United Nations Development Programme
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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

Regional Plan Report
Volume 3

Annex I Soils
Annex II Agriculture
Annex III Socio-Economics
Annex IV Environment

August, 1993

Sir M MacDonald and Partners Limited, UK
in association with
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CHAPTER I.1

AGRO-ECOLOGICAL ZONES

I.1.1 Introduction

Agro-ecology greatly influences the physical environment which is relevant for land use and for assessing the agricultural potential, cropping system, climate, soil and hydrological conditions. The agro-ecological regions based on the broad features of agro-ecological affecting crop production, provide a useful data for transferring all types of agro-technology. Major cropping patterns based on varied land types and soil fertility for farming systems are dependent on Agro-Ecological Zones (AEZs), which have been described in Land Resources Appraisal of Bangladesh for Agricultural Development (Report 2, Agro-Ecological Regions of Bangladesh, FAO, 1988) as Agro-Ecological Regions. However, there are 30 major agro-ecological regions and 88 sub-regions recognized in the country. Of these 30 Agro-Ecological Regions, eight AEZs (regions and sub-regions) fall within the study area of the south-east region (FAP-5). These are shown in the Soil Association Map (in the separate Album of Drawings), with components of soil mapping units. A map showing agro-ecological units is given in Figure I.1. The names of AEZs are as below:

1. Middle Meghna River floodplain (AEZ-16),
2. Lower Meghna River floodplain (AEZ-17),
3. Young Meghna Estuarine floodplain (AEZ-18),
4. Old Meghna Estuarine floodplain (AEZ-19),
5. Sylhet Basin (AEZ-21),
6. Northern and Eastern Piedmont Plains (AEZ-22),
7. Northern and Eastern Hills (AEZ-29), and
8. Akhaura Terrace (AEZ-30).

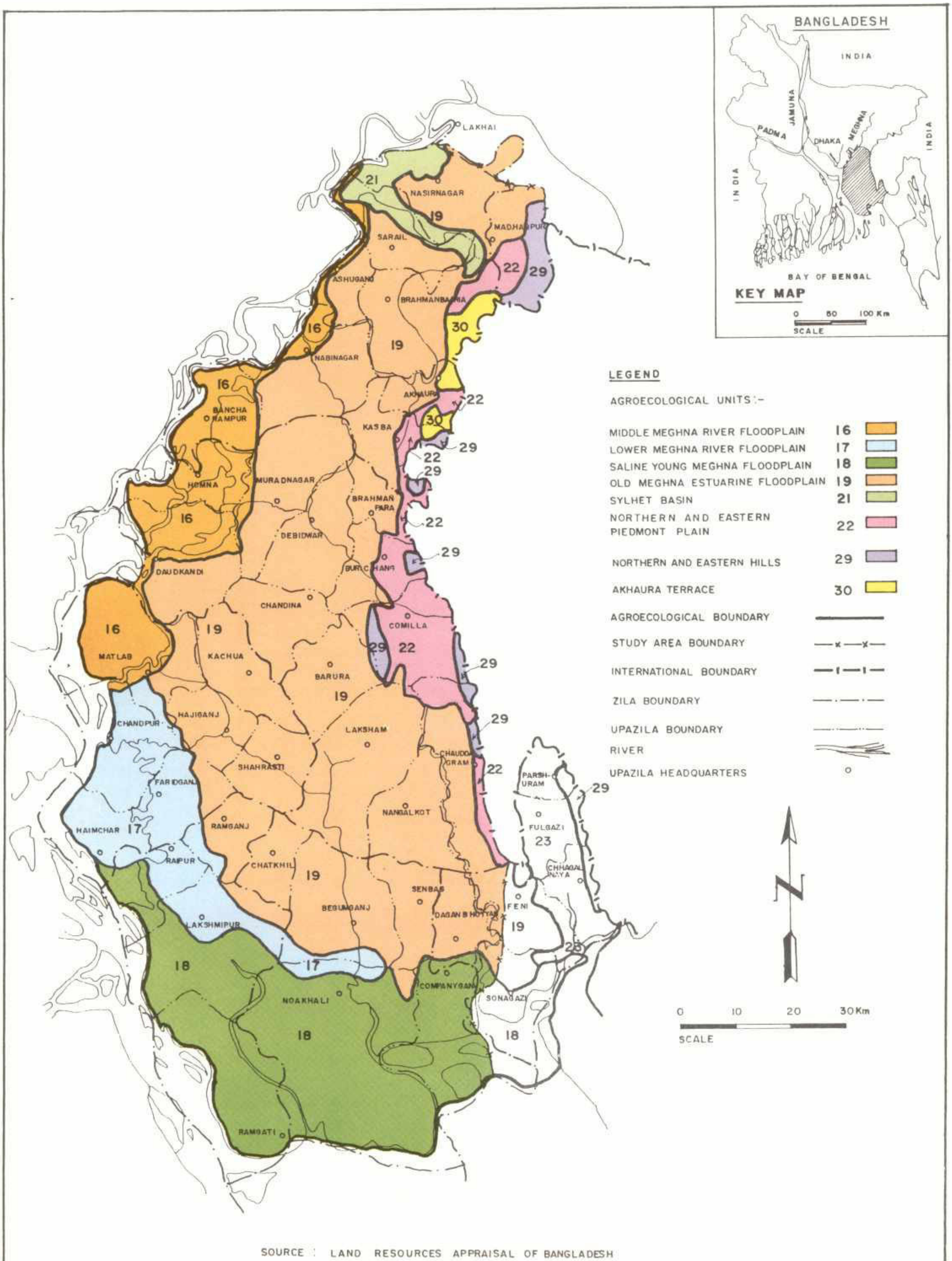
Except for some minor areas along the northern boundary and eastern fringes along the border, the greater part of the area is occupied by the first four regions. These regions essentially constitute part of the Meghna floodplain and the major difference occurs in the Young Meghna Estuarine floodplain (Saline Young Meghna floodplain). This occupies the recently accreted land (known as char land), that is located in Lakshmipur and Noakhali zilas. Salinity is very patchy and occurs in less than half of the regions and only in the surface soil layer. It is partially induced by flooding of sea water, but varies throughout the year and from year to year. There are intense salinity variations locally, even within fields. All the regions and sub-regions of AEZs are individually described below.

I.1.2 Middle Meghna River Floodplain (AEZ-16)

This region occurs along the Meghna river at the western margin of the project area to Sarail in Brahmanbaria through near Matlab in the Chandpur zila. It consists of a complex, rather irregular landscape of floodplain ridges and inter-ridge depressions, cut-offs, ox-bow lakes, with fresh spill deposits along active channels. The whole landscape is seasonally flooded by the Meghna and exposed to river erosion or buried by fresh deposits in each monsoon season.

Figure I.1

Agroecological Units of the Study Area



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

The region mainly includes low-lying basins with surrounding low ridges along river banks. There are areas with low ridges, inter-ridge depressions and old channels as well as higher sandy ridges.

Drainage

Most soils are seasonally deeply flooded, except on high floodplain ridges. Basins and inter-ridge depressions flood early and drain late. River levels may start to rise in March, following early rains in the upper catchment area of the Meghna. The rivers are tidal in the dry season, but not saline to the north of Rahmatkhali Khal. The percentage of land in different flood phases is shown in Table I.1.

TABLE I.1

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
1 (AEZ-16)	<1	8	29	36	27

Water Resources

Ample surface water exists in the Meghna channels to irrigate the whole region and groundwater is probably readily available for use by tube-wells if needed to supplement surface water supplies. Salinity may be a problem and is considered elsewhere in the report. The only limited irrigation water is that a certain flow is necessary in the Lower Meghna to prevent intrusion of saline water in the study area, the water available for irrigation in the study area depends on this minimum flow and abstractions elsewhere; this is being considered by the Master
Plan Organization.

Development Constraints

The main development constraints are early rise of floodwater, deep flooding and slow drainage of basins and depressions after the rainy season, poor communication, sandy soils and irregular relief in different areas exposure to cyclones and storm surges and as river bank erosion along parts of the main Meghna channel.

Agricultural Development Possibilities

The Meghna-Dhonagoda flood protection, drainage and irrigation project presently under construction, lies in the centre of this region.

In general, the provision of large-scale water control projects in this region is made difficult by:

- fragmentation of land between islands and main land areas of different sizes and shapes;
- the risk of erosion of flood embankments;
- irregular relief in some areas;
- large areas of sandy soils in some areas;
- the high cost of pump drainage low-lying basin areas with predominantly clay soils.

Soils

Three main kinds of soils occur in different areas:

a) Grey loams and clays developed in ridge and basin sites in areas of Meghna alluvium; these soils occupy the greater part of the region,

b) Grey loamy ridge soils and dark grey basin soils are neutral to slightly alkaline below an acid cultivated layer.

c) Grey sands to loamy sands with a compact silty top soil, occupying areas of old Brahmaputra char land which has been only buried by Meghna alluvium.

I.1.3 Lower Meghna River Floodplain (AEZ-17)

The major part of this region falls in the Chandpur zila along the Meghna River and stretching towards the south-east in the Lakshmipur and Noakhali zilas. This unit comprises slightly older tidal deposits between the Old Brahmaputra and the Meghna recent tidal floodplain. It has a rather irregular relief of gently undulating ridges and basins. The sediments appear to be a mixture of Ganges and Meghna alluvium. They are predominantly silty, sometimes slightly calcareous, but not saline.

Sub-regions

Originally, two sub-regions were recognised: the western half where the soils are very slightly calcareous; and the eastern half where the soils are not calcareous. Both parts were mainly moderately deeply flooded in the rainy season. The creation of the Chandpur Irrigation Project (CIP) polder with artificial drainage has divided each of these former sub-regions into a shallowly flooded and a moderately deeply flooded sub-region:

2a Calcareous, flood-protected (inside CIP) (AEZ-17a)

2b Calcareous, not flood-protected (outside CIP) (AEZ-17b)

2c Non-calcareous, flood-protected (inside CIP) (AEZ-17c)

2d Non-calcareous, not flood-protected (outside CIP) (AEZ-17d).

Drainage

The land is mainly moderately deeply flooded outside the CIP. Water-level fluctuates tidally in the south. Within the CIP, floodplain ridges are not flooded and depressions are mainly shallowly flooded with ponded river water (or by irrigation water in the dry season). However, during and after heavy pre-monsoon and monsoon rainfall, run-off water accumulates more deeply in basin centres for one or two weeks at a time, especially along the South Dakatia River and adjoining the CIP embankment. The proportion of land in different flooding depth classes (according to MPO) is shown in the following Table I.2

TABLE I.2

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
2a (AEZ-17a)	2	69	1	0	28
2b (AEZ-17b)	4	8	55	0	33
2c (AEZ-17c)	34	37	5	0	24
2d (AEZ-17d)	4	8	64	0	24
Region	11	31	31	0	27

Water Resources

The CIP area is irrigated with water drawn into the Dakatia River from the Lower Meghna River. There is ample water in that river to provide irrigation to the whole region, if desired. Groundwater apparently is readily available for exploitation by deep tubewells (DTWs), but saline in the south.

Development Constraints

Outside the CIP

a. Moderately deeply flooding with sudden rise and rapid flow of water near the Meghna River,

b. early flooding or waterlogging when pre-monsoon rains are heavy or start early, this may damage dryland rabi crops and High Yielding Variety (HYV) boro or it may prevent sowing of broadcast aus, deepwater aman and jute or destroy crops already sown,

c. silty soils which easily form a crust under the impact of heavy rainfall which are poorly aerated; this makes them better suited for paddy and jute than for dryland crops in the kharif season,

d. presence of large numbers of raised cultivated platforms, impeding irrigation lay-outs,

e. erosion along the Meghna River as well as exposure to cyclones and storm surges especially in the south-west,

f. poor road communication.

Agricultural Development Possibilities

This region has the highest rural population density in the country. Most parts are intensively cultivated, both under rainfed and irrigated conditions. Sub-region 2d is the least developed, mainly because of poor drainage.

Sub-regions 2a and 2c lie within the CIP. The area north of Chandpur is suitable for a similar polder project, using irrigation water from the Dhonagoda River. However, any large-scale irrigation/ drainage projects in this region need to take into account the following:

- the unstable banks of the Meghna River;
- the highly silty nature of most soils, causing easy slaking of the surface layer, with consequent slow infiltration, crusting etc.
- the large number of small raised platforms and associated tanks in the east and south,
- the high population density and predominance of small owner-cultivators,
- the possibility that with increasing abstraction of irrigation water from the Ganges-Brahmaputra-Meghna catchment in the upstream areas, salt water may eventually, in low-flow years, reach Chandpur and the intake to the CIP irrigation system.

Soils

Soils are relatively uniform within this region. Deep silts predominate. Soils in sub-regions 2a and 2b are very slightly calcareous because of the admixture of Ganges River alluvium with the Meghna sediments, whereas soils in sub-regions 2c and 2d are not calcareous.

In all sub-regions soils on ridges are lighter in texture and consistence than those in adjoining basins and depressions. Most ridge soils are olive silt loams, with grey gleyans along sub-soil cracks. Basin soils are mainly olive silty clay loams with dark grey gleyans. Soils in the extreme south show slightly saline patches in the dry season. Soils elsewhere are non-saline. Raised cultivation platforms are numerous in parts of the south and centre. They have been made from both calcareous and non-calcareous materials.

I.1.4 Young Meghna Estuarine Floodplain (AEZ-18)

This region occupies major parts of Lakshmipur and Noakhali, and small part of Feni zilas at the south and south-west of the study area. In the reconnaissance soil survey report the region has been shown as the Lower Meghna tidal floodplain while in AEZ as Young Meghna Estuarine floodplain. Although six sub-regions have been recognised to separate areas with differences in soils and salinity only sub-region 3f (18f) occurs in the study area. This sub-region comprises almost level recent char land and mud. The sediments are predominantly silty, stratified, slightly calcareous and usually somewhat saline. Usually there are few or no creeks, except on tidally flooded margins. Shifting channels constantly erode land and deposit new char formations. Mud is now cultivated.

Drainage

Mainly seasonally shallowly flooded by rain water retained within field bunds, but by river water or local run-off in depressions, where the water-level fluctuates tidally. The extreme northern part of sub-region 3f (AEZ-18f) on the Lakshmipur-Noakhali mainland is moderately deeply flooded. Flooding occurs only in the rainy season, except on marginal areas subject to tidal flooding through the dry season. Flooding is mainly by fresh water, except in the extreme south and in marginal areas which are tidally flooded in the dry season. Dry season soil salinity results from capillary rise of moisture to the surface from slightly to strongly saline groundwater at two to four metres depth. The percentage proportions occupied by various depth of flooding classes of this sub-region 3f (AEZ-18f) is shown in Table I.3.

TABLE I.3

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
3f (AEZ-18f)	0	41	10	0	49

Water Resources

River water in the Meghna estuary is fresh almost to the coast by the middle of rainy season, but salinity gradually penetrates northward in the dry season. Sweet groundwater apparently exists below 300 m, but it remains to be discovered whether or not this is recharged annually; also whether it would be economise to use such water for irrigation.

Development Constraints

Development constraints mainly include poor communication, big land-ownership (often absentee), dry season soil salinity and lack of fresh surface water or groundwater for dry season irrigation.

Agricultural Development Possibilities

Prospects for the intensification of rainfed agriculture are good in more accessible areas of Noakhali char land.

- The extreme north of Lakshmipur zila lies within the CIP area;
- Long term prospects exist for including the Noakhali mainland part of sub-region 3f in a comprehensive Comilla - Noakhali project drawing water from the Lower Meghna River;
- The possibility of making smaller polders inside existing Coastal Embankment Project polders deserves examination;
- Large-scale embankment and drainage projects in this region could be considered.

Soils

This is a very wet region and exposed to cyclones and storm surges. The soils consist of grey to olive, finely stratified, calcareous, silty alluvium which becomes saline in the dry season. A narrow strip of older, non-calcareous soils which are less affected by salinity occurs along the northern boundary of the sub-region on the Noakhali mainland. Cultivated topsoils are puddled and have a ploughman at the base.

Seasonal flooding is mainly by rainwater, but silty river water floods marginal areas and smaller chars, and fluctuates in level tidally. Salinity is mainly derived by capillary movement of moisture to the surface from a saline groundwater table, but calcareous mud on the outer edges of chars is tidally flooded with salt water during the dry season. River banks are subject to erosion and accretion as river channels change. This sub-region is badly exposed to cyclones and storm surges.

I.1.5 Old Meghna Estuarine Floodplain (AEZ-19)

This is by far the major region occupying almost half of the project area in Brahmanbaria, Comilla, Chandpur as well as northern parts of Feni, Noakhali and Lakshmipur zilas. This is a distinctive Agro-Ecological Zone (AEZ) unit that is no longer affected by river flooding and sedimentation. It lies relatively higher than the adjacent floodplain but merges gradually into them. According to Morgan and McIntire, this area has been uplifted one or two m higher than the adjacent Meghna floodplain. The landscape consists of an almost smoothed out plain of very low relief with low broad ridges and extensive shallow basins. Relief is made irregular locally by many man-made cultivation platforms in sub-region 4a east of Chandina. This extensive region has been divided into ten sub-regions, mainly on differences in flooding, partly soil differences and geographical separation.

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Drainage

Seasonal flooding ranges from shallow in sub-regions 4a and in the higher parts of 4b to moderately deep and deep in other sub-regions. Of the ten sub-regions, six are within the study area. The proportions of land in different depth of flooding classes in each sub-region are shown in Table I.4.

TABLE I.4

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
4a (AEZ-19a)	1	65	10	2	22
4b (AEZ-19b)	< 1	42	37	4	17
4c (AEZ-19c)	1	7	42	41	10
4d (AEZ-19d)	1	3	36	41	19
4e (AEZ-19e)	3	13	52	9	23
4i (AEZ-19i)	0	1	8	72	19
Region	1	22	31	28	18

The main features of the sub-regions are described below.

Sub-region 4a (AEZ-19a) in the east of Comilla, Noakhali and Feni zilas, has predominantly deep silty soils which are very shallowly or shallowly flooded; depressions are moderately deeply flooded. Flooding is mainly by rainwater, but occasionally by silty water when flash floods from adjoining hill areas occur. Areas adjoining the eastern border hills and the Dakatia River are subject to flash floods. Many low, man-made, cultivation platforms occur in the area between Chandina and the Lalmai Hills.

The medium highland soils have a puddled topsoil and compact ploughman which greatly reduces moisture availability for dry land rabi crops and broadcast kharif crops.

Sub-region 4b (AEZ-19b) occurs in Comilla, Brahmanbaria and a small outlier in the south of Habiganj zilas. The soils are deep silts similar to those in sub-region 4a, but the proportion of moderately deeply flooded basin land is greater. Areas near the eastern hills in Brahmanbaria and Habiganj are subject to flash floods.

Sub-region 4c (AEZ-19c) in Habiganj and the north of Brahmanbaria zilas, has deep silts which are predominantly moderately deeply and deeply flooded. Depression sites are subject to rapid rise of flood levels, especially in the east, and depression centres stay wet for part or all of the dry season. Extensive areas are kept wet by irrigation of boro paddy.

Sub-region 4d (AEZ-19d) has deep silty soils similar to those in the adjoining sub-regions 4b and 4c, but proportion of deeply flooded land is greater. The soils stay wet for some weeks after the rains end, especially in basin centres, and capillary recharge keeps the soils moist throughout the dry season in most years. The risk of rapid rise of flood levels is less than in sub-region 4c, except in areas close to rivers crossing the sub-region and adjoining the Middle Meghna floodplain (region 1).

Sub-region 4e (AEZ-19e) in Comilla, Chandpur, Lakshmipur, Noakhali and Feni zilas, has deep silty soils similar to those in adjoining sub-regions 4a, 4b and 4d, but flooding is mainly moderately deep and much of the area stays wet for most or all of the dry season. Drainage has deteriorated since the area was surveyed, apparently due to silting up of Noakhali Khal following large-scale land accretion in the south of Noakhali in the 1950's. With improved drainage, the area would become similar to sub-region 4b. A small area in the extreme western part of the sub-region lies within the CIP area where flood-levels are kept shallow by embankments and pump drainage.

Sub-region 4i (AEZ-19i) occupies the broad, partially-infilled channels of parts of the Titas River and Buri Nadi in Brahmanbaria zila. Soils are developed in different floodplain sediments. Old Meghna sediments are mainly silty and occupy the lowest relatively higher land. Surma-Kushiara sediments occupy the lowest sites and are grey and dark grey silt loams and clays while Middle Meghna sediments are grey loams and clays on narrow ridge and depression relief. Seasonal flooding is mainly deep or very deep, and flood-levels are liable to rise early and rapidly. Some soils stay wet for most or all of the dry season.

Water Resources

Surface water which could be used for irrigation is widely available or could be provided by large scale diversion from the Meghna.

Groundwater apparently is readily available for use by tube-wells, but salt water has been encountered locally in eastern parts of sub-region 4b in Brahmanbaria and Comilla zilas and might also be expected to occur near southern boundary of the region in Feni, Noakhali and Lakshmipur zilas.

Development Constraints

Main development constraints include:

a. Moderately deep or deep seasonal flooding over most of the region together with risk of early floods and flash floods, especially in north-east. Frequently breaching of embankments along rivers draining from the eastern hills aggravates this problem in sub-regions 4a, 4b, 4c and 4i.

b. Slow drainage (and poor aeration) of most soils after the rainy season ends, except on the highest ridge sites and in pump drained areas. This tends to delay the sowing of dryland rabi crops, and may prevent these crops from being grown at all in depression sites in years when late floods keep the soils wet until late December or January.

c. Very silty soils which are difficult to use for kharif dryland crops, even if artificially drained, because of easy slaking or puddling of the topsoil and consequent slow infiltration and poor aeration. Under the heavy rainfall conditions of the region, such soils are better suited for wetland crops than for dryland crops in the kharif season.

d. Irregular relief in areas with many cultivation platforms and tanks, hindering efficient irrigation layouts. The dense settlement pattern provides a similar constraint in many areas.

e. Congested drainage in sub-region 4e.

f. Exposure to cyclones in the south, especially in sub-regions 4a and 4e.

Agricultural Development Possibilities

Many parts of the region are highly developed, under both rainfed and irrigated conditions. The greatest needs are to extend flood protection, drainage and irrigation to remaining low-lying areas, where feasible, and to improve communications.

Soils

Soils are relatively uniform within this region, both between adjoining ridges and basins and between sub-regions. Silty soils predominate.

Most soils have a dark grey to black topsoil. In depression soils, the upper part or all of the subsoil is also dark coloured. In higher soils the subsoil generally is grey-brown to yellow-brown with dark grey coatings on the faces of subsoil cracks. Topsoil reaction generally is strongly or very strongly acid, but it is slightly acid or neutral in some soils. Subsoil reaction generally is neutral to slightly alkaline, but depression soils tend to be slightly to strongly acid in the upper subsoil, gradually becoming neutral or alkaline in deeper layers.

Organic matter contents in the cultivated layer range from 1 to 2.5% in most ridge soils and from 2 to 5% or more in depression soils. In depression soils, organic matter contents generally stay above 2% down to 50 cm or more. Permeability is mainly moderate in the higher soils and slow on depression soils. Higher soils used for transplanted aman cultivation have a puddled topsoil and strong ploughpan which make permeability slow. Moisture holding capacity generally is high except in some loose silty ridge soils and some basin clays. The predominant deep silty soils have a high capillary potential which keeps most soils wet and poorly aerated in the early part of the dry season and moist for most or all of the dry season. Depression soils generally stay wet early in the dry season, and many areas stay wet through the dry season, especially in sub-regions 4e and 4i.

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I.1.6 Sylhet Basin (AEZ-21)

This region occupies minor areas in the extreme north in Brahmanbaria zila. It comprises mainly smooth, broad basins with narrow rims of higher land along rivers. Relief is locally irregular near to rivers. Out of the three sub-regions, only one sub-region 5b (AEZ-21b) falls in the study area.

Drainage

Ridges are mainly moderately deeply flooded while the basins are deeply or very deeply flooded. The percentage proportions occupied by different depth of flooding classes in this sub-region are shown in Table I.5.

TABLE I.5

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
5b (AEZ-21b)	0	4	25	57	14

The region is subject to early floods and rapid rise in flood levels. Flooding is mainly by clear water but silty water affects basins when sudden floods occur. Floodwater drains rapidly from the ridges after the rainy season but basins stay wet for most or all of the dry season.

Water Resources

Surface water in rivers and in some beels is extensively used for dry-season irrigation. Irrigation could be extended with the help of canals, double-pumping or embankments (in different areas). Groundwater supplies may be available to supplement surface water supplies in marginal areas where the latter may be insufficient or the land may be too high to be easily commanded from surface water sources.

Development Constraints

Development constraints mainly include:

a. Early flash floods which destroy maturing boro paddy or young aus and deepwater aman;

b. Deep or very deep flooding, often with rapidly rising water levels due to the entry of flash floods from adjoining regions; this prevents deepwater aman from being grown over much of the region; deep water aman can also be uprooted by waves on open water surface and swamped by large rafts of water hyacinth brought in by flash floods,

c. Very heavy rainfall and persistent cloudiness in the pre-monsoon and monsoon seasons, which hamper harvesting, drying and storage of boro and aus paddy,

d. Predominance of heavy clays which are difficult to cultivate, both when wet and when moist,

e. Slow drainage of basin centres; extensive areas stay wet through the dry season; some have a soft mucky topsoil with a low bearing capacity, on perennially wet soils there are weeds that are difficult to control,

f. There are also social constraints such as poor or non-existent road communications, remoteness of interior areas from urban markets and many big land-owners who are often absentee.

Agricultural Development Possibilities

This is one of the more difficult regions for agricultural development in the whole country because of very high (and often heavy) rainfall, the severe flood hazards and the difficulty of controlling the enormous quantities of water entering from outside the region (and from outside the country). Yet the agricultural production has greatly increased during the past 20 years with the spread of Low Lift Pump (LLP) irrigation and HYV boro paddy cultivation.

However, there are limited possibilities to improve yields and production of kharif crop and dryland rabi crops because of the severe flood hazard and the greater suitability of most soils for boro paddy cultivation than for dryland rabi crops. Yet the possible opportunities to be examined in particular localities are (i) increased and more efficient use of fertilisers on aus and transplanted aman paddy where grown (ii) transplanting of aus and deepwater aman on land where the hazard of early flood damage is not too great, (iii) transplanting of adapted deepwater aman varieties, and (iv) field drains to speed up the drainage of margin soils so that quick-maturing mustard and pulses crops could be grown before HYV boro.

The small scale irrigation possibilities which may be considered are shown below.

1) Expansion of efficiency of irrigation in existing irrigated areas by:

   - lining channels crossing permeable river bank soils; providing control structures on sloping river-bank soils; levelling fields where necessary etc,

2) Expansion of irrigated area by excavating additional khals so that more LLP could be installed or by providing tubewells, where feasible, in areas which cannot be reached by surface water supplies,

3) Identification of other schemes for flood protection, drainage and irrigation,

4) In flood-prone areas which cannot easily be protected, make raised platforms for intensive cultivation of suitable rabi and summer vegetables, fruits and spices, provide dry-season irrigation from adjoining tanks or khal on by hand tubewells (HTW).

Prospects for large-scale irrigation/drainage are poor because of the difficulty of controlling the huge quantities of flood water entering from adjoining regions; the difficulty and high cost of pumps drainage the large volumes of water derived from rapid run-off and accumulation of heavy pre-monsoon and monsoon rainfall within polders against heads of upto five metres or more.

Soils

Soils in the small area of Sylhet Basin at the northern trip of the project in Brahmanbaria zila (sub-region 5b) have grey, heavy, silty clay loams and clays on ridges and basin margins. However, grey or bluish grey shallowly developed, clay soils occur in perennially wet basin centres.

I.1.7 Northern and Eastern Piedmont Plains (AEZ-22)

This region occur as a narrow discontinuous strip of land at the foot of the northern and eastern hills, except part of Feni zila where the narrow piedmont strips have been included with the Chittagong Coastal Plain. Piedmont plains occurring within hill areas have mainly been included within sub-region 7c. The physiography comprises merging alluvial fans which slope gently outward from the foot of the northern and eastern hills into smooth, low-lying basins. Locally, the relief is irregular close to rivers and streams crossing the region, especially on higher land near the hills.

Sub-regions

Four sub-regions have been recognised on the basis of difference in soils and flooding characteristics. However, the following three sub-regions have fallen in the study area.

6b Northern and Eastern Plains and Basins (AEZ-22b)

6c South Sylhet Piedmont Plains (AEZ-22c)

6d Northern and Eastern Basins (AEZ-22d)

I.1.7.1 Sub-region

Northern and Eastern Plains and Basins (AEZ-22b)

This sub-region occupies a narrow strip along the outer edge of the old piedmont apron at the east of the Comilla zila along the border and a small patch along the eastern side of the Lalmai Hills near Comilla town. It comprises continuous older and younger alluvial fans with a generally smooth gentle slope outward merging with the floodplain in the south and with the Comilla basin.

I.1.7.2 Sub-region

South Sylhet Piedmont Plains (AEZ-22c)

This sub-region occurs in the east of Brahmanbaria zila and South of Madhabpur Thana of Habiganj zila. This comprises valleys and level land sloping westward from the hill ranges and the unit is spotted by few basin depressions here and there.

I.1.7.3 Sub-region

Northern and Eastern Basins (AEZ-22d)

This sub-region mainly occurs in and around Comilla town which borders the piedmont apron and forms an elongated, nearly flat, trough between the Lalmai Hills and the eastern border hills. The sediments are mainly fine textured and probably mainly derived from the adjoining hills. A similar sub-region also accurse in the east of Brahmanbaria district.

Drainage

Large parts of sub-regions 6b and 6c stand above normal flood levels, but they are subject to shallow flash floods and rainwater is retained on the surface within field bunds. Lower parts are shallowly to moderately deeply flooded in the rainy season. Sub-region 6d is mainly moderately deeply to deeply flooded but parts in Comilla are only shallowly to moderately deeply flooded. This sub-region is also subject to early flash floods and rapid rise of flood levels following heavy rainfall in neighbouring hills. Basin centres stay wet during the early part of the dry season.

The average percentage proportions of the area occupied by different depth of flooding in each sub-region are shown in Table I.6.

TABLE I.6

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
6b (AEZ-22b)	35	26	24	7	8
6c (AEZ-22c)	46	36	6	< 1	12
6d (AEZ-22d)	6	24	22	35	13
Region	29	29	17	14	11

Water Resources

Dry season surface water supplies in rivers or streams are limited and are mainly fully used, either within the region or in downstream areas. Supplies are also uncertain in sub-region 6c due to diversions upstream in India. Artesian supplies occur locally.

Development Constraints

The main development constraints include: floods, mainly flash floods and early floods and deep flooding in basins; the difficulty of controlling floods because of the huge volumes of water and sediments entering the region from adjoining regions; heavy monsoon rainfall and cloudiness hamper harvesting, drying and storage of boro paddy; compact topsoil and plough pan in most ridge and basin soils makes tillage difficult and prevents or restricts the cultivation of dryland rabi crops, with or without irrigation.

Agricultural Development Possibilities

In view of the constraints listed above, and the difficulty of removing them, generally severely restrict development potential, especially in the kharif season.

Soils

This region has complex soil patterns due to the irregular deposition of sediments of different textures during successive flash floods. Sub-regions 6b and 6c occupy relatively higher piedmont plains adjoining the hills where flooding is mainly intermittent during flash floods. Sub-region 6b has the most complex relief and soil pattern, especially in areas close to the hills. Deposits range from sands to clays, though the greater part of the area is occupied by soils with sandy loam to silty clay texture. Sub-region 6c has soils similar to those in sub-region 6b but they occupy smoother relief and silty clay loams and silty clays predominate.

The piedmont plain in sub-regions 6b grade into moderately deep to deeply flooded basins which have predominantly clay soils. The largest basin areas have been shown separately in sub-region 6d. Relatively small areas of more loamy soils occur on higher land near rivers and streams. Depth of flooding is less in Comilla zila than elsewhere in this region.

I.1.8 Northern and Eastern Hills (AEZ-29)

This region includes very small parts of the country's hill areas and differs from all other areas in its hilly relief. The boundaries with adjoining regions generally are sharp. However, it should be noted that boundaries as shown on the map do not necessarily indicate the boundary of the hills. In some areas, especially in sub-regions 7b the boundary has been drawn along the outer boundary of narrow strips of piedmont soils adjoining the hills because they cannot be shown separately on the map scale used.

This region has been differentiated into three sub-regions. However, the following two sub-regions have fallen in the study area.

7b Mainly low hills (AEZ-29b)

7c Low hills and piedmont plains (AEZ-29c)

I.1.8.1 Mainly Low Hills (AEZ-29b)

This sub-region occupies a small area near Comilla town known as the Lalmai Hills. This is rather dissected low hill area developed over unconsolidated Dupi Tila and Dihing sandstones and shales. The relief varies from very steeply dissected to gently rolling. Floodplain land occupies less than 10% of the landscape. This sub-region also occurs in south-west of Madhabpur Thana of Habiganj in the extreme north-east of this project.

The area mainly constitutes an uplifted block bounded by faults. The summit is flat in many places. The sides are steep and strongly gullied especially in the West. The highest parts are more than 30 m above MSL, but the average elevation is in the neighbourhood of 20 m above MSL. The hills consist mainly of unconsolidated sands and silts. Gravel and cobble layers occur in the central and western part of the hills.

I.1.8.2 Low Hills and Piedmont Plains (AEZ-29c)

This sub-region occupies very minor area in small isolated patches at the extreme east of Comilla, south-east of Brahmanbaria and north of Feni zilas along the border. This comprises a narrow fringe of low hills flanking the western edge of the Chittagong-Tripura Hills along the eastern boundary of the area. These low hills have subsequently been dissected and eroded now have a gently rolling relief. Elevations vary from 15 m MSL at the eastern extremity to about 8 m adjoining the young piedmont apron. These hills, generally referred to locally as the foothills are also found at the eastern foot of the hills and from the transitional zone between those hills and the younger piedmont apron at lower elevations. They consist of unconsolidated sediments of young pleistocene or holocene age derived from the outwash of the Chittagong-Tripura Hills and the Lalmai Hills.

This sub-region has relief and rocks similar to sub-region 7b, but floodplain land occupies 10-30% of the landscape. Alluvium sediments mainly comprise sandy and loamy piedmont terrace and floodplain deposits similar to those in region 6 (AEZ-22).

Drainage

The hills are mainly excessively well drained, but in some places there is a narrow strip near valley bottoms which is imperfectly drained. Narrow strips of alluvial terraces in some broader valleys are moderately well drained, but valley soils are poorly drained and subject to flash floods.

The estimated percentage proportion of the landscape occupied by different depth of flooding classes are shown in Table I.7.

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TABLE I.7

Percentage of Land in Different Flood Phases

Sub-region	Highland	Medium Highland	Medium Lowland	Low and Very Lowland	Homesteads and Water
7b	85	2	< 1	0	13
7c	84	8	1	< 1	7
Region	85	5	< 1	0	10

Water Resources

Only limited amounts of surface water exist in perennial rivers. This is partially used on available alluvial soils for HYV boro paddy cultivation. Cross-dams are built seasonally on some hill rivers and streams to divert water into gravity irrigation channels.

Groundwater supplies in valleys apparently are erratic: artesian supplies exist locally; elsewhere there are no accessible aquifers. However, more detailed groundwater investigations are needed to locate aquifers which could be used to irrigate tea and other tree crops on adjoining low hills with soils suitable for these crops.

Development Constraints

Development constraints mainly include: steep slopes on most of land, difficult communications in most areas because of long, linear, hill ranges with steep slopes where roads are expensive to build and to maintain, low soil fertility and very strongly acid soils may be strongly phosphate - fixing, fertiliser nitrogen is rapidly leached during heavy monsoon rainfall, flash floods in valleys, unsuitability of most hill soils for terracing because of very steep slopes with very heavy rainfall and risk of land slip and erosion, and general lack of suitable rock material for building terrace retaining walls.

Agricultural Development Possibilities

There is a considerable potential as well as a considerable need for development of forestry and tea crops in all hill areas, both as an appropriate form of land use and in order to reduce the frequency and severity of flash floods on adjoining land. However, because of the difficult terrain, development costs may be high.

In rainfed conditions, dryland kharif crops and early rabi crops are grown on level tops of some low hills as well as on slopes that are terraced. Suitable crops include pineapple, ginger, cassava, aus paddy, maize, kharif pulses, oil seeds, early mustard, banana, betel leaf, fruit trees (especially jackfruit), coconut, and betel nut are also suitable. On sloping soils, tree crops are more appropriate: tea, coffee, rubber, banana on low hills with relatively gentle slopes and deep loamy soils; jackfruit on similar or moderately steep soils; forest (for fuel wood, fodder, timber or watershed protection) elsewhere.

Small scale irrigation facilities may be considered on levelled fields by lining channels where necessary, double-lifting water on to higher land where feasible. There is a need for identification of local schemes for improving valley land by flood protection, drainage and/or irrigation and improvement of soil and crop management on irrigated land.

The broken relief is unsuitable for large-scale irrigation/ drainage projects. However, other kinds of large-scale projects that are needed or deserve examination are: a) afforestation of hill soils that are not suitable for crop cultivation, b) soil conservation works in areas where it is practical to terrace soils for growing field crops on tree crops, and c) overhead irrigation of high-value tree crops either from DTWs where adequate groundwater supplies exist or from pumps located on perennial rivers.

Soils

The major hill soils are yellow-brown to strong brown, permeable, friable, loamy, very strongly acid and low in moisture holding capacity. However, soil patterns generally are complex due to local differences in sand, silt and clay contents of the underlying sedimentary rocks in depth to rock, and in the amount of erosion that has occurred. Piedmont and floodplain soils included in the region resemble those of the neighbouring areas of region 6 (22) and 7 (23).

I.1.9 Akhaura Terrace (AEZ-30)

This region occupies two areas on the eastern border of Brahmanbaria zila, and extends marginally into the south-west corner of Madhabpur Thana of Habiganj zila. The region resembles some dissected parts of the Madhupur Tract, with level upland soils having jackfruit trees on field boundaries and dissected by mainly deep, broad valleys used for paddy cultivation.

This region comprises mainly broad, level upland areas standing three to six metres above broad piedmont valleys and is variably dissected. Most of the terrace area has level landscape. However, a small part north-east of Akhaura adjacent to border has more undulations due to close dissection.

Drainage

Upland soils are mainly moderately well drained but some low terrace remnants are seasonally shallowly flooded. Valleys are shallowly to very deeply flooded and lower parts stay wet through the dry season. Major part of the area constitute highland (about 55%). However, medium highland and medium lowland areas are 11% and 10% respectively and low-very low land areas is 18%, while homesteads and water occupy only 6%.

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Water Resources

Surface water supplies are limited, and are mainly used for irrigation of boro paddy in lower valley sites. Groundwater show potential but supplies need further investigation.

Development Constraints

Low moisture holding capacity, flash floods in valleys, deep flooding of lower valleys and poor communication are the features in this region.

Agricultural Development Possibilities

The development potential is relatively low under rainfed condition, and high where irrigation can be provided.

Large scale water control projects would be impractical to implement in this small region with its fragmented upland areas and uncontrolled inflow of floods from India.

Soils

The upland soils are developed over a thick clay deposit and the main soils have a brown loamy topsoil overlying a yellow-brown or strong brown clay subsoil with red mottles which grades into a dominantly red-mottled clay substratum below about one metre. However, valley soils include grey, mottled, silt loams and silty clay loams in intermittently and shallowly flooded upper parts of valleys, and dark grey heavy clays and peat in deeply flooded lower valleys.

The area and percentage of Agro-Ecological Zones (regions and sub-regions) with of Soil Mapping Units(Soil Association Nr), area and percentage of the South-East Regional Study Area are shown in Table I.8.

TABLE I.8

Agro-Ecological Zones (Regions & Sub-regions) with Soil Mapping Units

Legend Nr	Name of Agro-Ecological Zones (Region & Sub-region)	Components of Soil Mapping Units (Soil Association Nr)	Area (sq km)	Per cent
1 (AEZ-16)	MIDDLE MEGHNA RIVER FLOODPLAIN	[1 to 5,6(Part),7,8,9,69,70,71,82,83 and 84]	817	7.65
2 (AEZ-17)	LOWER MEGHNA RIVER FLOODPLAIN			
2a (AEZ-17a)	Calcareous, flood-protected	[86(Part),87(Part),88(Part),89(Part) & 93(Part)]		
2b (AEZ-17b)	Calcareous, not flood-protected	[86(Part),87(Part),88(Part),89(Part) & 92(Part)]		
2c (AEZ-17c)	Non-calcareous, flood-protected	[80(Part),91(Part),92(Part) and 93(Part)]		
2d (AEZ-17d)	Non-calcareous, not flood-protected	[90 and 91(Part)]	938	8.79
3 (AEZ-18)	YOUNG MEGHNA ESTUARINE FLOODPLAIN			
3f (AEZ-18f)	Saline : Noakhali & Meghna Estuarine Mud	[94 to 100 and M]	1 746	16.35
4 (AEZ-19)	OLD MEGHNA ESTUARINE FLOODPLAIN			
4a (AEZ-19a)	Highland	[60,61(Part),66,68,72(Part),73,85 and 101]		
4b (AEZ-19b)	Medium Lowland	[10,12,14(Part),15,16,17,20(Part),21 40(Part),48,56(Part),57(Part),58,59,61(Part), 63,64,65,72(Part) and 74]		
4c (AEZ-19c)	Lowland: Habiganj-North Brahmanbaria	[18 & 40(Part)]		
4d (AEZ-19d)	Lowland: Daudkandi-Hajiganj and part Burichang-Debidwar	[20(Part),52 to 55,56(Part),61(Part),67,76,79 & 80(Part)]		
4e (AEZ-19e)	Very poorly drained : Laksham-Begumganj	[57(Part),61(Part),62,77,78,80(Part) and 81]		
4i (AEZ-19i)	Lowland: Titas Floodplain	[6(Part),11,13,19,20(Part),23(Part) and 24]	5 242	49.10
5 (AEZ-21)	SYLHET BASIN			
5b (AEZ-21b)	Northern	[14(Part),22 and 23(Part)]	171	1.60
6 (AEZ-22)	NORTHERN AND EASTERN PIEDMONT PLAINS			
6b (AEZ-22b)	Northern & Eastern Plains and Basins	[43(Part),45,46,47 and 50]		
6c (AEZ-22c)	South Sylhet Piedmont Plains	[25(Part),27,28 and 41(Part)]		
6d (AEZ-22d)	Northern & Eastern Basins	[26(Part),29(Part),30,36(Part) and 51]	445	4.17
7 (AEZ-29)	NORTHERN AND EASTERN HILLS			
7b (AEZ-29b)	Mainly Low Hills	[41(Part) and 42]		
7c (AEZ-29c)	Low Hills and Piedmont Plains	[25(Part),37,38,39,43(Part),44,49 and 75]	147	1.38
8 (AEZ-30)	AKHAURA TERRACE	[26(Part),29(Part),31 to 35, 36(Part) and 41(Part)]	111	1.03
		Sub-Total	9 617	90.07
		Water Bodies	1 011	9.47
		Urban Area	49	0.46
		Grand Total	10 677	100.00

Note: 1. Water Bodies, Urban area and others are not shown in different colours in the soil map separately and are distributed within different Agro-Ecological Zones of the study area.

2. Part of soil mapping units (soil associations) distributed in different AEZs are tentative.

Source: Areas shown in the table have been estimated from the figure available in the reconnaissance soil survey reports of Sunamganj-Habiganj (1976), Brahmanbaria (1973) and Noakhali, Comilla Sadar North & South and Chandpur Districts (1965-66) prepared by Department of Soil Survey (SRDI), SODAT of MPO, and Report-2, Agro-Ecological regions of Bangladesh, FAO, 1988.

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CHAPTER I.2

SOIL MAPPING UNIT

I.2.1 Introduction

The South-East Regional Study Area includes the present zilas of Brahmanbaria, Comilla, Chandpur, Lakshmipur, Noakhali (apart from Hatiya), and Daganbhuiyan Thana, 59% of Feni Sadar Thana, 53% of Sonagazi Thana of Feni zila and 65% of Madhabpur Thana of Habiganj zila. The study area has been covered by the Reconnaissance Soil Survey conducted during the mid sixties and seventies as part of the programme of soil survey project of former Pakistan for the systematic soil survey of the whole country.

I.2.2 Soil Associations

Soil associations are recognized as a soil mapping unit of this study area at the reconnaissance soil survey level by the Soil Resources Development Institute (SRDI).

Because of the reconnaissance nature of the survey and the fact that individual occurrence of particular soils could rarely be mapped separately on the map scale used (1:125 000, Album of Drawings). Soil association has been used as the mapping unit. A soil association is a group of related soils occurring regularly together in a distinctive patterns which is usually determined by relief and drainage. A total of 101 soil associations are shown on the Soil Association Map. These are grouped into Agro-Ecological Zones (regions/sub-regions) showing on the Soil Association Map in different colours. Within these associations there are 74 major soil series. Soil series are the sub-divisions of Soil Association. For details in this regard reference is made to the reconnaissance soil survey reports of Sonagazi-Habiganj (1976), Brahmanbaria (1973), and Noakhali; Comilla Sadar North and Sadar South and Chandpur District (1965-66) prepared by Department of Soil Survey (Now SRDI) of the study area.

The Thanawise distributions of different soil associations and soil textures in the study area are shown respectively in Table I.9 and Table I.10.

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TABLE I.9

Thana-wise Area of Land Type and Soil Association

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project Area (sq km)	Percentage of Project Area
	HABIGANJ						
1.	**Madhabpur (65% area of Thana)**						
	F0	30.45	1. Madhabpur - Richi (MH)	[40]	99.05		
	F1	96.30	2. Pritimpasa - Manu (mainly low hills)	[41]	57.94		
	F2	32.51	3. Pritimpasa - Manu (Akhaura terrace)	[41]	8.28		
	F3	1.55	4. Pritimpasa - Manu (Piedmont plains)	[41]	16.55		
		---------			---------		
	NCA	160.81			181.82	181.82	
	Misc	21.01				--------	
		---------				181.82	1.70
		181.82					
	BRAHMANBARIA						
2.	**Nasirnagar**						
	F1	1.69	1. Sandy and Silty alluvium complex	[1]	0.79		
	F2	146.57	2. Dhamti-Barura (MH & ML))	[14]	3.13		
	F3	107.72	3. Dhamti-Barura (ML)	[18]	199.72		
		---------	4. Sulla-Azmiriganj-Madhyanagar	[22]	50.28		
	NCA	255.98	5. Sulla-Nasirnagar	[23]	44.54		
	Misc	42.48			--------		
		---------			298.46	298.46	
		298.46	Water Bodies		-	15.05	

						313.51	2.94

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
3.	**Sarail**						
	F1	34.51	1. Sandy & Silty alluvium complex	[1]	6.20		
	F2	52.07	2. Homna-Borda	[7]	10.10		
	F3	90.88	3. Jalkundi-Dhamti	[13]	3.88		
		---------	4. Dhamti-Barura (MH & ML)	[14]	79.28		
	NCA	177.46	5. Dhamti-Barura (ML)	[18]	5.40		
	Misc	18.85	6. Dhamti-Godnail-Burichang	[19]	18.88		
		---------	7. Sulla-Nasirnagar	[23]	68.67		
		196.31	8. Nabinagar-Nasirnagar	[24]	3.90		

					196.31	196.31	
			Urban Area		-	8.56	
			Water Bodies		-	7.52	

						212.39	1.99
4.	**Brahmanbaria Sadar**						
	F0	42.73	1. Jalkundi-Debidwar (MH & ML)	[10]	37.03		
	F1	61.64	2. Godnail-Jalkundi	[12]	15.53		
	F2	90.20	3. Jalkundi-Dhamti	[13]	58.76		
	F3	162.93	4. Dhamti-Barura (MH & ML)	[14]	82.87		
		---------	5. Dhamti-Tippera	[16]	33.96		
	NCA	357.50	6. Sulla-Nasirnagar	[23]	5.45		
	Misc	30.28	7. Nabinagar-Nasirnagar	[24]	53.37		
		---------	8. Durgapur-Sahazibazar	[29]	11.66		
		387.78	9. Chakla-Purbabhag	[30]	30.33		
			10. Satgaon-Bagadi Chakla	[31]	9.32		
			11. Pattan-Nidarabad-Rupa	[32]	17.62		
			12. Nidarabad-Sibna	[33]	19.95		
			13. Pattan-Rupa	[34]	11.93		

					387.78	387.78	
			Urban Area		-	7.26	
			Water Bodies		-	22.03	

						417.07	3.91

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
5.	**Ashuganj**						
	F1	41.68	1. Sandy & Silty alluvium Complex	[1]	5.64		
	F2	41.71	2. Ikram-Fuldi	[3]	3.89		
	F3	12.11	3. Fuldi Series	[6]	2.84		
		---------	4. Dhamti-Barura (MH and ML)	[14]	95.82		
	NCA	95.50			--------		
	Misc	12.69			108.19	108.19	
		---------	Urban Area		-	2.08	
		108.19	Water Bodies		-	7.52	

	[Sandy & Silty alluvium complex area (1.36) deducted from F2 of project area]					117.79	1.10
6.	**Akhaura**						
	F0	17.25	1. Jalkundi-Debidwar (L & ML)	[11]	12.42		
	F1	11.17	2. Jalkundi-Dhamti	[13]	3.90		
	F2	21.23	3. Nabinagar-Nasirnagar	[24]	19.94		
	F3	31.44	4. Ramnagar-Chakla-Sahazibazar	[25]	0.54		
		---------	5. Chakta-Ramnagar	[26]	28.34		
	NCA	81.09	6. Sahazibazar Series	[28]	3.37		
	Misc	9.17	7. Satgaon-Bagadi-Chakla	[31]	0.80		
		---------	8. Pattan-Nidarabad-Rupa	[32]	6.21		
		90.26	9. Nidarabad-Rupa	[35]	12.41		
			10. Simrail-Durgapur	[36]	2.33		

					90.26	90.26	
			Urban Area		-	3.13	

						93.39	0.88

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
7.	**Kasba**						
	F0	36.88	1. Jalkundi-Debidwar (L & ML)	[11]	5.18		
	F1	55.78	2. Dhamti-Barura-Tippera	[17]	103.60		
	F2	60.41	3. Burichang-Jalkundi	[20]	5.69		
	F3	25.15	4. Burichang-Dakatia	[21]	8.80		
		---------	5. Nabinagar-Nasirnagar	[24]	6.46		
	NCA	178.22	6. Ramnagar-Chakla-Sahazibazar	[25]	11.64		
	Misc	26.84	7. Pritimpasa-Sahazibazar	[27]	13.46		
		---------	8. Sahazibazar Series	[28]	32.12		
		205.06	9. Nidarabad-Rupa	[35]	3.08		
			10. Nalua-Kamuri	[37]	3.89		
			11. Nalua-Salban-Sahazibazar	[38]	6.47		
			12. Rangamati-Juri	[39]	4.67		

					205.06	205.06	
			Water Bodies		-	2.08	

						207.14	1.94
8.	**Nabinagar**						
	F1	76.33	1. Sandy and Silty alluvium complex	[1]	6.98		
	F2	138.17	2. Fuldi-Bancharampur (MH)	[4]	14.00		
	F3	67.64	3. Fuldi Series	[6]	45.36		
		--------	4. Borda-Fuldi	[9]	1.56		
	NCA	282.14	5. Barura-Dhamti (ML)	[15]	129.00		
	Misc	46.61	6. Dhamti-Barura-Tippera	[17]	77.96		
		---------	7. Burichang-Jalkundi	[20]	27.20		
		328.75	8. Nabinagar-Nasirnagar	[24]	26.69		

					328.75	328.75	
			Water Bodies		-	23.64	

						352.39	3.30

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project Area (sq km)	Percentage of Project Area
9.	**Bancharampur**						
	F1	34.90	1. Sandy and Silty alluvium complex	[1]	33.93		
	F2	58.21	2. Tangerchar-Fuldi	[2]	6.48		
	F3	48.57	3. Fuldi-Bancharampur (MH)	[4]	13.20		
		--------	4. Fuldi-Bancharampur (ML)	[5]	51.80		
	NCA	141.68	5. Borda-Bancharampur	[8]	19.94		
	Misc	27.94	6. Barura-Fuldi	[9]	44.01		
		--------	7. Barura-Dhamti (ML)	[15]	0.26		
		169.62			---------		
					169.62	169.62	
			Water Bodies		-	37.57	

						207.19	1.94
	COMILLA						
10.	**Homna**						
	F2	7.46	1. Borda-Fuldi	[9]	10.34		
	F3	129.08	2. Borda-Silmondi	[69]	41.45		
		--------	3. Manikandi-Fuldi-Borda	[70]	1.57		
	NCA	136.54	4. Tangerchar-Borda	[71]	69.93		
	Misc	11.09	5. Tangerchar-Fuldi	[2]	24.34		
		--------			---------		
		147.63			147.63	147.63	
			Water Bodies		-	31.10	

						178.73	1.67

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
11.	**Daudkandi**						
	F2	17.86	1. Jalkundi-Godnail-Burichang	[52]	127.96		
	F3	297.27	2. Burichang-Simandi	[67]	58.79		
		---------	3. Borda-Fuldi	[9]	99.19		
	NCA	315.13	4. Manikandi-Fuldi-Borda	[70]	12.67		
	Misc	40.19	5. Tangerchar-Borda	[71]	56.71		
		---------			---------		
		355.32			355.32	355.32	
			Water Bodies		-	20.22	

						375.54	3.52
12.	**Muradnagar**						
	F0	11.67	1. Jalkundi-Godnail-Burichang	[52]	70.84		
	F1	58.15	2. Burichang-Godnail-Siddirganj	[53]	25.18		
	F2	86.64	3. Muradnagar-Burichang	[54]	24.38		
	F3	132.96	4. Barura-Burichang	[57]	70.62		
		---------	5. Burichang-Barura-Jalkundi	[58]	31.25		
	NCA	289.42	6. Debidwar-Barura	[59]	2.72		
	Misc	48.54	7. Tippera-Debidwar	[61]	49.67		
		---------	8. Tippera-Jalkundi	[64]	9.50		
		337.96	9. Tippera-Chandina	[65]	28.96		
			10. Borda-Fuldi	[9]	1.49		
			11. Manikandi-Fuldi-Borda	[70]	19.60		
			12. Gumti-Tippera	[72]	3.46		
			13. Dakatia-Burichang	[74]	0.29		

					337.96	337.96	
			Water Bodies		-	3.94	

						341.90	3.20

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
13.	**Debidwar**						
	F0	4.86	1. Jalkundi-Godnail-Burichang	[52]	27.67		
	F1	96.09	2. Burichang-Jalkundi	[20]	1.00		
	F2	69.69	3. Barura Series	[56]	28.34		
	F3	23.62	4. Debidwar-Barura	[59]	43.00		
		---------	5. Tippera-Debidwar	[61]	80.95		
	NCA	194.26	6. Tippera-Jalkundi	[64]	38.15		
	Misc	38.81	7. Gumti-Tippera	[72]	13.96		
		---------			---------		
		233.07			233.07	233.07	
			Water Bodies		-	2.61	

						235.68	2.21
14.	**Chandina**						
	F0	5.72	1. Jalkundi-Godnail-Burichang	[52]	96.71		
	F1	59.50	2. Barura Series	[56]	3.60		
	F2	19.27	3. Tippera-Debidwar	[61]	88.00		
	F3	82.20	4. Tippera-Debidwar-Dhamti	[63]	9.97		
		---------	5. Debidwar-Bharella	[66]	3.73		
	NCA	166.69			---------		
	Misc	35.32			202.01	202.01	
		---------				---------	
		202.01				202.01	1.89

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
15.	**Burichang**						
	F0	11.49	1. Lalmai-Kamuri-Kotbari	[42]	1.04		
	F1	79.06	2. Sankochail-Chakla-Kharrera	[44]	9.37		
	F2	44.13	3. Bharella-Chakla-Rangari	[45]	9.11		
	F3	2.29	4. Bharella-Bijipur	[47]	0.11		
		---------	5. Olipur Series	[48]	0.60		
	NCA	136.97	6. Chakla-Bharella	[51]	43.62		
	Misc	28.32	7. Burichang-Jalkundi	[20]	22.92		
		---------	8. Tippera-Debidwar	[61]	19.00		
		165.29	9. Debidwar-Bharella	[66]	38.60		
			10. Gumti-Tippera	[72]	20.92		

					165.29	165.29	
			Water Bodies		-	3.10	

						168.39	1.58
16.	**Brahmanpara**						
	F0	0.69	1. Bharella-Chakla-Rangari	[45]	11.30		
	F1	20.65	2. Chakla-Bharella	[51]	5.90		
	F2	78.32	3. Burichang Series	[55]	19.00		
	F3	6.55	4. Burichang-Jalkundi	[20]	31.33		
		---------	5. Barura Series	[56]	26.80		
	NCA	106.21	6. Tippera-Jalkundi	[64]	22.01		
	Misc	18.08	7. Dakatia-Burichang	[74]	7.95		
		---------			---------		
		124.29			124.29	124.29	

						124.29	1.16

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
17.	**Comilla Sadar**						
	F0	50.50	1. Lalmai-Kamuri-Kotbari	[42]	28.15		
	F1	116.39	2. Sankochail Series	[43]	13.97		
	F2	51.80	3. Bharella-Chakla-Rangari	[45]	29.47		
		---------	4. Bharella Series	[46]	35.52		
	NCA	218.69	5. Bharella-Bijipur	[47]	28.02		
	Misc	33.64	6. Olipur Series	[48]	3.80		
		---------	7. Chakla-Bharella	[51]	88.60		
		252.33	8. Tippera-Debidwar	[61]	10.48		
			9. Tippera-Debidwar-Dhamti	[63]	6.25		
			10. Debidwar-Bharella	[66]	7.60		
			11. Gumti-Tippera	[72]	0.47		

					252.33	252.33	
			Urban Area		-	14.59	
			Water Bodies		-	2.45	

						269.37	2.52
18.	**Chauddagram**						
	F0	42.60	1. Sankochail Series	[43]	9.43		
	F1	142.49	2. Bharella Series	[46]	8.18		
	F2	36.77	3. Pritimpasa Series	[49]	4.92		
	F3	1.77	4. Pritimpasa-Bijipur	[50]	18.65		
		---------	5. Chakla-Bharella	[51]	29.00		
	NCA	223.63	6. Tippera Series	[60]	92.99		
	Misc	45.07	7. Tippera-Debidwar	[61]	87.81		
		---------	8. Dakatia-Bashanda	[73]	17.72		
		268.70			--------		
					268.70	268.70	
			Water Bodies		-	5.84	

						274.54	2.57

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
19.	**Laksham**						
	F0	19.24	1. Bharella-Bijipur	[47]	0.76		
	F1	117.59	2. Chakla-Bharella	[51]	6.09		
	F2	180.24	3. Barura-Burichang	[57]	137.14		
	F3	35.66	4. Tippera Series	[60]	131.19		
		---------	5. Dhamti-Debidwar	[62]	81.33		
	NCA	352.73	6. Tippera-Debidwar-Dhamti	[63]	64.10		
	Misc	72.02	7. Tippera-Dhamti	[68]	4.14		
		---------			---------		
		424.75			424.75	424.75	
			Water Bodies		-	7.81	

						432.56	4.05
20.	**Barura**						
	F0	6.28	1. Lalmai-Kamuri-Kotbari	[42]	0.52		
	F1	75.97	2. Bharella-Bijipur	[47]	0.08		
	F2	113.22	3. Olipur Series	[48]	2.67		
	F3	0.31	4. Barura Series	[56]	51.29		
		---------	5. Barura-Burichang	[57]	1.20		
	NCA	195.78	6. Tippera-Debidwar	[61]	75.08		
	Misc	45.15	7. Tippera-Debidwar-Dhamti	[63]	110.09		
		---------			--------		
		240.93			240.93	240.93	

						240.93	2.26

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
21.	**Nangalkot**						
	F0	16.74	1. Barura-Burichang	[57]	10.12		
	F1	124.85	2. Tippera Series	[60]	118.17		
	F2	35.04	3. Tippera-Debidwar	[61]	3.31		
	F3	5.56	4. Tippera-Dhamti	[68]	60.35		
		----------	5. Dakatia-Bashanda	[73]	29.26		
	NCA	182.19			--------		
	Misc	39.02			221.21	221.21	
		----------	Water Bodies		-	4.16	
		221.21				--------	
						225.37	2.11
	CHANDPUR						
22.	**Matlab**						
	F0	0.19	1. Tippera-Debiwdar	[61]	2.84		
	F1	9.82	2. Tippera-Naraibag-Debidwar	[76]	27.20		
	F2	203.89	3. Jalkundi-Godnail-Burichang	[52]	8.03		
	F3	48.93	4. Burichang-Tippera	[79]	43.79		
		--------	5. Burichang-Debidwar	[80]	0.26		
	NCA	262.83	6. Burichang Series	[55]	1.29		
	Misc	71.80	7. Satnal-Matlab-Fuldi	[82]	150.22		
		--------	8. Fuldi-Matlab	[83]	31.85		
		334.63	9. Matlab-Fuldi	[84]	41.69		
	[Charland area		10. Chandpur-Madna	[87]	26.42		
	(11.66) deducted		11. Chandpur-Debidwar-Tippera	[88]	1.04		
	from F2 of				--------		
	project area]				334.63	334.63	
			Water Bodies		-	62.96	

						397.59	3.72

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
23.	**Chandpur Sadar**						
	F0	4.57	1. Tippera-Debidwar	[61]	2.03		
	F1	55.21	2. Fuldi-Matlab	[83]	3.35		
	F2	53.61	3. Chandpur-Madna	[87]	113.46		
	F3	1.49	4. Chandpur-Debidwar-Tippera	[88]	24.53		
		--------	5. Paikpara-Madna	[89]	35.55		
	NCA	114.88			--------		
	Misc	64.04			178.92	178.92	
		--------	Urban Area		-	5.03	
		178.92	Water Bodies		-	63.44	
	[Noakhali association & Charland area (5.15 + 24.64) deducted from F2 of project area]					---------	
						247.39	2.32
24.	**Faridganj**						
	F0	49.16	1. Tippera-Debidwar	[61]	2.33		
	F1	101.84	2. Burichang-Debidwar	[80]	34.20		
	F2	26.21	3. Chandpur-Madna	[87]	15.54		
	F3	4.87	4. Chandpur-Debidwar-Tippera	[88]	38.85		
		--------	5. Paikpara-Madna	[89]	11.65		
	NCA	182.08	6. Noakhali Series	[92]	18.64		
	Misc	53.60	7. Noakhali-Faridganj-Paikpara	[93]	114.47		
		--------			---------		
		235.68			235.68	235.68	

						235.68	2.21

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
25.	**Hajiganj**						
	F0	6.43	1. Tippera-Debidwar	[61]	95.82		
	F1	0.29	2. Burichang-Tippera	[79]	15.51		
	F2	90.84	3. Chandpur-Madna	[87]	43.00		
	F3	12.58	4. Burichang-Debidwar	[80]	1.57		
		---------	5. Chandpur-Debidwar-Tippera	[88]	2.06		
	NCA	110.14				---------	
	Misc	47.82			157.96	157.96	
		---------				---------	
		157.96				157.96	1.48
26.	**Shahrasti**						
	F0	11.21	1. Tippera-Debidwar-Dhamti	[63]	0.53		
	F1	23.20	2. Tippera-Debidwar	[61]	59.57		
	F2	80.20	3. Dhamti-Debidwar	[62]	22.24		
	F3	25.99	4. Barura-Burichang	[57]	3.88		
		---------	5. Burichang-Debidwar	[80]	100.23		
	NCA	140.60				---------	
	Misc	45.85			186.45	186.45	
		---------				---------	
		186.45				186.45	1.75
27.	**Kachua**						
	F0	4.75	1. Tippera-Debidwar-Dhamti	[63]	21.20		
	F1	40.28	2. Tippera-Debidwar	[61]	51.45		
	F2	111.32	3. Tippera-Naraibag-Debidwar	[76]	5.83		
	F3	34.71	4. Jalkundi-Godnail-Burichang	[52]	27.00		
		---------	5. Burichang-Tippera	[79]	0.27		
	NCA	191.06	6. Burichang-Debidwar	[80]	37.16		
	Misc	47.25	7. Burichang Series	[55]	95.40		
		---------			---------		
		238.31			238.31	238.31	

						238.31	2.33

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
28.	**Haimchar**						
	F0	9.17	1. Nilkamal Series	[86]	67.88		
	F1	28.31	2. Paikpara-Madna	[89]	3.03		
	F2	40.81	3. Noakhali Series	[92]	22.93		
	F3	0.01	4. Ramgati undevloped, cultivated phase-				
		---------	Chandraganj association	[96]	7.77		
	NCA	78.30			---------		
	Misc	23.31			101.61	101.61	
		---------	Water Bodies		-	75.56	
		101.61				---------	
	[Charland area (6.76) deducted from F2 of project area)					177.17	1.66
	LAKSHMIPUR						
29.	**Ramgati**						
	F1	165.89	1. Ramgati undevloped-Hatiya slightly				
	F2	36.81	developed, cultivated phase	[97]	210.27		
		----------	2. Ramgati association: undeveloped				
	NCA	202.70	cultivated phase	[98]	44.45		
	Misc	52.02			---------		
		----------			254.72	254.72	
		254.72	Water Bodies		-	169.52	
	[Charland & outside area (163.74) deducted from F1 of project area]					---------	
						424.24	3.97

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
30.	**Lakshmipur Sadar**						
	F0	31.41	1. Tippera-Debidwar (L & ML)	[61]	47.14		
	F1	236.24	2. Debidwar-Chandraganj	[77]	0.63		
	F2	106.30	3. Paikpara-Debidwar	[91]	112.15		
		---------	4. Noakhali Series	[92]	55.56		
	NCA	373.95	5. Noakhali-Faridganj-Paikpara	[93]	8.67		
	Misc	100.25	6. Ramgati undevloped, cultivated phase - Chandraganj association	[96]	81.89		

		474.20	7. Ramgati undeveloped-Hatiya slightly developed, cultivated phase	[97]	54.47		
	[Charland & Mud area (4.86) deducted from F1 of project area]		8. Ramgati association: undeveloped, cultivated phase	[98]	106.18		
			9. Ramgati associated: undeveloped, uncultivated phase	[99]	7.51		

					474.20	474.20	
			Water Bodies		-	36.36	

						510.56	4.78
31.	**Raipur**						
	F0	20.79	1. Nilkamal Series	[86]	23.19		
	F1	86.49	2. Noakhali Series	[92]	22.38		
	F2	12.27	3. Noakhali-Faridganj-Paikpara	[93]	39.45		
		---------	4. Ramgati undeveloped, cultivated phase - Chandraganj association	[96)	58.84		
	NCA	119.55					
	Misc	35.79	5. Ramgati undeveloped-Hatiya slightly developed, cultivated phase	[97]	11.48		

		155.34			---------		
	[Charland area (5.48) deducted from F1 of project area]				155.34	155.34	
			Water Bodies		-	25.68	

						181.02	1.70

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
32.	**Ramganj**						
	F0	21.89	1. Tippera-Debidwar	[61]	10.80		
	F1	33.53	2. Burichang-Debidwar	[80]	112.25		
	F2	57.19	3. Paikpara-Debidwar	[91]	15.68		
	F3	22.29	4. Noakhali-Faridganj-Paikpara	[93]	32.24		
		---------			---------		
	NCA	134.90			170.97	170.97	
	Misc	36.07				---------	
		---------				170.97	1.60
		170.97					
	NOAKHALI						
33.	**Chatkhil**						
	F0	5.30	1. Tippera-Debidwar	[61]	61.39		
	F1	42.59	2. Dhamti-Debidwar	[62]	15.80		
	F2	41.63	3. Debidwar-Paikpara	[78]	16.86		
	F3	10.49	4. Burichang-Debidwar	[80]	40.68		
		---------			---------		
	NCA	100.01			134.73	134.73	
	Misc	34.72				----------	
		---------				134.73	1.26
		134.73					

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
34.	**Begumganj**						
	F0	8.50	1. Tippera-Debidwar	[61]	3.74		
	F1	40.74	2. Dhamti-Debidwar	[62]	23.54		
	F2	255.49	3. Debidwar-Chandraganj	[77]	142.88		
	F3	4.50	4. Debidwar-Paikpara	[78]	165.37		
		---------	5. Paikpara-Chandraganj	[90]	47.26		
	NCA	309.23	6. Paikpara-Debidwar	[91]	25.80		
	Misc	100.07	7. Ramgati undeveloped - Hatiya slightly				
		---------	developed, cultivated phase	[97]	0.71		
		409.30			---------		
					409.30	409.30	

						409.30	3.83
35.	**Senbag**						
	F0	2.80	1. Tippera-Dhamti	[68]	55.63		
	F1	57.94	2. Dhamti-Debidwar	[62]	2.20		
	F2	62.90	3. Debidwar-Chandraganj	[77]	55.86		
	F3	0.74	4. Debidwar-Chandraganj	[78]	31.11		
		---------	5. Burichang-Paikpara	[81]	7.01		
	NCA	124.38	6. Ramgati undeveloped - Hatiya slightly				
	Misc	36.22	developed, cultivated phase	[97]	8.79		
		---------			---------		
		160.60			160.60	160.06	

						160.60	1.51

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
36.	**Companyganj**						
	F1	167.47	1. Hatiya-Ramgati: Hatiya slightly developed				
	F2	22.51	- Ramgati undeveloped, cultivated	[95]	0.94		
		---------	2. Ramgati undeveloped - Hatiya slightly				
	NCA	189.98	developed, cultivated phase	[97]	50.59		
	Misc	24.57	3. Ramgati: undeveloped cultivated	[98]	40.61		
		---------	4. Ramgati: undeveloped, uncultivated	[99]	65.27		
		214.55	5. Companyganj Series	[100]	30.60		
	(Mud included in				-------		
	F1 as NCA)				188.01		
			6. Meghna Estuarine Mud	[M]	26.54		

			Water Bodies		214.55	214.55	
					-	165.57	

						380.12	3.56
37.	**Noakhali Sadar**						
	F0	0.92	1. Debidwar-Chandraganj	[77]	12.96		
	F1	660.54	2. Paikpara-Chandraganj	[90]	13.14		
	F2	154.40	3. Paikpara-Debidwar	[91]	5.32		
		---------	4. Hatiya Association: moderately and				
	NCA	815.86	slightly developed, cultivated phase	[94]	57.18		
	Misc	105.51	5. Hatiya-Ramgati: Hatiya slightly developed				
		---------	- Ramgati undeveloped, cultivated	[95]	31.25		
		921.37	6. Ramgati undeveloped, cultivated				
	(Mud included in		- Chandraganj	[96]	93.74		
	F1 as NCA)		7. Ramgati undeveloped - Hatiya slightly				
			developed, cultivated	[97]	114.96		
			8. Ramgati: undeveloped, cultivated	[98]	300.26		
			9. Ramgati: undeveloped, uncultivated	[99]	146.88		

					775.69		
			10. Meghna Estuarine Mud		[M]	145.68	

					921.37	921.37	
			Urban Area		-	4.21	
			Water Bodies		-	182.99	
						-----------	
						1 108.57	10.38

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Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
	FENI						
38.	**Feni Sadar (59% area of Thana)**						
	F0	3.91	1. Kharrera-Bharella	[75]	7.52		
	F1	80.15	2. Tippera Series	[60]	38.33		
	F2	9.58	3. Tippera-Debidwar	[61]	46.80		
	F3	3.76	4. Burichang-Paikpara	[81]	7.25		
		---------	5. Chandraganj Series	[85]	5.45		
	NCA	97.40	6. Chhilania-Dagan-Biruli	[101]	9.06		
	Misc	27.62	7. Dakatia-Bashanda	[73]	10.61		
		---------			--------		
		125.02			125.02	125.02	
			Urban Area		-	4.15	
			Water Bodies		-	2.28	

						131.45	1.23
39.	**Dagan Bhuiya**						
	F0	1.65	1. Tippera-Dhamti	[68]	16.05		
	F1	55.04	2. Debidwar-Chandraganj	[77]	32.91		
	F2	43.14	3. Burichang-Paikpara	[81]	31.36		
	F3	3.57	4. Ramgati undeveloped - Hatiya slightly				
		---------	developed, cultivated phase	[97]	5.44		
	NCA	103.40	5. Companyganj Series	[100]	8.01		
	Misc	28.69	6. Chhilania-Dagan-Biruli	[101]	32.36		
		---------	7. Dakatia-Bashanda	[73]	5.96		
		132.09			--------		
					132.09	132.09	

						132.09	1.24

Sl Nr	Name of Thana with Land Type and Area (sq km)		Name and Nr of Soil Association		Area of Soil Association (sq km)	Area of Thana included in Project (sq km)	Percentage of Project Area
40.	**Sonagazi (53% area of Thana)**						
	F0	0.43	1. Tippera-Debidwar	[61]	40.81		
	F1	63.61	2. Chhilania-Dagan-Biruli	[101]	5.32		
	F2	9.43	3. Chandraganj Series	[85]	8.88		
		--------	4. Hatiya-Ramgati: Hatiya slightly developed - Ramgati - Ramgati undeveloped, cultivated phase	[95]	36.13		
	NCA	73.47					
	Misc	17.67					
		--------			--------		
		91.14			91.14	91.14	
			Water Bodies		-	29.66	

						120.80	1.13

	NCA:7 973.34				SGA:	10 677.00	100.00

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Note:

H	:	Highland
MH	:	Medium Highland
ML	:	Medium Lowland
L	:	Lowland
ML & L	:	Medium Lowland & Low
Highland (F0)	:	< 0.3m
Medium Highland (F1)	:	0.3m - 0.9m
Medium Lowland (F2)	:	0.9m - 1.8m
Lowland (F3)	:	Above 1.8m

Area of Soil Association includes the area of Misc

Area of Misc : Area of [Water + Home + (H + W)]

Area of Land Types excludes the area of Misc

Water Bodies	:	Permanant water/Haors/Beels
Water	:	River/Canal/Khal/Tank
Home	:	Homestead
(H + W)	:	House + Water, where W: Pond/Tank adjacent to house

Outside area (char land and others land which are exlcuded from the project) is deducted from the F1 and F2 type land.

