CHAPTER 3
STUDY AREA

3.1 The Greater Mymensingh Area

3.1.1 The Study Area

The Study Area covers the six Districts of the Greater Mymensingh area (Mymensingh, Tangail, Sherpur, Jamalpur, Netrakona and Kishoreganj). The Study Area is located in the north-central part of the country bordered by the Meghna River and Sunamganj District in the east, Greater Dhaka District containing Dhaka city in the south, the Jamuna (Brahmaputra) River in the west, and the Indian state of Meghalaya in the north. The old Brahmaputra River runs through the Area flowing from the northwest and to the southeast. In the southern part of the Study Area, the Madhupur terrace with the elevation of about 15 m lies in the lowland area of about 3m elevation.

3.1.2 Local Government Framework

The Study Area covers 11.3 % of the country with 16,672 km^2 of land area, and holds 12.6 % (15.62 million people) of the total population. The local administration comprises of 6 Districts, 58 Upazilas (sub-districts) and 562 Unions. Sherpur district was a former sub-division of the Greater Jamalpur Region. It was upgraded to a district in 1984. Also, Kishoreganj district was one of the sub-division of former Mymensingh district. It was upgraded to a district in the same year. The average area of one Union is approximately 3,000 ha with about 2,800 residents.

Area and Population by District

District	Area (km^2)	Population 1996, (,000)	Number of		
			Upazila	Union*	Mauza
Jamalpur	2,032	2,111	7	68	757
Kishoreganj	2,689	2,573	13	109	946
Mymensingh	4,363	4,450	12	146	2,172
Netrakona	2,810	1,938	10	86	1,591
Sherpur	1,364	1,279	5	52	446
Tangail	3,414	3,371	11	101	1,954
Study Area Total	16,672	15,722	58	562	7,866

Source: Census of Agriculture 1996, BBS, 2003, * union numbers were based on the JICA Study Team

3.2 Natural Conditions

3.2.1 Topography and Geology

The Study Area is surrounded the Meghalaya Hills (in India) in the north, Meghna River and the Haors of Sunamganj District in the east, the Greater Dhaka District in the south, and the Jamuna River in the west. The old Brahmaputra River passes through the center of the Study Area from the northwestern boundary to the center of southern boundary.

As shown in Fig. 3.2.1, the northern boundary area is formed as the alluvial fan with the elevation 40 to 25 m PWD[1], along the eastern boundary, there is a depression area, which is

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[1] m PWD: Meter above Public Works Datum. m PWD = m above mean sea level + 0.46m

called haor with an elevation of 3 to 7 m PWD. The central part of the area is the Brahmaputra floodplain with an elevation of 5 to 20 m PWD, while a part of the Jamuna floodplain including char land lies in the west. Between the old Brahmaputra and the Jamuna floodplain, the Madhupur Tract, comprising of a clayey river terrace, uplifts on the plain with the elevation of more than 15 m PWD. Geological classification of the Study Area is shown below:

Area by Geological Unit

Name of District	Area of Geological Unit (km^2)								Total
	Alluvium sand	Alluvium silt	Alluvium silt and clay	Chandina alluvium	Dihing & Dupi Tila undivided	Madhupur clay residuum	Marsh clay and peat	Young gravelly sand	
Jamalpur	63.09	1,768.68	194.71	27.55	-	-	4.84	12.76	2,064.63
Kishoreganj	-	380.01	676.30	8.23	-	-	1,446.07	-	2,510.60
Mymensingh	-	1,083.55	637.36	1,034.94	11.40	528.72	582.50	392.97	4,271.44
Netrokona	-	171.50	980.08	-	-	-	1,399.38	314.80	2,865.76
Sherpur	-	382.28	148.37	16.30	-	-	279.25	490.68	1,316.87
Tangail	32.28	976.15	1,159.48	11.56	-	1,002.22	265.32	-	3,447.01
Total Area	95.36	4,755.16	3,796.29	1,098.59	11.40	1,530.93	3,977.36	1,211.21	16,476.31
Share	0.6%	28.9%	23.0%	6.7%	0.1%	9.3%	24.1%	7.4%	100.0%

Source: DFID Study

3.2.2   Meteorology

(1) Climate

As shown in Table 3.2.1, there is only one BMD meteorological station in the Study Area, which is located in Mymensingh district. The monthly average data are summarized in the below table.

General Climate Data at BMD Mymensingh Station (ID 10609)

| Month	Total Rainfall (mm)	Total Evaporation (mm)	Temperature (°C)			Average Relative Humidity (%)
			Maximum	Mean	Minimum	
Jan	8	69	25	18	12	73
Feb	20	88	27	21	15	68
Mar	41	140	31	25	19	67
Apr	144	157	32	27	22	74
May	347	151	31	27	23	80
Jun	390	129	31	29	26	85
Jul	472	124	31	29	26	86
Aug	343	128	32	29	26	85
Sep	362	117	31	28	25	86
Oct	208	112	31	27	23	81
Nov	22	85	30	24	18	76
Dec	10	71	26	20	13	76
Annual	2,365	1,382	30	25	21	78
Period	1970 - 2003	1987 - 2002	1970 - 2002	1970 - 2002	1970 - 2002	1969 - 2001

Source: BMD daily data supplied by RDEC-JICA

(2) Rainfall

Location of rainfall stations and their annual mean rainfall is plotted in Fig. 3.2.2. The annual total rainfall, and rainfall by season (pre-monsoon, monsoon, post-monsoon and dry season) are summarized in Table 3.2.1. Maximum and minimum monthly total rainfalls are observed in July and January respectively. Among the stations, maximum and minimum annual total rainfalls are observed at Khaliajurii in Netrokona district (3,902 mm) and Kalihati in Tangail district (1,621 mm), respectively.

Table 3.2.2 presents annual total rainfall (1981 - 2002) by station in the Study Area. During the period from 1981 to 2002, maximum and minimum annual total rainfalls were observed in 1991 at Kendua in Netrokona district (5,949 mm) and in 1984 at Kalihati in Tangail district (803 mm) respectively.

Seasonal variation of rainfall by district are; maximum and minimum annual total rainfalls of 3,417 mm and 1,851 mm are observed in Netrokona and Tangail districts respectively. In terms of seasonal variation in the Study Areas, rainfall in monsoon season (Jun – Sep) is largest with the rate if 69.5%. Those of pre-monsoon (Apr - May), post monsoon (Oct - Nov) and dry season (Dec - Mar) are 20.0%, 8.0 % and 3.5%, respectively.
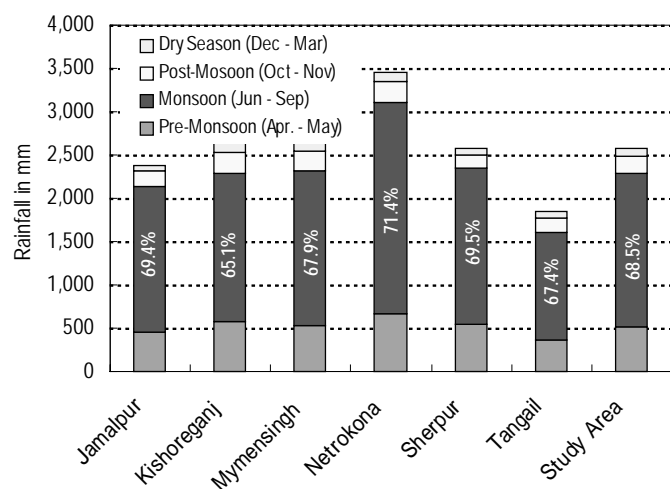
Seasonal Distribution of Average Rainfall by District

The figure on the right shows the variation in annual total rainfall (1981 – 2002) at BMD Mymensingh station. The highest and lowest rainfalls were observed in 1991 (3,312 mm) and 1976 (1,541 mm) respectively. A 5-point moving average trend line indicates that during the mid-1980s to mid-1990s, there was an increasing tendency in annual rainfall whereas in the last decade, the annual rainfall has a decreasing tendency.

Annual Rainfall Veriation
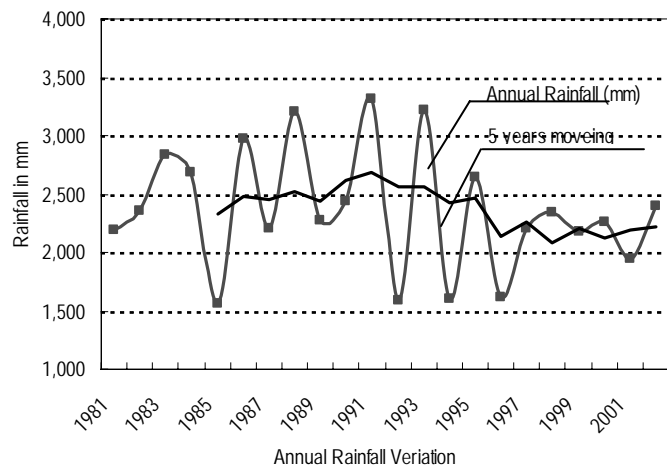
3.2.3 Hydrology and Water Resources

(1) River System in the Study Area

In the Study Area, there are around 250 rivers including the major river of Jamuna and the old Brahmaputra. River length in each district is summarized as follows:

River Length and Area in the Study Area

District Name	River Length by Width Range (Unit: km)					River Polygon Area (>>100m) (ha)
	Below 25m	25m - 50m	50m - 100m	Above 100m	Sub-Total	
Jamalpur	315.40	91.55	290.14	-	697.09	9,761
Kishoreganj	463.38	310.09	89.20	0.06	862.72	11,355
Mymensingh	642.73	851.14	268.52	12.77	1,775.15	3,548
Netrokona	771.21	835.61	170.69	1.14	1,778.65	2,300
Sherpur	179.87	220.11	83.85	-	483.82	594
Tangail	488.24	317.50	326.71	-	1,132.46	10,751
Total	2,860.82	2,626.00	1,229.12	13.97	6,729.90	38,309

Source: NWRDB (WARPO)

The river network diagram in the Study Area is summarized Fig. 3.2.3. As shown in the figure, tributaries are connected comprehensively and changing their names based on local names.

(2) Annual Water Levels

The annual average water levels at BWDB non-tidal stations are shown in Fig. 3.2.4. The data are summarized in Table 3.2.3. Water levels are high during the months of July-September and low during the months of March-May. During the period of 1981-2002, maximum water levels were observed in 1988 and then in 1998 whereas no specific year(s) could be identified in terms of lowest water levels.

There are 7 non-tidal and 3 tidal stations along the Old Brahmaputra River. Data has been collected at 4 non-tidal stations which are: 223 at Goal Kanda, 225 at Jamalpur, 227 at Offtake of Sutia and 228.5 at Mymensingh.

Annual Water Levels (1981 – 2002, m amswl)

Water level Station	St. 223 Goal Kanda	Sta. 225 Jamalpur	Sta. 227 Offtake Sutia	Sta. 228.5 Mymensingh
Maximum	23.64	17.81	14.88	13.70
Minimum	17.44	10.97	6.56	6.02
Difference	6.20	6.84	8.32	7.68

Source: NWRDB (WARPO)

(3) Surface Water Resources

Besides rivers and khals, another item of surface water resources is the perennial water bodies, which are shown in Fig.3.2.5. According to the NWRD compiled by WARPO, there are 2,802 perennial water bodies out of which 547 are beels. The remaining 2,255 are unnamed water bodies(ponds etc.). The total area of perennial water bodies is 21,921 ha, which covers 8.5% of the Study Area. In terms of number, Netrokona and Sherpur districts have the highest (813) and lowest (159) numbers of perennial water bodies. In terms of area,

Perennial Water Bodies in the Study Area

District		Perennial Water Body		
Name	Area (ha)	Number (nos.)	Area (ha)	(%)
Jamalpur	206,463	285	2,182	1.1
Kishoreganj	251,060	560	4,599	1.8
Mymensingh	427,144	635	4,943	1.2
Netrokona	286,576	813	5,380	1.9
Sherpur	131,687	159	2,415	1.8
Tangail	344,701	378	2,402	0.7
Total	1,647,631	2,830	21,921	1.3

Source: National Water Resources Database (WARPO)
Note: Actual number of water bodies in the Study Area is 2,802. However, due to sharing same water bodies by adjacent districts, total number of water bodies as shown in the above table is more than 2,802.

Netrokona and Tangail districts have the largest (5,380 ha) and smallest (2,402 ha) areas of perennial water bodies comprising 1.9% and 0.7% of the Study Area respectively. The overall inland surface water quality for domestic and agricultural use is said to be within tolerable limits, but in general, detailed data is yet to be collected.

(4) Ground Water Resources

The water-level fluctuation at a particular site reflect the situation of the aquifer, its proximity to major rivers and abstraction rates. In general, groundwater gradients over the country are low, typically between 1.0 m/km (1:1,000) in the north to as low as 0.01 m/km (1:100,000) in the south.

(5) Arsenic Contamination

Fig. 3.2.6 shows the situation of arseneic contamination in the Study Area extracted from the BGS-DPHE National Hydro-chemical Survey assisted by DFID. A total of 2,039 sites were sampled in 1998 Phase I survey, and 1495 in the 1999 Phase II survey, summing up to a total of 3,534 sites. Out of this, 496 samples fall within the Study area. The right table shows the types of wells surveyed in DFID Study. Out

Tubewell Surveyed by DIFID

Tubewell Depth (m)	No. of Tubewell	Shares
< 20	53	10.7%
20 – 35	106	21.4 %
35 – 70	207	41.7 %
70 – 100	109	22.0 %
100 – 150	19	3.8 %
> 100 m	2	0.4 %
Total	496	100 %

of the 496 wells, 326 were STW, 151 were Tara wells, 14 were DTW and the rest 5 were others.

The survey indicated that 1) there are no upazila with >80% of its tube wells contaminated with arsenic, 2) the west part of the Study area has high arsenic contamination whereas the east part has low arsenic contamination, 3) upazilas in Netrokona and Kishoreganj have the more severe arsenic contamination.

Upazilas with Arsenic Contamination

Rate of Contaminated wells		Nos of contaminated wells and name of Upazila
60 – 80 %	3	Dhobaura (Mymensingh), Kalmakanda and Madan (Netrokona)
40 – 60 %	4	Mohanganji and Khaliajuri (Netrokona), Kishoreganj Sadar and Bajitpur (Kishoreganj)
20 – 40 %	9	6 upazilas in Kishoreganj, one each in Mymensingh, Sherpur and Tangail
5 – 20 %	22	-
Less than 5%	20	-

3.2.4 Floods

(1) Hydrograph of previous Floods

Hydrographs of the several floods at Mymensingh and Jamalpur gauging stations along the old Bhramaputra river are shown as follows:
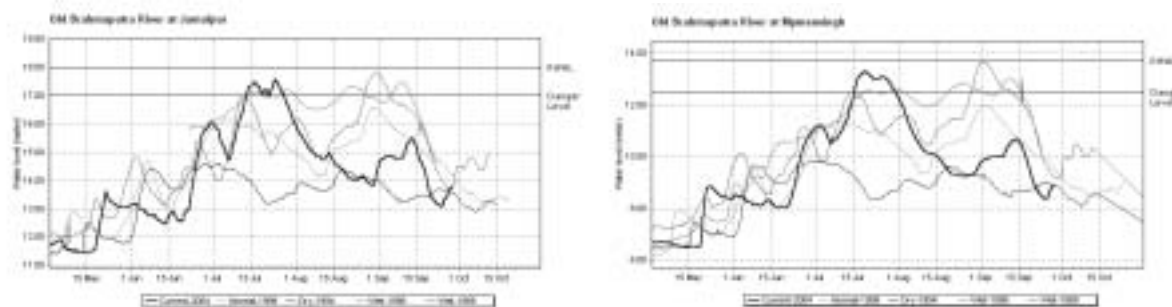
These hydrographs show the Flood in 1988 was the most severe flood as for the peak water level. However, the flood in 1998 had the longest inundation period and caused more serious damage to aman rice cultivation. Also the flood in 2004 during the Phase 1 survey of the Study, is the 2nd largest flood on its peak water level

(2) Inundation Land Types Classification

Inundation land classification prepared by BARC/UNDP/FAO in 1995 is shown in Fig. 3.2.7. The classified areas in the Study Area is summarized in the following table.

Inundation Land Type				Area of Inundation Land Type (km^2)						Total	
Code	Description	Flood Depth (m)	Suitability to Rice Cultivation	Jamalpur	Kishoreganj	Mymensingh	Netrokona	Sherpur	Tangail	Area (km^2)	%
F0	High Land	0.00-0.30	HYV rice in wet season	229.87	5.66	983.78	450.45	401.73	1,051.78	3,123.28	19
F1	Medium High Land	0.30-0.90	Local varieties of Aus and T.	1,674.16	713.20	3,186.28	1,576.27	828.20	2,047.44	10,025.56	61
F2	Medium Low Land	0.90-1.80	B. Aman in wet season	-	227.40	-	-	-	215.31	442.72	3
F3	Low Land	1.80-3.00	B. Aman can be grown	-	1,434.75	51.16	816.63	80.52	-	2,383.05	14
F4	Very Low Land	>3.00	B. Aman can't be grown	-	-	-	-	-	-	-	-
No Data				160.60	129.58	50.22	22.41	6.42	132.47	501.69	3
Total Area				2,064.63	2,510.60	4,271.44	2,865.76	1,316.87	3,447.01	16,476.31	100

Source: National Water Resources Database (WARPO)

3.3 Socioeconomic Conditions

3.3.1 Population

The two recent population censuses were carried out in 1991 and 2001. The population in the Study Area is estimated at 15,492 thousand in 2001, showing an increased by 10.5% since 1991 census. The rate of population increase is lower than that of the national population (15.96%), indicating that the population in the Study Area has been shifting to large cities such as Dhaka.

Population of the Study Area

District	Area(km^2)	Census 1991 (000s)		Census 2001 (000s)		
		household	Population	household	Population	increase
Bangladesh	147,570	19,398	111,455	25,362	129,247	15.96%
Jamalpur	2,032	380	1,874	481	2,089	11.5%
Kishoreganj	2,689	421	2,308	528	2,525	9.4%
Mymensingh	4,363	764	3,958	965	4,439	12.2%
Netrokona	2,810	327	1,732	406	1,938	11.9%
Sherpur	1,364	234	1,139	297	1,247	9.4%
Tangail	3,414	571	3,003	727	3,254	8.4%
Study Area	16,672	2,697	14,014	3,404	15,492	10.5%

Sources: Statistic Yearbook of Bangladesh 2001 and BBS homepage

3.3.2 Regional Economy

(1) District Gross Domestic Products (DGDP)

DGDP by industry is shown in Table 3.3.1. The DGDP per capita show smaller amounts than the national GDP per capita, which is US$ 363 or Tk. 18,269 (1999/2000, current cost). This indicates that the Study Area is one of the under developing regions in Bangladesh.
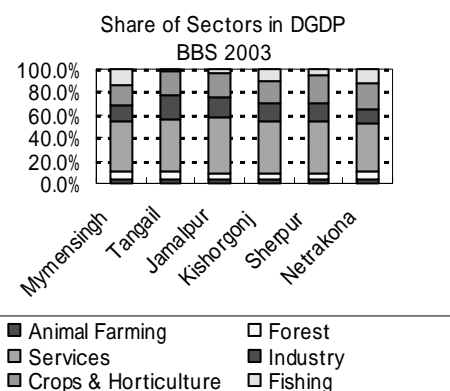
Comparison of DGDP and National GDP

District	Regional GDP 1999/2000	Share of District	Regional GDP per capita		Growth rate for year average	Rank based on per capita
			In Tk.	In US$		
Bangladesh	2,370,740	100%	18,269	363	5.36	(Total 64)
Jamalpur	31,429	1.3%	13,834	275	5.97	50
Kishoreganj	38,266	1.6%	13,903	276	4.96	43
Mymensingh	73,117	3.1%	15,430	307	5.58	33
Netorokona	32,020	1.4%	15,410	306	4.99	30
Sherpur	18,842	0.8%	13,748	273	5.61	55
Tangail	47,986	2.0%	13,297	264	4.81	56
Project Area	241,660	10.19%	14,270	284		

Sources: Statistic Yearbook of Bangladesh 2001

(2) Major Industrial Sectors in District GDP

As shown in the figure on the right, the major industrial sector in the Study Area is services, covering more than 40%. This is followed by agriculture and fisheries covering 30 to 43% respectively, and then by industry. Among the agriculture and fisheries sector, crop and horticulture occupy the major portion. Fisheries sector comes to the second in Mymensingh, Kishorganj and Netrokona districts, especially fisheries sector in Mymensingh district covers more than 13% of the DGDP. Industry in Tangail district shows the largest share of within the district GDP (21%).

Share of Sectors in DGDP BBS 2003

■ Animal Farming   □ Forest
□ Services   ■ Industry
□ Crops & Horticulture   □ Fishing

3.3.3 Social Infrastructure

(1) Utilities

There are 5,839 roads installed in with the total length of 32,276 km (1998). Out of this, 86% are categorized a kutcha (earthen) roads. Most of them are submerged during the monsoon season and are damaged during this period. Also a rail road line (line 29) operated by Bangladesh Railway runs through the Study Area. Most of this line is also submerged intercepted during the monsoon season. Inland navigation mainly takes place in the Jamuna, old Brahmaputra and the haor areas in the eastern part of the Study Area.

According to the Local Road Inventory List of 2004 prepared by LGED, the total length of local roads in the Study Area is 29,293km, with the density of 1.78 km/km^2. Local road density is the highest in Mymensingh with 2.16 km/km^2, and in lowest in Netrokona with 1.48 km/km^2.

