Flood Action Plan
FAP 3
North Central Regional Study

Supporting Report VIII and IX
Development Options VIII
Planning Units IX

February 1993

Financed by:

Commission of the European Communities and
Caisse Française de Développement
Project ALA/90/03

Consortium:
BCEOM, Compagnie Nationale du Rhone
Euroconsult, Mott MacDonald International,
Satec Développement

***in association with*:**
Desh Upodesh Ltd.
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Development Options

SUPPORTING REPORT VIII - DEVELOPMENT OPTIONS

CONTENTS

CHAPTER 1
Compartments/Embankments/Structures

1.1 General

Development options can be broadly categorised as "structural" and "other" options for flood damage mitigation. The "other" options are essentially non-structural although they may include some structural element. The planning approach for the North Central Region gives due attention to both.

Structural development options are based on the concepts of controlled flooding and controlled drainage whether partial or full.

The degree of control which can be imposed on both flooding and drainage within an area are totally dependent on the structural measures which are applied and the efficiency and effectiveness of the water management system. The degree of control of flooding and drainage which is required is a separate factor and is dependent on the production and economic activities or potentials of the area in question.

The proposed approach is one of permitting sufficient flooding so as not to adversely impact on fisheries and navigation whilst taking into account the benefits to be gained from reduced flood damage to agriculture, infrastructure, housing and industry. It is an approach which should not impact greatly on the natural systems.

The main imposed situations are :

- the existence or occurrence of major flood flows and hence levels around the entire region
- the occurrence of high rainfalls
- the existence of infrastructure which impedes natural drainage
- the downstream water level control at the confluence of the Meghna and Padma which impairs drainage.
- complex micro relief within each sub-region
- topography (e.g. Arial Beel)

The development options are proposed to address the problems caused by the above situations.

1.2 Structural Development Options

Two main structural development options are being studied, as follows:

- fully controlled flooding and drainage, based on full flood control along the major rivers by embankments and fully gated structures, and major drainage improvements;

- semi-controlled flooding and drainage, where flooding depends partly on embankments with fully gated structures, and partly on natural openings or semi-regulated ones.

These options are being refined by sub-region in order to obtain an optimum development situation according to technical, economical, financial, social and environmental criteria. They are compared to a reference option consisting of minor local drainage improvements and flood proofing.

All these "structural options" also consider additional non-structural options, as described below. The basic components to achieve the structural development options are:

- major river flood embankments
- minor river flood embankments
- submersible embankments
- major river training, under FAP-21/22
- major inlet/outlet structures on the embankments
- main and minor river drainage improvements
- gravity drainage outlets
- pumped drainage
- compartmentalisation - (water management systems comprising peripheral inlet/outlet structures, internal water control works, channel improvement, and infrastructure improvements).
- development of unprotected or partially protected areas in terms of flood proofing, both rural and urban etc.

1.3 Compartmentalisation

The concept of compartmentalisation has been proposed in the FAP study report of 1989 as a possible worthwhile approach to improving the water resources of Bangladesh. The term has been interpreted in several ways by various studies. This report understands the term as described by FAP 20 (the Compartmentalisation Pilot Project) as follows:-

The compartment is a management unit in which the involvement of beneficiaries are considered essential for its success. The objective is to provide, through water management, a more secure environment for intensive agriculture, fisheries and integrated rural/urban development, and thereby improve the economic security and quality of life of the flood plain population.

Within the various sub-regions of the North Central Region, compartmentalisation is expected to play a key role in all future development scenarios. The compartmentalisation of protected areas creating water management units organised by the local beneficiaries supported technically by the local institutions. Additional benefits are seen to come from compartments in terms of mitigating and distributing damage caused by the failure of part of an embankment adjacent to a major river.

The potential benefits of controlled flooding will only be achievable with the implementation of improvements at the local level. It is important , for example, that the local depressions, khals and beels are connected to the regional drainage system so that water flow and drainage can be achieved. Compartmentalisation is seen as the methodology for achieving these local improvements. The regional schemes, therefore, have been costed and evaluated on the assumption that as well as the major embankments, compartmentalisation is also implemented.

1.4 Improved Drainage

The water levels in the region are caused by a combination of flooding from local rainfall and from overspill from the major and regional rivers (see PSR II.2). In principle decrease water levels can be increase by improvements to the regional and local drainage systems. However the high water levels during the monsoon season at the downstream (south-eastern) end restricts the effectiveness of any major works at a regional level.

Improvement of local drainage can be recommended particularly in the more northern areas where there is some potential water level differences for removal of drainage water. Such local drainage improvements, however, are complicated by the fact that improved drainage in one part of the region results in higher water levels elsewhere in the Region. Drainage improvements are therefore subject to agreement being reached with local people and should therefore be the subject of approval being achieved through public participation and compartmentalisation initiatives.

CHAPTER 2
FLOOD PROOFING/FISHERY/OTHER INITIATIVES

2.1 Other Development Options

In addition to the mainly structural options, there are other options for flood damage mitigation which are essentially non-structural although they may include some structural element. These "others options" include:

- flood zoning
- flood preparedness
- early warning systems (linked to flood preparedness)
- flood proofing or adjustment

Each of these structural and non-structural options require a significant amount of study and include social, institutional and environmental considerations and programmes. The characteristics of some will vary from sub-region to sub-region, although a general approach to certain initiatives such as flood proofing is expected to be developed under the FAP.

The particular studies involved include :

- topography and mapping ;
- river morphology;
- hydrology and hydraulic modelling;
- flooding - occurrence and frequency, location and extent;
- drainage - internal river/drainage system, outfalls, congestion and backwater effects;
- general water resources - surface and groundwater;
- land use;
- agriculture - cropping patterns, yields, irrigation and livestock;
- fisheries;
- forestry;
- urban development
- communications, marketing and other productive sectors including rural industries;
- agricultural economics;
- socio-economics;
- social programmes through NGOs etc.;
- environment, and
- national and rural institutions.

2.2 Flood Proofing

A combination of flood proofing, flood preparedness and flood early warning is recommended for all areas in the North Central Region that experiences significant flooding that periodically inundates and/or damages land areas and habitation. Such an approach is applicable in PU's 1,6,7,10,11 and 13, which comprise the Jamuna and Padma flood plains.

Although there is localised flooding in the rest of the Region, the flooding is not of sufficient frequency or duration to merit flood proofing measures. Flood proofing will also not be required where controlled flooding schemes are to be implemented.

There are many approaches to flood proofing and proposals include:-

- raised housing (on stilts)
- raised homesteads (on earth mounds)
- centrally located protected buildings (schools, clinics etc.) which also act as shelters
- multipurpose use of embankments

Flood preparedness also includes measures such as the provision of boats and the facility for protecting crops, possessions etc. with improved raised storage facilities.

These aspects are being studied at present by FAP 23 and guidelines on Flood Proofing. Flood Preparedness and Flood Response Measures are expected to be produced by the FAP at a later date.

At present the NCRS has identified the areas that will require some form of flood response measures (see Final Report, Figures 6.3 and 6.4). The costing and benefit estimates of such measures will have to be made at the Feasibility Study level, when more specific aims and objectives of Flood Response Measures should be identified.

2.3 Fishery Initiatives

In view of the substantial potential reductions in floodplain-dependent fisheries resulting from possible FCD schemes, the regional plan should consider the inclusion of fisheries research and development programmes to minimise and/or compensate for the adverse effects of FCD interventions. Such fisheries initiatives should be established in those areas which face the greatest potential reduction in their existing capture fisheries, i.e. Pus 4,6,7 and 10. Important reductions to the fisheries of Pus 1 and 2 have also been predicted but, in the case of PU 1, more detailed fisheries investigations are to be undertaken as part of the Jamalpur Priority Project (FAP 3.1).

Two possible fishery projects are described below. These have not been formally included within the Regional Plan but should be considered further at the feasibility study level of the Regional Schemes.

2.3.1 Fisheries sub-project FS1 - Jamuna-Dhaleswari System

Project Area : Planning Unit 6

Objectives : To conserve and enhance wild fish stocks by the establishment of a more effective fisheries management programme and by the introduction of mitigatory measures to reduce the adverse impact of FCD interventions.

Strategy : The proposed programme combines elements of both adaptive research and fisheries development which can be divided into the following components.

Component 1 : Research into the most appropriate design of water control structures such as sluice gates and regulators to facilitate the free passage of fish (adults, juveniles and fry) and shrimp between rivers and floodplain, thereby enhancing natural colonisation and reduce the adverse impacts of FCD. This component of the programme may involve collaboration with FAP 17 and FAP 13 in the determination of the optimum designs of various structures and with FAP 20 in the construction and testing of the performance of new structures in the project area.

Component 2 : Research into natural annual migrations/movements of fish (adult, juvenile and fry) between floodplain habitats and rivers. A much greater under standing is needed of the seasonal movements of fish to provide sound advice on the magnitude and timing of floods which are necessary for the maintenance of fish populations.

Component 3 : Research involving stock assessment of selected species in rivers, beels and floodplain habitats. This will provide information essential to the formulation of rational fisheries management and development policies and for a more accurate quantitative assessment of the impact of FCD schemes on capture fisheries. Close collaboration with FAP 17 is envisaged during the implementation of this component of the programme.

Component 4 : Support of the district Department of Fisheries to enable it to effectively enforce fisheries regulations to protect and conserve fish stocks and to implement the New Fisheries Management Policy on those jalmahals recently transferred from the Ministry of Land, especially the jalmahal of the Dhaleswari river.

Component 5 : Protection of important large, perennial beels to conserve both water resources and the fisheries which they support from the adverse effects of FCD. One or two of the most important perennial beels should be designated as prohibited fishing zones to serve as natural reservoirs of floodplain fish stocks.

Component 6 : Provision of credit facilities to licensed fishermen involved in the NFMP. The most effective means of channelling credit to fishermen would appear to be through NGOs such as the Grameen Bank.

2.3.2 Fisheries Sub-project FS2 - Development of Aquaculture

Project Area: Planning Units 10 and 13.

Objectives : To encourage the spread of aquaculture in under utilised habitats and to explore the possibilities of utilising certain habitats for both fish and rice production.

Strategy : This project also contains elements of adaptive research and development which can be divided into the following components.

Component 1 : Stocking of carp fry by DOF and private sector hatcheries of under-utilised water bodies which are considered suitable for fish production. This component represents an extension and expansion of the stocking programme already undertaken by DOF in an effort to enhance major carp stocks in the NCR. It is important that a monitoring programme be established to determine the effectiveness of stocking different types of habitats, e.g. canals and beels at varying stocking densities, and to enforce fisheries regulations in those areas.

Component 2 : Support government institutions such as the Bangladesh Rice Research Institute and the Fisheries Research Institute in the implementation of research programmes concerned with rice/fish farming. The development of such integrated farming techniques should encourage mutual co-operation between the traditionally conflicting interests of fisheries and agriculture in areas of improved flood control and drainage.

Component 3 : Provision of credit to small-scale farmers to enable them to take advantage of the increased opportunities of aquaculture development using simple, low-cost, tried and tested techniques. The most effective channel for the provision of credit would seem to be NGOs such as the Grameen Bank.

Component 4 : Support of the district Department of Fisheries to enable it to effectively enforce fisheries regulations to protect wild and stocked fish and to implement aquaculture, extension and training programmes.

Planning Units

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SUPPORTING REPORT IX - PLANNING UNITS

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CHAPTER 1
Derivation of Planning Units

1.1 General

As a first stage in the development planning approach the Region has been divided into Planning Units (PU's). These Planning Units have been defined so as to assist with the classification of the Region's characteristics to allow alternative development strategies to be prepared.

The PU's have been delineated primarily using hydrological characteristics, but also allowing for resources characteristics such as soils, land use, population intensities and considering administrative boundaries where significant. Thirteen PU's have been designated (Figure IX.2.1). It should be stressed that the PU's are defined to assist ion the planning process, they are not development units and they have subsequently been aggregated together to from development areas that are proposed to be developed under the Regional Schemes (see SR X).

1.2 MPO Planning Areas

At first it was hoped that the MPO planning areas (PA's) could be adopted as the PU's but it was found that the MPO PA's were primarily defined on catchment boundaries (see Figure IX.2.1) and the PA's are not well suited for defining Regional Scheme boundaries as these schemes generally are bounded by rivers (not catchments).

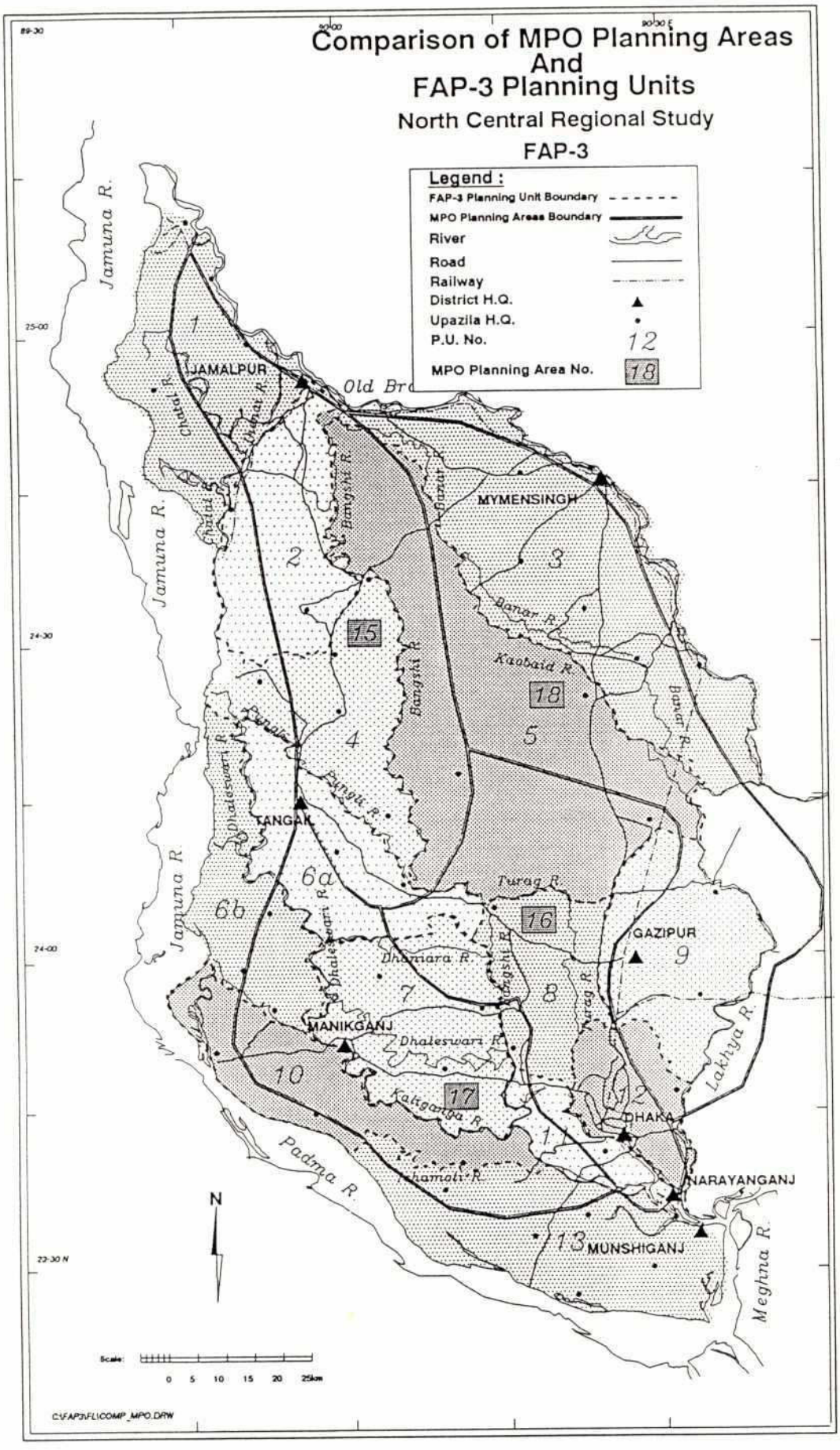
1.3 Planning Unit Data

Appropriate information has been collected for each Planning Unit on the following aspects:-

- rainfall
- hydrology
- land resources
- soils
- flood categories
- areas
- cropping
- groundwater
- fisheries
- population densities
- existing embankments
- possible water development options

This information is presented in the appropriate Supporting Reports. A summary of some additional data is presented in Chapter 2.

Figure IX.2.1
Comparison of MPO Planning Areas and Planning Units



CHAPTER 2
Planning Units

2.1 Planning Unit Information

The following information has been described elsewhere in other SR's, but has been collected together below, for ease of reference.

2.1.1 Agriculture

The land resources and agricultural characteristics are described in SR I. The information for each Planning Unit are presented in Tables IX.2.1a to IX.2.1x.

TABLE IX.2.1 a

Land Resources and Agricultural Data

P.U.1

Land Resources :

Active Jamuna Flood Plain	± 20%
Young Jamuna Flood Plain	± 45%
Old Brahmaputra Flood Plain	± 35%

Soils : Silt loam, silty clay loam, sandy loam, clay. Active Jamuna Flood Plain area near Jamuna, Southern Chatal and the Northern Old Brahmaputra rivers are facing river erosion problems and problems with fresh deposits of sand and silt.

Floods : About 25% of the area is flooded in normal years. Only the areas near the Jamuna and the Chatal rivers are moderately flooded. Risk of sudden flash floods on the active Jamuna Flood Plain. There are some small water bodies on the area N.W. of Melandaha on the Old Brahmaputra Flood Plain (± 5% of the area).

Land Types :

Highland	24%
Medium Highland	55%
Medium Lowland	21%
Lowland	negligible

Agriculture 1990-91 :

Agricultural area(cultivated)	70,009 Ha	= 78% of gross area
Irrigated area	39,197 Ha	= 56% of NCA
Cropped area	147,524 Ha	= 211% Cropping intensity
Potential increase irrigation	10 - 15%	(Active Floodplain and part of Highland Area are less suitable)

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Sugarcane/Spices/Jute/Aus/D.W.Aman/Fruittrees
Double cropped	Boro - T.Aman Aus/Jute - Boro D.W.Aman - Boro	Aus/Jute - T.Aman Sugarcane-Vegetables (mixed) T.Aman - Rabi crops
Triple cropped	Boro - Summer Vegetable - T.Aman Boro-T.Aman-Mustard	Summer Vegetables-T.Aman-Winter Vegetables/Chilli Aus-T.Aman-Winter Vegetables, Aus/Jute-T.Aman-Potato

	Area (Ha)					Production (Ton)				% of rice Production
Crops	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	23118	55	18775	45	41893	59.8	74872	37331	112203	37.0
Boro	34085	93	2392	7	36477	52.1	169201	6506	175707	57.9
Aus	1129	12	8249	88	9378	13.3	2802	11157	13959	4.6
B.Aman	--	--	1015	100	1015	1.4	--	1460	1460	0.5
Total Rice	58332	66	30431	34	88700	126.6	246875	57467	303329	100
Jute					10922	15.6			17830	
Wheat					4949	7.1			11036	
Mustard					3053	4.4			1582	
Other crops					39900	57.0				

Limitations : Some local drainage problems. Flash floods in early rainy season (June, July) River erosion in Active Flood Plain areas. Sand deposits due to floods.

TABLE IX.2.1 b

Land Resources and Agricultural Data

P.U.2

Land Resources :

Young Jamuna Flood plain, Western part	± 60%
Old Brahmaputra Floodplain, Eastern part	± 35%
Older Jamuna Floodplain, Middle part South	± 5%

Soils : Silty clay loam, some areas with a firm subsoil (plastic) especially in the area South of Jamalpur and North of Ghatail.

Floods : Mainly rain water floods, in basins floods from 4-6 months at a depth of 6-12 feet, east of Gopalpur, 4-10 months. About 40% of the cultivated area is flooded every year.

