

APPROACHES TO RESTORE WATER QUALITY OF BURIGANGA RIVER

BY
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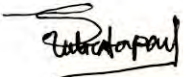


October, 2008

DECLARATION

I hereby certify that the research work embodied in this project report has been performed by the author under the supervision of Dr. Md. Delwar Hossain, Professor of the Department of Civil Engineering, BUET. Neither this thesis nor any part of it has been submitted or is being currently submitted else where for any other purpose (except for publications).

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CONTENTS

Acknowledgement	
Abstract	
	Page No
List of Figures	i
List of Tables	ii
List of Abbreviations	iii
CHAPTER 1	1
INTRODUCTION	1
1.1 General	1
1.2 Objective of the Study	3
1.3 Scope of the Study	4
1.4 Methodology	4
1.5 Organization of the Report	5
CHAPTER 2	6
LITERATURE REVIEW	6
2.1 General	6
2.2 Peripheral River System Around the Dhaka City	7
2.3 Profile of the Buriganga River	10
2.3.1 Prospects and problems	10
2.3.2 Water supply	10
2.3.3 Present situation and problems of the study area	10
2.4 Climatic Condition of the Study Area	12
2.5 Water Quality Parameters	13
2.5.1 Dissolved Oxygen (DO)	13
2.5.2 Biological Oxygen Demand (BOD)	14
2.5.3 Chemical Oxygen Demand (COD)	14
2.5.4 Nitrogen (N ₂)	15
2.5.5 Solids	15
2.5.6 Iron	16
2.5.7 Sulphate	16
2.5.8 Phosphorous and Phosphate	16
2.5.9 Turbidity	17
2.5.10 Alkalinity	17
2.5.11 pH	18
2.5.12 Electric conductivity	18
2.6 Environmental Quality Standard (EQS)	18
2.7 Previous Studies	20
2.7.1 Past studies of water quality on Buriganga river (before 1990)	20
2.7.2 Present studies of water quality on Buriganga river (after 1990)	21

2.8 Pollution	23
2.8.1 Industrial water pollutants	24
2.8.2 Pollution due to industry	25
2.8.3 Pollution due to thermal plant	26
2.9 Types of Pollution	27
2.9.1 Physical pollution	27
2.9.1.1 Encroachment of the banks of the Buriganga river	28
2.9.1.2 Shrinking of the Buriganga river	29
2.9.2 Chemical pollution	32
2.9.3 Biological pollution	32
2.10 Causes of Pollution	33
2.11 Sources of Pollution	33
2.11.1 Point sources of pollution	34
2.11.1.1 Encroachment	35
2.11.1.2 Solid waste	36
2.11.1.3 Untreated sewerage	37
2.11.1.4 Industrial pollution from Hazaribagh tannery	37
2.11.1.5 Other industries	38
2.11.1.6 Terminal and landing stations	39
2.11.1.7 Pollution from sewage	39
2.11.2 Non-point source of pollution	40
2.12 Pollution Loads Discharged into the River and it's Projection	41

CHAPTER 3 46

METHODOLOGY 46

3.1 Introduction	46
3.2 Water Quality Data Collection	46
3.2.1 Water quality data collected from Department of Environment (DOE)	47
3.2.2 Water quality data collected from Institute of Water Modelling (IWM)	47
3.2.3 Water quality data collected from Bangladesh Water Development Board (BWDB)	48
3.2.4 Water quality data collected from various thesis	48
3.3 Water Sample Collection from Different Locations of the Buriganga River and Tested in the BUET Laboratory	49
3.4 Photographs Collection from Different Locations of the Buriganga River	51
3.5 Data Analysis and Approaches to Restore Water Quality of the Buriganga River	51

CHAPTER 4 52

DATA ANALYSIS AND DISCUSSION 52

4.1 Introduction	52
4.2 Data Analysis for the Water Quality of Buriganga River	52
4.2.1 Dissolved Oxygen (DO)	53
4.2.2 Biochemical Oxygen Demand (BOD)	59
4.2.3 Chemical Oxygen Demand (COD)	63
4.2.4 Nitrogen	64

4.2.5 Phosphate	65
4.2.6 Heavy Metal (Chromium, Lead, Cadmium)	66
4.3 Data Analysis for Pollution Loadings	67
4.4 Result from Analysis on Pollutant Loadings	70
4.5 Approaches to Restore Water Quality of the Buriganga River from Different Types and Sources of Pollution	71
4.5.1 Restore water quality from physical pollution	71
4.5.2 Restore water quality from untreated sewage	73
4.5.3 Restore water quality from solid waste and biological pollution	73
4.5.4 Restore water quality from industrial pollution of Hazaribagh tannery	74
4.5.5 Divert sewage toward Pagla sewage treatment plant	75
CHAPTER 5	76
CONCLUSION AND RECOMMENDATION	76
5.1 Conclusion	76
5.2 Recommendations	77
5.3 Recommendation for Future Study	78
Reference	79
APPENDIX	
Appendix-A	Water Quality Data
Appendix -B	Photographs on Pollution scenario of the Buriganga River

LIST OF FIGURES

	Page No
Figure 2.1: Locations of Major Point Sources of Pollution on Buriganga River Satellite image of the Buriganga River and its surrounding	8
Figure 2.2: Peripheral River System around the Dhaka city	9
Figure 3.1: Satellite image of the Buriganga River and its surrounding	49
Figure 3.2: Location of Sample in the Buriganga River	50
Figure 4.1: Yearly variation of Dissolved Oxygen in the Buriganga River. (Data Source: Maniruzzaman, IWM, Magumdar, DOE, BWDB and BUET)	54
Figure 4.2: Seasonal variation of DO in Buriganga during the year of 2000	55
Figure 4.3: Seasonal variation of DO in the Buriganga River during the year of 2002	55
Figure 4.4: Seasonal variation of DO in the Buriganga Rivers in 2004- 2005 (Data source BWDB)	56
Figure 4.5: Yearly Variation of Minimum DO in the Buriganga	58
Figure 4.6: Present scenario of DO at peripheral river system of Dhaka city	58
Figure 4.7: BOD ₅ in the Buriganga during Jan'07 and Feb'07	59
Figure 4.8: Biochemical Oxygen Demand (BOD ₅ at 20°C) in the Buriganga during 1968 to 2007 (Data Source: Maniruzzaman, IWM, Magumdar, DOE, BWDB and BUET)	61
Figure 4.9: Biochemical Oxygen Demand (BOD ₅ at 20°C) at Hazaribagh	62
Figure 4.10: Biochemical Oxygen Demand (BOD ₅ at 20°C) at Chandnighat	62
Figure 4.11: Biochemical Oxygen Demand (BOD ₅ at 20°C) at Pagla	62
Figure 4.12: COD in the Buriganga River during Jun'07	63
Figure 4.13: Chemical Oxygen Demand on the Buriganga River	64
Fig 4.14: Profile of maximum ammonia-nitrogen (NH ₃ - N) concentration in the Buriganga river system (Observation Apr-03, Dec-03, Mar-04 and Apr- 04) (Data Source: IWM, 2005)	64
Fig 4.15: Profile of total nitrogen (NH ₃ - N+ NH ₄ ⁺ - N +NO ₃ - N) content in the Buriganga river (Observations: Apr-03, Dec-03, Mar-04 and Apr- 04) (Data Source: IWM, 2005)	65
Fig 4.16: Profile of phosphate (PO ₄ ³⁻) concentration in the Buriganga river system (Data Source: Subrata, Jun-2007)	65
Fig 4.17: Profile of maximum chromium content in the Buriganga river (Observations: Apr-03, Dec-03, Mar-04 and Apr- 04) (Data Source: IWM, 2005, Subrata, 2007)	66
Fig 4.18: Profile of maximum lead content in the Buriganga river system (Observations: Apr-03, Dec-03, Mar-04, Apr- 04 and Jun-07) (Data Source: IWM, 2005, Subrata, 2007)	67

LIST OF TABLES

Table 2.1: Climatic condition of study area	13
Table 2.2: EQS of some relevant water quality parameters (DOE 1991)	18
Table 2.3: EQS of some relevant water quality parameters, DOE 1997	19
Table 2.4: Drinking Water Quality Standard (source: Ahmed, et al, 2001)	19
Table 2.5: Industrial units in 5 Municipal Wards in Dhaka City	26
Table 2.6: Comparison cross-section data of Buriganga River for different year	30
Table 2.7: Pollution loads discharged into the river system (WSP, 1998)	43
Table 2.8: Industrial areas in and around Dhaka city (WSP, 1998)	44
Table 2.9: Summary of loading in the peripheral Rivers (Greater Dhaka, 1998)	44
Table 2.10: Shows the population (as in RAJUK, 1993) with corresponding BOD loadings considering a unit BOD load of 25 kg/c.d.	44
Table 2.11: Projected BOD loads in the peripheral rivers: 2016	45
Table 2.12: Summary of pollutant loadings in the in the peripheral rivers: 2000, 2005, 2010 and 2015 (Source: Akter, 07)	45
Table 3.1: Positions of River water monitoring locations	48
Table 4.1: Water Quality in Buriganga River during 1968-1980 (Source: Haque, 2003)	53
Table 4.2: Measured water quality parameter in June, 2007	53
Table 4.3: Seasonal variation of Dissolved Oxygen (DO) in Buriganga	54
Table 4.4: Analysis of historical data on DO at Hazaribagh	57
Table 4.5: Analysis of historical data on DO at Chandighat	58
Table 4.7: Analysis of historical data on BOD ₅ (at 20°C) at Hazaribagh	60
Table 4.8: Analysis of historical data on BOD ₅ (at 20°C) at Chandighat	60
Table 4.9: Analysis of historical data on BOD ₅ (at 20°C) at Pagla	61
Table: 4.10: BOD load discharged into the Buriganga river from PSTP	68
Table 4.11: Pollution load discharged through waste water generated within in Dhaka (point sources) (Estimation based on a single measurement in a day)	68
Table 4.12: Pollution Load contributed into the Buriganga through different point sources i.e. waste water drains	69
Table 4.13: Pollution loads added into the Buriganga through both point and non-point sources	69
Table 4.14 BOD loadings from industrial clusters (kg/day)	70
Table 4.15: Comparison of BOD loadings originated by industrial discharges	70

LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
BIWTA	Bangladesh Inland Water Transport
BRCP	Buriganga River Cleanup Program
BAPA	Bangladesh Paribash Andalon
COD	Chemical Oxygen Demand
CIDA	Canadian International Development Agency
DND	Dhaka Narayanganj Demra
DO	Dissolved Oxygen
DOE	Department of Environment
DWASA	Dhaka Water Supply and Sewerage Authority
DEPZ	Dhaka Export Processing Zones
DCC	Dhaka City Corporation
DMDP	Dhaka Metropolitan Development Planning
EC	Electrical Conductivity
EQS	Environmental Quality Standards
ETP	Effluent Treatment Plant
IWM	Institute of Water Modelling
JICA	Japan International Cooperation Agency
MOEF	Ministry of Environment and Forest
MLD	Million Liter per Day
NPS	Non Point Source
NGO	Non Government Organization
PSTP	Pagla Sewage Treatment Plant
PS	Point Source
SWTP	Sayedabad Water Treatment Plant
SWMC	Surface Water Modelling Center
T.C.	Total Coliform
TSS	Total Suspended Solid
TDS	Total Dissolved Solid
WTP	Water Treatment Plant
WHO	World Health Organization

DEDICATED TO MY GRANDFATHER

ABSTRACT

Over the last few decades environment and its pollution is the governing concern for the human being in this planet. People become conscious about the changing of their surrounding. Global warming, Acid rain are now very familiar to us. Still lot of work to be done for mass people awareness, which is very crucial for the country like ours. People here are so uneducated that few of them are conscious about the environment and its changing. But environment is degraded by day by day the weight of over crowded people. One of such example is the Buriganga River. Buriganga River which encompasses south-western periphery of Dhaka city receives uncontrolled discharge of pollution, solid waste, sewage and wastewaters discharged from domestic, commercial and industrial activities of the city. These waste materials are tremendously deteriorating the water quality of the Buriganga River. The contamination level reaches at such an alarming stage during dry periods that not only the ecosystem in the river collapse but also the water treatment plants of the city water supply system developed based on the river water, virtually losses their expected quality of production. Hence of restore the water quality of the Buriganga is crucial for its sustainability. This study on Buriganga is approaches to restore water quality of this river, which includes possible remedial measures to prohibit of water pollution such as physical, chemical and biological pollution of the river.

This study has focused on the present scenario of water quality, historical trend of water quality and percent increase of BOD loading. Data of water quality analysis in biological and chemical parameters are presented, analyzed in tabular and graphical form in this study. It is vivid the water pollution increased tremendously over the last few decades and the river Buriganga is going to be a canal carrying polluted water. The cross-sectional area, depth reduces by filling waste loads day by day and some where increases by unplanned dredging. Shrinking of river bed is found due to the heavy BOD load, sedimentation and bank encroachment. From 1968 to 2007 maximum BOD₅ of the river at Hazaribagh area increases from 0.8 to 60 mg/l and DO reaches 6.7 mg/l to zero in most places. BOD loading from industrial origin has increased at all industrial clusters from 1994 to 2006. The increase of BOD load is 37% in Tongi, 82 % in Hazaribagh, and 87% in Narayanganj.

Formulation of different types of approaches and management programs is very essential and important in order to restore the water quality of the Buriganga River. As Hazaribagh tanneries are responsible for causing a major pollution in the Buriganga river by the contribution of toxic and persistent pollutants, an Effluent Treatment Plant (ETP) should be established to treat the tannery waste or Tannery industries should be shifted. Moreover, proper treatments of domestic and industrial wastes are needed before discharge in the Buriganga. Proper solid waste management of the area is to be handled properly. Proper dredging and eviction of encroachers are emphasized to improve the water quality of the Buriganga river.

CHAPTER 1

INTRODUCTION



1.1 General

Water is absolutely essential for human life. Adequate water of good quality is a vital requirement for the maintenance and development of public health. Hence the important consideration and main responsibility of the modern public health Engineers is to supply potable water to the community. A potable water is one which is safe to drink, pleasant to taste and suitable for domestic uses (Islam, 1977).

Conceptually, water quality refers to the characteristics of a water supply that will influence its stability for a specific use, i.e. how well the quality meets the needs of the user. Quality is defined by certain physical, chemical and biological characteristics. Good quality river water which can be used successfully for irrigation may, because of its sediment load, be unacceptable for municipal use without treatment to remove the sediment. Similarly, snowmelt water of excellent quality for municipal use is too corrosive for industrial use without treatment to reduce its corrosive potential. Water quality degradation is the overall process of evaluation of the degradation of physical, chemical and biological nature of the water. Dhaka city is rich in both ground and surface water resources having an inherent problem of surface water pollution. Ground water is not yet being polluted but there is severe depletion of ground water table under laying the city, which may jeopardize its lives and developments. The water bodies located in the periphery of the city comprise ample water even in the dry season. Domestic and industrial wastes generated in the city are deteriorating the water bodies gradually and even are jeopardizing their sustainability.

Dhaka City is the capital of Bangladesh and main centre of all activities in this country is situated on the bank of the river Buriganga. It provides the main and dominant river transport facility to the city dwellers. The river is tributary of the Dhaleswari river. After passing 25 miles it once again meets with the Dhaleswari River near Naryanganj. In fact,

Buriganga forms the southern and western boundary of the city. The banks of the river have turned into unauthorized industrial districts. There has been unauthorized occupation on bank-side and illegal encroachment into the river. Bangladesh Inland Water Transport Authority (BIWTA) identified 204 illegal structures built on both banks of the river. Consequently the Buriganga is decaying and the environment is getting polluted. As the occupants are manufacturing units, there is discharge of the effluents. Besides, the river water is also getting discharge from the city sewers and garbage disposal. As a result, the river water color is getting turbid by the physical and biochemical contents from effluents of sewers. A survey in 1999 revealed that the water of the river Buriganga had been completely polluted. The report concluded that the water of these rivers posed a serious threat to public life and was unfit for human use. The national population growth rate is 2.4 percent while the growth rate in Dhaka is projected at 4.6-4.8 percent. At present the population of the city is around 12 million. This huge population needs a lot of water for domestic uses. Commercial and industrial activities also consume a large volume of water. Dhaka Water supply and Sewerage Authority (DWASA) tries its best to afford sufficient water for meeting up demand of the city (Magumdar, 2005).

The river Buriganga has to assimilate huge domestic and industrial wastes. Most of the industries are directly discharging their untreated wastes into either the sewerage system or the nearby drains or khal system. Wastewater being discharged from major drains/khals contains domestic as well as industrial wastes. The river receives partially treated sewage effluent, sewage polluted surface runoff and untreated industrial effluent including tannery wastes. Already the minimum dissolved oxygen (DO), the prime indicator of water quality; have been found to less than the desirable level at certain sections of the river. However, development and absence of proper management practices will undoubtedly result in further deterioration of the river quality. The major necessity for the city dwellers that how to restore and sustain the proper water quality of the Buriganga river.

1.2 Objective of the Study

For the population of about 12 million in Dhaka, present water demand is 2000 MLD considering per capita consumption of 160 l/person/day. In this situation, DWASA is capable of supplying only 1500 MLD. Production from surface water is 310 MLD out of which 225 MLD is from Sayedabad, 39 MLD from Chadni Ghat and 46 MLD from Narayanganj water treatment plants. The rest of the supply is satisfied from ground water through 382 DTW (1250 MLD). Surface water is available but not useable due to contamination and ground water lifting is not sensible concerning its depletion (Magumdar, 2005). There is requirement of water provision would have to be made to restore the Buriganga river water. This city is now over populated, produced an over estimated load of pollutants every year which directly goes to rivers without or insufficient treatment and there is no planning and policy execution to prevent this type of inappropriate discharge. The sources and occurrences of river pollution should be studied carefully and deserves an urgent adoption and implementation of necessary measures to recover the natural ecosystem of the rivers and to restore the water quality of the river Buriganga.

An overall objective of this study is to assess the present scenarios of surface water quality and comparison with the past scenarios of water quality of Buriganga. Besides this study will help to observe the seasonal fluctuation of water quality parameters of the river and will also help to take the necessary steps for sustaining proper surface water quality of the river Buriganga. Besides the present study helps to observe the range of the pollution over the river Buriganga.

The specific objectives of the study are:

The specific objectives of the study are:

- To review of the past water quality of the Buriganga river;
- To make a comparative analysis between past and present water quality of this river;
- To find out the causes of water pollution;
- To assess the trend of water pollution and suggest possible remedial measures;
- To find out the possible options for restoring the water quality of the Buriganga river.

1.3 Scope of the Study

During previous and current assessment of water quality of the Buriganga River, various point and non point pollution sources and a number of water qualities measuring stations have been identified. Bangladesh Water Development Board (BWDB) and Department of Environment (DOE) monitors' water quality the river of Buriganga and reserves information of different locations. Water quality in the river had also been monitored during several studies. Institute of Water Modelling (IWM) had carried out a detailed data program to assess the deterioration of water quality at the intake point of Sayedabad Water Treatment Plant (SWTP). Therefore, there is a scope to evaluate the surface water of Buriganga River as a whole through integrating of all available scattered information and observations so that fluctuation of water pollution level and a recent pollution level in the river can be outlined. Besides along a river reach, information regarding all water quality data was not available at all sampling stations. Again at a particular station, water quality data were not monitored continuously every year, hence a continuous trend analysis was difficult. The integrated knowledge of past and present surface water quality helps to make estimation and approximate relationship of the water quality of the river so that necessary steps can be taken to restore the water quality of this river.

The scope of work of the study includes:

- Systematic collection, organization and elaborate analysis of long term surface water quality data of river Buriganga.
- Assessment of long-term deterioration of surface water quality as far as possible.
- Observation of recent surface water quality scenario in the river Buriganga.
- Identification of a suitable surface water of adequate quantity and good quality with respect to drinking standards for future expansion of Dhaka Water Supply.

1.4 Methodology

The steps that have been adopted to attain the objectives of the study are as follows:

- i) Primary data, photos and information obtained from field observation. For this study, field observation was needed to know about the existing physical and environmental condition of the study area.

- ii) Secondary data, map and information has been collected from DOE, BWDB, BUET and IWM.
- iii) Water Samples and photographs have been collected from different Locations of the Buriganga River and water samples tested in the BUET laboratory.
- iv) Recent surface water quality data has been collected from DOE and Environmental laboratory in Civil department of BUET as test sample.
- v) Water quality and Pollution loads analyzed to find out the present water quality scenario, trend of water pollution and percent of increase in pollution loading. Besides, reports, thesis, journals and expert opinions were collected from different organizations.
- vi) These data of water quality have analyzed by Microsoft Excel software and the condition of water quality and pollution status have analyzed and find out the possible options for restoring the water quality of the Buriganga River.

1.5 Organization of the Report

This study comprises of **five** chapters.

Chapter 2 represents a detailed review of literature related to profile of the Buriganga River. In this chapter, a review of previous studies, Environmental Quality Standard (EQS), Water quality parameters have been described. Types of pollution, causes of pollution, and sources of pollution have been described in this chapter.

Chapter 3 describes the methodology of the study. This chapter also describes the detail study programme that is data collection, water sample collection and photographs collection. In this chapter, how and from where water quality data, water sample and photographs have been collected are described in details.

Chapter 4 illustrates the present Surface water quality scenario of the Buriganga River including historical trend of pollution with several parameters and discussion. It also describes the approaches to restore water quality of the Buriganga river.

Chapter 5, contains the conclusions of the study, recommendations for pollution control and restore the water quality of the Buriganga river.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The history of civilization is closely related to some major rivers of the world. Many of the ancient civilization prospered in the fertile valleys of these rivers routes. During the ancient time, trade and commerce flourished mostly using rivers. While mankind benefits from rivers, they also causes lots of sufferings through causing flood, land erosion, siltation etc. Therefore, engineers need to plan, design, operate and maintain projects for regulation, flood mitigation, water supply, navigation and irrigation. Hence they require adequate knowledge of river behavior.

Bangladesh is a revering deltaic country. Almost all the rivers that flow through Bangladesh are alluvial in nature. All alluvial rivers generally change its position and shape continually as a consequence for hydraulic force acting on its bed and banks and these changes to the geometric characteristics of the river. The river Buriganga encompasses the south-western periphery of Dhaka city. The river receives partially treated sewage effluent, sewage polluted surface runoff and untreated industrial effluent including tannery wastes. Already the minimum dissolved oxygen, the prime indicator of water quality, has been found to be less than the desirable level at certain sections of the Buriganga (Habib, 2006).

In this chapter, a review of previous studies, Environmental quality standerds, significance of water quality parameters, types of pollution, causes of pollution and sources of pollution have been described.

2.2 Peripheral River System around the Dhaka City

Dhaka is an ancient and historical city Buriganga is too much ancient. The identity of the Buriganga is known in the “Kalika Puuran” published two thousand years ago. There the writer identifies the Buriganga such as “Brithaganga”. During the period of Muslims, we have known about Dhaka and Buriganga by different records.

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Buriganga witnessed the rise and fall of many empires and dynasties and arrival of Moghul Subeder Mir Jumla, Islam khan, Shayesta khan and records itineraries of world travelers.

During the period of Sultan Fakruddin the Arab travelers Ibne Batuta came and visited Dhaka. In 1348 he traveled Buriganga and disembarked from Bajra to the Lalbag fort. To protect the Dhaka city from the attack of the Afghan rebels, Mogh, Arkan and Portuguese pirates the great Moghuls built Lalbag fort over the Buriganga.

For the period of Subedar Islam khan (1610) there were Shahi Bajras (large pleasure boat) and thousands of flotillas were all along the Lalbag on the bank of Buriganga. At that time the bank of the Buriganga was the only recreational place for all. Because of its transparent water, natural environment and advantage of communication, minister and Subeder wanted to build their residential house and recreational center there. Chhoto Katra, BoroKatra, Hossaini Dalan was made over the bank of the Buriganga. In 1859, the city was from northern part of the Buriganga to Race Course.

In 1835 Nawab Khwaja Abdul Ghani's father Khwakja Alimulla purchased Ahsan Manzil there was a factory of the French people. They lived in Farashganj. At that time "Ahsan Manjil" was only architectural art in the city area.

The Buriganga surrounded by a peripheral river system comprising Buriganga, Balu, Turag, Tongi Khal, and Lakhaya. There were much water in the Buriganga and sometimes it overflowed. On the bank of a four mile dam was made in 1735.

Six river reaches encompass the Dhaka city which includes Tongi khal, Turag River, Buriganga River, Dhaleawari River, Lakhya River and Balu River. There are some drainage khals inside the city such as, Dholai khal, Begunbari Khal, Norai Khal, Kallayanpur Khal, which are linked with the peripheral rivers. (Habib R.B, 2006)



Peripheral River System around the Dhaka City

Figure 2.2: Peripheral River System around the Dhaka city

2.3 Profile of the Buriganga River

2.3.1 Prospects and problems

The south-western periphery of the Dhaka city is surrounded by the Buriganga River. It is a tidal river and carries different kinds of domestic and industrial waste. It originates from Dhaleswari from north of Dhaka and meets it again south of Dhaka city. It is following a zigzag course for about 45 km skirting the edge of the old alluvium, before rejoining the large stream. The length of the Buriganga measured by Rota meter on 1:50,000 scale of spot image. Average width of the river around Dhaka city is nearly 500 m naturally. Large and small scale industries have been established on both bank of the river and innumerable municipal drains carrying sewage and sullage find their way in to the river.