(2) Social Facilities

There are 1,358 hat bazaars, 40 flood centers, and 443 community centers in the Study Area. As religious facilities, there are 17,413 mosques, 1,542 mandirs, 128 churches, and 2 pagodas.

(3) Educational institutions

There are 19,478 educational institutes from primary to high education; 1/3 of them are primary schools, while 2 are universities. Teachers and students were estimated as 80,650 and 3,360,688, respectively.

(4) Health facilities

There are 994 doctors together with 2,300 nurses/health assistances deployed at health care facilities from primary healthcare to hospitals. Also, a total of 4,024 beds are installed in these healthcare facilities in the Study Area.

3.4 Agriculture, Fisheries and Livestock

3.4.1 Agriculture

(1) General Condition of Agriculture

1) Agroecological Region and Land Type

The Study Area is divided into 11 agroecological zones (AEZ); their distribution is shown in Fig. 3.9.1. Inundation land type of the Study Area is shown in Fig. 3.2.7. Land type of the majority of the Study Area is medium Highland (61%), which is suitable for the production of rice and other upland crops through double cropping. The northern area and mid-southern area fall in highland (19% of the total study area). The eastern portion of the Study Area is medium lowland (3%) and lowland (14%), which forms haors covering large areas of Kishoreganj and southern Netrakona. The haors are deeply flooded during the monsoon season. In such areas, farmlands are cropped after the flood water recedes from the vast inundation areas, and single cropping is practiced.

Distribution and Share of Agroecological Zone in the Study Area (%)

Agroecological Zone	Jamalpur	Kishoreganj	Mymensingh	Netrakona	Sherpur	Tangail	Study Area
Active Brahmaputra-Jamuna	14.6%					7.6%	3.3%
Young Brahmaputra and Jamuna	47.5%	29.5%	18.3%	0.1%	6.5%	42.6%	24.1%
Old Brahmaputra Floodplain	32.7%	18.2%	54.3%	53.2%	41.3%	17.7%	37.6%
Middle Meghna River Floodplain		4.6%					0.7%
Old Meghna Estuarine Floodplain		17.4%					2.6%
Sylhet Basin		30.1%		24.4%			8.7%
North-western Plains and Basins	1.6%		5.1%	5.7%	35.5%		5.8%
Northern and Eastern Piedmont			4.3%	15.3%	0.1%		3.8%
Northern and Eastern Basins			1.2%	0.8%	5.7%		1.0%
Madhupur Tract	2.6%	0.2%	16.7%			32.0%	11.2%
Northern and Eastern Hills	0.9%		0.0%	0.6%	11.0%		1.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: National Water Resources Database (WARPO)

Drought prone areas in the Study Area are shown in the figure on the right. During the rainy season (Kharif-II), western parts of the Study Area tend to be slightly drought prone, while the highland areas are moderately prone. The land conditions of the Study Area are generally mild as compared with other areas of the country. In flood prone areas, farmers mainly keep their lands in fallow condition or wait until water recedes. The situation is reflected in the fact that single cropping is dominant in the lowland area in winter (*boro*) in eastern parts of the region. In such areas, farmers are more concerned for irrigation during the drying seasons.

Drought Prone Area

2) Soil type

There are 5 major soil types in the Study Area: 1) Non acid soils (Black, Dark, Grey and Brown), 2) Brown acid soils, 3) Noncalcareous alluvial soils, 4) Grey and grey dark non-saline soils and 5) Grey dark acid soils. Most of the area is covered by non acid soils (Black, Dark, Grey and Brown). Brown acid soil is distributed in the highlands and in small parts of the northern area. Non-calcareous alluvial soils are formed along the Jamuna River. Soil reaction in terms of acidity is not extreme and majority of the area is suitable for agricultural production.

For soil physical characteristics, the inundation land types are closely related to the soil classification: High Lands with silt loam, Medium Highlands with clay loam, Medium Lowlands with silty clay, Lowlands with clay and Very Lowlands with heavy clay.

3) Farm House Holdings

Total number of house holdings in the study area is approximately 2.1 million (1996). Among them, 35.4% are non-farm house holdings, while the remaining 64.6% are farm holdings. The distribution of farm households in the Study Area is shown in the following.

Farm House Holdings in the Study Area (%)

	District	All holdings	Non-farm house holds	Farm holdings	Farm holdings (Acre /holding)					Medium	Large
					Small					2.50-7.49	>7.50
					0.05-0.49	0.50-0.99	1.00-1.49	1.50-2.49	*Total*		
1	Jamalpur	380,336	37.3	62.7	16.7	15.0	10.3	10.2	*52.2*	9.6	1.0
2	Kishoreganj	417,186	39.3	60.7	16.4	13.6	9.9	9.3	*49.2*	9.6	1.8
3	Mymensingh	776,727	33.3	66.7	16.9	15.1	11.1	11.3	*54.4*	11.1	1.2
4	Netrakona	337,079	37.4	62.6	13.1	11.4	9.6	11.2	*45.3*	14.4	2.9
5	Sherpur	235,000	34.8	65.2	17.2	14.8	9.8	10.5	*52.3*	11.3	1.5
6	Tangail	561,241	30.1	69.9	19.5	16.7	11	11.6	*58.8*	10.2	1.0
	Total/ Average	2,707,572	35.4	64.6	16.6	14.4	10.3	10.7	*52.0*	11.0	1.6

Source: Census of Agriculture - 1996 (BBS)

Out of the total land holdings, 52.0% belonged to the small farm holdings with an area of less than 1 ha. Medium and the large farm holdings were 11.0% and 1.6% respectively. The farm holdings are dominated by small farm holdings, with the rate of 84.1%. Comparison of the 1983/84 of holdings with those of 1996 shows that non-farm holdings have significantly increased by the rate of 1.70 times during this period. The farm holdings also increased, but with a rate of 1.23 times, which is much smaller than the non-farm holdings. While small farm holdings increased by 1.42 times, medium and large farm holdings decreased by 0.82, and 0.62 times respectively.

By District, Kishoreganj has a relatively low percentage farm holdings, with the rate of 60.7%. Netrakona also has small percentage of small farm holdings. Though the level of the changes were different, all the districts in the Study Area showed the same tendency; Land area of farm holdings are decreasing, which induces vulnerable food supply conditions for households with small farm holdings.

An estimation of number of farm house holdings to secure the minimum level of rice-sufficiency is shown in the following.

Preposition: Requirements of grains per day per capita   454 g/day/person
Number of family of farm house   6 people
Yield of rice in milled rice   2.34 t/ha
Grain supply   All milled rice
Crop intensity   1.77
(454g/1000 x 365 days x 6 persons x) / 2.34 t/ha / 1.77 = 0.6 acre
% of small farm holdings less than 0.6 acre = 27.9% + (23.9% x 10/50) = 32.7%

Based on this estimation, one third of the farm holdings in the Study Area are it capable of obtain minimum amount of food grains from their own fields.

(2) Production Characteristics

1) Cropped area by major crops

Area, Production and Yield of major crops in the Study Area are shown in Table 3.4.1. Rice is the dominant crop in the Study Area, covering 77.3% of the crop in the Study Area. The rate of rice indicated the highest percentage in every district. Both Aman and Boro is cultivated in more than 30% of the area. However, the cultivation of Aus is as low as 12.9%. Following rice, wheat, jute, oil seeds, and maize were cultivated in 4-5% of the area. Distribution of rice in the Study Area is shown the following table.

Distribution of Rice in the Study Area

District	Gross Cropped area (Acre)	Aus			Aman			Boro			Rice
		Total %	Local %	HYV %	Total %	Local %	HYV %	Total %	Local %	HYV %	Total %
Jamalpur	592,689	6	83	17	32	48	52	28	16	84	66
Kishoreganj	570,559	10	63	37	20	43	57	49	29	71	80
Mymensingh	1,322,188	22	68	32	39	58	42	25	24	76	85
Netrakona	660,622	14	71	29	36	60	40	39	26	74	88
Sherpur	409,148	16	83	17	41	65	35	29	30	70	85
Tangail	828,577	10	93	7	26	61	39	30	15	85	65
Average	-	13	75	25	32	57	43	33	24	76	78
(2003-04)	-	-	38	62	-	41	59	-	5	95	-

Source: Census of Agriculture - 1996 (BBS)

Cropping patterns are decided based on water availability. Though differing by area, Boro (December – May) – Fallow (May – July) - T. Aman (August – November) is the typical cropping pattern. Most of the area is cropped 2 times per year. The current cropping intensity is 1.77 (2001).

The major farming style in the Study Area is rice based farming including rice and upland crops. By District, the highest percent of Boro cultivation is observed in Kishoreganj, while also indicating the lowest in Aman due to its water conditions. The area under rice cultivation is low in Jamalpur, while the district has the largest share of wheat, spices and jute cultivation among the districts. The area under sugarcane cultivation is high, owing to the sugar processing company in the district. The gross area under cultivation and the percentage of crop distribution in the Study Area is shown below.

Distribution of Crops in the Study Area (%)

District	Gross Cropped Area (1,000 acre)	Aus	Aman	Boro	Rice	Wheat/maize	Potato	Vegetables	Spices	Pulses	Oil Seeds	Jute	Sugar Cane
Jamalpur	593	6.4	31.6	27.4	65.3	7.8	1.5	1.4	5.1	1.1	6.8	8.9	1.7
Kishoreganj	571	9.7	19.2	48.1	77.1	4.1	2.1	1.2	2.6	1.4	4.3	5.5	0.1
Mymensingh	1,322	22.2	39.2	25.0	86.4	3.3	1.1	1.1	1.9	1.3	1.6	2.0	0.0
Netrakona	661	13.3	33.6	36.4	83.3	1.7	0.9	0.7	1.5	0.5	2.6	8.0	1.2
Sherpur	409	16.0	40.6	29.0	85.7	3.3	1.6	1.7	2.2	0.4	2.6	2.9	0.2
Tangail	829	9.7	26.2	29.9	65.7	5.0	1.3	1.4	1.7	2.8	14.5	6.0	1.4
Average		12.9	31.7	32.6	77.3	4.2	1.4	1.2	2.5	1.3	5.4	5.5	0.8

Source: Census of Agriculture - 1996 (BBS)

2) Varieties improvement

High Yield Varieties (HYVs) is a low-cost and cost-effective input for crop production. The advateges of HYVs in crop cultivation covers a wide variety such as high yielding, short-duration due to low photo-sensitive, resistant to lodging and high fertilizer effectiveness. HYVs have been widely cropped in all over the country, with the ratio of HYV rapidly increasing in the past decade (1996 - 2003/04): from 76% to 95% for Boro, from 43% to 59% for Aman and from 25% to 62%for Aus.

(3) Economic Factors

1) Value added of major crops

By District, the rated of value added to crop production are high in Jamalpur and Tangail, while those of Kishoreganj and Mymensingh are low. In animal farming, Tangail showed the highest share. Kishoreganj, Mymensingh and Netrakona indicated high percentages in fisheries. In regard to the change in the past 5 years, the value added to crop production increased by 27.3% on average. Spices showed the highest increase, while potatoes, Boro and vegetables also increased rapidly. Aman, Aus and jute showed a slight increas. Fruits, oil seeds, pulses and sugar cane decreased. Commercial edible oil is produced from imported oil seeds such as soybeans, and hence needs of domestic oil seeds have decreased. Long crop growth duration of sugarcane (About 13 months) causes lower profitability as compared with other crops. The major cash crops of Bangladesh are jute, sunhemp, cotton, sugarcane, etc. The decrease of value added in cash crops is one of the serious factors in stagnation of farmers' cash income.

Gross value-added of agriculture by District at constant Prices(2000/01)

(Unit: million Taka)

District	Crops	Animal farming	Forestry	Fishing	Total
Jamalpur	5,901	1,078	669	846	8,494
Kishoreganj	5,349	1,171	828	3,458	11,806
Mymensingh	12,183	2,478	1,567	8,667	24,895
Netrakona	6,584	1,154	894	3,255	11,887
Sherpur	3,746	642	443	752	5,583
Tangail	7,877	1,818	1,105	854	11,654
Dhaka Division	71,696	15,048	9,804	27,090	123,638
Bangladesh	287,664	59,470	36,996	120,020	504,150
<Share in Agriculture>					
Jamalpur	69.5	12.7	7.9	10.0	100.0
Kishoreganj	45.3	9.9	7.0	29.3	100.0
Mymensingh	48.9	10.0	6.3	34.8	100.0
Netrakona	55.4	9.7	7.5	27.4	100.0
Sherpur	67.1	11.5	7.9	13.5	100.0
Tangail	67.6	15.6	9.5	7.3	100.0
Average	59.0	11.6	7.7	20.4	100.0
Dhaka Division	58.0	12.2	7.9	21.9	100.0
Bangladesh	57.1	11.8	7.3	23.8	100.0

Source: Statistical Yearbook of Bangladesh (2001)

2) Marketing and Price of agricultural products.

Rural markets have various functions: obtaining of daily goods, exchange of agricultural products to cash, wholesale function to large cities such as Dhaka, collection and distribution function to large users (rice millers, livestock farmers), etc. The development of marketing is crucially important to effectively cope with the issues of poverty and low cash income. Several approaches are required for the improvement of marketing capacity: development of transportation, market information services and improvement of market infrastructure in all the areas of agriculture.

One of the major obstructions for marketing development is the poor road conditions of the Study Area. Major methods are based on human power such as rickshaw, vans and boats. In Kishoreganj and Netrakona, boats are used as major method of transportation. In Tangail, there is a high percentage of use of rickshaw, vans and bicycles.

Cottage Industry Rural Transport Facilities in the Study Area

(Units: 1,000 Farm holdings)

District	Cottage Industry	Rural Transport	Tractor	Power Tiller	Boat	Rickshaw	Rickshaw Van	Bicycle
Jamalpur	35.6	129.3	3.7	3.7	13.1	12.2	9.0	95.4
Kishoreganj	31.8	140.8	3.9	5.4	39.9	14.6	6.7	76.7
Mymensingh	23.8	104.7	4.3	3.8	8.0	17.8	10.9	69.4
Netrakona	33.0	101.9	3.9	4.8	50.4	10.2	3.5	40.5
Sherpur	30.8	124.9	5.1	3.4	9.0	20.9	15.5	81.8
Tangail	38.6	155.3	4.6	3.6	29.2	6.3	19.2	106.1
Average	32.3	126.1	4.2	4.1	24.9	13.7	10.8	78.3

Source: Census of Agriculture - 1996 (BBS)

3.4.2 Fisheries

(1) Production of Fishery in Greater Mymensingh Area

Inland water fisheries of Bangladesh are divided into two types. One is open-water (river & estuary, lake, flood land, etc.), and the other is close-water (pond & ditch, Baor, shrimp or freshwater shrimp and fish farm). In the rainy season, people in rural areas catch fish in the floodplain, public canal, river etc. In addition, backyard pond culture using the hole that has been dug when soil is taken for the construction of house, road etc., becomes active every year. Freshwater fish is an important source of protein, accounting for around 60% of the total animal protein intake. Moreover, freshwater fish, both caught in public water and cultured, is also an important source of cash income. The proportions of the fishery industry in DGDP of the Study Area are; 14 % in Netrokona, 11.8% in Netrokona, 10.5 % Kishoreganj, 4.7% in Sherpur and 3.1% in Jamalpur district. Annual fisheries production from inland waters, total catch is largest in Mymensingh District. The second is Kishoreganj District, followed by Netrakona District. Since Mymensingh District is the center of Greater Mymensingh, and the Faculty of Fisheries of Bangladesh Agriculture University as well as Bangladesh Fisheries Research Institute are situated, the fisheries activities are more active than in other districts.

Total Catch of Inland Water, 2002

(Unit: MT)

No.	District	River	Beel	Flood land	Pond	Shrimp farm	Total
1	Mymensingh	2,607	5,332	25,270	23,314		56,523
2	Kishoreganji	1,284	5,584	19,191	9,237	15.82	35,312
3	Netrakona	1,344	8,013	8,867	15,682		33,906
4	Tangail	1,032	1,456	9,341	5,605		17,434
5	Jamalpur	755	2,287	6,746	3,241		13,029
6	Sherpur	85	2,330	3,830	2,486		8,731
	Total	7,107	25,002	73,245	59,565	15.82	164,935

Source, Fisheries Statistical Yearbook of Bangladesh (2002), Department of Fisheries

Kishoreganj District and Netrakona District are most productive in Beel fisheries. So far, it is not known whether the high productivity in those two districts is due to abundance of fisheries resources or intensive fishing effort.

Area and fisheries production of Beels, 2002

District	Area of Beels(ha)	Total Catch(MT)	Catch(kg)/ha
Jamalpur	3,360	2,287	680.7
Kishoreganji	6,837	5,584	816.7
Mymensingh	7,346	5,332	725.8
Netrakona	8,355	8,013	959.1
Sherpur	3,508	2,330	664.2
Tangail	2,333	1,456	624.1
Total	31,739	25,002	4,470.6

Source, Fisheries Statistical Yearbook of Bangladesh (2002), Department of Fisheries

The household of subsistence fisheries in the Study Area is estimated at 70% in average. These subsistence fisheries households are not only engaged in fisheries activities but also engaged in other economic activities. Data indicate that many households in Study Area depend heavily on fisheries resources.

Number of subsistence fisheries households and its catch, 2002

District	Total number of households[*]	No. of subsistence fisheries households	Ratio of subsistence fisheries households (　)	Average Catch per household (Kg)	Estimated total catch (MT)
Jamalpur	481,152	409,000	85.0	16.50	6,746
Kishoreganji	726,561	343,000	47.2	37.80	12,973
Mymensingh	965,123	656,000	68.0	38.51	25,270
Netrakona	406,153	325,000	80.0	27.30	8,867
Sherpur	296,535	238,000	80.3	16.12	3,830
Tangail	528,323	407,000	77.0	17.84	7,263
Total	3,403,847	2,378,000	70.0	27.31	64,949

[*]: 2001 Statistical Year Book of Bangladesh
Source: Fisheries Statistical Yearbook of Bangladesh (2002), Department of Fisheries

(2) Netrokona District

In 2002, the total annual catch of fish recovered from the lowest level recorded in 2000 to the level in 1998. However, the catch from flood land is still at a very low level compared to that of 1998. Production from ponds (by fish culture) gradually increased. Catch from the river drastically decreased from 1999 to 2001, but recovered in 2002 to the level of 1/3 of the catch in 1998. Since, the haor area covers the eastern part of Netrakona District, its floodplain is wide and capture fisheries are active. The number of subsistence fisheries households increased in 2002. The average catch per household in 2000 dropped to about 1/3 of that in 1998.

(3) Kishorganj District

The eastern part of Kishorganj District consists of haor. Though the vast areas deeply inundated during the monsoon season is an ideal habitat for fish, the catch from rivers dropped in 2002 to 1/10 of the level in 1998. The production from shrimp farms has been increasing year by year. The ratio of fishery sector in DGDP is high (10.5%) in the district. While the ratio of subsistence fisheries household in the district is lower than other districts, average catch per household is high (37 kg).

(4) Mymensingh District

The Old Brahmaputra River flows through the center of Mymensingh District. In the rainy season, both sides of the river are inundated and create a large floodplain. The damage caused by the flood is not so serious because infrastructures are more advanced in the district than in other districts. As shown in Table 3.4.2, the catch from Beel in 2002 shows a drastic decrease. This is due to the change in the statistical system made in 2002. Previously, catches from Beel in other districts excluding that in Tangail District had been indicated as the catch for the whole Mymensingh area, but from 2002 they have been indicated separately by each district. The production from the ponds slightly dropped in 1999 due to damage caused by the deluge in 1998. However, it quickly recovered and by 2002, the catch recorded a higher level than that in 1998. The catch from the flood lands tended to decrease. The number of subsistence fisheries households increased in 2002, while the average catch tended to decrease.

(5) Tangail District

The Jamuna River flows along the western border of Tangail District, and causes flood damage every year. The general tendency of fisheries production is increasing every year, except for some decrease in the catch from the flood land recorded in 2001 (Table 3.4.2). The

fishery industry in this district seems not to be very active as it accounts for only 2 % of GDP. However, there are seven private hatcheries producing about 5,000 kg hatching/fry per year, along with about 360 nurseries. As shown in Table 3.4.2, it is likely to become over-fishing if catch increases any further.

(6)　Jamalpur District

Jamalpur District is situated in the area between two rivers, namely, the Jamuna to the west and the Old Brahmaputra to the east. Fish culture activities in the district suffer from flood damages every year. The total fisheries production in the district is low (5th among six districts), even though the ratio of subsistence fisheries households is the highest (85%). According to district fisheries officials, the present demand on fish fry can not be covered by production in the district, and the demand on fish fry is increasing. As shown in table 3.4.2, the average catch per household increased by 8 kg from 2000 to 2001, while the number of subsistence fisheries households did not change.

(7)　Sherpur District

The total production in this district is lowest among the six districts, and the ratio of fisheries industry production to DGDP is low (4.7%). In contrast, the ratio of subsistence fisheries households is high (80.03% which is second highest among six districts). As shown in Table 3.4.2, the catch from the flood lands rapidly decreased until 2002 to the level of almost half of the level in 1998. Due to difficult for obtaining fish fry in the District, fish culture farmers purchase them from Mymensingh District. The demand on fish fry by farmers is increasing. The total catch also tended to decrease year by year, while there was no change in the number of subsistence fisheries households from 1989 to 2001. The number of subsistence fisheries households increased in 2002, indicating the increase of population depending on fisheries.

3.4.3　Livestock

(1) Current Situation

Climatic and topographic conditions, especially the high temperature / humidity and frequent flooding, are not suitable to domestic animals. Pasture lands are not abundantly available for cattle and goats. Recent water shortages and development of agricultural machinery have caused unfavorable conditions to water buffalos. Due to the low feed efficiency, it has been difficult to enhance livestock farming in Bangladesh. From such reasons, livestock farming has not been attached with priority in the past. However, future development of livestock is necessary as an important income source of farmers and to improve the nutrition of the rural population. Livestock can be a demand-driven product. As the national economy develops, consumption of livestock will be increased.

