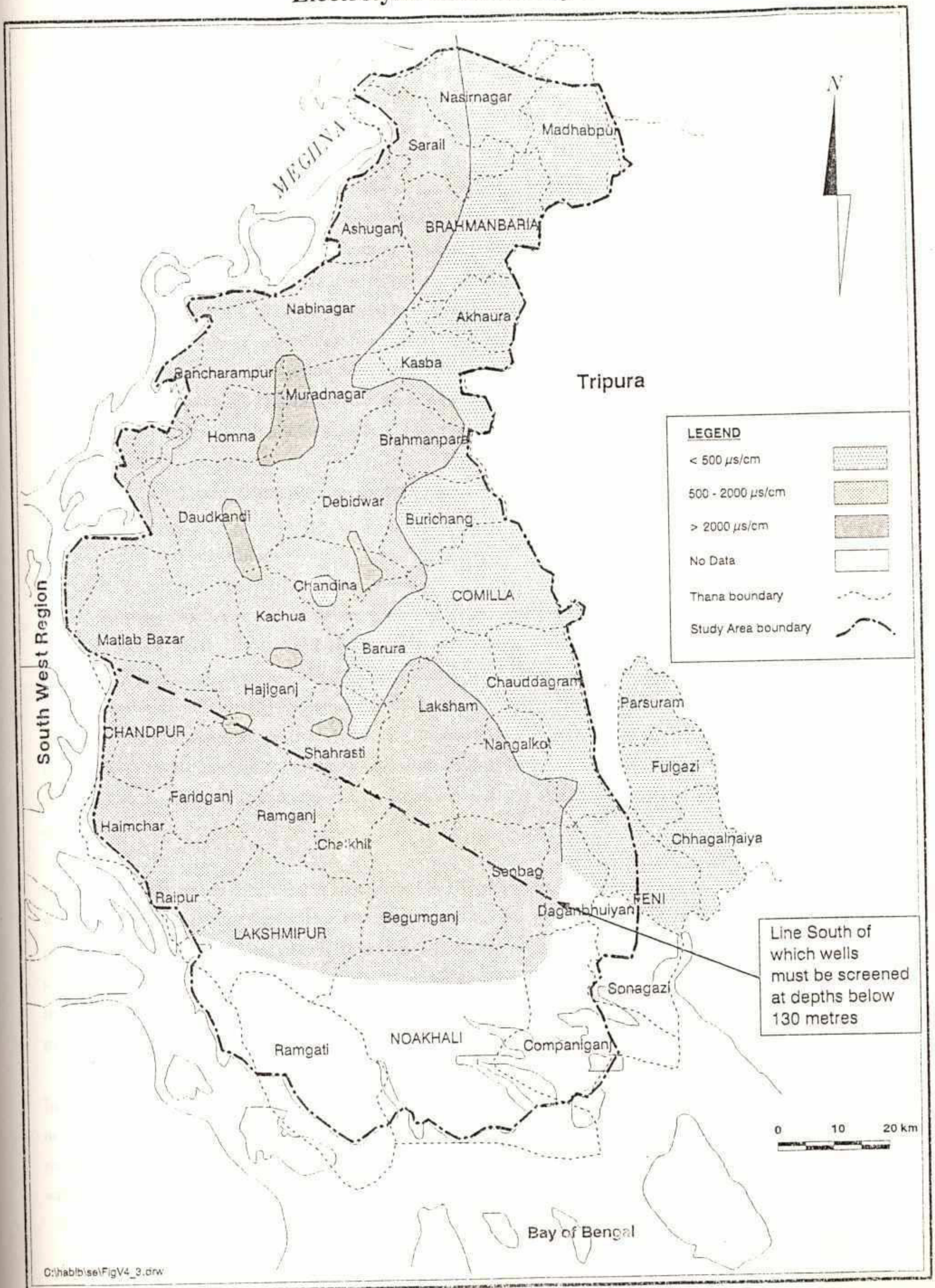
In the past, discharges of natural gas to tubewells have occasionally been noted as curiosities, but never treated as a major constraint on groundwater development. The parallel Gumti Phase II Feasibility Study is the first and only study to date to recognise gas discharges as a critical constraint on suction mode tubewells (and a minor constraint or nuisance for force mode wells). That study has shown that in large parts of Muradnagar, Debidwar and Nabinagar thanas, STWs are practically inoperable. The gas originates from the decomposition of organic matter trapped during the deposition of the Chandina Formation. In this sense there is a genetic connection between the gas and salinity constraints. However, this will not be a perfect correlation, because the gas is likely to be associated with over-bank and swamp facies deposits, while excessive salinities are likely to associated with estuarine facies deposits. Therefore, on geological grounds it may be reasoned that areas of gas constraints may extend northwards into the Sylhet Basin, and further south, where gas must be suspected throughout the area of elevated salinity shown in Figure 3.1. Unfortunately this area cannot be accurately mapped without further study.

3.2.3 Tubewell Technology

Tubewells for irrigation are still a relatively new technology in Bangladesh. Deep tubewells (high capacity wells with turbine, or less often submersible, pumps) have been promoted in large numbers since the early 1970's. Shallow tubewells (with surface mounted, centrifugal pumps) were introduced in the late 1970's. Manually powered tubewells have been promoted for about the same time. The DTW and STW were both introduced on a subsidised basis through the public sector (mainly BADC). In the mid to late 1980's STWs were successfully transferred to the private sector. In the late 1980's the National Water Plan gave great importance to the deep set shallow tubewell in accessing a vital extra increment of the available recharge. Current policy (to be implemented through the NMIDP project) is to privatise DTW irrigation.

Figure 3.1

Electrolytic Conductivity of DTWs in the Study Area



Groundwater irrigation stands at the cross roads, and its future is not clear. The proposed changes have provoked some fundamental re-thinking about the design and operation of irrigation wells. Conventional thinking has tended to over-simplify the options - that the STW is cheap and good and that the DTW is expensive and bad. This kind of thinking - that tubewells can be placed into distinct categories and that there is a 'best' kind of irrigation well - is fundamentally unsound. Unfortunately tubewells have been distributed through the public sector in this way. Large subsidies, applied without reference to actual cost, have prevented clear thinking about well design.

In this Regional Plan a sharp distinction between the small, private sector STW and the large, subsidised DTW is not seen as valid. Whether or not subsidies are entirely removed, it is clear that the future of tubewell irrigation will be directed by the actual costs of construction and operation. It is expected that there will be force mode wells of lower discharge capacities, shallower depths, cheaper components (either locally produced or from China and India) and smaller, informal irrigation groups. While it is recognised that such developments are likely to find the initial capital cost the critical step, it is thought that investments in such wells could be very effective, and may well be economically preferable to STW irrigation in all but the most favourable aquifer conditions. (See Annex V). Shallow force mode wells (SFMWs) will generally be more reliable than STW's (never running dry) and will not be subject to gas constraints.

3.2.4 Groundwater Resources Assessment

a) Methodology

The study team has developed a computer simulation model from the thana groundwater model which was initially used by MPO. This model calculates the potential of the aquifer by simulating its performance over a number of years and calculating the potential abstraction on the basis that the aquifer serving the wells is never allowed to run dry. Generally the aquifer is allowed to fill up during the flood season and is then drawn down during the irrigation season, January to March. In general the critical case arises when recharge in a dry year is insufficient to fill the aquifer in the flood season so that the storage in the aquifer "reservoir" is not at full capacity i.e. the water table at the start of the irrigation season is already slightly low compared with the normal case.

Modes of irrigation are described in more detail in Chapter 6 but briefly the shallow tubewells only operate when the pumping water depth does not exceed about 7 m, deep set shallow tubewells operate when the pumping water depth does not exceed about 9 m (depending on pit depth), while deep tubewells operate when pumping water levels do not exceed about 20 m. Because the flow in a one cusec DTW is less than the flow in a two cusec DTW the cone of depression is smaller, therefore a greater proportion of the available recharge may be used by pumps at the same level.

In most thanas where groundwater is not saline, the simulation studies reveal that recharge is sufficient to supply nearly all outstanding irrigation needs provided that existing surface irrigation continues, since surface irrigation reduces the demand for groundwater and simultaneously adds to the recharge. The case of full flood protection was also studied and again there is adequate recharge in most thanas.

b) Groundwater Potential

The methods used by the study team are not as conservative as MPO and Table 3.3 shows the groundwater potential in numbers of tubewells and percentage of area not irrigated by LLP which may be irrigated by tubewells for each thana. Figure 3.2 shows the present groundwater development in mm/unit gross area. Figure 3.3 indicates the WRPO maximum calculated development levels for STW indicate the effect of greater salinity in the deeper aquifers.

Account has also been taken of the requirements for public water supplies, although any programme to extend DTW should include the cost of replacing existing STW/HTW used for potable water with new wells and pumps where necessary; these costs will be comparatively small, but should be included. One Complication is the establishment of a mechanism whereby such a replacement can be effected. The quantitative impact of withdrawals for potable supply are negligible compared to those for irrigation.

3.2.5 Groundwater Quality

Groundwater almost universally provides the safest source of untreated drinking water in the region. Nevertheless shallow wells may be contaminated by bacteria where effective sanitary seals have not been provided. Iron and manganese constitute a pervasive nuisance, but do not endanger health. Salinity is a problem locally, but can be avoided by varying well depth. Nitrate locally exceeds drinking water standards, and is a long term health concern that needs further investigation.

Figure 3.2

Present Groundwater Development Levels (1989/90)

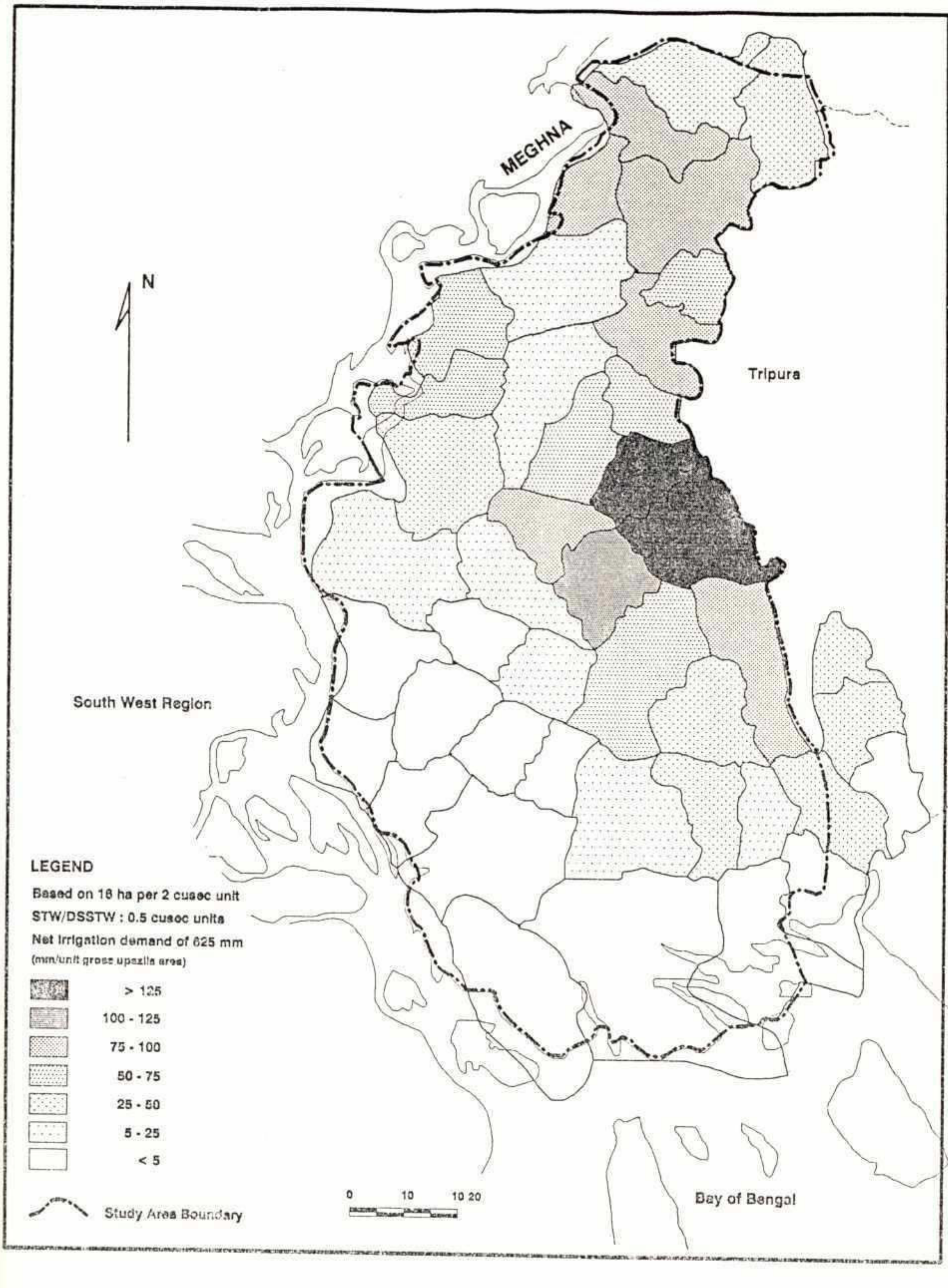


Figure 3.3

Suction Mode Only - Constrained Development Levels

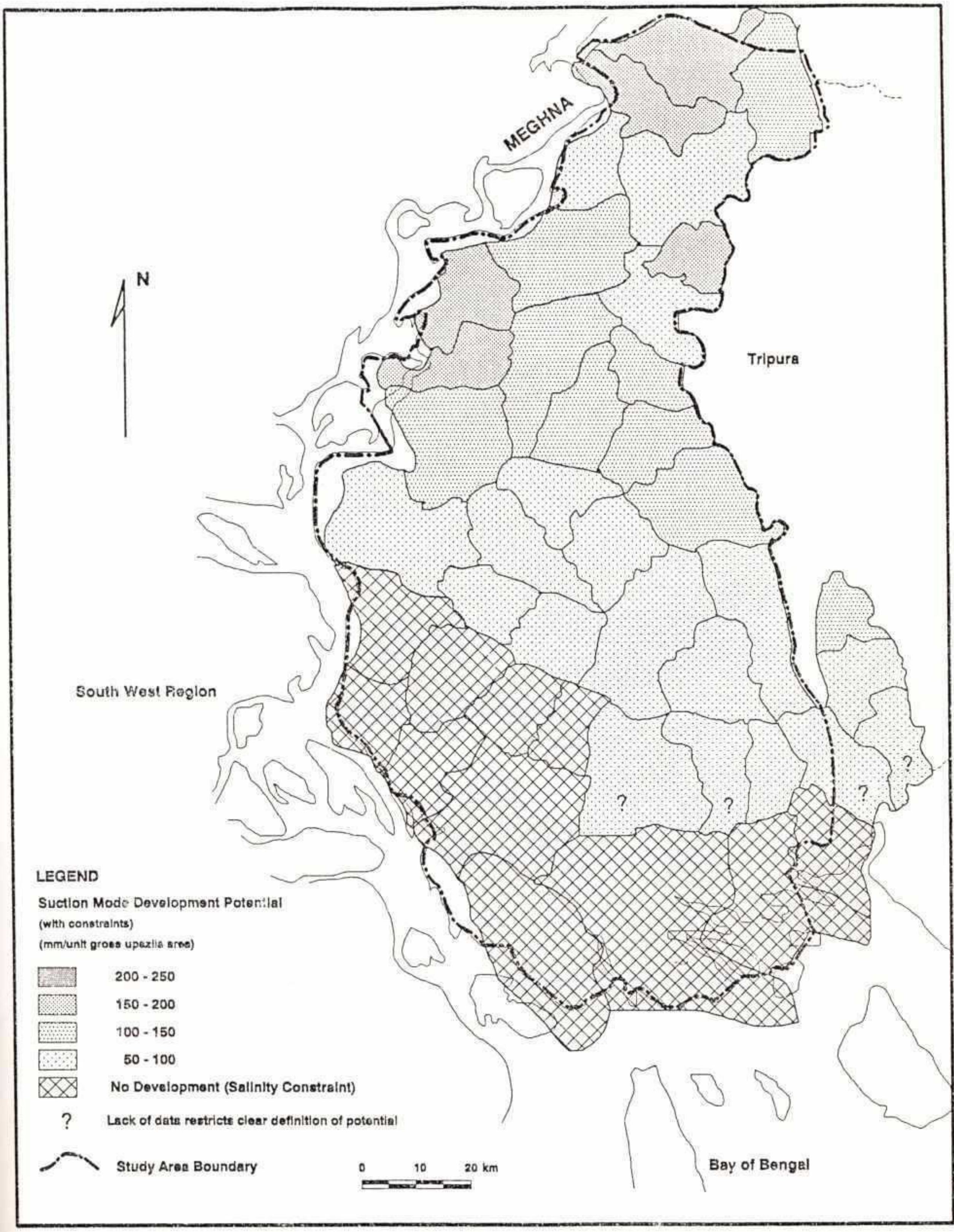


TABLE 3.3

Groundwater Development Potential (estimates without any constraints)

	Name of Thana	District	Area km2	Gross area irr. by SW %	Population yr 2000 (*1000)	GW Reserve Mm³	SERS GW Potential (MCM) (with existing SW) DSSTW All land	FMTW	Flood Phases (% of gross area) F0 %	F1 %	F2 %	F3 %	F0...F3 km²	Net Area for GW F0+F1 ha	F2+F3 ha	Tubewell Potential (number of units) Mode 1 DSSTW	Mode 2 DTW	Groundwater Potential Percentage of Net Area for GW Irrigated Tubewells DSSW	FMTW
1	Madhabpur	Habiganj	279	2	200	1.4	29.6	140.5	17	53	18	1	247	17062	4602	1117	1338	21	100
2	Nasirnagar	Brahmanbaria	313	17	297	2.0	51.2	133.0	0	1	47	16	197	107	12320	1945	768	63	100
3	Sarail	Brahmanbaria	212	27	304	2.1	36.3	154.0	0	16	25	28	145	1745	5622	1354	455	74	100
4	Brahmanbaria	Brahmanbaria	416	18	708	4.8	43.5	264.0	10	15	22	17	265	6434	9965	1531	1013	38	100
5	Ashuganj	Brahmanbaria	119	n.d.	n.d.	0.0	4.5	35.0	0	35	36	10	96	3749	4912	178	346	8	65
6	Bancharampur	Brahmanbaria	207	18	334	2.3	36.6	93.0	0	17	28	11	116	2021	4723	1358	417	81	100
7	Nabinagar	Brahmanbaria	352	24	542	3.7	46.9	252.0	0	22	39	9	245	4235	9369	1710	840	51	100
8	Kasba	Brahmanbaria	207	10	285	1.9	22.3	127.0	18	27	29	9	171	7210	6077	806	821	25	100
9	Akhaura	Brahmanbaria	93	22	165	1.1	17.9	70.0	18	12	23	21	69	1708	2456	664	257	65	100
10	Homna	Comilla	178	15	304	2.1	32.1	97.0	0	0	4	43	85	0	4956	1188	306	97	100
11	Muradnagar	Comilla	341	18	571	3.9	47.9	240.0	3	17	25	37	283	4756	14566	1741	1194	36	100
12	Brahmanpara	Comilla	119	14	192	1.3	14.7	64.0	1	17	63	5	102	1504	5982	530	462	29	100
13	Daudkandi	Comilla	375	28	633	4.3	60.2	203.0	0	0	5	57	231	0	10331	2211	638	87	100
14	Debidwar	Comilla	235	8	420	2.8	26.7	135.0	2	41	30	10	194	8082	7470	944	961	25	100
15	Burichang	Comilla	181	6	293	2.0	21.8	81.0	7	47	26	1	147	8041	4123	784	751	26	100
16	Chandina	Comilla	202	6	327	2.2	17.4	85.0	3	29	10	41	167	5394	8394	601	818	18	96
17	Barura	Comilla	240	2	387	2.6	23.1	120.0	3	32	47	0	195	7175	9902	810	1055	19	100
18	Kotwali	Comilla	277	6	635	4.3	44.1	138.0	19	43	19	0	225	14178	4400	1574	1148	34	100
19	Laksham	Comilla	427	12	632	4.3	39.6	200.0	4	27	42	8	348	10171	16048	1397	1620	22	100
20	Chouddagram	Comilla	271	5	395	2.7	18.1	91.0	16	52	13	1	221	15325	3191	610	873	13	76
21	Nangolkot	Comilla	235	3	333	2.2	24.7	158.0	7	55	16	2	190	12743	3654	888	1013	22	100
22	Matlab	Chandpur	409	11	666	4.5	28.8	157.0	0	2	53	12	274	738	19456	961	1247	19	100
23	Kachua	Chandpur	238	12	367	2.5	20.5	94.0	2	17	47	15	191	3373	10943	713	884	20	100
24	Chandpur	Chandpur	287	12	514	3.5	33.8	171.0	2	20	30	1	150	4148	5891	1199	620	48	100
25	Hajiganj	Chandpur	157	27	322	2.2	15.1	64.0	4	0	58	8	110	342	5274	511	347	37	100
26	Shahrasti	Chandpur	186	13	239	1.6	14.4	94.0	6	12	43	14	140	2498	7711	506	631	20	100
27	Faridganj	Chandpur	235	41	476	3.2	30.7	95.0	21	43	11	2	182	5561	1145	1087	414	66	100
28	Haimchar	Lakshmipur	186	5	143	1.0	8.6	109.0	6	15	26	0	86	3002	3810	302	421	18	100
29	Ramganj	Lakshmipur	170	16	301	2.0	14.7	67.0	13	20	33	13	134	3844	5512	501	548	22	94
30	Raipur	Lakshmipur	202	4	284	1.9	11.1	60.0	11	49	7	0	135	10263	1117	363	574	13	82
31	Lakshmipur	Lakshmipur	515	12	723	4.9	35.8	202.0	6	47	21	0	379	20060	7831	1222	1723	18	100
32	Ramgati	Lakshmipur	650	0	402	2.7	15.8	147.0	0	56	6	0	405	32795	3662	517	1426	6	63
33	Chatkhil	Noakhali	134	33	276	1.9	13.7	41.0	4	32	31	8	99	2170	2362	468	280	42	100
34	Begumganj	Noakhali	409	28	890	6.0	40.8	110.0	2	10	62	1	309	2605	13753	1376	1010	34	100
35	Senbag	Noakhali	160	13	272	1.8	15.5	54.0	2	36	39	0	124	4430	4642	540	516	24	92
36	Sudharam	Noakhali	828	2	737	5.0	40.6	203.0	0	59	14	1	609	42697	10486	1408	1957	11	50
37	Companiganj	Noakhali	189	2	209	1.4	25.5	124.0	0	44	6	0	94	7161	962	952	502	47	100
38	Daganbhuiya	Feni	132	12	245	1.7	11.5	46.0	1	42	33	3	103	4234	3488	389	438	20	92
39	Sonagazi	Feni	259	4	274	1.8	23.7	133.0	0	53	8	0	158	11456	1687	864	812	27	100
40	Feni	Feni	221	22	417	2.8	22.8	105.0	3	61	7	3	164	8524	1353	790	610	32	100
41	Chagalnaiya	Feni	157	44	210	1.4	18.6	54.0	24	65	1	0	141	5727	66	679	358	47	100
42	Fulgazi	Feni	108	31	149	1.0	10.5	57.0	27	63	2	0	99	5454	130	375	345	27	100
43	Parsuram	Feni	72	31	77	0.5	10.0	30.0	40	52	1	1	67	3749	82	375	237	40	100
44																			

Net Area for GW = 90% of area of F0...F3 land minus area area irrigated by LLP
45 l/d per capita consumption

40 acres per DTW
10 acres per STW
625 mm net irrigation demand
90 ratio net/gross irrigable (%)
Mode 1 SMTW
Mode 2 0.5>1 cusec FMTW

[ ] Salinity Constraints

[shaded] DTW Potential to be defined by investigation of confined aquifer

SMTW : Suction Mode Tubewells
FMTW : Force Mode Tubewells

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CHAPTER 4

FLOOD CONTROL AND DRAINAGE

4.1 Introduction

Floods are an annual phenomenon in Bangladesh. The study area is no exception to this. About two thirds of the country is vulnerable to flooding and half of this i.e one third of the country, is inundated every year. Vulnerable areas under different flood phases by Upazila are presented in Table 4.1 and 4.2. From the tables it may be observed that the total flooded area under different phases (F_1, F_2 and F_3) is about 790 000 ha which is 94% of Net Cultivable Area (NCA) of the region. The remaining area is flood free. The distribution of flooded land, F_1, F_2 and F_3+F_4 by upazila as a percentage of NCA are presented in Figure 4.1 to 4.3. It should be pointed out that the dominant flood phase of the region is F_1 indicating only shallow flooding. Only 17% of the area is prone to deep to very deep flooding (F_3+F_4). The area so far partly protected from flooding is presented in Table 4.3.

The table shows a list of projects already completed or in the process of completion in the study area. Flood control projects are normally combined with drainage and sometimes with irrigation. Irrigation projects (except the minor ones) are normally combined with drainage and some times with flood control. Drainage projects may be independent of both irrigation and flood control (embankments). The list of projects presented in the table is actually combined with one or other modes as indicated above.

Within the scope of the regional study drainage is primarily designed to remove surplus water from agricultural land so that flood depths on the land are limited to manageable proportions. Due to the lack of major relief, and micro topography, it is not feasible to maintain low levels of flooding throughout the study area, even in the best areas a comprehensive drainage solution will still leave some areas of deeply flooded land or permanent water bodies. Within the study area there are significant rivers which arise in the Tripura Hills and pass through the area on their way to the sea. The solution to these problems is more one of flood control. The drainage problem in the region is more related to high local rainfall in the monsoon season and restricted drainage. In Chapter 2 it was pointed out that the rainfall over a five day period is more than 0.4m about once every five years.

In comparison with the rest of the country the region does not suffer greatly from direct flooding by the major rivers, only the northern and western areas are so affected. However, the remainder of the area is often flooded because local rainfall cannot escape due to high water levels in the major rivers, flood control embankments will not prevent this, unless pumped drainage is adopted or unless improved natural drainage can be provided.

Figure 4.1

Proportion of Flood Phase F1 by Thanas

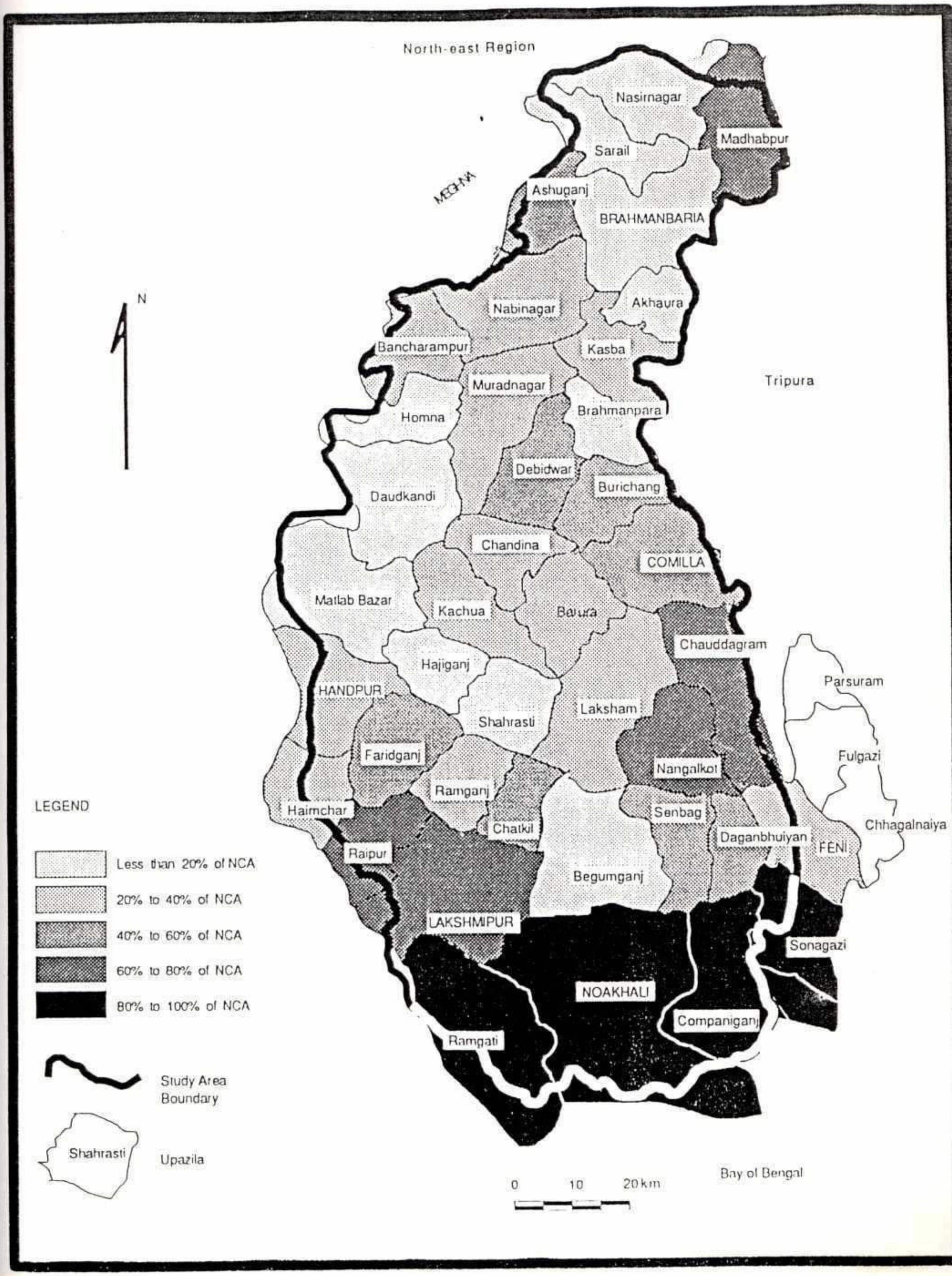


Figure 4.2

Proportion of Flood Phase F2 by Thanas

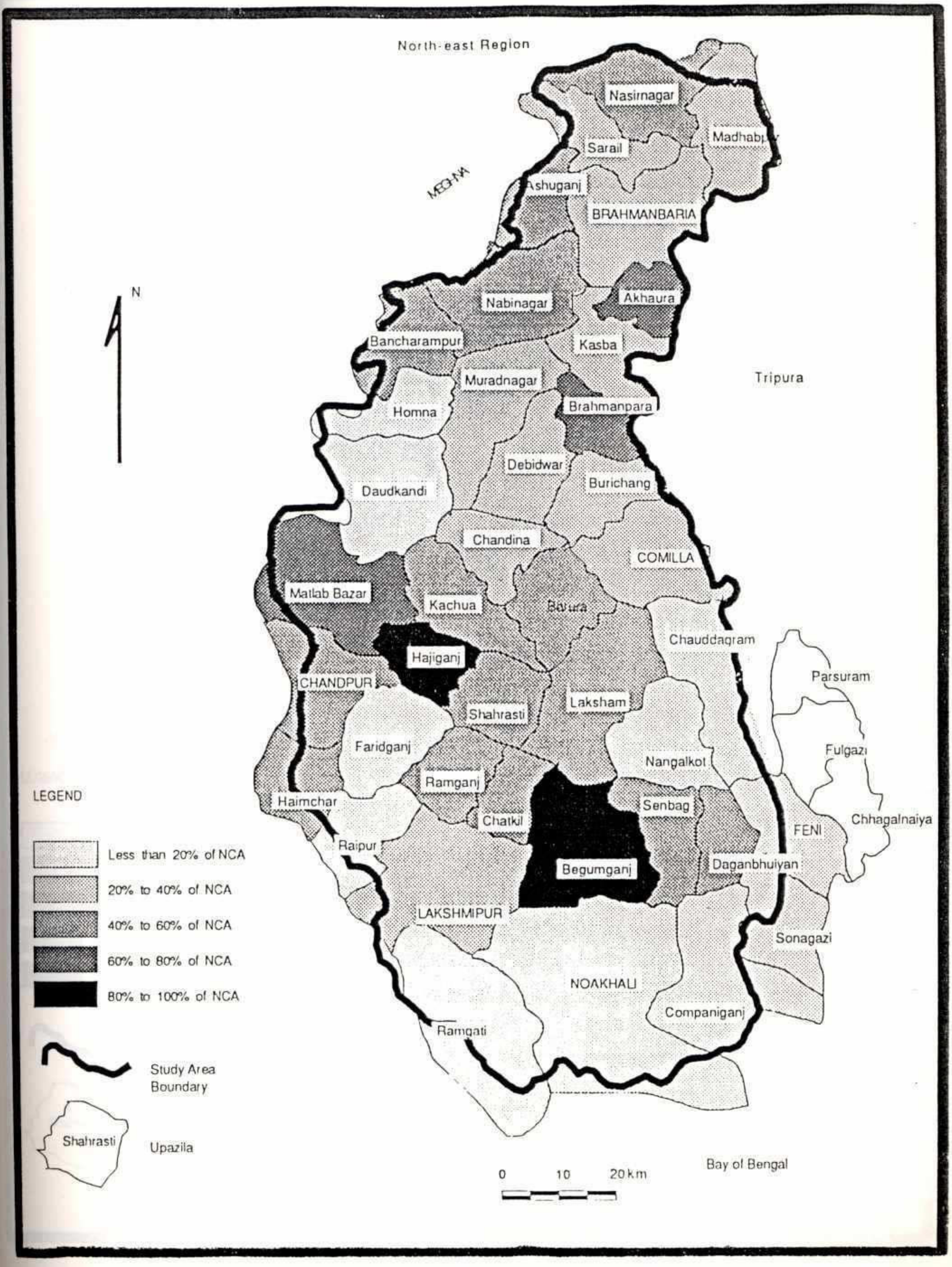


Figure 4.3

Proporation of Flood Phase F3 Plus F4 by Thanas

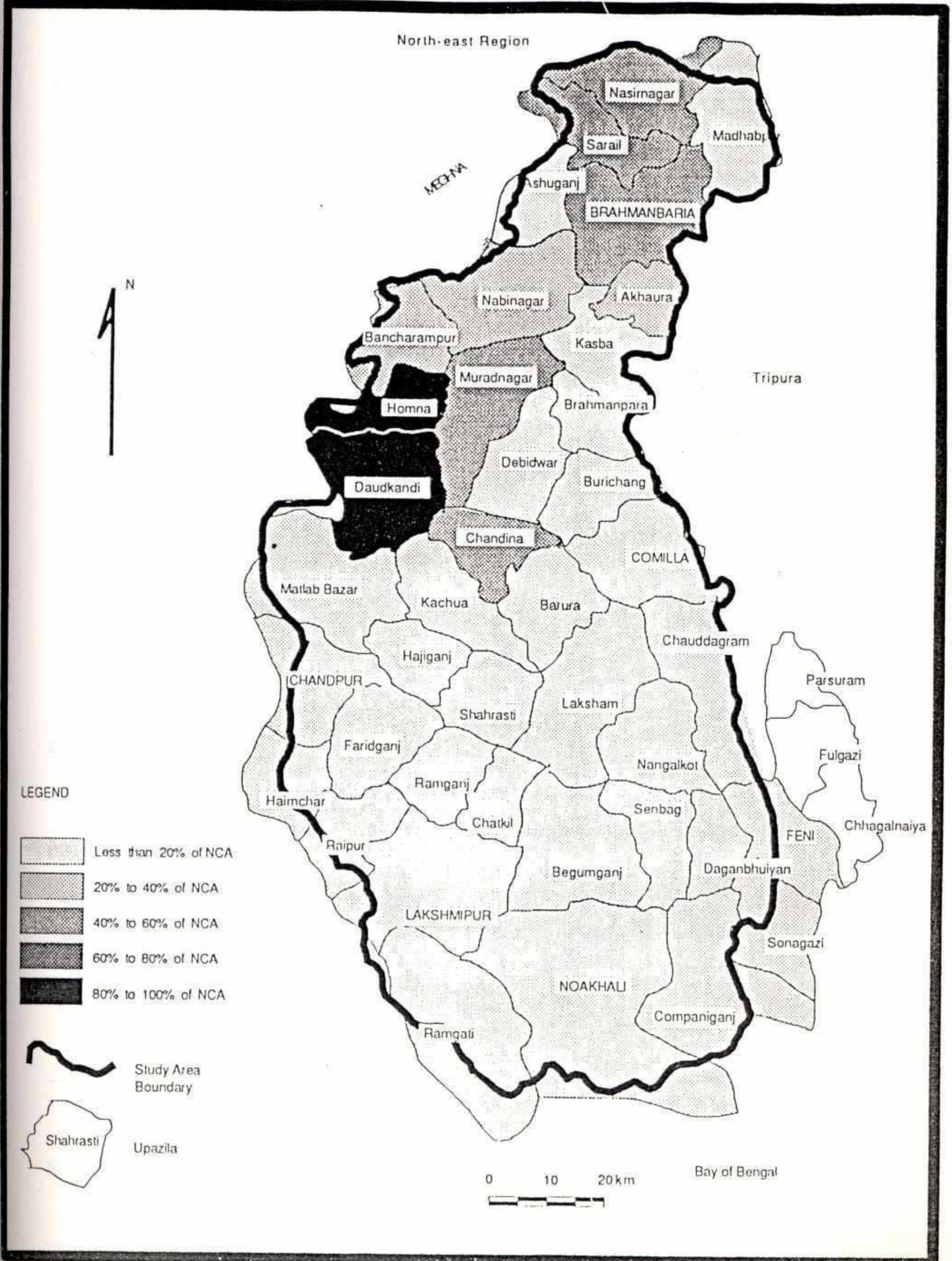


TABLE 4.1

Flood Phase Area By Thana

Dist./Thana	G.A (ha)	NCA (ha)	F0 (ha)	F1 (ha)	F2 (ha)	F3 (ha)
Habiganj						
Madhabpur	27 972	24 740	4 684	14 815	5 002	239
Brahmanbaria						
Nasirnagar	31 351	25 598	1	169	14 657	10 772
Sarail	21 239	17 746	1	3 451	5 207	9 088
Brahmanbaria	41 707	35 750	4 273	6 164	9 020	16 293
Ashuganj	11 915	9 686	1	4 168	4 307	1 211
Bancharampur	20 719	14 168	1	3 490	5 821	4 857
Nabinagar	35 239	28 214	1	7 633	13 817	6 764
Kasba	20 714	17 822	3 688	5 578	6 041	2 515
Akhaura	9 339	8 109	1 725	1 117	2 123	3 144
Comilla						
Homna	17 873	13 654	1	1	746	12 908
Muradnagar	34 190	28 942	1 167	5 815	8 664	13 296
Brahmanpara	12 429	10 621	69	2 065	7 832	655
Daudkandi	37 554	31 513	1	1	1 786	29 727
Debidwar	23 568	19 426	486	9 609	6 969	2 362
Burichang	16 839	13 697	1 149	7 906	4 413	229
Chandina	20 201	16 669	572	5 950	1 927	8 220
Barura	24 093	19 578	628	7 597	11 322	31
Comilla Kotwali	26 937	21 869	5 050	11 639	5 180	1
Laksham	43 256	35 273	1 924	11 759	18 024	3 566
Chouddagram	27 454	22 363	4 260	14 249	3 677	177
Nangolkot	22 537	18 219	1 674	12 485	3 504	556
Chandpur						
Matlab	40 925	27 449	19	982	21 555	4 893
Kachua	23 831	19 106	475	4 028	11 132	3 471
Chandpur	27 718	14 467	457	5 521	8 340	149
Hajiganj	15 796	11 014	643	29	9 084	1 258
Shahrasti	18 645	14 060	1 121	2 320	8 020	2 599
Faridganj	23 568	18 208	4 916	10 184	2 621	487
Haimchar	18 393	8 505	917	2 831	4 757	1
Lakshmipur						
Ramganj	17 097	13 490	2 189	3 353	5 719	2 229
Raipur	18 650	12 503	2 079	9 197	1 227	1
Lakshmipur	51 542	37 881	3 141	24 110	10 630	1
Ramgati	58 798	36 644	1	32 963	3 681	1
Noakhali						
Chatkhil	13 473	10 001	530	4 259	4 163	1 049
Begumganj	40 930	30 923	850	4 074	25 549	450
Senbag	16 060	12 438	280	5 794	6 290	74
Sudharam	110 857	81 586	92	66 054	15 440	1
Companiganj	38 012	18 998	1	16 747	2 251	1
Hatiya (*)						
Feni (part)						
Daganbhuiyan	13 209	10 340	165	5 504	4 314	357
Sonagazi	22 793	13 863	82	12 002	1 779	1
Feni	22 280	16 509	663	13 585	1 624	637
TOTAL	**1 119 703**	**841 642**	**49 977**	**359 198**	**288 215**	**144 271**

Source: WRPO

TABLE 4.2

Flood Phase Area by Thana (% NCA)

District Thana	MPO ref	G.A (ha)	NCA (% G.A.)	F0 (% NCA)	F1 (% NCA)	F2 (%NCA)	F3+F4 (% NCA)
Habiganj							
Madhabpur	302	27 972	88	19	60	20	
Brahmanbaria							
Nasirnagar	362	31 351	82	0	1	57	42
Sarail	437	21 239	84	0	19	29	51
Brahmanbaria	87	41 707	86	12	17	25	46
Ashuganj (#)	14	11 915	81	0	43	44	13
Bancharampur	42	20 719	68	0	25	41	34
Nabinagar	345	35 239	80	0	27	49	24
Kasba	249	20 714	86	21	31	34	14
Akhaura	6	9 339	87	21	14	26	39
Comilla							
Homna	204	17 873	76	0	0	5	95
Muradnagar	343	34 190	85	4	20	30	46
Brahmanpara	88	12 429	85	1	19	74	6
Daudkandi	125	37 554	84	0	0	6	94
Debidwar	130	23 568	82	3	49	36	12
Burichang	90	16 839	81	8	58	32	2
Chandina	94	20 201	83	3	36	12	49
Barura	53	24 093	81	3	39	58	0
Comilla Kotwali	271	26 937	81	23	53	24	0
Laksham	287	43 256	82	5	33	51	10
Chouddagram	111	27 454	81	19	64	16	1
Nangolkot	356	22 537	81	9	69	19	3
Chandpur							
Matlab	312	40 925	67	0	4	79	18
Kachua	225	23 831	80	2	21	58	18
Chandpur	96	27 718	52	3	38	58	1
Hajiganj	195	15 796	70	6	0	82	11
Shahrasti	447	18 645	75	8	17	57	18
Faridganj	155	23 568	77	27	56	14	3
Haimchar	194	18 393	46	11	33	56	0
Lakshmipur							
Ramganj	411	17 097	79	16	25	42	17
Raipur	405	18 650	67	17	74	10	0
Lakshmipur	288	51 542	73	8	64	28	0
Ramgati	413	58 798	62	0	90	10	0
Noakhali							
Chatkhil	102	13 473	74	5	43	42	10
Begumganj	58	40 930	76	3	13	83	1
Senbag	445	16 060	77	2	47	51	1
Sudharam	459	110 857	74	0	81	19	0
Companiganj	116	38 012	50	0	88	12	0
Hatiya (*)	201						
Feni (part)							
Daganbhuiyan	120	13 209	78	2	53	42	3
Sonagazi	465	22 793	61	1	87	13	0
Feni	161	22 280	74	4	82	10	4
TOTAL		**1 119 703**	**75**	**6**	**43**	**34**	**17**

Notes: Hatiya is outside the study area
Ashuganj is part of Brahmanbaria

TABLE 4.3

South East Region Flood Control and Drainage Projects

Name of Project	Type of Project	Gross Area (ha)	Net Area (ha)	Year of Start	Year of Completion
Little Feni River	FCD	105 000	88 900	1964	1980
Noakhali Comprehensive Drainage Project	FCD	72 500	54 000	1970	1977
Gumti Embankment	FC	25 000	18 000	1964	1980
Chandpur Irrigation	FCDI	54 000	29 000	1963 (a)	1978
Meghna-Dhonagoda	FCDI	19 000	17 600	1979	1988
Gumti Phase-I	FCD	37 500	29 000	1985	1993
Muhuri Irrigation (b)	FCDI	40 000	20 000	1978	1986
Chandal Beel	Submersible Embankment	913	615	1989	1993
Satdona Beel	Submersible Embankment	5 153	3 350	1988	1993
Ghugrajola	Submersible Embankment	8 500	6 375	1985	1993
Polder Embankment:					
Polder 59/1A	FCD	15 500	12 600	1963	1967
Polder 59/1B	FCD	18 200	15 400	1963	1966
Polder 59/2	FCD	26 600	15 500	1965	1971 (partly completed)
Polder 59/3A	FCD	38 500	28 800	-	incomplete
Polder 59/3B	FCD	31 400	9 000	1972	incomplete
Polder 59/3C	FCD	18 000	13 500	1982	incomplete
LRP Pilot Polder I	FCD	2 000	1 750	1980	1989
Total		**517 766**	**347 190**		

Note: (a) Work started in full swing in 1975-76.
(b) Muhuri Irrigation Project is actually outside the study area.

4.2 Causes of Floods

The flooding in Bangladesh is primarily dictated by the flows of the River Jamuna (Bangladesh) and the River Ganges. The catchment area of these two major rivers together with the Surma/Kushiyara complex covers an area of about 1.5 million km^2.

The flows in the major rivers are swelled by the rainfall runoff from this large catchment together with snownelt runoff from the Himalayas. Only 7% of the catchment lies within Bangladesh, nevertheless intense rainstorms in the country and on the adjacent Assam and Tripura hills worsen the flooding potential of the region.

The large volumes of runoff flow naturally to the Bay of Bengal. However the flooding situation is dictated by the downstream water levels and the hydraulic effectiveness of the drainage system. In the flat deltaic area of the region minor changes in these levels can have serious implications to the areal extent of flooding.

The monsoon flood occurs every year, as the water levels rise in the three major rivers Brahmaputra-Jamuna, Ganges and the Meghna. The situation becomes worse when the flood peaks of the three rivers coincide. Such phenomenon occurred in 1988 as shown in Figure 4.4. The area flooded is illustrated in Figure 4.5, although this figure understates the area flooded in the south east region since it is known that large areas of the region were flooded in 1988 (e.g. Dhonagoda, Dakatia and Noakhali areas).

There has been much speculation about the 1987 and 1988 floods and the existence of long term tendency for floods to increase. Studies have been carried out by different agencies for assessing the existence of any trend of increasing flood magnitudes as a result of activity in the upper catchment. All of the studies concluded that there is no trend to date of increasing flood frequency on the major rivers at either Bahadurabad or at Baruria. There is very weak evidence of a trend of increased flood levels in the Ganges at Hardinge Bridge.

Records of water level in the eastern rivers like the Kushiyara at Sheola, the Manu at Maulivi Bazar and the Khowai at Habiganj indicate (Figure 4.6) that there is a tendency for flood levels in those rivers to increase. Water levels at Bhairab Bazar however do not show any tendency to increase. Rising water levels in the Kushyara, the Manu and the Khowai may be mainly due to human interference such as building embankments or deforestation in the upper catchments of those rivers. The effect is greatly dampened at Bhairab Bazar due to the reservoir effect in the greater Sylhet hoar area.

4.2.1 Flash Floods

Flash floods are characterised by a sharp rise in discharges and levels followed by a rapid recession within a few days. The peak causes high stream flow velocities and results in damage to crops and properties. Flash floods affect the eastern part of the region. The catchments draining from the Tripura Hills are generally small and relatively steep, with short times of concentration. Only the large rivers, such as the River Gumti, are gauged. An annual hydrography of the river of Comilla is presented in Figure 4.7.

