

# Background Information for Rajshahi City, Bangladesh

Alexandra Clemett, Md. Maksudul Amin, Sharfun Ara, Md.  
Mashiur R Akan

2006



WASPA Asia Project Report 2

This report is one in a series of project reports written by the Wastewater Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA Asia) project. The WASPA Asia project aims to develop and test solutions for sanitation and wastewater management, to reduce the risks from wastewater use in agriculture. The approach involves the development of stakeholder coalitions at town and national level, called Learning Alliances, which will bring together the main stakeholders into a participatory process through which actions will be planned and implemented in a sustainable manner.

These project reports are essentially internal documents intended to inform the future activities of the project, particularly in relation to the development of Learning Alliances and participatory action plans. The reports have been made publicly available as some of the information and findings presented in them may be of use to other researchers, practitioners or government officials.

The WASPA Asia project is funded primarily under the EU Asia Pro Eco II Programme of the European Commission. It is being undertaken by the International Water Management Institute (IWMI), Sri Lanka; COSI, Sri Lanka; the International Water and Sanitation Centre (IRC), the Netherlands; NGO Forum for Drinking Water Supply and Sanitation, Bangladesh; and the Stockholm Environment Institute (SEI), Sweden. The project pilot cities are Rajshahi City in Bangladesh and Kurunegala City in Sri Lanka.

*The WASPA Asia Project is funded under the EU Asia Pro-Eco Programme.*

*The content of this publication is the sole responsibility of the WASPA Asia Project team and can in no way be taken to reflect the views of the European Union.*

# Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
<b>2</b>	<b>Rajshahi District and City Corporation .....</b>	<b>2</b>
	<b>Location and Land Use .....</b>	<b>2</b>
	<b>Administrative Units.....</b>	<b>4</b>
	<b>Population Statistics .....</b>	<b>6</b>
<b>3</b>	<b>Physical Characteristics .....</b>	<b>8</b>
	<b>Climate and Rainfall .....</b>	<b>8</b>
	<b>Water Resources .....</b>	<b>9</b>
<b>4</b>	<b>Socio-economic Conditions .....</b>	<b>10</b>
	<b>The Importance of Agriculture in Income Generation .....</b>	<b>10</b>
	<b>Education Levels .....</b>	<b>11</b>
	<b>Water Supply.....</b>	<b>11</b>
	<b>Water Quality.....</b>	<b>13</b>
	<b>Sanitation Facilities.....</b>	<b>15</b>
	<b>Drainage and Waste Management .....</b>	<b>17</b>
	<b>Health and Health Care .....</b>	<b>17</b>
<b>5</b>	<b>Land Utilization, Agriculture and Marketing .....</b>	<b>20</b>
	<b>Agricultural Land Use .....</b>	<b>20</b>
	<b>Irrigated Land.....</b>	<b>21</b>
	<b>Crop Production and Marketing.....</b>	<b>22</b>
<b>6</b>	<b>Industry .....</b>	<b>23</b>
<b>7</b>	<b>Project Location and Data Gaps .....</b>	<b>25</b>
	<b>Site Selection .....</b>	<b>25</b>
	<b>Further Data Requirements .....</b>	<b>26</b>

## List of Figures

Figure 2.1: Location of RCC within Rajshahi District.....	2
Figure 2.2: Rajshahi City Corporation area .....	3
Figure 2.3: Trends in urban and rural populations in Rajshahi Zila.....	6
Figure 2.4: Population by locality for Rajshahi Zila, 2001 .....	6
Figure 3.1: Total Monthly Rainfall During 2001 to 2003.....	8
Figure 3.2: Monthly average minimum and maximum temperature and relative humidity for Rajshahi in 2001, 2002 and 2003.....	9
Figure 4.1: Main income source for households in Rajshahi City Corporation area .....	10
Figure 4.2: Comparison of rural and urban water supply facilities in Bangladesh 1991-2002	12
Figure 4.3: Domestic water supply in Rajshahi Zila in 2001 .....	13
Figure 4.4: Water quality results for surface water in Rajshahi City.....	15
Figure 4.5: Sanitation facilities in Rajshahi Zila 1991 and 2001.....	16
Figure 5.1: Percentage of households owning agricultural land by <i>Upazila</i> or <i>Thana</i> .....	21
Figure 5.2: Method of irrigation by land area in Rajshahi Division 2002-2003.....	21
Figure 6.1: Percentage share by category of industries in Rajshahi Zila.....	23
Figure 6.2: Percentage of industries in various locations in Rajshahi Zila.....	24
Figure 7.1: Project site within RCC area .....	25

## List of Tables

Table 2.1: Land use of RCC area in 2003.....	4
Table 2.2: Administrative units in Rajshahi Zila.....	5
Table 2.3: Adjusted population 2001 .....	6
Table 2.4: Population statistics for Rajshahi City Corporation area .....	7
Table 3.1: Agro-ecological zones in Rajshahi .....	8
Table 4.1: Main income source for households in the four <i>thanas</i> of RCC area .....	11
Table 4.2: Literacy rates for Rajshahi City Corporation area .....	11
Table 4.3: Demand, supply and deficit of water in Rajshahi City .....	13
Table 4.4: Percentage of households with access to sanitation facilities.....	16
Table 4.5: Diseases suffered during the past three months.....	18
Table 4.6: Communicable diseases by district for 1998.....	18
Table 4.7: Types of facilities at different levels, 2002.....	19
Table 5.1: Land utilization for Bangladesh and Rajshahi Division 2002-2003 .....	20
Table 6.1: Type and Number of Industries in Rajshahi Zila .....	23

## List of Annexes

Annex I: Spatial Planning Zone (SPZ) with Functional Master Plan Area.....	I
Annex II: Major source of household income for Rajshahi Zila .....	II
Annex III: Standards from the Environmental Conservation Rules 1997 .....	III

## Acronyms, Abbreviations and Definitions

BBS	Bangladesh Bureau of Statistics
BSCIC	Bangladesh Small and Cottage Industries Corporation
CBO	Community Based Organizations
DAE	Department of Agriculture Extension
DPHE	Department for Public Health Engineering
DoE	Department of Environment
EU	European Union
GoB	Government of Bangladesh
IWMI	International Water Management Institute
NGOF	NGO Forum for Water Supply and Sanitation
PEC	Post enumerated check
RCC	Rajshahi City Corporation
RDA	Rajshahi Development Authority
SAAO	Sub-Assistant Agriculture Officer
WASPA	Wastewater Agriculture and Sanitation for Poverty Alleviation
MPO	Master Plan Organization
DTW	Deep Tube Well
DSSTW	Deep Set Shallow Tube Well
STW	Shallow Tube Well
m <sup>3</sup>	Cubic meter
mm	millimeter

Households are defined in the Government of Bangladesh Census as: “persons either related or unrelated, living together and taking food from the same kitchen” (BBS 2005a, p. 5).

Literacy denotes ability to write a letter in any language (BBS 2005c).

## **1 Introduction**

This report provides background information on the sanitation and agricultural situation in Rajshahi City Corporation (RCC) area and where appropriate sets it in the overall context of the current conditions in Bangladesh. It includes information from the Rajshahi District level down to the Ward level where such data exists. Specifically the information collected covers: demographics; water resources and water quality; wastewater and sanitation infrastructure; and agriculture.

This information has been used to select a number of sites in the RCC area in which the European Commission funded project, Wastewater Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA Asia), will be implemented. This report therefore also presents the rationale for site selection and more detailed information about those sites.

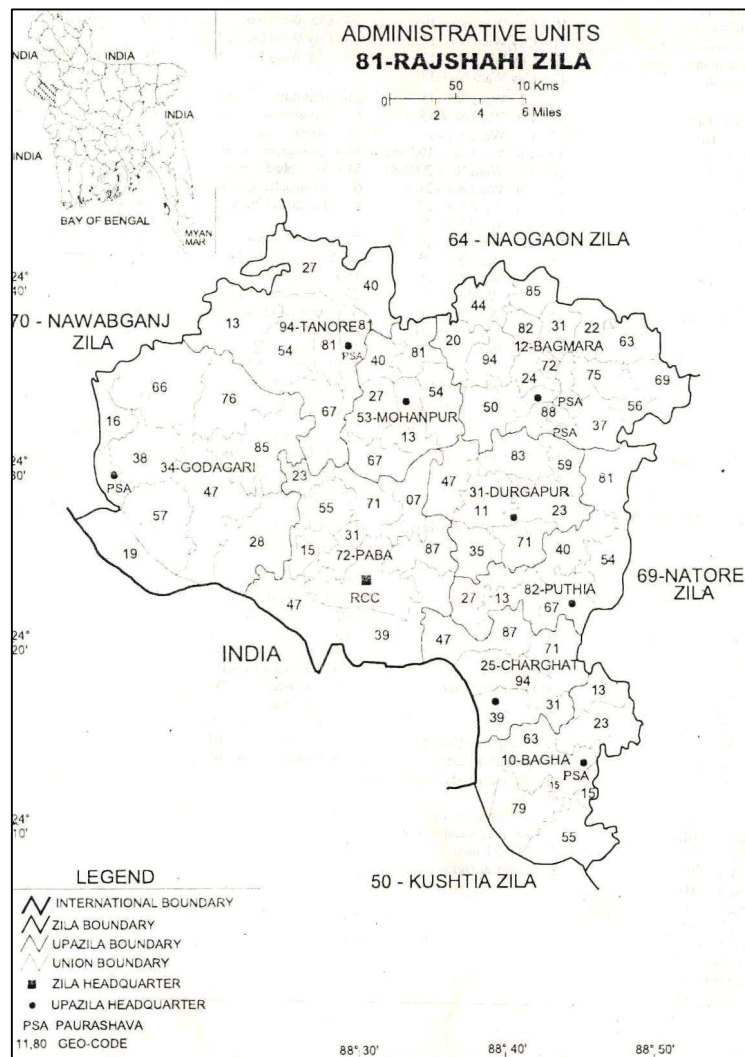
The report has been written primarily using secondary data and information gathered through meetings with institutional stakeholders. This provided an opportunity to identify local level information gaps and to design surveys for the project areas to obtain a more detailed understanding of the sanitation situation, wastewater management, and agricultural practices, in areas where wastewater is routinely used for irrigation.