Land Types :

Highland	30%
Medium Highland	49%
Medium Lowland	17%
Lowland	4%

Agriculture 1990-91 :

Agricultural area (cultivated)	=	59,850 Ha = 83% of gross area
Irrigated area	=	36,150 Ha = 60% of NCA
Cropped area	=	130,715 Ha = 218% cropping intensity.
Potential increase irrigation		± 10%

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Aus/Aman
Double cropped	Aus/Jute-Boro	Aus/D.W.Aman/Jute-Wheat/Potato/Rabi crops
Triple cropped	Aus/Jute-T.Aman-Boro, Mustard/Vegetables-T.Aman-Boro	Aus/Jute-T.Aman-Rabi crops

Crops	Area (Ha) HYV	%	Local	%	Total	Production (Ton) %of NCA	HYV	Local	Total	% of rice Production
T.Aman	20,994	62	12,605	38	33,599	56.1	66,709	24,360	91,069	36.6
Boro	35,689	97	1,124	3	36,813	61.5	125,882	2,364	128,246	51.3
Aus	1,346	14	8,294	86	9,640	16.1	3,476	11,076	14,552	5.9
D.W.Aman	--	--	9,309	100	9,309	15.6	--	15,457	15,457	6.2
Total Rice	58,029	65	31,332	35	89,361	149.3	196,067	53,257	249,325	100.0
Jute					7,961	13.0			13,271	
Wheat					3,513	6.0			6,523	
Mustard					3,434	6.0			2,765	
Other crops					17,655	44.7				

Limitation : Major limitation is drainage. This involves major system of rivers as well as local drainage impediments as river banks, roads etc.

TABLE IX.2.1 c

Land Resources and Agricultural Data

P.U.3

Land Resources :

Young Brahmaputra Flood Plain.Small area along Brahmaputra	±15%
Old Brahmaputra Flood Plain	±80%
Madhupur Tract	± 5%

Soils : Silt loam, silty clay loam, silty clay, clay loam, clay,

Floods : River valleys and depressions can be flooded during rainy season. Floods only from rainwater, 50% of area might be flooded for 1-2 weeks. Numerous beels and khals used for drainage purposes. Flash floods, early and late, are occurring.

Land Types :

Highland	27%
Medium Highland	51%
Medium Lowland	20%
Lowland	2%

Agriculture 1990-91 :

Agricultural area (cultivated)	= 127,979 Ha 75% of gross area
Irrigated area	= 40,472 Ha 32% of NCA
Cropped area	= 241,622 Ha 189% cropping intensity
Potential increase of irrigated area limited	Due to limited groundwater recharge

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Aus/Jute, T-Aman, Vegetable,Spices
Double cropped	Boro - T.Aman, Jute/Aus-Boro	Aus/Jute-T.Aman Aus/Jute-Rabi crops, T.Aman-Rabi crops
Triple cropped	Aus/Jute-T.Aman-Boro, T.Aman-Vegetables-Boro	Aus/Jute-T.Aman-Vegetables/Wheat/Spices

	Area (Ha)					Production (Ton)				% of rice Production
Crops	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	50453	50	50005	50	100,458	78	174,165	102,004	276,169	46.0
Boro	40,508	90	4,349	10	44,857	35	167,790	9,726	177,516	29.0
Aus	29,612	46	35,148	54	64,760	51	96,329	53,270	149,599	25.0
D.W.Aman	--		200	100	200	0.2	--	371	371	0.1
Total Rice	120,573	57	89,702	43	210,276	164	438,284	165,371	603,654	100.0
Jute					9,285	7			14,815	
Wheat					5,732	4			10,323	
Mustard					1,637	1			1,073	
Other crops					14,692	12				

Limitation : Drainage of rainwater, rivers and khals are silted and even used to grow crops (boro). Major drainage problems in SE area.

TABLE IX.2.1 d

Land Resources and Agricultural Data

P.U.4

Land Resources :	Madhupur Tract	± 15%
	Young Jamuna Floodplain Western part	± 15%
	Older Jamuna Floodplain middle part (M to S.)	± 20%
	Old Brahmaputra Floodplain Eastern part	± 50%
Soils :	Silty clay to clay, silty loam to silty loam. Some areas with very firm subsoil (plastic), S.E. area around Basail and the Bangsi valley east of Ghatail (east of the outcrops of the Madhupur Tract), recent sand deposits up to 2m thick.	
Floods :	Mainly rainwater floods with some river water flood risk in the area near Bhuapur. Flood depth 6-14 feet during 4-6 month in the S.E. area, 6-12 feet during 4-6 month is Bangsi valley local basins flooded 1/2 month - 4 months. About 70% of the cultivated area is flooded every year.	
Land Types :	Highland	25%
	Medium Highland	40%
	Medium Lowland	27%
	Lowland	8%
Agriculture : *1990-91*	Agricultural area (cultivated)	58,420 Ha = 76% of gross area
	Irrigated area	29,082 Ha = 50% of NCA
	Cropped area	121,066 Ha = 207% cropping intensity
	Potential increase of irrigation	15-20%

Cropping pattern	Irrigated	Non-Irrigated
Single	Boro	Vegetable/fruits/Aus+D.W.Aman/Jute
Double	T.Aman-Boro Aus/Jute-Boro Aus+D.W.Aman-Boro	Aus/Jute-T.Aman Aus/Jute-Rabi crops Aus/D.W.Aman-Rabi crops Aus/Jute-T.Aman-Rabi crops
Triple cropped	T.Aman-Mustard/Vegetables-Boro	Summer Vegetables-T.Aman-Rabi crops

	Area(Ha)					Production (Ton)				% of rice production
Crops	HYV	%	Local	%	Total	% of	HYV	Local	Total	
T.Aman	7823	52	7,256	48	15,079	25.8	29,879	15,681	45,560	25.6
Boro	29,218	97	934	3	30,152	51.6	88,009	1,340	89,349	50.3
Aus	1,320	11	10,698	89	12,018	20.6	3,651	13,641	17,292	9.7
D.W.Aman	--	--	24,194	100	24,194	41.4	--	25,538	25,538	14.3
Total Rice	38,361	47	43,082	53	81,443	139.4	121,539	56,201	177,740	100.0
Jute					6,742	11.0			11,577	
Wheat					4,536	8.0			8,695	
Mustard					7,155	12.0			5,305	
Other crops					21,380	36.6				

Limitations : River floods in western part near Bhuapur. Floods in Bangsi valley. Drainage constraints.

TABLE IX.2.1 e

Land Resources and Agricultural Data

P.U.5

Land Resources :

Madhupur Tract	95%
Old Brahmaputra Flood Plain	5%

Soils : Highland soils clay/clay loam; valleys and depressions, silt clay loam/clay.

Narrow valleys ± 30% and broad valleys ± 10% of the gross area, low soil fertility, some zinc deficiency and iron toxicity in the lower parts of valleys, which are deeply flooded and which stay wet for all or major part of the dry season.

Risks for erosion in areas with steep slopes.
Waterlogging in many parts of the highlands, poor drainage.
Prone to draughtiness during the dry season in most of the highlands and some valleys.

Floods : Narrow valleys flooded 1-3 feet during the rainy season.
Broad valleys seasonally flooded deeper than 6 feet.
Some valleys in the S.E. of the area have a high flood risk. About 20% of the area is flooded every year for approximate 6 weeks.

Land Types :

Highland	57%
Medium Highland	30%
Medium Lowland	9%
Lowland	4%

Agriculture *1990-91* :

Agricultural area (cultivated)	121,318 Ha = 57% of gross area
Irrigated area	42,600 Ha = 35% of NCA.
Cropped area	203,803 Ha = 168% cropping intensity

Potential increase of irrigation limited due to undulating land.

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Pineapples/Sugarcane/Fruittrees/Aus/T.Aman
Double cropped	T.Aman-Boro, Aus/Jute-D.W.Aman-Boro	Aus/Jute/Vegetables-T.Aman/Winter Vegetables
Triple cropped	Vegetables-T.Aman-Boro	Aus/Jute/Vegetables-T.Aman-Rabi crops

	Area(Ha)					Production (Ton)				
Crops	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	% of rice production
T.Aman	40,377	57	30,473	43	70,850	58.4	147.706	66,206	213,992	49.6
Boro	39,399	93	3,062	7	42,461	35.0	149,572	6,260	155,832	36.1
Aus	11,936	26	33,338	74	45,274	37.3	35,771	47,801	83,572	13.5
D.W.Aman	--	--	2,669	100	2,669	2.2	--	3,363	3,363	0.8
Total Rice	91,712	57	69,542	43	161,254	132.9	333,049	123,630	456,679	100.0
Jute					1,203	1.0			1,925	
Wheat					3,847	3.2			6,925	
Mustard					1,109	0.9			665	
Other crops					36,400	30.0				

Limitations : Poor drainage and waterlogging on highlands.
Droughtiness during the dry season.
Flash floods in narrow valleys in the S.E. area

Remarks : Fruittrees, mainly jackfruit, are planted scattered around homesteads and as boundaries in farm plots. Forest area under forest is very limited. Major part of the forest area is used for homesteads and crops as pineapples, fruittrees, sugarcane, etc.

TABLE IX.2.1 f

Land Resources and Agricultural Data

P.U.6

Land Resources :	Active Jamuna Floodplain, Western part	± 15%
	Young Jamuna Floodplain, middle part	± 25%
	Older Jamuna Floodplain, Eastern + Southern Part	± 60%
Soils :	Silt loam to silty clay loam, Silty and sandy on the Active Jamuna Floodplain, with slightly higher sand deposits locally.	
Floods :	Flood water moves rapidly over the land during river floods in the Active Jamuna Floodplain. The numerous basins are flooded during 4-7 months moderately deep to very deep. About 80% of the cultivated land is flooded every year.	
Land Types :	Highland	15%
	Medium Highland	48%
	Medium Lowland	29%
	Lowland	8%
Agriculture 1990-91 :	Agricultural area (cultivated)	95,880 Ha = 86% of gross area
	Irrigated area	40,640 Ha = 42% NCA
	Cropped area	200,550 Ha = 209% cropping intensity

Cropping pattern	irrigated	Non-Irrigated
Single cropped	Boro	Aus/Aman/Millet
Double cropped	Aus/Jute-Boro,D.W.Aman-Boro	Aus/D.W.Aman/Jute-Rabi crops Aus+D.W.Aman (Mixed)
Triple cropped	Aus/Jute-T.Aman-Boro T.Aman-Mustard/Vegetables-Boro	Aus/Jute-T.Aman-Mustard/Rabi crops

Crops	Area(Ha) HYV	%	Local	%	Total	Production (Ton) % of NCA	HYV	Local	Total	% of rice production
T.Aman	2,804	32	6,012	68	8,816	9.2	9,940	14,323	24,263	9.7
Boro	40,787	98	774	2	41,561	43.3	136,449	1,235	137,684	54.9
Aus	3,175	11	26,967	89	30,142	31.4	7,565	33,301	40,866	16.3
D.W.Aman	--	--	40,733	100	40,733	42.5	--	47,794	47,794	19.1
Total Rice	46,766	39	74,486	61	121,253	126.4	153,954	96,653	250,607	100.0
Jute					13,076	13.6			18,918	
Wheat					10,429	10.9			19,669	
Mustard					10,841	11.3			8,954	
Other crops					44,872	46.8				

Limitations : River floods from Jamuna/Dhaleswari in Western part. Rain water floods in the rest of the area. Impeded drainage in S.E. of the area and local drainage problems caused by roads, embankments raised river banks etc.

TABLE IX.2.1 g

Land Resources and Agricultural Data

P.U.6a

Land Resources :	Young Jamuna Floodplain	± 20%	
	Older Jamuna Floodplain	± 80%	
Soils :	Silty loam to silty clay loam.		
Floods :	Numerous basins and depressions are flooded for 4 to 7 months. About 80-90% of the cultivated area is seasonally flooded every year.		
Land Types :	Highland	14%	
	Medium Highland	45%	
	Medium Lowland	31%	
	Lowland	10%	
Agriculture 1990-91 :	Agricultural area(cultivated)	51,880 Ha	= 86% of gross area
	Irrigated area	25,500 Ha	= 49% of the NCA
	Cropped area	111,500 Ha	= 215% Cropping intensity
	Potential increase irrigation	± 20%	

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Aus/Aman/Millet
Double cropped	Aus/Jute - Boro D.W.Aman - Boro	Aus/D.W.Aman/Jute - Rabi crops Aus + D.W.Aman (Mixed)
Triple cropped	Aus/Jute - T.Aman - Boro T.Aman - Mustard/Vegetables - Boro	Aus/Jute - T.Aman - Mustard/Rabi crops

Crops	Area (Ha)						Production (Ton)			% of rice Production
	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	1,576	30	3,703	70	5,279	10.2	5,580	8,810	14,390	9.7
Boro	24,663	98	460	2	25,123	48.4	82,620	730	83,350	56.1
Aus	2,144	12	15,496	88	17,640	34.0	5,100	19,060	24,160	16.2
D.W.Aman	--	--	22,911	100	22,911	44.2	--	26,800	26,800	18.0
Total Rice	27,383	39	43,570	61	70,953	136.8	93,300	55,400	1,48,700	100.0
Jute	9,253					17.8			13,324	
Wheat	6,362					12.3			11,979	
Mustard	5,240					10.1			4,658	
Other crops	19,692					38.0				

Limitations : Floods by accumulated rainwater in the basins and depressions in May/June. River floods in July/August. Impeded damage in S.E. of the area and local drainage problems caused by roads, embankments, raised river banks etc.

TABLE IX.2.1 h

Land Resources and Agricultural Data

P.U.6b

Land Resources :

Active Jamuna Floodplain	± 50%
Young Jamuna Floodplain	± 50%

Soils : Silty and sandy in the Active Jamuna Floodplain.
Silty loam and silty sandy loam in the Young Jamuna Floodplain.

Floods : Seasonal river floods are moving rapidly over the so-called "Char" lands in the Active Jamuna Floodplain.

Numerous basins and depressions on the Young Jamuna Floodplain are flooded for 3 to 5 months every year.

Land Types :

Highland	16%
Medium Highland	57%
Medium Lowland	24%
Lowland	7%

Agriculture 1990-91 :

Agricultural area (cultivated)	=	44,000 Ha = 86% of gross area
Irrigated area	=	16,500 Ha = 38% of the NCA
Cropped area	=	89,000 Ha = 202% cropping intensity.
Potential increase irrigation		± 5%

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Sugarcane/Aus/Aman/Millet
Double cropped	Aus/Jute - Boro D.W.Aman - Boro	Aus/D.W.Aman/Jute - Rabi crops Aus + D.W.Aman (mixed)
Triple cropped	Aus/Jute - T.Aman - Boro, T.Aman-Mustard/Vegetables-Boro	Aus/Jute-T.Aman-Mustard/Rabi crops

	Area (Ha)						Production (Ton)			% of rice Production
Crops	HYV	%	Local	%	Total	%of NCA	HYV	Local	Total	
T.Aman	1,228	35	2,309	65	3,537	8.4	4,360	5,513	9,873	10.2
Boro	16,124	98	314	2	16,438	38.6	53,829	505	54,334	56.2
Aus	1,031	8	11,471	92	12,502	29.6	2,465	9,141	11,606	11.9
D.W.Aman	--		17,822	100	17,822	42.1	--	20,994	20,994	21.7
Total Rice	18,383	37	31,916	63	50,299	118.7	60,654	36,153	96,807	100.0
Jute					3,823	8.7			5,594	
Wheat					4,067	9.2			7,690	
Mustard					5,189	10.0			4,296	
Other crops					25,622	55.4				

Limitation : River floods from the Jamuna and Dhaleswari rivers. River bank erosion in the sandy areas along the main rivers.

TABLE IX.2.1 i

Land Resources and Agricultural Data

P.U.7

Land Resources :

Young Jamuna Flood Plain	± 95%
Active Jamuna Flood Plain	± 5%

along side left and right banks of the Dhaleswari river

Soils : Active Flood Plain: silty and sandy with some silt loam, silty clay, silty clay loam, light soils. Young Jamuna Flood Plain: loam, clay, heavy soils.

Floods : Ridges are 3-6 feet flooded by river water, basins 5-15 feet up to 6 months. About 80% of the cultivated area is flooded every year.

Land Types :

High Land	12%
Medium Highland	39%
Medium Lowland	27%
Low Land	22%

Agriculture *1990-91* :

Agricultural area (cultivated)	67,238 Ha = 73% of gross area
Irrigated area	23,243 Ha = 35% of NCA
Cropped area	130,690 Ha = 194% cropping intensity
Potential increase irrigation	20 - 25%

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Aus/Jute/D.W.Aman
Double cropped	Aus/Jute-Boro D.W.Aman-Boro	Aus/Jute-Mustard Aus/Jute/D.W.Aman-Wheat/Rabi crops
Triple cropped	D.W.Aman-Mustard-Boro/Vegetables	Aus/Jute/D.W.Aman-Mustard-Rabi crops

	Area(Ha)					Production (Ha)				% of rice production
Crops	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	1,714	44	2,170	56	3,884	5.8	6,117	4,249	10,366	5.8
Boro	22,801	97	621	2	23,422	34.8	107,354	1,278	108,632	60.9
Aus	619	2	26,906	98	27,525	40.9	1,242	24,446	25,688	14.3
D.W.Aman	--	31	27,471	100	27,473	40.9	--	34,167	34,167	19.0
Total rice	25,134		57,168	69	82,302	122.4	114,713	64,140	178,853	100
Jute					6,925	10.3			9,938	
Wheat					10,886	16.2			19,554	
Mustard					13,022	19.3			6,098	
Other crops					17,555	26.1				

Limitation : Major limitation: deep river flooding, river bank erosion along Dhaleswari.

Remark : Soil moisture in dry season is quite high in most of the area. Irrigation need is less, compared with PU 2, 4 and 6.

TABLE IX.2.1 j

Land Resources and Agricultural Data

P.U.8

Land Resources : Madhupur Tract ± 100%

Soils : Generally clay high land soils, and silty clay/loam valley soils
± 60% - high land and 20% narrow valleys and 20% broad valleys.
Low to moderate soil fertility, lower parts of the broad valleys may have some zinc deficiency or iron toxicity, especially on irrigated land. Poor drainage in some parts of the highlands, water logging, droughtiness in dry season.

Floods : Narrow valleys flooded 1-4 feet during rainy season, broad valleys up to 6 feet, lower Turag valley 8 to more than 15 feet. 30 - 40% of the area is flooded for about 3-4 months.

Land Types :

High Land	54%
Medium High Land	19%
Medium Low Land	16%
Low Land	11%

Agriculture 1990-91 :

Agricultural area(cultivated)	27,192 Ha = 59% of gross area
Irrigated area	12,719 Ha = 46% of NCA
Cropped area	46,620 Ha = 171% cropping intensity
Potential increase of irrigation limited to	10% due to undulating land and limited ground water availability.

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Fruittrees/Sugarcane/Aus/T.Aman/Vegetables
Double cropped	T.Aman-Boro, D.W.Aman-Boro	Aus/Jute-T.Aman/Summer Vegetables,T.Aman-Winter Vegetables/Rabi crops
Triple cropped	Vegetables-T.Aman-Boro	Jute/Aus/Vegetable-T.Aman-Rabi crops

Crops	Area (Ha) HYV	%	Local	%	Total	Production (Ton) % of NCA	HYV	Local	Total	% of rice production
T.Aman	6,093	79	1,611	21	7,704	28.3	20,657	2,998	23,655	26.4
Boro	11,583	89	1,371	11	12,954	47.6	53,199	2,955	56,154	62.6
Aus	1,583	39	2,515	61	4,098	15.1	5,486	3,676	9,162	10.2
D.W.Aman	--	--	529	100	529	2.0	--	733	733	0.8
Total Rice	19,259	76	6,026	24	25,285	93.0	79,342	10,362	89,704	
Jute					1,406	5.2			2,261	
Wheat					869	3.2			1,787	
Mustard					1,778	6.5			1,170	
Other crops					17,282	63.6				

Limitations : No major limitations, some local drainage problems in lower areas, water logging.