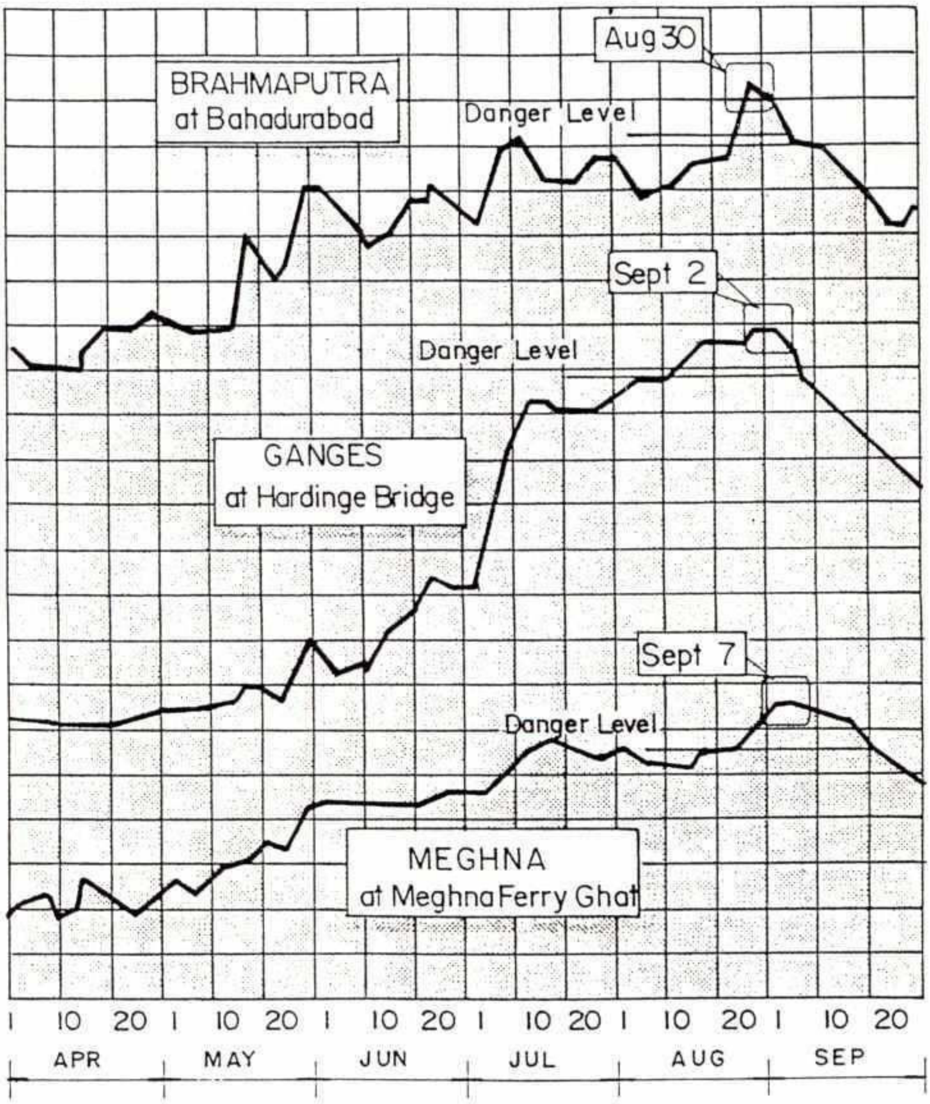
4.2.2 Local Flooding

Local flooding is principally caused by local rainfall runoff being subjected to poor drainage conditions. This is primarily caused by backwater effects from downstream imposed by the main river system and high tides. Poor drainage, may be further affected by the following:

- restricted drainage due to reduced carrying capacity of channels caused by siltation,

Figure 4.4

1988 Hydrographs of Major Rivers Compared



Source : Bangladesh Flood Policy Study, UNDP, May, 1989

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Figure 4.5

1988 Flood Extent

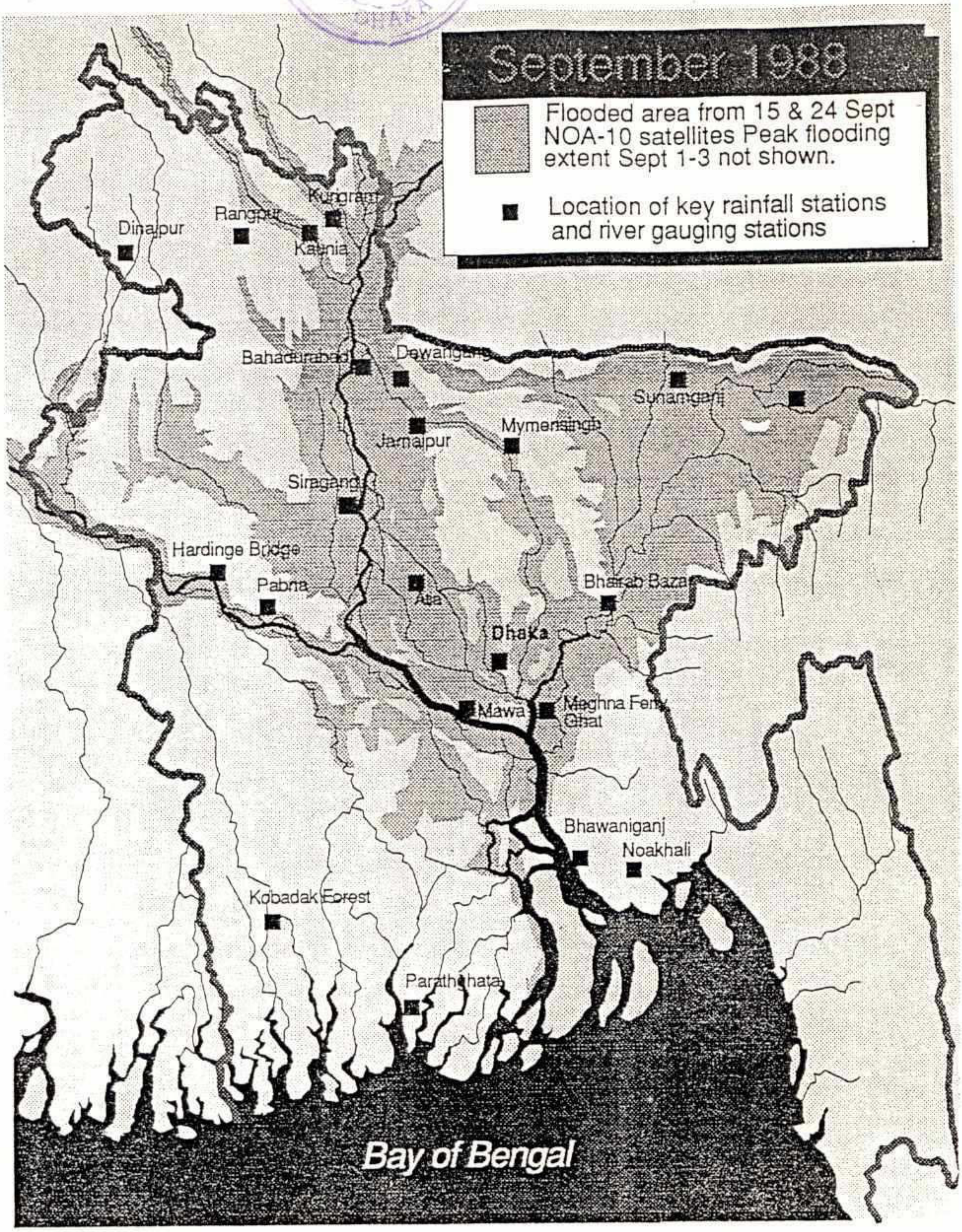


Figure 4.6

Time Trend of Annual HWL

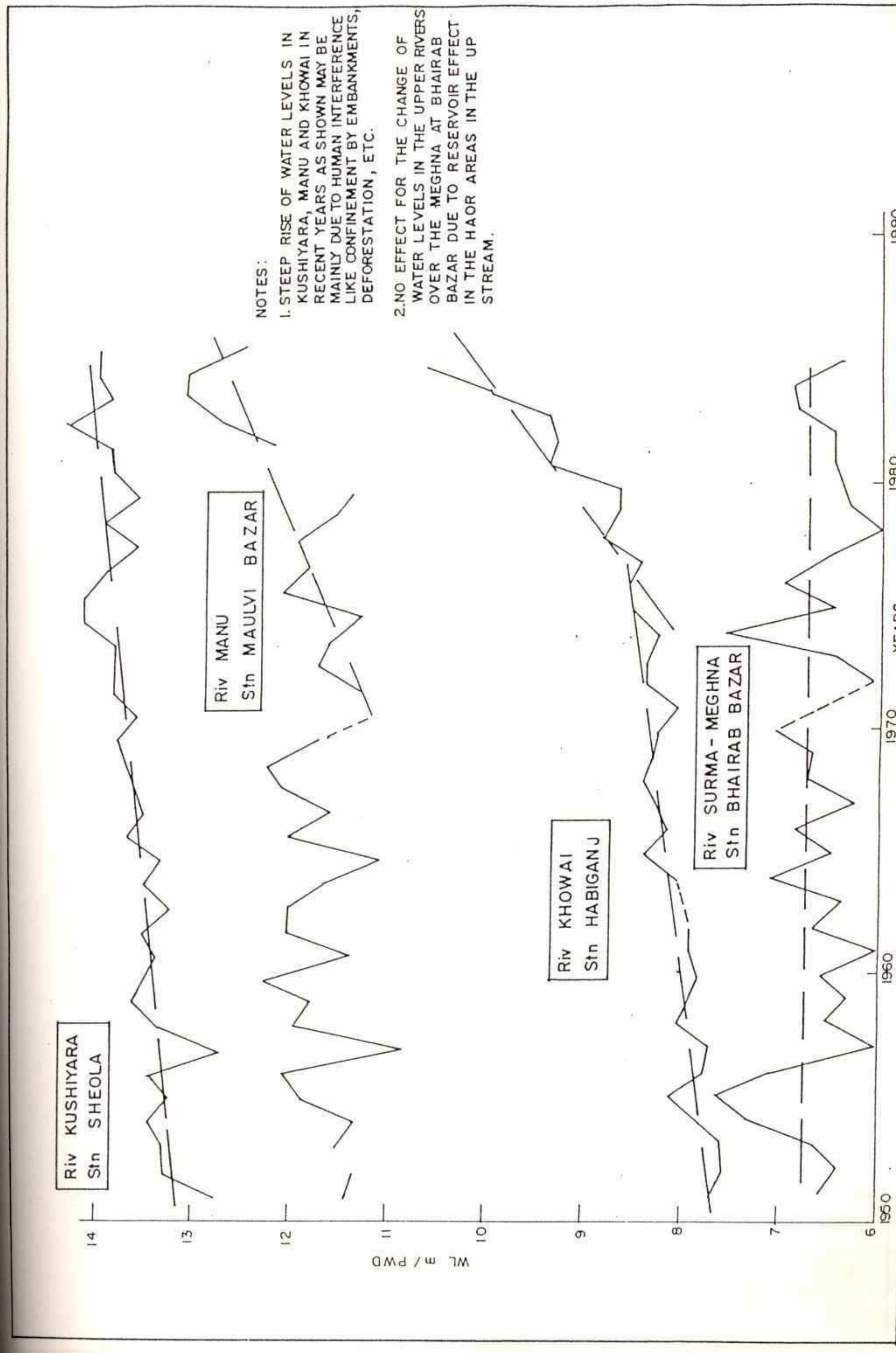
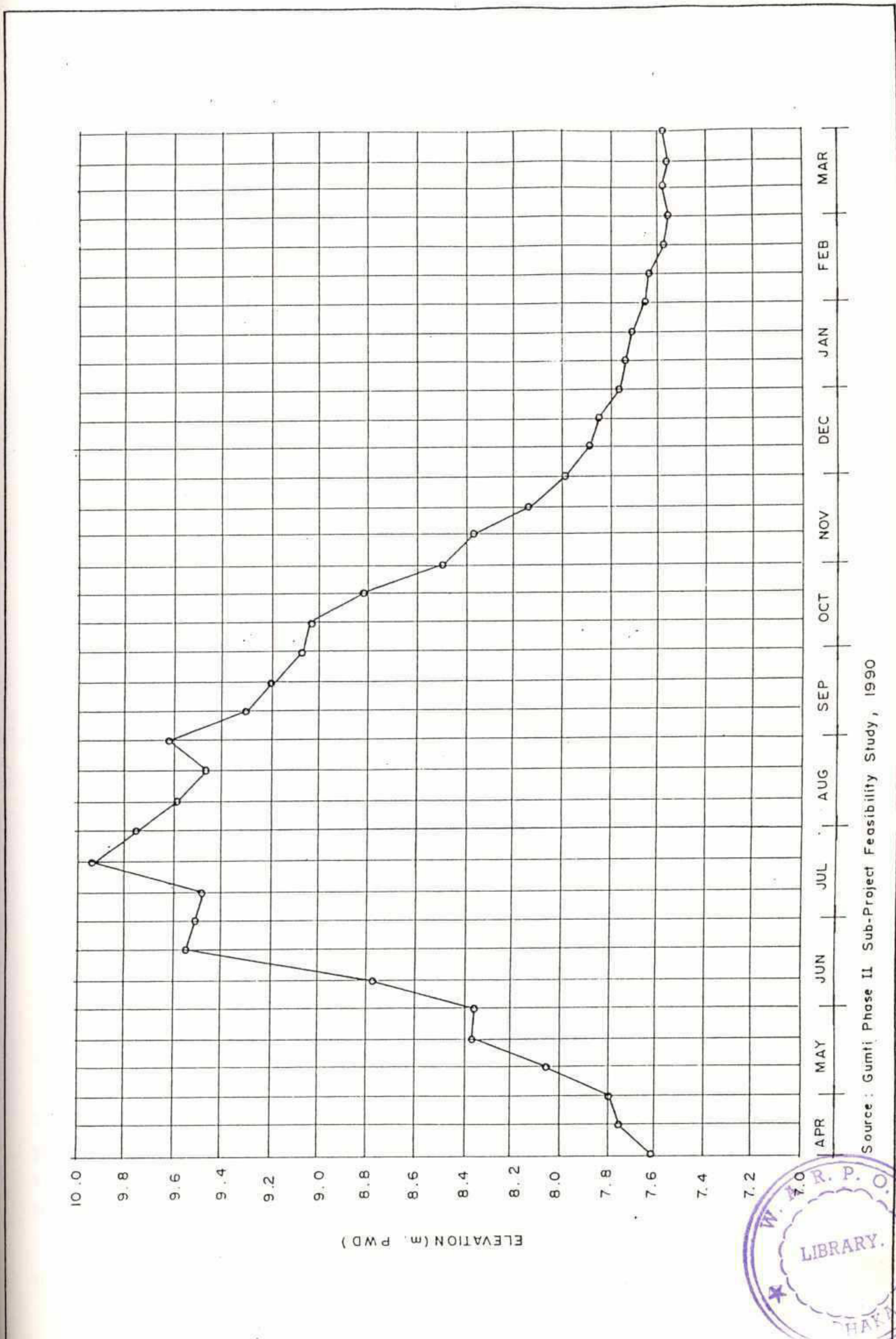


Figure 4.7
Hydrograph of River Gumti



Source : Gumti Phase II Sub-Project Feasibility Study, 1990

- increased head loss in the natural drainage network imposed by new cross drainage structures, (which may be too small),

- increased head loss in the natural drainage network imposed by new road embankments which increase drainage path lengths.

In particular, the impact of the accretion in the active delta area of Sudharam increases the length of drainage paths to the sea. These increased drainage channel lengths reduce water surface slopes, pushing up channel water levels to accommodate the required drainage flows. This effect is associated with reduced flow velocities and at tidal meeting points in particular sediment carrying capacities are low causing sedimentation within the channel system.

Local flooding may also be caused by the development of flood control embankments if drainage provisions are inadequate.

4.2.3 Cyclone Surges

Chapter 1 identified the problem of cyclonic surges which affect the southern coastal areas of the region. Wind effects of these cyclones also affect areas further inland.

4.3 Forms of Flood Protection and Alleviation

The major forms of flood protection are as follows:

- Embankments along major rivers.
- Embankments along flashy rivers.
- Submersible embankments.
- Polders.
- Coastal Embankments.
- Compartments.
- Tidal Drainage
- Pumped Drainage
- Dredging
- Loop Cutting

These are described further below:

4.3.1 Embankments along major rivers

The purpose of these embankments is to prevent the major rivers flooding the land or settled areas. They are generally set back from the river to allow a section of flood plain to take some of the flood and reduce the depth and velocity in the channel. They are usually earthen embankments but may have some protection on the river side against wave action and local erosion.

The advantage of these embankments are mainly that large areas of land and their populations behind the embankments are protected and they provide refuge in times of flood. They can also prevent coarse sediment from entering the protected agricultural areas. The level of protection can imporve land productivity and hence the living standards of the people. On the other hand the disadvantages are:

- the level of flooding on the river side may be increased because more water is retained in the river,

- the velocity of flow in the river may be increased, because more water passes down the river,

- maintenance is expensive,

- if the embankment fails due to erosion piping or overtopping the situation is worse than before because the rate of rise of water level on the countryside is much more rapid and the high water level difference between the country side and river side causes serious erosion at the point of overtopping or breach and consequently results in a heavy deposition of silt/sand on the agricultural land,

- localised drainage problems can be developed

- fish migration is prevented,

In practice major river embankments may not provide a flood free environment because part of the land behind the embankment is liable to flood by local rainfall.

In certain areas the main mode of failure of the embankments is partial erosion of the embankment at high flood followed by bank slip into the river on the recession. Construction of embankments too close to the active river channel is generally the cause. Other common causes of failure are due to poor original construction, lack of maintenance and public cuts.

The traditional designs of embankments for flood control may have to be modified to overcome some of these disadvantages e.g. adequate flushing sluices may be provided both for flushing and emergency flood by pass and compartmentalisation for controlled drainage and distribution of excess run-off.

4.3.2 Embankments along flashy rivers

Embankments along flashy rivers are similar to those along the major rivers but in this case, because the flash floods are of short duration, the problem of drainage of the land behind the embankment is not so acute. However the trained rivers usually carry a high sediment load in a flash flood and when the embankment ends the coarse sediment also tends to be dropped on the flood plain. Furthermore if the embankment fails the velocities downstream drop both in the river and after the breach, this leads to a rapid deposition of sediment. The embanking of flashy rivers, particularly if the embankments are set close together, causes the gradual accretion of the channel system with the consequent need to increase embankment heights to contain the flood flows.

4.3.3 Submersible embankments

In the deeply flooded lands specially in the greater Sylhet hoar area extending up to the northern part of the south-east region the only crop grown is boro. This crop can be damaged almost every year during the early monsoon (April/May) by quick accumulation of flood water from the neighbouring hills. Once the crops are damaged no more crops can be grown as the flood water normally, goes on rising through the monsoon. To overcome the problem farmers in association with rich land lords (Jamindars) developed a practice of constructing dwarf embankments on the bank of the rivers to prevent ingress of flood water until the boro crop is harvested. This was developed further in some areas by providing sluices at the outfall of the main drainage channel with the objectives of drainage in the pre monsoon period, prevention of flood water intrusion during the period of irrigation and also to allow gradual inundation after harvesting boro to prevent embankment erosion.

This idea has been further improved by the BWDB under the programme of Early Implementation Projects (EIP) and these ideas are accepted. One of the problems of submersible embankments is the major rehabilitation work which requires to be undertaken to the embankment section almost every year. Public participation (of the beneficiaries) must be encouraged to address this problem.

With little better management some areas under submersible embankments may grow double crops: boro followed by transplanted floating rice.

It is significant that FAP 12 reported two submersible embankment schemes in the top ranking of FCDI schemes in its economic evaluation.

In spite of its advantages and public acceptance submersible embankments have the following deficiencies:

- the operation is not good, sluices often closed by stoplogs which cannot be removed because of high water level difference between country side and riverside (i.e. high hydraulic pressures),

- because of the poor operation embankments are overtopped and water flows over and erodes the embankment,

- in many cases the stoplogs are kept by influential people or stolen/ damaged and not replaced,

- fish migration can be prevented at critical periods.

The problems reported above may be addressed by careful planning, including the incorporation/encouragement of local participation for operation and maintenance.

Submersible embankments appear to have less effect on fisheries than full embankments but they are still effective in reducing fish migrations since the sluices are kept closed at the spawning times of the migratory species. (ref 7.7.4) Data collected during the Gumti Phase II feasibility study (1993) suggest that submersible embankments can also have severe impacts on fisheries.

4.3.4 Polders

Another form of the flood control is the use of polders whereby a selected area is totally surrounded by embankments. The effects of these are similar to main embankments but the catchment area is more limited and thus local drainage problems may not be as severe. A succession of polders can contribute to greater flood problems downstream as each successive polder causes greater flooding downstream due to a reduction of the overspill in the upstream polder, i.e. the attenuation of the flood flows is reduced.

4.3.5 Coastal Embankment

Coastal embankments have three major functions:

- prevent flooding at high tide and in particular to exclude saline water,
- to reduce the effects of normal cyclonic surges.

Coastal embankments are generally constructed on newly accreted char land. The art of constructing such an embankment is to time the construction so that the accreted land has reached a level very close to its maximum so that drainage problems are reduced. This appears to be the case in general although there are several instances where some land has been empoldered before it has reached that state and once the tidal sediments are prevented from entering the area no further accretion is likely and polder ground levels are low and more susceptible to flooding.

The coastal embankments have been very successful in particular in Planning Unit 2 where thousands of people are settled within the embankments. In many cases the polder is not complete, the embankment being allowed to run out in higher ground.

Unfortunately many of the Coastal Embankments have not been completed since drainage regulators were omitted (and gaps left in the embankment). There are several reasons for this including implementation difficulties which might be caused by lack of funds, or, due to the silting up of the proposed drainage outlet.

By their nature Coastal Embankments are in areas where relatively rapid changes occur and they are particularly subject to erosion, due to changing river morphology or wave attack.

These problems are now being addressed by FAP 7 Cyclone Protection II, and a complete revision of standard designs is taking place involving much flatter side slopes to embankments, revetments to resist wave attack, and afforestation on the foreshore to provide added protection and frictional resistance both to wave attack and wind forces (set up).

4.3.6 Compartmentalisation

The concept of compartmentalisation as given by FAP 20 is:

"A compartment is an area in which effective water management, particularly through controlled flooding and controlled drainage, is made possible through structural and institutional arrangements".

The concept has yet to be defined in detail but the basic idea is that a compartment is a polder with inlet sluices upstream and drainage sluices downstream. The ideal size of a compartment is considered to vary between about 5 000 ha and 50 000 ha, and may be divided into sub-compartments. The advantage of controlled flooding is that it will go a long way to eliminating many of the problems caused by full flood protection. In practice it is considered that any compartments in the south east region are more likely to be operated on the principle of controlled drainage rather than controlled flooding because in many areas, particularly in the south-east, rainfall is so high that there is no point in flood protection from the major rivers except for mitigation. Greater control over water levels should enable migratory fish species to enter the compartment and controlled drainage may enable them to attain greater weight. If compartments are combined with irrigation there should also be benefits for resident species. However many problems remain to be resolved and there is potential conflict between farmers and fishermen in the method of operation of compartments, for example there is no reason to believe that operation of gates on compartments will be very much different to operation on more conventional schemes. The real issues will not become clear until the concept of compartmentalisation, and operation of compartments has crystallised

FAP 20 has already started to develop some pilot projects in order to study various options for compartmentalisation. Findings of the study may give definite guidance in planning compartmentalisation in the South East Region during the feasibility study phase. However, it must be pointed out that FAP 20 is a long term research and implementation project.

Applicability of this type of project in the South East region needs detailed study once the results of the Tangail scheme are known. Fisheries in the Tangail compartment area are of much less importance than in those areas of the South East which could make use of this type of project.

4.3.7 Tidal Drainage

In the north of the area the major rivers are barely tidal in the monsoon season when river levels are high. However at Rahmatkhali and possibly at Chandpur use may be made of the water levels at low tide to drain water provided that high tides are prevented from entering the system by regulators and there is sufficient storage in the drainage system. In the extreme south of the area, (Planning Units 1 and 2), drainage is a problem because the land is low in any case and the southward drainage channels are lengthening due to natural accretion. This process slows down the flow in the channels which back up for a long way. Regulators which are installed to keep out saline water or high tides can suffer greatly from siltation due to the reduction in the tidal wedge. The sediment concentration in the tidal current is greater than the concentration in the Lower Meghna river. Deposition of this sediment reduces the effectiveness of the drainage channels such as Noakhali Khal and Bagardona River. Also deposition during high tides has led to the siltation problems at Kazirhat regulator on the Little Feni River and downstream of the Muhuri regulator on the Feni river.

4.3.8 Pumped Drainage

The standard method of designing pumped drainage schemes in Bangladesh is to use a drainage co-efficient which varies from about 2 l/s/ha to about 4 l/s/ha depending on locality; the figure for the study area would be 4 l/s/ha or more. This may be compared with the figures given in Chapter 2 where the maximum rainfall for Sarail over 5 days with a return period of five years is 322 mm, (the 5 days rainfall for a two year return period is 236 mm). Rainfall of 322 mm over 5 days is equivalent to 7.5 l/s/ha. The irrigation requirement is of the order of 1.5 l/s/ha, so that if irrigation pumps are to be used for drainage they would only be able to handle about 20% of the normal design requirement. Pump station dimensioning is therefore dictated by drainage needs. However, the approach is generally not to cater for intense storms but to use the units to reduce the rate of rise of internal flood depths.

In the National Water Plan Phase I study MPO did not recommend the installation of pumps exclusively for drainage. Pumps used for both irrigation and drainage may be economic in certain cases but the returns are still less than the returns to minor irrigation.

The North-west Regional Study (FAP 2) analysed the benefits of pumped drainage in the Kurigram Irrigation and Flood Control Unit but found that none of the alternatives studied was viable even with a discount rate of zero. In that case they gave the pump station and plant a life of 22 years and found that the benefits were still less than the costs.

It is clear therefore that pumped drainage will be uneconomic except where a major irrigation pump has to be installed and the pumps may be designed for irrigation and a certain drainage function.

4.3.9 Loop Cutting

Many rivers tend to meander, this meandering increases the length of the river and reduces the carrying capacity although the effect may be reduced by the overbank flow in the flood season. Eventually the meander loops join and the river takes the shortest course leaving the old course in a cut-off section known as an ox-bow lake (baor). Drainage can be facilitated to a certain extent by artificially cutting a channel to short cut a loop and accelerate the natural process, however loop cutting is not necessarily a long term solution since the river tends to increase its cutting capacity upstream and downstream of the loop thus causing other meanders, loop-cutting should only be practiced after extensive morphological studies.

4.3.10 Dredging

In certain cases dredging of the rivers or khals may be beneficial but there is a tendency for the dredged section to silt up, there is no data available on the long term effectiveness of dredging khals and the morphology modules of the Surface Water Simulation Model at the WRPO Surface Modelling Centre cannot be calibrated for several years yet. Therefore, whilst dredging may be considered it should only be implemented after a thorough study of its long term sustainability otherwise it may be totally ineffective within a few years.

4.4 Completed Flood Control and Drainage Projects

The major works completed in the area are listed in Table 4.3 and Figure 4.8 shows the major embankments in the Study Area.

Figure 4.8 indicates that if all existing schemes were completed and fully functional there is a continuous embankment around the southern and western side from Sonaganj to Chandpur; however it is known that there are several gaps. For example Polder 59/3A has never been closed and there are gaps at Noakhali Khal. Elsewhere there are places without structures or where the embankment has been eroded (such as in Polder 59/2).

In the central part of the area the Gumti Phase I project and the Daudkandi Comilla road provide a complete embankment from east to west across the study area albeit with uncontrolled openings for cross drainage. It may be seen therefore that the whole of the southern area may be enclosed by a comparatively short embankments between Chandpur and Daudkandi. The fact that these have not been built yet is indicative that the southern part in general does not suffer from serious flooding from the main rivers. In the northern part of the region on the other hand there are relatively few embankments. This is not because there is no flooding, on the contrary, this area contains the most deeply flooded lands but is more due to a difficulty in addressing the problem. The area is complex and would need very extensive embankments and ancillary structures if a traditional FCD scheme were to be implemented. Such an intervention could however create much environmental concern.

The Noakhali Comprehensive Drainage Scheme set out to cure the drainage problem in the Begumganj depression. Construction of major drainage channels, WAPDA khal, and Rahmatkhali khal and a 14-vent regulator at the outfall of the Rahmatkhali khal to the Lower Meghna were the main features of the project. However, this scheme appears to have been based upon the assumption that Noakhali Khal would remain fully operational, and it is now grossly overloaded, through having to drain a catchment approximately twice the size of that for which the regulator was designed.

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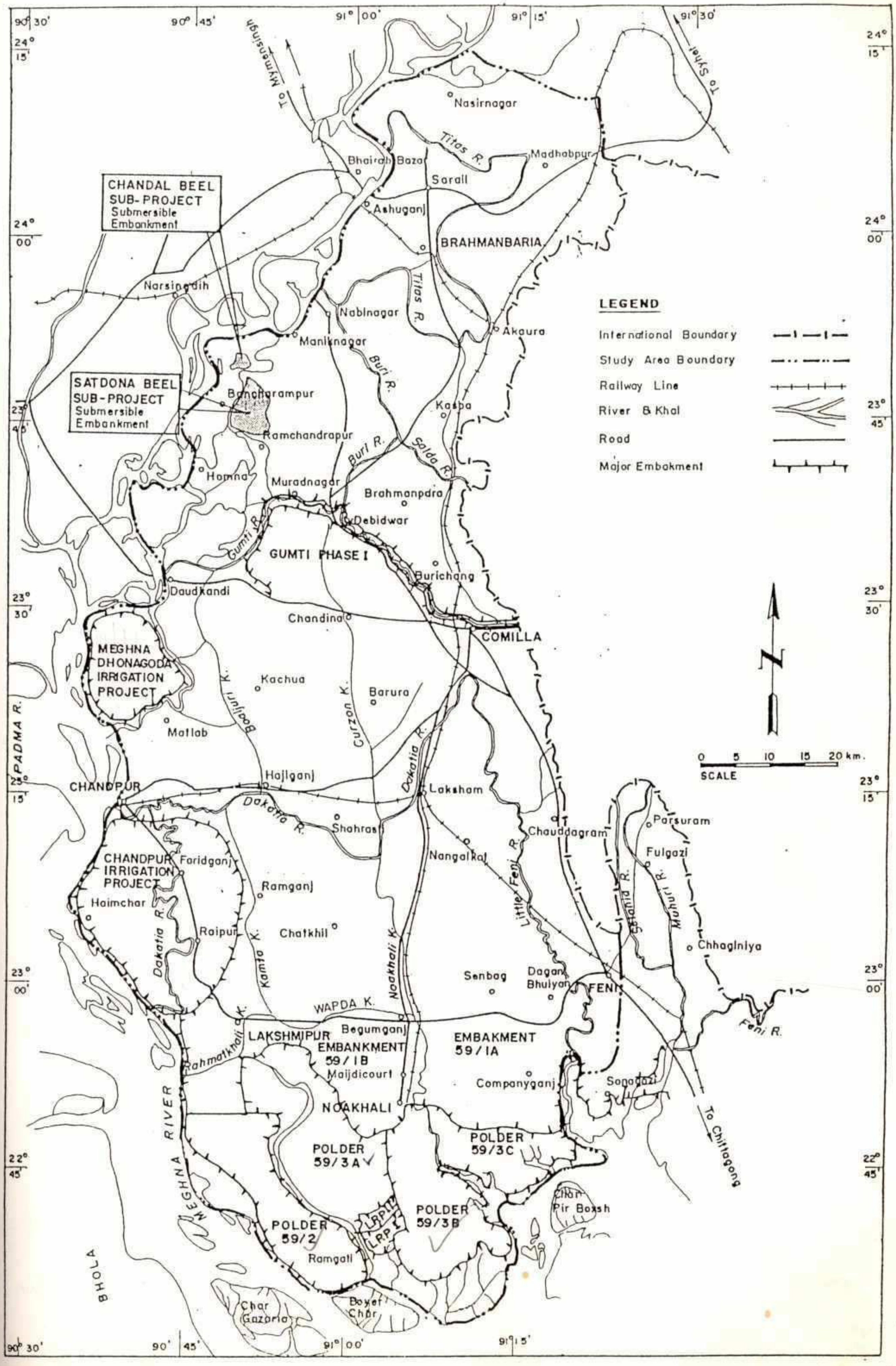
Figure 4.8

Major Embankments



CHAPTER 5

EXISTING INFRASTRUCTURE

5.1.1 Major Towns

The major towns in the area are Comilla, Chandpur Lakshmipur, Feni, Brahmanbaria and Maijdee Court. All these towns are zila headquarters.

5.1.2 Roads

Figure 5.1 shows the main roads in the area. The main Dhaka-Chittagong highway passes through Daudkandi, Comilla and Feni. Daudkandi is the site of the only ferry on this road and is some 40 km from Dhaka. This ferry will also shortly be removed when the new bridge, currently under construction and ahead of schedule, is completed. The main Dhaka Sylhet road passes through the north of the area entering the area at the ferry at Bhairab Bazar and leaving near to Madhabpur. There is a ferry across the Titas at between Sarail and Madhabpur but an old bridge is being rebuilt at that site. The main road from Comilla to Sylhet joins the Dhaka-Sylhet road at Brahmanbaria and is the main link between the north-eastern region and Chittagong. There are also major roads from Comilla to Chandpur and from Feni to Lakshmipur. All thana headquarters have all-season road access, apart from Nabinagar and Ramchandrapur which are cut off in the flood season. The road connections often take the form of a spur (feeder road) from a major road but the roads to Akhaura, Brahmanpara and Ramgati are not asphalted.

Roads are generally built on embankments which are designed to be above flood level. As such they have a major effect on drainage although significant channels are crossed by bridges or large culverts. However, they have major potential use in any flood control scheme since they should be above flood level, and structural works at drain crossings should be adequate for many flood control schemes.

After the 1988 floods the cost of damage to the road system was estimated as follows:

District	Damage Tk million
Comilla	35.5
Brahmanbaria	90.4
Chandpur	-
Noakhali	30.8
Lakshmipur	108.4
	265.1

In general the expenditure on embankments was negligible. Most of the repair costs were estimated for pavement and to a lesser extent, culverts, and therefore most embankments apparently survived. Even repairs to protection works were only nominal. The exception to this were repairs of thana roads, where the costs of restoration of embankments were about 50% of the total cost, particularly around Homna, Muradnagar, and Nasirnagar. Thana roads are often at lower levels and therefore more likely to be overtopped. All these estimates must be treated with caution since it seems that many other repair costs may have been included which may not have been due to the floods.

5.3 Railways

Railways are also shown in Figure 4.1. The main railway from Dhaka to Chittagong passes through Brahmanbaria Akhaura, Comilla, Laksham and Feni. From Akhaura the main line to Sylhet branches off. There are branch lines to Noakhali and Chandpur leaving the main line at Laksham. All railways in the eastern part of Bangladesh are metre gauge.

Railways embankments are also built above normal flood level but in any case the main line from Comilla to Ashuganj is mostly on higher land and avoids the deeply flooded areas where possible. However tracks were still damaged by flood in 1988, although the estimated cost of repair in the region (Tk 72 million) was less than 6% of the national repair bill.

5.4 Navigation

The northern and western part of the project area has very poor road communications because of low lying land and beel areas. In this area boats are a common form of transport. Outside Dhaka and Khulna, Chandpur is the largest inland port in the country and has good shipping connections with Chittagong, Mongla and Dhaka. Chandpur, being well-connected with Chittagong by water and railway, acts as a gateway of Chittagong port, with most of the country as its hinterland. The Upper and Lower Meghna Rivers from Bhairab Bazar to the Bay of Bengal provide a good all season navigation route for passenger and cargo vessels to Bhairab Bazar, Ashuganj, Nabinagar, Bancharampur, Homna, Daudkandi, Satnal, Chandpur, and Hajimara

5.4.1 Official Routes

In the Bangladesh Inland Waterway Transport Authority (BIWTA) Master Plan (1989), the waterways in the study area were classified under four classes depending on the clear water draft. Accordingly, the Meghna-Dhaleswari river complex on the route Chandpur-Dhaka (72 km) with a draft of 4.0 m is classified first class, and the Meghna river between Daudkandi and Bhairab Bazar (75 km) and the Dakatia river between Chandpur and Ichuli (7 km) with draft of 2.5 m are second class (see Figure 4.2). The Meghna-Titas-Burinadi rivers from Chitri to Kuti Bazar via Nabinagar (21 km) and the Titas river between Mohisher char and Selimganj (31 km) with draft of 2.0 m are classified third class. The Pagla-Salda Nadi from Kuti Bazar to Gokarnaghat (13 km), Dakatia Nullah from Ichuli to Faridganj (64 km) and South Dakatia from Charpagla to Raipur (20 km), all with a water draft of 1.5 m, are classified fourth class. Figure 4.2 illustrates the areas which are most significant in terms of water transport.

Figure 5.1

Roads and Railways

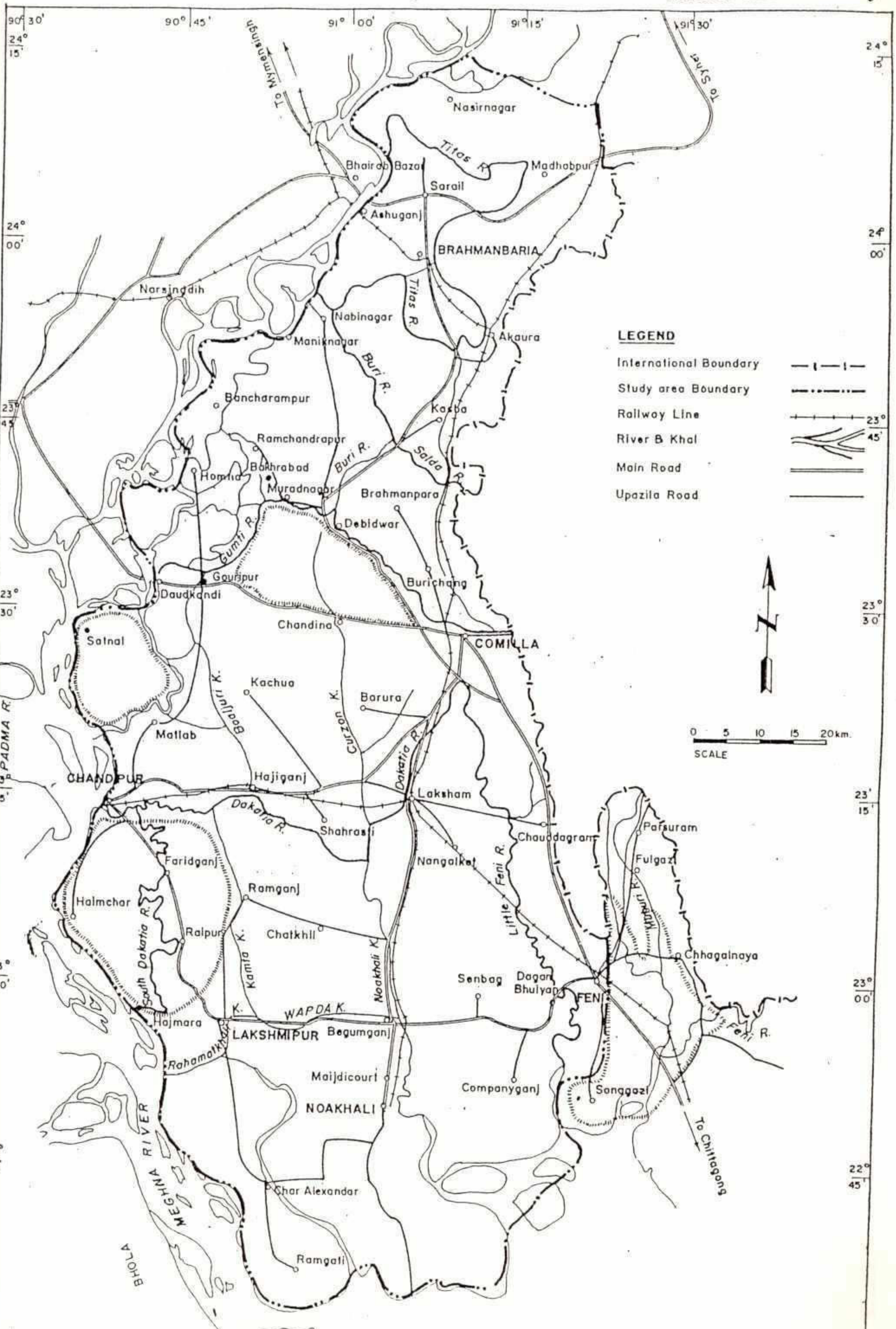
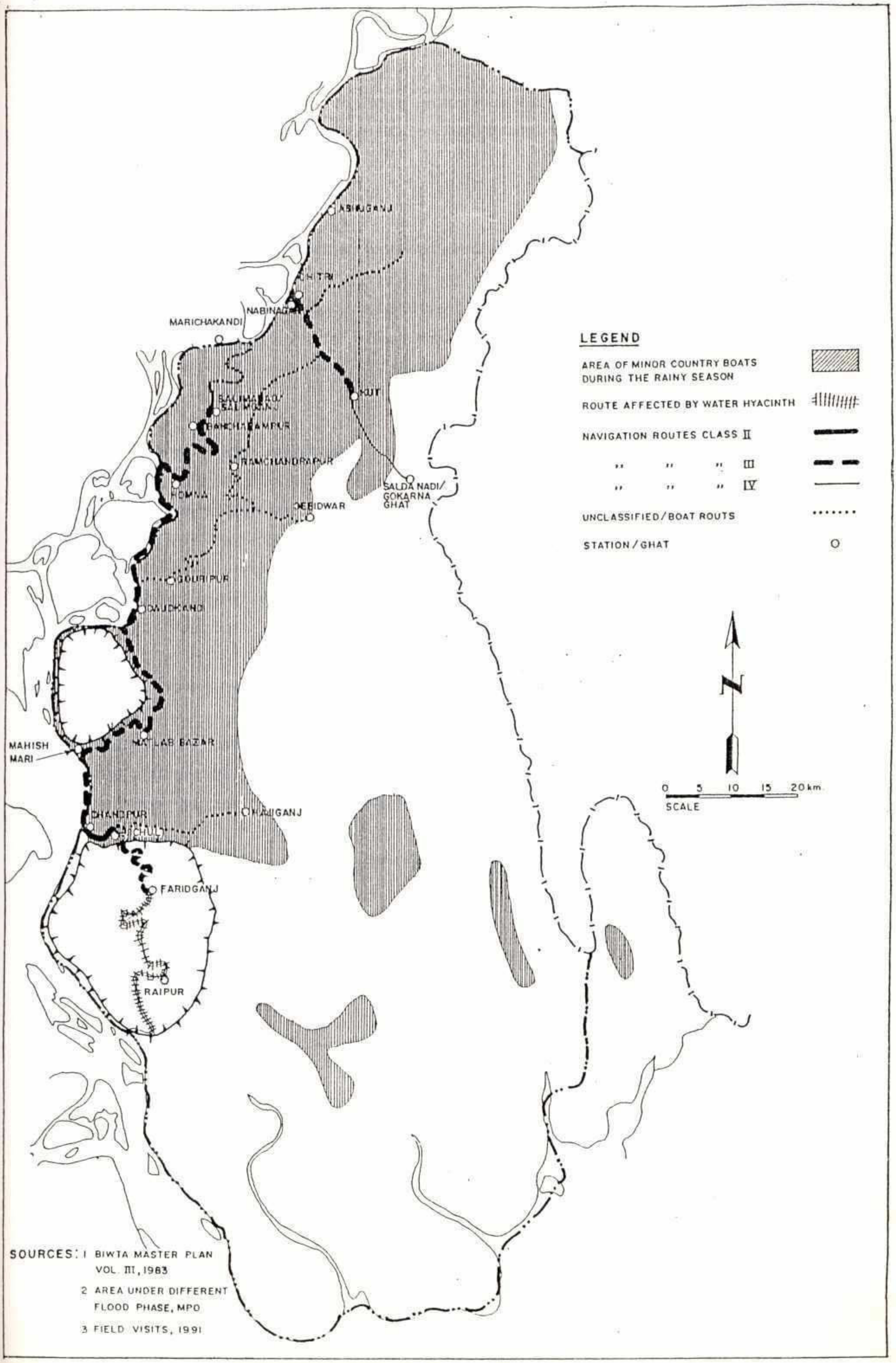


Figure 5.2

Navigation Routes Country Boat Areas



The BIWTA surveyed 40 km of Gumti River from Daudkandi to Companiganj for country boat routes. It is also planned to develop the Titas River from Homna to Ramchandrapur (21 km) and Selimganj to Majiara (16 km) by dredging.

Until recently there has been a decline in the use of country boats but they are now increasing their share of the market due to the installation of diesel engines. This requires modifications to traditional designs but boat builders appear to be adapting well.

5.4.2 Navigation along other unrecognised routes/passages

These routes/passages are generally shallower parts of rivers and khals plied by mechanised or non-mechanised country boats, basically serving as feeders to the classified routes. These routes serve the minor regional market centres and other settlements. Some of these routes are seasonal.

5.4.3 Cross-country navigation

During the rainy season in particular, most of the flooded F3 and F4 land is open to navigation by small or large country boats connecting either commercial centres or villages. The inter-village country boat navigation comes into its own particularly during the rainy season, specially along the flood plains of the Meghna and the Titas. A considerable number of social visits, particularly by women, take place during the rainy season.

5.4.4 Importance

The classified routes are commercially important, both for passenger and goods traffic, Chandpur is regionally the most important port, and the incoming cargo far outweighs in tonnage the outgoing cargo. Ashuganj and Daudkandi are other important cargo handling stations.

There are BIWTA launch stations as well as private ghats along routes which follow the rivers:

- Dakatia,
- South Dakatia,
- Dhonagoda,
- Gumti,
- Burinadi,
- Pagla,
- Saldanadi, and
- Meghna.

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The launch ghats are listed below:

1. Ashuganj
2. Bancharampur
3. Chatalpur
4. Char Pagla
5. Chitri
6. Farazikandi
7. Faridganj
8. Gokernaghat
9. Homna
10. Ichuli
11. Kulainagar
12. Kutibazar
13. Machuakhali
14. Maniknagar
15. Marichakandi
16. Miarbazar
17. Mohanpur
18. Nabinagar
19. Raipur
20. Ramchandrapur
21. Ramkrishnapur
22. Salimganj
23. Satnal
24. Uzanchar

5.4.5 Country Boats

Pending availability of thana level statistics on the number and type of country boats, the following sample data illustrate considerable regional variations between thanas which fall within the Meghna-Titas flood plain and those which fall outside it.

Sl. No.	Thana	Number of Boats			
		Ordinary	Engine	Fishing	Total
1.	Nabinagar	8 215	260	500	8 925
2.	Akhaura	300	30	N.A.	-
3.	Companiganj	200	25	550	775
4.	Bancharampur	6 685	90	N.A.	-

As more country boats are converted to engine boats, their importance as passenger and goods carriers will also increase.

5.5 Power Transmission

The 230 kV transmission line from Karnaphuli (Chittagong) passes through Feni and Comilla and reaches Dhaka via Siddeswari. Another 230 kV transmission line from Comilla to Ashuganj is under construction. One of the largest thermal power plants is situated at Ashuganj, within the study area, and is connected to Dhaka through Siddeswari grid station.

From Comilla sub-station to Chandpur, there is a 132 kV power transmission line. A 132 kV power transmission line is under construction between Feni and Chowmohani. The 132 kV transmission lines connect all the district head quarters of Brahmanbaria, Comilla, Chandpur, Feni, Sonapur and Lakshmipur whereas 33 kV transmission lines connect all thana headquarters. There are major national grid sub-stations at Comilla, Feni, and Chandpur and one is planned for Noakhali.

Electric power is of major significance with respect to FCD/I projects due to power requirements for pumping both for major pump stations and low lift pumps (LLP). However in each case direct diesel drive is an alternative, in fact, there is evidence that LLP operators find the electricity tariff punitive, use engines elsewhere during the monsoon season and also find electricity supplies unreliable, so the lack of rural electrification is not regarded as an obstacle to the development of LLP. Many DTWs are electrified but a smaller proportion of STWs are electrically driven.

5.6 Gas Distribution

The study area includes the largest gas fields in the country, Titas and Bakhrabad, and there are also gas fields in Marichakandi, and Begumganj, whilst the Feni gas field is going to be harnessed very soon.

There are gas pipelines from the Bakhrabad field to the Daudkandi Comilla road, whence one line goes to Daudkandi and on to Dhaka and the other goes across country to Laksham and then to Feni and Chittagong. From the latter there are spurs to Comilla, Chandpur and Maijdi Court. From the Titas field there are pipelines westwards towards Ashuganj and also north-east to Habiganj. None of these pipelines are likely to seriously affect any water resources development. There are proposals to extend gas supplies through Begumganj to Lakshmipur with a spur to Senbag.

It is to be expected that further expansion will take place connecting all the main urban centres in the region.

The gas fields mentioned above abstract gas from a depth of more than 2000 m. In many locations within the study area marsh gas is generated at very shallow depths. This may interfere with the operation of tubewells which depend on suction lift, such as shallow tube wells, since the intrusion of gas is sufficient to prevent priming of the pump.

5.7 Domestic Water Supply

It is estimated that the total urban and rural domestic water demand from surface and groundwater will increase from 13 Mm^3/month in 1985 to 56 Mm^3/month in 2 005 in the south-east region. According to the National Water Plan (NWP) there will be no increase in surface water pumping after 1990, with subsequent increased abstraction based on groundwater.

Per capita water demands are assumed to be: district town 120 l/person/day, thana centre 100 l/person/day, rural 50 l/person/day, underserved 17 l/c/day. These demands provide a guideline as to the current consumption levels.

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The current targets are the provision of one hand tubewell (HTW) for each 75 persons of the rural population and the full servicing by piped distribution systems of urban populations, through house connections or standpipes.

In some areas, including the Noakhali area, salinity levels are high in the groundwater. Additional groundwater development, in particular for irrigated agriculture, could aggravate the domestic water supply situation and extend the zone of saline subterranean water. The problem of the quality of water supplies in the coastal area is important. Fresh water flow to the aquifer during the monsoon period provides a two tier water quality situation in coastal aquifers. Although the changing coastline and deltaic development will tend to push the saline influence further south, this latter element is of minor significance.

The other aspect of the rural water supply situation which needs consideration is the need to avoid rapidly creating large regions where suction lift standard HTW cannot operate. Hand tubewells provide about 85% of the rural population with potable water supplies. The suction lift of the standard hand tubewell is about 7 m and hence their ensured functioning places a development constraint on the extent of use of deep tubewells and also deep set shallow tubewells (DSSTW). Normally, the situation is only critical in the period February to April, with the end of dry season being the most critical (i.e. April). Some unevenness in the piezometric level in the aquifer of a region is natural; hence HTW and STW can live in a degree of harmony with deep tubewells, but the spacing between units is an important factor. Currently there are no zoning regulations. This often affects the HTW user, who becomes the loser, since the deep tubewells lower the water table to below the critical level. In areas where water tables are below/beyond the suction capacity of standard HTW, a deep set suction unit has been developed, called the Tara Pump. The unit can operate with water tables up to 15m below ground level (or about 13m below normal field level). The Tara Pumps are significantly more expensive than the standard HTW and more difficult to install, whilst the current manufacturing capacity is limited. However, increasing the use of groundwater resources, within the constraints of environmental considerations, may need a planned transition to the use of Tara units in some demarcated areas.

Adapted well technology is required in the urban areas in Noakhali, where thin layers of fresh water are contained only in the upper fine sandy zone of the aquifer. Gauze-wrapped wide diameter tubewells of limited depth are used successfully in Maijdi Court, Noakhali, whereas in the char land in the south rower pumps are in use. One solution being adopted is to instal a tubewell near to a water tank, which guarantees the supply to the pump.

CHAPTER 6

AGRICULTURE AND IRRIGATION

6.1 Introduction

Agricultural production in the study area is affected by flooding, poor drainage and drought. Farmers have learnt to live with this and plan their cropping patterns according to their perception of the risks. Rabi crops are often planted late due to slow drainage of the monsoon floods, the boro harvest is liable to be reduced due to local flash floods, and the depth of flooding in the monsoon floods, the boro harvest is liable to be reduced due to local flash floods, and the depth of floodings in the monsoon season influences the choice of kharif crops. As a result farmers do not cultivate intensively and often reduce agro-chemical inputs because of the risks to the corp; yields are generally low.

Agricultural information in the original Draft Regional Plan was based on secondary data backed up by very limited field investigations. This has now been supplemented by field level data from the Gumti II and Noakhali North Feasibility Studies and from up-dated sources of secondary data.

6.2 Land Use

6.2.1 Cultivable land and cropping intensity

Agriculture is the dominant form of land use in the region. Out of a gross area of 955,000 ha, 777,000 ha (81%), is used by field crops and orchards. The remaining area is occupied by settlements, roads, rivers and other permanent water bodies, and wasteland. Data for individual planning units is shown in Table 6.1.

Most land is multiple cropped, and overall cropping intensity in the region is estimated at 171%, based on 1987/88 and 1988/89 MPO data. This is slightly higher than the overall average for Bangladesh. However there is considerable variation between planning units (see Table 6.1), with relatively low cropping intensities in South Sudharam (an area of char land with little irrigation), Titas and Ashuganj.

6.2.2 Flooding

In Bangladesh, flooding characteristics (i.e. flood depth, duration and timing), together with irrigation, are the most important factors in determining agricultural land use. Traditional cropping patterns and practices are adapted to these flood characteristics.

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TABLE 6.1

Land Utilization According to Planning Unit

Planning Unit	Gross Area (ha)	N.C.A. (ha)	Cropping Intensity
1. Polder 59/2	30,848	26,469	189
2. South Sudharam	110,046	89,636	134
3. Noakhali North	99,535	74,526	147
4. Little Feni River	97,362	77,901	185
5. Dakatia	86,108	68,507	175
6. Chandpur	52,398	39,750	191
7. Meghna Dhonagoda	16,189	13,440	213
8. Dhonagoda	112,405	88,065	203
9. Sonaichari	19,165	15,944	155
10. Gumti phase I	31,486	26,139	207
11. Gumti phase II	140,854	122,172	203
12. Ashuganj	28,913	25,919	133
13. Titas	101,510	89,979	115
Sub-Total	**926,819**	**758,447**	171
Misc	28,094	18,216	187
Total	**954,913**	**776,663**	171

Source: Derived from FAO, 1988. Land Resources Appraisal of Bangladesh for Agricultural Development, Report No. 2.

Land has been classified according to flood depth by The Master Plan Organization (MPO) of the Ministry of Irrigation, Water Development and Flood Control. This classification, known as "Flood Phases", is as follows:

Flood Phase	Flood Depth
F_0	0.0 - 0.3 m
F_1	0.3 - 0.9 m
F_2	0.9 - 1.8 m
F_3	1.8 - 3.0 m
F_4	More than 3.0 m

Although this classification does not take account of characteristics other than depth, such as timing and duration of flooding, it is the best available secondary data on flooding and has been used to define land types for the purposes of pre-feasibility studies in the Regional Plan. However these calculations have grouped F_3 and F_4 land together as F_3. This is partly because there is very little F4 land in the region. This is partly because there is very little F_4 land in the region. The distribution of flood phases in each planning unit is shown in Table 6.2.

6.2.3 Irrigation

The extent of irrigated areas in the study area was estimated from 1989 SPOT satellite imagery, followed by ground checks in May 1991. This was then compared with 1991 AST data for minor irrigation, which in most areas was reasonably compatible with the satellite imagery. However in two areas, Dakatia and Dhanagoda, the AST data indicated almost twice as much irrigation, and calculations have been based on the satellite imagery.

Overall 286,052 ha are estimated to be irrigated by different modes of minor groundwater and surface water irrigation (see Section 6.12). This amounts to 37% of the Net Cultivated Area (NCA), varying between planning units from zero (Polder 59/2) to 100% in the Meghna Dhonagoda Irrigation Project (see Table 6.3). The potential for irrigation development in terms of land available is greater in southern areas which now have relatively little irrigation compared with the north of the Region. Irrigated areas interpreted from SPOT imagery (1989) are shown on the irrigation map in the Album of Drawings.

TABLE 6.2

Distribution of Flood Depth in Planning Units

Planning Unit	N.C.A. (ha)	FO	F1	F2	F3+F4
1. Polder 59/2	26,469	0	24,987	1482	0
2. South Sudharam	89,636	0	83,624	6,012	0
3. Noakhali North	74,526	3,576	26,580	43,513	857
4. Little Feni River	77,901	7,779	53,019	17,103	0
5. Dakatia	68,507	3,957	16,287	41,798	6,465
6. Chandpur	39,750	9,398	28,944	1,408	0
7. Meghna Dhonagoda	13,440	0	0	10,797	2,643
8. Dhonagoda	88,065	2,373	20,062	38,861	26,769
9. Sonaichari	15,944	2,460	8,457	4,979	48
10. Gumti phase I	26,139	879	11,566	2,659	11,035
11. Gumti phase II	122,172	7,761	27,619	48,925	37,867
12. Ashuganj	25,919	103	10,893	11,279	3,644
13. Titas	89,979	12,926	13,195	30,144	33,714
Sub-Total	**758,447**	51,212	325,233	258,960	123,042
Misc	18,216	930	4,739	6,881	5,666
Total	**776,663**	52,142	329,972	265,841	128,708

Source: MPO

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TABLE 6.3

Irrigated Areas in Planning Units

Planning Unit	N.C.A. (ha)	Irrigated (ha)	Irrigated as % of NCA
1. Polder 59/2	26,469	0	0.0
2. South Sudharam	89,636	1,595	1.8
3. Noakhali North	74,526	25,833	34.7
4. Little Feni River	77,901	18,839	24.2
5. Dakatia	68,507	22,946	33.5
6. Chandpur	39,750	23,132	58.2
7. Meghna Dhonagoda	13,440	13,440	100.0
8. Dhonagoda	88,065	31,026	35.2
9. Sonaichari	15,944	9,757	61.2
10. Gumti phase I	26,139	8,500	32.5
11. Gumti phase II	122,172	60,980	49.9
12. Ashuganj	25,919	14,767	57.0
13. Titas	89,979	47,988	53.3
Sub-Total	**758,447**	278,803	36.7
Misc	18,216	7,249	39.8
Total	**776,663**	286,052	36.8

Source: **Estimated from 1989 Spot Imagery 1991 AST data and feasibility study data in Gumti II and Noakhali**

6.3 Crop Areas

Rice dominates the cropping pattern in all areas of the region, accounting for about 80% of the total area of all crops cultivated. Other crops such as wheat, oilseeds, jute and pulses each occupy around 4 to 6% of the crop area.

Figure 6.1 shows a typical schematic annual cropping calendar and compares this with seasonal water levels at chandpur and seasonal rainfalls.

Table 6.4 shows the cropping pattern, derived from BBS statistics, for districts covered by the study area (thanas in these districts that are outside the region have been excluded). It indicates that there is a considerable difference between the three northern districts of Brahmanbaria, Comilla and Chandpur, and the southern districts of Feni, Lakshmipur and Noakkali. Broadcast deepwater aman is more widespread in northern parts of the region, while local transplanted aman is more widely grown in the south.

Data collected in the field during farmer surveys suggest that official statistics may under-estimate the area of some crops. Nevertheless these figures do give an indication of the relative importance of different crops.

Table 6.5 shows how crop areas have changed over the last six years. The area of boro has increased at the expense of the aus crop and b.aman. The fact that the area of HYV aman has not increased suggests that it may be constrained by flooding in many areas.