2.3.2 Water supply

The main water supply system of Dhaka City depends on the Buriganga River as surface water source of intake. The city of one million inhabitants has a demand for 160 crore liters of water per day. There are two surface water treatment plants in the city, one at Chandnighat and another in Syedabad. Though there are 400 deep tube wells, this water management system has become an unsustainable one due to acute shortage of ground water. So the water supply system of the city considerably depends on the surface water sources for sustainable water supply for the city. (Amin , 2006)

2.3.3 Present situation and problems of the study area

Not long ago, the Buriganga was beauty of a river. Its clean and transparent flow was a soothing sight. Its catches were special delicacies to fish lover. Sailing on the river was a prime leisure of the Nawabs and aristocrats of the colonial Dhaka. Gone are those days of beauty and pride.

The capital city of Dhaka and Buriganga are related to each other. So that in 1959 a master plan was made to improve the river and urban beauty. In this master plan 291 acres of land was allotted for playground and park and a land of twenty-three acre was kept free along the river. But in reality, the land uses is changing due to increase the population for the purpose of the business and for building of houses, specially after the

independence. According to a survey of the NGO, 8 or 9 lack people are living besides the Buriganga River from Kamrangir char embankment of Hazaribag to Pagla. In 1998 a survey was conducted by The Department of Environment and they found that, the amount of dispossessed land was 50 acre. That's why the Buriganga is shrinking fast and its other geometric characteristics are changing. For this reason, Buriganga struggles to survive.

Otherwise, many factories, market and other establishment have come up along the river and far from the river. The pontoons and others metal structures along the river bank are occupying the major portion of the moving water of the bank. Due to occupying the river bank, Buriganga have changed its behavior. Now steamer can hardly enter Badamtoli that was once a busy station of steamers. Tanneries of Hazaribagh, chemical industry of Tejgaon and many other factories poisonous wastes are falling down in the river without any treatment. Every day 98 metric ton hard waste and half of eight million liquids are falling down from 270 tanneries, 90% of them are situated at Hazaribagh. Not only from tanneries, has waste matter from thousands of latrines on both sides of the river been connected with the flow. From the launches and engine vessels in Sadarghat and dockyard areas, there are discharges kerosene and Lubricating oil. There are floating residential hotels on the river. Human waste and other waste from the floating vessels are spilled. These wastes contaminate the river water affecting its aquatic life and ecological health. Analysis of long term data from some of the major river of Bangladesh shows that Buriganga is more polluted than any other river in the country. All the hard waste has been gathering in the riverbed. For this reason, 25 cm of polythin layer have been gathering in the riverbed of Buriganga and it is decreasing the river depth. According to BIWTA, huge volume of polythin layer has been found in the riverbed of Buriganga from Sadarghat to Narayanganj (4 Kilometer). Also, a large number of polythin has found from Sadarghat, Nawabgonj, and Showarighat are of the Buriganga

An offshoot of Jamuna and Dhaleswari River, Buriganga runs through Saver, Amin Bazar, and Basila. Presently the off take of the river is dead but it receives flow from the Turag River. It is divided in Keraniganj point. In Kamrangir Char one branch has died. The other is flowing through Sadarghat and falling in Dhaleswari. Buriganga has its

tradition. Historical monuments have been set up in Lalbagh, Keraniganj, and Backland Bund. But with the rise of population and unplanned urbanization in the city, it lost its heritage.

At Postogola Bangladesh-China Friendship Bridge of Buriganga has been constructed and communication with the remote areas has been extended in southern direction. As a result, several developers are developing their housing projects on the right bank of Buriganga River. Once upon a time, that region was a vacant and agricultural area.

Buriganga is extremely important for the Dhaka city. Many people live here for their employment opportunities and other facilities. It provides drainage for its internal waters; it is a potential source of water for domestic and drinking purpose, a place of recreation, and a number of other human activities. But will there be the image of Buriganga left in future? In the rush of construction and occupation of waterways will the flow of the Buriganga stop? If the wave of occupation of the banks and waters goes on uninterrupted and no dredging is conducted, may be there will be no Buriganga in the future. The river will turn into a canal and draining reservoir of polluted water and a passage of carrying sewage (Habib, 2006).

Unfortunately, the river is Dhaka's main outlet of sewage waste. Recent newspaper articles indicated that up to 80% of Dhaka's sewage was untreated. A number of industries, including tanneries also discharge their chemical waste in to the river. Large and small-scale industries are located on both bank of the river. Again innumerable municipal drains carrying sewage and sullies find their way into it. The indiscriminate discharge of domestic sewage, industrial effluents, open dumping of solid wastes are becoming a great concern from the point of view of water-environment degradation.

2.4 Climatic Condition of the Study Area

The climate of the study area is classified as topical monsoon type, characterized by 3 distinct seasons: monsoon cool and warm.

Table 2.1: Climatic condition of study area (Source: Haque, 2003)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Highest Temp (°C)	34.2	36.6	40.6	42.3	40.6	38.4	35.2	35.9	35.3	38.8	33.3	31.2
Lowest Temp (°C)	5.6	4.5	10.4	15.6	18.4	20.4	21.7	21.0	22.0	10.4	10.6	6.7
Average Temp(°C)	18.8	21.5	26.1	28.7	28.9	28.7	28.7	28.7	28.7	27.4	23.6	19.8
Relative Humidity (%)	70	66	63	71	79	86	87	86	86	81	75	74
Evaporation (mm)	104	79	81	77	78	83	87	130	118	106	75	105
Wind Vel. (Knot)	2	2	3	5	5	4	4	4	3	2	1	1

The lowest temperature varies from 4.5°C in February to 21°C in July. The highest temperature varies from 31.2°C in December to 42.3°C in April. The average temperature varies from 18.8°C in January to 28.9°C in May.

2.5 Water Quality Parameter

Chemically pure water is not available in nature and also is not desirable. In order to control the water quality parameters to the extent of International Standards of Drinking water. All the parameters can generally be grouped in three major heads: (i) Physical, (ii) Chemical and (iii) Bacteriological qualities. Some of water quality parameter with their relative importance in water supply is discussed here.

2.5.1 Dissolved Oxygen (DO)

Adequate dissolved oxygen is necessary for the life of fish and others aquatic organisms. The DO concentration may also be associated with corrosively of water, photosynthetic activity and septicity. The solubility of oxygen varies greatly with temperature over the range of interest to environmental engineers. The solubility of atmospheric oxygen in fresh waters ranges from 14.6 mg/l at 0°C to about 7 mg/l at 35 °C under 1 atm of pressure. Most of critical conditions related to dissolve oxygen deficiency in environmental engineering practice occur during the summer month when temperature is high, solubility of oxygen is minimum and consuming rate is maximum. In liquid wastes,

dissolved oxygen is the factor that determines whether the biological changes are brought about by aerobic or by anaerobic organisms. Dissolved oxygen measurement are vital for maintaining aerobic conditions in natural waters that receive pollution matter and in aerobic treatment processes intended to purify domestic and industrial waste waters. Dissolved oxygen determination is used for a wide variety of other purposes. It is one of the most important single tests that the environmental engineers use. In most instances involving the control of stream pollution, it is desirable to maintain conditions favorable for the growth and reproduction of a normal population of fish and other aquatic organisms. Determinations of dissolved oxygen serve as the basis of the BOD test; thus they are the foundation of the most important determination used to evaluate the pollution strength of domestic and industrial wastes.

2.5.2 Biological Oxygen Demand (BOD)

Biochemical oxygen demand is a measure of the amount of oxygen demand by living organisms in the water to oxidize organic matter present as food for the organisms. BOD is an empirical test, in which standardized laboratory procedures are used to estimate the relative oxygen requirements of wastewater, effluents and polluted waters. Microorganisms use the atmospheric oxygen dissolved in the water for bio chemical oxidation of organic matter, which is their source of carbon. The BOD is used as an approximate measure of the amount of biochemical degradable organic matter present in a sample. The 5-day incubation period has been accepted as the standard for this test. The "Ultimate BOD" of an organic waste is the amount of oxygen required by microorganisms in carrying out the aerobic cycles of carbon, nitrogen, sulfur, phosphorous etc. that is the amount of oxygen needed by bacteria in reducing organic matter to stable compounds. It is considered that a normal sewage has a 5 day, 20 °C BOD of 200 to 250 mg/l. and the value for industrial wastes may be from 3000 mg/l to more than a dozen times that figure, where as a stream fully saturated with oxygen at 20 °C contains only 9.20 mg/l of oxygen.

2.5.3 Chemical Oxygen demand (COD)

The chemical oxygen demand test indicates the quantity of oxidizable compounds present in water and will vary with water composition, concentration of reagent, temperature, period of contract and other factors. The concept of chemical oxygen demand is that all

organic compounds, with but few exceptions, can be oxidized to carbon dioxide and water. In contrast with the BOD test, which measures only the biodegradable fraction, COD may measure toxic as well as biodegradable organic compounds. It is therefore applicable to many industrial waste not readily analyzed for water quality factors by the sewage oriented BOD test.

2.5.4 Nitrogen (N₂)

The compounds of nitrogen are of great interest to environmental engineers because of their importance in the atmosphere and in the life processes of all plants and animals. The chemistry of nitrogen is complex because of the several oxidation states that nitrogen can assumed and the fact that change in oxidation state can be brought about by living organisms. To add even more interest, the oxidation state changes brought by bacteria can be either positive or negative depending upon whether aerobic or anaerobic conditions prevail. The nitrate formed may serve as fertilizer for plants. Nitrates produced in excess of the needs of plant life are carried away in water percolating through the soil because the soil does not have the ability to hold them. This results in relatively high concentration of nitrates in ground water. Under anaerobic conditions, nitrates and nitrites are both reduce by a process called denitrification. Presumably nitrates are reduced to nitrites and than reduction of nitrites occur. Reduction of nitrites is carried all the way to ammonia by a few bacteria, but most of them carry the reduction to nitrogen gas, which escapes to the atmosphere (Maniruzzaman , 2001).

2.5.5 Solids

Solids in water may be found in dissolved or in suspended state. For domestic purposes, the amount of total solids is of importance for the determination of suitability for uses. The idea of solid content is also essential for softening procedure and corrosion control. The usual definition of solid however refers to the matter that remains as residue upon evaporation and drying at 103 to 105 °C. In potable waters, most of the matter is in dissolved form and consist mainly of inorganic salts, small amount of organic matter and dissolved gasses. The total dissolved solids content of potable water usually ranges from 20 to 1000 mg/l, and rule, hardness increases with total dissolved solids. The undissolved substances are usually referred to as suspended matter or suspended solids, which is unexpected for water supplies. Maniruzzaman (2001)

Total Suspended Solids (TSS):

Solids suspended in water consist of inorganic or organic particles or of immiscible liquids are known as Total Suspended Solids.

Total Dissolved Solids (TDS):

Dissolved materials results from the solvent action of water on solids, liquids, and gasses are known as Total Dissolved Solids.

2.5.6 Iron

Iron is objectionable in a public water supply because it causes strains on plumbing fixtures, on clothing and on textile in laundry. It may causes tastes and odour and it offers difficulties in manufacturing processes. Sulphate of iron causes acidity and corrodes ferrous metal and brass. Iron exists in soils and minerals mainly as insoluble ferric oxide and iron sulfide (pyrite). It occurs in some areas also as ferrous carbonate, which is very slightly soluble. Iron also imparts a taste of water, which is detectable at very low concentrations. For these reasons public water supplies ought not to contain more than 0.30 mg/l of iron.

2.5.7 Sulphate

Sulphates are of hygienic significance because of their laxative affects. The concentration is limited therefore to higher concentrations which are in use in some communities; the higher concentration being disturbing only to persons not accustomed to them. The sulphate iron is one of the Major anions occurring in natural waters. It is of important in public water supplies because of its cathartic effect upon humans when it is present in excessive amounts. For this reason the recommended upper limit is 250 mg/l in waters intended for human consumption.

2.5.8 Phosphorous and Phosphate

The most common forms of phosphorus are organically bound phosphorus compounds, orthophosphate and polyphosphates. The principal source of phosphorus is domestic wastewater and agricultural return water. Thirty or fifty percent of the phosphorus in domestic wastewater is form sanitary wastes, while the remaining 50 to 70 percent is attributable to phosphate builders used in household detergents. Total phosphorus contribution is about 3.50lb per capita per year resulting in an average concentration of

10 mg/l domestic waste. Typically, the phosphorus enters the waste water from human body wastes, from food wastes discharged to the sewers from kitchen grinders, and from the condensed inorganic phosphate compounds used in various household detergents. Commercial washing and cleaning compounds are also a source of phosphates.

2.5.9 Turbidity

Water is turbid when it contains visible material in suspension. From considerations of aesthetic, filterability, and disinfection turbidity is a very important factor in public water supply. In lake or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions. In glacier-fed rivers and lakes most of the turbidity is due to colloidal rock particles produced by the grinding action of the glacier. As rivers descend from mountain areas into the plains, they receive contributions of turbidity from farming and operations that disturbed the soil. As the rivers progress towards the ocean, they pass through the urban areas where domestic and industrial wastewaters may be added.

2.5.10 Alkalinity

The alkalinity produced by carbonates is due to their hydrolyses into hydroxide and carbonic acid, the alkalinity of the hydroxide over balancing the acidity of the weak carbonic acid. The determination of alkalinity is of importance in connection with corrosiveness of water. The alkalinity of natural water is primarily due to the salts of weak acids, although weak or strong bases may also contribute. Although many materials may contribute to the alkalinity of water, the major portion of the alkalinity in natural water is caused by three major classes of materials which may be ranked in order of their association with help of pH values as : 1) hydroxide, 2) carbonate, and 3) bicarbonate. Information concerning alkalinity is used in a variety of ways of environmental engineering practice like chemical coagulation, water softening, and corrosion control, acid buffer capacity and industrial waste disposal

2.5.11 pH

Alkalinity and acidity of water, sewage, and sludge are frequently expressed in terms of their pH which is a symbol of hydrogen ion concentration. A pH test determines the strength of the acid or alkali in water, while the chemical tests for acidity and alkalinity determine the amounts of the acid or alkali present. pH values below 7 represent acidity, while pH value above 7 represents alkalinity. Magumdar (2005)

2.5.12 Electric conductivity

Electric conductivity is a measure of water's capacity to convey an electric current. This property is related to total concentration of the ionized substance in water and the temperature at which the measurement is made. The nature of the dissolved substances, their actual and relative concentrations and ionic strength of the water affect the electric conductivity. Magumdar (2005)

2.6 Environmental Quality Standard (EQS)

In Bangladesh like other countries, the environmental Quality Standards (EQS) of relevant parameter have been formulated by department of Environment (DOE; 1991). The Ministry of Environment and Forest (MOEF) published EQS in a Gazette for environmental protection and management in the working level.

Table 2.2: EQS of some relevant water quality parameters, (DOE 1991)

Parameter	Drinking water (BSTI)	Recreational	Fishing water	Industrial water	Irrigation water
Dissolved Oxygen mg/l	6	4-5	4-6	5	5
Temperature °C	20-30	20-30	20-30	20-30	20-30
Turbidity (FTU)	5	10	50		
TDS mg/l	500			1500	2000
BOD mg/l	0.2	3	6	10	10
COD mg/l	4	4		10	
pH	6.6-8.5	6-9.5	6.5-8.5	6-9.5	6-8.5
Total coliform /100 ml	2	200	5000		1000

Table 2.3: EQS of some relevant water quality parameters; (DOE 1997)

Parameter	Recreationa l	Fishing	Irrigation
pH	6.5-8.5	6.5-8.5	6.5-8.5
BOD(ultimate),mg/l	≤ 3	≤ 6	≤ 10
DO,mg/l	≥ 5	≥ 5	≥ 5
Coliform(total),Nos./100ml	≤ 200	≤ 5000	≤ 1000
Ammonia Nitrogen(N),mg/l	-	≤ 1.2	-
Electrical Conductivity(μmho/cm)	-	-	2250

Table 2.4: Drinking Water Quality Standard (source: Ahmed, et al, 2001)

Parameter	USEPA (2000)	WHO (1993)	Bangladesh (GOV, 1997)
Aluminum (mg/l)	0.05	0.20	0.1(0.2)
Antimony(mg/l)	0.006	0.005	
Arsenic(mg/l)	0.01	0.01	0.05
Barium(mg/l)	2.0	0.70	1.0
Bromide(mg/l)	10		10
Calcium(mg/l)			75 (200)
Cadmium(mg/l)	0.005	0.003	0.01
Chloride(mg/l)	250	250	200 (600)
Chloride(mg/l)	0.10	0.05	0.05
Chromium(mg/l)	1.31	0-2.0	1.5
Copper(mg/l)	2.0	1.50	1.0
Fluoride(mg/l)	100-500		200-500
Hardness (mg/l)	0.30	0.30	0.30 (1.0)
Iron(mg/l)	0.015	0.01	0.10
Lead(mg/l)	0.1	0.1-0.05	0.10 (0.50)
Manganese(mg/l)	0.10	0.02	
Nickel(mg/l)	10	50	10
Nitrate(mg/l)	1		
Phosphate(mg/l)	0.005		
pH	6.5-8.5	6.5-8.5	6.0
Selenium(mg/l)	0.05	0.01	6.5-8.5
Silver(mg/l)	0.10		
Sodium(mg/l)		200	
Sulfate(mg/l)	250	250	400
TDS(mg/l)	400-500	1000	500 (1500)

2.7 Previous studies

2.7.1 Past studies of water quality on Buriganga river (before 1990)

Das investigated the water quality of the River Buriganga in year 1967. Based on the test results, the investigator also concluded that treatment for controlling the water quality parameters like colour, turbidity, pH, hardness is required to make the water potable.

Mohammad (1988) reported a comparison of sampling data of the Buriganga river water near Chandnighat during 1968-80. It was apparent from the studies that DO level have decreased considerably during 1968-80. While average DO during 1968 was 6.7 mg/l, it came down to 3.3 mg/l during 1980. The average BOD value increased almost fourfold during that period. Number of coliforms also increased considerably during the same period.

In February 1987, Mohammed conducted a sampling programme of the Buriganga River. Six different stations were established along a 10 miles stretch of the river starting from 6 miles upstream of Pagla outfall up to 4 miles downstream. Six samples were taken from different depth at each sampling station. It was assumed for the study that the flows, temperature, BOD loads and rate constants at each point remained constant with time. It was further assumed that the concentration of BOD and DO were uniform over the cross section of any river station. Since, in most cases, there are daily variations in pollution loads, flows, temperature, oxygen produced by photosynthesis throughout 24 hours etc., the assumption of steady state condition introduce errors. Mohammed argued that for planning purposes, the simplified version of DO sag curve determination was an acceptable assumption.

The DO and BOD of river water at Pagla outfall were 4.2 mg/l and 2.1mg/l respectively, whereas the DO and BOD at a location 3.5 miles downstream of outfall were 7.8 mg/l and 1.4 mg/l respectively. These data indicated that a very high degree of mixing occurred in the Buriganga River. Mixing of the river water will also result in a relatively high degree of re-aeration. Algae were found to play a small role in the river flow aeration. This information and the associated computations lead to the conclusion that the river acts essentially as a large dilution and stabilization pond.

2.7.2 Present studies of water quality on Buriganga river (after 1990)

Buriganga River is comparatively the major polluted river in Dhaka, with Hazaribagh being the most polluting station. DO at Hazaribagh can be as low as 2 mg/l in May. For Fish DO should be at least around 4 mg/l. This water is under most septic conditions. Total solid and chloride is also sharply higher here. In addition, Hazaribagh main effluent drain discharges wastewater from tanneries which contains high levels of COD in the order of 1100 mg/l and chromium at around 11.5 mg/l whereas suitable standard for industrial water is around 200mg/l for COD and 0.5 mg/l for chromium respectively. It is also estimated that the total BOD load per day discharged in the surface water around Dhaka is 182 tons per day. Of this amount 161 tons or 88 percent is of domestic origin, and 21 tons or 12 percent is of industrial origin. Of the total 182 tons BOD approximately 55 tons are treated at the Pagla sewage treatment plant which lowers the BOD load to approximately 5 tons per day and finally discharged into Buriganga. Under normal condition Dhulai Khal represents the largest source of pollution with an estimated discharged of 35 tons of BOD per day. Hazaribagh is estimated to discharge around 15 tons of BOD per day into Buriganga. Another 10 tons BOD discharged into Buriganga through the drains along the river course. The entire above BOD discharged to Buriganga summed up around 65 tons per day and the rest 67 tons per day is discharged into the flood plans. For Buriganga discharged is essentially zero during the dry season and range between 400-850 cumec during the rainy season. Atomic Energy Center Laboratory in 1992 conducted a survey of chromium, lead and mercury for Buriganga. Except mercury, the concentration of chromium and lead is well within the proposed water quality standard of Bangladesh. Concentration of nitrate and nitrite downstream in Buriganga is 8.5 mg/l and 0.85 mg/l (DOE 1992), respectively. pH for all points are between 6.8-7.4 except at Hazaribagh where water is alkaline, pH being 8.0; turbidity for all points are less than 60 NTU which may be considered as moderately good.

Ahmed (1993) estimated the pollution load from industries in and around Dhaka. The discharge was estimated as 49000 kg/day of polluting load (BOD) in the river system in and around Dhaka. Ahmed opined that the industrial polluting load along with an approximately equal amount of BOD load from domestic sewage and other municipal

wastes reaching the river system was responsible for the pollution and degradation of the quality of the rivers around the Dhaka city.

Ahmed showed the expected improvement in DO profile after implementation of pollution control measures. It was seen that pollution control measures including discontinuation of tannery waste discharge in the river and upgrading of DWASA sewage treatment plant significantly improve the DO situation in the Buriganga in lean flow period.

Browder (1992) carried out a comprehensive study regarding the status of pollution of the Buriganga. He found that domestic waste water produced approximately 88% of Dhaka's BOD load while industrial sources account for the remaining 12%. He opined that those figure were consistent with other large South Asian cities which did not have a large industrial base such as Dhaka. The total amount of BOD discharged in Dhaka was estimated by Browder as 182 tons per day. Of that amount, approximately 55 tons were being treated at the Pagla sewage Treatment Plant, which used to lower the BOD load to approximately 5 tons per day. Then remains of 127 tons per day of BOD were being discharged through the storm water conveyance system to receiving water bodies. Contribution from Hazaribagh discharge was estimated to be about 30% of the total load discharged to the Buriganga. Discharged to the Turag River, which is a tributary of the Buriganga, were estimated as approximately 14 tons per day, representing about 10% of the total BOD.

Rahman and Rana (1995) had studied the management of Buriganga water quality under alternative scenarios. They opined that either a treatment plant should be established at Hazaribagh to treat tannery waste or shifting of tannery units to Saver would provide considerable opportunity to properly manage the Buriganga river water quality.

A study was conducted by Kamal (1996), to investigate the status of the Buriganga river water quality in terms of some important water quality parameters and to assess the impacts the pollutants using an existing the water quality model.

Siddique (1998) studied about the discharge and sediment data of the river of Buriganga. He found that the mean annual water discharge obtained from semi-log plotting was 2872

cumec and sediment discharge was 4600 kg/s using (Hossain formula) and 1900 kg/s using (Engelund-Hansen formula).

DOE (1998) conducted a survey and found that the Buriganga is one of the major polluted rivers in the country, with Hazaribagh station being the most polluting station. DO at Hazaribagh was as low as 2 mg/l during January to May. DO should be at least 4 mg/l for fish. TS and Chloride were alarmingly high there. Hazaribagh was estimated to discharge about 16,000 m³/day generating about 18 MT of BOD per day into Buriganga. In addition, Hazaribagh main effluent drain discharged wastewater from tanneries which contains high levels of COD in the order of 1,100 mg/l and chromium at around 11.5 mg/l whereas suitable standard for industrial water is 200 mg/l for COD and for Chromium is 0.1 mg/l.

Alam (2001) had studied about the valuing cleanup of the Buriganga River. The major findings of this investigation reveal that not only a significant proportion of the respondents are willing to pay for environmental improvements, but also they are willing to contribute in terms of time. In his study, he found that the cost of cleanup of the Buriganga would be about US\$ 7 million in a year. It was concluded that failure to consider such benefits in the decision-making calculations could lead to gross under-estimation of the role that general public can play in such environmental improvement activities.

2.8 Pollution

Pollution means the addition of much foreign material inorganic, biological, and radiological or any physical change in the natural water which may harm fully or affect the living life directly or indirectly; immediately, after sometime or after a very long time.

Major sources of pollutants:

- Municipal or Domestic Waste Water
- Industrial waste water
- Urban or suburban runoff

- Agriculture,
- Drainage/leaching from land disposal and solid waste
- Atmospheric deposition
- Natural erosion etc

Categories of pollutants:

- Oxygen Demanding waste
- Pathogens
- Nutrients
- Salts
- Thermal pollution
- Heavy metals
- Pesticides
- Volatile Organic compounds
- Radio active substances

2.8.1 Industrial water pollutants

The industrial Pollution Projection System (IPPS) has categorized water pollutants into four major categories:

- a) Conventional water pollutants,
- b) Non-conventional water pollutants
- c) Toxic Metal/Toxic Inorganic Compounds.

Each category of pollutants is listed below.