## 2 Rajshahi District and City Corporation

### Location and Land Use

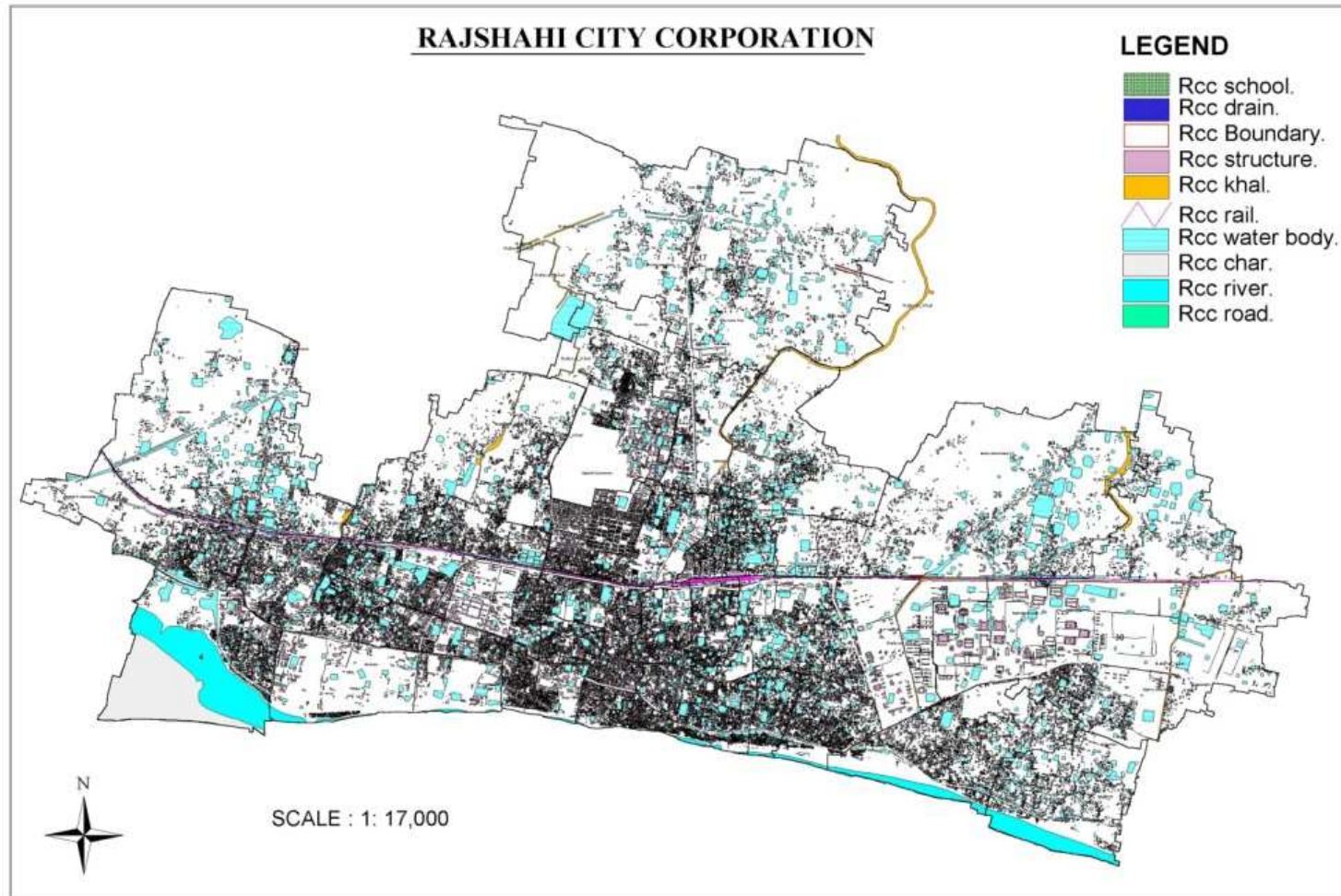
Rajshahi District (*Zila*), which covers an area of 2407 km<sup>2</sup>, of which 62 km<sup>2</sup> is river, is located in the north west of Bangladesh bordering India to the south (BBS 1993). Rajshahi City Corporation (RCC), which was formed in 1987, covers an area of approximately 48 km<sup>2</sup> being bounded on the east, north and west by Paba Thana (subdivision of a district) and on the south by the Padma River (Figure 2.1 and Figure 2.2).

**Figure 2.1: Location of RCC within Rajshahi District**



Source: BBS 2005b

Figure 2.2: Rajshahi City Corporation area



Source: RCC 2006



It should be noted that although the RCC maps (Figure 2.2) show an area of around 48 km<sup>2</sup>, and although this is the area acknowledged by the Rajshahi Development Authority (RDA) as the extent of the RCC area, official figures provided by RCC and the Bangladesh Bureau of Statistics (BBS) give an area of 96.72 km<sup>2</sup>. Attempts by the project team to understand this difference have not resulted in success, although it does appear, based on the GIS maps and the RDA 2003 Master Plan, that the figure of 48.06km<sup>2</sup> is correct as can be seen in Table 2.1.

Land use statistics also vary, depending on the categorization and method of measurement. The data used in the 1994 Drainage Plan suggested that agriculture and horticulture is the largest land use category in the RCC area, accounting for 31.0% of the land, followed by residential (26.2%), administrative and educational (14.6%), roads and embankments (11.3%), and commercial and industrial (1.7%); other uses account for 15.2% of the land area (Aqua Consult 1994, p. 24). A study by Development Design Consultants Limited for the Rajshahi Structure Plan and Master Plan recorded a much smaller area of 18.7% of agricultural land within the RCC area but also recorded a further 48% in the extended urban area included in the plan (RDA vol-I 2004, p. 9). The other land use categories identified in this survey are provided in Table 2.1.

**Table 2.1: Land use of RCC area in 2003**

Land use	Area (km <sup>2</sup> )	Percentage of total (%)
Residential	16.08	33
Agricultural	9.01	19
Educational	5.05	11
Business	0.95	2
Public administrations and institutions	0.96	2
Mixed use	0.11	0
Industrial and storage	0.39	1
Open space, vacant or char land	6.50	14
Defence	0.97	2
Roads and railways	2.86	6
Water bodies	5.18	11
TOTAL	48.06	

Source: Physical survey by the consultant, 2003; in RDA vol-I 2004, p. 9

### Administrative Units

Rajshahi Division is one of the six administrative divisions of Bangladesh and is divided into 16 *zilas* (districts), 128 *upazillas* (sub-divisions of *zilas*) and 1092 Unions (BBS 2003). One of these is Rajshahi Zila, which was a sub-division of the former Greater Rajshahi District until it was upgraded to a *zila* in 1984 (BBS, 1993). There are 9 *upazilas*, 70 unions, 1858 villages and seven *pourashava* (municipalities), including Rajshahi City Corporation (RCC) in Rajshahi Zila (BBS, 2005a, p. 28)<sup>1</sup>.

<sup>1</sup> A more detailed description of the administrative units of Bangladesh, and the roles and functions of local government can be found in another report in this series: Institutional Analysis for Wastewater, Agriculture and Sanitation Sectors in Rajshahi City, WASPA Project Report 6, forthcoming.

Rajshahi City Corporation was previously comprised of the whole of Boalia Thana (30 wards) and some of Paba Thana but by the 2001 census Boalia Thana had been reduced from 96.69 km<sup>2</sup> to 38.56 km<sup>2</sup> and a further three *thanas* formed: Matihar, Rajpara and Shah Makdhum from its original area (BBS, 2006, p. XXXI). The total number of wards recorded by BBS for 2001 therefore rose to 39 (Table 2.2), however discussions with RCC and RDA suggest that in practice they still work on the basis of 30 wards, with 30 Ward Commissioners (<http://rcc.gov.bd/default.php?link=RCCProfile>). Attempts to reconcile this difference did not result in success, and since the wards do not have names and are not properly mapped, it was made particularly difficult. What is certain is that management of the city is currently based on 30 wards.

**Table 2.2: Administrative units in Rajshahi Zila**

Administrative Level	Name of Administrative Unit	Number of Unions	Number of Mauzas	Number of Mahallah
<i>Upazila</i>	Bagha	6	98	25
	Bagmara	16	292	40
	Charghat	6	93	20
	Durgapur	7	114	-
	Godagari	9	389	18
	Mohanpur	6	167	-
	Paba	9	186	-
	Puthia	6	128	-
	Tanor	6	211	26
	Total		71	1678
		<b>Number of Wards</b>		<b>Number of Mahallah</b>
<i>Thana</i>	Boalia	21		82
	Mathihar	5		20
	Shahmukdum	3		22
	Rajpara	10		46
<i>Pourashava</i>	Bagha	9		
	Bhawbaniganj	9		
	Tahirpur	9		
	Charghat	9		
	Tanor	9		
Total		84		170

Source: BBS 2005c; BBS 2006, p. XXXI

## Population Statistics

In 2001 at the time of the last census the population of Rajshahi Division was 24% of the population of Bangladesh making it the second most populous division after Dhaka (Table 2.3). Of these 15% lived in urban areas, slightly below the national average of 23% (BBS 2003, p. 13-14). There were approximately 6.6 million households in Rajshahi Division in the 2001 census and the gender balance was such that there are slightly more males (51%) than females (BBS 2003, p. 29).

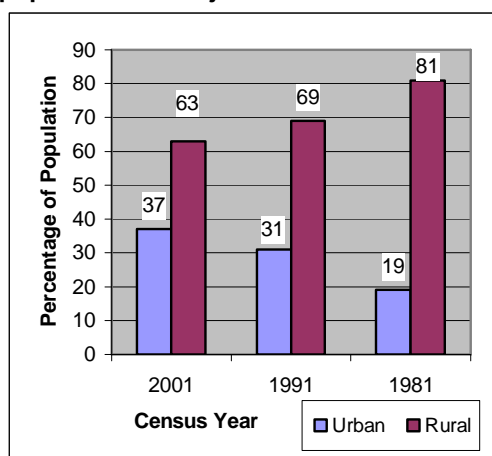
**Table 2.3: Adjusted population 2001**

Locality	All Area	Urban	Rural
Bangladesh	130029749	30459665	99570084
Rajshahi Division	31501479	4685924	26815555

Source: BBS 2003, pp. 13-14

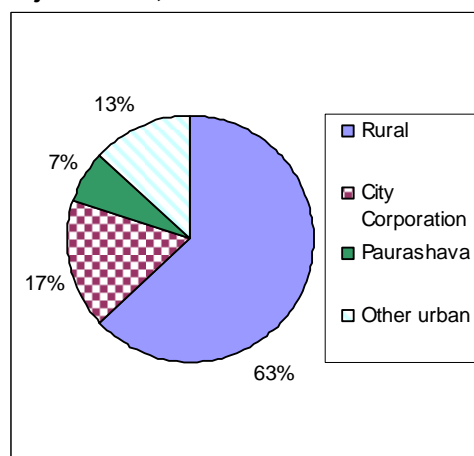
Rajshahi Zila makes up 7% of the land area of Rajshahi Division, and is also home to 7% of the population (2286874) of the Division and 8% of the households (BBS, 2003, pp. 12 and 28). The *zila* remains predominantly rural with 1443249 people (63%) residing in rural areas but there has been a significant change in the rural urban split since 1981 (Figure 2.3). The majority of the urban population lives in RCC area (Figure 2.4).