Figure 6.1

Relationship Between Rainfall Evapotranspiration, Floods and Crops

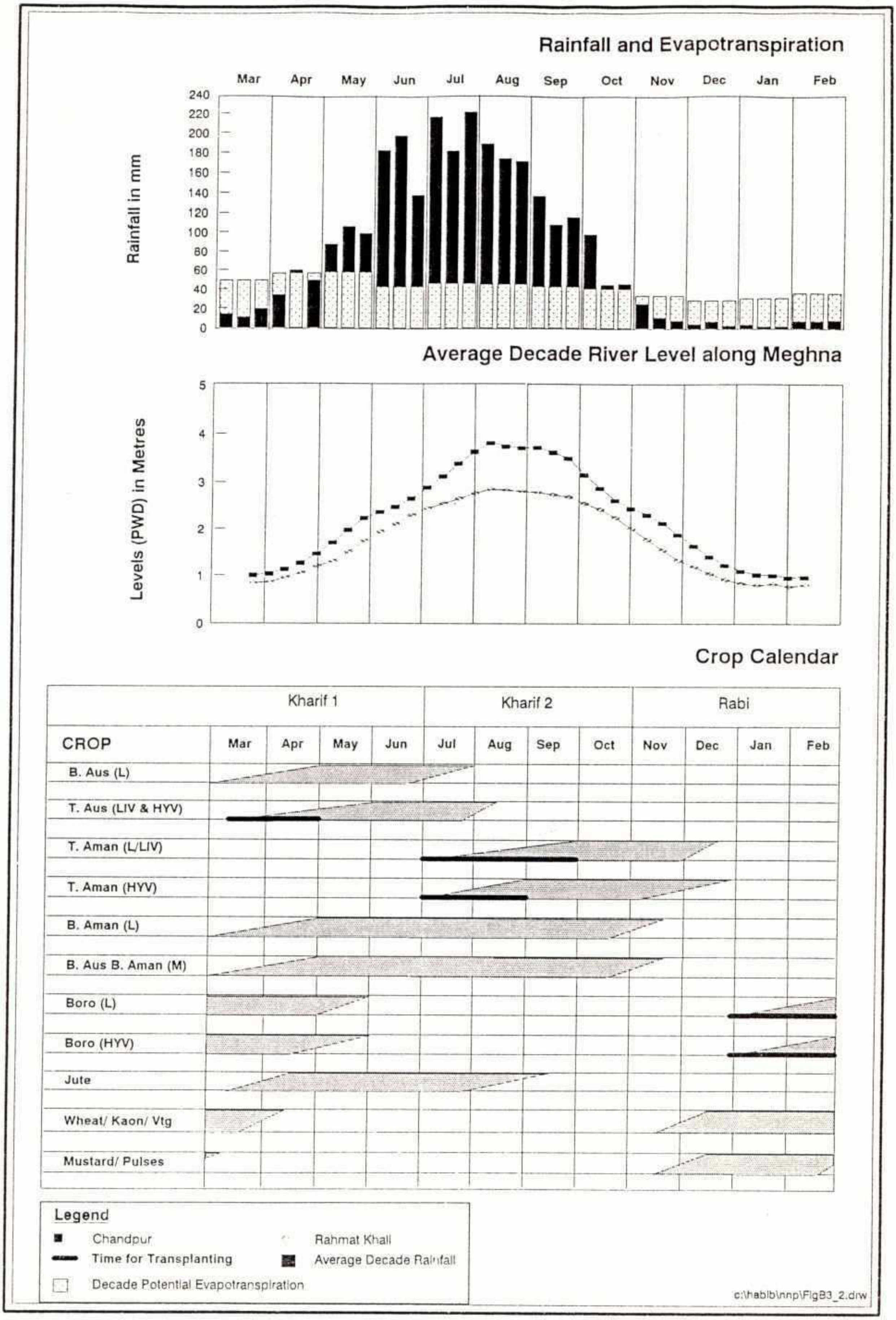

TABLE 6.4

Crop Areas as Percentage of Net Cultivable Areas

Area as % of NCA	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noakhali	REGION*
1990/1							
Local aus	16.3%	16.5%	23.4%	25.8%	32.7%	18.7%	19.7%
HYV Aus	1.2%	17.9%	2.0%	13.7%	6.5%	5.4%	8.4%
B Aman	37.3%	24.9%	41.4%	0.0%	4.7%	6.4%	23.1%
Local T Aman	9.6%	15.1%	11.6%	37.4%	57.0%	39.8%	23.3%
HYV Aman	0.6%	28.9%	23.3%	79.8%	17.4%	13.6%	19.6%
Local Boro	2.8%	0.8%	3.3%	0.1%	0.2%	2.2%	1.7%
HYV Boro	35.7%	34.9%	29.0%	32.8%	33.0%	30.6%	33.0%
Wheat	9.3%	10.0%	11.5%	0.4%	0.2%	0.0%	6.7%
Jute	5.1%	1.9%	4.8%	0.0%	0.4%	0.1%	2.4%
1991/2							
Local aus	15.7%	15.1%	23.9%	19.4%	28.1%	16.8%	18.2%
HYV Aus	1.8%	16.4%	3.2%	16.6%	7.9%	7.0%	8.7%
B Aman	32.4%	22.4%	41.5%	0.0%	4.3%	6.4%	21.3%
Local T Aman	11.0%	12.5%	11.7%	39.9%	62.8%	41.7%	23.8%
HYV Aman	1.2%	29.2%	22.7%	72.4%	14.0%	12.0%	18.8%
Local Boro	2.7%	0.5%	2.4%	0.0%	0.3%	1.9%	1.5%
HYV Boro	37.0%	37.4%	29.4%	36.9%	42.0%	32.6%	35.6%
Wheat	10.1%	8.3%	12.1%	0.3%	0.3%	0.0%	6.4%
Jute	5.1%	2.0%	6.7%	0.0%	0.4%	0.2%	2.7%

* includes part of Habiganj district in study area.

Source: BSS

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TABLE 6.5

Crop Areas as Percentage of Net Cultivatable Area
South-East Region Study Area, Main Crop Only

	1986/7	1987/8	1988/9	1989/90	1990/1	1991/2
Area as % NCA						
Local Aus	28%	30%	24%	20%	20%	18%
HYV Aus	12%	10%	14%	7%	8%	9%
B Aman	29%	26%	23%	25%	23%	21%
Local T Aman	28%	21%	24%	23%	23%	24%
HYV Aman	24%	24%	19%	20%	20%	19%
Local Boro	2%	2%	2%	2%	2%	1%
HYV Boro	21%	34%	38%	30%	33%	36%
Wheat	10%	15%	11%	7%	7%	6%
Jute	7%	3%	4%	2%	2%	3%

* includes part of Habiganj district in study area. source: BSS

6.4.3 Crop Yields

BBS data of the yield for the last two years, of major crops by district is in Table 6.6. Yields generally appear to be higher in the northern part of the region. In the south yields were higher last year than the year before, as possibly the cyclone of April 1991 caused significant salt damage in coastal areas.

Yields for the whole region over the last six years are shown in Table 6.7. This suggests that overall yields are static, although there was some increase in boro in the last year.

Statistics on crop yields are difficult to reconcile with yields reported directly by farmers. These generally indicate higher yields for rice crops than BBS data. DAE also collect crop yields statistics and their yield data is generally above that of BBS, but below that of farmer surveys. This study has carried out two extensive farmer surveys in the north and south of the region. The overall average of all plots reported in these surveys are shown in Table 6.8, together with the results of another recent farmer survey carried out by FAP 12 inside and outside the Meghna-Dhonagoda project, and the levels used in crop budgets in the regional plan.

TABLE 6.6

Crop Yield Statistics by District

Yield t/ha	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noakhali	REGION*
1990/1							
Local aus	1.56	1.48	1.73	1.50	1.53	1.08	1.47
HYV Aus	2.88	2.88	3.01	3.45	2.56	2.11	2.79
B Aman	2.69	1.99	2.13	1.87	1.69	1.44	2.23
Local T Aman	2.86	2.56	2.44	1.54	1.64	1.54	1.95
HYV Aman	2.99	3.50	3.38	2.06	1.93	2.27	2.96
Local Boro	2.13	2.36	2.50	2.95	2.37	1.84	2.19
HYV Boro	4.23	4.35	4.38	2.45	3.46	3.36	3.99
Wheat	1.98	1.99	2.28	0.78	0.61	0.62	2.05
Jute	2.35	1.69	2.37	0.64	1.38	1.17	2.16
1991/2							
Local aus	1.54	1.56	1.83	1.05	0.98	0.92	1.38
HYV Aus	2.95	2.92	3.00	2.78	2.04	2.47	2.76
B Aman	2.83	2.01	2.06	-	1.66	1.43	2.25
Local T Aman	2.79	2.65	2.45	1.87	2.41	2.24	2.40
HYV Aman	3.20	3.84	3.23	2.56	2.42	2.60	3.30
Local Boro	2.12	2.38	2.62	-	3.05	2.82	2.45
HYV Boro	4.46	4.19	4.42	3.65	3.86	4.26	4.23
Wheat	2.30	1.84	2.70	1.14	0.79	0.99	2.21
Jute	2.37	1.90	2.25	0.60	1.21	0.62	2.18

TABLE 6.7

Yields of Major Crops
South-East Region Study Area, main crop only

Tonnes per ha	1986/7	1987/8	1988/9	1989/90	1990/1	1991/2
Local aus	1.35	1.29	1.45	1.44	1.47	1.38
HYV Aus	2.60	2.74	2.78	2.73	2.79	2.76
B Aman	1.60	1.74	1.66	2.14	2.23	2.25
Local T Aman	1.92	1.80	2.11	1.86	1.95	2.40
HYV Aman	2.95	3.09	3.17	3.02	2.96	3.30
Local Boro	2.49	1.98	2.22	2.02	2.19	2.45
HYV Boro	3.80	4.08	3.95	3.95	3.99	4.23
Wheat	1.97	1.05	1.33	2.01	2.05	2.21
Jute	2.03	3.86	1.08	2.02	2.16	2.18

Source : BBS

Note : Rice yield is as paddy

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TABLE 6.8

Comparison of Yield Data from Different Sources

Tonnes per hectare (rice as paddy)	Farmer survey	FAP 12 (MDIP)		BBS avg. 1989-91	Used in crop budgets
		project	outside		
B Aus, local	1.89	2.08	2.04	1.43	1.90
B Aus, HYV	2.65	3.59			n/a
T Aus, local	2.36	2.99			n/a
T Aus, HYV	3.17	4.22		2.76	3.10
Mixed aus/aman	3.01	1.71	1.14		n/a
B Aman local d.w.	1.73	1.87	2.04	2.21	1.75
T Aman local d.w.	2.5				n/a
T Aman, local	2.3	3.31	1.29	2.07	2.30
T Aman HYV	3.52	4.66	2.8	3.09	3.55
Boro, local	0	3.15		2.22	2.80
Boro, HYV	5.37	5.04	4.47	4.06	5.10
Wheat irrigated	2.25	1.92	1.98	2.09	2.25
Wheat unirrigated	1.99	1.96	1.98	2.09	1.80
Potato irrigated	15.03	9.52	17.38	11.45	15.00
Potato unirrigated	11.49	9.52	17.38	11.45	11.00
Jute	1.83	1.26	1.02	2.12	1.90
Pulses: keshari	0.76		0.9	0.64	0.70
mung	0.62		0.9	0.66	0.60
masur	0.48		0.9	0.79	0.50
mash	0.70		0.9	0.00	0.70
Mustard	0.76	0.74	0.49	0.77	0.75
Sugarcane	38.41	32.8		32.64	36.00
Spices (chilli)	2.05	1.21	0.58	2.31	(1) 4.00
Veg. (brinjal)	8.01			7.18	8.00

(1) This yield refers to fresh chillies whereas the statistics refer to dried chillies.

6.5. Farm Size and Land Tenure

6.5.1 Agricultural Census Data

The South-East Region, is one of the most densely populated parts of Bangladesh and it is not surprising that farms are predominantly small. The distribution of farm size as ascertained in the 1983/4 Agricultural Census for the study area is shown in Table 6.9. Over 84% of farms are classified as small (under 1 ha) and these occupy half of the farm area, compared with 70% of the farms in Bangladesh as a whole. The average farm size (which includes homesteads and non-cultivable land) is only 0.69 ha, compared with 0.91 ha for the whole country.

However the definition of small farms excludes holdings with under 0.02 ha, which are classed as belonging to non-farm households. A more detailed breakdown of farm size showing these holdings is available from the Agricultural Census, but only on a regional (Greater District) basis. This is shown in Table 6.10 for Comilla and Noakhali regions, which together broadly comprise the study area. So called landless households account for 21% of rural households in Comilla and 22% in Noakhali. However almost half of these have at least some cultivable land and so may be more properly classified as marginal farmers. Table 6.10. also shows that the landless and many small farmers (most in Noakhali) are net lessors of land in that they own more land than they operate. Owners of small parcels of land (often inherited) frequently rent them out as they are too small to be worth farming and the owners have some other occupation.

Tables 6.11 and 6.12 show land tenure arrangements for Noakhali and Comilla Regions. They show that, although 14% of land in Comilla and 24% of land in Noakhali is operated by tenants rather than owners, there are very few farms where all the land is rented in - only 0.3% of farms in Comilla and 0.1% in Noakhali. Over a third of holdings in both areas combine tenanted and owned land, with about half the land on such farms in Noakhali and a third in Comilla being rented in. Overall the average amount of land operated is less 0.59 ha in Comilla and 0.83 ha in Noakhali.

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TABLE 6.9

Farm Size Distribution - South East Region

(classified by area of land operated)

	Small farms		Medium farms		Large farms		All farms	
	No.	Area	No.	Area	No.	Area	No.	Area
Habiganj*	13119	5286	3682	6045	553	2616	17354	13947
Brahmanbaria	171441	66090	37653	59774	3800	17685	212894	143549
Chandpur	214179	73429	27998	42680	1841	8698	244018	124808
Comilla	377423	141855	64908	100231	4152	18937	446483	261023
Feni*	48097	16757	6254	9519	358	1725	54709	28001
Lakshmipur	129847	59337	21803	45170	3801	20398	155451	124905
Noakhali*	181345	102324	28078	80715	5351	47257	214774	230296
Total	1135450	465078	190377	344133	19855	117317	1345682	926529
Habiganj*	75.6%	37.9%	21.2%	43.3%	3.2%	18.8%	100.0%	100.0%
Brahmanbaria	80.5%	46.0%	17.7%	41.6%	1.8%	12.3%	100.0%	100.0%
Chandpur	87.8%	58.8%	11.5%	34.2%	0.8%	7.0%	100.0%	100.0%
Comilla	84.5%	54.3%	14.5%	38.4%	0.9%	7.3%	100.0%	100.0%
Feni*	87.9%	59.8%	11.4%	34.0%	0.7%	6.2%	100.0%	100.0%
Lakshmipur	83.5%	47.5%	14.0%	36.2%	2.4%	16.3%	100.0%	100.0%
Noakhali*	84.4%	44.4%	13.1%	35.0%	2.5%	20.5%	100.0%	100.0%
Project area	84.4%	50.2%	14.1%	37.1%	1.5%	12.7%	100.0%	100.0%
Bangladesh	70.3%	29.0%	24.7%	45.1%	4.9%	25.9%	100.0%	100.0%

* only part of district in project area

source: BBS 1983/4 Agricultural Census

TABLE 6.10

Land Holdings in Comilla and Noakhali Regions (Greater Districts)

Land operated	Comila Region				Noakhali Region			
	No. of HH	Area of land (ha)			No. of HH	Area of land (ha)		
		operate	cultivate	own		operate	cultivate	own
Landless								
under 0.004 ha	131297	3190	0	8062	80272	2084	0	4786
0.004 to 0.02 ha	104209	3053	790	8267	67687	2172	594	5684
total landless	235506	6243	790	16330	147959	4257	594	10470
Small farms								
0.02 to 0.20 ha	254681	28081	22151	38898	168868	18034	13093	30323
0.20 to 0.40 ha	210990	61230	53206	61462	111605	31785	26278	37236
0.40 to 0.60 ha	141631	68555	61211	67751	71116	34109	29410	37839
0.60 to 1.00 ha	155741	120172	108809	115501	76254	58668	51660	57479
total small	763043	278038	245376	283612	427843	142597	120440	162877
Medium farms								
1.00 to 3.00 ha	130559	200314	184507	198825	72927	116363	106174	100512
Large farms								
over 3.00 ha	9793	44788	36908	41702	12659	64123	57741	46005
Total	1138901	529383	467580	540469	661388	327339	284950	319864
Landless								
under 0.004 ha	11.5%	0.6%	0.0%	1.5%	12.1%	0.6%	0.0%	1.5%
0.004 to 0.02 ha	9.1%	0.6%	0.2%	1.5%	10.2%	0.7%	0.2%	1.8%
total landless	20.7%	1.2%	0.2%	3.0%	22.4%	1.3%	0.2%	3.3%
Small farms								
0.02 to 0.20 ha	22.4%	5.3%	4.7%	7.2%	25.5%	5.5%	4.6%	9.5%
0.20 to 0.40 ha	18.5%	11.6%	11.4%	11.4%	16.9%	9.7%	9.2%	11.6%
0.40 to 0.60 ha	12.4%	12.9%	13.1%	12.5%	10.8%	10.4%	10.3%	11.8%
0.60 to 1.00 ha	13.7%	22.7%	23.3%	21.4%	11.5%	17.9%	18.1%	18.0%
Total small	67.0%	52.5%	52.5%	52.5%	64.7%	43.6%	42.3%	50.9%
Medium farms								
1.00 to 3.00 ha	11.5%	37.8%	39.5%	36.8%	11.0%	35.5%	37.3%	31.4%
Large farms								
over 3.00 ha	0.9%	8.5%	7.9%	7.7%	1.9%	19.6%	20.3%	14.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: BBS 1983/4 Agricultural Census

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TABLE 6.11

Comilla Region - Land Tenure on Different Sizes of Holding

Size of holding(ha)	0.02-0.2	0.2-0.4	0.4-0.6	0.6-1.0	1.0-3.0	over 3.0	all farms
Number of holdings as percentage of total							
owner operated	72.3%	59.3%	58.1%	55.0%	62.0%	80.8%	62.7%
tenant operated	0.6%	0.2%	0.3%	0.2%	0.1%	0.0%	0.3%
owner-cum-tenant	27.1%	40.6%	41.6%	44.8%	37.9%	19.2%	37.0%
total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
As percent of land operated							
land owner-operated	79.7%	78.1%	81.0%	83.2%	89.6%	97.7%	85.8%
land rented in	20.3%	21.9%	19.0%	16.8%	10.4%	2.3%	14.2%
total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average area per holding (ha)							
Owner operated							
area owned	0.17	0.38	0.58	0.92	1.83	5.14	0.69
area rented out	0.07	0.09	0.10	0.15	0.24	0.55	0.12
area operated	0.10	0.29	0.47	0.77	1.59	4.59	0.57
Tenant operated							
area operated	0.08	0.30	0.40	0.81	1.21		0.27
Owner-cum-tenant							
area owned	0.05	0.16	0.31	0.53	1.14	3.79	0.40
area rented out	0.01	0.02	0.03	0.04	0.08	0.15	0.03
area rented in	0.08	0.16	0.22	0.29	0.42	0.53	0.22
area operated	0.12	0.30	0.49	0.77	1.49	4.18	0.59
As percent of land operated							
Owner operated							
area owned	171.8%	131.8%	122.8%	119.4%	115.1%	112.0%	121.7%
area rented out	72.0%	31.8%	20.6%	19.5%	15.0%	11.9%	21.5%
area operated	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Tenant operated							
area operated	100.0%	100.0%	100.0%	100.0%	100.0%	-	100.0%
Owner-cum-tenant							
area owned	43.6%	53.2%	62.3%	68.4%	77.0%	90.8%	68.5%
area rented out	7.6%	5.7%	6.1%	5.5%	5.4%	3.6%	5.6%
area rented in	64.0%	52.5%	43.8%	37.1%	28.3%	12.8%	37.1%
area operated	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: holdings classified by size according to area operated

Source: BSS 1983/4 Agricultural Census - sample survey

TABLE 6.12

Noakhali Region - Land Tenure on Different Sizes of Holding

Size of holding (ha)	0.02-0.2	0.2-0.4	0.4-0.6	0.6-1.0	1.0-3.0	over 3.0	all farms
Number of holdings as percentage of total							
owner operated	83.2%	63.7%	61.7%	57.2%	50.5%	34.7%	65.9%
tenant operated	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%	0.1%
owner-cum-tenant	16.7%	36.2%	38.3%	42.7%	49.5%	65.3%	34.0%
total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
As percent of land operated							
land owner-operated	87.2%	80.0%	80.5%	79.6%	74.6%	64.9%	75.9%
land rented in	12.8%	20.0%	19.5%	20.4%	25.4%	35.1%	24.1%
total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average area per holding (ha)							
Owner operated							
area owned	0.18	0.42	0.72	1.03	1.85	6.12	0.67
area rented out	0.08	0.14	0.25	0.26	0.32	1.08	0.18
area operated	0.10	0.28	0.47	0.77	1.54	5.05	0.49
Tenant operated							
area operated	0.10	0.08	0.00	0.81	0.00	0.00	0.20
Owner-cum-tenant							
area owned	0.07	0.16	0.29	0.47	0.87	2.23	0.46
area rented out	0.01	0.02	0.04	0.05	0.06	0.16	0.04
area rented in	0.08	0.16	0.24	0.35	0.81	2.57	0.43
area operated	0.13	0.29	0.49	0.71	1.62	4.65	0.83
As percent of land operated							
Owner operated							
area owned	184.9%	149.3%	152.3%	134.0%	120.7%	121.1%	136.3%
area rented out	84.9%	49.3%	52.3%	34.0%	20.9%	21.3%	36.4%
area operated	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Tenant operated							
area operated	100.0%	100.0%	-	100.0%	-	-	100.0%
Owner-cum-tenant							
area owned	50.0%	53.4%	59.2%	65.8%	53.7%	48.0%	54.8%
area rented out	8.8%	7.2%	8.7%	6.6%	3.7%	3.4%	5.0%
area rented in	58.8%	53.8%	49.5%	50.0%	50.0%	55.3%	51.7%
area operated	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: holdings classified by size according to area operated

Source: BSS 1983/4 Agricultural Census - sample survey

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6.5.2 Farmer Survey Results

The data from the Agricultural Census is now 10 years old, and to see how land tenure may have changed it has been compared with the results of farmer surveys carried out for the Gumti and Noakhali feasibility studies. As part of these surveys the status of residents of sample mouzas was listed using tax lists and the assistance of knowledgable local people. The resulting breakdown of farm size is shown in Tables 6.13 and 6.14. Farm size groups are slightly differently defined than in the census, with marginal farms being defined as from 0.02 ha to 0.20 ha, and small farms from 0.2 ha to 1.0 ha. A similar definition has been applied to Census data which is shown in the following Table for comparison purposes. Overall the two sets of data are remarkably similar. The major difference is the division between marginal farmers and landless households, where the surveys suggest there are more landless households than marginal farmers. While it is possible that many people with very small plots of land have been forced to sell in recent years, it is also possible that errors were made in reporting people as landless when in fact they have small plots of land, but are not known in the village as farmers, primarily earning a living from some other occupation.

Comparison Between Statistics and Survey Data

	PROJECT SURVEY		STATISTICS	
	Gumti	Noakhali	Comilla	Noakhali
Large - over 3.0 ha	3.1%	2.2%	0.9%	1.9%
Medium - 1.0 to 3.0 ha	12.7%	11.3%	11.5%	11.0%
Small - 0.2 to 1.0 ha	36.5%	41.6%	44.6%	39.2%
Marginal - 0.02 to 0.2 ha	17.4%	21.4%	31.5%	35.8%
Landless - under 0.02 ha	30.2%	23.4%	11.5%	12.1%
total	100.0%	100.0%	100.0%	100.0%

Statistics: BSS Agricultural Census 1983/4

The proportion of households in the combined groups of marginal farmers and landless is similar for both surveys and census at 43-48%. This does not indicate any increase in landlessness which might have been expected with increasing population, but it is likely that the tax lists, which are usually some years out of date, fail to list all landless households. In fact preliminary results from the 1991 Population Census indicate that the proportion of landless households in the Noakhali planning unit have risen from 29% to 36% since the previous census in 1981. On this basis it would not be unreasonable to suppose the survey of mouza tax lists missed about 10-15% of all households - these being landless.

TABLE 6.13

Farm Size and Land Tenure - Results of Farmer Survey
Noakhali Project Area

	Farm size (cultivated land) - ha				All farms
	Marginal 0.004-0.20ha	Small 0.2-1.0ha	Medium 1.0-3.0ha	Large over 3.0ha	
Proportion of all farms	28.0%	54.4%	14.7%	2.9%	100.0%
Proportion of farms in class					
that: own land	100.0%	100.0%	100.0%	100.0%	100.0%
rent out land	5.9%	16.9%	49.7%	35.3%	19.2%
rent in land	20.9%	43.7%	22.0%	8.6%	33.1%
Average area for all farms					
land owned	0.27	0.73	2.53	5.01	0.99
- not cultivable	0.12	0.15	0.30	0.44	0.17
= cultivable owned	0.15	0.59	2.24	4.57	0.82
- land rented out	0.04	0.18	0.62	0.84	0.22
+ land rented in	0.03	0.12	0.18	0.23	0.11
= net area cultivated	0.14	0.53	1.80	3.97	0.71
Average for farms that rent land					
- land rented out	0.47	1.12	1.31	1.71	0.98
- land rented in	0.12	0.27	0.70	0.46	0.30
Proportion of land					
owned	7.6%	40.2%	37.6%	14.5%	100.0%
not cultivated	19.7%	47.3%	25.6%	7.5%	100.0%
rented out	4.8%	43.6%	40.9%	10.8%	100.0%
rented in	7.5%	61.0%	25.3%	6.2%	100.0%
cultivated	5.6%	40.6%	37.6%	16.2%	100.0%

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TABLE 6.14

Farm Size and Land Tenure - Results of Farmer Survey
Gumti Project Area

	farm size (cultivated land) - ha				All farms
	marginal 0.004-0.20ha	small 0.2-1.0ha	medium 1.0-3.0ha	large over 3.0ha	
Proportion of all farms	25.0%	52.3%	18.3%	4.4%	100.0%
Proportion of farms in class					
that: own land	100.0%	100.0%	100.0%	100.0%	100.0%
rent out land	9.1%	24.2%	65.8%	45.1%	28.9%
rent in land	7.6%	31.8%	18.5%	0.0%	21.9%
Average area for all farms					
land owned	0.19	0.69	2.29	4.87	1.04
- not cultivable	0.04	0.08	0.22	0.29	0.10
= cultivable owned	0.15	0.61	2.07	4.57	0.94
- land rented out	0.02	0.14	0.51	0.43	0.19
+ land rented in	0.01	0.08	0.07	0.00	0.06
= net area cultivated	0.14	0.55	1.63	4.14	0.80
Average for farms that rent land					
- land rented out	0.22	0.57	0.79	0.92	0.54
- land rented in	0.08	0.26	0.33	0.00	0.21
Proportion of land					
owned	4.5%	34.6%	40.2%	20.6%	100.0%
not cultivated	9.4%	39.4%	38.7%	12.5%	100.0%
rented out	2.3%	38.4%	49.2%	10.1%	100.0%
rented in	2.5%	75.6%	21.9%	0.0%	100.0%
cultivated	4.3%	35.9%	37.1%	22.7%	100.0%

Tables 6.13 and 6.14 show land tenure arrangements on the 768 holdings covered in the farmer surveys. Results have been weighted to take account of farm size distribution in the tax list analysis. Compared with the census data rather fewer farms rent in land in Gumti (22% against 33%, in Noakhali) and the overall amount of land rented in is quite small - although sample farms rented out quite a substantial area. Small farms are the group most likely to rent land in, and those that do rent about half their cultivated land.

Almost all rented land is on a share-cropped basis with the lessee supplying all inputs and giving about half the crop to the landlord. Such an arrangement could be expected to discourage the use of high levels of labour and inputs, but farmer survey data for the boro crop shows there is no significant difference in fertiliser use or yield between rented and owner-occupied land.

6.6. Agricultural Support Services

6.6.1 Agricultural Extension

The Department of Agricultural Extension (DAE) of the Ministry of Agriculture is responsible for providing farmers with technical advice and training.

In each district agricultural extension work is controlled by a Deputy Director of Agriculture (DDA). He is supported by Subject Matter Specialists (SMS) in crop production, pest control, and training. At the Thana level staff include a Thana Agricultural Officer (TAO) supported by a Subject Matter Officer, an Assistant Agricultural Extension Officer and a Junior Agricultural Officer. The grass roots level extension agent is the Block Supervisor (BS) who is responsible for a block, typically comprising two or three Mousas.

Agricultural Extension is organised through the Training and Visit (T&V) system. This involves a programme of regular visits by the BS to 8 sub-blocks according to a fortnightly programme. At each sub-block there are 10 contact farmers through which messages concerning improved practices are passed on to the farming community. In addition the BS attends one training and one conference session during the fortnight where he is given the next fortnight's messages and farmers' problems are discussed. He also maintains demonstration plots in farmers' fields.

Experience of the T&V system has highlighted a number of weaknesses, in particular the relevance of simple messages for the varied and sometimes complex problems faced by farmers, and the high cost and management problems in maintaining 12,000 Block Supervisors in the field. The T&V system is now being overhauled under the Agricultural Support Services Programme (ASSP - assisted by World Bank, ODA and USAID) which aims to concentrate activities in key areas including minor irrigation operation and on-farm water management.

6.6.2 Agricultural Research

Research is coordinated by the Bangladesh Agricultural Research Council (BARC) and carried out through five major research agencies, each specializing in a particular crop or crops.

The Bangladesh Rice Research Institute (BRRI) is responsible for research into rice, and provides comprehensive training on rice cultivation to officials of various agencies. It has two Regional Research Stations in the study area, one at Comilla and one, for saline conditions, at Sonagazi near Feni.

The Bangladesh Agriculture Research Institute (BARI) conducts research on non-rice food crops. To make research more applicable to farmers' problems BARI has an On-farm Research Division which operates a Farming System Research programme, however BARI has no research stations in the study area.

Agricultural Research suffers from many of the same problems as Extension. About 95% of its budget is absorbed by salaries and staff costs leaving inadequate funds for field trials and research. Research programmes have been funded by the World Bank and USAID, and a review is underway to determine future support.

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6.6.3 Input Supplies

The supply of fertilizer and chemicals to the farmers is now in the hands of the private sector. Bangladesh Agricultural Development Corporation (BADC) no longer has any responsibility for procurement or distribution of fertilisers. Fertiliser prices are no longer subsidised, but despite a sharp rise in prices, consumption has continued to grow at about 10% per year, partly because of more efficient distribution by the private sector, and its cost relative to the price of rice remains favourable compared with other countries in the region.

Seeds for major crops are provided from the farmer's previous harvest or purchased in the local market. The volume of improved seed produced by BADC is limited and accounts for less than 5% of the total seed requirement. Farmers complain that BADC seeds sometime have poor germination rates due to inadequate seed production, processing and storage practices. The ASSP project is providing assistance to BADC in seed production technology.

6.7. Marketing

6.7.1 Marketing Channels

The marketing system in the Region, as in the rest of Bangladesh, is largely traditional and in the hands of small traders. Products are channelled from the growers through hundreds of primary and secondary markets to the terminal markets of Dhaka and Chittagong both of which are within 200 km of all parts of the Region.

There are 53 regulated markets in the Region where marketing of farm products is officially supervised by the Department of Agricultural Marketing (AMD). Although this supervision is yet to develop, at nine of these markets AMD does collect farmer level prices. These markets are: Nabinagar, Kangshanagar, Gouripur, Matlab Ganj, Lakshmipur, Raipur, Chandraganj, Chatkhil, Chhagulnaiya and Sonagazi.

(a) Primary markets

Rural people sell surplus crops and procure the necessities of life and agricultural inputs in rural primary markets which generally sit twice a week. These markets are operated by growers, local traders and small retailers. About 90% of the paddy and 70% of milled rice marketed in primary markets is sold directly by farmers, the remaining share being undertaken by traders.

Most rural primary markets are long established and have not expanded even where marketed amounts have increased considerably. They suffer from extreme congestion, products being assembled on roads, lanes and pieces of waste ground. Inadequate space in the market limits entry by newcomers and concentrates marketing power in the hands of those with permanent stalls and processing facilities. Most markets have few permanent structures, and lack warehousing, basic amenities and sanitation.

(b) Rural Assembly Markets

Rural assembly markets gather small volumes of products from farmers and intermediaries for export to other regions or main centres. Traders travel from outside to procure local surplus production. These markets often have permanent structures, rice-husking mills, agricultural input merchants, wholesalers and banking and communication facilities.

(c) Secondary Markets

Commission agents, merchants, wholesalers, processors and exporters operate from secondary markets. They are generally connected to other main centers by national highways, railways and all weather waterways.

Chandpur is an important secondary market for rice in south-east region, importing rice from Barisal for both local consumption as well as onward transmittal to Dhaka. Locally produced rice is also brought to Chandpur to be processed and stored, before being re-distributed within the region or exported to other areas. Secondary markets deal mainly in milled rice rather than paddy, most husking and processing being carried out earlier in the marketing chain.

Secondary markets in surplus areas sell foodgrains to other districts, retaining only small amounts for local sale. They mostly handle aman and boro rice, with only negligible quantities of aus, reflecting the shift from aus to boro cropping in surplus areas, and the fact that most of the remaining aus would would be consumed within the district.

Local self-sufficiency in wheat is unusual; even foodgrain surplus areas tend to import wheat from other districts and re-distribute it within the area.

(d) Terminal markets

Terminal markets are large processing, export and distribution centres which receive their supplies from secondary markets. The south-east region lies between the two terminal markets of Dhaka and Chittagong. Traders usually buy rice directly from mills and transport it to terminal markets where they sell to retailers through wholesalers. Wholesalers have their own premises in the terminal markets and act as agents for both buyers and sellers and provide temporary storage for rice. They sell to local retailers and wholesalers from district markets or distributing traders. Some of the wholesalers in the terminal markets buy rice directly from the millers.

6.7.2 Marketing Margins

Price differentials between primary markets and the farmgate are generally 3-4%. Margins between primary and secondary markets are typically of a similar level. Table 6.15 presents data on average price differentials in the market for paddy in 1987/88. The price spread between farmgate and retail prices varies according to location, season and other factors, farmgate prices of rice generally being between 73 and 84% of retail prices. The rice market in Bangladesh is reasonably competitive and efficient, the profit margins are not excessive.

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TABLE 6.15

Price Differentials Between Markets in 1987/88

Crop		Farm gate Paddy Tk/Kg	Primary market Paddy Tk/Kg	Secondary market Paddy Tk/Kg	Terminal market Wholesale Rice Tk/Kg	Terminal market Retail Rice Tk/Kg
Aus		5.79	6.00	6.22	9.67	10.15
Aman	Coarse	5.90	6.08	6.27	9.81	10.21
	Medium	6.43	6.64	6.74	11.34	11.79
	Fine	6.70	7.23	7.50	12.57	13.10
Boro		5.76	5.94	6.16	9.83	10.20

Source: Ministry of Food, 'Study on Food Grain Marketing Trade and Operation'

6.8. Agricultural Credit

6.8.1 Credit Requirements and Sources

Farmers may require short-term credit to finance agricultural inputs such as fertiliser, seeds, irrigation charges, and hired bullocks and labour. They may also need longer term loans to cover purchase of livestock, irrigation equipment or power tillers. All households may also need credit to meet social obligations (such as weddings) and emergencies, while some, particularly the poorest group, may also need credit to buy food and other necessities during periods of hardship prior to harvests, or if they suffer losses in floods or other disasters.

Credit is available from institutional sources (banks, cooperatives and NGOs) and from a range of informal sources such as money-lenders, input suppliers, relatives and neighbours. The surveys conducted for the Gumti II and Noakhali feasibility studies suggest that farmers make surprisingly little use of credit, funding most of their requirements from crop sales or other sources of income. Although this low level of borrowing suggests that farmers have little need for credit, it could also could mean that they are unable to get credit, either because it is not available, or because they are unable to get access. This is discussed in detail in Annex II.

6.8.2 Future Credit Availability and Requirements

Future development of force-mode tubewells is being supported by the National Minor Irrigation Project. However this project does not have a credit component beyond the funding of equipment importers and dealers/contractors. There was provision for lending to farmers for irrigation equipment in the proposed Agricultural and Rural Credit Project II (IDA/ADB/USAID), but this project has been indefinitely postponed pending reforms of the institutions involved. However the problem in lending is not the availability of funds (banks are awash with cash), but rather in the delivery and recovery systems, which is dependant on major institutional reforms of the banking system and on changing the attitudes of borrowers towards loan repayment.

(49)

Investment by farmers in LLP to utilise improved surface water supplies developed by projects in the region need not be dependent on improvements in the availability of institutional credit. Rapid development in LLP and STW has already taken place without a major recourse to bank credit. In fact the problems that farmers perceive in getting access to bank credit suggests they would normally prefer to fund this investment from their savings.

Investment in FMTWs, that may provide an alternative to surface water in areas where conditions preclude STWs, is more problematic. Although their overall cost per hectare irrigated is competitive with STW, as relatively high capital costs are offset by greater operating efficiency, they do demand a larger investment. This means they are less easily affordable and the investment will be seen as a considerable risk, especially as they are a relatively untried technology. This may mean that uptake of this technology is relatively slow. However in a survey of 92 STW operators[1], over half said they were interested in purchasing FMTW. Almost half of the potential investors said they would use their own savings rather than using a bank loan.

6.9. Conclusions - Constraints on Agriculture

In the densely populated south-east region of Bangladesh farmers need to maximise the productivity of their very limited areas of land. Cropping intensity is limited by widespread flooding which also constrains the use of short strawed HYVs, and means there is a significant risk of crop damage. In the dry season lack of irrigation may also be a constraint, although rapid growth of minor irrigation means that around a third of the cultivable area of the region is now irrigated.

Future water resource projects may control flooding, reduce monsoon water depths, and add to the irrigated area. This would help reduce the land and water constraint on agriculture, but benefits for farmers pre-suppose that they have the resources available to utilise the improved agricultural environment.

There are a number of significant constraints to agriculture, that are not water related, and may mean that farmers are unable to respond to improved land and water conditions. In particular they may lack the labour, power and inputs needed to increase cropping intensity and switch to HYVs. The farmers' surveys have identified shortages of draught power (especially for small farmers who do not have their own animals), and labour (especially for medium and large farmers who rely more on hired workers). The institutional credit system is totally inadequate to help provide capital for inputs and irrigation equipment. Small farmers in particular may lack access to the resources they need. Support services for agriculture are also inadequate, with weak agricultural extension and research, overcrowded and ill-equipped rural markets, and rural roads in poor condition.

However there is little evidence that these factors will prevent farmers from exploiting improvements to land and water resources. Rapid expansion of minor irrigation has taken place, along with the adoption of HYVs (where flooding permits), and fertiliser use has increased, despite the lack of formal credit. There is no evidence from the farmer surveys that marginal and small farmers lack resources. In fact they use the same, if not more, fertiliser than other farmers, and get similar yields. Even though they are less likely to own irrigation equipment, there is no evidence that they irrigate a smaller proportion of their land or pay excessive irrigation charges.

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[1] DTW II Final Report (Credit Study)

Shortage of draught power is often cited as a factor that may limit cropping intensity through an extended turn-round time between crops. There is evidence of a growing shortage of draught animals as pressure on land squeezes out space for grazing. Animal populations appear, at best, to be static and due to a worsening feed situation, their capacity for work may be falling. FCD/I projects, by increasing the amount of crop cultivation may add to the problem by reducing fallow land available for grazing, switching land out of pulses into HYV rice (with a consequent loss of high quality crop residue), and increasing the need for cultivation. This would be a serious constraint were it not for the introduction of the power tiller, which although not yet in widespread use, is rapidly becoming popular.

Despite the high population density, farmers can still be short of labour at key times. This problem is also likely to be alleviated by use of power tillers, and farmers may eventually have to switch to labour saving techniques such as direct seeding of paddy and use of herbicides. There is some evidence that, labour and power constraints discourage the growing of deepwater b.aman in rotation with boro. With irrigation in deeply flooded areas farmers frequently switch from a b.aman - rabi crops rotation to a single boro crop, possibly preceded by oil seeds. It may in fact be possible to grow b.aman after the boro has been harvested, especially if the onset of flooding is delayed or the deepwater aman is transplanted rather than broadcast. However farmers, having switched to the substantially more productive boro crop seem unwilling to invest in the effort to grow still more rice, especially as there are risks associated with the aman crop, and considerable labour would be needed for seedbed preparation and transplanting at a busy time of year. However with increasing population pressure, and if the risk of abnormal flooding can be reduced, farmers may in time increase cultivation of boro - deepwater aman.

Perhaps a more serious constraint in the utilisation of improved land and water resources is that posed by short/medium term self-sufficiency in rice and the resulting fall in rice prices. This will reduce incentives to expand production, especially in irrigated crops using high levels of inputs. This is most likely to effect utilisation of groundwater where the aquifer is deeper requiring the more expensive force-mode technology or means STW operate less efficiently. Although falling paddy prices will give farmers more incentives to grow other crops, most of the south-east region is more suited to rice production and prices would need to change dramatically to get farmers to increase the areas of pulses and oilseeds.

With this background it is important that future irrigation development is low cost with minimal pumping and investment in infrastructure.

6.10 Irrigation Modes

Various irrigation modes are employed in the country, these include the following:

Major Irrigation:

- Single lift with gravity distribution,

- Double lift irrigation.

Minor Irrigation:

- Low Lift Pump (LLP),
- Shallow Tubewell (STW),
- Deep Set Shallow Tubewell (DSSTW),
- Deep Tubewell (DTW).

Micro Irrigation:

- Manually Operated Shallow Tubewells for Irrigation (MOSTI),
- Treadle pump,
- Rower pump,

Traditional Irrigation:

- Dug Well,
- Swing Basket,
- Dhoon.

6.11 Major Irrigation.

Single Lift with Gravity Distribution.

This is a surface water irrigation mode. Water from the source of irrigation is raised by pumps and supplied to the field by gravity through a canal system. The drainage system is generally separate from the irrigation system. This practice has limitations in this country specially in the south-east region for the following reasons:

- For a separate irrigation system land acquisition and capital investment are more expensive,
- precise survey, design, construction and efficient and intensive management are required,
- water losses can be high,
- implementation takes several years,
- private participation is limited,
- development costs are borne by the Government.

This mode may not be suitable in the region where there is high population density and land is scarce. The Meghna Dhonagoda Irrigation Project is an example of this system using major pump stations to lift water from the rivers to the canals and part of this scheme also incorporates double lift irrigation.

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Double Lift Irrigation

Under the Double Lift Irrigation System, irrigation water from the source (normally perennial rivers) is first lifted by the major pumps (primary pumps) into a primarily natural drainage system and then it is re-lifted by smaller pumps, LLP, for supply direct to the field. The LLP is normally of 57 l/s capacity. The drainage channels are used both for irrigation and drainage and to achieve this the supply water level is maintained low. Channels from the LLP to the field are normally elevated but, because of their size and length, do not need much land.

The following are the advantages and disadvantages of double lift irrigation.

Advantages:

- Less land acquisition and less capital cost,
- Less control of the system involving no or few control structures,
- Supply water level in the primary/secondary channels (up to the LLP) is not critical, this enables easy operation,
- Benefits can be realized quickly because of shorter construction periods and more public participation,
- Water losses are low; recirculation of irrigation water is possible,
- Private participation is high which gives the opportunity to reduce capital expenditure by the government,
- Open water culture fisheries could be developed in the perennial canal system.

Disadvantages:

- Using the natural drainage network as a irrigation supply system can affect its effectiveness as a drainage network.
- The primary supply system which is also a drain acts somewhat like a reservoir having low velocities in the channels, this could lead to water pollution during the dry season.
- Towards the end of the dry season low water levels are required to reduce drainage congestion at the onset of the monsoon season, this could conflict with the dry season irrigation requirements unless operating rules are enforced.
- O&M costs are high especially for the LLP.

The Chandpur Irrigation Project is a good example of double lift irrigation.

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6.12 Minor Irrigation

Characteristics of standard minor irrigation equipment are given in Table 6.16 and typical water abstraction schemes are shown in Figure 6.2 Diesel is used to power about 75% of the national total while the rest are electric. In the South-East Region the percentages are about 58 and 42 respectively.

TABLE 6.16

Characteristics of Minor Irrigation Equipment

LOW	DTW	STW	MOSTI	UNICEF/ DPH HTW	TREADLE PUMP	ROWER PUMP	TARA PUMP	LIFT PUMP
1. Capacity (Litre/sec)	57	14	0.85	0.85	1.25	1	1	57
2. Maximum Pumping Lift (m)	20*	8.5	8.5	6.5	5.5	8.5	16	8.5
3. Internal Head Losses (m)	1	1.5	0.3	0.3	-	-	-	1.5
4. Net Available Lift (m)	19	7	8	6	-	-	-	7.0
5. Drawdown (m)	6	2	0.3	0.3	-	-	-	-
6. Maximum Operation Head (m)	13*	5	7.7	5.7	-	-	-	Depends upon river stage.

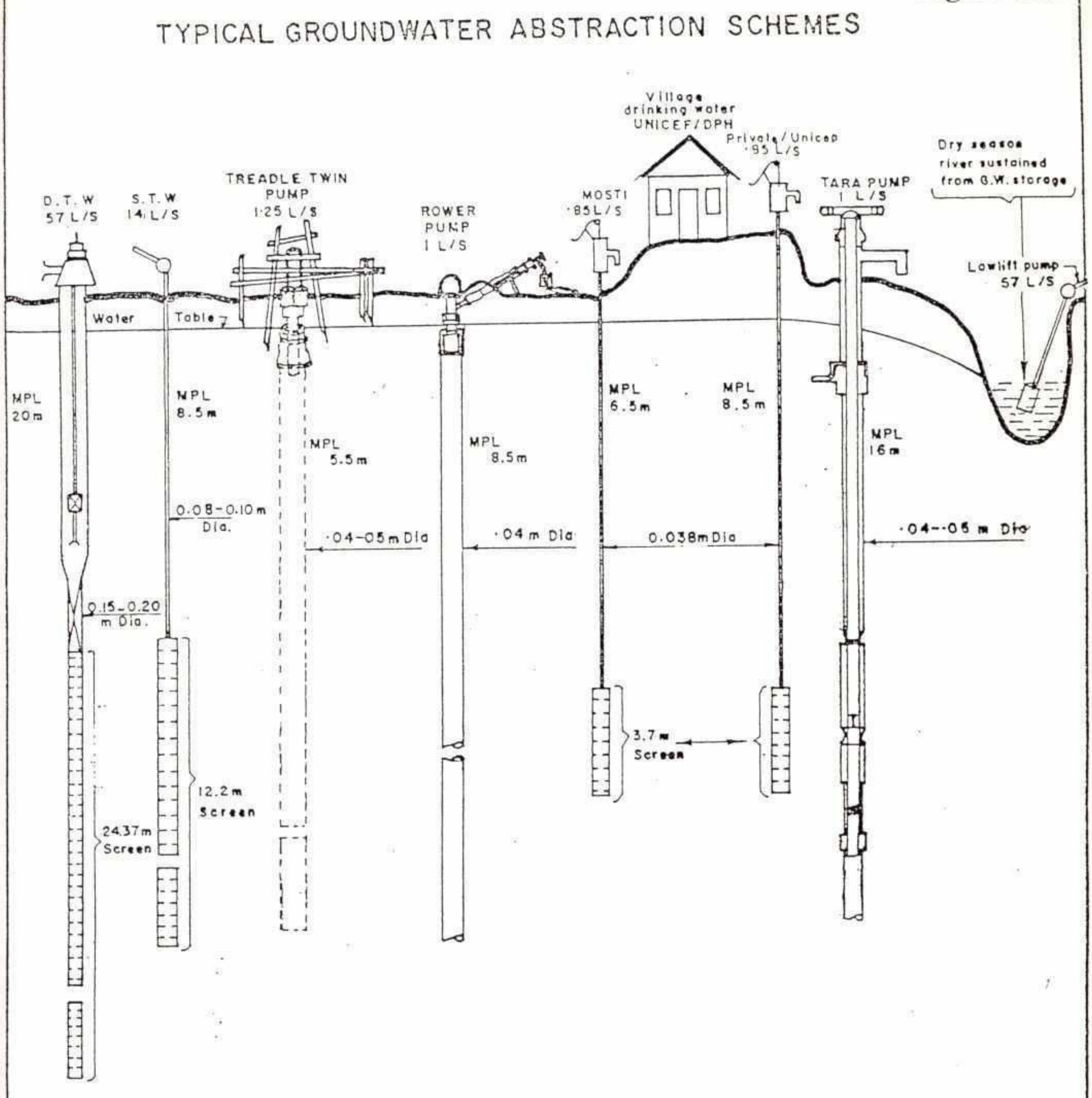
Source: MPO, TR No 13

Note: * These limits are set by the planning criteria to limit extensive lowering of the water table.

Figure 6.2

Typical Groundwater Abstraction Schemes

Figure 12.1



MPL – Maximum Pumping Lift
Source: Figure x–19 TIR, MPO.

MPO / HARZA OCT, 1985

6.12.1 Low Lift Pumps (LLP)

Low Lift Pumps were first introduced on a large scale for agricultural use by the Bangladesh Agricultural Development Corporation (BADC) in the early sixties through its rental programme. The unit consists of a diesel engine/electrical motor with a close coupled centrifugal pump sometimes mounted on a trolley. They are mainly of two types: 1 cusec (28 l/s) and 2 cusec (57 l/s) usually powered by 6 to 13 and 15 to 20 HP primemovers having a pump lift of about 9m. There are other types having discharge rates less than 22 l/s (fractional pumps) and between 84 l/s (3 cusec) and 140 l/s (5 cusec). Irrigation coverage by the later two types is very small (<5%). There is also another type which is low head mixed flow type capacity 57 l/s (2 cusec) powered by 5 to 6 HP diesel engines. These are normally used in the double lift irrigation system where a high head (9m) pump cannot be operated at its optimum rated efficiency.

LLPs are now freely available in the market as the government has liberalised its policy and is encouraging minor irrigation under private ownership. The mixed flow type however is not available in the market. These were specially manufactured for the double lift Chandpur Irrigation Project and the Barisal Irrigation Project. In spite of high cost and low efficiency people prefer to buy the centrifugal type for multi-use purposes. Normally irrigation is limited for about 100 days during the dry season, the rest of the time the equipment remains idle. The owners prefer to use the engine during this period for other uses like husking, boats, power tillers etc. Engines of higher power used for the centrifugal types are suitable for these purposes.

The total number of LLPs working in the region is about 12 300 over 6 000 have a capacity less than or equal to 30 l/s capacity with the remainder being classed as 2 cusec units with discharges of up to 55 l/s which reportedly irrigate an area of about 151 800 ha including the areas on the periphery of the Planning Units.

6.12.2 Shallow Tubewells and Deepset Shallow Tubewells

Shallow Tubewells (STW) are suction lift tubewells having a discharge capacity of about 14 l/s. These are centrifugal pumps normally installed at the ground level (surface set). Recently STW are being installed in a pit up to a maximum depth of about three metres where the groundwater table is low or has fallen due to excess groundwater abstraction. The latter type is called a Deep Set Shallow Tubewell (DSSTW). Like LLP, STW/DSSTW are also powered by diesel or electricity.

STW are now freely available in the market. These are highly popular because of low capital cost, easy manual sinking, and low operation and maintenance costs. However they are limited by the maximum suction head (7m) and other general physical constraints for groundwater development like salinity, etc. Total numbers of STW/DSSTW in operation in the region is 7 520 covering an area of 44 950 ha. Many of these wells suffer from low groundwater levels late in the dry season causing them to lose suction.

The possibility of further shallow tubewell development in the region is limited, but this is discussed at length in Annex V and Volume II.

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6.12.3 Deep Tubewell (DTW)

Deep Tubewells are cased wells with turbine pumps. The primemover is either a diesel engine or an electric motor mounted above the well and connected to the pump by a shaft. The pump is set inside the casing, generally to operate under a maximum pumping lift of 20 metres. The capacity is normally 57 l/s. DTW of higher capacity are also in operation but those are limited in numbers. Almost all of the DTW are supplied and installed by the government agency, BADC at a subsidised rate. Government policy is to privatise the DTW and the government is planning to withdraw the subsidy soon. Future development of DTWs is discussed in Volume II.

Because of high capital cost most of the presently operating DTW are owned by farmer groups, whereas LLP and STW are mostly owned by individuals.

The total number of DTW operating in the region is 2 230 irrigating an area of about 50 800 ha.

6.12.4 Micro Irrigation

Manually Operated Shallow Tubewells for Irrigation (MOSTI)

Hand Tubewells have long been used in Bangladesh for drinking water. During the early eighties, their use has grown rapidly for irrigating small plots of agricultural land under the MOSTI programme. This is a labour intensive method using locally made hand pumps for irrigation. The wells are shallow, around 20m deep, with a discharge capacity of 0.5-0.75 l/sec and a suction limit of nearly 6m. A MOSTI can irrigate about 0.20-0.25 ha of high yielding variety rice. There is little potential to develop MOSTI in the region.

Treadle Pump

The treadle pump is a foot operated STW introduced in the field for irrigation. It is a simple and cheap low capacity pump.

Rower Pump

The rower pump is another shallow suction pump tubewell. The pump employs an unusual design requiring a rowing action which gave the pump its name. About 4 000 rower pumps were sold from 1979 to 1983 in Comilla, Noakhali, Mymensingh, Dinajpur, Kushtia, and Khulna through the Mennonite Central Committee, the Mirpur Agricultural Workshop and Training School (MAWTS), and CARITAS Bangladesh. The pump set is manufactured in the workshops of MAWTS.

Tara Pump

The Tara pump is a new design developed by UNICEF and the World Bank in collaboration with MAWTS to provide water for drinking and small scale irrigation. It is a type of deep set force pump. The pump provides a cheap solution for water supply where suction pumps can no longer operate due to lowered water tables. The areas where suction pumps will no longer be operable during the dry season is growing as irrigation demand expands. (see section 6.12.2 above) In these places, the Tara pump may be practical.

6.12.5 Traditional Irrigation

Characteristics of manually operated equipment are given in Table 6.17. For centuries, Bangladesh farmers have used indigenous techniques for irrigating the boro crop on low lying lands and near perennial streams. The implements used are dhoons, swing baskets, and buckets (dugwells). Dhoon and swing basket techniques can be operated to lift only up to two meters. These modes are low cost, labour intensive, and popular among farmers because of the opportunity to deploy family labour. These may be used at the beginning of the irrigation season when both the surface water and groundwater levels are high.

TABLE 6.17

Characteristics of Traditional Irrigation Devices

	Swing Basket Two-man	Swing Basket One-man	Dugwell	Dhoon
Lift (m)	1.5	1	1-4	0.7-2
Flow (litre/sec)	4	4	1	6

Dhoon (Dipping Boat technique)

Dhoons are boat shaped scoops made with wooden planks or / hollowed out tree trunks. The design is simple and local carpenters make them. The scoop is attached to a cross beam and counterweight. This cross-beam rests on a support that acts as a fulcrum. The operator pulls the scoop into the water; lifting is assisted by the counterweight and the water is then discharged into the field. One dhoon may irrigate 1.6 to 2 ha, but generally less than this.