(a) Conventional water pollutants are Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Oil and Grease.

(b) Non-Conventional Water Pollutants are Aluminum, Ammonia, Iron, Barium, Boron, Chlorine, Cobalt, Fluoride, Manganese, Phosphorus, Titanium, Chemical, and Oxygen Demand (COD).

(c) Toxic Metals are Antimony, Arsenic, Asbestos, Beryllium, Cadmium, Copper, Cyanide, Mercury, and Zinc.

(d) Toxic Organic are Benzene- Chloethane- - Chlomethane- Zylene

2.8.2 Pollution due to industry

According to a study 67.7 million liters of untreated liquid industrial wastes are dumped into the nature every day polluting our land, water and air (Source: The Daily Star, 2006). The government is yet to adopt any firm policy to reduce pollution arising from tanneries, pharmaceuticals, chemical and dyeing factories releasing highly toxic untreated wastes every day contaminating land, air and water. Millions of gallons of untreated wastes from around 7,000 industries are polluting all the four rivers, canals and low-lying areas around the Dhaka city posing major environmental threat. Environmentalists warn that the extremely polluted waters might trigger an epidemic anytime during dry winter season, when the river waters are stagnant.

According to a survey jointly performed by Department of Environment (DOE) and Canadian International Development Agency (CIDA), more than 7,000 factories are located along the rivers and canals in Dhaka. These industries, excluding the Hazaribagh tanneries, discharge more than 60 million liters of toxic wastes per day into our waters, land and air. The Hazaribagh tanneries add to the massive pollution by pumping an additional 7.7 million liters of highly toxic liquid wastes directly into the nearby canals and the river Buriganga. Tanneries also dump 135 tones of solid wastes into the river per day. According to experts the most polluting industries in the city are tanneries textile, pharmaceutical and chemical industries (Maniruzzaman, 2001),

Table 2.5: Industrial units in 5 Municipal Wards in Dhaka City (Source: Amin, 2006)

Municipal Ward	Number of Units	Types of Unites
5 (Pallabi and its adjoining areas)	500	Saree, Paints, Mosquito repellent, Candle, Foundry, Moulding, Welding.
27(Sabujbag and its adjoining areas)	20-25	Foundry, Moulding, Welding.
42 (Mohammadpur and its adjoining areas)	40-50	Shoe, Rubber sandal, Foundry, Moulding, Welding, Incense Candle.
65 (Islamabag and its adjoining areas)	2500-3000	Plastic, Engineering.
81 (Gendaria and its adjoining areas)	100-150	Padlock, Engineering, Pharmaceuticals, Foundry,Moulding

2.8.3 Pollution due to thermal plant

A large steam-electric power plant requires an enormous amount of cooling water. A typical nuclear plant, for example, warms about 40 cum/s of cooling water by 10°C as it passes through the plant's condenser. If that heat released into a local river or lake, the resulting rise in temperature can dramatically affect life in the vicinity of the thermal plume. As water temperature increases, two factors combine to make it more difficult for aquatic life to get sufficient oxygen to meet its needs.

The first result from the fact that metabolic rates tend to increase with temperature, generally by about a factor of 2 for each 10°C rise in temperature. Thus, as temperature increases, the demand for oxygen goes up while the amount of DO available goes down.

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2.9 Types of Pollution

Lots of factors are involved in pollution of river water and physical meandering of the river which causes the ultimate pollution in the environment in large context. Human activities those may be essential for their survival create a severe pollution on a river as well as the environment. These include building of dams or embankment, use of fertilizer and insecticide, excavation of riverbed, deforestation in up stream, land slides. Besides they are disposal of waste water from the town or city sewer, industrial effluent, disposal of human waste and burned oil by vessels and so on.

Form the above discussion; it is clear to one that every time in our daily life we are polluting the river and its water. Sometimes which may be inevitable but we have to suffer in the long run of its consequences. However, when we talk about pollution in the river Buriganga, some additional parameters emerge. One of the major parameter is the encroachment of the river banks by the land grabbers which makes the river narrower, intensifies water pollution and break down whole eco-system of its surrounding area. Besides, huge volume of industrial (including tannery) wastewater is being disposed without any noticeable treatment. In addition to this waste, Buriganga River is flourished by sewer water of Dhaka city that contains huge quantity of BOD load. There are three types of pollution such as physical, chemical and biological is affecting the quality of the river. (Badshah, 2003). The pollutions are discussed below:

2.9.1 Physical pollution

Physical pollution of river includes sedimentation in the river channel and encroachment of its banks, which cause river meandering, shrinking of river, river erosion etc. Of them

encroachment by the land grabbers cause a serious threat in life of river Buriganga. Influential quarters have gone on encroaching and grabbing the river banks on both sides to set up industries there by causing the water more polluted. With bank being burdened

with the enormous pressure of pollution and economic activities, the Buriganga today struggles to survive. Thousand of new factories, markets and other establishments have come up along the river and all their wastes are dumped into its water. Motor launches and engine boats grow everyday. They release tones of smokes and toxic fluids.

2.9.1.1 Encroachment of the banks of the Buriganga river

Learning against the running water of the Buriganga, business establishments are springing up. Five years back about 500 meters off the bank and against the water front seven markets have been built on the other bank of the Buriganga. Not only has that establishment of commercial centers on both sides of the market been planned but the banks on eastern and western sides of Alam market, it appears, have been leased out to many local and foreign parties who will set up industries and factories there shortly.

The width of Buriganga is fast shrinking. For the rising of sandbanks and construction of business centers against running waters, half of the river has been occupied and filled up. From the steeping stairs of Alam market to the other front of Buckland Bund what a few years back was thousand meters away now it is laying not over 250 meter off. The pontoons and other metal structures on the other bank are occupying the major portion of the moving water of the other bank. Now a day, steamers can hardly enter Badamtoli what was once the busy station of steamers. An offshoot of Jamuna and Padma, Buriganga runs through saver, Amin Bazaar and in the name of Atirgang comes down in Washpur; Basila. It is dividing in Keraniganj point. In Keraniganj Char one brunch has died. The other is flowing through Sadarghat and receiving water from Dhaleswari falling in Meghna.

fields and sand field are found in Postogola area, most of the dockyard built in Millbarak area while market places are built both sides of the bank wide spread. Kamrangirchar is densely polluted and occupied by large numbers of created slums on the bamboo sticks. The Buriganga is now a dying river with heavy water pollution.

Survey conducted by the DOE in 1997 revealed that the river flowing by the capital's western flank had been boxed-in at least 133 illegal establishments, in 1998 District administration listed out of 244 illegal establishment, in 1999 again DOE found 267 illegal establishment and very recently Bangladesh Inland Water Transport Authority (BIWTA) listed out 303 encroachments; of them 38 at Kotwali thana, 9 at Kamrangirchar thana, 21 at Shampur thana, 47 at Sutrapur thana, 151 at Keraniganj and 37 at Fatulla thana.

Most of them are makes homes, small factories, dockyards and boat making workshops. They also showed that approximately 50 acres of the river was encroached by these components. Out of 50 acres of grabbed land, 38.7 acres of land under Kotwali circle, 7.01 acres under Tejgaon circle and 4.3 acres under Keraniganj Thana.

2.9.1.2 Shrinking of the Buriganga river

Buriganga is a shrinking river not only by land grabbers but also by the huge loads (BOD) carrying by the river in the form of Dhaka city and by the sedimentation process. Bangladesh Water Development Board (BWDB) does a survey on the channel cross-section of Buriganga River in every two years.

As the survey results are presented in graphical from at different stations along the river it shows how drastically channel carrying capacity reduces with the reduction of channel width as well as depth.

The selected cross-sections of the river Buriganga at eight location e.g. BGA-01 (Location: Jajera-Dhermagonj), BGA-02 (Location: Pangaon-Fatullah), BGA-03 (Location: Hazaribagh-Dhaka Match Factory), BGA-04 (Location: Mirerbag-Faridabad), BGA-05 (Location: Jinjira Bazar –Midfort Hospital), BGA-06 (Location: Karaniganj-Kamrangir Char), BGA-07 (Location: Ghatar char-Pachandana), BGA-08 (Location : Kalmar char-Dawlia).

Variation of Cross-section

Table 2.6 is seen that the section BGA-01(Location: Jajera-Dhermagonj), the cross-sectional area is about 2390 m² for 1973-74 and 8704 m² for 2001-02, which indicate that the cross-sectional area increased day by day because of dredging by the local people in this section from many years. Here, there is no natural reason.

Table2.6: Comparison cross-section data of Buriganga River for different year (Source: Habib R.B, 2006)

Cross-section Number	Cross-section area, m ²			
	1973-74	1985-86	1995-96	2001-02
BGA-01	2390	3286	7300	8704
BGA-02	2847	2237	1904	1325
BGA-03	2062	1642	1617	1802
BGA-04	1651	2434	1956	2930
BGA-05	2159	1723	1788	1502
BGA-06	1897	1653	1144	1112
BGA-07	43	98	60	36
BGA-08	–	1	25	14

Another section BGA-04 (Location: Mirerbag-Faridabad) and BGA-08 (Location: Kalmar char-Dawlia), it is seen from Table 2.6, that the cross-sectional area of 1973-74 is less than 2001-2002. The reason of increase cross-sectional area is dredging of the riverbed. From the table it is observed at section BGA-02 (Location: Pangaon-Fatullah), BGA-03 (Location: Hazaribagh-Dhaka Match Factory), BGA-05 (Location: Jinjira Bazar –Midfort Hospital), BGA-06 (Location: Karaniganj- Kamrangir Char), BGA-07 (Location: Ghatar char-Pachandana) the cross-sectional area of 2001-2002 in comparison

Another section BGA-04 (Location: Mirerbag-Faridabad) and BGA-08 (Location: Kalmar char-Dawlia), it is seen from Table 2.6, that the cross-sectional area of 1973-74 is less than 2001-2002. The reason of increase cross-sectional area is dredging of the riverbed. From the table it is observed at section BGA-02 (Location: Pangaon-Fatullah), BGA-03 (Location: Hazaribagh-Dhaka Match Factory), BGA-05 (Location: Jinjira Bazar -Midfort Hospital), BGA-06 (Location: Karaniganj- Kamrangir Char), BGA-07 (Location: Ghatar char-Pachandana) the cross-sectional area of 2001-2002 in comparison to 1973-74 have decreased. The reason is basically accumulation of sediment, sewage waste associated with a very low river velocity.

Changing Pattern of river Geometry:

BGA-01 (Location: Jajera-Dhermagonj)

In the section BGA-01, the depth of the river has increased, because of unplanned dredging.

BGA-02 (Location: Pangaon-Fatullah)

The depth has been decreased due to sedimentation, sewage disposal and other solid waste. Brickfield and encroachment is another cause to decrease the depth, width.

BGA-03 (Location: Hazaribagh-Dhaka Match Factory)

The riverbed has been eroded because of unplanned dredging.

BGA-04 (Location: Mirerbag-Faridabad)

The depth has been increased because of dredging. In this section people have been dredging the riverbed to fill up the low land along the riverside.

BGA-05 (Location: Jinjira Bazar -Midfort Hospital)

The maximum depth and water with remains same to this section.

BGA-06 (Location: Karaniganj- Kamrangir Char)

The major change has occurred in this section. Encroachment is higher in this location compared to other section.

2.9.2 Chemical pollution

Another parameter measuring the pollution range in the water and consequently the river pollution is the chemical compound present in the water. With the rise of population in the city and for commercial purposes floating vessels in the river has been increased. Effluents from the factories and house are being discharged in the Buriganga without any remedy.

It is turning an outlet of carrying sewage and waste matter of the city. Not only from the tanneries, have waste matter from thousands of latrines on both sides of the river been connected to the flow. From the launches and engine vessel in Sadarghat and Dockyard areas, there are discharges kerosene and mobil oil. There are floating residential hotels in the river. Human excretes from the floating vessel are spilled and the water is turning black and tinted. Thus water is being polluted day by day with the decomposed waste as well as heavy metal from the tannery and other industry situated at Tejgaon area.

The early mentioned table shows the water quality of Buriganga River. It is found that there are market metals in dry season as well as wet season and some important water quality parameters are also gradually deteriorating with time. In order to check further degradation of water quality, which may render the water, unfit for beneficial uses, there should be some legal measures against the indiscriminate discharge of sewage effluents, and pollutants from industries and commercial centers located on the banks.

2.9.3 Biological pollution

The third point in measuring the pollution on river is biological quality of the water, prevailing in that river. Biochemical condition is a vital criterion for the living bodies resident in the river ecosystem. The parameters measuring the biological conditions include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO). Measuring these indexes imply the aquatic life prevailing in the water bodies. These three parameters are directly related with pollution and can be used as an index in measuring pollution and their inclination is must when water is polluted.

Besides coliform presence, electric conductivity (EC) is also indicator of water pollution. (Badshah, 2003)

2.10 Causes of Pollution

Lost of factors are involved in pollution of river water and physical meandering of the river which causes the ultimate pollution in the environment in large context. Human activities those may be essential for their survival create a severe pollution on a river as well as the environment. These include

- Building of dams or embankments,
- Use of fertilizer and insecticide,
- Excavation of riverbed,
- Deforestation in up stream, land slides.
- Disposal of waste water from the town or city sewer,
- Industrial effluent,
- Disposal of human waste and burned oil by the vessels and
- The encroachment of the river banks by the land grabbers which makes the river narrow to narrower intensifies water pollution and break down whole ecosystem of its surrounding area.

Besides, huge volume of industrial (including tannery) wastewater is being disposed without any proper treatment. In addition to this waste, Buriganga River is flourished by solid waste of Dhaka city that contains huge quantity of BOD load.

2.11 Sources of Pollution

During previous and current assessment of water quality of the Buriganga different point and non-point pollution sources have been identified. A cursory examination of the water quality of the wastes of the plants indicates that significant amount of organic pollutants (in particular ammonia) and arsenic are released. The waste water treatment facilities

available at the plants involve operation of wastewater lagoons, which are apparently used in addition to other purposes, to store wastewater during low water period and released the same during high water periods. Releasing during unscheduled times, storage volume limitations as well as the complexity of tidal flows may occasionally result in high pollutants concentrations. Pollutants are mainly generated in and around the city through domestic, commercial and industrial activities. Wastewater and sewage generated in the city are carried into the river system through numerous outlets. Solid wastes are collected by the city corporation and dumped on the open land. According to the Industrial Management Control Task Report (BKH, 1994) six clusters of industries are located in the Dhaka and Narayanganj city.

From a reconnaissance industrial survey, conducted as a part of study by IWM (August 2006), the important findings about industrial pollution are as follows:

- Most of industries do not have any treatment facility for wastewaters
- Treatment plants possessed by few industries, however, do not operate regularly
- While most of the industries discharge wastewaters into drains or khals, which ultimately fall into nearby water courses, some of the industries dump the wastewaters directly on the ground
- Some of the industries, situated by the side of rivers, discharge their wastewaters into the rivers through underground/pipes, which are not visible from the land or water surface.

Understanding the pollution sources of the Buriganga River is very important. Instead of using expensive treatment techniques for the improvement of the water quality and its overall health, the best option would be to cleanup the sources of pollution and prevent the river from becoming contaminated. The river is affected along its course by both point and non-point sources of pollution. These are discussed below.

2.11.1 Point sources of pollution

Point source (PS) pollution comes from a number of discharges including domestic sewage, industrial facilities and mismanagement of solid waste. Major point source stressors or pollutants are as follows:

2.11.1.1 Encroachment

The Buriganga River has been steadily shrinking and slowly dying due to actions from a number of influential quarters engaged in encroaching and grabbing the river bit by bit. People have been grabbing the same river which has nourished their forefathers with its pure flowing waters and helped sustain life along its banks, provided protein to people, and drained out the dirt of city life to rejuvenate it. Dumping of garbage along the bank, apparently to reclaim land, has been practiced over the years. A visit to the river-front shows how structures built on platforms have sprung up along the banks of the dying river. To consolidate their holdings, encroachers resort to large scale and indiscriminate dumping of wastes and garbages for landfill.

The DOE undertook a survey in 1997 along the bank of the river and identified 113 illegally raised installations which encroached upon the riverbed, leading to its slow death (DOE, 1997). Among the installations, there were households, mills and factories, dockyards, mosques and madrashas (religious educational institution), dyeing and textile mills, saw mills, depots for fruits, vegetables, bamboos and timbers, wholesale markets and multistoried buildings. Most of the installations were found to encroach upon land at the river and discharge all their wastes directly into the river. Dhaka District Revenue Administration, in another field survey (DDRA, 1998), identified 244 encroachers, grabbing about 50.10 acres of land in total on both sides of the river as well as on the riverbed. In 2001, the BIWTA identified 304 encroachments along the 17.5 km long waterway, the shore and foreshore which are under its jurisdiction and warned that if these 'deadly obstacles' are not removed the river is 'sure to die'. The major encroachments identified by the BIWTA along the Buriganga included permanent buildings, markets, mosques, industrial units and educational institutions. Semi-pucca houses with tin-roofs, thatched houses and open space with boundary fences have also been included in the list of encroachments. These installations along the bank of the river are one of the major causes of and concerns for deterioration of the environment in and around the Buriganga. A number of slums and shanties also sprang up on the bank of the river, either on private land and illegally occupied khas land or on the encroached land of the Buriganga River. Encroachments, along with installations/establishments along the river, are the major point source of pollution. These are not only shrinking the channel

buildings, markets, mosques, industrial units and educational institutions. Semi-pucca houses with tin-roofs, thatched houses and open space with boundary fences have also been included in the list of encroachments. These installations along the bank of the river are one of the major causes of and concerns for deterioration of the environment in and around the Buriganga. A number of slums and shanties also sprang up on the bank of the river, either on private land and illegally occupied khas land or on the encroached land of the Buriganga River. Encroachments, along with installations/establishments along the river, are the major point source of pollution. These are not only shrinking the channel and obstructing the flow of water, but also directly discharge different types of wastes into the river.

2.11.1.2 Solid waste

Dhaka City suffers particularly from poor solid waste management practice. The Dhaka City Corporation (DCC) area, about 5.38 million people within an area of 360 sq km, generates about 3500 metric tons of solid waste per day (on an average 0.5 kg per person per day). Of this, 1800 tons are collected and dumped by the DCC, 900 tons go to backyard and land filling, 400 tons are on road side and open space, 300 tons are recycled by the rag pickers, and 100 tons are recycled at the generation point. Although the DCC collects about 50 percent of the solid waste generated in Dhaka City, it does not have any sanitary landfill for ultimate disposal of solid waste. Solid wastes are basically dumped in the low-lying areas in and around Dhaka City and many are close to the river (e.g. Lalbagh, Mohammadpur, Aminbazar and Rayerbazar). A large amount of leachate percolates through the surface and contaminates the ground water. In addition, the least expensive method of municipal solid waste disposal practiced among many residents is to place it on the streets. Part of this waste ultimately finds its way into the rivers through rainwater runoff. The city is currently suffering from the effects of highly toxic clinical wastes from a number of pathology centers, hospitals and clinics. Over 500 clinics and hospitals dump around 50 tons of waste daily, 20 percent of which is infectious and hazardous. Indiscriminate disposal of solid wastes including organic wastes from different kaucha bazaars, factories and shops aggravates the situation. Many landfill areas are either close to the Buriganga River or drainage channels, which ultimately meet the

quality. As a whole, solid waste in Dhaka City is considered one of the major point source pollutants to the Buriganga River.

2.11.1.3 Untreated sewage

According to the Dhaka Water and Sewerage Authority, the volume of waste being generated within Dhaka City is about 1,040,000 m³/day. Out of this, only 120,000 m³/day (11.54 percent) is under the scope of a modern treatment system. Only about 30 percent of the area and 20 percent of the population in Dhaka City are covered by these treatment facilities. Amongst the rest, 40 percent of the population employs their own treatment systems using septic tanks. Although a septic tank system is a type of sewerage treatment system, many septic tanks do not work properly due to lack of proper design and use. About 15 percent of the population, particularly slum-dwellers and low-income households of Dhaka City, use pit-latrines. In total, about 75 percent of the population of Dhaka City has access to some types of sewerage treatment system. The remaining 25 percent do not use any sewerage treatment facility; they use either open latrines or no latrines at all. A significant portion of the sewerage wastes of the people who use some types of latrine is being disposed either directly or indirectly (through different canals and open and low-lying areas) to the Buriganga River.

During the field visits, it was observed that many sewer lines in the city ended up in the river. Hence even sewerage lines are being used for dumping solid waste into the river. Many industries and factories discharge effluents into drains and canals which subsequently find their way to the river. Sewer pipes are broken in many places, and thus solid wastes enter into the sewer lines. In many areas, surface drains are connected to the sewer lines for disposing of liquid wastes from septic tanks, although such drainage is supposed to drain only wastewater from kitchens into the rivers and canals through low-lying areas. Untreated urban sewage discharge is considered to be another major cause of water pollution in the Buriganga River. The very low quality of the river water in turn contributes to poor hygiene along the river corridors and loss of biodiversity in the river itself.

2.11.1.4 Industrial pollution from Hazaribagh tannery

The tannery is one of the most polluting industries in Bangladesh, although it is one of the major export earners. Leather and leather products rank fourth in earning foreign

exchange and earned US\$1,583 million in 2001. Out of 270 registered tanneries in the country, about 25028 are located in a small area of 25 hectares in the Hazaribagh in the heart of Dhaka City. Leather processing involves a series of chemical operations. Both chromium and vegetable tanning processes are used in the production process. In the tanneries, 85 per cent of the hides (mainly cow) are processed by the chromium tanning process, and the remaining 15 per cent (mainly goat hides) by the vegetable tanning process. Both these tanning processes generate large quantities of liquid and solid wastes, most of which directly or indirectly find their way to the Buriganga River. According to the DOE estimate, more than 16,000 cubic meters of highly toxic waste from the Hazaribagh tanneries flow first to low-lying areas and then to the Buriganga River every day. The wastewater is usually characterized by high pH; high suspended and dissolved solids, high BOD and COD, strong color and potentially toxic compounds, such as chromium. Moreover, leather processing generates a significant quantity of solid wastes – about 115 tons per day. Only part of it is disposed by the DCC and the remainder litters the Buriganga River and its surrounds. The disposal of solid wastes from the tanneries generally creates a problem because of the quantity and the composition (i.e. non-biodegradable and toxic compounds). This waste contains sulfuric acid, chromium, ammonium sulfate, ammonium chloride and calcium oxides that may seep into the groundwater. Also, odours produced by these chemicals and wastes affect the health of the people in the surrounding areas. Previously, tannery effluents remained stagnant in the low lands inside the Dhaka Flood Protection Embankment. For the last four years, the effluents have been released without any treatment through large underground pipes (sluice gate no. 7 and 8) into the Buriganga River. The sludge containing high levels of chromium is also being deposited on the riverbed and is polluting the water. During the field visit, the effluents containing chemicals from the tanneries were found to be gushing out of the pipes and creating white foam in the river water. The water of the river turns septic under the huge burden of effluents from tanneries, particularly in the dry season.

2.11.1.5 Other industries

The DOE, in a survey in 1998, identified 249 industries along the bank of the river responsible for water pollution from industrial sources of pollution. Other than tanneries,

many industries, such as aluminium, dyeing, plastic, iron and steel, metal, pharmaceuticals, battery, washing, hardware and cold storage units are located on the bank of the Buriganga. They discharge their waste (both solid and waste water) directly into the river. Many small industries and factories located in the vicinity of the Buriganga River discharge in the local drains and subsequently into the river. Since the beginning of the development of small and medium industries in the 1960s, hundreds of small, mainly home-based industries have grown up either on the bank of the Buriganga River or close to it. All these establishments discharge effluents. Therefore, the results of these small land use decisions have a large cumulative impact on the Buriganga River.

2.11.1.6 Terminal and landing stations

With more than a hundred launches arriving and a similar number leaving the Sadarghat Terminal on the bank of the Buriganga River every day, it is one of the busiest river ports in the country. Due to the lack of railways and the inadequate capacity of road communication between Dhaka and most parts of the southern region, people depend heavily on the river route through this terminal for passenger and cargo traffic. However, it lacks a proper waste disposal system. Shadarghat Terminal discharges much solid and petrochemical waste into the river. In addition, there are spills from loading and unloading of house building materials such as cement, sand, rods and brickbats which are carried to many places along the river-bank.

2.11.1.7 Pollution from sewage

The Pagla sewage treatment plant can process around 30 percent of its collected sewage. The remainder is being drained to the river without any treatment. Some other point sources, in addition to the sources mentioned above, are also responsible for affecting the river. These include:

- Disposed solid waste and wastewater from floating restaurants at Shadarghat;
- Oil leaked from floating oil-seller boats;
- Petrochemical waste from boats and launches;
- Dockyards at Keranaging and Kaliganj;
- Fruit and vegetable depots/storage at Shambazar;

- Shipbuilding industries on the south side of the river (Keraniganj);
- Bazaars/shops located near the river;
- Saw mills located at Farashganj and Faridabad;
- Discharges from sluice gates along the Dhaka Integrated Flood Control Embankment;
- Discharges (both waste and storm waters) through many canals and drains linked with the river;
- Hanging latrines along the river;
- Brick kiln;
- Hospitals; and
- Indiscriminate stacks of sand quarrying from the Buriganga River and grinding of pebbles and stones on its bank at Postogola, Hasnabad and Rayerbazar.