SGA	:	Study Gross Area
NCA	:	Net Cultivable Area

Soil association Nrs are in [ ]

Source: MPO

TABLE I.10

Thana-wise Textural Distribution of Soils (sq km)

Zila/ Thana	Study Gross Area	Net Cultivable Area	C	SiC	SiCL	CL	SCL	L	SiL	SL	LS	CPT	S	UA	WB	Misc
Habiganj																
* Madhabpur (65%)	181.82	160.81	7.19	21.00	24.99	42.76	1.63	7.77	52.88	0.68	-	1.91	-	-	-	21.01
Brahmanbaria																
Nasirnagar	313.51	255.98	18.38	36.37	112.55	-	-	-	88.40	-	-	-	0.28	-	15.05	42.48
Sarail	212.39	177.46	23.95	25.43	67.15	-	-	-	58.66	-	-	-	2.27	8.56	7.52	18.85
Brahmanbaria Sadar	417.07	357.50	99.26	13.65	85.94	11.26	2.04	2.88	134.11	-	-	8.36	-	7.26	22.03	30.28
# Ashuganj	117.79	95.50	-	0.28	40.53	-	-	-	53.17	-	-	-	1.52	2.08	7.52	12.69
Bancharampur	207.19	141.68	-	26.59	37.13	-	-	-	48.99	-	-	-	28.97	-	37.57	27.94
Nabinagar	352.39	282.14	22.41	15.70	98.15	-	-	-	135.08	-	-	-	10.80	-	23.64	46.61
Kasba	207.14	178.22	13.28	11.55	70.00	9.53	4.01	10.68	56.61	-	-	2.56	-	-	2.08	26.84
Akhaura	93.39	81.09	36.07	8.57	7.83	7.48	0.38	7.86	11.96	-	-	0.94	-	3.13	-	9.17
Comilla																
Homna	178.73	136.54	-	43.38	32.10	-	-	-	21.91	-	-	-	39.15	-	31.10	11.09
Muradnagar	341.90	289.42	10.31	46.80	99.73	-	-	-	131.53	-	-	-	1.05	-	3.94	48.54
Brahmanpara	124.29	106.21	8.37	8.42	34.34	2.71		0.23	52.14	-	-	-	-	-	-	18.08
Daudkandi	375.54	315.13	6.88	74.16	138.16	-	-	-	67.66	-	-	-	28.27	-	20.22	40.19
Debidwar	235.68	194.26	1.11	39.15	35.09	-	-	-	118.91	-	-	-	-	-	2.61	38.81
Burichang	168.39	136.97	25.49	56.72	12.34	2.19	0.01	0.24	39.53	0.45	-	-	-	-	3.10	28.32
Chandina	202.01	166.69	3.87	32.28	51.26	0.10	-	-	79.18	-	-	-	-	-	-	35.32
Barura	240.93	195.78	1.89	51.05	32.08	1.10	0.01	0.04	109.39	0.22	-	-	-	-	-	45.15
Comilla Sadar	269.37	218.69	68.84	96.84	3.88	11.80	3.46	9.28	12.48	12.11	-	-	-	14.59	2.45	33.64
Laksham	432.56	352.73	2.38	60.35	92.42	0.64	0.04	0.21	196.69	-	-	-	-	-	7.81	72.02
Chouddagram	274.54	223.63	18.46	55.55	14.45	12.37	0.59	6.15	116.06	-	-	-	-	-	5.84	45.07
Nangolkot	225.37	182.19	2.93	13.66	38.44	-	-	-	127.16	-	-	-	-	-	4.16	39.02
Chandpur																
* Matlab	397.59	262.83	-	27.82	143.85	-	-	-	91.16	-	-	-	-	-	62.96	71.80
Kachua	238.31	191.06	-	37.70	91.00	-	-	-	62.36	-	-	-	-	-	-	47.25
* Chandpur Sadar	247.39	114.88	-	7.80	21.68	-	-	-	85.40	-	-	-	-	5.03	63.44	64.04
Hajiganj	157.96	110.14	-	39.89	25.51	-	-	-	44.74	-	-	-	-	-	-	47.82
Shahrasti	186.45	140.60	-	47.88	50.38	-	-	-	42.34	-	-	-	-	-	-	45.85
Faridganj	235.68	182.08	-	21.72	44.48	-	-	-	115.88	-	-	-	-	-	-	53.60
* Haimchar	177.17	78.30	-	-	6.14	-	-	-	72.16	-	-	-	-	-	75.56	23.31
Lakshmipur																
Ramganj	170.97	134.90	-	37.69	52.27	-	-	-	44.94	-	-	-	-	-	-	36.07
* Raipur	181.02	119.55	-	1.18	29.25	-	-	-	89.12	-	-	-	-	-	25.68	35.79
* Lakshmipur Sadar	510.56	373.95	-	32.31	103.96	-	-	-	237.68	-	-	-	-	-	36.36	100.25
* Ramgati	424.24	202.70	-	-	51.61	-	-	-	151.09	-	-	-	-	-	169.52	52.02
Noakhali																
Chatkhil	134.73	100.01	-	34.36	32.02	-	-	-	33.63	-	-	-	-	-	-	34.72
Begumganj	409.30	309.23	-	124.10	137.27	-	-	-	47.86	-	-	-	-	-	-	100.07
Senbag	160.60	124.38	-	32.88	47.81	-	-	-	43.69	-	-	-	-	-	-	36.22
Noakhali Sadar	1 108.57	815.86	-	5.87	248.96	-	-	-	561.03	-	-	-	-	4.21	182.99	105.51
Companyganj	380.12	189.98	-	-	59.05	-	-	-	130.93	-	-	-	-	-	165.57	24.57
Feni																
Daganbhuiyan	132.09	103.40	-	12.24	61.23	-	-	-	29.93	-	-	-	-	-	-	28.69
* Sonagazi (53%)	120.80	73.47	-	10.50	30.48	-	-	-	32.49	-	-	-	-	-	29.66	17.67
* Feni Sadar (59%)	131.45	97.40	0.35	29.22	23.28	0.36	-	-	44.19	-	-	-	-	4.15	2.28	27.62
Grand Total	10 677.00	7 973.34	371.42	1 240.66	2 388.79	102.30	12.17	45.34	3 673.12	13.46	-	13.77	112.31	49.01	1 010.66	1 643.99

Note:

UA=Urban Area; WB=Water Bodies; Misc=Home + Water + (H + W); C=Clay; Si=Silt; S=Sand; L=Loam; PT=Peat.

* Indicates that part of this area is outside the study area.

\# Ashuganj forms part of Brahmanbaria thana.

Source: MPO

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CHAPTER I.3

LAND TYPE

3.1 Introduction

Except for a minor area of low hills and terraces, the whole of Bangladesh is occupied by a landscape of floodplain ridges and basins.

During the monsoon season, most of the floodplain areas are flooded. The depth and duration of flooding however, vary according to topography, regions and sub-regions.

However, more than any other environmental factors the topographical position determines the present as well as future agricultural use of cultivated land, as it shapes the soil and hydrological conditions.

Most floodplain areas in Bangladesh are not as level as they may appear at first sight. They generally consist of a succession of ridges and depressions, varying in shape and size with range of elevation differences. These differences in elevation determine the depth of flooding in a particular area. This relation of land to seasonal flooding has been shown by land type.

I.3.2 Land Type Classification

The land type classification outlined here is that adopted by the Master Plan Organisation (MPO) being followed by other agencies as the nationally accepted classification, to permit exchange of data as well as to avoid confusion. The basis of the classification is mainly the depth and duration of overland flooding (normal flood level) in the monsoon season. The system has accommodated different lands under different depths of inundation.

The country's principal crops viz. rice, jute, wheat, tea, pulses, oil seeds, sugar cane, spices, fruits and vegetables have their specific positions in the annual cropping systems on different land types.

Of these crops, rice is grown in three seasons during the year, though not necessarily on the same land types in a particular area. The position of rice in the annual cropping system varies with land type in particular, as influenced by flooding depth, soil permeability, tidal fluctuations and salinity if any.

On the basis of depth and duration of overland flooding in the monsoon season the lands have been classified into the following land type classes (MPO).

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Highland (F_0)

Lands that remain either above normal flood level or are intermittently very shallowly flooded for a very short time upto a depth of less than 0.3 m. Generally such lands consist of floodplain ridges.

Medium Highland (F_1)

Lands that are flooded during the monsoon at a depth ranging from 0.3 m - 0.9 m. However, the water level in the fields is normally less than 0.3 m by the end of August (and so the land can be used for transplanted aman).

Medium Lowland (F_2)

Lands that are flooded during monsoon at a depth ranging from 0.9 m to 1.8 m depth of standing water. The water is not too deep for aus to be grown (if the soils are suitable for aus), but it is too deep for aman to be transplanted August/September. Generally such lands are on the margins of basins.

Lowland (F_3)

Lands that are flooded during monsoon at a depth ranging from 1.8 m to 3.0 m. This is too deep for either aus or transplanted aman to be grown and usually used for broadcast aman, sometimes mixed with aus. Generally such lands comprise basins that are considered as shallow and water drains out quickly at the end of the monsoon season, but too early or too quickly for broadcast aus or aman to be grown safely, they often remain flooded/wet for part or all of the dry season.

The upazila-wise distribution of main land type categories in the study area is also shown in Table I.11.

Very Lowland (F_4)

For the purposes of this report this category (flooding at a depth greater than 3.0 m) has been amalgamated with F3.

TABLE I.11

Thana-wise Land Type Distribution of Lands (sq km)

Zila/ Thana	Study Gross Area	Net Cultivable Area	F_0	F_1	F_2	F_3	UA	WB	Misc
Habiganj									
* Madhabpur (65%)	181.82	160.81	30.45	96.30	32.51	1.55	-	-	21.01
Brahmanbaria									
Nasirnagar	313.51	255.98	-	1.69	146.57	107.72	-	15.05	42.48
Sarail	212.39	177.46	-	34.51	52.07	90.88	8.56	7.52	18.85
Brahmanbaria Sadar	417.07	357.50	42.73	61.64	90.20	162.93	7.26	22.03	30.28
# Ashuganj	117.79	95.50	-	41.68	41.71	12.11	2.08	7.52	12.69
Bancharampur	207.19	141.68	-	34.90	58.21	48.57	-	37.57	27.94
Nabinagar	352.39	282.14	-	76.33	138.17	67.64	-	23.64	46.61
Kasba	207.14	178.22	36.88	55.78	60.41	25.15	-	2.08	26.84
Akhaura	93.39	81.09	17.25	11.17	21.23	31.44	3.13	-	9.17
Comilla									
Homna	178.73	136.54	-	-	7.46	129.08	-	31.10	11.09
Muradnagar	341.90	289.42	11.67	58.15	86.64	132.96	-	3.94	48.54
Brahmanpara	124.29	106.21	0.69	20.65	78.32	6.55	-	-	18.08
Daudkandi	375.54	315.13	-	-	17.86	297.27	-	20.22	40.19
Debidwar	235.68	194.26	4.86	96.09	69.69	23.62	-	2.61	38.81
Burichang	168.39	136.97	11.49	79.06	44.13	2.29	-	3.10	28.32
Chandina	202.01	166.69	5.72	59.50	19.27	82.20	-	-	35.32
Barura	240.93	195.78	6.28	75.97	113.22	0.31	-	-	45.15
Comilla Sadar	269.37	218.69	50.50	116.39	51.80	-	14.59	2.45	33.64
Laksham	432.56	352.73	19.24	117.59	180.24	35.66	-	7.81	72.02
Chouddagram	274.54	223.63	42.60	142.49	36.77	1.77	-	5.84	45.07
Nangolkot	225.37	182.19	16.74	124.85	35.04	5.56	-	4.16	39.02
Chandpur									
* Matlab	397.59	262.83	0.19	9.82	203.89	48.93	-	62.96	71.80
Kachua	238.31	191.06	4.75	40.28	111.32	34.71	-	-	47.25
* Chandpur Sadar	247.39	114.88	4.57	55.21	53.61	1.49	5.03	63.44	64.04
Hajiganj	157.96	110.14	6.43	0.29	90.84	12.58	-	-	47.82
Shahrasti	186.45	140.60	11.21	23.20	80.20	25.99	-	-	45.85
Faridganj	235.68	182.08	49.16	101.84	26.21	4.87	-	-	53.60
* Haimchar	177.17	78.30	9.17	28.31	40.81	0.01	-	75.56	23.31
Lakshmipur									
Ramganj	170.97	134.90	21.89	33.53	57.19	22.29	-	-	36.07
* Raipur	181.02	119.55	20.79	86.49	12.27	-	-	25.68	35.79
* Lakshmipur Sadar	510.56	373.95	31.41	236.24	106.30	-	-	36.36	100.25
* Ramgati	424.24	202.70	-	165.89	36.81	-	-	169.52	52.02
Noakhali									
Chatkhil	134.73	100.01	5.30	42.59	41.63	10.49	-	-	34.72
Begumganj	409.30	309.23	8.50	40.74	255.49	4.50	-	-	100.07
Senbag	160.60	124.38	2.80	57.94	62.90	0.74	-	-	36.22
Noakhali Sadar	1 108.57	815.86	0.92	660.54	154.40	-	4.21	182.99	105.51
Companyganj	380.12	189.98	-	167.47	22.51	-	-	165.57	24.57
Feni									
Daganbhuiyan	132.09	103.40	1.65	55.04	43.14	3.57	-	-	28.69
* Sonagazi (53%)	120.80	73.47	0.43	63.61	9.43	-	-	29.66	17.67
* Feni Sadar (59%)	131.45	97.40	3.91	80.15	9.58	3.76	4.15	2.28	27.62
Grand Total	**10 677.00**	**7 973.34**	**480.18**	**3 253.92**	**2 800.05**	**1 439.19**	**49.01**	**1 010.66**	**1 643.99**

Note:

UA=Urban Area; WB=Water Bodies; Misc=Home + Water + (H + W); F0=< 0.3m; F1=0.3m - 0.9m; F2=0.9m - 1.8m; & F3=> 1.8m.

*** Indicates that part of this area is outside the study area.**

 # Ashuganj forms part of Brahmanbaria thana.

Source: MPO

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CHAPTER I.4

LAND CAPABILITY

I.4.1 Introduction

Land capability classification is a method of grouping the soils of an area to show their relative suitability for the sustained production of common agricultural crops adapted to the environment. The classification system used is specially adapted for use in Bangladesh where the climate is suitable for the year round cropping and where both wet-land and dry-land crops can often be grown on the same soils at different seasons of the year.

Since rice will remain an important crop, even the most ambitious flood protection schemes are unlikely to reduce inundation levels to below one or two metres in most basin areas, land levels in relation to flooding will remain important in the future in determining the kinds of crops that can be grown. The traditional farmers' land classification system, recognizing high, medium high, medium low and lowland, has therefore been taken cognizance of in developing the land capability classification.

I.4.2 Land Capability Classes

The broadest grouping of land capability classes is categorized by Roman numerals I to V. Class I land (very good agricultural land) has least limitations for crop production throughout the year and relatively wide range of agricultural use. Class II to IV have increasingly severe limitations for crop production. Class V (very poor and non-agricultural land) is considered unfit for economic agricultural use. The soils within each land class have limitations of about the same degree. The kinds of limitations may vary, however, within the class. Figure I.2 summarises the land capability classes in the study area.

Class I - Very good agricultural land

Soils in this class have no limitations or very slight ones for crop production throughout the year and the widest range of agricultural use and easy to cultivate.

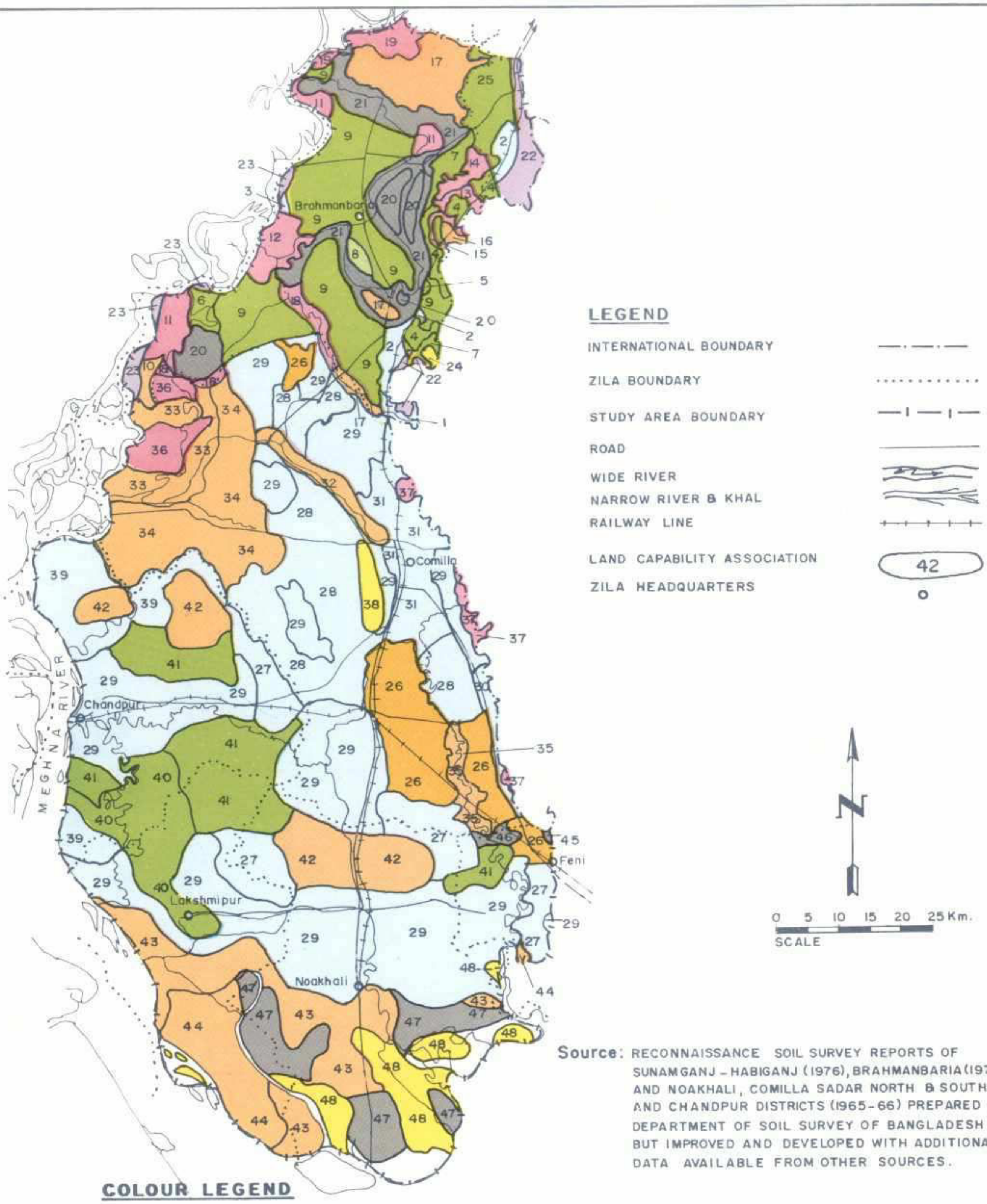
Class II - Good agricultural land

Soils in this class have no or slight limitations for crop production during most of the year, but moderate limitations during the remainder of the year. They are level to gently undulating and easy to cultivate.

Class III - Moderate agricultural land

Soils in this class have either moderate limitations for crop production throughout the year or severe limitations for crop production during one major season of the year and slight to moderate limitations during remainder of the year. Limitations include: droughtiness in the dry season or wetness early in the dry season followed by doughtiness; seasonal deep flooding (locally accompanied by rapid rise in water level or rapid flow of water

Figure I.2
Land Capability Association Map



Source: RECONNAISSANCE SOIL SURVEY REPORTS OF SUNAMGANJ - HABIGANJ (1976), BRAHMANBARIA (1973) AND NOAKHALI, COMILLA SADAR NORTH & SOUTH AND CHANDPUR DISTRICTS (1965-66) PREPARED BY DEPARTMENT OF SOIL SURVEY OF BANGLADESH BUT IMPROVED AND DEVELOPED WITH ADDITIONAL DATA AVAILABLE FROM OTHER SOURCES.

COLOUR LEGEND

Name of the Broad Land Capability Classes (I-V)	Land Capability Sub-class Numbers
1 (CLASS-I) VERY GOOD AGRICULTURAL LAND	26
2 (CLASS-II) GOOD AGRICULTURAL LAND	1, 2, 3, 27 to 31 & 39
3 (CLASS-II & III) GOOD & MODERATE AGRICULTURAL LAND	4 to 7, 9, 25, 40 & 41
4 (CLASS-III) MODERATE AGRICULTURAL LAND	10, 16, 17, 32 to 35, 42, 43 & 44
5 (CLASS-II & IV) GOOD & POOR AGRICULTURAL LAND	8
6 (CLASS-III & IV) MODERATE & POOR AGRICULTURAL LAND	11 to 15, 18, 19, 36 & 37
7 (CLASS-IV) POOR AGRICULTURAL LAND	20, 21, 45, 46 & 47
8 (CLASS-IV & V) POOR & NON-AGRICULTURAL LAND	22 & 23
9 (CLASS-V) VERY POOR & NON-AGRICULTURAL LAND	24, 38 & 48

Note: AREAS WITHOUT ANY COLOUR ON THE SOUTHERN PART OF THE PROJECT NOT CLASSIFIED DUE TO LACK OF AVAILABLE DATA.

resulting in occasional damage or loss of crops); irregular relief difficult to irrigate or till; moderate erosion hazard or moderate salinity hazard.

Class IV - Poor agricultural land

Soils in this class have severe limitations for crop production throughout the year. Limitations may be due to one or more of the following factors: seasonal deep flooding combined with waterlogging in the dry season or with high volume of run-off from surrounding land; severe erosion hazard, very low water-holding capacity and doughtiness; severe salinity hazard; or severe risk of crop loss or damage by on-rush or rapid rise of floodwaters. These soils have little potential for development.

Class V - Non-agricultural land

Soils in this class have very severe limitations which either made crop production impossible or hazardous. Limitations are due to very shallow depth of soil, severe salinity hazard, infertility and raw state of new alluvial deposits and hazard burial by new deposition.

At present, these soils are under a poor grass cover or barren. They have very little potential for improvement.

I.4.3 Land Capability Associations

As in the case of soils, land capability has also been mapped in the form of associations. Land capability associations comprise one or more land capability classes (and sub-classes) side by side in the landscape in defined proportions.

A total of 48 land capability associations were recognized in the study area. They are further taken into nine broad land capability classes which are (combinations of above 5 classes, as required) shown in the map in different colours (Album of Drawings).

The distribution of land capability association with components of soil mapping units, area and percentage of the study area are shown in Table I.12.

TABLE I.12

Land Capability Associations (Class/Sub-class) with Components of Soil Mapping Units (Soil Associations), Area and Percentage of South-East Regional Study Area

Legend Nr	Name of Broad Land Capability Class and its Sub-class numbers	Components of Soil Mapping Units (Soil Association Nr)	Area (sq km)	Per cent
1 (CLASS-I)	VERY GOOD AGRICULTURAL LAND Sub-classes Nr: 26	[60 and 65]	410	3.84
2 (CLASS-II)	GOOD AGRICULTURAL LAND Sub-classes Nr: 1.2.3.27.28.29. 30.31 & 39	[3.20(Part).27.28.41(Part).45. 46.47.49.50.51.52(Part).55(Part) 56.57.58.59.61.62.63.64.66.68. 76.77.82.83.85.86.87.88.90.91. 96.97(Part).100 & 101]	4 091	38.32
3 (CLASS-II &III)	GOOD & MODERATE AGRICULTURAL LAND Sub-classes Nr: 4.5.6.7.9.25. 40 & 41	[4.10.14.15.16.17.25.26.32.33. 34.35.36.40.41(Part)79.80.81. 89.92 & 93]	1 727	16.17
4 (CLASS-III)	MODERATE AGRICULTURAL LAND Sub-classes Nr: 10.16.17.32.33. 34.35.42.43 & 44	[8.9(Part).11.18.21.52(Part).53. 54.55(Part).67.69.70.72.73(Part). 74.78.84.94.95(Part).97(Part) & 98(Part)]	1 578	14.78
5 (CLASS-II &IV)	GOOD & POOR AGRICULTURAL LAND Sub-classes Nr: 8	[12]	16	0.15
6 (CLASS-III& IV)	MODERATE & POOR AGRICULTURAL LAND Sub-classes Nr: 11.12.13.14.15.18. 19.36 & 37	[2.5.6.7.19.20(Part).22.29.30. 31.43.44 & 71]	454	4.25
7 (CLASS-IV)	POOR AGRICULTURAL LAND Sub-classes Nr: 20.21.45.46 & 47	[9(Part)13.23.24.73(Part).75. 95(Part).97(Part).98(Part) & 99(Part)]	938	8.79
8 (CLASS-IV & V)	POOR & NON-AGRICULTURAL LAND Sub-classes Nr: 22 & 23	[1.37.38 & 41(Part)]	124	1.16
9 (CLASS-V)	VERY POOR & NON-AGRICULTURAL LAND Sub-classes Nr: 24.38 & 48	[39.42.48.99(Part) & M]	279	2.61
		Sub-Total	9 617	90.07
	Water Bodies		1 011	9.47
	Urban Area		49	0.46
		Grand Total	10 677	100.00

Note:

1. **Area of each land capability class includes the areas of homesteads, roads, canals etc.**
2. **Part of Soil Mapping Units (Soil Associations) distributed in different land capacity class & sub-classes are tentative.**

Source: Areas shown in the table have been estimated from the figures available in SODAT of MPO and RSS report of SRDI.

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ANNEX II

AGRICULTURE

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ANNEX II - AGRICULTURE

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ANNEX II - AGRICULTURE

II.1. Introduction

This annex describes the major agricultural systems of the South-East Region, and aims to identify major constraints to agricultural production that can be adressed by the control and development of water resources.

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 Noakali North Fesibility Studies and from up-dated sources of secondary data.

II.2. Land Use

II.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 II.1.

TABLE II.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.

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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 II.1), with relatively low cropping intensities in South Sudharam (an area of char land with little irrigation), Titas and Ashuganj.

II.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 to these flood characteristics.

Land has been classified acording 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 characteritics 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 F_4 land in the region. The distribution of flood phases in each planning unit is shown in Table II.2.

II.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. (see main report, Vol 1, Chapter 6).

Overall 289,299 ha are irrigated by diferent modes of minor groundwater and surface water irrigation. This amounts to 37% of the Net Cultivated Area (NCA), varying between planning units from zero (Polder 59/2) to 100% in the Mega Dhonagoda Irrigation Project (see Table II.3). The potential for irrigation development is greater in southern areas which now have relatively little irrigation compared with the north of the Region. Irrigated areas are shown on the irrigation map in the Album of Drawings.

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TABLE II.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 II.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	21,833	29.3
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	14,766	57.0
13. Titas	89,979	47,988	53.3
Sub-Total	**758,447**	282,050	37.2
Misc	18,216	7,249	39.8
Total	**776,663**	289,299	37.2

Source: Interpreted from 1989 Spot Imagery

II.3. Cropping Systems

II.3.1 Cropping Seasons

There are three cropping seasons in a year: two summer seasons (kharif-1, kharif-2), and the winter season (rabi). Most rain falls in summer but, although temperatures are high and soil moisture more than adequate, crop production can be limited by waterlogged soils, flooding, low solar radiation, and infestation by pests and diseases. Paddy, which is well adapted to these conditions is the predominant crop, and two rice crops may be grown - aus in Kharif-1 (March-June) during the early part of the monsoon, followed by aman in Kharif-2 (July-October). Deepwater rice, although termed an aman crop, actually requires both kharif seasons to mature. Jute and small areas of millet, maize, pulses, and vegetables are also grown during the kharif-1 season.

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Rabi is a short dry season from November to February. It is characterised by scanty rainfall, lower temperatures and clear skies, although the crop environment is favoured by high solar radiation, low humidity, and lower infestation of insect pests and diseases. A wide range of crops are grown during the rabi reason. They include both tropical and temperate crop such as boro paddy, wheat, potatoes, mustard, pulses, spices, millets, vegetables, tobacco and melons. Groundnuts, mungbeans, chilli and sesame are grown in both rabi and kharif-I seasons. However a lack of adequate soil moisture may limit yields and crops are restricted to land with adequate residual soil moisture, or where irrigation is available.

Winter temperatures in the Region remain high relative to more northerly parts of Bangladsh, which means that boro paddy, sown in nurseries in December, can be planted out in January/early February. This crop is harvested in April/May so it overlaps the rabi and kharif-1 seasons. The relatively short cool period means that wheat tends to suffer heat stress and is little grown in the more southerly part of the region. In parts of the coastal area annual crops can only be grown in the wet season because of excessive salinity of soils in the dry season.

II.3.2 Crop Sequences

The farmers' choice of crops is determined by a wide range of factors including flooding, soil type, climate, length of the growing season, availability of moisture, soil fertility and risk of pests and diseases. Socio-economic factors include the farm size, availability of labour and draught power, financial resources, food preferences, availability of inputs, and the relative profitability of different crops..

Among the factors mentioned above, flood depth and irrigation water availability are generally the dominant factors. It is therefore appropriate to describe cropping patterns according to land type.

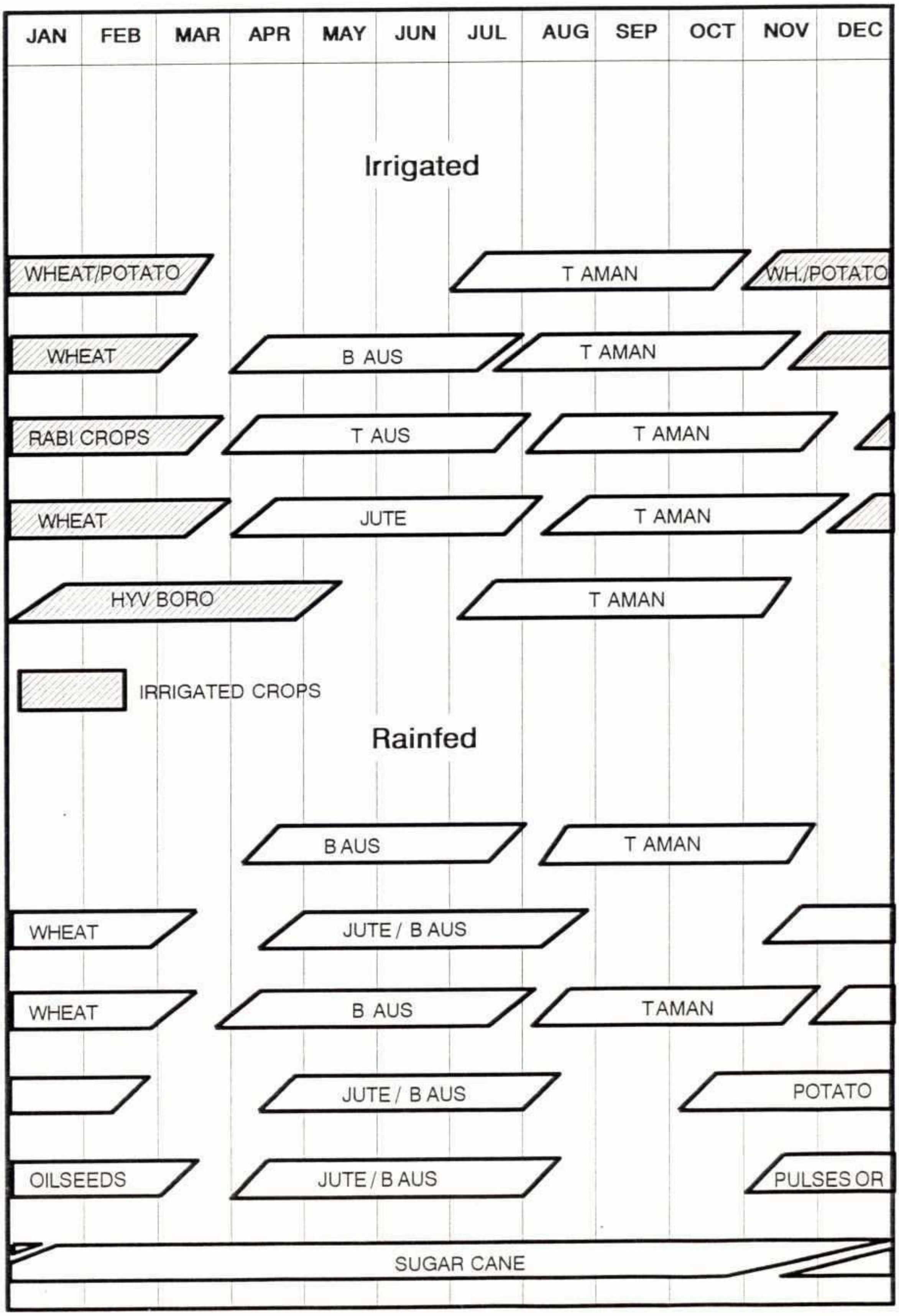
(a) F_0 (highland)

Under rainfed conditions on high ground (F_0), up to three crops can be grown in a year - aus paddy followed by transplanted aman paddy (usually HYV) which may then be followed rabi crops (taken to mean a range of pulses, oilseeds and potatoes) providing the soil retains enough residual moisture. Wheat may also be grown instead of rabi crops, but its longer duration means the following aus paddy would be transplanted rather than directly seeded. Jute is an alternative to aus paddy in this rotation. The aus/rabi crop - HYV aman paddy pattern is followed in many areas. Under irrigated conditions HYV boro - HYV aman is the most popular pattern, but some wheat and potatoes may also be irrigated. Cropping patterns under both rainfed and irrigated conditions are presented in Figure II.1. Based on MPO cropping patterns the cropping intensity in the study area for F_0 land is 117% under rainfed, and 208% for irrigated conditions, but consultants observations and farmer surveys would suggest that cropping intensities of about 200% can be achieved on most soils even without irrigation.

Perennial crops such as orchards and sugar cane are found on F_0 land. however niether orahards (with the exception of beetle nut palms and coconuts in some southern localities) or sugarcane are important crops in the region.

Figure II.1

Major Cropping Patterns in the Highland (F0)



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(b) F_1 (medium highland)

The predominant cropping patterns under rainfed and irrigated conditions in medium highlands (F_1) are presented in Figure II.2. Areas where flooding is limited to less than 60 cm may continue to grow HYV aman, but as flood depth increases, longer strawed local varieties become more popular. In areas where flooding starts later, kharif-I crops such as aus and jute are grown, while where floods come earlier, kharif-I crops are not cultivated, but B aman is sown one month before floods start, often as a mixed crop with b.aus.

b aman Growing on F1 land type is doubtful.

(c) F_2 (medium lowland)

The cropping patterns usually followed in the study area under rainfed and irrigated conditions are presented in Figure II.3. Flooding usually comes too early to permit aus or jute to be grown, making broadcast deepwater aman the main kharif paddy. In the rabi season it may be followed by rabi crops or wheat. Where irrigation is available, HYV boro is widely grown, but it is not normally possible to prepare a dry seedbed after the boro harvest in April/May to sow b.aman or for b.aman to be sufficiently well established to withstand the on-set of flooding. To overcome this problem some deepwater aman is transplanted into fields that are starting to flood. However the adoption of irrigated boro frequently means a switch from a b.aman - rabi/wheat rotation to a single, but more productive, boro crop. In some places boro is preceded in early winter with a short duration pulse or mustard crop.

Irrigated HYV Boro

The MPO cropping intensity is 119% for rainfed and 147% for irrigated areas.

(d) Lowlands and Very Lowland (F_3 + F_4)

The widely followed cropping patterns under rainfed and irrigated conditions in the lowland areas are presented in Figure II.4. Deep and longlasting floods severly limit cropping options to deepwater rice and cropping during the dry season becomes relatively important, although it may be at risk from unexpected or early floods.

The MPO cropping intensity is 87% for rainfed and 124% for irrigated areas.

II.3.3 General Crop Management Practices

II.3.3.1 Selection of Seeds

Most farmers retain part of the harvest as seed for the following year. Other farmers buy seed from their neighbours or in local markets. With adequate selection and storage this is satisfactory for local varieties but will result in a gradual deterioration in the purity of HYV seed. However, apart from vegetables, little improved seed is purchased. As a result there is considerable evidence in rice fields of mixed varieties and deterioration in genotypes. Farmer-produced seed often also has a low germination rate and, in order to obtain good stands, a high seed rate is used. Thinning, however, is rarely practised and the competition between plants reduces yields.

Figure II.2

Major Cropping Patterns in the Medium Highland (F1)

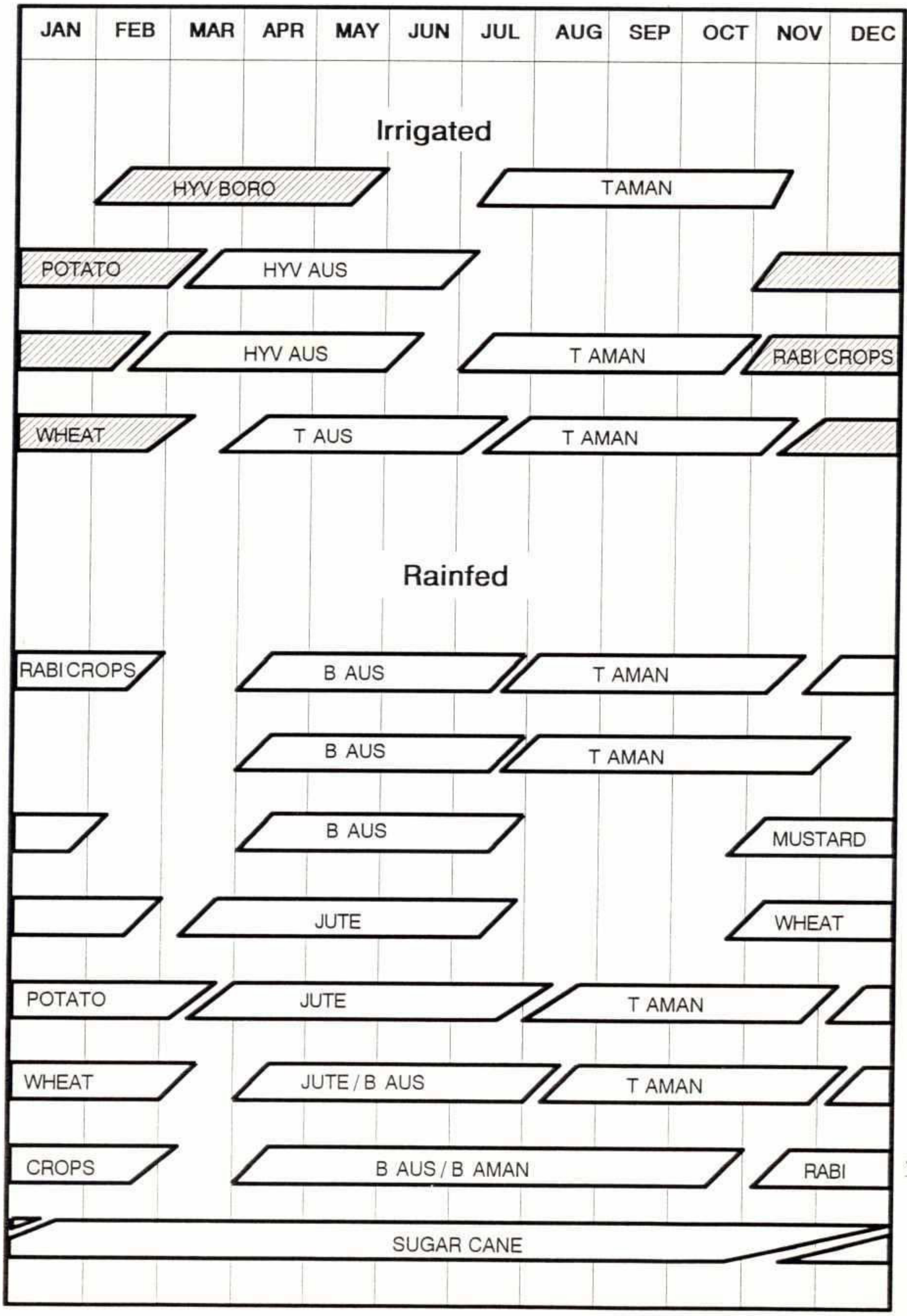

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Figure II.3

Major Cropping Patterns in the Medium Lowland (F2)

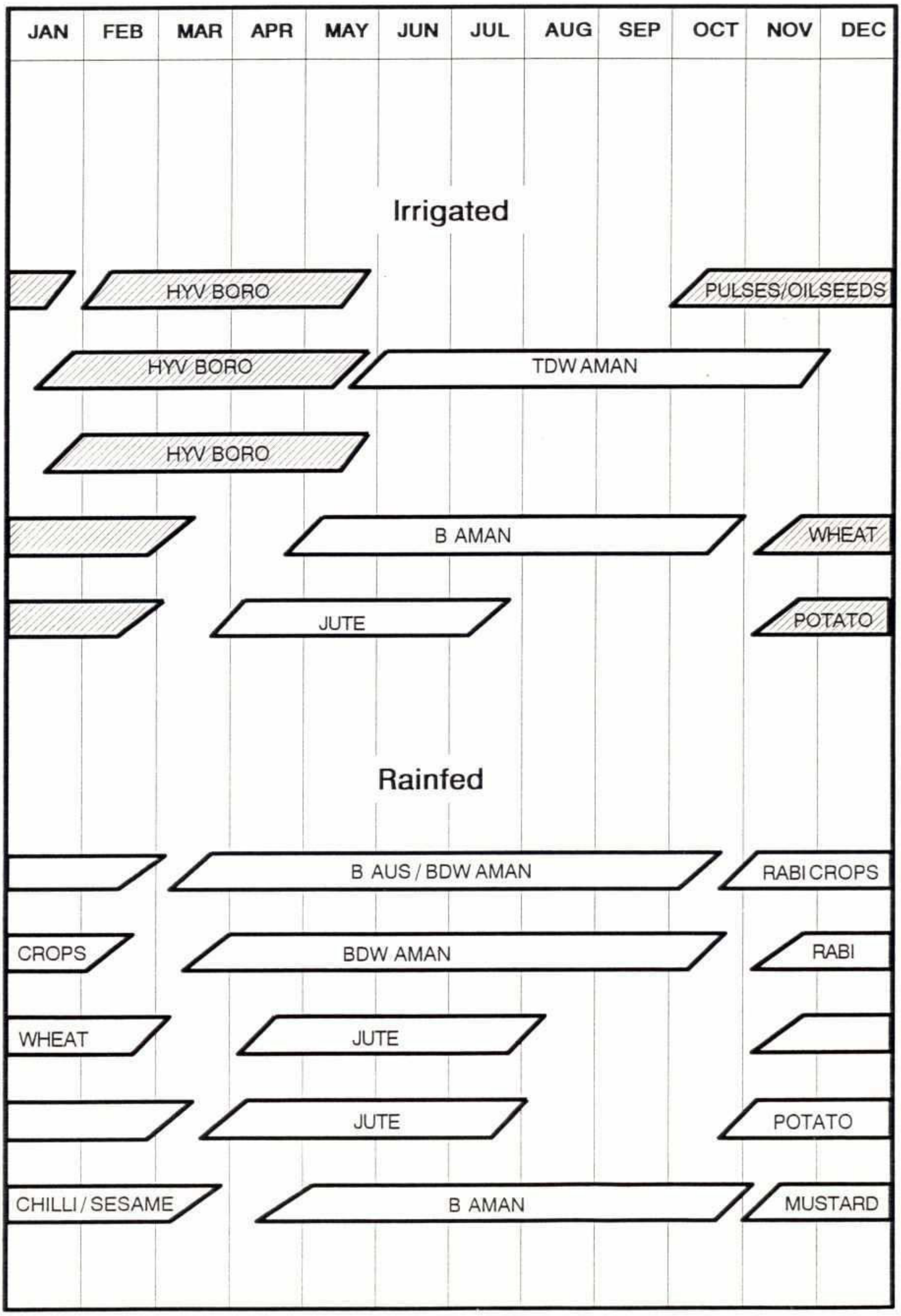

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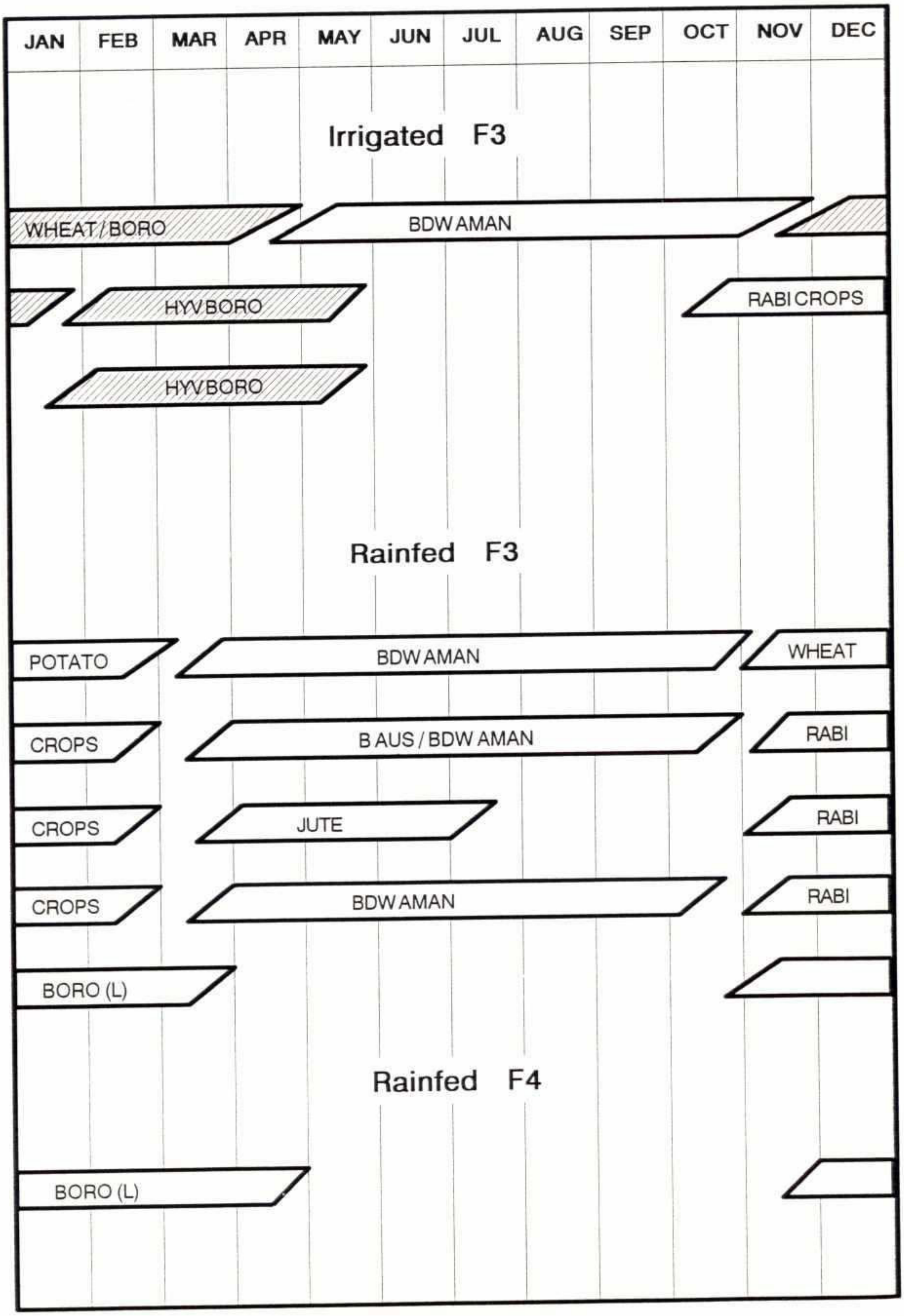
Figure II.4

Major Cropping Patterns in the Lowland (F3) and Very Lowland (F4)



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II.3.3.2 Land Preparation

shear

Most land preparation is done using a country plough drawn by a pair of draft animals. The country plough is basically a piece of wood tipped with a small steel share which can plough to a depth of 7.5 - 15 cm, breaking the surface but not turning the soil over. Land preparation may begin as much as three to four weeks before sowing/transplanting, depending on soil moisture and the availability of labour and power, and the land is ploughed up to six times depending on the type of crop. Following ploughing, the land is laddered, by drawing a wooden ladder-like implement across it a number of times to break the clods and level it.

A pair of draft animals can plough about 0.20 ha or level 0.4 ha a day, but it generally takes a farmer with a pair of animals about a month to prepare 1 ha of land. Other tillage equipment used by the farmers includes a harrow made of three split bamboos which is used for breaking clods, compacting soil, collecting weeds and covering seeds.

In parts of the Region power tillers are gaining in popularity, and their potential role is examined in sections II.3.7 and II.9.

II.3.3.3 Sowing and transplanting

Most aus, mixed aus-aman and deepwater aman rice is sown broadcast rather than transplanted. Sowing of these crops and other non-rice crops is done by hand: seed drills are not used.

When the flood recedes in October-November, rabi crops are sown. Some pulses and oilseeds are grown as a relay crop, being broadcast into a standing aman crop 15-20 days before the harvest of that crop. This is done to save time and maximise the use of residual soil moisture.

Paddy seedlings for transplantation are raised in nurseries located near water sources. Nursery land is generally prepared wet for boro and dry for aus and aman. The land is ploughed and the soils are pulverised before seeds are sown. The seedbeds are divided into several sub-blocks with intervening drains to improve drainage.

Before transplanting rice the land is puddled, which consists of flooding the field and laddering whilst the soil is saturated. A limited amount is transplanted in rows, which provides easier access for weeding and application of inputs. At least 3 seedlings are planted in one hill to ensure a complete stand.

II.3.3.4 Application of Fertiliser

Urea is applied both as top-dressing and basal dressing. Three or four applications are made in one season, the number depending on soil texture, nutrient status, and the availability of fertiliser. All MP & TSP zinc and gypsum are applied as basal dressing at the time of land preparation. Farmers also apply animal manure where available, particularly to lighter soils on higher ground where vegetables, sugarcane, aus and jute are grown.

II.3.3.5 Weed Control

Weeding depends on the severity of the weed problem and on the resources of the farmer. Racking (with a wooden harrow) is very commonly done in aus and jute at the early stage of these crops. Hand-weeding with a hand tool (nirani) is also generally done twice during the growing season, and, especially for jute and broadcast aus, is very labour-intensive. However, weeds are a valuable source of animal feed and are also used as a green manure and to make compost.

II.3.3.6 Pest and Disease Management

The incidence of insect damage is fairly high in rice crops, especially in HYVs grown in the kharif seasons. Major pests include stem borers, earcutting caterpillars, leaf hoppers and leaf rollers. Hispa damage in young rice plants was observed widely in 1991 aus rice in the study area (in Nangolkot about 80% of the crop was badly damaged). Brown plant hopper damage is still limited, but is an increasing problem that needs effective control.

Rice diseases include tungro virus and leaf blight but these are generally not serious. While pests can be controlled to some extent by selection of resistant varieties and desruction of stubbles and crop residues, the use of pesticides is increasing. However chemical control alone cannot prevent the spread of insect pests.

II.3.3.7 Harvesting

All crops are harvested by hand. Cereal crops are cut with a knife or sickle. Threshing may be done by hand, (knocking bundles on a drum or wooden plank), or by using cattle to trample the crop on the ground. Much paddy in some areas is threshed with small tredle-powered machines.

II.3.3.8 Post-Harvest Processing

Threshed rice is dried for 4 to 5 days on a tarmac road, mat or drying floor; and then winnowed before storing. Farmers face particular problems in drying the aus crop which is harvested during the monsoon. Post-harvest pests affect stored rice and wheat, especially if not properly dried. Rice is stored or sold as paddy, and only milled when needed for home consumption. Paddy is parboiled before milling and most farmers now take the paddy to a small engine powered mill for polishing.

Jute is harvested in July-August. The plants are cut and left in the field until leaves are shed. They are then bundled and submerged in water for 2-3 weeks, during which time the soft plant tissues rot, leaving only the fibres and central stick. The fibres are then washed in running water and dried before sale. The jute sticks are also dried before use as fuel or fencing.

II.3.4 Management of Individual Crops

Rice is the most important crop of the area and accounts for about 80% of the total area of all crops.

Too high for local aus

(a) Aus Paddy

Broadcast aus is sown in dry land at the start of the monsoon on medium to high land, and is harvested after a 100-120 day growth period. Local varieties are mainly grown, and widely used varieties are Shaita, Dharial, Kataktara and Hashikalmi. With relatively low yields of under 2t/ha farmers use less than recommended levels of inputs, although over 90% (Noakhali Farmer survey) use some fertiliser. Considerable labour is needed for hand weeding. Delayed seeding due to inadequate rainfall in March and April reduces yields and increases the risk of loss as flood water rises.

Some aus is also sown at this time on slightly lower land mixed with the seed of deepwater aman. The aus matures before the land is deeply flooded, and the whole crop is then cut. The aman then grows again from ratoons to give another harvest in November-December. In this way the farmer spreads his risk and will get a crop even if deep flooding drowns the aus or there is insufficient water for b.aman.

A smaller area of transplanted aus is also grown - more of this is of the HYV type, and it may sometimes be irrigated at the start of the growing season if there is insufficient rainfall. Although its yield potential is less than that of HYV boro which is planted somewhat earlier, it needs much less irrigation, and may be prefered on higher and better drained soils.

(b) Aman Paddy

Broadcast deepwater aman is sown in March and April. A number of local varieties of b.aman are grown depending on the flood depth from 1m to over 3m. Although their yield potential is limited, they do relatively well in the northern part of the region where yields average about 1.8 tons/ha (Gumti farmer survey). A limited amount of deepwater aman is transplanted rather than broadcast. This make it easier to follow a boro crop as often land has started to flood when boro is harvested. Even if land is still dry, the young plants up to 35 days old are vulnerable to floods, and delaying the sowing of b.aman into May severely reduces yields.

Local varieties still predominate in transplanted aman which means they can be grown on land that floods deeper than the 60 cm limit for HYVs. Seedlings are planted in puddled land in July-August. Although supplementry irrigation is beneficial during dry periods, only 2-3% of the t.aman grown in the region is irrigated. Aman is a photo-period sensitive crop with flowering triggered with the advent of shorter day lengths with harvesting in November to December.

c) Boro Paddy

The cultivation of boro has rapidly expanded with the availability of irrigation. By far the greater proportion is HYV, BR3 being the most popular variety. Farmers also grow a local improved variety known as Panjam. A small area of local boro is grown on wet bottom land which remains, even in the dry season, too deeply flooded for HYV rice, but which may need little or no irrigation. Farmers start transplanting HYV boro from January. Local boro, which is more cold resistant, may be planted earlier.

Flash floods are the major problems of boro transplanted in low lying areas such as near the Titas and Gumti rivers. For this reason boro may be grown earlier and harvested earlier to avoid these floods which sometimes occur in April and May (as happened in May 1991 and again in May 1993). However extremely early planting is limited by the danger of cold injury during panicle initation when temperatures below 17° C cause sterility. With air temperatures of around 12° C in January, 15° C in February, 19° C in March, heading should occur from April to avoid any risk.

(d) Wheat

Sowing of wheat is generally done from early November to the end of December. Although mostly grown using residual moisture, some wheat is irrigated, which produces higher yields. Although boro is considerably more profitable, farmers may grow wheat if they consider their soil too permeable to hold water for boro or if they are unsure of getting sufficient water for boro. However, wheat is a thermo-sensitive crop and its yield potential is limited by the short duration of cool weather. Old HYV varieties are grown (such as Sonalika and Kanchan) as well as local varieites.

(e) Jute

Two species of jute, **Corchorus capsularis (desi or mesta)** and **C. olitorius (tossa)**, are grown. The former is more usual and is more tolerant of deep water. It is planted in early kharif (March-May) for harvesting from June to August. Jute is often cultivated in areas prone to early floods since once the crop has grown tall, it can withstand rapidly rising water better than lower aus or broadcast aman which can be drowned by a sudden on-rush of water. It is a labour-intensive crop requiring much work for land preparation, weeding and post-harvest activities, and is not considered very profitable by farmers.

(f) Potato

Potatoes are mainly grown in Comilla, Daudkandi, Burichang, Muradnagar and Debidwar on well drained light soils. They are planted in late October or November and harvested in February and March. To obtain the best yields potatoes need large inputs of seed potato, fertiliser, pesticides and labour. A substantial proportion are irrigated. To obtain virus-free seed of improved varieties, farmers need to buy fresh seed potatoes every year from BADC. A major constraint of potatoes in the study area is the incidence of soil borne diseases which may be attributed to continuous cropping and heavy application of chemical fertilisers.

(g) Pulses

Although pulses are an important crop in the region, they are more widely grown some other parts of Bangladesh. They provide a valuable source of protein and improve the fertility of the soil through their nitrogen fixing capability. Most pulses are grown in the rabi season although a smaller area is grown as a catch crop in kharif-1. Pulses require lower levels of inputs than most other crops, and most farmers do not use fertiliser. Principal pulse crops include:

Khesari (vetch, **Lathyrus sativus**) pulses are grown on medium low land and low land in the rabi season. It may follow broadcast aman. Although the bean is of lower market value than some other pulses, the residue is a valuable animal fodder. Masur (lentil) is grown in the rabi season on highland areas where the soils are permeable and well drained. Masur is a quality pulse with high economic value. It is sown in November - December and harvested in February - March. Mung (green gram) is a very short duration rabi or kharif crop (60-75 days). Mash kali (black gram is another rabi or kharif pulse, but with a lower economic value. Chola (chick pea) is a rabi pulse while limited areas of Barbati (cow pea) are grown during kharif-1. The farmer surveys found keshari to be the most widespread pulse, with masur and mash kali also being common in Gumti and mung and mask kali in Noahkali.

(h) Mustard

Mustard is the predominant oilseed crop and is grown on most land types. It grows well on alluvial soils which remain moist but not water-logged. It is a short duration crop sown in November - December and harvested in January - February, and sometimes precedes a crop of boro paddy. There are two distinct types: rai (**Brassica juncea**) is taller, has a 90-100 day growth period and is grown on lower, wetter land. Lower yielding tori (**B. campestris**) is grown on higher land, and has a 70-85 day growth period. Mustard seed contains 40 to 45% oil. Yields of oil pressed by expeller are 36 to 39%, but much less is obtained by traditional methods.

(i) Sesame (Til): is a less important oilseed crop grown in the project area. It is mainly grown in kharif-1 (but can also be sown in rabi), and is a more assured crop than the mustard, as it is highly resistant to drought. The crop is often mixed with B aman. Sesame seed contains 44% oil which is used for hair oil and cooking.

(j) Groundnut can also be grown in rabi and kharif-1 and needs light soils and high, well drained, land often found on char land near rivers or the sea. It is mainly directly consumed rather than crushed for oil.

(k) Other cereals grown in small amounts include millet (kaon and cheena) maize and barley.

(l) Vegetables are grown in both winter and summer , but to a greater extent in winter. Winter vegetables include tomato, cauliflower, cabbage, radish, bottle gourd, pumpkin, carrot, spinach, sweet potato and brinjal (egg plant - also grown in summer). Summer vegetables include beans, cucumber, squash, ladies finger and watermelon. Brinjal was the most widely reported vegetable in both farmer surveys, with a number of farmers also growing edoe (taro).

(m) Spices include chillies, onions, garlic, coriander and turmeric. They are are grown both in rabi and kharif seasons. Chillies are particularly important in both the Gumti and Noahkali areas.

(n) Sugarcane is not an important crop in the region, being grown on small plots for chewing and fresh juice sales.

(o) Tree crops include: bananas, mangos and jackfruit, mainly grown on a small scale around homesteads. In parts of Lakishimipur there is widespread beetle palm groves, and coconuts are another commercial tree crop in the southern part of the region.

II.3.5 Use of Inputs

Typical rates of input use of fertilisers, pesticides and seeds for major crops are shown in Table II.4. These are primarily based on the farmer and case study surveys carried out for the Noahkali and Gumti feasibility studies. The results of these surveys have been checked against the secondary data used in the Draft Regional Plan, and modified where survey results are not thought to be reliable or realistic. In general input levels are higher than those assumed in the Draft Regional Plan, but this is associated with an increase in assumed crop yields.

II.3.6 Farm Labour

The labour requirement of transplanted paddy is generally higher than for direct seeded paddy and other crops such as wheat. However the extra labour for transplanting is offset to a large extent by the need for extra weeding. Rabi crops have a relatively low weeding requirement because the cold weather reduces the growth of weeds.

Most work is done by the farmer and his family. Women do most of the post harvest work, especially grain drying and cleaning, but almost all now use a machine for milling par-boiled rice rather than the tradional hand-operated dheki. Despite the small size of farms, most farmers hire some labour, particularly at harvest time. It can be estimated from the farmer surveys that over 80% of farmers hire some labour. This includes around half of the smallest farms, who are more likley to hire extra labour just for the harvest.

A surprising proportion of farms (around 20% of the case studies) hire women as well as men. They are paid considerably less (around Tk 15 per day as against Tk 43 for men at harvest time and Tk 31 at other times.)

About half the farms (and two-thirds of the large farms) reported that lack of labour causes delays in farm work, particularly harvesting. Labour would appear to be a slightly more serious constraint in Gumti, where average farm size is slightly larger and the cropping intensity is generally higher.

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TABLE II.4

Use of Crop Inputs

Physical Input Quantities and Production per Hectare								
Crop	Labour (days)	Draft Animals (pair days)	Seed (kgs)	Fertiliser (kg)			Dung (kg)	Pesticide (kg)
				Urea	TSP	MP		
B Aus, local	140	45	85	80	40	0	1000	0.25
T Aus, HYV	177	47	30	140	50	10	1000	0.50
B Aman local dw	107	44	83	40	0	0	0	0.13
T Aman, local	169	40	44	100	40	0	0	0.25
T Aman, HYV	182	40	30	140	110	35	700	1.16
Boro, local	118	25	40	120	0	0	0	0.00
Boro, HYV irrig	212	45	30	193	160	45	1000	1.00
Wheat irrig.	127	45	130	130	115	80	0	0.30
Wheat unirrig.	100	45	130	130	80	50	0	0.30
Potato irrig.	194	44	1000	277	290	102	1500	1.10
Potato unirrig.	175	44	1000	277	290	102	1500	1.10
Jute	215	45	9	89	67	9	2000	0.00
Pulses: ave.	51	30	31	0	0	0	0	0
Mustard	58	37	10	192	144	40	750	0.10
Sugarcane	255	65	5000	88	41	7	3000	0.5
Spices (chilli)	157	30	1	100	180	90	2500	0.00
Veg. (brinjal)	270	44	1	100	60	40	2500	0.30

II.3.7 Draught Power

Some form of draught power, either animal or mechanical, is almost always used for land preparation, and animal power is also used for other farm tasks such as weed control, transport and threshing.

As can be seen from Table II.5 the survey of farmers in Gumti showed that 58% of farmers owned their own animals, but under 30% had animals in Noahklai. Ownership is strongly related to farm size with few small or marginal farmers having draught animals.

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TABLE II.5

Labour and Draught Power

FARMER SURVEY DATA					
Farm size:	**Marginal**	**Small**	**Medium**	**Large**	**All**
GUMTI					
Type of draft power					
animals	91.1%	93.8%	97.1%	90.9%	93.5%
power tiller	8.9%	11.9%	13.2%	18.2%	11.7%
none	1.0%	2.6%	1.5%	4.5%	2.1%
Source of power					
own	28.3%	59.1%	86.4%	100.0%	58.5%
hire/borrow	75.0%	48.1%	21.2%	10.0%	47.9%
Shortage of power					
no shortage	38.6%	54.9%	58.8%	63.6%	51.8%
shortage	61.4%	45.1%	41.2%	36.4%	48.2%
Employ labour					
none employed	44.6%	9.3%	0.0%	0.0%	16.4%
employ some	55.4%	90.7%	100.0%	100.0%	83.6%
(harvest only)	(10.9%)	(7.8%)	(1.5%)	0.0%	7.0%
Delayed by lack of labour					
no	78.2%	59.6%	33.8%	45.5%	59.1%
yes	21.8%	40.4%	66.2%	54.5%	40.9%
NOAHKALI					
Type of draft power					
animals	82.6%	86.1%	86.6%	100.0%	85.9%
power tiller	33.3%	47.1%	56.1%	60.0%	46.9%
none	0.0%	0.0%	0.0%	0.0%	0.0%
Source of power					
own	3.5%	25.0%	54.9%	70.0%	29.1%
hire/borrow	96.5%	77.1%	46.5%	30.0%	72.4%
Shortage of power					
no shortage	24.6%	26.5%	42.7%	40.0%	29.9%
shortage	75.4%	73.5%	57.3%	60.0%	70.1%
Employ labour					
none employed	58.0%	12.6%	2.4%	0.0%	18.2%
employ	42.0%	87.4%	97.6%	100.0%	81.8%
(harvest only)	(2.9%)	(5.8%)	(0.0%)	(0.0%)	(3.9%)
Delay from lack of labour					
no	80.3%	43.0%	35.4%	20.0%	47.2%
yes	19.7%	57.0%	64.6%	80.0%	52.8%

Some farmers now use power tillers (2-wheel tractors with rotary cultivators) to prepare their land. They can cover at least six times more land per day than a pair of animals. The farmer survey found that use of power tillers was widepread in Noahkali where 46% of farmers (and most large farmers) use power tillers (but 87% still use draught animals, so most of those who use power tillers continue to use animals for some operations).

Small and marginal farmers have poor access to draft power, being less likely to own animals, or hire power tillers. In Gumti about two thirds of marginal farmers reported a delay caused by lack of draught power, compared with only a third of larger farms. However shortages of draught power appears to give rise to greater problems in Noakhali where fewer farmers own draught animals, although more use is made of power tillers. According to the farm case studies in Gumti and Noahkali, a shortage of draught power causes delays in planting crops, and this is more likley to reduce yields than limit the area of the crop that can be grown. By a considerable margin, boro is the principal crop affected by these shortages, although local t.aman is also affected in Noahkali and b.aman in Gumti.

II.3.8 Fertilizers and Manures

The use of chemical fertilizers has increased over recent years and, according to farmer surveys, they are now applied to most crops. Survey data suggests over 90% of non-deepwater rice recives fertiliser (including almost 100% of HYV rice). Deepwater broadcast aman recieves less fertiliser, it being applied to 46% of plots in Noahkali and 62% in Gumti, although more of the transplanted deepwater aman is fertilised. Wheat, jute, mustard, potatoes, spices and vegetables almost always get fertiliser. Although it is widely believed that farmers rarely giver fertiliser to pulses, the survey indicated that around a third of plots growing pulses do get fertiliser, especially the higher value masur and mung.

Urea is the most widely used fertiliser. Although crop response to the nitrogen is good, yields may be limited by low levels of available phosphate. Application rates are generally at, or even above recommended rates for HYV rice where the yield potential is good. In areas, such as Noahkali, where yields tend to be lower for soil and/or water reasons, then lower levels of fertiliser are applied.

Traditionally cow dung was the main form of fertiliser. However, increasing pressure on land is limiting the number of animals, while more and more dung is used as fuel in the absence of wood. There have been attempts to persuade farmers to produce compost and grow green manure crops, but these have met with minimal response.

II.3.9 Pesticides

Although use of pesticides is increasing, farmers often prefer to remove the pests by hand if at all feasible or, failing that, they accept that yields will be reduced. The economic benefits of spraying are not always clear cut on small fragments of land.

II.3.10 Irrigation

Irrigation is primarily used in the rabi season for boro production. A proportion of HYV wheat is also irrigated in areas where lighter soils or limited water supplies make it a more appropriate crop than boro. Potatoes and rabi vegetables are also irrigated.

In the kharif season, supplementary irrigation is provided to a small part of the transplanted HYV aus (10% in Noahkali, 24% in Gumti according to the farmer surveys), and to very small proportion of transplanted HYV aman (3% in Noahkali and 8% in Gumti). This will vary considerably from year to year depending on rainfall, and on the availability of irrigation facilities that are primarily installed for boro cultivation.

In Gumti and Noahkali most farmers growing boro report that water supplies are to some extent limited, although it is not possible to discern that this has any impact on yields. As might be expected, groundwater supplies, especially from DTW, and almost 80% of LLP pump operators in both areas interviewed reported shortages of water, usually every year, and usually getting worse. Not surprisingly a lack of water in khals appears the most significant cause of shortage and also is the main cause of restricting areas irrigated by LLP. In contrast areas covered by tubewells are more likely to be limited by difficulties of water transmission (especially for DTW) and the cost of operating this higher cost form of pumping.

II.4. Crop Yields and Production

II.4.1 Crop Statistics

Bangladesh Bureau of Statistic (BBS) is the formal agency for collection of crop statistics and collects data by thana level. Annual crop statistics cover over 30 of the major and minor crops (although as over 100 different crops are grown many vegetables and other crops of little importance are grouped together).

Statistics are collected on a sample basis. Sample sizes per thana are six farmers for minor crops and 90 farmers for major crops. Major crops are surveyed by farmers' interviews and minor crops are estimated in most cases. A thana statistical office has crop sample cutting tools, a measuring tape and pegs but they are seldom used except for special surveys.

Typical staffing of a thana statistical office are one thana statistical officer, two junior statistical assistants and one chainman. A thana statistical officer has to report population census data, agricultural census data as well as annual crop statistics such as harvested areas, crop production and crop yields. The thana statistical officer reports to a regional statistical officer: there are no district level statistical officers.