Swing Basket

This is probably one of the simplest mobile irrigation techniques. The container is made of plain steel sheets, a kerosine can, or woven bamboo shaped into a triangular basket. Two men stand on either side of a water source holding ropes connected to the container which is lowered into the water and swung upward and inverted to discharge the water. Certain type of swings can be operated by one man if the lift does not exceed one meter. One swing basket can irrigate 1.5 ha of boro, but usually the irrigated area is much less than this.

Dug Well

Dug wells (dhab) are holes of nearly 3 ft (0.9m)/diameter in the ground. They may be lined or unlined. Dug wells have been used in many parts of this country for drinking water and have become popular for irrigation in recent years. A bucket is attached by a rope to a beam which holds a counterweight at the far end. The operator has to pull the bucket down against the counterweight until it fills itself with water. The lifting operation is assisted by the counterweight, and the bucket discharges into the irrigation field. About 0.4 ha of boro and 0.75 ha of rabi crops (tobacco, wheat, potato, etc.) can be irrigated by one well. The discharge capacity of the system is one l/sec. Because of depth limitations, their use is limited to where groundwater is available within 1 to 2 m of the surface.

6.12.6 Present Irrigated Area

Present irrigation coverage in the south east region is presented in Table 6.18 by planning units. Total irrigated area by different modes is estimated to be about 286 052 ha (36.8% of NCA). Mode wise distribution is summarised below:

Modes	Irrigated Area		% of Irrigated Area
	Ha	% of NCA	
LLP/Major Irrigation	151 552	19.5	53.0
STW	44 959	5.8	15.7
DTW	50 794	6.5	17.8
Traditional	38 747	5.0	13.5
	---------	--------	-------
Total	286 052	36.8	100

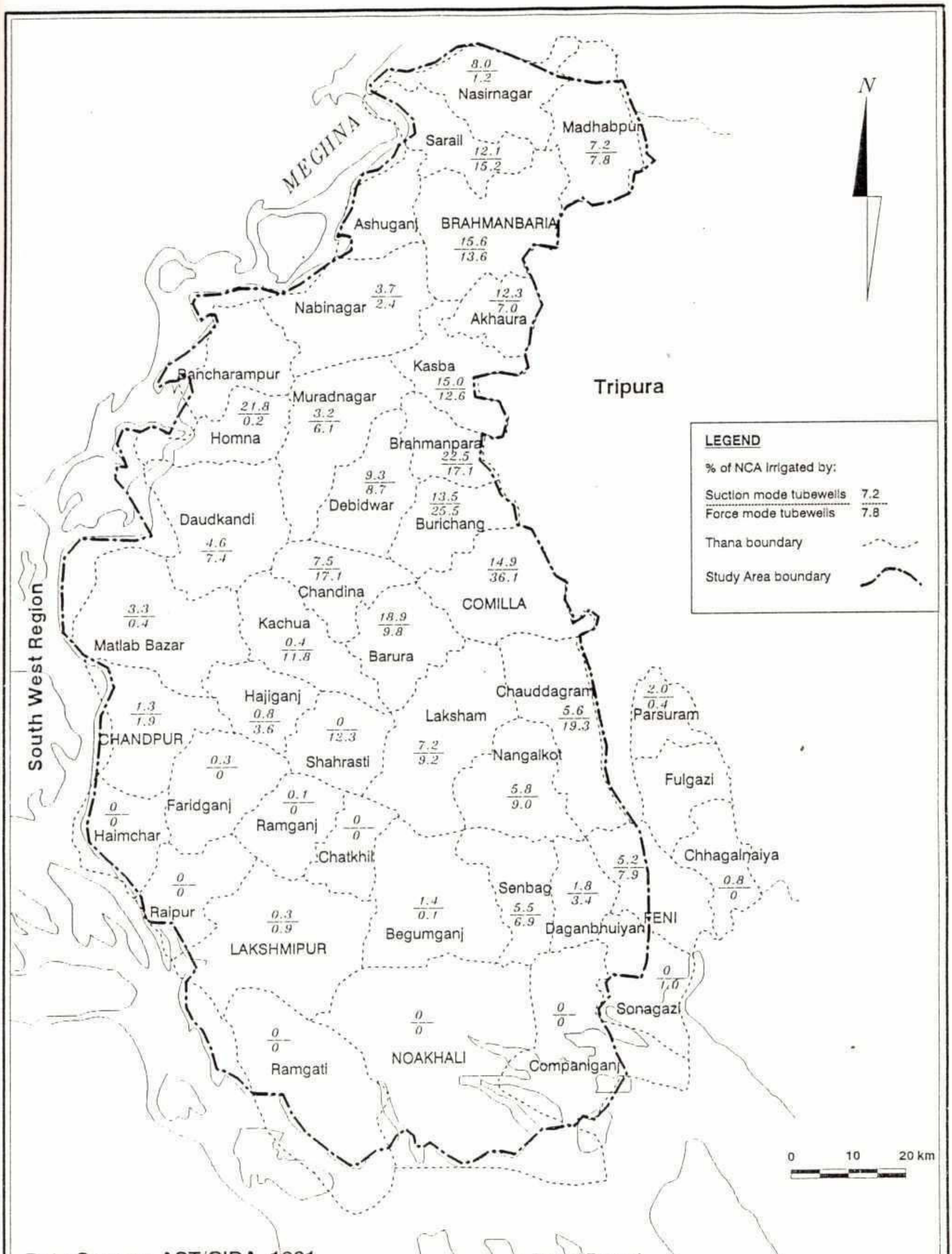
From table 6.18 it is observed that the maximum use of LLPs are in the Ashuganj, Titas, Meghna Dhonagoda and Chandpur planning units. In the Ashuganj Planning Unit the LLPs are mainly fed from the Ashuganj Cooling Water and directly from the Meghna Titas river. In the Titas Planning Unit the main source is the Titas river fed from the Meghna, in the Meghna Dhonagoda about 4 030 ha (30%) of 12 770 ha) is fed by LLP after initially being lifted by major primary pumps. In the Chandpur Planning Unit the area is mostly under double lift irrigation.

The next highest usage of LLP per unit area is in the North Noakhali Planning Unit; about half of this area is fed by the Rahmatkhali Regulator by tidal water capture.

Figure 6.3 shows the distribution of irrigated area by DTW. The figure shows the maximum concentration of DTW to be in the Sonaichari area where the joint use of groundwater and surface water has been developed. The area close to the Sonaichari khal is irrigated by LLP. Surface water is diverted from the Gumti river through a regulator. Area outside the LLP belt is fed by DTW. Overall groundwater development is constrained mainly by marine and local salinity problems as well as the existence of gas in some locations.

Figure 6.3

Present Groundwater Irrigation in the Study Area



For the total irrigated areas Table 6.18 shows the maximum concentration in Ashuganj, Titas, Gumti Phase II, Sonaichari, Meghna Dhonagodha and Chandpur Planning Units. Dhonagoda, Dakatia, Polder 59/2 and South Sudharam have the lowest percentage irrigated area. Some of these latter areas suffer a severe shortage of dry season water resources.

The estimate of irrigated area was based on interpretation of the 1989 SPOT satellite imagery followed by field verification. This was then compared to the AST data for minor irrigation which was published in 1991.

In most of the areas, the interpretation of satellite imagery gave results which were reasonably compatible with AST data but it should be remembered that the imagery was taken in 1989 and irrigated areas may still have been affected by the 1988 flood. In the case of Planning Unit 5, Dakatia, and Planning Unit 8, Dhonagoda, the area irrigated according to the satellite imagery was only about 55% of that according to the AST data; the differences in areas were significant 10 500 ha and 13 700 ha respectively.

In two other units, Planning Unit 3, Noakhali North, the Planning Unit 13, Titas, the interpretation of satellite imagery showed about 4 000 ha more irrigation than the AST data, this could be due to a larger area of land being irrigated by traditional methods for which the AST data is likely to be less unreliable. However it could also be due to local flooding.

The MPO data was also examined but this was not considered to be reliable and was out-of-date, the figures were considerably lower than the AST data or the areas estimated from the imagery.

The two feasibility studies recently completed in the Noakhali North and Gumti II areas collected significant primary data which suggests that, if anything, the AST data may understate irrigated areas and therefore it is now considered prudent to assume the AST data represents the minimum probable irrigated area and therefore in planning units 3, 5 and 8 the AST data has now been used and upwardly adjusted where the new data is available and where there was good agreement the figures have been unchanged from those given in the draft regional plan. In planning unit 11 the 1991 AST data presented in the Gumti II study has been used. It may be noted that both feasibility studies suggest that the irrigated area is continuing to expand (albeit at a slower rate than in the late 1980s). The data given in Table 6.18 are estimates based on 1989 SPOT imagery and 1991 AST data.

It is appreciated that by 1993 these areas are likely to have increased further and this was taken into account in the feasibility study areas but for the Regional Plan the 1991 data has been kept as the reference data.

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TABLE 6.18

Irrigated Area by Planning Units (1991)

Ref. No	Planning Unit Name	Net Cultivable Area (ha)	Existing Irrigated Area by Mode LLP (ha)	STW (ha)	DTW (ha)	Trad/ HTW (ha)	Total (ha)	Percent of NCA Irrigated by Modes LLP	STW	DTW	Trad/ HTW	TOTAL
1	Polder 59/2	26,469	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
2	South Sudharam	89,636	1,212	8	28	346	1,595	1.4	0.0	0.0	0.4	1.8
3	Noakhali North	74,526	17,781	877	850	6,325	25,833	23.9	1.2	1.1	8.5	34.7
4	Little Feni	77,901	7,217	2,857	6,554	2,211	18,839	9.3	3.7	8.4	2.8	24.2
5	Dakatia	68,507	12,406	2,707	5,196	2,637	22,946	18.1	4.0	7.6	3.8	33.5
6	Chandpur	39,750	21,562	117	102	1,351	23,132	54.2	0.3	0.3	3.4	58.2
7	Meghna Dhonagoda	13,440	12,770	0	0	670	13,440	95.0	0.0	0.0	5.0	100.0
8	Dhonagoda	88,065	12,585	5,855	8,780	3,806	31,026	14.3	6.6	10.0	4.3	35.2
9	Sonaichari	15,944	1,456	2,346	5,676	279	9,757	9.1	14.7	35.6	1.7	61.2
10	Gumti Phase I	26,139	3,356	1,991	2,675	478	8,500	12.8	7.6	10.2	1.8	32.5
11	Gumti Phase II	122,172	28,355	15,630	10,687	6,308	60,980	23.2	12.8	8.7	5.2	49.9
12	Ashuganj	25,919	7,538	2,479	2,629	2,121	14,766	29.1	9.6	10.1	8.2	57.0
13	Titas	89,979	20,178	9,482	7,129	11,198	47,988	22.4	10.5	7.9	12.4	53.3
14	Other	18,216	5,136	610	488	1,017	7,250	28.2	3.3	2.7	5.6	39.8
STUDY AREA TOTAL		776,663	151,552	44,959	50,794	38,747	286,052	19.5	5.8	6.5	5.0	36.8

Source: Consultants estimates from SPOT imagery and adjusted AST/CIDA (1991) data.

Note: (a) Chandpur Planning Unit is a double lift irrigation FCDI Project

(b) Meghna-Dhonagoda is a single lift Irrigation FCDI Project

(c) Major Pump 8 740 ha, LLP 4 030 ha.

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CHAPTER 7

FISHERIES

7.1 Introduction

As a whole, the importance of fisheries lies in the fact that they are an important source of income and cheap protein for a large proportion of the human population in Bangladesh. Thus, the objective of the present study is to prepare a regional water resources development plan with the integration of all aspects of water development, of which, fisheries is one of the most important as shown by the recent feasibility studies carried out in the Gumti Phase II and Noakhali North areas within the South East Region.

There are two main types of fisheries in the country, capture and culture fisheries. Capture fisheries takes place through the exploitation of fish in open waters such as rivers, Khals, Beels and in other depressions that hold water for any length of time. Culture fisheries occur in closed water bodies such as ponds, dighis, borrow pits and lakes, where stocking of fish, feeding and fertilization is carried out.

There is an extensive network of seasonal and perennial rivers with Khals cris-crossing the South East Region making it potentially very important for capture fisheries. A large proportion of the Region lies within the annual flooding area of the country and as such, it plays an important role as fish habitat, especially in those areas isolated during the dry season which often merge into one vast expanse of water during the floods. This extensive flooding enhances the fisheries every year by carrying those species which migrate from the main rivers into the floodplain aquatic habitats for breeding, feeding or dispersal purposes. In addition, the man-made Khals and other type of artificial depressions (estuaries, road-side borrow pits and canals) also found in the area, act as fisheries production sites and are good settings for the cultivation of commercially important species. However, ecological and biological data regarding fish and their utilization is lacking, especially for the smaller species and it is thus not possible at present to assess the fisheries situation of the Region in detail.

Therefore, it is vital that an evaluation of the existing fish diversity and fisheries in the region and the potential ecological impacts that any flood control project might have on their life cycles and on the natural environment be carried out, taking into account the lessons learnt from existing FCD/FCDI schemes in the region, as well as the experience gathered from the more recent feasibility studies in the Gumti Phase II and Noakhali North areas.

However, as has been pointed out in these two studies (Gumti Phase II and Noakhali North Studies, 1993), to carry out such an evaluation properly, a detailed ecological assessment of the interactions between the ecosystem and the use of these resources by the local human population is indispensable. Future studies for development projects must include the necessary resources to address these issues.

As a whole, fisheries studies in Bangladesh are currently undergoing substantial changes and it has become indisputable that capture fisheries are considerably more important than previously realised. Relevant studies in this respect include the work by FAP 17, who are looking at the fisheries from the national perspective; FAP 6 the North East Regional study, the fisheries component of this study identified important fishery areas which were termed 'mother fisheries'; and the Gumti Phase II and Noakhali North feasibility studies within the South East Region, which used hydraulic models to estimate the areas of floodland which together with current field data allowed more accurate estimates for the potential fisheries outputs for each area to be made.

The Gumti Phase II area, in the northern part of the SER, has been identified as one of the most important fisheries areas in the country benefiting directly from the Upper Meghna and Titas Rivers. Within Gumti Phase II, the northern, central and western areas are especially important because of the early flooding from the fish-rich Meghna waters which enter via the northern part, extending rapidly throughout the basin. In the Noakhali North area, the most important fishery areas appear to be the Dakatia River and its floodplain. It is expected that other such areas may be identified within the Region after further work is carried out in this respect.

7.2 Capture Fisheries

7.2.1 Open water situation in the Region

There is an extensive network of seasonal and perennial water bodies in the South East Region which often merge into one vast expanse of water during the floods. Figure 7.1 shows the river and Khal network in the Region as a whole while Figure 7.2 shows the areas that typically go under water in the SER in general. The area of these water bodies can be obtained with the aid of the MIKE II Hydraulic Model for most of the SER.

It should be pointed out that for both the 1993 Gumti Phase II and the Noakhali North feasibility studies, the areas of floodplain were calculated from the results of the MIKE II hydraulic model which aggregated all the water levels greater than the MPO Flood Phase F0 (30 cm). This water level was considered the minimum level for fish production. Direct comparison between these results with earlier ones for the same areas of floodplain or for different ones is thus not possible as other studies in general have only included the MPO Flood Phases F3+F4. Further analyses of the floodplain area including all MPO Flood Phases greater than F0 should be carried out for the Region as a whole in order to obtain a more realistic value for the extent and duration of the flooding within the SER.

Table 7.1 shows the areas of water bodies for each planning unit in the SER. However, it should be noted that further hydraulic model runs should be made including the MPO Flood Phases greater than F0 (30 cm) for any fisheries analysis in the future. The difference can be clearly seen in the values for Gumti Phase II and Noakhali North when compared to some of the other planning units.

Figure 7.1

Rivers and Canal Network in the Study Area

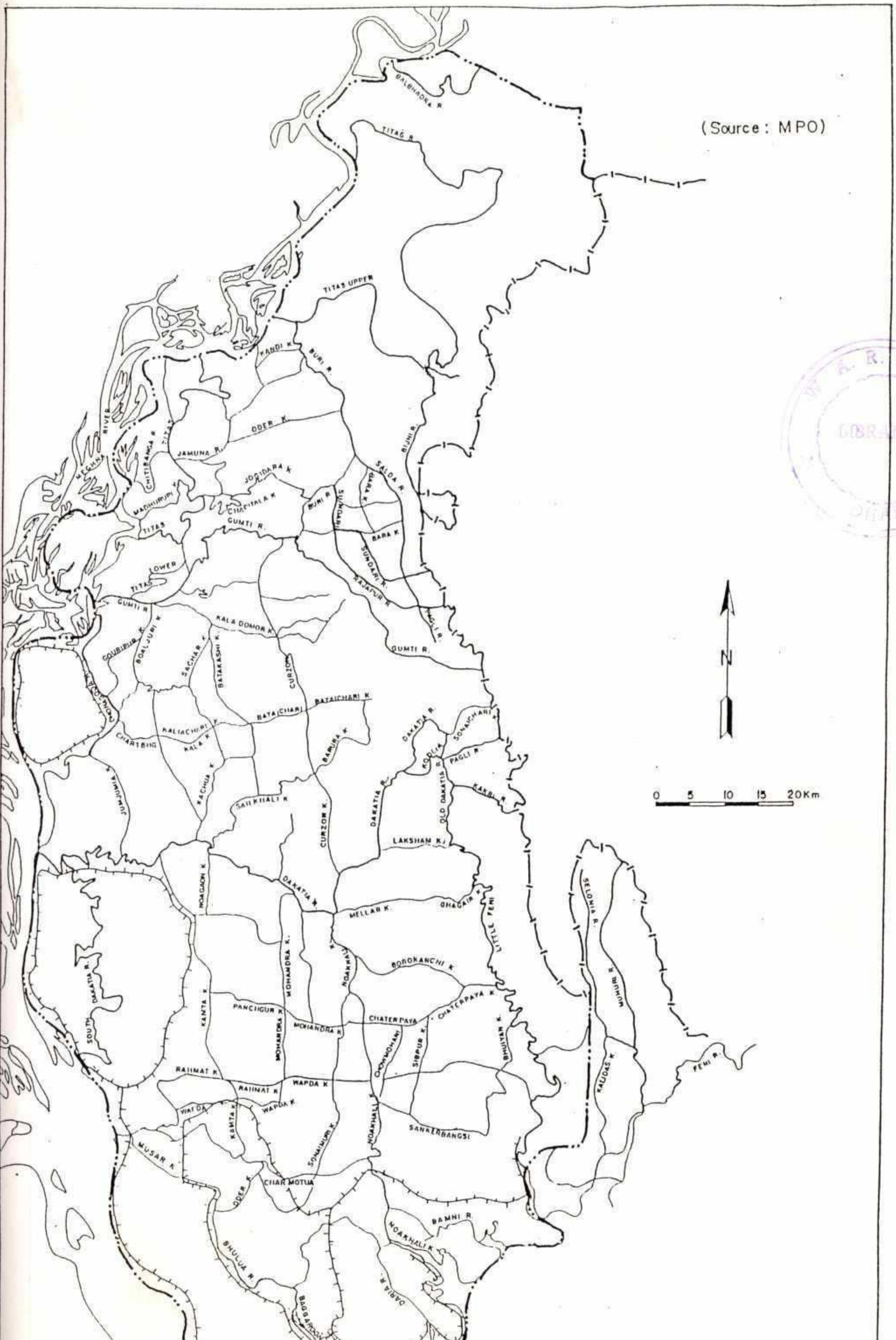

Figure 7.2

Presumed Fish Migration Path from the Meghna to the Floodplains/Rivers in the Area

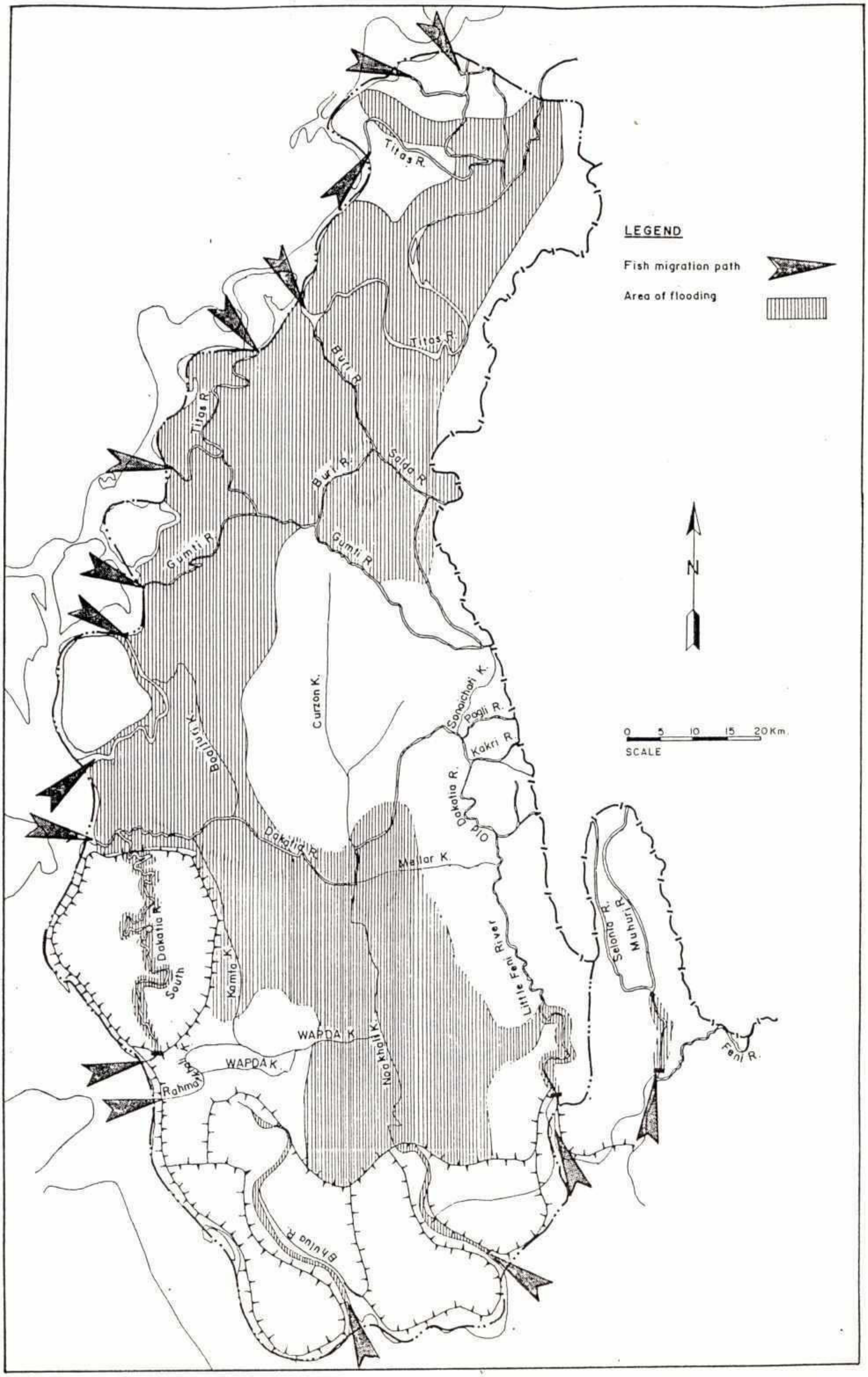

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TABLE 7.1

Areas of standing water and rivers

Planning Unit	Total area including Floodplain (ha)	Standing water (ha)	River (ha)	Total
Ashuganj	21 740	16	63	79
Titas	52 180	175	350	525
Gumti II	118 704	6 532	2 995	9 527
Gumti I	14 910	22	33	55
Meghna-Dhonagoda	620	-	508	508
Dhonagoda	65 230	122	314	436
Sonaichari	4 350	13	-	13
CIP	7 770	68	-	68
Polder 59/2	25 510	970	355	1 325
Noakhali North	82 592	8 014	1 810	9 824
South Sudharam	87 280	11 863	500	12 363
Little Feni	77 340	900	300	1 200

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Note: Excludes Meghna River.

Source: Surface Water Simulation Model

7.2.2 Jalmahals in the South East Region

Jalmahals are sections of permanent water bodies where fishing rights have been leased by the Government, usually on a three year basis. In the greater Comilla area there were 433 Jalmahals in the form of rivers, Khals, Beels, road-side ditches and large ponds with an estimated area of around 8,000 ha. These Jalmahals, according to information received from the Department of Fisheries (DOF), are scattered throughout the Region with areas ranging from 0.5 ha to over 500 ha. The numbers have been shown separately for the three old subdivisions, Brahmanbaria, Comilla and Chandpur. Jalmahals under the Chandpur subdivision have been further divided for three circles, i.e.: Matlab, Sharasti and Faridganj. The largest number of Jalmahal was reported for Brahmambaria (199 with an area of 5,139 ha), followed by Comilla (100, with an area of 1,500 ha) and lastly, Chandpur (34, with an area of 1,378 ha). In the greater Noakhali area, 258 Jalmahals were reported with an estimated area of approximately 400 ha.

However, a New Fisheries Management Policy (NMFP) has already been introduced by the Government and Jalmahals will eventually have to be leased under this policy.

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7.2.3 Fish Migrations and Movements

There is a lack of detailed information regarding the migration patterns of the numerous fish species reported for Bangladesh. By and large, existing information has concentrated on a few of the commercially important species such as the major carps (i.e. Rui, Catla, etc.) and Hilsa.

There are vast floodplain areas within the SER such as the Gumti Phase II study area, where fish migration is rather an important issue for the whole energetics of the system, especially since the number of fish species recorded there is so large. Please refer to the 1993 Gumti Phase II Fisheries and Ecology Annexes for full details (Annexes F and D respectively). In addition, it is important to note that although some fish are in general referred to as 'migratory' fish, by and large **all** fish species migrate or move from one area to another in the floodplain. These species have been referred to as 'long-distance' migrants and 'floodplain resident' species.

According to Welcomme (1979), most fish have two distinct centres of concentration, their wet and dry season habitats, and thus they have to travel sometimes over long distances in order to reach them. The two main components of such migratory movements recognised for tropical species are longitudinal and lateral migrations. Longitudinal movements taking place within the main river channel (i.e. 'long-distance' migrants), and lateral migrations being those where fish leave the main channel and distribute themselves over the floodplain, or the 'floodplain residents'. It is now known that both of these migrations are active since often fish migrate against the current to gain access to the main floodplain. Most healthy adult fish tend to direct their movements rather that drift in the current although fish eggs and larvae do drift.

There appear to be six main phases in the distribution of fish if both lateral and longitudinal migrations are combined. These are:

- longitudinal migration within the main channels for breeding: these are usually upstream
- lateral feeding migration in the floodplain
- local movements throughout the floodplain and distribution in seasonally flooded habitats
- lateral migration from the floodplain towards the main channels
- longitudinal migrations within the main channels for feeding, usually downstream
- local movements within the dry season habitats; these may be rivers, adjacent lakes, or the sea

In general, fish initiate their riverine migrations with the onset of the floods and lateral migrations when the banks spill onto the floodplain. In addition, fish appear to move actively against the current rather than to enter passively on incoming flows. Migration also appears to be an ordered sequence of species with some species moving first. Adult fish tend to leave the floodplain before the young-of-the-year, which appear to stay in the floodplain until the later stages of its emptying.

7.2.4 Environmental Stimuli Influencing Fish Breeding and Migration

a) Breeding

Breeding begins during the pre-monsoon flood and depending on the rain and water volume in the river and floodplain, most of the catfish, live fish and other species such as Magur, Singi, Koi, Tengra, Pabda, Air, Boal, Gazar and Sol, start breeding towards the end of March and early April. It would appear that piscivorous fish such as some of the catfishes Boal, Gazar and Sol breed earlier than the non-piscivorous species. Optimal environmental conditions for breeding are tempestuous and include flash floods, heavy continuous rain and thunder, which together stimulate fish breeding, especially for Ghonia, Boal, Pabda, Koi, Batasi, Puti and Laso.

b) Fish Migration

In general, a series of environmental factors appear to trigger fish migrations, although these may not always be effective as fish are on occasions left stranded. Some of the main factors influencing fish movements include depth of water, (there seems to be a general tendency for bigger fish to leave the floodplain earlier than the smaller fish), dissolved oxygen concentrations, temperature, light (many fish prefer to move at night) and lunar phase.

In the present review it was not possible to examine fish migration and/or movements in the floodplain or the channels throughout the SER as the period of time and the resources available to carry out the present study were insufficient. However, since fish access to the river channels and floodplain areas is crucial to the ecology and to the fisheries as a whole, especially in areas such as the floodplain areas in Gumti Phase II and Noakhali North, it is strongly recommended that such a study be carried out before any intervention takes place in areas already identified as important for fish access, such as the northern part of Zone C in Gumti Phase II, which carries the early floods into the system and presumably the fish and the Dakatia River floodplain in Noakhali North. Such a study should also consider other possible areas important for access for fish and other species.

It should be emphasised that floodplain areas in general are vast seasonal wetlands which are believed to be ideal for numerous species of flora and fauna. This has been confirmed from the preliminary evaluation of the biodiversity of the study area as described in Annexes D for both feasibility studies. It is therefore believed that any proposed polder schemes will also have devastating consequences on the wildlife, both flora and fauna, of the area.

7.2.5 Production Trends at National and District Levels

Fish Catch Statistics published by DOF from 1983-84 to 1989-90 have been used to assess National and District production. The annual fish production for each relevant system at these two levels is shown in Table 7.2 and Figures 7.3a and 7.3b. It can be seen that the contribution of each production system to the total catch is different at these levels. At the National level, rivers and floodplains contribute substantially and in a similar proportion to the annual total catch in the country, with pond production following closely, especially during the last three years up until 1989-90. Beel production remains low and shows a declining trend. Overall the levels of production remain fairly constant.

Figure 7.3a

Percentage Catch Composition per Fishery System

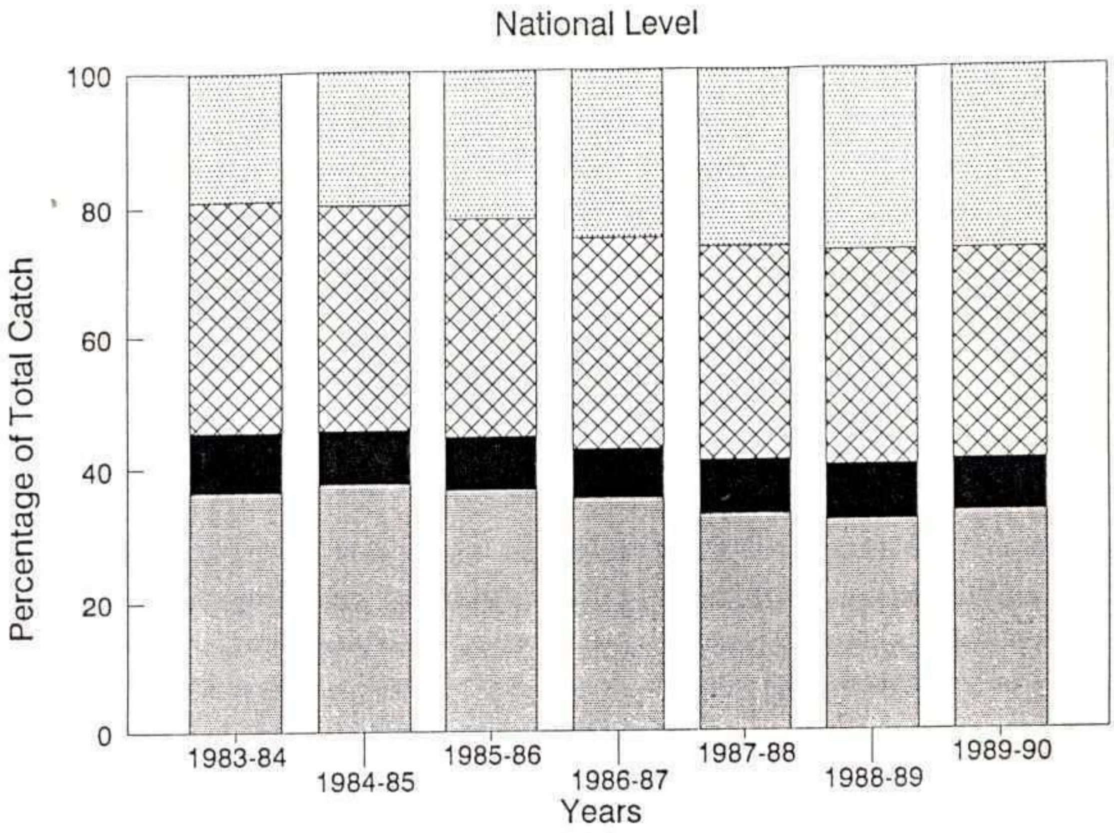
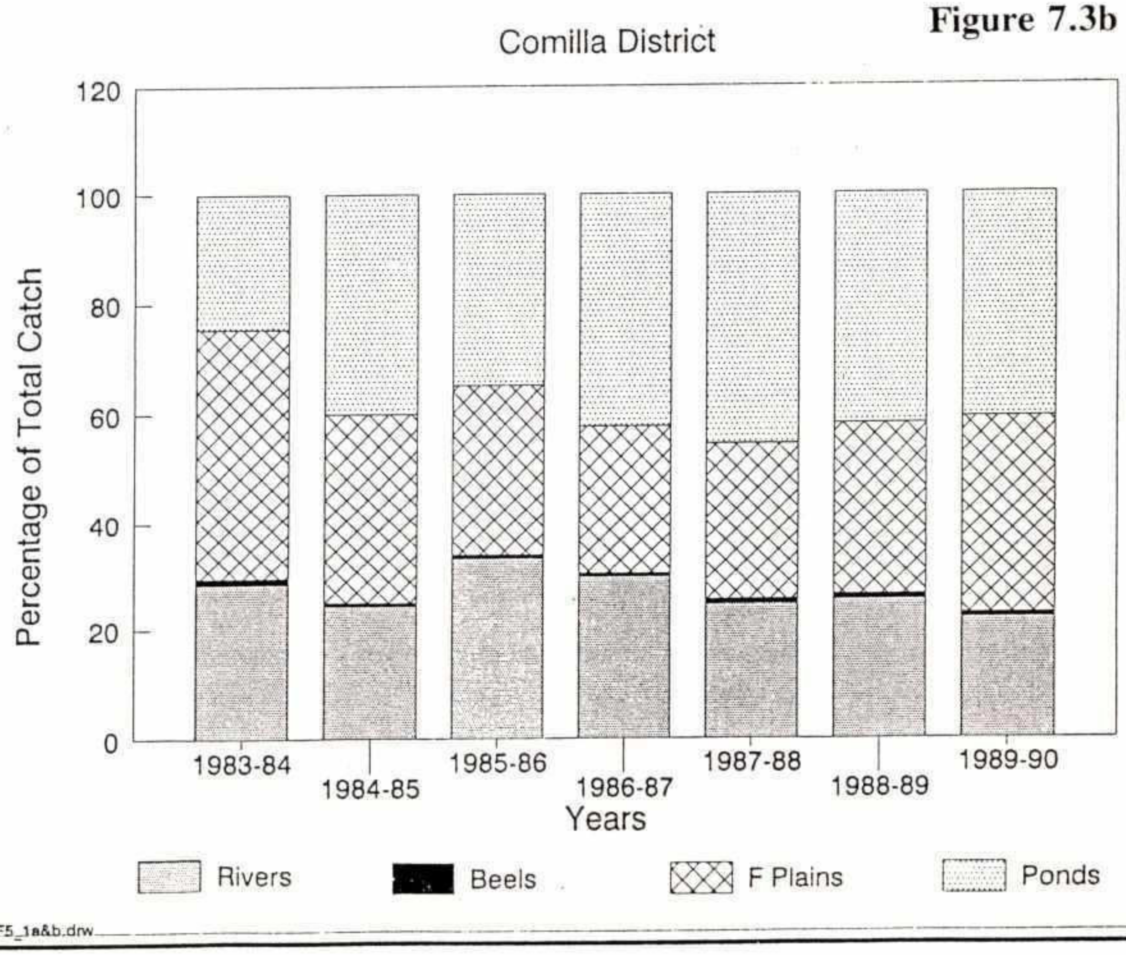


Figure 7.3b



The production of these systems for the Comilla District is variable throughout this period, with floodplain and ponds contributing mostly to the total catch, followed by rivers. Beel production appears to be virtually negligible.

The production in the Noakhali District was also variable with rivers contributing substantially to the total catch. It should be pointed out that most of the riverine catch consisted of Hilsa (*Hilsa ilisha*) with about 17,000 MT out of the total of 19,000 MT. Pond production reached nearly 50% of the total production in the Year 1984-85 and although fairly variable appears to have stabilized in subsequent years. Floodplain production remained relatively constant throughout the period, while production from Beels and Shrimp Farms was negligible (Table 7.2).

7.3 Existing Culture Fisheries in the SER

7.3.1 Hatcheries and Nurseries

According to SPARRSO (1984), there is a high pond concentration in both the Comilla and Noakhali Districts (120,608 and 99,781 respectively). Traditionally, ponds have been grouped into three categories: cultured (58%), culturable (30%) and delelict (12%). However, the proportion of Culturable and Derelict ponds do not appear to reflect reality as they are similar for both Districts. It is understood that the proportion of Culturable and Derelict ponds is estimated from the number of Cultured ponds.

The existence of hatcheries and nurseries might serve as good indicators of the development of aquaculture in an area. The south-east region appeares to lead in fish culture in general. The 1988 data shows that there were 14 fish seed farms with hatchery and nursery facilities under the public sector in the area. The actual production capacity of the farms has not been available, however the target production was 464 kg of spawn and 7 million fry/fingerlings; the actual production achieved in one recent year was 269 kg of spawn and 4 million fry/fingerlings. Figure 7.4 shows the locations of the major and minor hatcheries in the region. In the private sector on the other hand, the figure for the same period shows that there were 85 hatcheries and 730 nurseries in the area. The total capacity of production was about 9 000 kg of spawn and about 400 million fry/fingerlings, the actual production being obtained was about 3 000 kg of spawn and about 280 millions fry/fingerlings.

In Noakhali, the production of fish seed and fingerlings is notable and the Raipur Hatchery and Training Centre has been instrumental in developing this activity in the area.

7.3.2 Private Fish Farming

Together with the development of hatcheries and nurseries in the area, private fish farming on a commercial scale has also been under way. The 1988 data on the number of private fish farms in the greater Comilla and Noakhali areas show that there were a total of 97 fish farms, the total capacity of production of the farms was 356 tonnes with the actual production being 215 tonnes. The area of the individual fish farms is not known, thus the production per area of water cannot be calculated.

Figure 7.4

Location of Major and Minor Hatcheries in the Region

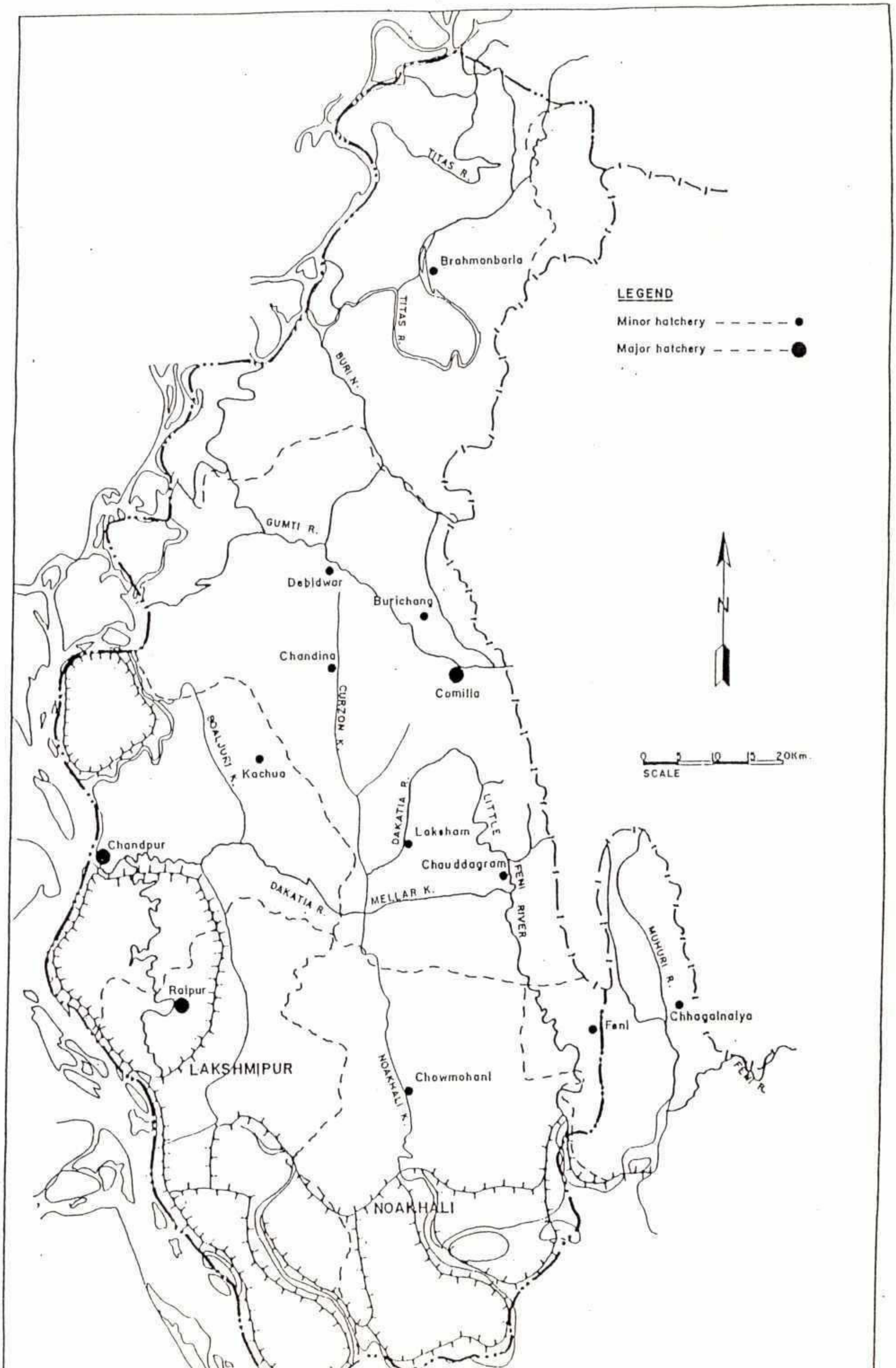


TABLE 7.2

Total Catch per Fishery System at National and District Levels

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
National Level							
Rivers	207,766	213,057	206,712	201,152	183,817	181,140	198,941
Beels	51,373	45,893	45,258	42,077	45,610	47,019	46,594
F Plains	200,616	194,130	187,396	183,796	182,037	186,126	193,762
Ponds	109,333	111,567	123,804	142,876	149,423	155,012	163,730
Total	569,088	564,647	563,170	569,901	560,887	569,297	603,027
Old Comilla District Level							
Rivers	13,678	10,860	17,297	17,082	13,692	15,345	14,659
Beels	497	267	337	316	480	458	474
F Plains	22,002	15,526	16,145	15,563	15,983	19,069	23,972
Ponds	11,845	17,726	17,960	24,077	24,983	24,935	26,753
Total	48,022	44,379	51,739	57,038	55,138	59,807	65,858
Noakhali District Level							
Rivers	24,845	7,807	11,960	15,244	16,568	18,966	NA
Beels	1	1	1	1	1	1	NA
F Plains	11,883	8,019	7,919	9,821	9,722	11,164	NA
Ponds	9,799	14,687	15,186	10,460	11,344	11,595	NA
Shrimp Farm	0	0	0	5	5	11	NA
Total	46,528	30,514	35,066	35,531	37,640	41,737	NA

Percentage of Total Catch per Fishery System at National and District Levels

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90
National Level							
Rivers	36.5	37.7	36.7	35.3	32.8	31.8	33.0
Beels	9.0	8.1	8.0	7.4	8.1	8.3	7.7
F Plains	35.3	34.4	33.3	32.3	32.5	32.7	32.1
Ponds	19.2	19.8	22.0	25.1	26.6	27.2	27.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Old Comilla District Level							
Rivers	28.5	24.5	33.4	29.9	24.8	25.7	22.3
Beels	1.0	0.6	0.7	0.6	0.9	0.8	0.7
F Plains	45.8	35.0	31.2	27.3	29.0	31.9	36.4
Ponds	24.7	39.9	34.7	42.2	45.3	41.7	40.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Noakhali District Level							
Rivers	53.4	25.6	34.1	42.9	44.0	45.4	NA
Beels	0.0	0.0	0.0	0.0	0.0	0.0	NA
F Plains	25.5	26.3	22.6	27.6	25.8	26.7	NA
Ponds	21.1	48.1	43.3	29.4	30.1	27.8	NA
Shrimp Farm	0.0	0.0	0.0	0.0	0.0	0.0	NA
Total	100.0	100.0	100.0	100.0	100.0	100.0	NA

Source: FRSS, DOF. Data for riverine catch for 1989-90 represents the average for 6 years.

7.3.3 Culture Fisheries Production

According to DOF (1988-1989) data, the total production obtained from ponds from the greater Comilla and Noakhali areas was estimated to be 24 935 tonnes and 11 595 tonnes respectively. Yield data is of poor quality but the thana statistics are based on yields of about 1 200 kg/ha, 640 kg/ha and 690 kg/ha for cultured cultivable and derelict ponds respectively. Yields may reasonably be expected to double with proper management in controlled flooding conditions.

The composition of species in the pond production/pond catch is shown in Table 7.3. In total, at least 12 different species and five species groups are known to be obtained from pond production.

TABLE 7.3

Species Composition (percentage by weight) of Pond Catch

Species	Comilla	Noakhali
Rohu (Labeo rohita)	34.62	34.88
Catla (Catla catla)	28.38	31.14
Mrigal (Cirrhina mrigala)	19.93	19.43
Minor carp	7.95	3.34
Silver Carp (Hypophthalmichthys molitrix)	5.42	0.00
Tilapia O. niloticus O. mossambicus	0.00	1.14
Shrimp	0.23	0.00
Boal (Wallago attu)	0.54	0.00
Shol/Gajar/Taki (Channa Spp.)	0.11	0.00
Shing/Magur (H. fossilis/C. batrachus	0.4	0.00
Puti (Puntius Spp.)	0.54	0.00
Others	1.79	9.78

7.3.4 Shrimp Farming Activities

(a) Introduction

During the last two decades or so, shrimp farming has become one of the most attractive investments in many coastal areas of Bangladesh. Shrimp has become the fourth most important foreign exchange earner. The shrimp export statistics do not show the amount of freshwater and brackish water shrimps; however, it is apparent that the bulk of the exported shrimps are of brackish water origin.

The brackish water shrimp forms the bulk of production because of its higher profitability due to several factors. The available higher international market is one of the main reason of the growth of farming of the species. Moreover, brackish water shrimp have faster growth rates, higher natural availability of seed and higher production per unit area than the freshwater species. One other main reason for the rapid expansion of the brackish water shrimp farming in Bangladesh is the comparative easy access of suitable coastal lands from the public sector against negligible fees, compared with the costs of water bodies suitable for freshwater shrimp culture.

During the last few years there has been an increasing trend of export earnings from freshwater shrimp in Bangladesh. Many countries of the world, especially Asian countries have taken up elaborate plans to culture the freshwater shrimp and have reported profitable financial returns.

The life cycle pattern of the freshwater shrimp is different from that of the brackish water shrimp. They do have overlapping ecological parameters in their life cycle, in that, although both of the two groups spawn in the estuarine area, the freshwater ones migrate at their juvenile stage to the inland freshwater areas while the brackish water ones spend their whole life in the saline waters. In Bangladesh, the brackish water shrimp Penaeus monodon is mainly cultured in three coastal districts of Satkhira, Khulna and Cox's Bazar. There are a few freshwater shrimps of which, Macrobrachium rosenbergii (giant freshwater shrimp) is the most suitable one for culture. This species can be introduced very easily in the pond aquaculture systems of Bangladesh.

(b) Shrimp culture in the coastal bheries of Noakhali District:

Not many coastal bheries have so far been developed for brackish water shrimp farming in the Noakhali area. DANIDA 1989 listed six bheries of total 80 ha of water area in the Sudharam thana. The situation is atypical there and development has not yet occurred as in the coastal districts of Satkhira, Khulna and Cox's Bazar, Although the bheries have been constructed for aquaculture, as these are mostly rainfed, there is no scope for using those exclusively for brackish water shrimp farming, instead, the bheries have been planned to be used for one monoculture of freshwater shrimp (July-January) and one monoculture of brackish water shrimp (February-June). The bheries do not have access to tidal flooding to ensure supply of saline water and as such there have to be arrangements for pumping saline water from nearby rivers, but the river is silting up very rapidly, thus making that provision more difficult.

(c) Freshwater Shrimp Farming

The Noakhali area in general, appears to have gone ahead in culturing freshwater shrimp in polyculture with carp in ponds, road-side ditches and in confined rivers and irrigation canals.

1. Culture in Ponds

In Noakhali area, fish culture in ponds has a good base, especially due to the development projects activities of Raipur Fish Hatchery and Training Centre and the DANIDA assisted carp culture development project under the Noakhali Rural Development Project. These development activities have led to stocking of freshwater shrimp together with carp in ponds. The common practice is to stock a few shrimps along with different species of carp. The practice is limited and at the same time widespread with little regard to stocking density, feed and fertilisation of the ponds. There is no information on the survival rate of the prawn stocked. There is not an available statistics either on shrimp culture in the old Noakhali district and the DANIDA report on the socio-economics of shrimp farming indicated that the statistics are fragmentary and based on estimates. However, the report suggests that the number of ponds under shrimp-carp polyculture is increasing in recent years though on a very limited scale. The report quoted the District Fishery Officer, Lakshmipur as saying that in 1989 a total of 73 ponds were under fish-shrimp polyculture which is 0.4 % of all ponds of the district and 1.3 % of the total existing cultured water area.

The reasons of the existing limited practice of the polyculture systems are lack of shrimp seed, either collected from nature or produced in a hatchery, and lack of proven culture technology that could be demonstrated to the farmers. Such technology could be based on better growth and production and gradual turnover to monoculture with the provision of higher stocking density and intensive feeding.

2. Shrimp culture in confined rivers, irrigation canals, and roadside ditches

As mentioned above, the initiation of the practice of polyculturing freshwater shrimp with carp is linked with the development of pond culture in general, in the greater Noakhali area the technical and management inputs have been provided by the development projects. However, aquaculture in the waters like large enclosed rivers, irrigation canals or in the road-side ditches, has not been started commercially. As one would know, the area has extensive areas of water under the above categories and thus provides an excellent opportunity to extend the pond aquacultural technologies. At present a few entrepreneurs have started. DANIDA 1989 reported aquacultural activities in a cut-off in the Dakatia river near the Hajimara regulator where a 2 km section of the 5 km long and 45-50 m wide river slope has been converted into a shrimp-fish farm by providing an earthen dam. Another such area suitable for shrimp-fish farming is a closed section of the Darianadi river that extends a few kilometres upstream from the BWDB's Darianadi sluice gate where it is closed by a privately constructed sluice gate.

Shrimp culture with fish is being done on a very limited scale in the irrigation canal of CIP in Lakshmipur district and in the MIP canal in Feni district. As has been said, the level is widespread with regard to stocking, feeding and fertilisation etc. In the CIP canals, at several locations, many private persons are at present engaged in shrimp-polyculturing with fish and their activities appear not to be officially approved of by the authority. The canals is under the control of the BWDB and utilisation of the water, it is feared, would damage the embankment.

There is a serious need to resolve the rights to use of the waters; the DOF can be given the right to use water, so that it can test and demonstrate the practice of fish-shrimp polyculturing in the waters without altering the existing physical condition of the embankment. Of late, the DOF has obtained approval to use the waters of CIP and MIP for stocking with fish as a culture-based capture fishery development.

The situation of shrimp farming in the road-side borrow pit is the same. Although detailed statistics are lacking, in the DANIDA report on the socio-economics of shrimp farming in the Noakhali area, it is suggested that quite a large stretches of the borrow pits in the area are now stocked, though at a very low rate and mainly with fish. Very occasionally the people put shrimp in the pits, but not in any planned way. The borrow pits result from road construction. They are mainly seasonal and dry up in the winter. The pits also function as drainage channels during the monsoon and thus the present aquacultural practices in the pits hamper to an extent, the drainage functions, as many earthen dams are constructed to hold water. There are huge borrow pits along the road leading from Begumganj via Sonaimuri, to Chatkhil and Ramganj. At present some aquacultural activities are going on in these waters but on a very limited scale; there is however big potential for development of shrimp-fish polyculture in these waters if some technical improvements are undertaken, for example drainage provisions with sluices to prevent flooding.

Freshwater shrimp polyculture with fish is not known in the greater Comilla area, however shrimp as a capture fishery in the Meghna, Dakatia, Gumti, and Titas rivers is important. As the study area is bounded by the Meghna from north to south, a considerable fishery for shrimp does exist in the area. A study of seven thanas of the area revealed that a total of 6 000 fishermen are engaged in full time fishing on shrimp in different waters of the area with an annual total production of 61.5 tonnes of shrimp.

7.4 Population Engaged in Fisheries Activities

There is a dearth of data on the actual number of full-time and subsistence fisherman in South-East Region as a whole. It would be assumed that the number and proportion of the people engaged in fishery either as full-time fishermen or as subsistence fishing would vary from area to area, and it would be safer to assume that the number and proportion would be higher in those areas which have more potential for capture fisheries (Table 7.4). The rapid rural appraisal conducted at a few of the thanas of the region revealed that about 2% of the population are engaged as full-time fishermen and about 5% of the population catch fish on a subsistence basis.

However, it should be pointed out that the number of fishermen, or fishing households, in the Region vary according to their surrounding environment and the type of fishing systems in the area.

In the Gumti Phase II and Noakhali North study areas, for example, the number of fishing households was estimated from information received from the Thana Fisheries Office survey. This indicated the number of fishermen per Thana and the number of households in the area as per the 1981 census (BBS, 1981) for the Gumti study and the 1991 census (BBS, 1991) for Noakhali North. It was assumed that there was one fisherman per fishing household and that these households were uniformly distributed through the project area. It would be valuable to verify these data from the 1991 BBS census for both studies when this census becomes available.

7.5 Market Price for Fish

An RRA conducted on market prices for fish in 11 different thanas of the study area revealed that prices for the different fish groups are similar in all the thanas, however, prices for some fish do vary according to the location of the thana with regard to natural fish resources and/or availability due to production.