(2) Production

The present conditions of livestock in the Study Area are summarized as flows.

　1)　The numbers of cattle, goats and fowls are 2.526 million, 1.351 million and 10.346 million heads, respectively (1996). In terms of the number of heads, cattle are the major animal in the Study Area. Due to the large size of the land area, Mymensingh District has the largest number in all the animals among the 6 districts.

　2)　Non-farm holdings shared substantial parts in livestock and poultry in 1996. For cattle the share was small. In farm holdings, the small farmers shared about 58%. In

comparison with the data of 1983-84, the share of the non-farm holdings and small farm house holdings increased, while he share of large farm holdings decreased.

3) The rates of households raising animals are generally high. This indicates that farming is closely related with animal husbandry, and recycling and scavenging of livestock are well functioning. Cattle were raised by 41.6% of all holdings in 1996. Some 88% of the large farmers reared cattle. There was no significant difference among the districts. For goat raising, the tendency is similar to cattle, but the ratio was generally lower. Farmers in Netrakona and Mymensingh had higher percentages in goat raising. 69.3% of the total holdings raised fowls. In Netrakona, the ratio was lower than other Districts.

4) The numbers of animals per farm holdings are 1.50 heads of cattle, 0.56 heads of goats 5.04 heads of fowls and 1.43 heads of ducks (1996). Though not significantly, the number of 1996 generally decreased from 1983/84. The number decreased in the large size of holdings.

5) Difference in the number by district was not large in cattle. However, for goats, Mymensingh showed a high value. Tangail showed the highest value in fowls. For ducks, Netrakona and Kishoreganj had high values. The high water level during rainy seasons is suitable for water animals and brings about high value. In the scavenging livestock, farming area of the farm lands has large effects on number of animals. Comparison of the 1996 data with 1983/84 does not indicate a large difference. The data shows that the farming system does not change largely in a decade.

Number of livestock in the Study Area

Number in 1000s

Districts	1983-1984						1996					
	Holdings		Farm Holdings				Holdings		Farm Holdings			
	All	Non-farm	Total	Small	Medium	Large	All	Non-farm	Total	Small	Medium	Large
Cattle												
Jamalpur	375	15	360	155	155	51	367	25	342	224	101	17
Kishoreganj	452	17	435	212	154	69	398	29	369	222	108	40
Mymensingh	835	30	805	355	355	95	833	53	780	488	247	45
Netrakona	57	2	55	20	27	9	57	3	54	30	20	5
Sherpur	219	7	212	83	98	31	233	14	220	128	74	18
Tangail	723	20	703	327	301	75	638	33	604	402	175	28
Total	2,661	91	2,570	1,151	1,089	329	2,526	156	2,370	1,493	724	152
Goats												
Jamalpur	324	52	272	157	90	25	180	42	138	104	30	4
Kishoreganj	207	31	176	121	43	12	167	38	128	102	22	4
Mymensingh	539	65	474	265	170	39	528	95	433	313	103	16
Netrakona	27	4	23	12	9	2	25	4	21	14	6	1
Sherpur	141	23	118	68	41	10	143	29	114	81	27	5
Tangail	449	47	402	233	136	33	309	52	256	190	56	10
Total	1,687	221	1,465	855	489	122	1,351	260	1,091	805	244	42
Fowls												
Jamalpur	1,218	195	1,023	570	354	100	1,517	333	1,184	881	262	41
Kishoreganj	1,658	253	1,405	882	393	130	1,742	419	1,324	973	282	68
Mymensingh	2,588	322	2,266	1,260	829	177	3,360	620	2,740	1,981	657	102
Netrakona	160	18	142	68	58	16	185	31	154	102	43	9
Sherpur	730	115	615	334	224	56	909	179	730	507	187	37
Tangail	1,734	192	1,543	933	506	104	2,632	488	2,180	1,643	465	72
Total	8,087	1,094	6,993	4,047	2,363	583	10,346	2,070	8,311	6,088	1,896	328

Source: Census of Agriculture - 1996 (BBS)

* In 1983-84, Cattle includes Cattle and Buffaloes, Goat includes Goats and Sheep, Fowl includes Fowls and Ducks.

(3) Feed Supply

Land limitation causes a shortage of feed supply in Bangladesh. As observed in Kishoreganj, large haors effect on feed supply in rainy seasons. In dry seasons, competitions between animal feeds and vegetables are also severe. Various chars along large rivers such as the

Jamuna River and the Old Brahmaputra River are expected to be good pasturing areas. For that purpose, the water management of the rivers is important.

(4) Animal Health

In Bangladesh, veterinary services are key issues for the development of livestock farming. According to the officers in Ministry of Livestock and Fisheries, veterinary services in the Greater Mymensingh are not much different among the districts. Vaccination to poultry is already well organized. However, vaccination services to cattle and ducks are not well managed.

(5) Possible Approaches to Develop the Livestock Farming

1) Use limited farm land efficiently by livestock and poultry. Landless and small farmers can have a chance to manage livestock farming efficiently
2) Extend feed efficient animals such as goats and poultry
3) Develop veterinary services to specific areas and animals
4) Develop grazing and pasturing areas along the Jamuna, Old Brahmaputra, etc.
5) Explore various promising aqua-animals to develop, such as ducks, water-buffalos, geese and reptiles (Ex. alligator growing in Mymensingh)
6) Develop and extend scientific technology in livestock farming to livestock holders

3.5 Union Questionnaire and Farm Household Interview Survey

Information of farmers and Unions is crucially important for the baseline data of the SSWRD. However, current data in the Study Area is insufficient in understanding the rural area having a wide variation in natural and socio-economic conditions. Questionnaire survey to Union, interview survey to upazila officers / Union Chairmen and interview survey to farmers were conducted to understand the current situation and to obtain the baseline data for the Study and sub-projects.

3.5.1 Union Questionnaire and Interview Survey

(1) Union Questionnaire Survey

Unions are positioned at the front line of the LGIs, shouldering the development of agriculture and rural welfare. Unions are the most appropriate organization for the collection of necessary information on current situations of agricultural production, problems farmers now face, possible countermeasures, and so on. The Union Questionnaire Survey was conducted to collect and analyze baseline data for SSWRD. The fundamental ideas on the existing situation and future development of water resources, agricultural and rural development, which Union Chairpersons have in their minds as a leader of grass-root level at a turning point of agricultural development, were focused in the survey.

(2) Procedure of Union Questionnaire Survey

Questionnaires were drafted by the JICA survey team in cooperation with counterparts of LGED. The drafts were preliminary tested by the cooperation with Unions of Mirzapur, Tangail by the member of Study Team. Later on the revised drafts were discussed by Upazila Engineers and Socio-economists at each District Work Shops, and were finalized. The

questionnaires were sent to Upazila Engineers by mail and requested to distribute them to the Union Chairpersons in September, 2004. The answer of questionnaires were collected through the Upazila Engineers by February 2005

(3) Contents of the Questionnaires

The questionnaire consists with the following three categories:

1) Outline of Union (location, population, Social infrastructure),
2) Farming conditions (conditions of agriculture, fisheries, livestock, and future development)
3) Water resources (water related problems, waterbodies, usages, and future development)

(4) Major Results of Questionnaire Survey

1) Current farming system

   i. The most common type (dominant) was Boro (Dec.- Feb.) ~ T/B Aman (July-Nov.). This type had a share of 60% in cropped area.   Boro and Aman are staple food, and a major source of cash income.

   ii. Another cropping pattern is wheat (Dec.-Mar.) ~ jute (May-Sept.) ~ vegetable (Nov.-Feb.) with about 30% of the share.

   iii. The third cropping type was Vegetables (Oct.-Dec.) ~ Fallow ~ Vegetables (Oct. – Dec.) with 10% of the share.

   iv. Based on the Boro-farrow-Aman system, there are many modified cropping patterns in views to profitable farming, adaptable to the Agro-ecological zones, and integrated farming systems with livestock and fisheries

2) Constraints of agricultural development

   i. Flood damage was regarded as the most serious constraints in almost all of the Unions

   ii. This was followed by diversification of agriculture (including crop, livestock and fisheries).and mechanization. These agricultural practices will be supported by well managed water use conditions.

   iii. Constraints of availability of irrigation water were also ranked as high importance.

   iv. It is estimated that improvement of breed, limitation of land holding, agricultural extension and insufficiency of agricultural inputs were more or less worked out by various projects, and hence they were regarded as " Low importance".

Constraints in agricultural production (%)						
Items	Jamarpur	Kishor.	Mymen.	Netra.	Sharpur Tangail	Average
1 Flood damages						
Serious	88	83	74	90	94	82	85
Medium	12	16	22	7	6	13	13
Low	0	1	4	2	0	5	2
2 Crop diversification						
Serious	62	51	70	71	66	82	67
Medium	32	27	21	12	20	15	21
Low	6	21	9	13	14	3	11
3 Mechanization						
Serious	72	54	65	62	66	71	65
Medium	22	35	22	28	28	19	26
Low	6	11	13	10	6	11	9
4 Constraints in marketing						
Serious	19	32	23	21	10	15	20
Medium	62	55	60	64	62	74	63
Low	19	13	17	15	29	11	17
5 Irrigation water supply						
Serious	26	15	18	17	13	12	17
Medium	53	67	70	75	63	80	68
Low	21	18	12	8	23	8	15
6 Agricultural technology						
Serious	6	13	8	2	2	2	6
Medium	30	29	32	21	31	29	29
Low	64	58	60	76	67	69	66
7 Low inputs (Ex. fertilizer)						
Serious	9	14	4	4	2	3	6
Medium	36	28	23	19	27	23	26
Low	55	59	72	78	71	74	68
8 Land preparation						
Serious	4	8	5	7	6	1	5
Medium	79	68	78	69	73	81	75
Low	16	24	18	23	21	18	20
9 Distribution of improved seeds						
Serious	0	12	5	1	4	5	4
Medium	40	29	27	28	25	21	28
Low	60	59	68	71	71	75	67
10 Limitation of agricultural land						
Serious	4	4	1	0	2	0	2
Medium	28	28	17	23	23	26	24
Low	68	69	82	77	75	74	74

3) Interest of farmers on water resources development

In this survey, the rank of importance of works by methods for water resources development by the average of 6 Districts, the embankments for flood control with attachments was the highest among various water management works, followed by irrigation and re-excavation dtainage.

Ranks of importance in water resources development.(%)

NO.	Works	Jamarpur	Kishor.	Mymen.	Netra.	Sherpur	Tamgail	Average
1	Embankment, equipment	28.9	27.9	23.4	34.0	27.1	31.9	28.8
2	Irrigation canal	21.4	22.4	23.4	24.0	24.8	27.6	23.9
3	(Re)Excavation	28.4	26.6	21.5	16.8	24.8	23.2	23.5
4	Drainage canal	2.5	4.5	17.6	14.1	0.0	6.7	7.6
5	Sluice gate	1.0	3.8	2.8	1.5	6.8	1.2	2.9
6	Electricity for irrigation	1.0	1.6	1.1	2.7	8.3	2.0	2.8
7	Road, bridge	2.5	1.9	0.2	0.0	1.5	0.8	1.2
8	Pucca dam, rubber dam	0.0	1.0	1.5	1.9	0.8	0.0	0.9
9	Shelter	4.5	0.0	0.0	0.0	0.0	0.0	0.7
10	Surface water use	0.0	1.6	0.0	1.1	0.0	0.0	0.5
11	River-ponds	0.5	0.0	0.0	0.0	0.0	0.0	0.1
12	Agricultural technology	4.5	7.4	6.1	0.8	3.8	5.5	4.7
13	HRD	3.5	1.0	0.4	0.8	0.8	0.4	1.1
14	Pavement	1.0	0.0	0.0	0.0	0.0	0.0	0.2
15	Loan	0.5	0.0	0.4	0.0	0.0	0.0	0.2
16	Others	-0.0	0.3	1.5	2.3	1.5	0.8	1.1
	Total	100	100	100	100	98	99	100

3.5.2　Farm Household Interview Survey

(1)　Interview survey

The following surveys were conducted in collaboration with LGED, Union Chairmen and related organizations:

1)　Questionnaire survey to all the Union Chairmen in the districts (All the Union Chairmen)

The JICA Study team prepared questionnaires in cooperation with LGED Counterparts. The questionnaire form composed of 3 major items including land use, farming system (agriculture, livestock and fisheries and water management).

The questionnaires were sent to Upazila Engineers, and were requested to distribute them to Union Chairmen and to collect their answer sheets. The JICA Study Team also requested Union Chairmen and Block Supervisors to fill up the questionnaires.

2)　Interview survey to selected Union Chairmen (24)

Two Upazilas from each district were selected from the view point of their convenience to marketing and transportation (On the assumption of a modernized farming area (Marketed area) vs. Remote area)). Two Unions were also selected in each Upazila from the view point of having dominant farming system, transportation and management capacity of Union.

3)　Interview survey to farmers (72)

Three farmers were selected for interviews by enumerators in the category of large scale farmers, medium scale farmers and small/landless farmers.

(2)　Agricultural Conditions Based on the Results of Interview Survey

Results of observation and the findings of the interview survey to Union Chairmen and interview survey to farmers are summarized below. The data and observation are not related to entire District. However, the information was collected from the people directly related

their duty, and is useful to understand the actual situation of related areas.

1) Land use and Crop Production

Based on the results of interview survey to Upazila and Union officials, the land use and cropping patters are summarized as follows:

i) The Study Area

Major Crop Rotation in Districts and Upazilas of the Survey Area.

District Upazila	Crop	Crop	Crop	Share (%)	District Upazila	Crop	Crop	Crop	Share (%)
Jamalpur					Netrakona				
Melandaha	Boro	Fallow	T. Aman		Netrakona Shadar	Boro	Fallow	T. Amon	71
	Wheat	Jute	T. Aman			Vegetables	B. Aus/Jute	T. Amon	15
	Boro	Fallow	Fallow			Boro	Fallow	Fallow	11
Dewaganj	Boro	Fallow	T. Aman			Boro	Fallow	T. Amon	3
	Boro	Aus/Jute	T. Aman		Mohanganj	Boro	Fallow	Fallow	50
	Sugarcane	Sugarcane	Sugarcane			T. Amon	Fallow	Vegetables	30
Kishoreganj						Wheat	Fallow	T. Amon	10
Kishoreganj Shadar	Boro	Fallow	T. Amon	60		T. Amon	Fallow	Boro	10
	T. Aus	T. Amon	Boro	20	Sherpur				
	T. Aus	Vegetables	Boro	5	Sherpur Shadar	Boro	Fallow	T. Aman	75
	Mixed	-	-	15		Wheat	Jute	T. Aman	25
Astagam	Boro	Fallow	Fallow	(100)		Vegetable	Fallow	T. Aman	
Mymensingh					Jhenaigati	Boro	Fallow	T. Aman	
Mymensingh	Boro	Fallow	T. Aman			Boro	Aus	T. Aman	
Iswarganj	Vegetable	Fallow	T. Aman			Wheat	Vegetables	T. Aman	
	Wheat	Fallow	T. Aman		Tangail				
Dhoboura	Boro	Fallow	T. Aman		Mirzapur	Boro	Fallow	T. Aman	75
					Sakipur	Boro	Fallow	T. Aman	60
						Vegetables	Vegetables	Vegetables	15

Source: JICA Farm household survey (2004)

* 1) Major cropping pattern is a Boro - Fallow - T. Aman type.

   2) Vegetable growing is developed in the near large city/markets.

ii) Other specific conditions

a) Melandaha Upazila in Jamalpur District

The cultivation area was 235,050 ha, of which 170,000 ha was irrigated for Boro. 12 pieces of low lift pumps (LLP) were used for irrigating 250 ha area. Use of surface water is an urgent issue to be solved.

b) Dewaganj Upazila in Jamalpur District

The upazila is located in a remote area in Jamalpur District, and its road conditions are not good. However, the operation of the sugar mill in the area creates a good effect on farm management of the farmers. The combination of sugar cane production and sugar mill-related activities is a kind of rural industrial complex. It is useful model to encourage agricultural production and rural development.

c) Dhobaura Upazila, Mymensingh Districts

This area is located in a remote area, close to Indian border. Although it has high potential for agricultural production, poverty is a serious problem due to many small-landless farmers and high ethnic groups (Muslim: 60%, Garo: 35%, Hindu: 5%). Various development projects are conducted to support the rural development.

d) Netrakona District

The district is located at the boundary of India. The eastern part of the district is located in lowland area. Ethnic groups live in the northern area. Agricultural activities vary according to location. Supplemental irrigation is followed for T. Aman, and extensive irrigation is practiced for Boro, wheat, vegetables etc. Water for irrigation is usually obtained by DTWs.

e) Sakhipur Upazila, Tangail District

Although the area is located in a medium highland area, main land use is rice production. It is a remote area in Tangail District and is also remote from the major road. However, the area is relatively near to Dhaka, the largest consuming area in Bangladesh, and a road connects the area with the Asian Highway with a distance of about 20 km. The area has advantages in upland crops, and it is one of the largest banana producing areas in surrounding areas. The market or the banana collecting place showed aggressive trading of banana and was jammed with large tracks. The main selling area is Dhaka, but banana is often sold to places as far as Chittagong. The upazila was selected as a remote and isolated area from the location of a map. However, it actually maintains an active business. It is a good model of profitable farming area developed by specialized farming.

2) Agriculture Income Sources

Income sources of interviewed farmers are summarized as follows:

Income structure in Districts and Upazilas in the Study Area.   Unit: %

District / Upazila	Agriculture	Aus	Aman	Boro	Vegetables	Fish	Live stock	Sugar cane.	Others
Mymensingh									
Iswarganj	75					18			7
Dhobaura	70					5	5		20
	80					10			10
Jamalpur									
Melandaha	80					0			20
Dewaganj	(40-50)	5	10	35	5-10	0		30	
Sherpur									
Sherpur Shadar	75					5			20
Jhenaigati	95					2			3
	80		65		15(w/wheat)	5			15
Netrakona									
Netrakona Shadar	55 - 60					8 - 10	15		15
Mohanganj	80					10	5		5
Kishoreganj									
Kishoreganj Sadar	(75)			75		10-15	10		10
	80					10	5		5
Astagam				90		5	5		1 - 2
Tangail									
Mirzapur	70		10	60	5	10	10		5
Sakhipur	80			25	55	2-5	5		10

* Interview survey to upazila officers and Union chairmen.
** 1) Rice (Boro) is the major income source.
  2) The shares of fish and livestock are about 10% of the total income, respectively: Varying 5-10%
  3) Others showed a higher percentage of the share

3) Others Issues and Findings

i) Quality seeds

Quality seeds are required for rice (Boro), and vegetables (Tomato, eggplants, cabbage, etc). DAE is now conducting the farmers-to-farmers seed exchange project. It was reported that no seed processing facilities or seed storage facilities are operated in the area.

ii) Rice processing

Paddy is collected from adjacent farmers and rural market. Paddy is usually boiled or par-boiled and milled by Engelberg- type rice mills by rural industries. Women are hired for drying steamed paddy with a wage of 50-60 Tk/day. Husk from paddy is used for fuel for boiling, and bran is used for feeding chickens and other animals. Ash from parboiled rice processing can be used for fertilizers of seed beds and vegetables (High content of carbon, good for "kuntan"). Agricultural residues can be efficiently recycled in small rural areas.

iii) Livestock

Due to large wet areas and food shortages, livestock farming was not well developed in the past, but its importance is increasing in the future.

    a. Cattle: Mainly local varieties were raised for beef and milk production.
    b. Goat: Black Bengal goat is the major variety. Goats are widely grown, but are not for rearing due to lack of finance and lands.
    c. Duck: It is a major animal for egg production. At present, the production is progressed to almost peak level - 100-1,000 heads/farmers.
    d. Poultry: It is reported that urban poultry is profitable for rearing and broiler. In the remote area, broilers and layers are important.
    e. Rearing: No hatchery machines were operated and only local practices were followed.

iv) Fishery in Lakshmiganj Union, Netrakona

There are 6,125 ponds with an area of 492 ha. Fishermen face various constraints relating to water management, such as, 1) lowering productivity due to silting of ponds, 2) decreasing surface water resources due to the development of irrigation, and 3) decreasing water sustainability is in dry seasons.

3.6 Water Resources Development

3.6.1 Large Scale Water Resources Development

(1) Large Scale Water Resources Development

Projects related Flood Control and Drainage (FCD) Project completed by BWDB from Year 1978 to Year 1995 are shown in Table 3.6.1 and the locations of those projects are shown in Fig. 3.2.5. Other information of BWDB project at each district is as follows.

District	Description
Netrakona	- As a district adjacent to the Haor area, there are 2 Haor development projects (No.34 & 35). - Nautana Khal Scheme (No. 40) is also located in the Haor area. - Thakurakona Sub-project (No.39), Kangsha River Sub-Project and Dampara Project (not listed) are ranged. - Khaliajuri Flood Control and Drainage Project (new project) is under implementation
Kishoreganj	- As a district adjacent to the Haor area, there are 2 Haor development projects (No. 13 & 18). - Bhera Mohana Temporary Closure Project (new project) is planned. - Re-excavation of Singua River has a plan of re-excavation along the 50 km.
Mymensingh	- Slope Protection is now planned for the Shambhuganj Embankment Project
Tangail	- Bailgana Khal Project (No.48) and Kamarnaogaon Project are useful projects. - Desilting of Nangli River Project (not listed) is on-going project. - Many other projects are under-going to obtain the approval by the Government.
Jamalpur	- Banar River System is now obsolete. - Subproject planned by LGED in relation to the BWDB's project that is finished the O&M duration will be approved by BWDB without any objection. Jamalpur Flood Control & Drainage Project (First Phase) is under-going to obtain the approval by the Government.
Sherpur	- Mirgi River System Project is old and obsolete. Now new project is replacing the old project. - North Mymensingh Tubewell Project (not listed due to very old) is released from BWDB's O&M support. Irrigable area is 65 ha. - Malijhee River Bridge cum Regulator Project is not functioned now.