Remark : Forest area under forest is limited. Most of the area is used for homesteads, fruittrees, crops like sugarcane, etc.

TABLE IX.2.1 k

Land Resources and Agricultural Data

P.U. 9

Land Resources :

Madhupur Tract	90%
Old Brahmaputra Flood Plain	10%

Soils : Friable clay on the highlands; clay, silty clay, silty clay loam, silty loam in the valleys and on right bank of Lakhya river.
Valleys occupy 35-40% of the area, some zinc deficiency and risk for iron toxicity in deep flooded valleys. Low fertility.

Floods : Narrow and higher parts of the valleys flooded 1-3 feet, lower parts 3-6 feet, some valleys 5-15 feet ± 25 - 30% of the area remains flooded for 3 to 4 ½ months.

Land Types :

High Land	54%
Medium High Land	19%
Medium Low Land	12%
Low Land	15%

Agriculture 1990-91 :

Agricultural area (cultivated)	57,757 Ha = 73%
Irrigated area	22,528 Ha = 39% of NCA
Cropped area	102,304 Ha = 177% cropping intensity

Potential increase of irrigation is limited due to undulating land and reduced groundwater availability.

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Fruittrees/Sugarcane/Pineapple/Aus/T.Aman
Double cropped	T.Aman-Boro, D.W.Aman/Aus/Jute-Boro	Aus/Jute-T.Aman Aus/Summer Vegetables-T.Aman/Winter Vegetables/Rabi crops
Triple cropped	Vegetables-T.Aman-Boro	Jute/Aus/Vegetables-T.Aman-Rabi crops

Crops	Area (Ha) HYV	%	Local	%	Total	Production (Ton) % of NCA	HYV	Local	Total	% of rice production
T.Aman	16,512	79	4,052	21	20,564	35.6	54,813	7,366	62,179	28
Boro	24,458	94	1,575	6	26,033	45.1	103,116	3,429	106,545	49
Aus	5,830	40	8,886	60	14,716	25.5	20,179	17,893	38,072	17
D.W.Aman	--	--	6,492	100	6,492	11.2	178,108	13,152	13,152	6
Total Rice	46,800	69	21,005	31	67,804	117.4		41,840	219,948	
Jute					3,071	5.3			5,390	
Wheat					864	1.5			1,283	
Mustard					1,145	2.0			790	
Other crops					29,420	50.1				

Limitations : No major limitations, some local drainage problems in valleys.

Remarks : Forest area actually under forest is limited. Most of the area is used for homesteads, fruittrees and crops like sugarcane, pineapples, etc.

TABLE IX.2.1 l

Land Resources and Agricultural Data

P.U.10

Land Resources	:	Eastern Ganges Flood Plain	100%
Soils	:	Silt loam, silty, clay, loamy clay	
Floods	:	Seasonal flooding by river water 2-5 feet on the highest ridges, more than 10 feet in the lower basins/depressions for 4 to 6 months. About 90% of the area is flooded every year.	
Land Types	:	High Land	9%
		Medium High Land	21%
		Medium Low Land	40%
		Low Land	30%
Agriculture 1990-91	:	Agricultural area (cultivated)	48,255 Ha = 72% of the gross area
		Irrigated area	13,094 Ha = 27% of NCA
		Cropped area	90,540 Ha = 188% cropping intensity
		Potential increase of irrigated area	± 40% if flood protection is provided

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Sugarcane/Rabi crops
Double cropped	B.W.Aman/Aus/Jute-Boro	D.W.Aman/Aus/Jute-Rabi crops
Triple cropped	D.W.Aman-Mustard/Pulses-Boro	D.W.Aman/Aus/Jute-Mustard/Pulses-Rabi crops Winter Vegetables/Rabi crops-Aus-Summer Vegetables

Crops	Area (ha)					Production (Ton)				% of rice production
	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	62	30	147	70	209	0.4	186	237	423	0.4
Boro	12,268	92	1,111	8	13,379	27.7	61,105	2,196	63,301	59.9
Aus	53	--	13,482	100	13,535	28.0	127	12,063	12,190	11.5
D.W.Aman	--	--	24,784	100	24,784	51.4	--	29,844	29,844	28.2
Total Rice	12,383	24	39,524	76	51,906	107.5	61,418	44,340	105,757	100.0
Jute					2,424	5.1			3,304	
Wheat					5,014	10.4			8,772	
Mustard					5,308	11.0			3,119	
Other crops					25,888	53.6				

Limitations : Flooding during a long time of the year without any possibility to drain.

TABLE IX.2.1 m

Land Resources and Agricultural Data

P.U.11

Land Resoures	:	Young Jamuna Flood Plain	± 90%
		Old Meghna Flood plain	± 10%, most eastern area
Soils	:	Silty clay/loam, isolated some loam, sand and lime, heavy texture, possible iron toxicity in soil which stays wet during dry season (deep flooded areas). On river sides: silt loam, silty clay or clay.	
Floods	:	Broad ridges flooded 5-10 feet, basins upto 15 feet during 4 to 6 months, deep flooded areas stay wet part or all of the dry season. About 85-90% of the cultivated area is flooded every year.	
Land Types	:	High Land	12%
		Medium High Land	24%
		Medium Low Land	22%
		Low Land	42%
Agriculture 1990-91	:	Agricultural area/cultivated)	= 18,564 Ha = 67%
		Irrigated area	= 5,683 Ha = 31%
		Cropped area	= 20,408 Ha = 109% cropped intensity
		Potential increase of irrigation ± 10 - 20% if flood protection is provided	

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Sugarcane/Rabi crops
Double cropped	D.W.Aman/Aus/Jute-Boro	Aus/D.W.Aman-Jute-Rabi crops
Triple cropped	Boro-Vegetables-T.Aman	Summer Vegetables-T.Aman-Winter Vegetables

Crops	Area(Ha) HYV	%	Local	%	Total	Production (Ton) % of NCA	HYV	Local	Total	% of rice production
T.Aman	758	57	318	43	1,076	5.8	2,496	573	3,069	7.0
Boro	5,570	94	373	6	5,943	31.9	26,284	713	31,419	71.8
Aus	282	15	1,603	85	1,885	10.2	806	2,909	3,715	8.5
D.W.Aman	--	--	3,438	100	3,438	18.4	--	5,533	5,533	12.7
Total Rice	6,610	54	5,732	46	12,342	66.5	29,586	9,728	43,736	100.0
Jute					1,399	7.5			2,197	
Wheat					584	0.3			1,092	
Mustard					1,373	7.4			993	
Other crops					4,710	25.4				

Limitation : Seasonally deep flooding is major constraint.

Remarks : North East area of Keranigranj is urban area, rapidly expanding. Many brick fields are operating on agricultural land.

TABLE IX.2.1 n

P.U.13 — **Land Resources and Agricultural Data**

Land Resources :

Active Ganges Floodplain	± 10%
Arial Beel	± 20%
Low Ganges Flood Plain	± 10%
Old Meghna Flood Plain	± 35%
Young Jamuna Flood Plain	± 25%

Soils : Silt Loam - silty clay loam - clay - silty clay.
Arial beel : heavy texture. Raised platforms (man made) in the area of Munshiganj, Tongibari and Keraniganj.

Soil toxicity risk in areas which stay wet during dry season. River bank erosion in south and east of the area.

Floods : Seasonal flooding 3-5 feet on the high river banks and ridges 10-15 feet in the flood plain. Raised platforms mostly above normal flood level. Inundated area ± 85%, for about 4-6 months.

Arial beel flooded 10-20 feet with some areas flooded during dry season.

Land Types :

High Land	11%
Medium High Land	22%
Medium Low Land	24%
Low Land	43%

Agriculture 1990-91 :

Agricultural area (cultivated)	76,616 Ha = 76% of gross area
Irrigated area (most L.L.Ps)	18,427 Ha = 24% of NCA
Cropped area	140,433 Ha = 183% of NCA

Potential increase of irrigation ± 10-20%, due to flood hazards in the Lowland areas.

Cropping pattern	Irrigated	Non-Irrigated
Single cropped	Boro	Potato/Pulses/Spices/Wheat/Vegetables
Double cropped	Aus/D.W.Aman-Boro Aus/Jute/Aus + D.W.Aman-Boro	Aus/D.W.Aman/Jute-Potato & other Rabi crops.
Triple cropped	Boro - D.W.Aman-Pulses/Mustard/Vegetables	Mustard-Vegetables-Potato/Rabi crops

	Area (Ha)					Production (Ton)				% of rice production
Crops	HYV	%	Local	%	Total	% of NCA	HYV	Local	Total	
T.Aman	341	66	174	34	514	0.7	1,185	274	1,459	0.9
Boro	19,431	91	1,843	9	21,276	27.8	97,675	3,720	101,395	59.9
Aus	836	5	15,881	95	16,717	21.8	2,989	29,542	32,531	19.2
D.W.Aman	--	--	27,422	100	27,422	35.8	--	33,932	33,932	20.0
Total Rice	20,608	31	45,320	69	65,928	86.1	101,849	67,468	169,316	100.0
Jute					7,750	10.1			11,472	
Wheat					4,051	5.2			6,113	
Mustard					4,896	6.4			3,687	
Other crops					57,808	75.5				

Remarks : P.U.13 is the main supplier of potatoes and vegetables for the Dhaka market. Area of potatoes in 1990/91 has been 24,000 HA.

Limitations : Seasonal flooding without drainage possibilities.

TABLE IX.2.1 o

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice in NCR Districts

District	1989–90						1990–91					
	HYV		Local		Total		HYV		Local		Total	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Jamalpur	55942	246790	4128	8671	60070	255461	57075	279834	3751	9376	60826	289210
Tangail	119986	523478	3862	6161	123848	529639	117065	350129	2781	4260	119846	354389
Mymensingh	46899	186800	5329	10633	52228	197433	45068	183736	4905	10917	49973	194653
Gazipur	42094	169829	2363	3860	44457	173689	42358	188594	1898	3996	44256	192590
Dhaka	29416	124648	2482	4486	31898	129134	30149	154696	1968	4250	32117	158946
Manikganj	23988	113151	1195	2252	25183	115403	23937	115613	1320	2382	25257	117995
Narayanganj	8272	35025	624	1029	8896	36054	8568	34956	530	1029	9098	35985
Munshiganj	15290	69624	1338	2595	16628	72219	15072	74922	1195	2321	16267	77243
Total	341887	1469345	21321	39687	363208	1509032	339292	1382480	18348	38531	357640	1421011
Yield(Ton/Ha)		4.30		1.86		4.15		4.07		2.10		3.97

TABLE IX.2.1 p

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Jamalpur District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Jamalpur	18907 (93.0)	85374	1414 (7.0)	3233	20321	88607	19665 (95.1)	92124	1010 (4.9)	2542	20675	94666
Sharishabari	9090 (90.0)	44024	1010 (10.0)	2076	10100	46100	9211 (91.9)	46095	808 (8.1)	1869	10019	47964
Melandah	12904 (94.6)	55450	735 (5.4)	1392	13639	56842	12651 (95.0)	64568	663 (5.0)	1692	13314	66260
Islampur	5948 (92.4)	23875	486 (7.6)	975	6434	24850	5869 (91.2)	28143	565 (8.8)	1373	6434	29516
Dewanganj	1727 (97.1)	7518	51 (2.9)	117	1778	7635	1389 (97.1)	6366	42 (2.9)	115	1431	6481
Madarganj	7366 (94.4)	30549	432 (5.6)	878	7798	31427	8290 (92.6)	42538	663 (7.4)	1785	8953	44323
Total	55942 (93.1)	246790	4128 (6.9)	8671	60070	255461	57075 (93.8)	279834	3751 (6.2)	9376	60826	289210
Yield(Ton/Ha)		4.41		2.10		4.25		4.90		2.50		4.75

Note : Figures within parentheses are percentages of total Boro Rice

TABLE IX.2.1 q

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Tangail District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Tangail	8261 (98.8)	35798	101 (1.2)	183	8362	35981	8243 (98.6)	26601	113 (1.4)	129	8356	26730
Basail	8425 (98.0)	35768	172 (2.0)	324	8597	36092	8765 (97.7)	28605	208 (2.3)	251	8973	28856
Ghatail	15101 (95.9)	65898	640 (4.1)	1266	15741	67164	15608 (97.5)	42584	404 (2.5)	580	16012	43164
Kalihati	12411 (95.5)	53769	586 (4.5)	1076	12997	54845	13138 (96.9)	40185	424 (3.1)	560	13562	40745
Nagarpur	11514 (99.7)	53360	40 (0.3)	74	11554	53434	8121 (99.5)	25729	40 (0.5)	55	8161	25784
Gopalpur	16054 (94.0)	70772	1020 (6.0)	191	17074	70963	16488 (99.5)	43612	81 (0.5)	90	16569	43702
Mirzapur	14785 (98.8)	65019	185 (1.2)	371	14970	65390	15636 (98.6)	46847	227 (1.4)	497	15863	47344
Madhupur	14366 (96.9)	63422	465 (3.1)	1041	14831	64463	13185 (96.1)	42409	533 (3.9)	891	13718	43300
Bhuapur	4826 (92.8)	21645	374 (7.2)	990	5200	22635	4760 (91.8)	15654	428 (8.2)	748	5188	16402
Shakipur	7648 (98.0)	29262	158 (2.0)	384	7806	29646	6828 (97.1)	18418	206 (2.9)	293	7034	18711
Delduar	6595 (98.2)	28765	121 (1.8)	261	6716	29026	6293 (98.2)	19485	117 (1.8)	166	6410	19651
Total	**119986** (96.9)	**523478**	**3862** (3.2)	**6161**	123848	529639	**117065** (97.7)	**350129**	**2781** (2.3)	**4260**	**119846**	**354389**
Yield(Ton/Ha)		4.36		1.60		4.28		2.99		1.53		2.96

Note : Figures within parentheses are percentages of total Boro Area

TABLE IX.2.1 r

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Mymensingh District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Mymensingh	5068 (93.0)	22626	382 (7.0)	708	5450	23334	4708 (91.4)	19821	439 (8.6)	1009	5147	20830
Muktagacha	7549 (91.4)	29969	703 (8.6)	1526	8252	31495	7769 (89.1)	30939	949 (10.9)	2256	8718	33195
Fulbaria	8282 (88.0)	34492	1131 (12.0)	1581	9413	36073	7636 (91.3)	32834	727 (8.7)	1770	8363	34604
Trisal	7771 (87.7)	27571	1089 (12.3)	2139	8860	29710	7365 (89.9)	28943	824 (10.1)	2089	8189	31032
Bhaluka	9122 (93.9)	34373	586 (6.1)	1154	9708	35527	8385 (93.2)	34286	606 (6.8)	1328	8991	35614
Gafargaon	9107 (86.3)	37769	1438 (13.7)	3525	10545	41294	9205 (87.1)	36913	1360 (12.0)	2465	10565	39378
Total	**46899** (89.8)	**186800**	**5329** (10.2)	**10633**	52228	197433	45068 (90.2)	183736	4905 (9.8)	10917	49973	194653
Yield(Ton/Ha)		3.98		2.00		3.78		4.08		2.23		3.90

TABLE IX.2.1 s

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Gazipur District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Gazipur	12483 (97.5)	47797	323 (2.5)	576	12806	48373	12307 (98.4)	55865	202 (1.6)	506	12509	56371
Kaliakair	7372 (97.3)	30874	202 (2.7)	337	7574	31211	7569 (95.9)	33779	326 (4.1)	675	7895	34454
Kaliganj	6524 (88.0)	28473	889 (12.0)	1434	7413	29907	7500 (94.9)	32453	400 (5.2)	922	7900	33375
Kapasia	6625 (91.1)	29190	646 (8.9)	1008	7271	30198	7032 (90.7)	34272	720 (9.3)	1393	7752	35665
Sreepur	9090 (96.8)	33495	303 (3.2)	505	9393	34000	7950 (97.0)	32225	250 (3.0)	500	8200	32725
Total	**42094** (94.7)	**169829**	**2363** (5.3)	**3860**	44457	173689	**42358** (95.7)	**188594**	**1898** (4.3)	**3996**	44256	192590
Yield(Ton/Ha)		4.03		1.63		3.91		4.45		2.11		4.35

Note : Figures within parentheses are percentages of total Boro Area

TABLE IX.2.1 t

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Dhaka District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Keraniganj	2929 (87.1)	13900	432 (12.9)	749	3361	14649	3343 (93.7)	20514	222 (6.3)	398	3565	20912
Nababganj	5482 (84.6)	27538	995 (15.4)	1702	6477	29240	6617 (88.5)	36600	853 (11.5)	2006	7470	38606
Dohar	1636 (81.7)	7520	365 (18.3)	675	2001	8195	2141 (86.2)	10496	340 (13.8)	629	2481	11125
Savar	9067 (94.1)	35906	569 (5.9)	1158	9636	37064	8582 (95.3)	42180	420 (4.7)	955	9002	43135
Dhamrai	10302 (98.8)	39784	121 (1.2)	202	10423	39986	9466 (98.6)	44906	133 (1.4)	262	9599	45168
Total	29416 (92.2)	124648	2482 (7.8)	4486	31898	129134	30149 (93.8)	154696	1968 (6.2)	4250	32117	158946
Yield(Ton/Ha)		4.24		1.81		4.05		5.13		2.16		4.95

Note : Figures within parentheses are percentages of total Boro Area

TABLE IX.2.1 u

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Manikganj District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Manikganj	4975 (98.8)	22065	60 (1.2)	86	5035	22151	4542 (97.8)	20430	104 (2.2)	165	4646	20595
Singair	3903 (97.0)	18687	121 (3.0)	280	4024	18967	4792 (96.8)	24594	159 (3.2)	383	4951	24977
Saturia	3171 (99.2)	13014	26 (0.8)	32	3197	13046	2592 (98.9)	12779	28 (1.1)	47	2620	12826
Ghior	3436 (97.9)	17190	75 (2.1)	173	3511	17363	3045 (97.5)	15377	77 (2.5)	156	3122	15533
Daulatpur	3130 (91.2)	15447	303 (8.8)	560	3433	16007	3409 (91.7)	15949	307 (8.8)	496	3716	16445
Shibalaya	2586 (96.8)	12190	85 (3.2)	114	2671	12304	2804 (88.4)	13342	369 (11.6)	659	3173	14001
Harirampur	2787 (84.1)	14558	525 (15.9)	1007	3312	15565	2753 (90.9)	13142	276 (9.1)	476	3029	13618
Total	23988 (95.3)	113151	1195 (4.7)	2252	25183	115403	23937 (94.8)	115613	1320 (5.2)	2382	25257	117995
Yield(Ton/Ha)		4.72		1.88		4.58		4.83		1.80		4.67

Note : Figures within parentheses are percentages of total Boro area

TABLE IX.2.1 v

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Narayanganj District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Narayanganj	2788	10458	349	519	3137	10977	2654	11461	228	457	2882	11918
	(88.9)		(11.1)				(92.1)		(7.9)			
Rupganj (54%)	5484	24567	275	510	5759	25077	5914	23495	302	572	6216	24067
	(95.2)		(4.8)				(95.1)		(4.9)			
Total	8272	35025	624	1029	8896	36054	8568	34956	530	1029	9098	35985
	(93.0)		(7.0)				(94.2)		(5.8)			
Yield(Ton/Ha)		4.23		1.65		4.05		4.08		1.94		3.96

Note : Figures within parentheses are percentages of total Boro area

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TABLE IX.2.1 w

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of Boro Rice Crop in Munshiganj District

Upazila	1989–1990						1990–1991					
	HYV/LIV		Local		Total		HYV/LIV		Local		Total	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Munshiganj	687 (70.8)	3173	283 (29.2)	418	970	3591	654 (68.6)	3024	299 (31.4)	415	953	3439
Tongibari	1234 (89.8)	6498	140 (10.2)	271	1374	6769	1167 (94.5)	5713	68 (5.5)	125	1235	5838
Srinagar	8120 (94.5)	39765	473 (5.5)	1180	8593	40945	7804 (96.3)	39658	296 (3.7)	849	8100	40507
Sirajdikhan	2837 (95.9)	11274	121 (4.1)	280	2958	11554	2951 (92.1)	14997	251 (7.9)	464	3202	15461
Lohajang	2412 (88.2)	8914	321 (11.8)	446	2733	9360	2496 (89.9)	11530	281 (10.1)	468	2777	11998
Total	15290 (91.9)	69624	1338 (8.1)	2595	16628	72219	15072 (92.6)	74922	1195 (7.4)	2321	16267	77243
Yield(Ton/Ha)		4.55		1.94		4.34		4.97		1.94		4.75

Note : Figures within parentheses are percentages of total Boro Area

TABLE IX.2.1 x

Land Resources and Agricultural Data

Area (Ha) and Production (Paddy in Ton) of T.Aman Rice in NCR Districts.