**Figure 2.3: Trends in urban and rural populations in Rajshahi Zila**



Source: BBS 2005b, p. 12

**Figure 2.4: Population by locality for Rajshahi Zila, 2001**



Source: BBS 2005b, p. 13

The problem with the change in the area of RCC before and after 2001, and the discrepancy between the figures provided by RCC and BBS, is that most publicly available figures, such as population and household numbers, arise from BBS data, consequently although the project team accept that there are only 30 wards, they still have to use other data that applies to 39 wards. Furthermore, it is difficult to compare the situation before and after 2001 as it is

not possible to determine the exact area under consideration in the two periods. The data that is available in BBS publications is presented in (Table 2.4).

Data provided by RCC suggests that the population figures were 0.5 million in 2001 (which is roughly similar to those for BBS) and had risen to 0.8 million by 2005 (<http://rcc.gov.bd/default.php?link=RCCProfile>). These are the figures used for the purposes of the project.

**Table 2.4: Population statistics for Rajshahi City Corporation area**

Rajshahi City Corporation Area	Boalia Thana	Boalia Thana	Matihar Thana	Rajpara Thana	Shah Makhdum Thana	All Thanas
	1991	2001				
Area (km <sup>2</sup> )	96.69	38.56	20.56	25.19	12.87	97.18
Household number	51063	38340	9369	23545	5262	76516
Household size	5.5	4.9	4.7	4.8	4.5	5.1
Total population	294056	191711	51724	121076	24300	388811
Male population	154481	102230	28781	64398	13116	208525
Female population	139575	89481	22943	56678	11184	180286
Population density per km <sup>2</sup>	3042	4972	2516	4807	1964	4001
City ward	30	21	5	10	3	39
City Mahallah	165	82	20	46	22	170

Source: BBS 2005c

The urban area however is not restricted to the RCC area and under the Rajshahi Metropolitan Development Plan (2004-2024) 25 Spatial Planning Zones (SPZ) have been created of which seven are RCC SPZ, five are urban but not RCC and 13 zones are within the extended area. The plan includes the original 30 wards of the RCC as well as 12 *unions*<sup>2</sup> and two *paurashava*<sup>3</sup> (Annex I). The RCC area accounts for 13% of the overall Functional Master Plan (FMP) area and 55% of the 2001 population; whilst the total urban area accounts for 24% of the FMP area and 62% of the population (RDA vol. II 2004). The area defined as urban has also grown over the years from 18 km<sup>2</sup> in 1970 to 45 km<sup>2</sup> in 2002 (RDA vol.I 2004, p. 16).

<sup>2</sup> Barogachi, Parila, Huzuripara, Harogram, Damkura, Harian, Haripur, Yousufpur, Belpukuria, Baneswar, Sardah and Salua.

<sup>3</sup> Naohata Paurashava and Khatakhali Paurashava.

### 3 Physical Characteristics

#### Climate and Rainfall

Rajshahi falls into the western dry zone, one of the seven climatic zones into which Bangladesh can be divided, and has a mean annual rainfall of below 1524 mm compared to a national average of 2540 mm (BBS 2005). Rajshahi District also covers five of the 30 agro-ecological zones that Bangladesh has been divided into. Predominant soil textures are Loamy and Clayey and soil pH varies from pH 4.5 to pH 7.9; organic matter contents in the soils are low or medium (Table 3.1 **Error! Reference source not found.**).

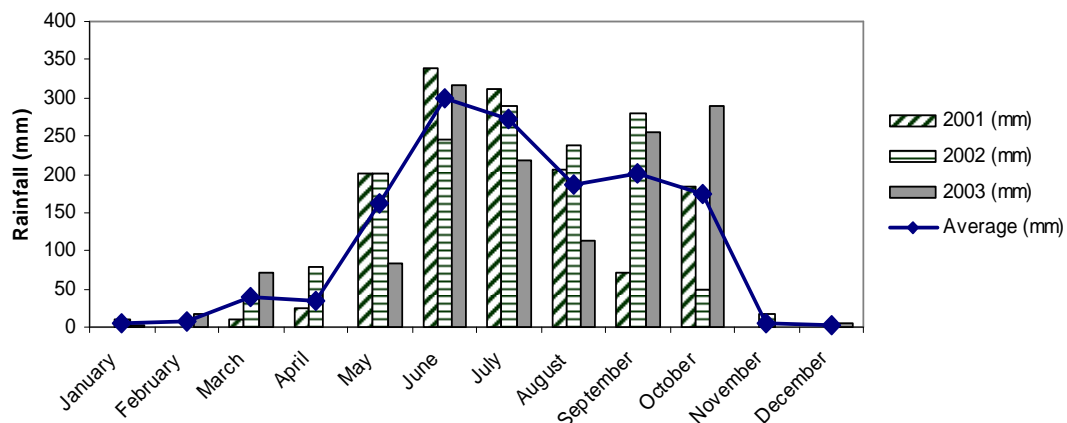
**Table 3.1: Agro-ecological zones in Rajshahi**

Agro Ecological Zones	Texture	pH	Organic matter content
AEZ-3 Tista meander floodplain	Sandy, Loamy	4.5 – 5.5	Low
AEZ-5 Lower Atrai basin	Clayey	4.8 – 6.0	Medium
AEZ-10 Active Ganges floodplain	Loamy, Clayey	6.9 – 7.9	Medium
AEZ-11 High Ganges river floodplain	Silt, Loamy, Clayey	6.1 – 7.9	Low, Medium
AEZ-26 High Barind tract	Loamy	4.8 – 5.9	Low

Source: BBS 2005e

The rainfall pattern in Rajshahi is uni-modal with 70% of the annual rainfall occurring between June and September (BBS 2005d). The average monthly rainfall data from the Rajshahi rainfall monitoring station shows some monthly variation between years but clearly shows that November to March are months of very low rainfall (Figure 3.1).

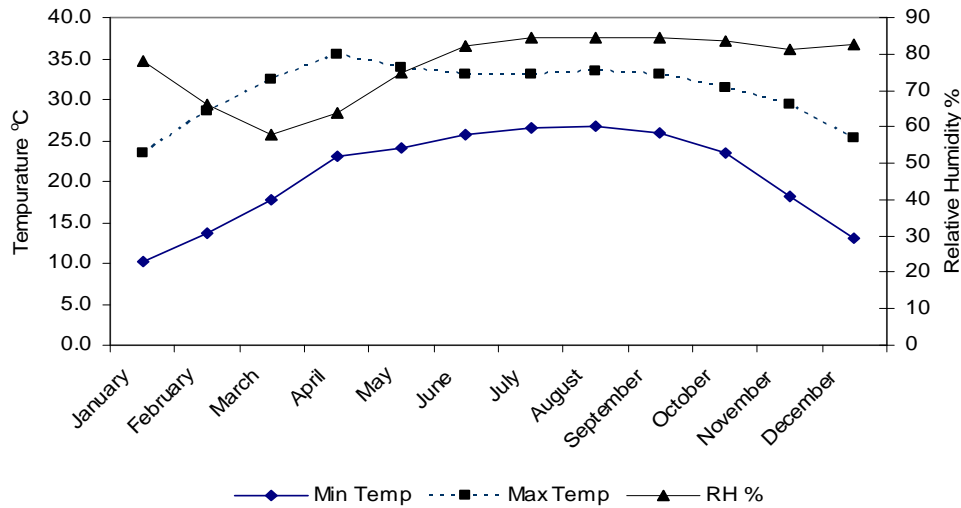
**Figure 3.1: Total Monthly Rainfall During 2001 to 2003**



Source: Weather Office, Shampur, Rajshahi

The minimum temperature varies from year to year from between 10°C to 27°C and the maximum temperature varies between 24°C to 36°C. During April and May Rajshahi experiences the highest temperature (Figure 3.2).

**Figure 3.2: Monthly average minimum and maximum temperature and relative humidity for Rajshahi in 2001, 2002 and 2003**



Source: Weather Office, Shampur, Rajshahi

### Water Resources

The River Padma flows along the southern side of Rajshahi District and the Jamuna lies across the eastern border. The River Baraonai flows through the District to the north of the RCC area. The city is located on the alluvial planes of the Padma and consequently the water level rises to about 19 m during the rainy season, which is the level of the main developed part of the town (Aqua Consult 1994, p. 1). Within the RCC area there exist several water bodies covering 2.3 km<sup>2</sup> (5% of the total land area) (Aqua Consult 2004, p. 21; Figure 2.2). These water bodies are used for various purposes including bathing; disposal of wastewater; and irrigation of some of the 14.8 km<sup>2</sup> of agricultural and horticultural land that is located within the RCC area.

Ground water is also an important source of domestic and irrigation water in Bangladesh: availability of ground water for the whole country was estimated by BBS (2005e) to be 21088 million m<sup>3</sup> in 2004, with an agricultural use of 8806 million m<sup>3</sup> and a domestic and industrial use of around one third of the agricultural use at 3191 million m<sup>3</sup>. Most of the drinking water (about 85%) comes from ground water sources and in some rural areas increasing demand for irrigation water will affect availability of drinking water (BBS 2005e).

Groundwater, in Bangladesh contains varied amounts of dissolved minerals arising from natural processes and as a result, the presence of chloride, iron and hardness in excess of acceptable limits restricts the consumption of tube well water (UNDP 1982). The concentration of iron is less than 2 mg l<sup>-1</sup> in most of the north-east and north-western part of Bangladesh and hardness ranges from very soft (50-100 mg l<sup>-1</sup>) in the north-west and north-east regions to very hard (400-500 mg l<sup>-1</sup>) in the coastal areas of the country. Rajshahi exhibits higher hardness than the rest of the country (Rahman and Ravenscroft 2003).