3.6.2 Minor Irrigation

In the Study Area, water in the small-size water source, e.g. khals, branch rivers, small ponds etc. is utilized for the supplementary irrigation water by the low-lift pumps (LLPs). Small Scale Water Resources Development Sector Project aims at this type of irrigation system as the Water Conservation Project. However, in the Study Area, most of the water sources except the beels are dried up in the middle of dry season. So, many of the large-scale farmers constructed shallow tubewell (STW) pump systems or deep tubewell (DTW) pump systems and get the irrigation water from those to cultivate the Boro HYV or Rabi crops.

Irrigation equipment & irrigated area during boro 2003 in the Study Area is summarized as follows:

Name of Items	Deep Tubewells	Shallow Tubewells	Low Lift Pump	Floating Pump	Manually operated pumps	Traditional Equipment	Total
Total No.	4,930	156,497	8,068	8	1,758	3,272	174,533
Area (ha)	106,650	441,009	79,708	2,284	338	1,279	631,268
Share within total area	16.9%	69.9%	12.6%	0.4%	0.1%	0.2%	-

Source: Survey Report on Irrigation Equipment and Irrigated Area in Boro/2003 Season, MADC - Survey and Monitoring Project for Development of Minor Irrigation, Oct. 2003

3.6.3 Small Scale Water Resources Development

After entering into effectiveness of the loan on SSWRDSP-2, each Union had submitted proposals to LGED. There are 2,335 subprojects (SPs) were submitted to the SSWRDSP-2 in 61 districts (38 SPs/district) by 29 September 2004. According to information from the LGED headquarters, number of proposed subprojects for SSWRDSP-2 and their process of screening in Greater Mymensingh as of 10 February 2005 are summarized in the table shown below:

Progress of Subprojects Screening in the Study Area

Zila	LGI		Proposal Submission		Reconnaisance Passed		Appraisal Passed	Implementation scheduled SP
	Number of Upazilas	Number of Unions	Number of Unions	Number of SP	Number of Unions	Number of SP	Number of SP	
Jamalpur	7	68	26	40	5	5	1	0
Kishoreganj	13	109	40	73	10	11	7	5
Mymenshingh	12	146	58	146	13	13	4	3
Netorakona	10	86	38	155	10	13	5	3
Sherpur	5	52	15	21	6	7	1	0
Tangail	11	101	21	29	4	5	3	2
Total / Average	58	562	198	464	48	54	21	13

Considering these conditions of the submission of SPs, the following inferences can be made.

- The total number of SPs in the greater Mymensingh (6 districts) is 461, and is nearly 18% of the total number of SPs from 61 districts.
- Considering the share of the Study Area in the target area of SP-2 (6/61or10%), submission of SPs in the Study Area seems high.
- However, in regard that nearly 300 SPs were implemented in the 37 districts (8.1 SPs/district) of the western part of Bangladesh in SSWRDSP-1 (SP-1), and that these 37 districts are also included in the target area of SP-2, it may be said that more SPs should be submitted from the 6 districts of the Study Area.
- In the Study Area, SP proposals were submitted by 35% of total unions, and average

SP proposal from unions were 2.34 SPs/union.

- Proposed SPs passed by the screening of reconnaissance, appraisal and final acceptance are 11.6%, 4.5% and 3.0% of the total, respectively.
- In the number of submitted SPs, there is a big difference between the 6 districts in the Study Area.
- From now onwards, the reason of this difference should be analyzed considering the geographical condition (e.g. area of the district), topographical/hydrological conditions (e.g. ground elevation of the area, flood elevation), agricultural condition and social condition (e.g. willingness of the village people), etc.
- The results of the above analysis should be introduced to the formulation of the Master Plan of this project.

3.7 Relevant Project/Program in the Districts

3.7.1 Previous Water Resources Development Projects and Studies in the Study Area

The FAP studies in relation to the Study Area are described below:

(1) FAP 3:   North Central Regional Study (NCRS)

The Study submitted the Final Report in February 1993. The Study area was 12,000 km^2 lying between Jamuna, Padma, Meghna, old Brahmaputra and Lakhya rivers. The objective of the Study was to formulate a Regional Water Resources Development Plan (RWRDP) with emphasis on flood control and drainage. In the Development Plan, the region was divided into 13 Planning Units (PUs) based on hydrology, soils, land use, population density and socio-economic characteristics. After considering the main physical development constraints, PUs 1, 2, 4, 6, 7 and 10 were selected as priority development areas. Pre-Feasibility Studies were carried out on 6 Regional Schemes (RS). Among them the following study and project are important:

1) FAP 3.1: Jamalpur Priority Project Study

The Study submitted Final Feasibility Report in January 1993. The total mainland project area, based on 6 upazilas (Madarganj, Melandaha, Islampur, Jamalpur, Sarishabari and Dewanganj) extended over 86,000 ha. The inclusion of char land area within scope of the studies increased the total project area to 179,842 ha involving 3 more upazilas (Dhunat, Sonatala and Sughatta). The project includes construction of embankments, inlet and outlet structures, flushing sluices, drainage works and pilot flood proofing schemes. It also involves a fisheries program.

2) FAP 20: Compartmentalization Pilot Project (CPP)

The goal of CPP was to test the technical and economic viability of the compartmentalization concept, in which an area enclosed by an embankment would be provided with a comprehensive water control system designed and operated in order to provide a more secure environment for intensive agriculture, fisheries and integrated rural and urban development. CPP is located in Tangail on the left bank of the Brahmaputra (Jamuna) river, some 80 km north of Dhaka. It encompasses 13,305 ha of which around 9,858 ha is cultivable land. Implementation period of the project is 1991-1992 to 1999-2000. The project area is protected by 47 km flood embankment.

(2) FAP 6: North East Regional Water Management Project (NERWMP)

The Study submitted Final Report on May 1994. The Study area was 24,200 km^2 which is 17% of total Bangladesh area. The Study proposed 44 Initiatives under 8 Strategic Thrusts to

manage water resources. A list of the 8 Strategic Thrusts is mentioned below.

- Urban and Infrastructure Protection
- Intensive Agriculture for Urban Consumption
- Enhanced Production Systems on Seasonally Flooded Areas
- Integrated Development of Deeply Flooded Areas
- Biodiversity Enhancement and Sustainable Management
- Improved Liveability of Rural Settlements
- Navigation Improvement
- Institutional Strengthening and Development

3.7.2   Agricultural and Livestock Development Projects/Programs

Various field projects are conducted in agriculture, livestock and fisheries. Some of the important projects are summarized below for reference.

(1) Soil Fertility and Fertilizer Management Project (SFFP) (DANIDA)

Major objectives of the project are to develop "Optimized integrated and sustainable agriculture production for improved living conditions". The project covers training, soil test, compost, vegetable growing, gender issues, seed management, and homestead management. SFFP-I was implemented during 1993 and 1999), SFFP-II is on-going since 2000.

(2) Seed Exchange Management Project (Government 2002-   )

Objectives of the project are to develop self-supply of seeds among farmers by their own efforts through community work. The activities are as follows:

1st step: DAE supplies good seeds.

Crop	Seed: kg/acre	No of farmers	Total seeds
Boro	10 kg/acre	10	1000 kg
Wheat	50 kg/acre	16	3000 kg

Select appropriate farmers and provide the seeds.
2nd step: Multiplication
3rd step: Number of farmers: Boro – 100 ha, Wheat – 300 farmers

(3) Recent projects of Livestock Development

1) Small holder livestock development project
Phase-II is on-going in 6 districts in southern Bangladesh

2) Participatory livestock development project

Phase-I 2001-2003	17 Districts	(Mymensingh: 1 upazila) (Netrakona: 1 upazila) (Sherpur: 1 upazila)
Phase-II 2004- Approved	20 Districts	157 upazilas Mymensingh: 12 upazilas (all) Netrakona: 10 upazilas (all) Sherpur: 5 upazilas (all)
	Contents	Target to landless farmers Provide training and other technical support Provide loans

3) Goat development project

Phase-I	2002-2005 All Districts in Bangladesh
Contents:	Target to landless farmers and small farmers Provide training and other technical supports Provide loans

3.7.3　Fishery Development Projects/Programs

Three projects related to SSWRD implemented in the study area

(1)　Aquaculture Extension Project

1)　Financial supports: supported by DANIDA and implemented by GOB

2)　Period: from 1983 to 2003.

3)　Objectives:

　　The objectives of the project were as follows;

　　　1) Improvement of seed production technique of private hatcheries,
　　　2) Extension of integrated fish culture,
　　　3) Technical training on fish culture,
　　　4) Improvement of marketing system, and
　　　5) Support program of micro-credit through the partnership with NGOs.

(2)　Community Based Fisheries Management Project Phase 2

1)　Financial supports:　Department of International Development (DFID), UK, through a grant to Worldfish

2)　Implementation Agencies and Period

　　The project is implemented with collaboration among the Department of Fisheries, Worldfish Center and several NGOs and supported by from 2001 to 2006.

3)　Project Area

　　Three districts (Mymensingh, Jamalpur and Sherpur) were not included in the project.

4)　Objectives

　　The purpose of the project is to generate a policy dialogue and a process for policy formulation for pro-poor sustainable fisheries management.

　　Some of the project earthwork activities are

　　　1) Establishment of small fish sanctuaries using traditional *katas* or *kaus* as no-fishing refuges and closed seasons (no fishing in early monsoon).
　　　2) Fish habitat restoration, by re-excavating channels between *Beel* and river.

(3)　Forth Fisheries Project

"Forth Fisheries Project" is being implemented by Department of Fisheries and financially supported by World Bank/ DFID/GEF/GOB for a period of 5 years 1999 to 2004 through the country.

The project objectives are increasing fish and management of fisheries and supporting sustainable growth in fisheries sector and equitable distribution of benefits generated from increased fisheries production.

Project component are as follows;

　　　1) Open water fisheries management
　　　2) Shrimp and coastal aquaculture
　　　3) Freshwater aquaculture, extension and training

4) Aquatic resource development, management and conservation
5) Credit
6) Institutional development

This project establishes about 50 sanctuaries in whole Bangladesh. Several types of sanctuaries, such as permanent sanctuaries, temporary sanctuaries, have been established. Area of each sanctuary varied from 50 ha to 1,000 ha or more.

3.7.4 Rural Development Projects/Programs

(1) Rural Development Project-21 (TRIDP: Third Rural Infrastructure Development Project/ NRIDP: Northern Rural Infrastructure Development Project)

1) Objectives

Since 90 %t of the country's poor people live in rural Bangladesh, agriculture and rural development are critical elements of the Government's poverty reduction strategy. Key constraints for rural poverty reduction include (a) lack of physical infrastructure; (b) lack of support services including extension, marketing, and financial services; (c) lack of high-quality agricultural inputs; (d) suboptimal utilization of water resources; and (e) lack of access to basic social services.

This Project aims at the support to the Government activities on the strengthening of rural infrastructure at the northern 13 districts in which poverty ratio is high and development is retarded.

2) Location of the Project

This Project is targeting the following districts; Rangpur, Kurigram, Nilphamari, Gaibandha, Lalmonirhat, Dinajpur, Thakurgaon, Panchagarh, Mymensingh, Kishoreganj, Netrakona, Jamalpur and Sherpur districts (13 districts).

3) Summary of the Project

  i) Construction/Rehabilitation of Road Network (Northern 5 districts = Mymensingh, Kishoreganj, Netrakona, Jamalpur and Sherpur, by JBIC; North-Western 8 districts by ADB),
  ii) Establishment of the RDEC (Rural Development Engineering Center; by JBIC),
  iii) Construction of Social Infrastructures (Growth Center, Ferry Ghat, etc.),
  iv) Measures for Flood (Flood Refuges Shelter, etc.), Support to the Community,
  v) Strengthening of the Institutions, Support to the Implementation of the Projects.

4) Financial Status

  Total amounts of US$ 179.6 million financed by ADB (39%), JBIC (27%), IFAD (7%), SIDA (4%), and the Government (20% and 3% by Local Government Institutions).

5) Completion of the Project

The Project was completed by March 2005.

6) Relevancy with SSWRDSP-2

Construction/Rehabilitation of Road Network under the RDP-21 is targeted on rural road especially Upazila roads for communication. Flood embankment cum road will be constructed SSWRDSP-2 and this flood embankment cum road is not duplicate to the RDP-21.

3.8   GIS and Remote Sensing

3.8.1   Satellite Images

In order to identify position of rivers and lakes in the survey areas, land use, inundation during rainy season, infrastructures of water management, etc., satellite images for both rainy and dry season were purchased during Phase I Study. The ASTER and IRS satellite images were purchased for rainy season and for dry season, respectively. The GIS data base is composed by a data base developed by the GIS Unit of LGED as basic system, and the National Water Resources Database (NWRDB) organized by WARPO were used as major data source, adding results of analysis of the satellite images, the field survey and others as necessary. The combined data base has been used for various purposes such as zoning of the survey areas, preparation of development strategy by zone, selection of candidate development areas and preparation of basic maps for the master plan.

Satellite Images and use of satellite images

Season	Name of satellite and capacity	Purposes
Dry season	Name of satellite: IRS (India) Resolution: 5.8 m Area of 1 scene: 70 km x 70 km Necessary pieces: 10 pcs.	1. Identification of location of inland water area existing through out the year. 2. Latest position and situation of rivers. 3. Identification of position of water works. 4. Study of land use by combining images by ASTER.
Rainy Season	Name of satellite: ASTER (Japan) Resolution: 15 m Area of 1 scene: 60 km x 60 km Necessary pieces: 12 pcs.	<Use in Japan> 1. Outline of inundated area in rainy season and finding of poor drainage areas. 2. Preparation of survey plan for the Survey in Bangladesh (1) in rainy season. 3. Study of zoning of the survey areas. <Use in the field survey> 1. Detailed zoning of the survey areas. 2. Comparison with inland fisheries (IRS images) in dry season and use for the master plan.

3.8.2   Collection of Existing GIS Data

(1) Topographic Control Points

In order to combine the satellite images and existing GIS data, the topographic control data of GPS Station which was installed by JICA Study in 1991-1995 and meteorological station information of BMD were collected.

There are 141 GPS stations in Bangladesh and 27 stations are in the Study Area and adjacent areas. Among 27 stations, 9 stations are on the first order leveling lines, 3 stations are linked with national bench marks by the third order level and 15 stations are interpolated from Geoid Model.

Among 31 BMD meteorological stations, only one station at Mymensingh Agriculture University is installed in the Study Area, and its geodetic data was also collected.

(2) Existing GIS Data

Existing GIS data of LGED GIS and NWRDB of WARPO were collected on the following themes:

- Administrative boundaries (National, Districts, Upazilas and Unions) are included in database theme. As the characteristics of the data, the lines that compose the boundaries can be virtually assembled into polygon features

- Administrative boundaries and area of over 1,000 ha BWDB projects overlaid and confirmed using GIS database
- Roads and Railways are categorized as National highways, Regional highways, Feeder roads and Rural roads. And Railway data is categorized by the track width (Board gauge and Meter gauge)
- Major public buildings (Administrative headquarters, Schools, Hospitals and Police stations) are showed by the point data
- Rivers (Main, Major, Model and Detail) are categorized by FAP19 and NWRD. These thematic maps will be the output in Phase 2 by IRS satellite images
- Other related data on the Study

(3) Input of Existing Data to the GIS Database

Corrected existing data formulated in GIS database by the following GIS specification.

GIS Specification	
Data type:	Shapfile
Base map:	Map scale 1/50,000(Survey of Bangladesh)
Elipsoide:	Evelest 1830
Coordinate:	Bangladesh Tranceverse Melcator(BTM)
Parameters:	0.9996

1) Subprojects under SSWTDSP-2

Subproject location of SSWRDSP-II in the Study Area were collected from LGED headquarters and they were digitized to GIS database. Control point data based on the previous JICA survey for installing national geodetic benchmark network (1991-1995) and BWDB hydrographic control point data have been included to GIS database.

2) Zoning Data

During the Study Area zoning, agroecological regions and inundation land classification were combined to the GIS database.

3) Identified potential subprojects

Potential SSWRD subprojects identified by the inventory survey and Union Questionnaires verification survey in this Study were digitized to GIS database. They are used for the grouping subprojects and confirmation of subprojects at the UDCC and DSSWRDC consultation meetings during the field study.

3.8.3 Analysis of ASTER Satellite Images

ASTER satellites images (rainy season) analyzed for Land use, Location of water bodies, and secular changes for major rivers has been done. But faulty point of drainage facilities could not be analyzed, because floodwater covered all drainage facilities in 2004.

(1) Actual Land Use

ASTER satellites image verification by field survey on land use was planned to be conducted in the Phase I Study, but it could not implemented because of the severe flood and deep inundation in the Study Area. Verification of field survey were done from main roads.

(2) Analysis of IRS Satellite Images

IRS satellite images (6m resolution) and generated GIS river data (based on topographic map scale 1/50,000) overlaid for checking for secular changes for major rivers has been done. But faulty point of drainage facilities could not analyzed, because flood water covered all drainage facilities in 2004.

3.9   Zoning of the Study Area

3.9.1   Zoning and Clusters of the District

(1)   Requirement of Zoning in the Study Area for the Formulation of Development Strategy

In order to analyze the present conditions and to formulate the small scale water resources development master plan in the Study Area, firstly it is necessary to formulate the water resources development plan. The zoning of the Study Area for small scale water resources development needs different types of development plan. The approaches are 1) flooding; inundation depth and duration, 2) water resources availability; especially dry season including groundwater, 3) regional socio-economic conditions; industrial development, population and homesteads in the region, 4) agricultural conditions such as soils, climate, type of crops and cropping patterns.

Based on this zoning, a land use plan in the Study Area will be established considering crop cultivation plan and regional economy.

(2)   Scale of Zoning

The small scale water resources development master plan is formulated at the district level. In the master plan, only a single strategy of development can not cover each district (with average 2,700 km^2), because of the wide variation of natural, socioeconomic, agricultural and hydrological conditions in the District. For example, Sherpur District spread from the foot of high mountain to the easily flooded plain along the old Brahmaputra River.

The strategy of small scale water resources development plan shall be defer area by area and subprojects aiming to protect the flash flood or to retain the food water are needed in the former area and subprojects aiming to minimize the flood damages and to shorten the inundation period are needed for the later. Considering that the scale of subproject beneficiary area is less than 1,000 ha, government administration levels, etc., the scale of the strategy planning shall be upazilas, which cover the area of 290 km^2 and composed of 10 unions in this Study.

3.9.2   Zoning by Natural Conditions and Flooding

(1)   Elevation and Slope

According to the digital elevation data as shown in Fig. 3.2.1, the Study Area is rather flat plain with elevation between 3 m to 40m PWD. And the slope from northeastern border of Sherpur district to southeastern border of Kishoreganj district is 1 : 2,900, the river slope of the Brahmaputra river is 1 : 11,000, and flood plain is generally 1 : 6,000 in the Study Area. Therefore, elevation and slope factors might not be major cluster of the zoning in the Study Area except the Haor area which is topographically depression area with lower elevation at the eastern boundary and Char area on the western boundary of the Study Area.

The cropping pattern of the upazila can have a high correlation with elevation. Major crops in the higher elevation area are aman paddy, wheat and vegetable which have favorable dry conditions, and the major crops in the lower elevation area are boro and/or aus paddy which are cultivated during dry season; on the other word, aman paddy can not be cultivated during monsoon season. From the hydrological view points, even at high elevation area, it is inundated based on the hydraulic conditions except Madhupur Tract area which is an uplifted area and free from inundation damage but having the risk of drought.

(2) Type of Floods and Hydrological Zone

Two hydrological regions of North East region and North Central divide the Study Area; North East region cover the northern part of Sherpur and Mymensingh and almost of all Netrokona and Kishoreganj districts. Based on the hydrological region, NWMP set the development strategy and plan. Flood management is the major issue on water resources development in Bangladesh. The Study Area can be categorized by the degree of inundation, which is determined mostly based on the regional elevation and flooding scales. And water resources strategy of the region can be categorized by degree of inundation, as shown in Fig. 3.2.7. As far as duration of flood inundation is concerned, it is possible to consider the deep inundation area having longer period except small scale depression area.

As far as the flood type such as flash flood and normal flood is concerned, the damage of flash flood is big, but the duration of damages is short. Even when the flash flood washes out the paddy before harvesting, it is possible replant aman paddy if the field damage by flush flood is not severe. In case of normal flood, not only the depth of inundation but also duration of the inundation is the major issue, because the replanting aman paddy becomes crucial. It is possible that the countermeasures of flood damage will be differing by the type of floods.

(3) Groundwater Availability, Arsenic Contamination and Drought Prone Area

Groundwater is not directly related to the flood damages, but it is a major issue in the dry season irrigation for agriculture. Also the arsenic contamination of groundwater, as shown in Fig. 3.2.6, is a major factor on the domestic and irrigation water supply. In these areas, retaining the flood water for the dry season and domestic usage of water is the major issue. Retention of the water during monsoon season is also a major issue in the drought prone area.