District	1989–90						1990–91					
	HYV		Local		Total		HYV		Local		Total	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Jamalpur	39291	149706	36668	75282	75959	224988	46020	154959	31840	65354	77860	220313
Tangail	30832	104038	36671	69476	67503	173514	38238	137784	33740	76290	71978	214074
Mymensingh	58222	204971	59709	123173	117931	328144	55614	188962	59324	118533	114938	307495
Gazipur	34339	154649	10099	23011	44438	177660	34995	159621	10239	25963	45234	185584
Dhaka	3543	12818	1191	2421	4734	15239	3280	10330	2280	4289	5560	14619
Manikganj	175	658	378	707	553	1365	515	1888	846	1557	1361	3445
Narayanganj	2235	8447	382	679	2617	9126	2460	8681	571	946	3031	9627
Munshiganj	26	111	27	80	53	191	49	106	28	53	77	159
Total	168663	635398	145125	294829	313788	930227	181171	662331	138868	292985	320039	955316
Yield(Ton/Ha)		3.77		2.03		2.96		3.66		2.11		2.98

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2.1.2 Surface and Ground Water Resources

The surface and groundwater resources are described in SR II. The thanawise analysis of minor irrigation and groundwater resource potential for the study area has been re-evaluated in terms of the 13 planning units, by considering the proportions of each thana in each PU. The results are summarised in Table IX.2.2, which presents PU averages and totals for key development and resource parameters. A brief discussion of the characteristics of each PU is given below.

PU 1

This PU is located in Jamalpur and Tangail districts. The aquifer conditions are among the best in the North Central region, with average storage coefficient exceeding 12% and tubewell specific capacities of 17 l/s/m. At present, maximum SWL averages 6.5m at the end of April, allowing STWs to operate in almost all areas.

Existing minor irrigation is well developed and already meets some 60% of estimated irrigation demand. STWs are the dominant method in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the estimated residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 6%, but this would have no significant effect on resources which would still substantially exceed demand.

PU2

This PU is located in Jamalpur and Tangail districts. The aquifer conditions, which are similar to PU1, are favourable, with average storage coefficient exceeding 9% and tubewell specific capacities of 14 l/s/m. At present, maximum SWL averages 6.9m at the end of April, allowing STWs to operate in almost all areas.

Existing minor irrigation is very intensive and already meets some 64% of estimated irrigation demand. STWs are the dominant method in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the estimated residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 5%, but this would have no significant effect on resources which would still substantially exceed demand.

PU3

This PU is located in mainly in Mymensingh district. The terrain is predominantly Madhupur Tract. The aquifer conditions are relatively unfavourable, with storage coefficient averaging only 1.8% and tubewell specific capacities of averaging 6.5 l/s/m. At present, maximum SWL averages 11.8m at the end of April, allowing STWs to operate only on the lowest land. Force mode tubewells are required for irrigation over most of this area.

TABLE IX.2.2

Planning Unit Summary

		Planning Unit												
		1	2	3	4	5	6	7	8	9	10	11	12	13
LAND AREAS														
Gross	km2	894	740	1724	762	2125	1144	901	420	770	672	250	80	1015
F0-F3 Land	%	91.7	91.1	89.8	91.4	93.8	89.7	92.1	92.1	89.0	83.8	78.6	67.0	82.2
WATER DEMAND														
Irrigation (80% F0-F3)	mm	459	456	449	457	469	448	460	461	445	419	393	335	411
Potable Reserve	mm	25	27	27	19	18	28	31	25	27	25	62	68	34
AVERAGE AQUIFER CONDITIONS														
Storage Coefficient	%	12.4	9.1	1.8	10.4	3.5	9.4	7.1	3.2	1.2	6.2	4.9	2.4	3.9
DTW Specific Capacity	l/s/m	17.4	14.1	6.5	11.2	7.1	12.8	10.4	6.0	5.6	12.5	7.9	9.1	10.5
Maximum SWL	m	6.5	6.9	11.8	7.1	10.4	7.5	7.6	11.3	11.9	7.4	6.0	3.7	5.8
Seasonal Fluctuation	m	1.9	2.6	7.9	2.4	5.4	2.4	2.4	4.7	6.1	1.6	1.2	1.4	1.6
GROUNDWATER RESOURCES														
Useable Recharge NFP	mm	663	563	496	587	486	650	690	558	583	921	915	880	1282
Useable Recharge PFP	mm	628	535	485	543	476	597	641	542	557	839	871	813	1224
Groundwater Potential NFP														
STW	mm	597	458	134	452	159	410	274	141	75	202	166	166	182
DSSTW	mm	661	524	180	556	226	578	449	221	106	348	288	226	280
DTW	mm	663	563	281	587	328	647	682	433	187	680	634	500	549
Groundwater Potential PFP														
STW	mm	574	442	134	447	159	410	274	141	75	202	166	166	182
DSSTW	mm	628	504	180	522	225	549	449	221	106	348	288	226	280
DTW	mm	628	535	281	543	322	594	633	420	187	641	631	500	546
PRESENT MINOR IRRIGATION														
STW	Ha*1000	32.9	24.2	6.3	24.2	19.7	28.0	15.2	1.4	3.2	7.9	2.3	0.3	10.5
DSSTW	Ha*1000	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
DTW	Ha*1000	4.4	7.4	28.9	5.7	23.7	9.4	9.0	6.7	7.6	2.9	1.1	0.2	0.4
LLP	Ha*1000	0.5	0.4	4.7	0.9	6.1	4.5	2.2	3.2	7.8	1.0	1.7	0.8	5.8
Total Groundwater	Ha*1000	37.3	31.6	35.3	30.0	43.6	37.4	24.3	8.1	10.9	10.7	3.4	0.5	10.9
Total All	Ha*1000	37.7	32.0	40.0	30.8	49.7	41.9	26.5	11.3	18.7	11.7	5.2	1.3	16.6
STW	mm	247	229	21	204	57	152	102	21	22	72	59	29	61
DSSTW	mm	0	0	0	0	0	0	0	1	0	0	0	0	0
DTW	mm	28	58	113	46	72	52	59	100	62	29	20	8	2
LLP	mm	3	3	17	9	19	21	13	48	69	8	43	57	35
Total Groundwater	mm	275	287	134	250	129	204	161	122	84	101	79	37	63
Total All Types	mm	278	290	151	259	148	225	174	170	153	109	122	94	98
PRESENT MINOR IRRIGATION														
Percentage of Demand														
Groundwater	%	60	64	30	55	28	45	35	26	19	24	20	11	15
LLP	%	1	1	4	2	4	5	3	10	16	2	11	17	9
All Minor Irrigation	%	61	65	34	57	32	50	38	36	35	26	31	28	24
Percentage of Groundwater Potential														
NFP	%	44	52	49	44	39	33	24	34	48	14	12	9	11
PFP	%	46	54	49	47	40	36	26	34	48	15	12	9	11
FUTURE G'WATER DEVELOPMENT LIMITS														
PERCENT IRRIGATION DEMAND														
NFP	%	100	100	59	100	65	100	99	80	42	100	100	88	100
PFP	%	100	100	59	99	65	100	99	80	42	100	100	88	100
GROUNDWATER RESOURCE DEFICITS														
PERCENT IRRIGATION DEMAND														
NFP	%	0	0	41	0	35	0	1	20	58	0	0	12	0
PFP	%	0	0	41	1	35	0	1	20	58	0	0	12	0
LOSSES DUE TO PFP	%	0	0	0	1	0	0	0	0	0	0	0	0	0

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Existing minor irrigation currently meets some 34% of estimated irrigation demand. DTWs are the dominant technology. The assessment indicates that under present conditions, groundwater could supply a maximum of 60% of the estimated residual irrigation demand in PU3, due to the unfavourable aquifer conditions.

The introduction of partial flood protection would have little effect on groundwater recharge (2% reduction), and would not affect resource potential, which is already constrained by aquifer conditions.

PU4

This PU is located mainly in Tangail district. The aquifer conditions, which are similar to PU2, are favourable, with average storage coefficient exceeding 10% and tubewell specific capacities averaging 11 l/s/m. At present, maximum SWL averages 7.1m at the end of April, allowing STWs to operate in almost all areas.

Existing minor irrigation is well developed and already meets some 57% of estimated irrigation demand. STWs are the dominant method in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the estimated residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 7%, but this would have no significant effect on resources which could still satisfy irrigation demand. Although the assessment indicates a decline in groundwater resource potential in Ghatail by about 4%, this is considered to be insignificant relative to the precision of the estimate.

PU5

This PU is located in Gazipur, Mymensingh and Tangail districts. The terrain is predominantly Madhupur Tract. The aquifer conditions, which are similar to PU3, are relatively unfavourable, with storage coefficient averaging 3.5% and tubewell specific capacities averaging 7.1 l/s/m. At present, maximum SWL averages 11.4m at the end of April, allowing STWs to operate only on the lowest land. Force mode tubewells are required for irrigation over most of this area.

Existing minor irrigation currently meets some 32% of estimated irrigation demand. DTWs are the dominant technology. The assessment indicates that under present conditions, groundwater could supply a maximum of 65% of the estimated residual irrigation demand in PU5, due to the unfavourable aquifer conditions.

The introduction of partial flood protection would have little effect on groundwater recharge (2% reduction), and would not affect resource potential, which is already constrained by aquifer conditions.

PU6

PU 6 is located mainly in Tangail district. The aquifer conditions, which are similar to PU4, are favourable, with average storage coefficient exceeding 9% and tubewell specific capacities averaging 12.8 l/s/m. At present, maximum SWL averages 7.5m at the end of April, allowing STWs to operate in most areas.

Existing minor irrigation is moderately well developed and already meets some 46% of estimated irrigation demand. STWs are the dominant method in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the estimated residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 8%, but this would have no significant effect on resources which would still substantially exceed irrigation demand.

PU7

PU7 is located mainly in Dhaka and Manikganj districts. The aquifer conditions, are favourable, with average storage coefficient exceeding 7% and tubewell specific capacities averaging 10.4 l/s/m. At present, maximum SWL averages 7.6m at the end of April, allowing STWs to operate in most areas.

Existing minor irrigation is moderately well developed and already meets some 38% of estimated irrigation demand. Both STWs and DTWs are important in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the estimated residual irrigation demand except in Kaliakoir..

The introduction of partial flood protection would reduce groundwater recharge by about 7%, but this would have no significant effect on resources which would still substantially exceed irrigation demand.

PU8

This PU is located in Gazipur and Dhaka districts. The terrain is predominantly Madhupur Tract. The aquifer conditions are unfavourable, with storage coefficient averaging only 3.2% and tubewell specific capacities of 6 l/s/m. At present, maximum SWL averages 11.3m at the end of April, allowing STWs to operate only on the lowest land. Force mode tubewells are required for irrigation over most of this area.

Existing minor irrigation currently meets some 36% of estimated irrigation demand. DTWs and LLPs are the dominant technologies. The assessment indicates that under present conditions, groundwater could supply a maximum of 80% of the estimated residual irrigation demand in PU8, due to the unfavourable aquifer conditions.

The introduction of partial flood protection would have little effect on groundwater recharge (3% reduction), and would not affect resource potential, which is already constrained by aquifer conditions.

PU9

This PU is located in Gazipur and Narayanganj districts. The terrain is predominantly Madhupur Tract. The aquifer conditions are the poorest in the North Central region, with storage coefficient averaging only 1.2% and tubewell specific capacities of 5.6 l/s/m. At present, maximum SWL averages 11.7m at the end of April, allowing STWs to operate only on the lowest land. Force mode tubewells are required for irrigation over most of this area.

Existing minor irrigation currently meets some 35% of estimated irrigation demand. DTWs and LLPs are the dominant technologies. The assessment indicates that under present conditions, groundwater could supply a maximum of 42% of the estimated residual irrigation demand in PU9, due to the unfavourable aquifer conditions.

The introduction of partial flood protection would have little effect on groundwater recharge (4% reduction), and not affect resource potential, which is already constrained by aquifer conditions.

PU10

This PU is located mainly in Dhaka and Manikganj districts. The aquifer conditions are favourable, with average storage coefficient of 6% and tubewell specific capacities averaging 12.5 l/s/m. At present, maximum SWL averages 7.4m at the end of April, allowing STWs to operate in most areas.

Existing minor irrigation is relatively limited and meets some 26% of estimated irrigation demand. STWs are the dominant technology in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 9%, but this would have no significant effect on resources which would still substantially exceed irrigation demand.

PU11

This PU is located in Dhaka, Keraniganj and Narayanganj districts. The aquifer conditions are moderate, with average storage coefficient of 5% and tubewell specific capacities averaging 7.9 l/s/m. At present, maximum SWL averages 6m at the end of April, allowing STWs to operate in most areas.

Existing minor irrigation is relatively limited and meets some 31% of estimated irrigation demand. STWs and LLPs are the dominant technologies in this area. The assessment indicates that under present conditions, groundwater could supply 100% of the residual irrigation demand.

The introduction of partial flood protection would reduce groundwater recharge by about 5%, but this would have no significant effect on resources which could still satisfy irrigation demand.

PU12

This PU is located in Dhaka, Gazipur and Narayanganj districts and covers the Dhaka metropolitan area. The present assessment covers only the parts in Narayanganj district which are outside the urban area.

The aquifer conditions are relatively unfavourable, with storage coefficient averaging 2.4%, and tubewell specific capacities of 9 l/s/m. Maximum SWLs vary considerably, from 3m in Narayanganj up to 9m in Rupganj. Force mode tubewells are normally required for irrigation development in Rupganj.

Existing minor irrigation is relatively limited and currently meets some 28% of estimated irrigation demand. STWs and LLPs are the dominant technologies, particularly in Narayanganj. The assessment indicates that under present conditions, groundwater could supply a maximum of 88% of the estimated residual irrigation demand in PU12, due to relatively unfavourable aquifer conditions.

The introduction of partial flood protection would reduce groundwater recharge by about 8%, but this would not affect resource potential, which is already constrained by aquifer conditions.

Special conditions apply in the Dhaka metropolitan area where intensive abstractions for municipal and industrial water supply have caused permanent depression of piezometric levels in the deep aquifer. The situation has been studied in detail by Dhaka WASA. Expansion of municipal water supply abstractions in areas outside the urban area is under consideration. This could affect irrigated agriculture in areas surrounding the city.

PU13

This PU is located in Dhaka, Munshiganj and Narayanganj districts. The aquifer conditions are moderate, with storage coefficient averaging 3.2%, and tubewell specific capacities of 10.5 l/s/m. At present, maximum SWL averages 5.6m at the end of April, allowing STWs to operate in most areas.

Existing minor irrigation is relatively limited and currently meets some 24% of estimated irrigation demand. STWs and LLPs are the dominant technologies. The assessment indicates that under present conditions, groundwater could supply 100% of residual irrigation demand in PU13.

The introduction of partial flood protection would reduce groundwater recharge by about 5%, but this would have no significant effect on resources which could still satisfy irrigation demand.

2.1.3 Fisheries

Fishery aspects are described in SR III. Information relating to each Planning Unit are given in Tables IX.2.3a to IX.2.3m. Further information relating to rivers and water bodies are given in SR III, Annex III-7 to III-13 and III-19 to III.26 .

TABLE IX.2.3 a
Fishery Resource Data

P.U.1

Area	:	Total	:	89,351 ha
		Cultivated	:	70,009 ha
Population			:	737,706 (1981)

Aquatic Habitats :

Rivers	:	Principal	:	98 km
		Others	:	162 km
		Total	:	260 km
Beels	:	Total Nos. 31, Area	:	420 ha
Floodplain (% area)	:	F_0 = 24%, F_1 = 55%, F_2 = 21%, F_3 = <1%		
Area	:	(F_1 - F_3) = 53,207 ha		
Ponds	:	Total Nos. = 2,682 Area 378 ha		

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	1237	33	49.4	40
	Others	334	9	13.4	11
	Sub-Total	**1571**	**41**	**62.8**	**51**
Beels		221	6	6.6	5
Floodplain		1581	42	39.5	32
Total Capture Fisheries		**3373**	**89**	**108.9**	**88**
Ponds		428	11	15.6	12
Total Capture & Culture		**3801**		**124.5**	

Catch Rates

Rivers	Principal	12.6 tonnes/km
	Others	No. data: above catch estimates do not relate to total river length but rather to unspecified lengths of rivers surveyed by FRSS, 1981.
Beels		526 kg/ha
Floodplain		30 kg/ha
Ponds	Cultured	2026 kg/ha
	Culturable	488 kg/ha
	Derelict	455 kg/ha

TABLE IX.2.3 b
Fishery Resource Data

50

P.U.2

Area	:	Total	:	73,963 ha
		Cultivated	:	59,850 ha
Population			:	604,558 (1981)

Aquatic Habitats	:					
Rivers	:	Principal	:	18 km		
		Others	:	125 km		
		Total	:	143 km		
Beels	:	Total Nos. = 43, Area	:	666 ha		
Floodplain (% area)	:	F_0 = 30%,	F_1 = 48%,	F_2 = 17%,	F_3 = 5%	
Area	:	(F_1 - F_3) = 41,895 ha				
Ponds	:	Total Nos. = 2,230	Area	314 ha		

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	243	13	9.7	17
	Others	60	3	2.4	4
	Sub-Total	**303**	**16**	**12.1**	**21**
Beels		261	14	7.8	14
Floodplain		1020	53	25.5	45
Total Capture Fisheries		**1584**	**83**	**45.4**	**80**
Ponds		330	17	11.6	20
Total Capture & Culture		**1914**		**57.0**	

Catch Rates

Rivers	Principal	13.5 tonnes/km
	Others	No. data: above catch estimates do not relate to total river length but rather to unspecified lengths of rivers surveyed by FRSS, 1981.
Beels		391 kg/ha
Floodplain		24 kg/ha
Ponds	Cultured	1633 kg/ha
	Culturable	670 kg/ha
	Derelict	569 kg/ha

TABLE IX.2.3 c
Fishery Resource Data

51

P.U.3

Area	:	Total	:	172,391 ha	
		Cultivated	:	127,979 ha	
Population			:	1,486,749 (1981)	
Aquatic Habitats	:				
Rivers	:	Principal	:	--	
		Others	:	480 km	
		Total	:	480 km	
Beels	:	Total Nos. = 222,	Area	:	4850 ha
Floodplain (% area)	:	F_0 = 27%,	F_1 = 51%,	F_2 = 20%,	F_3 = 2%
Area	:	(F_1 - F_3) = 93,425 ha			
Ponds	:	Total Nos. = 13,325	Area	1506 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	899	11	36.0	15
	Sub-Total	**899**	**11**	**36.0**	**15**
Beels		2551	32	76.5	31
Floodplain		2904	36	72.6	29
Total Capture Fisheries		**6354**	**79**	**185.1**	**15**
Ponds		1649	21	62.1	25
Total Capture & Culture		**8003**		**247.2**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		526 kg/ha
Floodplain		31 kg/ha
Ponds	Cultured	1222 kg/ha
	Culturable	705 kg/ha
	Derelict	689 kg/ha