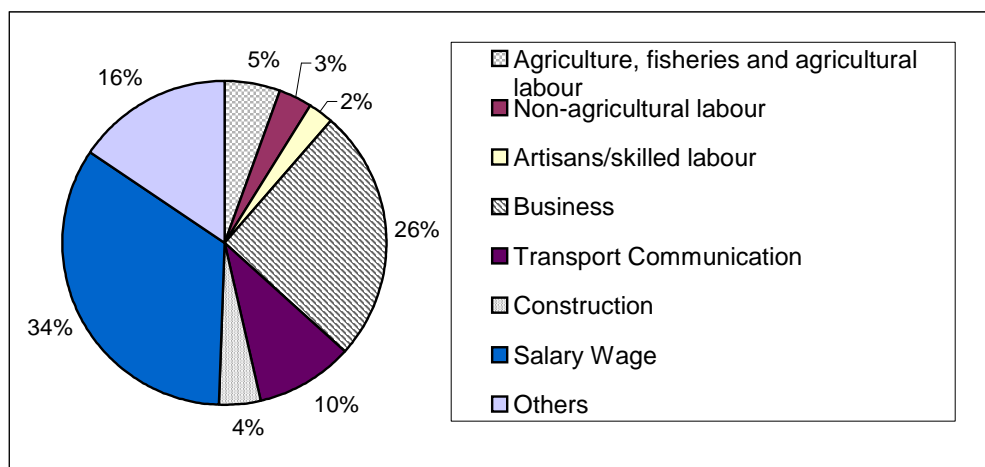
## 4 Socio-economic Conditions

### The Importance of Agriculture in Income Generation

In 2002-2003 the civilian labour force in Bangladesh was estimated to be 44.3 million, of which 22.8 million (51%) were involved in some way in agriculture, forestry or fisheries (BBS 2005a, p. 61). Data is not available for the population involved in major income generating activities in Rajshahi Zila but BBS (2005c, p. XV) reports that 39% of households in the *zila* depend on cultivation, livestock and forestry; less than 1% on fisheries; and 34% on agricultural labour as their main source of income (Annex II).

The majority of households in the RCC area earn their income through paid employment and business, as would be expected in an urban area. Five percent of the households rely on agriculture, fisheries and agricultural labour for their main income (Figure 4.1), of which 3% (1965 households) earn their income from agriculture, forestry and livestock; 2% (1735 households) from agricultural labour; and just 314 have fisheries as their main income source.

**Figure 4.1: Main income source for households in Rajshahi City Corporation area**



Source: BBS 2005b

A household survey conducted by the consultants for the Rajshahi Development Plan (2001-2002) found that in the RCC area trade and commerce employed about 35% of the income earners, followed by government departments and autonomous bodies (28%), the informal sector (19%), skilled mechanical work (5%), non-agricultural day labour (3%), and rickshaw and van pulling (3%) (RDA vol.-I 2004, p. 20).

Shah Mahdum Thana however has a somewhat larger percentage (18%) involved in agriculture (Table 4.1), though the total number is quite low (agriculture 421, fisheries 31 and agricultural labour 487); and the number in Rajpara is the highest (agriculture 704, fisheries 101 and agricultural labour 475) although the percentage is about average (BBS 2005b; Table 4.1). The total number of households and people relying on agriculture and agriculture related activities may however be much higher as the national census statistics do not include

secondary or tertiary income sources, nor do they define “businesses”, which are likely to include trading of agricultural produce and food processing industries.

**Table 4.1: Main income source for households in the four *thanas* of RCC area**

Income source	Percentage of Households				Total
	Baolia	Matihar	Rajpara	Shah Makhdum	
Agriculture, fisheries and agricultural labour	3	6	6	18	5
Non-agricultural labour	2	9	3	4	3
Artisans/skilled labour	3	2	1	2	2
Business	28	21	25	18	26
Transport Communication	10	13	8	10	10
Construction	4	5	4	3	4
Salary Wage	33	26	39	34	34
Others	17	17	14	11	16

Source: BBS 2005b

The income arising from these activities was found to result in 61% of the households of the RCC area and 70% of the households in the extended area earning a monthly income of Tk. 2500-4500 (RDA vol.-I 2004, p. 20).

### Education Levels

Adult (15 years and over) literacy rates in Bangladesh were 48% at the time of the 2001 census, with male literacy rates slightly higher than female rates at 54% and 41% respectively (BBS 2003, p. XVIII). Literacy rates for persons of 7 years and over were 45% for both sexes, 50% for males and 41% for females in 2001 (BBS 2003, p. 71). This is similar to the literacy rates in Rajshahi Zila, which are: 48% for both sexes; 52% for males; and 42% for females (BBS 2005c, p. xi). They are however much higher in the RCC area averaging 67% for both sexes and reaching a maximum of 75% for males in Boalia Thana (Table 4.2).

**Table 4.2: Literacy rates for Rajshahi City Corporation area**

Literacy rates for persons of 7+ years	Boalia Thana	Boalia Thana	Matihar Thana	Rajpara Thana	Shah Makhdum Thana	All Thanas
	1991	2001				
<b>Total literacy</b>	58	71	63	70	64	67
<b>Male literacy</b>	64	75	69	73	68	71
<b>Female literacy</b>	51	66	56	66	59	62

Source: BBS 2005c, p. xi

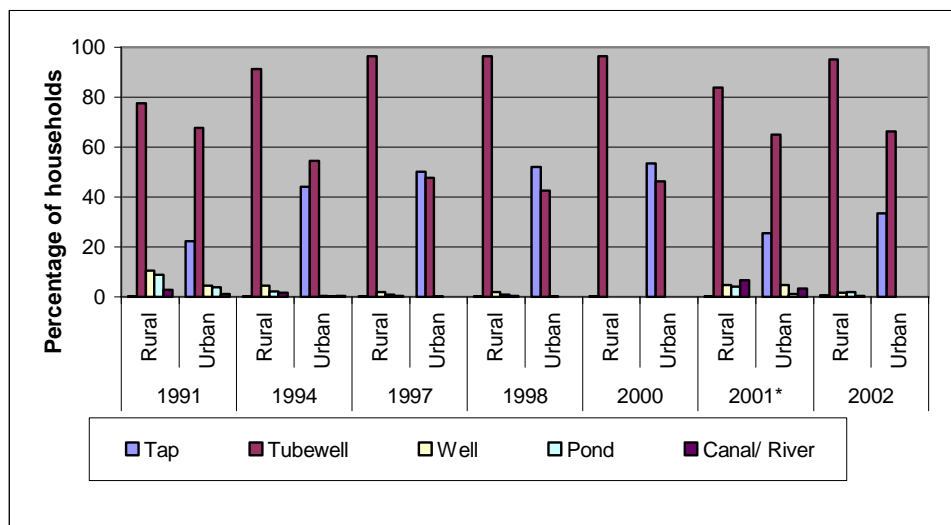
### Water Supply

In Bangladesh as a whole drinking water is predominantly provided by tube well (80%), although this figure may have declined since the 2001 Census as a result of the arsenic



problems in Bangladesh (BBS 2005a, p. 54). Provision of piped water has increased steadily in urban areas over the past fifteen years, but not in rural areas. Statistics also suggest a slight decline in the number of households served by piped water in urban areas since 2000 (Figure 4.2).

**Figure 4.2: Comparison of rural and urban water supply facilities in Bangladesh 1991-2002**



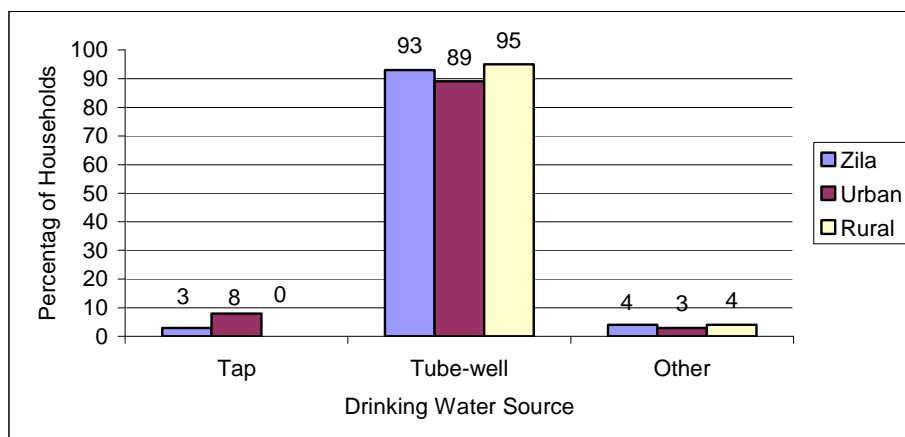
Source: SVRS 2004

\*Population Censuses (2001): Well = Deep tube-well in 2001; Canal/River = Others in 2001.

In Rajshani Zila the trend is similar to the national trend with the vast majority (93%) of households relying on tube-well water for their drinking purposes. This is the case in both rural and urban areas although in urban areas some 8% of households have piped water supplies compared to less than 1% in rural areas (Figure 4.3). These figures have not changed dramatically since the 1991 census, although reliance on tap water has declined slightly (by 1%) and tube-well use has increased at the expense of wells, ponds and other sources (BBS 2005b).

In Rajshahi City there are 785 community water stand-posts, 85 on-street water stands, eight overhead tanks and three water treatment works. The RCC has provided around 20000 water supply connections from 45 pumps. In addition to this Rajshahi University, Rajshahi Medical College, RDA and some other organizations have their own water supplies (RDA vol- I 2004, p. 38).

**Figure 4.3: Domestic water supply in Rajshahi Zila in 2001**



Source: BBS 2005b

According to the RCC the current water demand for the city is 103000 m<sup>3</sup> per day and will rise to 160000 m<sup>3</sup> per day by 2010. The Rajshahi Water Supply Project Phase-2 proposed 10 new production tube wells; and one water treatment plant for ground water and two for surface water, to meet this demand (RDA, vol-I, 2004, p. 38).

**Table 4.3: Demand, supply and deficit of water in Rajshahi City**

Item	Position
Present water demand (m <sup>3</sup> /day)	103000
Present piped water supply (m <sup>3</sup> /day)	47000
Deficit after piped water supply (m <sup>3</sup> /day)	56000
Daily water availability (pumping period in hours)	12
Number of pumps	45
Pipe line length (km)	348
Number of public tap	750
Number of hand tube well	4500
Number of communal reservoirs	47
Number of house connections	12000
House connection per km. of pipe line	34.48
Unit piped water consumption (supplied) (litters per capita per day)	114

Source: RCC 2004

### Water Quality

Ground water pollution has been found to be a critical problem in Rajshahi City and the surrounding areas. The main problems relate to the high iron content, which is in the range 0.4-3.5 mg l<sup>-1</sup> in the RCC area and 0.23-7.12 mg l<sup>-1</sup> outside the RCC area, both of which exceed the national drinking water standards for iron of 0.3-1.0 mg l<sup>-1</sup> (RDA vol-I 2004, p. 29; GoB 1997). The level of manganese was also found to be high, ranging from 0.1-1.52 mg l<sup>-1</sup> in the RCC area to 0.23-2.40 mg l<sup>-1</sup> outside the area, and exceeding the drinking water

standard of  $0.1 \text{ mg l}^{-1}$  (RDA vol-I 2004, p. 29; GoB 1997). High levels of arsenic contamination were also reported in some areas. Tests on 25 pumps showed that four were contaminated by arsenic and the Department of Public Health Engineering (DPHE) reported minimum levels of  $0.01 \text{ mg l}^{-1}$  and maximum levels of  $0.23 \text{ mg l}^{-1}$  in the pumps that it sampled (RDA vol-I 2004, p. 29), which is above the limit for drinking water of  $0.05 \text{ mg l}^{-1}$  (GoB 1997; Annex III). Hardness levels are below the Bangladesh standard but above the WHO standard (RDA vol-I 2004, p. 29).