A regional statistical officer has eight staff i.e. one regional statistical officer, one assistant statistical officer, four assistants and two investigators. The annual budget for a thana statistical office is about Tk 168,000 including salaries of Tk 99,000. The regional statistical officer for the south-east region in Comilla claimed that present BBS crop statistics collection system should be renovated and more staff and budget should be allocated.

BBS crop statistics seem to be of dubious accuracy. There are major jumps in yields from year to year that are not easily explained. For instance in the study area, from 1983/4 to 1985/6 around 350,000 tonnes of potatoes were produced from about 60,000 ha at a yield of 5.8 tonnes per ha. While from 1986/7 to 1988/9 production fell to between 220,000 and 310,000 tonnes, yields suddenly more than doubled to 13.5 to 16 tonnes per ha, with the only a third or less of the previous area being grown.

MPO maintains a data base on thana crop statistics, but its information originates from BBS data, although, because of its doubts about BBS thana crop statistics, MPO makes some adjustments to the BBS data.

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II.4.2 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.

Table II.6 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 Noahkali. Broadcast deepwater aman is more widespread in northerm parts of the region, while local transplanted aman is more widely grown in the south.

TABLE II.6

Crop Areas as Percentage of Net Cultivable Areas

Area as % of NCA	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noahkali	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

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 II.7 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.

TABLE II.7

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

II.4.3 Crop Yields

BBS data of the yield for the last two years, of major crops by district is in Table II.8. 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 II.9. This suggests that overall yeilds 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 II.10, 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.

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TABLE II.8

Crop Yield Statistics by District

Yield t/ha	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noahkali	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 II.9

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 II.10

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.

II.4.4 Crop Production

About 1.7 million tons of polished rice were produced in the study area in 1986/87. The average unit yield of rice in 1986/87 was 1.5 ton/ha, which was equal to the 2.3 ton/ha in paddy form.

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It is observed that an area of 36% of the NCA planted in rabi season, producing 41% of the total rice production. Again 66% of the NCA is planted during the rainy season, of which 23% is planted to B aman (DW aman) and 43% in areas, which are flood free. The most important crop, the HYV boro planted to 25% of the total area has been producing 40% of the total rice production, 47% of the total area has been planted to HYVs producing 64% of the total production.

II.4.5 Trends in Production of Major Crops.

Trends in the area of the different rice crops are shown in Figure II.5 for the whole country and for Comilla and Noahkali Regions since 1970. although the overall area of the total crop has grown little, the relative importance of HYVs, especially boro, has increased enormously.

In the Comilla region B.aman remains a relatively important crop. It does well on the large areas of deeply flooded land in the region. Local b.aus is being squeezed by the growth of hyv boro and hyv aman. In Noahkali local t.aman rather than b.aman remains an important crop. HYV aman increased up to 1980 but has changed little since, suggesting it is constrained by flood depths. HYV boro has increased but less than in Comilla or nationally, sugesting that it may be constrained by lack of irrigation - much of the area lacks the groundwater resources of other parts of Bangladesh.

II.4.6 Crop Flood Damage

The calculation of damage to crops by flood is fraught with difficulty and there is a great risk of double counting, for example farmers assess flood risk in planning their cropping pattern and losses are avoided to a large extent by reducing risks. The use of traditional cropping patterns therefore implicitly allows for flood damage. A simple method would be to assume that the average yields include the years when crops are damaged and therefore include the flood damage. Unfortunately the BBS statistics are based on harvested areas and therefore do not allow for the situation when a crop is abandoned due to flooding. It is therefore recessary to calculate a factor which is applied to yields to compensate for flood damage.

Crops are particularly vulnerable to flood damage at the following times:

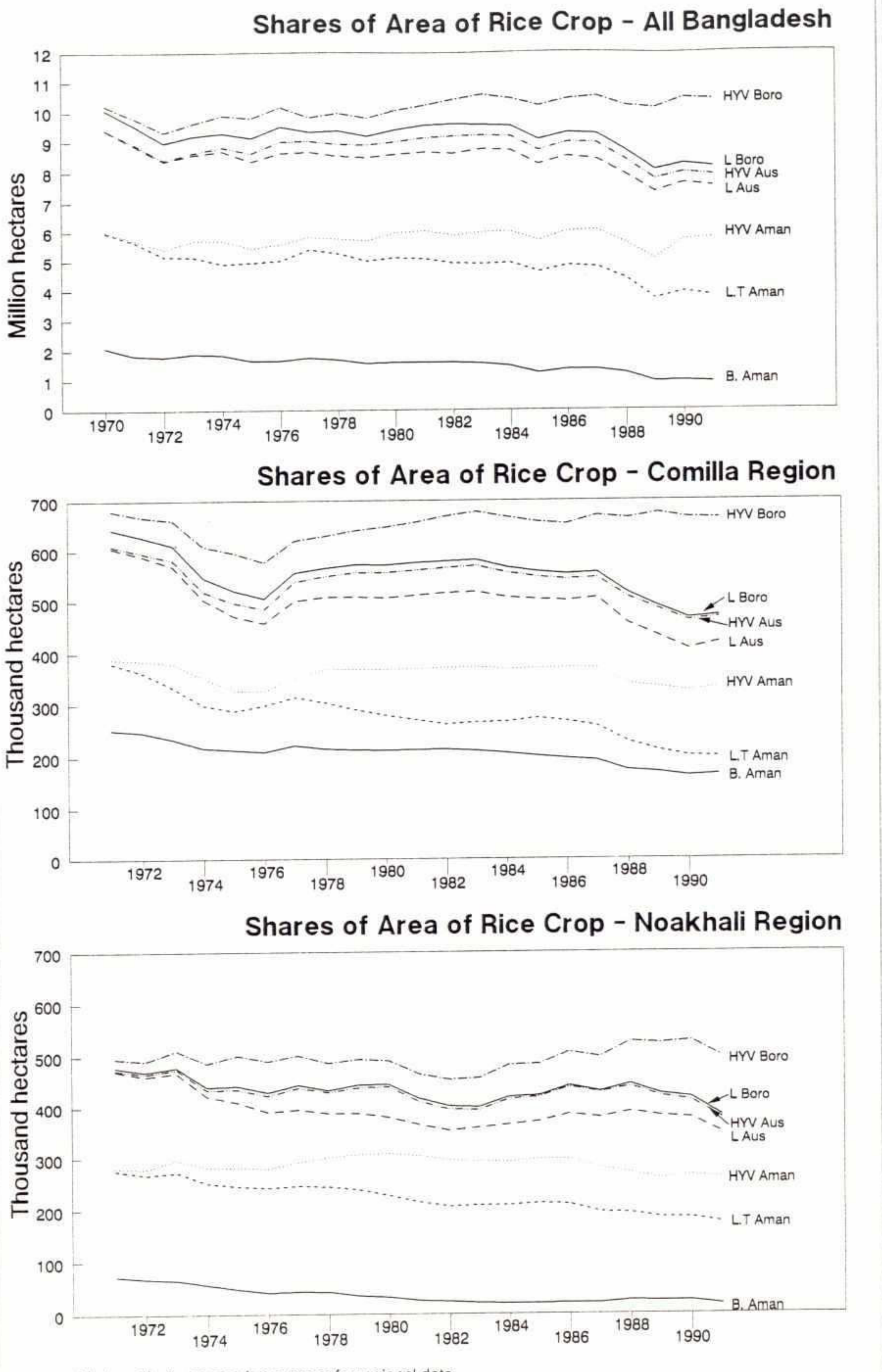
Boro	April 15 to June 15
Aus	June 1 to July 31
Aman	July 1 to Sept 30

An objective appraisal of agricultural flood damage requires that flood depths and durations be related to the stage of growth of the crop. Critical flood depths are given in Table II.11.

The evaluation of damage frequency on the basis of specific years of data may not be quite as appropriate as it is for land enhancement benefits because of the critical nature of the stage of crop growth to flood damage. The requirements for the evaluation are however fairly simple, being a cropping calendar and the distribution of the crop between various land categories. Time series water level results from the SERM would be used with the land level database and the cropping calendar to estimate yield losses. A thorough analysis would, however, require a long term simulation. This level of analysis will be appropriate at full feasibility level, but for the present (pre-feasibility) analysis a simplified approach based on recorded crop losses has been adopted.

Figure II.5

Trends of Different Rice Crops



Note: 1) 3 year moving average for regional data

2) Areas Shown are cumulative the gap between lines represents area of each crop

Source: BBS

B:\DRW\BCN.drw

TABLE II.11

Probable Crop Damage at Critical Flood Depths

Crop	Land Type	Crop growth stage	Critical Flood Depth (cm) 20%	50% (damage)	80%	Vulnerable period for flood damage
HYV Boro	F_3	Heading to maturity	60	80	100	1 May to 30 June
	F_2	Heading to maturity	60	80	100	15 May to 30 June
Local Boro	F_4	Heading to maturity	80	100	130	15 April to 15 May
B Aus	F_2	Heading to maturity	80	130	150	1 June to 31 July
B Aman	F_3	Vegetative			150	1 July to 15 August
T Aman, HYV	F_1	Seedling establishment			30	1 July to 31 August
		Tillering			45	1 August to 30 September
T Aman, Local	F_1	Seedling establishment			45	1 August to 15 September
		Tillering			60	1 August to 30 September

Source: MPO Technical Report Nr 1, Crop Production Limitations in Bangladesh (1987)

Estimates for crop flood damage over the period 1983-1988 are available from the Bangladesh Bureau of Statistics (BBS). These are based on data from the Department of Agricultural Extension (DAE). The data are shown in Table II.12. The levels of damage are given in terms of areas 'fully' (100%) damaged; this includes areas defined both as fully damaged and as 'partially' damaged, with the latter being expressed in terms of equivalent areas of full damage. Figures from the DAE for 1988 are also shown in the table for comparison: these are slightly higher than the BBS figures, but have been used to derive the damage by district figures in Table II.13 which are not available in the data published by BBS. Other data on crop damage are available from the Ministry of Relief and Rehabilitation for the period 1985-1988; these are not consistent with the BBS/DAE data and appear to contain a number of internal inconsistencies. The BBS data have therefore been used for the analysis in this report.

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TABLE II.12

Flood Damage to Crops, South East Region, 1983-1988

hectares

	1983	1984	1985	1986	1987	BBS est. 1988	DAE est. 1988
Comilla Region							
Boro	1 117	18 017	0	0	0	273	0
Aus	3 245	34 247	571	0	4 764	9 825	36 954
Aman	11 247	11 669	16	0	40 681	119 512	121 052
Sub-total:	15 609	63 933	587	0	45 445	129 610	158 006
Jute	275	0	0	0	254	2 810	3 603
Vegetables	0	0	0	0	0	1 473	3 316
Other	0	0	0	0	0	44	390
Total crops	15 884	63 933	587	0	45 699	133 936	165 315
Noakhali Region							
Boro	1 892	1 456	0	0	0	0	0
Aus	2 763	5 816	0	0	6 282	288	1 235
Aman	465	378	0	0	11 900	5 796	8 369
Total:	5 120	7 650	0	0	18 182	6 084	9 603

Source: BBS, Yearbook of Agricultural Statistics, 1987-88
DAE, Department of Agricultural Extension, 1988

Note: Estimates include areas of crops totally damaged and partially damaged (converted to totally damaged equivalent according to % of damage)
Estimates for flood damage only; hailstorms, cyclone, etc. damage excluded.

TABLE II.13

Aus and Aman Damage by District, 1988

	Hectares	Share (%)
Comilla Region		
Comilla	70 100	44.4
Chandpur	30 275	19.2
Brahmanbaria	57 631	36.5
Total:	158 006	100.0
Noakhali Region		
Feni	3 239	33.7
Lakshmipur	5 031	52.4
Noakhali	1 333	13.9
Total:	9 603	100.0

Source: Department of Agricultural Extension

Note: Estimates include areas of crops fully damaged and partially damaged (converted to totally damaged equivalent according to % of damage)

On the basis of the SERM runs for the years 1974, 1983, 1984, 1986, 1987 and 1988, which may be considered to be the six highest ranked events in the past 20 years, return periods have been attached to the damages by considering the rank of the events from the F3 and F4 flood phase classification derived from the summary table of flood phase classifications. The results of this calculation for the Noakhali, Dakatia and Dhonagoda Planning Unit areas is shown in Table II.14.

Crop damage frequency curves have been plotted using the SERM results and the BBS damage data, expressed in terms of the proportion of the planted areas of aus, aman and jute which were damaged in the different years (see Table II.15 and II.16. Damage in 1985-86 was negligible (at about 0.1% of the area planted to aus and aman in Comilla region, and zero in Noakhali region). This year has therefore been used as the base year for the damage frequency calculations; its probability of non-exceedence according to the SERM results ranges from 0.71 in Dhonagoda and Dakatia (both in Comilla region) to 0.76 in Noakhali.

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TABLE II.14

Probability of Non-Exceedence of Flood Phase Distributions
Noakhali North Project Area

Flood Phase as percentage of NCA F3 + F4 (x)	Rank (r)	Return Period T (x)	Probability of Non-Exceedence (Fx)
8.7	1	35.9	0.972
2.2	2	12.9	0.922
2.2	3	7.9	0.873
1.2	4	5.7	0.823
0.7	5	4.4	0.773
0.3	6	3.6	0.724

Dhonagoda Project Area

40.9	1	35.9	0.972
36.6	2	12.9	0.922
20.9	3	7.9	0.873
8.8	4	5.7	0.823
8.1	5	4.4	0.773
1.7	6	3.6	0.724

Dakatia Project Area

18.7	1	35.9	0.972
2.9	2	12.9	0.922
1.5	3	7.9	0.873
1.4	4	5.7	0.823
0.7	5	4.4	0.773
0.5	6	3.6	0.724

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TABLE II.15

Flood Damage to Aus and Aman as per cent of Planted Area, 1983, 1984, 1987 and 1988

Region	Year	Planted Area (ha)	Damaged Area (ha)	Damaged/Planted Area (per cent)
Comilla	1983/84	536 741	14 492	2.7
	1984/85	540 188	45 916	8.5
	1987/88	541 181	45 445	8.4
	1988/89	451 246	129 337	28.7
Noakhali	1983/84	403 500	3 228	0.8
	1984/85	412 933	6 194	1.5
	1987/88	405 894	18 182	4.5
	1988/89	345 288	6 084	1.8

Source : BBS

TABLE II.16

Flood Damage to Jute as per cent of Planted Area, 1983, 1984, 1987 and 1988

Region	Year	Planted Area (ha)	Damaged Area ha)	Damaged/Planted Area (per cent)
Comilla	1983/84	32 581	275	0.84
	1984/85	30 490	0	0.00
	1987/88	21 466	254	1.18
	1988/89	24 685	2 810	11.38

Source: Consultants' estimates based on BBS, see previous tables.

The 'expected' annual average crop damage, calculated as the sum of the cost and frequency differentials between 1985 and the other years for which data are available (1983, 1984, 1987 and 1988) has been estimated to be as follows:

Annual Average Crop Damage
(per cent of planted area)

	aus and aman	jute
Comilla region	3.26	0.63
Noakhali region	0.22	0.00

Details of the estimates are shown in Table II.17.

TABLE II.17

Calculation of Expectation of Flood Damage to Crops

Year	Frequency	Estimated Damage (% of planted area) Aus/Aman	Jute	Damage & Frequency Differential Aus/Aman	Jute	Cumulative Aus/Aman	Jute
Comilla Region (Dhonagoda Project)							
1985	0.714	0	0	0	0	0	0
1986	0.810	8.7	0	0.418	0	0.418	0
1987	0.857	8.5	1.2	0.418	0.028	0.418	0.028
1988	0.952	31.3	11.4	2.840	0.599	3.258	0.627
Noakhali Region (Noakhali North Project)							
1985	0.762	0	0	0	0	0	0
1983	0.810	0.8	0	0.019	0	0.019	0
1984	0.857	1.5	0	0.054	0	0.244	0
1988	0.905	4.7	0	0.149	0	0.222	0

For the evaluations of those projects which would provide a significant degree of flood protection, the average crop damage reductions have therefore been taken as being equivalent to 3.26% of areas planted to aus and aman and 0.63% of jute areas for projects in planning units within Comilla region. The expected flood damage levels in Noakhali are negligible (0.2% for aus and aman) and therefore no reductions in crop flood damage have been assumed for projects in Noakhali region.

Damage to boro has been difficult to assess as losses due to flash floods are generally not recorded in flood loss statistics. Analysis of farmer interviews in the Gumti II area suggest that the average annual loss is between 3% and 5% in areas prone to flash flooding. As the higher figure refers to a quite limited sub-project area, the regional plan has assumed an overall loss of 3% in planning units that are vulnerable to flash floods.

II.5. Farm Size and Land Tenure

II.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 II.18. Over 84% of farms are classified as small (under 1 ha) and these occupy half 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 II.19 for Comilla and Noahkali regions, which together broadly comprise the study area. So called landless households account for 21% of rural households in Comilla and 22% in Noahkali. However almost half of these have at least some cultivable land and so may be more properly classified as marginal farmers. Table II.A also shows that the landless and many small farmers (most in Noahkali) 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.

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TABLE II.18

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
Hobiganj*	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
Noakali*	181345	102324	28078 *p1218X80715		5351	47257	214774	230296
total	1135450	465078	190377	344133	19855	117317	1345682	926529
Hobiganj*	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%
Noakali*	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 II.19

Land Holdings in Comilla and Noahkali Regions (Greater Districts)

	Comila Region				Noakhali Region			
Land operated	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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Tables II.20 and II.21 show land tenure arrangements for Noahkali and Comilla Regions. They show that, although 14% of land in Comilla and 24% of land in Noahkali 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 Noahkali. Over a third of holdings in both areas combine tenanted and owned land, with about half the land on such farms in Noahklai 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 Noahkali.

TABLE II.20

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 II.21

Noahkali 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

II.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 Noahkali 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 II.22 and II.23. 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, primarliy earning a living from some other occupation.

Comparison Between Statistics and Survey Data

	PROJECT SURVEY		STATISTICS	
	Gumti	Noahkali	Comilla	Noahkali
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 prelimary results from the 1991 Population Census indicate that the proportion of landless households in the Noahkali 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 II.22

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%

TABLE II.23

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 II.20 and II.21 show land tenure arrangements on the 768 holdings covered in the farmer surveys. Results have been wieghted 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.

II.6. Agricultural Support Services

II.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 includes 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 managment problemes 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 managment.

II.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 Songazi 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.

II.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.

II.7. Marketing

II.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.

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(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 and 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.

II.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 II.24 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 II.24

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'

II.7.3 Role of Government

II.7.3.1 Marketing Institutions

Many government departments and parastatals are engaged in advisory, promotional, regulatory or financing activities in respect of the marketing of agricultural products. For the south-east region these include:

(a) The Directorate General of Food (DGF) of the Ministry of Food (MOF) is concerned with local procurement of paddy and wheat at the support price. It operates the Central Storage Depots (CSD) and Local Storage Depots (LSD) of the Food Department for rice, wheat, sugar, salt and edible oils with a view to maintaining food prices at a reasonable level. It operates the Public Foodgrain Distribution System (PFDS) in rural areas.

(b) The Agriculture Marketing Department (AMD) of the Ministry of Agriculture is concerned with collection and dissemination of market information, licensing of traders and fixing of market charges and advising the government on agricultural marketing. The department has staff at district headquarters.

(c) The Department of Agricultural Marketing and Grading under the Ministry of Commerce enforces grading of farm products for export purposes. Jute is the main export item from the region.

(d) The Directorate of Jute is entrusted with licensing and regulation of the jute trade.

(e) The Bangladesh Standards and Testing Institute of the Ministry of Industries is introducing the metric system of weights and measures.

(f) The Local Government Engineering Bureau (LGEB) under Ministry of Local Government and Rural Development and Cooperatives (MLGRDC) undertakes provision of rural infrastructure including expansion and improvement of rural roads, markets and construction of godowns,

(g) The Bangladesh Swiss Agricultural Project under Ministry of Agriculture is providing warehousing facilities at village level, particularly for small farmers.

(h) Bangladesh Rural Development Board (BRDB), the Department of Co-operatives (DOC) and the Milk Producers Co-operative Union (Milk Vita), all under MLGRDC engaged in providing, among other things, agricultural marketing co-operatives within the integrated rural development concept,

(i) The Bangladesh Krishi Bank (BKB) under the Ministry of Finance provides marketing loans to traders and processors.

II.7.3.2 Public Sector Marketing and Procurement

Public sector foodgrain procurement and marketing aims to stabilise the price of foodgrains, improve the welfare of the poorer sections of the community and foster rural infrastructure development. The main policy instruments used are foodgrain imports, open market sales, internal procurement, provision of 'statutory and modified rations', food for work and vulnerable group development activities.

Public sector foodgrain distribution is equivalent to around 15% of net foodgrain production, or 25-30% of the amount marketed. Over two million people receive either daily, weekly or monthly foodgrain quotas from the Public Foodgrain Distribution System (PFDS) through the following channels:

(a) 'Statutory Rationing' in six major cities including Dhaka and Chittagong.

(b) 'Modified Rationing' for the lowest income groups in the rural areas, but is not operating at present.

(c) 'Essential Rations' for priority groups such as the armed forces, police, hospitals and students.

(d) Other priority areas include employees of government, semi-government and autonomous bodies, educational institutions, etc., and large employers (with more than 50 employees).

(e) Open market sales: under this system, designed mainly for price stabilisation, anyone can buy any amount of foodgrain from government stores at a price fixed periodically depending on market prices.

(g) Flour Mills: wheat is supplied to both private and government mills.

(h) Relief supplies: under which foodgrains are distributed directly to consumers for:
- Vulnerable Group Development,
- Food for Work,
- Gratuitous Relief.

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A summary of the levels of foodgrain production, imports, internal procurement and PFDS distribution is presented in Table II.25. It may be seen that the food gap grew steadily from 1981/82 up to 1988/89, but dropped sharply after the bumper harvests of 1989/90, and will have declined further in the last year. The food gap is estimated from domestic net production less projected population times 168 kg/person/year. Imports varied between 9 and 20% of production partly reflecting carry over of PFDS stocks from year to year.

PFDS stocks are mainly supplied by aid donors with only limited quantities originating from domestic and international purchases. Domestic procurement has typically been only of the order of 2% of production, and appears to have been used primarily for the purposes of food security, and not for the purpose of providing farmers with a reliable floor price during periods of market glut. Policies have had only a limited effect on farmgate prices since the government has never procured all that was offered by farmers, and since 1977/78 grower's prices have been below procurement prices more than half the time during the main harvest months.

Dispite this, Govennment foodgrain management and price stabilization policies have been fairly successful in avoiding large fluctuations in rice prices. This has been helped by the increasing share of production from the more stable boro crop.

TABLE II.25

Foodgrain net production, Foodgap, imports and internal procurement (in million tonne)

Year	Net Production	Food gap	Import	Internal Procurement	PFDS Distribution
1980/81	12.48	2.41	1.08 (9%)	1.03	1.5
1981/82	13.41	1.87	1.26 (9%)	0.30	2.7
1982/83	13.78	1.90	1.84 (13%)	0.19	1.9
1983/84	14.15	1.93	2.06 (15%)	0.26	2.1
1984/85	14.48	2.00	2.59 (18%)	0.35	2.6
1985/86	14.48	2.42	1.20 (8%)	0.35	1.5
1986/87	14.85	2.46	1.77 (12%)	0.19	2.1
1987/88	14.89	2.83	2.92 (20%)	0.38	2.5
1988/89	14.99	3.16	2.14 (14%)	0.42	2.9
1989/90	16.90	1.67	1.53 (9%)	0.96	2.2

Source: Ministry of Food, Food Planning and Monitoring Unit

Notes: Net Production of foodgrains estimated from gross production of rice and wheat after deduction of 10% for seed, feed and waste. Food Gap estimates are based on Net Production less demand estimates based on BBS population projections and consumption of 168 kg/person/year. Figures in parenthesis indicate imports of foodgrain as a percentage of net production of foodgrains.

II.7.4 Storage

Warehousing and storage are undertaken both by the public and private sectors. Information on private sector godowns and storage facilities is not readily available. Table II.26 shows the capacity of major government storage facilities in the Comilla and Noahkali Regions. The Ministry of Food operate silos, the Central Storage Depots (CSD) and the Local Storage Depots (LSD). Their total capacity in 1990 was 173,330 tonnes. LSD are located in most thanas for distribution of PFDS foodgrains. The principal CSD capacities in the region are in Brahmanbaria, Chandpur, Burichang, Sudharam, Begumganj and Comilla.

TABLE II.26

Capacity of Major Storage Facilities (tonnes)

	Comilla Region	Noahkali Region
Food godowns (Ministry of Food)		
local storage depot	59,050	50,780
central storage depot	13,500	0
silos	50,000	0
Cold stores (for potatoes)	81,000	6,000
BADC fertiliser stores	24,500	15,800

Source: BBS (note food stores for 1990, potato 1991, fertiliser 1988)

Fertiliser used to be distributed from BADC godowns in Thanas. The principal fertiliser godowns are at Begumganj (9,226 tonne), Chandpur (8,449 tonne), Daudkandi (4,400 tonne), Feni (3,500 tonne), Brahmanbaria, Comilla and Laksam.

The area also has a jute godown capacity of about 150,000 tonne, with godowns at Begumganj (103,800 tonne), Lakshmipur (20,180 tonne), Chandpur (12,285 tonne), Hajiganj (7,275 tonne), Daudkandi (2,200 tonne) and Burichang (1,200 tonne). The region has 15% of the jute godowns capacity in the country.

II.7.5 Commodity Marketing

II.7.5.1 Rice

According to a study by the Minsitry of Food (Table II.27), although farmers sell on average 35% of their production, the net marketable surplus (the production less home consumption) is only around 6% of total production, as farmers sell rice much of their rice at harvest time, in order to meet cash needs and repay loans, and as they lack suitable storage facilities. Most of this grain is then re-purchased later in the year using cash from other sources. This estimate of gross marketed amount of 35% in the above study is broadly in line with results from other surveys showing gross marketed amount to vary between 28% and 37%.

TABLE II.27

Comparison of Marketed Amounts and Gross Marketed Surplus

Farm Size (ha) production	Marketed Amount as % of production	Marketed Surplus as % of
0.0 - 0.2	(274)	22
0.2 - 1.0	(27)	28
1.0 - 2.0	26	31
2.0 - 3.0	41	35
3.0 and above	56	49
All Samples	6	35

Source: Ministry of Food, 'Study on Food Grain Marketing Trade and Operation', 1985

Many marketing agents deal in rice. They have specialised functions and include:

- Beparies, larger traders operating in primary and secondary markets
- Farias, smaller traders operating in primary and secondary markets
- Kutials trade and process rice.
- Aratdars maintain permanent trading establishments and storage facilities

Private rice traders generally only deal in domestically produced foodgrains, although in 1987-88 the government allowed 82 000 tonne of rice to be imported by the private sector.

There are significant regional variations in rice prices, which are more pronounced for the fine grades of rice. The wholesale price of fine rice price is normally 25-33% higher in Chittagong than in Dhaka, while the Chittagong coarse rice price often falls below that in Dhaka, ostensibly because the Chittagong area produces a considerable amount of boro rice.

Rice prices show considerable seasonal variation. With the emergence of boro, there are now three seasonal patterns for rice prices. The aman harvest of mid-November brings about a downward trend in rice price from November which continues up to the end of January. Prices tend to rise from the end of January reaching a peak in April then fall in May/June with the boro harvest. From June, prices tend to rise again up to the aus harvest. The coarse rice price appears to be more susceptible to this seasonal variation than fine rice, which is mostly harvested as aman in November.

In the ten years between 1975-1984, the rice price variation within each 12 month period was more than 20% in seven years and more than 50% in three years. The annual price variation seems to be decreasing along with the increased importance of the more stable boro crop.

II.7.5.2 Wheat

There appears to be a shift of taste of the consumer in favour of wheat, which is the second largest crop in the country after rice. Production started to grow in the mid-seventies, and increased by 100% in less that a decade. Output reached a peak in 1984/85 of 1.1 million tonne, but has stagnated in recent years, mainly due to falling yields.

More than 60% of the wheat produced is marketed. However imports meet about two-thirds of the demand compared to about 10-12% in the case of rice. Most of the imported wheat is funded by external assistance, though government has lately allowed some import of wheat by the mills (all of which, bar one, are private). Therefore PFDS (which handles wheat procured through offical channels) accounts for over 70% of wheat supplies.

II.7.5.3 Jute

The south-east region produces only about 4% of the raw jute grown in Bangladesh. Jute marketing has a pyramid structure, with a large number of traders at the primary level, but very few (balers, millers and shippers) at the terminal level resulting in limited competition.

The first link in the marketing chain is formed by licensed jute dealers ("farias or "beparies") who purchase jute direct from the growers' farms, rural assembly markets or unlicensed petty traders. They sell their assorted loose jute in the secondary markets to balers, shippers, or jute mills including the Bangladesh Jute Corporation.

Two parastatals, the Bangladesh Jute Corporation (BJC) and the Bangladesh Jute Mills Corporation (BJMC) (which owns 67% of the jute looms) deal in jute. BJMC is responsible for jute purchasing with the objective of stabilizing jute market prices which tend to suffer from considerable seasonal and annual fluctuations. The statutory minimum jute price has been suspended since the 1980/81 season; the corporations purchase jute at the prevailing market price as periodically approved by the government. The BJMC operates as the purchasing agent for BJC and also exports raw jute.

In the south-east region there are jute godowns at Begumganj, Lakshmipur, Chandpur, Hajiganj, Daudkandi, Brahmanbaria and Burichang. There are also jute spinning and weaving mills in Chandpur (7,600 employees), Noakhali (3,800 employees), Comilla (1,400 employees) and Feni (300 employees). These private sector jute mills buy jute mostly from the growers and jute dealers, either at mills or through their purchasing centres or agents.

However much of the jute produced in the region is sold direct by traders to Narayanganj, the largest jute trading centre in the country on the outskirts of Dhaka. Begumganj and Lakshmipur have recently emerged as large centres for jute storage before processing and final export via Chittagong. Jute pressing and baling units are located in Brahmanbaria, Chandpur and Lakshmipur.

II.7.5.4 Potatoes

Production of potatoes, has shown considerable expansion over the last few decades. Potato growers generally take their potatoes to the nearest market or may sell the crop on the field to visiting traders. Some of the bigger growers and traders take potatoes to wholesale markets or even direct to cold storage whose owners play a very significant role in potato marketing.

There are over 30 cold storage in the region. Liberal credit policies in the 1980's led to overcapacity in the around Commila which now contains 16% of the cold storage capacity of the country. Strong competition tends to reduce the rents charged. Cold stores have extended the potato consumption season to twelve months whereas in the past potatoes normally disappeared from the market by July or August.

II.7.5.5 Vegetables and Spices

Parts of south-east region are well known for production of cabbage, cauliflower, aubergine, radish, tomatoes and water melons. Areas near Comilla, Chandina, Burichang, and Muradnagar produce considerable amounts of winter vegetables. Farmers generally sell vegetables to small traders who sell to merchants for transport by truck to Sylhet, Chittagong and Dhaka. Some farmers in Lakshmipur and Chandpur areas produce chillies in commercial quantities, the dried chillies being sent out of the region or distributed internally. Onions, garlic and coriander seeds are also grown although the region has a deficit in these products as well as in pulses and mustard.

II.8. Agricultural Credit

II.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 Noahkali feasibility studies suggest that farmers make surprisingly little use of credit, funding most of their requirements from crop sales or other sources of income (see Table II.28). 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.

TABLE II.28

Sources of Finance for Farm Input

	Fertiliser & pesticides	Hire of draught	Hire of labour	Purchase of water
None (not bought/hired)	1.0%	21.8%	9.9%	26.7%
Borrow from bank	4.0%	3.0%	5.9%	3.0%
Borrow from friends & relatives	4.0%	5.9%	5.0%	6.9%
Borrow from supplier	2.0%	0.0%	0.0%	0.0%
Borrow from money lender	2.0%	4.0%	2.0%	2.0%
Cash from sale of crops	41.6%	29.7%	41.6%	28.7%
Cash from other source of income	34.7%	24.8%	27.7%	24.8%
Cash from sale of assets	2.0%	1.0%	1.0%	2.0%
other source	8.9%	9.9%	6.9%	5.9%

Source: Farmer's case studies in Gumti and Noahkali

II.8.2 Bank Lending

The main sources of institutional credit for agriculture are the four Nationalised Commercial banks (NCB - Agrani, Janata, Rupali and Sonali Banks), two specialist agricultural banks, the Bangladesh Krishi Bank (BKB) and RKUB (the latter only operates in the North-west). More limited funds are lent by the Cooperative Bank (BSBL). These banks lend direct to individual farmers, although in the past loans have also been channelled through BRDB/KSS (Bangladesh Rural Development Board/farmers' cooperatives) to cooperative group members. Disbursemens of Bank Credit to Agriculture can be seen in Table II.29.

TABLE II.29

Disbursements of Bank Credit to Agriculture

Taka million

	1985/6	1987/8	1987/8	1988/9	1989/90	1990/1
Krishi Bank	2973	3092	2755	3431	3769	3242
RKUB					461	371
PCBs	1802	1842	2307	2686	2070	1822
BRDB	595	5167	5943	577	548	499
BSBL	102	148	126	170	19	23
total	5472	10249	11131	6864	6867	5957

Source: BBS

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Table II.32 shows how nationally disbursements to agriculture have declined, especially with the sharp fall in BRDB disbursements to farmers' cooperatives. Data from Krishi Bank for the south-east region in Table II.30 show how disbursements have fallen, even though, at the national level, Krishi Bank continues to lend substantial sums.

TABLE II.30

Krishi Bank Disbursements in the South-East

Taka million

	Comilla	Noahkali	Total
1983/84	379	108	487
1984/85	487	167	654
1985/86	202	93	295
1987/88	24	214	238
1987/88	12	88	100
1988/89	184	129	313
1989/90	158	128	286
1990/91	112	92	204

Source: BBS

Rapid expansion in agricultural credit and rural bank branches overstretched the management capacities of the banks involved. Loan recovery rates are low, and a study into agricultural credit[1] estimated that the recovery rate declined from 44% in 1980 to 19% in 1989. As a result of poor recovery many borrowers have become defaulters and are disqualified from future borrowing.

In addition bank lending to agriculture often does not reach those who need it most - small farmers for purchase of inputs such as fertiliser. Much agricultural credit is used for agro-industries and related activities rather than farming. Of the credit that farmers do get, only some is used for agricultural production, the rest goes to non-agricultural enterprises or is used to fulfil social obligations.

Poor performance of the banking sector is attributed to a weak mangement capability and inadequate operating proceedures, together with a shortage of qualified staff. The banks have been subject to political and social pressures to increase lending volumes, and lack field level contact with farmers. Where they have attempted to utilise local organisations to approve loan applications, the vetting procedures involved have resulted in access to credit becoming a form of political patronage.

Although banks may insist on the mortgaging of land as collateral (many small farmers find it difficult and expensive to establish proper title to their land), enforcement of such recovery instruments is almost non-existant: there are no records of banks obtaining possession and selling land belonging to a defaulter.

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[1] Institutional Credit in Bangladesh Agriculture. R Navin. USAID 1988

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The government, through the Financial Sector Reform Project (FSRP), is attempting to improve the banks' accounting, management information systems, and credit delivery/recovery systems. This prioject, which is supported by the World Bank and USAID, started in 1990. It is attempting to classify outstanding loans and get the NCBs to make provision against profits for loans of dubious quality, and generally improve loan discipline. However these attempts suffered a setback in 1991 when a general waiver was announced on agricultural loans under Tk5,000. Many borrowers with larger loans have ceased repayments in the hope that their loans will also be forgiven. Dispite this write off, overdue agricultural loans still amount to over Tk32,000 million.

Greater attention to the viability of lending, with branch officers being made more accountable, appears to be making banks extremely reluctant to lend in all sectors of the economy. Although they have a large supply of liquid funds, and continue to allocate large amounts to the agricultural sector, only a small proportion of this is actually disbursed.

II.8.3 Lending by NGOs for Agriculture

A number of NGOs have credit programmes which have been strikingly successful in reaching the rural poor, and in achieving rates of loan repayment in excess of 95 percent. Although the volume of this lending is large (Grammeen bank disbursed Tk. 6.2 Million in 1990), the bulk of it is for non-agricultural purposes, as most NGOs exclude people owning over 0.2 ha of land, so its effect on agricultural productivity is limited.

II.8.4 Informal Lending

Informal credit has expanded rapidly since the decline in disbursements by formal credit institutions in the late 1980s. Sources such as traders, neighbours and relatives provide around 80% of all agricultural credit (see Table II.31. The cost of credit from traders or "mahajans" is high at around 50% to 120% per year, while borrowing from neighbours and relatives may involve a complex web of economic and social obligations. However it has considerable advantages over formal sources including ease of access and reduced collateral requirements. Moreover the cost is often more competitve with formal credit if the cost of paperwork and unofficial payments to bank officials is added to bank interest charges.

II.8.5 Lending for Minor Irrigation Equipment

II.8.5.1 Lending by Banks

Banks have, since 1977, lent about Tk4,900 million purchase of STW, DTW and LLP by individuals and groups of farmers. A total of Tk974 million for 8,649 DTWs has been lent by the Sonali Bank through BRDB to KSS groups. Over half of this money has come from the World Bank and other donors.

The performance of loans for irrigation equipment has been extremely poor. Table II.32 shows that, due to accumulated interest, the total outstanding amount exceeds that originally let by 157%. The recovery rate on lending for BRDB/KSS tubewells is only about 7% (on a demand basis).

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TABLE II.31

Sources of Credit in Three Villages in Noahkali

	Hasanpur	Madhupur	Rajendrapur
Institutional Sources	9.4%	21.1%	32.9%
Money Lender (Mahajan)	15.8%	0.5%	0.0%
Land owner	16.9%	0.0%	0.0%
Shopkeeper/Dealer	8.0%	0.0%	0.4%
Relative, Friends and Neighbour	24.9%	46.2%	38.2%
Housewives	3.7%	2.7%	0.1%
Unregistered Cooperative	2.4%	2.6%	0.5%
Others	18.9%	26.9%	27.9%
Total non-institutional sources	**90.6%**	**78.9%**	**67.1%**

Source: Sajjad Zohir, "Rural Credit Market in Noakhali District, BIDS Research Report Nr 106, (June 1989), p. 25.

TABLE II.32

Bank Lending for Irrigation Equipment (all Bangladesh)

Name of Bank	Disbursed	Recovered	Overdue	Outstanding
Agrani	104.7	92.9	112.2	125.4
Janata	197.6	124.4	251.5	296.9
Rupali	25.6	15.9	25.7	26.0
Sonali: of which (BRDB/KSS)	2,620.4 (973.5)	247.9	2,252.0 (329.0)	3,868.6 (1,066.8)
BKB/RAKUB*	1,950.1	1,222.0	1,637.7	3,352.1
Total	4,898.4	1703.1	4,279.1	7,669.0

* includes RAKUB (Rajshahi Krishi Bank) source: DTW II Final Report (Credit Study)

II.8.5.2 Lending by NGOs

A number of NGOs have developed specific irrigation credit programmes. BRAC and Proshika support the formation groups of landless people who buy and operate irrigation pumps and generate income via water sales. Although these programmes have been successful their scope is limited to landless groups. Grammen Bank has had a less happy experience in taking over reponsibility for over 1000 DTW formerly operated by a government project in the north-west.

II.8.5.3 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 indefinitiely postponed pending reforms of the institutions involved. However the problem in lending is not the availiablity 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.

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 percieve in getting access to bank credit suggests they would normally prefer to fund this investment from thier 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[2], 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.

II.9. Conclusions - Constraints on Agriculture

In the densely populated south-east region of Bangladesh farmers need to maximise the productivitiy of their very limited areas of land. Cropping intensity is limited by widespread flooding which also contrains the use of short strawed HYVs, and means there is a signifiant 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

[2] DTW II Final Report (Credit Study)

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.

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 popuations 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 alieviated 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 substatially 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.

Prehaps 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 backgound it is important that future irrigation development is low cost with minimal pumping and investment in infrastructure.

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ANNEX III

SOCIO-ECONOMICS

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ANNEX III - SOCIO-ECONOMICS

III.1.1 Introduction

This annex presents an analysis of the main socio-economic characteristics including demographic features, the standards of living of the population, employment, land ownership and social impact in the south-east region of Bangladesh. Firstly, trends in population growth, distribution and structure have been discussed; an assessment of the main factors determining population growth is contained in Appendix I of this Annex. Land ownership, and housing have also been analysed, as Labour force participation rates, the structure of employment levels of access to basic amenities and levels of literacy and education have been analysed in the main report.

III.1.2 Demographic Characteristics

III.1.2.1 National and Regional Population Growth

Bangladesh, with a population of over 109 million (1991), 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.

In 1901, the population of Bangladesh was 29 million. By 1931, it had grown to 36 million, and by 1961 had reached about 52 million. Between 1961 and 1981, the population increased by 71%, to just over 87 million. According to Planning Commission projections, the population was increasing at an annual average rate of about 3% between 1981 and 1990. The current (1991) population growth rate is officially estimated at 2.17% per year. It is estimated that net emigration from Bangladesh since 1961 has numbered about 1.5 million persons a decade, which reduced the rate of population growth 0.2 percentage points a year (Khan, 1974).

The history of census taking in the area now forming Bangladesh dates back more than 100 years. The first population census was undertaken in 1872, the second in 1881, with subsequent censuses every ten years until 1961. Further censuses were conducted in 1974, 1981 and 1991. The 1981 census provided bulk of the population data; the 1991 census is used for some information which are covered in the preliminary report of population census 1991.

Despite this long period of demographic data collection, systematic analysis of trends in the growth and distribution of the population of Bangladesh is handicapped by a lack of reliable data. Data from the censuses and from records of vital population statistics are subject to serious errors in coverage and contents. Natural demographic trends have also been seriously affected by a succession of man-made and natural calamities, including famines, refugee movements, floods, cyclones and wars. Analysis is further complicated by frequent past changes in administrative boundaries.

III.1.2.2 Population Growth and Distribution in the South-East Region

a) Past Growth and Distribution by District

The population of the south-east 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 below 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 Tables III.1 and III.2.

This indicates that there was net emigration from the region to other parts of Bangladesh (and/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 (see Table III.3). 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 (8.1%) than for women (1%).

TABLE III.1

Population in Bangladesh and the South-East Region: 1951-1991

Division/ District	Population ('000)				
	1951	1961	1974	1981	1991
Brahmanbaria	1 038	1 151	1 472	1 728	2 137
Comilla	1 783	2 077	2 802	3 356	4 023
Chandpur	971	1 158	1 544	1 796	2 022
Feni	540	590	760	899	1 095
Lakshmipur	710	816	1 118	1 120	1 309
Noakhali	821	975	1 356	1 736	2 216
SE region	5 863	6 767	9 052	10 635	12 802
Bangladesh	41 932	50 840	71 479	87 120	107 992
SE region as a share of Bangladesh	14%	13.3%	12.7%	12.2%	11.93%

Source: Population of Bangladesh Country Monograph Series 8-ESCAP,
Population Census of Bangladesh 1981 and 1991 District Census Report
Combined and duplicated to show greater congruency

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TABLE III.2

Intercensal Growth Rate by District *
1951-1991

(Average annual rates, %)

Division/ District	1951-61	1961-75	1974-81	1981-91	Average 1951-91
Brahmanbaria	1.03	1.89	2.29	2.15	1.82
Comilla	1.53	2.30	2.58	1.83	9.06
Chandpur	1.76	2.21	2.09	1.19	1.85
Feni	0.89	1.95	2.40	1.99	1.78
Lakshmipur	1.39	2.42	0.03	1.57	1.54
Noakhali	1.72	2.54	4.02	2.47	2.51
SE region	1.43	2.24	2.36	1.87	1.97
Bangladesh	1.93	2.62	2.83	2.17	2.39

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

TABLE III.3

Life Time Net Migration by Districts

Locality	Male	Female	Total	Rate (% of 1974) 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	- 9 4486	- 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: Base on the national growth rate method

The distribution of the region's population between its different districts is shown in Table III.4. The figures indicate that population increased (between 1961 and 1981) at above the average rate for the region in Comilla and Noakhali Districts, and at below average rates in the other four Districts. Growth was particularly rapid in Noakhali District in the 1974-1981 inter-censal period, averaging over 4% per year. However, preliminary returns from 1991 indicate that population growth in Noakhali, though still steady, was below 2.5 % per year during the 1981-91 decade.

TABLE III.4

Distribution of the Population by District 1951-1991

(%)

	Year				
Locality	1951	1961	1974	1981	1991
Brahmanbaria	17.7	17.0	16.3	16.2	16.59
Comilla	30.4	30.7	31.0	31.4	31.2
Chandpur	16.6	7.1	7.1	16.7	15.7
Feni	9.2	8.7	8.3	8.4	8.5
Lakshmipur	12.1	12.1	12.3	10.5	10.2
Noakhali	14.0	14.4	15.0	16.8	17.2
Total	100	100	100	67.0	

Source: Population of Bangladesh Country Monograph Series 8-ESCAP
Population Census of Bangladesh 1981, District Census Report

b) Projected Future Growth

The population of the south-east region, 12 million in 1991, was projected (NPC) to increase to 18.4 million by the year 2010. Rates of population growth are forecast by the NPC to decline over this period as follows:

Years	Average Annual Growth Rate (%)
1990-1995	2.03
1995-2000	1.68
2000-2005	1.42
2005-2010	0.96

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The projections are shown in Table III.5. The distribution of population between the different Districts in the region has been assumed to remain as in 1990 for the purpose of these projections. Following the 1991 census the projected growth is lower and the estimated population by 2010 is now 16.6 m. An analysis of the factors influencing population growth at both the national and the regional levels is contained in Appendix I to this Annex.

TABLE III.5

Population Projection 1990-1991

Population ('000)

Locality	1990	1995	2000	2005	2010
Brahmanbaria	2 193	2 425	2 635	2 828	2 966
Chandpur	2 269	2 509	2 727	2 926	3 069
Comilla	4 262	4 712	5 122	5 495	5 765
Feni	1 141	1 262	1 372	1 472	1 544
Lakshmipur	1 423	1 573	1 710	1 834	1 924
Noakhali	2 282	2 523	2 742	2 942	3 085
SE region	13 570	15 004	16 308	17 497	18 353

Source: National Planning Commission.

III.1.2.3 Population Density

Population density in the region in 1991 averaged 1 078 persons per sq. km. This was about 30% higher than the average for the country as a whole. Densities in the region were highest in Brahmanbaria, Comilla, Chandpur and Feni Districts (at between 1 108 - 1 300 per sq km) and lowest in Noakhali and Lakshmipur (789 - 899 per sq km). On the basis of the NPC projections, population density will have increased to an average of 1 529 persons per sq km by the year 2010. Details are shown in Table III.6.

The relatively low population densities in Lakshmipur and Noakhali Districts are due to the extensive areas of char lands in the south of these areas, which are generally unsuitable for agricultural development. 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.

TABLE III.6

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

III.1.2.4 Rural-Urban Distribution of Population

The urban population comprises people resident in municipal areas, thana headquarters and hats and bazars with electrification. The large scale transfer of rural population to urban centres has led to a substantial increase in urban population in the country over the last 20 years. The urban population constituted 5.2% of the total population in 1961, which increased to 8.8% by 1974. According to the 1981 census, the proportion of the urban population was 15%; this large increase was due partly to the extended definition of the urban population used in the 1981 Census, as well as reflecting an actual acceleration in the rate of rural-urban migration.

The proportion of urban population in the SE region, according to 1981 census results for greater Comilla and Noakhali districts, was 8% and 11% respectively. This is low compared to the national figure of 15%, although there has been a substantial increase since 1961. Urban population shares by District in 1981 are shown in Table III.7.

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TABLE III.7

Urban Population, 1981

Locality	Total Population	% Urban
Brahmanbaria	1 728 273	8.7
Comilla	3 345 594	8.1
Chandpur	1 977 245	6.8
Feni	898 861	6.4
Lakshmipur	1 120 260	10.1
Noakhali	1 735 573	13.9
SE region	10 635 587	9.1
Bangladesh	87 119 965	15.2

III.1.2.5 Population Structure in the SE region

The age and sex-structure of a population at any point of time is the outcome of the past experience in fertility, mortality and migration, which in turn influences the levels of vital processes and population growth. The dynamics of age and sex-structure thus constitute an important component of demographic analysis. This section provides an overview of the age and sex-structure and some demographic ratios for the SE region.

a) Age Structure

The population of Bangladesh is not only growing rapidly, it is also very young: the 0-14 years age group has constituted more than 45% of the total population since the 1960s. Only a small proportion of the population is in the over-60 years age group.

The distribution of the population of the SE region by age and sex is shown in Table III.8; the age structure of the population by District is shown in Table III.9. The tables show that the age group 0-14 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%). This may be related to socio-cultural attitudes to status of women and family planning. The proportion of old age population (60 and over) was about 6% for all Districts, which compares well with the national figure (5.6%).

TABLE III.8

Distribution of Population by Age and Sex: 1981

Age	Total	Male	Female
0-4	1 899 936	968 840	931 096
5-9	1 783 264	917 625	865 639
10-14	1 429 068	757 623	671 445
15-19	964 566	478 255	486 311
20-24	750 966	331 671	419 295
25-29	710 624	322 718	387 906
30-34	571 300	257 856	313 444
35-39	526 885	255 820	271 065
40-44	449 696	217 718	231 978
45-49	355 862	187 277	168 585
50-54	333 397	170 143	163 254
55-59	207 696	116 419	91 277
60-64	253 381	134 460	118 921
65-69	122 086	72 327	49 759
70+	276 971	162 259	114 712
All ages	10 635 587	5 351 001	5 284 686

TABLE III.9

Population age structure, 1981 (%)

Locality	0-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60 +	Total
Brahmanbaria	18.0	16.5	12.7	8.7	14.2	10.8	7.9	5.2	6.0	100.0
Comilla	17.8	16.3	12.8	9.3	14.3	10.5	7.7	5.2	6.2	100.0
Chandpur	17.6	17.1	13.9	9.1	13.4	10.1	7.5	5.0	6.3	100.0
Feni	17.7	16.3	13.3	9.2	13.9	10.0	7.4	5.2	6.5	100.0
Lakshmipur	18.0	17.2	14.0	9.1	13.4	10.2	7.4	4.9	5.7	100.0
Noakhali	18.1	17.5	13.8	8.9	13.2	10.0	7.5	4.9	6.0	100.0
SE region	17.8	16.8	13.3	9.1	13.8	10.3	7.6	5.1	6.1	100.0
Bangladesh	17.0	16.2	13.4	9.3	15.1	10.8	7.5	4.9	5.6	100.0

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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. For a population with high fertility and low life expectancy, the median age of the population is expected to be low. An examination of the age distributions of Bangladesh for various census years shows that median age has declined over time, from 19.3 years in 1951, to 17.6 years in 1961 and to 16.6 years in 1981. With the declining trend in the mortality rate and the control of infectious diseases, the median age may decline further in future.

The average median age for the SE region is estimated at 16.1 years, compared with the national average of 16.6 years. The median age by District is shown in Table III.10: Lakshmipur and Noakhali have significantly lower medians (at 15.4% and 15.3% respectively) than other Districts in the region.

TABLE III.10

Median age by District (1981)

District	Age (year)
Brahmanbaria	16.6
Comilla	16.6
Chandpur	15.6
Feni	16.2
Lakshmipur	15.4
Noakhali	15.3
SE region	16.1

b) Dependency Ratios

The dependency ratio - a measure of the dependency burden that the productive population must bear - fluctuated only a little between 1911 and 1951. By 1974 the dependency situation had grown much worse, with the ratio reaching 116.0. Although this burden had eased somewhat by 1981, the ratio was still very high, at 109.2. The dependency ratio was estimated to be about 86 in 1990. According to the BBS medium variant projection, the ratio is expected to decline to 71.4 at the turn of the century, a level which has already been reached in many other developing countries.

The dependency ratio of the SE region according to the 1981 census was about 107.5, which was similar to the national figure. Table III.11 presents the dependency ratios of the region by districts. 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 of Chandpur district had the highest dependency ratio (130) followed by Chatkhil (129) and Senbag (128) of Noakhali district. As many as nine thanas were burdened by a dependency ratio of more than 125. Only three thanas out of a total of 43 had a dependency ratio below 100.

TABLE III.11

Dependency Ratios 1981

Locality	Dependency Ratio
Brahmanbaria	103.7
Chandpur	102.4
Comilla	112.0
Feni	106.8
Lakshmipur	111.1
Noakhali	100.0
SE region	107.5

$$\text{Dependency Ratio} \quad \frac{P(0\text{-}14) + P(65+\ )}{P(15\text{-}64)} \times 100$$

Where P(...) is population in different age groups.

c) **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 south-east region by districts are compared with those for the country as a whole in Table III.12. The sex ratio for the south-east region is lower than the national ratio.

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

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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 thana level, Ramgati thana of Lakshmipur district recorded the highest sex ratio (108) as topography does not permit good family settlement; Ramganj, in the same district, had the lowest sex ratio (91), due to male-out migration.

TABLE III.12

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

Age	Bangla-desh	SE region	Brahman-baria	Comilla	Chand-pur	Feni	Laksh-mipur	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

d) Marital Status and Age at Marriage

Marital status plays a vital role in the composition and growth of a population. The proportion of married persons in a population has direct bearing on the fertility performances and hence on the rate of population growth, particularly in a non-contraceptive society where the majority of births occur within marriage. Thus, when a population is accurately classified according to marital status categories, separately by sex and age groups, it may provide useful information on major aspects of nuptiality.

Table III.13 shows the distribution of males and females aged 10 years and over, by marital status, for the south-east region by districts, as obtained in the 1981 census. Figures for the country as a whole have been shown for comparison. Nearly a quarter of the female population remained single in the south-east region; this is close to the national figure. The marital status data for the SE region appear to be consistent with those for the country as a whole. The proportions of females never married, by age, are shown in Table III.14.

TABLE III.13

Population 10 years and over by sex and marital status - 1981

Locality	Sex	Never Married	Married	Widowed	Divorced/ Separated
Brahmanbaria	M	42.4	56.6	1.0	
	F	22.4	65.1	11.8	0.8
Chandpur	M	46.8	52.1	1.1	
	F	26.4	62.9	10.1	0.5
Comilla	M	45.0	53.8	1.2	0.0
	F	24.0	63.6	10.6	1.0
Feni	M	47.3	51.3	1.3	0.0
	F	25.7	61.9	11.4	0.9
Lakshmipur	M	45.1	53.5	1.2	0.0
	F	25.2	64.4	9.8	0.6
Noakhali	M	47.9	50.8	1.3	0.6
	F	24.6	64.2	10.6	0.6
SE region	M	45.7	53.0	1.2	0.0
	F	24.7	59.7	10.9	0.7
Bangladesh	M	42.8	55.9	1.3 *	
	F	23.7	63.4	12.9 *	

Note: * Divorced/widowed/separated

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TABLE III.14

Proportion of females never married - SE region and Bangladesh 1981

Age	Brahman-baria	Chandpur	Comilla	Feni	Lakshmi-pur	Noa-khali	SE region	Bangla-desh
10-14	95.5	95.6	95.1	95.6	92.7	92.7	94.3	98.0
15-19	33.8	43.2	40.1	41.9	32.4	35.0	37.1	31.3
20-24	5.4	7.9	8.4	7.2	4.9	5.7	6.6	5.1
25-29	1.2	1.7	2.1	1.5	1.2	1.8	1.5	1.3
30-34	2.4	1.4	1.8	1.7	0.9	1.1	1.6	1.0
35-39	0.4	0.5	0.7	0.6	0.5	0.6	0.5	0.4
40-44	0.7	0.5	1.3	1.4	0.9	0.8	0.9	0.7
45-49	0.2	0.4	0.5	0.4	0.4	0.4	0.4	0.3
50-54	0.7	0.1	0.2	0.8	0.7	0.9	0.6	1.4
55 +	0.3	0.2	0.9	0.9	0.5	0.8	0.9	0.7
All ages	22.4	26.4	24.0	25.7	25.2	24.6	24.7	23.7
SMAM (1981)	17.0	17.6	17.4	17.3	16.5	16.7	17.0	16.8
Median age	16.9	17.3	17.7	16.5	16.5	16.2	16.8	
Mean age at marriage 1990 *	16.6	17.0	17.2	16.2	16.8	16.2	16.7	

* **Source: Houssan & Ashraf 1990 - Table 6**

The percentage of widowed females is significantly higher than that of widowed males (Table 13). This can be attributed mainly to the socio-economic and cultural pattern and conservative philosophy which prevent the remarriage of a proportion of widows.

The Signulate Mean Age at Marriage (SMAM) calculated from the proportion never married varies between 16.5 years (Lakshmipur) and 17.6 years (Chandpur), as shown in Table 14. The overall mean for the south-east region is 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 - by about half a year - during the inter censal period 1974-1981. The latest estimate of median age at marriage, as obtained in a 1990 survey (Hossain and Ahmed), also shows that the median age 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.

III.1.2.6 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 during the inter-Censal period 1974-81 was 16.6%.

The number of households in the south-east 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 III.15.

TABLE III.15

Household growth and size, 1974-1981

Locality	% Increase (1974-81)	Household Size ave. No. of persons		
		1974	1981	1990
Brahmanbaria	13.5	5.7	5.9	5.9
Chandpur	16.8	5.6	5.6	6.2
Comilla	15.5	5.6	5.8	5.6
Feni	8.8	5.2	5.7	5.8
Lakshmipur	15.8	5.5	5.5	5.8
Noakhali	17.7	5.5	5.6	6.1
SE region	15.2	5.6	5.7	5.8
Bangladesh	16.6	5.6	5.7	-

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

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 of the south-east region appears to have been similar. The recent study by the Population Development and Evaluation Unit (Hossain and Ahmed, 1990) confirms that the average size of the household in the SE region is increasing over time. Among the six districts in the region, Chandpur had the largest household size (6.2 persons) in 1990, and Comilla the smallest (5.6 persons). Faridganj thana appeared to have the highest average household size (6.7 persons).

Table III.16 shows the change in household composition between 1981 and 1990. The percentage of households with 1-2 members has consistently decreased over this period, in all the districts under consideration. These findings are in contrast with the trend observed during the period 1960-1973, but the data sources for the two periods are different, and hence caution must be taken in drawing any conclusion regarding the change in the household structure.

TABLE III.16

Household Composition: 1981 and 1990 (%)

Household	Brahmanbaria		Comilla		Chandpur		Feni		Lakshmipur		Noakhali	
Size	1981	1990	1981	1990	1981	1990	1981	1990	1981	1990	1981	1990
1-2	9.9	6.3	9.0	5.6	9.9	2.0	10.3	5.7	10.8	5.0	9.5	3.0
3-4	24.0	26.3	23.3	30.3	25.8	20.6	24.2	25.5	27.0	24.4	25.0	23.4
5-6	29.1	33.2	29.1	34.4	29.9	37.9	29.4	32.2	30.8	34.6	29.9	35.4
7-8	20.5	21.8	21.5	19.3	21.3	27.7	20.4	22.6	20.9	23.1	20.9	23.7
9 +	16.5	12.3	17.1	10.4	13.1	11.7	15.7	14.6	10.5	12.9	14.7	14.5
	100	100	100	100	100	100	100	100	100	100	100	100

Source (a) 1981: District Census Report, Bangladesh ... Census 1981
1990: Hossain and Ahmed (1990)

III.1.3 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 patron-client type.

The "income 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 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.

In Table III.17, two different sets of data are presented to illustrate the extend of the landlessness issue. According to BBS population census figures, 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. In other words, the agriculture census gives an idea of the landlessness issue among rural households while the population census look at the issue for the entire population. Obviously, the landless rate is expected to be very high in urban areas and this would explain the differences in the figures of the two censuses.

TABLE III.17

Percentage of Households with less than 0.05 acres of Cultivable Land

	BBS Population Census % of all Households			BBS 1983 Agriculture Census % of Rural Households		
	1981	1991	Est 1993	< 0.05	0.05 - 0.49	below 0.5
Comilla Region	**27.9%**		**36.2%**	**14.5%**	**31.3%**	**45.8%**
Brahmanbaria	33.5%		41.1%	14.1%	30.5%	44.7%
Chandpur	26.1%		34.6%	15.3%	33.0%	48.2%
Comilla	26.0%		34.5%	14.2%	30.8%	45.0%
Noakhali Region	**32.2%**		**40.0%**	**13.5%**	**36.4%**	**49.9%**
Feni	31.4%		39.2%	13.1%	35.4%	48.5%
Laksmipur	31.7%		39.5%	14.0%	37.6%	51.6%
Noakhali	33.0%	39.4%	40.6%	13.4%	36.1%	49.5%
South East Region	**30.0%**		**38.0%**	**14.1%**	**33.2%**	**47.3%**

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

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In Table III.18, 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 marginal farmers or 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.

TABLE III.18

Distribution of Rural Households by Size of Landownership

Landowning Groups	Bangladesh		Noakhali Region		Comilla Region	
(in acres)	% 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%	49.9%	31.3%	45.8%
0.50 - 0.99	12.0%	58.3%	16.1%	66.0%	17.0%	62.8%
1.00 - 2.49	21.6%	79.9%	21.7%	87.7%	24.3%	87.1%
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

III.1.3.1 Farm Holdings and Land Tenure Patterns

In this section, focus is placed on investigating farm holdings, their size, their distribution and the different tenurial systems involved.

A farm holding, defined as a techno-economic unit of agriculture production under single management, can be managed by one or several households. In this regard, the total number of farm holdings is higher than the number of farming households. As seen from Table III.19, the average number of persons per farm holding is well above six while the average household size is well below six. Therefore, it should be kept in mind that, throughout this section, data presented refers to farm holdings and not to households.

TABLE III.19

Farm Population, No of Holdings and Operated Area

Population Figures in '000'
Area Figures in '000' acres

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 census**

From Table III.19, 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. In 1961, the farm population was 37 million in Bangladesh as against nearly 63 millions today. However, though the number of persons depending on farming has rapidly increased in absolute terms over the last 30 years, it should be mentioned that this dependency has decreased in relative terms. In 1961, the farm population accounted for 75% of the total as against slightly less than 68% in 1984. This indicates that employment in other economic sectors is growing more rapidly and that an increasing proportion of the population does not depend any longer on agriculture to sustain their livelihood.

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. Beacuse other employment opportunities are scarce, the majority of the rural labor force tries to get hold of a piece of farmland. Due to increasing population pressure and land fragmentation, the avergae 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 III.20 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 conentration is more acute in the region, especially in Comilla. In this 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.

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TABLE III.20

Distribution of Farm Holdings by Size

Size of Hodlings (in acres)	Bangladesh % Holdings	% Area	Noakhali Region % Holdings	% Area	Comilla Region % 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

As shown in Table III.21, 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 Noakali 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 patterns 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 III.22 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. For holding size of more than 5 acres, the proportion of rented land is unusually high, culminating at 38.8% for holdings between 7.5 and 15 acres. For the same size of holding, the rented land proportion is only 2.8% in Comilla and 10.6% in the country as a whole.

TABLE III.21

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%	20.0%
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 III.22

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

Area in '000' acres

Size of Holdings (in acres)	Bangladesh		NoakhaliRegion		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 imortant issue is to investigate who are the owners giving out their land. Table III.23 intends to indicate the proportion of owned land rented 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 table provides a very clear illustration of the process through which a majority of households are gradually losing land resources and, sooner or later, irrevesibly, will become landless. Most of the households with expenditures greater than income might have to sell their land usually to repay outsdanding debts. 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 III.24, though sharecropping remains the primary system under which land is rented in, the importance of mortgage is still very significant.

TABLE III.23

Percentage of Land "Given Out" and "Taken In" by Tenancy Groups and Size of Holdings

Holding Size	Bangladesh			NoakhaliRegion			ComillaRegion		
(in acres)	Owner	Owner -Tenant		Owner	Owner -Tenant		Owner	Owner -Tenant	
	% out	% out	% in	% out	% out	% in	% out	% out	% in
Small Holdings									
S1 0.05 - 0.99	43.9%	18.3%	57.6%	46.7%	14.4%	54.9%	31.3%	12.1%	55.3%
S2 1.00 - 2.49	19.1%	8.5%	46.9%	29.2%	11.7%	47.1%	16.5%	8.6%	39.4%
Medium Holdings									
M1 2.50 - 4.99	11.1%	5.8%	40.4%	15.9%	7.3%	48.6%	13.0%	6.6%	30.8%
M2 5.00 - 7.49	10.5%	5.8%	34.4%	20.9%	6.0%	52.7%	13.3%	8.3%	18.8%
Large Holdings									
L1 7.50 - 14.99	10.4%	5.8%	29.9%	19.3%	6.5%	57.9%	12.8%	2.9%	14.5%
L2 15.00 +	10.3%	7.6%	29.8%	14.5%	8.5%	48.3%	4.5%	7.9%	5.4%
All Holdings	16.6%	7.1%	39.7%	26.7%	9.2%	50.9%	17.6%	8.1%	41.3%

Sources : Bangladesh Agriculture Census 1983-84, Volume III

TABLE III.24

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%	0.2%
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

III.1.3.2 Housing and Household Amenities

The type of construction of housing, and access to other basic household amenities, are indicative not only of the economic well-being of the household, but also of modernity variables. Such statistics have been collected in a few recently conducted surveys, with a view to seeing the differentials in contraceptive use, fertility and child mortality with respect to ownership of household assets. The most recently conducted survey (Hossain and Ahmed, 1990) attempted to see the extent of possession of household goods such as radios and televisions, and other assets such as bicycles. The data were urban biased, but do give an indication of the regional picture. Table III.25 shows the extent of household possessions for the south-east region by districts.

TABLE III.25

Household possessions: 1990

% of Households

Locality	Radio	T V	Boat/ Cycle	Rickshaw	Cow/ Cart	Buffalow
Brahmanbaria	26.5	8.7	5.8	3.4	0.2	28.5
Comilla	36.9	12.3	11.2	5.3	0.2	40.8
Chandpur	66.2	14.1	10.8	30.4	0.9	56.1
Feni	31.8	14.6	10.3	2.4	0.5	29.9
Lakshmipur	32.9	6.8	13.1	1.3	0.5	28.4
Noakhali	40.2	6.6	8.7	2.4	1.3	38.4

Source: Hossain and Ahmed (1990)

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APPENDIX III.I

ANALYSIS OF THE DETERMINANTS OF POPULATION GROWTH

APPENDIX III.I

ANALYSIS OF THE DETERMINANTS OF POPULATION GROWTH

Introduction

In the absence of an adequate vital registration system in Bangladesh, birth, death, migration and other demographic rates and indices have to date been estimated from data obtained in censuses and specially designed surveys. The difficulties of using this basis of estimation are greater when the estimates have to be made for smaller geographical areas. Keeping in mind the serious limitation of the required information, a brief overview of the main factors determining population growth - namely, fertility, family planning, immunization, and mortality - of the SE region has been given in this Appendix. Migration, another important factor in population growth, has been discussed in the preceding Annex.

Fertility

From the available evidence, it can be concluded that no sustained trend in fertility (either up or down) was evident in Bangladesh from the early 1960s to mid-1970s. In most years, the total fertility rate was between 6.8 and 7.3 and the crude birth rate between 47 and 51 per thousand in National Surveys. The absence of an obvious trend does not necessarily mean that fertility was constant. In fact fertility rates varied greatly between years and from one survey to another. In general, national surveys gave higher fertility rates than small local surveys. This variation, besides indicating differences in data quality, might also reflect local variations due to special circumstances.

The latest available estimate of crude birth for the country stands around 36 per thousand population in 1989 (Planning Commission, 1990). The BFS 1989 provided an estimate of the total fertility rate in the neighbourhood of 48. Experts in the field opine that these rates might have been underestimates of the current level of fertility.

The crude birth rates as obtained in a recent survey (Hossain & Ahmed, 1990) for the South-east region are shown in Table III.A.1. The general marital fertility rate (GMFR) and the indirectly estimated total marital fertility rate (TMFR) have also been compared in the same table. The estimates indicate higher fertility rates for the South-east region than for the country as a whole. The level of fertility appears to be highest for Lakshmipur among the six districts, followed by Chandpur.

The indirect estimates of the various measures of fertility for the 12 months preceding the 1981 Census, based on the census age distribution, are also presented in the same table for comparison. For the 1980-81 period the crude birth rate of the region was close to 45 per thousand; the rate in 1990 was slightly lower, at about 41 per thousand. This decrease must however be interpreted with great caution, because the estimates are entirely based on the enumerated census age distribution, an assumed level of mortality and the constant intercensal rate of growth; these assumptions may not have been valid.

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TABLE III.A.1

Crude birth rate (CBR), General marital fertility rate (GMFR) & Total marital fertility rate (TMFR) 1990

	1990				1980-'81		
Locality	CBR	GMF	TMF	TFR*	CBR	GIR	TFR
Brahmanbaria	36.8	190	5.1	4.0	44.9	197	6.3
Comilla	39.6	207	6.1	4.6	44.4	195	6.2
Chandpur	38.0	262	7.9	5.8	43.8	193	6.1
Feni	41.9	196	5.8	4.4	44.3	195	6.2
Lakshmipur	42.6	265	8.0	6.0	45.0	198	6.3
Noakhali	44.8	247	7.4	5.6	45.2	199	6.3
SE region	40.5	225	6.6	5.0	44.5	196	6.2
Bangladesh	36.0	183	5.9	4.6	42.4	186	6.0

* **Based on proportion married as of 1981; 1991 figures are not yet published.**

Source: Hossain and Ahmed (1990)

Family Planning

The overall knowledge of family planning methods in Bangladesh is nearly universal, but there are gaps in knowledge about specific methods, particularly those which have been introduced more recently. The possibility of regional variations in knowledge and use of contraceptive methods, particularly for some conservative areas of the country, cannot be ruled out. A recent survey (Hossain and Ahmed, 1990) attempted to throw light on this aspect. Among the six districts of the region, the percentage of women who had heard about at least one modern family planning method was the least (84%) for Lakshmipur district. The method-wise and overall knowledge of family planning methods are shown in Table III.A.2. The table reveals that although the awareness of at least one method of contraception is almost universal, there is a wide gap in method-specific knowledge. This is true for almost all the districts. Between district variation is also quite noticeable. Knowledge of traditional methods is surprisingly low in the study area compared to the BFS findings.

The current use rates of contraceptives by methods are presented in Table A.3. Use of the oral pill appears to be dominant in the SE region, at about double the national figure. Condom, injection and IUD use has also been reported to be higher than the BFS estimates. The overall current use rate for the region appears to be about 26%, which is some 5 percentage points lower than the national rate calculated by the BFS. The difference has resulted from the uneven distribution of use of the traditional methods, which has been reported to be higher in the 1990 survey. The correspondence between the 1989 BFS survey results and 1990 estimate is not close at all. The range of current use rates for 1987 and 1989 reported by Rafique Zaman (1990) have also been presented in Table III.A.3 for comparison.

TABLE A.2

Knowledge of family planning methods 1990.