3.9.3 Zoning by Socio-economic Conditions

(1) Degree of Industrial Development

Considering the flood damages caused by inundation, the present development conditions shall be accounted. It is easy to understand that the damage amount will be bigger for the industrial factories, social infrastructure such as road, bridge, power stations, etc., after the life of human beings. There is no major industrial centers in the Study Area, and it is regarded not to be a major factor for zoning.

(2) Population and its Density and the Vulnerabilities

Population density shall be one of major scale to measure the flood damages. In the Study Area, population density distribution is rather homogeneous at 200 to 400 persons/km^2, with the exception of Mymensingh and Kishoreganj municipality area, where population density is higher. Therefore, the factor will not directly affect water resources development zoning. As shown in section 2.3.1, high concentration areas of population below the lower poverty line are along the Jamuna river, and north eastern part. Distribution of poverty is an important issue in developing the strategies for the Master Plan, which aims at the alleviation of poverty. However, the category does not necessarily affect the contents of water resources development activities (ex. flood management, drainage improvement, etc.), and therefore will be regarded with emphasis in the prioritization of development activities.

3.9.4 Zoning by Agriculture, Fisheries and Livestock Conditions

(1) Major Issues to be considered for the Agriculture, Livestock and Fishery Development

Agricultural development depends on i) climatic conditions, ii) social conditions, iii) land-use

and topographic conditions, iv) surface water and groundwater availability, and v) soil conditions. In case of the Study Area, the flood plain except Madhupur tract and northern mountain foot areas, i) there is no significant difference of climate within the Study Area, ii) social conditions in the Study Area is rather homogeneous and it does not influence on agriculture. Therefore, the zoning by agricultural will be classified mainly based on 1) inundation land type, 2) soil conditions, 3) topographic conditions on the slope and drainage.

(2) Land type

The current land type is classified into 5 groups: High, Medium High, Medium Low, Low and Very Low. The Land types are basically decided by the elevation of farm land and depth of inundation by water flow. Therefore, agricultural factors on crop production are also different by the land types. The main important agricultural factors are soil type, appropriate crops, necessity of drainage, constraints and opportunity. Farmers have good knowledge on soil characteristics and crop suitability by their field experiences and better results are attained by selecting suitable crops. In highland and medium highland, rice can be cultivated by preparing ridge and puddling. If farm lands which are located close to markets or major roads, farmers can develop strategic producing areas. Though Sakhipur, of Tangail District is located in a medium highland area and is not suitable to rice production, due to its good access to Dhaka, it became a large banana producing area. This is a successful case of appropriate use of land type.

Characteristics of Land Types and Suitable Crops

Items	Land types				
	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland
Soil	Silt loam	Silt, Clay loam	Silty clay	Clay	Heavy clay
Crop	Aus, T. Aman, wheat, pulses, sugarcane, spices vegetables	Aus, T. Aman, HYV Boro, jute, spices vegetables wheat, pulses oil seeds,	Aus, T. Aman, DWR, HYV Boro, pulses, oilseeds, vegetables, spices	DWR, HYV Boro, Local Boro	Local Boro
Drainage	Well drained	Shallow	Shallow to moderate	Moderate to deep	Deep
Constraints	Low moisture, drought, salinity in dry season	Drought water logging, salinity in dry season	Flooding slow drainage, drought, salinity in dry season	Flooding, late drainage, salinity in dry season	Deep flooding, salinity in dry season
Opportunity	Irrigation	Drainage improvement irrigation	Flood control, Drainage improvement irrigation	Flood control, Drainage improvement	Flood control

Source: LGED Document (2004)

(3) Agro-ecological zone (AEZ), ref. Fig. 3.9.1

AEZ is composed of various factors such as land elevation, soil type, floods, droughts and soil fertility. It is a good indicator for crop production/ biomass. It is used for

- identification of crop suitability
- estimation of crop yields
- examination of farming system
- information for agricultural extension
- improvement of food security through "Right place, right crop".

However, agricultural production in the future will be focused on the economic view point such as cash income and poverty alleviation in rural areas. Profitability will be a major target which can not be achieved by AEZ only. In addition, extension of fertilizer application and

water management technology compensate the defects of farm land conditions. Consideration to human welfare is also an important factor to be considered. Farmers usually do not use AEZ as additional information to the Land type.

In the future, diversification of agricultural production to more profitable crops under the same AEZ and development of agricultural technology will be advanced. Agricultural zoning requires natural and socio-economic factors. Some of the important items are as follows:

- mapping with 0.5 m contour,
- major soil type (Clay, silt, loam, sandy, etc.),
- vegetation,
- current major crops,
- irrigation, drainage facilities and recipient areas,
- hazard areas,
- road net work,
- markets/ growth centers
- major agricultural processing companies,
- public offices,
- water bodies with regions in summer and winter.

More practical land classification which the farmers can easily use for their daily farming is needed.

3.9.5 Comprehensive Zoning of the Study Area

(1) Comprehensive Zoning

Comparison of factors discussed above with the three approaches for zoning, along with the importance of the categories among zoning of the Study Area is summarized in the following:

Factor	Natural Condition & Flood	Socio-economy	Agriculture	Importance among zoning of the Study Area
Elevation & Slope				Low: The terrain of the Study Area is generally flat and will not effect the strategies for SSWRD
Type of Flood and Hydrological Zone				High: Strategies should be established based on actual flood conditions of the Study Area
Groundwater				Medium: Availability of groundwater should be considered in regard of retaining surface water
Industrialization				Low: There are no major industrial centers in the Study Area
Population density				Low: The population density is regarded to be rather homogeneous with the exception of major municipalities
Poverty Distribution				-: Though considered important, the factor will be regarded in the prioritization of development activities
Land Type				High: Directly effects agricultural production after the realization of effective water resources management
Agroecological Zone				High: Directly effects agricultural production after the realization of effective water resources management

Land classification by land type and flood inundation type is almost similar, because the elevated area has less opportunity of inundation by flood except flush flood area. As shown in Fig. 3.9.2, the agroecological zone is overlapped with land type and flooding conditions, because the Agroecological zoning includes the land type and flooding conditions which is a dominant factor in ecological zoning and effect on agricultural patterns.

(2) Zoning for Water Resources Development in the Study Area

As a result of the comprehensive comparison, upazilas in the Study Area will be categorized by the Agroecological and flood inundation type zoning as shown below:

Zones	Degree of inundation	Agroecological Zone	Typical Area in the Study Area
Highland	Less than 30 cm	Madhupur Tract	Madhupur tract in Tangail and Mymensingh districts
Medium High Land	30 to 90 cm	Old Brahmaputra Floodplain	Area adjacent to Madhupur tract and river terrace of the old Brahmaputra River left bank
Medium Lowland	90 to 180 cm	Young Brahmaputra and Jamuna Floodplain	Along the old Brahmaputra Rivers and out of active Jamuna floodplain
Lowland	180 to 300 cm	Sylhet Basin and Active Brahmaputra-Jamuna Floodplain	Outside of Haor area in Kishoreganj and Netrakona Districts and along the Jamuna River
Very Lowland	More than 300 cm	Old Meghna Estuarine Floodplain	Haor area in eastern part of Kishoreganj and Netrakona Districts

(3) The Study Area Zoning

Zoning, applying the agroecological region and inundation type land classification, was conducted in the Study Area. Location and area of each zone are estimated based on the GIS and district wise areas by zone are summarized as follows:

Agroecological Zone	Inundation Land Type	Jamalpur Area (ha)	Share (%)	Kishoreganj Area (ha)	Share	Mymensingh Area (ha)	Share	Nerakona Area (ha)	Share	Sherpur Area (ha)	Share	Tangail Area (ha)	Share	Study Area Area (ha)	Share
Active Brahmaputra-Jamuna	F1	27,818	14.6%									24,784	7.6%	52,602	3.3%
Young Brahmaputra and Jamuna	F1	90,314	47.5%	71,428	29.5%	78,574	18.3%	155	0.1%	9,823	6.5%	138,837	42.6%	389,131	24.1%
Old Brahmaputra Floodplain	F0	16,247	8.6%			10,550	2.5%			28,189	18.6%			54,986	3.4%
	F1	45,819	24.1%			188,433	44.0%	62,125	22.4%	34,342	22.7%	36,240	11.1%	366,958	22.7%
	F2			10,613	4.4%	33,608	7.8%	76,170	27.4%			21,531	6.6%	141,922	8.8%
	F3			33,395	13.8%	21	0.0%	9,311	3.4%					42,728	2.6%
Middle Meghna River Floodplain	F2			11,064	4.6%									11,064	0.7%
Old Meghna Estuarine Floodplain	F2			1,612	0.7%									1,612	0.1%
	F3			40,555	16.8%									40,555	2.5%
Sylhet Basin	F3			72,759	30.1%			67,786	24.4%					140,544	8.7%
North-western Plains and Basins	F1	3,014	1.6%			21,890	5.1%	15,710	5.7%	53,853	35.5%			94,467	5.8%
Northern and Eastern Piedmont	F0					18,618	4.3%	42,559	15.3%	93	0.1%			61,270	3.8%
Northern and Eastern Basins	F3					5,308	1.2%	2,227	0.8%	8,582	5.7%			16,116	1.0%
Madhupur Tract	F0	4,990	2.6%	566	0.2%	71,388	16.7%					104,189	32.0%	181,134	11.2%
Northern and Eastern Hills	F0	1,797	0.9%			198	0.0%	1,642	0.6%	16,702	11.0%			20,339	1.3%
Total Area		189,999		241,992		428,390		277,685		151,583		325,580		1,615,229	

Most major zones in the Study Area are Young Brahmaputra and Jamuna Floodplain F1 and Old Brahmaputra Floodplain F1 covering 24.1% and 22.7%, of total Study Area, respectively.

Table 3.2.1   Mean Month and Seasonal Rainfall in the Study Area

S No.	Code	Name	Location (District)	Agency in Charge	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual	Pre-Monsoon	Monsoon	Post-Monsoon	Dry
1	28	Pigna	Jamalpur	BWDB																	
2	32	Sharishabari	Jamalpur	BWDB	7	10	21	97	323	408	463	298	325	126	22	7	2,159	420	1,494	147	**45**
3	62	Dewanganj	Jamalpur	BWDB	8	15	26	139	333	449	522	347	357	196	13	8	2,440	472	1,674	209	57
4	66	Islampur	Jamalpur	BWDB																	
5	67	Jamalpur	Jamalpur	BWDB	8	22	33	119	346	495	516	378	400	164	17	16	2,526	465	1,788	181	80
6	61	Bajitpur	Kishoreganj	BWDB	8	27	70	146	378	365	383	308	313	183	34	14	2,248	524	1,369	217	119
7	71	Kishoreganj	Kishoreganj	BWDB	7	30	53	138	350	413	412	405	367	187	18	13	2,346	488	1,597	205	103
8	101	Bhairab Bazar	Kishoreganj	BWDB	4	31	60	165	403	324	417	326	295	172	28	11	2,235	568	1,361	200	106
9	112	Itna	Kishoreganj	BWDB	6	28	89	244	446	476	626	500	566	227	37	11	3,272	690	2,168	264	134
10	5	Bhaluka	Mymensingh	BWDB	8	34	67	188	364	439	530	351	392	230	44	23	2,644	552	1,713	**274**	132
11	27	Phulbaria	Mymensingh	BWDB	6	21	44	131	338	400	409	325	318	187	20	13	2,217	469	1,451	208	84
12	46	Rasulpur	Mymensingh	BWDB																	
13	64	Gafargaon	Mymensingh	BWDB	13	40	58	147	334	347	425	360	373	190	19	17	2,408	481	1,504	210	129
14	65	Gouripur	Mymensingh	BWDB	9	18	45	132	397	459	502	410	414	168	25	16	2,565	529	1,785	194	87
15	72	Muktagacha	Mymensingh	BWDB	9	22	29	135	326	397	485	345	419	176	20	13	2,424	461	1,646	195	74
16	73	Mymensingh	Mymensingh	BWDB	10	24	34	145	379	448	546	409	440	225	21	14	2,666	524	1,843	246	82
17	75	Nandail	Mymensingh	BWDB	6	22	50	151	421	468	553	445	481	208	37	13	2,861	572	1,947	245	92
18	77	Phulpur	Mymensingh	BWDB	8	21	37	136	385	458	649	408	442	188	39	10	2,749	521	1,957	227	77
19	63	Durgapur	Netrokona	BWDB	6	16	41	194	450	634	765	615	589	202	23	13	3,566	645	2,603	225	75
20	68	Jaria-Jhanjail	Netrokona	BWDB	7	21	44	189	483	607	755	611	576	209	22	10	3,515	673	2,549	231	82
21	113	Khaliajuri	Netrokona	BWDB	6	33	73	290	541	654	690	629	705	238	34	9	**3,902**	830	**2,679**	272	121
22	115	Kendua	Netrokona	BWDB	5	26	58	163	510	560	608	560	548	235	25	15	3,230	672	2,276	261	104
23	121	Mohanganj	Netrokona	BWDB	12	35	81	212	415	580	683	598	591	230	26	14	3,356	627	2,453	256	**142**
24	123	Netrokona	Netrokona	BWDB	8	23	48	200	429	544	708	509	534	213	32	17	3,242	629	2,295	245	96
25	74	Nalitabari	Sherpur	BWDB	8	20	28	163	427	487	565	355	402	144	15	14	2,668	591	1,809	159	70
26	78	Sherpur Town	Sherpur	BWDB	12	18	29	124	353	423	481	339	322	130	16	15	2,258	477	1,565	146	74
27	227	Nakuagaon	Sherpur	BWDB	13	23	47	137	559	638	810	449	595	168	14	20	3,471	697	2,492	182	103
28	2	Atia (Tangail)	Tangail	BWDB	5	22	34	120	258	344	375	306	345	161	22	13	2,014	378	1,369	183	74
29	13	Gopalpur	Tangail	BWDB	5	15	24	76	236	319	353	232	284	141	12	9	1,708	**312**	1,188	153	52
30	18	Kalihati	Tangail	BWDB	7	26	40	99	224	262	285	242	290	125	19	8	**1,621**	323	**1,079**	**144**	82
31	21	Mirzapur	Tangail	BWDB	3	20	44	145	235	284	361	239	261	144	24	11	1,757	380	1,146	168	78
32	10609	Mymensingh	Agri Unive., Mymensingh	BMD	8	20	41	144	347	390	472	343	362	208	22	10	2,365	491	1,566	229	79
33	41909	Tangail	Near Mosque	BMD																	
		Maximum			13	40	89	290	559	654	810	629	705	238	44	23	3,902	830	2,679	274	142
		Minimum			3	10	21	76	224	262	285	232	261	125	12	7	1,621	312	1,079	144	45

Definition of Season

Pre-Monsoon :   *April – May*
Monsoon :   *June – September*
Post-Monsoon :   *October - November*
Dry :   *December - March*
Source: BWDB and BMD rainfall data (1981 - 2002)

Table 3.2.2   Annual Total Rainfall (1981 - 2002)

S/N	Code	Name	Location (District)	Agency in Charge	Annual Total Rainfall (mm)																					
		Station			1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	28	Pigna	Jamalpur	BWDB																						
2	32	Sharishabari	Jamalpur	BWDB	1,497	1,204		4,335	2,915	1,533	1,718	3,175	3,050	2,274	2,841	1,197	2,236	1,320	2,212	1,597		2,201	1,837	1,639		2,241
3	62	Dewanganj	Jamalpur	BWDB	1,993	2,453	2,730	2,749	2,674	3,028	3,258	3,017	2,370	2,479	2,054	1,571	2,570	1,481	2,628	1,706		2,582	2,467	2,367		2,620
4	66	Islampur	Jamalpur	BWDB																						
5	67	Jamalpur	Jamalpur	BWDB	1,797	2,646	2,298	2,370	2,131	2,815	3,067	3,169	2,667	3,417	3,596	1,690	3,375	1,528	3,320	1,987		2,253	1,750	2,456	1,977	2,748
6	61	Bajitpur	Kishoreganj	BWDB	1,947	2,176	2,483	3,012	1,808	2,349	2,013	3,483	1,997	2,189	2,516	1,592	3,336	1,485	2,366	1,817	2,165	2,042	1,855			2,340
7	71	Kishoreganj	Kishoreganj	BWDB	1,913	1,948	2,590	2,648	1,725	2,330	2,093	3,510	2,631	2,486	2,504	1,725	3,679	1,416	2,291	2,579		2,005	2,913	2,009	1,920	
8	101	Bhairab Bazar	Kishoreganj	BWDB	2,409	1,534	2,469	2,373	1,665	2,027	2,271	2,969	1,844	2,334	2,541	1,608	3,010	1,512	2,397	1,969	2,629	2,230	1,721	1,598	2,916	3,155
9	112	Itna	Kishoreganj	BWDB	3,090	2,271	4,503	3,885		3,384	2,744	4,638	2,910	3,719	3,466	2,477	3,646	2,131	3,974	2,707	3,477	2,831	2,368	3,951	3,266	
10	5	Bhaluka	Mymensingh	BWDB	2,935	1,690	2,401	2,830	2,383	3,333	3,923		2,178	2,866	3,932	2,337	3,546	1,768	2,426	2,162		2,877	2,193	2,643	1,843	2,622
11	27	Phulbaria	Mymensingh	BWDB	1,715	1,637	2,586	2,482	1,733	2,761	2,406	2,208	1,564	3,492	2,946	1,347	3,208	1,676	2,298	1,593		1,948	2,020	2,068	2,653	
12	46	Rasulpur	Mymensingh	BWDB																						
13	64	Gafargaon	Mymensingh	BWDB	2,112	1,601	2,523	2,464	1,874	1,625	2,015	2,869	2,167	1,398	3,108	3,135	3,002	2,054	2,319	2,542		3,611	2,237	3,564	1,939	
14	65	Gouripur	Mymensingh	BWDB	2,367	2,405	3,312	2,875	2,410	2,076	1,802	3,431	2,540	2,581	2,934	2,078	3,202	1,996	3,241	2,182		2,556		2,189		
15	72	Muktagacha	Mymensingh	BWDB	2,326	2,573	2,682	3,110	2,948	2,580	2,242	2,999	2,446	2,347	3,058	1,670	3,650	1,817	2,693	1,444		2,197	2,310	1,867	1,531	
16	73	Mymensingh	Mymensingh	BWDB	2,383	2,023	3,102	2,654	2,071	2,810	2,384	3,373	2,451	3,002	4,094	2,265	3,053	2,074	2,836	1,697	2,547	2,542	4,166	2,288	2,095	2,742
17	75	Nandail	Mymensingh	BWDB	2,698	1,898	2,751	2,605	1,826	2,044	2,019	3,561	3,401	4,466	4,600	1,585	3,557	1,709	2,907	2,638		3,058	2,729	3,396		3,780
18	77	Phulpur	Mymensingh	BWDB					2,297	2,875	2,540	4,016	2,561	3,325	3,771	2,343	3,245	1,840	2,579	2,449		2,505	2,536	2,501	2,612	2,745
19	63	Durgapur	Netrokona	BWDB	3,491	3,196	4,067	3,962	2,720	3,154	3,740	4,943	4,226	4,099	4,347	3,302	4,467	2,970	3,717	2,996		2,041	3,073	2,615	3,338	4,419
20	68	Jaria-Jhanjail	Netrokona	BWDB	3,330	3,634	4,043	3,675	2,694	2,922	3,822	4,952	3,539	3,789	3,779	3,035	3,945	2,435	3,352	2,379		2,740	3,959		3,385	4,885
21	113	Khaliajuri	Netrokona	BWDB	3,038	2,271	3,572	3,303	2,670	3,744	3,254	4,939	3,045	5,551	4,332	2,419	4,205	2,178	4,760	3,535	5,048	4,658	4,308	5,339	4,312	5,365
22	115	Kendua	Netrokona	BWDB	3,248	2,562	3,614	3,480	2,662				3,068	4,980	**5,949**	3,166	3,562	2,113	3,730	2,463			2,662	2,649	2,166	2,841
23	121	Mohanganj	Netrokona	BWDB	3,130	3,103	3,304	2,335	2,662	2,803	2,964		4,074	5,244	4,676	3,311	4,807	3,106	4,388	4,068		4,241	2,031	1,435	1,902	3,528
24	123	Netrokona	Netrokona	BWDB	2,463	3,114	3,491		2,178	3,063	3,293	4,327	3,371	3,721	4,221	3,375	3,976	2,619	3,474	3,076		3,072	3,404	2,972	2,211	3,421
25	74	Nalitabari	Sherpur	BWDB	2,596	2,132		3,243	2,029	2,569	2,796	3,639	3,107	3,439	3,637	1,746	2,969	2,026	2,675	2,309			2,436	2,661	1,821	2,863
26	78	Sherpur Town	Sherpur	BWDB	2,197	2,185	2,340	2,332	1,718	2,407	2,682	2,833	2,419	2,762	2,612	1,858	2,712	1,224	2,840	1,846		2,527	1,926		1,477	
27	227	Nakuagaon	Sherpur	BWDB				3,735	2,334	2,521	3,260	3,145	3,354	3,563	5,425	3,089	4,282	2,953	3,997							
28	2	Atia (Tangail)	Tangail	BWDB	1,677	1,546	2,286	2,355	1,644	2,510	1,732	2,133	1,502	1,814	3,079	1,821	2,582	2,398	3,049	1,908		1,038	1,488	1,702		
29	13	Gopalpur	Tangail	BWDB	1,850	1,025	1,684	2,448	1,289	1,960	1,766		1,561	1,411	1,455	2,551	2,052	1,486	1,890	1,268		1,442	1,284	1,516	1,604	2,610
30	18	Kalihati	Tangail	BWDB	1,375	902	2,132	**803**	1,369	1,859	1,946	2,218	1,593	1,361	1,643	1,433	2,235	1,245	1,662	1,392	1,414	1,976	1,663	1,753	1,629	2,052
31	21	Mirzapur	Tangail	BWDB	1,604	1,216	1,877	4,027	1,319	1,977	1,421	2,227	1,416	1,007	1,035	1,779	2,446	1,349	1,804	1,715		1,712	1,844	1,694	1,671	
32	10609	Mymensingh	Agri University, Mymensingh	BMD	2,187	2,354	2,840	2,679	1,559	2,971	2,209	3,209	2,274	2,439	3,312	1,584	3,213	1,604	2,645	1,620	2,208	2,347	2,174	2,266	1,948	2,395
33	41909	Tangail	Near Mosque	BMD																						
		Maximum			3,491	3,634	4,503	4,335	2,948	3,744	3,923	4,952	4,226	5,551	**5,949**	3,375	4,807	3,106	4,760	4,068	5,048	4,658	4,308	5,339	4,312	5,365
		Minimum			1,375	902	1,684	**803**	1,289	1,533	1,421	2,133	1,416	1,007	1,035	1,197	2,052	1,224	1,662	1,268	1,414	1,038	1,284	1,435	1,477	2,052