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TABLE 7.4

Number of Rural Population Involved in Fishing

Name of Thanas	Nr of Fishermen Full-time	Nr of Fishermen Subsistence	Total population
1. Sarail	3 250	3 750	198 005
2. Nasirnagar	10 000	15 000	250 000
3. Madhabpur	200	30 000	194 710
4. Nabinagar	3 300	61 519	335 179
5. Bancharampur	8 000	19 500	222 705
6. Homna	5 100	69 685	250 000
7. Hajiganj	2 000	4 000	221 176
8. Matlab	2 000	25 000	434 680
9. Chandpur	8 600	3 000	336 539
10. Lakshmipur	7 385	6 000	473 611
11. Daganbhuiyan	2 015	4 500	160 722
12. Sudharam	1 169	53 730	542 000
13. Chauddagram	160	4 000	366 002
Total:	53 179	299 684	4 005 529

7.6 Support Services

7.6.1 Involvement of Department of Fisheries

Other than the regular administrative and management arrangement the DOF works in the study area under four main development projects. A brief account of the areas and the project activities is given below:

(a) Integrated Fisheries Development Project

This is a three year project which started in 1987/88, and the first phase ended in 1990. The second phase for another three year is under approval. The project has seven different sub-project activities, these are:

1. Improved management of natural spawn fishery in Halda River.

2. Pond fish culture development in the rural areas; under this sub-project 15 mini hatcheries will be constructed in 15 different thanas throughout Bangladesh, of which three thanas fall within the region, the thanas are: (i) Nasirnagar, (ii) Nabinagar and (iii) Bancharampur, all in Brahmanbaria District. There will be arrangements for spawn production and fry raising, however at present, only the hatchery at Nasirnagar is under construction.

3. Aquaculture development in public waters in and around Dhaka,

4. Establishment of fish sanctuaries for conservation in and management of open water fisheries, this sub-project does not have work within the region.

5. Development of fisheries in the irrigation and flood control project areas e.g. South Dakatia River, Muhuri River, Gohala River, and Chunar River; the Chandpur Irrigation Project falls within the region; it has been gathered from DOF that the activities for the sub-project have started in CIP; the programmes there include bringing the entire water area in CIP under artificial stocking; the total water area within CIP is estimated at 2 800 ha of which, the project proposes to bring 2 000 ha under stocking. A 25 ha nursery pond area will be developed and 5" (125 mm) size fingerlings will be stocked in the open waters of borrow pits, the South Dakatia river and in the canals, the project has established an office at Chandpur and until now has stocked 4 km of the borrow pits on both side of the Char Bagadi Pump Station, the 1991 further programme under the project was cleaning of the water hyacinth from South Dakatia with wheat obtained from Food For Works (FFW) programme in association with the CIP,

   In Muhuri Irrigation Project there is a similar programme to stock the Muhuri Reservoir; the project has established on office at Feni; no stocking has so far been made in the reservoir, the DOF has obtained 15 ha of land from the Bangladesh Water Development Board (BWDB) to construct a hatchery near the regulator area; the production capacity of nursery will be 600 000 of fingerlings per year.

6. Culture based flood plain fisheries development, this sub-project does not concern the region.

7. Survey of public water bodies, how far progress has been made under this sub-project is not known.

(b) Second Aquaculture Development Project

This Asian Development Bank (ADB) funded project run for a five year development period which terminated in June 1992. The project had four different components. These were:

- Shrimp culture development,
- Carp culture development,
- Culture based floodplain fisheries development and,
- General implementation and institutional support.

Out of these four components, only the second component concerns the Region. Under this component there were programmes of establishing demonstration ponds in about 6-7 ponds of 181 thanas in 21 districts. There were credit components of the programme to be given to the pond owners. All the thanas of greater Comilla and Noakhali fall within the programme, stocking of ponds for demonstration has started in 27 different thanas.

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(c) **Institutional Strengthening Project**

This is a Food and Agriculture Organization/United Nation Development Program (FAO/UNDP) funded project. It is mainly connected with the institutional building of the DOF. However, it has a programme on fisheries training and extension system development. Under the extension part, the project will work among other areas of the country, in Daudkandi, Muradnagar and in Chauddagram, where carp polyculture technology will be demonstrated.

(d) **New Fisheries Management Policy**

The inland open water capture fishery in the forms of river, canal, floodplain, haor, boar and beel constitute more than 50 % to the total fish production of the country. The production from the sector is declining at an alarming rate due to many reasons, proper management and conservation of the fishery has become imperative. At present the fishery is managed and looked after by several Departments through which waters are leased out to fishermen's co-operatives but, due to the poor socio-economic conditions of the fishermen, and weak organisational set up of the co-operatives, they cannot act as the lease holder, instead the local elite tend to control the situation. Through this system the conservation and sustainability of the fishery resources decline year after year.

As such in 1986 the government decided to formulate and adopt a new fisheries management policy. Under this policy, a licensing system was introduced in place of the leasing system of the water bodies. The genuine fishermen's groups or co-operatives are being identified and will be given a license to fish in the waters under government supervision and control. Through this system, it is hoped that the fisheries will be more controlled by the creation of some sort of identify with the fishery in the mind of the fishermen.

Under this policy, initially ten jalmahal were selected from throughout Bangladesh. Subsequently jalmahal from twelve sites covering three environmental situations such as flowing river, dead river (baor) and beel/haor were taken and put in experimental management under different organisational set up and management issues. After the experimental trials were over, 300 jalmahal from all over the country have now been put under the new management policy including 8 in Comilla, 6 in Brahmanbaria, 6 in Chandpur, 4 in Feni and one each in Lakshmipur and Noakhali.

7.6.2 Fisheries Research Institute's involvement in the SER

The Fisheries Research Institute (FRI) was established by a Presidential Ordinance in 1984. Before that, both fisheries research and management were looked after by the DOF. The FRI has four different research stations located at different places of the country to carry out environment specific adaptive research.

The head-quarters of FRI are located at the freshwater station campus in Mymensingh, but the riverine station at Chandpur comes within the SER and conducts problem oriented riverine and open water research connected with management and conservation of fisheries.

The role of the Chandpur station of FRI in riverine and open water capture fisheries research and technology derivation and conservation of the fishery is significant. The completed projects on local fish toxicants and survey of major carp reproduction areas have come up with important findings and suggestions. With regard to Hilsa stock/strains assessment and spawning biology, the team, discerned the spawning area of hilsa in the Padma-Meghna river systems for the first time. Pen and cage culture of fish offer promise for developing culture systems in the various seasonal and perennial waters. The station has started a pilot project on pen culture in the borrow pit of CIP and similarly cage culture trials have been conducted in the Kaptai lake. Other project works are Macrobrachiun integrated farming with paddy, and rice pesticides toxicity on fish/shrimp, these are remarkably important and relevant for capture fisheries in general.

7.6.3 DANIDA Activities

There was a DANIDA assisted programme called Noakhali Integrated Rural Development Programme (NIRDP). It's Phase I was completed in 1982, the second Phase, called Noakhali Rural Development Project was recently completed with regard to the assistance to the agricultural extension services through training and demonstrations, availability of credits, formation of co-operatives and making provision of minor irrigation and drainage in the greater Noakhali area.

The main objectives of the fisheries component were:

- To increase fish production, so that more fish are available for local consumption.

- To create financial means through surplus of production, so that poor fishermen can organize themselves.

7.6.4 Mennonite Central Committee Activities

The Mennonite Central Committee (MCC) has been working in Noakhali and Comilla areas for many years and has a strong and wide base in the study area. The agricultural programme adopts a comprehensive farming system approach taking into consideration year-round cultivation of horticultural crops, agriculture in general, livestock, and fisheries activities, mainly with resource poor farmers, with rural women at the homestead level, (in order to improve general health and nutrition conditions), and with groups of rural men and women, (to increase their savings for them to find other opportunities), and literacy and social awareness. The whole agricultural work falls into three broad types of activities, extension, marketing and research.

The involvement with fisheries activities is not as old as the other activities, beginning in 1988. At first a survey was conducted in the working area of southern Comilla and greater Noakhali area to obtain information on present fishery technology, costs and returns, fish species available at the farm level and the feasibility of introducing integrated fish culture systems (duck-fish, paddy-fish, etc.).

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The activities are widespread in the greater Noakhali area with regards to introducing culture system of small indigenous species which could be cultured in seasonal shallow ponds/ditches with minimum of inputs, and integrated aquaculture with other components viz. paddy, livestock, poultry, etc. The aquacultural programmes are very relevant and technical linkages have been established with the FRI aquacultural research programmes; training and demonstration on adaptive aquacultural technologies on Thai sharpunti and carp breeding, nursery, pond preparation etc. has been done in conjunction with FRI.

7.7 Impacts of Water Control Projects

7.7.1 General Impact

Flood control drainage and irrigation projects have effects on both culture and capture fisheries. Any water control project has negative effects on the capture fishery. The open water fisheries grounds are mainly the flooded lands, beels khals and the rivers from where flood water comes; flood protection, drainage improvement and/or irrigation reduce the flooded area. Construction of embankments or regulators prevents migration and recruitment of fish inside the project. As the flooded lands serve as the nursery grounds of the freshwater migratory species are well as for the resident species, flood protection and embankments also cause reduced stocking of the outside waters.

Reduced or full flood protection can create new possibilities for culture fishery inside the project area, as there will then be no risk of fish loss from the culture ponds. This however, will entail availability of the culture inputs and support services. Nonetheless, the ponds which used to be naturally restocked due to the flood will have no production and would add negatively to the flood protection option.

In general the beneficiaries of culture fisheries are the more wealthy elements of society, i.e. pond or tank owners.

The beneficiaries of the open water capture fisheries are the subsistence households in general and the poor and lower class fishermen in particular, thus loss to that category cannot be overcome by the gain in culture fishery unless alternative cultural methods in the closed waters are developed and the affected people/fishermen inside are grouped into co-operatives. Culture programmes increase production, but the species diversity cannot be protected, thus the low priced fish that are consumed by the poor people through their subsistence catching are lost from the area, causing socio-economic problems.

The water use conflicts between dry season agriculture and fisheries can reasonably be reduced through having irrigation options in the project together with drainage. If, for example, the channel inside the project is topped up with water throughout the dry season, the resident small species can find places for breeding in the shallow areas of khals and creeks during the monsoon season; care should be taken to prevent the khals from drying up.

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7.7.2 The Chandpur Flood Control and Irrigation Project (CIP)

Thompson (1989) conducted a study on the impact of flood control on agricultural development in Bangladesh. The report on the main household survey concluded that the water control within CIP evidently induced wide-spread fish cultivation in private ponds thus benefiting more people, given that the aquacultural techniques and inputs were available to the people of the area. Even so the wealthier farmers have gained more because they normally own ponds, the others, who depend on open water fisheries, have suffered because they are now catching less fish or are employees of the larger fishermen.

Thompson's summary also indicated the following pattern inside CIP compared to the control situation.

- Fishermen in CIP have lower catches
- The composition of the catch is reduced, in particular the shrimp catch has suffered
- There is a decline in large fish (but medium size fish were always more important)
- Commercial fishermen catch from rivers but are interested in cultivation by hiring ponds or sharing the catch
- New fishermen and farmers are fishing but mainly in the khals because this requires less capital than fishing in the rivers, they also fish in ponds.

Of late, the DOF has undertaken a programme for bringing a total water area of 2 800 ha into production with a yearly target 3 484 tonnes. As a pilot trial, in 1990, four km of borrow pit has been stocked with carp for polyculture. About half of the South Dakatia river from Charbagadi up to Faridganj have been cleared of water hyacinth under Food For Works Programme.

The FRI Chandpur station, which is mandated with the task of river and open water fisheries research, is currently conducting a pilot project on the feasibility of pen culturing in the borrow pit of CIP.

7.7.3 Impact of Polder Projects

The Coastal Embankment Project was to control saline intrusion and flooding in the areas potentially important for cultivation. Empoldering of the coastal areas has had both positive and negative effects on fisheries. The positive impact is mainly the development of brackish water shrimp aquaculture industry. The area empoldered is known as bheri where tidal water is retained and the larvae of shrimp and fin fish that come with the tide are managed and harvested. This practice has not developed in the study area, due mainly to lack of tidal flooding and the difficulty of pumping saline water from rivers which are rapidly accreting.

The negative impact is the conflict between various land uses in the coastal areas. Although the wild fishery in the coastal rivers and creek is lost because of empoldering, new fisheries situations arise with culture either in the created freshwater river sections, in the creeks or, allowing tidal water in the constructed ghers. The main conflicts that have arisen are the gradual conversion of the crop lands or the salt pans into shrimp farms. As shrimp farming is capital intensive and does not require as much labour as agriculture, the poor farmers or the fishermen in the coastal areas cannot be engaged in the industry. The introduction of brackish water into the creeks also affects adjacent paddy areas.

7.7.4 Fisheries in the Meghna-Dhonagoda Irrigation Project

The Meghna-Dhonagoda Irrigation Project (MDIP) was commissioned in 1987-88 in the Matlab Thana of Chandpur district. The project area was an island circumscribed by the Meghna River in the west and north, and the Dhonagoda river on the east and south. It is a deep flooded area with very little area above 4.0 m and the lowest was 1.5 m above mean sea level. During the monsoon the entire area used to go under water.

The fisheries situation in the MDIP differs from that in the CIP. In MDIP there is no borrow pit inside the embankment, instead, there is an irrigation canal to supply water through other secondary and tertiary canals.

The potential water area in the project is about 700 ha including the ponds, khals and marshes. As the area was deep flooded, the flood water used to bring different species of fish and prawn. After the closure of the area the khals which had connection with the rivers have been blocked and the natural fishery of the khals and ponds has been badly damaged. There are 22 different khals inside the project area and those khals used to harbour a lot of fish before the project; after the completion of the project, the fishermen are getting less fish and they have been forced to catch fish in the Meghna River proper or in the Dhonagoda River.

There are about 7 000 ponds in the Matlab thana; about 4 000 of these ponds are cultivable. About half of these ponds are within MDIP. Although flood protection has created new possibilities for aquaculture in the ponds, controllable khals and marshes, and although the feasibility report recommended a fisheries development programme in the form of pilot projects in the khals, no significant fishery development has taken place there until very recently.

It was suggested in the feasibility report that the main irrigation canal would be divided into 58 management units and pilot scale government projects will be undertaken in three such units; the other units will be leased out to the farmers living nearby or to the dislodged fishermen. Suitable weir mesh materials will be used to partition the canal to allow irrigation water to pass. The pond fishery development programmes were to take place through utilisation and application of feeding and fertilisation of the ponds. Similarly the khals would be artificially stocked with major carp and the shallow seasonal marshes would be utilised for culture with small indigenous species. The facility for fish seed provision in the project was deleted because the seeds were to be provided by the government fish seed farms nearby but this has not occurred. For easy availability of fish seed of the desired species and for rapid development of fish culture and stocking in the waters inside the project, establishment of a hatchery and nursery appears essential.

Recently the government has decided to establish a hatchery and nursery inside the project. In 1989 the government released 0.8 million fingerlings in the Gazipur khal. There is a nursery in a village called Amirabad within MDIP and fingerlings produced from that nursery have been released into 21 different khals through co-operatives formed with people residing along the khals.

CHAPTER 8

SOCIO-ECONOMICS

8.1 Demography

8.1.1 Introduction

A summary of the demographic and socio-economic characteristics of the south-east region is deemed necessary in order to reflect the development needs of the region. Important features include the levels of landlessness, the levels of unemployment and the age distribution profile within the region. The south east region district population densities are among the highest in the country if Dhaka District and environs are set aside. The other important factor is the proportion of the population living in the rural areas and relying on agriculture as the basis for employment activities, either totally or impart. A full report on the population structure of the area is given in Annex III.

8.1.2 Population Growth and Distribution in the South-east region

The Preliminary Report, Population Census, 1991 (Bangladesh Bureau of Statistics, July 1991) gives only a summary of statistical information on a limited number of items, such as population (national, district and municipality), household size, literacy and sex-ratio. Therefore the 1981 Census has had to be used as the source for most statistical data, in conjunction with other reports, until the full 1991 Census Report is published.

Bangladesh, with a population of over 108 million, now ranks as the world's eighth, and Asia's fifth, most populous country. Its population density is one of the highest in the world, at an average of about 750 persons per square kilometre. Systematic analysis of trends in the growth and distribution of the population of Bangladesh is handicapped by a lack of reliable data. Analysis is further complicated by frequent past changes in administrative boundaries.

The population of the region grew slightly less rapidly than that of the country as a whole between 1951 and 1991. In 1951, the region's population was 5.9 million, and its share of the national total was 14%; by 1991, the region's population had increased to 12.8 million, but its share of Bangladesh's total population had fallen to just under 12%. Over the same period, population in the south-east grew at an average rate of 1.97% year, while the national population increased at an average of 2.39% per year. The figures are shown in more detail in Table 8.1. The current population growth rate is officially estimated at 2.17% per year, but it is higher according to some observers.

The figures indicate that between 1961 and 1981 the population increased at above the average rate for the region in Comilla, Noakhali and Chandpur Districts, and at below average rates in the other three districts. Between 1981 and 1991 the pattern has changed, with Brahmanbaria, Feni and Noakhali growing at faster than the average and Chandpur falling back to the slowest. Growth was particularly rapid in Noakhali District in the latest inter-censual period, averaging over 3.5% per year between 1974 and 1981.

TABLE 8.1

Population Growth in Bangladesh and the South-east region : 1951-1991

Locality	Population ('000)					Percentage Increase	Average Annual Rate of Growth (%)	
	1951	1961	1974	1981	1991	1981-91	1951-81	1981-91
Brahmanbaria	1 038	1 151	1 472	1 728	2 137	23.7	1.70	2.1
Comilla	1 783	2 077	2 802	3 356	4 023	19.9	2.11	1.8
Chandpur	971	1 158	1 544	1 796	2 023	12.6	2.05	1.2
Feni	540	590	760	899	1 095	21.8	1.70	2.0
Lakshmipur	710	816	1 118	1 120	1 309	16.9	1.52	1.6
Noakhali	821	975	1 356	1 736	2 216	27.6	2.76	2.5
SE region	5 863	6 767	9 052	10 635	12 803	20.4	1.98	1.9
Bangladesh	41 932	50 840	71 479	87 120	107 990	24.0	2.44	2.2
SE region as share of Bangladesh	14%	13.3%	12.7%	12.2%	11.9%			

Source: (a) Population of Bangladesh - Country Monograph Series 8-ESCAP
Population Census of Bangladesh 1981 - District Census Report
Combined and duplicated to show greater congruency

(b) 1991 figures are from the Census Report of 1991, P.9.

Table 8.2 indicates that there was net emigration from the region to other parts of Bangladesh or abroad in this period. Based on 1981 Census data, out-migration from the region between 1974 and 1981 was equivalent to nearly 5% of the total 1974 population. All districts of the region experienced out-migration, but the loss of population was highest in Lakshmipur (7%), Chandpur (6%) and Brahmanbaria (6%). As would be expected, out-migration rates were higher for men (8%) than for women (1%).

8.1.3 Population Density and Characteristics

Population density in the region in 1981 averaged 890 persons per sq. km. This was about 18% higher than the average for the country as a whole. Densities in the region were highest in Comilla, Chandpur and Feni Districts (at between 967-1085 per sq km) and lowest in Noakhali and Lakshmipur (618-769 per sq km). Details are shown in Table 8.3. By 1991 the density had risen to 1078 persons per sq km.

TABLE 8.2

Life time net migration by districts 1974-1981

				Rate (% of 1974 Population)		
Locality	Male	Female	Total	Male	Female	Total
Brahmanbaria	- 43 703	-35 055	- 78 758	- 4.9	- 4.1	- 5.6
Comilla	- 63 167	- 4 149	- 67 316	- 3.7	- 0.5	- 3.2
Chandpur	- 85 641	- 8 845	- 94 486	- 9.5	- 0.1	- 6.4
Feni	- 26 286	- 5 731	- 32 017	- 5.8	- 1.3	- 4.6
Lakshmipur	- 59 437	- 5 118	- 64 555	-10.6	- 0.1	- 7.0
Noakhali	- 59 997	+15 176	- 44 821	- 6.7	+ 1.7	- 3.7
SE region	-338 231	-43 722	-381 953	- 8.1	- 1.1	- 4.7

Note: Based on the national growth rate method

TABLE 8.3

Density of population by districts 1951 - 1991

Persons per square km

Locality	**1951**	**1981**	**1991**
Brahmanbaria	541	896	1 108
Comilla	576	1 085	1 300
Chandpur	572	1 053	1 145
Feni	581	967	1 182
Lakshmipur	430	769	899
Noakhali	305	618	789
SE region	488	890	1 078
Bangladesh	312	624	750

Note: Source - BBS. Figures in Annex III differ slightly because of non-correspondence of study area and administrative boundaries.

The relatively low population densities in Lakshmipur and Noakhali Districts are due to the extensive char lands in the south of these areas, which are generally unsuitable for agricultural development at the present time. The high population density in Comilla is explained in part by the inclusion within this district of Comilla town, (much the largest urban settlement in the region), coupled with relatively favourable agricultural conditions. High densities in other districts result almost wholly from high rural (rather than urban) populations. The national setting of these population densities is given in Figure 8.1. These high population densities probably reflect the good agricultural conditions in the region, but other factors are also likely to relate. However, the high population densities indicate that development considerations are vital particularly considering the out migrations evident in Table 8.2.

Rural-Urban Distribution of Population

The proportions of urban population for greater Comilla and Noakhali districts, according to 1981 census results, were 8% and 11% respectively. This is low compared to the national figure of 15%, although there has been a substantial increase.

Age Structure

The age structure of the population by district is given in more detail in Annex III. However, the age group 0-14 years alone constitutes 48% of the total population of the region. This proportion is higher than the national figure of 46.6%. Noakhali district appears to have the highest proportion of population in the age group 0-14 (49.5%), the lowest being recorded for Comilla (46.9%). These figures may be related to socio-cultural attitudes to the status of women and family planning. The proportion of older people (60 years and over) was about 6% for all districts, which is comparable with the national figure (5.6%).

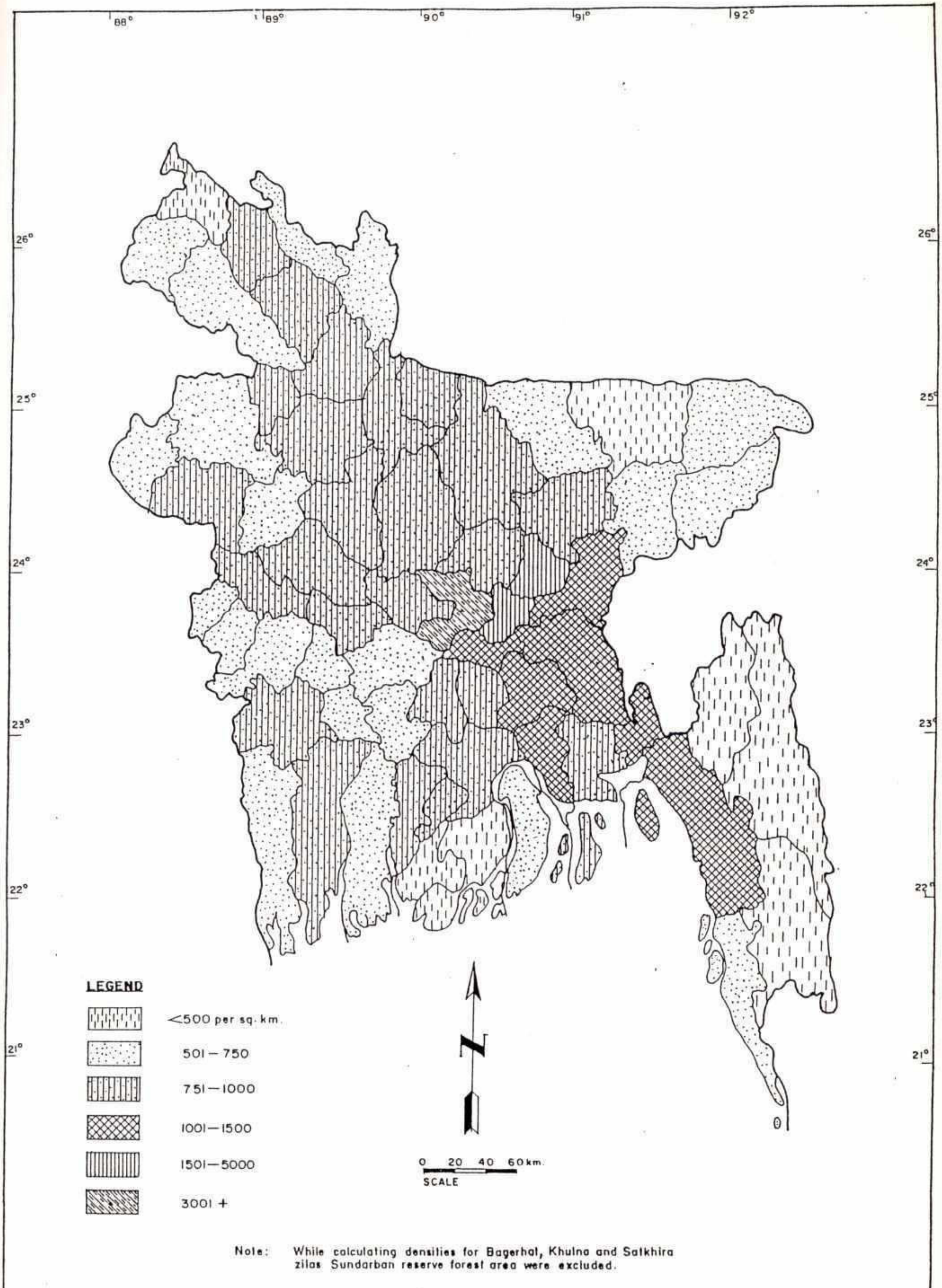
The most useful single measure summarising a population's age structure is the median age, which divides the population into two equal parts, half older and half younger. The average median age for the region is estimated at 16.1 years, compared with the national average of 16.6 years. Lakshmipur and Noakhali have significantly lower medians (at 15.4 and 15.3 years respectively) than other districts in the region. The need for future employment opportunities for this emergent population is an important consideration within the context of development planning.

Dependency Ratios

The dependency ratio (defined as the ratio of the population in the age groups 0-14 years and 65 years and over to the working population in the age group 15-64 years) of the region according to the 1981 census was about 107.5%, which was similar to the national figure. The ratio was highest for the Comilla and Lakshmipur Districts. This may be attributed to the migration of the working age population of these districts to other parts of the country. Among the Thanas, Faridganj in Chandpur district had the highest dependency ratio (130%) followed by Chatkhil (129%) and Senbag (128%) in Noakhali district. As many as nine thanas were burdened by dependency ratios of more than 125%. Only three thanas out of a total of 43 had a dependency ratio below 100%.

Figure 8.1

Density of Population Bangladesh 1991



Note: While calculating densities for Bagerhat, Khulna and Satkhira zilas Sundarban reserve forest area were excluded.

Sex composition

The sex composition of a population is conveniently described by the sex ratio, which is the number of males per 100 females. The sex ratios of the region by district are compared with those for the country as a whole in Table 8.4. The sex ratio for the region is lower than the national ratio.

TABLE 8.4

1981 Sex ratios: SE region and Bangladesh (males/females %)

Age	Bangladesh	SE Region	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noakhali
0-4	101.4	104.0	102.6	103.9	104.5	103.9	104.6	104.6
5-9	103.0	106.0	104.9	105.3	106.7	106.2	107.3	106.7
10-14	114.8	112.8	119.4	114.7	109.5	110.1	109.5	110.7
15-19	102.8	98.3	107.0	96.6	96.4	102.3	93.8	96.7
20-24	91.8	79.1	82.4	79.5	75.3	84.1	79.4	75.8
25-29	101.9	83.2	89.6	87.0	78.1	83.6	81.8	75.2
30-34	100.8	82.3	88.6	85.8	76.5	83.7	81.2	75.0
35-39	113.4	94.4	104.3	98.7	90.8	92.2	92.3	82.6
40-44	108.3	93.8	101.9	98.0	94.3	88.9	92.6	81.8
45-49	124.1	111.1	121.8	116.2	110.1	100.5	110.5	102.2
50-54	111.3	104.2	110.4	107.2	103.9	96.4	107.1	95.5
55-59	132.6	127.5	126.5	130.9	125.5	121.9	137.5	121.1
60-64	115.8	113.1	109.0	114.0	113.8	107.7	123.6	111.3
65-69	137.6	145.4	135.4	146.1	149.3	149.8	153.3	143.4
70 +	135.0	141.1	133.5	147.3	150.4	139.0	130.5	137.4
All ages	106.4	101.2	104.4	102.4	100.1	100.8	100.3	97.8

Source - BBS

Sex ratios by age show a very erratic pattern. With a few exceptions, the ratios are uniformly below 100 from age group 15-19 to 40-44 for all the districts of the region, indicating an excess of females over males. This may be attributed mainly to emigration of young males to other districts and to Dhaka. Ratios are above 100% for age groups from 45-49 and upwards. The differences between male and female mortality rates in these higher age groups are small, and would not account wholly for the very high sex ratios observed for the older age groups. Inaccurate statement of age as well as under-enumeration of females could explain the higher sex ratio at the older ages. At the upazila level, Ramgati upazila of Lakshmipur district recorded the highest sex ratio (108%) probably because topography does not permit good family settlement; Ramganj, in the same district, had the lowest sex ratio (91%), probably due to male-out migration.

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High unemployment rates have encouraged out-migration of males. The region is renowned for being a common source for construction labour gangs which become itinerant work forces. This might help to account for the abnormal ratios in the 20-40 year age group.

Marital Status and Age at Marriage

Nearly a quarter of the female population remains single in the region, close to the national proportion. The marital status data for the region also appear to be consistent with those for the country as a whole. The percentage of widowed females is significantly higher than that of widowed males. This can be attributed mainly to a socio-economic and cultural pattern and conservative philosophy which prevent the remarriage of most widows.

The Singulate Mean Age at Marriage (SMAM) for females in 1981 varied between 16.5 years (Lakshmipur) and 17.6 years (Chandpur). The overall mean for the region was 17 years, which is slightly higher than the national figure of 16.8 years. The mean age at marriage for the country as a whole recorded a slight rise of about half a year during the inter censual period 1974-1981. The recent study by the Population Development and Evaluation Unit (Hossain and Ahmed, 1990) also estimates the median female age at marriage to be in the neighbourhood of 17 years. The mean age for marriage is higher in the greater Comilla district than in greater Noakhali district.

8.1.4 Household Growth, Size and Composition

For Bangladesh as a whole, the rate of household formation did not keep pace with population growth in the period 1961-1974: the population increased by about 41%, whereas the number of households increased by only 32%. The increase in households during the inter-censual period 1974-81 was 16.6%. The number of households in the region grew by about 15% over the intercensal period 1974-81, slightly below the national average. Noakhali district recorded the highest growth in numbers of households (17.7%), followed by Chandpur. The growth was the lowest (8.8%) for Feni district. Details are shown in Table 8.5.

The average number of persons per household increased from 5.4 in 1961 to 5.6 in 1974 and 5.7 in 1981 for the country as a whole. The increase in household size in the south-east region appears to have been similar. The Population Development and Evaluation Unit study (Hossain and Ahmed, 1990) confirms that the average size of households in the region is increasing over time. Amongst the six districts in the region, Chandpur had the largest household size (6.2 persons) in 1990, and Comilla the smallest (5.6 persons). Amongst the thanas, Faridganj appeared to have the highest average household size (6.7 persons).

TABLE 8.5

Household growth and size, 1974-1981

Household Size (Average Number of Persons) (1)				% Increase in number of households (2)
Locality	1974	1981	1990	(1974-81)
Brahmanbaria	5.7	5.9	5.9	13.5
Chandpur	5.6	5.6	6.2	16.8
Comilla	5.6	5.8	5.6	15.5
Feni	5.2	5.7	5.8	8.8
Lakshmipur	5.5	5.5	5.8	15.8
Noakhali	5.5	5.6	6.1	17.7
SE region	5.6	5.7	5.8	15.2
Bangladesh	5.6	5.7	-	16.6

Source: 1) Bangladesh Population Census 1981 District Series
2) Hossain and Ahmed (1990)

8.2 The Regional Economy

8.2.1 The Region

The economic and social features of the region, as detailed in this section, are generally based upon the characteristics of greater Comilla and greater Noakhali districts. The minor difference in terms of spatial coverage compared with the study area is ignored at this level of analysis.

The region, constituting 8.3% of the land area of Bangladesh, accommodates 11.9% of the population and accounted for 11.0% of the Gross Domestic Product (GDP) of the country in 1988/89. Per capita Gross Regional Product (GRP) in current factor cost (1988/89) was Tk 5 206 in greater Comilla and Tk 4 944 in greater Noakhali, compared with a per capita GDP of Tk 5 700 for the whole of Bangladesh. Table 8.6 shows the position of the region's two greater districts in the national economy.

TABLE 8.6

Position of the South East Region in the National Economy

(1988/89 Factor Cost)

Locality		GRP/GDP		GRP/GDP per capita
Bangladesh	Tk	612.872 million	Tk	5 700
Comilla (greater)	Tk	44.878 million	Tk	5 206
Noakhali (greater)	Tk	23.633 million	Tk	4 944
Comilla and Noakhali	Tk	68.511 million	Tk	5 115
Comilla and Noakhali GRP as % of Bangladesh GDP		11.0%		
Comilla and Noakhali population as % of Bangladesh population		12.3%		
Comilla and Noakhali land area as % of Bangladesh land area		8.3%		

Source: **Statistical Year Book of Bangladesh, BBS, p. 513.**

Table 8.7 shows that greater Comilla contributes about 6.7% of Bangladesh's agricultural GDP while Noakhali contributes 4.1%. The two taken together contribute only about 5% of the industrial GDP of the country. The region's share of the various sectors of the national economy may be seen from the same Table.

8.2.2 The Structure of the Regional Economy

The structure of the regional economy is predominantly rural, with 9% of the population living in the urban areas as against 15% nationally. Industry contributes 3.10% of GRP in Noakhali and 4.31% in Comilla, as against 8.4% nationally (Tables 8.7 and 8.8). This must be viewed in the context of the distortion imposed by Dhaka and to lesser extant Chittagong. The service sectors, including trade, and professional and miscellaneous services, contribute 33.51% of GRP in Noakhali and 40.15% in Comilla compared with 34.92% nationally.

The importance of the non-farm sector may be appreciated through the distribution of employment in the major economic sectors in the greater districts as shown in Table 8.9.

TABLE 8.7

GRP of Comilla and Noakhali compared with GDP of Bangladesh

(1988/89 Current Market Prices)

Sector	Gross Domestic Product Bangladesh		Gross Regional Product Comilla		Noakhali		Comilla & Noakhali	
	Million Taka	Percent	Million Taka	Percent	Million Taka	Percent	Million Taka	Percent
Farm Sector	**245 267**	**37.19**	**16 345**	**6.66**	**10 021**	**4.09**	**26 366**	**10.75**
Crops	174 781	26.50	13 553	7.75	8 157	4.67	21 710	12.42
Forestry	27 286	4.14	56	0.21	112	0.41	168	0.62
Livestock	21 319	3.23	1 581	7.42	862	4.04	2 443	11.46
Fisheries	21 881	3.32	1 155	5.28	890	4.07	2 045	9.35
Non-Farm Sector	**414 202**	**62.81**	**31 304**	**7.56**	**15 259**	**3.68**	**46 563**	**11.24**
Mining and Quarrying	4	0.00	0	0.00	0	0.00	0	0.00
Industry	55 608	8.43	2 055	3.70	784	1.41	2 839	5.11
Construction	39 262	5.95	3 172	8.08	1 871	4.77	5 043	12.84
Service Sector	230 263	34.92	19 133	8.31	8 472	3.68	27 605	11.99
i) Power, Gas and Sanitary Services	6 719	1.02	851	12.67	229	3.41	1 080	16.07
ii) Transport, Storage and Communication	71 774	10.88	7 134	9.94	2 011	2.80	9 145	12.74
iii) Trade Services	55 015	8.34	3 367	6.12	1 975	3.59	5 342	9.71
iv) Banking and Insurance	13 126	1.99	806	6.14	502	3.82	1 308	9.96
v) Professional and Misc. Services	83 629	12.68	6 975	8.34	3 755	4.49	10 730	12.83
Housing	59 866	9.08	4 637	7.75	2 853	4.77	7 490	12.51
Public Administration and Defence	29 203	4.43	2 307	7.90	1 279	4.38	3 586	12.28
GDP/GRP at Current Market Price	**659 473**	**100.00**	**47 649**	**7.23**	**25 280**	**3.83**	**72 929**	**11.06**
Per Capital GDP/GRP at Factor Cost (Taka)	**5 700**		**5 206**		**4 944**		**5 115**	

Source: Statistical Year Book of Bangladesh, B.B.S, 1990, p. 513.

TABLE 8.8

Structure of the Regional Economy, Comilla and Noakhali

(1988/89 Current Market Prices)

Sector	Gross Regional Product Comilla Million Taka	Comilla Percent	Noakhali Million Taka	Noakhali Percent	Gross Regional Product Comilla and Noakhali Million Taka	Comilla and Noakhali Percent
Farm Sector	16 345	34.30	10 021	39.64	26 366	36.15
Crops	13 553	28.44	8 157	32.27	21 710	29.77
Forestry	56	0.12	112	0.44	168	0.23
Livestock	1 581	3.32	862	3.41	2 443	3.35
Fisheries	1 155	2.42	890	3.52	2 045	2.80
Non-Farm Sector	**31 304**	**65.70**	**15 259**	**60.36**	**46 563**	**63.85**
Mining and Quarrying	0	0	0	0	0	0
Industry	2 055	4.31	784	3.10	2 839	3.89
Construction	3 172	6.66	1 871	7.40	5 043	6.91
Service Sector	19 133	40.15	8 472	33.51	27 605	37.85
i) Power, Gas and Sanitary Services	851	1.79	229	0.91	1 080	1.48
ii) Transport, Storage and Communication	7 134	14.97	2 011	7.95	9 145	12.54
iii) Trade Services	3 367	7.07	1 975	7.81	5 342	7.32
iv) Banking and Insurance	806	1.69	502	1.99	1 308	1.79
v) Professional and Misc. Services	6 975	14.64	3 755	14.85	10 730	14.71
Housing	4 637	9.73	2 853	11.29	7 490	10.27
Public Administration and Defence	2 307	4.84	1 279	5.06	3 586	4.92
GRP at Current Market Price	**47 649**	**100.00**	**25 280**	**100.00**	**72 929**	**100.00**

Source: Statistical Year Book of Bangladesh, B.B.S, 1990, p. 513.

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TABLE 8.9

Employment by Major Economic Sectors, 1981

(per cent)

Noakhali			
Farm Sector	**61**	**64**	**60**
Cultivation	59	62	58
Fishery/Forestry/Livestock	2	2	2
Non-Farm Sector	**39**	**36**	**40**
Manufacturing	4	3	3
Business	11	12	12
Others	23	21	25

Source: District Statistical Series, Comilla & Noakhali, BBS.

Non-farm activities thus constitute 36% of total employment in Comilla, and 40% in Noakhali compared to 39% in the country.

The Bangladesh Census of Non-Farm Economic Activities (April 1990) published data on employment in non-farm economic activities for 1986 by mouza, union, upazila and district, following the Bangladesh Standard Industrial Classification (BSIC). The following discussion on non-farm economic activities makes use of data from this census.

(a) Manufacturing

Most of the manufacturing units in the region are categorised as Small and Cottage Industries. Units employing more than 50 people are highlighted here. Local cigarette (biddi) manufacturing units employing over 50 people/unit are found in all the new districts except Brahmanbaria. Brick and structural clay product manufacture also features in all the districts, employing a large proportion of those working for enterprises with more than 50 employees. Local raw-material based industries, mainly jute spinning and weaving mills, are found in Comilla, Chandpur, Noakhali and Feni. The largest factory in the area is a jute mill in Noakhali employing close to 4 000 persons, followed by the Ashuganj Zia Fertilizer Factory, employing 900 persons. Lakshmipur has a clothing factory with 50-100 employees, and a number of smaller apparel factories are reported to be starting up in the Chowmohoni/Lakshmipur areas. There are textile mills in Brahmanbaria, Comilla, Lakshmipur, and Feni. Comilla has a number of plastic/rubber and metal product enterprises. Alone amongst the Thana, Brahmanbaria has two rice mills employing more than 50 persons.

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The overall importance of jute product manufacturing and brick production in the area should be noted. The possibility of using gas-fired brick production units in the area provides a good development option.

Home-based small industries are prevalent to varying degrees in all districts. However, Bancharampur Thana in Brahmanbaria showed 17% of the population of 10 years of age and over employed in manufacturing, compared with the regional average of 3%. Bancharampur is known for its hand loom industry. Other thanas which showed manufacturing employment percentages higher than the regional average are Senbag, Companyganj, Daganbhuiyan and Matlab.

Weaknesses in the manufacturing sector in the region are similar to these found throughout the country. Despite a liberal industrial policy and the comprehensive programmes of the Bangladesh Small and Cottage Industries Corporation (BSCIC), the desired level of development has not taken place. There are BSCIC industrial estates in all six district headquarters of the region, but these have not developed well. The reasons for the low level of development in the small scale and cottage industries sub-sector include inadequate trade and management skills, low productivity, shortages of tools and equipment, market limitations, non-availability of raw materials, resource constraints and natural calamities. Policy objectives in the sub-sector include, among others, reduction of unemployment, especially of rural people (including women); development of entrepreneurial skills and manpower; promotion of sub-contracting linkages between small and large industries; production of import substitution and export-oriented goods, and use of indigenous resources. The Fourth Five Year Plan (FFYP) seeks to increase the sub-sector GDP by 67%. Adequate support services are to be provided, including credit, and fair distribution of foreign exchange and imported raw materials. Plan objectives also cover development and diffusion of appropriate technology, adequate protection and incentives, and market promotion.

(b) Business

Activities here are mostly characterised by retail trade and tea stalls. Retail trade includes grocery, foodgrain, pan/cigarette, textile, and medicine and drug shops. Tea stalls employ about 20% of the labour force employed in the Trade, Restaurant and Hotel sub-sector. A large number of small shopkeepers and tea-stalls is understandable in an overpopulated agricultural community. There is only one unit employing more than 50 persons, in the wholesale trade in raw materials in Brahmanbaria, while Lakshmipur has one fish and seafood wholesale trader of similar size. Wholesale trade offers around 10% of the employment found in the retail trade. Most wholesaling is based on grains and pulses, jute, petroleum products, lumber and construction materials, grocery and provisions, fish and seafood, warehousing of food, etc.

Problems faced by rural businessmen relate, among others, to proper development and operation of markets and market places, transport and storage, and appropriate credit facilities.

(c) Other Economic Sectors

This is a large category, employing around 20% of the labour force, and includes, among others, insurance and other financial institutions; legal and business services; educational health, medical, social and community services; recreation and cultural services; repair services, personal and household services. There is overcrowding in these areas of employment with consequent low wages in certain service sectors.

8.3 Labour Force Characteristics

8.3.1 Activity rates

The crude activity rate is the ratio of the economically active population aged ten years and over to the total population, and is an approximate measure of the size of the labour force. There has been a long-term downward trend in crude activity rates in Bangladesh, from 33.3% in 1901 to 28.7% in 1974 and 27.1% in 1981. This is in conformity with the age structure characteristics defined in section 8.1.3.

Economic participation rates were lower in the region than for the country as a whole according to the 1981 Census. The estimated crude and refined activity rates are shown in Table 8.10. (The refined activity rate is defined as ratio of the economically active population aged ten and over, to the total population aged ten and over.) Refined activity rates for males were 68.3% for the region, compared to a national average of 74.1%. The SE region rates for males is some 5% below the national value for both crude and refined activity rates. For females, the rate was 3% in the region compared to 4.2% nationally.

The relatively low labour force participation rates in the region presumably reflect a lack of job opportunities: this would be consistent with the observed migration out of the region in recent decades. There are no marked variations in activity rates between the different districts. The extremely low female labour force participation rates reflect the religious restrictions placed on females working outside the home. Housework is not included in the definition of 'work' used in calculating participation rates. It is notable that women in the rural areas of the region participate to only a very limited extent in farm-work, other than in their own household plots; this contrasts with the situation in many other muslim countries. Subsequent labour force surveys indicate that female activity rates are gradually increasing.

TABLE 8.10

Economic Participation Rates by sex and locality: 1981

Locality	Crude Activity Rate		Refined Activity Rate	
	Male	Female	Male	Female
Brahmanbaria	44.3	2.7	67.5	4.2
Chandpur	40.7	1.2	62.8	1.9
Comilla	46.9	2.4	71.7	3.7
Feni	44.9	1.9	68.9	2.9
Lakshmipur	46.3	1.5	72.5	2.4
Noakhali	41.3	1.4	65.6	2.2
SE region	44.3	2.0	68.3	3.0
Bangladesh	49.9	2.8	74.1	4.2

Notes: **Excludes persons engaged in household work**

Ratios are for persons aged 10 years and above

Source - BBS

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8.3.2 Employment by Major Occupation

The economically active population of the region, classified by major occupation groups, is shown in Table 8.11. Nearly two-thirds of male employment, and one-third of female employment, is in agriculture. 'Business' activities, including retail trade, are the second main category of employment, accounting for 12% of male, and 4.5% of female, employment. Employment in manufacturing is negligible (at 3% of the total for males and 1% for females). The regional distribution of employment by sector is very similar to that for the country as a whole, as can be seen from the same Table. The current importance of agriculture cannot be overemphasised, however these is found desire for individuals particularly the landless to find work in the non-agricultural sector primarily because wages are less seasonally dependent.

8.3.3 Agricultural and Rural Unemployment

Bangladesh suffers from chronic rural unemployment. However, the measurement of such unemployment with any degree of precision and consensus has eluded researchers in the field, for a variety of reasons. There is, for all practical purposes, no labour legislation governing payment and working conditions for farm labourers. As such, it is difficult to categorise labour as employed or unemployed. In addition, a large proportion of the agricultural labour force is self-employed, whilst daily hours of work may differ from season to season giving rise to the phenomenon of disguised unemployment. The characteristics and levels of unemployment are important to the development and assessment of the impact of the Regional Plan.

TABLE 8.11

Percentage Employed by Sex, Main Activity and District: 1981

District		Agricultural Cultivation	Agricultural Non-crop	Manufacturing	Business	Others
Brahmanbaria	Male	66.5	1.9	5.0	11.0	15.6
	Female	32.7	2.4	0.8	4.6	59.5
Comilla	Male	69.9	0.7	2.3	2.4	14.7
	Female	35.6	1.3	1.3	4.5	57.2
Chandpur	Male	60.7	2.0	2.9	12.4	22.0
	Female	32.3	2.2	2.1	5.5	57.9
Feni	Male	58.1	0.9	2.9	11.0	27.1
	Female	23.0	2.3	1.0	4.2	69.5
Lakshmipur	Male	64.9	1.8	1.5	12.4	19.4
	Female	32.7	2.3	0.6	4.2	60.2
Noakhali	Male	55.2	1.4	4.7	12.4	26.3
	Female	21.4	2.5	1.4	4.1	70.6

Source: **BBS**

Strikingly low rates of unemployment are indicated by the census and government sponsored surveys, due to the fact that the unemployed are defined as those who did not work at all during the reference period and were actively looking for work. These two tests are very stringent and lead to an estimated rural unemployment rate of less than 2% in the census and Labour Force Surveys (LFS).

Aggregate studies of national unemployment have assumed a total potential labour supply (in terms of standard man-days) per active member of the family (in most cases male) and found the 'actual' mandays used in the reference period. The extent of unemployment was then estimated as the difference between the potential and actually utilised mandays, expressed as a percentage of the potential mandays. Assumptions about the number of hours in a working day and working days in a year have varied between studies, but estimates of unemployment using this methodology are generally around 30%.

Some researchers have introduced the concept of peak period demand for farm labourers, and found that agricultural unemployment at the peak period was much lower. Masum (1982) found peak period unemployment to be around 20%. However, allowing for members of the family who were not fully employed working in the field with those who were, the "removable surplus" fell to only 2.26%. In another interesting study in this connection, Mugtada shows that under the optimistic agricultural growth scenario of the First Five Year Plan, the "transferable surplus" from the agricultural sector to other sectors could be only 1% in the peak season, with an assumed labour input profile for new technology in agriculture, rising to 47% if unemployed man-months spread over the year were aggregated. This peakiness of labour demand in the agricultural section could be reduced to a certain extant by more crop diversification.

Intensive village level studies have sought to distinguish between farm labour and non-farm labour. Hye (1989) found gross agricultural unemployment to be 33.8% in a village in Savar near Dhaka. When adjusted for non-farm employment of farm families, net visible unemployment fell to only 11.5%.

It is possible that agricultural unemployment may be affected by the gradual increase in the female labour force as shown in Table 8.12. Labour Force Surveys (LFS) have shown that 90% of females are engaged in non-agricultural activities. Rural development and new opportunities may well bring about considerable changes in the activities undertaken by women, although such changes are hard to predict.

TABLE 8.12

Changes in the Female Labour Force

	Civilian Labour Force (millions)		Female crude activity rate (%)	Female refined activity rate (%)
	Rural Female	Rural Male		
1961 Census	0.8	15.1	-	-
1974 Census	0.8	19.0	-	-
1981 Census	1.3	21.3	3.4	5.1
1983-84 LFS	2.2	23.2	5.6	8.2
1985-86 LFS	2.6	23.6	6.4	9.9

Source: **BBS Statistical Pocket Book 1990, p 101 and 107.**

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8.3.4 Employment Elasticity to Output

Employment estimations are measures of the ratio of the change in employment used to the change in output obtained through a transition in employment type. In agriculture, a transition from local boro production to HYV irrigated boro is estimated to need on increase in labour of 45% whilst production is almost doubled (increased by 100%). Various measures of elasticity to output are available in the employment literature. Jabbar estimated employment elasticities for 1975/76 which are presented in Table 8.13. Even though these are somewhat old estimates, little change is considered to have taken place.

TABLE 8.13

Employment Elasticities to Output

Cropping Comparison/ Substation	Employment (% change) (1)	Output (% change) (2)	Elasticity 1/2
B aus to T aus (HYV)	+ 44.6	+ 345.0	+ 0.13
T aman (Local) to T aman (HYV)	+ 35.6	+ 81.1	+ 0.44
L Boro to HYV Boro	+ 44.9	+ 97.2	+ 0.46
Low to high input level for dwarf wheat	+ 88.0	+ 140.0	+ 0.57
B aman and Mustard to HYV Boro	- 5.5	+ 27.7	- 0.20

Source: **Jabbar M. A. and Faruque, Quoted in the text, op cit. p. 101.**

These factors are borne in mind during Plan Formulation.

It can be seen that in most cases the rate of output expansion is higher than the rate of employment expansion. In fact, a change from B. Aman/Mustard to HYV Boro reduces employment. An employment-oriented development plan might include the following policies:

- intensification of cropping
- appropriate changes in the technology of production, avoiding the spread of mechanical cultivation, and increasing the use of traditional methods of irrigation or hand tubewells
- changes in cropping patterns (promote T aman in place of B aman, promote HYV boro in place of local boro and expand total boro area, increase the area under Jute during the aus season)

8.3.5 Agricultural Wages

Most studies of wages in Bangladesh have concluded that real wages have, by and large, fallen progressively since 1949-50, although there may occasionally have been rises over a two or three year period. This phenomenon has generally been explained only in terms of inflation and perhaps in relation to a supply-demand imbalance. However, analysis is lacking of the influence of social, institutional and patron-client relations on real wages in a traditional society.

Nominal agricultural wages are systematically higher in the region than in the country as a whole, especially in greater Noakhali. Table 8.14 shows nominal wages and real wages (indexed to rice prices) for 1979/80 onwards.

TABLE 8.14

Nominal Wages and Real Wage Indices for Agricultural Labour

	Coarse Rice Price (Tk/kg)	Nominal Daily Wage (Taka)			Real Wage Indices Adjusted for Rice Price		
		Bangladesh	Comilla	Noakhali	Bangladesh	Comilla	Noakhali
1979/80	6.03	12.46	14.75	14.42	100	100	100
1980/81	5.08	13.97	15.00	16.42	133	120	125
1981/82	5.09	15.48	17.50	18.17	147	140	149
1982/83	7.06	17.05	18.75	22.75	117	109	134
1983/84	7.80	19.58	25.42	24.75	121	133	133
1984/85	8.73	24.45	30.05	33.33	125	141	160
1985/86	8.39	29.54	32.27	37.50	170	157	187
1986/87	10.01	31.91	35.42	40.42	149	144	169
1987/88	10.91	31.15	31.00	37.00	138	116	142
1988/89	10.93						

Source: Statistical Year Book of Bangladesh (BBS,1990) for nominal wages and price of coarse rice.

Although there appears to be an overall increase in real wages over the period in question, a slippage is seen after 1986/87, as also noted by the World Bank (1989). The precipitous fall in both nominal and real wages in greater Comilla in 1987/88 could be due to the after-effects of the major floods of that year.

During the period under consideration, the real wage index for Bangladesh General Workers (adjusted against the Country Consumer Price Index) rose from 82 to 107, a rise of 30%.

8.3.6 Conclusions

Although farm labour estimates vary from area to area, depending on soil capability, topography and hydrology, distribution of farm size, tenurial system, cropping patterns, and the availability of non-farm activities, it may be concluded that seed-fertiliser-irrigation based technology will not create any scarcity of labour. As development of irrigated agriculture in the country will necessarily be phased over several years, migration of seasonal workers will be able to take care of any increased demand. A study of Chandpur Irrigation Project (CIP) revealed that migratory farm labour is needed during the peak season and is readily available in nearby areas.

The extension of irrigated agriculture will tend to spread the workload more evenly throughout the year, tending to ease under-employment. The FFYP projects a 1.9% annual growth rate in agricultural employment.

For a proper analysis, area specific employment surveys must be undertaken to understand the present condition of rural employment and unemployment and future prospects with the introduction of new technology. The main imponderable is the female labour force, which has increased very slowly over the years. Labour Force Surveys suggest that 90% of employed females are in any case at present engaged in non-agricultural sectors. How this vast reservoir of 'unutilized labour' reacts to new opportunities opened up by rapid changes in rural and agricultural development remains to be seen.