Surface water quality is similarly poor because untreated urban effluent is discharged through various drains into the *khals* (canals) and *beels* (seasonal ponds), and ultimately to the agricultural fields to the north, which according to the RDA report, is affecting agriculture and human health (*ibid*). Tests have shown that the water in surface water bodies in the area, including the Padma and Baraonai rivers, some *beels* and ponds, exceeds the national standards for drinking water for Bangladesh of 50 or less total coliform number/100 (TCN/100), having fecal coliform bacteria counts of 70-400 number/100 (RDA vol-I 2004, p. 29). It also exceeds the standards for water for recreational use, which is 200 TCN/100 (GoB, 1997; Annex III). Tests for iron, chloride and manganese showed that: the concentration of chloride is within limits; the Padma is within the drinking water limits for iron during the rainy season but not the summer, whilst the Baraonai exceeds it in both seasons; manganese is within limits in samples collected from the Padma in the dry season but exceeded limits in almost all locations in the rainy season. Dissolved oxygen (DO) measurements using a HACH kit showed that the Padma and Baraonai were within limits, as was Foliar Beel; but the water quality of Shilinder Beel and Tikure Beel was very poor due to the drainage discharge from Rajshahi city (RDA vol-I 2004, p. 29).

The RDA (vol.-I 2004) report that the drainage from the city, dumping of solid waste, overflow of pit latrines and the discharge from the sugar mill are all affecting the quality of surface water. They specifically site pollution of Shilinder Beel and Tikure Beel as the cause of poor rice yields in low land areas in the dry period, because the high levels of phosphate and nitrate are believed to result in excessive foliage growth but low grain production. Similarly they report that the pollution of Kukhandi Beel, Nol Khola Beel and Padda Beel by the sugar mill is inhibiting the cultivation of HYV Boro, as it contains high levels of sulphur, calcium and organic matter (RDA vol-I, 2004, p. 29).

An independent assessment undertaken by Rahman (2005) on eight ponds and two locations on the River Padma revealed that the DO in all sites was below the limit specified for water that can be disposed of to irrigated land, or that can be used for recreational purposes. All other parameters were within the required standards if they existed (Figure 4.4).

**Figure 4.4: Water quality results for surface water in Rajshahi City**

	Temp (°C)	TSS (mg l <sup>-1</sup> )	TDS (mg l <sup>-1</sup> )	CO <sub>2</sub> (mg l <sup>-1</sup> )	DO (mg l <sup>-1</sup> )	HCO <sub>3</sub> (mg l <sup>-1</sup> )	Cl (mg l <sup>-1</sup> )	EC (micro mho/cm)	pH
Standards for recreation					5 or more				6.5-8.5
Standards for discharge to irrigated land			2100		4.5-8		600.0	1200.0	6-9
RUET Pond	28.5	96.9	825.2	12.2	1.88	87.2	137.1	304.9	8.5
Kajla Pond	28.2	63.6	789.2	12.6	1.74	141.8	134.5	496.4	8.2
Kadirgong Pond	26.6	81.3	863.6	7.6	1.05	211.1	214.5	852.9	8.3
Horogram	24.8	74.0	733.6	16.6	0.56	22.5	194.5	694.6	8.3
University Pond	26.6	76.8	797.8	11.3	4.09	216.1	204.5	986.9	8.5
Binodpur Pond	26.3	100.5	680.0	11.9	3.17	116.5	136.5	398.1	8.5
Sopura Pond	27.1	83.1	755.8	11.7	3.00	157.4	160.0	560.5	8.4
Padma River (T-band)	24.6	97.5	231.0	2.5	5.52	90.1	36.2	191.0	8.0
Padma River (I-band)	24.2	147.5	203.0	2.8	6.44	52.5	33.4	177.4	7.9

Source: Rahman 2005

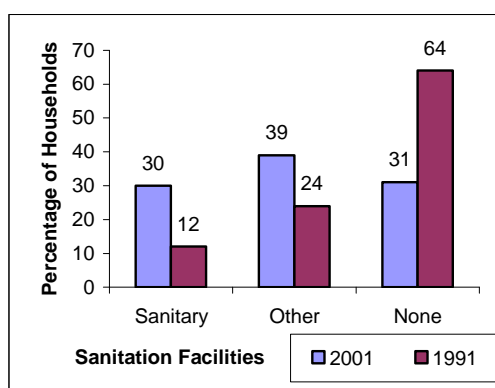
### Sanitation Facilities

The percentage of the population without access to any form of sanitation facility was calculated in the 2001 census to be 22%. Access in urban areas is much higher than rural areas with just over 67% of urban households having sanitary facilities in 2001 compared to just 28% of rural households (BBS 2005a, p. 54).

UNICEF estimated that access to sanitation facilities in Rajshahi Division was lower than in any other division in Bangladesh at just 43%. National statistics suggest that this is even lower in Rajshahi Zila where approximately 30% of households had sanitary facilities at the time of the 2001 Census. However this is a substantial increase since 1991 when the figure was just 12%. Using the BBS (2003) figure for the total number of households in the *Zila*, the number of household with sanitary facilities in 2001 was around 2.178 million. As with national statistics the proportion was higher in urban areas at 31% in 1991 and 49% in 2001.

In the city area the RCC reported in 2004 that about 50% of households have sanitary facilities: 30% have latrines with soak-away pits and 20% have latrines without soak-away pits. Based on the BBS (2005c) data this amounts to 22954 and 15303 households respectively. Water sealed pit latrines are used by 30% of the households and simple pit latrines by 10% (7651). The remaining 10% of the households do not have any sanitation facilities and defecate in the open (RDA vol-I 2004, p. 41).

**Figure 4.5: Sanitation facilities in Rajshahi Zila 1991 and 2001**



Year	Locality	Sanitary	Others	None
2001	Urban	49	33	18
	Rural	19	42	39
1991	Urban	31	26	43
	Rural	42	23	72

Source: BBS 2005b, p. 11

The figures provided by UNICEF (2004) for the same period are slightly different, suggesting that the percentage of the households with access to water sealed latrines was as high as 68% in the Rajshahi metropolitan<sup>4</sup> area and 35% in other urban areas (Table 4.4). The UNICEF (2004) study also considered hand washing and found that nearly 59% of the population of Rajshahi metropolitan area washed their hands with soap, but that this declined to 7% in rural areas and was just 11% for the whole of the Zila (Table 4.4).

**Table 4.4: Percentage of households with access to sanitation facilities**

	Water seal	Pit	Hanging	Open defecation	Water	Water + soil	Water + ash	Water + soap
Rajshahi District	17.6	35.6	30.5	19.3	20.0	40.6	20.0	19.3
Rajshahi division	13.2	30.7	20.8	38.0	15.6	41.6	32.0	10.7
Rural	9.2	30.4	21.1	41.9	16.7	43.4	32.7	7.1
Urban	38.2	33.0	18.6	13.2	8.7	30.9	28.3	32.1
Rajshahi City	68.4	23.2	7.3	1.1	6.1	24.2	11.0	58.7
Rajshahi other urban	35.5	33.9	19.6	14.3	8.9	31.5	29.9	29.6

Source: UNICEF 2004, p. 102

In addition to these private facilities there are 43 public toilets in locations such as markets and bus stations (RDA vol-I 2004, p. 41) and several sites specifically for men to urinate, from which the urine flows directly into the storm water drains (personal observation).

<sup>4</sup> UNICEF (2004) does not use the terminology of RCC but it is assumed that this area is the same or similar.

## **Drainage and Waste Management**

A network of drains to collect surface run-off covers Rajshahi City, running from near the Padma in the south through the city and out towards River Baraonai. The drains range from a few centimeters in width and depth between buildings, to several meters wide for the main drains. They are typically uncovered, which means that they collect a lot of solid waste, and though some of the smaller drains are lined, the main arteries are not. As Rajshahi does not possess any sewerage system these surface run-off drains essentially act as sewers, taking the overflow from septic tanks and increasingly being linked to directly by households. They also receive a large majority of the grey water used in the city including not only domestic waste but also waste from commercial units, markets and small industries. In addition to this the units in the industrial area mostly connect directly to this system. Despite plans for treatment facilities to the north of the city (RDA vol-I 2004) there is currently no form of management.

Solid waste management is also an issue for wastewater agriculture as a proportion of it ends up in the storm water drains which ultimately flow to the fields. The RCC area produces approximately 200 metric tons of solid waste per day, of which around 58 metric tons is not collected by the RCC and is therefore littered around the city. The RCC is also not responsible for collecting waste from households and in many *mahallas* the communities have organized themselves to collect the waste and dispose of it to the local collection points (RDA vol-I 2004, p. 39). The 1994 Drainage Feasibility Study commented that at that time the management of solid waste was satisfactory (Aqua Consultant, 2004), however observations suggest that there is room for improvement to both prevent it from entering storm water drains and to remove it before it reaches agricultural areas.

## **Health and Health Care**

A household survey was conducted by Development Design Consultants Limited for the Rajshahi Metropolitan Development Plan, in 2002. They interviewed 1102 households about the health problems that they had suffered in the past three months and found that 11% of people in the RCC area suffered from dysentery and 10% suffered from diarrhea. Levels were slightly higher in the extended area around the city, reaching 14% for dysentery and 12% for diarrhea (Table 4.5).

Data provided by the Chief Health Office of the RCC for 2005 based on patients seen in the government health centers in the 30 wards, records a total of 1652 patients with diarrhea, of which just 1 died. A further 143 had Jaundice and three had Dengue. Figures provided by the same source report no cases of Dengue in 2003, 5 in 2004 and 6 in 2005, of which three were from the RCC area (Chief Health Officer, RCC 2005). However it can be assumed that the numbers of these diseases may be higher as many people would not attend the hospitals or Primary Health Care Centers unless they had severe symptoms.