Methods	Brahman-baria	Comilla	Chandpur	Feni	Laksh-mipur	Noakhali	BPS 1989
Pill	93.3	98.0	98.9	99.1	82.4	99.0	99
Condom	81.3	87.4	86.8	91.1	70.0	95.8	83
Injection	81.1	82.3	49.2	84.9	48.6	90.5	81
Foam/Jelly	19.1	32.9	7.6	29.9	31.4	22.7	24
IUD	45.6	36.3	23.4	73.5	29.1	25.4	78
Vasectomy	38.0	50.7	41.4	31.9	28.9	61.0	87
Tubectomy	4.4	69.6	64.2	70.3	49.1	83.0	98
Withdrawal	3.5	3.8	2.6	2.3	9.2	2.6	30
Safe period	1.5	5.0	3.9	10.2	10.7	7.5	36
Abstinence	3.0	4.9	5.8	6.0	11.8	3.2	-
At least one modern method	95.0	98.0	100.0	100.0	84.0	99.0	-

Source: Hossain and Ahmed (1990)

TABLE III.A.3

Current Use of Family Planning Methods 1990

Method	Brahman-baria	Comilla	Chand-pur	Feni	Laksh-mipur	Noa-khali	BPS 1989
Pill	17.5	17.2	19.4	15.0	19.6	13.3	9.6
Condom	2.7	2.3	2.6	2.5	3.1	2.8	1.8
Injection	2.3	2.3	0.7	1.1	0.5	1.1	0.6
Foam/Jelly	0.1	0.3	0.0	0.1	0.2	0.1	0.1
IUD	2.3	1.4	1.0	2.1	1.3	1.1	1.4
Tubectomy	0.1	3.1	1.3	3.6	4.0	5.8	8.5
Abstinence	0.1	0.0	0.0	0.0	0.0	0.0	5.0
Withdrawal	0.1	0.0	0.1	0.0	0.2	0.1	1.8
Safe period	0.0	0.0	0.0	0.2	0.2	0.3	-
Others	0.0	0.0	0.0	0.1	0.0	0.6	2.0
Current Use (1990)	25.2	26.6	25.1	24.7	29.1	25.2	30.8
Ever Use (1990)	29.0	36.0	30.0	34.0	33.0	27.0	45.0
Current Use * (1987)	17.1-41.6	23.0-36.9	29.1-37.9	26.2-32.9	15.7-35.1	20.2-34.8	-
Current Use * (1989)	20.3-36.1	21.4-42.0	25.9-35.8	23.1-36.7	18.3-26.3	19.0-25.9	-

* **Rafiquzzaman (1990)**

Note: The ranges of current use rate covers the thana prevalence rates.

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Mortality

Indirect estimates of the crude death rate in the South-east region, obtained from 1990 survey data in conjunction with the West model life table, are presented in Table A.4. The highest crude death rate was estimated for Noakhali (16 per thousand population). The CDRs for other districts in the SE region are lower than the national average of 14 per thousand population. These estimates must be treated with great caution because they are based entirely on indirect information.

The estimates for infant mortality rates and expectation of life at birth, also shown in Table A.4, have also been based on the indirect information on the proportion of children dead, as obtained in a 1990 survey, in conjunction with the model life tables. Because of the data limitations, it has not been possible to throw light on the past trends in the infant mortality level of the study region, and the accuracy of the available estimates is questionable.

The estimates presented in Table III.A.4 indicate that the level of infant mortality in the South-east region is lower than in Bangladesh as a whole, at 86 per thousand live births, compared to the national average of 120. Life expectancy for males at birth is higher in the region (at about 57 years) than nationally (53 years), but is lower for females in the region (at 52 years) than the national average (56 years).

Immunization

The campaign to immunize children against life threatening diseases has a long history in Bangladesh. The immunization program of the government of Bangladesh gained momentum since the mid-1980s with the establishment of EPI (Extended Program for Immunization); it was only in December 1989 that EPI was extended to all thanas of the country. The CPS 1989 (Mitra et al, 1990) made an attempt to collect information on the extent of immunization for children who received at least one immunization under five years of age. Based on their findings, the proportion of children under age two who received immunization in Bangladesh stands at 52.7%. The comparable figure obtained in a 1990 survey for the south-east region is 69.1 (Hossain and Ahmed, 1990). This latter estimate was based on a simple question, i.e. whether the mothers immunized any of their children under age two. The percentage of mothers covered under the program by districts are provided below:

Locality	% immunized
Brahmanbaria	76.6
Comilla	73.1
Chandpur	58.0
Feni	69.2
Lakshmipur	72.2
Noakhali	65.5
SE region	69.1

TABLE III.A.4

Infant Mortality Rates, Crude Death Rates and Life Expectancy at Birth 1990

Locality	C D R	I M R	Life Expectancy Male	Female
Brahmanbaria	13.0	93.0	55.3	55.1
Comilla	10.0	69.0	62.0	61.2
Chandpur	10.0	70.0	61.5	60.0
Feni	13.0	93.0	55.2	54.6
Lakshmipur	13.0	94.0	54.5	54.0
Noakhali	16.0	106.0	51.9	50.7
SE region	12.0	86.0	56.6	52.0
Bangladesh (1989)	14.0	120.0	52.5	55.8

Note: **CDR - Crude death rate (per thousand population)**
IMR - Infant mortality rate (per thousand live births)
Life expectancy - in years, at birth.

The extent of immunization by some selected socio-economic characteristics of the mothers as recorded in the 1990 survey are summarized in Table III.A.5. None of the factors analysed appeared to have played any role in influencing the prevalence of immunization in any of the districts. The results in most cases were not in the expected direction. For example, the prevalence of immunization among the children whose mothers were working was lower than that for those whose mothers were not working. Education of the mothers, by and large, was found to have the results in the same direction, with the children of mothers who had received more education being less likely to have received immunisation than the children of less educated mothers.

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TABLE III.A.5

Children (under 2 years) Immunization

Characteristics	Locality					
	Brahmanbaria	Comilla	Chandpur	Feni	Lakshmipur	Noakhali
Residence						
Rural	55	54	56	53	50	51
Semi urban	46	53	51	46	49	53
Urban	60	45	60	55	56	
Work status						
Working	64	71	48	57	36	80
Non-working	53	51	56	51	54	52
Religion						
Muslim	57	51	55	51	50	54
Non-muslim	41	65	54	60	68	38
Education						
Illiterate	52	50	53	54	49	51
Can write	61	76	56	0	22	75
Primary	56	51	58	49	53	52
Secondary	30	61	52	81	55	60
Sanitation						
No sanitation	53	52	51	54	50	53
Sanitation	56	54	60	47	60	50
Electrification						
Electrified	52	54	53	49	63	53
Non-electrified	54	51	57	54	50	52
Possession of Radio/TV						
Yes	53	54	57	49	59	46
No	53	32	55	52	51	53
Age of mothers						
15-19	60	52	65	48	55	55
20-24	56	52	65	54	55	52
30-34	48	51	49	50	55	53
25-29	57	54	52	55	49	55
35-39	56	54	56	51	43	42
40-44	64	57	65	50	52	55
45-49	0	80	40	50	33	67

APPENDIX III.II

QUESTIONNAIRES

APPENDIX B

SELECTION OF SAMPLE

A two stage random sample is proposed. The first stage is to select a random sample of mouzas, and the second is to select farmers within the selected mouzas.

Unless a "large sample" (more than 10% of the population) can be selected, the statistical validity of a sample depends on its absolute size and not its proportion to the size of the population under investigation. The following formula is used to determine sample size:

$$N = K^2V^2/D^2$$

where: N = sample size
K = required level of confidence
V = inherent variability of the subject under investigation
D = acceptable margin of error in results

If K = 1.28 - 85% confidence that our estimates will be correct
V = 0.5 - maximum value and, without other evidence, accepted as a norm in agricultural surveys.
D = 10% - our estimates will be accurate +/- 10%

Then the sample size can be calculated as N = 41

For a clustered sample (as used in this survey) the sample size needs to be adjusted for the "cluster effect" - that is the members of the same cluster will tend to be more similar to each other than to members of other clusters. This depends on the size of the cluster (m) and the intra-cluster correlation coefficient (s): the relationship being $z = 1+s(m-1)$. If we take a typical value for s = 0.2 and m = 8 (as in this survey) then z = 2.4. The total sample size is now 41 x 2.4 = 98. Further details of sample size calculation can be found in the Methodology Report. FAP 12 (HTS 1991).

With 8 farmers being interviewed in each Mouza, a total of 12 mouzas should be covered for each group about which we wish to make separate estimates (8 x 12 = 96, which approximates to 98). These groups may be defined in terms of farm size, tenancy, land type or other factors. For sample selection, the study area has been divided into 4 zones (based on available agro ecological data) and 12 mouzas selected in each zone, giving a comparison to be made between 4 seperate groups of farms.

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METHODOLOGY FOR SAMPLE SELECTION

1. Selection of first stage sample

A random sample of 12 mouzas per zone is selected with probability of selection proportional to the population of the mouza.

2. Selection of second stage sample

The Union Council HQ for each of the selected mouzas will be visited by a survey supervisor to obtain from the Chairman or Secretary a tax list showing names of all the heads of households in that mouza. The list is then reviewed with a knowledgeable local person to up-date it and identify occupations of those on the list. Farm operators include people who rent or sharecrop land. From the list of farm operators, a random selection of sixteen is made (eight plus four eight spares).

Landless people and fish pond operators should also be identified on the list, and a sample of two landless people (plus 2 spares) and two fish pond operators (plus 2 spares) should be selected at random. If the village also contains professional fishermen, up to 8 (plus 8 spares) will be selected for interview.

The enumerator then visits the mouza and interviews the selected farmers. The selection of eight spare farmers enables the enumerator to make a second choice if the selected farmer is not available.

Much time and effort could be avoided if the second stage sample selection procedure is omitted, and enumerators just turn up to the selected mouza and interview the first farmers they meet. However previous surveys have shown that enumerators are more likely to find, and talk to, the larger, richer and full time farmer, who will be selected by the villagers as their representative to talk to an outsider. The sample would therefore not be statistically valid and would not give an accurate picture of the project area as a whole.

The case studies would be selected from the completed questionnaires so more detailed information can be obtained from example farmers with a range of resource levels and land types. The case studies will be based on a questionnaire but also include a considerable element of informal interviews.

SURVEY OF HOUSEHOLD OCCUPATIONS

100 households drawn at random from tax list

Name of mouza	
Name of Thana	

		total number	number who also have fishponds
Large farmer	over 7.5 acres		
Medium farmer	2.5 to 7.5 acres		
Small farmer	0.5 to 2.5 acres		
Marginal farmer	0.05 to 0.5 acres		
Fisherman			
Landless			
Fishpond owner*			
Occupation not known			
total			

* own fishponds but are not also farmers

SURVEY OF HOUSEHOLD OCCUPATIONS

100 households drawn at random from tax list

Name of mouza	
Name of Thana	

		total number	number who also have fishponds
Large farmer	over 7.5 acres		
Medium farmer	2.5 to 7.5 acres		
Small farmer	0.5 to 2.5 acres		
Marginal farmer	0.05 to 0.5 acres		
Fisherman			
Landless			
Fishpond owner*			
Occupation not known			
total			

* own fishponds but are not also farmers

SOUTH EAST REGIONAL STUDY

Date:
Enumerator
Serial no.

LANDLESS MAN'S QUESTIONNAIRE

IF FARM OVER 5 DECIMALS (INCLUDING RENTED LAND) USE FARMERS QUESTIONNAIRE

1. Village	2 .Mouza	3. Thana

4. Profession
Main
Secondary

1 labourer/casual worker
2 fisherman
3 skilled artisan
4 rickshaw driver
5 bus/truck driver
6 shopkeeper/trader
7 clerk
8 Government employee
9 Other [specify]

5. Sources of income in past year

month	Type of work	Type of employment	Where worked	Days worked	Income per day Taka	in kind
Baishakh						
Jaistha						
Ashar						
Srabon						
Bhadra						
Aswin						
Kartik						
Agrahayan						
Poush						
Magh						
Falgoon						
Chaitra						

Type of work
1. Farm work
2. Fishing
3. Livestock
4. Construction labour
5. Rice mill
6. Weaving
7. Carpentry
8. Other cottage industry
9. Large industry
10. Rickshaw/van
11. Bus/truck driver/conductor
12. Shopkeeping/trade
13. Goverment employee
14. Doctor/other medical
15.Other [specify]

Type of employment
1. Regular permanent employee
2. Self employed owner of business
3. Casual employment (for cash)
4. Casual work (for kind)

Where worked
1. local (within Union)
2. in district
3. in Dhaka
4. elsewhere in Bangladesh
5. abroad

6. Is it easier to get work in some months than at other times
1. no difference
2. yes

if yes:

7. In which months is it easiest to find work			
8. In which months is it most difficult to find work			

9. How easy is it to find work compared with 5 years ago:
1. No change
2. Now easier to find work
3. Now more difficult to find work

10. How has your worked changed in last 5 years

type of work that has increased		
type of work that has decreased		

use work type codes from Q5
0 if not working 5 years ago
maximum of two types in each

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11. Number in household (khana)		
	men	
	women	
	children	
	total	

12. Have any of your household members ever worked overseas [ ] 1. no 2. yes

13. Is your house [ ] 1. katcha 2. semi-pucca/tin 3. pucca

14. Do you own	tick		tick
1. house		6. rickshaw/van	
2. shop/other building		7. bicycle	
3. land		8. motor vehicle	
4. fish pond		9. rural industry	
5. hand or animal cart		10 other assett [specify]	

15. If own or rent land	decimals
area owned	
-	
area not cultivated	
=	
area cultivated	

NOTE - IF CULTIVATE OVER 5 DECIMALS SHOULD USE FARMER QUESTIONNAIRE

16. If cultivate land: area of

	decimals rabi	kharif
paddy		
vegetables		
other [specify]		

17. Has there been any change in the last 5 years in the area of land that you own

change [ ]

1. no change
2. area has decreased or no longer own any land
3. area has increased
4. not applicable/dont know

reason for change [tick]	
	land too small to be worth cultivating
	lack of time or labour to cultivate land
	sold land to pay debt
	sold land as flood losses
	sold land for cash for other reasons
	other reason [specify]

18. Livestock

	total number owned	Has number increased or decreased
cattle		
buffalo		
goats		
sheep		
poultry		

Increase or decrease
1. no change
2. increase
3. decrease

18a. If number decreased, what were the reasons

[tick]	
	lack of grazing/feed
	lack of time or labour
	lack of space to keep them
	sold to pay debt
	sold for other reasons
	lost in flood

19. Fishing

Type of fishing [ ]
1. never fish
2. fish pond operator
3. fish in open water
4. both pond and open water

If open water: [3 or 4 above]

20. Where do you mostly fish [ ]
1. permanent beel
2. seasonal beel
3. flood plain
4. khal/internal river
5. major river
6. other [specify]

21. Fishing done by:

	(tick)
Adult men	
Adult women	
Children	

22. Time of year that you fish

	[tick]
wet season	
dry season	

23. Approx average amount caught per month kg [ ]

24. Percentage of fish caught that you sell [ ]

25. How have fish catches changed in last 5 years [ ]
1. no change
2. big decrease
3. small decrease
4. big increase
5. small increase

26. If decrease: what is the reason:

[tick]

	over fishing
	decline in area of open water
	obstruction of migration
	polution from pesticides and towns
	fish diseases
	other [specify]

27. Flood damage

Have you suffered from floods in the last 5 years [ ]
1. no - not affected by flooding
2. yes - but no losses, inconvenient only
3. yes - have suffered losses as a result of floods

if suffered loss:

28. Flood losses

year	Damage done to:							
	House	Animals lost	Growing crops	Stored crops lost crop type	maunds	Trees	Furniture etc.	other [specify
1988								
1989								
1990								
1991								
1992								

house damage:
1. House slightly damaged
2. House badly damaged or partly destroyed
3. House totally destroyed

Animals lost
1. poultry
2. sheep/goat
3. buffalo cattle
4. combination of above

Growing crops
1. Yield reduced
2. Partially lost
3. totally lost

29. Name: son of:

SOUTH EAST REGIONAL STUDY

WOMEN'S QUESTIONNAIRE

Date:
Enumerator
Serial no.

1. Village	2 .Mouza	3. Thana

4. Type of family — 1. simple 2. complex

5. Number in khana — total; adult men; adult women; children under 12 [include those working away from home]

6. Is your house — 1. katcha 2. semi-pucca/tin 3. pucca

7. Profession of head of household
Main
Secondary

1 farmer
2 fisherman
3 labourer/casual worker
4 shopkeeper/trader
5 rickshaw driver
6 bus/truck driver
7 rural industry
8 large industry
9 clerk/office work (private sector)
10 Government employee
11 Domestic work
12 Other [specify]

7a. If household head a is a farmer: area of land cultivated — decimals/acres[delete]

8. Relationship to head of household
1. wife
2. mother
3. daughte
4. daughter-in-law
5. other relative
6. not related
7. respondant is head of household

9. What is your role in the household

9a. domestic/family work (non remunerative) [tick]
- care for children/old people
- work in own field and garden
- handicrafts/weaving/sewing
- poultry/livestock/fishpond
- fishing for own use
- make nets/dry fish
- post-harvest work
- collect/make fuel
- other [specify]

9b. work for money (remunerative) [tick]
- handicrafts/weave/sew for sale
- fishing for sale
- poultry/livestock/fishpond for sale
- collect/make fuel for sale
- process food for sale (eg puffed ric
- work outside the home (see Q9c)
- other [specify]

If work outside the home:

9c. type of work (remunerative)
paid in cash
paid in kind

1. work in rice mill
2. weaving/garment industry
3. work on other farms (harvest etc.)
4. domestic service
5. permanent salaried job (see Q9g)

If work on part-time/casual basis
9d. approximately how many days per year do you work
9e. average earnings per day Tk
9f. average payment in kind per day
[exclude husband's earnings]

OR If have a permanent job
9g. average earnings per year Tk

10. Who spends the money that you earn (from both work and sales)
1. self
2. husband/head of household/other
3. self and husband/others

11. How is this income spent [tick]
- food
- clothes and other household expenses
- other consumption
- invest in farm or other enterprise
- savings or loan out cash to other people

12. Does household head migrate to find work

1. no
2. yes

if yes: number of days per year away from home

how do you manage at this time [tick]

- with money sent by household head
- borrow from relatives, neighbours, moneylenders
- rely on own earnings
- sell assets (eg livestock)
- other [specify]

13. For how many years has your family lived in this village

13a. if your family migrated here, what was the main reason

1. river erosion at old home
2. flooding at old home
3. moved to in-laws village
4. other relatives are here
5. moved to get employment
6. other [specify]
7. dont know/not clear

14. What preparation do you make for normal monsoon "barsha" flood [tick]

- collect fuel
- make "khar"
- prepare food grains or spices
- make alga chula
- collect soil for mopping up
- other [specify]

15. In a normal monsoon "barsha" flood is your house effected by flood

1. no
2. yes

if yes: [tick]

- does water normally rise above floor level
- do you move to another place
- does your house suffer damage most years

16. Have you suffered from abnormal "boonya" floods in the last 5 years

1. no - not affected by flooding
2. yes - affected by boonya

if yes: 16a. in what years were you effected by boonya

	no.months effected
1988	
1989	
1990	
1991	
1992	

16b. Where did you go during boonya (for most severe flood)

1. stayed at home
2. went to nieghbours/relatives nearby
3. migrated out of area
4. onto the embankment
5. other place [specify]

16c. What losses did you suffer:

year	house	Animals lost	Growin crops	Stored crops lost type	maunds	Trees	Furnitur etc.	other [specify
1988								
1989								
1990								
1991								
1992								

house damage:
1. House slightly damaged
2. House badly damaged or partly destroyed
3. House totally destroyed

Animals lost
1. poultry
2. sheep/goat
3. buffalo/cattle

Crops
1. Yield reduced
2. Partially lost
3. totally lost

16d. How did you get food during and after the boonya (for most severe flood)

[tick]

	use stored food		sell other assetts
	sell livestock/poultry		borrow money
	sell trees		get relief
	sell land		other [specify]

16e. How did you get drinking water during and after the boonya (for most severe flood)

[tick]

	tubewell (including hand pump) near residence
	flood water (not boiled)
	flood water (boiled)
	went by boat to get water
	relief supplies

16f. What help did you get from nieghbours/relatives during and after boonya

[tick]

	no help
	shifting homestead
	shopping/fetching food or water/use of boat
	house repairs
	loan of cash or food
	shelter/use of their house
	other [specify]

16g. What help did you get from outside the village during and after most severe boonya

[tick]

Government dept	NGO	Voluntary group	
			no help
			relief food
			building materials
			tubewell
			medical assistance
			boat transport
			other [specify]

16h. What were the most prevelent diseases during and after the boonya

[tick]

	during boonya	after boonya
fever		
cold		
dysentary		
diarrhoeo		
sores		
scabies		
other [specify]		

17. What do you think should be done to prevent flooding or mitigate its effect in your village

[tick]

	build an embankment to keep out flood water
	dredge and improve river/khal to drain water away
	raise floor level of our house
	build up an area of high ground as a communal refuge during floods
	ensure water supplies continue during flood
	improve relief services to provide emergency assistance
	other [specify]

18. Name of respondant | head of household

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SOUTH EAST REGIONAL STUDY

FISHERMAN'S QUESTIONNAIRE
(CAPTURE FISHERIES)

Date:	
Enumerator	
Serial no.	

1. Village	2. Mouza	3. Thana

4. Do you have any other sources of income other than fishing [ ] 1. no 2. yes

if yes: 4a. What are your main sources of income:
main [ ]
second [ ]

1. Fishing (capture)
2. Farming
3. Operator of fish ponds
4. Agicultural labourer
5. Other daily labour
6. Rural industry
7. Rickshaw/other transport
8. Trader/ shop
9. Government job
10. Other - specify

5. How do you mainly catch fish: [ ]
1. in a group
2. as a family
3. employed by someone else
4. on your own
5. other - specify

6. How do you receive your income: [ ]
1. sale of fish
2. cash from employer
3. both sales and employer

7. How many days per year do you fish [ ]

8. What is your average catch per day this year [ ] worth Tk. [ ]
last year [ ] [ ]

8a. if this split between a group, how many fishermen in the group [ ]

9. Where do you fish and how much do you catch per season

	AUS	AMAN	RABI
Permanent beel			
Seasonal beel			
Flood plain			
Khal/internal river			
River (major)			
Fish pond			

seasons: aus: Baishakh, Jaistha, Ashar
aman: Srabon, Bhadra, Aswin, Kartik, Agrahayan
rabi: Poush, Magh, Falgoon, Chaitra

10. Apart from this year, how have fish catches changed in last 5 years

	change	main reason	second reason	third reason
Permanent beel				
Seasonal beel				
Khal/minor river				
River (major)				
Flood plain				
Fish pond				
Overall				

change
1. no change
2. big decrease
3. small increase
4. small increase
5. big increase

reason
1. over fishing
2. decline in amount of water
3. obstruction of fish migration
4. polution from pesticides and towns
5. fish diseases
6. other..........

11. Fishing practices	Main types of fish caught	Ownership of water	Main type of gear used
Permanent beel	Vo		
Seasonal beel			
Flood plain			
Khal / minor river			
River			
Fish pond			

Gear code:
1. bichan/masher/chapra/tana-ja
2. jhaki/khapla/pak-jal (cast)
3. khara/dharma-jal (dip)
4. khaya/current-jal (trapnet)
5. other net
6. fand/chai (trap)
7. barshi (hooks)

Ownership of water
1. public water - free fishing
2. Government/khas - leased
3. WDB
4. Cooperative
5. private (individual)
6. private firm
7. NGO group
8. other............

12. Name species of fish that, in the last 5 years
catches have decreased

catches have increased

1?. Equipment used

Boats	
Nets	
Traps	

1. own
2. part own
3. hire
4. use employers
5. combination of above

17. Do you catch fish at night ☐
(includes nets and traps left overnight)
0. no
1. often
2. sometimes

14. Do you use same size mesh (fak) in your net as you did 5 years ago ☐
1. no change in mesh size
2. smaller mesh
3. larger mesh
4. dont know/not applicable

19. How much time do you spend fishing compared with 5 years ago ☐
1. no change - spend same time
2. fish for more days per year
3. fish for more hours per day
4. fish both more hours & more days
5. dont know/not applicable

15. Overall what are your main problems
1. no specific problems
2. decline in fish catches
3. capital to buy boats and gear
4. marketing of fish
5. theft/law and order
6. other.....

main ☐
second ☐

16. What do you think could be done to improve your income from fishing

control fishing/limit catches/licences	
ban currentjal/fanshjal (mist/gill) nets	
credit for gear and boats	
increase area/depth of water	
maintain existing water level for longer	
improve roads and markets	
improve law and order	
other [specify]	

17. Name of fisherman

SOUTH EAST REGIONAL STUDY

Date:	
Enumerator	
Serial no.	

POND FISH CULTURE QUESTIONNAIRE

1. Village	2 .Mouza	3. Thana

4. Pond information

Pond no.	Area decimal	Water all year	Origin	Owner -ship	Status	Other uses			Fish type:		Feed use	Add fertiliser		Output per year	
						house--hold	ducks/ poultry	irrigati	main	other	yes/no	urea yes/no	manure yes/no	maunds	Taka
1															
2															
3															
4															
5															
6															

codes

Water all year
1. contains enough water for fish whole year
2. dry for part of the year

Origin
1. purpose built as a fish pond
2. formerly a borrow pit
3. natural pond/lake/river
4. dont know

Ownership
1. sole owner and operator of the pond
2. sole owner - rent out pond to others
3. shared/joint ownership with other
4. rent in private pond for cash
5. rent in governmant/khas pond for cash
6. rent in for share of fish
7. other.....

Status
1. Pond disused - no fish caught
2. Pond not stocked - wild fish caught
3. Pond stocked with fingerlings

Fish type:
1. Major Carps: e.g. Catla, Rui, Mrigal, Calabaush;
2. Exotic Carps e.g. Silver, Mirror, Grass Crap;
3. Catfish e.g. Magur, Shingi.
4. Tilapia
5. Shrimp
6. Mixed wild species
7. Other

Feed: do you give oilseed cake, bran, grain etc.
1 = no, 2 = yes

Output per year: production in maunds of fish and value in a year of NORMAL RAINFALL

5. How much is production going to be reduced this year because of drought
percent reduced from normal output shown above

6. Supply of fingerlings
Main source of finglerlings
Cost

1. caught in river by pond owner
2. fingerling dealer
3. government hatchery
4. private hatchery or nursery
5. other.....

7. Labour What source of labour do you use for the following jobs
- draining pond
- cleaning and preparation
- guard/chokidar
- catching/netting fish
- feeding/other work

1. hire workers
2. contract work out
3. own and family labour
4. both own/family and hired/contract

Cost of hired labour per day Tk.

8. Flood damage
Have your ponds been affected by floods in the last 5 years?

1. no - never
2. yes - some damage or loss

if yes,

	damage to pond	reduction in output %
1988		
1989		
1990		
1991		
1992		

Pond damage
1. fish washed away
2. banks washed away
3. filled with silt
4. fish washed away and banks damaged
5. fish washed away and filled with silt
6. other

9. Are you ever short of water [ ]

1. no - no shortage
2. yes - in most years
3. yes - only in this year

if yes, Do you ever use supplementry supply of water [ ]

1. no additional water supply
2. water from own LLP
3. water from hired LLP
4. water from own STW
5. water from hired STW
6. water from DTW

10. What do you do with the fish you produce

main [ ]
second [ ]

1. consume at home
2. sell in market
3. sell at farm/pond
4. sell complete pond to fishermen

11. Where do you obtain advice on pond fish culture

main source of advice [ ]
second source of advice [ ]

1. no advice ever obtained
2. other pond operators
3. Fisheries Officer
4. Agric. Officer
5. BRDB
6. NGO
7. other

12. Finance

a) sources of funds for operating expenses in the last year

main source [ ]
second source [ ]

b) if excavated or purchased pond source of funds to dig or buy pond

main source [ ]
second source [ ]

1. Borrow from Bank
2. Borrow from KSS/UCCA/BRDB
3. Borrow from Grameen Bank/other NGO
4. Borrow from relatives/friends
5. Borrow from fish trade (ie sell in advance)
6. Borrow from money lender/Mohajan
7. Cash from sale of fish last year
8. Cash from sale other sources of income
9. Cash from sale of animals
10. Cash from sale of land
11. Cash from sale of other assets
12. Other [specify]

13. Sources of income in order of importance

main source [ ]
second source [ ]
third source [ ]

1. fish pond owner
2. fishing in open water
3. own farming
4. land rents/crop share
5. farm labour
6. other daily labour
7. trading/shop
8. transport
9. rural industry
10. government service/pension
11. other salaried job
12. other [specify]....

14. Problems of Pond fish culture

main problem [ ]
second problem [ ]
third problem [ ]

1. Getting loan in time
2. Getting cooperation from Govt. officials
3. Getting fish fry at right time
4. Getting good quality fish fry
5. Getting fertilizers or feeds in time
6. Harvesting fish
7. Getting technical know-how
8. Marketing fish
9. Disputes over pond ownership
10. Poaching/theft problems
11. Lack of water in dry season
12. Damage or fish loss due to flood
13. Fish diseases
14. Predator fish or birds
15. Other problem (specify)

15. Name of pond operator

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SOUTH EAST REGIONAL STUDY
FARMER'S QUESTIONNAIRE

Date:
Enumerator
Serial no.

1. Village	2. Mouza	3. Thana

4. Size of farm

unit used
acres [ ]
decimal [ ]

Conversion
decimals
gonda = [ ]
khani = [ ]

Total land owned
- area not cultivated
= cultivable area owned
- area rented (poton) out
- area sharecropped out
- area mortgaged out
+ area rented (poton) in
+ area sharecropped in
+ area mortgaged in
= total area cultivated

NEXT GO TO QUESTION NUMER 5 ON LAST PAGE

6. Source of draft power

animals [ ]
power tiller [ ]

1. not used
2. own
3. hired
4. borrowed
5. both own and hire/borrow

7. Do you ever suffer from a shortage of draft power

[ ]
1. no
2. yes

8. Do you employ labour for farm work ?

[ ]
1. No - no labour employed
2. Yes - for harvesting only
3. Yes - for other work only
4. Yes - for harvesting and other work

9. Is farm work ever delayed for lack of manpower ?

[ ]
1. no
2. yes

10. Do you think the normal monsoon flooding "barsha" of your farm (in a normal year) is: [ ]

1. OK - would not want any change
2. excessive - would like less water
3. insufficient - would like more water
4. would like more control of water
5. no opinion / dont know

10a. if think barsha is excessive:
is: Flood is too deep [ ]
Flood comes too early [ ]
Flood remain too long [ ] [tick one or more]

11. How has the barsha of your farm changed in the last 10 years [ ]

1. no change
2. more water
3. less water
4. don't know

12. Abnormal flooding "boonya" and drought - damage to crops

year	Crops effected (code)	Proportion of crop effected	Flood or drought	Type of damage	Yield reduction (% down)
1988					
1989					
1990					
1991					
1992					

Flood or drought
1. flood - too much water
2. drought - too little water

Type of damage:
1. seedlings lost - crop replanted
2. seedlings lost - crop not replanted
3. Crop damaged or destroyed
4. Other [specify]

13. Abnormal flooding "boonya" - other damage

year	Damage done to:					
	Hous	Furnitur etc.	Livestock drowned	Stored crops lost crop type	maunds	other [specify
1988						
1989						
1990						
1991						
1992						

house damage:
1. House slightly damaged
2. House badly damaged or partly destroyed
3. House totally destroyed

livestock lost
1. poultry
2. sheep/goat
3. buffalo/cattle

If use irrigation (see Q5)

14a. Is your irrigation water:
1. good quality - not saline
2. slightly saline - but yields not effected
3. saline - enough to reduce yields

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14b. Do you ever suffer from a shortage of irrigation water
1. no - never a shortage
2. yes - shortage some years
3. yes - shortage every year

if yes: 14c. Cause of shortage [tick]

- Lack of water in khal (for LLP or tradtional only)
- Fall in groundwater level/lack of water on well
- Poor distribution from pump/irrigation ditch inadequate
- Poor repair of pump
- Disputes with nieghbours/pump owner or money problem
- High cost of deisel fuel
- Electric power failure
- other [specify]

15. Fishing — Type of fishing
1. never fish
2. fish pond
3. open water
4. pond and open water

If open water:

15a. Where do you mostly fish
1. permanent beel
2. seasonal beel
3. flood plain
4. khal/internal river
5. major river
6. other [specify]

15b. Time of year that you fish
wet season
dry season [tick one or more]

15c. Approx average amount caught: kg per month/year [delete]

15d. Percentage of fish caught that you sell

15e. How have fish catches changed in last 5 years
1. no change
2. big decrease
3. small decrease
4. small increase
5. big increase

16. Do you have any other sources of income other than farming
1. no
2. yes

if yes, 16a. What are your main sources of income

main source
second source
third source

1. farming
2. land rent/crop share
3. fishing
4. fish pond owner
5. work on other farm
6. other daily labour
7. trading/shop
8. transport
9. rural industry
10. government service
11. other salaried job
12. other (specify)

17. Name of farmer son of:

5. CROPPING IN A NORMAL SEASON

	Plot size	Tenure	Flood	Salt	AUS / KHARIF 1					AMAN / KHARIF 2					RABI					BORO				
Plot no.	decimals	(code)	depth in monsoon	soil	crop code	area dec.	irrigate code	fertilise (kg)	output maund	crop code	area dec.	irrigate code	fertilise (kg)	output maund	crop code	area dec.	irrigate	fertilise (kg)	output maund	crop code	area dec.	irrigate	fertilise (kg)	output maund
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								

INSTRUCTIONS
1. ASK ABOUT PLOT NO. 1 FIRST, AND THEN DIFFERENCES BETWEEN OTHER PLOTS
2. ASK IF THE SAME CROP GROWN ON LAND WITH DIFFERENT FLOOD DEPTHS, TENANCY, IRRIGATION OR PR (a) DIFFERENT YIELDS (b) DIFFERENT FERTILISER
3. CHECK THAT CROP PLANTING AND HARVEST DATES REALLY ALLOW CROPS TO BE GROWN IN THE SEQUENCE REPORTED BY THE FARMER

Notes

Tenure
1. owned
2. sharecropped in
3. rented in
4. mortgaged in

Irrigation source
1. no irrigation
2. hired STW
3. own STW
4. hired LLP
5. own LLP
6. hired DTW
7. own DTW
8. manual TW
9. traditional

Flood depth
enter depth in feet of barsha in a normal year

Salty soil
1. not saline
2. slightly saline but yields not effected
3. saline - yields reduced

5. CODING SHEET

Farmer serial number

					AUS / KHARIF 1					AMAN / KHARIF 2					RABI					BORO				
Plot no.	Plot size acres	Tenure (code)	Flood depth in (feet)	Salt soil	crop abr.	crop code	irrigate code	fertilise (kg/acr	output md/ac	crop abr.	crop code	irrigate code	fertilise (kg/acr	output md/ac	crop abr.	crop code	irrigate	fertilise (kg/acr	output md/ac	crop abr.	crop code	irrigate	fertilise (kg/acr	output md/ac
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								

INSTRUCTIONS
1. Convert plot size to acres, fertiliser to kg per acre, and yield to maunds per acre
2. Allow one plot per cropping pattern - seperate plots if any division of crops during the year.
3. Enter numeric crop code beside abreviation

Notes

Tenure
1. owned
2. sharecropped in
3. rented in
4. mortgaged in

Irrigation source
1. no irrigation
2. hired STW
3. own STW
4. hired LLP
5. own LLP
6. hired DTW
7. own DTW
8. manual TW
9. traditional

Flood depth
enter depth in feet of barsha in a normal year

Salty soil
1. not saline
2. slightly saline but yields not effected
3. saline - yields reduced

SOUTH EAST REGIONAL STUDY

Date:	Serial no.
	Enumerator

FARMER'S CASE STUDY –
SUPPLEMENTARY TO FARMER'S QUESTIONNARIE

1. Village	2. Mouza	3. Thana

3. Name of farmer	son of

NOW GO TO QUESTION NUMBER 4 ON LAST PAGE

5. What are the dates of the normal monsoon flooding ("barsha") [include dates of all barshas] [for a normal year]

Date barsha flood starts to rise

Date barsha flood drains away

6. What changes have there been in crop areas in the last 10 years [specify if hyv, irrigated, broadcast etc

Name of crop	increase or decrease	Reason for change

7. How have crop yields changed in the last 10 years

Name of crop	increase or decrease	Reason for change

8. Irrigation

if irrigation water scarce

in what months is water scarce

does scarce water
1. limit area of irrigated crops that can be grwon
2. reduce yield of irrigated crops
3. both limit area and reduce yield

is this a problem getting worse year-by-year
1. no - no change in situation
2. getting worse every year
3. supply improving every year

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9. Draft animals

number owned		bullocks	other adult used for draft	other adult not used for draft	young
	cattle				
	buffalo				

10. Buying, selling, breeding

	total number owned	number during one year that normally: born	buy	sell	eat
cattle					
buffalo					
goats					
sheep					
ducks & geese					
chickens					

11. Animal feeds:

	maunds per year: buy	sell
straw		
bhushi (bran)		
oilseed cake		

12. How has the number of animals owned changed in the last 10 years

type of animal	increase/decrease	reason
draft bullocks		
other cattle		
buffalo		
sheep		
goats		
duck/geese		
chickens		

13. If you ever suffer from a shortage of draught power

13a. Cause of shortage [ ] 1. unavailability/shortage of either own or hired animals
2. lack of money to buy or hire animals or tiller

13b. effect of shortage: what crops effected

13c. does this shortage
[ ] delays planting [tick one or both]
[ ] reduce time for cultivation
if planting delayed does this: [ ] reduce yields [tick one or both]
[ ] limit the area that you grow of this crop

14. Family size (khana)

total		number	involved in farm work	number
	men		men	
	women		women	
	children		children	

15. If women of your family work on the farm, what tasks do they do ? [including post-harvest]

16. Rice husking: done by [tick as applicable]

- [ ] own modern machine
- [ ] hired modern machine
- [ ] own dheki
- [ ] hired dheki
- [ ] hand (no machine)

17. If hire labour
do you hire [ ]
1. men only
2. women only
3. men and women

amount paid as wages

Tk/day	harvest season	other times
man		
woman		

meals also given [ ] 1. no 2. yes

18. Extension
What contact do you have with agricultural extension [ ]
1. none
2. occasional
3. regular

Do you think you need more advice than you now get. [ ] 1. no 2. yes

19. Marketing
19a. what crops do you sell –
approx proportion of production of:
rice [ ]
wheat [ ]
pulses [ ]
oilseeds [ ]
potatoes [ ]
vegetables [ ]
1. none
2. some
3. most
4. all

19b. in a normal year do you buy:

	tick		tick
rice		fish	
oilseeds		meat/chickens	
vegetable oil		potatoes	
pulses		vegetables	

19c. where do you sell your crops [ ]
1. at the farm
2. in the market
3. both at the farm and in the market

19d. distance to local market [ ] kms.

19e. means of transport used for crops/fertiliser [tick]

rickshaw		boat	
bicycle		truck/bus	
oxcart		power tiller	
horsecart		hand carry	
hand cart		other	

19f. average cost of hired transport from farm to market [ ] Tk per maund

20. Prices
Tk per maund/acre/ [delete]
price of animal manure if were to buy [ ]
price of straw if were to sell at time of harvest [ ] (lowest of range of prices)

21. Finance
a) sources of funds in last year for
fertiliser and pesticides — main source [ ] second source [ ]
hire of draught power — main source [ ] second source [ ]
hire of labour — main source [ ] second source [ ]
hire of tubewell/LLP — main source [ ] second source [ ]

1. Borrow from commercial Bank
2. Borrow from KSS/UCCA/BRDB
3. Borrow from Grameen Bank/other NGO
4. Borrow from relatives/friends
5. Borrow from fertiliser supplier
6. Borrow from money lender/Mohajan
7. Cash from sale of crops
8. Cash from other sources of income
9. Cash from sale of livestock
10. Cash from sale of land
11. Cash from sale of other assets
12. Other [specify]
13. No other source

b) if own a tubewell or LLP
how many years ago was this purchased [ ]
how did you get the money to pay for it
main source [ ]
second source [ ]

c) if own a power tiller
how many years ago was this purchased [ ]
how did you get the money to pay for it
main source [ ]
second source [ ]

Other comments

4. Input use for major crops

Crop name						
HYV or local type						
Transplant or broadcast						
Date:	planted					
	harvested					
Land type	flood depth					
Land area or unit used (ie acre)						
Land preparation (plough+plank)						
own power tiller		hours				
hired power tiller		hours				
	total cost if hired	Tk				
hired draught animal pair		days				
own draught animal pair		days				
	total cost if hired	Tk				
labour (excl driver)						
	family	days				
	hired	days				
Sow/Planting						
seed		kg				
labour	family	days				
	hired	days				
Fertiliser (total application)						
chemical	urea	kg				
	TSP	kg				
	MP	kg				
	gypsum	kg				
	other	kg				
animal manure		kg				
labour	family	days				
	hired	days				
Pesticide application						
amount applied		kg				
cost		Tk.				
labour	family	days				
	hired	days				
Weeding and thinning						
draught animal pair		days				
labour	family	days				
	hired	days				
Irrigation						
source of water						
full or part irrigated						
labour to control water						
	family	days				
	hired	days				
Harvesting						
labour	family	days				
	hired	days				
Threshing						
per ton of output or acre grown						
draught animal pair		days				
labour	family	days				
	hired	days				
Other post harvest work						
type of work						
labour	family	days				
	hired	days				
Yield	main crop	maunds				
	by-product	maunds				

SOUTH EAST REGIONAL STUDY

Date:	Serial no.
Enumerator	

PLOT QUESTIONNAIRE

1. Grid reference/location	2. Name of farmer

3. Village	4. Mouza	5. Thana

6. Size of plot		decimals

7. Tenancy of plot [ ]
1. owner operated
2. sharecrop
3. cash rent (poton)
4. other lease/mortgage

8. Does farmer have other cultivated land ? [ ]
1. no
2. yes

if yes: Area of all plots farmed this year (including sample plot) [ ] decimals/acres[delete]

Elevation of other plots: [ ]
1. same as this plot
2. higher than this plot
3. lower than this plot
4. both higher and lower

9. This year is much drier than normal. Is the flooding of this plot reduced in terms of flood depth or duration [ ]
1. no
2. yes

if yes: answer Questions 10 and 11, if no: go to Question 12

10. What is the monsoon flooding (barsha) of this plot THIS YEAR

date flooding started	month	
date flood ended	mont	[indicate if plot still flooded]
depth of flood at peak	feet	

11. Cropping pattern and inputs THIS YEAR
(include planned boro crop and expected yield)

	aus	aman	rabi	boro
Crop name(code)				
Date planted				
Fertiliser used - total				
Irrigation source				
harvest date				
yield (mds)				

12. What is the monsoon flooding (barsha) of this plot IN A NORMAL YEAR

date flooding starts	month	
date flood ends	month	
depth of flood at peak	feet	

13. Cropping pattern and inputs in a NORMAL YEAR

	aus	aman	rabi	boro
Crop name(code)				
Date planted				
Fertiliser used - total				
Irrigation source				
harvest date				
yield (mds)				

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14. If improved drainage/flood control meant that flooding was allways reduced to this year's level

	aus	aman	rabi	boro
would you change your cropping pattern. if yes what would you grow (crop code)				
would you change the planting date ? if yes new planting date				
would you change fertiliser use ? if yes new fertiliser use - total				
would you change irrigation? if yes new irrigation source				
would you get a different yield if yes new yield				

14. Do you ever suffer from abnormal (boonya) floods on this plot ? 1. no 2. yes

if yes:

			1988	1989	1990	1991	1992
when did abnormal flood start							
when did abnormal flood end							
peak depth of flood (feet)							
as a result did you							
	change crop type:	from					
		to					
	delay planting (y/n)						
	suffer damage to any crops						
if suffer damage	what crops lost						
	what crops damaged						
	what crops had to be planted again						
as a result of flooding did you make any change to farming in the next boro/rabi							
if yes	changed crop type:	from					
		to					
	used more fertiliser						
	used more irrigation						

14. Other comment or observation

SOUTH EAST REGIONAL STUDY

IRRIGATION PUMP QUESTIONNAIRE

Date:

Enumerator

Serial no.

1. Village	2 .Mouza	3. Upazila

4. Type of pump
1. DTW
2. STW
3. LLP
4. MOSTI
5. traditional [type.........................]

5. Source of power
1. diesel
2. electricity
3. manual

6. Engine size		HP/KW

7. Date installed

8. Ownership
1. private
2. KSS/BADC
3. other Government
4. NGO group
5. other group

9. Area of each crops irrigated in this boro and previuos aus and aman.

acres	owners /group	other farmer	total
boro			
aus			
aman			
wheat			
potato			
vegetable			
other [specify]			

10. Total area irrigated

acres	1989/90	1990/1	1991/2
aus			
aman			
rabi			
boro			

11. Total area commanded (potentially irrigated)		acres

12. What factors limit area irrigated

tick	
	capacity of pump
	unreiability of pump
	poor supply of electricity
	supply of water in well or khal
	little demand from farmers/high cost fuel etc
	difficulties of transmission
	difficulties in management/payments
	competion from other pumps
	other [specify]

13. Does the area irrigated adjoin land irrigated by other pumps
1. no
2. yes

if LLP 14. Is the location of the pump normally moved during the season
1. no
2. yes

If moved 15. Is the same land irrigated after the move as before
1. no
2. yes

16. Has the area irrigated increased or decreased since the pump first started operation
1. no change
2. increase
3. decrease

17. If there has been a change in the area irrigated, what are the reasons

18. Is the supply of water in khal or well limited [ ]

1. no - water supply OK
2. water supply limited in some years
3. water supply limited every year

if yes: periods when supply limited [name months]

is this a problem getting worse year-by-year [ ]

1. no - no change in situation
2. getting worse every year
3. supply improving every year

what is the cause of this change ?

19. Water quality — is irrigation water saline [ ]

1. no - water good quality
2. yes - a little saline
3. yes - a very saline

if yes, at what times of year [name months]

does it reduce yields [ ] 1. no 2. yes

is salinity increasing year-by-year [ ] 1. no 2. yes

20. What improvements needed to improve irrigation supply or expand area

[tick]

- [ ] no improvement needed
- [ ] improve supply of water in khal
- [ ] install electical power supply
- [ ] line distribution channels
- [ ] replace/repair engine/pump
- [ ] improve management of pump/group
- [ ] other [specify]

21. Is any other use made of the engine when not used for irrigation [tick]

- [ ] no - irrigation only
- [ ] used in boat
- [ ] used for rice mill
- [ ] used for wheat mill
- [ ] used for oilseed crusher
- [ ] used in power tiller
- [ ] other [specify]

22. Water Charges

	Taka per acre		or	Share of crop (%)	
	group member	other farmer		group member	other farmer
boro					
aus					
aman					
wheat					
potato					
vegetable					
other [specify]					

[enter either Taka or crop share]

23. Operating cost for last year (irrigation only)

Taka	maximum month	average month	total for year
fuel			
oil			
spare parts			
mechanic			
operator			
management			
total			

Note: if respondant unable to give this information, write down anything known about operating cost

24. Name of respondant

25. Position [ ]

1. pump owner
2. group manager
3. farmer/water use
4. other [specify]

INFORMATION ON FISHERIES

Name of Thana | Total Population

Total Areas of Ponds (ha) | Annual Fish Production (MT)

Total Areas of Beels (ha) | Annual Fish Production (MT)

Total Areas of Small River (ha) | Annual Fish Production (MT)

Total Areas of Flood Plains | Annual Fish Production (MT)

Areas of Natural Spawn Collection (if any)

Annual Collection of Spawn (Kg)

No. of Fish Hatchery: a) Government owned | Private

b) Annual Production | Annual Production

No. of Nurseries a) Government owned | Annual Production (in Lacs)

b) Private | Annual Production (in Lacs)

No. of Fishermen | Permanent | Temporary

Occasional

Name Ten Fish Gears Used in the Area: (1) (2)

(3) (4)

(5) (6)

(7) (8)

(9) (10)

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Name Ten Dominant Fish Species; Annual Catch (%)

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

Do you have any development Programme in Fisheries? If so, please state briefly about it.

Five Main Problems in Fisheries:

(1)

(2)

(3)

(4)

(5)

Names of Beel	Location	Area (ha)	Dry Season	Monsoon	Annual Fish Production (MT)

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Names of decreasing species of the area.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

16.

17.

18.

19.

20.

SERS - GUMTI PHASE II AND NOAKHALI NORTH PROJECTS

CATCH ASSESSMENT SURVEY

FORM 1 - PAGE 1

INYESTIGATOR

DATE

UPAZILA

COMPARTMENT

A. GENERAL INFORMATION

1. IDENTIFICATION

Name of beel

Mouza

Union

2. DIMENSIONS

Monsoon hec. Winter hec. Minimum hec.

Sketch showing contours, depth contours, surrounding beels, rivers and connections

3. OWNERSHIP

GOB kash land Private Mixed GOB list No.

4. LEASING ARRANGEMENTS

Fishermen cooperate Private individuals Retained by owner None

Other (specify)

Name & address of leasee

Lease period years Value Tk. per year/total

180

CATCH ASSESSMENT SURVEY

FORM 1- PAGE 2

B. FISHING ACTIVITY

1. OPERATORS

Owner [ ] Leasee [ ] Sub-leasee [ ]

2. FISHING CONTRACT

Owner [ ] leasee [ ] Sub-leasee [ ] Hired fishermen [ ]

Share basis with fishermen [ ] Villages (in case there is no managemnt) [ ]

3. FISHING SCHEDULE

Annual [ ] Alternate year [ ] Pile (reserve) Fishery every third year [ ]

4. FISHING PERIOD

From [ ] to [ ]

5. FISHING METHODS

Nets & traps [ ] Partial dewatering [ ] Complete dewatering [ ]

Kata fishing [ ] Others [ ]

6. KATA FISHERY

Number of katas [ ] Area of each kata [ ]

7. FISH MARKETING

On the site [ ] Landing center [ ]

Transport mode [ ]

Local market [ ]

C. ECONOMICS

1. MANAGEMNT COSTS

Lease value		tk.	Sheds/construction		tk.
Guard salaries		tk.	Feed, fertilizers		tk.
Cost of katas		tk.	Other		tk.

2. FISHING EXPENDITURES

Fish. wages		tk.	Other wages		tk.
Nets/traps		tk.	Boats		tk.
Maintenance		Tk.	Housing		tk.
Other costs		Tk.			tk.

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CATCH ASSESSMENT SURVEY

WORKSHEET

OBSERVATION OF SAMPLE CATCHES AND ESTIMATION OF TOTAL CATCH IN THE SAMPLE DAY

INVESTIGATOR | | | | | | | | | | | | | DATE | | | | | | |

BEEL | | | | | | | | | | | | | | COMPARTMENT | | | |

TYPE OF FISHING KATTA [ ] OTHER [ ]

TYPE OF GEAR | | | | | | | | | | | | |

Total FU in the day | | | | | (N)

Sample FU observed | | | | | (n)

Raising factor (N/n) | | | |

SPECIES	Sample catch data observed (kg)								Sample Total	Est. total catch
01. RUHI										
02. CATLA										
03. MRIGAL										
04. KALBASU										
05. CHANIA										
06. BOAL										
07. AIR										
08. PANGAS										
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI										
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17.										
18.										
19.										
20. MISCELLANEOUS										
TOTAL										

Remark: Estimated total catch of the day = Sample total x raising factor

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CATCH ASSESSMENT SURVEY

FORM IV

ESTIMATED TOTAL CATCH FOR THE WHOLE SEASON

INVESTIGATOR		DATE	
BEEL		COMPARTMENT	
FISHING PERIOD	from	to	
WINTER AREA	ha	ANNUALLLY HARVESTED	PILE EVERY

SPECIES	ESTIMATED TOTAL CATCH FOR THE WHOLE SEASON (kg)		TOTAL
	KATTA FISHING	OTHER FISHING	
01. RUHI			
02. CATLA			
03. MRIGAL			
04. KALBASU			
05. CHANIA			
06. BOAL			
07. AIR			
08. PANGAS			
09. SILON			
10. GHOL/GAZAR			
11. GHITAL/PHALI			
12. KOI			
13. SINGI/MAGUR			
14. SAR PUNTI			
15. BIG SHRIMPS			
16. SMALL SHRIMPS			
17.			
18			
19			
20. MISCELLANEOUS			
TOTAL			

Type of gear used				
Number if FU operated				
Number of fishermen				

CATCH ASSESSMENT SURVEY

FORM III

TOTAL CATCH IN SAMPLE DAY & THE PAST 3 DAYS

INVESTIGATOR

DATE

BEEL

COMPARTMENT

FISHING PERIOD from to

SPECIES	TOTAL CATCH IN SAMPLE DAY (kg)			CATCH IN PAST 3 DAYS (kg)			TOTAL 4 DAYS CATCH (kg)		
	Katta fishing	Other fishing	Total	Katta fishing	Other fishing	Total	Katta fishing	Other fishing	Total
01. RUHI									
02. CATLA									
03. MRIGAL									
04. KALBASU									
05. CHANIA									
06. BOAL									
07. AIR									
08. PANGAS									
09. SILON									
10. GHOL/GAZAR									
11. GHITAL/PHALI									
12. KOI									
13. SINGI/MAGUR									
14. SAR PUNTI									
15. BIG SHRIMPS									
16. SMALL SHRIMPS									
17.									
18									
19									
20. MISCELLANEOUS									
TOTAL									

Number of Kattas fished during these 4 days

Gear used during these 4 days

Average FU operated per day

Average no of fishermen per day during these 4 days

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Fish Migration Record Format

Name of Research Assistant : ____________________

Date of sampling:________/________/________ Time of sampling:________ to __________ hours

Name and location of canal/river:——————————

Av. depth of canal:______________ m Breadth of canal:______________ m

Water flow direction: Towards river/Towards beel/floodplain

Type of gear:__________ Size of gear: le.________ L________H________D________mm

Position of gear setting:______________Direction of gear:______________

Wheather record: Rainfall during the sampling period________________hours

Rainfall during last 3 days________hrs/last day 1________last day 2__________ last day 3

Fish species record

Species	Sampled fish To. No. To. kg	Total Weight of 10–20 sample fish (cm)

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SERS - GUMTI PHASE II AND NOAKHALI NORTH PROJECTS

MARKET SURVEY QUESTIONNAIRE

A: MARKECT SURVEY

Name of Research Assistant:__________________ Survey Period [ ]

Survey Cycle: Survey Date: [| | | | 1 | 9 | 9 |] Day Month Year

1. Name of the Project Area: [ ] GUMTI - NOAKHALI

A) HOMNA, B) BANCHARAMPUR, C) NABINAGAR, D) MURADNAGAR, E) KASBA
F) RAHMATKHALI, G) BEGUMGANJ, H) HAJIGANJ, I) CHATKHIL

2. Name of Market/Hat ____________________

A) Village:__________ B) Mouza:__________ C) Union:__________ D) Upazila:__________

3. Type of Market (Code) [ ]

1) Wholesaler, 2) Retailer, 3) Wholesaler & Retailer

4. Description of Fish Saler

Type of Saler	No.
Arotdar/Stockist	
Wholesaler	
Retailer	
Temporary Seller	
Total	

5. Fish Sale Information:

	Description of Saler		Fish Species		Weight of Fish			Source of Fish Code)	Locality of Source	Fishing Gear (Code)	Fish Caught by Himself Purchased Catch (Code)
Sl.	Type 1 (Code)	Type 2 (Code)	Name	Code	(%)	No.	Weight (Kg)				

Type 1 of Saler : 1. Only Saler (Whole Year), 2. Only Saler (Seasonal), 3. Fisherman (Whole Year), 4. Fisherman (Seasonal), 5. General

Caught/Purchased of Fish : 1. Caught, 2. Purchased, 3. Caught & Purchased

Type 2 of Saler : 1. Arotdar/Stockist, 2. Wholesaler, 3. Permanent, 4. Temporary

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B. MARKET PRICE OF FISH BY SPECIES

INVESTIGATOR______________________ DATE:______________________

Name of Market:______________ Union:______________ Upazila:______________

Fish species		Unit of weight	Market price of fish (Taka/Unit)
Name	Code		

Weight Unit: 1. kg, 2. Sare, 3. Others (Describe)

C: Dried Fish

Number of Saler	Species (Code)	Weight (Kg)	Price (Tk./Kg)	Weight of Salted Hilsha (Kg)	Price (Tk./Kg)

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CATCH ASSESSMENT SURVEY

SUMMARY SHEET

SUMMARY OF 4 DAYS CATCH AND ESTIMATION OF TOTAL CATCH FOR THE WHOLE SEASON

INVESTIGATOR | | | | | | | | | | | | DATE | | | | | | |

BEEL | | | | | | | | | | | | | | COMPARTMENT | | | |

TYPE OF FISHING KATTA [ ] OTHER [ ]

Days in fishing period | | | | (N)

Days covered | | | | (n)

Raising factor (N/n) | | | |

SPECIES	Total catch in these 4 days (kg)								Sample total	Est. total catch of season
01. RUHI										
02. CATLA										
03. MRIGAL										
04. KALBASU										
05. CHANIA										
06. BOAL										
07. AIR										
08. PANGAS										
09. SILON										
10. GHOL/GAZAR										
11. GHITAL/PHALI										
12. KOI										
13. SINGI/MAGUR										
14. SAR PUNTI										
15. BIG SHRIMPS										
16. SMALL SHRIMPS										
17.										
18.										
19.										
20. MISCELLANEOUS										
TOTAL										

Remark: Estimated total catch of the season = Sample total x raising factor

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ANNEX IV

ENVIRONMENT

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ANNEX IV - ENVIRONMENT

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ANNEX IV - ENVIRONMENT

CHAPTER IV.1

INTRODUCTION

IV.1.1 Introduction

This Initial Environmental Evaluation (IEE) evaluates the environmental impacts of the water resource development proposals reviewed by South East Regional Study (SERS) under the Flood Action Plan (FAP) Study FAP 5. The region is subjected to various water problems. These include flash floods from the Tripura Hills in India, tidal and cyclonic surges from the Bay of Bengal, bank overtopping floods from the Meghna river, impeded drainage in backswamp areas, and waterlogging from local rainfall and poor design and layout of transport and other embankment infrastructure. The main intervention possibilities included flood control, drainage and irrigation, as well as rehabilitation and completion of existing projects. The measures assessed aim to increase the intensity of land use and agricultural production.

The total area of interest to environmental assessments is shown in Figure IV.1.1 and would include the total catchment areas of the three river systems. The projects which are considered suitable for feasibility study under the Regional Water Plan (RWP) are shown in Figure IV.1.2. Those projects which are selected for feasibility study will be subjected to a more detailed Environmental Impact Assessment (EIA). The SER study was not asked to consider the planning and cost-benefit analysis of non-structural options, either as an alternative to the structural solutions assessed, or as a complementary sub-component of the structural approach. Thus, the relative differences in environmental impact of these two approaches has not been determined.

Various schemes have been built and proposed to improve the flood control, drainage and irrigation conditions, as discussed in Part 2 of the Main Report. The most recent studies conclude that sufficient groundwater is available for irrigation development over most of the region, subject to constraints of intrusions of both inland and coastal salinity. Considerable development of small-scale pumped irrigation has already taken place and achieved the main available development options. Flood control projects have a less certain role, as long as the main benefits for agricultural production and employment can still be derived from irrigation investments. The removal of drainage constraints has been identified as a potentially important development option.

The approach to the environmental assessment has been to take the region and its people, economy, ecology and project interventions as a indivisible system if the impacts of the proposed developments are to be properly appreciated. It is necessary that the detailed descriptions and analysis of the other specialist inputs which appear in other annexes are read together with the information provided in this document.

Figure IV.1.1

Ganges-Brahmaputra-Meghna Catchment Area

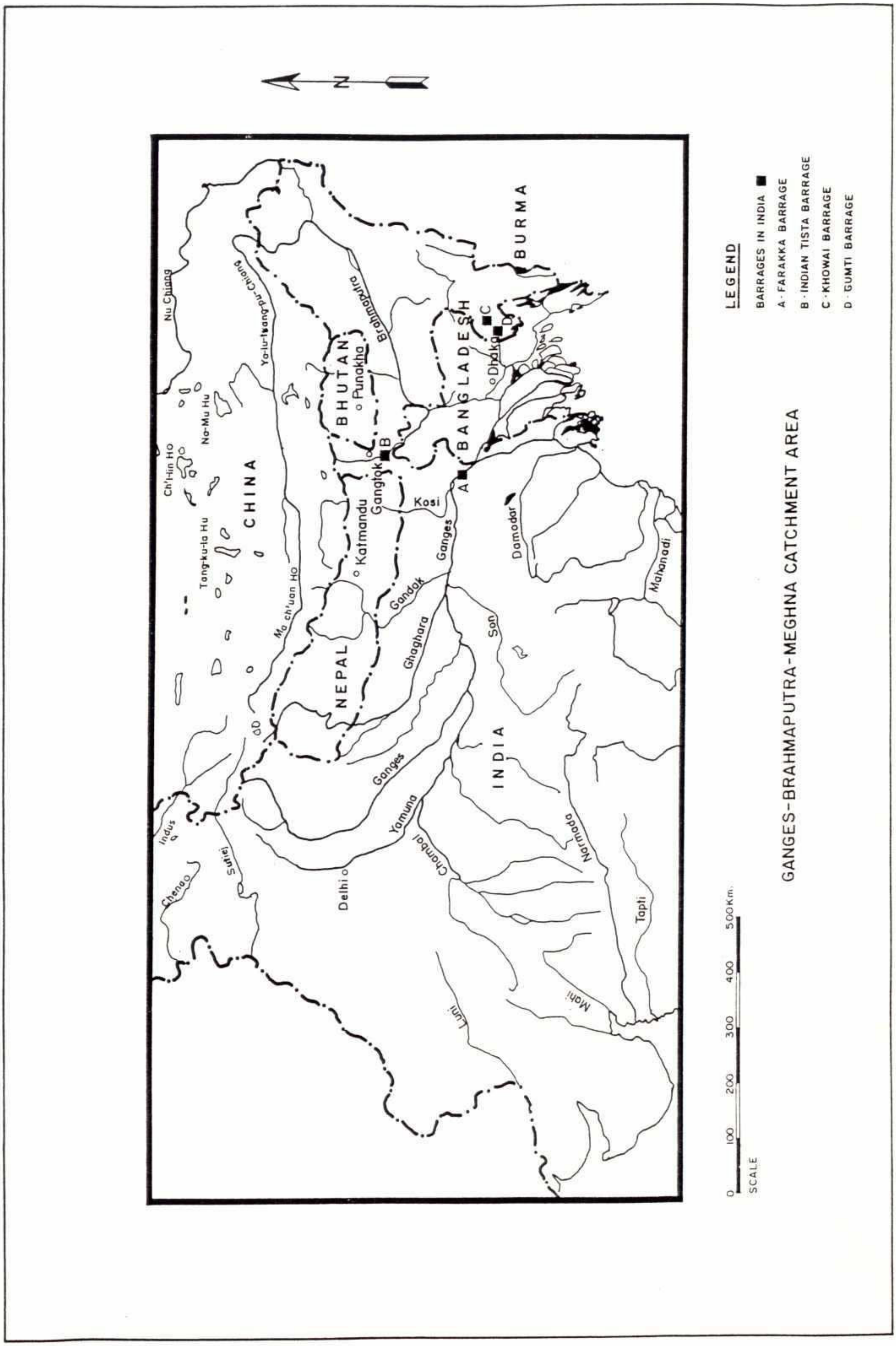
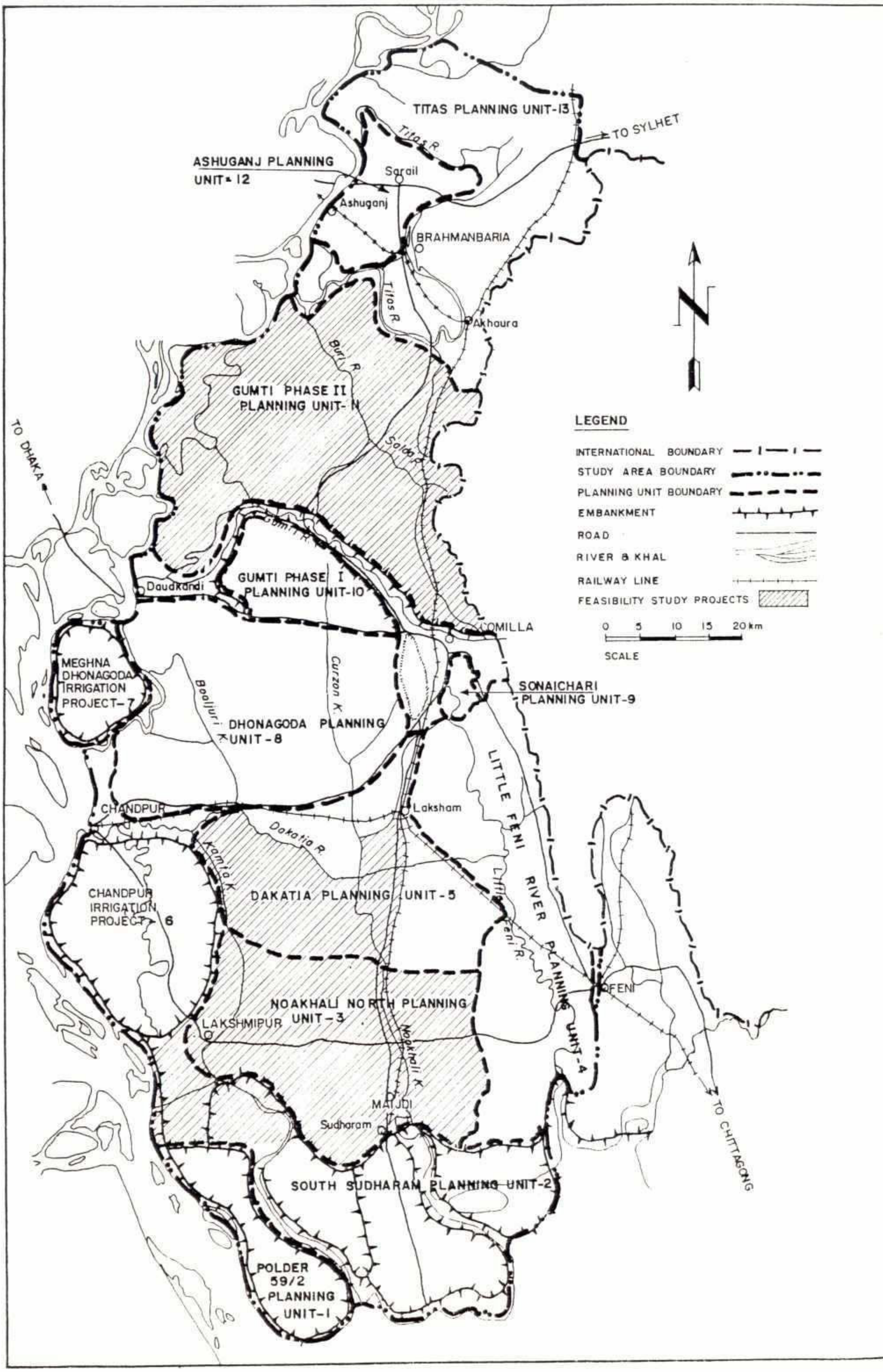


Figure IV.1.2

Planning Units Showing Proposed Feasibility Study Projects



IV.1.2 Regional Setting

The social and economic background to the South East Region and the development of flood control, irrigation and drainage (FCDI) schemes and the planning details of schemes and options analysed under the SERS are given in Annexes III and Part 2 of the Main Report.

The region's climatic and hydrological regime is dominated by the mountain ranges of the Tripura hills running north-south on its eastern flank and the tidal and monsoonal systems in the Bay of Bengal. Virtually the whole area is under some degree of tidal influence. The drainage morphology is structurally influenced. Frequent changes in river courses are associated with high rates of sedimentation arising from the Tripura Hills and being deposited in the Meghna floodplain. The region falls within an active zone of medium seismicity. Tectonic uplift also affects the drainage structure in the region.

Physically, the south of the region comprises very recent and recent char lands in an active and poorly stabilised coastal delta and estuarine system. These are biologically immature and poorly colonised. This system has been influenced by three major coastal projects which have led to the considerable acceleration in the accretion of land. This includes two cross-dams built in 1957 and 1964 and the associated coastal embankment which now lies between 15-20 km inland. The southern coastal belt has been polder developed since the 1960s and extensive study by the Land Reclamation Project. It is also the subject of the Cyclone Protection Project (FAP 7). Its low lying aspect and sedimentary formation has created inland backswamp areas subject to impeded drainage. Here there is intense settlement activity in an unstable and uncertain environment.

The areas to the north and east of the coast have a much longer history of settlement and disturbance to any natural ecology. Increasing population and flood damage have led to concern about deepening rural property and the deteriorating quality of the region's resources. While some alleviating measures can be undertaken within the region, the problems of land use and water regulation across the border in India involve international agreements and cooperation.

Considerable compartmentalisation of the region by the construction of road and rail networks has taken place. Since these were not designed per se for flood control or management, their influence on the hydrologic and drainage network is not necessarily rational for effective management of floods, drainage, irrigation, crop production and integrated land use.

IV.1.3 Plan Components

The RWP proposes a phased programme of development in irrigation, drainage, flood control and rehabilitation of existing projects. The main components, areas and population to be benefitted are described in Part 2 of the Main Report. This also details the preliminary schedule of pre-project preparation, future studies and land acquisition necessary, together with the proposed phasing of project developments and their expected economic life. Detailed project boundaries, specific location of project works, exact land resources to be expropriated and the number of people to be resettled cannot be accurately estimated at the pre-feasibility stage. Projects taken through for implementation would mainly fall into the 1995-2000 and 2000-2005 five year plan periods.

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IV.1.4 Plan Benefits

The major objectives of the RWP are to reduce the production risks and damage from uncontrolled flooding and to develop drainage and irrigation facilities. The outcome of the interventions are expected mainly to increase production, farm income and employment. The RWP benefits envisaged are as follows:

a. Savings in foreign exchange and dependency on international aid due to increased crop production.

b. Regional development benefits accruing from increased irrigation and modern agricultural practices and a safer investment environment.

c. A reduction in the under-employment of labour accruing from the more intensive agricultural methods to be promoted.

d. Improvements in the quality and marketability of farm products associated with the impact of controlled flooding.

e. Improvements in the reliable water supply situation resulting from the improved flood management and irrigation systems.

f. Improved fishery opportunities in the protected ponds and water bodies to mitigate the production, but not social, equity or ecological, losses likely to open water capture fisheries.

g. Improved quality of life resulting from reduced flood damage, and the increased incomes and employment from improved crop production.

h. Improved catchment management benefits could only result from international cooperation and programmes to address the problems of sedimentation resulting from deforestation and poor land use practices in the upper catchments which are all in other countries.

IV.1.5 Environmental Policy and Standards

Although the history of concerns on various issues goes back to the last century contemporary environmental policy formation has received little support until recently. In 1977 the Department of Environment and Pollution was set up in the Ministry of Local Government and Rural Development (MOLGRD) which had very limited funds and trained staff. Some aspects of environmental policy were drafted in 1983, but never ratified. In 1986, a seminar on conservation and development was organised jointly by the International Union for the Conservation of Nature and Natural Resources - The World Conservation Union (IUCN) and the Bangladesh Centre for Advanced Studies (BCAS). The seminar led to the setting up of an inter-ministerial committee under the Ministry of Agriculture (MOA) which approved the preparation of a National Conservation Strategy (NCS) with the assistance of IUCN. The draft NCS was ready in 1987, but was never approved. However, a further study for a comprehensive NCS was approved. A further draft was submitted in July 1991, together with a draft of the Department of the Environment's "Environmental Quality Standards for Bangladesh".

The 1988 floods and growing pressure for environmental action led to the Ministry of Environment and Forests being created in 1989. This still remains under-staffed and with limited finance. Their work has continued in the field of limited water quality and pollution monitoring. They also have revised the 1983 draft national policy on environment which is now superseded by the draft environment policy and environmental action plan. This was submitted in 1990 and is now awaiting cabinet approval. This is expected before the important Brazil Conference in 1992.

The government's environmental concerns are also reflected in the Fourth Five year Plan (1990-1995) as well as in the National Environmental Management Action Plan (NEMAP). This plan was supported by the MOEF and the United Nations Development Programme (UNDP).