All these point sources of pollution are diverse in nature and very substantial in terms of impact on the Buriganga River.

2.11.2 Non-point sources of pollution

Degradation of water quality by non-point source (NPS) inputs is an important phenomenon and urgent attention is required in reducing NPS inputs to receiving river waters. The NPS pollution comes from many diffuse sources. It generally results from land run-off caused mainly by rainfall, precipitation, atmospheric deposition, drainage, seepage and hydrologic modification. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into the river and other receiving waters and even the underground sources of drinking water. Urban storm water runoff carries various pollutants washed off from streets, roof-tops and various types of land cover. It is revealed that the city storm runoff with very high pollutant loads is directly discharged into receiving water bodies threatening the natural aquatic environment. However, this is not unexpected considering the developing nature of the city and the poor waste management practices. Although there are separate sewer systems for carrying storm water within Dhaka City, the storm sewers often receive domestic wastewater causing an unwanted deterioration of the storm sewer discharges. Moreover, the existing waste disposal practice and management of wastes are not organized in Dhaka City. Wastes are often disposed of at roadside open dumps which are very likely

a number of pollutants in the storm runoff. Many landfills within the city are open and close to drainage. Discharge from construction sites also adds pollutants to the runoff. Pollution by sediments is another concern. Although there is no accurate estimate of sediment discharge to the Buriganga River, it is obvious that the river receives an enormous sediment flow both from its upper catchments and from the city. Experience indicates that sediment concentration/deposition due to human activities (e.g. cutting of trees, lack of vegetation on the top-soil, poor management of construction and digging of roads throughout the years) impacts the Buriganga River. Sediments are a major source of chemical pollution for the Buriganga due to the close existence of industries, particularly tanneries at the Hazaribagh.

Polythene bags have been identified as another hazard for deteriorating environmental quality in and around the Buriganga River. According to various estimates, about six million polythene bags are used daily in Dhaka City and only twenty percent are properly disposed of. The rest litter the roads, streets and everywhere and finally end up in drains and sewer lines, clogging these and creating serious water logging problem and blocked sewer lines in the city. Some of these polythene bags finally end up in the river. The rainfall pattern in Dhaka has important implications for both sanitation and water pollution control. Data shows that Dhaka experiences a typical monsoon climate with high rainfall in the months from June to September and is relatively dry at other times. With regard to water pollution control, during the monsoon period the high flow rates in the rivers and flooding in the surrounding low-lying areas provide a large dilution capacity for the river. This reduces the water pollution problems in the monsoon season. Conversely, in the dry season the lack of dilution capacity results in more severe water pollution problems in the Buriganga River. In many countries, agriculture is the leading non-point source pollutant for rivers. Although increased use of fertilizers and agro-chemicals have become a concern for river water quality, in the case of the Buriganga, agriculture as a source of pollution has little impact. (Alam, Khorshed. 2003)

2.12 Pollution load discharged into the river and its projection

According to a survey jointly performed by Department of Environment (DOE) and Canadian International Development Agency (CIDA), more than 7,000 factories are located along the rivers and canals in Dhaka.

These industries, excluding the Hazaribagh tanneries, discharge more than 60 million litres of toxic wastes per day into our waters, land and air. The Hazaribagh tanneries add to the massive pollution by pumping an additional 7.7 million litres of highly toxic liquid wastes directly into the nearby canals and the river Buriganga. Tanneries also dump 135 tonnes of solid wastes into the river per day. Factories in Tejgaon industrial area drain wastes into the Begunbari canal that winds its way into Norai canal and the river Balu

Since, it is not possible to compute loadings from all the points of wastewater effluent through measurement of flows directly, it is necessary to estimate the total loadings, which may be discharged into nearby stream. There are two methods of computing pollutants load. One is 'Dry method' and another is 'Wet method'. In dry method, sub-catchments, this may contribute wastewater to the river, are delineated using information from relevant studies.

$$\text{Total domestic load} = \text{Per capita waste production} \times \text{Number of inhabitants} \times \\ \text{Percentage of population unsewered}$$

The waste produced per capita varies with the standard and type of living. Besides the physiological excreted amounts of pollutants, the pollution load from kitchen, bathroom, washing clothes and storm waters can be also considered in the per capita waste production estimates. To account for loadings due to industrial wastes, per capita pollution loads are increased by an arbitrary percentage when only small industrial plants are considered.

$$\text{Total loading} = (\text{Per capita waste production} \times \text{Number of inhabitants} \times \\ \text{Percentage of population unsewered}) + \text{Contribution of small} \\ \text{Industries}$$

In the weight method loading is calculated from the measured rate of flow through drains / khals and concentration of specific parameter determined through laboratory analyses.

Loading for water quality parameters are computed by following equation:

$$\text{Loading} = \text{Flow discharge} \times \text{Concentration of a parameter (e.g. BOD)}$$

Table 2.8: Pollution loads discharged into the river system (WSP, 1998)

Name of Outfalls	Discharge into	Pollution Load (kg/d)					
		BOD5	NH3-N	PO4-P	Cr	Pb	Zn
Sluice No. S-3	Tongi Khal	700	20	2	1	1.5	80
Sluice No. S-4	Turag	2900	350	60	1	2.5	80
Sluice No. S-5	Turag	990	115	35	0.25	1	4
Sluice No. S-6	Turag	6800	600	150	2.5	6	50
Sluice No. S-7	Turag	24200	3800	500	750	10	150
Sluice No. S-8	Buriganga	1300	100	30	0.6	0.25	5
Sluice No. S-9	Buriganga	6000	1000	250	0.8	2.5	45
Sluice No. S-10	Buriganga	3800	300	100	0.9	1	30
Dholai khal	Buriganga	30000	3100	1050	6	9	140
Pagla STP	Buriganga	9000	425	650	4	2	200
Majheepara K	Lakhaya	1350	40	10	0.1	0.3	9
Tanbazar K	Lakhaya	1300	230	75	0.2	0.2	3
DND K	Lakhaya	14325	690	350	7	4	325
Kalibazar K	Lakhaya	1250	250	80	0.1	0.2	10
Norai K	Balu	75300	7700	2200	8	40	1000
Kashipur K	Dhaleswari	30000	870	500	3	30	45
City drain	Buriganga	8000	840	250	5	3.5	100
Lakhaya L/B	Lakhaya	4150	430	140	1	1.5	48
Tongi	Tongi K	5160	540	170	1.5	2	60

Projection of Pollutants loadings

Higher increase of population and industries in and around Dhaka city, it is necessary to estimate future pollutants loadings which would further deteriorate the river water quality.

The following points were taken into account in projecting the present polluting loads:

1. According to BKH, 1994 report, Table 2.9 shows waste water quantities and BOD5. In reality, there are approximately 1500 industries in and around Greater Dhaka, most of which are directly discharging untreated wastes into either the sewerage system or the peripheral river system. A detail quantification and characterization of industrial pollutants is lacking. The BOD loading is given by BKH (1994) in Table 3.10 represent a fraction of the total loading being emitted by more than 2000 industries in and around Dhaka city.

Table 2.9: Industrial areas in and around Dhaka city (WSP, 1998)

Cluster Name	Type of Industries	Number of Industries	Total wastewater Discharge (m ³ /day)	Total BOD load (kg/d)	Discharge into
Hazaribag	Leather	136	15,800	17,600	Turag
Tongi BSCIC	Textiles	13	4,300	4,400	Tongi khal
Fatulla	Textiles	6	3,400	3,850	Buriganga
Kanchpur	Textiles	9	4,300	3,480	Lakhaya
Tejgaon	Textiles, Chemical	16	3,350	1,960	Begunbari Khal
		27	535	475	
Tarabo	Textiles	14	1,150	1,475	Lakhaya

2. Industries in around the Greater Dhaka do not have any treatment facility. The Pagla STP is the only sewage treatment plant serving less than 20% of the total population of Dhaka city.

3. Projected population figures have been extracted from a study report of the Dhaka metropolitan Development Planning, DMDP (RAJUK, 1993).

The Greater Dhaka has been divided into 19 strategic, Planning Zones (SPZ's) for which population figures have been given.

Table 2.10: Summary of loading in the peripheral Rivers (Greater Dhaka, 1998)

Name of outfall	BOD load (kg/day)	NH3-N load (kg/day)	PO4-P load (kg/day)	Cr load (kg/day)	Pb load (kg/day)	Zn load (kg/day)
Tongi Khal	5860	560	173	3	4	140
Turag	34890	4865	745	754	19	284
Buriganga	58000	5762	2333	17	18	520
Dhaleswari	32800	1160	600	3	31	77
Lakhaya	23275	1774	707	9	7	406
Balu	75300	7700	2195	8	40	1000
Total loading	230125	21823	6756	794	119	2427

Table 2.11: shows the population (as in RAJUK, 1993) with corresponding BOD loadings considering a unit BOD load of 25 kg/c.d.

Population	BOD load kg/day	Discharge into
658,000	16,450	Tongi Khal
2,006,000	50,150	Turag
3,080,000	77,000	Buriganga
1,378,000	34,450	Dhaleswari
1,580,000	39,500	Lakhaya
4,503,000	112,575	Balu
Total=13,205,000	=330,125	

The following **Table 2.11** shows the population and BOD loads to be discharged into the peripheral rivers around Greater Dhaka by the year 2010 using FAP-8A information (JICA, 1991). Unit BOD load has been assumed the same as 25 g/c.d.

Table 2.11: Projected BOD loads in the peripheral rivers: 2016

Year	Population	BOD load, kg/day
1991	7,346,000	1,83,650
1996	9,059,000	226,475
2001	10,850,000	271,250
2006	12,623,000	315,575
2011	14,230,000	355,750
2016	15,679,000	391,975

Table 2.12: Summary of pollutant loadings in the in the Buriganga river: 2000, 2005, 2010 and 2015 (Source: Akter, 2007)

Name of River	BOD Load kg/day				NH3-N load (kg/day)				PO4-P load (kg/day)			
	2000	2005	2010	2015	2000	2005	2010	2015	2000	2005	2010	2015
Buriganga	74746	90787	101263	109531	4127	5013	10516	11371	1322	1605	3252	3520

CHAPTER 3

METHODOLOGY

3.1 Introduction

To find out the trend and present condition of water quality of the Buriganga River needs a vast water quality data on so far as previous years to recent year. Data of previous years was collected from various thesis, reports and organizations. Besides the measurement of water quality is very expensive, requires skilled manpower, sophisticated instruments and well organized laboratory facilities. In spite of the remaining of leakage of these facilities an attempt was taken to collection of water sample from different locations in the Buriganga River. In this study relevant and important water quality data and information have been collected from various agencies, primarily from concerned governmental agencies and their publications on conducted studies. Then the data have been analyzed to produce a significant and representative presentation of the water pollution occurrences and ongoing trends of degradation of the Buriganga.

3.2 Water Quality Data Collection

3.2.1 Water quality Data collected from Department of Environment (DOE)

Historical water quality data at Hazaribagh, Chandni Ghat and Pagla measured by DOE from 1980 to 1994 have been collected from Kamal, (1996). Measured parameters include pH, Chloride, alkalinity, total suspended solid, DO, BOD, COD, NH₃-N, coliform and chromium. Data measured by DOE from 2000 to 2003 has been collected from Magumdar (2005) which include data on turbidity, temperature, DO, BOD₅ at 20° C, COD, pH, EC and alkalinity. Only limited data on COD data was available.

Water qualities data of the year 2003 and 2004 are collected from DOE tabulated in the appendix -A. Recent data on water quality from January to February, 2007 have been collected from DOE and also tabulated in the appendix -A. All data of DOE have been tabulated in appendix -A.

3.2.2 Water quality data collected from Institute of Water Modelling (IWM)

Institute of Water Modelling (IWM) measured water quality during December 1997, January 1998 and February 1998 in connection with the "Fourth Dhaka Water Supply Project" in the peripheral river system have been collected from Magumdar (2005). Measured parameters include BOD₅, NH₃, NO₃, PO₄⁻ Cr, Pb, Zn and coliform. The institute also measured water quality during Apr'03, Dec'03, mar'04 and Apr'04 also has been collected from Magumdar (2005).

3.2.3 Water quality data collected from Bangladesh Water Development Board (BWDB)

Bangladesh Water Development Board measured water quality of the Buriganga river. They measured BP, T, pH, DO, Salinity, TDS, EC, and Transparency. Water quality data on the river of Buriganga, during the year of 2001 to 2005 have been collected from BWDB. All data of BWDB have been tabulated in appendix -A.

3.2.4 Water quality data collected from various thesis

Water quality of Buriganga River on the year of 1973-1974 has been collected from Islam (1977). Water quality of Buriganga river measured by BUET (1968), DPHE (1975), and study team (1980) collected by Mohammad (1988) has been collected from Moazzem (2005). Measured parameter includes EC, pH, Chloride, DO, BOD, Nitrate, Coliform.

3.3 Water Sample Collection from Different Locations of the Buriganga River and Tested in the BUET Laboratory

A Water sample collection program was conducted at 21st June; 2007. Water samples have been collected from the Buriganga River at industrial and sewage disposal points. Clean plastic bottles were used for preserving the water sample for examination. A total 6 samples were collected from different places of the Buriganga River.

During this campaign, DO, Temperature, EC, and pH were measured at each location. A total of 7 locations were selected Buriganga river system. Table 3.1 shows the positions of these monitoring locations. Collected samples were tested in the BUET laboratory. Water quality parameters DO, pH, EC, Cr, Cd, Pb, BOD₅, COD, NO₃-N, NH₃-N, Turbidity, PO₄³⁻ were tested. Table 4.2 shows the tested data.

Table 3.1: Positions of River Water Monitoring Locations

Location Name	River	Latitude(N)	Longitude((E)
Chadnightat	Buriganga	23 ⁰ 42.08	90 ⁰ 23.48
Shiddirgonj	Buriganga	23 ⁰ 41.11	90 ⁰ 31.54
Fatullah	Buriganga	23 ⁰ 39.80	90 ⁰ 28.09
Pagla	Buriganga	23 ⁰ 42.24	90 ⁰ 27.40
Forashgonj	Buriganga	23 ⁰ 42.37	90 ⁰ 24.63
Sadarghat	Buriganga	23 ⁰ 42.80	90 ⁰ 22.32
Hazaribagh	Buriganga	23 ⁰ 43.78	90 ⁰ 21.80

Note: Positions of the locations were observed from a Trimble Nav Trac GPS

3.4 Photographs Collection from Different Locations of the Buriganga River

Photographs have been collected from different locations of the Buriganga River at industrial and sewage disposal points. Photographs were collected from different places of polluted water near the discharge/sewage/industrial waste outlet points and also from

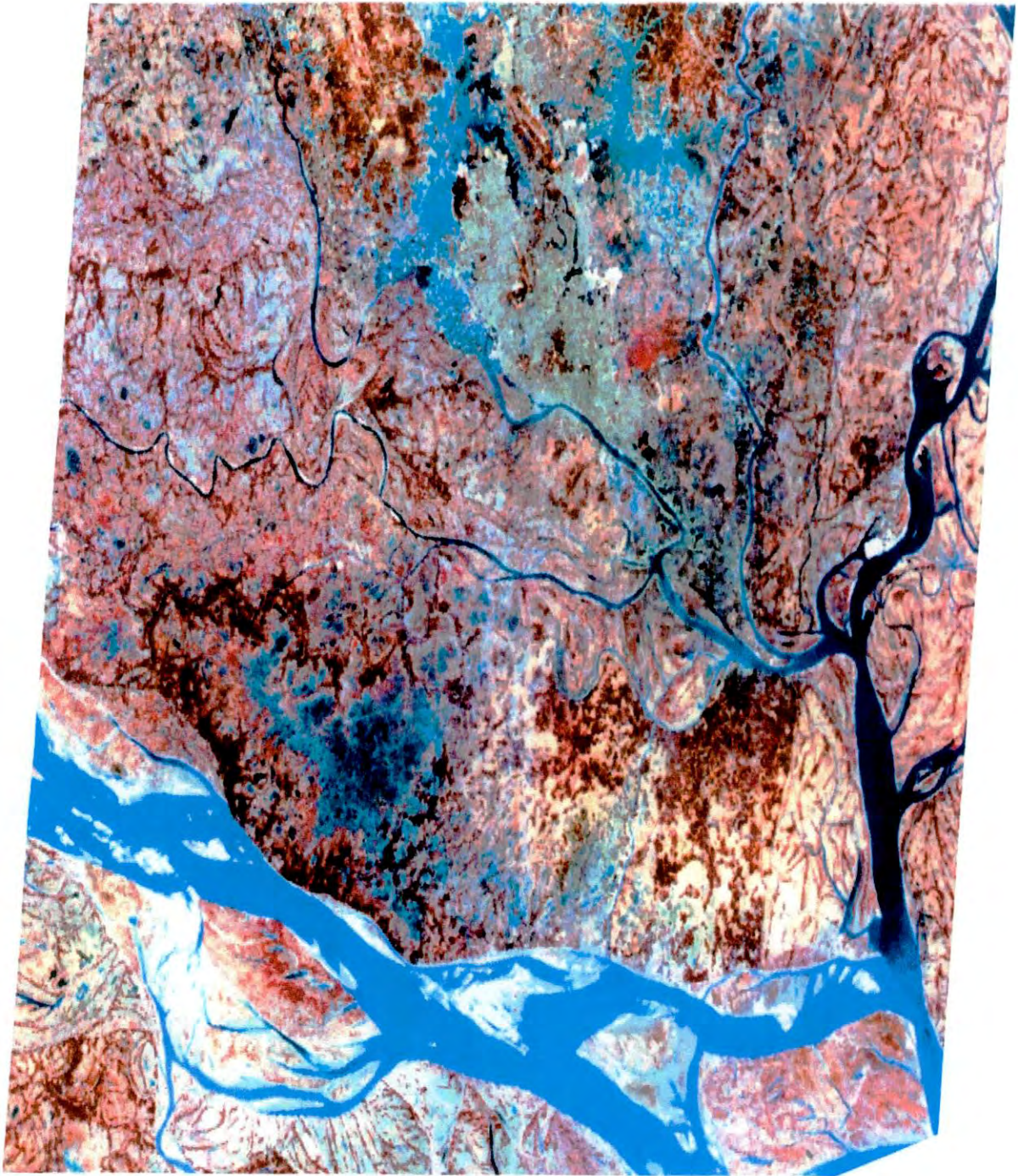


Figure 3.1: Satellite image of the Buriganga River and its surrounding

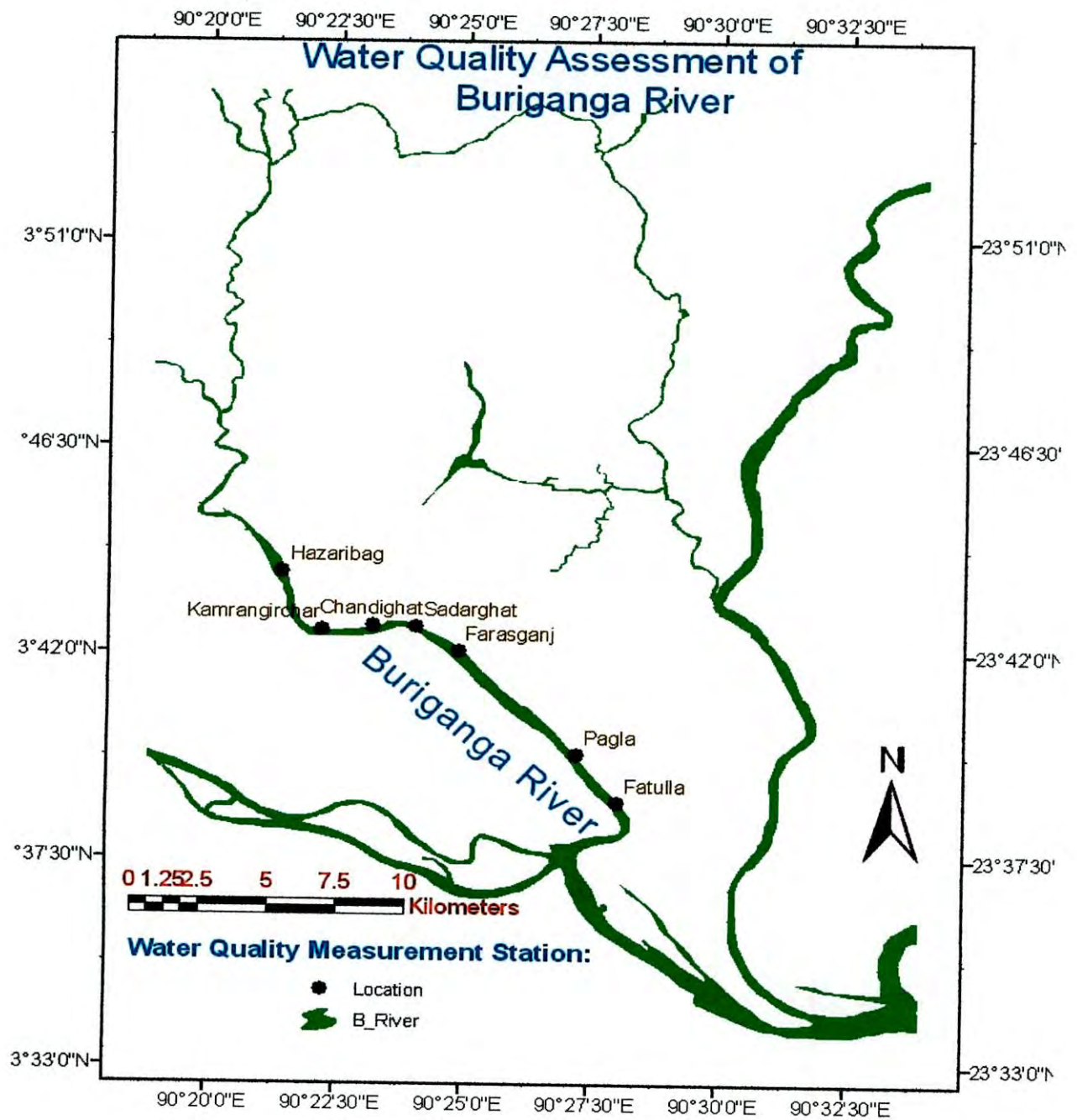


Figure 3.2: Location of Sample in the Buriganga River

different types of news papers and thesis. Photographs were collected to find out the causes and sources of pollution of the Buriganga River water and observe the present pollution scenario of this river. Photos have been found in appendix-B.

3.5 Data Analysis and Approaches to Restore Water Quality of the Buriganga River

All the available data and information recorded and analyzed. On the basis of the analyses of the data and information made a discussion on findings and conclusions were drawn and recommendation are made.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

Water samples and photographs were collected from the Buriganga River. The samples were tested in the BUET Laboratory. From the field observation it has been found that the effluent from Hazaribagh Tannery are discharged, sewage disposal and oil seepage from ships are caused for water pollution. The analysis includes both stream and waste water quality. This chapter illustrates elaborately the consistency of data, present water quality scenario in the river system as well as pollution load discharged into them.

4.2 Data analysis for the water quality of Buriganga River

In this investigation, surface water quality data around Dhaka city were collected from various sources for analysis and to investigate the trend of degradation of water quality in and around Dhaka city. The data are presented in the Appendix- A. The degradation and seasonal fluctuation of important water quality parameters are analyzed and presented graphically in this chapter. In order to simplify the presentation of data analyses, analysis for some important water quality parameters has been performed separately. While performing analyses on surface water quality, special attention has been given for yearly or seasonal degradation or fluctuation water quality.

As the study is focused on pollution trend in the rivers, the variation of water quality parameters over the years have been analyzed. Finally, an analysis has been performed on the pollutant loads, especially contributed by industrial effluent and domestic wastewater to reflect the alarming increase of pollutants and consequent degradation of surface water quality around Dhaka. Stream water quality has been assessed keeping attention on the drinking standard as well as sustainability of aquatic lives. The water quality data have been analyzed to produce a significant and representative presentation of the water pollution and the trends of degradation of water quality of the Buriganga River.

Table 4.1: Water Quality in Buriganga River during 1968-1980 (Source: Haque, 2003)

Parameters	BUET 1968			DPHE 1975			Study Team 1980		
	min	max	Ave.	min	max	Ave.	min	max	Ave.
EC($\mu\Omega/\text{cm}$)	150	332	207	325	650	-	282	512	-
PH	7.1	8.2	-	7.1	8.5	-	7.1	7.7	-
Chloride (mg/l)	1	7	-	14	62	-	28	30	29
DO(mg/l)	5.4	8	6.7	1.55	10	-	2.4	4.6	3
BOD(mg/l)	0	1.5	0.8	1.4	6.5	-	1.6	8.4	3
Nitrate (mg/l)	0.1	0.6	0.3	2.6	6.2	-	0.1	1.9	-
Coliform(#/100 ml)	268	600	1450	200	20000	-	-	> 20000	-

Table 4.2: Measured water quality parameter in June, 2007

Location Parameters	Chandi- ghat	Fotulla	Pagla	Farashganj	Sadar- ghat	Kamranghir- char	Hazaribagh
DO(mg/l)	1.65	1.49	1.10	0.20	0.15	0.57	1.65
pH	6.8	6.7	6.6	6.6	6.4	6.5	6.7
EC(micro S/cm)	11.34	142.4	13.75	8.93	14.79	9.74	14.25
Cr(ppm)	0.010	<0.001	0.001	<0.001	0.001	0.051	0.074
Cd(ppm)	0.0013	0.0008	0.0008	0.0014	0.0009	<0.0004	0.0002
Pb(ppm)	0.004	<0.002	0.007	0.003	0.007	0.007	0.013
BOD ₅	24	22	21	17	44	30	60
COD	50	44	41	42	107	40	145
NO ₃ -N (mg/l)	0.3	0.4	0.5	0.2	0.3	0.2	0.6
NH ₃ -N (mg/l)	0.97	0.7	0.75	0.91	0.89	2.05	0.36
Turbidity (NTU)	18.3	14.3	16.5	20	25	14.7	34
PO ₄ ³⁻ (mg/l)	0.6	0.54	1.35	0.53	1.67	0.09	2.36

4.2.1 Dissolved oxygen (DO)

The most important parameter, frequently considered in river pollution studies is Dissolved Oxygen. This parameter has been analyzed to find out the trend of degradation of DO around the year of 1968 to 2007. The critical concentration of DO is 4 mg/l, which must be maintained for healthy aquatic lives in the water. Historical trend of DO has been tried to evaluate in spite of insufficient data. From this research work, it is observed that generally Dissolved Oxygen concentration remains low in January, February, March, and April that means dry season.