Source: BWDB and BMD rainfall data (1981 - 2002)

Table 3.2.3　Average Monthly Water Level at BWDB non-tidal Station in the Study Area

Serial No.	Code	Station Name	Location River Name	District	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
1	47	Bahadurabad	Brahmaputra-Jamuna	Jamalpur													
2	48	Jagannathganj	Brahmaputra-Jamuna	Jamalpur	9.02	8.70	8.85	9.91	11.36	13.26	14.58	14.45	14.23	12.96	10.79	9.62	11.48
3	134	Jukerchar	Jhenai	Jamalpur	8.27	8.15	7.97	7.89	8.43	9.94	11.58	11.62	11.52	10.25	8.68	8.41	9.39
4	**223**	**Goal Kanda**	**Old Brahmaputra**	**Jamalpur**	**18.38**	**18.25**	**18.13**	**18.18**	**18.79**	**19.94**	**21.07**	**20.81**	**20.59**	**19.69**	**18.76**	**18.51**	**19.26**
5	**224**	**Offtake of …**	**Old Brahmaputra**	**Jamalpur**													
6	**225**	**Jamalpur**	**Old Brahmaputra**	**Jamalpur**	**11.77**	**11.60**	**11.51**	**11.64**	**12.40**	**14.05**	**15.64**	**15.31**	**15.07**	**13.78**	**12.29**	**11.92**	**13.08**
7	**226**	**Oftake of …**	**Old Brahmaputra**	**Jamalpur**													
8	134A	Baushi Bridge	Jhenai	Jamalpur	10.61	10.42	10.29	10.32	11.30	13.16	14.75	14.52	14.27	12.97	11.24	10.82	12.06
9	134B	Offtake of Jhenai	Jhenai	Jamalpur	12.63	12.48	12.29	12.24	13.09	14.65	16.19	15.93	15.77	14.41	12.91	12.67	13.77
10	46.7L	Kholabarichar	Brahmaputra-Jamuna	Jamalpur	15.61	15.44	15.41	15.76	16.84	18.55	19.87	19.61	19.40	18.13	16.39	15.88	17.24
11	46.9L	Bahadurabad (Transit)	Brahmaputra-Jamuna	Jamalpur	13.64	13.38	13.59	14.59	15.99	17.71	18.90	18.67	18.47	17.24	15.24	14.20	15.97
12	47.3L	Jognaichar	Brahmaputra-Jamuna	Jamalpur													
13	311.4	Chamraghat	Mogra	Kishorganj	-	-	-	-	-	-	-	-	-	-	-	-	-
14	8	Basuri	Banar	Mymensingh	7.82	7.73	7.63	7.62	8.42	9.45	10.11	9.68	9.77	9.14	9.03	7.90	8.61
15	35.5	Sarchapur (Mymensingh)	Bhogai-Kangsa	Mymensingh	8.02	7.67	7.33	7.64	9.25	11.00	12.11	11.77	11.49	10.42	8.72	8.32	9.48
16	**227**	**Offtake of Sutia**	**Old Brahmaputra**	**Mymensingh**	**7.43**	**7.26**	**7.13**	**7.21**	**8.13**	**10.00**	**11.96**	**11.57**	**11.37**	**9.96**	**8.12**	**7.62**	**8.98**
17	**228**	**Mymensingh**	**Old Brahmaputra**	**Mymensingh**													
18	**228.5**	**Mymensingh**	**Old Brahmaputra**	**Mymensingh**	**6.87**	**6.68**	**6.53**	**6.61**	**7.43**	**9.22**	**10.95**	**10.72**	**10.43**	**9.09**	**7.45**	**7.04**	**8.25**
19	314	Ghosegaon	Nitai	Mymensingh	13.21	13.84	14.00	13.91	13.54	14.57	14.50	14.29	14.18	13.58	13.13	13.00	13.77
20	36	Jaria-Jhanjail	Bhogai-Kangsa	Netrokona	4.76	4.37	4.26	4.76	6.59	8.58	9.79	9.43	9.08	7.85	5.91	5.23	6.72
21	36.1	Mohangonj	Bhogai-Kangsa	Netrokona	4.29	3.67	3.15	3.72	5.23	6.43	7.13	7.06	6.82	6.12	4.82	4.40	5.24
22	262	Bijoypur	Sameswari	Netrokona	13.36	13.28	13.24	13.39	13.83	14.60	15.09	14.78	14.65	14.19	13.67	13.47	13.96
23	263	Durgapur	Sameswari	Netrokona	10.30	10.25	10.21	10.35	10.74	11.54	11.95	11.65	11.56	11.11	10.60	10.42	10.89
24	263.1	Kalmakanda	Sameswari	Netrokona	2.85	2.17	2.25	3.64	5.22	6.39	7.21	7.12	6.83	6.21	4.97	3.85	4.89
25	310	Netrokona	Mogra	Netrokona	4.10	3.66	3.46	3.71	5.23	7.09	8.28	8.23	7.93	7.01	4.99	4.20	5.66
26	311	Atpara	Mogra	Netrokona	4.34	3.84	3.66	4.38	5.92	7.32	8.21	8.20	7.95	7.30	5.77	4.97	5.99
27	344	Ghog Bazar	Saiduli Baruni	Netrokona	2.55	2.10	2.20	2.92	4.31	6.13	7.12	7.23	7.12	6.07	4.68	3.22	4.64
28	34	Nakuagaon	Bhogai-Kangsa	Sherpur	20.31	21.13	20.22	20.31	20.68	21.32	21.82	21.54	21.45	20.96	20.49	20.36	20.88
29	35	Nalitabari	Bhogai-Kangsa	Sherpur	14.43	14.41	14.33	14.40	14.80	15.38	15.91	15.61	15.51	15.03	14.58	14.45	14.90
30	53	Bath Kuchi	Chellakhali	Sherpur	23.81	23.78	23.75	23.82	23.98	24.19	24.42	24.31	24.32	24.10	23.92	23.87	24.02
31	12	Madhupur	Bangshi	Tangail	7.50	7.64	7.48	7.22	7.81	9.04	10.58	10.70	10.66	9.76	8.06	7.65	8.67
32	13	Kawaljani	Bangshi	Tangail	6.48	6.09	5.83	5.87	6.74	8.27	9.73	9.95	9.96	9.33	7.50	6.72	7.71
33	14	Mirzapur	Bangshi	Tangail	2.53	2.04	1.81	1.99	3.22	5.10	7.38	7.98	7.92	6.67	3.93	2.92	4.46
34	50	Porabari	Brahmaputra-Jamuna	Tangail	6.22	5.83	5.97	6.98	8.19	9.59	11.08	11.13	11.03	9.78	8.16	7.01	8.41
35	186	Jugini	Louhajang	Tangail													
36	342	Nolsafa	Futikjani	Tangail	7.38	7.01	6.54	6.55	7.28	8.60	10.50	10.89	10.88	9.52	7.83	7.54	8.38
37	343.5	Bhuiynapur	Futikjani	Tangail	-	-	-	-	-	-	-	-	-	-	-	-	-
38	68A	Elashin	Dhaleswari	Tangail	5.72	5.73	5.63	5.73	6.13	7.97	9.57	9.87	9.75	8.14	6.40	5.88	7.21

Source :　BWDB daily average water level data (1981 - 2002)

Table 3.2.4   Annual Average Water Level at BWDB non-tidal Station in the Study Area (1981 – 1998)

Serial No.	Code	Station Name	Location River Name	District	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	47	Bahadurabad	Brahmaputra-Jamuna	Jamalpur																		
2	48	Jagannathganj	Brahmaputra-Jamuna	Jamalpur				11.63	11.75	11.44	11.77	11.58	11.32	11.32	11.38	11.45	11.64	10.89	11.34	11.38	10.98	12.18
3	134	Jukerchar	Jhenai	Jamalpur	9.02	8.61	9.23	9.63	9.40	9.40	9.81	9.61	9.41	9.57	9.64	9.10	9.64	9.44	9.42	9.30	9.16	9.65
4	**223**	**Goal Kanda**	**Old Brahmaputra**	**Jamalpur**	**19.38**	**19.18**	**19.05**	**19.27**	**19.18**	**19.00**	**19.38**	**19.57**	**19.58**	**19.53**	**19.71**	**19.38**	**19.54**	**19.11**	**19.44**	**19.02**	**18.72**	**19.58**
5	**224**	**Offtake of …**	**Old Brahmaputra**	**Jamalpur**																		
6	**225**	**Jamalpur**	**Old Brahmaputra**	**Jamalpur**	**13.14**	**13.16**	**13.26**	**13.36**	**13.54**	**12.95**	**13.23**	**13.29**	**13.00**	**13.12**	**13.33**	**12.82**	**13.15**	**12.48**	**13.08**	**13.00**	**12.70**	**13.39**
7	**226**	**Oftake of …**	**Old Brahmaputra**	**Jamalpur**																		
8	134A	Baushi Bridge	Jhenai	Jamalpur	11.76	11.77	12.15	12.33	12.19	11.89	12.24	12.37	12.10	12.31	12.43	12.01	12.42	11.76	12.33	11.96	11.71	12.25
9	134B	Offtake of Jhenai	Jhenai	Jamalpur	13.96	13.55	13.97	14.54	13.69	13.50	13.70	13.81	13.53	13.87	14.11	13.57	14.09	13.35				
10	46.7L	Kholabarichar	Brahmaputra-Jamuna	Jamalpur	16.84	16.72	16.75	17.10	17.22	17.10	17.11	17.27	17.33	17.39	17.31	17.09	17.45	17.07	17.39	17.35	17.16	17.88
11	46.9L	Bahadurabad (Transit)	Brahmaputra-Jamuna	Jamalpur	15.74	15.64	15.94	16.04	16.07	15.67	15.96	16.18	16.18	16.31	16.21	15.94	16.29	15.75	16.01	16.15	15.72	16.13
12	47.3L	Jognaichar	Brahmaputra-Jamuna	Jamalpur																		
13	311.4	Chamraghat	Mogra	Kishorganj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	8	Basuri	Banar	Mymensingh			8.59	8.88	8.49	8.79	8.67	8.94	8.61	8.63	9.05	8.23	9.03	8.36	8.75	8.13	8.39	8.71
15	35.5	Sarchapur (Mymensingh)	Bhogai-Kangsa	Mymensingh	9.69	9.40	9.69	9.89	9.28	9.42	9.75	9.85	9.46	9.85	9.75	9.12	9.68	9.08	9.24	9.18	9.15	9.54
16	**227**	**Offtake of Sutia**	**Old Brahmaputra**	**Mymensingh**	**8.81**	**8.77**	**8.88**	**9.18**	**9.33**	**8.70**	**9.18**	**9.36**	**8.92**	**9.08**	**9.27**	**8.69**	**9.08**	**8.45**	**9.10**	**8.94**	**8.76**	**9.29**
17	**228**	**Mymensingh**	**Old Brahmaputra**	**Mymensingh**																		
18	**228.5**	**Mymensingh**	**Old Brahmaputra**	**Mymensingh**	**8.36**	**8.31**			**8.65**	**8.22**	**8.50**	**8.65**	**8.33**	**8.37**	**8.54**	**8.00**	**8.32**	**7.61**	**8.26**	**8.15**	**7.87**	**8.56**
19	314	Ghosegaon	Nitai	Mymensingh	13.04	13.14	14.55	14.51	14.37	14.36	13.98	13.64	13.57	13.68	14.96	13.62	13.89	13.67	13.77	13.57	13.38	13.47
20	36	Jaria-Jhanjail	Bhogai-Kangsa	Netrokona	6.73	6.55	6.87	7.01	6.42	6.54	6.91	7.16	6.92	7.12	7.07	6.37	6.86	6.18	6.42	6.39	6.28	6.64
21	36.1	Mohangonj	Bhogai-Kangsa	Netrokona	4.88	4.97		5.32	5.17	5.14	5.40	5.49	5.23	5.50	5.41	5.26	5.53	5.12	5.04	5.24	4.84	5.14
22	262	Bijoypur	Sameswari	Netrokona	13.55	13.72	13.97	14.04	13.82	13.76	13.93	14.29	14.22	14.11	14.26	13.95	14.20	13.99	14.05	14.01	13.90	
23	263	Durgapur	Sameswari	Netrokona	10.69	10.62			10.26	10.45	10.74	10.89	10.56	10.73	10.78	10.64	10.94	11.20	11.20	11.26	11.16	11.25
24	263.1	Kalmakanda	Sameswari	Netrokona	4.13	4.42	4.77	4.95	5.23	4.67	5.06	4.82	5.80	5.82	4.77	4.76	5.08	4.78	4.66			
25	310	Netrokona	Mogra	Netrokona	6.72	6.51	6.89	6.82	6.43	5.74	5.53	5.87	5.45	5.62	5.68	5.05	5.54	4.86	5.16	4.96	5.57	5.25
26	311	Atpara	Mogra	Netrokona			8.93			5.96	5.47	5.72	5.36	5.60	5.50	5.01	5.34	4.95	4.97	5.22	5.57	6.23
27	344	Ghog Bazar	Saiduli Baruni	Netrokona																	4.53	5.53
28	34	Nakuagaon	Bhogai-Kangsa	Sherpur	20.83	20.80	20.87	22.54	20.77	20.76	20.92	21.02	20.92	21.02	21.10	20.93	21.13	20.85	21.03	20.69	20.49	20.65
29	35	Nalitabari	Bhogai-Kangsa	Sherpur	15.01	14.95	15.02	15.10	14.91	14.91	14.81	15.10	14.95	14.99	14.99	14.76	14.95	14.75	14.87	14.80	14.68	14.79
30	53	Bath Kuchi	Chellakhali	Sherpur	24.01	24.01	23.99	24.01	24.20	24.18	24.09	24.08	24.06	24.18	24.12	24.01	24.04	23.96	23.91	24.10	24.11	24.08
31	12	Madhupur	Bangshi	Tangail	8.60	8.29	8.67	9.13	8.74	8.77	8.94	9.23	8.48	8.82	9.09	8.12	8.96	7.92	8.81	8.33	8.32	9.03
32	13	Kawaljani	Bangshi	Tangail	8.31	7.56	7.77	8.11	7.80	7.88	8.04	7.98	7.71	7.79	8.06	7.25	7.92	7.13	7.48	7.50	7.41	
33	14	Mirzapur	Bangshi	Tangail	4.60	3.80	4.22	5.01			4.73	5.02	4.75	5.06	5.08	3.92	4.78	3.87	4.37	4.15	3.93	4.63
34	50	Porabari	Brahmaputra-Jamuna	Tangail	8.36	8.11	8.56	8.60	8.61	7.97	8.28	8.27	8.45	8.47	8.17	7.63	8.60	8.24	8.33	8.47	8.51	8.89
35	186	Jugini	Louhajang	Tangail																		
36	342	Nolsafa	Futikjani	Tangail																		8.63
37	343.5	Bhuiynapur	Futikjani	Tangail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	68A	Elashin	Dhaleswari	Tangail																	6.69	

Source : BWDB daily average water level data (1981 - 2002)

Table 3.3.1 District GDP of Current and Constant (1995/96) Price in the Study Area

District		Current Prices					Constant Prices (1995-96)				
		1995-96	1996-97	1997-98	1998-99	1999-2000	1995-96	1996-97	1997-98	1998-99	1999-2000
Mymensingh	Agriculture	20,081	19,694	22,777	25,443	27,720	20,081	19,315	20,498	21,713	24,695
	Crops and horticulture	8,927	9,936	11,015	12,694	13,186	8,927	9,670	9,600	10,452	12,193
	Animal farming	2,249	2,343	2,517	2,672	2,836	2,249	2,300	2,369	2,417	2,478
	Forest and related services	1,306	1,419	1,551	1,758	1,870	1,306	1,358	1,420	1,493	1,567
	Fishing	7,599	5,996	7,695	8,330	9,828	7,599	5,784	7,130	7,350	8,957
	Industry	6,842	7,623	8,628	9,442	10,494	6,842	7,387	8,006	8,544	9,217
	Service	22,752	23,957	26,540	29,406	32,546	22,752	23,194	24,385	25,795	27,548
	Import duty	1,829	1,848	1,940	2,057	2,358	1,829	1,839	1,923	2,028	2,199
	GDP at market prices	51,504	53,122	59,884	66,348	73,117	51,507	51,736	54,813	58,080	63,859
	Growth rate (%)	-	3.14	12.73	10.79	10.20	-	0.45	5.95	5.96	9.95
	Per capita GDP (Tk.)	11,477	11,665	12,963	14,163	15,430	11,477	11,361	11,866	12,416	13,476
	Per capita GDP (US$)	281	273	285	295	307	281	266	261	258	268
	Share of Agriculture in DGDP	39.0%	37.1%	38.0%	38.3%	37.9%	39.0%	37.3%	37.4%	37.4%	39.0%
Tangail	Agriculture	10,069	11,222	12,194	13,819	14,463	10,069	10,953	10,893	10,539	11,654
	Crops and horticulture	6,979	7,722	8,513	9,714	10,101	6,979	7,576	7,267	6,900	7,877
	Animal farming	1,651	1,745	1,838	1,946	2,074	1,651	1,690	1,731	1,773	1,818
	Forest and related services	921	1,001	1,093	1,240	1,319	921	958	1,001	1,053	1,105
	Fishing	518	754	750	920	969	518	727	694	812	854
	Industry	6,561	7,274	8,213	8,890	9,779	6,561	7,022	7,568	8,011	8,582
	Service	15,724	17,009	18,612	20,397	22,360	15,724	16,452	17,096	17,828	18,816
	Import duty	1,112	1,263	1,249	1,260	1,388	1,112	1,257	1,238	1,242	1,290
	GDP at market prices	33,466	36,768	40,268	44,366	47,986	33,466	35,683	36,586	37,620	40,343
	Growth rate (%)	-	9.87	9.52	10.18	8.16	-	6.63	2.47	2.86	7.24
	Per capita GDP (Tk.)	9,803	10,608	11,446	12,454	13,297	9,803	10,296	10,394	10,560	11,179
	Per capita GDP (US$)	240	248	252	259	264	240	241	229	220	222
	Share of Agriculture in DGDP	30.1%	30.5%	30.3%	31.1%	30.1%	30.1%	30.7%	29.2%	28.0%	28.9%
Jamalpur	Agriculture	6,630	7,250	7,869	9,085	9,582	6,630	7,098	7,404	7,898	8,494
	Crops and horticulture	4,415	4,890	5,475	6,321	6,651	4,415	4,824	5,159	5,485	5,901
	Animal farming	983	1,039	1,093	1,171	1,248	983	1,005	1,028	1,053	1,078
	Forest and related services	558	606	682	751	799	558	580	606	630	669
	Fishing	674	715	659	842	959	674	689	610	743	846
	Industry	3,794	4,207	4,778	5,218	5,771	3,794	4,076	4,422	4,712	5,064
	Service	10,383	11,225	12,375	13,742	15,037	10,383	10,859	11,368	12,041	12,687
	Import duty	661	740	761	819	808	661	736	755	800	829
	GDP at market prices	21,467	23,423	25,804	28,865	31,248	21,467	22,769	23,949	25,458	27,074
	Growth rate (%)	-	9.11	10.17	11.86	8.26	-	6.07	5.18	6.30	6.35
	Per capita GDP (Tk.)	10,056	10,802	11,716	12,946	13,804	10,056	10,500	10,676	11,417	11,986
	Per capita GDP (US$)	246	253	258	269	275	246	246	236	238	238
	Share of Agriculture in DGDP	30.88%	30.95%	30.57%	31.47%	30.57%	30.88%	31.17%	30.92%	31.02%	31.37%
Kishoreganj	Agriculture	9,799	10,273	11,399	12,836	13,658	9,799	9,972	10,455	10,779	11,806
	Crops and horticulture	5,456	5,797	6,241	7,123	7,389	5,456	5,656	5,678	5,753	6,349
	Animal farming	1,053	1,116	1,185	1,275	1,358	1,053	1,081	1,109	1,139	1,171
	Forest and related services	690	751	820	930	989	690	718	751	789	828
	Fishing	2,599	2,609	3,152	3,510	3,922	2,599	2,518	2,916	3,097	3,458
	Industry	4,063	4,530	5,120	5,565	6,167	4,063	4,385	4,742	5,031	5,419
	Service	12,358	13,172	14,374	15,787	17,256	12,358	12,758	13,204	13,859	14,600
	Import duty	919	997	1,033	1,077	1,184	919	992	1,024	1,061	1,105
	GDP at market prices	27,139	28,972	31,927	35,266	38,266	27,139	28,107	29,425	30,729	32,930
	Growth rate (%)	-	6.76	10.20	10.46	8.51	-	3.57	4.69	4.43	7.16
	Per capita GDP (Tk.)	10,400	10,948	11,899	12,988	13,903	10,400	10,621	10,967	11,310	11,964
	Per capita GDP (US$)	255	256	262	270	276	255	249	241	235	238
	Share of Agriculture in DGDP	36.11%	35.46%	35.70%	36.40%	35.69%	36.11%	35.48%	35.53%	35.08%	35.85%
Sherpur	Agriculture	4,492	5,007	5,769	6,511	6,734	4,492	4,917	5,251	5,443	5,593
	Crops and horticulture	3,029	3,448	3,907	4,525	4,606	3,029	3,416	3,537	3,700	3,746
	Animal farming	584	619	668	701	747	584	597	612	628	642
	Forest and related services	369	402	439	497	529	369	384	402	422	443
	Fishing	510	538	798	787	852	510	519	701	694	752
	Industry	2,084	2,313	2,613	2,858	3,171	2,084	2,243	2,426	2,587	2,783
	Service	5,648	6,340	7,031	7,750	8,403	5,648	6,133	6,449	6,798	7,081
	Import duty	399	455	482	510	535	399	454	476	503	489
	GDP at market prices	12,622	14,116	15,896	17,632	18,842	12,622	13,747	14,605	15,321	15,946
	Growth rate (%)	-	10.09	12.61	10.93	6.86	-	7.21	6.24	4.90	4.08
	Per capita GDP (Tk.)	9,883	10,725	11,896	13,033	13,748	9,883	10,445	10,931	11,324	11,635
	Per capita GDP (US$)	242	251	262	271	273	242	245	240	236	231
	Share of Agriculture in DGDP	35.03%	35.47%	36.29%	36.93%	35.74%	35.03%	35.77%	35.95%	35.53%	35.01%
Netrokona	Agriculture	9,968	10,203	11,298	12,741	13,614	9,968	9,960	10,242	10,624	11,807
	Crops and horticulture	5,529	5,827	6,432	7,285	7,543	5,529	5,740	5,741	5,811	6,594
	Animal farming	1,040	1,101	1,163	1,238	1,313	1,040	1,067	1,095	1,124	1,154
	Forest and related services	745	810	885	1,003	1,067	745	775	810	852	894
	Fishing	2,653	2,465	2,806	3,215	3,692	2,653	2,378	2,596	2,837	3,256
	Industry	2,655	2,948	3,315	3,637	4,049	2,655	2,862	3,090	3,301	3,561
	Service	9,370	9,927	10,901	12,075	13,315	9,370	9,613	9,997	10,579	11,258
	Import duty	814	958	870	924	1,041	814	853	862	911	972
	GDP at market prices	22,806	23,836	26,342	29,377	32,020	22,806	23,289	24,191	25,413	27,678
	Growth rate (%)	-	4.96	10.05	11.52	9.00	-	2.12	3.87	5.05	8.91
	Per capita GDP (Tk.)	11,596	11,990	13,004	14,322	15,410	11,596	11,866	11,943	12,389	13,320
	Per capita GDP (US$)	284	281	286	298	306	284	273	253	258	265
	Share of Agriculture in DGDP	43.71%	42.60%	42.73%	43.37%	42.52%	43.71%	42.77%	42.34%	41.81%	42.95%