TABLE IX.2.3 d
Fishery Resource Data

52

P.U.4

Area	:	Total	:	76,170 ha
		Cultivated	:	58,420 ha
Population			:	589,207 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	11 km
		Others	:	155 km
		Total	:	166 km
Beels	:	Total Nos. = 68,	Area	: 568 ha
Floodplain (% area)	:	F_0 = 25%,	F_1 = 40%,	F_2 = 27%, F_3 = 8%
Area	:	(F_1 - F_3) = 43,815 ha		
Ponds	:	Total Nos. = 2,312	Area	326 ha

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	35	2	1.4	4
	Others	--	--	--	--
	Sub-Total	**35**	**2**	**1.4**	**4**
Beels		147	10	4.4	12
Floodplain		919	65	23.0	58
Total Capture Fisheries		**1101**	**78**	**28.8**	**73**
Ponds		316	22	10.6	27
Total Capture & Culture		**1417**		**39.4**	

Catch Rates

Rivers	Principal	3.2 tonnes/km
	Others	--
Beels		259 kg/ha
Floodplain		21 kg/ha
Ponds	Cultured	1239 kg/ha
	Culturable	851 kg/ha
	Derelict	682 kg/ha

TABLE IX.2.3 e
Fishery Resource Data

53

P.U.5

Area	:	Total	:	212,467 ha	
		Cultivated	:	212,318 ha	
Population			:	1,139,598 (1981)	
Aquatic Habitats	:				
Rivers	:	Principal	:	--	
		Others	:	115 km	
		Total	:	115 km	
Beels	:	Total Nos. = 69,	Area	:	1463 ha
Floodplain (% area)	:	F_0 = 57%,	F_1 = 29%,	F_2 = 9%,	F_3 = 4%
Area	:	(F_1 - F_3) = 52,167 ha			
Ponds	:	Total Nos. = 11,316	Area	1,421 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	576	13	23.0	17
	Sub-Total	**576**	**13**	**23.0**	**17**
Beels		492	11	14.8	11
Floodplain		1992	44	49.8	36
Total Capture Fisheries		**3060**	**68**	**87.6**	**63**
Ponds		1437	32	51.2	37
Total Capture & Culture		**4497**		**138.8**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		336 kg/ha
Floodplain		38 kg/ha
Ponds	Cultured	1407 kg/ha
	Culturable	1038 kg/ha
	Derelict	630 kg/ha

TABLE IX.2.3 f
Fishery Resource Data

P.U.6

Area	:	Total	:	114,395 ha
		Cultivated	:	95,880 ha
Population			:	1,006,383 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	48 km
		Others	:	261 km
		Total	:	309 km
Beels	:	Total Nos. = 40,	Area	: 451 ha
Floodplain (% area)	:	F_0 = 15%,	F_1 = 48%,	F_2 = 29%, F_3 = 8%
Area	:	(F_1 - F_3) = 81,498 ha		
Ponds	:	Total Nos. = 4,290	Area	590 ha

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	9	<1	0.4	<1
	Others	478	18	19.1	25
	Sub-Total	**487**	**19**	**19.5**	**25**
Beels		116	4	3.5	5
Floodplain		1417	55	35.4	46
Total Capture Fisheries		**2020**	**78**	**58.4**	**75**
Ponds		570	22	18.7	24
Total Capture & Culture		**2590**		**77.1**	

Catch Rates

Rivers	Principal	0.2 tonnes/km
	Others	--
Beels		257 kg/ha
Floodplain		17 kg/ha
Ponds	Cultured	1239 kg/ha
	Culturable	851 kg/ha
	Derelict	682 kg/ha

TABLE IX.2.3 g
Fishery Resource Data

P.U.7

Area	:	Total	:	90,090 ha
		Cultivated	:	67,238 ha
Population			:	831,126 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	--
		Others	:	175 km
		Total	:	175 km
Beels	:	Total Nos. = 17,	Area	: 303 ha
Floodplain (% area)	:	F_0 = 12%,	F_1 = 39%,	F_2 = 27%, F_3 = 22%
Area	:	(F_1 - F_3) = 59,169 ha		
Ponds	:	Total Nos. = 6,555	Area	769 ha

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	521	22	20.8	27
	Sub-Total	**521**	**22**	**20.8**	**27**
Beels		68	3	2.0	3
Floodplain		1091	46	27.3	36
Total Capture Fisheries		**1680**	**70**	**50.1**	**66**
Ponds		712	30	25.6	34
Total Capture & Culture		**2392**		**75.7**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		224 kg/ha
Floodplain		18 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

TABLE IX.2.3 h
Fishery Resource Data

P.U.8

Area	:	Total	:	46,065 ha
		Cultivated	:	27,192 ha
Population			:	391,729 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	--
		Others	:	63 km
		Total	:	63 km
Beels	:	Total Nos. = N/A,	Area :	257 ha
Floodplain (% area)	:	F_0 = 54%,	F_1 = 19%,	F_2 = 16%, F_3 = 11%
Area	:	(F_1 - F_3) = 12,508 ha		
Ponds	:	Total Nos. = 3,565	Area 409 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	167	16	6.7	20
	Sub-Total	**167**	**16**	**6.7**	**20**
Beels		58	5	1.7	5
Floodplain		439	41	11.0	33
Total Capture Fisheries		**664**	**63**	**19.4**	**58**
Ponds		394	37	13.9	42
Total Capture & Culture		**1058**		**33.3**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		226 kg/ha
Floodplain		35 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

TABLE IX.2.3 i
Fishery Resource Data

P.U.9

Area	:	Total	:	78,936 ha
		Cultivated	:	57,757 ha
Population			:	661,348 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	--
		Others	:	71 km
		Total	:	71 km
Beels	:	Total Nos. = N/A,	Area :	279 ha
Floodplain (% area)	:	F_0 = 54%,	F_1 = 19%, F_2 = 12%,	F_3 = 15%
Area	:	(F_1 - F_3) = 26,568 ha		
Ponds	:	Total Nos. = 5,905	Area 732 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	299	16	12.0	21
	Sub-Total	**299**	**16**	**12.0**	**21**
Beels		62	3	1.9	3
Floodplain		803	44	20.1	35
Total Capture Fisheries		**1164**	**63**	**34.0**	**59**
Ponds		681	37	23.8	41
Total Capture & Culture		**1845**		**57.8**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		222 kg/ha
Floodplain		30 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

TABLE IX.2.3 j
Fishery Resource Data

P.U.10

Area	:	Total	:	67,187 ha
		Cultivated	:	48,255 ha
Population			:	514,328 (1981)

Aquatic Habitats	:					
Rivers	:	Principal	:	54 km		
		Others	:	53 km		
		Total	:	107 km		
Beels	:	Total Nos. = N/A,	Area	:	369 ha	
Floodplain (% area)	:	F_0 = 9%,	F_1 = 21%,	F_2 = 40%,	F_3 = 30%	
Area	:	(F_1 - F_3) = 43,912 ha				
Ponds	:	Total Nos. = 5,037	Area	631 ha		

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	175	10	7.0	13
	Others	109	7	4.4	8
	Sub-Total	**284**	**17**	**11.4**	**22**
Beels		83	5	2.5	5
Floodplain		716	43	17.9	34
Total Capture Fisheries		**1083**	**65**	**31.8**	**61**
Ponds		589	35	20.6	39
Total Capture & Culture		**1672**		**52.4**	

Catch Rates

Rivers	Principal	3.2 tonnes/km
	Others	--
Beels		225 kg/ha
Floodplain		16 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

TABLE IX.2.3 k
Fishery Resource Data

P.U.11

Area	:	Total	:	24,987 ha
		Cultivated	:	18,564 ha
Population			:	437,568 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	--
		Others	:	49 km
		Total	:	49 km
Beels	:	Total Nos. = N/A,	Area :	4 ha
Floodplain (% area)	:	F_0 = 12%,	F_1 = 24%, F_2 = 22%,	F_3 = 42%
Area	:	(F_1 - F_3) = 16,336 ha		
Ponds	:	Total Nos. = 2,108	Area 224 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	932	61	37.3	68
	Sub-Total	**932**	**61**	**37.3**	**68**
Beels		1	<1	<0.1	--
Floodplain		375	24	9.4	17
Total Capture Fisheries		**1308**	**85**	**46.7**	**85**
Ponds		223	15	8.0	15
Total Capture & Culture		**1531**		**54.7**	

Catch Rates

Rivers	Principal	--
	Others	--
Beels		250 kg/ha
Floodplain		23 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

TABLE IX.2.3 I
Fishery Resource Data

P.U.12

Area	:	Total	:	36,970 ha
		Cultivated	:	
Population			:	3,195,129 (1981)
Aquatic Habitats	:			
Rivers	:	Principal	:	--
		Others	:	66 km
		Total	:	66 km
Beels	:	Total Nos. =	Area :	
Floodplain (% area)	:	Mainly urban area		
Ponds	:	Total Nos. = 2,722	Area 589 ha	

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	--	--	--	--
	Others	157	20	6.3	23
	Sub-Total	**157**	**20**	**6.3**	**23**
Beels		--	--	--	--
Floodplain		110	14	2.8	10
Total Capture Fisheries		**267**	**34**	**9.1**	**34**
Ponds		519	66	17.8	66
Total Capture & Culture		**786**		**26.9**	

TABLE IX.2.3 m
Fishery Resource Data

P.U.13

Area	:	Total	:	101,485 ha
		Cultivated	:	76,616 ha
Population			:	1,129,512 (1981)

Aquatic Habitats	:					
Rivers	:	Principal	:	73 km		
		Others	:	36 km		
		Total	:	109 km		
Beels	:	Total Nos. = N/A,	Area	:	1967 ha	
Floodplain (% area)	:	F_0 = 11%,	F_1 = 22%,	F_2 = 24%,	F_3 = 43%	
Area	:	(F_1 - F_3) = 68,188 ha				
Ponds	:	Total Nos. = 8,180	Area	1041 ha		

Annual Fish Catch (tonnes) and Value (Tk. millions) 1988-89

Waterbody Type		Weight	% Wt. Capt & Cult	Value (Tk)	% Value Capt & Cult
Rivers	Principal	900	23	36.0	29
	Others	91	2	3.6	3
	Sub-Total	**991**	**25**	**39.6**	**32**
Beels		441	11	13.2	11
Floodplain		1499	38	37.5	30
Total Capture Fisheries		**2931**	**75**	**90.3**	**73**
Ponds		977	25	34.2	27
Total Capture & Culture		**3908**		**124.5**	

Catch Rates

Rivers	Principal	12.3 tonnes/km
	Others	--
Beels		224 kg/ha
Floodplain		22 kg/ha
Ponds	Cultured	1759 kg/ha
	Culturable	1558 kg/ha
	Derelict	519 kg/ha

2.1.4 Human Resources and Institutions

Human Resources characteristics are described in SR IV and information presented by Planning Unit are given in Table IX.2.4 to Table IX.2.8.

A. Estimated Population of Planning Units in 1981 and 1991

Population of Planning Units in 1981 has been estimated using the ratios (%) of total area of thana which is included in planning unit (see Table IX.2.4). Total number of households is also calculated using the proportion (in %) of thana included in each planning unit.

Population of PU for 1991 has been projected using two different AGR intercensus 1981-91 of 1.86% and 2.17%. Corresponding estimated population are given in Table IX.2.5. Number of households has been calculated dividing the total population of 1991 (two variant) by two different average sizes of household; 5.7 (which was the average size of household in the NCR in 1981) and is certainly still the same in 1991, and 5.2 (which is the average size of households of the 8 districts of the NCR in Preliminary Research of Census 1991, but seems too optimistic.

B. Density of Population per Planning Unit

Density of population of each planning unit has been calculated (Table IX.2.5) from adjusted population of 1981 and adjusted projected population for 1991. A detailed study of density of population per union for each Planning Unit is presented here for 1981 population. Densities of 1981 population per union for each Planning unit are indicated on individual planning units maps in SR IX.

Average density of population per thana does not reflect the distribution of population of overall thana as one or two highly populated union may increase the average density of thana and therefore of planning unit.

Most of the Planning Units have an average density of population comprising of between 750 to 960 persons per Km^2. Two Planning Units have a high average density of population (PU 11 and 13, 1362 and 1348 per Km^2 respectively). One (1) PU5, is much less populated (average = 564/Km^2).

PU 1 : Lowest and highest densities are respectively 411 and 1235. Less populated unions are situated along the Jamuna river, in Dewanganj and Islampur Thana (411 and 537). This phenomenon is due to river bank erosion. Highly populated unions are close to Thana Headquarters: Islampur, Melandah, Sarishabari (1148, 1235, 1215 per Km^2).

PU 2 : Lowest and highest densities are respectively 339 and 1565 per Km^2. Lowest densities are near Bhuapur. It is interesting to note that all around Jamalpur District Headquarters densities of population are not so high (700 to 900 per Km^2; only the union has 1000 inhabitants./km^2).

PU 3 : Lowest and highest densities are 396 and 1628 per Km^2. But many unions have a relatively high

TABLE IX.2.4

Distribution of Area in the Different Planning Units of NCR and Corresponding Population

DISTRICT					Total	1	2	3	4	5	6	7	8	9	10	11	12	13	Corresponding Population	
	Planning Unit																			
	Area of Planning Unit (ha) :-				1184460	89332	73963	172591	76171	212466	114395	90091	46066	78936	67188	24986	36971	101486		
	Check with 1981				1208372	92051	73686	171205	76224	212147	121687	90520	48082	84171	68643	25204	35138	109614		
	Check with 1985				1184459	89531	73963	172591	76170	212467	114395	90090	46065	78936	67187	24987	36970	101485		
	Check with 1990				1157689	88487	76000	179967	75272	216034	115999	89579	44145	78034	67778	25012	3016	99767		
	UPAZILA					% of Upazila according to Area estimated for 1985.														
	Sl. No.	Name	Tot. Area (ha) [1981]	Tot. Area (ha) [1985]	Tot. Area (ha) [1990]														Total Population of Upazila [1981]	Population of Upazila (included in NCR) [1981]
DHAKA	*	Dhaka	26745	29008																
	01.	Dhamrai	30680	30742	30741 *													100	2747570	2747570
	02.	Dohar	18430	15182	15182 *							100							265593	265593
	03.	Keraniganj	16700	16688	16687 *													96	145007	139543
	04.	Nawabganj	24240	24481	24484 *							11				89			361625	361625
	05.	Savar	27710	28012	28011 *							5			49			46	242139	242139
		TOTAL	144505	144115								5	77			18			261904	261904
GAZIPUR	06.	Joydevpur	44510	34716	43982 *														4025858	4018374
	07.	Kaliakair	31150	31152	31151 *					20			23	57					231811	231811
	08.	Kaliganj	19550	19719	15646 *					48	6	6	40						165766	165766
	09.	Kapasia	35280	35281	35280 *									100					168813	168813
	10.	Sripur	46190	46187	46186 *									51					250998	80254
	11.	Tongi	6020	5957						68				32					238984	238984
		TOTAL	182480	175012									68	32					119760	119760
JAMALPUR	12.	Dewanganj	42480	41397	26638	12													1176132	1003568
	13.	Islampur	37040	34301	34327	52													246987	41375
	14.	Jamalpur	48170	48117	48154	17	30	25		19									221114	117420
	15.	Madarganj	23300	23015	23016	100													424089	394205
	16.	Melandaha	24350	23962	24856	100													169607	169607
	17.	Sarishabari	26940	25832	25868	44	52												206917	206917
		TOTAL	202280	196824	182839														226664	218268
MANIKGANJ	18.	Daulatpur	22360	21178	21177 *														1495378	1147791
	19.	Ghior	14340	14467	14466 *						33				42				138740	103026
	20.	Harirampur	24670	24431	24425 *						23	6			71				109511	109511
	21.	Manikganj	19170	19297	21280 *										60			6	162373	111086
	22.	Saturia	15910	15427	13444 *							70			30				197043	197043
	23.	Shibalaya	19320	18127	18126 *						9	91							136642	136642
	24.	Singair	20960	20963	20962 *										82				119494	98200
		TOTAL	136930	133890	133880 *							100							202184	202184
MUNSHIGANJ	25.	Lohajang	12750	12889	12889 *														1065987	959692
	26.	Munshiganj	17520	15532	15532 *													100	148758	148758
	27.	Sirajdikhan	17840	17836	17835 *											4		81	244862	213679
	28.	Srinagar	21830	19714	19714 *										4	14		82	197583	197583
	29.	Tongibari	16220	14628	14627 *													90	191063	171957
		TOTAL	86140	80599	80597 *													100	169416	169416
MYMENSINGH	30.	Bhaluka	44290	44287	46577														951662	901575
	31.	Fulbaria	48540	48541	42994			26		74									215789	215789
	32.	Gaffargaon	39170	39170	37414 *			75		25									329739	329739
	33.	Muktagachha	30000	31331	31780			97											318705	309756
	34.	Mymensingh	37270	37415	38102			84		16									256906	256906
	35.	Trishal	24940	24931	37013			62											446529	349471
		TOTAL	224210	225675	235682			100											217818	217818
NARAYANGANJ	36.	Narayanganj	9570	8584															1783486	1679479
	37.	Rupganj	23480	23612	25205 *											23	57	20	423040	423040
		TOTAL	32850	32196	25205									50			13		293244	205576
TANGAIL	38.	Basail	17270	17569	15631				68		52								716284	628616
	39.	Bhuapur	22640	22361	21646		29		58										163224	163224
	40.	Delduar	20620	17052	17592						100								135851	92251
	41.	Ghatail	43080	45064	45101		5		61	34									145670	145670
	42.	Gopalpur	20620	21592	22368		100												264389	264389
	43.	Kalihati	30910	29186	29538				77		18								205025	205025
	44.	Madhupur	48140	47773	52126		33		9	58									286192	272285
	45.	Mirjapur	36650	36614	36753				4	57	55	6							262544	262544
	46.	Nagarpur	32420	28892	26875						95	5							294447	294447
	47.	Sakhipur	41940	43524	43011					100									237218	237218
	48.	Tangail	25980	26324	30187						99								171498	171498
		TOTAL	340250	333951	340626														277705	275692
N.C.R.	GRAND TOTAL		1549645	1522240															2445765	2384220
																			13638350	12724914

Note : Area data 1981 (except Dhaka) collected from Bangladesh Population Census 1981, BBS(GOB).[Supplied by Mr.K.Nizamuddin,Socio-economist,DUL]
Area data 1981 for Dhaka collected from Small Area Atlas of Bangladesh (Mauzas and Mahallahs of Dhaka District) BBS(GOB).[Supplied by Mr.K.Nizamuddin,-Do-]
Area data 1985 collected from BBS Statistics (GOB).[Supplied by Mr.Manoranjan Das, Civil Engineer, BETS]
Area data 1990 [incomplete] collected from BBS Statistics (GOB) and some are from Adam Shumari (asterisk "*" sign).[Supplied by Mr.S.I Choudhury, Hydrologist, BETS]
Population data 1981 collected from Bangladesh Population Census 1981, BBS(GOB).[Supplied by Mr.K.Nizamuddin,Socio-economist,DUL]

TABLE IX.2.5 a

Estimated Population of Planning Units in 1991

(Ratio calculated in percentage of percentage of upazila included in Planning Unit)

Planning Unit Number	Area [1985]		Estimated Population 1981 (Census '81)			Estimated Population 1991 [AGR=1.86%] [Average size of H/H = 5.7]			Estimated Population 1991 [AGR=2.17%] [Average size of H/H = 5.7]		
	(in km²)	%	No.	%	Density persons/km²	Number	Density persons/km²	No. of Household	Number	Density persons/km²	No. of Household
1	2	3	4	5	6	7	8	9	10	11	12
1	893.52	7.54	737,706	5.80	826	886,993	993	155,613	914,360	1,023	160,414
2	739.63	6.24	604,558	4.75	817	726,900	983	127,526	749,328	1,013	131,461
3	1723.91	14.55	1,486,749	11.68	862	1,787,617	1,037	313,617	1,842,772	1,069	323,293
4	761.71	6.43	589,207	4.63	774	708,443	930	124,288	730,301	959	128,123
5	2124.66	17.94	1,139,598	8.96	536	1,370,214	645	240,388	1,412,491	665	247,805
6	1143.93	9.66	1,006,383	7.91	880	1,210,041	1,058	212,288	1,247,376	1,090	218,838
7	900.91	7.61	831,126	6.53	923	999,318	1,109	175,319	1,030,151	1,143	180,728
8	460.66	3.89	391,729	3.08	850	471,002	1,022	82,632	485,534	1,054	85,181
9	789.36	6.66	661,348	5.20	838	795,182	1,007	139,506	819,717	1,038	143,810
10	671.88	5.67	514,328	4.04	766	618,411	920	108,493	637,491	949	111,841
11	249.86	2.11	437,568	3.44	1,751	526,117	2,106	92,301	542,350	2,171	95,149
12	369.71	3.12	3,195,129	25.11	8,642	3,841,715	10,391	673,985	3,960,248	10,712	694,780
13	1014.86	8.57	1,129,512	8.88	1,113	1,358,087	1,338	238,261	1,399,990	1,379	245,612
N.C.R	11844.60	100.00	12,724,941	100.00	1,074	15,300,038	1,292	2,684,217	15,772,107	1,332	2,767,036

Note :

Percentage in column 3 is calculated on the basis of total area of NCR (bottom of column 2).
Percentage in column 5 is calculated on the basis of total area of NCR (bottom of column 4).