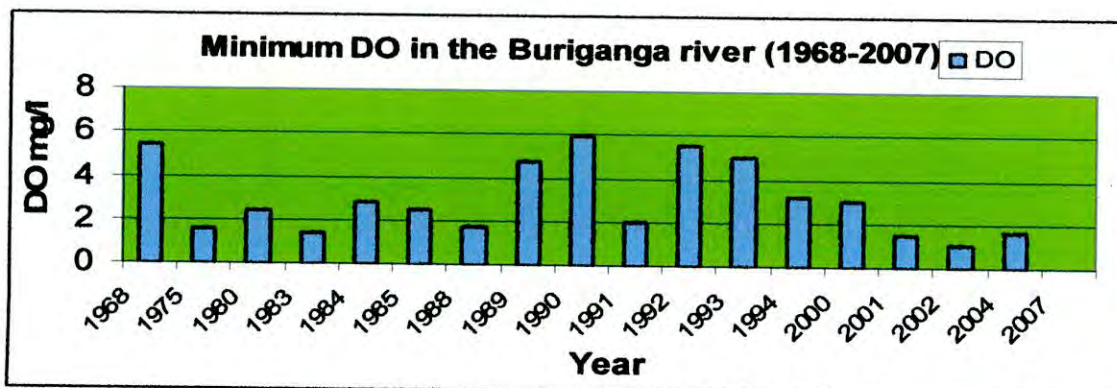


Figure 4.1: Yearly variation of Dissolved Oxygen in the Buriganga River. (Data Source: Maniruzzaman, IWM, Magumdar, DOE, BWDB and BUET)

Seasonal Variation of Dissolved Oxygen:

Table 4.3: Seasonal variation of Dissolved Oxygen (DO) in Buriganga

Year	Hazaribagh		Chandighat		Pagla	
	Min. DO (mg/L)		Min. DO (mg/L)		Min. DO (mg/L)	
	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season
1980	6.8	3	1.5	3.1	-	-
1983	3.45	1.4	2.75	1.7	-	-
1984	4.3	4	3.2	2.8	-	-
1985	3.3	4.5	2.5	4.5	-	-
1987	-	6.4	-	4.8	-	-
1988	5	4.3	4.7	1.7	5.1	5.9
1989	5.3	5.7	4.7	4.9	4.9	5
1990	6.1	6	6	6	6	6.1
1991	6	2	5.4	5.1	6	6
1992	5.3	5.7	5.3	5.5	5.6	5.3
1993	5.4	5.7	5.5	5	5.1	5.7
1994	3.3	6	3.2	4.3	-	-
2000	3.1	3	3.4	5.5	3.1	5.4
2001	1.5	2.8	2	6	3.2	4.6
2002	1	5.2	1.1	6.3	1.2	6

Note: “-” indicates that data is not available

Dissolved Oxygen concentration generally remains low in the dry seasons (i.e. January, February, March, and April) and it maintains the level more than 5mg/l (required for sustaining aquatic habitats) from May to December in the entire of the Buriganga River. Seasonal variation of DO at Hazaribagh, Karaniganj, Chandnighat, Sadarghat, Dholaikhal, and Pagla during the year of 2000 and 2002 has been shown in figure 4.2 and figure 4.3 respectively. Variation of DO through all the year round during 2004 and 2005 has been plotted in Figure 4.4. It is observed that 2004-05 show relatively low DO content during dry period at the station of Mill Barrack and Hariharpara of the Buriganga.

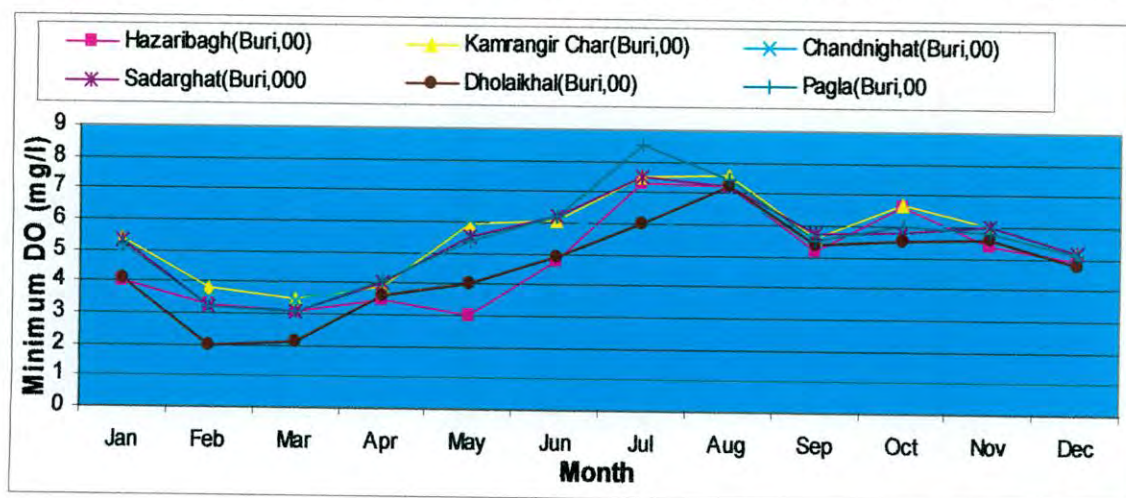


Figure4.2: Seasonal variation of DO in Buriganga during the year of 2000

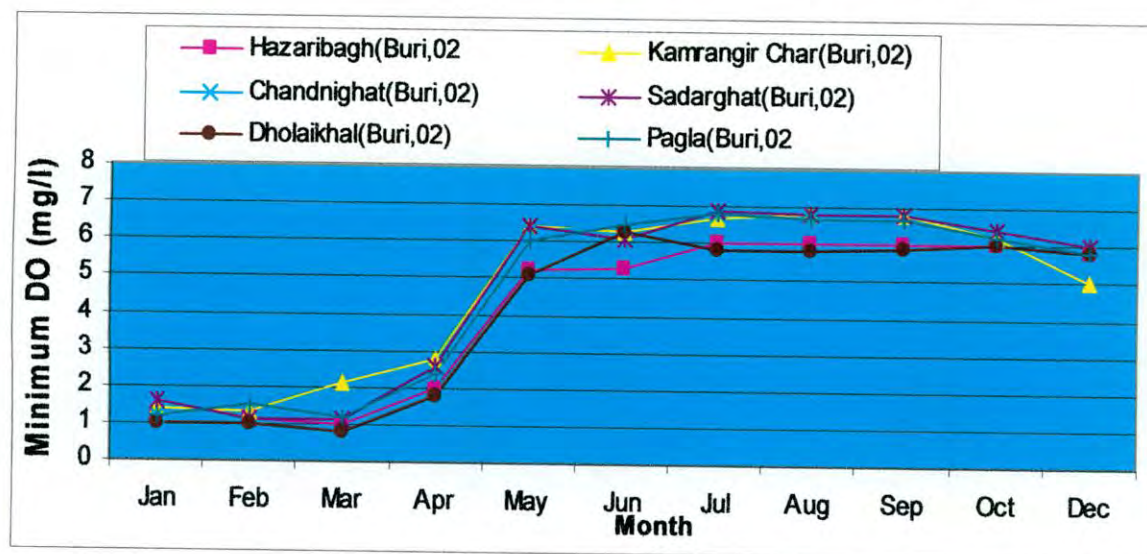


Figure4.3: Seasonal variation of DO in the Buriganga River during the year of 2002

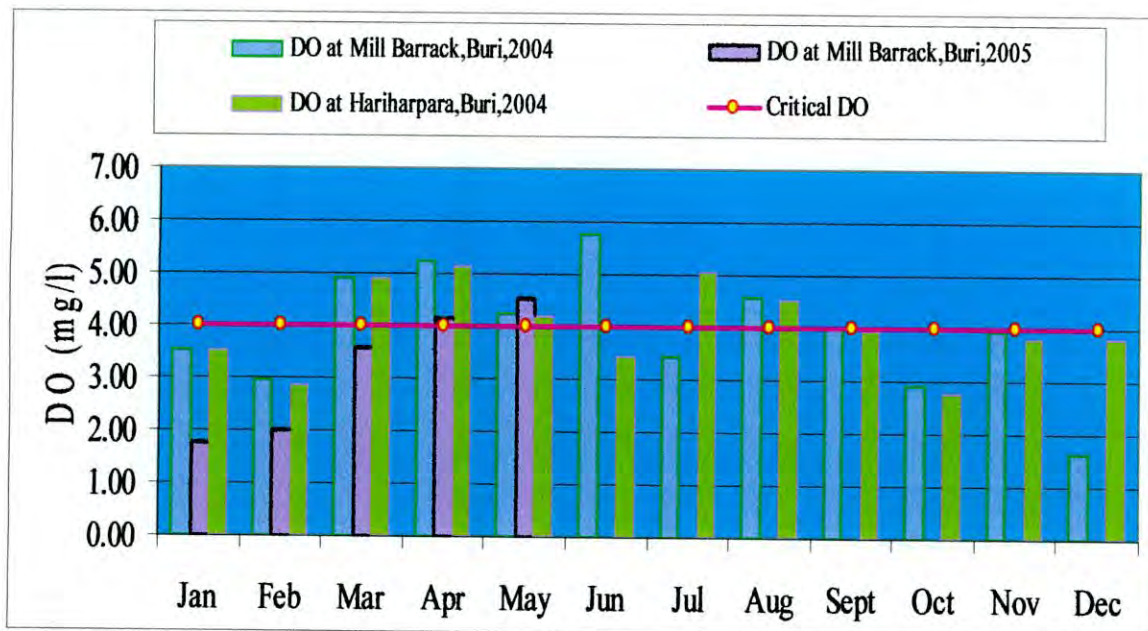


Figure 4.4: Seasonal variation of DO in the Buriganga Rivers in 2004- 2005(Data source BWDB).

Minimum Dissolved Oxygen:

Water quality data for the Buriganga River from 1980 to 1994 have been shown in Appendix-A. Analyzing DO and BOD data for three locations of Hazaribagh, Chandighat and Pagla maximum, minimum and most occurring range of these parameters have been shown in tables from Table 4.6 to Table 4.11. Figure 4.6 represent the variation of DO from 1980 to 2002 at Hazaribagh, Chandighat and Pagla. The variation of DO have been shown to reflect the deviation of actual DO from the critical DO concentration of 4 mg/L, which must be maintained for healthy aquatic lives in the river. Hence, this analysis can give significant indication of the pollution status of the river. It is observed from the Fig.4.5 that the min. DO content at Hazaribagh before 1994 was moderately well but after 1994 it lay down below critical level. Recent scenario at Hazaribagh is worse than the scenario of Chandnighat and Pagla. During dry season in 2007 DO go to zero at Hazaribagh, Chandnighat and Pagla. From the Fig. 4.6 it is observed that the Present scenario of DO in the Buriganga is worse than the river of Sitalakha, Balu, and Dhaleswari. The minimum dissolved oxygen contents required for maintaining standards of drinking, fishing, recreation and agriculture is 4, 5, 4 and 5 mg/l.

Table 4.4: Analysis of historical data on DO at Hazaribagh

Year	DO concentration (mg/L)		DO concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. value	Occur in	
1980	3	Jun	11.9	Jan	4 - 6
1983	1.4	Oct	8.7	Sep	6 - 7.5
1984	3.4	Aug	10.9	Dec	6 - 9
1985	3.3	Mar	7.7	Apr	4.5 - 7
1988	3.7	Jun	8.1	Aug	5 - 7
1989	5.3	Apr	7.5	Jan	6 - 7
1990	6	Oct	6.6	Jul, Aug	6 - 6.6
1991	2	May	6.3	Jan	5 - 6
1992	5.3	Nov	6.7	Aug	6 - 6.5
1993	5.4	Apr	6.8	Aug	5.5 - 6.8
1994	3.3	Dec	8	Jul	5.5 - 6.5

Table 4.5: Analysis of historical data on DO at Chandighat

Year	DO concentration (mg/L)		DO concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. value	Occur in	
1980	1.5	Apr	7.1	Sep	4 - 6
1983	1.7	Jul	6.7	Sep	4.5 - 6.5
1984	2.8	Jun	6.45	Dec, Mar	4.5 - 6
1985	2.5	Feb	5.8	Jun	3 - 5
1988	1.7	May	6.5	Nov	5 - 6
1989	4.7	Jun	6.8	Aug	5 - 6
1990	6	May, Jun, Nov, Dec	7	Aug	6 - 7
1991	5.1	Jun	6.9	Jan	5 - 5.5
1992	5.3	Nov	6.4	Aug	5.5 - 6.4
1993	5	Oct	6.6	Jun, Jul, Aug	5.5 - 6.5
1994	3.2	Dec	6.8	Jul	4 - 6

Table 4.6: Analysis of historical data on DO at Pagla

Year	DO concentration (mg/L)		DO concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. value	Occur in	
1988	5.1	Nov	6.3	Oct	5 - 5.5
1989	4.9	Feb	6.7	Jan	5 - 6
1990	6	Mar, Apr, Dec	7	Oct, Nov	6 - 7
1991	6	May, Nov, Dec	6.6	May, Aug	6 - 6.5
1992	5.3	Oct	6.5	Aug	5.5 - 6.5
1993	5.1	Apr	7.4	Sep	5.5 - 7

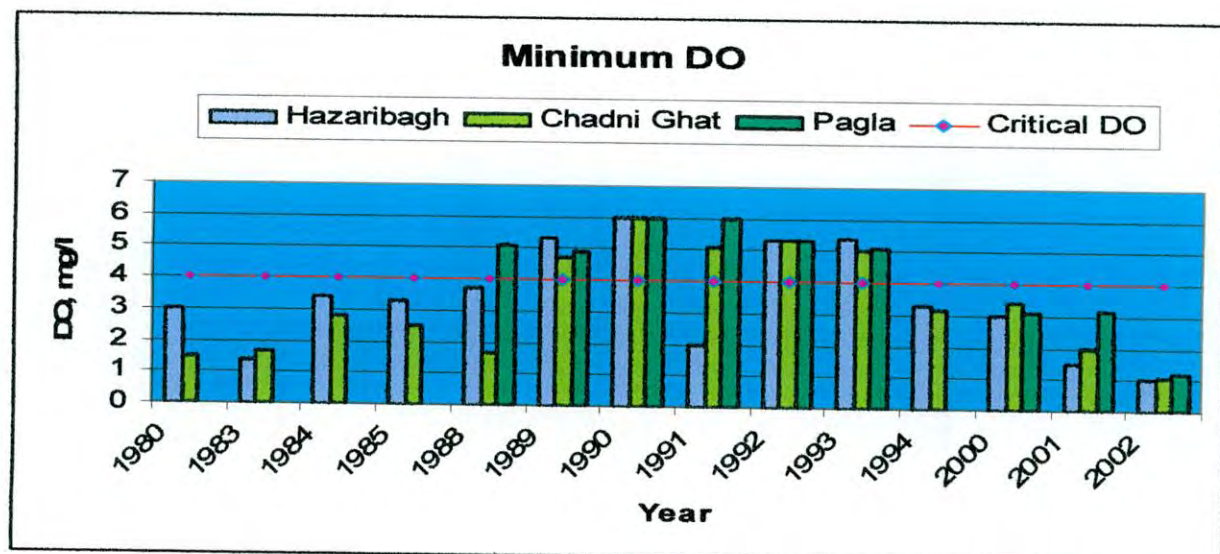


Figure 4.5: Yearly Variation of Minimum DO in the Buriganga.

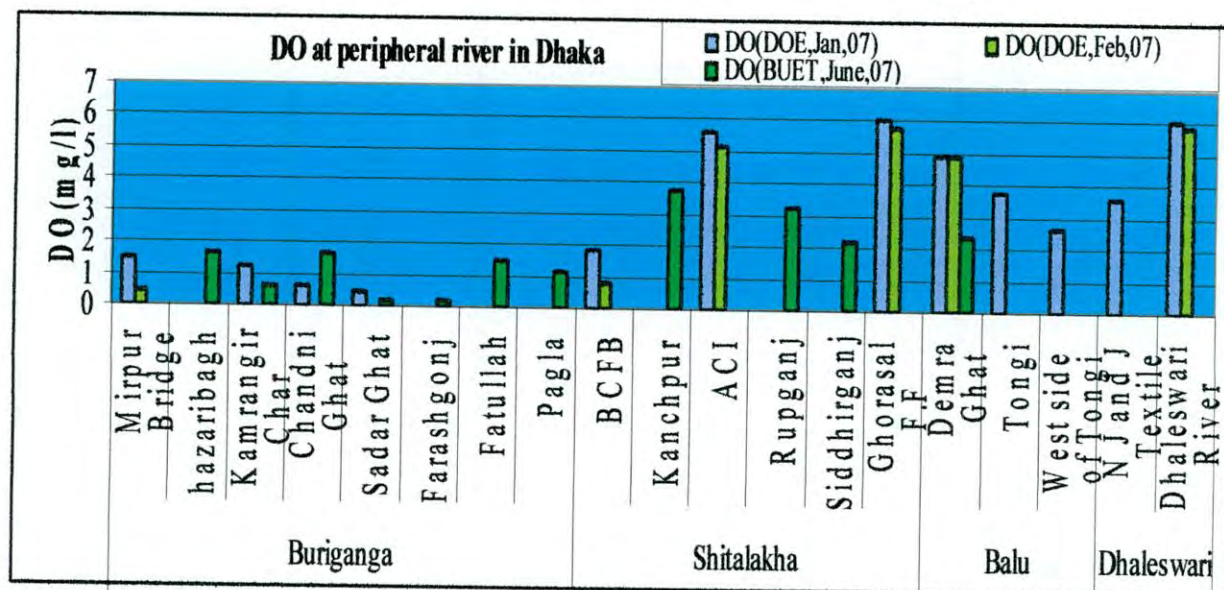


Figure 4.6: Present scenario of DO at peripheral river system of Dhaka city.

Minimum dissolved oxygen contents recorded in different places of the Buriganga River during last two campaigns (January and February, DOE, 2007) are as follows:

Places	Minimum DO
Mirpur Bridge	0.4
Hazaribagh	0
Kamragir char	0
Chandnighat	0
Dholai khal	0
Pagla	0
BCFB	0.8

4.2.2 Biochemical Oxygen Demand (BOD)

Present Scenario

The high BOD generally occurs at Hazaribagh in the Buriganga River during January, February, and June. BOD varies from 28 mg/l to 60 mg/l at Hazaribagh during January to June. The low BOD generally occurs at Bangladesh China Friendship Bridge in Buriganga and BOD varies from 10.2 mg/l to 12.8 mg/l during January and February. BOD measured during Jan'07 is relatively low due to dilution may be resulting from early premonsoon rainfall. It is observed that BOD at Hazaribagh is higher than that measured in Kamrangir char, Chandnighat, Sadarghat, Dholai khal, and Pagla. It is resulted due to tannery waste, which is drain out at Hazaribagh in the Buriganga River.

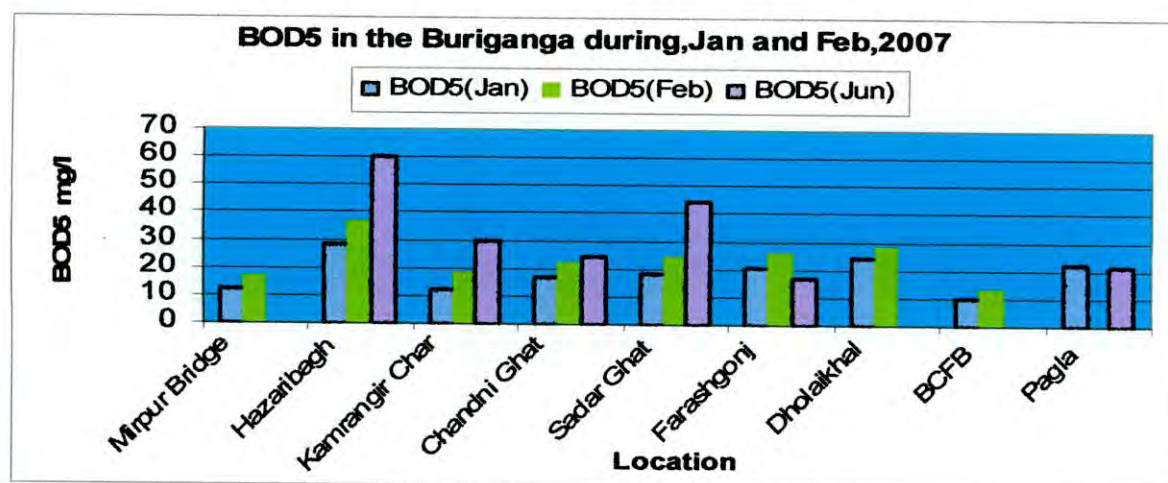


Figure 4.7: BOD5 in the Buriganga during Jan'07 and Feb'07

Maximum BOD contents recorded in different places of the Buriganga River during last three campaigns (January and February, DOE, 2007 and Jun, BUET, 2007) are as follows:

Location	Biochemical Oxygen Demand (BOD ₅ at 20°C), mg/l
Mirpur Bridge	16.8
Hazaribagh	60
Kamragir char	30
Chandnighat	24
Sadar Ghat	44
Dholai khal	28.4
Pagla	22
BCFB	12.8

Table 4.7: Analysis of historical data on BOD₅ (at 20°C) at Hazaribagh

Year	BOD ₅ concentration (mg/L)		BOD ₅ concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. value	Occur in	
1980	1.7	Jan, Jun	7.4	Jan	1.7 - 4
1983	0.45	Aug	24.5	Oct	2 - 6
1984	0.4	Sep	6.6	Feb	4 - 6.5
1985	1.1	Jan	3.4	Apr	1.1 - 3
1988	0.3	Jun	3.6	Jun	1 - 2.5
1989	1.2	Feb	2.5	Nov	1.5 - 2.5
1990	1.1	Oct	2.8	Jul	1.7 - 2.3
1991	1.5	Jan	210	May	1.5 - 2.5
1992	2.7	Apr, Jun, Jul	4	Oct	2.7 - 3.4
1993	0.4	Jan	3.3	Apr	2 - 3
1994	2.5	Jul	3.8	Aug, Oct	2.5 - 3.5

Table 4.8: Analysis of historical data on BOD₅ (at 20°C) at Chandighathat

Year	BOD ₅ concentration (mg/L)		BOD ₅ concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. value	Occur in	
1980	1.1	Feb, Apr	4.9	Sep	1.5 - 4
1983	0.75	Aug	31	Jul	5 - 30
1984	0.09	Feb	5.75	Dec	1 - 5
1985	1.09	Feb	3.55	Jun	1.5 - 3
1988	1	May	50	May	1.5 - 4
1989	0.2	Feb	3.5	Nov	1 - 2
1990	1.7	Sep, Nov	2.7	Apr	1.5 - 2.5
1991	2.5	Jul	3.3	Mar	2.5 - 3
1992	1.9	Aug	3.5	Oct, Nov	2 - 3
1993	1.8	Oct	3.7	Apr	2 - 3.5
1994	1.1	Jun	4.2	Oct	2 - 3.5

Table 4.9: Analysis of historical data on BOD₅ (at 20°C) at Pagla

Year	BOD ₅ concentration (mg/L)		BOD ₅ concentration (mg/L)		Data range mostly vary between
	Min. value	Occur in	Max. Value	Occur in	
1988	1.9	Nov	4.1	Dec	2 - 2.5
1989	1.1	Feb	3.2	Jan	2 - 3
1990	1	Feb	2.8	Mar	1.5 - 2.5
1991	2	Aug, Nov	3.5	Dec	2 - 3
1992	2	Sep	4.4	Nov	2 - 4
1993	2.8	Sep	3.9	Aug	3.3 - 3.9

Historical Trend of BOD Concentration

Maximum allowable BOD for drinking, fishing, recreational and agriculture standards are 3, 6, 3, and 10 mg/l, respectively. Historical observation of BOD since 1968 to 2007 has been plotted in Figure 4.8. High BOD observed in 2007 which was 60 mg/l. The observation at Hazaribagh, Chandnighat, and Pagla on the Buriganga River has been plotted in Figure 4.9, Figure 4.10, and Figure 4.11 respectively. A gradual increase of BOD is seen in the Buriganga River. High BOD observed in 1998, 2004 and 2007.