The main objectives of the draft environmental policy are to maintain ecological balance, protect against natural disaster, prevent pollution and degradation, ensure integrated and environmentally sound development and ensure long-term sustainability of natural resources. These general objectives are being translated into more detailed policy priorities across all sectors in the economy. Environmental cells are being set up in all the main ministerial and parastatal bodies to carry out project by project assessments. In addition, considerable work is ongoing in the media and private organisations to raise public awareness, promote education and research, and to pressure for an improved legal and institutional framework.

IV.1.6 Prevailing Legislation

The history of environmentally related legislation in Bangladesh goes back more than one hundred years. These early acts have been amended, amalgamated or replaced from time to time. These acts or ordinances may be divided into four broad categories:

a. Laws relating to natural resources like forests, animals, birds, fisheries and other varieties of flora and fauna,

b. Laws relating to protection of cultural and natural heritage,

c. Laws relating to health and sanitation, including water supply, drainage, pond, sewerage, urban planning and occupational hazard,

d. Laws relating to control, prevention, and abatement of pollution of air, water and soil,

Current enforcement of natural resource legislation is the responsibility of Divisional Forestry Officers, but their effectiveness is extremely limited, particularly with regard to floodplain situations. Cultural and natural heritage issues are dealt with by the Ministry of Sports and Culture and the National Museum. Local government institutions, such as the District Boards, Union Councils and Municipalities, are responsible for protecting environmental health in areas such as sanitation, water supply, public bathing, conservancy services, the administration of public water courses and contamination of water. The administration of pollution controls was given to the Environment Pollution Control Board in 1977. This has now been transferred to the Department of Environment under the recently established MOEF. The Director has limited powers to actually control commercial or industrial pollution as the main tools available are only information collection, inspection and testing of disposal systems. A summary listing of pertinent legislation is given in **Appendix A**.

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The national environmental policy requires that special considerations be given to the protection of the natural and human ecological systems to avoid degradation and pollution and loss of bio-diversity. Most natural wetland and forest habitats have already disappeared or have been thoroughly influenced by human intervention. Thus, already the loss of natural habitats may appear to be of less significance than the socio-economic impacts on the local communities and the maintenance, through good management, of the habitats which communities now depend on. However, the fact that certain habitats are now critically affected means that this is perhaps the last occasion when conservation measures in the SER could be undertaken.

IV.1.7 Aims of the Study

The aims of the IEE study are:

a. To identify the composition and condition of the existing environment which will be subjected to interventions under the proposed Regional Water Plan (RWP) projects and to integrate important features into the planning process.

b. To identify and evaluate the likely future environmental impacts and changes associated with the proposed plan activities.

c. To highlight important impacts and key policy issues early in the identification of problems and planning of solutions, and to recommend ameliorative measures to ensure sound environmental management and monitoring.

The series of studies from pre-feasibility through to feasibility stages seek to provide decision-makers and planners with information to assist the harmonising of the interactions between the proposed interventions, the local communities affected, the economic and technical desires involved, and requirements for a more stable political and self-sustaining living environment. If taken as being complementary to the economic analysis the study aims to aid the search for development strategies which can sustain the natural resource base for future generations, enable people to survive better with the changing resource implications of new project plans and policies and, where possible, improve the quality of the living and non-living environment.

The conclusions reached through the environmental assessments should provide policy and decision-makers with an overview of potentially important implications. Modern environmental assessment is focused on appraising issues which typically have been excluded from development planning in the past. With hindsight these areas are now seen as those which have often contributed to unacceptable political, social, economic and ecological costs in developed and developing countries alike. This includes cross-sectorial impacts into areas such as human health, environmental pollution, loss of survival strategies, irrational technology transfer and industrial infrastructure development.

The aims of the RWP concentrate on the quality of the human environment, sustaining food production systems and minimising pollution from sources of human waste, industrial pollutants and agro-chemicals. The maintenance of a diversity of species and habitats is vital to these aims. The ecology of the floodplain, estuarine and coastal systems are still diverse. Yet, they are believed to be changing significantly under the influence of FCDI and modern agricultural and industrial programmes. The RWP aims to ensure that continued development

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is fostered in a way that can sustain the development potential of the natural and human resources. If this is to be achieved in practise it will require considerably more environmental management inputs than are currently provided.

IV.1.8 Scope of Study

The NEMAP has specifically allocated the survey and planning for the nation's major floodplain wetlands to the FAP. Although this aspect is not specifically mentioned in any of the FAP TOR, this need has been taken into account and areas for conservation identified for consideration as future Protected Areas. A separate study has been proposed under FAP 16 to undertake a comprehensive survey and study of these areas. This would be in more detail and over a longer period of time than can be provided for under the individual regional studies. It should also be noted that FAP is temporary in nature and thus cannot take any real responsibility for the inter-sectorial and inter-subject management of the floodplains. This will have to be integrated into NEMAP sooner rather than later if this fundamental landscape of key resources is not to be left in a precarious and uncertain situation.

The study area for preparing the IEE was necessarily based on both administrative, project, socio-economic and ecological areas of influence. The components assessed for their environmental impact include the proposed major structural works, supporting facilities (such as access roads, source sites for construction materials) and the operational area affected by the interventions. The latter might be inside or outside project boundaries, or upstream or downstream of them.

The main downstream impact area for the region is the Meghna estuarine and marine delta. No survey data exists for this area which has allowed this study to make any reasonable judgements on the impacts on this important ecological and economic national resources. Neither is it likely that within the confines and constraints of FAP 5 that this will be possible even during the feasibility stage of EIA analysis. The issues involved also will be critically determined by the outcome of the other FAP interventions. It is recommended that the coastal and estuarine impacts and management implications of the final FAP be taken up for special study and include adequate resources for primary data collection and analysis.

Upstream impact areas include both land within India which would involve international cooperation and integration with other upstream FAP proposed programmes and industrial and agro-chemical sector development. Again the confines of the FAP TOR and study resources do not make it possible for any special study to be carried out on many of these cross-sectorial issues and further study should be allowed for before proceeding with implementation.

Previous studies have indicated possible water shortage in the Feni and Muhuri areas, both to allow for complete irrigation potential and to allow flushing of sediments downstream of the Feni Regulator, which was commissioned in 1985. The SERS review has shown that the extent of irrigation is far more considerable than previously believed and has concluded that the transfer of water from the Meghna river to serve these needs is of lower priority than originally foreseen and is also possibly not technically viable in view of abstraction constraints and competing upstream demands. No impact assessment has therefore been carried out on this option as it was identified in the terms of reference.

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The regional planning approach adopted is directed mainly to planning for the improved use of water in the agricultural sector, but there are critical linkages which this same water has with other sectors, such as public health and other water users. Thus, overall, only a limited number of issues and impacts have been adequately addressed. This reflects the limitations of the TOR, the level of detail appropriate to a pre-feasibility level of planning, the availability of specialist staff on the planning team, and the quality of the data bases already available. Similarly, the planning has focused resources on developing engineering options and designs for FCDI interventions. Significantly greater time and resources ought to be invested in the planning and design of the mitigatory measures and appraising the linkages with other sectors during feasibility planning.

The areas where there are deficiencies in the planning relate to a lack of data and/or specialists in assessing linked impacts and issues of water quality, aquatic and terrestrial ecology, archaeology, culture, survival strategies, agricultural and industrial pollution, political economy and public health. None of these inputs were available for regional planning work.

Institutional strengthening activities for environmental management and monitoring are considered under the SERS. The TOR focuses the attention for this on the needs within BWDB, which is responsible for the overall implementation of FCDI projects. However, the main environmental monitoring work required falls outside of their responsibility. What responsibilities they do have need to be far more closely integrated with the other institutions concerned with environmental issues and management. These issues are discussed in Chapter 6.

IV.1.9 Limitations and Implications for Planning

The study suffers from a number of basic limitations which should be considered during the assessment of its results and considering how to proceed into project selection and the terms of reference for any following feasibility studies. The remaining sections of this chapter discusses these problem areas.

Access to Guidelines and Methodology

The IEE work for this study took place in advance of the issuing of the FAP Environmental Guidelines and the Guidelines for Environmental Impact Assessment expected from FAP 16 and the MOEF (issued by FPCO in October 1992), as well as the Project Assessment Guidelines which prescribe consideration of non-structural elements, complementary development and various programme approaches. Many of the alternatives approaches are the subject of other FAP supporting studies. After reviewing the early drafts of the FAP 16 guidelines, maintaining close liaison with FAP 16, and considering the direct requests received from the MOEF, every effort has been made to align the methodology closely (in terms of the content and presentation) to that which will be finally agreed upon. The approach is along the lines of typical methodologies required elsewhere in Asia and the Far East by national governments and donors. It is not expected that there will be any incompatibility of approach with the other FAP environmental studies, particularly for this regional planning and pre-feasibility level of analysis. The Final FAP 16 guidelines are expected to deal primarily with the needs of an EIA at the feasibility level of analysis. The adopted method should also satisfy the requirements and a range of donors and the MOEF.

Most standard approaches to environmental impact assessment have been worked out for single projects which have reached either the feasibility or detailed design phase. There is little experience of developing equally rigorous methodologies to the level of detail appropriate to pre-feasibility or regional planning, when broad conceptual and strategic planning options are more important than specific project details. However, SERS planning has included a large number of project sites with many potential alternative modes of development for each planning area. To run detailed assessments on each project and each alternative would have not been possible with the resources available. Similarly, because of the phasing, scaling and other problems discussed below, such an approach would probably have produced results that were meaningless and produced a vast quantity of undigestible material. This could obscure the key issues. The methodology followed is discussed in the following chapter.

Unfamiliarity with Impact Assessments and Environmental Planning Objectives

The specialists comprising the FAP planning teams, and many local planners, were not familiar or conversant with the analytical perspectives required of modern environmental assessments. The approach requires a holistic approach and more comprehensive assessment of linkages between specialist inputs, as well as between different sectors. The planning needs for true sustainable development, pollution avoidance, maintenance of bio-diversity, conservation of resources and re-assessments of irreversible implications are now being understood to be complex.

Lack of Primary Data

Reviews of the available regional database in a number of subject areas have raised concern over the quality of data on which good regional and project planning can proceed. Data on some natural resources (climate, geology, geo-physics and soils) appear adequate, although the length of time series data on dynamic seasonal and annual system responses is limited. Official data sources on basic agricultural, irrigation and yield statistics, while available down to detailed local level statistics, have often proved inconsistent and unreliable on closer examination. Data on the species diversity of the natural flora and fauna and the homestead, field and livestock is less available and, in the field of ecology and water quality, is virtually non-existent. These are the primary data required for sound ecological impact analysis. Proposals for basic field surveys and analysis have been drafted both through FAP 2, 5 and 16 to attempt to overcome these deficiencies for FAP planning. However, the time frame available is unlikely to allow any data collection over the minimum period of one year (to cover the main seasonal variation in the dynamic biological and chemical phenomena involved). Whether this research can be mobilised and completed in time to assist even the feasibility planning is open to question.

Lack of Reliable Predictive Models

The theory and tools to appraise many of the complex physical, climatic, chemical and biological inter-actions with changing technology and human activity is still evolving. Thus, the capacity to achieve rapid insight or to model and provide reliable prediction of the response of the environment to proposed interventions is limited or impossible. The models being used to appraise the FCDI interventions are also of concern. The overall planning and analysis are heavily dependent on hydrological models, not only of the main rivers, but also the floodplains. The models in use are limited in their ability to show how channel or floodplain conditions will change. Yet the dynamics of these changes is a known main feature of the river systems. The deltaic

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hydrological conditions are considerably affected by the morphological changes and rate of change of sedimentation, accretion and erosion. These are not fully taken account of in the hydrological models. Also, the two models of hydrology and morphology are not integrated due to a lack of data and the current state of the art.

Apart from this the deltaic conditions are also affected in the longer-term by the outcome of seismic and tectonic events. These have many features which should require some consideration of their potential impacts on project designs and selection. If these dynamics were not considered at all it could lead to strategic decision-making errors.

There is some evidence that the rate of change in a number of key environmental variables (i.e. driving factors in climatic change, dynamic feedback in global energy use and industrial pollution) appears to have increased over recent decades. Both cumulative effects and new phenomena are now being recognised which are affecting the way in which the dynamic workings and linkages between the living and non-living environment are understood. Significant re-assessments are being made of previously acceptable, theoretical and analytical assumptions in many fields of study. During such a period of transition, uncertainty on predictive abilities increases. The dynamic and uncertain hydrologic, physiographic and seismic conditions of the active floodplains and delta impose more serious uncertainties for planning and investment strategies than those associated with more stable landscapes.

The significance of these issues cannot be easily determined. Final decision-making needs to proceed with a balanced and critical judgement on the problems which are raised, and the unforeseen issues which may have been missed.

Phasing, Scaling and Indivisibility Problems

The current planning stage of environmental assessment can make no realistic assumptions as to which series of projects will actually be implemented and when. At the regional level, the responses of the social, economic and ecological environment will be quite specific to a particular scale and phasing of development. Thus, the assessment of cumulative effects and the point where the scale and geographical density of interventions breach thresholds are very difficult to appraise, except as broad generalisations. The type of threshold which may be crossed as more projects are implemented include, for example, a sudden and disproportionate increase in the spread of major disease vectors and disease if once isolated habitats are joined together through projects.

This problem also affects the relationship of the SER to the developments of other regions. At present only region by region and project by project planning is going ahead during this early phase of the FAP studies. This is based on preliminary assumptions of design and impact criteria. Only when the final sum of FAP interventions nationwide is decided on can the final rationale and optimisation of the schemes, and their environmental impacts in the SER, take place with any confidence. The South East, particularly, will be subject to the full downstream impacts of any FCDI project interventions and their phasing in the upstream parts of the delta and floodplains. Even then, because the coastal region is the active part of the delta, any project design rationale established as suitable for the present situation can soon be overtaken by the rapid erosion or accretion of land along the coast.

The land use, cropping pattern, drainage and flood damage situations are clearly very sensitive to minor changes in topography and the precise seasonal timing and source of flooding. This scaling problem is so sensitive that broad generalisations on the benefits and dis-benefits of interventions could be very misleading. Similarly, pre-feasibility, and even feasibility design of engineering works, can easily miss the significance of micro-drainage and soil type problems requiring small-scale structures or detail site survey to avoid real embankment breaching problems. This information is not available at this pre-feasibility stage.

The planning process and approach has focused on a project by project design and analysis, as though these would be somehow divisible in terms of their costs, benefits and impacts. However, this is not the case for many potential impacts which accumulate with each additional FCD(I) project. Thus, not only are project links to other sectors essentially indivisible, but also the linkages between projects themselves.

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CHAPTER IV.2

PLANNING AND ASSESSMENT METHODOLOGY

IV.2.1 Study Organisation

The SERS environmental planning and impact assessment has been broken into two phases in the way the inputs have been planned so far. This has allocated inputs for the pre-feasibility and feasibility stages. In practice, environmental assessment ought to involve three phases:

Stage 1: Pre-Feasibility and Regional Planning

During the pre-feasibility and preliminary regional planning stage an initial environmental evaluation (IEE) is conducted of the conditions in the region and how these affect, or will be affected by, planning options for water resource development. This assessment starts with a generic analysis in this annex by mode of development, rather than a project specific approach. This analysis screens and scopes all issues and impacts to identify those key areas of policy and strategic importance. In the main report only key issues for specific projects are identified to assist in the project ranking exercise to help select projects to go through for feasibility study. Once a list of likely projects is available the linkages of the whole proposed plan should be appraised by a systems analysis and regional planning approach.

Stage 2: Feasibility Planning

Once projects have been selected for feasibility study the first stages of a more thorough environmental impact assessment (EIA) will be carried out on each project to appraise the impacts of the alternative options and to look more closely at some of the issues related to construction, implementation and regional planning implications.

Stage 3: Detailed Design, Contract Preparation and Tendering

The EIA process should continue into the detailed design phase, as more data from primary data collection and planning details become available, and as the downstream implications of other FAP projects become clearer. In practical terms, this is the most vital stage for these inputs. It is only then that the specific details of actual structure location, resettlement needs, impact areas, construction and contractor operations, and operating criteria become known. Many environmental aspects should be dealt with and specified in detail in the contract documents, and specifically planned for the tendering, the remaining pre-construction and construction activities and support facilities. Typical specific areas that are usually priority inputs for this stage include among others:

- detailed land acquisition, compensation and resettlement surveys and programmes

- detailed planning of construction operations and facilities to avoid environmental impacts and contractor short-cuts (including public health needs and planning for construction camps)

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- detailed planning and specifications for site works and restoration

- undertaking final baseline surveys and setting up of environmental monitoring programmes.

These inputs are now standard requirements in many other developing countries and are likely to become so in Bangladesh. This matter will have to be considered before the feasibility planning phase proceeds too far.

IV.2.2 Environmental Assessment Methods

The IEE methodology follows a conceptual approach similar to an EIA. At this pre-feasibility stage, and also because the inputs of the environmentalists came before many projects were sufficiently designed to analyse, the aims have been to screen and scope for impacts associated with FCDI interventions in general. Only later, as completed designs and operating specifications on each project became available, could a project by project assessment be carried out, using the generic analysis as a reference base. This project work had to be carried out by the local environmentalist alone. In each case the reference to this generic analysis has questioned the validity of the ranking, given the individual circumstances of each project area and the interventions proposed. In some cases this can lead to a re-assessment of importance that differs from that shown in the generic analysis.

There were insufficient resources and time available to allow a proper analysis of these implications by a full systems and regional analysis of the final basket of projects selected for future study. However, the methodology adopted, which involved a general analysis of all potential impacts, does provide insights to rank issues in future policy on project design and implementation. It also aided the planning of a regional environmental management programme, albeit with an extremely limited data base, a lack of knowledge about specific projects and with the limitations discussed in the previous chapter.

The approach first considers the impact of the status and condition of the existing environment as it may affect any part of the overall planning. Then, the impacts which the various FCDI interventions may have on the state and condition of the future environment are assessed during the pre-construction, construction and post-construction periods. The impacts during the operational period could occur anywhere in the short, medium or long-term planning horizons. Mitigatory measures are identified to overcome inevitable adverse impacts, as well as planning options to avoid any irretrievable and unacceptable losses. The approach also highlights the complementary measures required in other sectors to ensure the water resource proposals can achieve their objectives. Environmental monitoring and training needs for improved environmental management are also identified.

The screening and scoping for the planning strategy and project options looks for both beneficial or adverse effects. This evaluation is holistic and tries to identify linkages across disciplines and sectors. Any potential implications were immediately fed back to the planning team from the start of the planning process, rather than simply identifying them at the end of the analysis. Linkages can occur between any of the physical, chemical, technical, social, economic and ecological systems. Ranking the scale and importance of processes has proved difficult due to the limited data base, the complexity of the floodplain environment in its totality and given the problems discussed in the previous chapter. The evaluation has had to rely heavily on professional judgement following discussions with the other team members and other specialists.

The impact assessment methodology has tried to ensure:

- A rigorous presentation and ranking of all identifiable positive and negative impacts, but with an emphasis on key issues which would potentially downgrade or eliminate projects from the selection process or require special consideration during any feasibility study

- An assessment of the benefiting and vulnerable areas affected by interventions, whether human or other species, their habitats, or the different geo-physical or economic, social, and ecological processes on which sustained productivity depends

- An assessment of whether the hidden costs, externalities and multiplier effects, which are not normally taken into account in individual project analysis can, in practice, be dealt with at this stage in the planning cycle in a meaningful way.

The detailed approach required the planning team to jointly identify a comprehensive checklist of potential areas of impact. These were initially compiled through ***a priori*** reasoning, examination of existing studies and ex-post evaluations, discussions with local people and officials in the study area. Reference was also made to other specialist institutions and government bodies. Cross-subject and inter-sectorial linkages were identified by a series of systems and network analyses. The checklist continued to be refined as the planning progressed.

The checklist can employ a variety of classification systems. Each has its usefulness, as long as it encompasses all potential areas of concern. The breakdown used was based on six inter-related systems reflecting the living and non-living environment; these being: physical, socio-economic, biological and ecological, quality of life, and externalities. Externalities are those influences which often are not possible to incorporate directly into the planning process but, nevertheless, may have a unpredictable influence on the viability and sustainability of the proposals. The final checklist, systems and network analysis formed the basis of the discussion and impact analysis which follow.

The impact analysis looks for the following chain of events:

Monitoring

↑ ↑ ↑ ↑ ↑ ↑

Existing environmental status → Intervention → Response → Impact → (Feedback Loop) → Future environmental status

↓

Vulnerable Group/Area

↓

Mitigation Proposals and Complementary Programmes

The initial physical responses and their resultant social, economic or ecological impacts might have a number of levels. These are often referred to as primary, secondary and tertiary, or as direct and indirect. This terminology can be misleading, as the end result from a chain of response and impacts could be of major importance. It could even outweigh the significance of a primary impact found at the beginning of the chain. It is sometimes difficult to make a clear distinction between responses and impacts, as this depends on the type of process involved.

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The linkages identified can become complex and frequently involve feedback paths (in chapter 3 see Figure IV.3.2). They can affect different socio-economic groups in different ways. What were initially positive changes might reverse into negative impacts or change their intensity over time. Wherever possible, the benefiting and vulnerable groups have been identified. As the number of variables directly associated with a particular feedback system increase, trying to identify direct cause-effect relationships can be meaningless. It is an understanding of the overall process and the development of measures to manage the impacts which is more important.

Reference was made to a number of existing network analyses prepared for the Jamuna Bridge and National Minor Irrigation Development project (Huntings Technical Services, personal communication, and Environmental Resources Ltd, May 1990) and others assessing FCD interventions through MPO studies. In view of their extended nature, the detailed network analyses have not been presented.

The assessment assessed a number of impact features, such as their magnitude, duration, intensity, frequency, scale and cumulative nature, and chain or multiplier effects, and whether the impacts are reversible or not. It also considered the sensitivity, resilience and stability of the environment affected and whether the interventions or mitigatory measures are likely to affect whether local survival systems would be sustainable. At this, pre-feasibility stage, and given the dearth of data, these assessments are necessarily limited, based on professional judgement and not always possible to complete. The large number of process-orientated and qualitative factors involved make it more of an art than a science. The assessments provided are meant as a basis for critical discussion and to raise awareness of certain key and critical issues.

The general impact analysis has had to assume that the maximum number of interventions will be implemented. In parts the analysis inevitably makes broad generalisations which, for a specific project, might be found deficient or redundant. This could be due to varying responses, for instance, in topography, morphology, soil types, social groups and habitats, among others. These complexities can only be dealt with at the feasibility study stage. Alternatively it would be for other research bodies to tackle. The object here is to flag important policy issues.

The first stage separated the checklist into two categories of impact. First, major issues which could affect the strategic selection or rejection of projects or which affect design criteria. These impacts were subject to a series of key questions as listed below. Since a considerable number of impacts were identified impacts have been grouped wherever possible. Second, those less important impacts, which would still have to be dealt with at feasibility level or through other complementary programmes. These were not put through the list of key questions, but simply listed, together with their vulnerable groups, mitigation and complementary programmes.

The analysis details are given in Appendix I and follow the format below. This has used a number of qualitative answers to questions which it is difficult to define in such a way that they would be totally unambiguous. In the analysis "critical" has been used to denote three categories of potential problem for the ranking and future consideration of problems.

- Problems which would lead to projects being rejected even if they proved economically viable:

- Problems which are so important that the basic design concept should be re-assessed or special priority given to mitigatory and complementary measure. This would also affect the ranking of project in the multi-criteria analysis.

- Problems which, while they may only affect a small proportion of a total population affected by the project, would affect one group so critically as to undermine or remove their means of survival. This category would be specifically noted to address in the feasibility planning.

"Notable" has been used to identify the next most important group of problems areas which should be individually listed in the terms of reference for the feasibility study and adequate time and resources provided to ensure that these issues can be adequately planned for or mitigated at that stage.

"Negligible" has been used to show the remaining group of issues where change due to the project is likely to occur but at a relatively minor level. While these features need to consider in future planning they would not be given the emphasis of the two categories above.

For the questions on duration there are some impacts that would only last a discrete period of time, i.e. some construction impacts. This would be measured in a matter of up to a few years. Other impacts would create a disturbance to a system which would again be discrete and "phase out" over a period of time. This might be measured in period up to one or two decades. Other would lead to a indiscrete and permanent change which, may or, may not, be irreversible.

The Overall Evaluation of Impact: None - Negligible - Notable - Critical
Associated with either: - Flood Control - Drainage - Groundwater (GW)/Surface Water (SW) Irrigation or combinations of them

The key questions asked and the possible responses were:

1. Magnitude of impact likely: Negligible - Notable - Critical
   Asks the questions how many and how much will be affected

2. Intensity of impact likely: Negligible - Notable - Critical
   Asks the question how penetrating is the effect

3. Scale accumulation likely: Negligible - Notable - Critical
   Asks the questions how combinable or synergistic with same or other impacts

4. Duration of impact likely: Short - Medium - Indefinite
   Asks the questions how long and discrete

5. Frequency of impact occurring: Once - Seasonal - Annual - Occasional
   Asks the questions when and how often

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6. Effect of impact reversible: Yes - Difficult - No - Uncertain

Asks the questions can it be stopped and repaired

7. Resilience of environment being affected: Poor - Reasonable - Good

Asks the questions how adaptable

8. Effect on instability of environment: Increase - None - Decrease - Uncertain

Asks what response to disturbance

9. Effect on sustainable production (ecology/production systems): Improve - None - Decline - Uncertain

Asks the question what constancy will result in long-term productivity

Process: A short description is given of the process and linkages involved

Benefiting or vulnerable group/area being affected: The group(s) in society or the geographical areas most at risk are identified

Mitigation measures possible: Identifies the mitigation which could be directly combined into project planning and financing.

Complementary programme desirable: Identifies other areas where work and financial investments could be required. It is often difficult to rationally separate mitigation measures and complementary programmes and duplications occur in the two lists.

IV.2.3 Coordination with the Economic Analysis

Although the approach identifies the direct mitigation and compensation programmes, as well as the complementary programmes required (outside of water resources development), project economic analysis (as opposed to financial budgeting or analysis) does not normally attribute the costs of complementary programmes to individual projects. Usually the achievement of a project's primary objectives are not considered as being dependent upon these additional development strategies. Investments in other sectorial development programmes are assumed to be taking place simultaneously with investments in water resource development, and as part of a wider and integrated development approach. The environmental assessment highlights where other sectorial investments need to be sustained if the full benefits of the RWP are to be achieved.

The primary impacts of the RWP relate to changes in flood risk and the productivity of land, measured only in terms of increased agricultural crop biomass. Other quantified impacts will occur as a result of irrigation or flood protection, e.g. changes in land use, cropping patterns, and agro-chemical use. These are quantified in the preparation of the crop budgets and assumption built into the economic analysis. These will have further effects in the secondary processing, transport and marketing trades, in the patterns of consumer consumption and expenditure patterns, and also in the fields of nutrition and indebtedness. At the pre-feasibility level these are not assessed on a project by project basis, as there will be considerable differences in the scale of regional changes, depending on the type of project, the number of them and their implementation phasing.

At a local level, changes in the balance of different aquatic and terrestrial floral and faunal species and population levels. Such changes will be detectable in both macro- and micro-organisms. This will affect pest and disease levels and their economic impact. There will also be associated changes in the productivity of humans and economic flora. There will also be potential changes in the physical and chemical status of soils. It has proved difficult, and often impossible, to derive any reliable measure of the magnitude of these potentially quantifiable impacts, because of the paucity of data or knowledge.

There are other areas where quantification would, in any case, be difficult. In some cases, the adverse effects may only become apparent in the long-term, such as future costs associated with long-term accumulation of project induced pollution (i.e. increased pesticide use), the health costs induced by changed lifestyles, or the greater costs of flood damage in unusual events, such as earthquakes liquifying embankments. There are also cases where future development options might be foregone as a result of the selection of a particular strategy today. The main example would be the reduction in genetic diversity due to a loss of fish species attributable to FCD interventions.

There have also been difficulties in including any costs of lost benefits from impacts on the social and economic floodplain uses of local country boats. It has also been impossible to generate the costs and benefits of downstream impacts as these are too integrally linked to the complexities of how the various SER FAP projects, and FAP projects from other regions, will interact one with another in a yet unknown sequence and phasing of project implementation. Also, the ability of the hydrological modelling to deal with these questions in a timely and reliable fashion is still limited. It should be recognised that some of these impacts might be considerable, and may even be critical enough to reverse decisions on any particular project or phasing of them.

It was concluded that to attempt to include these items in the economic analysis would have been a matter of insupportable guesswork and could easily have clouded the first stage comparisons before considering these impacts. Thus, only qualitative assessments and ranking have been attempted. Nevertheless, some of these impacts are believed to be significant and should not be overlooked. It is these impacts which are taken through into the multi-criteria matrix analysis required by the Guidelines for Project Assessment. Other impacts are, in any case, qualitative and could not be quantified, even with an improved data base. They, too, are potentially important for the long-term sustaining of the productive resource base on which the RWP will depend. These are highlighted so that they can be taken account of in strategic decision-making, in conjunction with the criteria of economic efficiency.

One important strategic limitation imposed by the economic analysis is the underlying assumptions on society's preferences which are built into the reliance of monetary valuation of costs and benefits. Particular difficulties arise through discounting future costs and benefits back to present day values (which usually attaches less value to events and outcomes in the future than if they occurred today). For the types of issues discussed above the results of the economic analysis alone may not give the best guidance on important strategic decisions concerning the national interests overall. It is for these reasons that the range of impact assessments and economic analysis are complementary and have been specifically requested for the multi-criteria analysis of FAP projects. Together, they provide policy makers with an assessment which explicitly indicate the differing tactical implications and strategic trade-offs for the national interest of economic efficiency, social objectives and sustained long-term management of all environmental resources according to a set of standards.

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IV.2.4 Incorporation of Environmental Criteria into Regional Planning

The approach adopted by the IEE and EIA procedures introduce certain key concepts in a rigorous way which otherwise commonly have led to deficiencies in integrated project and regional planning. Many of the concepts are not new, their rigorous application through EIA procedures are new and poorly appreciated. The environmentalists have worked within the planning team to try to ensure that problems are not only mitigated but, where possible, avoided. This approach to problem solving was taken up at the earliest point in the identification of alternative strategies and projects. Once potentially viable projects have been ranked for selection through the multi-criteria analysis, the focus has shifted to identifying mitigation measures. In addition, complementary interventions in other sectors were identified which might be necessary to allow the project to achieve its objectives.

The approach has relied on circulating and rigorously refining a checklist of key issues. This has been complemented by frequent individual meetings with specialists and some formal team meetings to discuss key issues and consider ways of finding alternative strategies and projects to deal with them.

While the main planning focus has focused on increased rice production and efficient economic and engineering options, the IEE and EIA approach has constantly raised the need to not exclude on *a priori* grounds the following key features:

- Integrated resource and sectorial linkages

- Multi-purpose production objectives

- Sustainable development objectives

These criteria inevitably raise questions of trade-offs. FAP planning trade-offs would commonly affect rice production, the scale of engineering projects and possibly economic efficiency (given the valuation systems assumed). However, their inclusion is vital if strategies and project designs are to be found that are both economically viable, socially acceptable, politically implementable and ecologically sustainable. Optimality, therefore, can be measured either by achieving short, medium or long-term objectives.

The pressure of population, the food demands for rice and the current good economic returns to rice production, give priority to short-term strategies which may mask and contribute to the accumulation of problems for the future. A typical example is the move to mono-cropping of rice and the pest problems and crop losses that this encourages by providing an unbroken habitat for rice pests and diseases. This will demand much more intensive means of pest control than natural biological methods are likely to provide, if high yields are to be maintained in the short-term. However, any extensive move to costly chemical control methods will raise many issues of imported input supplies, farmer credit and indebtedness, as well as basic risks of pollution, resistant species, loss in species diversity and the loss of production in other sectors (mainly fishing). This, in turn, could raise the levels of future health problems and lead to increased public health costs, both in terms of loss of quality of life and labour productivity, and the need for special health training and hospital facilities to deal with the future pollution-related problems. Sooner or later, as has been experienced in countries elsewhere, the costs to Bangladesh of reclaiming degraded habitats, land and water resources can soon mount.

In spite of the pressing needs facing the food production and demand systems today, alternative production and environmental management systems could be considered as an integral part of the FCDI proposals. If they are not then ideas of sustaining human settlement and food production overall are likely to remain rhetorical and redundant.

The proper inclusion of future cross-sectorial cost:benefit flows cannot be adequately dealt with in a project by project economic analysis. Policy makers will have to give clear guidelines on how they wish such issues to be reflected in the forthcoming appraisal of feasibility study alternatives.

IV.2.5 Identification of Alternatives

In the vast majority of previous water resource development plans and projects few have been subject to a full environmental study. In most, alternative development strategies, institutional options or environmental resource management alternatives were rarely identified or analysed. Furthermore, little development was assumed to take place in the without project scenario. These deficiencies have been highlighted by a number of post-project audits and evaluations. The need for a more exacting approach to identifying and analysing alternative projects and strategies has been stressed in the formulation of the economic and environmental guidelines for the FAP studies. The incorporation of environmentalists in the FAP studies does give greater weight to the expectations of the national environmental policy in identifying alternative strategies which can deal with the growing environmental problems in the floodplains.

The main consideration of alternatives has been on the basis of different modes of development between different types of irrigation, through to drainage or different types of structural flood control measures, as well as various alternative combinations of them. Non-structural alternatives on their own have not been considered as one of the options, as this study is set up only to consider the viability of structural options and the strategic options of either FC, D or I to solving the supply side of food production problems. Non-structural approaches are the subject matter of other FAP studies and will be required, in any case, given that the design criteria for any FCD structure under the SERS either do not provide for, or else cannot guarantee total flood protection. Demand orientated strategies are also not considered, except as important complementary measures identified in the environmental assessment to accompany any supply-biased development strategy under the RWP.

The second consideration has been based on the scale of development. Thus, where physically viable, small projects were considered, as well as amalgamations of these smaller areas into large single projects.

The third consideration was based on multi-purpose production objectives. This examined the possibilities of integrating capture and/or culture fishery systems into water and agricultural development plans within particular project areas, as well as maintaining conditions and access for major and minor navigation. Similarly, in agriculture the possibilities of linking integrated pest management programmes with paddy production systems and integrating paddy fish and frog culture were also discussed in the team meetings. Engineering options were discussed to assess the type of structures and operating criteria which might maintain access of migratory fish species. This is dealt with further in Annex VII (Fisheries). Consideration was also given to maintaining habitats to protect the requirement of resident species. This was concluded to be best achieved through the identification of floodplain zones which could be protected from any structural developments which would affect water and flood conditions adversely as discussed below. All these discussions highlighted that planning suffers from

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limited data on the differing requirements of the large variety of species. The detailed appraisal is a subject for the feasibility level of analysis.

The fourth consideration arose from the evaluations of existing FCD. Poor drainage design, inadequate reclamation of borrow pits and lack of planning for micro-topography have meant that small-scale structures and/or flushing of embankment protected areas will be required to remove any build up of nutrients and pollutants in the water bodies and sediments. There is also a need to allow for the means of flushing out aquatic weeds. Accumulation of some pollutants in water can be managed through vegetative removal and management using aquatic plants, like water hyacinth. Removal of pollutants in the benthic sediments would need other approaches using rooted vegetation programmes.

The fifth consideration involved identifying where broader development objectives and environmental management criteria would identify specific areas for special integrated land and resource use planning and environmental management. This has included the potential conservation areas of wetland and migratory birds habitats, selected planning zones and monitoring areas related to industrial and agricultural pollution problems, and selected zones for forestry and livestock management. Consideration was also given to a zoned approach to maintain those areas, which currently are the most important open water fisheries areas, for a fisheries development programme without any structural intervention.

IV.2.6 Liaison and Public Participation

Close links were maintained with all the main institutions and other FAP studies concerned and, in particular, with FAP 16. Their guidelines envisage full public participation during the screening and scoping period. In the context of the pre-feasibility studies this approach has not been possible in any widespread or formal manner. The field work undertook a number of discussions with both local officials and selected groups of local people (including farmers, fishermen and landless). A number of group discussions were held in some thanas once the basic project alternatives were identified. This process should be possible to carry out in a more rigorous manner during the feasibility study stage.

IV.2.7 Photographic Records

Early drafts of the Environmental Guidelines request photographic records. No attempt at this pre-feasibility stage were made to compile a specific photographic record of project areas as it is not known which might be implemented. At the feasibility study stage a photographic record can be made of specific areas of monitoring interest. However, there is little point in compiling photographic records unless there is a proper archiving and retrieval system set up to allow them to be used for future monitoring. No such facility exists at the current time. The consultants will have to be advised as to whether either BWDB or the MOEF wishes such records to be taken and where and in what form these should be deposited.

CHAPTER IV.3

THE EXISTING ENVIRONMENT AND ITS INFLUENCE ON REGIONAL AND PROJECT PLANNING

IV.3.1 Conceptual and Analytical Models

The consultants were asked to provide conceptual models to aid qualitative understandings of the important impacts areas. Work on this was coordinated with group meetings with other FAP environmentalists and the systems analyst on FAP 16. The scope of potential interventions and the nature of the floodplain and delta environment of Bangladesh is a highly complex network of interwoven systems. It will take many years of basic data collection before the details of these linkages and inter-actions can be worked out to produce meaningful predictive models, either of a qualitative or of a quantitative type. This work has started and generalised systems can aid some aspects of environmental impact assessment.

Figure IV.3.1 provides a highly generalised framework of nested feedback system that represent the macro and micro structure of the environment. It encompasses large and small magnitudes of time, scale and processes responsible for the present status and condition of the environment. The planning process in the regional study necessarily has a confined perspective, restricted mainly to observation of localised regional events and limited time series data. The influence of macro processes involving solar, planetary and stellar forces are still not well understood, unpredictable and yet easily overlooked. Some macro processes do play a direct role in determining the hydrological and morphological characteristics of the active delta of Bangladesh. These factors mainly have strategic implications in the contingency planning.

The early systems analysis developed a number of general charts as visual aids to raise awareness. An adapted version of the main system chart is given in Figure IV.3.2. To the general reader these charts immediately appear confused and unhelpful. However, they need time and consideration for their insights to become apparent. As there will be some readers, particularly amongst those undertaking environmental studies, who will wish to follow this thinking through, these are presented as being valuable.

These generalised conceptual frameworks only indirectly help the practicalities of regional water resource planning and impact analysis and can only be meaningfully applied when a known set of FCD(I) interventions and data on the local environment is available. These types of models, while identifying linkages, say nothing about the scale or significance of the particular linkages and possible impacts. For this approach far more detailed models and indicators are required.

The surface water and groundwater models are discussed in Annexes V to the Interim Report and Annexes V and VI to this report respectively. Models to assess changes in morphology are being developed under FAP 24 and results were not available at the time of writing. These only deal with the possible systems of the main river channels and do not address the effects on the floodplain or major or minor tributaries. No direct modelling is being carried out on tectonic, seismic or climatic change. However, the available international database has been referred to in assessing the possible implications of the dynamics of these systems on the RWP and its planning horizons. This is discussed further in section IV.3.2.1 below.

Figure IV.3.1

Environment as Nested Systems

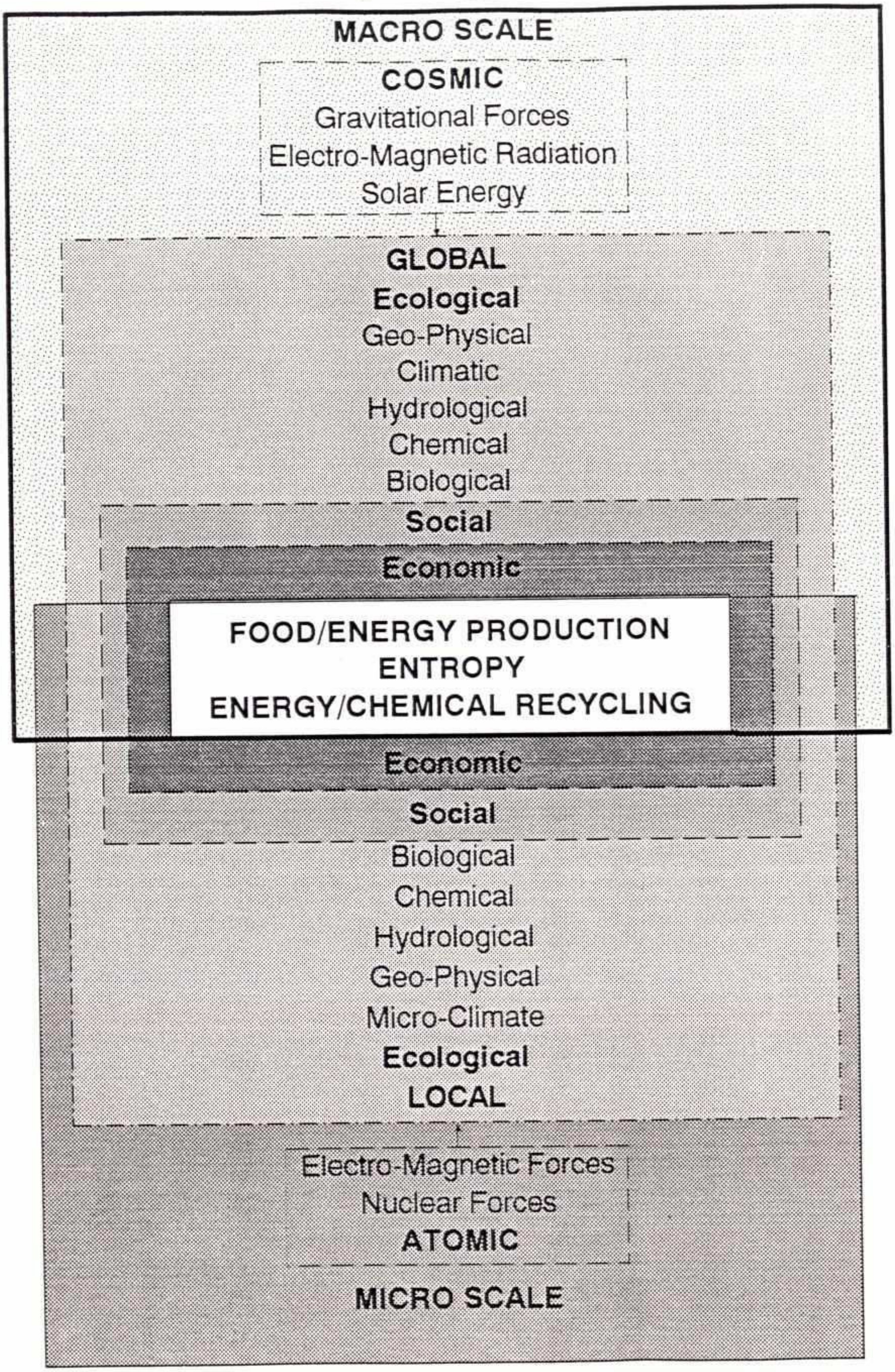
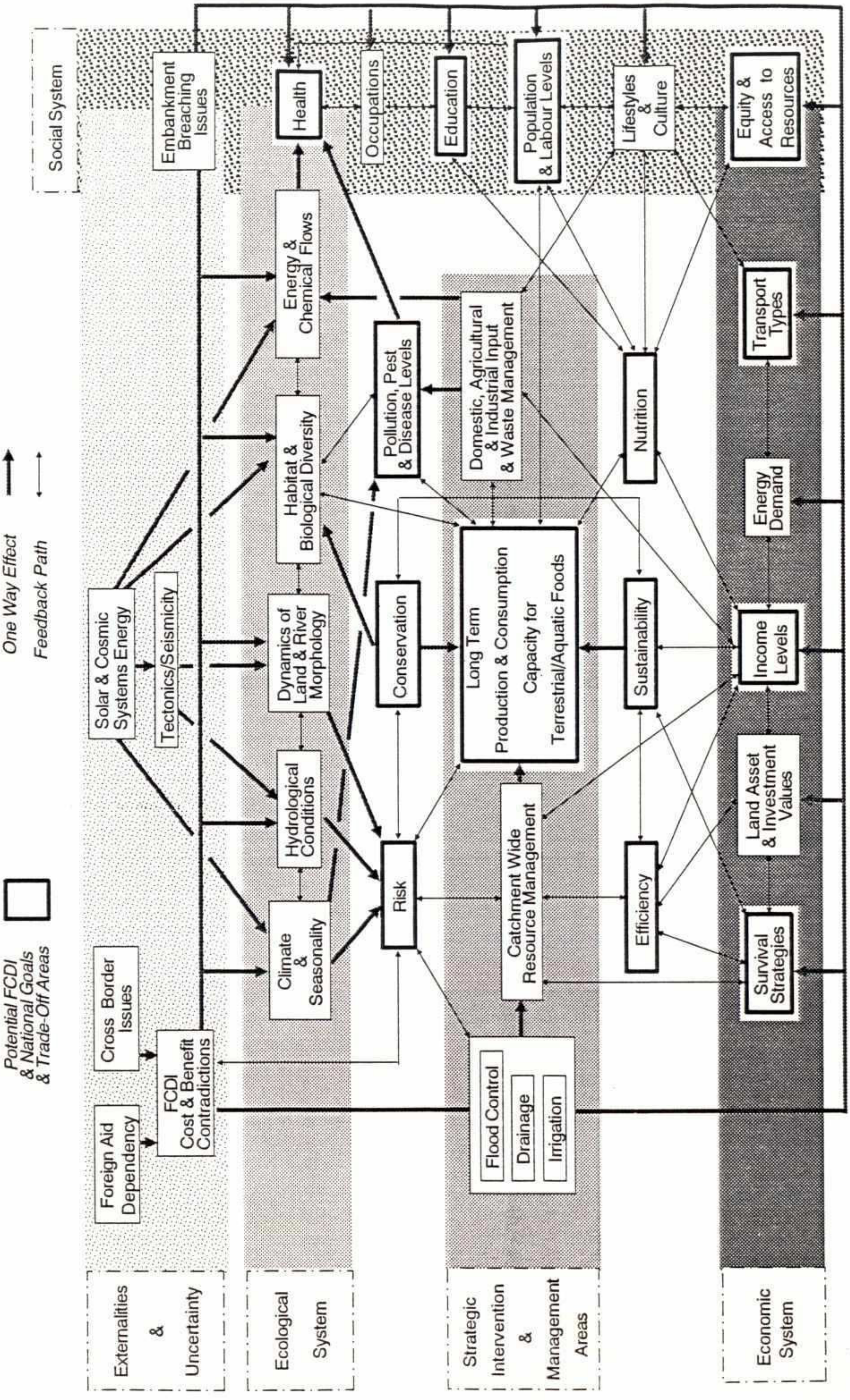


Figure IV.3.2

Simplified Systems Analysis of FCDI Interventions, Linkages and Trade-Offs



Analysis to identify changes in social and cultural features is based on past experience and knowledge of the socio-political framework of how resources and access to resources is organised. Models of human, wetland and field ecology are poorly developed because of a lack of data and previous work in Bangladesh, although some limited information on soil and crop ecology is available through the work of the International and Bangladesh Rice Research Institutes (IRRI/BRRI).

Models were specifically requested for the ecological structure and biological diversity of the haors, beels and streams in the region, to aid the impact assessment on open-water fisheries. Without basic primary data on the species structure and trophic relations in the different systems, it is not possible for this to be prepared. However, the general nature of these processes is known from general freshwater, estuarine and marine ecology theory. Visual systems diagrams for this are available in a number of standard references and could be presented during the feasibility study stage if required. Descriptions and analysis of the fisheries systems in the SER are given in Annex VII.

IV.3.2 Physical Environment

IV.3.2.1 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 impacts assessment:

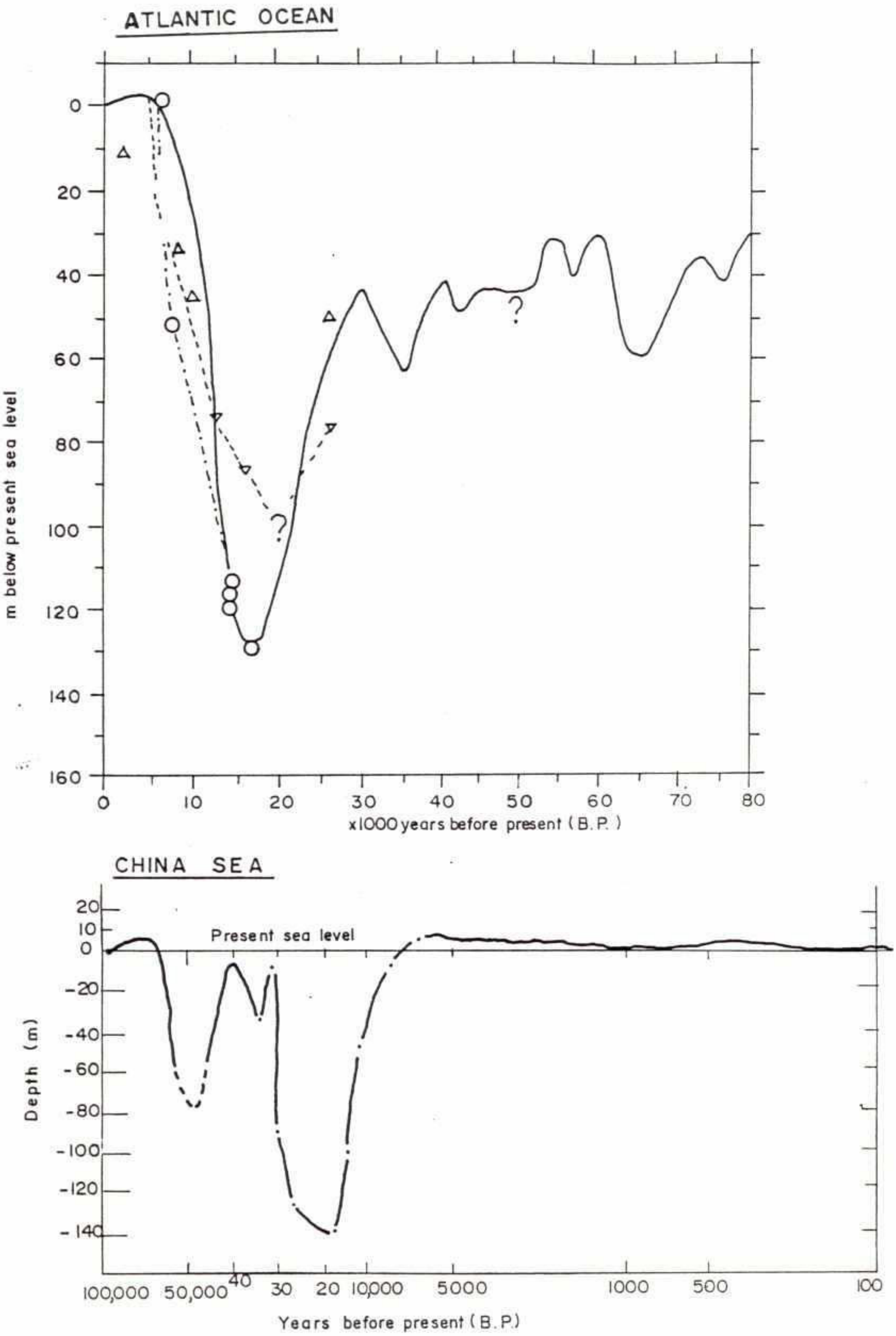
- Above average events which exceed the design criteria, but do not lead to structural damage.
- Extreme and catastrophic events that will need emergency measures and consideration of both structural and non-structural contingency plans.
- Changing global climate patterns that will affect the base conditions of the existing situation and on which the design criteria for projects have been designed.

The events which exceed the design criteria will impinge on the viability and designs 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. Methods to include these various costs have not been included in the economic analysis. The most serious problems 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 implications of analysis of historic data series on global climatic change do 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 horizon. Figure IV.3.3 gives indication of the data on historic changes in sea levels and Figure IV.3.4 gives indications of the coastal areas which would be flooded by a sea rise of 1 meter 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.

Figure IV.3.3

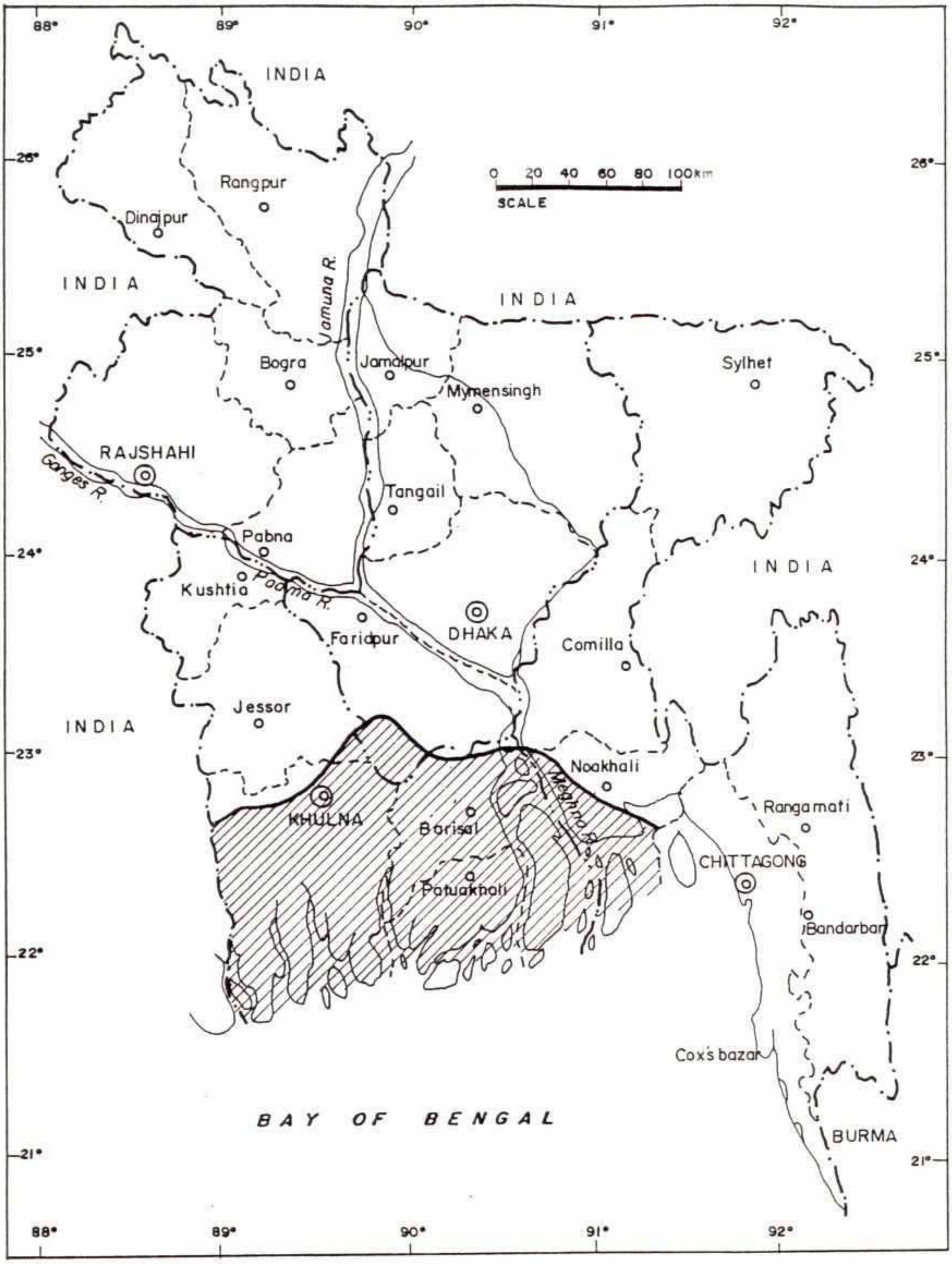
Historic Changes in Sea Levels



WATER RESOURCES DEVELOPMENT PROGRAMME
SOUTH EAST REGION

Figure IV.3.4

Areas Likely to be Inundated Due to Sea Leavel Change by One Metre



WATER RESOURCES DEVELOPMEN PROGRAMME
SOUTH EAST REGION

IV.3.2.2 Influence of Aerial Pollution

The present levels of rural aerial pollution are low in Bangladesh but output from industrial areas is growing and there is very little data available on which to make any assessment of its significance. Global aerial pollution is of far more significance as a factor potentially affecting climate and future hydrological conditions. The RWP will not inter-act with the existence of gas fields in the area in any way that would increase aerial pollution problems from gaseous emissions.

IV.3.3 Land Resources

IV.3.3.1 Landscape and Geological Processes

The basic geology, seismicity and tectonic characteristics of the area is described in **Annex V**. The SER lies within an active seismic zone which has been classified as of medium risk. For any major engineering structures design standards ought to take these into account. The design of embankments is less amenable and the risks of liquefaction or breaches from collapse in the events of a major seismic events in the area have to be allowed for in the non-structural preparation and contingencies plans for all areas protected by embankments.

The landscape of the SER varies in altitude from the Lalmai Hills (30 masl) and the base of the Tripura Hills (7-8 masl) to the banks of the Meghna (1-2 masl). The height variations of the floodplain vary between 1-5 masl. Tidal effects along the coast are generally up to 2 m above mean sea level, while on the floodplain these effects are generally masked by the depth of river flooding. The depth and seasonality of flooding from the various sources of sea, river and rain are the primary influences which determine the types of ecology, settlement patterns and land use found in any particular area. The nature of the topography, hydrology and morphology is complex and dynamic. This produces the similar levels of variability and complexity in the ecology, settlement and land use patterns. These create considerable problems for planning, particularly at the pre-feasibility level when broad generalisations necessarily have to be made.

IV.3.3.2 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, nutrient deficiencies and organic matter 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. Where they have been used settlement, subsidence and erosion of organic matter materials leads to breaches. Similarly very sandy soils are also unsuitable as an embankment material due to the rapid passage of water through them. Breaches have also occurred through inadequate screening and rejections of these

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embankment materials. This is mainly a matter for proper site supervision and contractual controls in the drafting of contracts which should be addressed in the detailed design phase.

IV.3.3.3 Landscape Value

Value systems which lead to significant appreciation of the aesthetic value of the landscape are not to be found generally amongst local people. However, the nature of the landscape is integrally linked to lifestyles and an local appreciation and dependency on them. 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. If taken to their fullest extent, these interventions are likely to reduce the range and diversity of habitats, unless the proposed range of integrated planning and mitigatory measures are adopted as part of the FAP planning approach.

IV.3.4 Water Resources

Surface water resources, hydrology and morphology data, monitoring and modelling details are discussed in Annex V of the Interim Report. This is the main focus of the overall study and is not commented further here.

Groundwater resources are also a major component of potential development are discussed in depth in **Annex V**. The main observation is the limiting factors of salinity in the coastal belt for shallow wells and still poorly defined areas inland where salinity in deep groundwater is a limiting factor.

Domestic water supplies are taken from a number of sources and, even when tube wells have been installed, surveys have found that families continue to use a variety of other surface supplies, either for drinking water supplies, but more commonly for other uses, such as bathing and washing.

IV.3.5 Water Quality

Pollution of shallow groundwater has been identified in some areas. This is of concern for the extended development of FCD, FCDI and I schemes particularly where there is also the growing use of fertilisers and potentially dangerous agro-chemicals. There is a great deficiency in the data base for assessing the regional problems of water quality for potable and other uses. From groundwater there are some cases of iron and bromide problems which have been recorded. For surface water sources the main risks are from industrial pollution, agro-chemical pollution, eutrophication in stagnant pools, low available oxygen due to enrichment and pollution with sewage and waste effluent, and the health risks from poor sanitation and drainage conditions, both inside and outside FCD schemes. Considerably more survey and monitoring work is required to make proper regional or project planning responses to these problems. The needs for monitoring and surveys are dealt with in Chapter IV.6.

The SER has as its southern border active coastal and estuarine environments. Water quality and hydrological interventions will have direct impacts on the quality of water and the resultant impact on local ecology. Considerable research on these areas has been undertaken by the Land Reclamation Project over the last two decades. There are khals and rivers emanating from the SER with locally important estuary systems, in addition to the major significance of the Meghna estuary.

IV.3.6 Biological Environment

IV.3.6.1 Habitat Types and Importance

The ecology of the SER (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 IV.3.5 and include the sites discussed below. Figure IV.3.6 shows the main general locations of bird and fishery uses.

Coastal and Estuarine

The coastal habitats bounding the SER are very recently formed and still active. They are characterised by active mudflats and unstable low islands with high levels of seasonal silt accretion and erosion which lead to seasonally turbid waters. As a result, as found by surveys carried out by MPO and the Land Reclamation Project, these areas are found to be very low in species diversity. The mudflats 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. The estuaries are affected by both siltation and structures. The Feni and Little Feni estuaries have regulators and silt up below the structures. The Noakhali Khal is blocked with sediments but unregulated. The Daria river is closed with a cross dam under the Land Reclamation Project but was damaged by the 1991 tidal surge accompanying the disastrous cyclone. The Bagger Dona is open and very influenced by the close proximity of the Meghna estuary.

The Meghna estuary has very different characteristics due to its size, major nutrient inflows from all the main rivers of Bangladesh and its role as the main migration route for migratory fish species. It will be very important for FAP to consider overall impacts of the regional plans on the ecology, productivity, morphology and economic value of the Meghna estuary. This will be important, not just because FAP projects may adversely affect this estuarine system, but also because there could be considerable problems of salinity intrusion up the Meghna, which could affect projects in the south-east and south-west regions. This will need careful study and monitoring, but is outside the scope of the SERS.

The need for afforestation programmes to stabilise the coastline and help create high productivity systems based on mangroves, with all their potential major benefits for cyclone protection, are also beyond the scope of the SERS.

Figure IV.3.5

Main Habitat Types

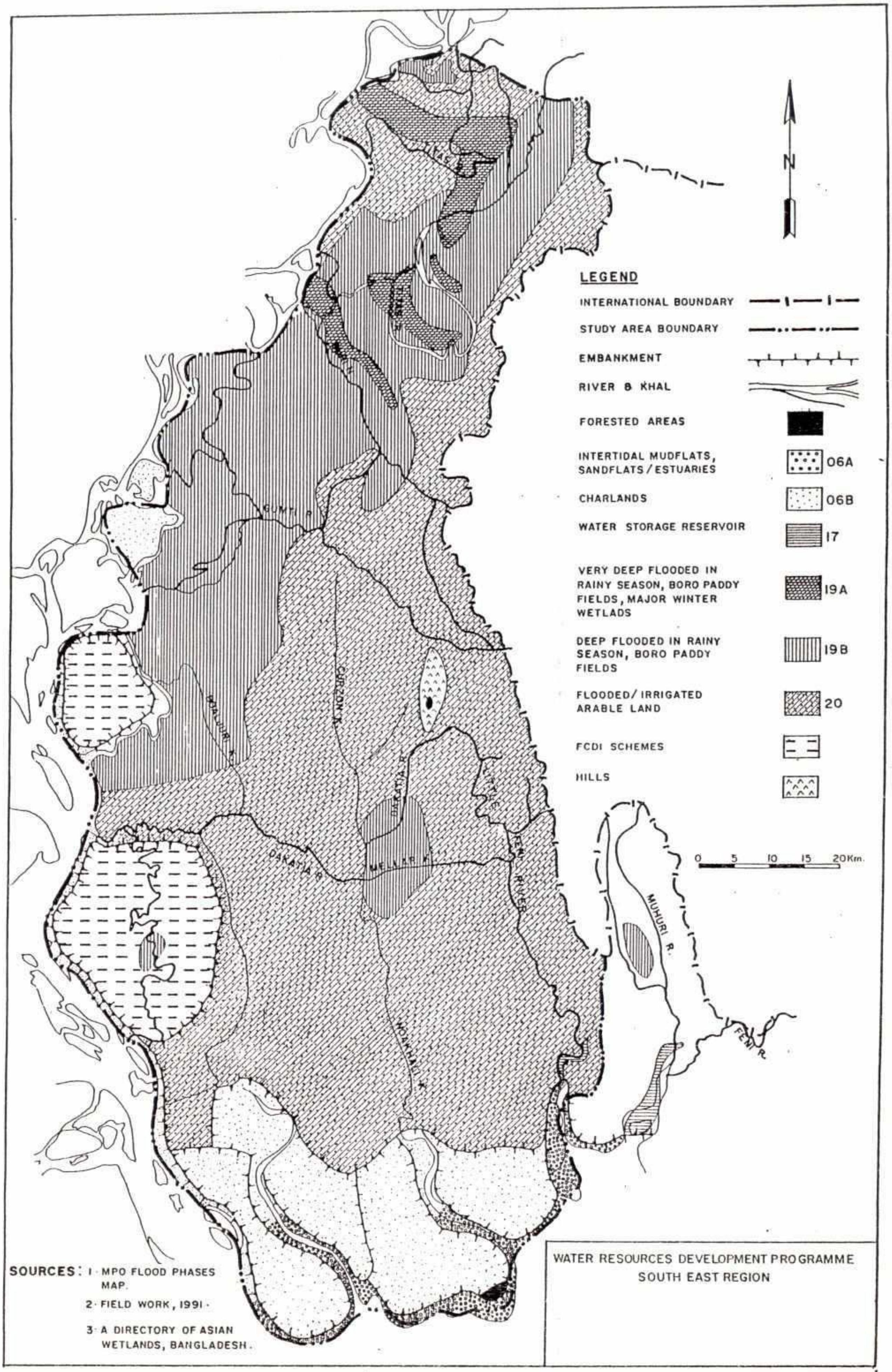
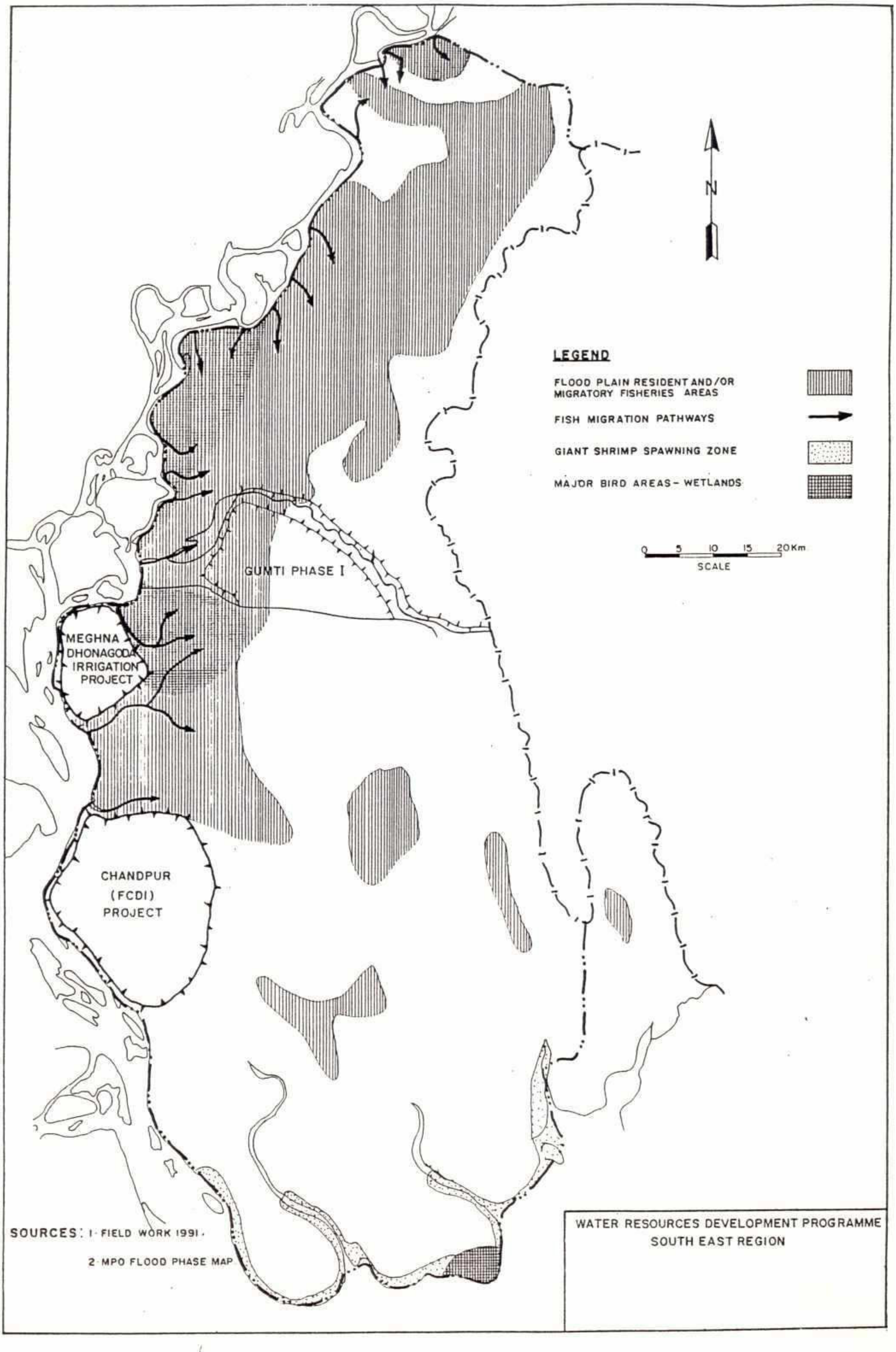


Figure IV.3.6

General Location of Bird and Fisheries Areas



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Subsequently these charland become an important habitat for wildlife including birds.

Charlands

Both actively forming, recently reclaimed and old charland are the main feature of the southern Noakhali area. Each of the types of charland have distinct differences in the succession of natural and management vegetation, settlement patterns and land use that are to be found in these habitats. These have been the subject of considerable research under the Land Reclamation Project. Actively forming charlands are mainly under natural forms of floral and faunal primary colonisation systems. As they stabilise a politically and socially insidious form of human 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. These areas may have significance in providing potential land resources for the resettlement of people affected by any FAP projects in the SER.

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 development 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 ecology, health and productivity of the field ecology which surrounds the homestead, as well as the ponds where aquaculture and a range of other facilities are provided for washing and bathing. 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.

Wetlands, Lowlands and Water Bodies

The whole planning area of concern to FAP falls under this category. The IUCN, the Asian Wetland Bureau (AWB) and the MPO have used a number of different sub-classifications to distinguish between various characteristics of these areas based on landscape types, flood depths and agricultural use. 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.

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Two types of water body habitats can be distinguished - natural and man-made. The natural systems include the intricate network of perennial and seasonal drainage channels which contain a wide variety of differing aquatic environments and ecologies (the river channels, the beels, khals and floodplains). The man-made areas include the ponds, borrow pits and impeded drainage areas in low-lying ground which are affected by structures for roads, railways and FCD(I) projects. These too exhibit a wide range of different ecological, social and economic features.

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 IV.5.

Field and open country

The main agricultural areas virtually coincide with the wetland and lowland areas described above. Some higher dryland 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 dryland, 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 in the fields, in the 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. These have impacts which can occur locally, across schemes, and outside to downstream areas. The system is integrated with indivisible linkages across space and time and is already managed by human decisions. The linkages are discernible in any field of study, whether physical, chemical, biological, social, political and economic. 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 IV.5.

Hilly lands

These areas are not part of any FAP study and are being dealt with under NEMAP planning. Nevertheless, there are again probably important ecological, physical, social and economic linkages to the floodplains of which little is currently known. These issues have not been considered further.

Forested Areas

The SER once was covered in a dense network of dryland 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 Comila. The coastal management programmes have developed some sites of afforestation based on mangrove and acacia species. These have not formed a part of the planning criteria for this stage of planning. If the final selection of projects will interact with these areas, these will be studied in more detail.

IV.3.6.2 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 SER 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.