**Table 4.5: Diseases suffered during the past three months**

Disease Reported	RCC (H/H)	%	Extended area (H/H)	%	Total (H/H)
Dysentery	358	11	319	14	677
Diarrhea	305	10	262	12	567
Malaria	60	2	34	2	94
Typhoid	63	2	25	1	88
Jaundice	27	1	37	2	64
Cough/Cold	1484	47	1020	46	2504
Fungal Infection/ Itching	22	1	34	11	56
Breathing Problem/Asthma	98	3	42	2	140
Pox	13	0	27	1	40
Others	695	22	407	18	1102

Source: Development Design Consultants Limited, 2003

National statistics on these diseases are collected but only those published in the BBS reports are publicly available. Statistics for the Districts are available in this form and figures for 1998 show that the percentage of the population in Rajshahi District suffering from Diarrhea and Blood Dysentery was below the average in both cases (Table 4.6). However, as stated previously it is likely that the total number of cases are actually much higher than those reported here as patients may not seek medical advice or will go to local pharmacists or doctors, whose records are not included in this count.

**Table 4.6: Communicable diseases by district for 1998**

Districts	Population	Diarrhea			Blood Dysentery		
		Attacks	%	Deaths	Attacks	%	Deaths
Rajshahi	2274340	2832	0.12	2	283	0.01	0
Dhaka	8618700	10381	0.12	10	3117	0.04	0
Khulna	2357940	10868	0.46	20	1463	0.06	6
Barisal	2348440	1809	0.08	18	1013	0.04	3
Sylhet	2547320	26710	1.05	122	8857	0.35	24
Chittagong	6543860	15102	0.23	77	10750	0.16	1

Source: Health and Demographic Survey, BBS 2005d

Health care facilities are reasonably good in the RCC area with one general hospital, the Rajshahi Medical College Hospital, with 550 beds; and three specialized hospitals, including a 150 bed TB hospital and a 20 bed infectious diseases hospital (Table 4.7). The RCC has also established seven Primary Health Care Centers, which are run by NGOs, as part of a project with the Asian Development Bank (ADB), to provide health services to women and children. They also have a Nursing Training Institute and a Family Welfare Visitors Training Institute. In addition to the government facilities there were 25 private clinics in the city in 1998 and this number has been increasing. Consequently the patient to bed ratio in Rajshahi

City was approximately 1:354 in 2004, compared to 1:1265 in Khulna City in 2001 and 1:2951 nationally (RDA vol-I, 2004, p. 35).

**Table 4.7: Types of facilities at different levels, 2002**

<b>Rajshahi</b>	<b>District hospital</b>	<b>Other government hospitals</b>	<b>Private hospitals</b>	<b>Thana Health Complex (THC)</b>	<b>Union sub-centre rural dispensary</b>	<b>Other outdoor facilities</b>
Zila	-	3 (770)	20	9	32	2
Division	14 (1295)	11(2450)	127	111 (3378)	410	

Source: Health Information Unit (UMIS), Director General of Health Services, 2002

Note: The figures in bracket indicate the number of beds.

Perhaps as a result of the good access to medical facilities, people appeared to be aware of the need to seek proper health advice, with 70% reporting in the survey that they visit qualified doctors and 16% visit government hospitals. Outside the RCC area 48% of households visit qualified doctors because they are less available and because people can not afford them (RDA vol-I, 2004, p. 32).



## 5 Land Utilization, Agriculture and Marketing

### Agricultural Land Use

In 2002-2003 the net cropped area<sup>5</sup> for the country was 19845000 acres (54%): a further 764000 acres was “cuturable waste”<sup>6</sup> (2%) and 957 (3%) was “current fallow”<sup>7</sup> (Table 5.1). In Rajshahi Division the percentage of net cropped land is much higher at 73% (1697000 acres), with the major difference being in the single cropped land category (Table 5.1).

**Table 5.1: Land utilization for Bangladesh and Rajshahi Division 2002-2003**

Land Utilization Category	Land Area Bangladesh (000 acres)	Land Area Rajshahi Division (000 acres)
Forest	6418	8
Not available for cultivation	8685	549
Culturable waste	764	15
Current fallows	957	64
Single cropped area	7108	902
Double cropped area	10193	674
Triple cropped area	2544	121
Total land area	36669	2333

*BBS, 2005d, p. 343*

In the area defined as “urban” under the Master Plan, 43% of the land is used for agriculture and 20% is homesteads (RDA vol.-I, p. 9). In the RCC area residential use covers the largest area (33%) but a large part (19%) is used for agriculture (RDA vol.-I, p. 7) and a further 11% is vacant (RDA vol.-I, p. 10).

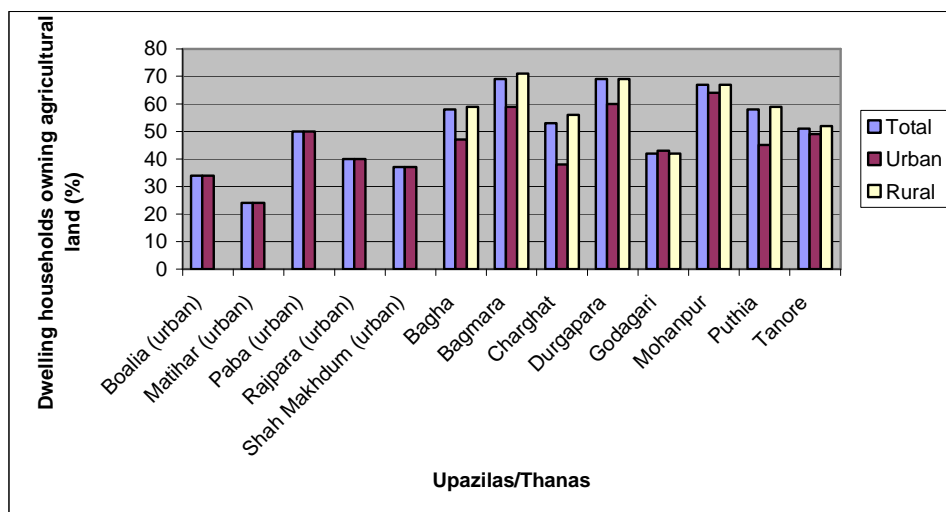
Statistics on agricultural land ownership in these areas reveal that land ownership by households in urban areas is 37% compared to 59% in *Upazilas* with both urban and rural areas, and 45% in the urban areas of those *Upazilas* (Figure 5.1).

<sup>5</sup> The total of single cropped area, plus double cropped area, plus triple cropped area.

<sup>6</sup> Cuturable waste is defined as the area suitable for cultivation but lying fallow for more than one year (BBS, 2005a, p. 133).

<sup>7</sup> Current fallow is the area already brought under cultivation but not cultivated during the year (BBS, 2005a, p. 133).

**Figure 5.1: Percentage of households owning agricultural land by *Upazila* or *Thana***



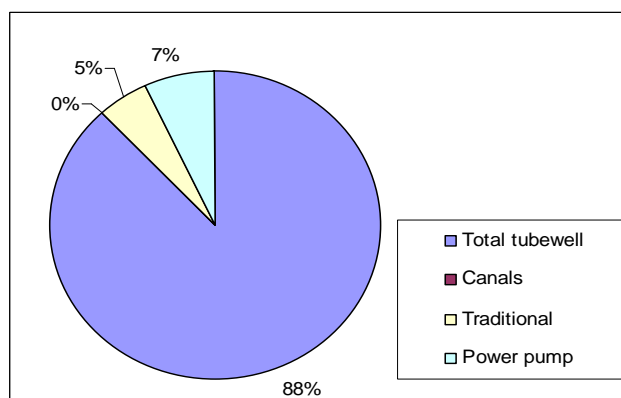
Source: BBS 2005c, pp.9-62

### Irrigated Land

In 2002-2003 the total irrigated area in Bangladesh was 11676000 acres of which 74% was irrigated by tube-well, 17% by power pump, 6% by traditional method and 3% by canal (BBS 2005a, p. 135). Of this the majority is used to irrigate *aus*, *aman* and *boro* paddy (82%), with 8% irrigating wheat and the remainder being used on a variety of crops including potato, vegetables, oil seed, sugarcane, other cereals and pulses (BBS 2005a, p. 135).

In Rajshahi Division 49% of the cropped land (46000 acres) in 2002-2003 was irrigated, compared to a national average of 33%. The sources of irrigation were similar to national figures with the majority of land being irrigated by tubewell (88%) including shallow tubewell (65%) and deep tube-well (35%) (Figure 5.2).

**Figure 5.2: Method of irrigation by land area in Rajshahi Division 2002-2003**



Source: BBS 2005a, p. 136

The total irrigated area in Rajshahi Zila was 194199 acres at the time of the 1996 Bangladesh Census of Agriculture which was 65% of the net cultivated area of 297777 acres (BBS 2005d, p. 223).

### **Crop Production and Marketing**

Rice production in Rajshahi stood at approximately 1.32 million metric tons in 1995 from an area of 1.63 million acres; this increased to 2.06 million metric tons from an area of 1.97 million acres by 2003, a yield of 1.05 tons per acre (BBS 2005d, p. 145). This is compared to a national average yield of 0.95 tons per acre. Other crops are very important in Rajshahi District, including vegetables (spinach, cabbage and cauliflower), maize, wheat, potatoes, sugarcane and jute. Mango is a particularly important crop, with a production level of 78270 metric tons on 24310 acres (3.22 tons per acre), which is more than twice the national production average of 1.14 tons per acre (BBS 2005d).

The agricultural produce of the area is traded in 12 bazaars, and there are four important wholesale markets (Shaheb Bazar, Kadirganj Bazar, Katakhal Bazar and Rani Bazar) in the centre of the city that trade in a number of goods including vegetables. The agricultural produce traded in these markets are transported to Dhaka and other regions (RDA vol-I, 2004, p. 36), meaning that any wastewater produced vegetables may well be consumed, and impact on health, in these other cities.

## 6 Industry

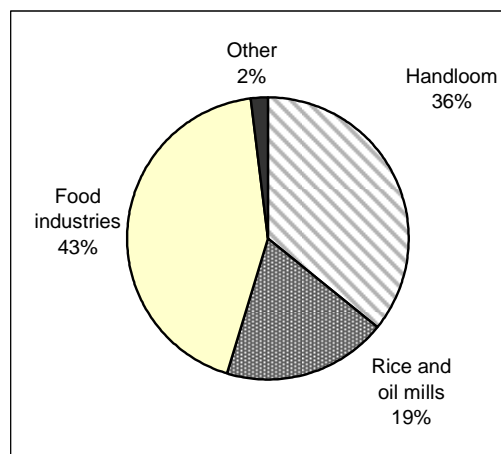
There are, according to the 2003 economic census, roughly 5162 industries of varying sizes in Rajshahi Zila (BBS 2006, p. XXXIV). These industries are dominated by hand looms, rice and oil mills, and other food industries (Table 6.1 and Figure 6.1).