Source: Statistic Yearbook of Bangladesh 2001, BBS, Table 11.63, 64, 68, 71, 74, 75, 76

Table 3.4.1　Major Crop, Area, Production and Yield in the Study Area (1999/2000)

Crops	Jamalpur [1]			Kishoreganj [2]			Mymensingh			Tangail		
	Area Acres	Production M.Tons	Yield Ton/ha	Area Acres	Production M.Tons	Yield Ton/ha	Area Acres	Production M.Tons	Yield Ton/ha	Area Acres	Production M.Tons	Yield Ton/ha
Rice												
Aus	73,760	28,300	0.95	131,680	81,420	1.53	194,930	100,660	1.28	71,400	26,660	0.92
Aman	422,720	295,220	1.73	515,480	380,920	1.83	612,230	467,410	1.89	313,510	229,520	1.81
Boro	349,460	419,870	2.97	791,260	960,670	3.00	478,340	602,130	3.11	323,240	388,080	2.97
Total Rice	845,940	743,390	2.17	1,438,420	1,423,010	2.44	1,285,500	1,170,200	2.25	708,150	644,260	2.25
Wheat	84,170	66,960	1.97	41,480	32,030	1.91	31,090	22,610	1.80	78,390	56,790	1.79
Pulses	5,890	1,805	0.76	11,602	3,528	0.75	17,645	5,635	0.79	30,565	7,210	0.58
Oil seeds	20,285	6,195	0.75	35,226	18,045	1.27	16,920	6,575	0.96	128,150	20,490	0.40
Condiments & Spices	30,385	20,285	1.65	20,270	35,226	4.29	25,455	16,920	1.64	13,130	128,150	24.12
Sugarcane	14,200	261,960	45.59	815	10,130	30.71	11,650	172,640	36.62	16,325	245,595	37.17
Jute	64,770	254,550	9.71	43,760	170,660	9.64	34,040	119,140	8.65	65,260	262,350	9.93
		(bales)	(bales)		(bales)	(bales)		(bales)	(bales)		(bales)	(bales)
Tobacco	330	110	0.82	420	135	0.79	215	65	0.75	65	20	0.76
Banana	2,505	14,575	14.38	2,035	14,115	17.14	2,795	16,390	14.49	3,540	19,580	13.67
Mango	3,255	3,885	2.95	2,780	3,980	3.54	2,920	4,560	3.86	6,715	6,850	2.52
Pineapple	255	615	5.96	160	350	5.41	1,495	3,545	5.86	6,110	27,385	11.08
Jackfruit	755	2,595	8.49	1,795	4,235	5.83	2,495	8,390	8.31	5,285	22,650	10.59
Total Fruits												
Potato	12,630	50,730	9.93	15,955	67,440	10.44	14,385	33,265	5.71	11,695	36,090	7.63
Vegetables	14,040	48,720	8.57	9,965	33,115	8.21	15,825	46,390	7.24	14,255	38,740	6.72

Ref : Yearbook of Agricultural Statistics of Bangladesh, 2000

Notes:　　1) Jamalpur includes Sherpur dsistrict
　　　　　2) Kishoreganj includes Netrakone district

Table 3.4.2 Number and Catch of Subsistence Fisheries Households in the Study Area

District	Items			1998	1999	2000	2001	2002
Jamalpur District.	Annual Catches (MT) by Water Bodies		River	1,985	1,708	963	905	755
			Beel*					2,287
			Floodland	4,522	4,535	4,377	6,948	6,746
			Pond	3,286	4,184	4,623	2,272	3,241
			Shrimp farm					
			Total	9,793	10,427	9,963	10,125	13,029
	Subsistence Fisheries Household ('000)			323	323	323	323	409
	Average Catch per Household(Kg)			14	14	14	22	17
	Estimated Total Estimated (MT)			4,535	4,535	4,377	6,948	6,746
Kishoreganji District	Annual Catches (MT) by Water Bodies		River	11,145	2,712	1,795	1,316	1,284
			Beel*					5,584
			Floodland	23,104	18,254	23,389	31,214	19,191
			Pond	10,933	13,089	8,410	7,167	9,237
			Shrimp farm	5	5	8	11	16
			Total	45,187	34,060	33,602	39,708	35,312
	Subsistence Fisheries Household ('000)			274	274	274	274	343
	Average Catch per Household(Kg)			84	67	85	114	38
	Estimated Total Estimated (MT)			23,104	18,254	23,389	31,214	12,973
Mymensingh District	Annual Catches (MT) by Water Bodies		River	3,753	2,818	3,444	2,587	2,607
			Beel*	18,300	18,878	20,143	20,437	5,332
			Floodland	44,190	30,649	33,946	29,697	25,270
			Pond	21,473	18,617	21,052	22,819	23,314
			Shrimp farm					
			Total	87,716	70,962	78,585	75,540	56,523
	Subsistence Fisheries Household ('000)			520	520	520	520	656
	Average Catch per Household(Kg)			85	59	65	57	39
	Estimated Total Estimated (MT)			44,190	30,649	33,946	29,697	25,270
Netrokona District	Annual Catches (MT) by Water Bodies		River	3,440	848	808	715	1,344
			Beel*					8,013
			Floodland	19,925	14,203	6,872	9,249	8,867
			Pond	11,262	11,988	13,783	13,921	15,682
			Shrimp farm					
			Total	34,627	27,039	21,463	23,885	33,906
	Subsistence Fisheries Household ('000)			262	262	262	262	325
	Average Catch per Household(Kg)			76	54	26	35	27
	Estimated Total Estimated (MT)			19,925	14,203	6,872	9,249	8,867
Sherpur District	Annual Catches (MT) by Water Bodies		River	169	223	46	78	85
			Beel*					2,330
			Floodland	6,754	5,838	5,507	2,575	3,830
			Pond	1,585	2,642	2,741	1,905	2,486
			Shrimp farm					
			Total	8,508	8,703	8,294	4,558	8,731
	Subsistence Fisheries Household ('000)			187	187	187	187	238
	Average Catch per Household(Kg)			36	31	29	14	16
	Estimated Total Estimated (MT)			6,754	5,838	5,507	2,575	3,830
Tangail District	Annual Catches (MT) by Water Bodies		River	605	955	928	1,072	1,032
			Beel*	2,273	2,387	2,250	2,282	1,456
			Floodland	3,533	5,034	7,002	5,917	9,341
			Pond	4,341	4,913	5,902	5,301	5,605
			Shrimp farm					
			Total	10,752	13,289	16,082	14,572	17,434
	Subsistence Fisheries Household ('000)			320	320	320	320	407
	Average Catch per Household(Kg)			11	16	22	18	18
	Estimated Total Estimated (MT)			3,533	5,034	7,002	5,917	7,263
Study Area	Annual Catches (MT) by Water Bodies		River	21,097	9,264	7,984	6,673	7,107
			Beel*	20,573	21,265	22,393	22,719	25,002
			Floodland	102,028	78,513	81,093	85,600	73,245
			Pond	52,880	55,433	56,511	53,385	59,565
			Shrimp farm	5	5	8	11	16
			Total	196,583	164,480	167,989	168,388	164,935
	Subsistence Fisheries Household ('000)			1,886	1,886	1,886	1,886	2,378
	Average Catch per Household(Kg)			307	241	242	260	154
	Estimated Total Estimated (MT)			102,041	78,513	81,093	85,600	64,949

*: Old statistic system from 1998 to 2001, in which catches in all districts
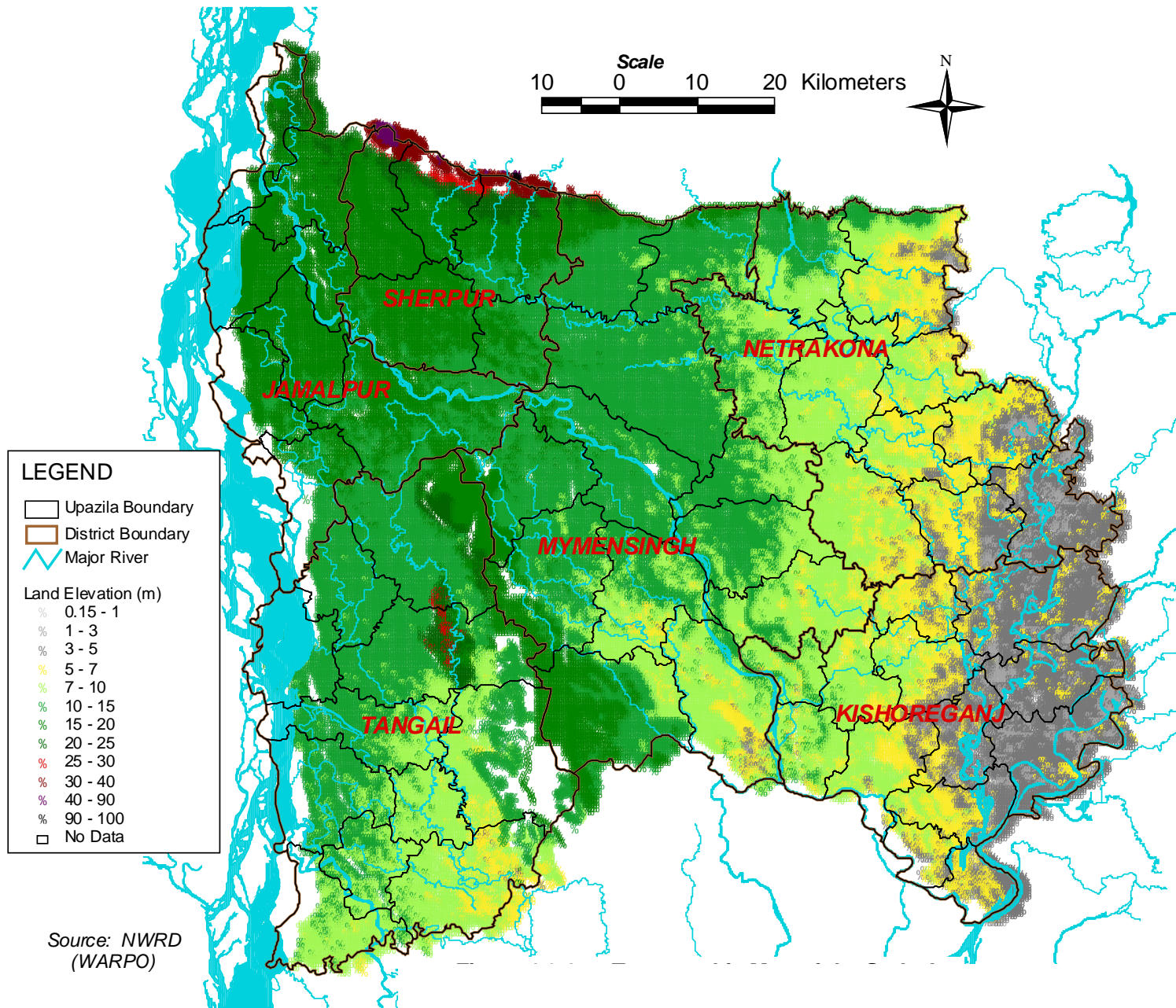were combined and recorded as a catch in Mymensingh District.

Source, Fisheries Statistical Yearbook of Bangladesh, Department of Fisheries
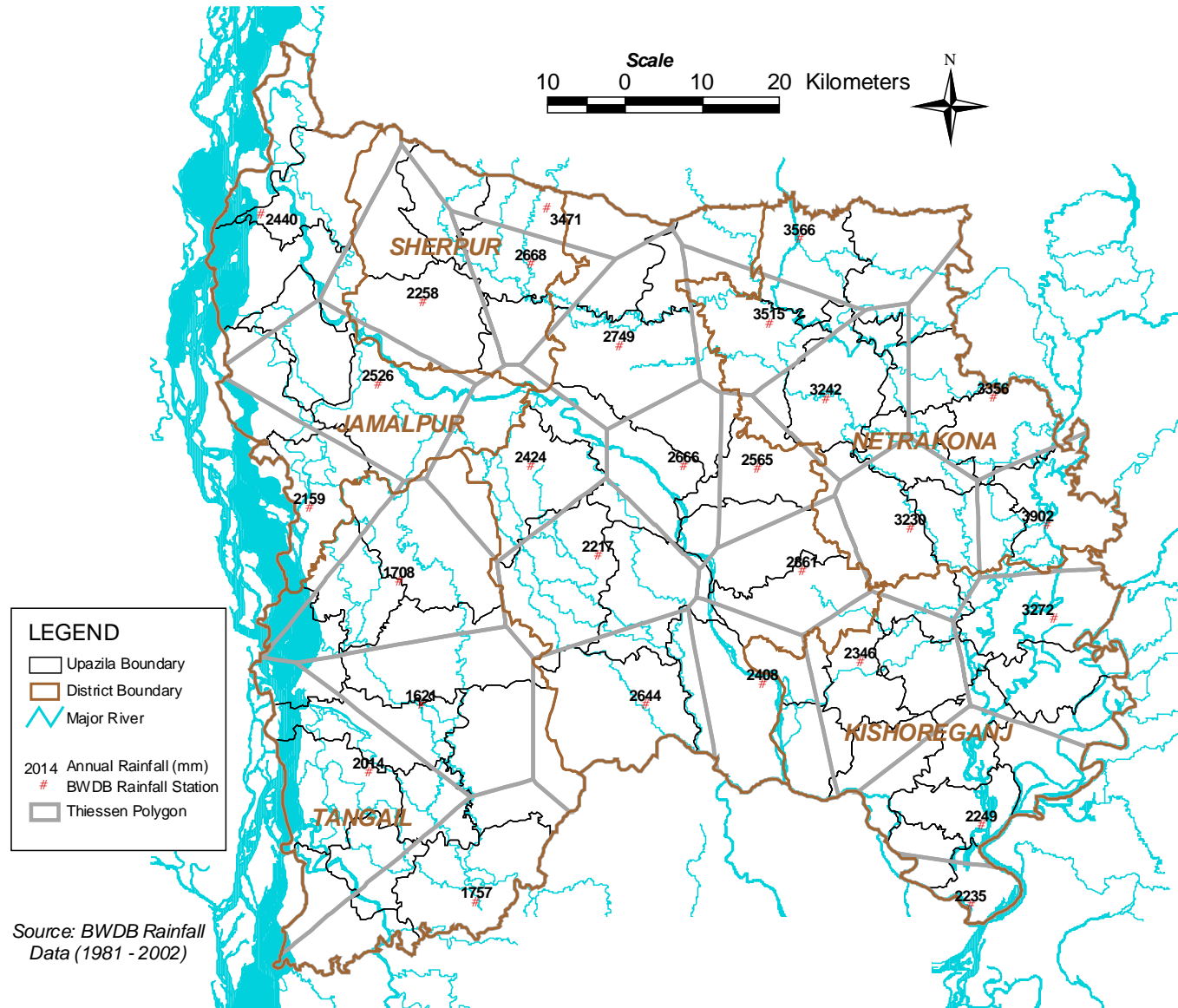
Table 3.6.1   Inventory on Large Scale FCD Projects of BWDB in the Study Area