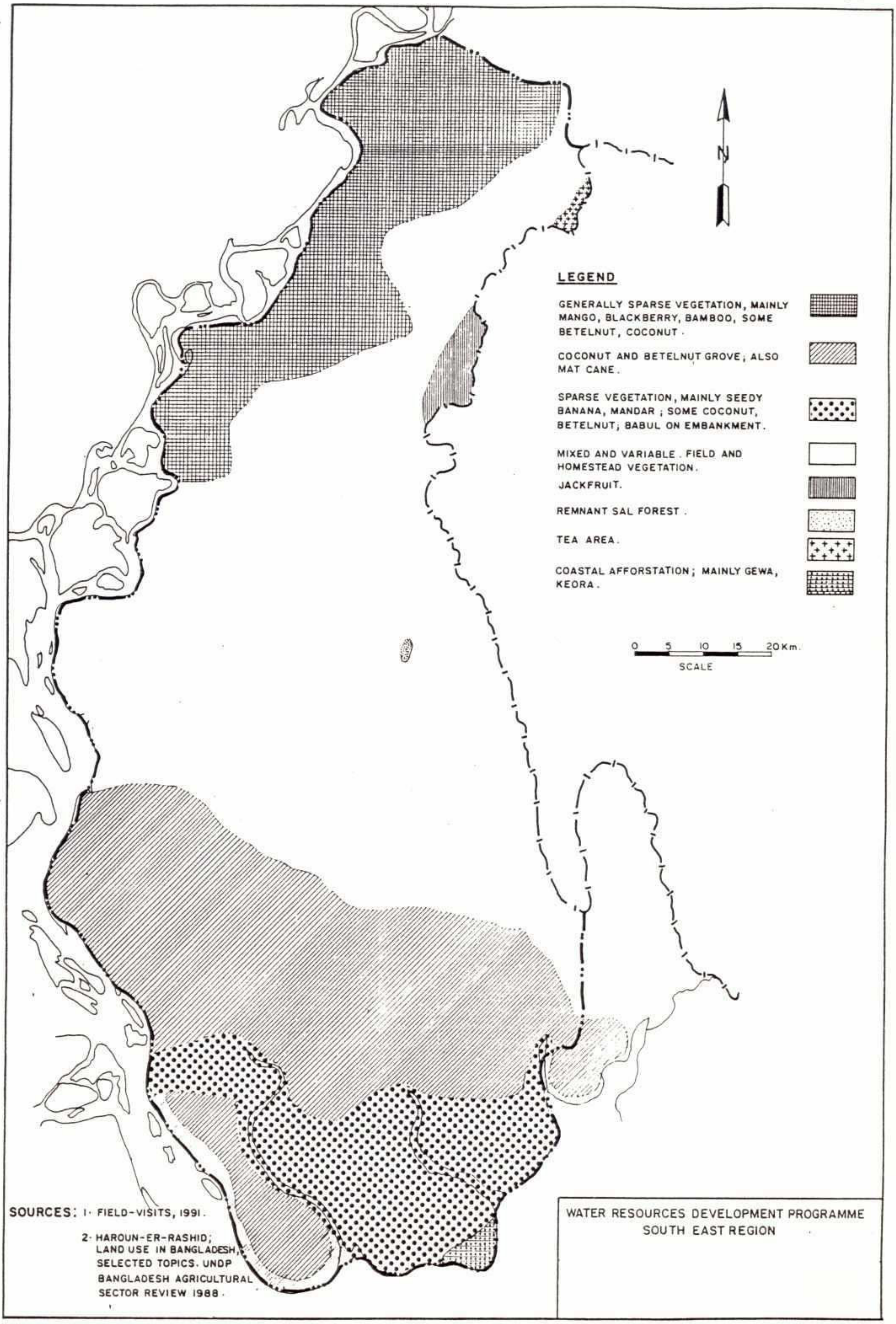
The IUCN Red Data Book of remaining endangered species is not area specific, neither are most of the other easily available data sources which allow an appreciation of the general levels of species diversity. The study was not able to carry out any original field work to confirm the current local situation. For the time being, the general references have been used to give an overview. In most cases the information presented refers to Bangladesh as a whole. Since the FAP interventions will involve national linkages and implications this preliminary national overview is believed useful. Appendix B provides a list of rare faunal wildlife. Appendix C gives the tentative list of threatened vascular plants. A list of birds and their habitats found in the SER was available and is given in **Appendix D**. Information on amphibians and reptiles is given in Appendix E and wetland mammals in **Appendix F**. None of these lists can be regarded as complete, as relatively little detailed field survey and identification has been completed in recent times in most areas of the country. Those species dependent on the habitats which will be directly affected by FAP interventions are the most vulnerable. This includes the water bodies, wetlands and lowland shrub and grassland. Provision for field survey in the feasibility study stage is vital if proper analysis, comment and planning is to take place on the whole areas of impact and inter-action involving the local flora and faunal ecology. Important

Flora

A general indication of distribution of the main vegetation types is given in Figure IV.3.7. The SER can be divided into four major and three minor zones in terms of dominant vegetation and cover. This map is based mainly on tree crops and indicates the main regional distribution of types according to various limiting factors, such as soil types, historical and current salinity in the coastal zone, depth of flooding or topography. 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.

Figure IV.3.7

Distribution of Main Vegetation Types



At the more detailed scale of mapping there are important variations in habitats were differences in species composition are important. The most important distinction would be between the aquatic and terrestrial species as indicated in Appendix G. These different habitats would include river banks, permanently waterlogged swampy and marshy ground, seasonally waterlogged marshy ground, cultivated fields, uncultivated field borders and sides of embankments, stagnant ponds and standing water bodies, flowing minor drainage channels, the major flowing streams and river channels, the estuarine and coastal mud and sand flats, and the varying degree of saline soils found in the charlands.

It is not known out of the 5 000 species in Bangladesh how many are to be found in the SER or the full ecological and economic significance of the diversity of the remaining natural flora. The predominance of the cultivated crops and tree crops means that the landscape across the majority of the area are primarily of economic significance. Whether there are any endangered species which could be affected by the SER 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 exists between these different habitats areas in providing habitats suitable for pests and diseases. The changes which FCDI can bring about will have implications for the ecology in the homesteads systems, the field systems and most importantly on the species composition, trophic relationships and inter-actions of species and nutrient transfer from the wetland and natural floodplain flora and micro-flora into the new agricultural systems under FCDI.

Birds

The birdlife of Bangladesh occupies a very important position in the worldwide avifaunal distribution, and particularly in South and Central Asia. The 660 species recently definitely recorded in Bangladesh represents about 50 percent of the South Asian species and just more than 7 percent of the globally known species. The reason for this is the unique geographical position of Bangladesh between the different bio-geographical regions. Of these there are some 220 which are migratory and 170 which are associated with wetlands. Over 70 of the water fowl are now rare or rarely seen in Bangladesh. There are 71 resident and migratory species which have been definitely recorded in the SER. Of these, four are internationally important as the numbers only in Bangladesh are significant.

The wetland and coastal habitats are of importance for the migratory birds, particularly of northern Asian origin. These include two type; those that over-winter in Bangladesh; and those passage on route west 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 come 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 mudflats. The main important habitat areas are shown in Figure IV.3.6.

Of the four significant international species the Lesser Adjutant is dependent on the wetland habitats, while the Spoon-billed Sand Piper, the Green Shanks 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

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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.

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 the through to the 1970s. The loss of habitats has been so significant that little can now be done to restore the balance in the areas. This study does attempt to highlight the few last remnant systems which need urgent consideration and planning for conservation under FAP. The focus of current attention has shifted to the remaining forested and hill tract areas and to the Sundarbans.

The few mammals which remain in the SER 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. The role of rats in creating a network of burrows in embankments has been directly associated with creating erosion routes for drainage water and destabilising them leading to breaches. This has been noted in the Meghna Dhonagoda project.

Amphibians and Reptiles

19 species of amphibian have been recorded in the country which includes 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 an important role as predators on field pests. Research in BRRI has found this 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. These issues were raised with the agricultural planning team, but little serious attempt was made to include this as an alternative at this pre-feasibility stage of planning. These issues need to be taken up more seriously in the feasibility stage and evaluated more rigorously in the economic analysis.

There are 150 reptile species recorded nationally, including 31 turtles and tortoises. 24 of these are freshwater species, four are marine species and three are terrestrial. There are three species of crocodile of which one is found in saltwater and two in freshwater. There are 18 known species of lizards and skinks, and 78 species of snake.

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.

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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. In the 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 the FAP 12 and previous evaluations.

Fish, as well as crustaceans are sensitive to contamination of their environment, and are thus good indicators. The outbreaks of Epizootic Ulcerative Disease since 1988 has not been definitively researched or understood. But, like some cancers in humans, may be associated with background disturbances in the food web, low thresholds having been crossed in water pollution which are difficult to detect by simple causal-effect analysis, and a general increase in the level of environmental stress caused by pressure on habitats and lifestyles.

Figure IV.3.6 shows some of the more important fish habitats areas in the SER. A number of discussions took place amongst the planning team to identify means of mitigating losses in FCDI interventions. In the environmental zoning plan given in Chapter IV.5, specific areas for protecting the open water fisheries and recruitment systems are identified.

Crustaceans and Bivalves

Both marine, brackish and freshwater crustaceans have a long history of extensive exploitation in Bangladesh which has seriously depleted stocks this century. There are 20 species of freshwater prawn, 11 species of marine crab and four freshwater species. There are also a minimum of 10 marine and freshwater bivalves. The potential economic possibilities of crustaceans are discussed later in Chapter IV.5. The pink pearl culture has a distribution which includes Brahmanbaria and parts of Comilla. Traditional the Bede people are associated with their collection and sale. A few of these groups are to be found in the SER dependant on this economy. The degree of impact of FAP on this economic culture could not be determined. The numbers involved are small and it seemed likely that no project under the SERS would affect the main production areas. These are more likely to be at risk from other sources of urban and industrial pollution.

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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 the 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, has great value in the issues of pollution, bio-diversity, pest and disease control and maintenance of soil fertility, amongst others.

Micro Flora and Fauna

The primary basis of the food 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 catchment 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 food 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 haver 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.

Until there can be some concerted field research to examine all these issues there is little concrete assessment that can take place. The approach to this research must also be carefully designed and well-executed in the field and laboratory if it is to be of value. These areas are the single most important area of change that will likely come about as a result of FCDI. Given the reliance that human survival has on this little known world, it would be wise to address these issues seriously before major investments, and perhaps irreversible changes, were embarked on. There are already sufficient warning signals available from degraded environments and loss of species to provide the justification for proper research resources to be allocated to the study of the floodplain and wetland ecology.

IV.3.7 Social and Cultural Environment

IV.3.7.1 Historical Background and Settlement

The earliest references to the history of the area are mythological. 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. The Brahmanbaria-Noakhali area formed the heartland of the land of Samatata. This was located then much closer to the coastline than at present. There is considerable evidence that maritime activity with traders, merchants and missionaries journeying to the South-East Asian mainland and Indonesian islands was important. A large number of archaeological sites have been discovered associated with this old regional kingdom and its successions of religious affinity through Buddhism, Brahmanical Hinduism and after the arrival of the Muslims in the 13th century. These sites are shown in Figure IV.3.8. These and other notable sites are listed in **Appendix H**.

Without some more detailed knowledge on the specific location of project infrastructure 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 will be reviewed in greater detail during the feasibility stage.

The rural areas are believed to have been sparsely settled, apart from some isolated towns and villages, during the 13th to 18th centuries. Settlement was characterised by considerable influxes of immigrants, including Turks, Arabs, Paktuns, Persians and muslims of many other extractions. This mixed background characterises the current majority of the population who are non-tribal people. Rough estimates indicate that in the mid-19th century the overall population densities in Comilla and Noakhali may have been of the order of 230 people per sq.km. compared to a figure five times that today. This rapid increase in pressure has lead to flows of migrants out to Dhaka and the north-west. At the same time the rapid accretion of land in the coastal zone has also become the focus of immigration.

IV.3.7.2 Social Structure and Status

Details on the social structure and status of different groups in society are given in **Annex III**. Issues of note that have implications for planning are the role of the homestead economy and the issues of women's participation and access to water supplies. The impacts on these are dealt with later. These planning areas are mainly relevant for the feasibility level of planning. There are minority social and ethnic groups in the SER who will need some special consideration in the feasibility planning to ensure that their access to resources is not compromised by FCDI developments. This is an area of planning which has had very little attention in previous FCDI preparation. Some further discussion is given later in relation to environmental management and dealing with the issues of common property resources.

IV.3.7.3 Cultural Facets of Importance to FCDI

The basis of local culture is rooted both in recent and ancient history. Many of the facets of life have not been considered as important planning issues in the past. At the pre-feasibility level it has not been appropriate to introduce these as anything other than a topic to note. In practice, these facets are changing fast in contemporary

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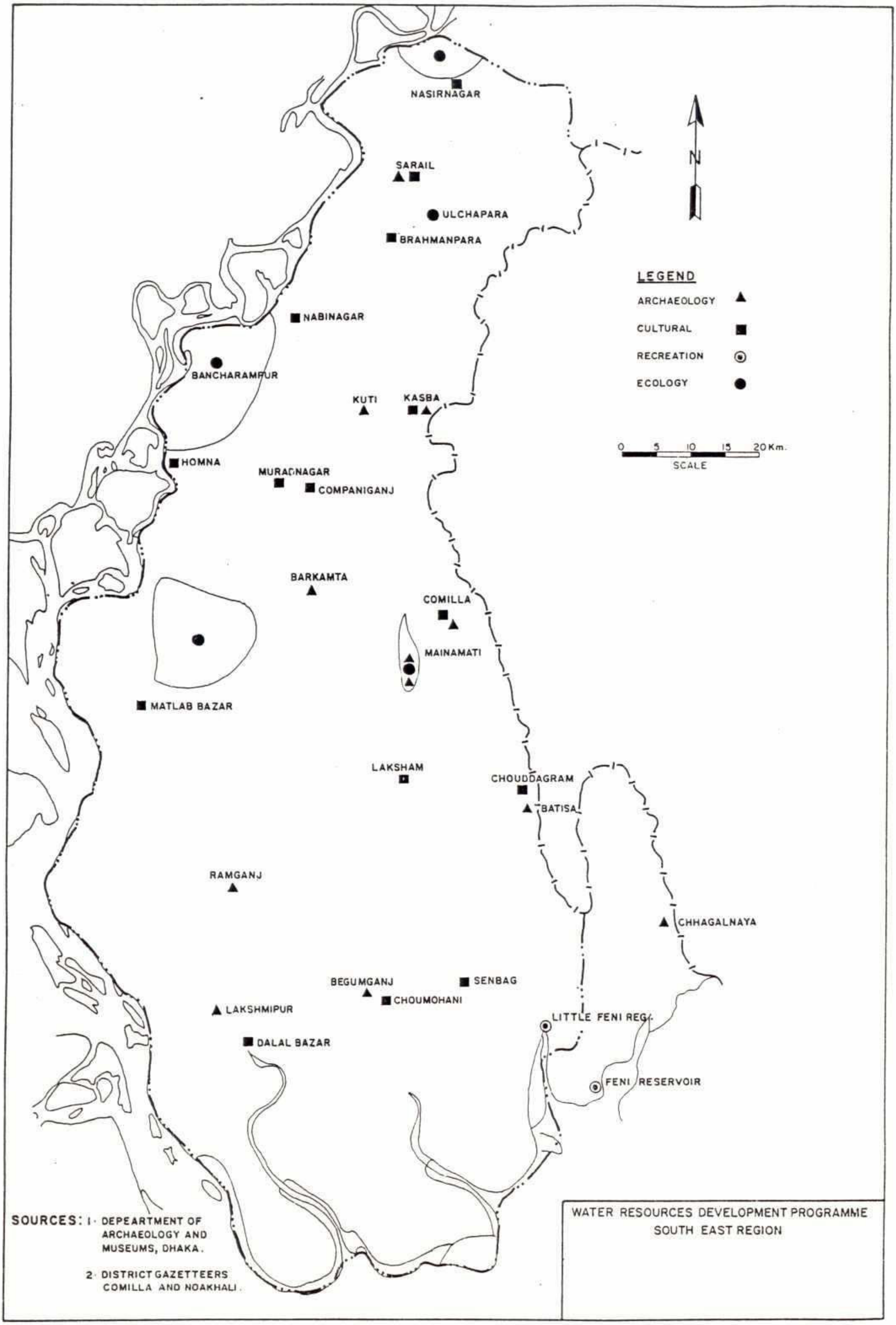
Figure IV.3.8

Sites of Cultural and Scientific Interest



society in any case, and FCDI developments are just one of the factors which are already contributing to change. The key linkages which have been identified relate to the cultural importance of the many different rice varieties and lifestyles associated with different social, ethnic, religious and occupational groups, particularly where these facets are handed down from previous generations. The importance of the local network of water-based transport and access to fishing also are relevant in this respect. Changes to these features would have ramifications in the roles and arrangements surrounding marriages. It would also affect the movements of labour and local formal and informal marketing. Some of these issues are analysed further in **Chapter 4** and its associated appendix.

IV.3.7.4 Inheritance and Conflict Systems

Impacts on inheritance systems and conflicts systems are likely to have many attributes which will be of a specifically local nature. These cannot be accommodated at the pre-feasibility stage and will be examined further in the feasibility studies in known locations. The type of issues will relate to the change in land values and development potential which may result from FCDI interventions and new social and economic pressures which will build up as a result. No major existing problem areas have been identified which would change the pre-feasibility level of approach to selecting projects and strategy options. It is of note that in new charland a complex social and politically sensitive system of colonisation does occur as previously discussed. In the feasibility stage problems of land speculation before and after construction, or the introduction of irrigation will be examined and institutional and local participation plans drawn up to minimise these and other implementation problems.

IV.3.8 Socio-economic Environment and Social Services

Details on the socio-economic conditions in society are given in Annex III. This deals with demography, population, migration, occupations, incomes and resource use. The planning resources available have not allowed an adequate collection of field data at this stage on survival strategies, environmental resource management and their linkages to the capacity for future sustainable development. These are study areas which ought to be given special attention during the feasibility study stage. However, these studies require experienced inter-disciplinary groups of specialists and generalists who are used to these types of studies. These skills are not readily available locally at present and this analysis probably cannot be currently accommodated without additional arrangements in the next phase of planning.

The social services provisions in the SER are broadly covered in Part 1 of the Regional Study.

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IV.3.9 Quality of Life

IV.3.9.1 Nutrition and Health

The health problems of the SER 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 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 considerable by both the hydrological regime and by poor sanitation and public health. These can only be effectively dealt with through careful detailed designs 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.

Schistosomiasis is also not present and the nearest location known is at Orissa in India. The fact that FCD projects will affect the landscape, habitat conditions and ecology means that the risks of the introduction of these diseases onto the floodplains should be carefully examined and monitored. The linking up of suitable habitats as more projects are implemented and the transmission of diseases into the area cannot be ruled out.

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 the 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 the FAP planning if the basic minimum levels of nutrition are to be maintained at current levels, and if any hope of providing the minimum basic needs to all in society in the future. This fundamental need cannot be adequately represented in the economic analysis of projects, or necessarily in the planning considerations of the agriculturalists given their background, training and planning perspectives. These limitations need to be considered carefully in the next stage of the FAP planning. It would be recommended that both public health and nutrition are given specific specialist inputs in the feasibility stage.

IV.3.9.2 Navigation and Country Boats

Details on regional infrastructure are given in Part 1 of the Regional Plan Report. The most important area of potential impact which has affected project planning relates to navigation. There are the costs of loss of navigation to consider in the economic analysis if disruptions were not mitigated. However, the approach assumed for planning purposes is that all possible arrangements to mitigate for loss would take place. The specific details relating to navigation issues, surveys of local routes, dredging requirements, locks and minor bridges to maintain local communications routes will be taken up at the feasibility stage. The following provides some information on the significance of navigation in the SER.

Experience from the CIP and the MDIP has shown that unplanned flood protection measures have stopped, not only through traffic, but have also seriously impacted internal navigation within the embanked area. In particular, rainy season navigation on former F3-F4 lands have disappeared altogether.

Three types of navigation systems are important in the SER:

(a) Navigation along routes recognised and classified by the Bangladesh Inland Water Transport Authority (BITWA),

(b) Navigation along other unrecognised routes,

(c) Non-routed short and long distance navigation, particularly on F3 and F4 land during the rainy season.

Routes are classified by the BIWTA on the basis of sustainable Least Available Depth (LAD) as shown in Table IV.3.1 and in Figure IV.3.9. This figure also shows the areas of impeded navigation due to water hyacinth, the general location where minor country boats can ply during the flood season and the station and ghats sites:

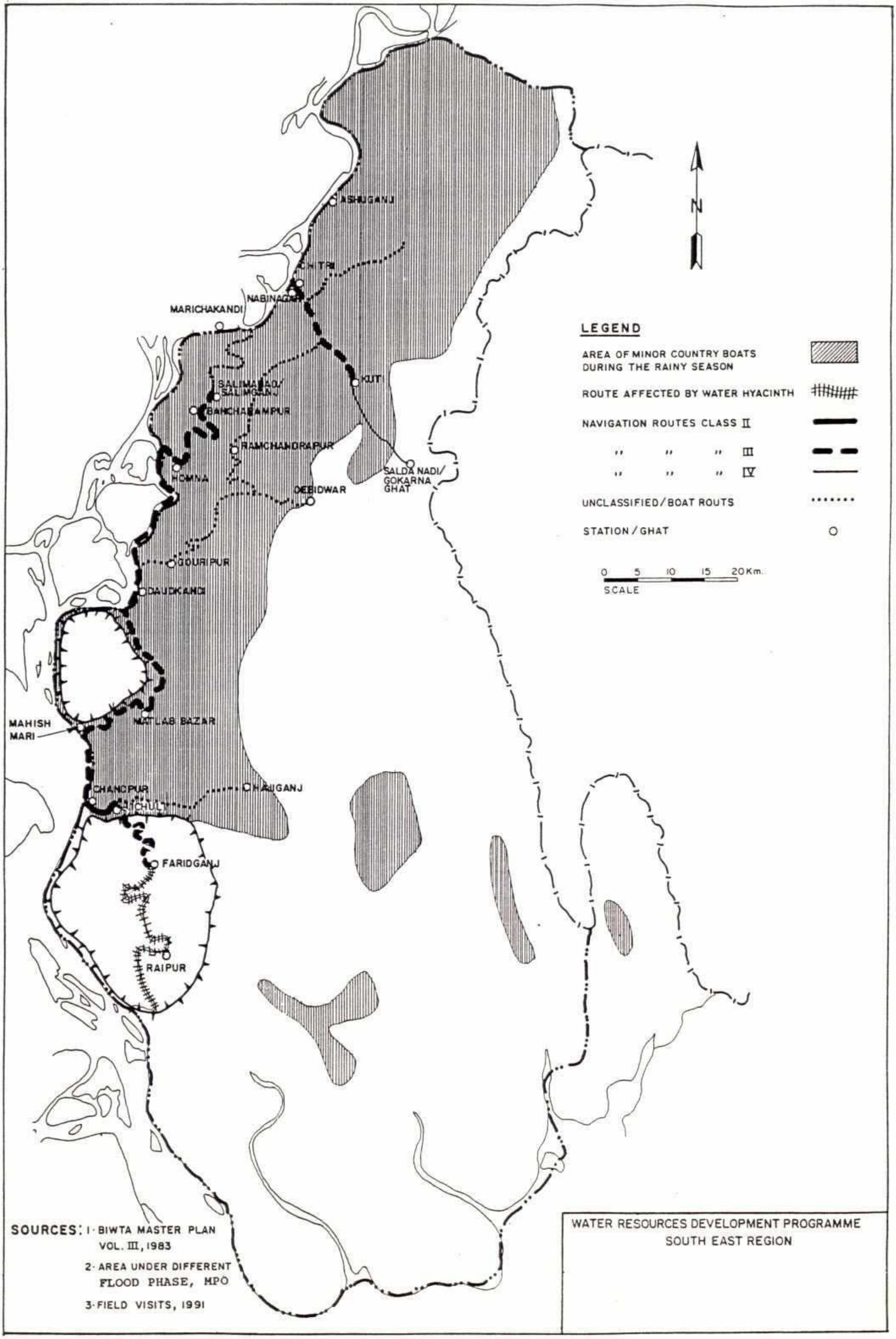
TABLE IV.3.1

BIWTA Route Classification and Lengths

	Class	LAD (m)	National (km)	SER (km)
I.	Perennial routes. Comprising the spine of the national water ways system; includes Chandpur, Daudkandi and Ashuganj.	3.6 - 3.9	885	0
II.	Perennial routes. Links the major ports for the hinterlands.	2.1 - 2.4	1 000	7
III.	Usually not perennial, Generally 'transit' or 'feeder' routes connecting class I or II routes.	1.5 - 1.8	@ 1 900	59
IV.	Basically seasonal, Feeder route in the dry season	< 1.50	2 400	97

Figure IV.3.9

Navigation Routes Country Boat Areas



In the SER there is one class II route, three class III routes (out of which 31 kms is seasonal) and three class IV routes (all seasonal) which serve the major regional commercial centres. The inter-regional commerce and passenger traffic is mainly routed through Chandpur, Ashuganj, Daudkandi and Matlab. Major vessel plying are passenger/cargo launches and large mechanised country boats. The classified routes are commercially important, both for passenger and goods traffic. Chandpur is regionally the most important port, and nationally ranks fourth in terms of port revenue. The incoming cargo tonnage of Chandpur far outweighs 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 main river channels of the Dakatia, South Dakatia, Dhonagoda, Gumti, Burinadi, Pagla, Saldanadi and Meghna. The launch ghats are located at Ashuganj, Bancharampur, Chatalpur, Char Pagla, Chitri, Farazikandi, Faridganj, Gokernaghat, Homna, Ichuli, Kulainagar, Kutibazar, Machuakhali, Maniknagar, Marichakandi, Miarbazar, Mohanpur, Nabinagar, Raipur, Ramchandrapur, Ramkrishnapur, Salimganj, Satnal and Uzanchar.

Other unrecognised routes/passages are generally along shallower parts of rivers and khals plied by mechanised and 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.

Non-routed navigation are mainly during the rainy season for inter-village communications and contact. 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 different villages especially 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. Even if major navigation routes are maintained, closure of minor passages, (by embankments or by reduced water levels), is likely to have a significant effect on many of these visits; poor people in particular are dependent on these routes, since time is often less important than cost.

Pending availability of thana level statistics on the number and type of country boats, the sample data in Table IV.3.2 illustrate considerable regional variations between upazilas which fall within the Meghna and Titas flood plain and those which fall outside it. As more country boats are converted to engine boats, their importance as passenger and goods carriers will also increase.

TABLE IV.3.2

Numbers of Boats in the SER

Number of Boats Thana	Ordinary	Engine	Fishing	Total
Nabinagar	8 215	260	500	8 925
Akhaura	300	30	N.A	330
Companiganj	200	25	550	775
Bancharampur	6 685	90	N.A	6 775

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The impacts of FCD/I interventions on navigation could be high along the rivers listed unless mitigated. Some of the inland routes and stations/ghats may close altogether. Navigation during the rainy season inside the embankment will be confined to major drainage channels only. Social visits, so common during the rainy season, will fall drastically.

Projects on the floodplains of Meghna and Titas systems, particularly Dhonagoda project (No. 8), Gumti Phase II (No. 11), Ashuganj (No. 12) and Titas (No. 13) are most likely to create adverse impact, depending on the type of project intervention. This is because of the considerable regional variations within the SER in terms of perennial navigable water ways.

IV.3.9.3 Pollution

The main potential sources of pollution will involve any drainage alterations to discharges from upstream urban, industrial or agro-chemical sources and from local sewage disposal and agro-chemical use. **Figure 3.10** shows the main areas identified which have been looked at for potential impacts. Industrial, agro-chemical and urban discharges as well as agro-chemical use have been rising steadily in recent decades and this is causing concern with regard to the public health risks and the degradation and pollution of the soil, water, fisheries and ecological processes. Confinement of channels and drainage routes will both stop upstream pollutants from entering the floodplain but also prevent those from within getting out. Also, it will route these pollutants in more concentrated forms to other downstream areas. The final arrangement of schemes selected for the RWP did not appear until after the main environmentalist's inputs were completed. It has therefore not been possible to analyse properly the main implications for proper regional planning of the monitoring and response priorities.

IV.3.10 Externalities

IV.3.10.1 Coincident Events

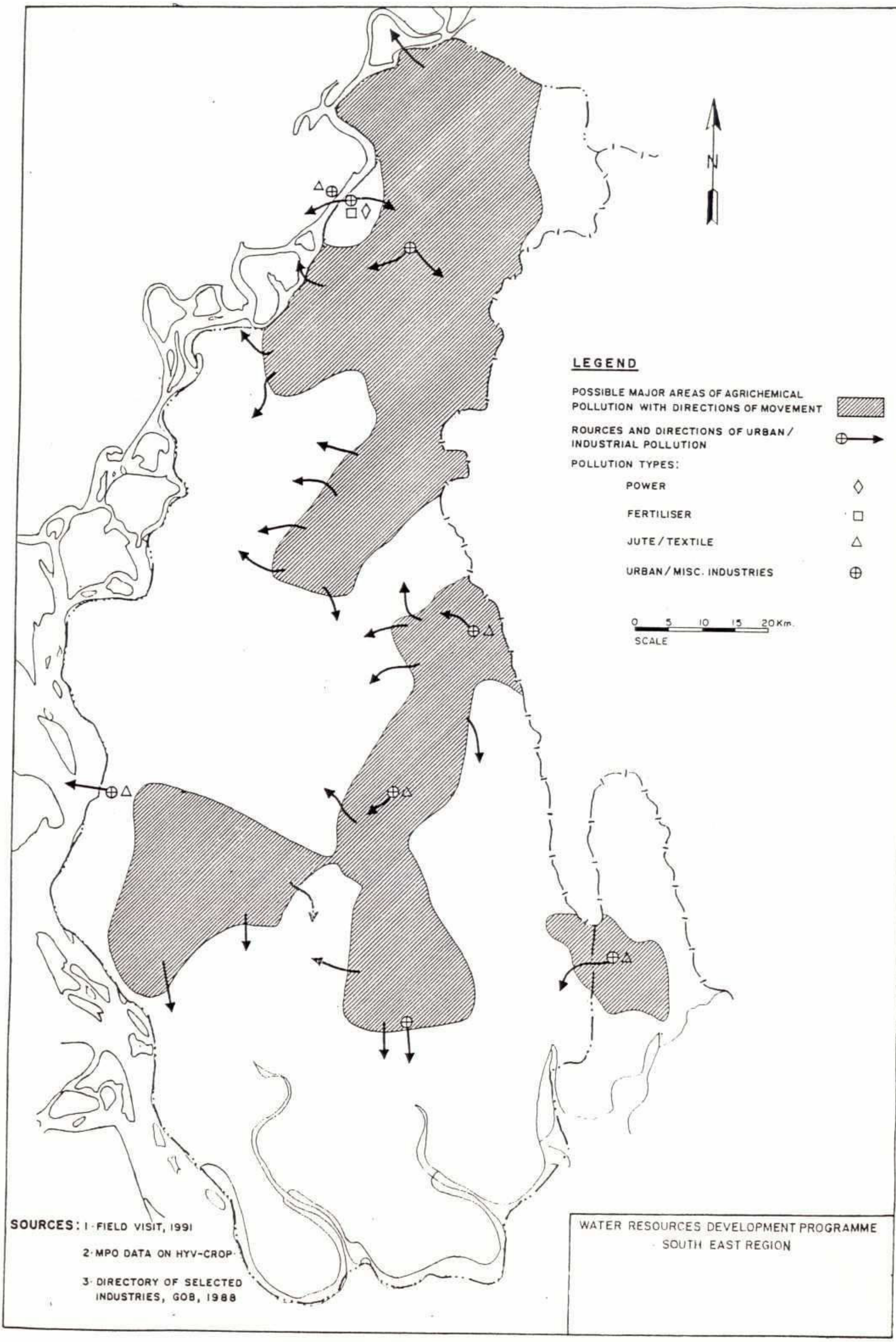
The problems of coincident events has formed a major part of the surface water modelling methodology which are appraised in **Annex VI (Hydrology)**. It is believed that the methodology adequately encompasses the range of possible scenarios involving coincident events. The main limitation would be that the 25 year historic data base would not cover some important series of events of which current knowledge of climatic triggers or forcing factors gives no indication. A typical example being the changing climate due to the eruption of volcanoes.

IV.3.10.2 Global Events

There are a number of global events which might have an influence on the reliability of the current planning techniques. The most important would be the effects of global warming. This might lead to a rise in sea level, a change in the rainfall and cyclonic patterns in the catchments and Bay of Bengal and/or a change in the timing and quantity of snow melt from the Himalayas. There is insufficient data available upon which any of these factors can be satisfactorily analysed for the regional planning at the current time, other than by sensitivity analysis of the base models.

Figure IV.3.10

Potential Sources of Pollution



Forcing factors for tectonic and seismic events are also still insufficiently understood to be able to reliably assess their significance in quantitative terms. Tectonic movements are measured in geological time scales and will be highly unlikely to be of significance. Seismic events are known to occur regularly and should be planned for at a regional and local level. Contingency planning along these lines is required in the SER because of the risks of cyclone disasters. However, this falls outside of the TOR of the pre-feasibility detail of planning and should be considered during the feasibility study or clearly allocated to other institutions.

The rapid change in global politics, communications, instability and finance will continue to have major impacts on the technological, political and financial context in which the RWP projects will be implemented. The effects of these features on the planning assumptions which have been made to derive a coherent water resource strategy for the region are very unpredictable. They would not necessarily affect project options in the same way. Some options could be less reliant on foreign trade, technology and finance than others. Some unexploited local resources opportunities have been highlighted which need the protection of key habitats. These are resources which may have significant additional value in the future than is apparent now, such as the crustaceans and fauna with chitinous bodies. Other areas where effects could be significant involve the assumptions on the integrity of the protection against flooding and the assumptions on the projects being financed and completed. The coastal embankments are a typical example. Limitations of international finance or a lack of capacities to effectively implement planned projects due to events elsewhere may lead to uncompleted projects not providing the protection or engineering integrity originally intended. These factors may favour the selection of a slower pace of implementation of smaller less complex projects under close supervision, even if their economic ranking is less than the larger and speedier developments.

IV.3.10.3 Hidden Costs and Subsidies

There is growing historical accumulation of events which indicate how traditional economic pricing under-estimates the true costs of oil-based project linkages. The pricing analysis starts at a border cost (usually FOB in the Gulf) and then simply adds transport costs to arrive at the CIF border price at the country of import. This approach avoids taking into account a range of other costs which the international consumers are increasingly being asked to pay for. These are the costs for pollution control and monitoring which are rising at a rapid pace in recent decades; the costs for pollution clean up operations; the costs incurred from production losses in the crop, forest and fishery sectors as a result of oil-product pollution and linkages to other limiting environmental changes, such as climatic changes, ozone depletion and acid rain; the increasing public health costs to deal with these effects in the international health systems; and the costs of defence expenditure to protect the oil production and transport systems. Recent specific examples are the Gulf War and the Exon Valdiz disaster. The need to finance these defense expenditures have lead to the finances being withdrawn from other international budget allocations some of which would otherwise have been available for investment in the developing countries. The real cost of oil fuel and all products from oil-based industries (i.e. agro-chemicals, transport, processing etc) should all contain some representation of these hidden elements of real oil resource use costs. It is inadequate to just attempt to cover these through the sensitivity analysis which suggests that the taxpayers are not really having to pay these costs, either now or in the future.

Within the context of the SERS it would only make sense to include these costs if there was a general agreement between all the FAP studies economic analyses that a common approach was to be adopted. If this is not done, then policy makers should be aware that there is a potential imbalance caused by this general subsidy that would

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tend to under-estimate these project costs. Similarly, there would be a tendency for a bias against those projects which were less reliant on oil-based inputs and technologies. However, the basis of FAP planning has not been to develop options which would specifically deal with these problems. They are likely to remain overlooked.

IV.3.10.4 Contradictions

Bangladesh faces a limited revenue generating capability and is heavily dependent on foreign aid. The full costs of FAP proposals are likely to limit the sums available in other sectors. Unless the FAP projects are compared with the relative benefits of investment opportunities through other development sectors the full implementation of FAP could result in better development strategies being delayed or foregone.

In some FCD projects there have been considerable problems of deliberate breaching of embankments from people either, on the inside or, from people on the outside. This has involved different social and occupational groups with different motives. In all cases examined the reasons for carrying out the breaching were rational. These imply that fundamental contradictions exist. These have been associated with the poor design of the schemes or because of the effects which even well designed schemes have, per se, in their particular locations. Planning and analysis almost invariably proceeds on the assumptions that the integrity of the protection is maintained. Yet, in reality, in some schemes this is not the case. Unless the reasons for these breaches can be clearly identified and mitigated, then analysis ought to take into account the costs which these breaches will impose in the with project situation. It is significant that no attempt has been made to include the outcome and costs of breaches in the economic analysis.

IV.3.10.5 Cross Border Issues

Water, sediments and pollutants all flow into Bangladesh from across its borders. Many issues of cross border water regulation, land use, population density and discharge of pollutants into the main rivers and streams are outside of local control. Planning can only proceed on the understanding that international cooperation will be promoted in monitoring and resolving important issues. The details of monitoring inside the SER are dealt with in Chapter IV.6. The monitoring programme would established and assess the importance of any changes which might be cause for concern. The main problems might be the failure of upstream structures or the rise in toxic discharges or general sewage pollution.

CHAPTER IV.4

ASSESSMENT OF REGIONAL ENVIRONMENTAL IMPACTS

IV.4.1 General Appreciation

The continuing construction of road and rail infrastructure, flood control and drainage schemes, and the expansion of irrigation systems, has already affected the seasonal hydrological, soil moisture and ecological characteristics over many parts of the region. The objective of flood control and drainage schemes is to introduce a more controlled water regime. This will also create a more terrestrial environment on higher ground and divert water quicker into the remaining hydrological network. Irrigation objectives seek a moister local climate and soil environment through the dry season and divert water flows from the drainage system or recycle stored groundwater. These physical diversions modify the physical, biological and chemical status of each micro-environment inside and outside of particular projects. Moreover, with each additional project the scale of response increases until effects can be seen at a regional level. The physical responses of the hydrological surface or groundwater systems induce changes in the habitats of both terrestrial and aquatic flora and fauna which then feed into the wide network of ecological processes affecting the food chain and health of economic plants and humans.

The implications of continuing interventions in FCDI, therefore, will potentially affect many features of sociology, economics and ecology of life in the region. These interactions and modifications are often complex and simple causal-effect relationships are only one part of the outcome of FCDI interventions. Complex feedback and long-term accumulative processes will be involved. The geographical scale and phasing of development will determine which environmental thresholds are crossed and when. Current data and analytical knowledge, and this pre-feasibility level of planning, can only begin to identify some of the likely implications and their importance. The indivisibility of the political, social, economic and ecological processes forms the foundations upon which environmental impact assessment should and has tried to been made. The assessments here therefore summarises the complete impact scenario, and not those which are solely ecological.

IV.4.2 Previous Impacts Identified

The most critical problems identified in previous studies which were raised for discussion by the environmentalists in the formulation of the RWP planning include:

- the loss of land and economic livelihood to families displaced by development projects either through public land acquisition, or the loss of common property resources and access to open water fisheries.

- the adverse nutritional and distributional impacts of modern agricultural and flood control projects on poorer groups, in spite of an overall increase in production from HYV technologies.

- the loss and change in habitats that affect wildlife, biological population controls and natural soil fertility mechanisms.

- the critical nature of river and coastal erosion and sedimentation systems on the planning of projects.

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- the rate of change in seasonal land use management systems and input use, due to FCD and I. and the risk of agro-chemical pollution where natural flushing or removal of pollutant is impeded or diverted.

- the lack of early planning and preparation for land acquisition, resettlement and catering for landless and the disadvantaged poor, and

- the cross border interventions in the upstream catchment involving land and water use.

In most cases these were regarded as issues either going beyond the study's terms of reference or issues which should be dealt with at the feasibility stage or by other studies.

IV.4.3 The RWP Demand on Resources

The most considerable demand on resources of the RWP will be the drain on current and future foreign exchange and local financial resources. There will also be a considerable demand for construction materials, management and labour.

IV.4.3.1 Financial Resources

The implications of the RWP on the demands which could be made on foreign and local resources is appraised under the economic analysis of the Regional Plan.

IV.4.3.2 Construction Materials

The main use of construction materials will be embankment materials taken from the local borrow areas. The areas taken for embankments and borrow pits will sometimes displace land from productive agricultural use, but the materials themselves are widely available and will only be of importance for those directly affected. These earthfill materials in situ are alluvial silts and silty clays with no gravel content. Occasional areas are high in organic matter and derive from old marsh deposits. These deposits are not suitable as an embankment material.

Aggregates are quarried from the government owned river bed area in Syhlet. The demand levels of the RWP and competition with existing users has not been assessed and would need to be reviewed at the feasibility stage. These sites have not been surveyed to establish if sites of historical or archaeological interest may be affected by RWP demands, but this is unlikely and should be easily avoided.

Good quality building sand is available from government leased extraction sites in river beds in the old Meghna floodplain where it lies adjacent to the Tripura Hills. Building sand demands will compete with the long-term needs of alternative users. These users operate under leases on government-owned sites. These resources have a limited renewal, depending on the rate of erosion from the Tripura Hills in India. Large short-term RWP demands for building sand might affect the medium-term economic viability of existing lease sites. A survey on the supply and demand for building sand might be required during the feasibility stage. As these rivers are inherently flashy and the best sand deposits appear to be of recent origin, damage to sites of archaeological interest is unlikely.

Kiln burnt bricks will also be required for building and road construction. These are obtainable from privately owned brick works scattered throughout the region. Brick demand will have resource implications. The kilns use both imported coal from India and limited timber resources, even though there are official restrictions on the use of the latter. The national stocks of timber are being denuded rapidly. The availability of natural gas supplies as an alternative is problematical. Pipeline distribution systems to kiln sites would be costly and impractical. Tank storage and tanker delivery, possibly through private sector arrangements, might offer a more viable alternative. These fuel issues might be looked at in more detail during the feasibility study stage when the scale of demands under the RWP can be more accurately determined.

Table IV.4.1 shows the source areas, their ownership and general status of availability of construction materials.

TABLE IV.4.1

Construction Material Sources and Features

Material	Source	Current Ownership	Availability
Earthfill	Local Borrow Pits	Private	Extensive
Sand	Border River Beds	Government	Limited
Aggregates	Syhlet River Beds	Government	Limited
Brick	Local Brickyards	Private	Extensive

Access to project site for construction work will be limited by the existing distribution of navigation, road and rail network as shown in Figure IV.1.2. Aggregate materials would be brought from Syhlet by either cargo boats or by goods train. The nearest available off-loading points would be used before transferring materials onto truck or smaller boats. The major inland ports available would be Chandpur, Daudkandi and Matlab. Various stations are distributed throughout the region for the use of goods trains. From these sites the final access will require the construction of further access roads. This will require additional land to be acquired on a temporary or permanent basis. The details of these and their impacts will be considered in more detail during the feasibility study stage.

IV.4.3.3 Labour

Estimates for skilled, semi-skilled and common labour have not been estimated at this stage. Secondary employment will be generated through sub-contractors, and new local economic forces. During the operational phase of the project labour demands will be limited. Some permanent labour will be required for maintaining structures, primarily embankments and keeping the operating structures like regulators clear of sediments. Certain other seasonal tasks may arise, such as the removal of aquatic weeds. Some limited employment creation for fisheries development might replace the loss of agricultural livelihoods in areas of construction impact.

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Government does encourage contractors to employ local labour wherever possible. However, the contractor may prefer skilled and semi-skilled labour from outside the area to protect his own contractual interests. The contractual requirements will likely vary with mode of development as shown below.

Mode Of Development	Contract	Likely Labour Policy	
		Skilled	Unskilled
Flood Control & Drainage			
Major Embankments	ICB	Int/Nat	Local
Major Drains	ICB	Int/Nat	Local
Irrigation			
Major Canals	ICB	Int/Nat	Local
LLP	LCB	Local	Local
STW	LCB	Local	Local
DTW	LCB	Local	Local

IV.4.3.4 Water

The primary demands of the RWP projects for water would be for temporary flood storage with compartmentalisation and controlled flooding. This would divert quantities of water from the natural seasonal timetable and geographical floodpaths. The main focus has been for diversion or drainage of water. The allocation to the region by the National Water Plan Phase II is about 10% of the flow of the Lower Meghna in the month of March. While these figures may not seem significant in terms of a change to the existing river flow pattern, it is the conditions in the drier years which are more critical to the quality of the downstream river ecology and economy. There has been no consideration in the hydrological modelling to this downstream analysis and there is little data easily accessible by which any appraisal can be given of these impacts. The most significant impacts of this are the subject of the main analysis and affects many areas of the society, economy and ecology.

IV.4.4 Resource Conflicts and Trade-Offs

The focus of FAP planning tends to be biased towards the need to remove the "problems" of flooding and increase food production (usually defined solely in terms of rice). A wider view of natural and human resource development would introduce different engineering, agricultural and economic perspectives. The environmental analysis and regional planning approach highlight other crucial areas which are fundamental for sustaining all aspects of life and the economy.

Some local people and planners see a conflict between terrestrial and aquatic production systems. This need not be the case if rational allocation of land resources and an integrated approach to their complementary aspects were encouraged. This broader framework and political commitment there is likely to be a continued loss of access to the resources required for survival strategies. Increased development of FCDI will increase the pressures for those who do not benefit from them. These groups and their resource needs before and after FCDI schemes need to form a clear component of planning if future political and resource problems are to be avoided.

The rising tide of environmental planning and public concerns often suggest that wildlife, habitats and wetlands need to be preserved. However, there is nothing sacrosanct and fixed in any examination of the history of nature. Thus, it is not that wetland areas and systems should be preserved (few vestiges of undisturbed environments and ecologies remain). Rather policy and management should ensure that, within the new forms of water management which might result from FAP, the vital processes and functions provided by these ecologies are appreciated and, where they are vital for people, flora and fauna alike, maintained. If they are not, the real costs of development will become serious and costly legacies for future generations to tackle. The scale of these problems already inherited is appearing in media articles and scientific studies from many areas of Bangladesh; falling water tables, polluted water bodies, declining fish stocks, declining health and nutritional status, amongst others. The fact that these environmental issues are being recognised and studied in the regional studies, may allow some major mistakes to be avoided.

Adoption of modern HYV associated with irrigation and FCD projects is often associated with the sole objective of high grains yields. The experiences of country's employing Green Revolution techniques might suggest that this strategy results in the loss of biological, social and economic diversity and multi-purpose production systems. Whatever the conclusions of this debate are, the existing gene pool should be maintained and carefully managed. Conscious decisions and policy is also required to protect or not existing local production and cultural systems.

There is a likely contradiction between the known employment and Food for Work benefits of public construction programmes which will be generated by embankment projects. While, these may alleviate short-term poverty problems, it should be clear whether the works themselves generate more long-term poverty before this forms any justification for proceeding with implementation.

IV.4.5 Assessment of Impacts

This assessment does not attempt detailed descriptions of cause-effect or feedback linkages, but just provides a summary list of impacts. The more detailed analysis of some key characteristics is given in **Appendix I**. An impact is defined in the evaluation as anything which can cause a change in the "before" and "after" project comparisons of the composition and condition of the environment. Some of these might be simple physical effects which reflect the response of the physical environment to the project interventions, such as rising or eroding river bed levels, the seasonal changes in floodplain hydrology. Others are the impacts which these physical changes cause to the composition or condition of the biological, ecological, social, economic or cultural features of the environment.

IV.4.5.1 Potentially Critical or Notable Impacts

The following major impact areas have been identified which might be found in the pre-construction, construction or post-construction phases. Those impacts against which a critical answer is found are marked with asterisks. The remaining impacts are notable. This follows the definition discussed in **Chapter 2**. In some cases the impacts will be specific to a particular type of intervention or will critically affect a selected group. It is also likely that the distinction of criticality and notability might change with particular project circumstances.

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PHYSICAL IMPACTS

ATMOSPHERE

Climate:	None
Quality:	

LAND AND SOIL RESOURCES

Morphology:	- *Scouring and rising bed levels* (FC) ***
	- *Changing bank erosion* (FCD) ***
Soil Quality:	- *Change in soil fertility status inside schemes* (FCDI)
	- *Change in limiting factors for food production* (FCDI)
	- *Induced drought conditions and drying of soils* (FCDI) ***

GROUNDWATER

Hydrology:	- *Reduction in seasonal water tables and redundant HTW technologies on high ground and potential health problems* (GW.I) ***
Quality:	- *Salinity problems with irrigation* (GW.I) ***

SURFACE WATER

Hydrology:	- *Reduction of flood and salinity risks in coastal and floodplain areas* (FCD)
	- *Increase in downstream flood risks* (FCD)
	- *Increase in risks from extreme events in schemes* (FCD)
	- *Increase in waterlogging in low lands and health problems* (FCDI)
Quality:	- *Reduction in flood dispersal of contaminants inside schemes* (FC)
	- *Closed system needs flushing for pollution control* (FCDI)
	- *Increased problems of agro-chemical and sewage pollution* (FCDI)

BIOLOGICAL AND ECOLOGICAL IMPACTS

Bio-Diversity:	- *Loss of grain species* (FCDI) ***
	- *Loss of straw species* (FCDI) ***
	- *Loss of fish species* (FCDI) ***
	- *Loss of other aquatic species* (FCDI) ***
	- *Loss of bird species* (FCDI) ***
	- *Loss of endangered species* (FCDI) ***
Population Imbalance:	- *Aquatic weeds in distribution and drainage systems* (FCDI)
Land Use and Habitat:	
- Field Ecology	- *Loss of rotation and fallow systems* (FCDI) ***
	- *New farming systems cropping patterns, different varieties, new HYV and inputs* (FCDI)
- Wetland	- *Reduction in open system floodplain wetland* (FCD) ***
- Charland	- *Increase in riverine, estuarine and coastal chars* (FC)
- Forest	None
- Homestead	**None but study needed**
- Rare Habitats	**Wetlands identified, survey needed**

SOCIO-ECONOMIC IMPACTS

Displacement: - *Land acquisition and compensation will increase landlessness* (FCDI) ***
- *Lack of equity strategies will increase marginalised groups* (FCDI) ***

Investment & Assets: - *Better investment climate (but implications of extreme events)* (FCDI)
- *Land values artificially manipulated in pre-project/acquisition phase and raised after FCDI due to speculation and production increases* (FCD,SW.I)

Production Levels: - *Crop/livestock/tree losses reduced in frequent events inside scheme* (FCD)
- *Crop/livestock losses increased in extreme events* (FCD)
- *Crop/livestock losses increased in frequent events outside scheme* (FCD)
- *Increased food production with irrigation* (I)
- *Reduced fisheries inside and outside of project due to lack of migration paths* (FCDI) ***

Income: - *Improved farm income to landowners, sharecroppers and labourers* (FCDI)
- *Reduced fisheries income* (FCDI)

Employment/Wages: - *Increased farm labour demands for intensive agriculture* (FCDI)
- *Increased labour demands for agro-industrial/service sector* (FCDI)
- *Reduced fisheries employment* (FCDI)

Equity and Access: - *Distribution of benefits by land types, social status, resource ownership and income levels unlikely to be equal* (FCDI)
- *Participation levels of poor and landless disadvantage them* (FCDI)

Farming Systems: **Minor**

Government Services: **Minor**

Private Sector: **Minor**

Survival Strategies: - *Potential loss of diversity of common property resource access to floodplains fisheries accelerated by FCDI and input use* (FCD)
- *Raised economic dependency through more intensive agriculture and cash needs for farming will marginalise the poorer groups unable to make transition* (FCDI)

Gender & Age:

- Men **Minor**

- Women - *Role of women and irrigation in homestead farms and impact of flood and water table reduction on livestock, nutrition and income potential particularly affecting pregnant and nursing mothers* (FCDI)
- *Increased post-harvesting demands and raised economic activity may displace women from traditional occupations in processing* (FCDI)
- *Increased fodder availability could raise chances of increases occupational and income opportunities for women in livestock rearing* (FCDI)

- Children **Minor**

QUALITY OF LIFE IMPACTS

Heritage: - *Impacts unclear until specific sites locations given and surveys carried out* (FCD, SW.I)

Culture & Traditions: - *Change in lifestyle, traditions, kinship, family and patron-client systems* (FCDI)

Settlement/Migration: - *Psychology of embankment may induce some relocation/redesign of housing on lower ground or on embankments as a result of apparent protection* (FC) ***

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Health and Nutrition:	
- Human	- *Increased availability of cereals* (FCDI)
	- *Increased consumption capacity for other protein sources amongst benefiting groups from improved farm incomes and increased employment levels* (FCDI)
	- *Decline in nutritional status of selected groups in community from drying impact on high ground and loss of common property resources* (FCDI)
	- *Changes in water-borne disease* (FCDI)
	- *Changes in disease vectors* (FCDI)
- Animal	**Minor**
Education:	**Minor**
Transport Systems:	- *Loss in major and minor inland navigation access through rivers and khals due to closed and regulated structures and increase in aquatic weeds* (FCD)
	- *Disruption of marine to estuarine access if khals closed* (FCD)
	- *Loss of local minor navigation through draw down on water levels and introduction of HYV varieties into paddy fields* (FCDI)
Energy and Fuel:	**Minor**

IV.4.5.2 Minor Impacts

The following minor impacts were identified which could occur during the pre-construction, construction or post-construction phase:

PHYSICAL IMPACTS

ATMOSPHERE

Climate:	- *Changing micro and macro climates* (FCDI)
Quality:	- *Noise disturbance to birds from pumps and engines* (I)
	- *Increased construction dust and exhaust pollution* (FCD)
	- *Increased fuel exhaust from irrigation and processing* (FCDI)

LAND AND SOIL RESOURCES

Morphology:	- *Accelerated land settlement and subsidence* (FCDI)
Soil Quality:	- *Lowered organic matter and sediment deposition in schemes* (FC)
	- *Increased organic matter and sediment deposition downstream* (FC)
	- *Change in limiting factors for food production* (FCDI)
	- *Induced micro-nutrient changes* (FCDI)

GROUNDWATER

Hydrology:	- *Reduction in seasonal water tables and drainage to wetlands* (FCD,GW,I)
	- *Increase in storage for floodwater early in season* (GW,I)
Quality:	- *Toxicity problems (Fe-Mn-Br) with irrigation* (GW,I)

SURFACE WATER

Hydrology: - *Loss of low lying ground to irrigation storage in dry season* (FC)

Quality: - *Downstream adverse affects on water users outside systems* (FCDI)

BIOLOGICAL AND ECOLOGICAL IMPACTS

Bio-Diversity: **All major negative impacts**

Population Imbalance: - *Pest-predator changes* (FCDI)
- *Food chain alterations* (FCDI)

Land Use and Habitat:

- **Field Ecology** - *Loss of fodder species diversity in fallow* (FCDI)
- **Wetland:** **Major negative impact**
- **Charland:** **Major positive impact**
- **Forest:** - *Already historically replaced by homestead tree crops* (FCDI)
- **Homestead:** - *Change in tree crops planted* (FCD)
- **Rare Habitats:** - *Risk to quiet wetlands sites for migratory birds* (FCDI)

SOCIO-ECONOMIC IMPACTS

Displacement: - *Loss of productive land and water resources but creation of high land on embankment with high value for settlement* (FCDI)

Investment & Assets: - *Loss of assets worth due to under-valuation and manipulation of compensation payments* (FCD,SW.I)

Production Levels: - *Reduced losses of pond culture from flood dispersal of species* (FCD)

Income: - *Possible increased production effect on depressing rice prices* (FCDI)

Employment & Wages: - *Increased labour during construction, maintenance and rehabilitation* (FCD,SW.I)

Equity and Access: - *Local elites and institutions likely to appropriate best resources* (FCDI)

Farming Systems: see also Habitats - Field Ecology
- *Increased cultivation demands for draught power* (FCDI)
- *Reduced open grazing areas in fallow and around beels* (FCD)

Government Services: - *Extra road usage, maintenance costs and traffic accidents due to construction work and increased economic activity after* (FCDI)
- *Extra crime risks and social tensions during pre-construction activities with changed investment expectations* (FCD)
- *Extra crime risks and social tensions during construction with presence of migrant labourers* (FCD)
- *Decline in government education and general facilities maintenance costs due to reduced flood risks* (FCD)
- *Increase in maintenance costs for FCD structures* (FCD)
- *Extended health training and facilities to deal with pollution problems if flushing and pollution controls not implemented* (FCDI)
- *Psychological problems as economic pressures increases and cultural systems transformed* (FCDI)
- *Marginalised poorer groups, induced landless and lost occupation will increase strain on urban services as rural-urban migration increases* (FCDI)

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Private Services:	- *Private sector stimulated by demand for irrigation pumps, inputs, processing and marketing services* (FCDI)
Survival Strategies:	**- Major mostly negative impacts**
Gender & Age:	
- Men	- *New pressures on men from increased agricultural labour demands leading to loss of leisure activities and folk/artistic cultural contributions to social cohesion and continuity of cultural heritage for the next generation* (FCDI)
- Women	**Mostly major negative some positive impacts**
- Children	- *Increased agricultural labour and economic demands may force parents to deny children access to schooling to assist in field activities* (FCDI)

QUALITY OF LIFE IMPACTS

Heritage:	- *Impacts unclear until specific sites located* (FCD,SW.I)
Culture & Traditions:	- *Loss of access to open water fisheries leads to loss of traditional occupational activities with all its attendant cultural and folk activities and artistic/skilled artisan creativity* (FCDI)
	- *Loss of diversity of rice varieties leads to loss of cultural norms for Hindu cultural and ceremonial activities* (FCDI)
Settlement/Migration:	- *Assets and homestead systems not protected from extreme events* (FC)
	- *Increased agricultural, economic activity and better investment climate may induce growth in minor or major urban centres and migration for seasonal labour* (FCDI)
Health and Nutrition:	
- Human	- *Increased income will improve quality of housing and homestead provisions for healthier environment* (FCDI)
	- *Improved health as sewage systems not flooded but stagnant water pools and pollution of potable water source from surface water or shallow groundwater* (FCD)
- Animal	- *Decline in animal nutrition from loss of fallow grazing and fodder diversity* (FCDI)
	- *Increased availability of rice bye-products, husk and bran* (FCDI)
	- *Changes in water-borne disease* (FCDI)
	- *Changes in disease vectors* (FCDI)
Education:	- *Flood protection will increase the protection to educational institutions* (FC)
Transport Systems:	- *Creation of new road linkages by new embankments* (FC)
	- *Increased freight demand from increased construction material demands in construction phase and agricultural production and demand for inputs in operational phase* (FCDI)
Energy and Fuel:	- *Increased demand for power for pump station and electric irrigation pumps* (DI)
	- *Increased straw and husks* (FCDI)
	- *Increased demand for oil-based products based on agro-chemicals, creation of road networks and extra demand for power tillers, grain mills and freight by motorised minor boats and road vehicles* (FCDI)

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IV.4.5.3 Vulnerable and Benefiting Groups and Areas

The assessment undertaken on a general level of FCD(I) impacts resulted in the following list of key vulnerable groups and areas:

Major Adverse Impacts

Physical Impacts

All assets and people within the path of a embankment breach flood path (FC) and downstream people affected by increased damage due to re-routing of main floods and drainage channels (FCD), including settlements and farms near to erodible river banks (FCD).

Floodplain, poor farmers with little credit worthiness and without access to organic manures due to declining soil fertility (FCDI).

Farms and poor farmers on high ground, women's homestead plots and shallow rooted species vulnerable to falling seasonal water tables and settlements on high ground with traditional HTW technologies and falling dry season water tables (FCDI).

Farms and settlements in zones of poor quality groundwater (GW.I).

Farms, water users and ecology on low lying ground inside schemes unconnected to main drainage channels and without drainage/flushing measures. The wetland, low lying ground outside schemes where drainage waters accumulate and concentrate pollutants. All farms, water users and ecology associated with these areas (FCDI).

Biological and Ecological Impacts

Industrial and agricultural polluters if costs of pollution control are properly instituted, monitored and regulated.

Areas of uncontrolled agro-chemical use where risks will rise for contamination of groundwater, soil ecology and sensitive aquatic and wetland ecology (HYV FCDI schemes).

Some threatened flora and fauna of wetland habitats, some crop land flora and fauna, some local rice grain and rice straw varieties, some migratory and open water fish, and migratory and some resident birds (FCDI).

Water bodies susceptible to nutrient enrichment and impeded drainage where population imbalances will advantage aquatic weeds (FCDI).

Changes to land use, farming systems and field ecology potentially unsustainable in all FCD, FCDI and I schemes with long-term use of recommended systems. Most at risk are the poor and small-medium scale farmers with potential cash flow and employment constraints.

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Loss of all and last key wetland sites, potentially to be substituted or affected by FAP projects (FCDI).

Socio-economic Impacts

Small politically weak farmers, sharecroppers and socially bound labourers in areas of project land acquisition (FCDI).

Farmers (and smaller landholders and sharecroppers and labourers attached to them) potentially at risk through commercialization and improved land values and associated land sales (FCDI).

Groups losing access to common property resources. Poor, small farmers, landless, traditional and occasional fishing and other minority groups with greater dependence on common property resources.

People induced to settle on embankments or lower ground within schemes due to reduce flood hazards.

Quality of Life Impacts

Health risks potentially could affect all people, each disease having with specific mechanisms dependent on local circumstances (FCDI).

Major and minor existing navigation routes at risk if not mitigated (FCD).

Cultural heritage of local societies affected by changing social, economic and ecological conditions and pressures and farming/transport systems (Potentially all FCDI schemes and communities).

Minor Adverse Impacts Areas

Physical Impacts

Farmers on farms overlying marsh/peat deposits subject to oxidation (FCD) and selected farms with soil susceptible to micro-nutrient deficiencies and toxicity problems (FCDI).

Low lying lands receiving less water in dry season due to FCDI or subject to greater duration flooding due to managed flooding (compartmentalisation) or regulator operations (FCD).

Biological and Ecological Impacts

Wetlands sites with noise sensitive wildlife species not yet developed for pump irrigation (I).

Construction workers and villages in close vicinity of construction works (FCDI).

General long-term problem of increased oil-based pollution in mechanised and irrigated areas (FCDI).

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Potentially any tree or field crop area affected by changing pest-predator relations (FCDI).

All free grazing livestock and particularly farms dependent on draft animals suffering from reduction in green fodder materials (FCDI).

Socio-economic Impacts

Rice farmers if price depression due to FCDI affects rice markets and farmer incomes (FCDI).

Government budgets and resources in other sectors (health, law & order, infrastructure maintenance etc) due to extra needs caused by adverse impacts (FCDI).

Quality of Life Impacts

Pregnant and nursing mothers and young children at risk from reduced access to nutrition amongst the adversely affected groups.

Children kept away from school for agricultural labouring due to family economic pressures (FCDI).

Energy conservation and pollution strategies in face of irrational commercial and consumer demands.

Major Benefiting Groups

Those with access to land and resources where flood protection is properly designed and operated.

Settlers, land owners, sharecroppers and labourers in flood protected and drained areas, but at temporary or long-term expense of people or areas adversely affected downstream. Benefit remains as long as scheme integrity maintained.

Productive ponds, owners and users assisted by flood protection and mitigation programmes.

New investors and asset owners inside FCDI schemes.

Well managed and financed farms inside schemes.

Families with access to credit and maintaining good repayment capacity.

Road transporters, agricultural processors and project contractors and supervisors.

Families who can afford to consume the additional nutritional produce stimulated.

Urban consumers from sales of surplus produce and that from indebted, financially inviable families.

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Rural water users and aquatic ecology if pollution controls and regulation instituted.

Agricultural pests and diseases from increase habitat and feeding materials.

Minor Benefiting Groups

Children advancing to school through increased income of benefiting groups.

Aquaculture species.

IV.4.5.4 Impact Summary

Table IV.4.2 summarises the total number of impacts and breaks down the results of the criteria used to assess mainly the notable and critical impacts. This analysis is obviously visually biased towards negative impacts and has to be carefully interpreted. It is meant to be indicative only. Nevertheless, it does indicate that there are many impacts indicating that the FCDI interventions may contain a number of features which would contribute to future instability in the social, economic and ecological realms. This implies an associated rise in political uncertainty which policy makers should not want to ignore.

A similar number of impacts also point to the possibility that the FCDI scenarios as they are currently being conceived could produce results that are unsustainable. This is of major concern and implies two responses:

- either the basic strategies or designs may need to be re-assessed
- or the strategy must rely solely on the expectations that future technologies and solutions will be found that can overcome these basic deficiencies.

Whatever the response of the policy makers and donors may be to this conclusion, it is also clear that the mitigatory and complementary measures ought to rank high in the development strategy for the region. If they do not, the analysis suggests that the structural and technical options, which dominate the RWP would be insufficient to really achieve its economic and productivity objectives.

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TABLE IV.4.2

Numerical Summary of Impacts by Assessment Criteria

	POSITIVE	NEGATIVE
Total Number of Impacts Listed	30	69
Total Number of Major Impacts	10	30
Total Number of Minor Impacts	20	39
Of the Major Impacts		
- No. Critical Magnitude	2	9
- No. Critical Intensity	1	7
- No. Critical Scale Accumulation	NA	7
- No. Irreversible Effects	NA	6
- No. Increased Instability	NA	19
- No. Unsustainable Productivity	NA	19

N.B. These figures have allowed for the areas of potential double counting

IV.4.6 Mitigation and Complementary Programmes

This study has been the first to approach the environmental analysis of FAP projects. Not surprisingly it has faced a number of difficulties which could not have been foreseen. The first stages of mitigation concern the next phase of this pre-project planning. The following conclusions have been reached:

- Careful consideration and review is needed by policy makers and donors of the full range of potential impacts presented.

- A re-assessment is needed of the role, resources and planning of environmental research and planning inputs during feasibility, detailed design, construction and post-construction phases of FAP planning.

- A broader perspective is needed which can result in better planning and greater coordination to address the linkages between development activities on and off the floodplains, inside and outside potential projects, between rural and urban areas, between different regions and between different sectors in the economy.

The mitigation and complementary programmes identified from the analysis have formed the basis of the environmental management planning which appears in the following chapter.

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CHAPTER IV.5

ENVIRONMENTAL MANAGEMENT AND MITIGATION PLANNING

IV.5.1 Planning Framework

IV.5.1.1 Aims, Scope and Benefits

The RWP would physically and ecologically transform aspects of the functioning and landscape of the river, coastal, estuarine and floodplain system. The environmental plan discussed here aims to ensure that any new environment could maintain the productive resource base in surety and intact for future generations of users. This involves mitigating the adverse impacts of the interventions. Yet, the RWP would be only one of many activities affecting the quality of life and environment in the region. To be effective environmental management also needs to be linked and coordinated, not only with FAP projects in other regions, but also with other sector activities.

The national environmental policy and the NEMAP lay out the general direction and issues for an integrated approach to environmental management. The potential scope of a regional environmental plan is wide. But it also needs to be specific and directly appreciate and support the daily decision-making world of individual environmental managers at the level of agricultural and fishing communities and industrial managers.

To overcome the lack of present knowledge on the expression and intensity of adverse impacts, an integrated research, monitoring and management system is required of key hydrological, chemical and biological variables. This system will allow some forewarning of issues which might otherwise go unnoticed, until it was too late to do anything about them. New types of specialists, management concepts, and an active commitment to new strategies, will be required. This will take time to organise, but can build on a foundation already in the making within various sectors in Bangladesh. It would be an integral part of the operating procedures of the RWP integrating engineering design, water management, sanitation, chemical and biological strategies within an ecological and economic systems approach.

Many mainline ministries will be involved. Support would also be required from other national and international institutions, research institutions and environmental agencies. The coordination required goes beyond the BWDB responsibilities and much of the work beyond their professional capacities. This limitation reflects the historical criteria which established such institutions and did not sufficiently appreciate the indivisible linkages between the supply of water, the rural economy and the environmental resource base, and the difficulties of achieving effective coordination between different institutions. The problems emphasise the need for additional professional training for BWDB staff and stress the need for the closer involvement of other institutions, the public and the media in the planning, implementation and monitoring of water resource projects.

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Other agencies, apart from BWDB, likely to be involved include:

International Border Issues	:	Joint River Commission (JRC)
Irrigation Development	:	Ministry of Irrigation, Water Development and Flood Control (MOIWDFC)
Agricultural Development	:	Ministry of Agriculture (MOA) /Bangladesh Agricultural Development Corporation (BADC)
Watershed Management	:	Intergovernmental Cooperation
Land Use Planning	:	Ministry of Land (MOL)
Livestock Management	:	Ministry of Fisheries and Livestock (MOFL)
Fisheries Management	:	Ministry of Fisheries and Livestock (MOFL)
Local Management	:	Ministry of Local Government, Rural Development and Cooperatives (MOLGRDC)
Flood/Disaster Management	:	Ministry of Relief and Rehabilitation (MORR)
Public Health	:	Ministry of Health and Family Planning (MOHFP)
Water Quality Monitoring	:	Ministry of Environment and Forestry (MOEF)
Industrial Investment	:	Ministry of Industry (MOI)
Pollution Monitoring and Controls	:	MOEF/Private Sector
Urban Planning and Controls	:	No single body, UDD
International Support	:	e.g IUCN, IRRI, ICLARM

Much of the research and planning required involves subject areas that remain poorly developed in Bangladesh. Until local educational curriculum have been installed and sufficient local trained staff are available, international resources will have to be relied on to assist in the process and a patient attitude adopted to the speed with which progress can be made. The upgrading of training and education will require a considerable medium-term investment. Existing MOEF proposals already are looking to strengthen their capabilities. Further support from other sources will be required if a more rapid transition is to be made.

The main programmes required for the SER are to:

- Incorporate planning and management criteria and methods to sustain development potential by conserving resources through proper zoning and integrated use of resources.

- Improve policies to deal with the problems of construction.

- Improve policies to deal with the problems of land acquisition, compensation and resettlement.

- Integrate into planning the research and if necessary protection of cultural and heritage sites.

- Establish a coordinated pollution monitoring system to plan for trends in industrial, agricultural and sanitation pollution problems.

- Integrate public health programmes and monitoring into water resource projects to deal with changing disease and disease vector profiles associated with FCDI interventions.

- Develop multi-purpose water management criteria for the design and operation of FCDI projects to maximise the biological and economic diversity of the productive resource base in agriculture, to reduce pest and disease risks and to minimise the build up of nutrients, aquatic weeds and pollutants within engineered schemes.

- Maintain a monitoring programme on the Gumti and other confined rivers where rising bed levels would lead to high future flood damage risks.

IV.5.1.2 Sustaining Development Potential

Technical solutions for increasing food supplies and protecting farmland and assets from damaging floods will interact with an existing social and ecological context. Yet, these environments are where water and floods remain an elemental influence and also a major benefit for much of the basis of existing survival strategies and production systems. The importance of this must not be lost in the search for solutions to reduce the risks associated with floods. To be unaware of this existing status could lead planners to be uninformed of the hidden, often unquantifiable, price which may have to be paid in social, physical and ecological terms by intervening in the natural system. The impact of new and fundamental changes to the hydrological and aquatic eco-system will require wide-ranging appreciation in policy formation, if the long-term interests of the people are to be well served. This is all the more so since, at this stage, the data and methods to adequately quantify many of the affects are not available to include into the economic analysis. The project analysis by numbers, therefore, only gives one insight into the real scale of potential and problems.

Bangladesh continues to move through a crucial development period. Although people are increasingly concentrating in urban areas, close ties are being maintained with their rural lands. The population increase, together with rapidly changing values and life styles, has already created major impacts on the terrestrial landscape and aquatic eco-system which have altered dramatically, even within living memory. The remaining renewable and non-renewable productive resources are limited, and potentially fragile. This sensitivity can exceed key thresholds when put under extremes of use by humans for production and consumption, and when waste products are so poorly managed and create pollution. Whatever the scale of population demands may be now, to exceed certain thresholds may produce even greater human suffering in the future.