Source : Bangladesh Population Census 1981, BBS(GOB).

Source file :C:\FAP3\DTNR\DT_EST91.WK1

Estimated Population of Planning Unit in 1991.

(Ratio calculated in percentage of percentage of upazila included in Planning Unit)

Planning Unit Number	Area [1985]		Estimated Population 1981 (Census '81)			Estimated Population 1991 [AGR=1.86%] [Average size of H/H = 5.2]			Estimated Population 1991 [AGR=2.17%] [Average size of H/H = 5.2]		
	(in km²)	%	No.	%	Density persons/km²	Number	Density persons/km²	No. of Household	Number	Density persons/km²	No. of Household
1	2	3	4	5	6	7	8	9	10	11	12
1	893.52	7.54	737,706	5.80	826	886,993	993	170,576	914,360	1,023	175,838
2	739.63	6.24	604,558	4.75	817	726,900	983	139,788	749,328	1,013	144,102
3	1723.91	14.55	1,486,749	11.68	862	1,787,617	1,037	343,772	1,842,772	1,069	354,379
4	761.71	6.43	589,207	4.63	774	708,443	930	136,239	730,301	959	140,442
5	2124.66	17.94	1,139,598	8.96	536	1,370,214	645	263,503	1,412,491	665	271,633
6	1143.93	9.66	1,006,383	7.91	880	1,210,041	1,058	232,700	1,247,376	1,090	239,880
7	900.91	7.61	831,126	6.53	923	999,318	1,109	192,176	1,030,151	1,143	198,106
8	460.66	3.89	391,729	3.08	850	471,002	1,022	90,577	485,534	1,054	93,372
9	789.36	6.66	661,348	5.20	838	795,182	1,007	152,920	819,717	1,038	157,638
10	671.88	5.67	514,328	4.04	766	618,411	920	118,925	637,491	949	122,594
11	249.86	2.11	437,568	3.44	1,751	526,117	2,106	101,176	542,350	2,171	104,298
12	369.71	3.12	3,195,129	25.11	8,642	3,841,715	10,391	738,791	3,960,248	10,712	761,586
13	1014.86	8.57	1,129,512	8.88	1,113	1,358,087	1,338	261,171	1,399,990	1,379	269,229
N.C.R	11844.60	100.00	12,724,941	100.00	1,074	15,300,038	1,292	2,942,315	15,772,107	1,332	3,033,097

Note :

Percentage in column 3 is calculated on the basis of total area of NCR (bottom of column 2).
Percentage in column 5 is calculated on the basis of total area of NCR (bottom of column 4).

Source : Bangladesh Population Census 1981, BBS(GOB).

Source file :C:\FAP3\DTNR\DT_EST91.WK1 [Lower part]

density of population of between 700 and 900 per Km^2. Areas with high densities are located along the Old Brahmaputra River from Mymensingh downstream, lowest densities are represented in the western part of the planning unit.

PU 4 : Lowest and highest densities are 378 and 1492 per Km^2

PU 5 : Lowest and highest densities are 306 and 931 per Km^2

PU 6 : Lowest and highest densities are 604 and 1533 per Km^2. All the areas in the PU are densely populated except along the Jamuna river (600-700 inhabitants km^2 only).

PU 7 : Lowest and highest densities are 632 and 2101 per Km^2 (near Dhamrai Thana Head Quarter). Densities above 1000 per Km^2 are near Saturia, Manikganj, and Singair Head Quarter.

PU 8 : Lowest and highest densities are 408 and 1752 per Km^2. Tongi Union is partly in urban area, partly in cantonment Area of Dhaka SMA. Highest density is near Savar Head Quarter (1750 per Km^2).

PU 9 : Lowest and highest densities are 354 to 2113 per Km^2. Planning Unit is not so populated; average is between 300 and 700 per Km^2. Densities above 1000 are near Gazipur and Kaliganj.

PU 10: Lowest and highest densities are 492 and 1442 per Km^2. Lowest densities are along the Padma river and in the North-Western part of the Planning Unit, at the confluence of the Jamuna and the Padma river.

PU 11: Planning Unit 11 is highly populated, as it partly comprises of 2 thanas situated quite close to Dhaka (922 and 2892 per Km^2)

PU 12: Includes Dhaka SMA, i,e urban areas (see population of Dhaka in the table showing population per administrative units).

PU 13: Lowest and highest densities are 303 and 7961 per km^2. All Planning Units have a very high density of population, only 2 specific unions along the Padma and the Meghna river, have less population.

C. Total Number of Households per Planning Unit

Total number of households per Planning Unit can be obtained using two methods:

1. Adjusted Projected Populations (using two different AGR, 1.86 and 2.17), for each Planning Unit, divided by two different average sizes of households (which was 5.7 in the NCR in 1981, and is estimated to be now 5.2 in 1991).

2. By extrapolation of the total number of 1981 households using the percentage area of each thana included in each Planning Unit, then using the same AGR, for estimating total number of households in 1991 in each Planning Unit.

Both methods screen the spatial distribution of population in the administrative units as well as in the Planning Units. As a consequence, results can only be considered as approximate ratios.

The only method of knowing the distribution of population in Planning Unit would be the use of aerial photographs, making a detailed land use survey by interpretation of aerial photographs.
All estimations do not take into consideration the important variable of migration, which is unknown.

D. Urban/Rural Population in Planning Units

Rural Population in Planning Units

There are two methods of estimating (approximately) the rural population in Planning Units in 1991.

1. The first one could be to use the respective percentages of urban and rural population per thana in 1981 and/or in 1991, then to calculate these two percentages for the percentage of population of each thana which is included in each Planning Unit.

   In practice, this method cannot be used and would be absolutely inaccurate as the spatial distribution of urban and rural population inside thana is not known, as the definition of urban population in 1981 census comprised many different kind of population concentration or administrative centres, bazaars etc., criteria for classifying a population as"urban" do not allow to put them on a map.

   Furthermore, the evolution of this kind of urban population cannot be estimated.

2. The second one, much more easy and simplified would be to use the percentage of rural and urban population using the BCAL 1983-1984 definition of urban population (see main report on Population characteristics).

   The same percentages could be arbitrarily considered to be the same in 1991, using the projected total number of households for 1991 (4 variants: AGR 1.86 and 2.17, average size of HH 5.7 and 5.2).

   Here again, Bangladesh Agricultural and Livestock Census of 1983 makes it difficult to forecast any type of population characteristics from 1983-84 data, as the survey had been conducted during 2 years. It is not known, which part (half per year) of the country had been surveyed in which year.

Urban Population in Planning Units

The only type of urban population which can be estimated per Planning Unit with accuracy in 1981, 1983-84, and 1991 is the population of municipalities. Here again there are some dangers in the definition of municipalities between different censuses. There is also a new municipality since 1983-84, which is Gazipur, in Joydevpur thana of Gazipur district.

Population and total households of municipalities are given in Table IX.2.6 for 1983-84 and 1991. Table IX.2.7 gives the total number of urban and rural households in 1983-84 and in 1991.

- Total households in rural area in 1983-84 have been calculated using the figures of BCAL and percentage area of thana within each Planning Unit (column (1)).

- Total households in municipalities in 1983 are obtained from BCAL, an addition of 6% has been applied as PEC (post enumeration checking) concluded that 94% only of municipal households had been covered).

  Information for Dhaka are not that accurate and is not checked, as Planning Unit 12 is completely in Dhaka SMA.Many information should be obtained to adjust all data in Dhaka SMA, due to the evolution of nearby areas. (column (2)).

- Total households 1983 is columns (1)+ (2).

- Total households in rural areas are obtained using the rural AGR of 1.76.

  Following the inexactitude of statistics which do not allow us to know if the study area has been surveyed in 1983 or 1984, 2 variants have been calculated, one for the period 1983-91, the other for the period 1984-1991.

- Total households in municipalities are obtained from Preliminary Results of Population Census 1991. Column 6 gives the total number of households per planning unit in 1991, with 2 variants.

E. Distribution of Different Types of Households in Planning Units in 1983-84

Distribution of the different types of households in the Planning Units is estimated using the percentage of each type of household (for rural area only) for the percentage of thana which is included in Planning Unit.(% area has been used for co-relations and for simplification, all ratios for Planning Units are calculated assuming, that there is some correlation between areas, population and households, this is, of course, only a theoretical ratio and not a geographical or regional reality).

This distribution of different types of households cannot be extrapolated to the year 1991, as it would be without any significance. It is also not made for urban areas or municipalities, as evolution or increase of municipalities has not been the same for each of them during the last decade, as it is explained in chapter on "Urban growth" in the Main Report.

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Total, rural and urban households per planning unit in 1983–84 and 1991.

Planning Unit Number	Total Households							
	Rural 1983	Municipalities 1983 (+6%)	Total 1983 [2]+[3]	Rural 1991 AGR=1.76% P1	Rural 1991 AGR=1.76% P2	Municipalities	Total 1991 [5]+[7] P1	Total 1991 [6]+[7] P2
1	2	3	4	5	6	7	8	9
1	124997		124997	141234	143719			
2	97389	22983	120372	110039	111976	28858	138897	140834
3	251593	17572	269165	284274	289277	37241	321515	326518
4	96069		96069	108548	110458			
5	204309		204309	230848	234911			
6	152351	13778	166129	172141	175170	19825	191966	194995
7	136801	6826	143627	154571	157291	8691	163262	165982
8	50804	16565	67369	57403	58413	16155	73558	74568
9	102959	16565	119524	116333	118380	34920	151253	153300
10	85291		85291	96370	98066			
11	69362		69362	78372	79751			
12	26170	34704	60874	29569	30089	661292	690861	691381
	Without Dhaka Municipality							
13	182657	6313	188970	206383	210016	7632	214015	217648
NCR Toal	1580752	135306	1716058	1786085	1817517			

Note : Computed from BCAL 1983-84.

Explanations

1) Total Household 1983 BCAL 1983-84 in % of % area of upazila included in PU,

2) Total Household in municipalities + 6% to cover 100% of survey , as PEC showed that 94% only of household were surveyed.

3) extrapolated total household from total household 1981 AGR 2.17 from census Pocket Book 1991 of Bangladesh (6) = (4) + (5).

PU 8 & 9 have a part of Tongi municipality

PU (2) is in Dhaka SMA.

It should be studied much more in details & be a study in itself. It is out of the scope of the study. figures are approximate.

4) Projections are made using 1983-84 data, with AGR = 1.76 but it is not possible to know if 1983-84 data for the Project Area, give the situation of 1983 or 1984 (so projections have been made for 7 or 8 years).

P1 = Projection 1 = on 7 years

P2 = Projection 2 = on 8 years

5) Projections are not made from 1983-84 data, as the respective increase rate of each municipality is not known.

TABLE IX.2.7

Total number of household in 1981, 1983-84 & 1991(estimated) in the Planning Units of the NCR.

Planning Unit Number	Total Households				
	1981 [Census] No.	1983-84 [estimated]		1991 [estimated]	
		AGR=1.86% No.	AGR=2.17% No.	AGR=1.86% No.	AGR=2.17% No.
1	2	3	4	5	6
1	126754	133960	135186	152405	157108
2	104195	110118	111127	125281	129147
3	255508	270033	272505	307215	316693
4	98649	104257	105212	118613	122272
5	202292	213791	215749	243229	250734
6	167403	176919	178540	201280	207490
7	144629	152850	154250	173897	179262
8	67515	71352	72006	81177	83682
9	109422	115642	116701	131565	135624
10	91217	96403	97285	109677	113061
11	87683	92668	93516	105428	108680
12	48589	51351	51821	58422	60224
13	200592	211995	213936	241185	248627
NCR Toal	1704448	1801339	1817834	2049374	2112604
Upazila Total	*1892288*	*1999854*	*2018168*	*2275223*	*2345423*

Source file :C:\FAP3\DTNR\07-11PUH.WK1

F. Mauzas with a Population of more than 10,000 in 1981

It is important to know for each Planning Unit, where the biggest concentrations of population are, either in the district Headquarters or only in the mauzas, to prepare the regional development plan, see Table IX.2.8.

Modern and traditional urban centres network will be the basis for development of income generating activities to absorb a part of the poor and unemployed people [1]. Creation and development of cottage industries, small scale industries workshops are the only solution to develop all rural areas.

TABLE IX.2.8
Mauzas with a Population of More than 10,000 in 1981, and Population of District Head Quarters in 1981 (Dhaka excluded)

Planning Unit	Number of Mauzas populated more than 10,00	District Head Quarters		
		Name	Population	No.of HH
1	6	Jamalpur Close to	91815	14456
2	1	Jamalpur	91815	14456
3	11	Mymensingh	98724	14231
4	1			
5	8			
6	1	Tangail	84942	13659
7	1	Manikganj	37035	6611
8	1	1 Part included in SMA		
9	2			
10	2 (also in PU 13			
11	4	Narayanganj close to but located in PU 12	246515	42218
12	1	Narayanganj	246515	42218
13	2 (also in PU 10) + 6 45			

1 Modern urban population, Dhaka population & Gazipur and Narayanganj urban areas population which are included now in Greater Dhaka. Traditional urban populations are those of Thana Headquarters & District Head Quarters except Mymensingh

2.2 Possible Developments by Planning Units

The present situation and proposed developments for the Planning Units are given in Figures IX.2.2 to IX.2.5. Preliminary compartmentalisation boundaries have been given where appropriate. These are to be considered as indicative only and will have to be reassessed at Feasibility Study level.

2.3 Flooding Characteristics

Additional information is also presented on flooding characteristics and cropping patterns, see Figures IX.2.6 to IX.2.13. These are the result of runs from the hydraulic model (see SR II.5). They are based on the coarse pilot model and should be considered as indicative only.