**Table 6.1: Type and Number of Industries in Rajshahi Zila**

Type of industry	Number of units
Rubber and plastic	7
Cotton and Spinning mill	26
Cigarette Factory	1
Match Factory	8
Glass Factory	10
Soap Factory	2
Iron and Metal Factory	9
Rice and oil Mills	1848
Handloom	973
Dairy product	39
Food industries	2238
Pharmaceutical industries	1
<b>Total</b>	<b>5162</b>

Source: BBS 2006; BBS 2005b

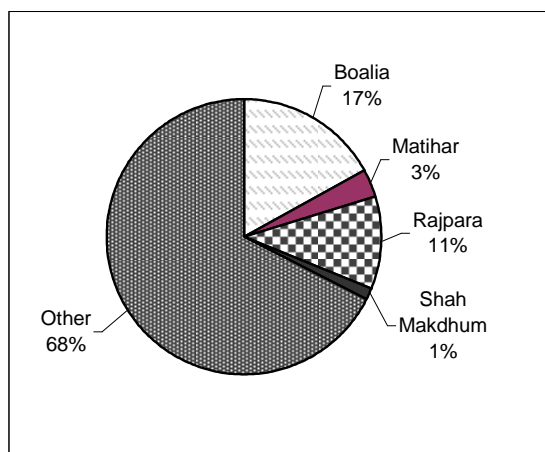
**Figure 6.1: Percentage share by category of industries in Rajshahi Zila**



Source: BBS 2006, p. XXXIV

The industries are located throughout the *zila* but around 32% are found within the four *thana* that make up the RCC area and employ over 25000 people (Figure 6.2). The Bangladesh Small and Cottage Industries Corporation (BSCIC) established an industrial estate with 325 plots in Sopura, on the northern edge of Rajshahi City in an area of just under 96 acres. Of these, 173 have been filed and the others have remained vacant for 42 years (RDA vol.-I 2004, p. 14). It is therefore clear that Rajshahi is not a major industrial area like Dhaka, Narianganj or Gazipur but it is famous for its silk and it is still likely that industrial waste may have a significant effect on agricultural production where wastewater is being used. Two of the major industrial silk mills have a combined annual production capacity of 290000 yards of silk (RDA vol.-I 2004, p. 23).

**Figure 6.2: Percentage of industries in various locations in Rajshahi Zila**



Area	Number of macro-establishments	Total persons employed
Boalia	292	9802
Matihar	55	1814
Rajpara	186	12668
Shah Makdhum	25	948
Other	1156	31834
<b>Total for Rajshahi Zila</b>	<b>1714</b>	<b>57066</b>

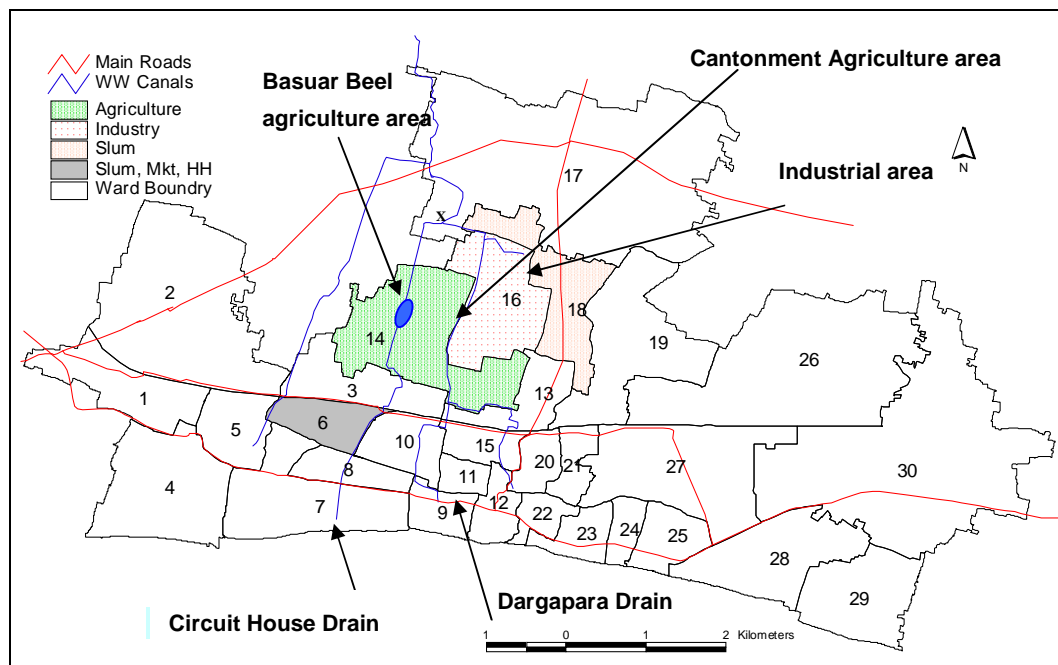
Source: BBS 2006, p. XXXVI

## 7 Project Location and Data Gaps

### Site Selection

The size, population and number of drains in the city made it impossible for the project to work throughout the whole of the city. In addition there were certain key locations where wastewater agriculture covered a large area. Given these conditions the project team selected an area drained by two main drains that flow through the town of Rajshahi called the Bashuar Beel Drain and the Cantonment Drain (Figure 7.1).

Figure 7.1: Project site within RCC area



Source: RCC 2006

The Circuit House Drain, also known as Bashuar Beel Drain starts in Ward 7 from the place identified as Circuit House Road. This drain flows through Ward 8, along the edge of Ward 6 and through Ward 3. It passes by the Rajshahi Metropolitan Police, Rajshahi Medical College Hospital, Clinic and Women's Complex. After that the Bashuar Beel Drain enters Bashuar Beel, in Ward 14 and emerges the other end of the *beel* before flowing through agricultural land in Ward 14, Paba Thana and Ward 17, and onto Banaoni River (Figure 7.1).

Dargapara Drain, also known as Cantonment Drain starts from Natore Road in Ward 9. It flows through Ward 10, Ward 14, and Ward 16, passing by Rajshahi College, a women's hostel, Sadar (Main) Hospital, the Passport Office, the Fisheries Office and the Cantonment Area. In Ward 16 a second drain joins the Dargapara Drain, bringing untreated industrial effluent from the BSCIC industrial area and any residences also located there. The water

from these drains is used in Ward 14 (before the industrial wastewater enters the system) and Ward 16 where some areas are likely to be using wastewater containing industrial waste.

In Ward 17, in an area known as Terokhadia, the Bashuar Beel Drain and the Cantonment Drain meet. The drain flows on and is continuously used for agricultural purposes, finally meeting the Baraonai River approximately 11-12 Kilometers away from the place where both the drains meet (GIS map of Institute of Water Modeling).

### **Further Data Requirements**

There is significant national and regional data collected by the BBS through various surveys such as the national census but this is generally reported at an aggregate level, with only some data reported to the level of *thana*. Furthermore this data is, by necessity, limited in its scope and does not cover all the areas that are required for this project. In addition to this data local government departments collect other data of relevance to them or as per their mandates. For example, hospital records are kept, compiled by RCC and also sent to Dhaka for analysis. Finally various projects or studies have collected data or compiled data; this has been extremely useful and the main source of information at the local level for this background report.

This is not however sufficient to provide a full understanding of agricultural activities, sanitation, hygiene and wastewater management at the sub-ward level in Rajshahi, and the project team has identified some data gaps that need to be filled. These data gaps exist either because the data is not collected or because it is not routinely analyzed and publicly reported. The methodology for further data collection therefore includes meetings with various government officials and other individuals who may already have unpublished data, as well as primary data collection.

The areas requiring further data collection include:

- Sources of waste entering the drains;
- Agricultural use practices and crop yields;
- Sanitation and hygiene behavior;
- Institutional analysis;
- Health statistics; and
- Water quality.

Methodologies will be developed to facilitate data collection. These will include focus group discussions, key person interviews, physical observations (mapping and transect walks) and water quality sampling. The results of these assessments will be provided in future project reports.

## References

- Ahmed, M. F. and Md. M. Rahman .2000. *Water supply and Sanitation, Rural and Low Income Urban Communities*. Bangladesh, ITN.
- Bangladesh Bureau of Statistics (BBS). 1993. *Bangladesh Population Census 1991, Zila: Rajshahi*. Dhaka, Bangladesh, Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2003. *Population Census 2001, National Report (Provisional)*. Dhaka, Bangladesh, Planning Division, Ministry of Planning. Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2005a. *Statistical Year Book of Bangladesh, 24<sup>th</sup> Edition*. Dhaka, Bangladesh, Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2005b. *Population Census-2001, Zila Series, Zila: Rajshahi*. Dhaka, Bangladesh, Planning Division, Ministry of Planning. Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2005c. *Population Census-2001, Community Series, Zila: Rajshahi*. Dhaka, Bangladesh, Planning Division, Ministry of Planning. Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2005d. *2004 Year Book of Agricultural Statistics of Bangladesh*. Planning Division, Ministry of Planning. Dhaka, Bangladesh, Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2005e. *Compendium of Environment Statistics of Bangladesh*. Dhaka, Bangladesh, Government of the People's Republic of Bangladesh.
- Bangladesh Bureau of Statistics (BBS). 2006. *Economic Census 2001 and 2003: Zila Series, Zila: Rajshahi*. Dhaka, Bangladesh, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh.
- Development Design Consultants Limited. 2003. *Social and Municipal Services: Working Paper for the Rajshahi Metropolitan Development Plan*. Bangladesh, Dhaka.
- Director-General of Health Service .Health information unit. Ministry of Health and Family Welfare.
- DP/UN. 1996. *Local Government in Bangladesh: An Agenda for Governance*. United Nations Department for Development Support and Management Services, New York.
- Government of the People's Republic of Bangladesh (GoB). 1997. *The Environment Conservation Rules 1997*. Bangladesh, Ministry of Environment and Forests.



National Sanitation Secretariat .2006. *National Sanitation Status*. Bangladesh, Government of the People's Republic of Bangladesh.

Rahman, A. A. and P. Ravenscroft. (eds.) 2003. Groundwater resources and development In Bangladesh. Dhaka, Bangladesh, The University Press Limited.

Rahman M. M. 2005. Surface Water Quality in Rajshahi City. *The Journal of Geo-Environment*. Vol. 4, 2004, pp. 15-22

Rajshahi City Corporation (RCC). 1994. Feasibility Study and Preparation of Drainage Master Plan for Rajshahi City Corporation, Government of the People's Republic of Bangladesh, consulted by Aqua Consultant and Associates Limited, Dhaka, Bangladesh.

RCC. 2005. BR/PGR/EPI and Disease Surveillance Report. Rajshahi, Bangladesh.

RCC. 2006. GIS shape files provided by RCC to the project team.