The approach to environmental and population management needs long-term vision, if future options and flexibility are to be maintained. Trade-offs are inevitable and will demand sacrifices, particularly in political and financial terms. However, talk of conserving resources and of sustainable development should not be seen as convenient development jargon. The vision is about survival. The essence of the strategies is to repair and reverse the mistakes of previous generations which can now be clearly recognised. The inherited system and scale of exploitation, of the only resources available to this and future generations, can no longer be seen to be sustainable, except to some who have the most to loose. Unfortunately, this includes the poorest and the rich, both internationally and nationally; the poor because it is today's literal survival that is threatened and they have no choice; and the rich because they are threatened by pressure to change the system that accumulated the wealth and the power it brings. Change is required from both groups if new and sustainable health and wealth is to be generated.

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This, and many other studies, have highlighted various growing environmental problems. The primary long-term constraint concerns the pollution hazards resulting from any continued ad hoc and uncoordinated approach to domestic, agricultural and industrial water sources and the role that FCDI interventions play in exacerbating these problems now, or in the future. Nutritional and equity problems have been placed high on the agenda, again mirroring concerns raised in other studies. Only through concerted commitment to new FCDI strategies and complementary programmes in other sectors, will meaningful solutions be found. The over-exploitation of fisheries, particularly by the continued widespread use of the "current net", is also of major concern to sustaining the fish resource base.

The catchment's settlement pattern, survival strategies and economy depend on the floodplain, estuarine and coastal resource system. To intervene in this system and change its fundamental nature should only be considered viable and sustainable if vulnerable groups do not end up worse off as a result. Given the reviews of existing studies, it is not clear that this will be the case. Thus, serious attention must be given to selecting strategies that can avoid these repercussions which, if not addressed will, in the longer term, only add to the problems of poverty alleviation and inadequate nutrition. Even if food production overall is increased this is of little value unless the mass of poor and landless people can afford to gain access to the food resources potentially available.

The interventions imply some basic changes to the energy and chemical flow systems. The local vegetation and fauna will adapt to this, but the extent to which all species could be successful and maintain their regenerative capacity is not well understood, given the lack of basic data on the ecological systems and their dynamics. This, and other studies, have highlighted the need for more research. If embarked upon seriously, this research will initially raise many more questions than answers, until a number of years of monitoring and analysis have been conducted. Policy makers will have to decide whether they wish to proceed with more interventions before some of these basic questions can be satisfactorily answered or, whether to delay and reduce the risks of a poorly designed approach to resource management. Given the complexities and dynamics of the systems involved, there is no guarantee that research would be able to find simple answers or new solutions, either to maintain the present situation, or to mitigate better the adverse consequences of the current FCDI strategies. Even if FCDI projects do continue, it is still vital to monitor the situation. Financing and organisational resources to achieve this need to be guaranteed for monitoring before any further implementation proceeds.

IV.5.1.3 Resource Conservation, Management and Zoning

The sites of special interest which have been given consideration in the planning are listed below and shown in **Figure 5.1**:

Natural Beauty or Recreational Value

Coastal Zones and Lalmai Hills

Special Scientific Value

Offshore island and mudflats

Worthy of Protection and Conservation

Remaining habitat sites for migratory birds

Sites of high value for open water fish ecology

Remaining site of Sal forest

Sites of cultural and historic value

Worthy of Special Environmental Management & Monitoring

Sources of industrial pollution

Sources of agro-chemical pollution

Sources of concentrated urban sewage and wastes

Specific areas for resource conservation include the zoning of the region's main archaeological sites, forest areas, recreational sites and areas of last remaining important wetland habitats that are important for migratory birds and open water fisheries. Loss of these sites will not only affect the local ecology, but may have long-term economic and international ramifications which cannot be ignored. These, few sites should be examined closely from the viewpoint of the national importance. Their inherent value might warrant their consideration for national conservation and protection under the RWP, and if not coordinated through another programme to be specified by policy makers as a result of the SERS. Areas of agricultural lands where more intensive input use is already occurring, and other areas where it is likely to occur, should also be zoned for monitoring and pollution planning purposes. Particular emphasis needs to be given to such areas as the Muhuri irrigation and reservoir, and low-lying and drainage sites in the existing FCDI projects. The proposed environmental zoning plan, assuming a complete future development of FCDI, is shown in Figure IV.5.1. In addition, regular water quality monitoring at the sites shown in Figure IV.6.1 should be supported to enable a better understanding of the implications of pollution control measures associated with FCDI projects and the costs of raising pollution control standards in spite of these.

The IEE analysis has highlighted some aspects of development strategy which go beyond the scope of the immediate feasibility work and later management of any FCDI programme. The need for international coordination is an example. The Joint River Commission and the National Water Council are the two bodies concerned with the cross border issues and cooperation in planning and water management. Although the size of cross border flows in the south-east are not large by national standards, their flashy nature makes coordination important. The failure of cross-border regulatory structures, any increase in sediment erosion and increase in pollution from the cross-border catchments will all directly affect the downstream areas in Bangladesh to a greater or a lesser degree. It is unlikely that Bangladesh can have any direct influence on planning in the upper catchment, but should be in a position to know the potential ramifications of changing patterns of development, population, land use and industry in these areas.

IV.5.2 Construction Management

IV.5.2.1 Policy

Construction policy is a subject which will be taken up in further detail at the feasibility study. At that stage a range of topics would be appraised including service facilities, labour policy, public health and safety, contractor's site installations, services and pollution control, operations and disturbance, rehabilitation and reclamation provisions, social problems and consultation with local authorities.

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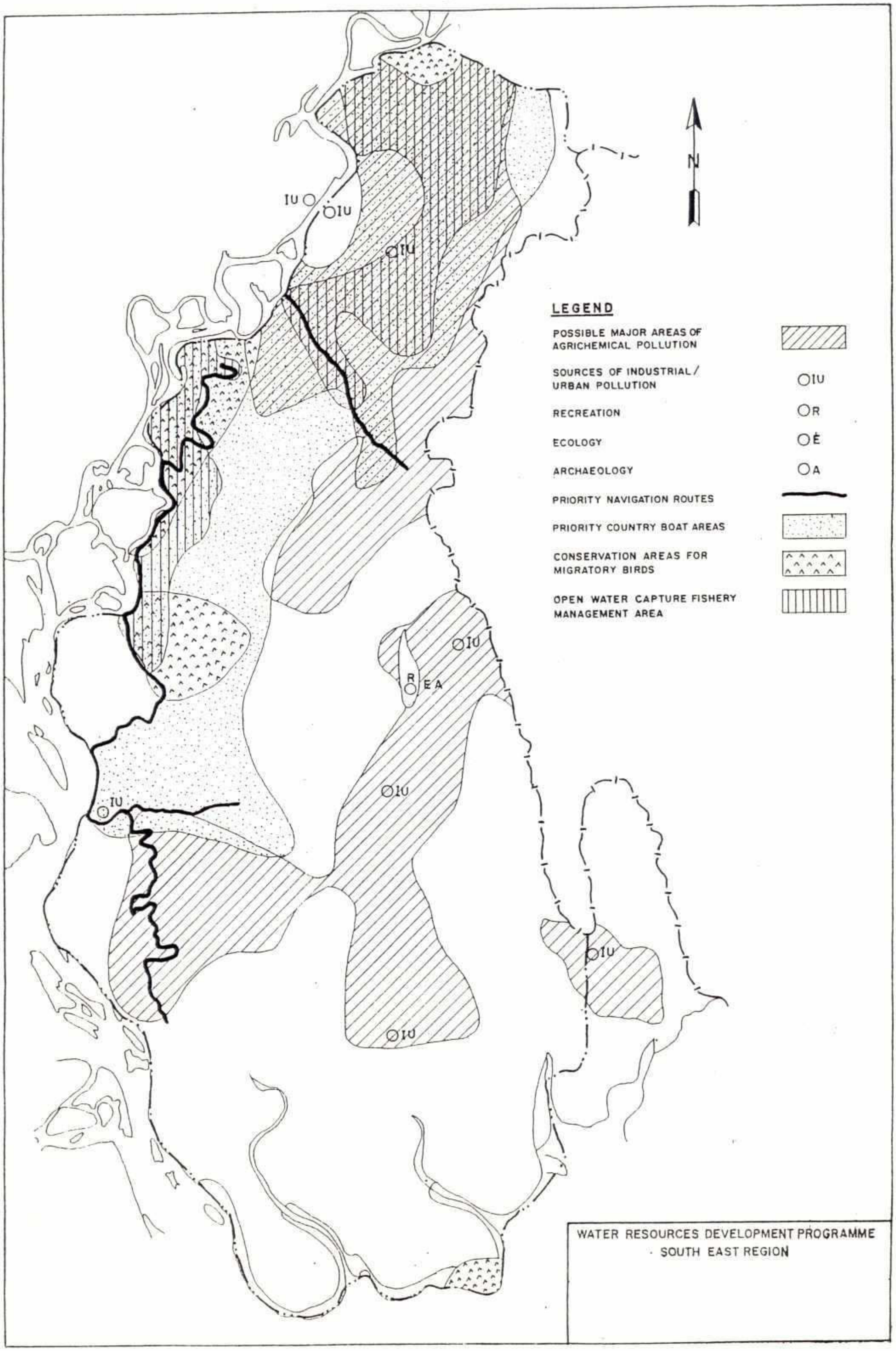
Figure IV.5.1

Regional Environmental Management Zones



IV.5.2.2 Resettlement, Land Acquisition and Compensation

The pre-project process of land acquisition and considering the needs for compensation for private and communal assets and resettlement will be a major impact of any embankments, canals and roads. It will also be the major feature which will delay construction. These aspects are the topics of special study under FAP 15 and their conclusions and guidelines will be taken into account during the feasibility study planning. Detailed surveys and planning for resettlement and compensation will be required in the feasibility stage covering a wide range of topics, such as cadastral issues, private and communal asset losses and values, socio-economic impacts and secondary impacts areas and public attitudes.

There is often an increased strain on government services during construction phase which can raise the costs of local government services. To avoid and mitigate these, careful preparation of construction contracts, contractors responsibilities and construction planning and coordination with other government services, is required. Ensuring that labour intensive and a local labour recruitment approach is adopted may require negotiating with donors and contractors, if contracts go to ICB. These provisions can help reduce social problems and tensions.

Resettlement Planning

Early and coordinated preparations are essential to ensure that any resettlement programme can be successful and planned, evaluated and implemented in an orderly and sympathetic way. If this does not occur it could induce an unnecessary increase in economic hardship, psychological problems, crime or other social disturbances. Carefully designed cadastral surveys, supported by full socio-economic surveys, are required to fully understand the negative impacts which the land acquisition and compensation programme can impose on the local community. Furthermore, a comprehensive inventory has to be made of the full range of private and community assets to be lost to the construction programme. A clear policy of compensation also has to be discussed and agreed upon with the communities to be affected. Credit programmes may have to be considered to establish families in new enterprises generated by projects. The provision of free community legal aid services also assist in this difficult period for local people.

A survey of any areas selected to resettle affected families must also be carried out in a timely fashion to establish the suitability of the resources available, and the environmental, cultural and political conditions which the settlers will have to adapt to. It should identify any additional special assistance or training needs in the receiving areas and the likely period of time required for assistance to ensure the shortest adaptation period to their new environment. Estimates are also needed of the time, resources and budgets required to provide these.

The options for resettlement in such a densely populated region are extremely limited. Local resettlement would increase the pressure on resources in an area which is already over-populated. Although specific surveys cannot take place until the feasibility or, more appropriately, the detailed design phase, families are likely to prefer resettlement in areas close to their existing villages for three main reasons: (a) so as to not disturb their existing social and family kinships bonds (b) to allow them to maintain other plots of land they own or work on outside the affected area and (c) their possible strong cultural ties with their traditional land and environment.

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Land re-allocation would be a complicated process, but the options available would be for allocation of government land (khas) through the Guchha Gram project or a planned programme of settlement into newly reclaimed char lands. This latter option will have to face many social and political difficulties involved in the organised hierarchies of private landlords who use strong arm tactics to appropriate such land, as has been documented through the Land Reclamation Project.

There are a number of social issues important in resettlement planning. Farmers look to a wide variety of activities to supplement their income; often moving to local towns on a temporary basis. A similar drift of young people to the towns on a more permanent basis has also started. The role of women is also under-estimated as they provide a major labour input in homestead farming, livestock rearing and crop processing, in addition to the daily responsibilities in the home and with children. In areas affected by embankments many will be concerned about the loss of livelihoods as fishermen, and having to face a future transformed into one of unfamiliar alternative occupations. This would include both professional commercial fishermen or traditional fishing communities based on their caste history. The social implications will affect the two groups differently.

Although Muslims are the majority population, minority ethnic and religious groups exist that will require special attention. Respect for influential figures in the community, particularly traditional and religious leaders, is an important part of community organisation and decision-making. Local leaders are key local representatives to consider if any compensation, land acquisition and resettlement programmes are to proceed smoothly and with minimum conflict. Most conflicts derive from disputes over the use of land and irrigation water and the location of irrigation facilities and conflict of interests arising out of differences in inter- and intra-religious values and traditional customs.

The principle of mutual assistance in village and community life is a powerful factor, confirming a strong adherence to religious and social commitments. Community members will often compete to participate in these activities setting aside any consideration for material gain. The generally poor education level, "closed" attitude, dominance of the patron-client relationships in social and production systems, high dependence on religious and social figures, and the close bonds of kinship relations are significant social features. These will influence the success of both the resettlement programme and the reactions of the local communities to the sudden onslaught of a major construction project. They will also affect their treatment of construction workers who might be recruited from other areas and who will have to live locally for the duration of their contracts.

Compensation

Experience of cash compensation payments worldwide shows it is often not invested wisely or very often used for replacement of lost assets. Often it will be spent on consumer goods or other services with little potential of preserving the present level of economic livelihood. This can particularly occur when compensation is paid as one ad hoc lump sum and is not linked or phased to the agricultural calendar or assigned for specific items, such as land or buildings or draft animals. Direct replacement is far more likely to preserve economic livelihoods. The transactions have to occur in a timely fashion to avoid discontent, or even destitution for specific households with no other forms of livelihood.

The loss of buildings or other assets should be given compensation equal to their replacement value. Judicious planning of the engineering works could allow settlement to continue on the higher ground provided. This would reduce the likelihood of social and economic displacement, the squandering of cash compensation payment on unproductive expenditures and provide housing with greater flood protection. In high flood risk and densely populated areas, spontaneous settlement on embankments is likely to occur anyway. It would be better to design for it, rather than to assume that it would not happen or could be controlled.

Surveys have been carried out to establish land or assets values based on current market sale values. Allowances of Tk 400 000 has been applied to cover all costs at this stage. If land acquisition and compensation are to be implemented in successive phases, land valuations would have to keep pace with the recognised inflation increase. This may lead to some conflict amongst the local population, unless the valuation basis is clearly understood and agreed with them. Elsewhere, payments for notional losses, such as the disruption and dislocation, are commonly paid, often as a percentage of the total claim based on the quantifiable assets.

Displacement often leads to a chain of secondary impacts and disruption to a number of hidden groups who will be economically or socially vulnerable. These vulnerable groups include sharecroppers and labourers not resident in the affected area who will lose their access to farms or work places, either as a result of the project works, or due to the displacement of families to whom they have been linked by contract or patron-client relationships. The loss of access to economic assets as the means of a family's survival is often of far more significance than the loss of residence site. However, the considerable work and investment in land-raising for settlements means that both factors must be given due attention. If well-planned, compensation and mitigatory provisions can be made for these additional secondary impact problems, and for compensation claims to be lodged for a specified period after the initial displacement.

Avoiding corruption and abuse in all these displacement, compensation and resettlement procedures is a major problem to be overcome. It is in the interest of all parties that procedures are seen to be fair so that the political system retains credibility. Continuity of approach and participation of the affected population are crucial to this process. An early moratorium on land transactions is needed before land acquisition. The monitoring and review of land tenure and ownership conditions and legislation would be important to continue through the remaining planning phases.

A major problem with compensation is that, when self-sustaining assets which provided a livelihood are lost, it is very difficult to replace them. Even in cases where this is possible, there is a time lag during which some affected households become particularly vulnerable. The payment of cash compensation by itself is normally unlikely to provide a sustainable livelihood. It is not until detailed enumeration and socio-economic studies are carried out that policies and strategies can be formulated. Priorities for each household can be very different.

Communal assets are those which have no recognised individual rights attached to them. Most of these are in practice owned and controlled by government, but open access systems still traditional apply. Overall, the range of items might include access to natural grazing and browse, livestock watering points, thatching and craft materials, medicinal herbs and forest products, open access to surface water and river bed resources (physical and biological), communication routes, community structures (religious facilities, tubewells, veterinary and government infrastructure and development projects), future development potential, health and social impacts, and disruption factors. The direct losses to any project might only include a few of these assets.

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Compensation for communal items are likely to be restricted to loss of infrastructure. Any project should unconditionally undertake to provide land, capital and the facilities to relocate lost community assets, whether they be government property or not. Further provision for compensating communities could be in the form of cash payments or selected development assistance. This provision may not necessarily reach the sections of a community who were most affected. The sensitivity of the local political system has to be relied upon to ensure that an overall notion of fairness is satisfied.

Valuation of communal assets is difficult in either commercial or economic terms since these methods cannot reflect the long-term value to society of processes and contributions which local facilities, grazing lands and river ecology make and for which there is no market. The loss of communal assets will intensify the pressure on resources elsewhere in the economy.

IV.5.2.3 Protection of Cultural and Heritage Resources

Palaeolithic sites and other archaeological items might be uncovered or affected by the construction activities. A detailed survey and planning programme for these sites might be recommended after reconnaissance surveys in the feasibility study. Archaeological surveys have not yet been allowed for and should be carried out by professional staff supplied from or approved by the National Department of Archaeology. Preliminary surveys need to identify the possible impacts and to detail the remaining needs for the pre-construction period. In some cases, the source of construction materials may be the same as sites used by other FAP projects in other regions. Whether this work needs to be carried out as part of the SERS, or coordinated under FAP supporting work overall, needs to be clarified.

The RWP would probably not significantly affect cultural resources, as most known sites are already on high ground. However, until detailed project location and design details are known this problem cannot be adequately ranked. The main cultural resources which might be affected would be religious sites, infrastructure and graveyards. To reclaim or preserve the cultural and heritage resources affected before construction work begins could require considerable attention and time. Early consultations will be required with the relevant authorities and local communities to establish if any such sites are sufficiently valuable to warrant a relocation programme. If any graveyards were to be affected, detailed discussions would have to be held with the concerned communities to establish fully their desires. A sensitive and highly personal approach would also be vital to make it clear that the authorities fully recognise the importance of the adverse consequence of the construction works. Wherever possible schemes should be designed to avoid having to disturb such sites.

The changes in lifestyles associated with FCDI projects can lead to a loss in various socio-cultural features of potential importance. These can be mitigated by the promotion and conservation of cultural traditions through encouraging multi-purpose production strategy in the engineering and planning design and by the specific allocation of support resources under the regional plan. This could involve the Ministry of Culture, as well as arts, crafts, educational and media organisations to help establish cultural conservation and educational strategies.

IV.5.3 Regional Employment Strategy

The creation of employment and a diversification of the economy is a major development need. The contribution of the RWP overall is likely to be of some, but not major significance. As such, the focus must be shifted to other sectors of the economy which may have more to offer in achieving government's strategic objectives.

While agriculture will continue to provide the main means of employment for the future the remaining natural resources and their current systems of use offer little scope for major employment generation. The livestock and arable sectors are unlikely to become commercialized systems in the near future, as they are still mainly family enterprises. In order to promote employment in the RWP labour intensive methods would need to be specified for all construction work. This would imply some careful consideration in the case of ICB contracting. Alternative industrial developments are being considered and developed within the framework of the other aid projects and existing commercial interests.

Some possibilities exist for the development of tourism and amenity but would need to maintain the integrity of the important archaeological and cultural heritage sites. Wetland and wildlife sites are unlikely to be more than of specialist and scientific interest, rather than of commercial value for tourism.

IV.5.4 Urban, Industrial and Other Development

It has not been possible to review plans for new urban or major industrial developments in the region. Studies and coordination ought to be carried out at the feasibility stage to ensure that conflicting interests do not arise in the need for future gas or mineral exploration/development, other industrial needs or for the defence needs of cantonment and communication infrastructure. The existing exploited minor deposits of high quality glass and ceramics sand which exist near to Comilla are not believed to be of impact importance. The industries shown in **Figure IV.3.10**, the existing urban layout and the high density of rural settlements throughout the region do raise serious questions for future water quality and water management.

IV.5.5 Public Health

IV.5.5.1 Nutrition

In spite of the major benefits from FCDI, in terms of the overall increase of food production, there are major concerns for the nutritional impact of FCDI projects. This focuses on the loss in open water fisheries and the potential ramifications of inadequate mechanisms for the equitable distribution of benefits and adverse impacts. The worries are that the poorer and more vulnerable groups have and will be affected dis-proportionately. The access to free sources of the minor species of floodplain fish is believed to have an important role in providing some vulnerable groups with protein, vitamins, minerals, oils and calories. Some of these would be difficult to mitigate without requiring the affected groups to move into raising extra income. The losses have important ramifications for various health problems including general anaemia and lowered resistance, eye problems and difficulties for pregnant and nursing mothers.

Mitigation could be by three approaches. The first would need a carefully planned and targeted health and nutrition monitoring and action programme integrated with each project. However, as malnutrition is a major national issue, irrespective of FCDI developments, these programmes ought to be part of the general regional development strategy. The second would leave the planning bodies and donors to coordinate and ensure that the general health sector plans were addressing the specific problems which FCDI might exacerbate. The third approach would be for replacement culture fisheries to be placed under the direct control and targeted towards these specific social issues and groups, and not developed or leased as commercially orientated businesses. The practical problems of targeting programmes are probably insurmountable and unrealistic to consider, unless there were a strong political commitment, particularly at the local level.

Specific advice on which mitigation strategy options which should be studied and planned for in feasibility studies will be required. Different strategies would require the inclusion of specialists such as nutrition and public health inputs at the feasibility stage. The relationship of these studies to the research studies being undertaken by FAP 16 will also be important to rationalise and to avoid unnecessary duplication. It is still unclear as to which research studies will actually be carried out.

IV.5.5.2 Disease and Disease Vectors

Current disease conditions are seasonally controlled by the annual cycle of flood events, drainage patterns and the seasonal changes in temperature and humidity. These provide physical limitation on the ability for habitats and breeding cycles to be maintained throughout the year. Certain diseases are favoured by this condition and others are restricted by it. Local micro-climatic changes brought about by dry season irrigation, and by the drying out of the environment through flood control, will alter the balance of habitats and their suitability for, either the existing, or new disease and vector regimes.

The major risks associated with FCDI interventions throughout Bangladesh will be the spread of habitats suitable for the mosquito vectors responsible for malaria, lymphatic filariasis, Japanese encephalitis and dengue virus fever and the sandfly vector of leishmaniasis. Increased populations of biting insects can also lead to skin irritation and infections. Presently filariasis and leishmaniasis are confined to areas in the north west region and malaria mainly to the hill tracts and higher ground of the country. However, a number of confirmed blood slides and deaths are confirmed every year of people in the SER. The risk of a spread of the disease cannot be ignored in feasibility study planning.

Similarly, FCDI projects will change the conditions of waterborne diseases such as diarrhoea and cholera. The prediction of the impact of these health factors is more difficult, as it will depend upon the ability of the designs to avoid poor drainage and stagnant and permanent pools of water. The prevalence of disease is also primarily determined by the quality of sanitation and waste disposal techniques and the access of the population to clean sources of potable water. Thus, with no mitigatory or complementary programmes, the impacts could be either positive or negative. There is a high international and national priority being given to provide people with access to clean water. It would seem appropriate that the RWP should have this as a specific objective of the plan.

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Some health problems can be caused by the excessive growth of phytoplankton and aquatic macrophytes. This is usually a symptom of eutrophication and build up of nutrients from decaying organic matter and flows of human and animal excreta, which themselves contain pathogens affecting health. These blooms often occur on a highly seasonal basis soon after there is little or no inflow, turbidity is declining and when water temperature increases. This occurs mainly from late July to early September. The main risk species are the Cyanobacteria, Microcystis spp. and Anabaena flos-aquae. They impart bad odour and taste to the water. Both species can be toxic, even lethal at high concentrations, to people and animals drinking untreated or poorly treated water. In most cases, the effects are sublethal and cause intestinal and dermatological disorders.

There is insufficient knowledge at present to predict, for any particular mix of local conditions and FCDI interventions, when, and if, these changing disease or vector profiles might become a problem. More research is required on the disease and vector species, habitat requirements, seasonal limiting factors and their geographical distribution within the region. There is a scaling problem involved in the thresholds which have to be crossed in terms of species and disease transmission from region to region and area to area. The transformation of habitats would also depend on the scale and proximity of FCDI interventions. The risks and potential future costs are, however, potentially too great to ignore. Proposals under FAP 16 seek to have considerably more research work done on these issues.

IV.5.6 Water Management Planning

FCDI interventions bring many consequences. Some have been anticipated and others will be unforeseen and have unforeseen consequences. Embankments will cut off the supply of water-borne organic materials and organisms brought in with the annual flood from the upper catchment areas. This will leave a new local aquatic ecology reliant mainly on local supplies of organic matter and resident organisms. Meanwhile the lost organic matter will be passed downstream into the estuarine and marine system. Tidal regulators will cut of the ebb and flow of water with as yet unknown affects. Irrigation will spread water over larger areas in the dry season. New health and pest hazards will occur as habitats change. Aquatic weed populations and species composition will change as nutrients build-up in drainage channels and pools from run-off from a densely populated landscape of urban and rural people and their associated industries, farms and livestock. The nutrients, chemicals and pathogens these sources provide also pose a potential pollution problem for the water supplies of downstream consumers. These risks need to be traced and properly managed if problems are to be avoided. Since these phenomena involve macro-scale and localised systems and movements, they cannot be seen simply from a project perspective and require a regional, national and ultimately international planning perspective.

The detailed study of the biological properties and ecological processes of man-made water systems which is proposed is still a relatively new science. However, certain criteria and guiding principles are available to plan with. But, biological controls and ecological management alone cannot be regarded as being sufficient or wholly effective. Only coordinated action involving a number of authorities and strategies will suffice. Any analysis must concern the dynamic ecological, social and economic framework into which the water development programme is to be set. Planned management must ensure that the nature of these processes are properly understood and that the planned interventions contribute to the protection of water quality, public health and development in an integrated way. To achieve these long-term objectives will require considerably more research and testing of plans. It will require the recruitment and training of staff with new backgrounds and education. It will also require an integrated management system to coordinate, supervise and monitor the programme which collaborates with public health officials and social workers.

The objective will be to reduce risks to public health or poor water quality and to make better economic use of the new productive resources FCDI will provide. To enhance water quality is contingent on how nutrients and pollutants can be managed and extracted from the system. The focus should shift to a closer examination of the chemical, nutrient and energy cycle as a whole. It should examine how this system can be more effectively managed to enhance water quality and economic productivity. Many of the existing nutrients are an organic source of a "free imported or local good" which can reduce the need for expensive manufactured inorganic fertilisers. Pollutants need to be avoided altogether, controlled at source or extracted and disposed of safely in the drainage network.

IV.5.6.1 Channel Morphology, Navigation and Breaches

Continued access for major and minor navigation is crucial to the viability of both community services, commercial and marketing activities and fishing needs. There should be no scheme which does not place navigation criteria on an equal footing to the needs for agriculture. The access for boats applies as much along the coast, as it does from river to floodplain. The needs are for the fishing communities and fish landing, and for general communications and travel. This will require careful survey of routes and landing points use to enable both locks and the careful siting of bridges to maintain the logic of route directions. Wherever structures are located sedimentation problems downstream will need to be dealt with by careful design and operation of the system or by a costed dredging programme and strategies to flush or remove aquatic weeds.

If roads and embankments were well-designed as a continuous system with multi-purpose objectives in mind, they could form a linked system for the movement and management of fish stocks, as well as maintaining lines of access for navigation and evacuation of water hyacinth to open water. Such an approach would involve some redesign to avoid road/bank erosion, but might prove viable when the multiple benefits are taken into account.

Sedimentation problem will also be associated with the confinement of the flood paths of most rivers draining from the Tripura Hills. The construction of any embankments that will contain the natural flood spreading pattern will lead to changing sedimentation, scouring and bank erosion characteristics. The option of containing the flashy rivers from the Tripura rivers has been rejected. This was because of the future problems of scouring and rising river bed levels increasing the flood risk considerably on surrounding land which would have ended up lower than the river. The Gumti river has already been embanked for most of its course. Special care over monitoring this scheme will be needed. Continued dredging may be one option, but disposal of this material will create problems in the long-term. Decisions on how to re-route the river, once rising bed levels create unacceptable high risks need to be planned and taken well in advance of any breaches which would re-route the river in an uncontrolled fashion causing major damage in settled areas.

Embankment breaches and extreme events will likely occur in the lifetime of the project. Coordinated and designed means of removing water quickly from behind coastal and other embankments will have to be considered at feasibility stage as well as the integration of non-structural measures into the plan.

Increased downstream flooding from FC and the costing of adverse impacts has not been specifically analysed in the hydrological or economic analysis. The reason for this is that the analysis only makes sense once a known series and implementation sequence of projects is specified. This will have to be considered in more detail at feasibility stage. As the SER lies downstream of the all the other FAP regions it will be susceptible to their downstream flood effects. Careful phasing of FAP projects would be needed and flood warning system or non-structural measures. It is also clear that interregional planning and mitigation for downstream effects is required to allow proper analysis of these effects.

Induced drainage problems could occur inside embankments. Detailed topographic surveys and drainage planning for small scale drainage structures is required. Continued monitoring of problems in practice (inside and outside schemes) and installation of small structures if necessary after main works are completed would be a recommended mitigation.

IV.5.6.2 Soil Quality and Management

There are a range of minor impacts identified which are likely to occur in very specific local sites. As soil surveys and planning continues these sites might be identified and a selective monitoring programme established. In the longer term improved local soil testing facilities can be set up supported by local extension services. The general loss of fertility associated with intensive agriculture involve the decline or low levels of organic matter. The major quantities of domestic sewage and aquatic weeds available suggest that concerted efforts to develop composting programmes should involve recycling and use of these resources. Protecting the ecological processes that maintain soil fertility are also vital and would involve encouraging crop rotations, minimal use of harmful chemicals and the use of green or livestock manures.

The moisture loss on high ground and homesteads associated with FCDI projects will require the monitoring of water table and impacts. Small-scale irrigation technologies and agro-forestry programmes for homestead farms might be associated with the water supply programme recommended. Where water tables fall, conversion to deeper tubewells would, in any case, be required. This would have the added advantage of avoiding the present health risks known to be associated with polluted shallow groundwater.

IV.5.6.3 Water Quality and Pollution

The water quality problems which may be encountered and should be planned for include algal blooms, pollution from faecal bacteria and pathogens, increase in pest and disease vector breeding sites, agro-chemical pollution of surface and groundwater water sources, industrial pollution, loss of biological diversity and controls reducing water quality problems, and the proliferation of aquatic weeds. The intensity of problems can be expected to increase in drought years and the concentration of nutrients by evaporation is greatest. The intensity of problems may also increase under the influence of FCD because an open draining system has been converted to a closed controlled drainage system. This means that water levels are continuously lower due to the absence or reduction of inflow. Also, micro-topography presents problems of designing a fully effective drainage operation. Reduced flow also means a decline in turbidity which allows a greater depth of penetration of sunlight and a possible stimulation of algal production. This would be further aggravated if fish and aquatic and amphibious organisms feeding on micro-organisms were not managed and protected as part of the strategy.

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HYV cropping, induced by FCDI and current extension methods, demands good control of pests and diseases to ensure economic feasibility and debt repayment capacity. Modern agro-chemicals provide the only answer as farming systems support lacks the research and institutional means to extend alternative integrated pest control management systems. Government is already aware of this. Limited research is testing alternative ways to protect the environment as agricultural techniques become more intensive. The shift to non-chemical means of pest control are already being adopted in a number of other countries where historic irrigation and mechanised farming schemes have created a range of physical, biological, economic, health and structural problems caused by the excessive and uncontrolled use of agro-inputs.

Bangladesh already uses between 4-5 000 tonnes of pesticide annually. If all farms in the region were to apply agro-chemicals, the long-term risks to local ecology, water quality, the food chain and human health would be considerable and strategically very important. By definition, most agro-chemicals are poisons, often derived from naturally occurring chemicals originally discovered in plant materials. Some are highly selective in their action, others indiscriminate. Some are bio-degradable, others gradually dissipate or are fixed in the soil or water medium. Some can enter and accumulate in the food chain, and many are hazardous to the health of workers, unless strict precautions are taken.

A number of international organisations and pressure groups monitor and release information on dangerous and banned chemicals which have a tendency to be dumped in Third World countries. These include amongst other the Pesticide Action Network, the United Nation's Consolidated List and the FAO's International Code of Conduct. Amongst the most hazardous agro-chemicals banned or severely restricted for use are DDT, EDB, Aldrin/Endrin, Chlordane/Heptachlor, Parathion, 2,4,5-T, Paraquat, DBCP, Lindane/HCH, Toxaphene and PCP. New research is also coming to light that suggests that, even those agro-chemicals passed by the strict standards in the developed countries, may have unacceptable levels of adverse human and ecological toxicity in the environment due to their inter-actions and synergist effects which are features which cannot be measured in the standard trials and testing procedures. There are also considerable problems in Bangladesh with the illegal smuggling of banned and undefined mixtures of agro-chemicals.

It is already known that considerable care is needed in the selection and management of chemicals because of the location of the irrigable areas and the nature and use of the waters entering the drainage system. Harmful effects can feed back through the groundwater system or through the aquatic based food chain. The floodplain aquatic faunal system, particularly fish, crustaceans and molluscs, as well as soil micro-organisms, are sensitive to toxicity. Specialized ecological zone exist in the estuarine and coastal areas which are also sensitive. These sensitivities means that careful monitoring will be an essential part of the routine activities of the MOEF working in close conjunction with the Fishery Department.

It is unlikely that the short-term maintenance of high yields using intensive chemical approaches in agriculture would cover the costs of the long-term loss in the degradation of these other productive resource systems, the potential public health risks, the later need to repair any damage and the resistance to chemicals which is already a well-established phenomena worldwide and in Bangladesh. This would be a typical area where some sacrifice of yields may be advisable while replacing these loss through other productive ventures in paddy culture, such as fish and bullfrog culture which themselves aid pest control measures.

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The effects of long-term use on soil and water chemistry, micro-biology and local flora and fauna ecology are poorly researched, but the potential risks should not be ignored. The evidence worldwide indicates that proper planning and guidance to farmers should be carefully prepared based on long-term needs rather than short-term expediency. To do otherwise may disturb important local ecological features and without prior knowledge of the implications. The need for a closer examination of the alternative measures of pest control and maintaining sustainable yield levels should be a high priority for implementation as a rational policy.

Other sources of pollution are the discharges of industry and sewage and waste from domestic sources. These impose both chemical and biological problems with potentially serious health and ecological risks if not planned for and managed properly. Oil-based pollution is spreading with the conversion of the transport, agricultural processing and farming systems to engines. This involves more spillages and exhaust gases. The industrial complexes involving newsprint, tanneries, jute mills, sugar mills are discharging mercury, lead, chromium arsenic and iron into the water network which FCD projects under FAP will be intervene in. Concentrated discharges of sewage greatly increase the biological oxygen demand. All these sources of pollutants seriously affect water quality for the proper functioning of the aquatic, terrestrial and human ecology.

IV.5.6.4 Pollution Management

The management approach should seek to integrate different methods to minimise the conditions which can lead to poor water quality. This would concentrate on physical and biological management techniques to counteract or remove the causes of poor water quality in situ. This would include the protection and stocking of fish and other fauna to encourage the uptake of nutrients, potentially toxic micro-organisms and disease vectors in the food chain. This policy should be encouraged in the main drainage systems, in the fields and in the standing water bodies. Encouragement would be given to systems of harvesting of these fauna and useful vegetation to remove biomass and pollutants from the system. The only sensible measures for the management of industry is for the treatment and payment at source. The setting up of these capacities, both in terms of staff and finances, is a considerable task beyond the terms of reference of this study. The MOEF would be the main body to liaise with donors on these issues.

All agro-chemicals are part of an industrial trade network which actively promotes the expansion of their markets and sale. Commercial interests should not be allowed to interfere with good farming practices and the preservation of a healthy environment for future resource users. Public education through agricultural research and extension, as well as the role of the media and NGOs, all have a role to play in combating these problems. As part of the FAP project donors could specifically fund and support such programmes.

No FCD schemes should be allowed to proceed to implementation unless their capacity to drain and, if need be, flush areas of potential risk had been carefully studied. Similarly, no schemes should proceed until they have shown adequate analysis of the implications of their agricultural chemical use on the enrichment and degradation of the ecological and economic systems that they may affect, either within schemes, or as a result of passing on problems to downstream areas. The direct effects of schemes on the drainage mechanisms for sewage and industrial pollutants should also be clearly analysed and planned.

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Further research into the dynamic interactions with climate, seasons, flora and fauna could establish other biological control and management mechanisms. This research work of ecologists and other specialists should be coordinated under the MOEF. It could call upon the a range of other institutions to assist, such as BRRI, the Fisheries Research Institutes, and the Engineering Research Institutes. International assistance could involve specialists supplied through such organisations as UNEP, IUCN, AWB and ICLARM.

Deterioration of environmental sanitation conditions and the protection of water quality for downstream users are not just responsibilities associated with BWDB projects. Improved public health, sanitation and proper waste disposal provisions in the villages and towns are vital if a deterioration in the quality of life is to be avoided. Where embankments intervene in the flood and drainage regime and divert external sources of nutrients and pollutants directly downstream and out into the sea, the impacts on the estuarine and marine resources and economy must be assessed.

Major improvements to sewage disposal, industrial pollution and agro-chemical pollution would be advisable with or without the RWP and must be seen as a complementary programme. Nevertheless, pollution planning data is virtually non-existent and feasibility study provisions to collect relevant data should be considered, as well as the urgent needs for direct support to a proper regional and national monitoring and training programme.

IV.5.6.5 Wetlands and Aquatic Flora and Fauna

The remaining wetlands sites have a number of potentially important roles apart from their productive use in water supplies and crop production. They maintain an important habitat for a diversity of aquatic flora and fauna and provide sites for resident and migratory birds.

Detailed research is required into the role of aquatic flora and fauna. This should include research into the life histories and habitats of those major and minor species which are valuable as a source of economic products, poor people's protein, vitamins and oils, and which provide important biological controls on pests and diseases.

Fisheries already play an important role in providing employment, generating exports, enhancing water quality, sustaining public health and aiding nutrition for the poorer groups. Various indigenous species readily consume vegetable detritus, eat the algae responsible for undesirable blooms, control the growth of water weed, and eat pest and disease vectors which affect humans and livestock. Apart from the locally consumed range of minor species and the commercially marketed major species of fish, there are other important economic aquatic fauna which sustain livelihoods as described in Chapter IV.3. Crustacean shell materials are already used in lime making and major new industrial uses for crustacean shells are being developed based on chitin and its products. There are many potential uses in the chemical, medical, pharmaceutical and food industries whose economic values could be a significant loss if habitats and bio-diversity were threatened by short-sighted FCDI planning. Some of the most notable uses being developed are their roles as food preservatives and their applications in the treatment of sewage, paper mill effluent, food factory waste and purification of water. In the medical field it has been found to have uses in accelerating wound healing and for skin grafting. The cosmetic industry has found uses for chitosan as have the hi-fi and acoustic industry.

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To sustain the varied forms of survival strategies, commercial opportunities and feeding systems which minimise disease and pest problems is vital, and should not be threatened by FCDI development. While the data base is limited, the important areas which could be identified have been have been included in the zoning plan. Integrated management for economically and socially important aquatic fauna is mainly based on the preservation of suitable habitats and the avoidance of pollution or over-exploitation. The approach taken has encouraged the maximum research into the engineering and regional planning options for maintaining these. The main possibilities are shown below.

- Engineer the means to maintain the capacity of migratory species to move from floodplain to river. The viability of this appears uncertain. Effective management planning would require a better understanding of the ecological and engineering requirements of the major and minor species.

- Engineer the means to maintain the capacity of resident floodplain species to move from beel and khal to floodplain through flood management criteria that allow for this and to integrate these systems with paddy culture and integrated pest management systems. The viability of this is more likely.

- Specifically allocate minimum wetland and floodplain sites within schemes to be fisheries development areas in the main flood season, but still allowing rabi and boro cropping on suitable lands. The viability of this appears certain, but would need careful design, a political commitment and would imply a trade-off with crop production in limited seasonal areas. As development has not already occurred, this trade-off is only notional and would not be any loss to current farming. It would imply a loss if the policy were introduced into the existing FCDI schemes. This aspect would require more detailed study.

- Specifically reserve areas within the region that would never be brought under flood control so as to maintain reserves for open water fish systems, bird habitats and to sustain the aquatic bio-diversity. These areas would mostly be the deeper flooded zones closer to the main rivers and would still have the capacity to continue with their current cropping systems. They could also be the more expensive areas to develop for full FCD and could be used for flood storage under any national FAP strategy.

Whether to maintain selected deep flooded zones as protected areas is a fundamental question which policy makers must answer for the feasibility study stage. The present evaluation indicates that it is unlikely that embankment works and structures could effectively offer solutions which could sustain the present open water fisheries and wetland ecology system and its inherent species diversity. Thus, this may be the last occasion when this type of alternative could be seriously looked at. The allocation of conservation areas to maintain integrity of original habitat and floodplain systems should be registered under the Protected Areas Network under the NEMAP. Improved conservation and management programme are required integrated under national management approach with defined priorities for each set of regional sites. Loss of species will needs to have an extended field survey capacity and gene bank programmes. Further works would also be advisable through national and community environmental education programmes.

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IV.5.6.6 Aquatic Weeds

Most of the common aquatic flora have been recorded in the watercourses around the region. The most important problem is water hyacinth and the blockage to navigation channels it creates, as shown in **Figure 3.9**. In heavy concentrations it can lead to de-oxygenation of the water body, threaten the viability of aquatic flora and flora (particularly fish) and create human health problems. These sites are often associated with nutrient enriched water, areas of poor drainage and where obstructions impede flushing. Otherwise, various species are present in water bodies throughout the region, but are flushed out with the annual floodwater and die and decay rapidly in the saline water of the estuaries.

In spite of its voracious growth characteristics and classification as a problem weed which is virtually impossible to eradicate, it also has many existing productive and future potential uses. It is used for livestock fodder, organic fertiliser, floating seedbed nursery and fuel. Its high cellulose content makes it useful as a raw material for industry. Its ability to rapidly absorb nutrients and chemicals (including heavy metals) in the water system give it a potentially important role in controlling the over-enrichment of water bodies. It could also be used for the extraction of some industrial pollutants at source and allow for their safer disposal.

In productive and navigation areas, and in water routes controlled by structures, it is important to control its presence. The current system is based on hand removal and the natural flushing of drainage channels in the floods. Any system which blocks these routes will inevitably face the problems of removing the backup of floating weed vegetation. Either the drainage systems have to be designed to let this flow of material through directly or through a bypass channel, or else specific development projects should be sited at these blockage locations to make use of the material which will accumulate there. These could be small-scale industries either making fertiliser or creating the raw material for composting, craft materials or industrial cellulose purposes. Research, education and a support programme for economic utilisation of prolific water weeds could be designed at the feasibility stage.

IV.5.7 Research and Management Coordination

The considerable scope of future work in the field of environmental management and monitoring will require a properly established and coordinated units of trained staff within the MOEF and the BWDB. At the present time there is a considerable reliance on consultants to carry out one-off studies. While it may be possible to rely on the inputs of international and national consultants for some initial planning surveys and studies, this approach should only be a short-term strategy. The long-term work requires daily coordination and development by personnel properly trained in the fields of environmental monitoring, planning and management. The major thrust of overall coordination should rest with the MOEF, but the BWDB should have the responsibility to bring its planning and design criteria up to the standards which reflect this more comprehensive and inter-linked approach to water resource development. The BWDB already has responsibility for monitoring various water variables important to the overall planning.

Recommendations have already come from the MOEF for environmental cells to be set up within the main government institutions. The minimum requirement would be for one senior management post within each region to allow the coordination and supervision. This post would need to be supported by field staff to carry out sampling and monitoring work. The questions of the full institutional staffing, facilities and management systems are not within the scope of the terms of reference of this study. The content of the next chapter will have some relevance to the final approach which might be adopted in each organisation.

IV.5.8 Consultation and Public Participation

It is important that the future planning procedure incorporates a major element of public participation and liaison at all levels. The present study has done this to a limited degree. Once some policy reaction has been indicated as a result of this study report, then the major affected parties can be drawn into the continued planning and future implementation. This would include administrative, political, media, NGO and community representatives. The basic structural and non-structural provisions and problems of land acquisition and compensation will initially need careful consideration. Later, in the feasibility stage, close liaison and coordination with other departments who would be involved in the execution would be necessary.

CHAPTER IV.6

ENVIRONMENTAL MONITORING, TRAINING & FUTURE STUDIES

IV.6.1 Aims and Objectives

This study has found insufficient basic research analysis and data to allow an appreciation of the likely magnitude of changes in key parts of the ecological and socio-economic systems. Current levels of basic monitoring and the availability of trained staff to carry out environmental monitoring are also in short supply. Further research and analysis will be needed to confidently assess how FCDI should be operated and effectively managed to mitigate adverse consequences and protect the environment.

The primary aim now is twofold. First, to ensure that adequate baseline studies are carried out during this feasibility phase, and before any final decisions on implementation of a final programme. This work will be mainly carried out probably by consultants and will draw together in greater detail the available data base. Second, to feed this programme into a longer term institutional monitoring programme. Both approaches should establish sufficient baseline data to catalogue and model the "before project" situation. It would then develop a capacity to detect and monitor change and assess the implications of this change. As a result, it ought to be able to advise, on an on-going basis, the actions necessary to offset any foreseen and, as yet, unforeseen adverse consequences arising from projects. The monitoring programme should also serve to refine the mitigation strategies as they are currently identified, given present knowledge.

Without trained staff and proper facilities being immediately available, this programme will take some time to establish. The major expenditures will be for training programmes since international resources will have to be relied upon in the initial stages to create a core of local staff who can take over this training function. Some limited investments in field and laboratory facilities will also be required.

The objective of the programme will be:

- to provide the operational facilities, personnel, technical and analytical skills, and the necessary finance to identify any adverse changes in the structure and quality of the environment which might threaten the self-sustaining nature of the resource base or the quality of the resources in current use.

- to provide the means to increase the database on, and understanding of, natural seasonal and annual fluctuations in key environmental parameters and inter-relationships.

- to provide the means of reporting to the relevant government authorities and the public the changes in environmental conditions brought about by the increasing interventions with the biological, chemical, physical and hydrological systems.

- to provide one mechanism whereby the management of a variety of currently isolated project activities within the floodplains and catchment may be brought together and an integrated resource management capacity installed to protect the interests of future generations of resource users.

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IV.6.2 Benefits Expected

The benefits of providing the necessary finance and resources for monitoring will include the means to assess water quality and management of supplies for potable uses and for irrigation and fishing in a project area. It will provide the means to monitor conditions outside project areas where other downstream river, estuarine and marine users and ecology may be affected. It will also identify the management needs for important wetland and river bed resource users and ecology. Competing demands do, and will, exist between some of these categories. The monitoring programme will help identify the nature of the minimum needs required by these various groups to maintain future development potential and conservation of resources. The monitoring programme will also help identify the main sources of pollutants and ensure that a programme of pollution control at source can be instituted. This will help ensure that the real costs are borne by the polluters and do not become a hidden cost paid by other sections of society. It will also ensure that industrial producers, in time, price their goods at the true market values which would include the pollution protection costs.

IV.6.3. Institutions Available

Under the current system the institutions which are responsible and available for monitoring are as follows:

SUBJECT AREA	INSTITUTIONS INVOLVED
WATER	
Water Tables	BWDB
River Flow	BWDB
Sedimentation and Morphology	BWDB & SPARRSO
Climate and Rainfall	BWDB & Department of Meteorology, MOD
Navigation	BIWTA
POLLUTION	
Potable Water Quality	Dept Public Health Engineering, MOLGRDC
Water Quality (biological & chemical for major towns and rivers	DOE, MOEF
Pollution Sources (industrial)	DOE, MOEF
Pesticide Research	Plant Protection Division, MOA
Pesticide Residues (limited capability)	DOE, MOEF
Atmospheric (occasional)	DOE, MOEF
Soil Quality	Soil Research and Development Institute (SRDI)
HERITAGE	
Archaeological Sites	Dept of Archaeology, MOCS & National Museum

BIOLOGICAL

Wetlands	Revenue Department, MOLGRDC & Natural History Dept, National Museum
Forests & Forest Products	Dept of Forests, MOEF
Flora	University Depts of Botany, National Herbarium
Fauna and Birds	University Depts of Zoology, Life Science Institute (JU), National Zoological Garden
Fish	Dept of Fisheries, MOFL
Endangered Species	MOEF, BRRI, FRI, WWF & IUCN
Wildlife	Wildlife Advisory Board, MOA

There are also a number of private agencies, NGOs and societies with particular or general interests in the field of general conservation and environment:

Bangladesh Centre for Advanced Studies (BCAS)
Bangladesh Wildlife and Nature Conservation Society (BWNCS)
Bangladesh Bird Preservation Society (BBPS)
Bangladesh Academy for Rural Development (BARD)
Bangladesh Institute of Herbal Medicine
Barind Protection Society (BPS)
Centre for Development Research (CDR)
Coastal Area Resource and Management Association (CARDMA)
Fisheries Society of Bangladesh (FSB)
Forum of Environmental Journalists (FEJ)
Friends of the Earth - Bangladesh (FOEB)
Nature Conservation Society (NCS)
Society for the Protection of the Environment (SCOPE)
Society for Conservation of Nature and Environment (SCONE)
Wildlife Society of Bangladesh (WSB)
Zoological Society of Bangladesh (ZSB)

IV.6.4 Socio-economic Surveys for Resettlement and Compensation

Numerous FCDI impacts have already been felt in the region. The RWP will extend and intensify these and affect many central linkages in the operations and structure of the social and economic systems. Some of these will have important political and social ramifications which government should be aware of. Socio-economic studies can assess the key areas where the planning and implementation of the programme might cause hardship and a re-structuring of the social and economic framework.

Socio-economic research (as opposed to monitoring) is currently carried out by a number of research institutes and project consultancies on an ad hoc basis. These give a good general data base for a number of areas and issues in the region. The needs of the next planning phase will become specific to particular project areas and type of interventions. The feasibility studies will need to carry out some semi-detailed socio-economic survey and inventory of private and communal assets of areas where land acquisition, resettlement and compensation

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may occur. This will provide important data on costs and planning options to help optimise amongst project alternatives at the feasibility stage. These surveys would also form one benchmark for future monitoring, if projects went on into detailed design and implementation. It would be preferable that these surveys be supported by new air photography to correlate sample household data with land tenure arrangements and cadastral data.

IV.6.5 Culture, Heritage and Archaeology

National research capacity to follow up on the historical and archaeological heritage is limited by the pressure on their scarce skilled resources. It would be preferable to integrate the research under an on-going programme which incorporates it into the scope and understanding of the history and significance of the whole region.

IV.6.6 Water Resources

Detailed discussion on groundwater and surface water modelling are discussed in Annexes V and VI. In general, the groundwater model and monitoring is adequate to assess likely physical impacts at the macro, but not local level. The available monitoring is less coherent for assessing the full range of water quality issues which might affect potable water supplies and the use of groundwater for irrigation and its impact on fisheries and lowland ecology. A considerable amount of analysis has been undertaken by the IDA Deep Tubewell Projects that is relevant to part of the project area.

The understanding of surface water impacts suffers from a lack of monitoring sites and modelling reliability on the floodplain and in the wetlands to assess ecological implications. A few isolated studies and some ad hoc sampling by the DOE have looked into water quality issues in selected locations. Regular monitoring of surface water supplies is desirable and Figure IV.6.1 proposes some typical sites where this would cover the issues of monitoring pollution from industry, sewage and agro-chemicals. This programme should be coordinated under the DOE once its institutional strength has been improved.

The key characteristics of morphology and sedimentation in lesser rivers should be dealt with by BWDB. The monitoring of channel sedimentation as it affects navigation is already an on-going planned responsibility of BIWTA. Marine and freshwater navigation paths will have to be carefully surveyed during the feasibility surveys and give special attention to internal routes within schemes, as well the more obvious major routes used by larger boats and ferry/commercial services. Close liaison is required with them to ensure that any RWP structures, drains and canals can maintain or even enhance access for navigation. The Gumti river has already been embanked for most of its route to the Meghna confluence. There is a need for a continued and careful monitoring programme to track the rate of scour and bed rise along the confined channel. This is the direct responsibility of BWDB.

IV.6.7 Ecology

The surveys during this study found that the relative importance and distribution of the natural and lesser known economic terrestrial and aquatic flora and fauna of the area are poorly known. Although this study has provided a general list of known species, significant gaps remain. Basic information on the dynamics of the chemistry, micro-biology and productivity of the systems is lacking. More detailed surveys will be required if these issues are to be addressed in the feasibility planning stage. However, the minimum required will be monitoring over

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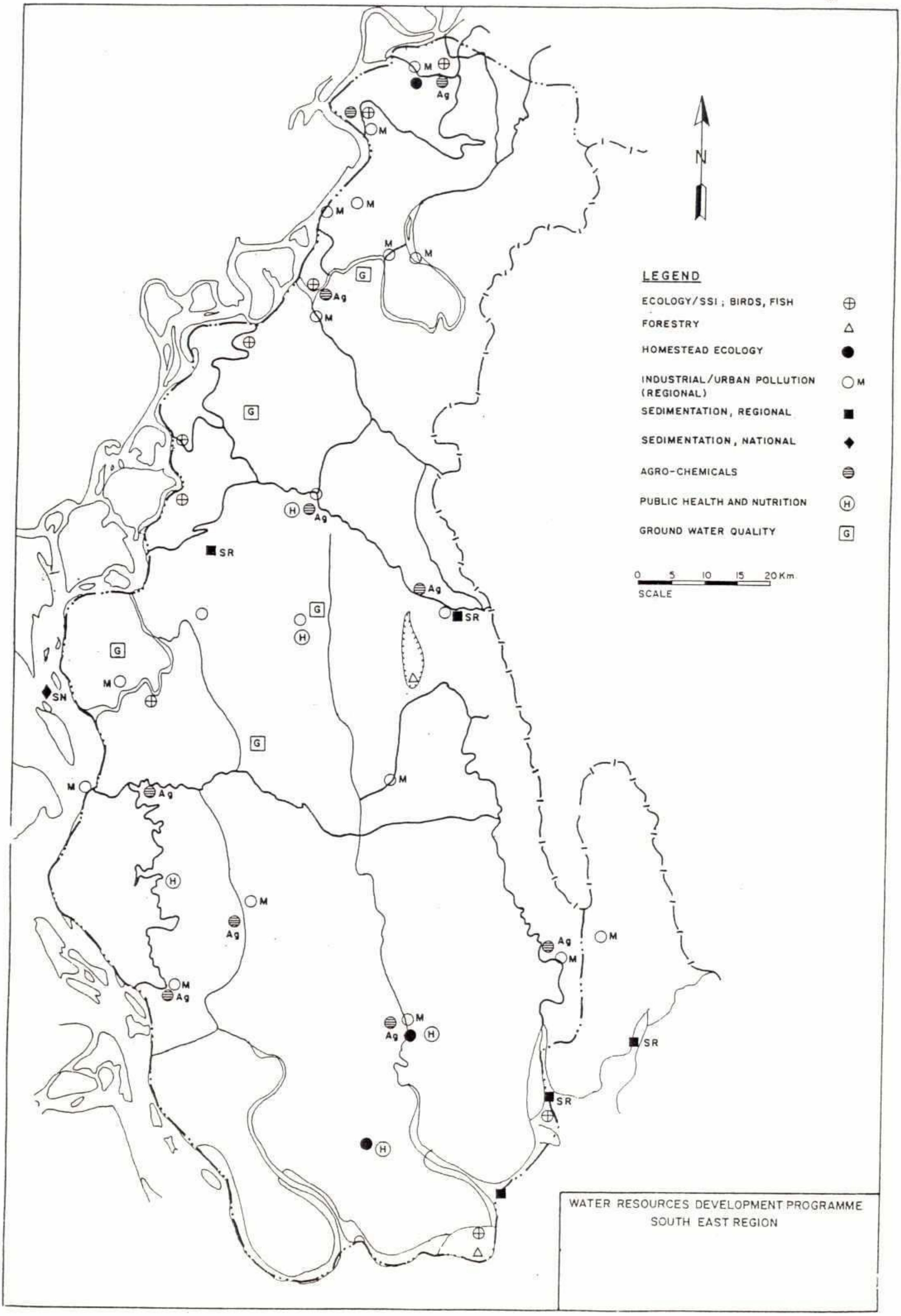
Figure IV.6.1

Environmental Monitoring Sites



one year to cover the main seasonal variations. This would not allow the implications of annual variations to be assessed. Thus, the contribution of feasibility surveys in these areas will be extremely limited. The best that could be done would be to undertake a structural survey of habitats and species types with basic biological and chemical parameters specified for the time of survey. If this approach is to be adopted as part of the SERS, additional resources will be required to provide the botanical, zoological, micro-biological and chemical specialists and laboratory facilities to enable the study to carry out rapid identification and assessments in the field and follow this with proper analysis and interpretation. The scale of this programme would depend on the number of project sites select for feasibility study and the complexity of the habitats and potential impact areas in each.

The importance of the wetland and estuarine/coastal ecology and its major fisheries has been stressed. Little is really known of how this system operates and maintains itself and how the fluctuations in the water levels, extreme climatic events and impact of FCDI and agricultural inputs influence the system. Basic ecological research is required to allow further understanding on the dynamics and regenerative processes which control the development and survival of these ecology systems and their relationships to agricultural production and human health.

The status of research studies recommended under FAP 2, 5 and 16 are not known as yet, but these have recommended a number of representative sites where research and monitoring should be undertaken which includes sites in the SER. It has yet to be determined who would carry these out. In the longer term this ecological and habitat monitoring work should fall under the general coordinating control of the MOEF. They would require the assistance of research institutions, such as IUCN, WWF, ICLARM, BRRI, the various local NGOs and the proposed environmental cell of BWDB. These could provide monitoring and data in their own specific areas of interest. One example would be the monitoring of population trends in the remaining wetland and coastal sites for migratory birds and the impact of development and noise pollution from irrigation pumps. Some of this work can also be encouraged through research grants to university students as the environmental training systems evolve. The basis of this work is, by nature, inter-disciplinary and process orientated. This implies the need for a strong institutional and academic support service.

More information is also needed on the functional relationships between the wetland and floodplain ecology/habitats and the groundwater aquifers. How much water moves laterally and how far? How dependant is the lowland ecology on water levels in the river channels or draining from higher groundwater? What sorts of feedbacks exist between the wetland ecology and the field and human ecology system? How much organic matter from the floodplain ecology enters the river system and visa versa, and what is its contribution to soil fertility and crop productivity? How important is agro-chemical and industrial pollution in affecting the quality of the river and groundwater water or bottom sediments?

Little or no information is available, even though the problems have been long identified. Research aimed at answering some of these questions should be encouraged and should form a major national research objective. These are all beyond the capacity of feasibility studies to address and can only come from longer term and detailed research and monitoring. The priority areas to monitor are the critical wetland and fish habitats, the remaining forest area, the sites of freshwater mollusc extraction, the impacted areas at the major FCDI schemes, the Meghna and Feni estuarine zones and the coastal mudflats.

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IV.6.8 Water Quality

Water destined for domestic, fisheries, irrigation and estuarine use must be of sufficiently good quality to maintain productivity and a basic quality of life. This involves standards that require minimum physical, chemical, biological criteria to be met. There is much concern over the imposition of too high a set of standards in poor countries like Bangladesh which may incur high costs to achieve. There is therefore some demands from politicians and planners to seek to reduce standards set in the developed countries which are more appropriate to the local financial constraints. However, this may be false economy as the costs of the degradation to productivity and the quality of life may end up costing the country and health system far more in the long-term. The crucial issue is to aim to understand what the minimum requirements actually should be. On this issue there is no simple answer and the debate is still strong worldwide. Draft water quality standards were issued by the MOEF in July 1991.

The most cost-effective approach, which can immediately be followed, is to ensure that there is a coordinated and integrated approach to water management between various sectors and built into the design criteria of projects and that the primary quality indicators are monitored. This means that the processes which lower water quality and introduce human, floral and faunal health-related problems need to be identified, understood and the systems managed to avoid or minimise these problems.

The current management approach is not sufficiently integrated and is reactive, rather than pre-emptive (i.e. actions taken to maintain or enhance water quality are generally implemented in response to declines in water quality to unacceptable levels even if these were known). Moreover, the actions which might be taken appear to treat the problems as physical and chemical ones, rather than as ecological or overall resource use management issues.

Effective management requires first, that the kinds, amounts and timing of the inputs are known (the object of monitoring) and secondly, that there is a realistic plan for the management of the catchment, which is able to affect the inputs. Regular monitoring is needed to establish the direction, rates and magnitude of any changes in the levels of nutrients and other biologically active substances in the system. Monitoring of selected biological variables is also necessary in order to provide some index of response to any physical-chemical changes. Since most water quality problems arise from high inputs of sediments, nutrients, sewage, agro-chemicals and industrial wastes, monitoring of these inputs is essential to detect any changes and thereby provide advance warning of potential problems. Potential sources of these substances need, on an on-going basis, to be identified, evaluated and, where possible, controlled through legislation on controls at source and by sanitation and public health and educational programmes. In view of the sensitivities of the aquatic fauna to pesticide levels and use the ability to measure residues through a monitoring programme is vital. This facility is very restricted in Bangladesh at present.

It is recognised that the full range of sources are diffuse and difficult to manage and that the programme will take many years to implement. But the longer that the problems are not seriously addressed, the greater the impacts will be as population, agricultural and industrial development proceeds.

IV.6.9 Health

The major risks to public health discussed in the evaluation are not subjects directly for BWDB to monitor. But unless the conditions before and after interventions are monitored under careful supervision, and in close liaison with the other research elements, it will be difficult to tie the individual research results together. Baseline surveys by the Ministry of Health using its research institutes are advisable as part of the planning process.

The baseline surveys must determine the current status of the vectors and disease and trace the likely paths of impact of FCDI to help the final project design to fully mitigate and avoid future problems. Basic monitoring should then continue to test the various models and examine, in practice, what happens in each location. It should trace the thresholds which are reached as more and more geographical locations come under the influence of the various FCDI interventions. The surveys should also test for the possible transmission of the disease that could be brought into the area during the construction activities and identify the occupational health units which will be required during the construction operations.

The most important factor in promoting a healthy environment during and after construction is the on-going programme of health education to make people aware of any new risks that they may face as a result of the interventions. This must be directed towards two distinct target groups - health professionals and the general public. Health professionals require specific in-service up-dating in the new potential health hazards, their epidemiology, prevention and treatment. The general public requires a less technical and less formal programme of health education. This should be designed to explain in the most appropriate ways the possible health hazards, the means of recognizing them, the ways of avoiding them when they do occur, and the availability and (when appropriate) the urgency of treatment. This programme should be designed during feasibility study phase so that the health sector has the opportunity to respond in a coordinated way with the various activities of the BWDB.

These are studies that should be carried out to support all future projects. The availability of data and planning needs in time for feasibility studies could be a major limitation unless feasibility studies are given adequate resources to carry out the necessary studies at the project level.

IV.6.10 Training Requirements

BWDB has recently started to change its approach to water resource development away from an engineer-dominated attitude with little co-operation undertaken with other agencies although all its staff are engineers it employs no specialists in the natural or social sciences. It has cooperated with the Department of Forestry to test out tree planting on embankments, with the Department of Fisheries, in BWDB controlled water bodies, and with landless co-operatives and women in earthwork construction and maintenance.

The question of training should first address the employment strategy which BWDB intends to follow in the future. If it did not recruit non-engineering staff then environmental training needs would be considerably different from those required of BWDB if it did. Many of the fields of environmental management require direct access to teams of inter-disciplinary specialists and multi-disciplinary analysts. If these people were not available in BWDB then much closer direct links would have to be set up with the MOEF which does intend to recruit such staff in the future.

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The first level of training would need all engineering staff entering BWDB to be made aware of the linkages which BWDB work has with other sectors and the social and ecological responsibilities which water resource interventions imply. This can be dealt with by induction courses. For those staff already in service, annual orientation and regular refresher courses can be held. The preparation and delivery of these courses are best prepared through a multi-disciplinary approach involving a range of competent and knowledgeable social, economic and natural scientists, together with people with planning and engineering backgrounds. Once a basic portfolio of material is ready its presentation has to be made appropriate to the age, educational backgrounds and level of responsibility of the participants who will be involved. These course materials then only need some reviewing on an annual basis to improve and update their content on the basis of the experience in use and changing circumstances in the country.

The second level of training would use actual projects in various stages of planning, design, construction and operation as research case studies to identify key issues of concern and where major strategic or tactical re-thinking is required on historic BWDB approaches to water resource planning. These issues would have to be professionally researched and prepared for use in seminars and workshops. This would involve a research programme calling in various research institutes to collect data and make case study material available in a suitable format for educative discussions, usually over a two to three day period. This type of training is most fruitful when the researchers and training facilitator coordinate the topic material with field trips that expose the participants to the actual field sites/habitats and communities where the problems are arising. The critical debates have to be carefully summed up and conclude with the identification of potential solutions and new ways of approaching the design and operation of the particular facet of concern.

First this general approach to training it would be necessary to consider either the re-training of engineers in other subject fields, or training new specialists to enter BWDB employment. There are three main areas where this could be necessary:

- the creation of professionals to staff an environmental cell who, in the future, would be able to become legally registered as competent to carry out EIA on behalf of the BWDB for presentation of projects for environmental clearance through the MOEF. The alternative to this is for BWDB to continue recruiting consultants to prepare these EIAs for them.

- the creation of a body of environmental scientists (physical, natural, social and economic sciences) capable of carrying out field research to enable environmental considerations to be fed directly into the planning and design of BWDB projects and to establish a coherent ecological and socio-economic database and models. This work could be carried out both in BWDB and the MOEF in a coordinated fashion or the work could be left solely with the MOEF. The less coherent approach would be to continue to have ad hoc surveys and research through consultants and university research.

- the creation of field officers trained in the skills of monitoring key environmental indicators to ensure that each region had a consistent monitoring capability. Again this could be carried out alongside and complement the work being proposed in the MOEF or can be left to them alone. This work is not most appropriately done by consultants as it requires permanent facilities and staff presence on a long-term basis.

The training requirements for these subject fields are quite different. There is currently no institutional training capacity in Bangladesh for EIA. However, private local organisations, such as BCAS, could offer this facility in conjunction with their international networks and linkages. This facility could also be offered through training budgets which brought international trainers into the country or else took students out to overseas training courses. Typical institutional locations for such training are available, for example, through the IUCN in Switzerland, at Wye College at the University of London and the University of Aberdeen in Scotland. There are also a number of private international companies who offer services in EIA training.

The second area requires an extension of basic specialist university science training to encompass the new fields of research coming to the fore in modern environmental studies. The most obvious gap is that there are no courses or training available in ecology and environmental pollution. Dhaka University does offer degree courses in environmental management. Funding to address these issues would take some years to organise and produce a sufficient cadre of staff. Thus, in the meantime, it will be necessary to set up scholarships to have more people trained overseas until the local facilities can be created. The former strategy should receive the priority in this approach with the overseas component only seen as a short-term stop-gap measure.

The third area of monitoring skills is less difficult to deal with as, within the scope of existing institutions, this type of training should be possible to organise, if the funds and commitment were made available.

IV.6.11 Financing

The estimation of training and other environmental management costs has not been possible at this stage as there are so many policy and strategic issues on which decisions are required by the BWDB, MOEF and the donors. These issues will have to be taken up in more detail in the feasibility planning stage.

There are many issues raised which concern the future studies required to enable a coordinated approach to feasibility surveys if future projects are to be taken straight on into the detailed design and tendering stages. These include:

Compensation and Resettlement Studies
Ecology Studies
Water Quality
Pollution Monitoring
Archaeology Studies
Sedimentation Studies
Public Health Studies

The costs of these will depend on the projects selected for study, the area they cover and their complexity. These aspects should be given greater emphasis and resources at the outset of the studies than was the case with FAP 5.

APPENDIX A

LEGISLATION RELATING TO ENVIRONMENT

APPENDIX A

LEGISLATION RELATING TO ENVIRONMENT

A. Laws Relating to Natural Resources:

- Constitution of a reserved forest,
- Prohibition of certain kinds of uses of forest,
- Punishment for contravention of uses of forest resources,
- Stopping of public or private way or water course,
- Manner and seasonal restrictions on fishing and hunting,
- Sanctuaries for endangered species,
- Manner in which game animals are to be hunted,
- Legal protection to specified wild animals,
- Declaration of wild life sanctuary and national park,
- Protection and conservation of fish in the inland water,
- Prohibition and regulation of the use of various fishing gears and means,
- Prescription of fishing seasons, catch size and species,
- Prohibition of fishing in any specified water or waters for a specified period,
- Management, conservation and development of marine fisheries,
- Specification of types, classes and numbers of fishing vessels and manner of fishing in marine water,
- Designation of marine fisheries reserve for protection of aquatic flora and fauna, natural breeding grounds, habitats and natural regeneration,
- Scientific studies and research in protected areas,
- Special measures to preserve and enhance the natural beauty of protected areas and may prohibit fishing, dredging, extracting sand or gravel, discharging or depositing waste or any other polluting matter,
- Conservation, use and exploitation of marine resources as well as the control of marine pollution,
- Establish conservation zones and take measures in order to maintain the productivity of the living resources.

The main legislation includes:

1. Indian forest acts of 1878, 1890, 1891, 1901, 1911, 1914 and 1918,
2. Forest act of 1927 (Act No. XVI of 1927),
3. Regulatation of hunting, shooting and fishing within the controlled and vested forests, 1959,
4. Bangladesh wildlife preservation order, 1973
5. The Elephant preservation act, 1879,
6. The wild birds and animals protection act, 1912,
7. The Rhinoceros preservation act, 1932,
8. Protection and conservation of fish (Amendment) ordinance, 1982
7. The Rhinoceros preservation act, 1932,

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APPENDIX A (Contd)

8. Protection and conservation of fish (Amendment) ordinance, 1982
9. East Bengal protection and conservation of fish act, 1950,
10. The East Bengal state acquisition and tenancy act. 1950 (Act, XXVIII of 1951),
11. Indian fisheries act of 1897,
12. Marine fisheries ordinance, 1983,
13. Territorial water and maritime zones act, 1974.
14. The haor development board ordinance, (Ordinance No. IX of 1977).

B. Laws Relating to Protection of Cultural and Natural Heritage:

These provide for the government to:

- Declare ancient movements to be protected movements,
- Take into custody, preserve and protect the antiquity,
- Acquire land that contains antiquity,
- Purchase, lease, accept gifts or bequests of antiquity,
- Prevent antiquity being destroyed, injured, mutilated or falling into decay,
- Prevent pollution and desecration of monuments,
- Prevent unauthorized export of antiquity,
- Prevent unauthorized archaeological excavations,
- Prevent taking of unauthorized pictures of antiquities for commercial purposes.

The key legislation includes:

1. The ancient monument conservation act, 1904,
2. The antiquities (Export Control) act, 1947,
3. The antiquities act of 1968,
4. The antiquities (Amendment) ordinance, 1976.