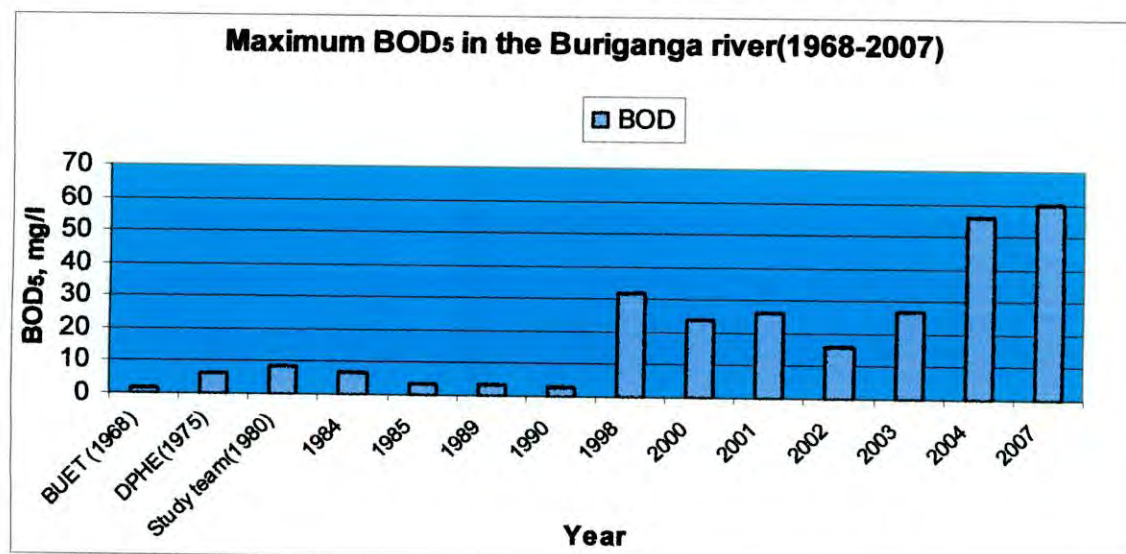


Figure 4.8: Biochemical Oxygen Demand (BOD₅ at 20°C) in the Buriganga during 1968 to 2007 (Data Source: Maniruzzaman, IWM, Magumdar, DOE, BWDB and BUET)

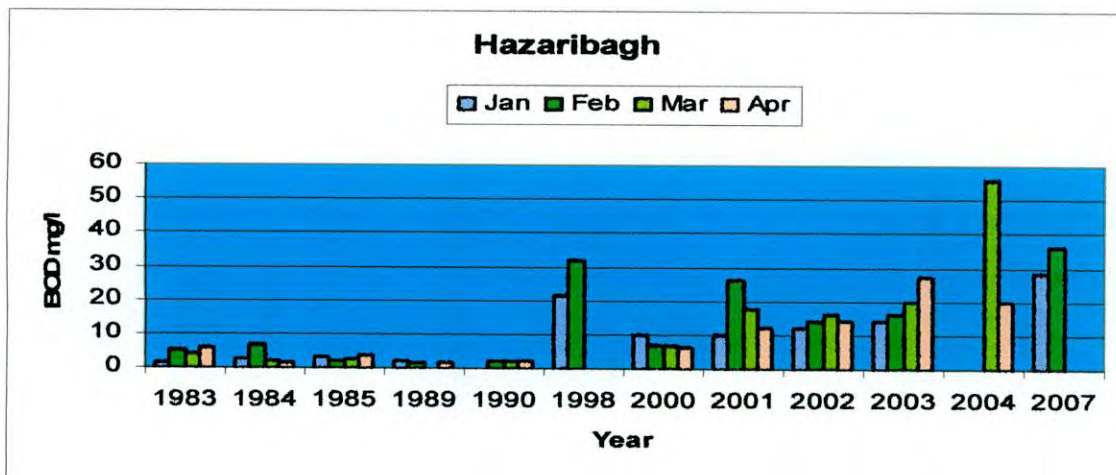


Figure 4.9: Biochemical Oxygen Demand (BOD₅ at 20°C) at Hazaribagh

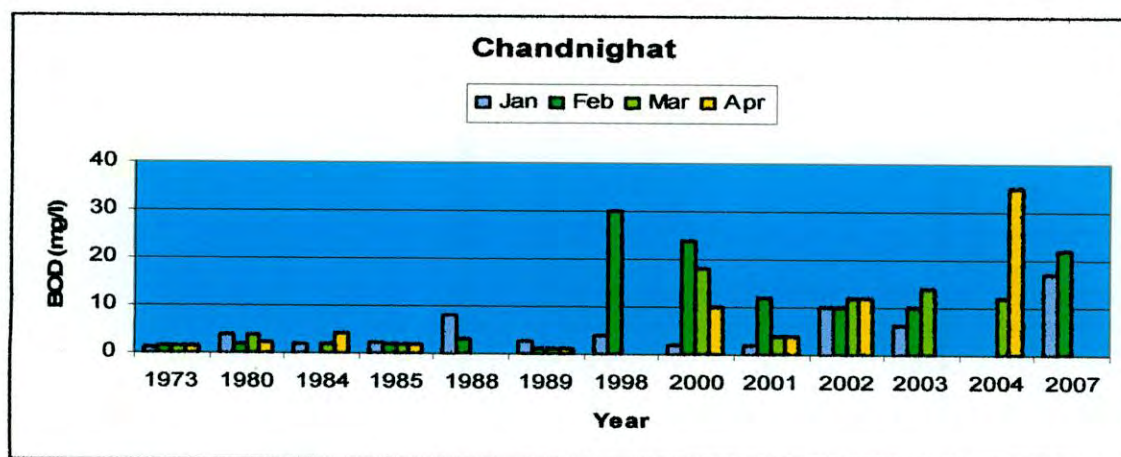


Figure 4.10: Biochemical Oxygen Demand (BOD₅ at 20°C) at Chandnihat

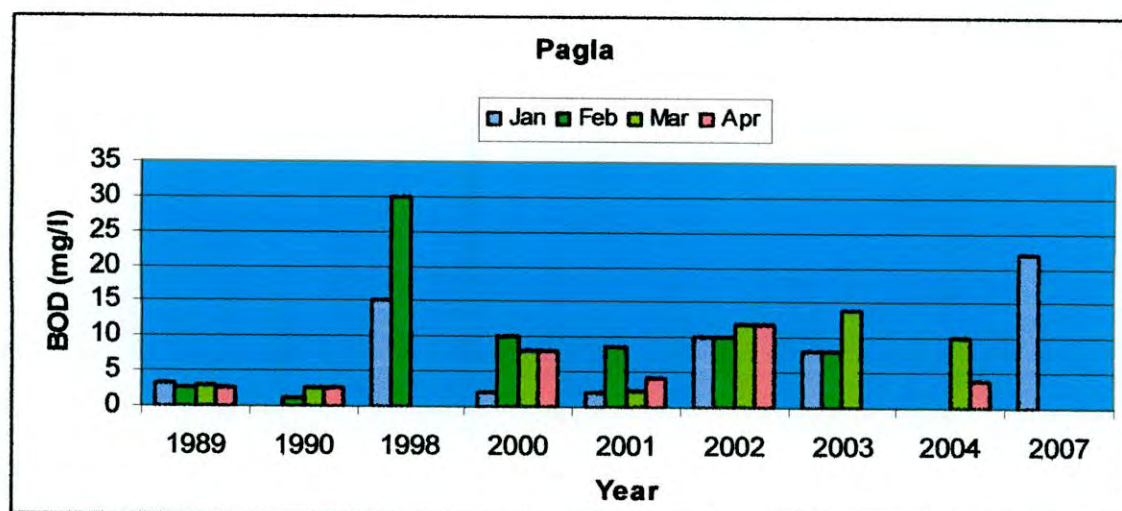


Figure 4.11: Biochemical Oxygen Demand (BOD₅ at 20°C) at Pagla

4.2.3 Chemical Oxygen Demand (COD):

Present Scenario:

In Figure 4.13 is shown, high COD occurs at Hazaribagh in the Buriganga River. In Buriganga River remains COD varying from 40 mg/l to 145 mg/l during June, 2007. Hazaribagh having COD around of 145 mg/l. COD is drastically reduced in Kamrangir Char. Profile of COD, occurred at different locations on the Buriganga River during June, 2007 has been shown in Figure 4.13.

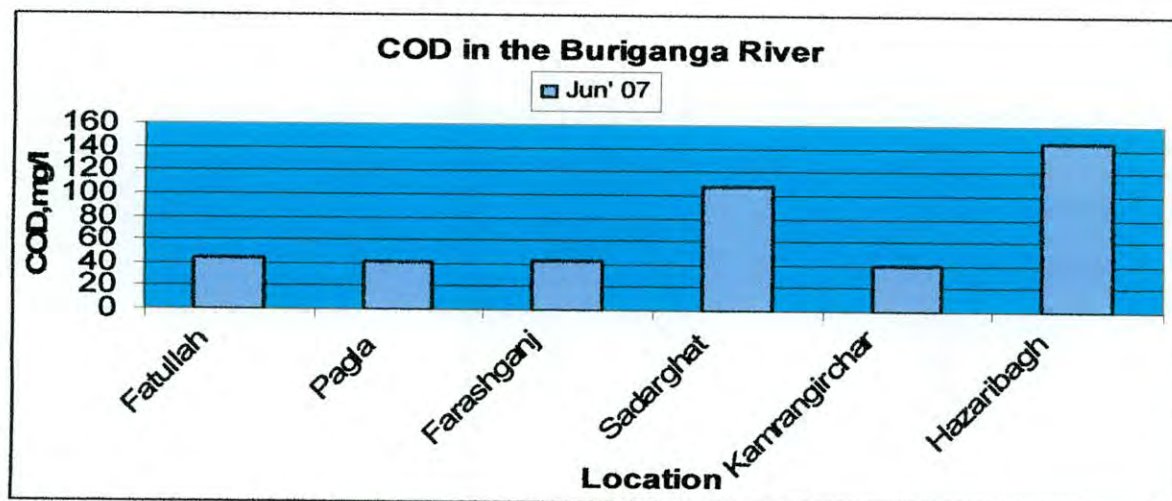


Figure 4.12: COD in the Buriganga River during Jun'07.

Historical Trend of COD Concentration:

High COD nearly 200 mg/l was observed during 1988 at Hazaribagh and the common value ranges from 40 mg/l to 145 mg/l in Figure 4.13. A gradual increase of COD is seen in the Buriganga River. High COD observed in 1988 and 2007. From historical records it is observed that COD content remains high normally in February and March in each year.

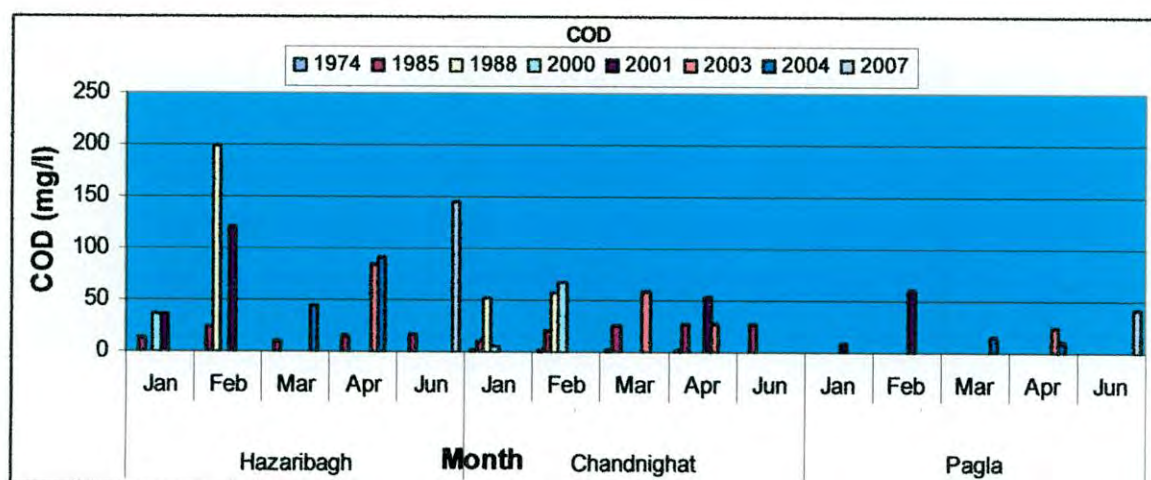


Figure 4.13: Chemical Oxygen Demand on the Buriganga River

4.2.4 Nitrogen

Nitrogen content at three states i.e. $\text{NH}_3\text{-N}$, $\text{NH}_4^+\text{-N}$ and $\text{NO}_3\text{-N}$ have been evaluated in the river Buriganga. High ammonia-nitrogen concentration (around 10 mg/l) is observed at Kamrangirchar and Keraniganj on the Buriganga River. Maximum $\text{NH}_3\text{-N}$ concentration in the river system is more than the allowable limit USEPA guideline (0.02 mg/l) to avoid toxic effect for fishes. Profile of maximum ammonia-nitrogen content has been shown in following figure 4.15.

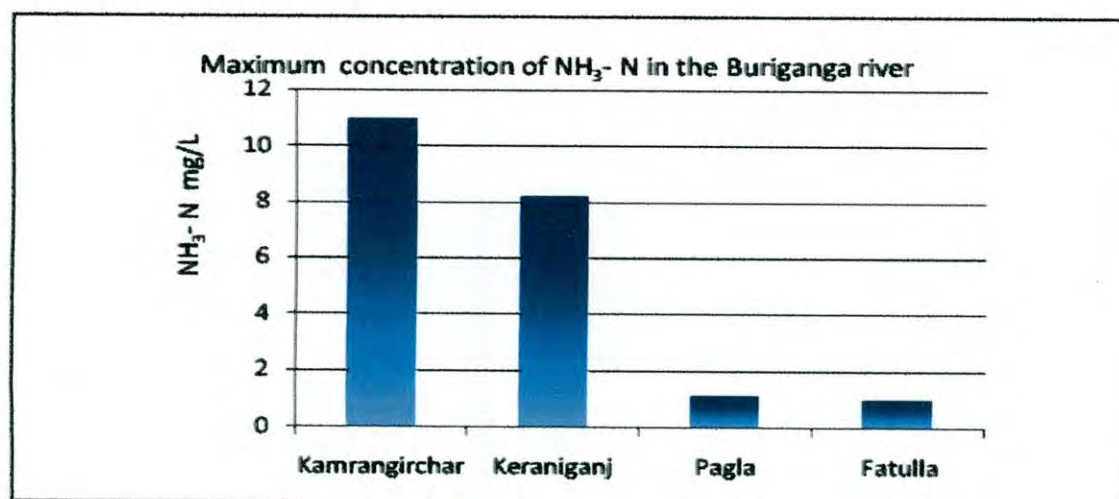


Fig 4.14: Profile of maximum ammonia-nitrogen ($\text{NH}_3\text{-N}$) concentration in the Buriganga river system (Observation Apr-03, Dec-03, Mar-04 and Apr-04) (Data Source: IWM, 2005)

Total nitrogen content ($\text{NH}_3\text{-N} + \text{NH}_4^+\text{-N} + \text{NO}_3^-\text{-N}$) remains more than 5 mg/l in the entire reaches. Profile of total nitrogen content in the Buriganga River has been shown in following figure 4.16.

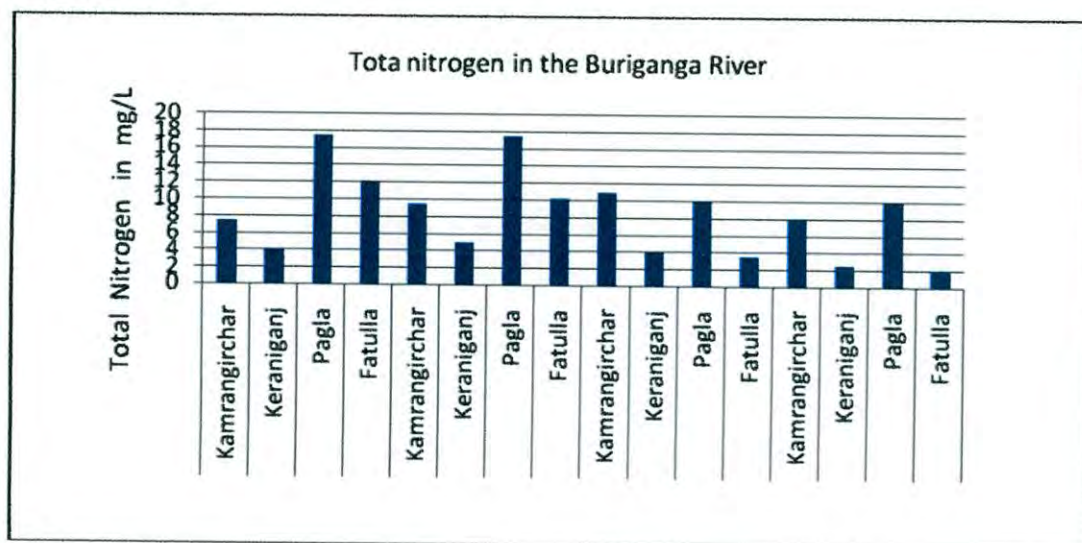


Fig 4.15: Profile of total nitrogen ($\text{NH}_3\text{-N} + \text{NH}_4^+\text{-N} + \text{NO}_3^-\text{-N}$) content in the Buriganga river (Observations: Apr-03, Dec-03, Mar-04 and Apr-04) (Data Source: IWM, 2005)

4.2.5 Phosphate

Phosphate has been measured in river system during June-07 data campaign. Concentration less than 3.0 mg/l is observed in the Buriganga River. This value is less than drinking standard followed by Bangladesh guideline i.e. 6.0 mg/l.

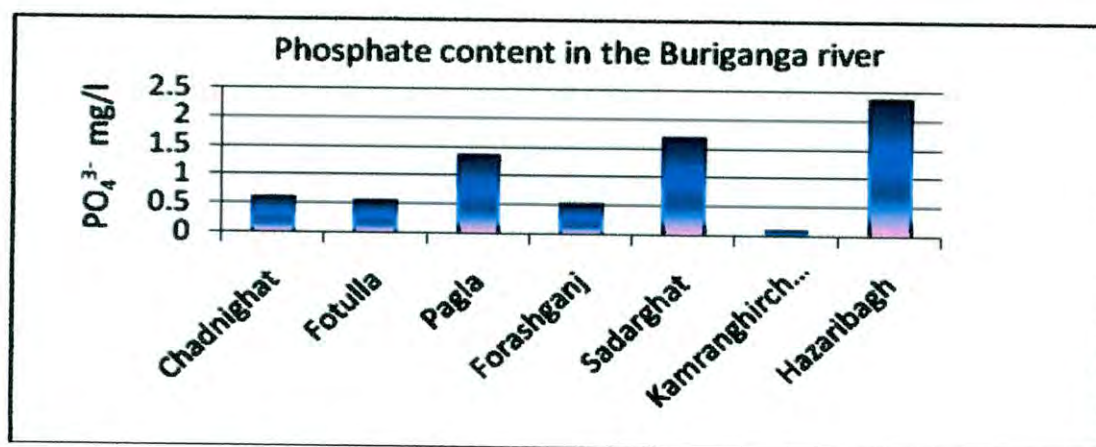


Fig 4.16: Profile of phosphate (PO_4^{3-}) concentration in the Buriganga river system (Data Source: Subrata, Jun-2007)

4.2.6 Heavy metal (Chromium, Lead, Cadmium)

Chromium (Cr)

Chromium concentration is quite low than the allowable limit of Bangladesh guideline value (0.05 mg/l) except Hazaribagh, where the concentration rises above 0.25 mg/l due to discharge of effluent from tanneries. The maximum concentration has been shown in following figure.

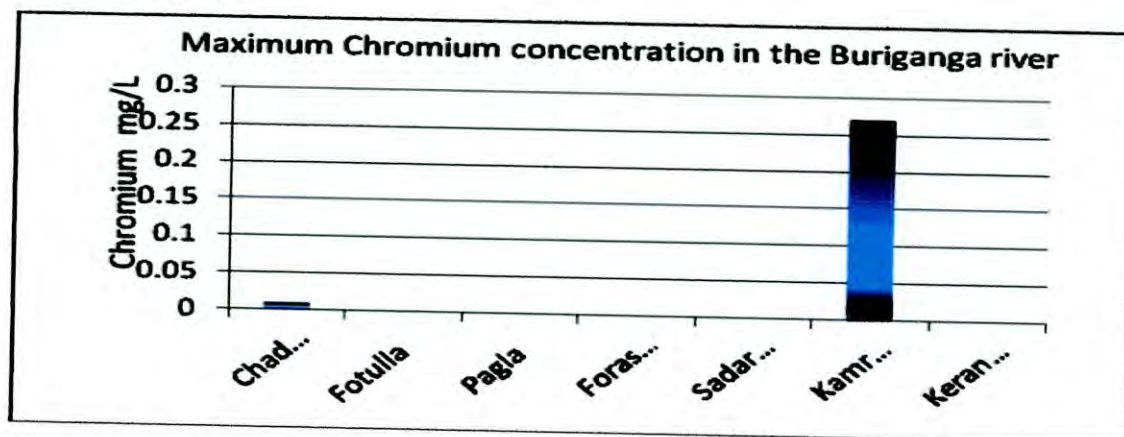


Fig 4.17: Profile of maximum chromium content in the Buriganga river (Observations: Apr-03, Dec-03, Mar-04 and Apr- 04) (Data Source: IWM, 2005, Author, 2007)

Lead (Pb)

Lead concentrations in the Buriganga river have been measured in five campaigns (Apr-03, Dec-03, Mar-04, Apr- 04 and Jun-07). Lead concentration is quite high compared to the other four campaigns. Possibly, it may be associated with errors in testing. Maximum lead concentrations of the four campaigns have shown in following figure, which reveal that lead content remains almost below the allowable limit of WHO guideline value (0.01 mg/l) in the river system.

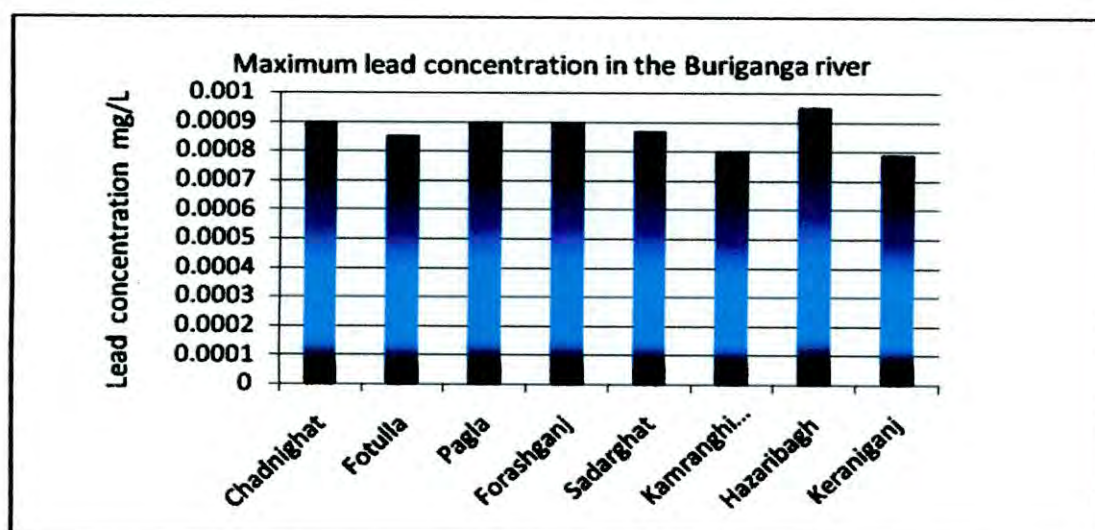


Fig 4.18: Profile of maximum lead content in the Buriganga river system (Observations: Apr-03, Dec-03, Mar-04, Apr- 04 and Jun-07) (Data Source: IWM, 2005, Author, 2007)

4.3 Data Analysis for Pollution Loadings

The trend of the rapid fall in water quality of the Buriganga river is mainly due to the reason of indiscriminate discharge of industrial effluents and domestic waste without treatment. So the analysis on waste water quality and pollution loads associated with the waste water occupies an important part in river pollution studies.