No.	GIS Area (ha)	NWMP Code	BWDB Code	Hydrologic Zone	Name of District	Name of Structure	Length of Embankment (km)	Length of Canal (km)	No. of Regulator or Sluice Gate	No. of Pump	No. of Tube Well	Old Type of System	New Type of System	Code Type	Project Area (ha)	Benefited Area Irrigation (ha)	Benefited Area Proper Drainage (ha)	Benefited Area Flood Control (ha)	Starting Year	Completion Year	Overall Cost	Cost in Terms of Wheat	Status
1	2,871	113	43900	NC	Jamalpur	Gobakhali Khal Brdg Cum Regltr	1.21	9.66	1	0	0	FCDI	FCDI	03	1,710	710	350	365	1979	1982	0.28	0	Complete
2	2,259	72	44400	NE	Jamalpur	Dewanganj Protection Scheme	0.00	9.50	0	0	0	DR	DR	05	18,212	0	7,300	0	1982	1986	1.98	0	Complete
3	2,852	122	72700	NC	Jamalpur	Banar River System	0.00	48.50	2	0	0	DR	DR	05	284	0	284		1988			482	Complete
4	5,744	1121	910004	NC	Jamalpur	Ganakkhali Sub-Project	14.97	0.00	0	0	0	FCD	FCD	02	2,665	0	630	1,750	1992	1993	1.01	36	Complete
5	8,760	123	44200	NC	Jamalpur, Mymensingh	Rouha Bakchori & Other Beel System	17.50	4.45	1	0	0	FCD	FCD	02	810	0	810	500	1983	1987	0.27	0	Complete
6	9,583	148	11600	NC	Jamalpur, Tangail	Kabaria Bari System	36.00	11.00	2	0	0	FCDI	FCDI	03	6,342	1,790	2,190	800	1990		0.06	142	Complete
7	4,051	140	44300	NC	Jamalpur, Tangail	Katakhali Sub- Project	0.00	0.00	1	0	0	FCDI	FCDI	03	2,662	1,110	550	565	1981	1983	0.95	0	Complete
8	4,836	204	14100	NC	Kishoreganj	Adampur Sub-Project	0.00	6.00	0	0	0	FCD	FCD	02	1,440	0	680	1,200	1990	1992	0.6	0	Complete
9	21,362	183	43400	NC	Kishoreganj	Re-Excavation Of Singua River	0.00	50.00	0	0	0	IRRI & DR	I + DR	06	12,500	800	10,100	0	1976	1979	0.95	0	Complete
10	9,879	171	43600	NC	Kishoreganj	Baraikhali Khal Sub-Project	5.30	8.50	1	0	0	FCDI	FCDI	03	9,385	180	1,830	7,500	1992	1993	1.39	0	Complete
11	1,922	199	43800	NC	Kishoreganj	Alalia Bahadia. Sub-Project	0.00	7.00	1	0	0	FCDI	FCDI	03	1,822	115	610	1,797	1981	1983	0.23	0	Complete
12	2,238	188	45500	NC	Kishoreganj	Charfaradee-Jangalia Sub-Proj.	11.62	0.00	4	0	0	FCD	FCD	02	3,485	0	310	3,015	1989	1991	0.77	0	Complete
13	4,662	200	58800	NC	Kishoreganj	Humaipur Haor Project	57.75	29.00	8	0	0	FCDI	FCDI	03	5,263	280	530	3,110	1957	1986	1.04	0	Complete
14	6,414	169	59200	NC	Kishoreganj	Gazaria Beel Project	0.00	18.50	2	0	0	FCDI	FCDI	03	2,030	200	850	1,650	1985	1986	1.2	0	Complete
15	11,286	1110	74302	NC	Kishoreganj	Re-Excavation Of Bardal Khal	0.00	16.00	0	0	0	FC	FC	01	2,591	0	0	2,591	1992	1994	1.16	0	Complete
16	1,675	168	100400	NE	Kishoreganj	Bashira River Re-Excavation	0.00	20.00	2	0	0	FCI	FCDI		7,150	1,600		1,900	1981	1987	0.25		Complete
17	2,045	1112	261122	NC	Kishoreganj	Modkhola-Bhairagirchar Sub-Pro Project	10.80	0.00	1	0	0	FCD	FCD	02	2,060	0	680	1,855	1990	1993	0.66	635	Complete
18	1,621	1122	261123	NC	Kishoreganj	Dewghar Haor Sub-Project	15.40	0.00	6	0	0	FCD	FCD	02	231	0	0	231	1991	1993	0.88	0	Complete
19	12,048	190	58900	NC	Mymensingh	Shilla River Sub-Project	38.00	0.00	9	0	0	FCDI	FCDI	03	12,024	2,885	9,619	9,619	1986	1994	8.71	0	Complete
20	3,058	1123	74312	NC	Mymensingh	Re-Excavation Baralia Khal	0.00	12.00	0	0	0	DR	DR	05	2,000	0	0	0	1977	1978	0.3	0	Complete
21	3,069	155	34700	NC	Mymensingh	Ujanpara Komarbhanga Sub- Project	18.57	8.50	1	0	0	FCDI	FCDI	03	1,556	464	1,160	1,160	1990	1992	0.48	692	Complete
22	1,317	187	42200	NC	Mymensingh	Laithi River Sub-Project	0.00	11.90	2	0	0	FCDI	FCDI	03	2,000	400	1,210	1,210	1989	1990	1.02	0	Complete
23	4,104	152	56500	NC	Mymensingh	Bannyar Khal Sub-Project	6.00	6.00	1	0	0	FCDI	FCDI	03	1,542	346	1,155	1,155	1990	1992	0.46	0	Complete
24	8,822	133	59300	NC	Mymensingh	Dublakuri Kala Khal Project	0.00	8.00	3	0	0	FCDI	FCDI	03	11,141	3,565	8,913	8,913	1979	1985	0.72	0	Complete
25	2,834	193	74300	NC	Mymensingh	Suktajuri Project	20.00	0.00	7	0	0	FCDI	FCDI	03	3,650	1,180	2,950	2,950	1986	1992	1.78	0	Complete
26	2,366	1125	74303	NC	Mymensingh	Boka Beel Sub-Project	5.93	0.60	1	0	0	FCDI	FCDI	03	1,893	793	1,698	1,698	1994	1995	0.88	0	Complete
27	3,574	1116	74306	NC	Mymensingh	Garamara Sluice Project	0.00	6.00	1	0	0	FCDI	FCDI	03	813	200	650	650	1959	1959	0.2	0	Complete
28	2,316	185	74400	NC	Mymensingh	Khiro River Sub-Project	0.00	12.00	3	0	0	FCD	FCD	02	3,040	0	2,960	2,960	1988	1992	2.91	0	Complete
29	1,215	137	108300	NC	Mymensingh	Shambhuganj Embankment Project	5.03	0.00	0	0	0	FC	FC	01	7,670	0	0	6,500	1977	1978	0.43	14,548	Complete
30	416	143	108300	NC	Mymensingh	Shambhuganj Embankment Project	5.03	0.00	0	0	0	FC	FC	01	7,670	0	0	6,500	1977	1978	0.43	14,548	Complete
31	7,301	178	108400	NC	Mymensingh	Upper Shilla River Sub-Project	18.00	7.62	3	0	0	FCDI	FCDI	03	6,770	2,708	6,770	6,770	1986	1994	8.73	0	Complete
32	3,554	1128	74301	NC	Mymensingh, Kishoreganj	Sukaijuri Bathai Sub-Project	29.00	24.00	5	0	0	FCD	FCD	02	6,778	0	2,050	5,700	1990	1992	1.25	0	Complete
33	15,179	1120	72900	NE	Netrakona	Kangsha River Sub-Project	22.77	30.54	8	0	0	FCD1	FCD1	03	11,620	11,200	11,200	11,620	1982	1991	9.39	3,000	Complete
34	65	101	40900	NE	Netrakona	Pagner Haor System	32.41	8.26	2	0	0	FCD	FCD	02	19,000	0	17,200	17,200	1990	1995	8.49	1,256	Complete
35	72	117	41700	NE	Netrakona	Chandra Sunarthal Haor System	55.50	1.73	3	0	0	FCDI	FCDI	03	5,714	1,600	5,714	5,714	1974	1978	7.11		Complete
36	16,877	1118	59500	NE	Netrakona	Haijda Embankment Sub-Project	28.34	129.60	13	0	0	FCDI	FCDI	03	9,716	8,000	6,000	8,000	1982	1993	9.61	0	Complete
37	4,299	1113	71200	NE	Netrakona	Mohadao Nadi Embankment	16.93	0.00	0	0	0	FC	FC	01	2,800	0	0	2,000	1986				Complete
38	3,073	1115	105900	NE	Netrakona	Balali - Padmasree Sub-Proj	14.10	6.50	2	0	0	FCDI	FCDI	03	2,398	2,024	2,024	2,398	1984	1995	3.91	0	Complete
39	3,146	107	106000	NE	Netrakona	Thakurakona Sub-Project	13.15	0.00	3	0	0	FCDI	FCDI	03	3,160	2,400	2,400	2,680	1989	1992	4.29	0	Complete
40	6,185	1117	106100	NE	Netrakona	Nautana Khal Scheme	5.50	1.13	1	0	0	FCDI	FCDI	03	3,120	2,000	2,000	2,150	1985	1989	1.04	0	Complete
41	4,876	103	44100	NC	Sherpur	Janokipur Khal Regulator	0.37	1.25	1	0	0	FCDI	FCDI	03	950	380	200	197	1980	1982	0.38	0	Complete
42	2,277	78	58400	NC	Sherpur	Malijhee River Bridge Cum Reg.	0.00	0.00	1	0	0	IRR & DR	I + DR	06	3,832	1,990	1,073	0	1983	1986	0.46	0	Complete
43	7,397	73	58600	NC	Sherpur	Chilla Khali System Reh.	35.00	0.00	1	0	0	IRR & FC	FC		1,970	502	0	308	1982	1986	0.31	1,382	Complete
44	7,362	1124	910005	NC	Sherpur	Mirgi River System	0.00	0.00	1	0	0	FCD	FCD	02	316	0	300	300	1981	1982	0.38	0	Complete
45	32,333	156	58500	NC	Tangail	Pigna Jokerchar Project	36.50	10.00	7	0	0	FCD	FCD	02	11,821	0	3,400	5,000	1983	1988	2.45	3,135	Complete
46	2,669	210	44000	NC	Tangail	Pathakali Konaibeel And Bhulua Khal Project	23.34	5.00	2	0	0	FCDI	FCDI	03	4,127	405	1,600	2,672	1978	1983	3.72	296	Complete
47	592	151	44301	NC	Tangail	Noa Khal Sub-Project	0.00	0.00	1	0	0	FCD	FCD	02	1,024	0	500	500	1981	1983	0.25	0	Complete
48	9,759	159	44500	NC	Tangail	Bailgana Khal Project	9.08	10.36	2	0	0	FCDI	FCDI	03	4,896	1,000	1,000	300	1982	1992	0.8	1,164	Complete
49	1,139	208	58000	NC	Tangail	Barkati Beel Project	2.55	9.66	1	0	0	FCD	FCD	02	314	0	150	150	1981	1986	0.27	0	Complete
50	4,146	191	58100	NC	Tangail	Charan And Laxshmibasha Beel And Sapai River Project	45.24	16.76	3	0	0	FCDI	FCDI	03	4,230	700	800	1,330	1982	1983	0.85	1,315	Complete
51	7,731	174	72600	NC	Tangail	Futa Nadi Project	0.00	22.03	1	0	0	DR	DR	05	1,200	0	1,050	0	1980	1981	0.05	902	Complete
52	4,372	206	106400	NC	Tangail	Kamarnaogaon Project	21.14	4.82	3	0	0	FCD	FCD	02	6,200	0	3,000	2,000	1988	1991	2.06	82	Complete
53	1,578	1127	281201	NC	Tangail	Jhony Khal Sub-Project	7.90	3.95	3	0	0	FCDI	FCDI	03	1,796	1,500	708	600	1980	1993	1.35	0	Complete
54	1,568	1111	900150	NC	Tangail	Babupur Lauhati Fcd Project	20.69	7.62	1	0	0	FCD	FCD	02	4,100	0	1,500	2,000	1990	1992	1.15	591	Complete
55	3,719	213	910007	NC	Tangail	Moshajan- Lauhajan Sub Project	0.00	17.00	2	0	0	FCD	FCD	02	2,024	0	1,500	500	1985	1986	1.61	0	Complete
Total	300,466						706.62	620.94	131	0	0				255,517	53,027	130,158	152,233					

Source: National Water Resources GIS Data Base (NWRDB)

LEGEND

Upazila Boundary
District Boundary
Major River

Land Elevation (m)
% 0.15 - 1
% 1 - 3
% 3 - 5
% 5 - 7
% 7 - 10
% 10 - 15
% 15 - 20
% 20 - 25
% 25 - 30
% 30 - 40
% 40 - 90
% 90 - 100
□ No Data

*Source: NWRD
(WARPO)*

Scale

10   0   10   20   Kilometers
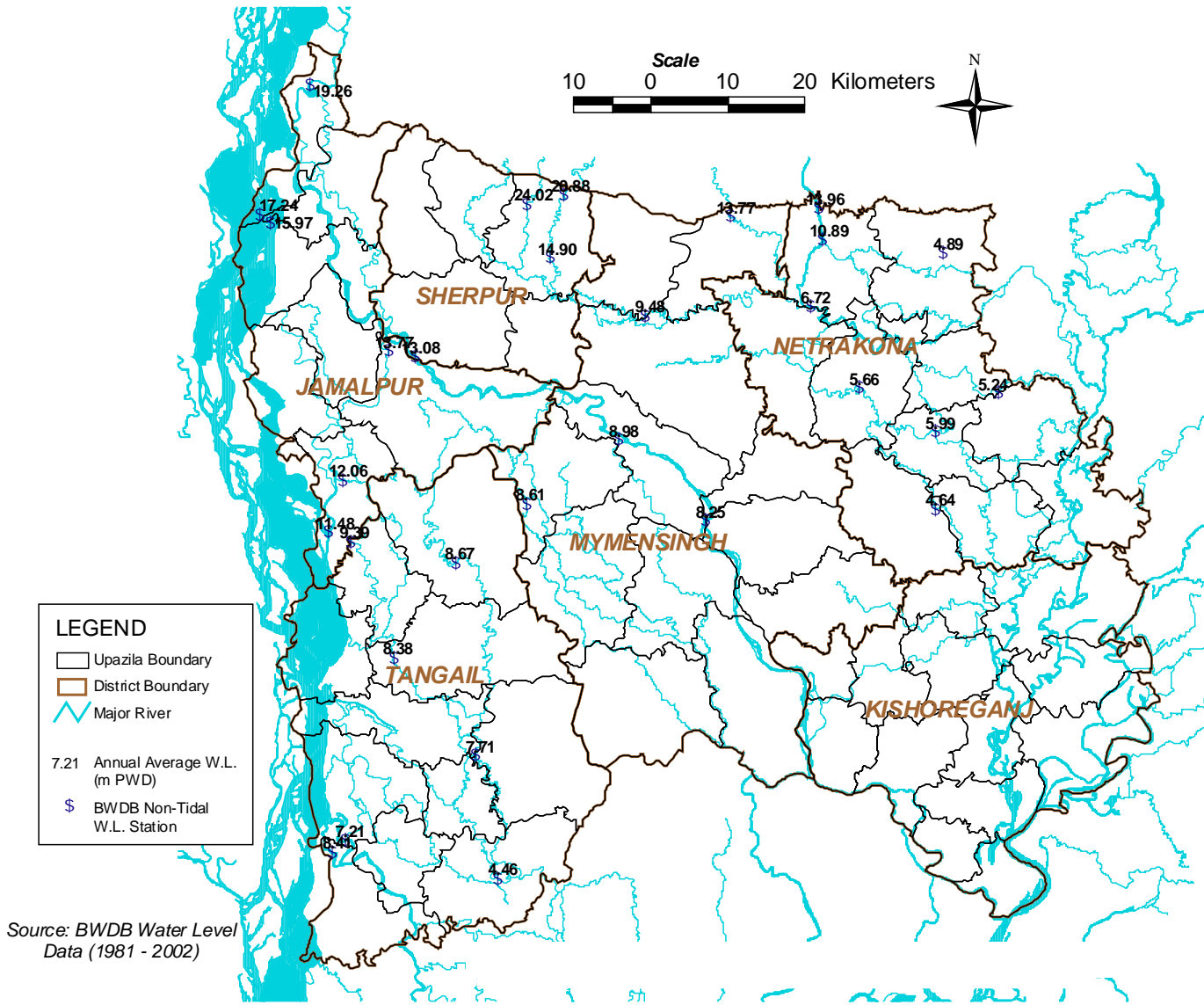
SHERPUR

JAMALPUR

NETRAKONA

MYMENSINGH

TANGAIL

KISHOREGANJ

Fig. 3.2.1   Topographic Map of the Study Area

Fig. 3.2.2   Location of Rainfall Station and Annual Mean Total Rainfall

Fig. 3.2.3   River System and Gauging Stations in the Study Area

Fig. 3.2.4   BWDB Gauging Stations and their Annual Average Water Level (Non-tide)
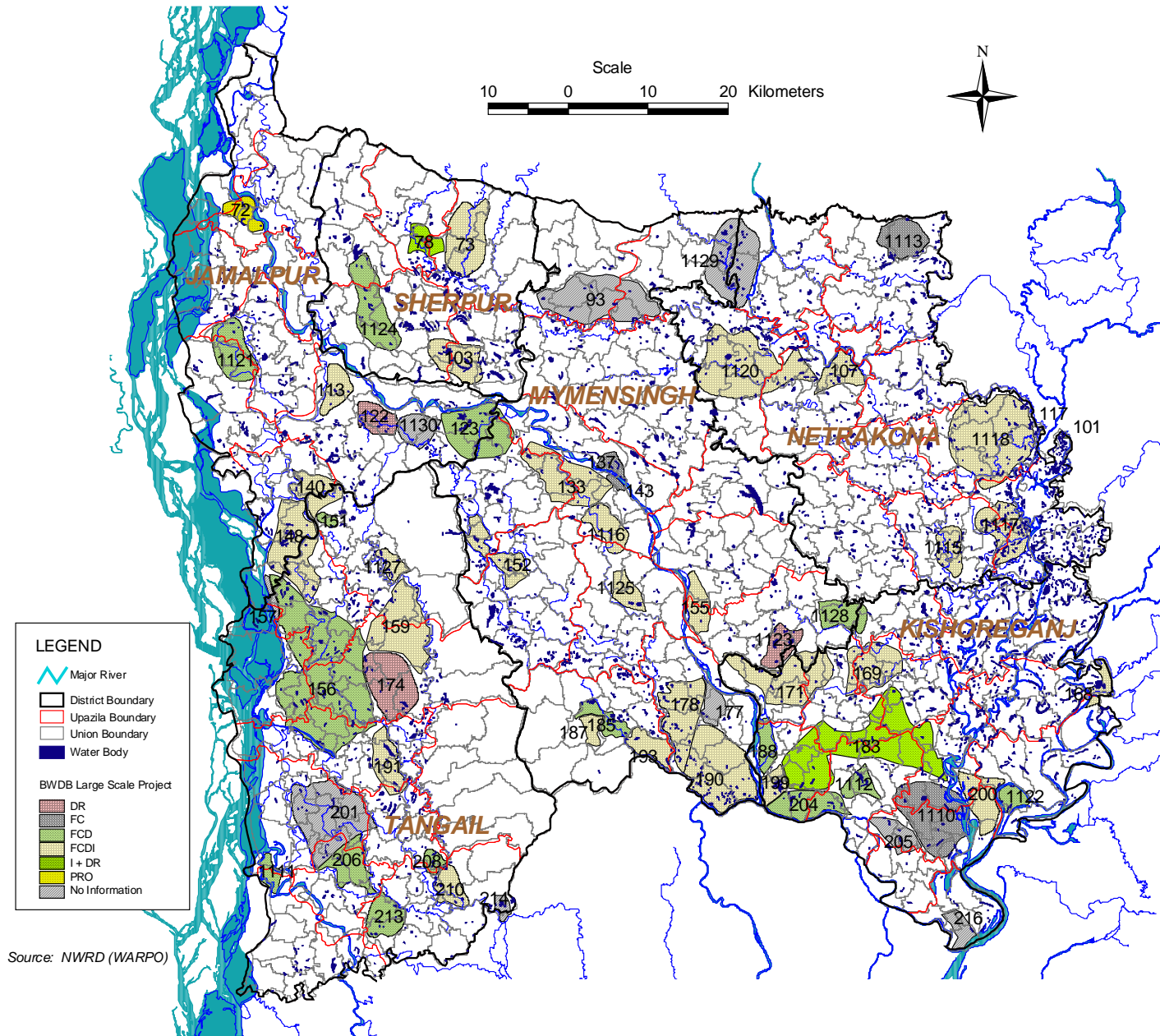
Fig. 3.2.5(1) Perennial Waterbodies and Large Scale FDC Projects of BWDB

LEGEND

Major River
District Boundary
Upazila Boundary
Union Boundary
Water Body

BWDB Large Scale Project
DR
FC
FCD
FCDI
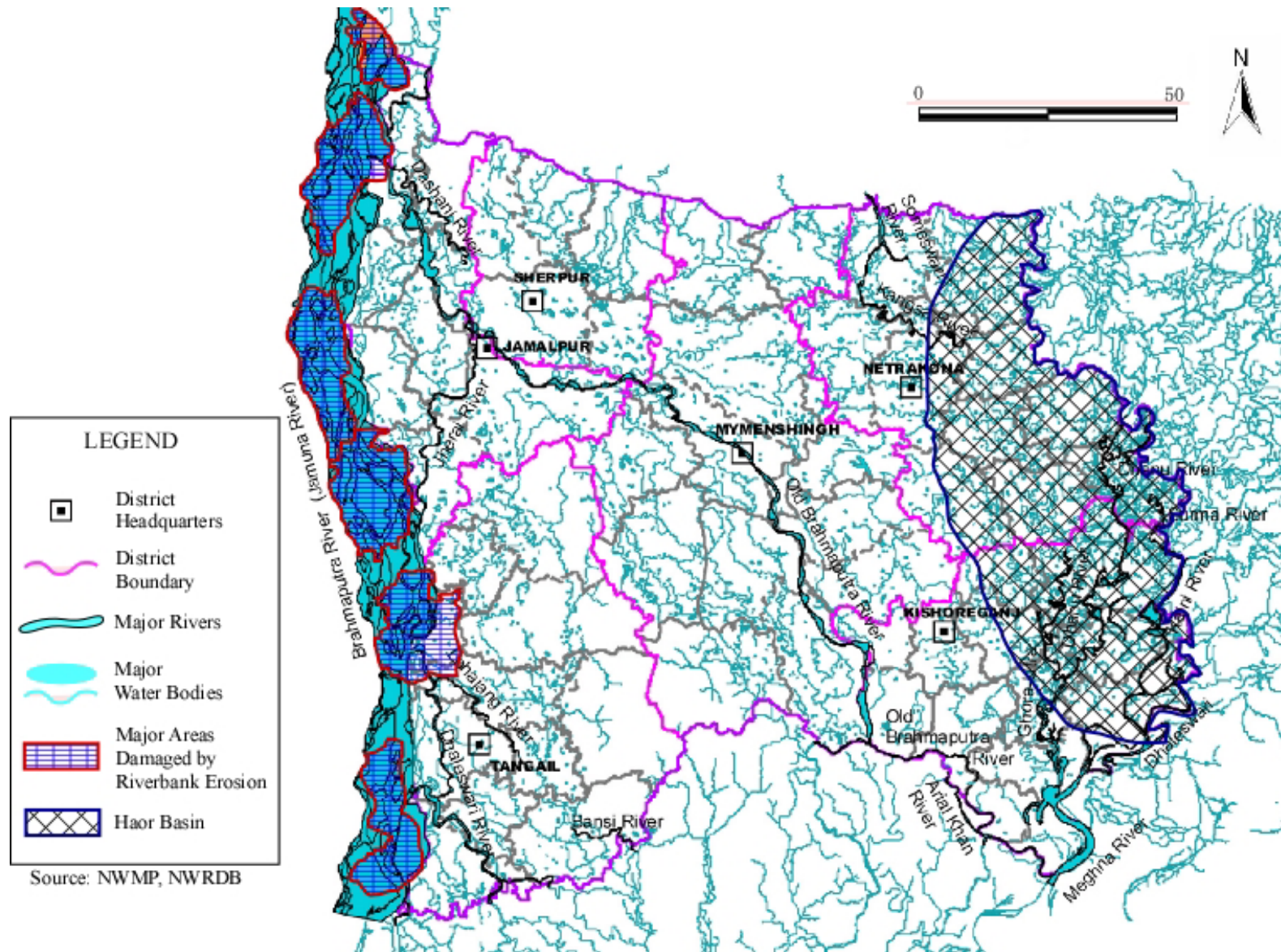I + DR
PRO
No Information

Source: NWRD (WARPO)

Fig. 3.2.5(2) Location of Major Rivers, Haor Basin and Erosion Damage