8.4 Social Condition of the Population

8.4.1 Socio-Economic Groups

The ownership of agriculture land being one of the key determinants of a households's socio-economic position, status, the stratification of households on the basis of the amount of cultivable owned is of particular relevance to the study. Following BBS approach, five ownership groups can be considered:

- Landless (below 0.05 acres of land, with or without homestead)
- Marginal Landowners (0.05 to 0.5 acres of land)
- Small Landowners (0.5 to 2.5 acres of land)
- Medium Landowners (2.5 to 7.5 acres of land)
- Large Landowners (more than 7.5 acres of land)

The households economic strategies are, to a large extent, defined by the size of land ownership. For those households who do not own sufficient amount of land to earn a living from farming, they have to either try to rent some land in or they have to get involved in non-farming activities such as wage employment. As a result,

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it is worthwhile to stratify the households by size of their land holdings, because it gives a more accurate picture of the overall land distribution since it includes other tenure patterns then ownership only. In the 1983 BBS agriculture census, 4 broad categories of land holding groups were considered:

- No Holdings (holding less than 0.05 acres of land)
- Small Holdings (farm size between 0.05 acres and 2.5 acres)
- Medium Holdings (farm size between 2.5 acres and 7.5 acres)
- Large Holdings (farm aixe of more than 7.5 acres)

The zamindar/jotdar who were present and dominant in the past in many districts are almost extinct except in some pockets since the zamindari system was abolished by the government. However, through the misuse of land ownership law and/or local policies/factional powers, some very high land holding groups are still to be found in some parts in the country including the south-east region. According to available recent field work data, there are big land holding families in the char lands. There are reportedly 14 very large land holding families locally known as jotdars in Ramganj thana. In Ramgati and in Sarail and Nasirnagar adjacent flooded areas, a large number of fishermen were reported.

Another very important aspect to bear in mind when defining socio-economic groups is to classify the households based upon their primary and secondary occupations. This approach gives an insight of the nature of the household livelihood and of its main components. This is particularly necessary for households having no holdings or only small holdings because they cannot rely only of crop cultivation for their survival and have to get involved in other type of activities including:

- agriculture wages employment
- earth work wages employment
- industrial wages employment (urban areas)
- transport employment, either self-employment or wages employment
- services employment, including government job
- fisheries
- cottage industries
- trade and business

For those households with limited holdings, farming is not the main source of income and the socio-economic position of the household will depend on the level of incomes earned from other economic sector. These households can be further segregated in at least two different sub-groups:

- Rural/Urban formal households, formally engaged in non-agricultural sector through regular employment contracts, or having well established self-employment activities such as business, trade, manufacturing.... Though some of these households might be quite rich while others are just above the poverty line, they have one thing in common, they have a stable and secure livelihood.

- Rural/Urban informal households, the weakest population, mainly dependent on wage employment and access to common resources (such as fisheries) to earn a living. With no landed property, some of these households are not even owing their homestead, those households who do not have regular employment are on the edge of exclusion and marginalization. having not much left to offer as a client (no land, no house, no assets), they are gradually falling outside the patron-client network and are slowly rejected outside the precarious "safety net" through which the poor is maintain alive. Among these informal households, hardcore poverty is widespread and they have to permanently struggle to service. Among these informal households are found widows, divorcees, handicapped and dispossessed groups; indeed they may be considered as separate socio-economic groups needing particular attention for their own unique distressed condition and low level status in the community.

8.4.2 Landlessness and Land Ownership Distribution

Agriculture being the mainstay of the rural economy, the ownership of cultivable land is the most important determinant of household economic and social position. The amount of a land owned by a household is, to a large degree, dependent on how much the household inherited. However, if land inheritance is essential to explain the initial position of the household, there are other mechanisms of land transfer.

Longitudinal studies have shown that ten to twenty years after they have been established, most households will own either less or more land those than the amount they have inherited. Sale of land between two households is the most important way through which land changes ownership, though it is often a long lasting process before the final take over by the purchaser. In fact, transfer of land through sales usually takes place in a "many-stranded" relationship, quite often involving also sharecropping, employment, credit and political support. This has clear implications for the social organization of rural Bangladesh because this relationship is usually of a pation-client type.

The "surplus" households, meaning those who have an income greater than their expenditures, try to consolidate their dominant position by expanding their property and assets. In this regard, land is still the premium choice of rural households as far as capital formation is concerned, for at least two sets of different reasons:

- first, because of the inheritance rules, it is necessary to have much land for the division among children;

- second, because of the uncertainty of obtaining a satisfactory return on investment for increasing land productivity, many "surplus" households found it less risky to expand their holdings, which, in a long-term perspective, represents a better security than does a smaller holding with higher yield.

Different villages studies and BBS census data as well revealed that the landlessness phenomenon is increasing over time while, in the meantime, a few privileged rural elites tend to control more and more land.

As shown in Table 8.15, 30% of the households of South East region (including urban households) were landless in 1981, which means that they possess less than 0.05 acre of cultivable land. However, the extend of the landlessness phenomenon is far from being uniform throughout the region and significant discrepancies were observed between districts, with lower landless rates in Comilla and Chandpur and higher in Brahmanbaria and Noakhali. From the available information of 1991 BBS population census, it can be seen that a slight increase (+6.4%) of the proportion of landless households occurred during the last decade in Noakhali district. Assuming the same increase in the entire region, the percentage of landless households is now probably around 38%.

Data from 1983-84 BBS agriculture census are not similar than the figures from the population census. The main reason is that the agriculture census referred only to rural households and did not consider the urban population.

TABLE 8.15

Percentage of Households with less than 0.05 acres of Cultivable Land

	BBS Population Census			BBS 1983 Agriculture Census
	% of all Households			% of Rural Households
	1981	1991	Est 1993	< 0.05
Comilla Region	**27.9%**		**36.2%**	**14.5%**
Brahmanbaria	33.5%		41.1%	14.1%
Chandpur	26.1%		34.6%	15.3%
Comilla	26.0%		34.5%	14.2%
Noakhali Region	**32.2%**		**40.0%**	**13.5%**
Feni	31.4%		39.2%	13.1%
Laksmipur	31.7%		39.5%	14.0%
Noakhali	33.0%	39.4%	40.6%	13.4%
South East Region	**30.0%**		**38.0%**	**14.1%**

Source : Bangladesh Population Census 1981 and 1991, Zila series
Bangladesh Agriculture Census 1983-84, Volume I

In Table 8.16, the distribution of land ownership among rural households is presented. A majority of households, in both Noakhali and comilla regions, do own less than an acre of land, while nearly 50% possess less than half an acre and can be regarded as functionally landless. This highlights the fact that most of the rural households cannot sustain their livelihood by only cultivating their owned plots of land and have to, either increase the size of their holding through renting land in, or get engaged in other renumerative activities such as wage employment, fishing, business/trade and cottage industries.

8.4.3 Farm Holdings and Land Tenure Patterns

A farm holding, defined as a techno-economic unit of agriculture production under single management, can be managed by one or serval households. In this regard, the total number of farm holdings is higher than the number of farming households. As seen from Table 8.17, the average number of persons per farm holding is well above six while the average household size is well below six.

TABLE 8.16

Distribution of Rural Households by Size of Landownership

Landowning Groups (in acres)	Bangladesh		Noakhali Region		Comilla Region	
	% of HH	cumul. %	% of HH	cumul. %	% of HH	cumul. %
below 0,05	18.1%	18.1%	13.5%	13.5%	14.5%	14.5%
0.05 - 0.49	28.2%	46.3%	36.4%	39.9%	31.3%	45.8%
0.50 - 0.90	12.0%	58.3%	16.1%	66.0%	17.0%	62.8%
1.00 - 2.49	21.6%	91.4%	8.1%	95.8%	9.4%	96.5%
2.50 - 4.99	11.6%	91.4%	8.1%	95.8%	9.4%	96.5%
5.00 - 7.49	4.7%	96.1%	2.3%	98.1%	2.3%	98.8%
7.50 - 14.99	3.0%	99.2%	1.4%	99.5%	1.0%	99.8%
15.00 +	0.8%	100.0%	0.5%	100.0%	0.2%	100.0%
	100.00%		100.00%		100.00%	

Sources : Bangladesh Agriculture Census 1983-84, Volume I.

TABLE 8.17

Farm Population, No of Holdings and Operated Area

Basic Indicators	Bangladesh		Noakhali Region		Comilla Region	
Farm Population	62,990	67.8%	2,951	73.7%	5,830	79.5%
Non-Farm Population	29,925	32.2%	1,054	26.3%	1,507	20.5%
Total Population	92,915	100.0%	4,005	100.0%	7,338	100.0
Farm Holdings	9,970		475		904	
Mean Holding Size	6.32		6.22		6.45	
Operated Area	22,674		716	1,281		
Mean Area / Holding	2.27		1.51		1.42	

Sources : Bangladesh Agriculture Census 1983-84, Volume III

Remarks : Total population in 1984, at the time of the sensus

From this table, it can be noted that the population depending on farming for their livelihood is still quite high, especially in Comilla region where around 80% of the population has farm holdings in 1983-84. Due to the lack of development of other economic sectors, the population of the south-east region still is very much relying on agriculture for its living. Because other employment opportunities are scare, the majority of the rural labour force tries to get hold of a piece of farmland. Due to increasing population pressure and land fragmentation, the average farm size is declining. This is particularly true in the south east, with both Noakhali and Comilla having an average farm size well below the national level.

The distribution of farm holdings by size given in Table 8.18 highlights that a majority of farms are below 1 acre in both Noakhali and Comilla. In terms of area, farms holdings below 2.5 acres account for around 50% of the total operated land of the south east region while, for the country as a whole, these holdings occupied less than 30% of the total farm land.

Also, the land concentration is more acute in the region, especially in Comilla. Int his sub-region, only 3.6% of the farm holdings are bigger than 5 acres but, in terms of land, they account for some 20% of the total operated land. In Noakhali, 5.1% of the farm holdings (more than 5 acres) account for nearly 30% of the total farm land.

TABLE 8.18

Distribution of Farm Holdings by Size

Size of Holdings (in acres)	Bangladesh		Noakhali Region		Comilla Region	
	% Holdings	% Area	% Holdings	% Area	% Holdings	% Area
Small Holdings						
S1 0.05 - 0.99	40.1%	7.6%	53.3%	15.6%	52.1%	17.2%
S2 1.00 - 2.49	29.9%	21.1%	30.4%	31.2%	32.7%	36.2%
Medium Holdings						
M1 2.50 - 4.99	18.2%	27.6%	11.2%	25.1%	11.6%	27.4%
M2 5.00 - 7.49	6.7%	17.5%	2.9%	11.4%	2.5%	10.5%
Large Holdings						
L1 7.50 - 14.99	4.2%	18.3%	1.8%	11.4%	0.9%	6.3%
L2 15.00 +	0.9%	7.9%	0.4%	5.3%	0.2%	2.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Concentration index						
	0.47		0.49		0.54	

Sources : Bangladesh Agriculture Census 1983-84, Volume III

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As shown in Table 8.19, the dominant pattern through which people are holding farm land is direct ownership. In this respect, two third of the farms in the region are entirely owned by the cultivator while the remaining third is consisting of a combination of owned and rented plots. It should be noted that pure tenant holdings are very scarce in both Noakhali and Comilla (less than 0.5%).

Though the situation looks pretty similar in both Comilla and Noakhali, some salient differences appeared when looking at the tenancy pasterns for different holding size. While in Noakhali region the proportion of owner-cum-tenant holdings increased with the holding size, and even become dominant for holdings of more than 5 acres, the situation is exactly reversed in Comilla region. This indicates that comparatively smaller landowners are getting comparatively higher holdings in Noakhali because they rent in bigger areas of land. This point is clearly demonstrated in Table 8.20 where it can be seen that 24% of the total operated land of Noakhali region is "rented in" as against 14.2% only in Comilla.

TABLE 8.19

Distribution of Farm Holdings by Tenancy Groups

Size of Holdings (in acres)	Bangladesh		Noakhali Region		Comilla Region	
	Owner	Owner Tenant	Owner	Owner-tenant	Owner	Owner-tenant
Small Holdings						
S1 0.05 - 0.99	73.3%	24.3%	75.0%	24.9%	66.4%	33.1%
S2 1.00 - 2.49	55.2%	43.7%	59.4%	40.5%	56.4%	43.1%
Medium Holdings						
M1 2.50 - 4.99	51.2%	48.2%	52.5%	47.5%	59.6%	40.3%
M2 5.00 - 7.49	59.4%	40.4%	42.9%	57.1%	73.1%	26.9%
Large Holdings						
L1 7.50 - 14.99	64.2%	35.8%	33.3%	66.7%	80.0%	20.3%
L2 15.00 +	73.0%	26.8%	41.2%	58.8%	85.7%	14.3%
All Holdings	62.6%	36.0%	65.9%	34.0%	62.7%	37.0%

Sources : Bangladesh Agriculture Census 1983-84, Volume III

TABLE 8.20

Percentage of the Total Operated Land "Rented In" by Size of Holdings

Size of Holdings (in acres)	Bangladesh		Noakhali Region		Comilla Region	
	Area	%	Area	%	Area	%
Small Holdings						
S1 0.05 - 0.99	348.1	20.2%	19.8	17.7%	47.2	21.4%
S2 1.00 - 2.49	1,057.3	22.1%	43.8	19.6%	81.8	17.6%
Medium Holdings						
M1 2.50 - 4.99	1,251.6	20.0%	42.3	23.5%	43.7	12.4%
M2 5.00 - 7.49	559.5	14.1%	24.5	30.0%	6.9	5.1%
Large Holdings						
L1 7.50 - 14.99	439.8	10.6%	31.7	38.8%	2.3	2.8%
L2 15.00 +	143.3	8.0%	10.1	26.7%	0.2	0.7%
All Holdings	3,799.5	16.8%	172.1	24.0%	182.1	14.2%

Sources : Bangladesh Agriculture Census 1983-84, Volume III

Having discussed the importance of rented land in farm holdings, one importance of rented land in farm holdings, one important issue is to investigate who are the owners giving out their land. Data collected tend to indicate (cf annex III, Table III.23) that the proportion of owned land rated out for different size of holdings. As expected, the percentage of owned land "rented out" is very high for small farm holdings and is gradually decreasing with the size of holdings. This pattern is valid both in both regions though the percentages are systematically higher in Noakhali than in Comilla.

This is an illustration of the process through which a majority of households are gradually loosing land resources and, sooner or later, irreversibly, will become landless. Most of the households with expenditures greater than income might have, usually to repay outstanding debts, to sale their land. However, this is a long lasting process because these households will try to postpone the sale as long as possible using several strategies including some forms of land mortgages. This would explain why a high percentage of owned land is given out by small landholders. As shown in Table 8.21, though sharecropping remains the primary system under which land is renting in, the importance of mortgage is still very significant.

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TABLE 8.21

Distribution of Farm Holdings Renting Land by Tenure Systems and Size of Holdings

Tenure Systems	Bangladesh		Noakhali Region		Comilla Region	
	% Holdings	% Area	% Holdings	% Area	% Holdings	% Area
Sharecropping						
- share 1/3	4.5%	6.6%	0.5%	0.5%	0.5%	0.7%
- share 1/2	58.8%	66.4%	71.6%	82.6%	41.0%	45.6%
- share 2/3	0.7%	1.0%	0.5%	0.3%	0.3%	0.3%
Other Arrangements						
- lease/fixed amount	13.5%	11.4%	10.3%	5.3%	19.1%	17.5%
- mortgage	13.7%	7.9%	13.2%	7.2%	33.7%	30.2%
- Others	8.8%	6.7%	3.9%	4.1%	5.4%	5.8%

Sources : Bangladesh Agriculture Census 1983-84, Volume III

8.4.4 Food and Nutrition

Of the landless and the marginal farmers who constitute 70% to 80% of the rural population, the adults in most households have only one main meal per day, ie a heavy late panta rice meal (rice cooked the previous night and kept soaked in water overnight). Children may have two meals a day; a late rice breakfast and a late rice lunch, and no dinner. For the majority of the population, meals contain little fish or dal, and scarcely any meat or other protein/energy food, such as milk, butter or ghee. The protein intake in general is thought to be much lower than the FAO recommended level.

8.4.5 Housing and Household Amenities

Type of house construction and access to basic household amenities are indicative not only of the economic well-being of a household, but also of attitudes to modern life.

Between 92% and 97% of houses in three representative thanas in the region, surveyed in 1990, were classified as 'katcha' (ie poor quality), as shown in Table 8.22. Despite the major rural electrification programmes of the past two decades, the great majority of households in the region remain without electricity. The upazila survey showed (Table 8.23) that between 84% and 92% of households used kerosene rather than electricity as their major source of light. As to fuel, Table 8.24 shows that dry leaves, husks and cow-dung are the major sources, followed by wood and bamboo. Kerosene is used as a fuel by less than 2% of households, whilst the use of electricity as a fuel is insignificant. The need for greater rural coverage of electrical power for the betterment of rural life is dearly demonstrated.

TABLE 8.22

Percentage Distribution of Households by Type of Construction of Housing Unit

District	Thana	Pucca	Semi-pucca	Katcha
Comilla	Burichang	2.8	5.2	92.0
Chandpur	Faridganj	0.6	1.8	97.6
Noakhali	Chatkhil	0.8	4.2	95.0

Source: **Report on the Thana Development Monitoring Project Vol. 1 Nov. 1991, BBS.**

TABLE 8.23

Percentage distribution of households by source of light

		Source of light		
District	Thana	Electricity	Kerosene	Other
Comilla	Burichang	15.6	84.4	-
Chandpur	Faridganj	9.0	90.8	0.2
Noakhali	Chatkhil	8.0	92.0	-

Source: **Report on the Thana Development Monitoring Project Vol. 1 Nov. 1991, BBS.**

TABLE 8.24

Percentage Distribution of Households by Source of Fuel

		Source of fuel				
District	**Thana**	**Leaf/Cow-dung/Husk**	**Wood/ Bamboo**	**Kerosene**	**Electricity**	**Other**
Comilla	Burichang	52.6	45.0	1.6	0.8	-
Chandpur	Faridganj	72.8	26.8	0.2	0.2	-
Noakhali	Chatkhil	74.6	24.2	1.2	-	-

Source: **Report on the Thana Development Monitoring Project Vol. 1 Nov. 1991, BBS.**

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8.4.6 Source of Potable Water

A clean source of drinking water is considered to be the most important precondition for good health in any community. Diarrhoea and other waterborne diseases are the dominant health hazard in Bangladesh, and are thought to be the main causes of child and infant mortality. The condition of water supplies in various parts of the country has greatly improved in recent years. UNICEF has played a vital role through a massive programme of sinking tubewells for drinking water supply throughout Bangladesh. The data presented in Table 8.25 show that tubewells are by for the most important source of drinking water in the thanas surveyed.

However problems do exist with regards to the quality of water in the region and the impact of overall groundwater exploitation. This subjects are dealt with in subsequent sections.

8.4.7 Sanitation

Possession of a sanitary latrine is perceived as an indicator of social status as well as of environmental hygiene. Improved types of latrine reduce environmental pollution, thereby decreasing the risk of diarrhoea and other health hazards. In spite of the government's efforts, in collaboration with international agencies and NGOs, sanitation provisions throughout the country remain at a very low level. As can be seen from Table 8.26, only about 5% to 12% of households in the surveyed thanas in the south east region were reported to have a sanitary toilet.

8.4.8 Literacy and Education

Information on literacy and educational attainment has been collected in all censuses in Bangladesh, because of its crucial importance to policy makers and planners. However, due to the adoption of varying definitions in different censuses, the task of comparison of the literacy level over time has become extremely difficult. The 1961 and 1974 censuses used largely similar definitions: a person was defined as literate if they could read any clear print with understanding. The 1981 and 1991 census considered a person literate if he/she could read and write a letter in any one of the local languages. This stricter definition reduced the reported literacy rate.

The 1981 Census data showed an overall literacy rate for the south east region of 24.1%, slightly above the national average of 23.8%. There was a marked difference in the literacy rates for males (31%) and females (only 16%). Details are shown in Table 8.27. Among the districts in the region, Feni had the highest literacy rate (28.4%), followed by Chandpur (28.1%). The lowest level of literacy was recorded in Brahmanbaria district (17.9%). At the upazila level, Chatkhil in Noakhali district had the highest literacy rate (40.2%), and Nasirnagar upazila in Comilla district the lowest (13.1%).

However, by 1991 the south east region literacy rate of 24.48% was slightly lower than the national rate of 24.82%, although higher than in 1981.

The level of education of the region's population, as recorded in the 1981 Census, is shown in Table 8.28 by sex for persons aged 5 years and above. The majority of the population was classified as having had no schooling; for males, the proportions without schooling ranged from 50.5% in Feni district to 63.5% in Brahmanbaria. For females, the proportion without schooling was higher than for males in all districts, ranging from 66.5% in Chandpur district to 79.7% in Brahmanbaria. Comparative data on literacy and educational levels in the region in 1990 are shown in Table 8.29: definitions varied in this source from those used in the 1981 Census, but the figures are broadly consistent. Table 8.29 distinguishes between currently married women and households including currently married women.

TABLE 8.25

Percentage distribution of households by source of drinking water

District	Thana	Pond	Well	Canal	River	Tube-well	Tap	
Comilla	Burichang		6.8	-	-	-	93.2	-
Chandpur	Faridganj		27.2	-	-	1.2	71.6	-
Noakhali	Chatkhil		14.6	-	0.2	-	85.2	-

Source: **Report on the Thana Development Monitoring Project Vol. 1 Nov. 1991, BBS.**

TABLE 8.26

Percentage Distribution of Households by Type of Latrine

District	Thana	Sanitary	Katcha (Temporary)	Katcha (Permanent)	Unspecified (Open field)
Comilla	Burichang	12.4	35.6	22.6	29.4
Chandpur	Faridganj	9.6	29.8	55.4	5.2
Noakhali	Chatkhil	5.4	56.8	29.4	8.4

Source: **Report on the Thana Development Monitoring Project Vol. 1 Nov. 1991, BBS.**

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TABLE 8.27

Literacy Rate by Sex - 1981

Locality	Literacy Rate 1981 * Both Sexes	Male	Female	Literacy Rate 1991 ** Both Sexes
Brahmanbaria	17.9	23.9	11.6	19.13
Comilla	22.6	30.3	14.7	25.28
Chandpur	28.1	34.5	21.6	29.02
Feni	28.4	37.6	19.2	29.91
Lakshmipur	23.7	29.7	17.5	25.50
Noakhali	25.9	33.5	18.3	28.00
SE region	24.1	31.3	16.8	24.48
Bangladesh	23.8	31.0	16.0	24.82

Note: * Based on population 5 years and above.
** Based on population of all ages

Source: Bangladesh Population Census 1981, District Census Report.

TABLE 8.28

Education Level 1981

(%)

Education Level	Brahmanbaria M	Brahmanbaria F	Comilla M	Comilla F	Chandpur M	Chandpur F	Feni M	Feni F	Lakshmipur M	Lakshmipur F	Noakhali M	Noakhali F
No schooling	63.5	79.7	52.2	67.4	51.9	66.5	50.5	75.4	56.9	72.1	60.7	77.5
Class 1-5	21.1	19.3	24.5	20.8	28.2	25.6	27.4	18.1	26.4	23.3	23.8	17.5
Class 6-9	9.6	4.6	15.2	8.4	12.1	6.4	13.3	5.3	10.9	4.1	9.3	4.0
SSC/HSC	4.6	1.1	5.9	2.9	6.4	1.3	7.1	1.2	5.0	0.5	5.0	0.9
Degree and above	1.1	0.2	2.2	0.4	1.3	0.2	1.6	1.5	0.8	0.0	0.9	0.1

Source: District Census Report 1981, 1991 Figures are not available

Note:
- SSC = Secondary School Certificate
- HSC = Higher Secondary Certificate
- M = Male
- F = Female

TABLE 8.29

Level of Education 1990

Category	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noakhali
Currently Married Women						
Illiterate	66.1	49.8	46.0	47.5	49.7	43.8
Can write a letter	2.9	3.4	5.7	0.3	1.8	0.9
Madrasha	0.4	0.5	2.9	0.5	-	0.3
Primary	18.2	26.5	25.8	27.2	29.9	30.9
Secondary	10.5	15.7	16.8	19.6	15.4	20.8
College/University	1.9	4.0	2.7	5.3	3.2	3.1
Others	-	-	0.2	0.1	0.0	
Households of Currently Married Women						
Illiterate	49.5	37.5	36.2	32.0	42.2	30.5
Can write a letter	3.7	3.6	2.9	0.4	2.3	0.6
Madrasha	0.2	1.1	2.1	1.0	1.1	0.2
Primary	21.8	21.8	19.1	20.8	17.2	22.3
Secondary and above	16.9	36.4	26.8	27.9	26.6	46.2
Others	8.0	0.2	12.9	17.9	10.6	0.1

Source: **Hossain and Ahmed, 1990**

The Centre for Integrated Development for Asia and the Pacific (CIRDAP) conducted a study of 38 sample families in two villages in Kotwali (Comilla) upazila, and showed that the literacy rate was 73%. This is much higher than the national average, and even higher than that of Comilla upazila. The percentages of literacy among the males and females in the sample families were 82% and 63% respectively. Although the female literacy rate looks very impressive (50% were educated up to the primary level), those who have achieved Secondary School Certificate and above were only 4%, while the rate was 20% among males (Akhanda and Karim pp 54-55).

An almost identical situation was observed in the village studies conducted by other researchers in Comilla upazila (Quddus, Solaiman, and Karim 1984; Samad and Karim 1984, quoted in Akhanda and Karim). Two of the village studies conducted in five villages of Comilla upazila have documented the rural literacy rate to be about 60% (op cit). The reasons for the higher literacy rates in the sample villages probably relate to the better socio-economic condition of Comilla villages due to implementation of various development programmes by BARD since the 1960s and the proximity of Comilla town.

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8.4.9 Health and Family Planning

Despite many laudable achievements, health and family planning services lag behind policy targets. Previous plans in the health sector have endeavoured to provide essential health care, but reach only 40-50% of the entire population. In the family planning sector the current national contraceptive prevalence rate (CPR) is estimated to be slightly above 30%, compared with the target of 40% as at the end of the TFYP (1990). Over the years the provision of health and family planning services has been integrated and re-divided, complicating the delivery of an effective service. At present the services are administered separately but the situation is still in a process of change.

Health and family planning services at upazila level and below have two distinct features, the first being static service facilities and the second, domiciliary services.

The static services include an Thana Health Complex (THC) with 31 bed hospitals - 6 beds for maternal and child health and family planning (MCH-FP) - in each of the rural thanas. These THC hospitals provide indoor and outdoor patient care, some laboratory services, and training facilities for field workers in MCH-FP, and also act as first referral centres from union level service centres. The THCs also include family planning services. The professional staff comprise an Thana Health Officer, Thana Family Planning Officer (not a medical doctor), three specialized doctors in medicine, surgery and gynaecology, a dental surgeon, a Resident Medical Officer and two Medical Officers plus an additional Medical Officer (MCH-FP) from the Family Planning Department.

The domiciliary services are carried out through house-to-house visits by the basic health workers (Health Assistants - HA) and family planning workers (Family Welfare Assistants - FWA). Their jobs are somewhat overlapping, since they provide services for the same population.

The country has Primary Health Care (PHC) and MCH-FP services provided through three tiers:

(a) at village level through community outreach,
(b) at ward level through health posts with mid-level health and family planning, and
(c) at union level with the Union Health and Family Welfare Centre (UHFWC).

The THCs serve as back up service provision.

Immunization and other related programmes like the Expanded Nutritional Programme in Public Health, the Malaria Protection Programme and the Intensive Health Care Education Programme are operating in all thanas. There are rural dispensaries in the unions. At the district level there is one hospital in each district headquarters.

All these facilities are theoretically available to the whole rural population of Bangladesh. However, in many thanas the programmes do not function fully, whilst UHFWCs are still in the process of implementation. The situation regarding services is paradoxical. On the one hand services are not available for many people due to problems of physical accessibility, as well as the absence of doctors, since most doctors do not reside in the field. Hospitals and service centres do not have even the minimal requirements of medicine and equipment. On the other hand, such services as are available are not fully used, perhaps through people's lack of confidence, based upon experience. The quality of services is thus very variable within the region.

There are many NGOs providing health and MCH-FP services in the region, but with an urban or semi-urban bias. The rural population rarely uses private medical facilities as there are not enough available and their cost is too high.

The need for more development focus in rural health is clearly apparent.

8.4.10 The Role and Status of Women

An important requisite of a good development plan is to ensure the access of every member of society to the development process. For balanced socio-economic growth and development of the country, the optimum participation of women is a necessity. Women still tend to be seen as pre-occupied with the home, motherhood and domesticity, and dependent upon men for economic and other security. The circumstances of poverty, unemployment and economic uncertainty in which most women are struggling is far from the ideal.

Traditional attitudes of society towards the stereotyped roles of women limit their involvement in the development process. About 16% of women are literate compared with 31% of males. In higher education the difference is even wider. The female labour force, though increasing fast, is extremely small (Table 8.13). Historically also, women have been displaced from their traditional work in agriculture and cottage industries in the process of economic development and modernisation, and forced into marginal occupations based on low technology and labour intensive techniques of production, where labour is largely unorganised and non-monetised. According to BBS, women's participation in the non-agricultural sector is of the order of 18.7%. Such a low representation can be attributed to the traditional lower status of women in the family, and their minimal access to the holding and control of land and other resources.

Women play a significant role in household chores. Nevertheless, such contributions remained unaccounted for. This is probably because of the:

(a) difficulty in defining the 'labour force' in simple terms, as the boundary between economic and non-economic activity is blurred (a substantial proportion of economic activity is carried out by family enterprises in which both housewives and children participate, and the definition of 'dual' activities varies from census to census),

(b) considerable variation in the dates on which data are collected,

(c) differences in criteria for defining unemployed and economically inactive persons, and

(d) inaccuracies in reporting age and economic activity.

Most rural women who are not economically active outside the home are engaged in productive activities within it, ie rendering services and producing goods of high economic value, yet they fall under the general heading of unpaid family workers. When viewed as a potential resource, women are either mis-utilised or under-utilised, which deters their participation in the mainstream of development. Therefore, as a long term aspect of the planning process, the total integration of women is deemed essential to bring them into the purview of development activities through adequate exploitation of their skills and potentials.

To increase the participation of women in development activities, the government has made firm commitments to Women in Development (WID) programmes. Accordingly, the Ministry of Women's Affairs has been undertaking different activities to create a favourable atmosphere for the adequate involvement of women in social and economic development and policy formulation, and different sectors of various line ministries and NGOs are also initiating special projects for women in consonance with the objectives and principles of the UN Decade for Women.

Consequently the woman's role is changing fast. The main impact upon this changing pattern has however come from economic necessity. Poverty, landlessness, dowry, divorce and desertion and male out-migration have changed women from dependent, docile wives/daughters/mothers to secondary, and often the primary earners, of their households. Traditional gender divisions of labour, and 'purdah' values, are changing under economic pressure.

Data collected by the Agriculture Sector Review (ASR) "Women in Agriculture" census of 3 949 randomly selected households in 20 districts in different agro-ecological zones showed that 42.6% of women have agriculture as their primary occupation and 12.1% as their secondary occupation. The highest participation is from very small farm households (0.04-0.2 ha) followed by the landless. One third of women of small and medium size farm households are actively involved in homestead farming including horticulture, livestock rearing, goat rearing, poultry and birdkeeping. Women in female-headed households (15% of all rural households) and small and marginal farm households are heavily involved in agricultural activities directly. Women's role in direct crop production decreases with increasing size of farm household. In farm households with 1 ha and over, women are more involved in pre- and post-harvesting activities than in crop production.

Crop processing is primarily the responsibility of women. More than half of the paddy and almost all pulses, chillies and other spices are retained and processed by women at home. However, women's work in home-based rice processing has decreased due to the introduction of mechanised milling. Recently women have started to move into some male spheres of agriculture, such as transplanting, sowing, weeding and harvesting. In the south east region, this is not yet so common, although one does occasionally see groups of women working in the fields.

Women will become active in field crop production out of economic need, given the opportunity. This type of participation will be related to the kind of crops, the nature of work, the intensity of labour, the level of mechanisation, women's access to land resource etc and some socio-demographic factors such social class, age, parental ties, absence of male members in the family, lack of other job opportunities and cultural attitudes.

In areas where there is male unemployment it is more difficult for women to find work. Widows, divorcees or deserted women, and the wives of the landless, may find work such as road maintenance under CARE on the Food for Work programme. Opportunities for industrial and off-farm jobs for women are otherwise limited in the region.

A true development approach should recognize all these issues and identify strategies to utilise all potential resources to reach the objective of poverty alleviation, and should focus on equity and the sustainable development of women through their involvement in projects.

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The particular impacts upon women of FCDI schemes have been studied by FAP 12 (FCDI Agriculture Study). Conditions within a range of schemes (impacted areas) were compared with those prevailing in similar areas outside the project (control areas), leading to the following conclusions:

"- in no case is there an unambiguous increase or decrease of any activity either in the impacted or the control area, which probably reflects the socio-economic differentiation that exists among women;

- in seed preservation comparatively more women have experienced an increased work load in both impacted and control areas, but more so in the former;

- in the case of parboiling and storage, both in the impacted and control areas the proportion of women claiming an increased work load is lower than those claiming a reduction, but the proportion claiming an increase is again higher in the impacted areas compared to the control areas;

- in the case of husking, the majority of women have indicated a lower work burden in both impacted and control areas but the proportion of women claiming a decrease is somewhat lower in the impacted areas;

- although women are generally not involved in pre-harvest operations it is interesting to note that, among those who have reported a change, most have indicated an increase in the women's work.

In none of the above cases, except for storage, is there a statistical difference in the response of women between the impacted and control areas.

The overall conclusion that one may draw here is that in the impacted areas, because of higher production compared to the control area, the work load of women has increased, particularly in activities where women play the major role. However, none of these differences are yet pronounced as the changes are not uni-directional across all households". (FAP 12 Draft Final Report Volume 1, December 1991).

8.4.11 Conclusion

From the foregoing, the needs of the region are apparent. As elsewhere in Bangladesh, the population is mainly rural and a great majority of households is still depending on agriculture to earn a significant part of their living. Agriculture is the main source of employment, providing either self-employment for those who hold land (farmers) or wages employment for others (daily labour), and is the key economic sector of the region.

In order to cope with the ever increasing rural population and land pressure, resulting in a regular decrease in the land/man ratio and in the average farm size, which is indeed very low in the region as compared to the national average (cf. Table 8.17), the development efforts in the region should primarily be aimed at developing agriculture production. Increase of cropping patterns and yields will have positive effects on a wide array of households, including those who have farm holdings, and those who are primarily depending on the availability of wage paid agriculture employment for their living.

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To accelerate the growth of agriculture GDP in the region, a comprehensive multi-component strategy has to be designed which involves the following aspects:

- development of a better access to water during the dry season (extension of irrigated areas);
- provision of a better protection against flooding;
- land reclamation in the coastal parts of the region;
- development of institutional services support to farmers (training, extension and credit);
- improvement of the marketing channels for the supply of agriculture inputs such as fertilizers and pesticides.

However, if the growth of agriculture sector is vital to the development of Bangladesh, it has to be emphasized that the growth of non-farm sectors is badly needed to diversify the economy and to absorb the rapidly increasing rural labour force surplus as well. This would mean, in the context of the southeast region, that development efforts should also be placed on promoting and supporting the emergence and growth of non-farming activities in rural areas.

As a whole, the central issue for the future is linked with accelerating capital formation in rural areas which is badly needed to generate economic growth. In this regard, public investment is required to develop rural infrastructure such as electricity, roads, flood control and irrigation structure, markets, waterways and harbours, and should be considered as a pre-requisite to private investment in both agriculture and non-agriculture activities.

Moreover, as noticed in a recent BIDS study ("rethinking rural poverty, a case for Bangladesh, 1992) the development of infrastructure is not only warranted on economic grounds and bears outstanding significance as far as poverty alleviation is concerned. In this study, it was observed that the proportion of population living in extreme poverty was significantly lower (by around 50%) in areas with good irrigation, electricity and transport facilities. Other findings of this study indicates that:

- the spread of new technology in agriculture has considerable effect on increasing rural income;
- the development of rural infrastructure has a very high poverty alleviating effect;
- the promotion of non-farm activities is also bearing strong poverty alleviating effects;
- the spread of education tends to have significant impact on increasing rural incomes and thus on reducing poverty.

In order to contribute to the socio-economic development of the region, meaning to both economic growth and poverty alleviation, the South East Water Resource Development Programme should be designed with the following objectives:

- to enable a simultaneous growth of the agriculture and fisheries GDP;
- to support the development of water related rural infrastructure including irrigation, flood control, water supply and sanitation;
- to encourage public and private investment in both agriculture and non-agriculture sectors;
- to promote participation of the poor in the construction and maintenance of the infrastructure through appropriate institutional settings (such as SRP);

The SERWRDP is not expected to tackle all the social issues at stake in rural areas. In particular, the needs for specific human development programme, including education, health, family planning, income transfer for poverty alleviation and social services to the poor and destitute, though very much acute, are far extending beyond the scope of the plan and cannot be addressed in the sole framework of water resources development planning.

Though the regional plan is expected to make a positive contribution to poverty alleviation efforts, it will have very marginal impact on the most vulnerable segment of the rural poor, those who are trapped in har-core poverty. Because they are usually left out of the routinised market process, lacking land as well as other assets, the scope for their increased self-employment and employment through both GOs and NGOs programmes is extremely limited. Without owning any assets to give as collaterals, or having the capacity to develop personal attachment to prospective patrons, they are deprived of the benefits of both institutional and informal credit markets. Persisting as a floating underclass social group, it is difficult to project nay growth-induced trickledown programme for this population, and specific social security programmes designed specifically to target these populations are required.

CHAPTER 9

INSTITUTIONS

9.1 Introduction

Water Resources Development does not merely consist of projects but involves many government agencies and the whole of society in rural Bangladesh, for example Flood control, drainage and irrigation projects affect the local infrastructure, health and agriculture including livestock and fisheries. Major projects have to be approved by central government but successful implementation involves many ministries, local government and the community. At present major water development projects are the responsibility of the Bangladesh Water Development Board, (BWDB), but small irrigation schemes, (less than 1 000 ha) are undertaken by the Local Government Engineering Bureau and agricultural extension is the responsibility of the Ministry of Agriculture as is minor irrigation.

For any intervention it is important to involve the local community and this cannot be done merely through civil servants and locally elected committee members, it is also important to seek the support of other groups which may not be represented, this is particularly the case where a large proportion of the population in illiterate. One way to contact local people is through non-government organisations (NGO); these organisations may also be of great assistance at implementation and in operation and maintenance of schemes.

This Chapter aims to explain the roles of the most important institutions and put them into context.

9.1.1 National Institutions

Figure 9.1 shows the various ministries and agencies involved in water resources development, only the most relevant are described below.

9.1.2 National Water Council

The National Water Council (NWC) is headed by the Prime Minister and is responsible for overall policy guidance for water resources development planning.

9.1.3 National Flood Council

The National Flood Council (NFC), has two committees a Technical Committee and an Implementation Committee. The Technical Committee is headed by the Prime Minister and composed of selected Ministers. The Chairman of the Implementation Committee is the Secretary of the Ministry of Irrigation and Flood Control.

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Figure 9.1

Ministries With Direct Water Resources Interest

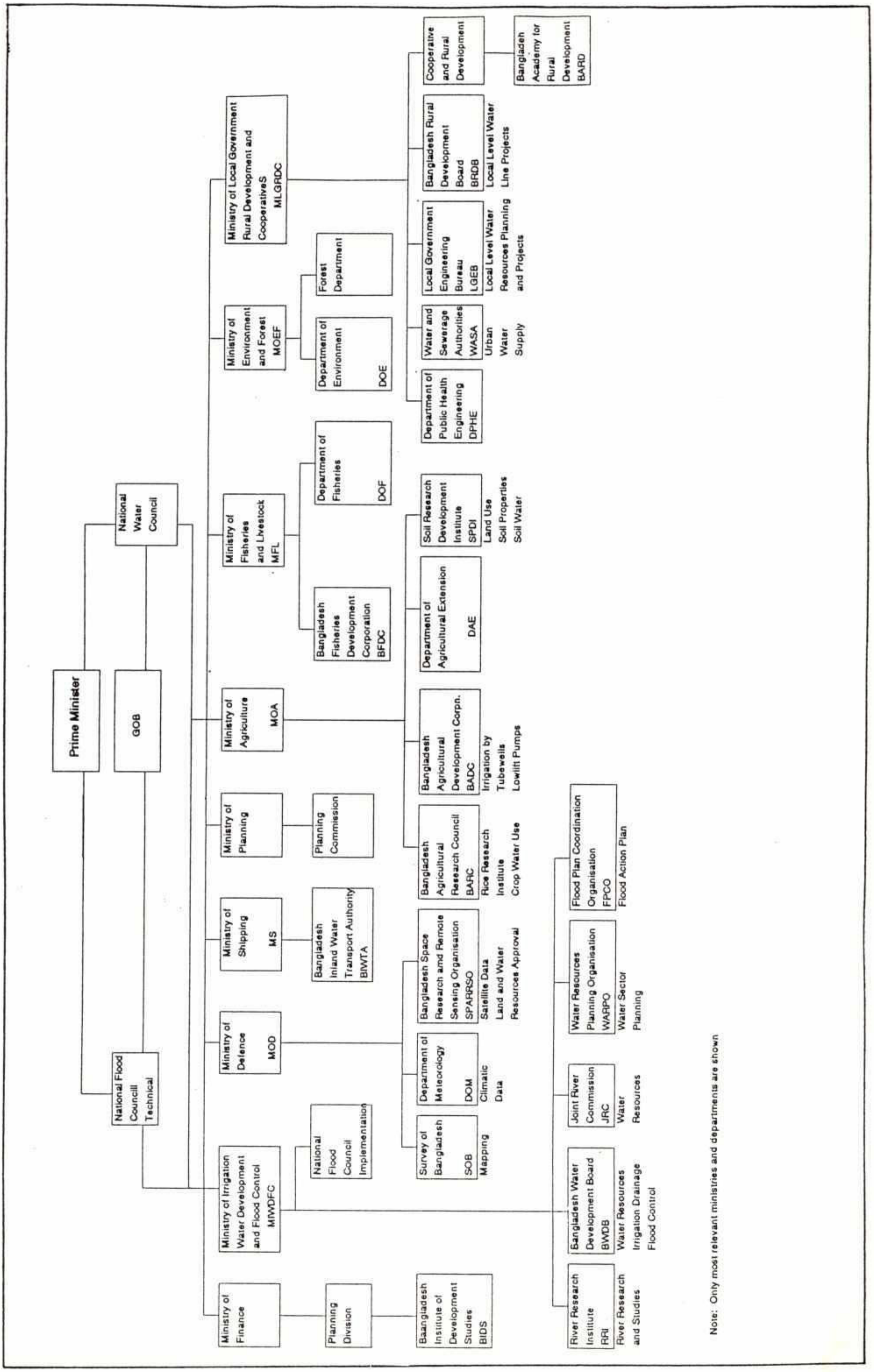
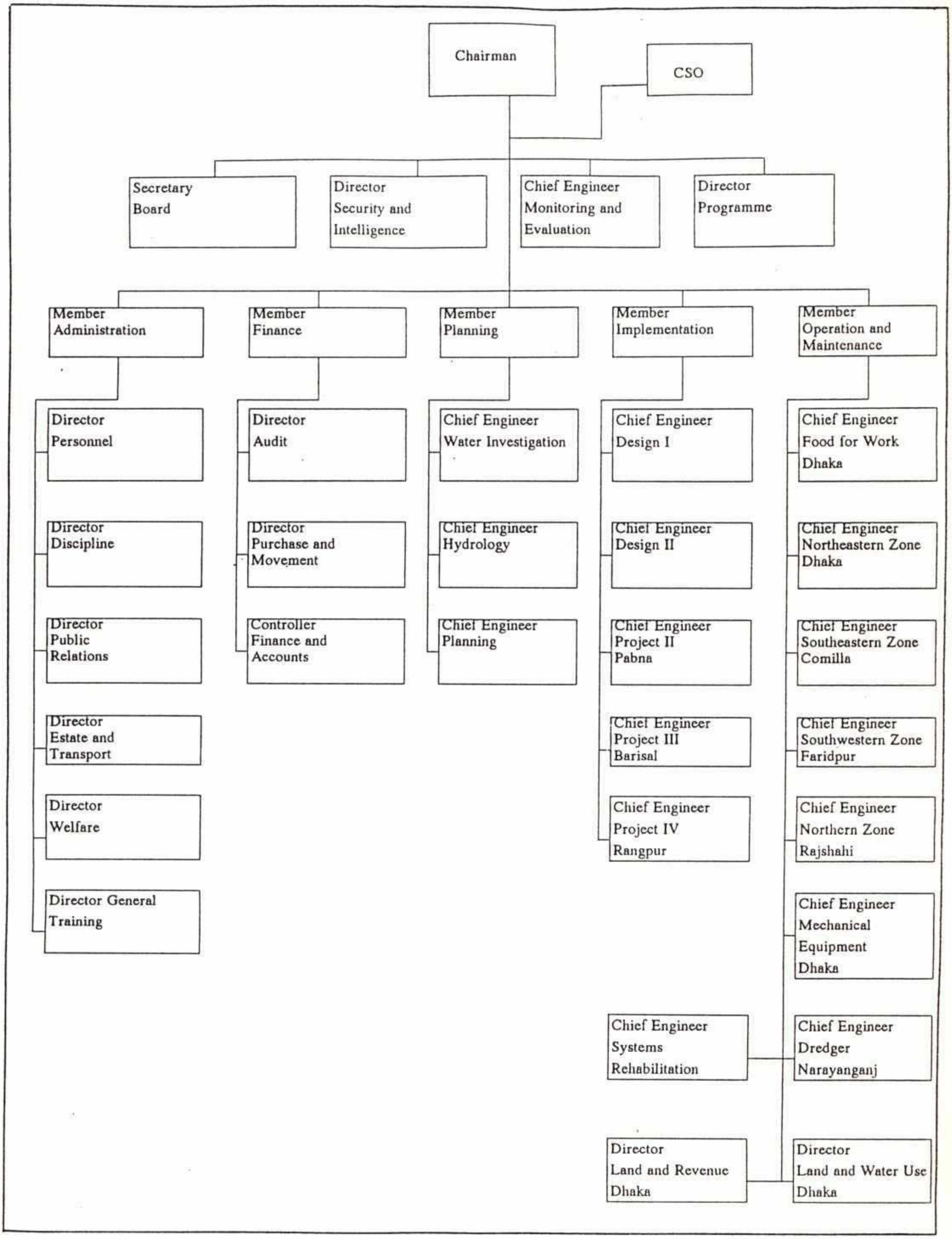


Figure 9.2

Organogram - Bangladesh Water Development Board



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9.1.4 Planning Commission

The Bangladesh Planning Commission comes under the Ministry of Planning. The Planning Commission has a three fold involvement in development planning; advisory, executive and co-ordination. The Ministry of Planning has to approve all projects costing up to Tk 60 million and all feasibility studies. Projects costing more than Tk 60 million must also be approved by the Executive Committee of the National Economic Council, (ECNEC).

9.1.5 Ministry of Irrigation, Water Development and Flood Control

The Ministry is responsible for the assessment of water resources, and for implementation of major projects covering flood control, drainage and major irrigation schemes. The ministry supervises five agencies: the Joint River Commission (JRC), the Water Resources Planning Organization (WRPO), formerly the Master Plan Organization (MPO), the Bangladesh Water Development Board (BWDB), the Flood Plan Coordination Organization (FPCO), and the River Research Institute.

(a) Water Resources Planning Organization

The Government created the Master Plan Organization (MPO) in 1982/83 to develop a comprehensive National Water Plan (NWP) covering the period 1985-2005. A second phase of the development planning was initiated in December 1988. The objectives of the NWP Project Phase II were:

- to develop a viable capability for planning water resources development;
- to produce an updated and upgraded NWP; and
- to plan development of water resources during the FFYP.

In 1991 at the culmination of NWP Phase II, the name of the MPO was changed to Water Resources Planning Organisation (WRPO) and the organisation was to have a permanent role within government.

(b) Bangladesh Water Development Board

The BWDB was assigned functions and responsibilities which may be summarised as follows:

- schemes for the control of floods and the development and use of water resources including:
    - construction of dams, barrages, reservoirs;
    - flood control, or
    - drainage, and
    - maintenance, improvements, and extension of channels;

Ministries with direct water resources interest are shown in Figure 9.1, the organisation of the BWDB is shown in Figure 9.2 and that of the Chief Engineer, South Eastern zone is shown in Figure 9.3. Formerly the Executive Engineers for Chandpur O&M Division and Muhuri O&M Division, were responsible for agricultural extension in their respective irrigation projects. This responsibility has now been transferred to the Department of Agricultural Extension, although BWDB still employ some staff in this sector.

(c) **Flood Plan Co-ordination Organization**

The Flood Plan Co-ordination Organization (FPCO) is an independent unit which co-ordinates and manages the FAP, MPO, River Research Institute, and other Ministries and organisations concerned with the FAP.

9.1.6 Ministry of Agriculture

Department of Agricultural Extension

The functions of the Department of Agricultural Extension (DAE) are as follows:

- to motivate and help farmers adopt improved production practices;
- to develop self-reliance and co-operation by training local leadership for organised group action;
- to provide efficient linkage between the various research institutions and the farmers;
- to serve as liaison agency between farmers and other organisations, both public and private concerned with overall socio-economic development of rural people;
- to help promote storage and fair price for farm produce.

The institutional foci for the management of the extension services are the Block (Union), Unit (Thana), Zone (District) and the Headquarters (National level). The line functions over the field extension services are exercised by the Field Services Division of DAE. The organisation chart is shown in Figure 9.4.

The following staff are attached to all thanas:

- Thana Agricultural Officer
- Additional Thana Agricultural Officer
- Subject Matter Officer
- Assistant Agricultural Extension Officer
- Junior Agricultural Extension Officer
- Plant Protection Inspector

Figure 9.3

BWDB Organogram of South-Eastern Zone

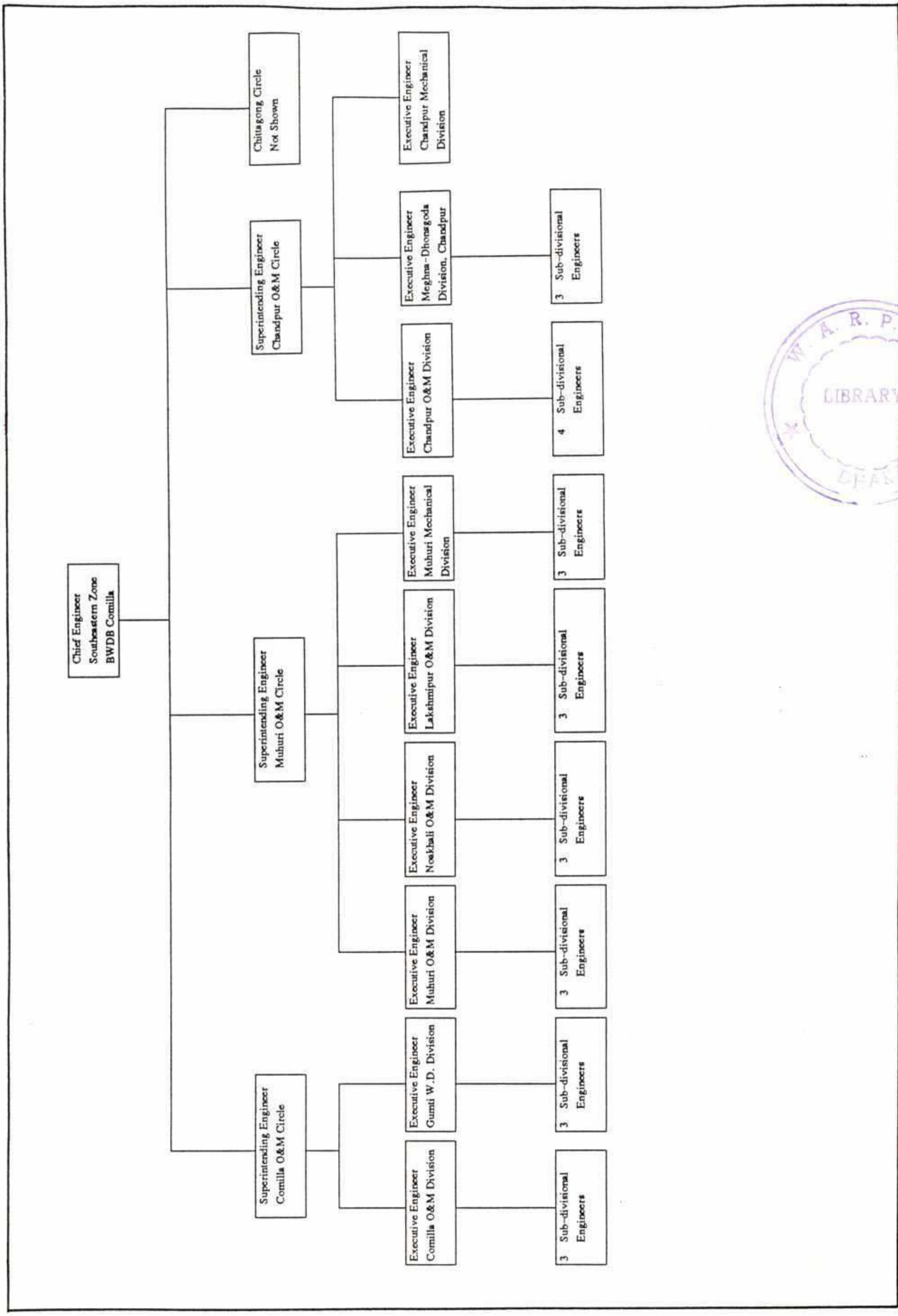
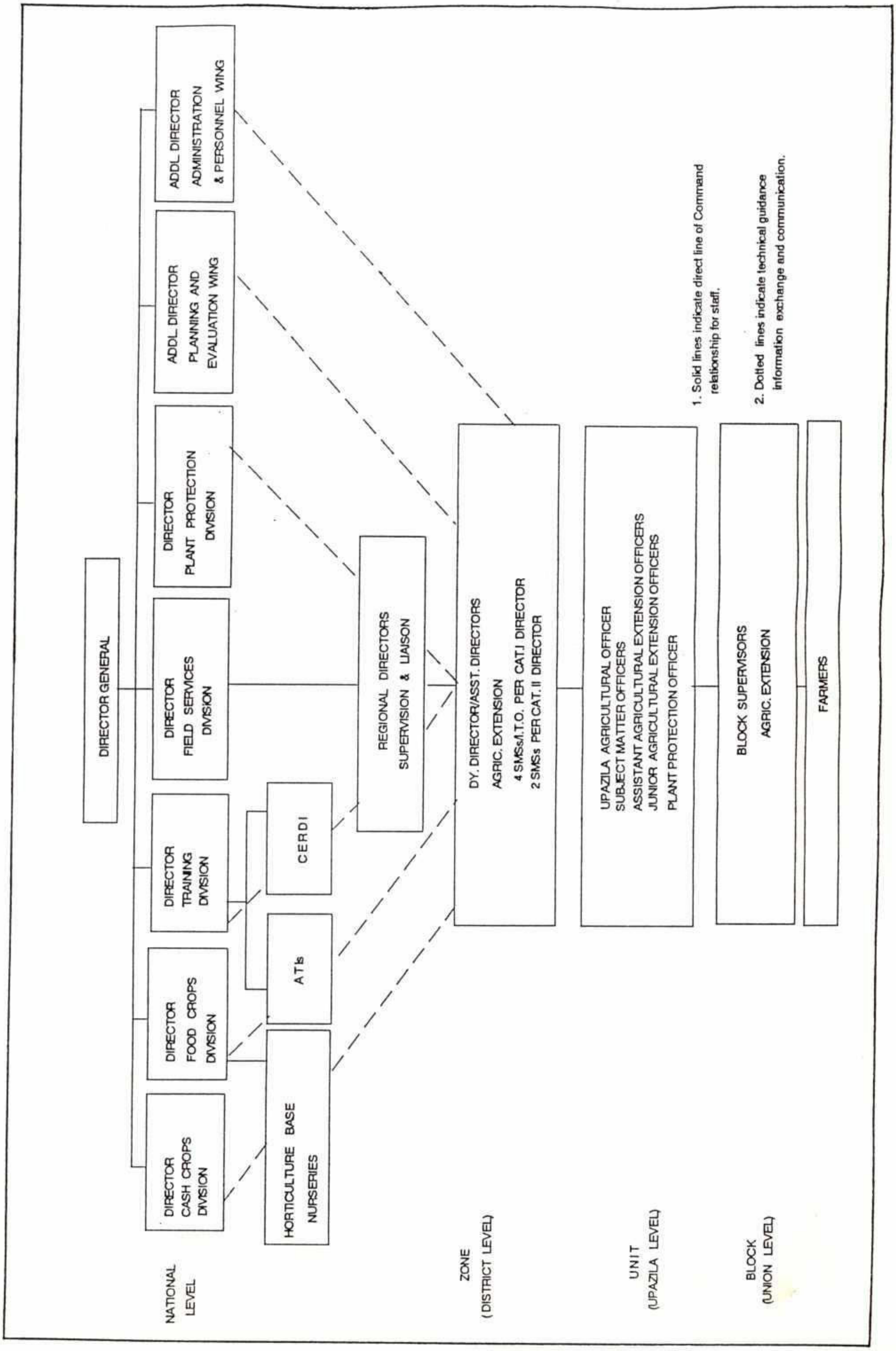


Figure 9.4

Organization Chart - Department of Agricultural Extension



At the Block (Union) level there is a Block Supervisor (BS) who provides extension services to farmers or groups of farmers. A Block Supervisor covers 600 to 1 200 farm families (an overall average of 900) depending upon the intensity of agriculture in a given area.