The expression used in computation of pollution load in wet method is as following:

$$\begin{aligned}
 \text{Pollution load} &= \text{Concentration (mg/l)} \times \text{Flow (m}^3/\text{s)} \times \text{Flow time} \\
 &= \text{Concentration (mg/l)} \times Q \text{ (m}^3/\text{s)} \times 12.0 \text{ h} \\
 &= \text{Conc. (gm/ m}^3\text{)} / (1000 \text{ gm/Kg)} \times Q \text{ (m}^3/\text{s)} \times (3600 \text{ s/h)} \times 12.0 \text{ h}
 \end{aligned}$$

Pagla Sewage treatment Plant Authority routinely measures BOD and also records average volume of daily Discharge. BOD load has been computed from the measured data of PSTP authority and shown in **Table 4.10**

Table: 4.10: BOD load discharged into the Buriganga River from PSTP

Date	BOD5 (mg/l)	Flow rate(m ³ /d)		Average Flow(m ³ /d)	BOD5 Load (kg/d)
		Max.	Min.		
Mar'98	240	46440	38700	42570	10216.80
Apr'98	240	52200	39960	46080	11059.20
May'98	60	56520	41328	48924	2935.44
June'98	20	49680	40860	45270	905.40
Apr'03	150	31000	15000	23000	3450.00
Dec'03	170	29952	15000	22476	3820.92
Feb'04	240	27360	16338	21849	5243.76
Mar'04	200	29016	14028	21522	4304.40
Apr'04	200	39780	19278	29529	5905.80

Pollution loads in the other waste water outlets located around Dhaka city have been computed from measure data of IWM and shown in **Table 4.11**

Table 4.11: Pollution load discharged through waste water generated within in Dhaka (point sources) (Estimation based on a single measurement in a day)

Station	Date of Collection	Load (kg/day)						
		BOD5	COD	NH ₃ -N	NH ₄ -N	PO ₄	Cr	Pb
S8	27 Apr-03	544	2994	8.9	725	NA	0.82	2.55
S8	31 Dec-03	1913	3732	5.8	815	NA	2.64	NA
S8	15 Mar-04	25855	43074	45.0	1298	NA	479.91	0.18
S8	27 Apr-04	778	2657	3.7	272	20.09	0.62	NA
S9	27 Apr-03	5616	18101	1.7	646	NA	1.64	6.31
S9	31 Dec-03	3672	8208	6.0	924	NA	1.62	NA
S9	16 Mar-04	16200	27009	1.4	413	NA	2.20	2.90
S9	27 Apr-04	2074	8087	2.2	378	130.34	0.19	NA
S10	27 Apr-03	5400	23112	2.2	829	NA	1.47	6.31
S10	31 Dec-03	13893	23879	6.9	1527	NA	2.37	NA
S10	16 Mar-04	4277	7023	0.5	171	NA	0.31	0.26
S10	27 Apr-04	7258	29290	4.4	1330	396.58	0.58	NA
S11	31 Dec-03	2350	4804	5.9	1324	NA	1.97	NA
S11	16 Mar-04	197	812	1.0	191	NA	0.02	0.05
Dholai khal	27 Apr-04	14010	91800	21.6	6890	NA	4.75	30.6
Dholai khal	31 Dec-03	72576	127008	32.8	7361	NA	69.12	NA
Dholai khal	16 Mar-04	18960	77112	19.7	5613	NA	0.73	NA
Dholai khal	23 Apr-04	60604	112669	6.9	1885	152.70	2.76	NA

Table 4.12: Pollution Load contributed into the Buriganga through different point sources i.e. waste water drains

River	Point source	Time	Load (kg/day)						
			BOD5	COD	NH3-N	NH4-N	PO4	Cr	Pb
Buriganga (Point Source)	S8,S9,S1,S11 Dholai Khal	Feb'98	41100	NA	4500	NA	1430	8.3	12.75
		Apr'03	26097	136891	35	9285	NA	8.7	45.88
		Dec'03	94404	167631	57	12002	NA	77.73	*
		Mar'04	65729	155030	67.5	7689	NA	483.17	3.39
		Apr'04	76270	153511	18	4060	905	4.19	*
Buriganga, Non point source (WSP,1999)	City drains	WSP,98	8000	NA	840	NA	250	5.0	3.5

Total pollution loads discharged into the Buriganga River around Dhaka city through both point and non point sources have been summarized in **Table 4.13**.

Table 4.13: Pollution loads added into the Buriganga through both point and non-point sources

River	Observation Period	Discharged pollution loads (kg/d)				
		BOD5	NH3-N	PO4	Cr	Pb
Buriganga	Apr-95	45388	NA	NA	NA	NA
	Feb-98	58000	5762	2333	17	18
	Apr-03	37547	1038	NA	15	50
	Dec-03	106225	1078	NA	84	*
	Mar-04	78033	1111	NA	490	8
	Apr-04	90176	1137	1582	12	*

Pollution loadings of industrial origin from different clusters have been shown in Appendix-A. The fraction of domestic loading (in terms of BOD) in the combined waste load from the industrial clusters were also estimated by the following formula-

$$\text{Total domestic load} = \frac{\text{Per capita waste production} \times \text{Number of inhabitants} \times \text{Percentage of population unsewered}}{100}$$

Table 4.14 shows the BOD loads being contributed by industries and domestic sources for the nine industrial clusters.

Table 4.14 BOD loadings from industrial clusters (kg/day) (Source: DPM, 2006, Akter K.S, 2007)

Cluster No	Cluster name	Total load	Industrial load	Domestic load	Domestic load retained in situ
1	Tongi	12621	6954	5667	3362
2	Hazaribagh	106834	99550	7284	13055
3	Tejgoan	104916	87550	17411	11691
4	Tarabo	53751	53751	0	17854
5	Narayanganj	81209	58047	23162	20085
6	Savar	3340	2997	343	6534
7	Gazipur	37844	37844	0	1043
8	DEPZ	62099	62099	0	16839
9	Ghorashal	10843	1084	0	10428

Percent increase of BOD loading has been calculated by the following formula-

$$\% \text{ increase in BOD load} = 100 \times (\text{Percent higher BOD} - \text{Previous lower BOD}) / \text{Present higher BOD}$$

Table 4.15: Comparison of BOD loadings originated by industrial discharges

Cluster No	Cluster Name	Total BOD loadings (kg/day)		% increase in BOD loading
		BKH, 1994	DPM, 2006	
1	Tongi	4400	6954	37
2	Hazaribagh	17600	99550	82
3	Tejgaon	2435	87550	97
4	Tarabo	1475	53751	97

4.4. Result from Analysis on Pollutant loadings

It is observed from the table 4.15 that BOD loading from industrial origin has increased at all industrial clusters from 1994 to 2006. The increase of BOD load is 37% in Tongi, 82 % in Hazaribagh, 97 % in both Tejgaon and Tarabo and 87% in Narayanganj. The increase of domestic pollutant loads can be attributed to the rapid increase of population and subsequent increase of people without proper sanitation facilities.

Low flow of water, lack of rainfall and increase in temperature during dry season also contribute to the pollution status of the river. In the wet season there is a scope of dilution of pollutant loads by high water flow enhanced by rainfall.

4.5 Approaches to Restore Water Quality of the Buriganga River from Different Types and Sources of Pollution

The Buriganga River receives a large quantity of waste (both solid waste and wastewater), surface runoff, untreated industrial effluents and treated sewage effluents directly or indirectly from the city. These wastes contaminate the river water affecting its aquatic life. Analysis of long term data from some of the major rivers in Bangladesh shows that Buriganga is more polluted than any other river in the country. Most importantly, the quality of the Buriganga river water has been deteriorating. Water quality parameters, such as pH, dissolve oxygen, biological oxygen demand and chloride; hardly satisfy the standards set out by the Department of Environment. In addition to the pollution problems, Buriganga is also under threat of becoming a 'dead' river in the future. Influential people are grabbing the riverbanks resulting in narrowing of the channel. The Buriganga is extremely important for the city of Dhaka. It provides drainage for its internal waters; it is a source of drinking water, a place of recreation and a number of other human activities. Different types of approaches needed to restore and rehabilitate the river water quality.

Lots of factors are involved in pollution of river water and physical meandering of the river which causes the ultimate pollution in the environment in large context. Human activities those may be essential for their survival create a severe pollution on a river as well as the environment. These include building of dams or embankment, use of fertilizer and insecticide, excavation of riverbed, deforestation in up stream, land slides. Besides they are disposal of waste water from the town or city sewer, industrial effluent, disposal of human waste and burned oil by vessels and so on. However, when we talk about pollution in the river Buriganga, some additional parameters emerge. One of the major parameter is the encroachment of the river banks by the land grabbers which makes the river narrower, intensifies water pollution and break down whole eco-system of its surrounding area. Besides, huge volume of industrial (including tannery) wastewater is being disposed without any noticeable treatment.

4.5.1 Preventing pollution from physical pollution

Physical pollution of river includes sedimentation in the river channel and encroachment of its banks, which cause river meandering, shrinking of river, river erosion etc.

Encroachments by the land grabbers cause a serious threat in life of river Buriganga. Influential quarters have gone on encroaching and grabbing the river banks on both sides to set up industries there by causing the water more polluted. Thousand of new factories, markets and other establishments have come up along the river and all their wastes are dumped into its water.

All illegal houses along the riverside should be removed, demolition of illegal structures in the Buriganga River following the rules and regulation, which were established by the “Bangladesh environment conservation law”. Effective urban planning and land use regulation is required to maintain the river. Regular maintenance dredging of the



Figure 4.19: Encroach mental pollution of the Buriganga River

riverbed. Though the adjacent area of the Buriganga is foreshore/ shore, assurance should be given from the ministry of land that the land would not be encroached further. When dredging is activated properly the slope of the bank will be steeper and the depth will increase which will discourage encroaching. Dhaka bypass road can be implemented along the both side of the river and trees can be planted between the bypass and the river. Thus we can increase the total environment of old Dhaka and thereby increasing the transportation facilities of the city as well as reducing the opportunities for further encroachment. Through massive advertisement public awareness can be arise to demolish encroachment. With the demolish works local people should be involved to ease and smooth performance of the demolish work.

4.5.2 Preventing pollution from untreated sewage

Another parameter measuring the pollution range in the water and consequently the river pollution is the chemical compound present in the water. With the rise of population in the city and for commercial purposes floating vessels in the river has been increased. Effluents from the factories and house are being discharged in the Buriganga without any remedy. Not only from the tanneries, have waste matter from thousands of latrines on both sides of the river been connected to the flow.



Figure 4.20: Untreated sewage disposal in the Buriganga River

During the field visits, it was observed that many sewer lines in the city ended up in the river.

Proper laws should be enforced from the Department Of Environment to reduce the pollution of river water from adjacent pollution. Uproot every kind of pollution making industry including tannery. Proper treatment of sewage needed before sewage disposal in the Buriganga River. Proper dredging of the riverbed. Fumes of all vehicles must be strongly controlled. Use of radioactive material must be controlled. Impact of hazardous or polluted chemicals must be banned for certain purposes under an act. New and old industries must be regulated under pollution control law.

4.5.3 Preventing pollution from solid waste and biological pollution

Solid wastes are basically dumped in the low-lying areas in and around Dhaka City and many are close to the river (e.g. Lalbagh, Mohammadpur, Aminbazar and Rayerbazar.

Part of this waste ultimately finds its way into the rivers through rainwater runoff. The city is currently suffering from the effects of highly toxic clinical wastes from a number of pathology centers, hospitals and clinics. Indiscriminate disposal of solid wastes including organic wastes from different kaucha bazaars, factories and shops aggravates the situation.



Figure 4.21: Solid waste dump into the Buriganga River

In river management a short-term solution such as the application of aquatic herbicides to quietly kill unwanted algae. Such chemical applications can go on year after year. This short term approach needs dredging for every year for Buriganga. Immediate in river rehabilitation techniques are necessary for Buriganga. Such immediate rehabilitation efforts are followed by appropriate long term management techniques. Such as Buriganga river augmentation, Sewage & industrial waste management. Should be improved of solid waste collection and disposal through government-private sector partnership. Proper waste treatment plant should be established for the industries to mitigate the water pollution in the Buriganga River.

4.5.4 Preventing pollution from industrial pollution of Hazaribagh tannery

In tanning process generate large quantities of liquid and solid wastes, most of which directly or indirectly find their way to the Buriganga River. According to the DOE estimate, more than 16,000 cubic meters of highly toxic waste from the Hazaribagh tanneries flow first to low-lying areas and then to the Buriganga River every day. The

sludge containing high levels of chromium is also being deposited on the riverbed and is polluting the water. During the field visit, the effluents containing chemicals from the tanneries were found to be gushing out of the pipes and creating white foam in the river water.



Figure 4.22: Tannery waste discharge into the Buriganga River

Should be established a treatment plant at Hazaribag to reduce current load. Establish a treatment plant at Hazaribag or shifting of tannery units will provide considerable opportunity to properly manage the Buriganga river water quality. A treatment plant at Hazaribag is necessary not only to manage the BOD load but also to treat the chromium contents of the discharges from Hazaribag tanneries.

4.5.5 Divert sewage toward Pagla sewage treatment plant

The Pagla sewage treatment plant can process around 30 percent of its collected sewage. The remainder is being drained to the river without any treatment. Current discharge through Dholai Khal and through city drains need to be totally discontinued. This is a helpful indication in the sense such discharge can be easily diverted to Pagla through existing sewerage network. Capacity at Pagla Sewage Treatment Plant need to be expanded and reroute the discharge from Dholai khal and city drains to Pagla Sewage Treatment Plant.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The Buriganga river receives solid wastes, sewage and wastewater, containing biodegradable materials and industrial effluent, are being disposed indiscriminately in the Buriganga river. These pollutants constantly deplete the most important parameter, Dissolved Oxygen (DO). Summary of findings are given below.

The water quality of the Buriganga river is deteriorating over the years. The increase of domestic and industrial pollutant loads can be attributed to the rapid increase of population, industries and subsequent increase of people without proper sanitation facilities. Low flow of water, lack of rainfall and increase in temperature during dry season also contribute to the pollution status of the Buriganga river. In the wet season there is a scope of dilution of pollutant loads by high water flow enhanced by rainfall.

Dissolved Oxygen (DO) for sustaining aquatic lives (4-5 mg/l) does not prevail in any of the selected locations along this river. Dissolved Oxygen (DO) reaches to zero in some locations especially at Hazaribagh, Chandnighat and Pagla during dry season. It is observed that generally Dissolved Oxygen (DO) concentration remains low in January, February, March, and April that means dry season. Recent scenario at Hazaribagh is worse than the scenario of Chandnighat and Pagla.

Maximum Biochemical Oxygen Demand (BOD₅) generally occurs at Hazaribagh in the Buriganga river during January, February, and June in 2007. BOD₅ varies from 28 mg/l to 60 mg/l at Hazaribagh during January to June. Maximum BOD₅ observed in the year of 2007 was 60 mg/l which is about 21 times greater than the BOD₅ of the year 1990. Chemical Oxygen Demand (COD) of the Buriganga river is also quite high.

It is essential to make provisions for protection and improving water quality of the Buriganga river to sustain the ecosystem in this river and overall environment of the Dhaka city. Current pollution will be minimized if necessary approaches are properly implemented. Hazaribagh tanneries are responsible for causing pollution in the Buriganga river by the contribution of toxic and persistent pollutants, for that an Effluent Treatment Plant (ETP) should be established without delay. Uproot every kind of pollution making industry including tannery from both sides of the Buriganga river. Pagla sewage Treatment Plant will need to be expanded to handle extra pollution load.

5.2 Recommendations

In order to arrange proper and systematic approaches to restore water quality of the Buriganga River, the following recommendations should be considered:

- Though the adjacent area of the Buriganga is foreshore/ shore, assurance should be given from the ministry of land that the land would not be encroached further.
- Dhaka bypass road can be implemented along the both side of the river and trees can be planted between the bypass and the river. Thus we can increase the total environment of old Dhaka and thereby increasing the transportation facilities of the city as well as reducing the opportunities for further encroachment.
- Proper dredging of the riverbed. When dredging is activated properly the slope of the bank will be steeper and the depth will increase which will discourage encroaching.
- Tannery industries should be shifted from the surrounding of the Buriganga River.

- Proper laws should be enforced from the Department Of Environment to reduce the pollution of river water from adjacent pollution.
- Uproot every kind of pollution making industry including tannery.
- Proper treatment of sewage needed before sewage disposal in the Buriganga River for that every pollution making industry should have effluent treatment plant (ETP).
- New and old industries must be regulated under pollution control law.
- Establish a treatment plant at Hazaribag or shifting of tannery units to provide considerable opportunity to properly manage the Burigganga river water quality.
- Pagla Sewage Treatment Plant need to be expanded and reroute the discharge from Dholai khal and city drains to Pagla Sewage Treatment Plant.

5.3 Recommendations for Future Study

Since so far no study has been carried out regarding approaches of restore the river water quality, this study was undertaken to bring out the restoration issues and provide future directions.

- While performing this study, lack of adequate data was a major problem. To represent the pollution trend over a long period of time, sufficient water quality data at specified locations are necessary. Further study may be undertaken to upgrade the existing data.
- Only for some selected stations on the Buriganga, this study has been conducted. To get overall pollution scenario of the whole river reaches, study on more stations as far as possible are recommended.
- Pollution load should be estimated properly considering both the point sources and the non-point sources.
- A more appropriate or specific approaches should use which improve the Buriganga River water quality.

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APPENDIX-A
Water Quality Data

Table A.1 : Measured Dissolved Oxygen Data(Kamal,1996;WSP International 1998;IWM, 2005)

Location	Date	Time	Temp	DO	Location	Date	Time	Temp	DO	Location	Date	Time	Temp	DO
Kamrangir	26 Dec,94	8:20	20.6	2.7	Kamrangir	18 Feb,98	14:12	22.8	0.6	Karanigan	18 Dec,	8:33	21.4	0.9
Char,	26 Dec,94	9:40	20.7	2.9	Char,	18 Feb,98	15:26	22.7	7	Buriganga	18 Dec,	9:45	21.4	0.8
Buriganga	26 Dec,94	10:50	20.8	2.7	Buriganga	26 Apr,03	9:30	29.9	0.2		18 Dec,	10:57	21.7	0.5
	26 Dec,94	11:45	20.8	2.9		16 Mar,04	10:00	26.1	0.12		18 Dec,	12:17	21.8	0.3
	26 Dec,94	12:45	21.3	3		16 Mar,04	11:00	26.8	0.07		18 Dec,	13:27	21.9	0.4
	26 Dec,94	13:45	21.3	3.1		16 Mar,04	12:25	26.7	0.12		18 Dec,	14:55	21.8	0.4
	26 Dec,94	14:50	21.3	3.1		16 Mar,04	14:00	27.4	0.11		18 Dec,	16:10	21.8	1.1
	16 Feb,95	9:35	21.8	0.4		16 Mar,04	15:00	27.4	0.07		20 Jan, 98	9:15	18.8	0.3
	16 Feb,95	11:10	22	0.3		5 Apr, 04	10:08	28.6	0.13		20 Jan, 98	10:35	18.9	0.4
	16 Feb,95	12:20	21.8	0.8		5 Apr, 04	11:00	28.7	0.1		20 Jan, 98	11:52	18.9	0.3
	16 Feb,95	13:45	22	2		5 Apr, 04	11:50	29	0.2		20 Jan, 98	12:58	18.9	0.4
	16 Feb,95	14:55	22.4	2.8		5 Apr, 04	12:45	29.3	0.15		20 Jan, 98	14:18	18.9	0.2
	20 Apr,95	8:50	30.4	1.7		5 Apr, 04	15:00	29.6	0.12		20 Jan, 98	15:23	18.8	0.2
	20 Apr,95	10:10	30.6	2.5		5 Apr, 04	16:10	29.5	0.25		18 Feb,98	9:18	22.5	0.5
	20 Apr,95	11:10	30.8	3.9	Karaniganj	26 Dec,94	7:40	21.1	0.9		18 Feb,98	10:45	22.5	0.4
	20 Apr,95	12:20	30.6	3.8	Buriganga	26 Dec,94	8:45	21	1.1		18 Feb,98	12:17	22.6	0.3
	20 Apr,95	13:30	31.4	5.2		26 Dec,94	10:00	21.1	1.5		18 Feb,98	13:27	22.5	0.1
	20 Apr,95	14:50	30.7	5.3		26 Dec,94	11:10	21.1	1.7		18 Feb,98	14:38	22.6	0.2
	20 Apr,95	16:00	30.6	4.3		26 Dec,94	12:12	21.2	1.9		18 Feb,98	15:51	22.7	0.3
	18 Dec,97	9:20	21.3	0.3		26 Dec,94	13:05	21.3	1.3		18 Feb,98	16:27	22.7	0.6
	18 Dec,97	10:34	21.5	2.4		26 Dec,94	14:15	21.4	0.3		26Apr, 03	10:15	31.1	0.8
	18 Dec,97	11:52	21.6	2		16 Feb,95	8:30	22	0.8		16 Mar,04	10:30	25.9	0.07
	18 Dec,97	13:05	21.7	2.1		16 Feb,95	10:10	21.8	0.1		16 Mar,04	11:50	26.6	0.08
	18 Dec,97	14:32	21.9	2.2		16 Feb,95	11:35	21.8	0.2		16 Mar,04	12:45	26.7	0.09
	18 Dec,97	15:45	21.8	2.4		16 Feb,95	12:55	22.1	0.3		16 Mar,04	13:30	27	0.11
	20 Jan,98	10:05	19.3	0.8		16 Feb,95	14:10	22.2	0.5		16 Mar,04	14:25	27.1	0.08
	20 Jan,98	11:27	19.4	0.8		16 Feb,95	15:45	23.2	0.6		16 Mar,04	15:30	27.1	0.06
	20 Jan,98	12:32	19.5	0.7		20 Mar,95	7:45	29.9	0.6		5 Apr, 04	10:38	28.7	1.4
	20 Jan,98	13:45	19.5	0.7		20 Mar,95	9:15	30	1.3		5 Apr, 04	11:25	28.9	1.8
	20 Jan,98	14:58	19.5	1.1		20 Mar,95	10:35	30.2	2.7		5 Apr, 04	12:15	28.8	0.82
	20 Jan,98	10:10	22.8	0.8		20 Mar,95	11:40	30.3	2.6		5 Apr, 04	13:10	29.1	1.3
	20 Jan,98	11:25	22.8	0.6		20 Mar,95	12:50	30.5	3.3		5 Apr, 04	14:30	29.5	1.5
	20 Jan,98	12:59	22.8	0.8		20 Mar,95	14:00	30.3	2.2		5 Apr, 04	15:35	29.3	0.52
						20 Mar,95	16:25	30.2	2.2		5 Apr, 04	16:42	29.3	0.39

Table A.1 : Continued

Location	Date	Time	Temp	DO	Location	Date	Time	Temp	DO	Location	Date	Time	Temp	Do
Pagla	21 Dec,94	8:10	21.3	0.3	Pagla	20 Feb,98	10:55	23	1.6	Fatulla	22 Apr,95	14:50	30.3	4.5
Buriganqa	21 Dec,94	9:45	21.3	0.9	Buriganqa	20 Feb,98	12:53	23.1	1.9	Buriganqa	22 Apr,95	15:45	30.3	4.2
	21 Dec,94	10:50	21.3	1.4		20 Feb,98	14:06	23.3	2.1		19 Dec,97	9:04	21.6	0.4
	21 Dec,94	12:25	21.5	1.5		20 Feb,98	15:08	23.2	2.2		19 Dec,97	10:40	21.7	0.7
	21 Dec,94	13:30	21.7	1.7		20 Feb,98	16:13	23.3	2		19 Dec,97	11:45	21.8	1
	21 Dec,94	14:40	21.8	2.5		26 Apr,03	11:30	30.3	2		19 Dec,97	13:15	21.8	2
	21 Dec,94	15:50	21.6	0.8		17 Mar,04	11:00	26.2	1.65		19 Dec,97	14:33	22	2.3
	21 Dec,94	17:00	21.5	0.5		17 Mar,04	12:30	26.4	1.62		19 Dec,97	15:24	21.8	1.4
	19 Feb,94	8:30	22.1	2.4		17 Mar,04	13:35	26.1	1		19 Dec,97	15:48	21.8	1.2
	19 Feb,94	10:10	22.2	6.2		17 Mar,04	15:20	26.5	1.1		21 Jan,98	11:15	18.3	0.4
	19 Feb,94	11:13	22.3	9.4		6 Apr,04	10:40	28.4	5.1		21 Jan,98	12:25	18.3	0.2
	19 Feb,94	12:21	22.5	12.7		6 Apr,04	11:23	28.5	5		21 Jan,98	13:26	18.3	0.5
	19 Feb,94	13:29	22.4	11.8		6 Apr,04	12:03	28.6	5.2		21 Jan,98	14:34	18.4	0.4
	19 Feb,94	15:05	22.6	8.8		6 Apr,04	12:50	28.7	5.2		21 Jan,98	14:55	18.4	0.4
	22 Apr,95	8:10	29.8	1.7		6 Apr,04	13:30	28.7	5.8		20 Feb,98	9:25	22.7	0.7
	22 Apr,95	9:35	29.9	2.6		6 Apr,04	14:20	28.9	5.02		20 Feb,98	10:08	23.2	1.9
	22 Apr,95	11:15	30.1	3	Fatulla	21 Dec,94	8:40	21.3	1		20 Feb,98	12:13	23	1.2
	22 Apr,95	12:15	30.3	4.3	Buriganqa	21 Dec,94	10:05	21.4	2.7		20 Feb,98	13:25	23	1.3
	22 Apr,95	13:20	30.3	3.5		21 Dec,94	11:10	21.4	3.8		20 Feb,98	14:19	23.3	3
	22 Apr,95	14:30	30.2	3.8		21 Dec,94	12:40	21.7	4.3		20 Feb,98	15:28	23.3	3.3
	22 Apr,95	15:25	30.2	3		21 Dec,94	13:35	21.6	2.6		26 Apr,03	12:15	30.5	1.8
	22 Apr,95	16:30	30.2	3.5		21 Dec,94	15:00	21.6	2		17 Mar,04	11:45	26.1	1
	19 Dec,95	8:38	21.6	0.3		21 Dec,94	16:10	21.5	1.7		17 Mar,04	13:30	26.8	2.3
	19 Dec,95	10:00	21.6	0.4		21 Dec,94	16:45	21.5	1.5		17 Mar,04	14:05	26.7	2.35
	19 Dec,95	11:20	21.7	0.7		19 Feb,95	9:00	22.2	9.9		17 Mar,04	14:45	26.6	2.4
	19 Dec,95	12:47	21.8	0.4		19 Feb,95	10:30	22.3	14.5		17 Mar,04	16:00	26.5	2.5
	19 Dec,95	14:05	21.8	0.8		19 Feb,95	11:36	22.3	15.5		6 Apr,04	10:20	28.3	5.4
	19 Dec,95	15:08	21.8	0.4		19 Feb,95	12:40	22.6	17.2		6 Apr,04	11:03	28.4	5.57
	19 Dec,95	16:10	21.8	0.5		19 Feb,95	14:23	22.6	16.2		6 Apr,04	11:44	28.4	5.3
	21 Jan,98	10:50	18.3	0.2		19 Feb,95	15:25	22.6	13.6		6 Apr,04	12:27	28.5	5.5
	21 Jan,98	12:07	18.3	0.4		22 Apr,95	8:40	29.8	2.3		6 Apr,04	13:10	28.7	5.65
	21 Jan,98	13:05	18.3	0.4		22 Apr,95	10:15	29.9	2.4		6 Apr,04	13:55	28.7	5.5
	21 Jan,98	14:14	18.3	0.2		22 Apr,95	11:30	30.2	3.4					
	21 Jan,98	15:17	18.3	0.2		22 Apr,95	12:35	30	2.7					
	20 Feb,98	9:52	22.7	0.3		22 Apr,95	13:44	30.3	3.3					