C. Laws Relating to Health and Sanitation, including Water Supply, Drainage, Food, Sewerage, Urban Planning and Occupation Hazard

These laws relate to Local Government Institutions, such as the District Boards, Union Councils and Municipalities ability to deal with the protection of environmental health :

- Sanitation
- Water supply
- Public bathing places
- Conservancy services,

APPENDIX A (Contd)

- Control and administration of public water courses,
- Environmental promotion, such as maintenance of public gardens, public places, plantation and preservation of trees, prevention and abatement of nuisance in public places, regulation of offensive and dangerous trades, prevention of contamination of sources of water etc.

The key legislation includes:

1. The Bengal local self government act of 1885,
2. The Bengal local self government act of 1919,
3. The Bengal village self government (Amendment) act, 1935,
4. The municipal act of 1932,
5. Basic democracies order, 1959,
6. Paurashava ordinance, 1977,
7. Local government (Upazila Parishad and Upazila Administration Re-organisation) ordinance, 1982,
8. Local government (Union Parishad) ordinance, 1983,
9. The town improvement act. 1953,
10. Factories act. 1965,
11. The factory rules, 1979,
12. Shops and establishment act, 1965,
13. Pesticides ordinance, 1971,
14. Agricultural pesticides (Amendment) act. 1980,
15. Agricultural pesticides (Amendment) ordinance, 1983,
16. Food adulteration act. 1919 (As amended up to 1931),
17. Bangladesh pure food ordinance, 1959,
18. Bengal motor vehicles act. 1939,
19. Motor vehicles rules, 1940 (As modified up to 1983),
20. The Bangladesh penal code, 1860 (As amended from time to time)

D. Laws Relating to Control, Prevention and Abatement of Pollution of Air, Water and Soil:

These acts provide for the control, prevention and abatement of pollution. The Environment Pollution Control Board (now the Department of Environment) established under this 1977 ordinance would be responsible for :

- Formulating policies for the control, prevention and abatement of pollution of environment,

and - Suggesting measures for the implementation of its policies.

The key legislation includes:

1. The water pollution control ordinance, 1970,
2. The environment pollution control ordinance, 1977 (Ordinance No. XIII of 1977).

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APPENDIX B

RARE AND ENDANGERED WILDLIFE SPECIES IN BANGLADESH

APPENDIX B

RARE AND ENDANGERED WILDLIFE SPECIES IN BANGLADESH

Key to Status: 1 = Very Common, 2 = Fairly Common, 3 = Common
4 = Uncertain 5 = Threatened 6 = Endangered

CATEGORY/NAME	PAST STATUS (@ 1940)	PRESENT STATUS
MAMMALS		
Slow Loris *Nycticebus coucang*	2	6
Common Macaque *Presbytis entellus*	2	6
Crab Eating Macaque *Macaca fascicularis*	2	5
Hoolock Gibbon *Hylobates hoolock*	3	6
Large Civet *Viverra zibethina*	3	6
Fishing Cat *Felis viverrina* *	2	6
Jungle Cat *Felis chaus*	2	5
Tiger *Panthera tigris*	2	6
Leopard *Pantheris pardus* **	3	5
Clouded Leopard *Neofelis nebulosa*	2	6
Asiatic Elephant *Elephas maximus*	3	6
Barking Deer *Muntiacus muntjak*	3	5
Sambar *Cervus unicornis*	3	5
Serow *Capricornis sumatraensis*	2	6
Hispid Hare *Caprolagus hispidus* *	3	6
REPTILES		
Estuarine Crocodile *Crocodylus porosus* *	3	6
Gharial *Gavialis gangeticus* **	3	6
Olive Ridley Turtle *Lepidochelys olivacea*	3	6
Green Turtle *Chelonia mydas*	3	6
Hawksaw Bill Turtle *Eretmochelys imbricata*	3	6
Loggerhead Turtle *Coratta coratta*	3	6
Leatherback Turtle *Dermochelys coriacea*	3	6
Batagur Turtle *Batagur baska*	3	6
Bostami Turtle *Trionyx nigricans*	3	6
Land Tortoise *Geochelone emys*	3	6
Grey Lizard *Varanus bengalensis*	3	5
Monitor/Ring Lizard *Varannus salvator*	1	5
Yellow Lizard *Varanus flaviscens*	3	5

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Clouded/Black Lizard *Varanus nebulosa*	3	5
Rock Python *Python molurus*	2	6
King Cobra *Ophiophagus hannah*	2	6
Dog-faced Water Snake *Cerberus rhynchops*	3	5
Hook-nosed Sea Snake *Hydrophis cyanocintus*	1	5
Banded Sea Snake *Hydrophis fasciatus*	4	5
Estuarine Sea Snake *Hydrophis obscurus*	3	5
Common Narrow-headed Sea Snake *Microcephalophis gracilis*	3	5
Cantor's Narrow-headed Sea Snake *Microcephalophis cantoris*	3	5
Amphibians		
Bull Frog *Rana tigrina*	1	5
Green Frog *Rana hexadactyla*	4	5
BIRDS		
Little Grebe *Podiceps ruficollis*	1	5
Darter *Anhinga rufa*	2	5
Purple Heron *Ardea purpurea*	2	6
Grey Heron *Ardea cinerea*	3	5
Openbill Stork *Anastomus oscitans*	3	6
Lesser Adjunct *Leptoptilus javanicus*	2	6
Whitenecked Stork *Ciconia episcopus*	2	6
Glossy Ibis *Plegadis falcinellus*	2	6
Spoonbill *Platalea leucorodia*	2	6
Greater Whistling Teal *Dendrocygna bicolor*	3	6
White Winged Wood Duck *Cairna scutulata*	2	6
Comb Duck *Sarkidiornis melanotos*	2	6
Black Winged Kite *Elanus caeruleus*	3	6
White Bellied Sea Eagle *Haliaeetus leucogaster*	3	6
Pallas's Fishing Eagle *Haliaeetus leucoryphus*	2	6
Greyheaded Fishing Eagle *Ichthyophaga ichthyatus*	3	5
White Backed Vulture *Gyps bengalensis*	1	5
Assam Black		

APPENDIX B (Contd)

Partridge *Francolinus francolinus*	2	6
Rain Quail *Coturnix coromendelica*	3	6
Common Peafowl *Pavo cristatus*	2	6
Pheasant-tailed		
Jacana *Hydrophasianus chirurgus*	2	5
Painted Snipe *Rostratula bengalensis*	2	5
Brown Fish Owl *Bubo Zeylonensis*	2	6
Great Hornbill *Buceros bicornis*	3	6
Hill Myna *Gracula religosa*	3	5
Paradise Flycatcher *Terpsiphone paradisi*	2	5

Source: MOEF, Draft National Conservation Strategy, July 1991.

APPENDIX C

THREATENED FLORA - TENTATIVE LIST

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APPENDIX C

THREATENED FLORA - TENTATIVE LIST

PTERIDOPHYTA	DISTRIBUTION
Psilotum triquetrum	Khulna
Tectaria chattagramica	Barisal
ANGIOSPERMS	
Aglaonema clarkei	(endemic) Chittagong
Aldrovanda vesiculosa	Bandarban
Aquillaria agallocha	Dhaka, Rajshahi
Cirrhopetalum roxburghii	Sylhet
Cymbopogon osmastonii	(endemic) Sunderban
Debregeasia dentata	Bogra, Dhaka
Elaeocarpus lucidus	Chittagong
Hippocratea macrantha	Chittagong
Homalium schichtii	Chittagong
Justica oreophila	Chittagong
Knema bengalensis	Chittagong
Limnophila cana	(endemic) Cox's Bazar
Mantisa spathulata	(endemic) Jamalpur, Pabna, Dhaka
Marsdenia thyrsiflora	(endemic) Chittagong, Sylhet
Ophiorrhiza villosas	Central Regions
Phrynium imbricatum	Chittagong
Quercus acuminata	Chittagong
Rotala simpliciuscula	Chittagong
Semecarpus subpanduriformis	(endemic) Chittagong, Sylhet
Sonneratia griffithii	Chakaria, Sunderbans
Spatholobus listeri	(endemic) Chittagong
Toournefortia roxburghii	Chittagong, Rangamati
Typhonium listeri	Chittagong
Vatica scaphula	(endemic) Chittagong
Vernonia thomsonit	Chittagong

Source: MOEF, Draft National Conservation Strategy, July 1991.

APPENDIX D

AMPHIBIANS AND WETLAND REPTILES

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APPENDIX D

AMPHIBIANS AND WETLAND REPTILES

N.B. Total species given are for all land and water based

NAME	STATUS
AMPHIBIANS 19 total species known and include:	
Bull Frog *Rana Tigrina*	Threatened
Green Frog *Rana hexadactyla*	Threatened
Skipper Frog *Rana cyanophyctis*	Very Common
Cricket Frog *Rana limnocharis*	Common
Frog *Rana temporalis*	Rare
Frog *Rana tyleria*	Rare
REPTILES 150 total species known, aquatics include:	
Lizards and Skinks 18 total species, aquatics include:	
Large Land Lizard *Varanus bengalensis*	Threatened
Ring Lizard *Varanus salvator*	Threatened
Yellow Water Lizard *Varanus flaviscens*	Threatened
Common Skink *Mabuya carinata*	Common
Striped Skink *Mabuya dissimilis*	Common
Crocodiles known total species are:	
Salt Water Crocodile *Crocodilus porosus*	Endangered
Fresh Water Crocodile *Crocodilus palustris*	Extinct
Ghorial *Gavialis gangenticus*	Endangered
Turtles and Tortoises 31 total species known, of which 3 terrestrial and 24 freshwater, 4 marine include:	
Spotted Flap Shell Turtle *Lissemys punctata*	Fairly Common
Coast Soft Shelled Turtle *Pelochelys bibroni*	Rare
Soft Shelled Turtle *Chitra indica*	Rare
Ganges Soft Shelled Turtle *Trionys gangeticus*	Fairly Common
Bostami *Trionys nigricans*	Endangered
Pezcock Soft Shelled Turtle *Trionys hurum*	Common

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APPENDIX D (Contd)

Leatherback Turtle *Dermochelys coriacea*	Endangered
Common Roofed Turtle *Kachuga tectum*	Common
Sylhet Roofed Turtle *Kachuga sylthensis*	Uncommon
Smithi Roofed Turtle *Morenia petersii*	Fairly Common
Common Batagur Turtle *Batagur baska*	Endangered
Loggerhead Turtle *Coratta coratta*	Endangered
Green Sea Turtle *Chelonia mydas*	Endangered
Olive Ridley Sea Turtle *Lepidochelys olivacea*	Endangered
Hawksbill Sea Turtle *Eretmochelys imbricata*	Endangered
Loggerghead Sea Turtle *Caretta caretta*	Rare
Burmes Tortoise *Geochelone elongata*	Rare
Freshwater Tortoise *Cyclemys dentata*	Rare
Three Keeled Tortoise *Melanochelys triciarinatz*	Rare
Pond Tortoise *Melenochelys triguga*	Rare
River Turtle *Hardella thurji*	Fairly Common

Snakes 78 total species known, floodplain and aquatics include:

Cobra *Naja naja*	Common
King Cobra *Ophiophagus hannah*	Endangered
Russells Viper *Vipera russellii*	Rare
Rock Python *Python molurua*	Endangered
Common Royal Python *Python reticulatus*	Uncommon
Checkered Keelbacked Water Snake *Xenochrophis piscator*	Very Common
Darkbellied March Snake *Xenochrophis cerasogaster*	Rare
Olive Keelbacked Water Snake *Afretium schistoeum*	Fairly Common
Dogfaced Water Snake *Cerberus rhynchops*	Threatened
Hooknosed Sea Snake *Enhydrina schistosa*	Threatened
Estuarine Sea Snake *Hydrophis obscurs*	Threatened
Annulated Sea Snake *Hydrophis cyanocinctus*	Fairly Common
Banded Sea Snake *Hydrophis fasciatus*	Threatened
Blackbanded Sea Snake *Hydrophis nigrocincta*	Rare
Common Narrowheaded Sea Snake *Hydrophis gracilis*	Threatened
Cantor's Narrowheaded Sea Snake *Hydrophis cantoris*	Threatened
Yellowbellied Sea Snake *Pelamis platurus*	Rare

Sources: MOEF, Draft National Conservation Strategy, July 1991 and Sarker, M.D. & Husain, K.Z. appearing in Environmental Aspects of Surface Water Development in Bangladesh. Eds Rahman, A.A., Huq, S., & Conway,G.R. 1990

APPENDIX E

LIST OF BIRDS RECORDED IN THE SOUTH-EAST REGION

APPENDIX E

LIST OF BIRDS RECORDED IN THE SOUTH-EAST REGION

NAME	Habitat	Status
1. Indian Shag	On rivers and coast	Scarce ? resident
2. Spot Billed Pelican	Wetlands	Former? resident now rare vagrant
3. Yellow Bittern	Wetlands	Local breeding resident
4. Purple Heron	Wetlands, mangroves	Local breeding resident
5. White Stork	Wetlands and coast	Rare winter visitor
6. Lesser Adjutant	Wetlands, mangroves	Locally breeding resident*
7. Black Headed Ibis	Coast	Rare visitor
8. White Spoonbill	Coast	Rare winter visitor
9. Greylag Goose	Coast	Local winter visitor
10. Common Sheld Duck	Coast	Local winter visitor
11. Cotton Pygmy Goose/ Cotton Teal	Lakes	Scarce winter visitor
12. Garganey	Coast	Common winter visitor
13. Northern Shoveler	Wetland, coast including mangroves	Scarce winter visitor
14. Common Pochard	Wetlands	Scarce winter visitor
15. Tufted Duck	Wetlands	Locally common winter visitor, sometimes over-summering
16. White-bellied Sea Eagle	Coast, including mangrove	Local breeding resident
17. Cinereous Vulture	Near rivers	Rare winter visitor
18. Eastern Marsh-harrier	Wetlands, coast	Scarce winter visitor
19. Palled Harrier	Open country	Scarce winter visitor
20. Pied Harrier	Open country	Scarce winter visitor
21. Common Buzzard	Coastal rivers	Scarce winter visitor
22. Great Spotted Eagle	Open country, usually near water	Scarce winter visitor
23. Northern Hobby	Wooded country and Coast	Scarce winter visitor
24. Slaty-breasted Rail	Wetlands, mangroves	Local resident
25. Bronze Winged Jacana	Wetlands	Local breeding resident
26. Pied Avocet	Rivers and coast	Scarce winter visitor
27. Crab Plover	Coast	Rare winter visitor
28. Oriental Pratincole	Open country,	Local breeding resident including coast
29. Small Pratincole	Coast	Local breeding resident
30. Kentish Plover	Open country near water, coastal	Common winter visitor and ? resident

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31. Mongolian Plover	Coast	Abundant winter visitor,non breeders, over-summering
32. Great Sand Plover	Coast	Scarce winter visitor,non-breeders over-summering
32. Great Sand Plover	Coast	Scarce winter visitor,non-breeders over-summering
33. Grey Plover	Coast	Locally common winter visitor, non-breeders over-summering
34. Great Knot	Coast	Local passage migrant and winter visitor
35. Red Knot	Coast	Scarce winter visitor
36. Sanderling	Coast	Local winter visitor,non-breeders, over- summering
37. Rufous-necked Stint	Wetlands and coast	Scarce winter visitor,non-breeders over-summering
38. Little Stint	Rivers and coast	Local winter visitor
39. Temminck's Stint	Wetlands, coast	Scarce winter visitor
40. Long-toed Stint	Coastal marshes	Scarce winter visitor
41. Spoon-billed Sand Piper *	Coast	Local winter visitor
42. Broad-billed Sand Piper	Coast	Local winter visitor
43. Ruff	Wetlands, coast	Passage migrant, and rarewinter visitor
44. Asian Dowitcher *	Coast	Rare winter visitor
45. Black-tailed Godwit	Coast	Scarce winter visitor
46. Bar-tailed Godwit	Coast	Local winter visitor
47. Whimbrel	Coast, particularly mangroves	Local winter visitor, non-breeders over-summering
48. Eurasian Curlew	Coast	Locally common winter visitor
49. Nordmann's Green Shank Spotted Green Shank *	Coast	Local winter visitor
50. Terek Sand Piper	Coast	Common winter visitor,non-breeders over-summering
51. Ruddy Turnstone	Coast	Scarce winter visitor,non-breeders over-summering
52. Great Black-headed Gull	Coast	Locally common winter visitor
53. Brown-headed Gull	River and coast	Common winter visitor
54. Yellow-legged Gull	Coast	Scarce winter visitor

APPENDIX E (Contd)

55. Caspian Tern	Coast including mangroves	Local winter visitor
56. Common Tern	Rivers and coast	Scarce winter visitor,non-breeders over- summering
57. Little Tern	Coast and large rivers	Scarce breeding resident
58. White-Winged Tern	Coast and wetlands	Rare passage migrant
59. Indian Skimmer	Coast and rivers	Local winter visitor
60. Plaintive Cuckoo	Open wooded areas	Common breeding resident
61. Short-eared Owl	Open country near water	Rare winter visitor
62. Indian Nightjar	Open woodland?	Rare resident
63. Black-capped Kingfisher	Rivers and coast including mangroves	Locally common winter visitor
64. Collared Kingfisher	Coastal wetlands including mangroves	Locally breeding resident
65. Blue-eared Kingfisher	Wooded wetlands	Rare ? resident
66. Yellow-hooded Wagtail	Near water	Locally common winter visitor
67. Grey-breasted Prinia	Open grassy areas and scrub	Locally common breeding resident
68. Rufous-necked Laughing Thrush	Thick scrub	Locally common resident
69. Asian Fairy Bluebird	Forest	Locally common breeding resident
70. Philippine Starling	Open forest	Rare passage migrant
71. Chestnut Munia	Open country, near water	Local resident

Note : 1. * Probably internationally significant populations occur in Bangladesh.

Source : Harvey, W.G. Birds in Bangladesh U.P.L. 1990.

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Summary of Species by Habitat Type

Habitat	Nr of Species	Comment
1. Rivers	9	Habitat would be affected if project intervention birds changes in river regime
2. Wetlands	22	Habitat changes most likely to occur due to project intervention
3. Mangrove	9	No likely change in habitat due to project intervention
4. Coast/coastal marshes	47	Ditto
5. Coastal rivers	1	Ditto
6. Open country/wooded	10	Some changes in habitat likely to occur due to extension of agricultural land as a result of project intervention
7. Forest, open forest	2	Ditto
8. Thick scrub, open grassy areas	2	Ditto
Total :	102	

Note: Some species have been counted in more than one habitat.

APPENDIX F

AQUATIC AND FLOODPLAIN MAMMALS

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APPENDIX F

AQUATIC AND FLOODPLAIN MAMMALS

NAME	PRESENT STATUS IN BANGLADESH
Floodplains and Rivers	
Rhesus monkey *Macaca mulatta*	Common
Leopard *Panthera pardus*	Threatened
Leopard Cat *Felix bengalensis*	Uncommon?
Bengal Fox *Vulpes bengalensis*	Common
Common Mongoose *Herpestes edwardsi*	Common
Small Mongoose *Herpestes auropunctatus*	Common?
Wild Boar *Sus scrofa*	Rare
Common Otter *Lutra lutra*	Uncommon
Smooth Coated Otter *Lutra parspicillata*	Fairly Common
Lesser Bandicot Rat *Bandicota bengalensis*	Common
Gangetic Dolphin *Platanista gangetica*	Rare

There are many species of rodents not listed here

Marine and Estuarine	
Common Dolphin *Delphinus delphis*	Fairly Common
Malay Dolphin *Stenella malayana*	Rare
Melon Headed *Dolphin Peponocephala*	Fairly Common
Frawaddy Dolphin *Orcaella breavirostris*	Rare
Rough Toothed Dolphin *Steno bredanensis*	Uncommon
Plumbeous Dolphin *Sotalia plumbea*	Uncommon
Pilot Whale *Globicephala macrorhyncha*	Uncommon
Little Piked Whale *Belenoptera acutorostrata*	Uncommon
Great Blue Whale *Belenoptera musculus*	Fairly Common
Fin Backed Whale *Belenoptera physalus*	Uncommon
Black Finless Porpoise *Neomeris phocaenoides*	Rare

Source: Sarker, M.D. & Husain, K.Z. 1990, Rashid, Haroun-Er. Geography of Bangladesh, 1978.

APPENDIX G

LIST OF COMMON AND/OR ECONOMICALLY IMPORTANT TREES AND OTHER VEGETATION FOUND IN THE SER

APPENDIX G

LIST OF COMMON AND/OR ECONOMICALLY IMPORTANT TREES AND OTHER VEGETATION FOUND IN THE SER

BOTANICAL NAME - Bangla Name

DRYLAND AND HOMESTEAD TREE CROPS

Acacia nilotica - Babla
Aegle marmelos - Belguchh
Albizzia procera - Korroi/Silkoroi
Albizzia lebbeck - Shirish
Alstomia scholaris - Satim
Annona squamosa - Ata Phal
Annona reticalata - Nona phal
Anthocephalus chinensis - Kadam
Areca catechu - Supari
Artocarpus heterophullus - Kanthal
Averrhoa carambola - Kamranga
Avicennia officinalis - Baen
Azadirachta indica - Neem
Bambusa spp. - Bans
Barringtonia racemosa - Hijol
Bombax ceiba - Shimul
Borassus flabellifer - Tal
Butea monosperma - Palash
Caesalpinia palcherrima - Radhachura
Carica papaya - Pepe
Cassia fistula - Sonalu
Cocos nucifera - Narikel/Dab
Dalbergia sissoo - Shisoo
Delonix regia - Krishnachura
Dendrocalamus spp. - Bans
Diospyros peregrina - Gab
Erythrina spp. - Mandar
Excoecaria agalloeha - Gewa
Ficus hispida - Dumur
Ficus religiosa - Aswatha
Ficus benghalensis - Bot
Gliricidia sepium - Madder tree
Impeveta cylindrics - Chhan
Litchi chinensis - Litchu
Mangifera indica - Am
Melocanna bambusoides - Bans
Mimusops elengi - Bakul
Moringa oleifera - Sajna
Musa spp. - Kola
Peltophorum pterocarpum - Halud Krishna Chura
Phoenix sylvestris - Khejur
Phyllanthus emblica - Amloki
Pithecolobium dolce - Babla
Polyalthia longifolia - Debdaru
Psidium gaujava - Piara
Shorea robusta - Sal/Gazari
Sonneratia apetala - Keora
Spondias dulcis - Amra
Streblus aeper - Sheora
Sumanea saman - Koroi (Rendi)
Swietenia mahagoni - Mahagony
Syzygium spp. - Jam
Tamarindus indica - Tentul
Terminalia chebula - Haritaki
Terminalia belerica - Bahera
Terminalia arjuna - Arjun
Zanthoxylum rhetsa - Bajna
Zizyphus mauritiana - Boroi/Kul

CULTIVATED FLOODPLAIN CROPS

Ananassa sativa Anaras
Brassica unca
Brassica spp. Kapi
Corchorus spp. Pat
Lablab spp.
Lathyrus sativus
Lens culnaris
Oryza sativa Dhan
Phaeseolus aureus Sim
Phaeseolus mungo Sim
Solanum melongena Mishti Alu
Solanum tuberosum Alu

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APPENDIX G (Contd)

WETLAND AND RIVER BANK VEGETATION

Aldrovenda vesiculosa
Alisma spp.
Alternanthera spp.
Ammophila arenaria
Andropogon contortus
Arundinaria spp.
Arundo spp.
Barringtonia acutangula
Barringtonia racemosa - Hijol
Butomus spp.
Ceratophyllum spp.
Cyperus spp.
Eclipta spp.
Eichhornis crassipes - Pana (Kachuri)
Eleocharis spp.
Enhydra fluctosa
Erianthus ravanae
Euryle ferox - Makhna
Fimbristylis spp.
Geum spp.
Hottonia spp.
Hydrilla spp.
Hydrocharis spp.
Hygrorhiza spp.
Ipomoea aquatica; - Kalmilata
Lemna spp. - Pana (Khudi)
Lepidium sativum
Ludwigia adsendens
Menyanthes spp.
Monochoria spp.
Monochoria spp.
Myriophyllum spp.
Nasturtium palustre
Nechamandra spp.
Nelumbo nucifera - Paniphal
Nymphea spp. - Shapla
Nymphoides spp.
Oryza spp.
Otellia spp.
Panicum spp.
Paspalum spp.
Phragmites spp.
Pistia stratiotes - Pana (Topa)
Polycarpacea spp.
Polygonum spp. - Bishkata
Polygonum amphibium
Potamogeton spp.
Potentilla spp.
Ranunculus aquatilis
Saccharum spp.
Sagittaria spp.
Schumannianthus dichotomus - Padma
Scirpus spp.
Setaria spp.
Spirodela spp.
Spirodela spp.
Spirodela polyrhiza - Patibet
Thysanoleana maxima
Trapa bispinosa
Utricularia spp.
Utriculuria stellaris - Jhangi
Vallisneria spiralis

Sources: Field Surveys, IUCN, AWB et al, Directory of Asian Wetlands, 1989

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APPENDIX H

SITES OF HISTORICAL, ARCHAEOLOGICAL OR ECOLOGICAL INTEREST

APPENDIX H

SITES OF HISTORICAL, ARCHAEOLOGICAL OR ECOLOGICAL INTEREST

	Name & Location	Description of Interests	
Greater District: Comilla			
1.	BANCHARAMPUR Upazila headquarter Brahmanbaria district	Many beels abundant fish supply	Gazetteer Comilla
2.	BATISA Village on Chittagong road in Chouddagram Upazila	Mughal period. Old Tripura capital 1.5 miles to the east. Gobinda Manikya Tank. Holiday resort. Picnic and angling.	Ditto
3.	BRAHMANBARIA	The Kazi's tomb (Kazi Mohammad khandkar) an object of popular veneration	Ditto
4.	CHANDINA Upazilla headquarter (formally Barakanta)	Ruins on the bank of large tank; an isolated mound; locally known as Mahamenya mound; buddhist images found; old mosque and idgah; (built by Shah Shuza ?) Hindu shine of Kali. Chandina Raj Kachri; both built c. 1670.	Ditto
5.	CHOUDDAGRAM Upazilla headquarter	Big tank known as Jagannath Dighi	Ditto
6.	COMILLA Town	200 tanks in and around town. Dharma saqar, excavated by Raja Dharma Manikya, is about 1 mile in circumference. Sha Shuja mosque; Satara Tatna Temple Krisna Manikya. c-16/17th cent	Ditto

APPENDIX H (Contd)

7.	HOMNA Upazilla headquarter	Former headquarter of Pargana of Zamindar Shahjada Amir Mirza Humayun Khan Humnabazee Homnabad.	Ditto
8.	KAITALA Village in Upazila Nabinagar	Few big Dighis, viz. Shoksagar, Barabari Dhighi etc.	Ditto
9.	KASBA Upazila Headquarter	Kamala Sagar Dighi, Kaliar Garh, ruin of a fort built by Hussain Shah, @ 16th cent	Ditto
10.	KHARAMPUR In Kasha Upaza (Akleanra N. Union Council)	Historical place. Holy shrine of Hazrat Sayed Ahmed Gesudaraj, popularly Hazrat Killa Shaheed bazar sharif.	Ditto
11.	KUTI Village in Kashba Upazilla	Bungalow of a British jute merchant (Kuthi) on the bank of river Titas.	
12.	LALMAI Comilla	Extensive centre of Buddhist culture, @ 7th & 8th cent. to 10th cent., remnant of sal/gazari forest.	
13.	MATLAB BAZAR Upazila Headquarter	Previously known as Bairagir Bazar; about 125 years ago some Bairagi settled here. Motaleb Zamindar Motlabganj Bazar.	
14.	MURADNAGAR Upazila Headquarter	Named after prince Murad Baksh, son of Emperor Shahjahan.	Ditto
15.	NASIRNAGAR Upazila Headquarter	Temple with a huge idol of Chill Bhuirabi, 15 ft. high, @ 19th cent.	

APPENDIX H (Contd)

16.	PASHIMGAON Village of Laksam thana	Darga Sharif, Known as Ghazi Shahibs Durgah. Birth place of Nawab Faizunnesa.	
17.	SARAIL Upazila Headquarter	Old mosque, @ 1670.	

NOAKHALI

18.	AMISHAPARA Upazila Begumganj	Ancient village. Bishwambar sur, son of Raja Adi Sur King of Uithila established capital and erected temple. The temple is very decrepid.	Ditto
19.	BAJRA Upazila Begumganj	One of the earliest muslim divines came here to preach, in @ 15th cent. Mosque built by Delhi architect, special architectural significance, some mazares. Attracts visitors from far.	Ditto
20.	BHAWANIGANJ In Lakshmipur Upazila	Scenic beauty attracts visitors.	Ditto
21.	CHHAGALNAIYA Upazila Headquarter	Seat of Shamsher Gazi, @ 18th cent. Stone implements of Paleolithic period found.	Ditto
22.	CHOUMUHANI Township Begumganj Upazila	Asram of High saint Ram Thakur, thousands of people from many places of Bangladesh assemble annually.	
23.	COMPANIGANJ Upazila Headquarter	Established as a Ganj during the East India Company rule.	Ditto

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APPENDIX H (Contd)

24.	DALAK BAZAR Lakshmipur Upazila	Once a strong hold of big Hindu Zamindars. Several fine buildings, temples and tanks. Khoasagar Dighi, biggest in the district. Place of indigo cultivation during British period.	Ditto
25.	KANCHANPUR Ramganj Upazila	Mira Shahetis Dargah 800 years old	
26.	LAKSHMIPUR Upazila Headquarter	"Jackson's Kothi", @ 1756 old cloth producing centre. Important British centre during early colonial period. Charming natural scenery.	Ditto
27.	MOHAMMADPUR Senbag Upazila	Dargah of Bhuiya Anis Mohammad	Ditto

Source: District Gazetteers - Comilla and Noakhali.

List of Archaeological Sites in Greater Comilla and Noakhali Districts

District Comilla (All in the Lalmai, Mainamati area)

1. Shalban Vihar
2. Anauda Vihar
3. Kotila Mura
4. Charpatra Mura
5. Rupban Mura
6. Itakhola Mura
7. Palace and temple of Queen Mainamati
8. Satura Ratna temple
9. Bairagi Mura
10. Bara Kamta Dhibi
11. Bhoj Rajas Palace
12. Chandi Mura
13. Chila Mura
14. Hati Gara
15. Kotbari Dhibi
16. Mainamati Dhibi - 1 & 2
17. Pakka Mura
18. Rupban Kanya Mura
19. Rupban Mura
20. Ujirpur Dhibi
21. Bara Sharifpur Masjid
22. Balagajir Mura

District Noakhali

23. Shiluar Dhibi
24. Ulchapara Masjid
25. Arifile Masjid
26. Arifile Majar

District Chandpur

27. Satyaram Majumdarer Moth
28. Jatra Munir Moth
29. Alipur Shahi Masjid
30. Bakhtiar Khans Masjid

(Source: Department of Archaeology and Museums, Dhaka)

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APPENDIX I

ASSESSMENT OF ENVIRONMENTAL IMPACTS

APPENDIX I

ASSESSMENT OF ENVIRONMENTAL IMPACTS

I.1 Critical or Notable Impacts Associated with FCDI

PHYSICAL IMPACTS

A. ATMOSPHERE

Climate: - No major issues
Quality: - No major impacts

B. LAND AND SOIL RESOURCES

Morphology: *- Scouring and rising bed levels*

Overall Evaluation of Impact: Critical and negative in long-term
Associated With: Flood Control River Embankment

Magnitude:	Critical
Intensity:	Notable
Scale Accumulation:	Critical
Duration:	Medium
Frequency:	Annual
Effect Reversible:	Difficult
Resilience of Environment:	Good
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decrease

Process: Confined channels will reduce sediments spreading on floodplain. Increased levels and velocities will increase scouring and bank erosion on the section of steeper river slopes and create additional channel sedimentation downstream with problems rising bed levels. Will require constant dredging on high sediment rivers and raising of embankments to maintain protection. Without effective dredging bed levels will continue to rise above surrounding ground level requiring eventual re-routing of river channel. It will remain uncertain as to whether this can be a controlled event. Need for dredging requires land for disposal of spoil. Issue has led to rejection of this option in preference for retired embankments/polder schemes on Meghna tributaries. The question of existing Gumti embankments will have to be resolved. Sedimentation downstream of regulators will also be a potential problem which in the case of the Dakatia regulator could affect the operation of Chandpur port unless appropriate design measures are incorporated and operation rules are properly implemented.

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Vulnerable Groups: All assets and people within the path of a breach and flood path and eventual re-routing of main drainage channels.

Mitigation: Constant monitoring and dredging and perhaps eventual re-routing of main channel.

Complementary Programme: None

Morphology: - *Changing bank erosion*

Overall Evaluation of Impact: Notable and negative unless mitigated
Associated With: Flood Control - Drainage

Magnitude:	Notable
Intensity:	Critical in selected areas
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Annual
Effect Reversible:	No
Resilience of Environment:	Good
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline in areas affected

Process: Confinement of natural evolving flood channels will alter flow velocities and sediment uptake. This will create new regimes of bank erosion and river morphology in time and space. With existing high population density and settlement patterns major risks to settlement areas within the confined areas and downstream could result.

Vulnerable Group/Area: Settlements and farms near to erodible river banks.
Mitigation: River training and bank protection
Complementary Programme: Non-structural warning and relief measures.

Soil Quality: - *Change in soil fertility status inside schemes*

Overall Evaluation of Impact: Notable and negative in FC schemes and Positive to other downstream floodplain and estuarine areas.
Associated With: Flood Control, Drainage and Intensive Agriculture

Magnitude:	Notable
Intensity:	Negligible
Scale Accumulation:	Negligible
Duration:	Indefinite
Frequency:	Seasonal

Effect Reversible:	No, but mitigation possible
Resilience of Environment:	Good
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline, unless replaced

Process: Drier soils inside FCD schemes and more intensive cropping methods can lead to nutrient and micro-nutrient problems (including zinc and sulphur on certain soil types) which, although often easily rectifiable, are a cost to the system and something which poor farmers have the least access to knowledge and identification of problems and the financial means to purchase inputs.

Vulnerable Group/Area: Floodplain agriculture, poor farmers with little credit worthiness and farms without access to organic manure

Mitigation: Composting programme (sewage/aquatic weeds), improved local soil testing facilities and extension services

Complementary Programme: More detailed floodplain and aquatic/soil ecology research.

Soil Quality: *- Induced drought conditions and drying of soils*

Overall Evaluation of Impact: Notable and negative on high ground

Associated With: Flood Control - Drainage - GW Irrigation

Magnitude:	Notable
Intensity:	Critical in high land localities
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Yes
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: Lowering of water tables by groundwater pumping or drainage and/or the prevention of flooding will reduce the amount of moisture available to soil profiles on high ground in the dry season unless these are irrigated. Farmlands will suffer in the dry season from becoming more drought prone or will have increased pumping costs if taking from lowered water tables. Soil physical structure may also be affected in certain localities due to soil features or by the oxidation of organic matter.

Vulnerable Group/Area: Farms and poor farmers on high ground, women's homestead plots and shallow rooted species vulnerable to falling seasonal water tables.

Mitigation: Monitoring of affected areas to include water table studies and impacts. Small scale irrigation technologies and programmes for homestead farms associated with water supply programme (see below).

Complementary Programmes: Women's credit programmes, homestead agro-forestry research, potable water supply programme.

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C. GROUNDWATER

Hydrology: *- Redundant HTW technologies on high ground and potential health problems*

Overall Evaluation of Impact: Notable and negative for settlements on high ground

Associated With: Ground water irrigation

Magnitude:	Notable
Intensity:	Critical in selected locations
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	No, but substitution possible
Resilience of Environment:	Good
Effect on Instability of Environment:	Increase if not mitigated
Effect on Sustainable Productivity:	Decline if not mitigated

Process: Lowering of dry season water tables makes present local HTW seasonally redundant. This requires alternative surface water supplies to be used which can be polluted and create health risks.

Vulnerable Group/Area: Settlements on high ground with traditional HTW technologies.
Mitigation: Conversion to deeper tubewells. This will have an added advantage of avoiding the present health risks known to be associated with polluted shallow groundwater.
Complementary Programme: Health and sanitation education facilities and educational programmes

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Quality: *- Salinity problems with irrigation*
- Other chemical problems with irrigation

Overall Evaluation of Impact: Notable and negative in selected areas

Associated With: Groundwater Irrigation

Magnitude:	Critical in selected areas
Intensity:	Critical
Scale Accumulation:	Critical
Duration:	Medium
Frequency:	Seasonal
Effect Reversible:	Yes
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: See **Annex V** for description of salinity risks areas for groundwater. Deep tube wells extract old sources of water not associated directly with current rainfall or surface recharge sources. The chemical composition of these waters are therefore potentially different from existing surface water sources. Risks for other chemicals in groundwater are less well-defined and less critical. The main problems are with excessive iron causing mechanical problems and rectifiable induced micro-nutrient problems.

Vulnerable Group/Area: Farms and settlements in zones of poor quality groundwater.

Mitigation: None. Avoid deep or affected sources of groundwater and depend on cheaper sources of shallow groundwater or surface irrigation modes.
Complementary Programme: More detail and extensive surveys to identify scope of problem and monitoring of existing users.

D. SURFACE WATER

Hydrology: *- Reduction of flood and salinity risks in coastal and floodplain areas*
- Increased downstream flood risks

Overall Evaluation of Impact: Notable positive impact inside schemes, and undefined problems downstream.
Associated With: Flood Control - Drainage

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite while embankments maintained
Frequency:	Seasonal
Effect Reversible:	Yes
Resilience of Environment:	Good
Effect on Instability of Environment:	Increase due to downstream dis-benefits
Effect on Sustainable Productivity:	Decline due to loss in diversity except in saline zones

Process: The major impact of FC embankments are the reduction of risk and an improved environment in which to avoid damage from the particular type(s) of flood affecting that area. Can reduce damage and more notable lead to a change in cropping patterns and intensity and farming methods, as well as other forms of investment.

Advantaged Group/Area: Settlers, land owners, sharecroppers and labourers in flood protected and drained areas at expense of adversely affected people downstream.
Mitigation: Careful phasing of FAP and flood warning system or non-structural measures.
Complementary Programme: Needed for equity and health issues and loss of occupations and nutrition.

Hydrology: *Increased potential flood and saline damage from extreme events or breaches*

Overall Evaluation of Impact: Notable and negative unless mitigated

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Associated With: Flood Control Embankments - Drainage. Design criteria not for infrequent events

Magnitude:	Notable or critical if major investment or settlement has occurred
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Short
Frequency:	Occasional
Effect Reversible:	No if embankments built
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase due to risk re-assessment when 1st event occur
Effect on Sustainable Productivity:	Decline

Process: The design criteria for embankment cannot guarantee total flood protection. Statistical infrequent flood levels exceeding the design criteria can happen at any time in the life of the project. A number of physical, biological, socio-economic or political problems can cause embankments to be breached.

Vulnerable Group/Area: Any settlements, assets and farms in potential flood areas.
Mitigation: Coordinated and designed means of removing water quickly from behind coastal and other embankments.
Complementary Programme: Non structural warning and response measures.

Hydrology: *Increased waterlogging in low lands*

Overall Evaluation of Impact: Notable and negative
Associated With: Flood Control - GW/SW Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Negligible
Duration:	Medium
Frequency:	Seasonal
Effect Reversible:	Yes
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	None
Effect on Sustainable Productivity:	Decline

Process: Micro-scale topography inside and outside schemes will lead to drainage problems which cannot be seen at the planners scale of design. Raises problems of stagnant water, health risks and lost production until rectified. There are also potential problems of increased nematode damage in such areas.

Vulnerable Group/Area: Farms on low lying ground unconnected to main drainage channels.

Mitigation: Detailed topographic surveys and drainage planning for small scale drainage structures. Continued monitoring of problems in practise (inside and outside scheme) and small structures installed after main works completed.

Complementary Programme: None needed if mitigated.

Quality:

- Reduction in flood dispersal of contaminants inside schemes increases downstream problems

- Loss of flushing of protected areas for pollution control

- Increased problems of agro-chemical and sewage pollution

Overall Evaluation of Impact: Notable positive and negative impacts. Potentially critical negative impacts.

Associated With: Flood Control - Drainage - Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite if not mitigated
Frequency:	Seasonal
Effect Reversible:	Difficult
Resilience of Environment:	Poor
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: Natural flooding spreads sewage and pollutants across the floodplains. Health problems and contamination of existing water supplies are removed as problems but are passed onto downstream areas. Unless there is good drainage and flushing of schemes there is an accumulation and concentration of these pollutants in the low lying pools and drainage channels. These can become severe health and ecological risks. Increased use of agro-chemical associated with the uptake of HYVs in FCDI or I schemes pose serious threats to the balance and integrity of the eco-system.

Vulnerable Group/Area: The wetland, low lying ground where drainage waters accumulate and concentrate pollutants. All water users and species in the food chain associated with these areas and the areas of agro-chemical use.

Mitigation: Proper design of schemes to maintain proper drainage and, if necessary, flushing of system. Careful monitoring of ecology, water bodies and agro-chemical use, particularly selection and applications of pesticide and fertilisers.

Complementary Programme: Integrated pest management, improved potable water supplies and sanitation programmes.

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BIOLOGICAL AND ECOLOGICAL IMPACTS

A. SPECIES DIVERSITY

Bio-diversity: *- Loss of species*

Overall Evaluation of Impact: Potentially critical and negative unless mitigated
Associated With: Flood Control - Drainage - Irrigation

Magnitude:	Notable and Potentially Critical
Intensity:	Notable and Potentially Critical
Scale Accumulation:	Critical
Duration:	Indefinite
Frequency:	Continuous
Effect Reversible:	Uncertain
Resilience of Environment:	Poor
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: There are a set of complex inter-linkages involving the spread and impact FCD projects and the spread of HYV and modern agricultural systems which will reduce the species diversity. The loss of open water fisheries, loss of wetland habitats, the move to continuous rice and HYV cropping, the reduction in leguminous cropping and fallow, the loss of floodplain organic matter, the change in species population and food webs, the imbalances in pest-predators relations caused by pesticides and the food chain implications are some of the issues involved.

Vulnerable Group/Area: Some flora and fauna of wetland habitats, some crop land flora and fauna, local rice gene pool for various grain and straw types, some migratory and open water fish, migratory and some resident birds.
Mitigation: Allocation of conservation areas to be unaffected by FCD within the region to maintain integrity of original habitat and floodplain systems. Monitoring and controls over use of agro-chemicals.
Complementary Programme: Integrated pest management programme, extended gene surveys and gene bank programmes, ecological research, national and community environmental education programmes

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B. POPULATION CHANGES

Weeds: *- Aquatic weeds in distribution and drainage systems*

Overall Evaluation of Impact: Notable and negative unless managed properly

Associated With: Flood Control - Drainage - Irrigation

Magnitude: Notable

Intensity:	Notable in selected areas
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Difficult
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: A number of prolific and non-prolific aquatic weeds can congest drainage and water distribution channels either because their free passage in flood and drainage waters is impeded by obstacles and structures, or because enrichment of water bodies with fertilisers, decaying organic matter or sewage causes prolific growth. Their presence in congested mats can de-oxygenate waters, prevent healthy aquatic eco-systems, prevent navigation and clog gates.

Vulnerable Group/Area: Nutrient enriched waters and impeded channels
Mitigation: Allow for flushing. Design bypass channels around structure. Establish small scale industries at site of congestion for composting, craft materials or industrial cellulose purposes.
Complementary Programme: Research, education and support programme for economic utilisation of prolific water weeds.

C. LAND USE AND HABITAT CHANGES

Field Ecology: *- Loss of rotation and fallow systems*
- New farming systems, cropping patterns, crop varieties and inputs

Overall Evaluation of Impact: Notable. Short-term agricultural mining gains and potentially negative long-term effects.
Associated With: Flood Control - Drainage - Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Critical
Duration:	Indefinite
Frequency:	Annual
Effect Reversible:	Yes
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: The uptake of HYV and modern agricultural systems is encouraged by both FC,D and I. The pressures for increased rice production and their good economic returns means that increasing areas are being double cropped, and in some limited areas triple cropped, with mono-cropping of rice. By cutting out fallow periods

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and rotations with other families of economic crops a continual habitat for rice pests and carry over of diseases is provided. The continual and similar method of uptake of nutrients and the lack of leguminous nitrogen fixing or organic manuring is also potentially a limiting factor. Although many issues of soil fertility and pest control are rectifiable it requires the widespread use of the good management techniques supported by a strong cash flow or credit capacity. This capacity in rural Bangladesh is not available and would be difficult to envisage within the foreseeable future. Loss of fallow reduces the species diversity and area of fodder for livestock which in nutritional terms cannot be replaced simply by extra yields of bulk straw from HYV varieties.

Vulnerable Group/Area: FCD, FCDI and I schemes, poor and small-medium scale farmers with potential cash flow constraints. Livestock and particularly timely and effective draft power animals.
Mitigation: Agricultural education and extension based on sound agricultural research.
Complementary Programme: Agricultural research and multi-purpose production systems/integrated pest management.

Wetland: *- Reduction in open system floodplain wetland*

Overall Evaluation of Impact: Notable and potentially critical negative

Associated With: Flood Control - Drainage

Magnitude:	Notable and Potentially Critical
Intensity:	Notable
Scale Accumulation:	Critical
Duration:	Indefinite
Frequency:	Annual
Effect Reversible:	Uncertain
Resilience of Environment:	Uncertain
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: A full programme of FCD across the region and together with those possible in the other regions could threaten the basic ecological integrity of the wetlands habitats and species supported by them. The main loss would be seen from the continued decline in open water fisheries, the loss of birds and a range of other wetland flora and fauna which could not colonise the few remaining wet habitats that might remain within the system and which would be potentially subject to pollution and nutrient enrichment. Ecologically the total elimination of these habitats over the decades to come could reach a threshold where loss of some species and the eco-system as it is currently known would be lost altogether. It would be replaced by a new a different eco-system with a different species structure and ecology. The potential loss of economic value can not be quantified or its ecological significance really assessed given the present data base. Given the uncertainty involved but the absolute habitat and species losses which could occur the issue needs a clear and balanced appreciation and a strategic policy decision taken which should involve the public at large.

Vulnerable Group/Area: All wetland sites potentially affected by FAP projects.

Mitigation: Allocation conservation areas within the context of the regional plan to be registered under the Protected Areas Network under the NEMAP.

Complementary Programme: A full programme of basic wetlands and ecological research and monitoring under the FAP programme and delaying of decisions on full development proposals until there has been full political and public debate.

Charland: *- Increase in riverine, estuarine and coastal chars*

Overall Evaluation of Impact: Potentially notable with both positive and negative impacts.

Associated With: Flood Control

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Uncertain
Resilience of Environment:	Good
Effect on Instability of Environment:	None
Effect on Sustainable Productivity:	None

Process: Flood control will divert sediments to downstream areas. Under a full FAP embankment programme the rate of sedimentation in the river and estuary areas will be increased. Quantifying this awaits the results of the morphological studies under other FAP studies. If the next phase of coastal cross dams were to proceed with a full river embankment programme under FAP additional coastal accretion could be significant in the long term. The estuarine sedimentation could have a number of adverse consequences affecting existing settlement, land and estuarine resources while new land accretion would offer an additional land for eventual development.

Vulnerable Group/Area: Assessment awaited

Mitigation: Assessment awaited

Complementary Programme: Assessment awaited

Rare Habitat: - Potential major impacts (Wetlands not yet classified as rare), survey needed.

SOCIO-ECONOMIC IMPACTS

A. DISPLACEMENT

- Land acquisition and compensation will increase landlessness

- Lack of equity strategies will increase marginal groups

Overall Evaluation of Impact: Notable and critically negative for some

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Associated With: Flood Control - Drainage - S/W Irrigation major structures

Magnitude:	Notable and Critical for some
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Once
Effect Reversible:	Difficult
Resilience of Environment:	Poor
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: The high degree of existing landlessness and lack of available land for resettlement, together with the problems of hidden groups displaced, secondary displacement problems and manipulations of the land acquisition and compensation procedures will be major problems to address in implementation. As the scale and numbers of projects increase under the plan these problems will also multiple in the impact. (see also **Chapter 6**)

Vulnerable Group/Area: Small politically weak farmers, sharecroppers and socially bound farm labourers in areas of project land acquisition.

Mitigation: Carefully designed preliminary and detailed surveys. Scrupulous monitoring and supervision of procedures and full public participation in process.

Complementary Programme: Innovative approach to community reallocation of resources, retraining and re-employment schemes. Credit programmes to establish families in new enterprises generated by projects.

B. INVESTMENT & ASSET VALUES

- Better investment climate (but implications of extreme events)

- Land values artificially manipulated in pre-project/acquisition phase and raised after FCDI due to speculation and production increases

Overall Evaluation of Impact: Notable positive with important caveats which are negative

Associated With: Flood Control - Drainage - GW/SW Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Medium
Frequency:	Occasional
Effect Reversible:	No
Resilience of Environment:	Poor
Effect on Instability:	Decrease
Effect on Sustainable Productivity:	Uncertain

Process: FCD will reduce the risks of damage and a floodplain lifestyle and create a better investment environment for agriculture, government infrastructure and services (i.e. schools) and industry. The raised levels of production from irrigation will have the same effects making land inherently more valuable as an economic assets. In the period prior to land acquisition considerable land speculation can occur. During the operational phase appropriation of land by the richer land owners and other land investors can become more of pressure issue in the rural economy and society.

Vulnerable Group/Area: Poorer farmers and smaller landholders and sharecroppers and labourers attached to them.
Mitigation: Early moratorium on land transactions before land acquisition and monitoring and review of land tenure and ownership conditions and legislation.
Complementary Programme: Provisions of free community legal aid services.

C. PRODUCTION LEVELS

- *Crop/livestock/tree losses reduced in frequent events inside scheme*
- *Crop/livestock losses increased in extreme events*
- *Crop/livestock losses increased in frequent events outside scheme*

See Surface Water - Hydrology analysis above and economic analysis in Main Report

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- *Increased food production with irrigation*
- *Reduced production of capture fisheries inside and outside of project due to lack of migration paths*

(Includes assessment for income, employment, equity and survival strategy impacts below)

Overall Evaluation of Impact: Notable positive impact for food overall and potentially Critical losses for fisheries (see nutrition below) and poor or vulnerable groups
Associated With: Flood Control - Drainage - Irrigation

Magnitude:	Notable and Critical for some
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Difficult
Resilience of Environment:	Reasonable
Effect on Instability of Environment:	Increase
Effect on Sustainable Productivity:	Decline

Process: The major objective and impact of the FCD and FCDI or I strategies is to increase food production. This is likely to be achieved mainly for rice at the expense of common property open water fisheries which has other socio-economic and nutritional impacts discussed below. The trade offs with other crop and food types

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is less clear from the available evidence. More data is being collected by FAP 12/13 to assess this impacts. Although food production per se may rise it is less clear that in the market this will alleviate the poverty and nutritional problems for those who cannot afford to buy it. Raised farm, processing and non-farm employment levels generated by projects and access of poor to these opportunities will be important in this respect. The distribution of land and the benefits are of prime concern for the effectiveness of the overall strategy. The equity issue appears to be a major question which FAP studies will hopefully elucidate further on. There are fears that a widening gap between rich and poor may be one consequence in some areas. The need to maintain crop yields with agro-chemicals in irrigation may threaten food and income possibilities from other sectors.

Benefiting/Vulnerable Group/Area: Benefitors mainly in areas receiving irrigation and some areas where flood protection is properly designed and operated. Vulnerable groups are those losing access to common property resources or facing high risks with increased cash needs for HYV and modern farming. Those who cannot make the transition into the higher benefits system or who are weak in socio-economic terms. Aquatic resource areas receiving pollution.

Mitigation: Better survey and design for multi-purpose objectives and allocation of lands for common property resource systems to be maintained within and outside of schemes and for management of pollution.

Complementary Programme: Improved cooperative field research programme and pilot trials of fish engineering and ecological research to sustain the productivity of all species within future development context of floodplains. Special emphasis on targeting sub-projects and complementary programmes so as to ensure participation and distribution of benefits as widely as possible. Programmes to ensure appropriation of resources not skewed to wealthy (i.e. mitigatory fish programmes)

D. INCOME

- *Improved farm income to landowners, sharecroppers and labourers*
- *Reduced fisheries income*

(See also production levels above)

E. EMPLOYMENT & WAGES

- *Increased farm labour demands for intensive agriculture*
- *Increased labour demands for agro-industrial/service sector*
- *Reduced fisheries employment*

(See also production levels above)

F. EQUITY AND ACCESS TO RESOURCES

- *Distribution of benefits by land types, social status, resource ownership and income levels unlikely to be equal*
- *Participation levels of poor and landless disadvantage them*

(See also production levels above)

G. SURVIVAL STRATEGIES

- Potential loss of diversity of aquatic common property resources and access to floodplains fisheries accelerated by FCDI and input use

- Raised economic dependency through more intensive agriculture and cash needs for farming will marginalise the poorer groups unable to make transition

(See also production levels above)

H. GOVERNMENT SERVICES

- No major impacts

I. PRIVATE SECTOR SERVICES

- No major impacts

J. GENDER AND AGE ISSUES

Women: *- Role of women and irrigation in homestead farms and impact of flood and water table reduction on livestock, nutrition and income potential particularly affecting pregnant and nursing mothers*

Overall Evaluation of Impact: Notable potentially negative impact

Associated With: Flood Control - Drainage - GW Irrigation

Magnitude:	Notable in some areas
Intensity:	Negligible
Scale Accumulation:	Notable in some areas
Duration:	Medium
Frequency:	Annual
Effect Reversible:	Yes
Resilience of Environment:	Good
Effect on Instability:	Increase
Effect on Sustainable Productivity:	Decline

Process: Falling water tables on higher ground may affect the soil moisture characteristics and suitability of existing water supplies systems in some homesteads farms which are run by women. Unless monitored and mitigated this affect could adversely impact on women's occupational activities, homestead productivity or management systems and possibly affect income and nutrition.

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Vulnerable group/area: Homesteads on higher ground

Mitigation: Physical and homestead monitoring programme for water tables and water supply. Replacement of seasonally redundant water supply systems.

Complementary programme: Homestead production support programme and research

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QUALITY OF LIFE IMPACTS

A. HERITAGE AND ARCHAEOLOGICAL IMPACTS

- Impacts unclear until specific sites locations given

B. CULTURE & TRADITIONS

- Change in lifestyle, traditions, kinship and patron-client systems

Overall Evaluation of Impact: Notable change - direction uncertain

Associated With: Flood Control - Drainage - GW/SW Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Once
Effect Reversible:	No
Resilience of Environment:	Reasonable
Effect on Instability:	Uncertain
Effect on Sustainable Productivity:	Uncertain

Process: Traditional lifestyle based on isolated aquatic/flood-based and low levels of dry season agricultural activity system heavily reliant on seasonal boat navigation are being converted to year-round intensive agricultural activity, with greater monetary demands and rewards and increasing reliance on road networks. Likely to lead to erosion of extended family and local kinship systems and change the present patron-client systems. Process very much linked to general evolution of society and integration into global society.

Vulnerable Group/Area: Cultural heritage of local societies

Mitigation: Promotion and conservation of cultural traditions

Complementary Programme: Involvement of Ministry of Culture, arts, education and media organisations

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C. SETTLEMENT AND MIGRATION SYSTEM

- Psychology may induce some relocation/redesign of housing on lower ground or on embankments as a result of apparent protection

Overall Evaluation of Impact: Notable and negative unless designed for
Associated With: Flood Control

Magnitude:	Notable and potential critical for design criteria
Intensity:	Notable and potentially critical
Scale Accumulation:	Critical
Duration:	Indefinite
Frequency:	Once
Effect Reversible:	Difficult
Resilience of Environment:	Poor
Effect on Instability:	Increase
Effect on Sustainable Productivity:	Decline

Process: Settlement on embankments or on lower ground will raise the chance of breaches and greater damage and loss with an failure of the system in infrequent flood events.

Vulnerable Group/Area: People settling on embankments or lower ground within schemes
Mitigation: Design embankments for settlement and with specific attached settlement sites. Planning controls or contingencies in other areas.
Complementary Programme: Non structural measures

D. HEALTH AND NUTRITION

Human:

- Increased availability of cereals
- Increased consumption capacity for other protein sources amongst benefiting groups from improved farm incomes and increased employment levels
- Decline in nutritional status of selected groups in community from drying impact on high ground and loss of common property resources. Particular loss of fish protein and vitamins

Overall Evaluation of Impact: Notable with both positive and negative effects for different groups
Associated With: Flood Control - Drainage - GW/SW Irrigation

Magnitude:	Notable and critical for some
Intensity:	Notable and critical for some
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal

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Effect Reversible:	Difficult
Resilience of Environment:	Reasonable
Effect on Instability:	Increase
Effect on Sustainable Productivity:	Decline

Process: Projects will directly affect the diversity of food supplies available and the access of different groups to the benefits. Loss of common property resources and impact on survival strategies and linked to these effects. Some will be better off and some will be worse off. Quantifying this is very difficult.

Vulnerable Group/Area: Poor, small farmers, landless, traditional and occasional fishing and groups with greater dependance on common property resources
Mitigation: Emphasis on multi-purpose production objectives, distributional strategies and allocation of common property mitigation schemes for adversely affected groups. Very difficult to plan and implement.
Complementary Programme: Social welfare, public health and NGO programmes

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Human: - *Changes in water-borne disease*
- *Changes in disease vectors*

Overall Evaluation of Impact: Notable and negative and positive effects
Associated With: Flood Control - Drainage - GW/SW Irrigation

Magnitude:	Notable
Intensity:	Notable
Scale Accumulation:	Notable and potentially critical
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Difficult
Resilience of Environment:	Reasonable
Effect on Instability:	Uncertain
Effect on Sustainable Productivity:	Uncertain

Process: Human, livestock and crop disease profiles occur in any environment. FCDI will change the profiles with some disease problems declining and some being enhanced or introduced due to new environment. Disease profiles are also determined by public health facilities, income levels and changing social factors which will also be affected by FCDI interventions. Some groups will be better off and others worse off. Major problems of scale will occur as new FCDI habitats link up across landscape and allow transmission of disease and vectors from one area to another.

Vulnerable Group/Area: Potentially all people, each disease with specific mechanisms
Mitigation: Monitoring and pre-emptive engineering designs to minimise risks for introduction of new problems and avoidance of pollution and drainage problems.
Complementary Programme: Public health and sanitation facilities and education

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E. EDUCATION

- No major impact

F. TRANSPORT SYSTEMS

- Loss in major and minor inland navigation access through rivers and khals due to closed and regulated structures and increase in aquatic weeds
- Disruption of marine to estuarine access if khals closed
- Loss of local minor navigation through draw down on water levels and introduction of HYV varieties into paddy fields

Overall Evaluation of Impact: Notable and negative unless mitigated
Associated With: Flood Control - Drainage

Magnitude:	Notable
Intensity:	Notable in some areas
Scale Accumulation:	Notable
Duration:	Indefinite
Frequency:	Seasonal
Effect Reversible:	Yes with careful design and operation
Resilience of Environment:	Reasonable
Effect on Instability:	Increase
Effect on Sustainable Productivity:	Uncertain

Process: Both commercial major and minor navigation, plus occupational (fishing) navigation and domestic transport minor navigation can be denied access to traditional routes through impediments across channel (structures and unbridged embankments, also by increased sedimentation in channels or by accumulation of aquatic weeds. Assumed benefits of substitution effect of new roads inappropriate to mitigate losses to each groups and financial implications for loss of boat assets and re-investment in road transport facilities usually deny this substitution to groups adversely affected.

Vulnerable Group/Area: Major and minor existing navigation routes
Mitigation: Careful survey and multi-purpose design to maintain and enhance navigation routes through planned development of borrow pits and canals. Use of locks, judicious location of bridges for local domestic uses. Monitoring and dredging programmes and strategies to flush or remove aquatic weeds.
Complementary Programme: None

G. ENERGY AND FUEL

- No major impacts

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I.2 Lesser Impacts and Those to be Noted for Feasibility Study of FCDI

PHYSICAL

A. ATMOSPHERE

Climate: *- Changing micro and macro climates*

Potentially negative associated with FC, D & I

Potential Vulnerable Groups and Areas: Farmers with low credit rating; Farms with high mono-cropping intensity;
Mitigation Possibilities: Careful layout and design to avoid project induced waterlogging; Protection of predator populations and habitats; Integrated pest management programmes.
Complementary Programmes: Agro-climatic and ecological field research; credit and input programmes.

Quality: *- Noise disturbance to birds from pumps and engines*

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Wetlands sites with sensitive species not yet developed for pump irrigation
Mitigation: Conservation and management programme
Complementary Programme: Integration of national management approach and defined priorities for each set of regional sites

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Quality: *- Increased construction dust and exhaust pollution*

Negative associated with: Flood Control

Vulnerable Group/Area: Construction workers and villages in close vicinity of construction sites
Mitigation: Careful planning of construction works and provision of necessary protection to workers and local residents.
Complementary Programme: National construction codes and standards

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Quality: *- Increased fuel exhaust from irrigation and processing*

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: General long-term problem of increased oil-based pollution in mechanised farming and irrigated areas
Mitigation: Consideration of alternative fuel sources
Complementary Programme: Energy and technology research and international networking

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B. LAND AND SOIL RESOURCES

Morphology: *- Accelerated localised land settlement and subsidence*

Negative impact associated with FC & D

Potential Vulnerable Groups and Areas: Farmers on farms overlying marsh/peat deposits subject to oxidation.
Mitigation: Problem so small, none likely required
Complementary Programmes: none

Soil Quality: *- Lowered organic matter and sediment deposition in schemes*
- Increased organic matter and sediment deposition downstream

Negative in FC schemes and positive to other downstream floodplain and estuarine areas.

Vulnerable Group/Area: Floodplain agriculture, poor farmers with little credit worthiness and farms without access to organic manure
Mitigation: Composting programme (sewage/aquatic weeds), improved local soil testing facilities and extension services
Complementary Programme: More detailed floodplain and aquatic/soil ecology research.

Quality: *- Change in limiting factors for food production*
- Induced micro-nutrient changes

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Selected farms with susceptible soils
Mitigation: Improved extension and soils testing facilities at local level
Complementary Programme: Agricultural research and extended surveys for groundwater

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C. GROUNDWATER

Hydrology: *- Reduction in seasonal water tables and drainage to wetlands*
- Increase in storage for floodwater early in season

Potentially negative associated with: Flood Control - Drainage - GW Irrigation

Vulnerable Group/Area: Low lying lands
Mitigation: More data and modelling needed in detailed monitoring and survey sites
Complementary Programme: none identified as yet

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Quality: - *Toxicity problems (Fe-Mn-Br) with irrigation*

Negative in selected areas associated with: GW Irrigation

Vulnerable Group/Area: Farms in selected susceptible locations
Mitigation: Improved agricultural extension and local soil testing services
Complementary Programme: Agricultural research and monitoring of groundwater

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D. SURFACE WATER

Hydrology: - *Loss of low lying ground to irrigation storage in dry season*

Negative in small areas associated with: Flood Control - Drainage - SW Irrigation

Vulnerable Group/Area: Low lying ground affected by storage from regulators.
Mitigation: Compensation and survey programme
Complementary Programme: Assistance in farm planning to switch to new suitable production systems, perhaps with emphasis on aquatic resources

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Quality: *Downstream adverse affects on water users outside systems*

Negative and some positive associated with: Flood Control - Drainage - GW/LLP Irrigation

Vulnerable Group/Area: A range of downstream situations
Mitigation: Increased integrated planning and mitigation for downstream effects
Complementary Programme: To be identified

BIOLOGICAL AND ECOLOGICAL IMPACTS

A. SPECIES DIVERSITY

- No minor impacts

B. POPULATION CHANGES

- *Pest-predator imbalance*
- *Food chain imbalance*

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Potentially any field or tree crop area
Mitigation: Integrated pest and environmental planning and management
Complementary Programme: Ecological research, monitoring and institutional coordination

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C. LAND USE AND HABITAT CHANGES

- Field Ecology

- Loss of fodder species diversity in fallow

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: All free grazing livestock and particularly farms dependant on draft animals
Mitigation: Promotion of sound rotational and organic farming, planned planting of fodder rich species on bunds and embankments
Complementary Programme: Monitoring and research

Wetland: - No minor impacts

Forest: - Floodplains systems already historically replaced by homestead tree crops. No minor impacts. Last sal forest area to be protected, but not on floodplain

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Homestead: *- Change in tree crops planted*

Uncertain impact but generally positve associated with: Flood Control - Drainage - GW Irrigation (Select)

Vulnerable Group/Area: Homestead plots and women
Mitigation: Need not yet identified for any adverse impacts
Complementary Programme: Research and monitoring

Rare Habitats: *- Risk to quiet wetlands sites for migratory birds*

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Wetland sites used by migratory birds
Mitigation: Conservation and protection programmes
Complementary Programme: Integration with national programme and strategy

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SOCIO-ECONOMIC IMPACTS

A. DISPLACEMENT

- Loss of current productive land and water resources but creation of high land on embankment with high value for settlement

Negative and some positive associated with: Flood Control

Vulnerable Group/Area: Sites of land acquisition
Mitigation: Well designed compensation and resettlement strategy
Complementary Programme: None

B. PRODUCTION LEVELS

- Reduced losses of pond culture from flood dispersal of species

Positive associated with: Flood Control

Benefiting Group/Area: Existing productive pond sites and users
Mitigation: None required
Complementary Programme: None required

C. INVESTMENT & ASSET VALUES

- Loss of assets worth due to inordinate delays and possible under-valuation and manipulation of compensation payments

Negative associated with: Flood Control - Drainage

Vulnerable Group/Area: Land acquisition areas
Mitigation: Full public participation and strong political commitment and supervision
Complementary Programme: None required if mitigated

D. FARMING SYSTEMS

- Increased cultivation demands for draft power
- Reduced open grazing areas in fallow and around beels

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Farms dependant on draft animals
Mitigation: Promotion of sound rotational and organic farming, planned planting of fodder rich species on bunds and embankments
Complementary Programme: Monitoring and research

E. INCOME

- Possible increased production effect on depressing rice prices

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Rice markets and farmer incomes
Mitigation: None possible except crop diversification and price intervention
Complementary Programme: none

F. EMPLOYMENT & WAGES

- Increased labour demands and migration during construction, maintenance and rehabilitation

Positive associated with: Flood Control - Drainage - GW/SW Irrigation

Benefiting Group/Area: Construction labour
Mitigation: Ensuring maximum labour intensive approach adopted
Complementary Programme: Donor and contractors agreement if contracts go to ICB

G. GOVERNMENT SERVICES (strain during construction period)

- Marginalised poorer groups, induced landless and lost occupation will increase strain on urban services as rural to urban migration increases
- Extended health training and facilities to deal with pollution problems if flushing and pollution controls not implemented
- Extra road usage, maintenance costs and traffic accidents due to construction work and increased economic activity after
- Extra crime risks and social tensions during pre-construction activities with changed investment expectations

- Extra crime risks and social tensions during construction with presence of migrant labourers
- Increase in maintenance costs for FCD structures
- Psychological problems as economic pressures increases and cultural systems transformed

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Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Government budgets and resources
Mitigation: Careful preparation of construction contracts, contractors responsibilities and construction planning and coordination with other government services.
Complementary Programme: National construction codes and standards

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- Decline in government education and general facilities maintenance costs due to reduced flood risks.

Positive associated with: Flood Control - Drainage

Benefiting Group/Area: Government budgets and resources
Mitigation: None required
Complementary Programme: None required

H. PRIVATE SECTOR SERVICES

- Private sector stimulated by demand for irrigation pumps, inputs, processing and marketing services

Positive associated with: Flood Control - Drainage - GW/SW Irrigation (Select)

Benefiting Group/Area: Private sector companies
Mitigation: None required
Complementary Programme: None required

I. SURVIVAL STRATEGIES

- No minor impacts

J. GENDER AND AGE ISSUES

Men: *- New pressures on men from increased agricultural labour demands leading to loss of leisure activities and folk/artistic cultural contributions to social cohesion and continuity of cultural heritage for the next generation*

Women: *- Increased post-harvesting demands and raised economic activity may displace women from traditional occupations in processing*

- Increased fodder availability could raise chances of increases occupational and income opportunities for women in livestock rearing.

Children: *- For some families increased agricultural labour and economic demands may force parents to deny children access to schooling to assist in field activities. For others increased incomes will open up greater educational opportunities for their children.*

Mainly negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Children in kept at home for agricultural labouring due to family economic pressures.
Mitigation: None identified
Complementary Programme: Cultural conservation and educational strategies

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QUALITY OF LIFE IMPACTS

A. HERITAGE AND ARCHAEOLOGICAL IMPACTS

- Impacts unclear until specific sites locations given and surveys carried out

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B. CULTURE & TRADITIONS

- Loss of access to open water fisheries leads to loss of traditional occupational activities with all its attendant cultural and folk activities and artistic/skilled artisan creativity.
- Loss of diversity of rice varieties leads to loss of cultural norms for Hindu cultural and ceremonial activities.

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: All FCDI schemes and communities adjusting to new cultural, social, economic and ecological pressures
Mitigation: Integrated multi-purpose production strategy in engineering and planning design and allocation of resources under regional plan.
Complementary Programme: Expansion of national gene bank programme. Cultural conservation and educational strategies

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C. SETTLEMENT AND MIGRATION SYSTEM

- Assets and homestead systems not protected from extreme events.

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: All areas inside FCD schemes susceptible to damage in extreme events and system failures

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Mitigation: Integration of non structural measures into plan

Complementary Programme: None

- Increased agricultural, economic activity and better investment climate may induce new growth in minor or major urban centres and migration patterns for seasonal labour

Positive associated with: Flood Control - Drainage - GW/SW Irrigation

Benefiting Group/Area: FCD schemes, new investors and unemployed

Mitigation: None required

Complementary Programme: Careful planning and pollution controls

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D. HEALTH AND NUTRITION

Human: *- Increased income will improve quality of housing and homestead provisions for healthier environment*

- Improved health as sewage systems not flooded but problem of stagnant water pools and pollution of potable water source from surface water or shallow groundwater

Positive and negative associated with: Flood Control - Drainage - GW/SW Irrigation

Benefiting Group/Area: Families having access to increase incomes from schemes

Mitigation: None required

Complementary Programme: Public health programmes

Animal: *- Decline in animal nutrition from loss of fallow grazing and fodder diversity*

- Increased availability of rice bye-products, husk and bran

- Changes in water-borne disease

- Changes in disease vectors

Negative and some seasonal positive impacts associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Livestock and particularly draft animals

Mitigation: Sound multi-purpose farming systems and veterinary planning and support services

Complementary Programme: Agricultural and ecological research

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E. EDUCATION

- Flood protection will increase the protection to educational institutions

Positive associated with: Flood Control

Benefiting Group/Area: Schools in schemes
Mitigation: None required
Complementary Programme: None required

F. TRANSPORT SYSTEMS

- Creation of new road linkages by new embankments

- Increased freight demand from increased construction material demands in construction phase and agricultural production and demand for inputs in operational phase.

Positive associated with: Flood Control - Drainage - GW/SW Irrigation

Benefiting Group/Area: Local road users and transport sector
Mitigation: None required
Complementary Programme: None required

G. ENERGY AND FUEL

- Increased demand for power for pump station and electric irrigation pumps

- Increased demand for oil-based products based on agro-chemicals, creation of road networks and extra demand for power tillers, grain mills and freight by motorised minor boats and road vehicles

Negative associated with: Flood Control - Drainage - GW/SW Irrigation

Vulnerable Group/Area: Energy conservation and pollution strategies
Mitigation: None identified
Complementary Programme: Alternative energy and technology research

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- Increased straw and husks

Positive associated with: Flood Control - Drainage - GW/SW Irrigation (Select)

Benefiting Group/Area: Livestock and fuel users
Mitigation: None required
Complementary Programme: None identified

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

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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

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

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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
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WRC	Water Resource Cell
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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.

360

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.