In the extension service, the farmers are oriented with Intensive Crop Production Programme (ICPP), in which the "Package Technology" is given to the farmers through use of improved seeds with emphasis on HYV, balanced fertiliser application; efficient and economic use of irrigation water, adoption of pest and disease control measures. There are three intensive crop production programmes. Intensive Transplanted Aman Programme (ITAP), Intensive Rabi Crop Production Programme (IRCP) and Intensive Aus Production Programme (IAPP). There has also been a programme for jute. The total staff strength (professional and sub-professional) of DAE is about 23 000 including those involved in service and regulatory functions.

Bangladesh Agricultural Development Corporation

The Bangladesh Agricultural Development Corporation (BADC) was established in 1961 to promote the use of modern agricultural inputs among farmers. Section 13 of its Ordinance sets forth the function of the corporation:

The Corporation shall (inter alia):

- make suitable arrangements on a commercial basis for the procurement, transport, storage and distribution to agriculturalists of essential supplies such as seed, fertiliser, pesticides and agricultural machinery and implements;
- promote the setting up of co-operative societies with a view to handing over the supply function;
- encourage the development of co-operatives in other spheres.

The corporation may (inter alia):

- organise the supply, maintenance and operation of low-lift pumps and set up workshops for repairs;
- encourage the expansion and improvement of industries for the manufacture of diesel engines used in agriculture;
- make arrangements for servicing machinery; and
- provide and maintain transport facilities and assist other public or private agencies to provide such facilities for the use of the corporation.

The BADC has established a Unit Office in each thana for the supply of irrigation equipment, fuel and lubricants. In every thana, there is a BADC go-down for storage of irrigation equipment, seeds and fertilisers and a team of mechanics provides maintenance services to farmers. The distribution of seeds and fertilisers is done through private wholesale and retail traders. However, as the agricultural inputs and services develop, many of BADC functions are being transferred to the private sector. BADC is no longer the sole supplier of all recurrent agricultural inputs including the procurement and marketing of fertilisers, promotion of new irrigation technologies and the production and distribution of improved seeds. It no longer monopolizes the sale and servicing of low lift pumps (LLP) and Shallow tubewells (STW) and has sold virtually all of the previously rented LLP and STW. Its main function is now the installation, operation and maintenance of Deep tubewells (DTW). There are approximately 24 000 DTW installed throughout Bangladesh and the process of turning these over to the private sector has already commenced.

9.1.7 Ministry of Local Government Rural Development and Co-operatives (MLGRDC)

Local Government Engineering Bureau (LGEB)

The Local Government Engineering Bureau (LGEB) provides technical support primarily to zila parishads and thana parishads. Zila and thana engineers are primarily concerned with roads, cross drainage structures and market developments but some water resources scheme are also undertaken in the construction, operation and maintenance of local civil infrastructure. In addition to their responsibilities to local water control facilities such as embankments and their appurtenant structures, the responsibilities of the bureau also extends to schemes transferred from the jurisdiction of BWDB to LGEB.

Bangladesh Rural Development Board (BRDB)

The BRDB is the main government agency in charge of social and socio-economic aspects of rural development. It is also involved in the assistance to the rural poor and landless.

The BRDB is responsible for the supervision of Krishi Sambaya Samity (KSS) groups, farmers' cooperative and assisting and guiding Thana Central Cooperative Associations (TCCA). This involves:

- co-ordinating with concerned governmental organisations for mobilizing supplies, services and support for KSS and TCCA; including channelling institutional credit to KSS-TCCA organisations, while encouraging the accumulation of shares and savings by KSS members;
- promotion of intensive agriculture by farmers, particularly through the use of mechanised facilities and surface water, including liaison with BADC;
- provision of appropriate training to KSS managers, model farmers and other members to increase the technical and management skills;
- encouraging TCCA to expand their activities to include marketing the inputs and products of KSS groups and to diversifying into other kinds of business ventures.

The BRDB operates at three levels with a board of directors based in Dhaka, a deputy director based in each district and a Rural Development Officer and Assistant Rural Development Officer attached to each TCCA.

9.1.8 Ministry of Fisheries and Livestock

Within the Ministry of Fisheries and Livestock (MOFL) is the Department of Fisheries (DOF), which is represented at district and thana levels. Other agencies of the Ministry are the Bangladesh Fisheries Development Corporation (BFDC), a parastatal fish marketing organisation, and the Fisheries Research Institute (FRI).

Department of Fisheries

The DOF is the principal organisation responsible for fisheries development and management with marine and inland wings in four administrative divisions with a staff of over 2 500 individuals. In each thana, there should be one Thana Fishery Officer (TFO) assisted by two field assistants.

Besides the above, the DOF has following institutions in the study area:

- Raipur Fishery and Training Centre;
- Fisheries Training Institute at Chandpur;
- Freshwater Fisheries Research Station, Chandpur;
- Fisheries Technological Laboratory at Chandpur;
- Noakhali Integrated Rural Development Project, fisheries component (DANIDA).

9.2 Local Government

9.2.1 Districts

Local Government is regulated by the Ministry of Local Government, Rural Development and Co-operatives. One of the main units of local government used to be the districts, of which the Districts of Comilla and Noakhali covered almost the whole of the study area. These have now been replaced by smaller units called zilas of which there are six in the study area, namely Brahmanbaria, Comilla, Chandpur, Lakshmipur, Noakhali and Feni although parts of Noakhali and Feni are outside the area. The study area also includes a part of Madhupur thana which lies in Habiganj district. The old districts are referred to as Greater Comilla and Greater Noakhali. The districts have now only minor importance the power having been transferred to the thana, but in case of staff shortages the district officer may have to take the part of the thana officer when the latter post is vacant.

9.2.2 Thana Parishads

Thanas generally cover an area of between 150 and 400 km^2 and a typical population is about 250 000. The Thana Chairman used to be directly elected but in November 1991 the government published a decree delegating the Chairman's powers to the senior local government officer, the Thana Nirbahi Officer. The organogram of an thana office is given in Figure 9.5. The thana Parishad is highly influential in all decision making related to rural development; members of the parishad are frequently related in some from or other to the rural elite. The delegation of powers to the thana level is part of a policy to decentralise, these responsibilities are summarised below:

Responsibilities

Thana parishads have also been given the following responsibilities by the government :

- Preparation of all thana level development programmes/projects
- Implementation and evaluation of all development programmes projects

Figure 9.5

Organogram of Thana Parishad

Thana Nirbahi Officer (TNO)

- Thana Health & Family Welfare Officer
- Thana Agriculture Officer
- Thana Engineer
- Thana Livestock Officer
- Thana Fishery Officer
- Thana Education Officer
- Thana Co–operative Officer
- Thana Social Welfare Officer
- Thana BRDB Officer
- Assistant Commissioner (Land Revenue)
- Officer–in–Charge, Police/ Station/Thana of the UP

- Rural water supply and sanitation
- Rural construction work
- Food for Works
- Natural calamity relief
- Co–operative and co–operative based rural development
- Fishery development
- Livestock development
- Social welfare service

- Preparation of thana development projects based on development projects prepared by and for the union parishad, within the thana
- Providing help and encouragement to the activities of the Union Parishad (UP)
- Advancement of health, family planning and family welfare programmes
- Looking after the environment management work
- Training for thana chairman, members and secretaries
- Implementation of government policies and programmes in the union parishad
- Supervision, management and co-ordination of deputed officers to union parishad
- Strengthening social and recreation activities
- Encouragement of employment generation/programmes
- Extension and expansion of co-operative movement in the union parishad
- Helping zila parishad (district) in development programmes
- Planning and extension of all construction work in the UP
- Strengthening agricultural activities for increased production
- Expansion of educational and skilled jobs
- Development of livestock, fishery and forest resources
- Implementation of other programmes/tasks assigned by the government

As stated earlier, union parishad are responsible for many of the functions assigned to thana parishads, but to a limited extent, and only within their respective jurisdiction; UPs also have a supervisory and implementing responsibilities for projects approved by the thana parishad.

Sources of funding

The Thana Development Fund consists of the following:

- Development assistance fund provided by the national government through the Annual Development Plan (ADP)
- Revenue surplus of the thana parishads
- Local contribution
- Funds available from other sources for undertaking development.

An evaluation of the development activities undertaken by the thana parishads in the FFYP states that:

- Most thana parishads undertook too many schemes (50-80 per thana, on average) with the limited funds most of such schemes were not viable and physically sound
- There is a propensity to distribute the annual grant union-wise regardless of the merit of such investments or priorities
- There is a bias towards civil works notably to buildings, roads, bridges, culverts and supply of furniture
- There has been a concentration of investment around the thana headquarters
- Co-ordination with national projects/programmes have been inadequate both at the stages of project preparation as well as implementation

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- The technical expertise of the deputed personnel in areas like agriculture, forestry, fisheries, livestock, irrigation and physical infrastructures were not properly used
- The effort of the thana parishads to mobilise local resources for financing a part of their development programmes has not been perceptible
- The thana parishads do not have properly prepared five year plans

9.2.3 Union Parishads

The unions are the divisions of rural areas (villages) within the police jurisdiction of a thana (thana). A Union Parishad is constituted by a chairman, nine elected members and three women from each ward nominated by the responsible thana parishad.

The civic functions of the union parishads include:

- implementation of development schemes in agriculture, irrigation and flood protection
- protection and maintenance of public property such as roads and bridges, canals and embankments.

9.3 Rural Development Organizations

9.3.1 Farmer Co-operative Society/Krishak Samabaya Samity (KSS)

Krishak Samabaya Samity (KSS) are village based farmers' groups, the membership of which comprises farmers with land holdings of more than 0.2 ha. These groups are formed into co-operative societies to derive benefits from large scale operations by organizing joint services, input supplies and output marketing through collective strength and bargaining power; KSS groups are able to secure cheap institutional credit and are provided with regular training by official of various government departments involved in rural development. Their ultimate goal is self-reliance in terms of their own funds and management capabilities.

The key objectives of the KSS groups are to:

- increase crop production and yield levels;
- expand irrigation;
- organize the mechanization of irrigation.

Individual KSS groups elect a management committee consisting of six to twelve members, including a chairman, vice-chairman and secretary/manager.

9.3.2 Thana Central Co-operative Association

Thana Central Co-operative Association (TCCA) have been established as a central institution in individual thanas to co-ordinate, support and supervise the activities of the village based primary societies (KSS). Their main functions are to:

- train and educate KSS members in new skills, attitudes and motivations necessary to successfully attain the goals of the KSS; particular emphasis being placed on developing leadership and management skills;

- organise procurement and supervise the distribution of production inputs and services (e.g. fertiliser, credit, irrigation equipment);
- assist with the marketing of outputs;
- provide servicing centers for repair and maintenance of machinery operated by KSS groups;
- operate central co-operative banks owned and managed by the KSS members.

A TCCA has an elected management committee of 12 directors, inclusive of a chairman and vice-chairman.

9.4 Non-government Organizations

Non-government Organisations (NGO) play a significant part in the country in all aspects of community life, and are both national and international. Figure 9.6 lists the NGOs working in the area, the thana codes are listed in Table 9.1. The table indicates that there are 12 thanas with no major NGO operating. The data has to be looked at with care, for example it is known that the Mennonite Central Committee (MCC) and DANIDA both work outside the thanas shown whilst Figure 9.6 indicates that Comilla Proshikha Centre for Development covers an extensive area and nearly all the topics registered. Table 9.2 gives the main spheres of activity of the larger NGOs in the area.

A brief summary of these NGOs is given below:

DANIDA

DANIDA is the Danish government aid organisation and in 1978 it started the funding of the Noakhali Integrated Rural Development Project. In 1984 this became the Noakhali Rural Development Project (NRDP). It is due to close in June 1992. The objectives are to promote economic growth and social progress, in particular aiming at the poorer segments of the population including women. The project is active in all thanas of Lakshmipur, Noakhali and Feni Districts and works through and with government organisations. Main activities include:

- Irrigation and drainage
- Agricultural extension
- Cooperative agricultural marketing
- Cooperative training
- Cooperative credit
- Development of Cottage Industries
- Pisciculture
- Livestock (animal nutrition and health)
- Health nutrition and family planning and
- Mass education (literacy of adults and children)

The project has trained more than 3 000 health workers and field workers to the estimated benefit of more than 20 000 farmers, fishermen etc.

Figure 9.6

NGOs Working in South-East Region

NGO	District and Upazila Code (WRPO)																									
	Brahmanbaria			Comilla									Chandpur			Lakshmipur				Noakhali					Feni	
	362	437	87	345	88	130	90	94	53	271	287	111	312	225	194	411	405	288	413	102	58	445	459	116	465	161
International Development Enterprises	■	■																								
Comilla Proshikha Centre for Development	■	■	■	■	■	■	■	■	■			■		■					■							
Save the Children - USA	■																									
Enfants du Monde (EDM)		■		■		■	■									■				■						
PROSHIKHA - MUK				■															■		■					
NIBEDITA			■																							
DISHARI SANGSHAD			■															■	■				■	■		
Grameen Unnayan Kendra			■																							
Concerned on National Problems (CONP)			■																							
Consumers' Association of Bangladesh (CAB)			■																							
Bangladesh Rural Advancement Committee (BRAC)			■										■													
UJJIBON			■																							
Gana Kalayan Kendra	■																									
Anirban Sangsad		■																								
Juba Unnayan Samaj Sheba Samity		■																								
DAKUB					■																					
Palli Unnayan Sangstha							■																			
BAMANE								■																		
NIJERA KORI													■						■							
Sheba Manabik Unnayan Kendra										■	■															
Ansar Ali Memorial Vocational Institute										■																
Kotwali Thana Central Cooperative Association (KTCCA)										■																
Rural Development Foundation (RDF)											■															
Shajeda Palli Sangstha and Palli Unnayan Kendra												■														
Bangladesh Association for Community Education (BACE)													■													
Malerhat Juba Shangha															■											
Chandpur Atma Nibedita Mohila Sangstha																										
CARITAS Bangladesh															■											
SHOPIRET																■		■								
Action-Aid-Bangladesh																■										
Miraj Samaj Kallayyan Sangstha																	■									
CODEC (Community Development Centre)																		■	■							
Mennonite Central Committee (MCC)											■						■	■					■	■		■
MEP (Mass Education Programme)																			■							
Gandhi Asram																				■	■					
DANIDA (Danish Aid)																■	■	■	■	■	■	■	■	■	■	■
Bangladesh Association for Voluntary Sterilization (BAVS)																					■	■				
BONDHON																										
Society for Economic and Basic Advancement (SEBA)																									■	■

Note: Upazila codes are listed in Table 3.1
Upazilas with no NGO omitted from this Table

TABLE 9.1

Thana Codes

District	Thana Name	WRPO thana code ref.	NGO working in thana
Habiganj	Madhabpur	302	N/A
Brahmanbaria	Nasirnagar	362	Yes
	Sarail	437	Yes
	Brahmanbaria	87	Yes
	Ashuganj	14	No
	Bancharampur	42	No
	Nabinagar	345	Yes
	Kasba	249	No
	Akhaura	6	No
Comilla	Homna	204	No
	Muradnagar	343	No
	Bramanpara	88	Yes
	Daudkandi	125	No
	Debidwar	130	Yes
	Burichang	90	Yes
	Chandina	94	Yes
	Barura	53	Yes
	Kotwali Comilla	271	Yes
	Laksham	287	Yes
	Chouddagram	111	Yes
	Nangolkot	356	No
Chandpur	Matlab	312	Yes
	Kachua	225	Yes
	Chandpur	96	No
	Hajiganj	195	No
	Shahrasti	447	No
	Faridganj	155	No
	Haimchar	194	Yes
Lakshmipur	Ramganj	411	Yes
	Raipur	405	Yes
	Lakshmipur	288	Yes
	Ramgati	413	Yes
Noakhali	Chatkhil	102	Yes
	Begumganj	58	Yes
	Senbag	445	Yes
	Sudharam	459	Yes
	Companiganj	116	Yes
Feni	Daganbhuiyan	120	Yes
	Sonagazi	465	Yes
	Feni	161	Yes

TABLE 9.2

NGOs With Wide Coverage in the South East Region

Programme Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
NGO																				
Comilla Proshikha Centre for Development	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes				
Enfants du Monde (EDM)	Yes				Yes	Yes					Yes	Yes				Yes	Yes	Yes		
PRASHIKHA – MUK	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Yes	Yes	Yes	Yes		
NIBEDITA	Yes	Yes	Yes		Yes	Yes	Yes	Yes		Yes						Yes	Yes			
DISHARI SANGSHAD	Yes	Yes						Yes										Yes		
SHOPIRET						Yes				Yes	Yes					Yes				
CODEC (Community Development Centre)	Yes	Yes	Yes		Yes	Yes														
Mennonite Central Committee (MCC)				Yes	Yes			Yes								Yes		Yes	Yes	Yes
Gandhi Asram	Yes	Yes	Yes		Yes	Yes	Yes	Yes									Yes			
Bangladesh Association for Voluntary Sterilization (BAVS)						Yes														

Coding

Code	Programme	Code	Programme
A	Group Formation	L	Mass Communication
B	Functional/Adult Education	M	Housing
C	Children's Educaiton	N	Social – Forestry
D	School Education	O	Research & Evaluation
E	Training	P	Health/Water & Sanitation
F	MCH & Family Planning, PHC/CSP	Q	Handicrafts & Rural Enterprises
G	Women's Development	R	Job Creation
H	Agriculture Development	S	Food for Work
I	Pisciculture	T	Emergency Relief
J	Poultry & Livestock		
K	Credit		

Mennonite Central Committee (MCC)

Maijdee Court is one of the two major centres of MCC work in the country. MCC is renowned for its promotion of soya bean as a crop but other works include:

Agriculture Development

- Extension and rural savings
- Provision of vegetable seeds and irrigation pumps
- Development of horticulture and poultry keeping
- Training

Job Creation

- Cottage industries for paper making, rope making, coconut drying etc.
- Food Product Development
- Food Marketing
- Education, scholarships, books, etc.
- Health and nutrition including installation of tubewells and latrines
- Food for Works - particularly reexcavation of ponds for lease to cooperatives of landless people
- Emergency relief and rehabilitation.

9.5 Conclusions

Any major water resources development in the area is likely to be implemented by BWDB but from the previous sections it is clear that there are major tasks for MOA (BADC and DAE) and MFL. There will also be a considerable role for local government and such bodies as co-operatives. Finally it is important to consult with all people who are possibly affected by the project and in this respect the NGOs may be of considerable assistance.

There may be many different types of development but not all will follow the same format, each must be formulated according to its specific requirements but the most significant features described above must be taken into account when looking at projects and programmes. These issues are discussed further in Chapter 10.

CHAPTER 10

DEVELOPMENT ISSUES

10.1 Introduction

The previous chapters of this volume have described the present situation of the South East Region in terms of the human and physical resources, existing infrastructure and the problems which exist in terms of water resources development. This chapter seeks to set these scenarios in context in terms of other forthcoming or ongoing programmes and projects and it also attempts to identify issues requiring attention for future development by examining implementation experience of completed projects.

The third section of this chapter describes the peoples' participation activities undertaken during the studies and also sets out an approach for peoples participation at future stages of project development. In this respect the work recently undertaken for this Gumti Phase II and Noakhali North feasibility studies has been most useful revealing a number of common problems which appropriate participation at the planning stage can help to overcome.

10.2 Ongoing and Forthcoming Projects and Studies

10.2.1 Flood Action Plan Studies

A list of the FAP supplementary studies is given in Table 10.1. All the studies will have some relevance to the south-east region but the most important physical components are described here.

a) FAP 7 - Cyclone Protection Project - (Now the Coastal Embankment Rehabilitation Project).

The first phase of this project involved the rehabilitation of the coastal embankments to resist cyclones and the rehabilitation of existing roads to ensure that they would be able to meet the needs of relief organisations immediately after a cyclone. After the cyclone of April 1991 the roads component was suspended. There is now an extensive Mid Term programme and it is proposed to resection or retire some of the embankments in the study area, i.e. in Polders 59/2, 59/3B and 59/3C.

The embankments will generally be designed with a sea side slope of 1:7 and a countryside slope of 1:3. The embankment height will be designed to resist overtopping from a monsoon flood and a cyclone surge with a return period of five years, there is a further requirement that the depth of inundation on the countryside will be limited to 1 m for a return period of 20 years. Afforestation on the sea side to inhibit the height of the surge is included but there is no intention to provide cyclone shelters under the project. This aspect is now included in separately financed projects.

Recent amendments to the scope of work of the CERP have been identified and consequential changes to the regional plan are now included in Volume 2 of this report.

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TABLE 10.1

Flood Action Plan Supplementary Studies

Ref.	Name	Consultants
3.1	Jamalpur Priority Project	Sir William Halcroew and Partners, Lahmayer International, Sogreah, Engineering and Planning Consultants Ltd, Aqua Consultants and Associates Ltd.
5.B	Meghna Estuary Study	Not yet started.
7	Cyclone Protection Study	Kampsex International A/S, BCEOM, Danish Hydraulic Institute, Development Design Consultants Ltd.
9B	Meghna Left Bank Protection Project	Haskoning, Delft Hydraulics, BETS Ltd.
10	Flood Forecasting and Early Warning	UNDP (direct), Japan (direct)
11	Disaster Preparedness	Not yet started. (Preliminary studies in progress).
12	FCD/I Agricultural Review	HTS, SANYU Consultants Inc. (JICA), Flood Hazard Research, Hunting Fish Technology, Technoconsult International, BIDS Bangladesh
13	O&M Study	Hunting Technical Services, SANYU Consultants Ltd., Technoconsult International
14	Flood Response Study	Irrigation Support Project for Asia and the Near East (ISPAN), Development Planning Consultant
15	Land Acquisition and Resettlement Study	Multi Disciplinary Research Centre, HIFAB International
16	Environmental Study	ISPAN, Development Planning Consultant
17	Fisheries Study and Pilot Project	Overseas Development Administration, UK (direct)
18	Topographic Mapping	SPOT (france), FINNMAP
19	Geographic Information System	ISPAN, Development Planning Consultant
20	Compartmentalisation Pilot Project	Euroconsult, Lahmeyer International, BETS, House of Consultants Ltd.
21/22	Bank Protection and AFPM Pilot Project	Rhein Ruhr Ingenieur - Gesellshatt, CHN, Lockner, Danish Hydraulics Institute, BETS, Desh Upodesh Ltd.
23	Flood Proofing Pilot Project	ISPAN, Development Planning Consultant
24	River Survey Programme	Delft Hydraulics, DHI, Qsiris and Approtech-Hydroland
25	Flood Modelling/Management Project	I Kruger A/S, BCEOM
26	Institutional Development Project	(Needs Assessment Report completed) POE to undertake further studies.

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b) FAP 9B - Meghna Left Bank Short Term Protection Study

This study investigated the problems of eight sites on the Meghna and Lower Meghna Rivers including Maniknagar in the Gumti Phase II area, Eklashpur in MDIP area, Chandpur town and Haimchar in CIP area; the other four other sites were outside the SE study area. The study forecast that erosion at Maniknagar would eventually cause a further 700 m to be eroded in the near future; in these circumstances there seems to be little justification in spending large sums to protect agricultural land and local villages in the vicinity. Liberal set-back distances must be allowed.

The study has been very brief and has come to the tentative conclusion that providing hard points at Eklashpur, Chandpur and Haimchar would keep the Lower Meghna on its present course, although there may be minor erosion in between these points until the river has stabilised. It may be that there is need for one or two intermediate hard points. The works at Haimchar and Eklashpur are discussed in the sections on CIP and MDIP respectively in Part II. The protection of Chandpur town has recently been deferred. The FAP5 consultants consider that without this protection not only is the town at risk but also the integrity of the Chandpur Irrigation Project and its communications are also threatened. This is discussed in Volume 2.

c) The Meghna Estuary Study FAP 5B

It is most unfortunate that this FAP component has still not started since it could have major implications for planning units 1.2 and 4.

10.2.2 Other Studies

a) Meghna Muhuri Transfer

In September 1972, International Engineering Co./Rahman & Associates published a Draft Planning Report on the Meghna Muhuri Transfer. This was a plan to irrigate the whole area from Chandpur to Chittagong North.

The plan was divided into several stages and phases as follows:

Phase I	Water Transfer Canal from Dakatia river to the Little Feni River and from there to the Muhuri River.
	Dakatia Project
	Little Feni River Project
	Muhuri River
Phase II	Dhonagoda Project
Phase III	Noakhali North Project
Phase IV	Gumti South Project (present Planning Unit 10)
Phase V	Chittagong North Project

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The last phase contained only an irrigation component but all other phases were split into Stage I, development of irrigation, and Stage II, FCD. The basic concept of the transfer was to raise the water level in the Dakatia river by a pump station near the confluence with Kamta Khal. There would be a pump station at Disaganj to raise the water into the Mellar khal whence it would flow by gravity to the Little Feni River and on to the Muhuri River. In Phases II to V separate pump stations would have been required in each case.

b) Gumti Phase II

This area was the subject of a Feasibility Study which was completed early in 1991. This has now been restudied by FAP-5 team staff and the draft feasibility study report was presented in June 1993. A Summary of the recommendations is included in Volume 2.

c) Model Rural Development Phase II

In February 1991 the LGEB published a Master Plan Study which was concerned with Kachua, Nabinagar, Bancharampur and Debidwar thanas all of which are in Planning Unit 11 Gumti Phase II area. Amongst other components this recommended the development of LLP in those areas under a scheme whereby BRDB would rent LLP to BSS and MBSS through UCCA. This has been taken into account in the Gumti II study (see b above).

10.2.3 Existing Projects

a) Chandpur Irrigation Project

Chandpur Irrigation Project is typical of a double lift pump irrigation and drainage scheme within a polder. The project covers 54 000 ha gross and has a cultivable area of 29 100 ha and an irrigated area of 24 200 ha. Irrigation water is pumped up to main canal which runs round the periphery of the scheme. Most farmers pump water from this peripheral canal and its distribution network using LLP. The irrigation pumps are also used to drain the system. although gravity drainage is also possible. The CIP is further described in Part II Section 5.5.

b) Meghna Dhonagoda Irrigation Project

Meghna Dhonagoda Irrigation Project is similar to CIP except that the water is only pumped once, at two major pump stations one in the north and the other the south; these are supplemented by two smaller booster pump stations. The design was for gravity tertiary supply. The major pump stations were designed for drainage purposes and their capacity is three times the capacity required for irrigation. The scheme irrigates an area of 14 387 ha.

c) The Land Reclamation Project

In 1978 the Governments of the Netherlands and Bangladesh started the Land Reclamation Project (LRP). The aim was to address the problems of floods and coastal erosion and to exploit the potential for the reclamation and development from the Lower Meghna to the mouth of the Karnafuli River in the southeast. At the start of the project, the main emphasis was technical with implementation by the BWDB. The Dutch Consultants consisted mainly of engineers in water related subjects.

As the project progressed the initial emphasis shifted from the reclamation of new land to the consolidation of existing young land. A pilot polder taken up for demonstrating methods of improved agricultural development, became the focus for settling landless people. LRP developed into two distinct sets of activities: those related to the development of the polder, notably to the settlement of landless people and those related to the study of the process of erosion and accretion. Both components continued under the same project.

One feature of the project was the recommendation to develop the Sandwip cross dam which would connect the island of Sandwip to Polder 59/3B and accelerate accretion to establish new char land.

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

1. Char Development and Settlement Project (CDSP)
2. Meghna Estuary Study (MES) (FAP 5B see section 10.2.1)

d) Gumti Phase I

The project was implemented under the Third Flood Control and Drainage project and provides flood control and drainage to a cultivable area of about 37 340 ha. The project is bounded by main trunk road Daudkandi-Comilla in the south and river Gumti at the east, north and west. There area suffers almost annually from flooding from the River Gumti and flooding due to the backwater effect from the river Meghna. During the high stage of the Meghna most drains across the trunk road flow into the project area and cause inundation. There are embankments on both banks of the Gumti river from the Indian border to Companiganj. The main elements of the project were to complete the left embankment of the Gumti to link with the Daudkandi-Comilla road near Elliotganj, and to construct regulators at the outfall of rivers and khals to avoid inflow of water from the area south of the trunk road to the project area. A few regulators are being constructed on primary drains to retain water during the post-monsoon period for irrigation.

The project area is effectively a polder with no overland inflow, local rainfall will be the sole cause of flooding. There is no provision for pump drainage and therefore total water level control will not be possible when the Meghna is in flood.

The major constraint to irrigation development is the availability of water in the dry season, presently approximately 3 700 ha is being irrigated from groundwater sources. Water from khals is being used for irrigation by LLP in a very limited manner. The original project included an irrigation component from Gumti Phase II.

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e) Systems Rehabilitation Project

There have been three components of this project which have worked in the study area. In 1991 EPC and MMP wrote about the repair of Charbagadi pump station in CIP and also presented proposals in Polder 59/2 (Planning Unit 1). The status of the structural integrity of charbagadi Pump Station had not apparently changed over recent years and more intensive structural monitoring was recommended. Polder 59/2 was also studied but was classified as a complex project being affected by erosion of the Meghna and a problematic drainage situation. The setting back of the western peripheral embankments were proposed whilst for drainage, the need for an east to west drainage system was identified. It was recommended that this latter development be linked with the overall drainage plan which would be formulated within the SE Regional Plan.

The first phase of the project included 16 projects altogether. The second phase of the project commenced in 1991 and is investigating a further 62 projects including:

- i) Noakhali Khal,
- ii) Noakhali Comprehensive Drainage Scheme and
- iii) Polder 59/1B.
- iv) Polder 59.2

Items i) to iii) above are now all included in the Feasibility Study for Noakhali North for which the draft report has just been submitted (July 1993).

f) Model Rural Development Project Plan, Homna and Daudkandi

In November 1989 JICA published a report on the Model Rural Development Project for Homna and Daudkandi Thanas. This recommended integrated rural development of these Thanas including feeder roads, bridges, markets, primary schools, potable water supplies, health centres, irrigation, drainage and fish pond development. The present scope of the project has been reduced but in the water sector the scope of work in phases I to III is now as shown in Table 10.2 below:

TABLE 10.2

Irrigation and Drainage Facilities
Planned for Daudkandi and Homna

Item	Unit	Daudkandi	Homna	Total
Reexcavation of Khals	Km	55.3	8.7	64
Low Lift Pumps	No.	n.a.	n.a.	140
Buried Pipelines	No.	n.a.	n.a.	2

n.a. - information not available on split between Thanas

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The buried pipelines from existing deep tubewells are intended to overcome problems of land acquisition for water courses.

g) Submersible Embankment Projects

Two submersible embankment projects are being constructed at Satdona Beel and Chandal Beel, in Bancharampur thana in the Gumti Phase II area. These are sub-projects under IDA Second Small Scale FCDI Project and they were the subject of brief review of the economic prospects by Northwest Hydraulic Consultants Ltd in 1987 and 1988. Chandal Beel covers a gross area of 813 ha and has a net cultivable area of 615 ha and Satdona Beel has a gross area of 5 153 ha and an NCA of 3 350 ha. Further details are covered in the section on Planning Unit II in the Annex VI.

h) Bangladesh-Canada Agriculture Sector Team

The Agriculture Sector Team (AST) supports the Ministry of Agriculture on policy and planning and also gives advice on Institutional Strengthening. The team have assisted on the preparation of policy for the Fourth Five Year Plan and also produced the 1991 Census of Lift Irrigation. Other publications include the Development of Potential for Minor Irrigation in Bangladesh and the team has also advised on the implications of withdrawal of subsidies from deep tubewells.

i) Crop Diversification Programme

The Crop Diversification Programme is a joint programme of the government of Bangladesh, Canada, and the Netherlands. The programme is designed to balance the diets of rural populations and to promote food self-sufficiency particularly by increasing production and consumption of tubers, oilseeds and pulses including soyabean. This will be done by bringing these crops into rotations through better use of fallow land, introduction of high yielding varieties, improved cultural practices and post-harvest technology. Women receive special attention particularly regarding crop storage, processing and use, and priority is to be given to maximising benefits to women and the poor.

The programme is targeted at 90 thanas including Comilla Kotwali, Laksham, Matlab Bazar and Feni in the study area; the programme works through BARI, BADC, DAE and DAM within the Ministry of Agriculture.

j) Assistance the Transformation to Irrigated Agriculture

This is a three year project which commenced in October 1991 and is financed by UNDP (BGD/89/039). The project covers the whole country and intends to establish a Management Information System, to improve monitoring and evaluation, and to improve the extension services by reorienting them towards irrigation requirement and by training. The project will also examine the research requirements and investigate crop diversification. There will be close liaison with DAE, BARC, BADC and research stations.

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k) **The Comilla Kotwali Thana Central Co-operative Association Ltd.**

The Comilla Kotwali Thana Central Co-operative Association Ltd. (KTCCA) is a co-operative for rural development in Comilla Kotwali thana which is closely associated with BARD, Comilla. The Cooperative covers the following major development aspects:

Training, including adult education and women's activities
Agricultural extension including pisciculture, and encouragement of savings
Irrigation
Mechanised cultivation
Storage, marketing and processing
Livestock
Non-agricultural activities including promotion of services to the poor
Assistance to primary co-operatives, advice on credit etc.

The KTCCA has two major objectives, to promote, service and support the sound development of members co-operatives, and to serve as a research and demonstration laboratory in co-operative development for BARD. KTCCA is self supporting although it did seek advice and assistance from BWDB for the provision of a regulator and canal to bring 5 m^3/s of water from the Gumti river near to Comilla to the Sonaichari area. KTCCA is a model for development.

l) **Second Aquaculture Project**

This project is financed by ADB and the broad aims of the project are as follows:

- Increase fish production for local consumption
- Increase employment opportunities
- Increase shrimp production for export
- Encouragement of development of natural resources

Under the project these aims are to be achieved by the following methods:

- Enhancement of flood plain fisheries by stocking of beels which are isolated in the dry season so that fish can spread over the flood plains in the monsoon season, this will be in the Sylhet area.
- A carp demonstration extension programme in which extension officers attached to the project will train Thana Fisheries Officers so that they may pass on the techniques to farmers and fishermen.
- A shrimp methodology to the carp programme.
- Upgrading of DOF regional officers in 31 districts.

There is also an allocation of US$ 20 million of credit under the project which may be spent anywhere in the country, it has been indicated that some of these funds may be spent in other projects.

The project officially commenced in 1987 but consultants did not arrive until February 1991, the project is due to be completed in June 1992 but it is expected to be extended until 1995.

l) **Agricultural Support Services Project**

This is a project with the Department of Agricultural Extension to develop extension and training and includes institutional development and improvement of the seed industry. The programme is scheduled for more than four years started in 1992 and could have a major impact in the long term.

m) **National Minor Irrigation Development Project**

The project (NMIDP) started in 1993 and is co-financed by the World Bank, the European Communities and the Government of Bangladesh; the project will run for seven years and will cost about US$ 170 million.

The main aim of the project is to increase agricultural growth by transforming the present supply-driven, public sector-controlled system (in which public sector agencies such as BADC largely control irrigation development) into a demand-driven, competitive supply system in which the role of the public sector becomes one of facilitating and supporting the private sector and farmers' initiatives. This will be achieved by:

- institutionalising policy changes recently introduced by the government to liberalize the trade, distribution and siting of minor irrigation equipment;
- assisting both public and private sectors in efficiently assuming and performing their new roles in a liberalised irrigation market;
- providing wider and more equitable access to minor irrigation through the introduction and development of promising, cost-effective and appropriate irrigation technologies;
- improving access to DTW ownership by making it possible for groups other than traditional cooperatives to buy such equipment;
- minimising the potential negative environmental effects (e.g. on groundwater quality) of the liberalised irrigation policy promoted under the project;
- assisting the Government in developing an appropriate policy framework for minor irrigation development.

The project will obviously make a very important contribution to development of minor irrigation in the region as well as in the country as a whole. The active involvement of NMIDP in new projects in the region during the first five years of the plan period could greatly enhance their effective implementation.

10.2.4 Forthcoming Studies

a) **FAP 5B - Meghna Estuary Study**

The draft terms of reference for FAP 5B were published in March 1992. This study is partially a continuation of the LRP. The study area is the Meghna Estuary from the Karnaphuli river to the outlet of the Tentulia river just west of Bhola Island and the area goes upstream to Chandpur. The study is expected to last for two years but will probably be the start of a long term project. The recommendations of FAP5 for the planning units 1,2 and 4 must be taken into account by the estuary study and serious consideration given to the possible effects of further land accretion on drainage of these units.

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The outputs of the study are expected to include:

Plans to enhance the security of the population in the coastal area and on the islands.
Plans to strengthen the technical and institutional aspects of water/land management on the coastal islands.
Reports describing the hydraulic and morphological processes that shape the area and the changes expected as a result of FAP interventions.

Proposals for effective measures to protect existing land and potential reclamation areas against erosion.
Approaches and techniques for rapid and low-cost land reclamation, employing local labour and materials to the maximum extent.

Small scale interventions using locally available facilities.
An indicative master plan for the estuary aimed at a net sustainable gain in land, together with proposals for surveys and studies required for updating the plan.
Phased development plan for land and water use (pre-feasibility level), embodying the above approaches and proposals, which includes:

- strategies for progressive implementation.

b) The Char Development and Settlement Project

This project (CDSP), is also an extension of LRP and was also expected to commence in 1992 and to concentrate on development and settlement in Char Masjid and Char Batirtek in the study area and the char which has formed immediately downstream of the Feni Regulator, and to provide models for development of new land.

10.3 Implementation Experience

10.3.1 Selection of Projects

For a review of implementation experience, case studies were made for ten projects. Chandpur Irrigation Project (CIP), Meghna-Dhonagoda Irrigation Project (MDIP), Muhuri Irrigation Project (MIP), and Gumti Phase I Project were selected from the South-East Region. Brahmaputra Right Flood Embankment (BRFE) and Pabna Irrigation and Rural Development Project from the Northern Zone, Chenchuri Beel Project (CCB), Kolabashukhali Project (KBK), Bhola Irrigation Project (BIP), from the South Central region and Karnafuli Irrigation Project (KIP) from the Chittagong area were also selected.

10.3.2 Construction Costs and Implementation Periods

From the list of the projects indicated in Table 10.3 it appears that the project cost increases varied from about 5% to 340% of the original cost and the implementation periods were exceeded from one up to six years. With regard to cost increases, the unit rates considered by BWDB were according to the approved schedule of rates and works were awarded on open tender basis. The implementation schedules could not be maintained. As a result project costs increased due to inflation. Some of the projects had to be rehabilitated prior to completion of works incurring further additional expenditure.

For the identification of the reasons delaying the project implementation, a study was carried out of the pertinent project records, final project proformas and completion reports listed below.

- Agricultural Development Project (ADP) M/s Leedshill-De-Liew 1977,
- The Fortunes of a Major Water Development Scheme (CIP) Paul M Thomsan 1986,
- Improved O&M Programme (CIP, MIP and KIP) Euroconsult 1988,
- IDA Project Completion Report of Chanchuri Beel (CCB), Kolabashuakhali (KBK) and Brahmaputra Right Embankment (BRE) Credit 864-BD 1989,
- BWDB Recommendation Committee Report for protection against damage of flood embankment (MDIP) 1989,
- BWDB Completion Reports of seven Projects.

The principal reasons for the delays and cost escalations are described in the following sections.

10.3.3 Project Start-up

From the outset, almost all of the projects suffered due to delay in the approval of the Project Proforma (PP) delaying the flow of funds. Also delay in credit effectiveness, delay in initial BWDB staff mobilisation and also delay in the process of appointment of Engineering Consultants for the design of the project contributed to sub-optimal implementation. The Chandpur Irrigation Project (CIP), Muhuri Irrigation Project (MIP), Karnafuli Irrigation Project (KIP) and Pabna IRD Project are the best examples of this.

10.3.4 Design Problems

The CIP commenced in 1963 but the only decision which had been taken at that time was that there was to be a surrounding embankment in the south. By 1969 it had been decided not to work on the northern component (north of the Dakatia river) and at that stage the concept was changed from single lift irrigation to double lift irrigation. It was not until 1972 that the design of the project was more or less finalised. Even then the Meghna embankment at Haimchar had to be retired twice.

The Meghna-Dhonagoda Irrigation Project (MDIP) was officially completed in June, 1988 but during its implementation in 1987 the flood embankment on the Dhonagoda River breached at Durgapur and the following year in 1988 it again breached near the same place at Krishikandi. This caused serious damage to the internal infrastructure including project canals and roads.

TABLE 10.3

List of BWDB Projects Studied for Implementation

Sl. Nr.	Name of Project	Donor Agency	Estimated Amount (In Lakh Taka)		Period of Implementation		Actual Date of Completion	Remarks
			Original	As per Final Revision	Date of Commencement	Date of Completion		
1.	Chandpur Irrigation Project (CIP)	IDA	1609.00	5430.00	1963-64	1973-74	1979-80	-
2.	Meghna-Dhonagoda Irrigation Project (MDIP)	ADB	8400.00	14662.49	1973-74	1984-85	1987-88	Officially completed but not in actual
3.	Muhuri Irrigation Project (MIP)	IDA	5934.00	15973.30	1977-78	1981-82	1985-86	-
4.	Third Flood Control & Drainage Project (Gumti Phase I)	IDA	7282.05	11453.00	1984-85	1989-90	1991-92 (Proposed)	-
5.	Drainage and Flood Control Project I:							
	(a) Chenchuru Beel Sub-project (CCB)							
	(b) Kolabashukhali Sub-project (KBK)	IDA	1100.0	1126.00	1979-80	1982-83	1986-87	-
	(c) Brahmaputra Right Flood Embankment(BFPB)	IDA	930.00	881.00	1979-80	1982-83	1983-84	-
		IDA	2160.00	3733.00	1975-76	1982-83	1986-87	-
6.	Karnafuli Irrigation Project (KIP)	IDA	3796.60	4805.17	1975-76	1978-79	1982-83	-
7.	Bhola Irrigation Project (BIP)	ADB/EEC	4644.07	6307.47	1982-83	1986-87	1990-91	-
8.	Pabna Irrigation & Rural Development Project (Pabna IRD Project)	ADB	7664.17	33644.24	1970-71	1988-89	1991-92 (Proposed)	Total Cost may exceed 33644.24

Source: Director, Economic Planning, Bangladesh Water Development Board.

There are two main reasons for the failure, change in design and poor construction. During construction the embankment width was reduced by 1.2 m to save cost. At the same time the embankment was taken across old river channels having coarse bed material which provided a ready seepage path. No attempt was made to seal these channel beds.

In Muhuri Irrigation project, the late design of piles and back-fill materials behind the retaining walls of Feni regulator caused an abnormal delay in inviting tenders. The site of the closure dam was shifted upstream from the original site, and the closure dam was redesigned by Dutch consultants.

In the Brahmaputra Right Flood Embankment the land owners constantly opposed acquisition of land to retire the embankment. The BWDB proposed construction of groynes in the Brahmaputra river; one groyne was started at Kazipur but failed after an investment of about Tk 6.5 million by BWDB (1981).

10.3.6 Revision of Project

The CIP was revised many times because of change of mode of irrigation, change of boundaries and change of design (see above). Sometimes, the work was suspended and started again after a revised financing plan had been arranged. The cost increased by a factor of three.

The Muhuri Irrigation Project (MIP) was also subject to change of designs and cost estimates during implementation. After the original IDA credit, an EEC grant of US$ 5.6 million in 1978 and another supplemental IDA assistance of US$ 10.0 million and finally a CIDA grant of US$ 8.6 million had to be raised to meet the cost overruns due to design changes and consequent delays.

In the Brahmaputra Right Bank Flood Embankment, the re-sectioning of embankment increased from 129 km to 185 km, the number of cross embankments from 78 to 115, drainage regulators from 8 to 16 all bringing about cost increases.

The Meghna-Dhonagoda Project (MDIP) included many components of works which had not been originally envisaged. The embankment itself had to be protected from bank erosion and wave action. The cost increase was about 75%.

10.3.7 Land Acquisition

Land acquisition is a prerequisite to implementation of project work. The land owners are often reluctant to part with land. It is difficult to acquire land when the owner is not a beneficiary. Besides, compensation has usually been inadequate and often delayed.

During negotiations for the credits, the Donor Agencies received assurances from the government that sufficient funds would be deposited with the Deputy Commissioners in good time to ensure timely acquisition of the land required but this has seldom happened.

The problem of land acquisition, is the same for all FCD/FCDI projects. Land acquisition procedures take longer than foreseen in all Staff Appraisal Reports (SAR) and there are strenuous objections by landowners, sometimes assisted by their MPs or other political leaders.

The process of land acquisition often involves very poor farmers with limited or no alternative assets. The situation is further complicated by unfair assessment of land value for compensation, this discrepancy is the result of substantial deflation of reported land prices at the time transactions were recorded, for the purpose of tax evasion. Moreover, even when owners agree to accept the low assessed value of the land, they may be subject to substantial delays in payment (often years) and to complex and costly payment procedures. These factors have resulted in resentment by farmers and in active opposition to projects. Failure to resolve the problem not only delayed implementation but also resulted in insufficient land being acquired in some places to construct works properly.

According to land acquisition rules, about fourteen steps are required which can take about two years. If any litigation or racketeering is involved acquisition may take longer. The Final report of FAP 15, Land Acquisition and Resettlement Project has not yet been released.

However new rules for land acquisition are in process of elaboration and these could lead to some improvements. Also the donor agencies are insisting on much more rigorous procedures which are designed to ensure proper compensation to land owners, renters, sharecroppers and squatters whilst these requirements may initially delay implementation they should also result in better implementation thereafter.

10.3.8 Construction

Almost all FCD/FCDI projects suffer in the first year of construction.

The Chandpur Irrigation Project (CIP) suffered due to increased costs, inadequate execution, doubts about the design of the irrigation system (gravity irrigation versus double lift irrigation), problems of land acquisition for irrigation canals and Meghna river erosion. The project was completed after 17 years in 1980 after re-allocation of two IDA credits due to delays and cost increases.

Muhuri Irrigation Project suffered during the first eighteen months, due to poor performance of BWDB contractors and little progress was made on the large Feni Regulator. Under pressure from IDA, the contractor started the regulator after two years in 1979 with existing equipment since BWDB could not procure the required equipment. Work of the closure embankment commenced after completion of the regulator in 1984. Six specialists in marine works were brought in to supervise the closing of the embankment which was completed in 1985.

In Gumti Phase I Project, land acquisition plans for the new embankment on both right and left bank were submitted in 1988-89 and work orders to contractors to resume works were issued in December 1990. The contractors could not complete the embankment even in 1990-91 due to the land acquisition problem and left many gaps in the right embankment. In June, 1991 much of the Gumti flash flood passed through these gaps widening and deepening them and damaging the bridge on the existing road between Companiganj and Muradnagar. (BWDB interviews, Comilla and public participation meeting, Muradnagar July, 1991).

Some other projects outside the study area were investigated and the results are mentioned below:

- The Chenchuri Beel Project (CCB) was scheduled for completion in 1983 but it was delayed due to public opposition to land acquisition, poor quality works requiring rectification, and construction work irregularities. The irregularities involved black-listing of 23 contractors and disciplining of BWDB staff. Sixteen km of embankment and ten km of drain were still incomplete in 1985 including one regulator which needed replacement due to sub-standard work and a bridge which was delayed by disagreement between the designer and site staff.

- The implementation of Brahmaputra Right Flood Embankment (BRFE) suffered in the initial year due to lack of approval of the Project Proforma. The next year, a disagreement between BWDB and the Donor Agency emerged over BWDB's proposal to construct groynes in the Brahmaputra river. The Donor Agency decided not to finance the groynes. The original BRFE was constructed after designing the alignment with variable offset distances of about 1.0 km to 2.5 km from the river. In the seventies, the Brahmaputra river started attacking the BRFE. Most of the reaches having setback distances of less than 1 km have already been eroded and the embankment retired. The rest of the embankment is under constant threat of erosion and retirement is going on continuously almost every year except for the portion on the Teesta river which needs only resectioning from time to time. The BRFE original embankment stood well against rain and flood as this was consolidated and compacted by D8 tractors during construction. The breaches, occur not in the original embankment but in the retired part of the embankment which has been constructed without consolidation and compaction and with inadequate width due to land acquisition problems.

- The Pabna Irrigation and Rural Development Project was much delayed by land acquisition, change of location of the pump station, change in the design of the pump house (incorporating piled foundations) dewatering problems and procurement of equipment by the contractor.

10.3.9 Procurement

For large hydraulic structures, pumping plant and complicated works, the works are generally tendered through International Competitive Bidding (ICB) and the civil works which were simple and labour-intensive were allotted by Local Competitive Bidding (LCB). Too many small contracts cause excessive paper work and the minimum size should be limited to avoid contractual irregularities resulting from deployment of large numbers of contracts as payment control is difficult.

10.3.10 Quality Control

In general, there has been little mechanical compaction of embankments under BWDB apart from the Brahmaputra Right Flood Embankment (BRFE). In all other embankments, earth is placed in thicknesses of 225 mm (9 in). The earth of each layer is systematically broken using wooden mallets and then rammed with 7 kg rammer to a thickness of 150mm (6 in). Above this, a shrinkage allowance of 10% above the design height is provided. The 'method' specification as adopted by the BWDB, is very difficult to enforce without strict supervision which is generally lacking. There are many examples of reduced embankment cross-sections

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being adopted when it was difficult to acquire land. Land owners are not interested in keeping their private land at the river side of the embankment and they persuade BWDB staff to move the embankment closer to the river bank. Embankments have also been overtopped because of poor maintenance work.

Poor workmanship results from poor storage of cement, hand mixing of concrete, unsatisfactory concrete and formwork, lack of concrete quality control, improperly installed flap gates and excavation of regulator inlet and outlet channels to incorrect profiles. The quality of earthworks done under FFW appear generally less satisfactory than contracted works. Problems are aggravated by inadequate operation and maintenance (O&M). Other problems include the collapse of bank protection near regulators, especially when regulators are not operated in accordance with BWDB instructions.

10.3.11 Post Implementation Problems

a) Agriculture

Once a project is commissioned there may be substantial delay before farmers start to benefit. This may be caused by many factors including lack of appreciation of the project and delays in procurement of LLP and other equipment. Another complication is the construction of tertiary canals which is often delayed due to farmers' reluctance to donate land.

It is essential that all government departments concerned should work in unison to exploit these new works to the maximum potential. Extension services should be promoting the project in the field at least one year before each phase is commissioned and should motivate the farmers to construct tertiary canals etc. purchase pumps and other equipment, benefit from new agricultural technology and exploit credit which may be available from local institutions.

b) Fisheries

In all projects development of culture fisheries, either in open water or in ponds, has lagged seriously behind other works. There is no need for this to be so especially in view of the experience gained particularly in CIP.