Rajshahi Development Authority (RDA). 2004. *Rajshahi Metropolitan Development Plan. 2004-2024. Volume-I Structure Plan and Master Plan*. Prepared by RDA under the Ministry of Housing and Public Works, Government of the People's Republic of Bangladesh.

Rajshahi Development Authority (RDA). 2004. *Rajshahi Metropolitan Development Plan. 2004-2024. Volume-II Detailed Area Plan*. Prepared by RDA under the Ministry of Housing and Public Works Government of the People's Republic of Bangladesh.

UNICEF. 2004. *Progotir Pathay 2003: On the Road to Progress*. Dhaka, Bangladesh, Planning Division, Ministry of Planning. Government of the People's Republic of Bangladesh.

**Annex I: Spatial Planning Zone (SPZ) with Functional Master Plan Area**

SPZ Number	Local area coverage	Area type	Area (Acre)	Population	
				2001	2014
1	Naohata Paurashava	Extended area	9131.00	42180	51032
2	Barogachi Union (part)	Extended area	2886.39	9818	11879
3	Barogachi Union (part) and Parila Union (part)	Extended area	2408.27	6734	8147
4	Barogachi Union (part) and Parila Union (part)	Urban area	2563.99	9416	11392
5	Huzuripara Union (part) and Harogram Union (part)	Extended area	2348.90	7023	8497
6	Damkura Union (part) and Harogram Union (part)	Extended area	4788.97	21155	25594
7	Harogram Union (part)	Urban area	2319.47	9436	11417
8	RCC Ward No. 17	Urban area	1726.43	12805	15492
9	Parila Union (part)	Urban area	1707.52	8520	10308
10	Parila Union (part)	Extended area	2669.95	9379	11347
11	Harian Union (part)	Extended area	2098.16	6917	8368
12	Harian Union (part)	Urban area	3265.49	17645	21349
13	RCC Ward No. 26	Urban area	1078.29	11712	14170
14	RCC Ward No. 14-16, 18, 19 and cantonment	Urban area	2055.54	63283	76565
15	RCC Ward No. 1,2,4	Urban area	1753.66	32200	38959
16	Haripur Union	Extended area	23887.79	30239	36586
17	RCC Ward No. 3, 5, 6-11, 13	Urban area	1679.85	91384	110564
18	RCC Ward No. 12, 20-25, 27	Urban area	1372.89	93140	112687
19	RCC Ward No. 28-30	Urban area	2204.33	43212	52281
20	Katakhali Paurashava and Yousufpur Union (part)	Urban area	2992.45	26766	32384
21	Yousufpur Union (part)	Extended area	3148.73	14111	17072
22	Belpukuria Union (part)	Extended area	2556.98	11270	13636
23	Baeswar Union (part) and Belpukuria Union (part)	Extended area	2482.90	18136	21942
24	Sardah Union (part) and Yousufpur Union (part)	Extended area	4862.10	29927	36208
25	Salua Union (part)	Extended area	1967.32	8266	10000
	<b>Total</b>		<b>89957.37</b>	<b>634674</b>	<b>767876</b>
	RCC total		11870.99	347736	420718
	<b>RCC as % of total</b>		<b>13</b>	<b>55</b>	<b>55</b>
	Urban total		21727.46	392753	475184
	<b>Urban as % of total</b>		<b>24</b>	<b>62</b>	<b>c62</b>

Source: RDA Vol.-II, pp. 1-2

**Annex II: Major source of household income for Rajshahi Zila**

Source of Income	All area		Urban		Rural	
	2001	1991	2001	1991	2001	1991
Agriculture/Forestry/Livestock	33.60	39.40	16.25	17.63	42.84	48.15
Fishing/ Pisciculture	0.85	0.82	0.84	0.82	0.86	0.82
Agriculture Labour	24.91	23.64	14.95	13.23	30.22	27.82
Non Agriculture Labour	3.36	3.50	4.20	4.78	2.91	2.98
Weaving	0.26	0.13	0.34	0.06	0.21	0.16
Industry	0.73	0.66	1.30	0.85	0.43	0.58
Business	14.01	12.64	20.86	20.35	10.36	9.26
Hawker	0.24	0.26	0.37	0.47	0.17	0.18
Transport	4.36	2.36	7.30	5.76	2.79	1.00
Construction Work	1.45	0.89	2.98	2.03	0.63	0.43
Religious Work	0.12	0.12	0.15	0.14	0.11	0.12
Employment	8.97	8.81	19.73	23.85	3.24	2.77
Rent and remittances	0.41	0.11	0.90	0.34	0.14	0.02
Other Services	6.74	6.86	9.83	9.68	5.09	5.72

Source: Population census – 2001, BBS

### Annex III: Standards from the Environmental Conservation Rules 1997

Best practice based classification	pH	BOD (mg l <sup>-1</sup> )	DO (mg l <sup>-1</sup> )	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activities	6.5-8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000 or less
d. Water usable by fisheries	6.5-8.5	6 or less	5 or more	---
e. Water usable by various process and cooling	6.5-8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation	6.5-8.5	10 or less	5 or more	1000 or less

#### Notes:

1. In water used for pisciculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg l<sup>-1</sup>
2. Electrical conductivity for irrigation water is 2250  $\mu\text{mhos.cm}^{-1}$  (at a temperature of 25°C); sodium less than 26 %; boron less than 0.2 %

### Drinking Water Quality Standards

Water Quality Parameter	Unit	Bangladesh Standards	WHO guide lines value (1993)
Aluminum	mg/l	0.2	0.2
Ammonia	mg/l	0.5	1.5
Arsenic	mg/l	0.05	0.01
Barium	mg/l	0.01	0.7
Benzene	mg/l	0.01	0.01
BOD5 at 20 C	mg/l	0.2	
Boron	mg/l	1	0.3
Cadmium	mg/l	0.005	0.003
Calcium	mg/l	75	
Chloride	mg/l	150-600*	250
<i>Chlorinated alkenes</i>			
Carbon tetrachloride	mg/l	0.01	0.002
Trichloroethylene	mg/l	0.001	
Dichloroethane	mg/l	0.03	0.03
Tetrachloroethylene	mg/l	0.03	
Trichloroethylene	mg/l	0.09	
<i>Chlorinated Phenols</i>			
Pentachlorophenol	mg/l	0.03	
2,4,6 Trichlorophenol	mg/l	0.03	0.02
Chlorine (residual)	mg/l	0.2	.6-1
Chloroform	mg/l	0.09	0.2
Chromium (hexavalent)	mg/l	0.05	
Chromium (Total)	mg/l	0.05	0.05
Chemical Oxygen Demand	mg/l	4	
Coliform (faecal)	N/100ml	0	0
Coliform (total)	N/100ml	0	0
Colour	Hazen Unit	15	15

Copper	mg/l	1	1
Cyanide	mg/l	0.1	0.07
Detergents	mg/l	0.2	
dissolved Oxygen	mg/l	6	
Fluoride	mg/l	1	1.5
Hardness (as CaCO <sub>3</sub> )	mg/l	200-500	
Iron	mg/l	.3-1	0.3
Khehidal Nitrogen (total)	mg/l	1	
Lead	mg/l	0.05	0.01
Magnesium	mg/l	30-35	
Manganese	mg/l	0.1	0.1
Mercury	mg/l	0.001	0.001
Nickel	mg/l	0.1	0.02
Nitrate	mg/l	10	50
Nitrite	mg/l	<1	3
Odour	mg/l	odour less	
Oil and grease	mg/l	0.01	
PH	Unit less	6.5-8.5	
Phenolic compounds	mg/l	0.002	
Phosphate	mg/l	6	
Phosphorus	mg/l	0	
Potassium	mg/l	12	
Radioactive substances			
Total alfa radiation	Bq/l	0.01	
Total beta radiation	Bq/l	0.1	
Selenium	mg/l	0.01	0.01
Silver	mg/l	0.02	
Sodium	mg/l	200	200
Suspended solids	mg/l	10	
Sulphaide	mg/l	0	
Sulphate	mg/l	400	250
Total dissolved solids	mg/l	1000	1000
Temperature	o C	20-30	
Tin	mg/l	2	
Turbidity	JTU	10	5
Zinc	mg/l	5	3

\*For coastal areas of Bangladesh, in case of non-availability of alternative sources value is 1000.

Source: Ahmed and Rahman, 2000

**National Standards - Waste discharge quality standards for industrial units and projects: Quality standard at discharge point**

Parameter	Unit	Inland Surface Water	Public Sewer secondary treatment plant	Irrigated land
Ammoniacal Nitrogen (N molecule)	mg/l	50	75	75
Ammonia (free ammonia)	mg/l	5	5	15
Arsenic	mg/l	0.2	0.5	0.2
BOD <sub>5</sub> 20 <sup>0</sup> C	mg/l	50	250	100
Boron (B)	mg/l	2	2	2
Cadmium (Cd)	mg/l	0.05	0.5	0.5
Chloride (Cl <sup>-</sup> )	mg/l	600	600	600
Chromium (total Cr)	mg/l	0.5	1.0	1.0
COD	mg/l	200	400	400
Chromium (hexavalent Cr)	mg/l	0.1	1.0	1.0
Copper (Cu)	mg/l	0.5	3.0	3.0
Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
Electrical Conductivity	micro mho/cm	1200	1200	1200
Total Dissolved Solids (TDS)	mg/l	2100	2100	2100
Fluoride (F)	mg/l	7	15	10
Sulfide (S)	mg/l	1	2	2
Iron (Fe)	mg/l	2	2	2
Total Kjeldahl Nitrogen (N)	mg/l	100	100	100
Lead (Pb)	mg/l	0.1	0.1	0.1
Manganese (Mn)	mg/l	5	5	5
Mercury (Hg)	mg/l	0.01	0.01	0.01
Nickel (Ni)	mg/l	1.0	1.0	1.0
Nitrate (N molecule)	mg/l	10.0	Undetermined	10.0
Oil & grease	mg/l	10	20	10
Phenol compounds (C <sub>6</sub> H <sub>5</sub> OH)	mg/l	1.0	5	1
Dissolved Phosphorus (P)	mg/l	8	8	10
Radioactive materials:	As determined by Bangladesh Atomic Energy Commission			
pH		6-9	6-9	6-9
Selenium (Se)	mg/l	0.05	0.05	0.05
Zn (Zn)	mg/l	5.0	10.0	10.0
Temperature	Centigrade			
Summer	mg/l	40	40	40
Winter	mg/l	45	45	45
Total Suspended Solid (TSS)	mg/l	150	500	200
Cyanide (CN)	mg/l	0.1	2.0	0.2

Source: Government of the People's Republic of Bangladesh, Ministry of Environment and Forests, The Environment Conservation Rules 1997, Schedule 10, Rule 13 (Un-official English Version)