Figure IX.2.2
Planning Units 2 and 4 - Possible Development

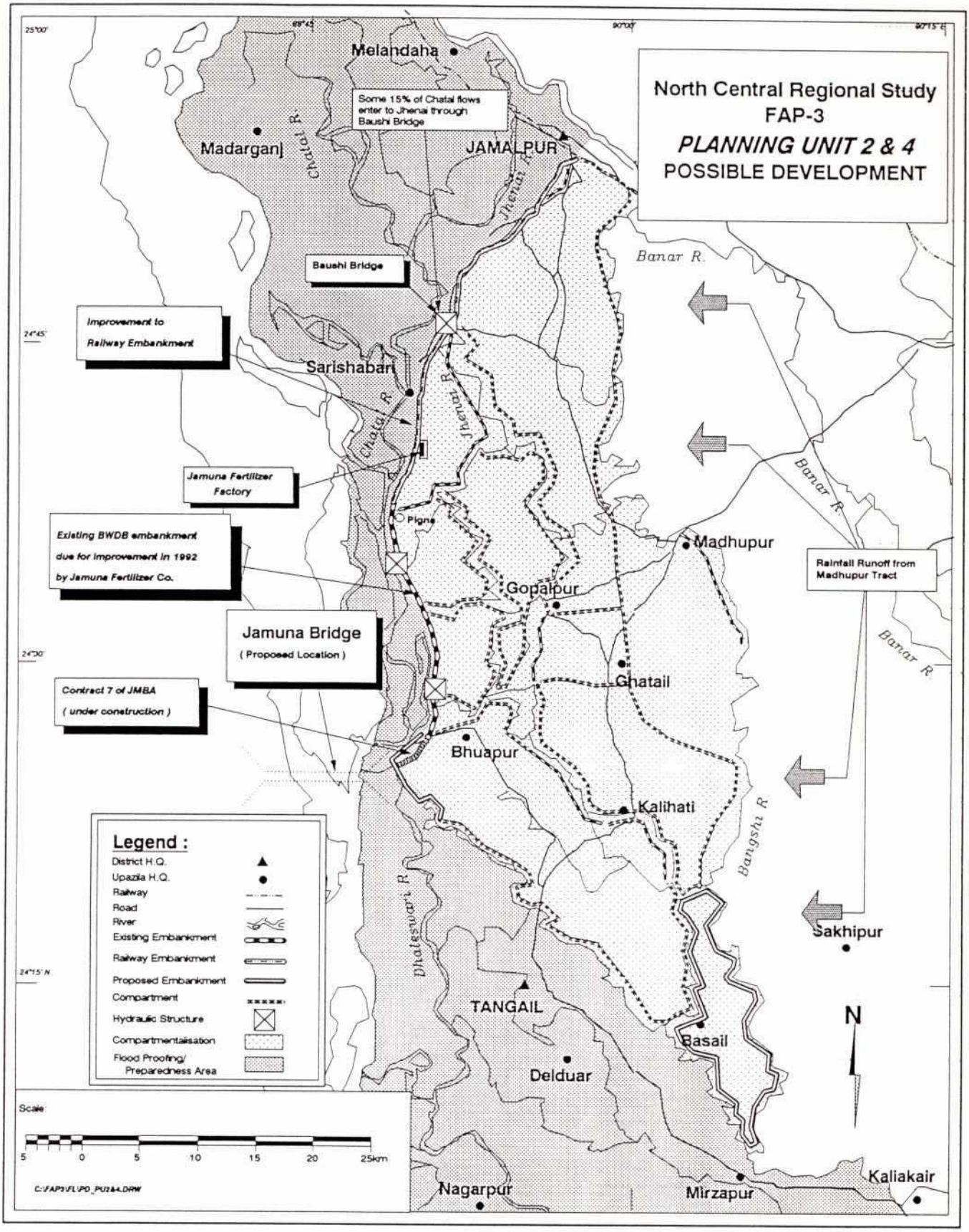


Figure IX.2.3
Planning Unit 3 - Possible Development

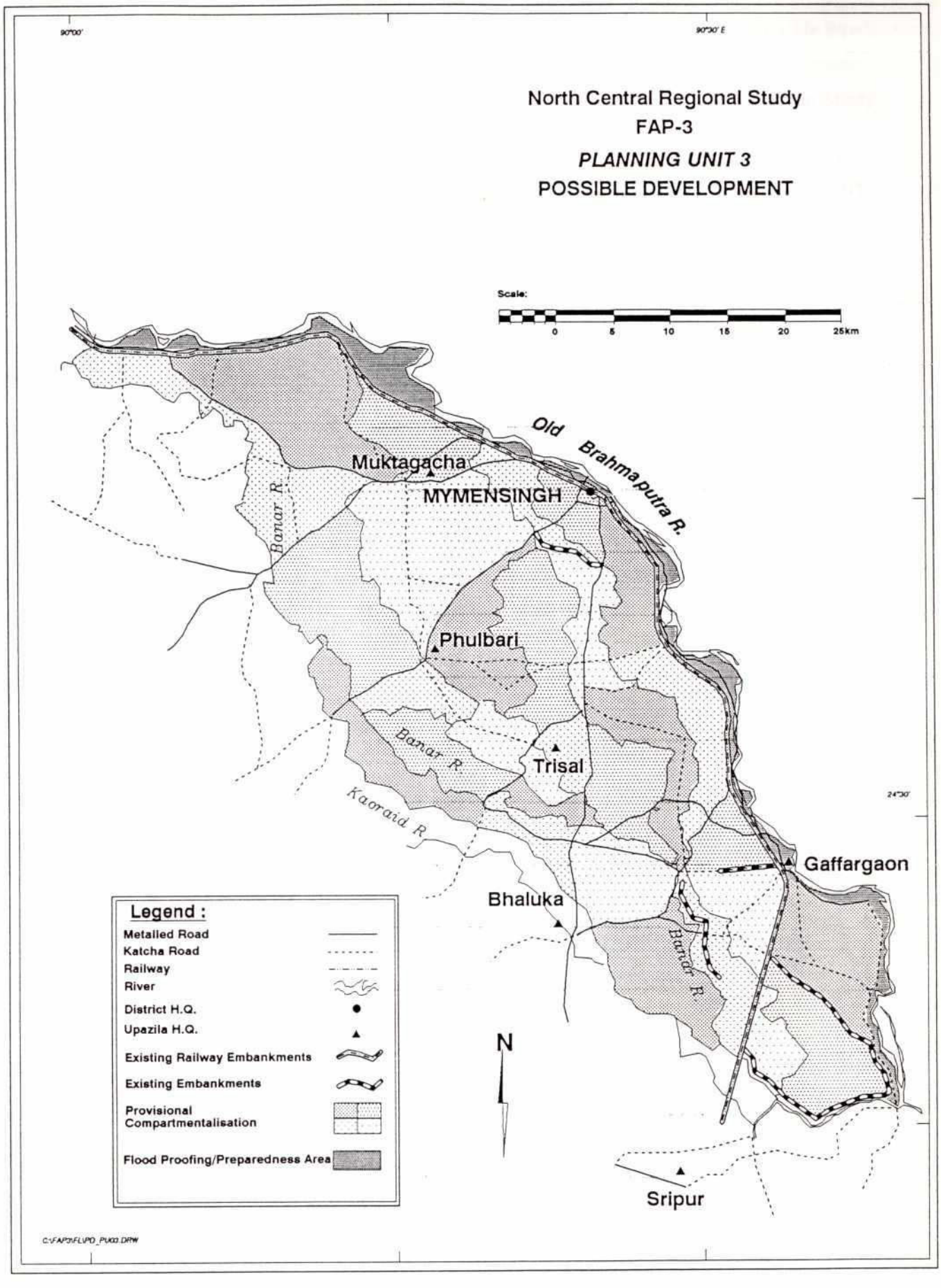
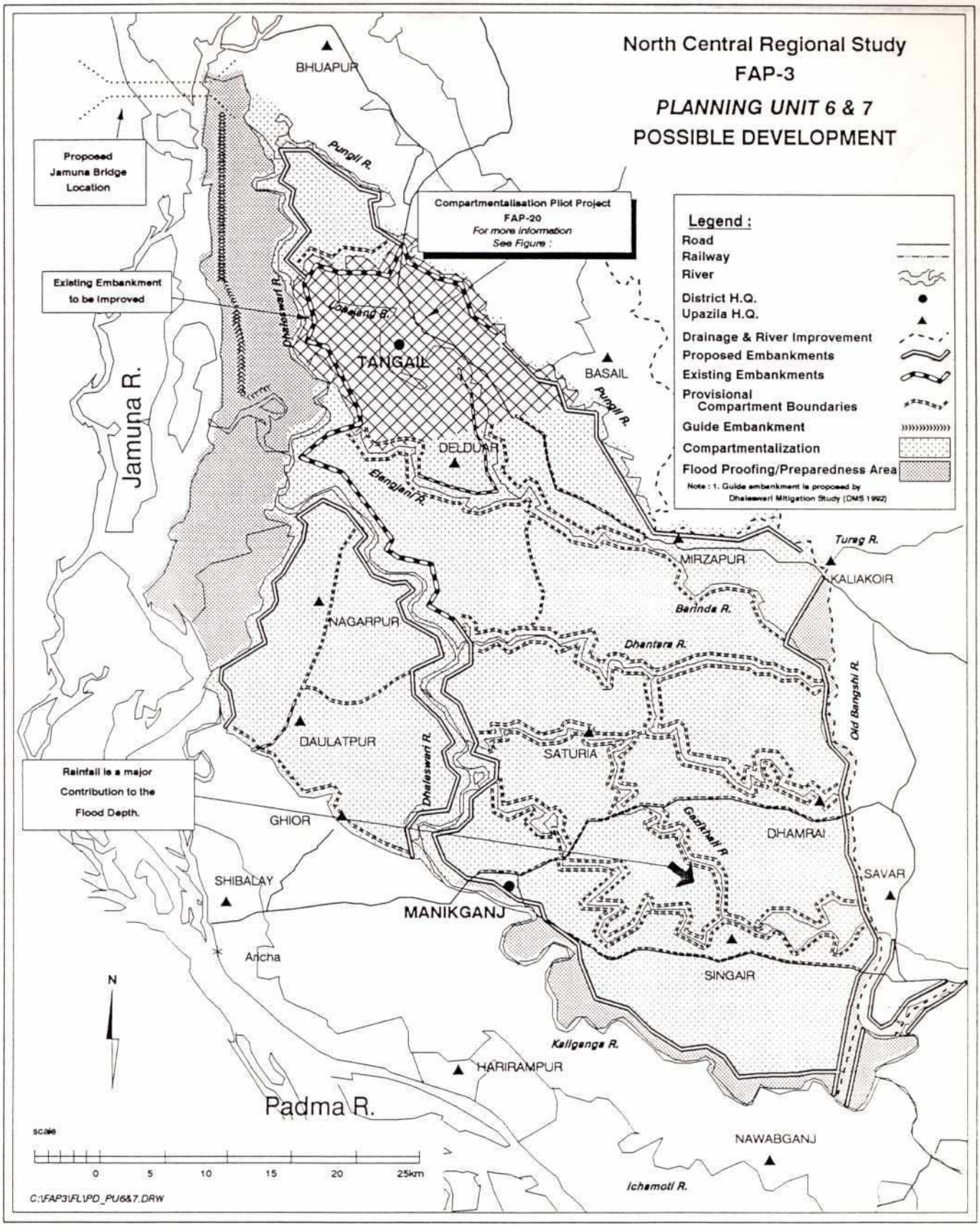


Figure IX.2.4
Planning Units 6 and 7 - Possible Development



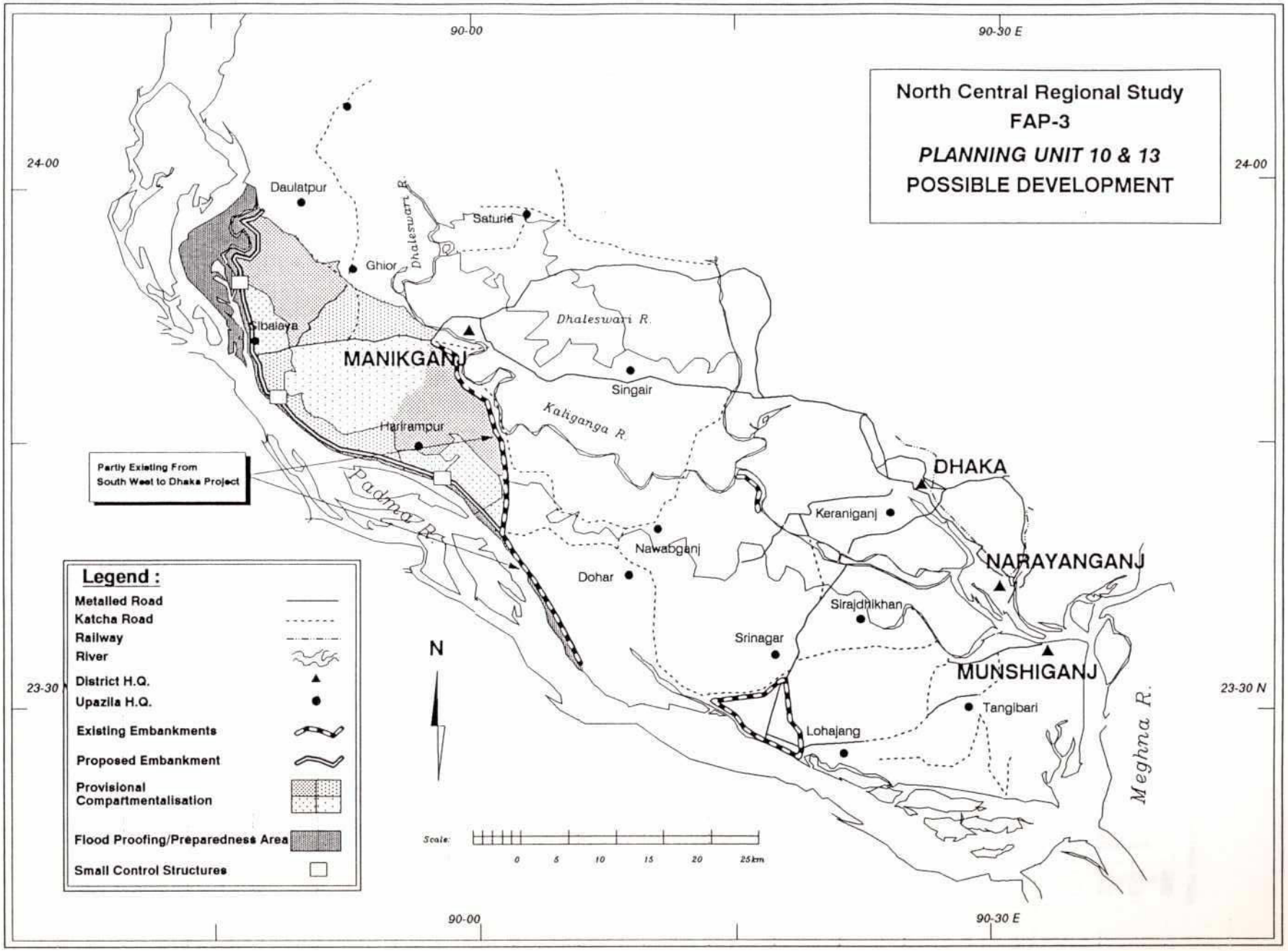
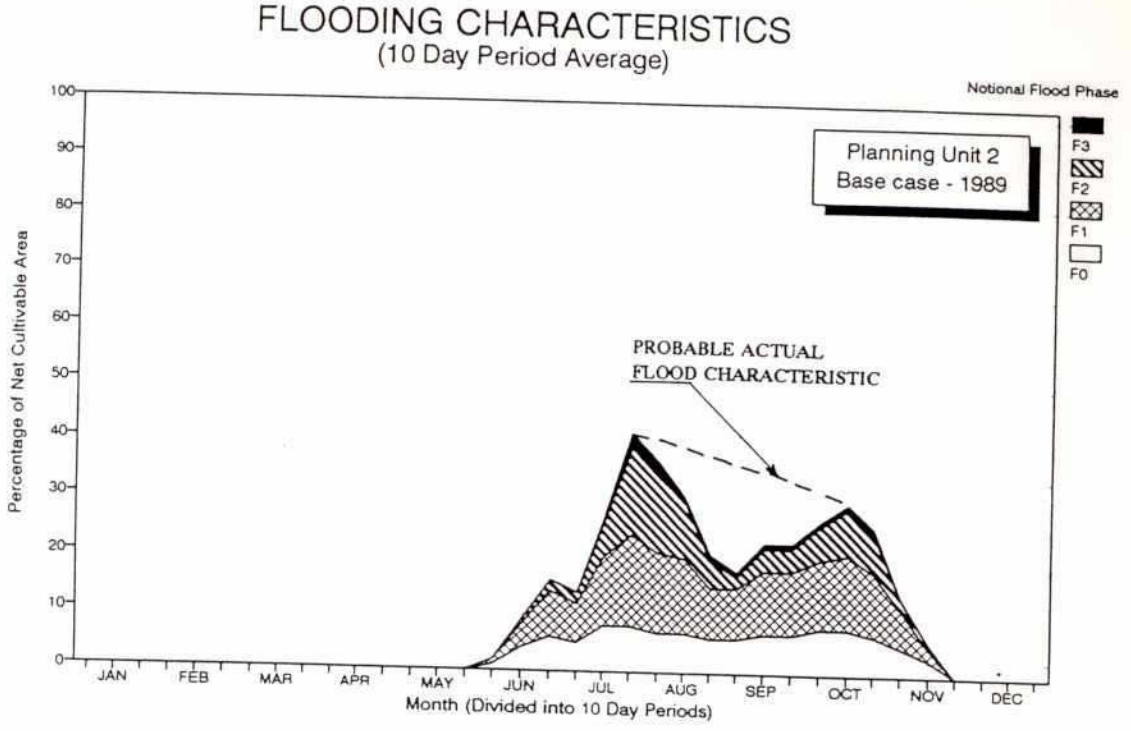


Figure IX.2.5
Planning Units 10 and 13 - Possible Development

Figure IX.2.6
Flooding Characteristics- Planning Unit 2



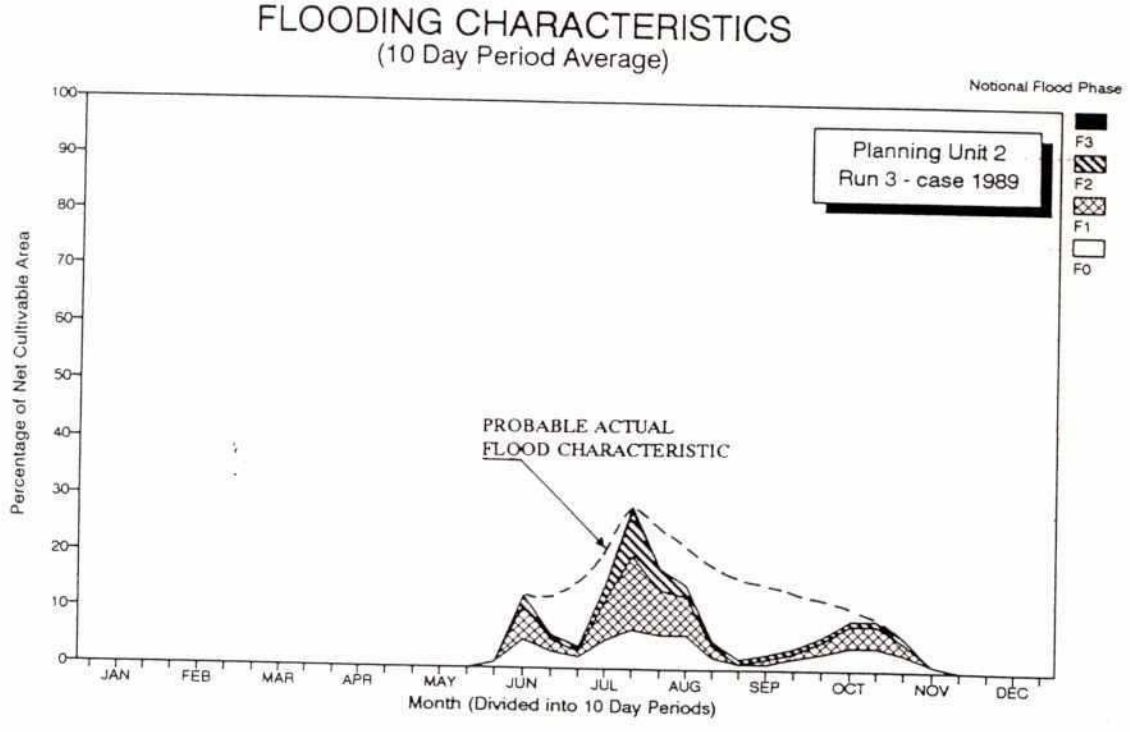
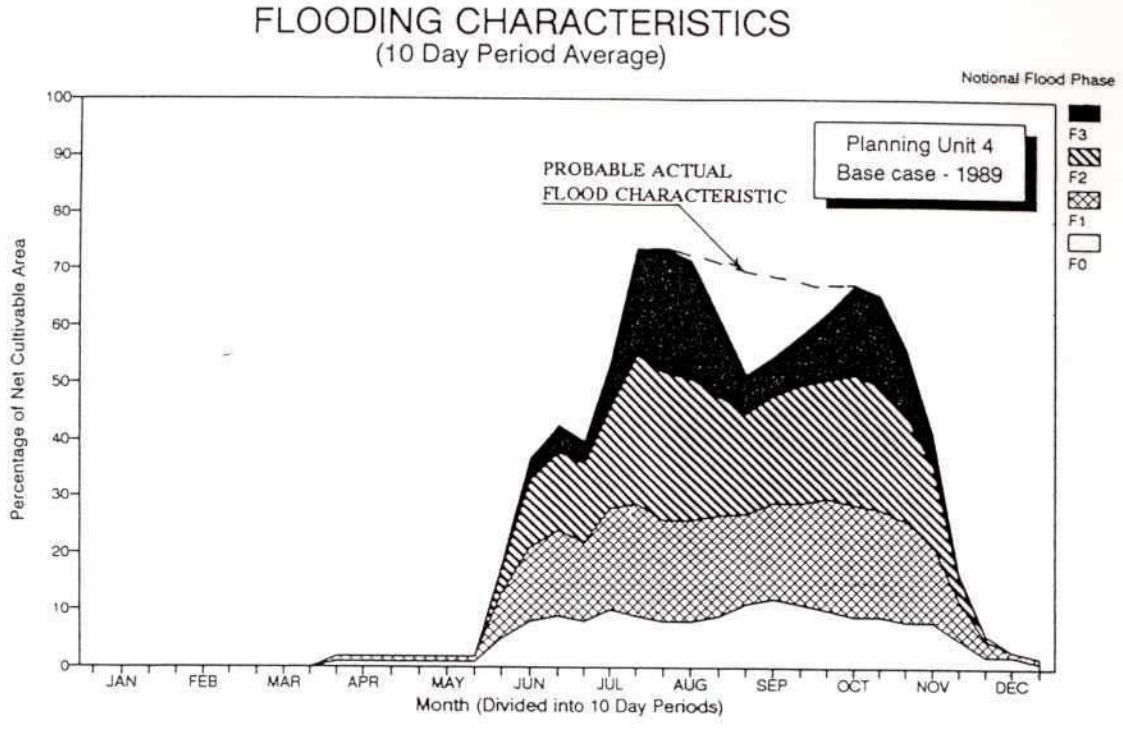