10.3.12 Summary

1. A clear concept of the project is essential before any work commences. In many cases major changes in concept have taken place after the works have commenced.

2. Major embankments must only be designed after thorough investigation of rates of erosion, embankment foundations and suitability of soils for the earthworks.

3. Project start up has been delayed due to late approval of the Project Proforma, and delays in securing credits, appointment of consultants, and mobilisation of BWDB staff.

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4. Land Acquisition is of major concern and needs to be planned well in advance. The findings of FAP 15 must be considered and unnecessary complications eliminated. The development of resettlement plans needs to be incorporated into project planning procedures.

5. Only contractors with substantial resources should be awarded large contracts. Many small contracts for earthworks requiring compaction or other machinery should be avoided.

6. Construction supervision needs to be improved particularly by senior BWDB staff.

7. Local participation is important to ensure that the project is actually wanted by the local communities and to assist in generation of benefits as quickly as possible after commissioning.

8. Extension services need to commence well before the project, or any part of it, is commissioned.

9. Tertiary development must be considered most carefully and may possibly be incorporated into the project by way of technical assistance to farmers to form water users associations for tertiary unit development.

10. Mitigation measures for fisheries should be planned well in advance and may even commence during the construction period.

10.4 People's Participation

At the regional planning stage the nature of the possible proposals only become clear towards the end of the planning period. Local participation has an integral part of the planning process and teams have been sent out into the field to consult local opinion and attempt to modify the projects as conceived either to meet local objections, or to improve on the project concept following the knowledge gained from the participation process.

Local participation is a continuous process involving constant interaction between the planners, designers, implementation and operation teams and the local communities. As such it cannot be completed at the regional planning stage and must continue throughout the ensuing stages. This chapter summarises the local participation consultations completed during the regional planning stage. Volume 2 includes a section on identified and tested methods of participation at the feasibility stage and also makes recommendations for later stages of development.

10.4.1 Approach to local participation in formulation of the Regional Plan

The participation and involvement of local people and their views on potential FCD/I and other water resources development projects at the identification stage is vital. In particular it can help identify potentially undesirable side effects and ways in which the project can help improve living standards for the disadvantaged groups of people such as the landless, women and fishermen. A participatory approach can also help in design of project institutions and implementation systems so that local people are fully involved at all stages of detailed planning, construction, operation and maintenance of project facilities.

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As part of the Regional Planning stage of the study six thana organizations were contacted to arrange participation meetings, preferably at the union level. This involved the participation of 21 unions. The number of participants varied from 40 to 80 in each meeting. The participants were divided into four groups: first, local elites, big and medium farmers; second, small and marginal farmers and landless people; third, women; and, fourth, fishermen. Each group was met separately, although in some instances the local elite wished to be present at all discussions. The meetings were held in July 1991 by a team of consultants consisting of Senior Water Resources Engineer (Co-Team Leader), Fisheries Specialist, Sociologist, and Local Participation Expert. Although, at this time, the potential projects were at an early stage of formulation, the team explained the study objectives and outlined the scope of identified possible developments. The views and opinions of the attending communities were then sought in order to gain impressions concerning the people's problems, needs and their percepions in terms of solutions.

10.4.2 Views of Local People in the Regional Plan

People were asked to both identify major problems, as they perceived them, and to suggest potential solutions and development priorities. The following six projects came into discussions at the six meetings at the locations shown in Table 10.4

TABLE 10.4

Location of Local Participation Meetings

Projects		Meeting place	Unions	Thana
1.	Gumti Phase I	Muradnagar	3 Nr	Muradnagar
2.	Gumti Phase II	Thana Head Quarter (at local request)		
3.	Dhonagoda	Korsia Union	Gohat South No 1	Kachwa
4.	Dhonagoda	Nayargaon North	Nayargaon South Upadi North Upadi South	Matlab
5.	Dakatia	Suchipara North	Durgapur	Shahrasti
6.	Noakhali North	Hajipara	Digholi Chandraganj Charsaki	Lakshmipur
7.	Little Feni	Shaksadi		Feni.

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The responses are summarised in Table 10.5, in which only the most varied replies are shown, all groups welcomed the increase in employment and the possible work opportunities in construction and maintenance. Because of the varied response the replies are analysed by thana. These comments must be treated with caution, the groups of underprivileged persons may not have fully understood the impacts of the projects or may not have been fully aware of the causes of problems. For example the farmers in Feni complained that Kazirhat regulator was operated for the benefit of local fishermen who fish resident species in the pond upstream of the regulator and who do not want the regulator opened. The farmers say that this causes flooding of the boro crop because the gates are still closed at the time of the first flash floods. This is almost certainly incorrect, the BWDB take great pains to open the gates before every flood season by excavating the silt from downstream of the regulator so that the flap gates can open and the first flood can pass. It takes a month or so for the silt in the 17 km reach downstream of the regulator to be completely flushed out. Flooding occurred in the 1991 season because the wheat which was allocated to desilt the regulator under the FFW was reallocated before desilting was completed, this was because of the need for disaster relief due to the cyclone.

10.4.3 Local Elite, Big and Medium Farmers

The local elite, big and medium farmers appeared to be better informed about the hydrological/agricultural problems and potential of their areas. They took a close interest in the project map and its hydrological boundaries and related features. Discussion started from the present problems of flooding, drainage congestion and shortage of irrigation water which hinder agricultural production. Their views on unemployment, fish production and women in development were also discussed. Useful information was obtained on impediments to project implementation and on how these should be overcome. The main points of discussions on individual projects are described below:

a) Gumti Phase I (Muradnagar)

The then on-going Gumti Phase I FCD project is intended to provide full protection, from river flooding. So far many irrigation outlets have not been constructed from the Gumti river, even though they have been planned. Farmers were very critical because some existing irrigation supplies have been cut. They also pointed out that simple outlets at the river will not enable efficient distribution of water in places remote from the river and they estimated that the irrigated area will be only 25% to 30% of the total area which could be irrigated. Flood control was regarded as incomplete without irrigation works.

b) Gumti Phase II (Muradnagar)

Participants had no idea of the alignment of the proposed embankment along the Meghna and so could not discuss the proposed boundary of the project. In Muradnagar thana they want full flood control during the monsoon and irrigation during the dry season. Aman is now grown on 25% of the area and boro crop on about one-third of the area, being limited to the bank of the Oder/Arshi khal which dries up in February when irrigation is done from stored water. Some DTW bring up saline water when ground water levels in STW decline from February.

TABLE 10.5

Summary of Comments

Group Type of comment Comment	Upazila						Ref	Remarks
	Muradnagar	Kachua	Matlab	Shahrasti	Lakshmipur	Feni		
Large and medium farmers and rural elite								
Comments on present situation								
DTW are saline	•						1	
STW run dry in February	•		•	•		•	2	
DTW run dry in February			•	•		•	3	
Only 33% of the area can be irrigated by tidal water	•						4	
Irrigation from LLP and TW covers only 25%, with project 3 crops can be grown		•		•			5	
STW affected by gas breaking the prime		•					6	
Groundwater salinity is a problem in part of the area		•	•	•			7	
Existing khals dry up			•				8	
All paddy is broadcast			•				9	
Kazirhat regulator is operated for the benefit of fishermen, boro crop may be damaged by flood						•	10	See also 52
Most farmers have ponds and culture fishery is developing		•					11	
Crop transport costs are very high				•			12	
Pumps have been electrified				•			13	
Electrification should be expanded				•		•	14	
Electricity for TW is very expensive and payment difficult to organize through a group						•	15	
BADC did not install the DTW deep enough, deepening has improved the quality and quantity of water						•	16	
Land is leased to groups of poor through KSS and BSS			•				17	
Requirements								
With FCD, aman can be grown where flooding is too deep now				•			18	
Only one crop can be grown now (in the rabi season)				•			19	
Wide scale irrigation should be developed					•		20	
The new road should still allow water to flow from the the Dhonagoda to Boaljuri khal			•				21	
The Dakatia needs to be improved by loop-cutting and dredging				•			22	
Fish catch is decreasing due to over fishing	•						23	
Regulators need locks for boats				•			24	
DoF should release fry of large species in open water		•					25	See also 54 & 79
A bridge is required on the Dakatia near Chitosi				•			26	
Village roads should be developed			•				27	
Many creeks should be replaced by roads				•			28	
Locks are required on the new Matlab Gouripur road			•				29	
Bridges over khals should permit passage of boats			•				30	
Impact of project								
Present cropping intensity only 25% on flooded land, with FC, 300% will be possible	•						31	
The LLP outlets planned in Gumti Phase I have not yet been constructed	•						32	
Water distribution will be poor away from the embankments	•						33	
People will cooperate for the acquisition of land for Gumti II embankments	•						34	
Gumti I project controlled floods but cut off irrigation FC without irrigation is no good	•						35	
Development of tidal irrigation requires deepening of khals and some regulators will be needed				•			36	
A regulator on the Dakatia should be upstream of Hajiganj i.e. upstream of Boaljuri khal				•			37	
FC will be very beneficial			•				38	
Diversification will be possible when all facilities are there		•					39	
Fish can be reared in irrigation canals	•						40	
With irrigation, many fish species will not be reduced				•			41	See also 92 & 93
Local fishermen will produce fry if irrigation is introduced	•						42	
Closure of the Dhonagoda river would reduce capture fisheries			•				43	
Closure of the Dhonagoda river would reduce navigation			•				44	
Earthworks in construction will increase employment						•	45	
Embankment maintenance will increase employment						•	46	
The chairman of UCCA should form groups for local involvement						•	47	
Compensation for land must be paid directly to the farmers		•					48	

(continued)

TABLE 10.5 (continued)

Group Type of comment Comment	Upazila						Ref	Remarks
	Muradnagar	Kachua	Matlab	Shahrasti	Lakshmipur	Feni		
Landless people and marginal farmers								
Comments on present situation							49	
Flooding destroys crops			*				50	
Flooding allows fish to escape from ponds			*		*		51	
Rahmatkhali khal regulator is operated for the benefit of culture fishermen in the khal, fish migration is prevented					*		52	See also 10
Communication is poor in part of the area due to flooding		*					53	
Requirements								
DoF should release fry in open water		*					54	See also 25 & 79
Impact of project								
Increased agricultural production will increase employment	*	*		*		*	55	
Tubewells will be required to replace water polluted by FC			*				56	
Fish cultivation will increase in ponds	*						57	
Fish cultivation will increase in canals	*	*					58	
Capture fisheries will decrease		*					59	
Regulator gates should be operated to permit fish migration		*					60	
Fish will be cultivated in khals using nets					*		61	
Road communication is good, with FC it will improve			*				62	
Women (landless, destitute or abandoned and widowed)								
Comments on present situation							63	
Latrines and Rower pumps are given to society members		*					64	
Work on handicrafts		*		*			65	
Drinking water available from tubewell		*				*	66	
Tank water used for washing						*	67	
Requirements								
Groups must be formed for outside work			*	*			68	
Need guidance on group formation to avoid social obstruction				*			69	
Would like cottage industries to develop					*		70	
Would like to culture fish in ponds	*	*	*		*		71	
Need facilities for development of poultry					*		72	
Need facilities for development of livestock					*		73	
Gas connection wanted							74	
Impact of project								
Increased agricultural production a benefit		*				*	75	
Increased paddy husking a benefit		*				*	76	
More land for sharecropping will be available with FCD		*					77	
Livestock and poultry will benefit from flood control	*						78	
Fishermen								
Comments on present situation								
DoF should release fry into open waters	*					*	79	See also 25 & 54
Fishermen should negotiate with farmers to fish on farm land	*					*	80	
Fishermen are hatching their own fry for pond cultivation	*						81	
Fishermen are being employed in 60 local ponds	*						82	
Fish seed is brought from the Chandpur area			*				83	
Fish culture in ponds is well established				*			84	
Pesticides are becoming detrimental to fish					*		85	
Derelict ponds are not being cultured due to lack of finance						*	86	
Fishermen cannot afford nets						*	87	
One area has been leased to a businessman and not fishermen						*	88	
Requirements								
Tilapia could be cultivated				*			89	
Diseases are not being given enough attention					*		90	
Co-operatives should be organized by BRDB						*	91	
Impact of project								
Shrimp, koi, magur and jeol will increase with irrigation				*			92	See also 41
Irrigation will lead to increased fish in the khals					*	*	93	See also 41
FCD will enable tank culture to increase by stopping tanks overflowing					*		94	

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In Gumti Phase II area, one fisherman has taken out leases on more than 60 ponds and he is employing other fishermen in these ponds, fishermen are hatching their own fry using indigenous methods. In this area it was proposed that DOF should release fry into open waters, fishermen are already negotiating with farmers' co-operatives to lease fishing rights on flood land, and this might make it worthwhile for them to stock open waters themselves. In three other areas it was proposed that DOF should release fry into open waters but these proposals did not always come from fishermen.

In Feni area fishermen complained that they could not develop derelict ponds as finance was not available, they also said that they could not afford nets. In this area too their were bitter complaints about the lease of one fairly small area to a Dhaka businessman and they said that leases should only be given to co-operatives organised by BRDB.

c) **Dhonagoda Project (Katchua and Matlab)**

At the time of the meeting one proposal which was being considered was the closure of the Dhonagoda river to prevent flooding from the Meghna. This was vigorously opposed because of the effects on navigation and fisheries. At present a road is being built from Matlab to Gouripur, the alignment is east of the Dhonagoda. People were particularly concerned about the effect of this road on navigation and asked for all bridges to be constructed so that boats could pass. One additional navigation lock is considered necessary on this road. They were concerned about restriction on the supply from the Dhonagoda river to Boaljuri Khal and this is obviously regarded as a very important source of water, (this was also mentioned at the Shahrasti meeting in Dakatia Planning Unit). Both flood control and irrigation were considered necessary and this group seemed only to anticipate problems due to navigation (which could be avoided).

One particular point raised was that compensation for land acquired should be paid directly to farmers by a locally based organisation, this was to avoid middlemen.

d) **Dakatia Project (Shahrasti)**

The area on both banks of the Dakatia River is low and subject to flooding, mainly from the Meghna River and from the north of Chandpur-Laksham railway line. Due to deep flooding aman cannot be properly grown except in some small areas.

Both FCD and irrigation were requested and the only problems foreseen were the effects of any proposed project on navigation. However in this area the group also wanted improvement of road communications. Again local people were opposed to any regulator on the Dakatia river which would decrease the flow in Boaljuri Khal which is obviously regarded as being very important.

e) **Noakhali North Project:**

DTW to the south of Lakshmipur-Begumganj road are not viable due to salinity. Three DTW installed to the north of the road bought up saline water three years after installation. Coconut trees have also been affected. Two STW installed in Chandraganj are affected by gas, which may cause them the lose prime.

f) **Little Feni River:**

Retention of flash floods during early and peak monsoon is causing over bank spilling by the Kazirhat Regulator due to the conditions downstream. This causes partial damage to boro crops grown on both banks in the early monsoon period. Over bank flooding in the monsoon proper hinders transplantation of aman. This flooding is blamed on operation of Kazirhat regulator to suit fishermen although the study team consider this to be a misunderstanding.

Though there is no salinity problem, the water yield in DTW and STWs is low. Water output drops in February at the flowering stage of boro. The cost of irrigation by DTW is high and the irrigation coverage is low. The profit from agriculture, after meeting all expenses, is marginal and this is hindering the expansion of DTW and STW in the area.

This group was particularly critical of BADC and the installation of one tubewell which they said was not deep enough, did not produce enough water, and the water was brackish. After deepening of the well both water quality and discharge improved. However the co-operative running the well encountered serious difficulties in collecting funds with the result that the electricity supply was frequently cut off. They requested a form of electricity billing suitable for farmers' needs.

10.4.4 Small and Marginal Farmers and Landless People

In many ways this group provided the most varying views, they identified one problem of FCD being pollution of public waters and asked for a complimentary tubewell programme to supply clean potable water, this is probably due to the proximity of one group to Meghna-Dhonagoda project. This was the only group to express concern about loss of capture fisheries due to FCD projects and two groups requested that sluice gates should be operated to permit fish migration. However they admitted that flooding damages crops and permits fish to escape from ponds and that FCD schemes would provide greater possibilities for culture fish production. They welcomed the increased employment that any project would bring, and all groups said they would be willing to work in construction and maintenance of embankments. To summarise, they welcomed any FCD or FCD/I schemes but were concerned about the effect on capture fisheries and the risk of pollution.

10.4.5 Women (Landless, Destitute/Abandoned and Widowed)

The meetings were attended by some women who belong to Bithahin Shamabaya Society/Mahila Bithahin Shamabaya Samity (BSS/MBSS) or other associations, and some who work independently in the fields. Most of them have homesteads along with a pond or small piece of vacant land, but some are homeless and destitute. Almost all of them have a number of children to support. They had similar views in all six meetings as noted below:

- Women are actively involved in home gardens, raising poultry and livestock. They obtain food for their households but sell the larger part. Women involved in raising livestock and poultry have suffered from floods in the Gumti Phase-II, Dhonagoda and Dakatia areas. Summer vegetable gardens are also damaged.

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- With increased agricultural production women can find additional employment opportunities with big and medium farmers in the preparation of seed beds and planting seedings and, post-harvest, processing, drying and storing grain. They can also gain employment picking rabi crops like potatoes, onions, pulses, and vegetables.

- Women now husk the rice by 'Dhenki' (a traditional method) for home consumption. With agricultural development, husking of rice will increase to bring more income earning opportunities.

- In some areas BWDB leases out its land at the berms and borrow pits along an embankment. However BWDB does not have funds for effective maintenance of embankments. Destitute and landless women were willing do maintenance work in their own villages, in exchange the berms and borrow pits would be leased without charge to them by BWDB for production of vegetables, fruits and crops, and for poultry and livestock on the berms, and fisheries in borrow pits.

- Women were also willing to work on construction of embankments and re-excavation of khals in groups organized by BRDB as BSS/MBSS in the same way that groups are now formed by 'CARE' or 'DANIDA' in Noakhali.

- Many groups saw potential benefit in a general rise in prosperity in the area since they thought that they would be able to obtain housework with the more prosperous farmers.

- Many groups were also willing to start work in fish culture in ponds.

- Formation of groups and their training under the active guidance of some government organizations was seen as a key to poverty alleviation. This may involve non-agricultural work like making baskets, mats, dharma mats, shital pati, fish nets, brooms, kantha, mora, fans out of palm leaves and many types of hand-crafts from jute.

- One note of caution should be raised here, the development of groups for outside work was regarded as essential, this is in an attempt to avoid social conflict and overcome any objections to such work, in Shahrasti is seemed that this could be a major obstacle to be overcome.

10.4.6 Fishermen

All the meetings were attended by from 5 to 20 fishermen, except in Kachua, where only two persons came who were not full time fishermen. The discussions were preceded by a brief description of the possible implications of the proposed project interventions on the fisheries of the area. After this the opinions of the fishermen was sought. They were asked if they have any particular problems in the area. The opinion of the fishermen with regard to the possible implications of the project interventions appeared, in general, similar in all areas, and nowhere did the fishermen themselves state that FCD schemes were likely to reduce fish resources within the system, in fact three groups stated that irrigation would be of considerable benefit to resident species in khals and rivers. The other conclusions from meetings are given below:

- With the shrinking of the openwater catch, fishermen are turning to pond aquaculture and nursery operations.

- The pond aquacultural situation will be improved once flood control is guaranteed.

- Fishermen have financial problems in getting inputs like nets and boats.

- Although closed waters created by FCD/I projects may be stocked with fingerlings, fishermen have an inherent problem of getting leases of local fisheries as powerful local people may obtain the lease and exclude local fishermen.

- Fishermen, in most locations, were in co-operatives and they can manage any fisheries, including stocking and management activities, through these co-operatives.

- Small homestead ponds and ditches could be utilized for aquaculture if small scale cultural technologies are made available to the landless, destitute women and the poor fishermen,

10.4.7 Views Common to All Groups

The following views expressed regarding some general aspects were identical irrespective of the people's socio-economic status:

- The prospect of pond water being stagnant and polluted due to implementation of FCDI project, making it unsuitable for fish culture and drinking purposes, was discussed. The common view was that for the greater part of the year, most ponds have stagnant water anyway even without any FCDI project. If needed for fish culture, fresh water can be supplied by LLP from nearby irrigation canals. Most people now use tubewell water rather than ponds for drinking purposes. Overall, the view is that FCD/I projects will not create or aggravate the drinking water problems.

- People think that navigation will not be adversely affected as the project area is quite large and the movement of the country boats, especially during the rainy season, will not be affected. People were quick to add that even now most of the rivers remain dry or have little water for navigation anyway; moreover if the existing canals are excavated under a FCD/I project the boats could use these canals round the year, which they cannot do now.

- Women in general said they would like to have gas in the area, which would make cooking easier.

10.4.8 Other Interviews

Many other interviews were held in the study area including data collection exercises for agriculture, fisheries and the environment. The most significant are reported below.

The then Thana Chairman at Faridpur was also chairman of the Project Committee for Chandpur Irrigation Project. He complained about the lack of response from BWDB officers towards the committee. BWDB often ignored the committee's requests on the grounds that they were not practical but did not give any other details.

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A women's group in CIP were surprised to be asked their views when interviewed informally, they had no criticisms of the scheme but this may have been because they were interviewed without notice. When asked why fish were not cultivated in some ponds they said that the ponds were used for washing and bathing and they thought that they were not suitable for fish, they had not considered pumping the pond dry prior to a monsoon season and seeing if it would become clean.

Women interviewed at MDIP were most vociferous about the floods in 1987 and 1988 due to breaches in the embankments but gave no indications of dissatisfaction at present, they said that 1990/91 had been satisfactory but inputs had been expensive. It was too early to comment about 1991/92, but there were no complaints, which indicates that there were no pressing problems with the scheme. They did however say that farmers in the middle of the scheme, where canals were damaged during the floods, were still experiencing difficulties since there was no distribution system for irrigation and the inputs and outputs had to be carried to the peripheral road since there were no internal roads.

When the thana staff were interviewed at Hajiganj their only request was for more floating pump stations. One of these is used to pump water from the Dakatia into an adjacent khal, they seemed to prefer a quick solution to a major project,

Less formal interviews with fishermen's groups were held in Sarail, Madhabpur, Debidwar, Comilla, (Jangalia and Chawara), Hajiganj Matlab, Chandpur Sadar, Raipur (Denayetpur village) Lakshmipur, Begumganj and Daganbhuiyan. There were comments that capture fisheries had seriously declined in Sarail and Hajiganj. This is not due to any flood control works, however in Sarail the fishermen said that the increase in LLP in recent years had dried out many khals and borrow pits during dry seasons which also reduced the fish stocks.

In Denayetpur there was no clear conclusion about the effects of the CIP on fisheries, it appears the development of culture fisheries has almost made up for the losses on capture fisheries but the benefits are going to the larger farmers rather than the poor who do not have ponds.

In both Matlab (MDIP) and Begumganj the DOF has stocked the main khals under the open water stocking programme but no difference in fish catch had been observed.

In every thana visited apart from Madhabpur fish culture is increasing and in Comilla in particular there are important hatcheries and nurseries which supply an area as far as Kaptai Lake.

10.4.9 Institutional Aspects

People thought that whatever the type or extent of their participation in the project in various stages, it would be easier, more practical and, above all, more sustainable, if that could happen through some kind of group of societies or sanities, like KSS, BSS, MSS and MBSS of BRDB, or Mothers' Club/societies organized by the Social Services Department (SSD), or the DANIDA type groups. Such groups/societies are institutionalised and work under an existing authority which is responsible for formation, organization, providing inputs including training, and management, and supervision of the group's activities. Where needed new groups/societies may be formed by these agencies/NGOs or by national level NGOs under agreement with the concerned authorities.

Another suggestion from the people was that committees may be formed with representatives from every village or Union Parishad, to work as an advisory body which would provide guidance, co-operation and help for the solution of problems arising from land acquisition, land compensation, involvement of groups, and allocation of fishermen's right to government water bodies.

10.4.10 Summary of People's Participation for Regional Plan Development

The following paragraphs summarise the proceeding sections and bring out points which are useful both for regional plan formulation and for ensuing feasibility studies.

Small and marginal farmers were particularly concerned about the effects on capture fisheries but seemed to think that the situation could be improved by better operation of sluice gates. The fishermen on the other hand did not mention this as a problem and in some areas seem to be moving progressively into culture fisheries. Many groups wanted DOF to stock open water bodies.

The main concern of the large handowners were transport, they did not want any closure of navigation routes and they also wanted development of roads. This is understandable from the group which has greater commercial interests.

In general the women's groups did not raise any objections to the FCD or FCDI schemes, they saw them as reducing floods which is beneficial, increasing agriculture and increasing employment opportunities, but the reservations noted above about social objections to them working in groups on constructing embankments or maintaining embankments should be borne in mind when devising participation at the implementation and O & M stages.

Other points raised are summarised below:

- Flooding can damage boro and aman, and limits the area that can grow T aman. There is a demand for effective FCD, but this must not disrupt existing irrigation supplies.

- There is a considerable shortage of irrigation water. Surface water for LLP is limited. Shortages of ground and surface water from February can reduce boro yields.

- Development of irrigation will often require relatively large-scale developments to improve major regulators and khals, or provide pumping stations on major rivers.

- Small farmers can share in the overall improvements to agriculture brought about by FCD/I - it is not scale specific. However there is some doubt about the affordability of complementary inputs such as fertiliser.

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- The landless and marginal farmers see potential benefits from employment in an expanded agricultural sector and in project construction work. They also see considerable possibilities in non-farm employment created by the increase in rural incomes.

- Women attempting to support families with small home gardens and livestock appear particularly vulnerable to floods which can wipe out their assets.

- Like landless men, women see potential job opportunities in an expanded agriculture. They did not seem to think they might be replaced by male labour as crop intensification and farm incomes increase. Neither did they think increased rice production would result in the replacement, for rice husking, of female operated dhenkis by male operated modern mills.

- Women place considerable emphasis on the formation of groups and their support by BRDB/NGOs to promote a diversity of cottage industries and non-farm income earning activities.

- They identified embankment maintenance/leasing arrangements as a specific area in which they can derive direct benefit from FCD projects.

- Fisherman blame a general decline in capture fisheries on over-exploitation rather than on embankments and obstructions to fish migration. Irrigation has exacerbated this by depleting dry season water bodies in some locations (eg Titas).

- Fishermen are becoming involved in pond aquaculture, as catchers of fish, suppliers of fingerlings or through leasing of ponds. They will gain in this activity through FCD/I. The development of khals for irrigation will also provide additional water for capture fisheries in the dry season.

- Stocking of open waters with fingerlings to attempt to mitigate the adverse impact of flood control works may be of little benefit to fishermen if leases on these waters are obtained by more powerful interests.

- Larger landowners were concerned about land acquisition procedures and saw a need for a more streamlined and direct system.

- It was suggested that committees at the Union level could provide a useful avenue for the participation of local people in a range of project activities.

The group meetings did not elicit any opposition to FCD/I projects per se, and farmers were able to identify ways in which they thought water resources could be developed. People clearly thought existing water control systems could be improved but, for the poor, other income generating activities may be as useful in raising living standards.

10.4.11 Participation in on-going FCD/I projects

Local participation in FCD/I projects that are currently being implemented in the region is minimal. A top down approach has been adopted in planning of schemes and many of the problems that have arisen during implementation could have been avoided if local people had been consulted. Operation of projects are often organised to suit the scheme management rather than meet the needs of the supposed beneficiaries. For instance at CIP the irrigation season is defined by project maintenance requirements rather than by the irrigation needs of farmers. People in these projects often say they have had no contact with scheme management.

What participation exists is mainly limited to operation of LLP on irrigation projects by private individuals or groups of farmers. These groups however have no say in scheme management.

According to current BWDB O&M procedures, water control structures in FCD/I projects should be operated in consultation with "sluice-gate committees" who will, through the sluice-gate operator (kalashi), request BWDB to operate the gates to meet their requirements. This approach, although good in principle, in practices has a number of weaknesses including:

- dormant or non-existent committees

- committees dominated by powerful local interests which influence sluice operation; for example farmers want the gates closed to prevent crop damage may override fishermen who want to allow fish spawn to enter

- BWDB may ignore or overrule requests from a committee. This can be justified sometimes if it is necessary to balance the effect the sluice operation may have on a wider area with the needs of farmers close to the gate.

The result is that sluice operation is controlled by a balance of interests that vary from location to location. In some instances there are no kalashis and sluices are entirely under the control of local people, usually one or two powerful individuals. In other situations committees feel their influence is extremely limited. The result is that control structures are operated with little reference to local needs (or only reference to a powerful minority) and conflicts between local and regional needs and between groups are not resolved.

In an attempt to involve farmers in the management of FCD/I schemes and help resolve conflicts in the operation of sluicegates, BWDB has formed Project Management Committees (PMC) in the BWDB Small Scale Projects in the region. However these committees appear to be even less influential than sluice-gate committees. Although they may be chaired by powerful local interests (in the case of CIP by thana Chairman) and may meet regularly, committee members sometimes report that BWDB ignores their requests and suggestions. The concentration of power and funding at the national level means local interests are of little importance in the decision making process. Problems can sometimes be resolved in the District Co-ordination Committee meeting chaired by the Deputy Commissioner.

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10.4.12 Future Strategy to Improve People's Participation

Formulation of a more effective approach to participation by a wide range of local interests in the future development of water resources involves:

(a) The design of a system for BWDB (and other government organisations) to incorporate local people more effectively in the planning, design and operation of FCD/I schemes.

(b) Developing a balance of local interests in such schemes to ensure that the interests of weak and disadvantaged people are not excluded.

Considering the latter point first: the involvement of disadvantaged people in a project at a level where they have real say in project decisions to the extent of being able at times to overrule the wishes of other more powerful groups assumes that a substantial amount of power can be transferred to these groups. The feasibility of this largely depends on the structure of rural society.

Social structure in Bangladesh is a constantly changing network of patron-client ties. These stretch from national government to rural towns; to larger landowners, then small farmers and finally the landless. Development benefits are distributed through this patronage system with benefits flowing from one level to another as a means of cementing the ties between those with resources and power, and their clients.

As a result the poor look to their patrons rather than to themselves for survival and progress. They are not a homogeneous group and will not wish to act against the interest of their patrons or powerful groups. It will be difficult to include their full participation in the decision making on FCD/I projects when the present social/ political system effectively excludes them from other areas of public sector planning and management.

If disadvantaged people are to have a real say they may need to be supported by a powerful external organisation such as an NGO, or elected members of the Union Parishad which itself has access to central decision making processes. They will also need to see substantial benefits in the proposed development that will make it worth their while to oppose the interests of their erst-while patrons.

However, as is apparent from the discussions with groups of landless people and poor women, the poor do not see themselves as obtaining major advantages directly from FCD/I projects. Rather they see opportunities for themselves in providing labour and services to their richer patrons who will directly benefit from the improvement bought about in crop production.

The interests of the poor may be protected by the screening of projects at the planning stage via Social Impact Analysis (SIA) for any potential negative impacts such as agricultural mechanisation, reduction in land rental, and impact on fisheries. A proportion of project benefits should normally accrue to them by default through increased demand for farm labour and growth of the rural economy.

If appropriate, projects may include components targeted to the poor such as ownership of LLP by landless groups, re-stocking of open water fisheries, group maintenance and leasing of embankments. However the benefits from such activities will not be sustained unless these groups are continually supported by powerful outside forces. Given that these components are secondary to the principal activities of an FCD/I project it is unlikely that the implementing agencies will place great emphasis on their continued success. Thus there is a perceived need to involve outside agencies such as NGOs.

10.4.13 People's Participation and FAP Guidelines

The regional planning field work for this study was completed before even the first draft of the GPP was issued by FPCO. The GPP (guidelines for People's Participation) were finally issued in March 1993 after the fieldwork for the two feasibility studies for Gumti Phase II and Noakhali North area were completed. However FAP 5 staff members have been involved in the development of these guidelines since early 1992 and have been aware of the need for a meaningful dialogue with the people and officials of the relevant areas on a continuing basis though all stages of development. Ideas on how effective participation can be achieved for different types and sizes of project are still developing and it is clear that the new guidelines, whilst being a great improvement on earlier versions can still be improved further as experience is gained in the field.

However it is important that it is at all times remembered that they must be used as guidelines and not as a set of rigid rules and that their application must be approached in a manner which takes into account the financial and time resources available.

Most people's participation experience in various parts of the World has been based on relatively small scale development projects where effects of development can be easily understood by local communities and where disturbance is only local in extent. Interaction and interdependence amongst communities over wide areas have not been issues with small scale projects.

Regional Planning and large scale projects require a rather different approach although some of the same methods may be used. What was attempted during the regional planning stage of FAP 5 can now be seen to have followed the spirit if not the letter of the new GPP (pages 3.5 and 8 of the GRP). The study's TOR contained a separate set of guidelines (which it is now known were intended to have had far greater resource base than was in fact allowed for in the contract). Taking into account the time available for the regional planning work (9 months) the consultants chose to collect, compile and analyses much secondary data as possible, to review existing projects and to identify possible future development options. This period included numerous visits by members of the team to existing projects and to the various BWDB officers, thana officers and informal interviews as described in earlier parts of the Chapter.

Once the outline concepts of several developments options had been identified the series of Thana (then Upazila) meetings were held as has been described.

With hindsight and the new GPP available it may be argued that there should also have been number of village scoping sessions (GPP page 8 para 4.2 (i)). However bearing in mind the duration of the study, the number of project options being considered and the numbers of project personnel recommended to attend such meetings, it is considered that this could have been a serious misapplication of the limited available resources.

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It is interesting to note that the UNDP consultant who visited the project in March 1993 has very different views concerning the GPP and suggests that they are in fact guidelines for a definite methodology. The FAP 5 consultants did identify a methodology for the feasibility stage already being used on other FAP studies (FAP2 and FAP20) and have generally used similar methods adjusted to a more structured approach and used staff who had already worked on FAP2 and on FAP3.1.

The experience gained during the feasibility studies has allowed the revision of the Regional Plan proposals and the Regional Water Plan (Volume 2) now contains recommendations for implementation of plan components in terms of people's participation.

The final section of this chapter brings together the issues raised in the various sections of the chapter and shows how they are related.

10.5 Development Issues - Lessons for the Future

The previous sections of this chapter have indicated that past development projects in the water sector have suffered from a number of problems which are common to almost all of them. Also it is considered probable that most of them are closely interrelated. The principal problems are as follows:

i) Top down planning

ii) Lack of information to / consultation with local people and officials.

iii) Charges in project concept on design at late stages of implementation.

iv) Land Acquisition Procedures

v) Cost escalation

vi) Procurement delays

vii) Lack of support services

viii) Unforeseen negative impacts

ix) Tradequate compensation

x) Quality control during construction.

Almost without exception these problems could be greatly reduced by a more open attitude by development planners and agencies though a properly structured participation programme. However there is also a need for other actions in terms of implementation of existing government policies and regulations. In particular the new initiatives concerning land acquisition procedures and the levels of compensation will need to be applied in an efficient manner, if reasonable implementation periods are to be achieved.

The discussion on past project performance illustrates that BWDB staff can be subjected to extreme pressures during implementation to change designs by moving alignments of embankments or channels. The implementation of proper resettlement planning and cooperation prior to the commencement of construction would greatly reduce or eliminate these pressures and could, therefore, result in fewer changes to designs and the more effective implementation of projects.

The upgrading of project coordination committees and the involvement of NGO's to represent underprivileged groups on these committees could result in a much wider acceptance of projects by local communities. Implementations at the feasibility stage have identified that at present there is extensive cynicism and dissatisfaction with past implementation and therefore it will necessary to involve outside agencies such as NGOs in order to generate peoples faith that the new systems will be properly implemented.

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GLOSSARY OF TERMS AND ABBREVIATIONS

ACE	Associated Consulting Engineers Ltd.
ADB	Asian Development Bank
ADP	Annual Development Plan
AEZ	Agroecological Zones
Aman	Summer monsoon rice crop
AMD	Agriculture Marketing Department
ASR	Agriculture Sector Review
AST	Agricultural Sector Team
ATAP	Annual Technical Assistance Plan
Aus	Later winter/early summer rice crop
AWB	Asian Wetland Bureau
Baor	Ox-bow lake
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARD	Bangladesh Academy for Rural Development
BARI	Bangladesh Agricultural Research Institute
BB	Bangladesh Bank
BBPS	Bangladesh Bird Preservation Society
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCR	Benefit Cost Ratio
BDW	Broadcast Deep Water
Beel	Permanent water body
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Forest Research Institute
BIHM	Bangladesh Institute for Herbal Medicine
BIP	Barisal Irrigation Project/Bhola Irrigation Project
BIWTA	Bangladesh Inland Water Transport Authority
BJC	Bangladesh Jute Corporation
BJMC	Bangladesh Jute Mills Corporation
BJRI	Bangladesh Jute Research Institute
BKB	Bangladesh Krishi Bank
BM	Baor Manager
Boro	Winter rice crop
BPDB	Bangladesh Power Development Board
BPH	Brown Plant Hopper
BPS	Barind Protection Society
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BRE	Bramaputra Right Embankment
BRFE	Brahmaputra Right Flood Embankment

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GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

BRRI	Bangladesh Rice Research Institute
BS	Block Supervisor
BSCIC	Bangladesh Small and Cottage Industries Corporation
BSIC	Bangladesh Standard Industrial Classification
BTS	Bangladesh Transport Survey
BTMC	Bangladesh Textile Mills Corporation
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
BWNCS	Bangladesh Wildlife and Nature Conservation Society
CA	Catchment Area
CAD	Command Area Development
CARDMA	Coastal Area Resource and Development and Management Association
CARE	Cooperation for American Relief Everywhere
CBR	Crude Birth Rate/California Bearing Ratio
CCB	Cenchuri Beel
CDR	Centre for Development Research
CDSP	Char Development and Settlement Project
CE	Chief Engineer
CEA	Canadian Executing Agency
CEP	Chief Engineer, Planning
CEP	Coastal Embankment Project
CIDA	Canadian International Development Agency
CIP	Chandpur Irrigation Project
CIRDAP	Centre on Integrated Development for Asia and the Pacific
CSD	Central Storage Depot
CVDP	Comprehensive Village Development Programme
CWASA	Chittagong Water and Sewerage Authority (see WASA)
DAE	Department of Agricultural Extension
DANIDA	Danish Development Agency
DD	Deputy Director
DDP	Delta Development Project
DFC-I	Drainage and Flood Control Project (Phase I)
DFC-II	Drainage and Flood Control Project (Phase II)
DFR	Draft Final Report
DGF	Directorate General of Food
DHI	Danish Hydraulic Institute
DOC	Department of Cooperatives
DOF	Department (or Directorate) of Fisheries
Doincha	Sesbania sp. a crop used for green manure, fodder and firewood
DPEC	Department of Project Evaluation Committee
DPHE	Department of Public Health Engineering

GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

DPS	Directorate of Planning Schemes
DsHTW	Deepset Hand Tubewell
DSPEC	Departmental Special Project Evaluation Committee
DSSTW	Deepset Shallow Tubewell
DTW	Deep Tubewell
DW	Deep Water
DWASA	Dhaka Water and Sewerage Authority (see WASA)
EC	European Community
EC	Executive Committee
EC	Electrolytic Conductivity
ECI	Engineering Consultants International
ECNEC	Executive Committee for the National Economic Council
EIA	Environmental Impact Assessment
EIP	Early Implementation Project
EIRR	Economic Internal Rate of Return (IRR)
EMP	Environmental Management Plan
EPCB	Environmental Pollution Control Board
EPI	Extended Programme of Immunisation
EPWAPDA	East Pakistan Water and Power Development Authority
ERD	External Resources Division/Economic Relation Division
Eto	Evapotranspiration
EV	Extreme Value
FAO	Food and Agriculture Organization
FAP	Flood Action Plan
FC	Foreign currency
FCD	Flood Control and Drainage
FCDI	Flood Control, Drainage and Irrigation
FEC	Foreign Exchange Component
FEJ	Forum of Environmental Journalists
FFW	Food for Work
FFYP	Fourth Five-Year Plan
FiFYP	Fith Five Year Plan
FIR	Farmgate Irrigation Requirement
FMT	Force Mode Turbine
FMTW	Force Mode Tubewell
FOEB	Friends of the Earth - Bangladesh
FP	Floating Pump/Family Planning
FPCO	Flood Plan Coordination Organization
FRI	Fisheries Research Institute
FS	Feasibility Study
FSB	Fisheries Society of Bangladesh
FWA	Family Welfare Assistants

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GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

FY	Fiscal Year
FYP	Five Year Plan
GCA	Gross Cropped Area
GDP	Gross Domestic Product
GEPA	(West German Organisation)
G-K	Ganges Kobadak Project
GMFR	General Marital Fertility Rate
GOB	Government of Bangladesh
GPA	Guidelines on Project Assessment
GRP	Gross Regional Product
GSB	Geological Survey of Bangladesh
ha	Hectare
Haor	Deep lake (structured depression)/low-lying river backswamp
HTW	Hand Tube Well
HYV	High Yielding Variety
IAM	Investment Analysis Model
IAPP	Intensive Aus Production Programme
IBRD	International Bank for Reconstruction and Development (World Bank)
ICB	International Competitive Bidding/Investment of Corporation of Bangladesh
ICPP	Intensive Crop Production Programme
ICDDRB	International Centre for Diarrhoeal Disease Research of Bangladesh
ICLARM	Internationl Centre for Living Aquatic Resources management
IDA	International Development Agency
IDP	Infrastructure Development Project
IECO	International Engineering Company
IEE	Initial Environmental Evaluation
IFAD	International Fund for Agricultural Development
IBRD	International Bank for Reconstruction and Development (World Bank)
IMED	Inter-Ministerial Evaluation Division
IMP	Irrigation Management Programme
IMR	Infant Mortality Rate
IRCP	Intensive Rabi Crop Programme
IRDP	Integrated Rural Development Programme
IRR	Internal Rate of Return
IRRI	International Rice Research Institute
ITAP	Intensive Transplanted Aman Programme
ITCZ	Inter Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature and Natural Resources - The World Conservation Union
IUD	Intern-uterine Device
IWDFC	Irrigation, Water Development and Flood Control
IWWRB	International Waterfowl and Wetlands Research Bureau

GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

JICA	Japan International Cooperation Agency
JRC	Joint River Commission
JU	Jahangir Negar University
KBK	Kolabashukhali
Khal	Channel
Kharif	Summer and fall (kharif I - early summer, March through June; kharif II -late summer and fall, July through October)
Khesari	Grasspea, Lathyrus Satirus
KIP	Karnafuli Irrigation Project
KSS	Krishi Samabaya Samity (Village Cooperative)
KTCCA	Kotwali Thana Central Cooperative Association
LAD	Least Available Depth
LC	Land Category
LCB	Local Competitive Bidding
LFS	Labour Force Surveys
LGD	Local Government Division
LGEB	Local Government Engineering Bureau
LLP	Low Lift Pump
LPS	Litre Per Second
LRP	Land Reclamation Project
LV	Local Variety
Mashkalai	Blackgrain
MAWTS	Mirpur Agricultural Workshop and Training School
MCC	Mennonite Central Committee
MCH	Maternal and Child Health
MDIP	Meghna Dhonagoda Irrigation Project
MES	Meghna Estuary Study
Mha	Million Hectares
MIP	Muhuri Irrigation Project
Mm^3	Million Meter Cube
Mmt	Million MetricTon
MOA	Ministry of Agriculture
MOD	Ministry of Defence
MOEF	Ministry of Environment and Forestry
MOFL	Ministry of Fisheries and Livestock
MOHFP	Ministry of Health and Family Planning
MOI	Ministry of Industry
MOIWDFC	Ministry of Irrigation, Water Development and Flood Control
MOL	Ministry of Land
MOLGRDC	Ministry of Local Government, Rural Development and Cooperatives
MORR	Ministry of Relief and Rehabilitation
MOSC	Ministry of Sports and Culture

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GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

MOSTI	Manually Operated Shallow Tubewell for Irrigation
MP	Muriate of Potash
MPO	Master Plan Organisation
MS	Mild Steel
MSL	Mean Sea Level
MUV	Manufacture Unit Value
MTFPP	Medium-Term Foodgrain Production Plan
NACOM	Nature Conservation Movement, Mymensingh
NCA	Net Cultivable Area
NCS	National Conservation Strategy
NCSB	Nature Conservation Society of Bangladesh
NEC	National Economic Council
NEMAP	National Environmental Management Action Plan
NER	North East Region
NERWMP	Northeast Regional Water Management Project
NFC	National Flood Council
NGO	Non Government Organization
NHC	Northwest Hydraulic Consultants
N/K	Net Benefit/Investment Cost Ratio
NIRDP	Noakhali Integrated Rural Development Programme
NMIDP	National Minor Irrigation Development Project
NPK	Nitrogen, Phosphorus, Potassium
NPV	Net Present Value
NRDP	Noakhali Rural Development Programme
NWC	National Water Council
NWP	National Water Plan
NWPP	National Water Plan Project
O&M	Operation and Maintenance
ODA	Official Development Assistance (UK)
OER	Official Exchange Rage
OM	Organic Matter
PC	Planning Commission
PC-II	Application form for a feasibility study
PCR	Project Completion Report
PDB	Power Development Board
PDP	Primary Distribution Point
PEC	Project Evaluation Committee
PEP	Production and Employment Project
PFDS	Public Foodgrain Distribution System
pH	Acidity/Alkalinity unit
PHC	Primary Health Centre
PIT	Project Implementation Team

GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

PIU	Project Implementation Unit
PMC	Project Management Committees
PMU	Project Management Unit
PP	Project Proforma
PPP	Preliminary Project Proforma
PSO	Principal Scientific Officer
PTL	Project Team Leader
Purdah	The practice of secluding women
PVC	Poly Vinyl Chloride
PWD	Public Works Department
Rabi	Winter dry season (November through February) crop
RCB	Reinforced Concrete Block
RDI	Rural Development Infrastructure
RDO	Rural Development Officer
RDRS	Rangpur Dinajpur Rural Service
RESP	Rural Employment Sector Project
RPP	Revised Project Proforma
RRA	Rapid Rural Appraisal
R/S	River Side
RSC	Residual Sodium Carbonate
RSS	Reconnaissance Soil Survey
RWP	Regional Water Plan
SAR	Staff Appraisal Report
SCARP	Salinity Control and Reclamation Project
SCF	Standard Conversion Factor
SCONE	Society for Conservation of Nature and Environment
SCOPE	Society for the Protection of the Environment
SE	Superintending Engineer
SEG	Sell Environmental Group
SERM	South East Regional Model
SFYP	Second Five-Year Plan
SIA	Social Impact Analysis
SIDA	Swedish International Development Authority
SLI	Shawinigan Lavalin International
SMAM	Singulate Mean Age at Marriage
SOB	Survey of Bangladesh
SODAPS	Soil Data Processing System
SODAT	Soil Data (MPO version)
SPARRSO	Space Research and Remote Sensing Organisation
SPEC	Special Project Evaluation Committee
SRDI	Soil Resources Development Institute

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GLOSSARY OF TERMS AND ABBREVIATIONS (CONTD.)

SRP	Systems Rehabilitation Project
SSD	Social Services Department
STW	Shallow Tubewell
SWMC	Surface Water Modelling Centre
SWSMP	Surface Water Simulation Modelling Plan
TA	Technical Assistance
TAPP	Technical Assistance Project Proforma
T&V	Training & Visit
TCA	Total Cultivable Area
TDP	Transport Distribution Point
TDS	Total Dissolved Solids
TDW	Transplanted Deep Water
TFYP	Third Five-Year Plan
TMFR	Total Marital Fertility Rate
TOR	Terms of Reference
TRDP	Tangail Rural Development Project
TSP	Triple Super Phosphate
UAO	Upazila Agricultural Officer
UC	Union Council
UCCA	Upazila Central Cooperative Association
UDD	Urban Development Directorate
UE	Upazila Engineer
UFO	Upazila Fisheries Officer
UHC	Upazila Health Complex
UHFWC	Union Health and Family Welfare Centre
UNDP	United Nations Development Programme
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNICEF	United Nations International Children's Emergency Fund
Upazila	Subdistrict
USAID	United States Agency for International Development
VT	Vertical Turbine
WAPDA	Water and Power Development Authority
WASA	Water and Sewerage Authority (Chittagong and Dhaka)
WBS	Work Breakdown Structure
WHO	World Health Organisation
WID	Women in Development
WRC	Water Resource Cell
WSB	Wildlife Society of Bangladesh
WWF	World Wildlife Fund
XEN	Executive Engineer
ZSB	Zoological Society of Bangladesh

REFERENCES

1. Draft Report on the Meghna Muhuri Water Transfer, International Engineering Co./Rahman & Associates, September, 1972.

2. Muhuri River Project, Feasibility Studies, Pakistan Techno-Consult, January 1967.

3. Muhuri Irrigation Project - Project Completion Report (FAO, March 1987, amended and updated April 1989.

4. Evaluation of Muhuri Irrigation Project Bangladesh, Canadian International Development Agency (CIDA)/Keith Project Management Inc, June 1990.

5. Master Plan, International Engineering Co., December 1964.

6. Feasibility Report on Comilla and Noakhali Project - Phase I (Dakatia Unit), BWDB/Netherlands Engineering Consultants, February, 1980.

7. Feasibility Study, Comilla-Noakhali Project, Muhuri Unit, International Engineering Co./Rahman & Associates, December 1973.

8. Noakhali Irrigation Project Preliminary Report, Bangladesh Water Development Board, September 1982.

9. Inception Report on Noakhali Irrigation Project, Bangladesh Water Development Board, January 1983.

10. Rural Credit Market in Noakhali District, Sajjad Zohir, 1989.

11. Water Under the Bridge, The Final Report (1986-1989) of the Irrigation and Drainage Component of the Noakhali Rural Development Project - Phase II, NRDP-II/DANIDA, August 1989.

12. Water Under The Bridge, The Final Report (1986-1989) of the Irrigation and Drainage Component of the Noakhali Rural Development Project - Phase II, NRDP-II/DANIDA, 1989.

13. Little Feni and Noakhali Regulators, International Engineering Company Inc, October 1961.

14. Feasibility Report - Structures for Little Feni River Sub-Project (Second Small Scale Flood Control, Drainage and Irrigation Project), North-west Hydraulic Consultants Ltd., 1988.

15. Draft Feasibility Report - Rehabilitation of Old Dakatia and Little Feni River (Sub Project Nr 19, Rehabilitation of Water Development Project, EPC/Harza/MacDonald April 1988.

16. IDA Second Small Scale Flood Control, Drainage and Irrigation Project, Feasibility Reports for Appurtenant Structures Schemes (2 Nr) at Ichakhali and Bamansundar, Northwest Hydraulic Consultants Ltd, December 1987.

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REFERENCES (contd)

17. IDA Second Small Scale Flood Control, Drainage and Irrigation Project, Feasibility Report, Structures for Kahua River Sub-Project, Sub-Project Nr 35 (Appurtenant Structures), Northwest Hydraulic Consultants Ltd, 1988.

18. Second Flood Damage Rehabilitation Project, Feni Regulator: Downstream Scour. Report on Hydraulic Model Study and Design, Sir William Halcrow and Partners, March 1991.

19. Evaluation of Historical Water Resource Development and Implications for the National Water Plan, Harza Engineering, Sir M. MacDonald & Partners et al, June 1991.

20. Productivity and Employment Implications of Small Scale Family, CIRDAP Study Series Nr 98, Akhanda, A M and Karim, M R.

21. Bangladesh Population Census 1981, District Series, Bangladesh Bureau of Statistics, 1981

22. District Statistical Series, Bangladesh Bureau of Statistics, 1983.

23. Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, 1987/88.

24. Statistical Pocket Book of Bangladesh, Bangladesh Bureau of Statistics, 1990.

25. Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, 1990.

26. Bangladesh Census of Non-Farm Economic Activities 1986, Zila Series, Bangladesh Bureau of Statistics, 1990.

27. Preliminary Report, Population Census, Bangladesh Bureau of Statistics, July 1991.

28. Report on the Upazila Development Monitoring Project, Volume 1, Bangladesh Bureau of Statistics, November 1991.

29. Inland Fisheries Development Project, Fifth Annual Report, Department of Fisheries, 1982

30. Population of Bangladesh. Country Monograph Series 8, ESCAP.

31. Draft Rapid Rural Appraisal of Meghna Dhonagoda Irrigation Project, FAP 12 - FCDI Agriculture Study, June 1991.

32. Draft Project Impact Evaluation, Meghna Dhonagoda Irrigation Project, FAP 12 - FCDI Agriculture Study, 1991.

33. Draft Final Report, Volume 1, FAP 12 - FCDI Agriculture Study, December 1991.

REFERENCES (contd)

34. Guidelines on Economic Analysis, Flood Plan Coordination Organisation, May 1991.

35. Guidelines for Project Assessment, Flood Plan Coordination Organisation, July 1991.

36. Pattern of Agricultural Unemployment, Bureau of Economic Research, University of Dhaka, Habibullah, M - 1962.

37. Population Development and Evaluation Unit, Hossain and Ahmed, International Engineering Co Inc., 1964.

38. Labour, Employment and Wages in Bangladesh Agriculture, BIDS, Hye, S A, 1989.

39. Technical Report Nr 17 (Fisheries losses), Master Plan Organisation, 1985.

40. Technical Report Nr 1, Crop Production Limitations in Bangladesh, Master Plan Organisation, 1987.

41. Technical Report Nr 13, Procedure for Preparing Cost Estimates, Master Plan Organisation, 1987

42. Unemployment and Over-employment in Agriculture, a Case Study of Bangladesh. BR Publishing Corporation, Masum, M, 1982.

43. The Impact of Flood Control on Agricultural Development in Bangladesh. Flood Hazard Research Centre, Thompson, Paul M, 1989.

44. Land Resources Appraisal of Bangladesh for Agricultural Development, Report 2, Agro-Ecological Regions of Bangladesh, Food and Agricultural Organisation, 1988.

45. Study on Foodgrain Marketing, Ministry of Food, 1988.

46. MPO, SWSMP Phase I, Main Report, December, 1988.

47. MPO, NWP Project Phase II, Main Report, Volume I, June, 1991.

48. MPO, NWP Project Phase II, Bangladesh Water Balance Model, Users Manual, December, 1990.