Figure IX.2.7
Flooding Characteristics- Planning Unit 4



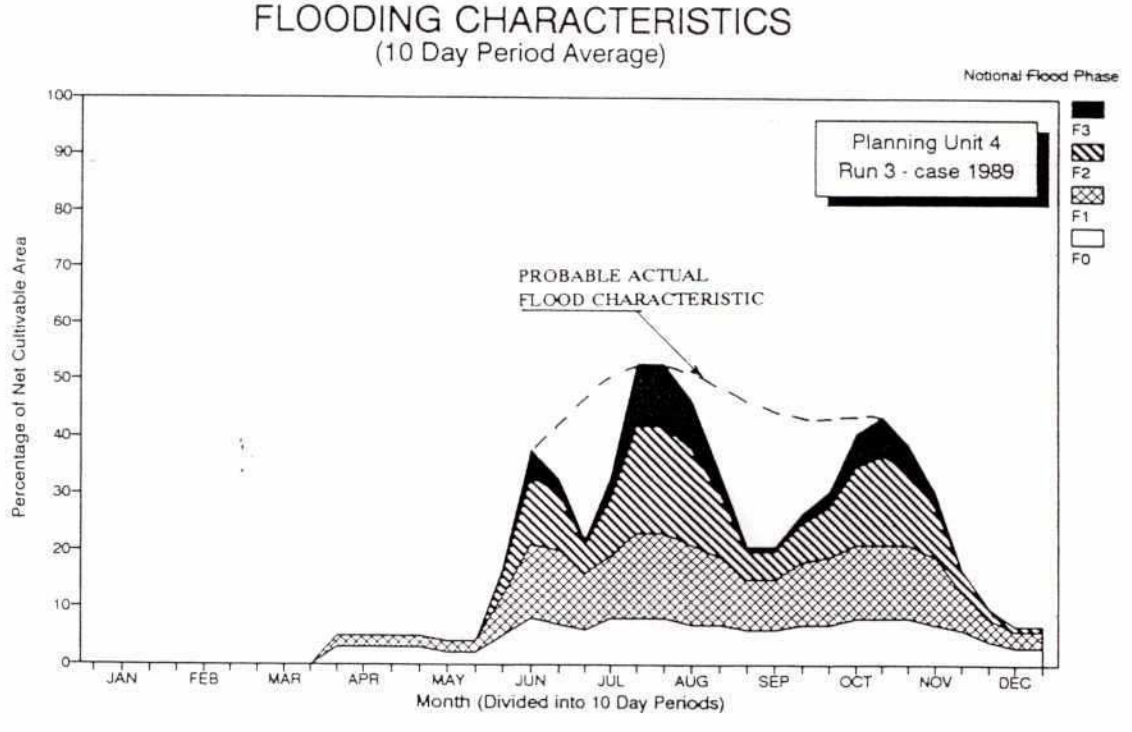
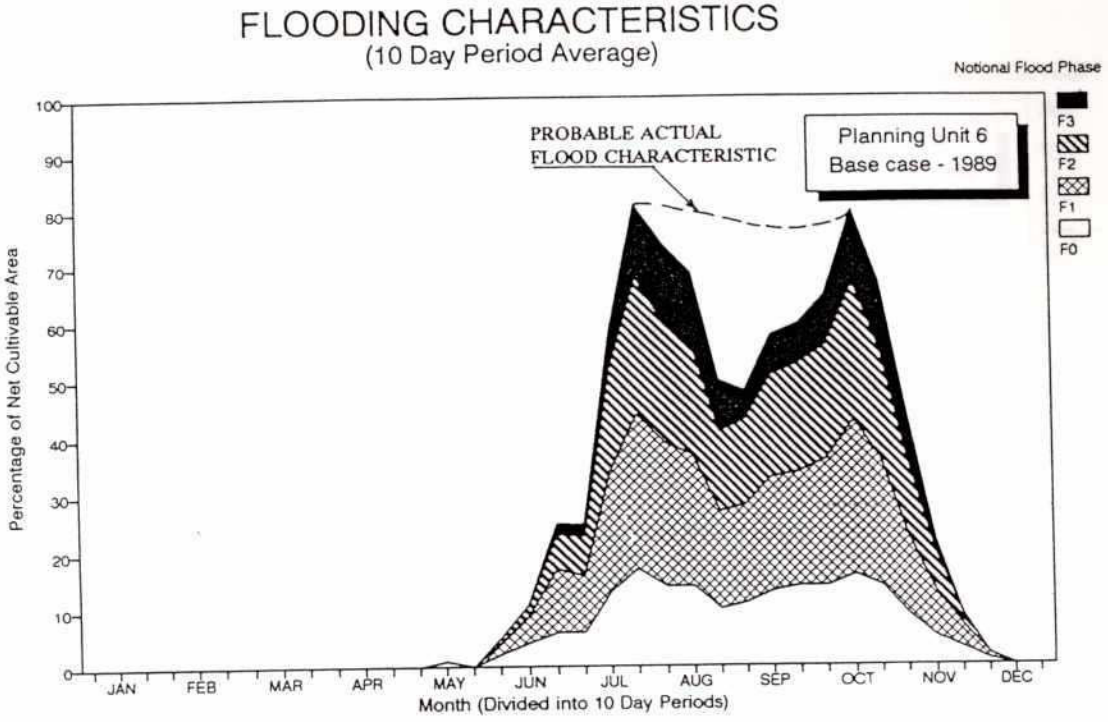


Figure IX.2.8
Flooding Characteristics- Planning Unit 6



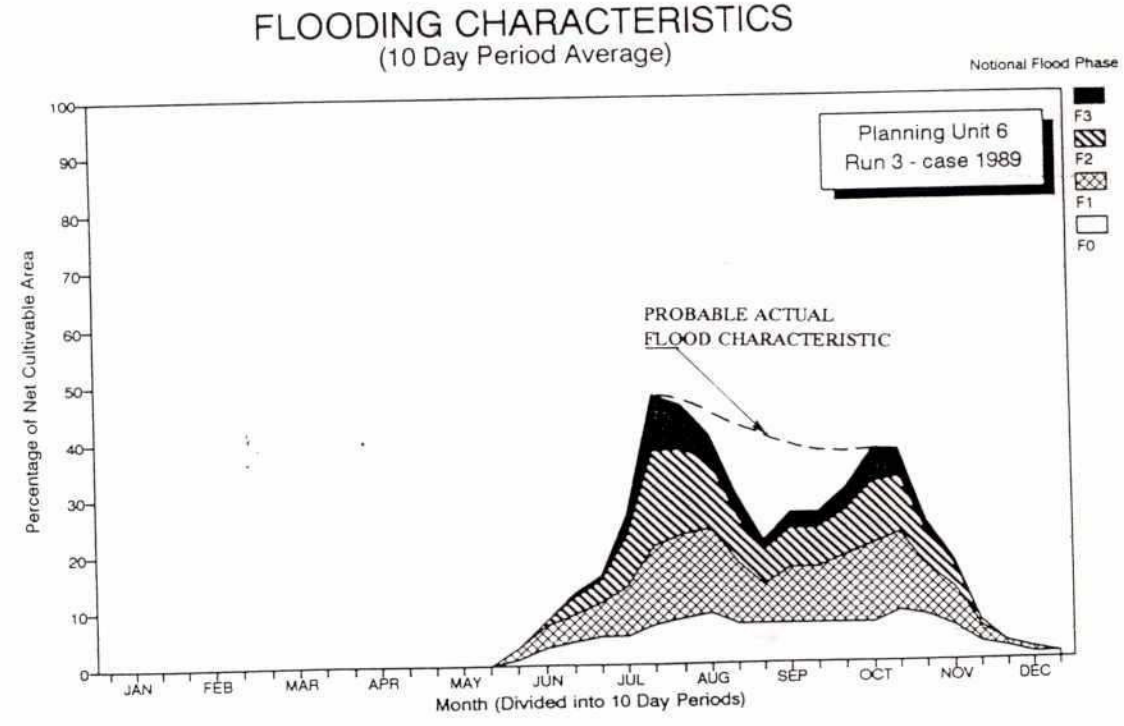
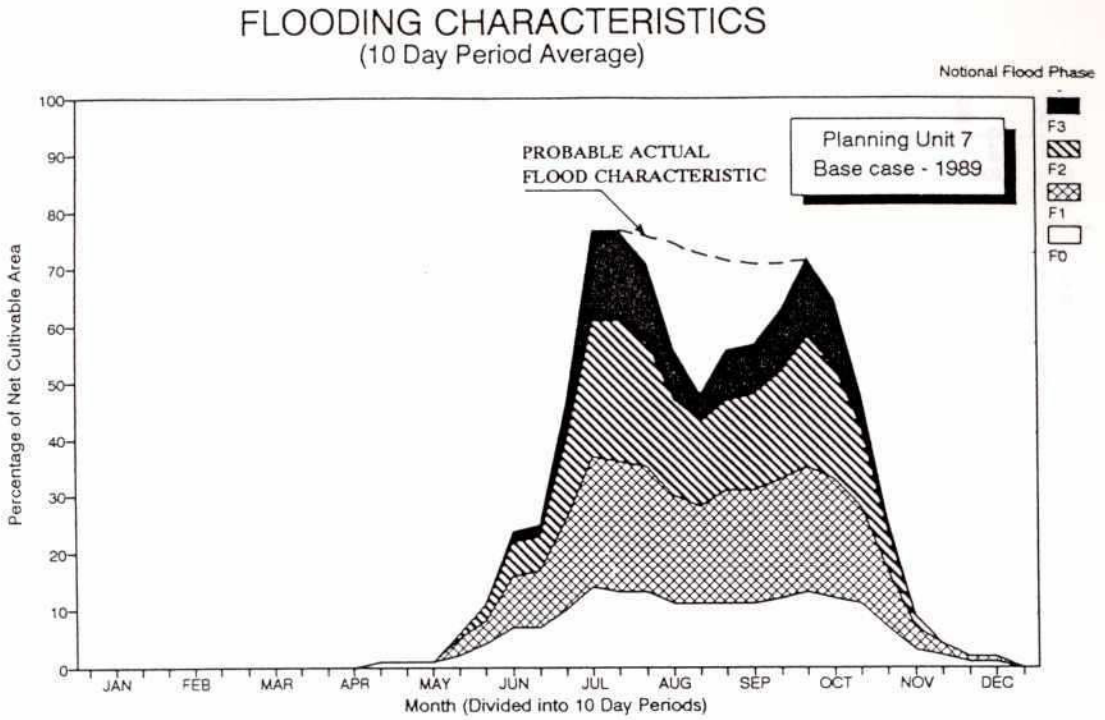


Figure IX.2.9
Flooding Characteristics- Planning Unit 7



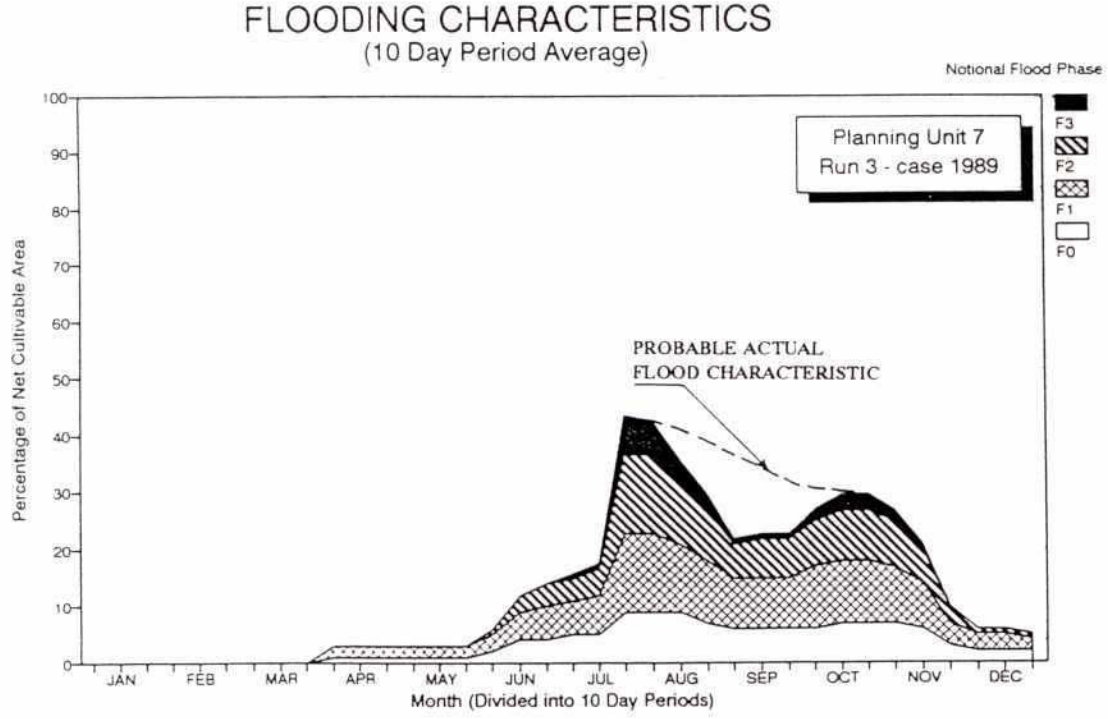
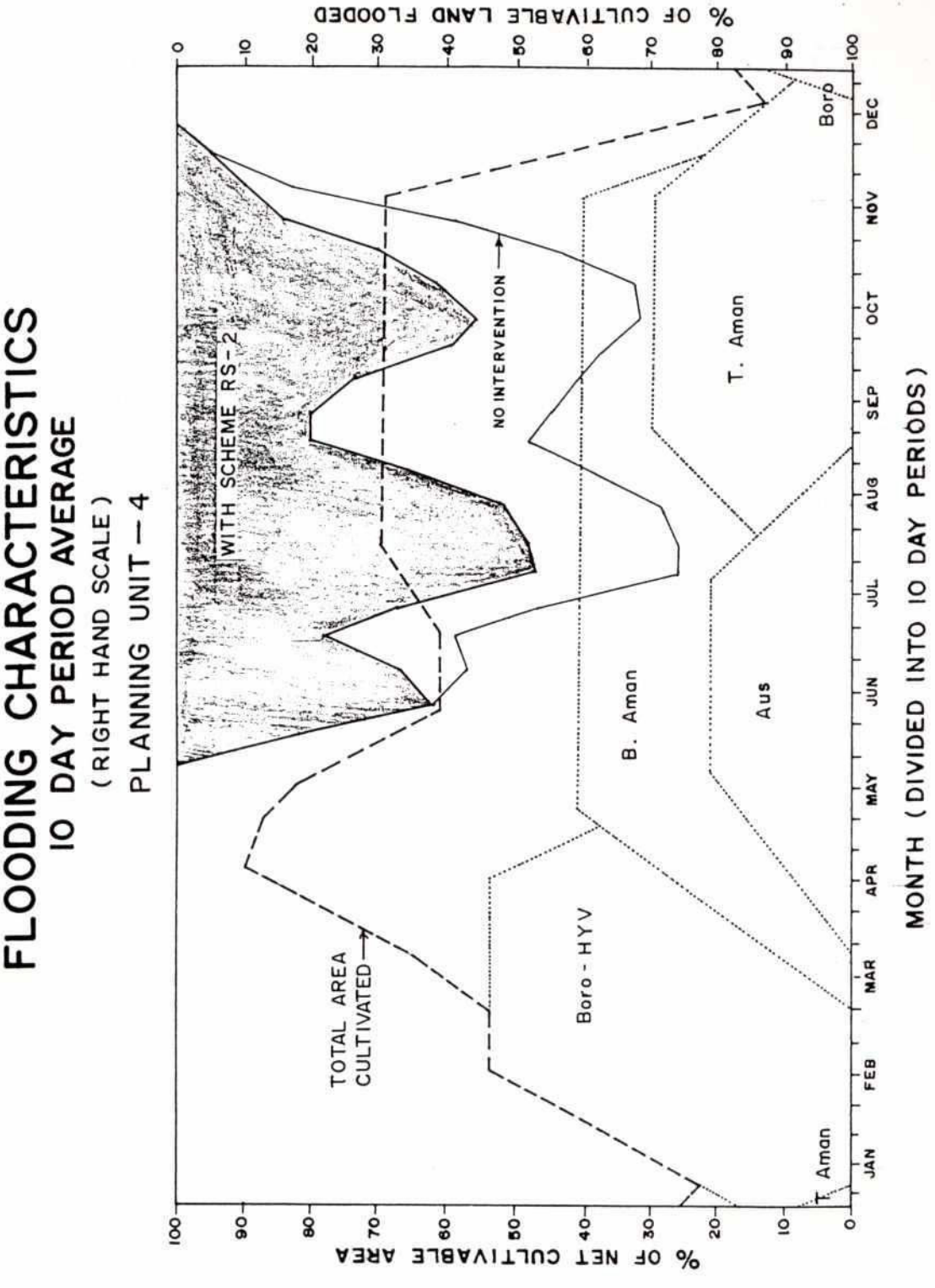


Figure IX.2.10
Cropping and Flooding Characteristics- Planning Unit 2

Figure IX.2.11

Cropping and Flooding Characteristics- Planning Unit 4



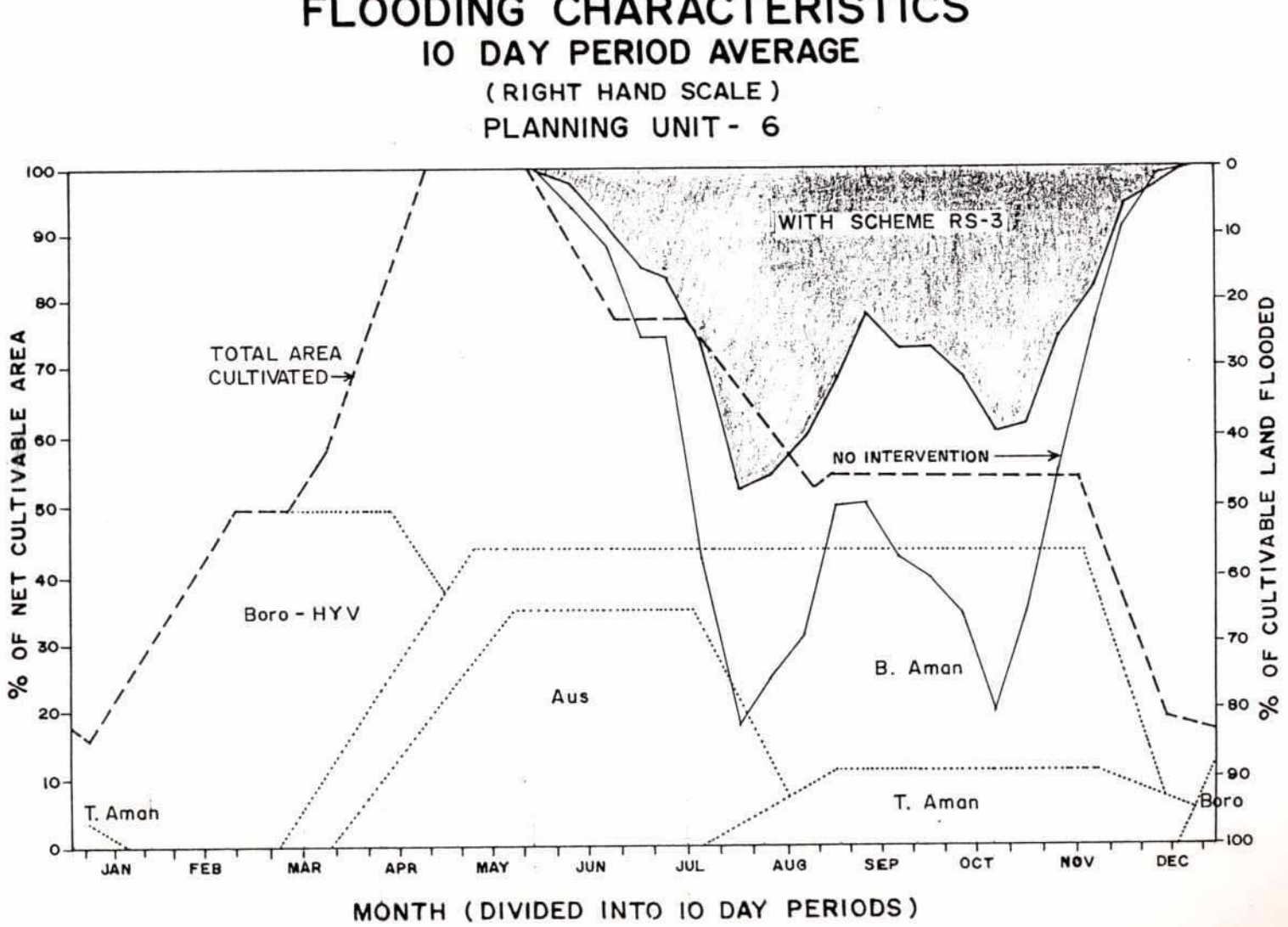


Figure IX.2.12
Cropping and Flooding Characteristics- Planning Unit 6

Figure IX.2.13

Cropping and Flooding Characteristics- Planning Unit 7