Table A.2: Water Quality Data at Hazaribagh on the Buriganga River (Source: Kamal, 1996)

Date	PH		T.Alkali		TSS		DO		BOD		COD	
9-Jan-80	7.7	7.8	172	180	11	15	6.8	11.9	1.7	7.4		
10-May-80	7.5	7.8	112	120	6	30	5.8	6.2	2.1	3.1		
14-Jun-80	6.5	6.8	44	48	8	10	3	4.1	1.7	3	0	0
10-Jul-80	7.1	7.3	56	60	19	38	5.2	6.2	3	4	0	0
6-Aug-80	7.4	7.7	56	68	5	45	5.9	6.2	3.6	4.4	0	0
5-Jan-83	6.9	7.15	182	183	23	28	6.75	6.9	1.1	1.55		
3-Feb-83	7.1	7.1	172	173	81	81	5.05	6	2.9	5.35		
9-Mar-83	6.9	7.05	174	176	102	103	3.45	3.7	3.5	4		
12-Apr-83	6.65	6.75	177	183	102	105.5	5.9	6.1	5.45	5.55		
12-May-83	7.1	7.15	154	156	163	171.5	3.9	4.2	5	3.51		
22-Jun-83	6.3	6.55	83	185	96	107.5	2.2	2.6	3.5	4		
21-Jul-83	6.2	6.2	52	54	30	30.5	6.4	6.7	0.95	2.2		
17-Aug-83	6.55	6.65	53	57	33	44	6.75	7.1	0.45	1.62		
11-Sep-83	7.05	7.05	56	61	34	34.5	8.4	8.7	1.4	1.5		
5-Oct-83	6.9	6.9	57	57	26.5	27	1.4	1.45	21.5	24.5		
10-Nov-83	7	7.1	56	62	30.5	34	7.3	7.4	1.2	1.3		
7-Dec-83	7.35	7.45	103	116	49.5	51.5	6.8	6.85	1.9	1.95		
4-Jan-84	7	7.2	122	160	73	80	4.3	5.1	2.2	2.8		
9-Feb-84	7.1	7.3	154	166	74	77	7.4	7.5	5.8	6.6		
13-Mar-84	7	7.2	150	158	94	104	6.9	8.1	1.1	1.9		
7-Apr-84	7.4	7.5	140	154	61	64	6	7.3	1.3	1.8		
19-May-84	7.2	7.6	44	50	35	40	7.2	8.5	3.5	6.2		
5-Jun-84	7	7.2	42	48	43	53	4.3	4.7	3.7	4		
7-Jul-84	7.1	7.4	34	44	43	55	6.2	7.2	1.4	2.2		
5-Aug-84	7.1	7.2	32	46	30	32	3.4	4.1	1.3	1.6		

Table A2: Continued

Date	PH		T.Alkali		TSS		DO		BOD		COD	
12-Sep-84	7	7.1	44	48	31	52	4	4.8	0.4	1.8		
7-Oct-84	7	7.3	40	194	13	33	7	7.4	4.1	4.5	5.5	11
8-Nov-84	7.2	7.4	64	70	36	45	5.9	10.9	0.5	2.3	7	10
9-Dec-84	7.2	7.4	120	144	66	80	6.2	6.6	5.1	6.1	22	29
3-Jan-85	7.5	8.4	128	760	92	110	6.3	7	1.1	2.9	6	13
6-Feb-85	7.1	7.4	148	156	81	86	5.1	5.3	2	2.3	18	25
4-Mar-85	6.6	6.8	136	142	111	124	3.3	3.9	2.1	2.7	7	11
4-Apr-85	6.1	7.1	136	148	74	86	7.2	7.7	3	3.4	12	16
8-May-85	6.1	6.8	130	240	60	70	4.5	5.7	1.3	2.8	11	14
3-Jun-85	6.7	7.5	144	260	66	72	6.2	6.5	1.6	1.9	11	18
14-Aug-85	6.9	7.1	42	46	121	152	5.1	6	2.3	3		
13-Oct-87	6.9	7.1	84	92	40	49	6.4	6.8	2.2	2.4	46	46
8-Feb-88	6.8	7.1	63	70	122	127	5.8	6.4			49.2	198
9-May-88	7.3	7.9	110	114	96	176	4.3	5.3	2.1	2.6		
6-Jun-88	6.8	6.9	36	46	46	61	3.7	4.6	0.8	3.6		
7-Aug-88	6.9	7.1	26	54	15	20	6.6	8.1	0.3	2.2		
15-Oct-88	7	7.1	60	64	20	22	7	7.1	1	1.4		
27-Nov-88	7.1	7.2	64	72	47	50	5	6.5	1.7	1.8		
12-Dec-88	7.1	7.2	64	72	38	40	6.3	6.6	1.5	2.1		
21-Jan-89	7.2	7.4	60	68	36	47	6.2	7.5	1.7	1.9		
20-Feb-89	7.3	7.4	64	76	93	101	5.8	6	1.2	1.5		
10-Apr-89	7.4	7.4	68	80	45	48	5.3	5.6	1.4	1.7		
27-Jun-89	7.1	7.3	92	104	40	47	5.7	5.9	1.7	2.2		
25-Jul-89	7.1	7.2	56	72	25	27	6.1	6.5	1.8	2.1		
9-Sep-89	7.3	7.4	64	76	31	33	6.6	6.9	1.9	2.2		
11-Nov-89	7.3	7.5	72	88	29	30	6.2	6.4	1.8	2.5		

Table A2: Continued

Date	PH		T.Aikali		TSS		DO		BOD		COD	
17-Feb-90	7.5	7.6	140	152	40	44	6.3	6.5	2	2.3		
8-Mar-90	7.4	7.5	140	156	44	48	6.2	6.3	2	2.3		
10-Apr-90	7.7	7.8	152	168	51	53	6.2	6.5	2	2.1		
10-May-90	7.4	7.5	164	176	50	55	6.1	6.4	1.8	2.1		
3-Jun-90	7.2	7.4	156	164	48	50	6	6.3	2	2.3		
15-Jul-90	7	7	60	72	60	63	6.3	6.6	2.3	2.8		
11-Aug-90	7	7.2	84	88	70	73	6.3	6.6	2	2.3		
9-Sep-90	7.2	7.4	84	100	49	53	6.2	6.5	1.7	2		
14-Oct-90	7.3	7.4	96	112	50	53	6	6.3	1.1	1.9		
20-Dec-90	7.2	7.4	88	92	32	34	6.1	6.4				
5-Jan-91	7.3	7.5	96	100	11	25	6	6.3				
8-May-91	7.2	7.3	196	204	42	45	2	2.3	190	210		
9-Jun-91	6.7	7.2	160	168	50	52	5.3	5.6	1.5	2.2		
7-Aug-91	7.3	7.5	178	210	62	65	5.5	5.8	1.7	2.4		
18-Apr-92	7.3	7.5	168	184	38	44	6	6.2	2.7	3.2		
8-Jun-92	7.4	7.5	180	188	37	41	6.1	6.4	2.7	3.1		
5-Jul-92	7.2	7.4	152	168	50	52	5.8	6	2.7	3.4		
17-Aug-92	7.2	7.3	148	160	49	52	6.4	6.7	2.7	3.1		
5-Oct-92	7.3	7.6	184	204	51	57	5.7	6.2	3.4	4		
13-Nov-92	7.6	7.7	192	196	34	38	5.3	5.7	3.1	3.7		
3-Dec-92	7.6	7.7	188	204	24	26	6.2	6.5	3	3.8		
27-Apr-93	7.5	7.7	220	232	36	40	5.4	5.8	2.8	3.3		
30-Jun-93	6.7	6.8	28	32	36	40	6.4	6.7	0.4	2	26	36
6-Jul-93	6.4	6.5	24	30	52	60	5.8	6.2	1.9	2.1		
24-Aug-93	6.8	7.2	24	30	60	63	6.6	6.8	1.6	2		
6-Oct-93	6.8	6.9	40	46	49	54	5.7	5.9	2.5	3	8	10
20-Nov-93	7.1	7.2	42	50	37	40	5.4	5.6	2.2	2.5		
3-Mar-94	7.2	7.4	112	124	33	36	5.6	5.8	2.6	3.3		
3-Jun-94	7.1	7.3	124	132	38	42	6.2	6.5	2.2	2.6		
3-Jul-94	6.8	7.1	64	70	44	49	7	8	2.5	3		
1-Aug-94	7.1	7.3	72	76	47	52	6	6.5	3.4	3.8		
7-Sep-94	7.1	7.2	76	82	40	43	6	6.5	3.1	3.5		
6-Oct-94	7.1	7.2	78	82	35	38	6.2	6.7	3.2	3.8		
10-Dec-94	7.3	7.5	74	82	44	46	3.3	3.8	2.9	3.3		

Table A.3: Water quality Data at Chandnighat, Buriganga (Source: Kamal, 1996)

Date	pH		T Alkalinity		TSS		DO		BOD		COD	
8-Jan-80	7.7	7.9	172	180	12	16	5.1	5.8	1.3	4	0	0
12-Feb-80	7.4	7.6	172	180	19	23	2.8	4.2	1.1	2.1	0	0
14-Mar-80	7.1	7.4	160	196	31	32	6.2	6.6	3.2	3.7	0	0
4-Apr-80	6.8	7.1	152	180	29	33	1.5	3	1.1	2.2	0	0
16-Jun-80	6.3	6.5	24	56	41	45	3.1	4.1	1.6	2	0	0
9-Jul-80	7.5	7.6	32	68	25	61	3.8	4.1	1.6	2	0	0
6-Aug-80	7	7.1	56	64	7	180	4.4	6.1	1.8	4.1	0	0
6-Sep-80	7.1	7.4	60	68	31	49	6.1	7.1	3.9	4.9	0	0
6-Apr-83	6.6	6.75	127	153	96.5	103.5	2.75	3	21	25		
5-May-83	7.3	7.45	98	99	56	75.5	3.1	3.3	20	23		
20-Jun-83	6.15	6.2	63	69	42.5	46	4.75	4.8	4.3	4.35		
5-Jul-83	7.2	7.5	52	58	36	44	1.7	1.9	30	31		
3-Aug-83	5.7	5.95	53	54	57.5	65.5	6.05	6.15	0.75	0.85		
4-Sep-83	7.25	7.25	53	67	21.5	36.5	6.35	6.7	4.85	5.3		
3-Jan-84	7.15	7.2	152	156	71.5	74	4.55	4.65	1.65	1.9		
7-Feb-84	6.85	7.1	163	169	64.5	65	3.2	3.3	0.09	0.09		
6-Mar-84	7.7	7.85	160	170	108.5	114	5.85	6.45	1.75	1.9		
3-Apr-84	7.2	7.3	170	171	56	59	5.75	5.9	3.95	4.15		
7-May-84	7.1	7.15	124	128	62.5	64	3.1	3.3	1.05	1.55		
3-Jun-84	6.85	6.85	46	48	48	50	2.8	3.35	1	1.5		
5-Jul-84	7.15	7.25	54	55	46.5	49	4.55	4.75	4.2	4.2		
2-Aug-84	6.95	6.95	82	132	29	30.5	4.8	5	1.2	1.2		
1-Sep-84	6.1	6.1	96	101	46	50	4.55	5.35	3.35	4.05	91.5	104
11-Oct-84	7.45	7.45	55	56	66.5	74	4.25	4.9	1.95	2.3	18.75	2025
3-Nov-84	7.15	7.25	63	71.3	38.5	39	5.45	5.65	4.6	4.8	5	5

Table A3: Continued

Date	PH		T Alkalinity		TSS		DO		BOD		COD	
10-Dec-84	7.2	7.3	110	124	52	54	5.9	6.45	5.15	5.75		
1-Jan-85	7.45	7.6	140	144	76.5	79	5.2	5.4	2.3	2.35	9.5	10
3-Feb-85	7.15	7.2	154	158	85.5	98	2.5	3.05	1.09	1.95	16	20
2-Mar-85	6.1	6.1	142	150	113	114	2.85	3	1.8	1.95	23.5	25.5
2-Apr-85	6.05	6.15	144	153	79	81	3.1	3.15	2	2	24	28
7-May-85	6.25	6.45	143	148	73.5	77	4.9	5.15	3.05	3.25	23.5	29
2-Jun-85	6.8	7.1	146	152	78	79.5	5.5	5.8	2.45	3.55	22	27
5-Aug-85	6.85	6.85	46	47	195	30.5	4.5	4.65	1.55	1.8		
4-Sep-85	6.1	6.2	33	37	20.5	25.5	4.9	5	2.75	3		
8-Oct-87	6.8	7	84	90	38	46	4.8	5.3	1.8	2.1		
14-Jan-88	6.8	7	90	94	45	55	5	6	2.1	8.2	44.2	51
24-Feb-88	6.8	7.1	148	152	107	114	5	6.2	3	3.2	50.7	57
4-May-88	6.75	7	122	126	74	114	1.7	4	3.5	50		
25-Jun-88	6.8	6.9	36	40	32	39	5.1	5.2	1.7	2		
5-Jul-88	6.8	6.9	24	36	15	22	4.9	5.1	1	1.8		
11-Aug-88	7.5	7.2	46	50	22	25						
6-Nov-88	7.2	7.3	42	46	25	26	6	6.5	1.6	2.1		
1-Dec-88	7.3	7.3	23	25	28	30	4.7	5	1	1.2		
10-Jan-89	7.2	7.4	136	140	48	57	4.7	4.9	2.3	2.8		
11-Feb-89	7.2	7.4	176	180	40	50	5	5.2	0.2	1		
14-Mar-89	7.3	7.4	172	176	33	50	4.9	5.1	0.9	1.1		
5-Apr-89	7.2	7.3	172	180	35	38	5	5.2	0.8	1		
10-May-89	7.3	7.4	168	172	50	52	4.9	5.1	1.5	1.8		
7-Jun-89	7.1	7.2	124	132	49	51	5	5.3	1.1	1.9		
2-Jul-89	7	7.2	52	64	50	55	5.5	5.9	0.9	1.2		
5-Sep-89	7.1	7.3	56	68	33	36	6.3	6.8	1.9	2.1		

Table A3: Continued

Date	PH		T Alkalinity		TSS		DO		BOD		COD
8-Nov-89	7.3	7.4	80	96	30	32	6	6.3	2.4	3.5	
6-Mar-90	7.5	7.6	128	148	45	47	6	6.2	2.1	2.5	
4-Apr-90	7.4	7.6	144	152	49	52	6.1	6.4	2.4	2.7	
6-May-90	7.3	7.4	160	168	47	50	6.2	6.6	1.9	2.3	
2-Jun-90	7.2	7.4	144	156	44	46	6	6.3	2	2.3	
6-Aug-90	7	7	80	92	77	80	6.7	7	1.7	2.2	
4-Sep-90	7.1	7.2	92	100	52	55	5.9	6.2	1.7	2	
7-Nov-90	7.3	7.5	96	112	46	50	6	6.3	1.8	2.4	
3-Dec-90	7.3	7.4	92	108	25	28	6	6.3			
8-Jan-91	7.3	7.4	112	118	28	66	6.7	6.9			
9-May-91	7	7.2	112	114	30	33	5.4	5.7	3.1	3.3	
8-Jun-91	6.7	7	40	42	40	47	5.1	5.6	2.8	3	
11-Jul-91	6.6	6.8	40	44	52	53	5.2	5.5	2.5	2.8	
10-Apr-92	7.4	7.5	60	68	23	25	5.9	6.2	2.3	2.8	
6-Jun-92	7.5	7.5	126	140	32	35	5.9	6.3	2.3	2.7	
4-Jul-92	7.1	7.3	120	124	45	46	5.9	6.1	2.4	2.9	
6-Aug-92	6.9	7	112	116	48	54	6.1	6.4	1.9	2.3	
24-Sep-92	7.2	7.5	116	128	48	52	6	6.2	1.9	2.2	
5-Oct-92	7.3	7.6	124	136	58	61	5.5	6	2.7	3.5	
11-Nov-92	7.5	7.7	92	100	8	32	5.3	5.8	3	3.5	
12-Dec-92	7.5	7.6	100	104	20	24	5.7	6.1	2.4	2.8	
21-Apr-93	7.4	7.6	104	112	28	32	5.5	5.8	3.2	3.7	
27-Jun-93	7	7.3	108	116	38	42	6	6.6	2.8	3.2	
4-Jul-93	6.7	6.8	72	80	55	61	6.2	6.6	2	2.9	
8-Aug-93	6.7	7.1	48	68	55	58	6.2	6.6	3.2	3.5	
7-Sep-93	6.6	7	52	64	46	50	5.5	5.7	2.5	3.1	
4-Oct-93	7.1	7.2	68	72	46	50	5	5.3	1.8	2.9	
3-Nov-93	7	7.1	82	88	40	44	5.6	5.9	2.8	3.2	
2-Mar-94	6.9	7.3	88	96	26	31	4.4	4.8	1.8	2.2	
6-Jun-94	7.2	7.4	154	156	35	38	4.3	4.6	1.1	1.2	
4-Jul-94	6.9	7.2	58	62	40	45	6.4	6.8	2.4	3	
2-Aug-94	6.9	7.2	46	50	42	47	6	6.4	3.3	3.6	
3-Oct-94	7.1	7.2	58	64	30	34	5.7	5.9	3.8	4.2	
13-Dec-94	7.4	7.6	64	68	38	44	3.2	4	3	3.5	

All parameters are in mg/l except pH

Table A.4 : Water Quality at Pagla on the Buriganga River (source :Kamal,1996)

Date	PH		Chloride		T Alkalinity		TSS		DO		BOD		COD	
9-Aug-88	7.1	7.2	5	5.5	54	58	24	30						
16-Oct-88	7	7.1	7	8	80	88	40	53	5.9	6.3	2	2.2		
15-Nov-88	7.1	7.2	12	14	140	190	70	72	5.1	5.3	1.9	2		
7-Dec-88	7.3	7.4	26	30	24	36	52	54	5.2	5.5	2.3	4.1		
17-Jan-89	7.3	7.4	20	21	84	88	42	43	6.1	6.7	2.8	3.2		
8-Feb-89	7.2	7.2	27	29	200	204	42	50	4.9	5	1.1	2.6		
18-Mar-89	7.3	7.4	36	37	172	188	42	50	5	5.1	2.8	3		
27-Apr-89	7.3	7.4	39	40	182	200	28	32	5.6	5.9	2.6	2.8		
15-May-89	7.4	7.4	38	42	180	184	42	44	5	5.3	2.4	2.6		
8-Jun-89	7.1	7.3	29	32	136	140	33	36	5.1	5.5	1.5	1.8		
5-Jul-89	7	7.1	12	14	60	72	40	47	5.1	5.5	1.1	1.4		
19-Feb-90	7.4	7.5	36	39	120	136	36	39	6.1	6.3	1	1.3		
11-Mar-90	7.4	7.5	39	42	128	140	38	44	6	6.3	2.5	2.8		
16-Apr-90	7.3	7.4	45	49	144	156	47	52	6	6.2	1.4	2.6		
20-May-90	7.3	7.4	47	51	156	168	44	45	6.2	6.4	1.9	2.2		
9-Jun-90	7.2	7.3	44	48	136	148	48	50	6.1	6.4	1.8	2.2		
13-Aug-90	6.9	7	26	29	52	60	62	70	6.3	6.5	1.8	2.2		
11-Sep-90	7.1	7.2	26	30	56	68	50	52	6.1	6.6	1.5	1.8		
22-Oct-90	7	7.2	30	33	64	76	47	49	6.7	7	1.2	1.6		
13-Nov-90	7.1	7.3	31	34	68	80	42	45	6.7	7	1.2	1.6		
17-Dec-90	7.2	7.3	29	30	68	72	27	30	6	6.2				
20-May-91	6.6	6.8	5.5	6	42	48	41	44	6	6.6	2.1	2.4		
21-Aug-91	7.1	7.3	7	7.5	50	54	23	26	6.3	6.6	2	2.5		
17-Nov-91	6.9	7	8	9.5	44	50			6	6.4	2	2.5		
3-Dec-91	6.9	7.2	9	10.5	50	56			6	6.3	3	3.5		
9-Jul-92	7	7.2	12	13	112	120	40	42	6	6.2	3	3.8		
25-Aug-92	7	7.3	11	12.5	108	120	44	48	6.1	6.5	3	3.5		
14-Sep-92	7.2	7.3	12	13.5	120	128	49	52	6	6.4	2	2.3		
25-Oct-92	7.3	7.6	10	11	116	132	30	35	5.3	5.8	3.8	4.2		
25-Nov-92	7.4	7.5	11.5	12	136	140	27	30	6.2	6.5	4	4.4		
5-Dec-92	7.5	7.6	11	12.5	136	148	24	28	5.6	5.8	3.4	3.8		
25-Apr-93	7.3	7.5	16.5	18	144	156	36	38	5.1	5.4	3.4	3.8		
14-Jun-93	6.9	7.1	15.5	17	132	140	47	56	5.7	5.9	3.3	3.8		
20-Jul-93	6.7	6.8	12.5	14	104	116	85	98	6.4	6.7	3.2	3.8		
21-Aug-93	6.6	7.9	10	11	48	84	60	164	6	6.5	3.5	3.9		
29-Sep-93	7	7.2	12.5	13.5	80	92	47	52	7.2	7.4	2.8	3.4		

All Parameter are in mg/l except pH

Table A .5 :Water Quality Data Measured by DOE (Source: IWM , August,2004)

Station/River	Month/Year	Terbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Hazaribagh	Jan-00	38	4	10	36	7.4	218
Brriganga	Feb-00	38	3.3	7		7.8	192
	Mar-00	34	3.1	7		7.79	189
	Apr-00	38	3.5	6.5		7.55	170
	May-00	42	3	18		7.4	132
	Jun-00	36	4.8	10		7.38	110
	Jul-00	47	7.3	0.8		7.2	54
	Aug-00	50	7.2	1.4		7.25	56
	Sep-00	32	5.2	1.7		7.25	58
	Oct-00	30	6.6	2.1		6.8	56
	Nov-00	36	5.4	1.8		7.3	86
	Dec-00	25	4.9	1.6		7.36	96
	Jan-01	38	4	10	36	7.4	218
	Feb-01	27	1.5	26	120	7.45	160
	Mar-01	9.8	2.8	18		7.2	72
	Apr-01	10	2.4	12		7.3	78
	May-01	9.8	2.8	18		6.9	72
	Jul-01	12	6.2	4		7.2	78
	Aug-01	14	6.7	4		7.3	48
	Sep-01	12	6.7	3.6		7.35	60
	Oct-01	12	6.5	2.8		7.1	62
	Nov-01	4.5	6	2.9		7.1	25
	Dec-01	6.5	4.8	6		7.4	34
	Jan-02	6	1.2	12		7.21	80
	Feb-02	6.5	1.1	14		7.21	84
	Mar-02	9	1	16		7.3	86
	Apr-02	12	2	14		7.32	90
	May-02	9.5	5.2	3		7.4	72
	Jun-02	12	5.3	3.1		7.18	58
	Jul-02	12	6	2		7.2	56
	Aug-02	12	6	2.8		7.25	65
	Sep-02	12.5	6	3		7.26	68
	Oct-02	10	6	2.8		7.25	62
	Dec-02	8.5	5.8	2.6		7.28	80
	Jan-03	16	1.6	14		7.3	120
	Feb-03	10	1.4	16		7.34	126
	Mar-03	8	1.2	20		7.48	150

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Kamrangir Char Buriganga	Jan-00	28	5.4	2.2	7	7.18	140
	Feb-00	30	3.8	6		7.7	178
	Mar-00	30	3.5	7.5		7.72	180
	Apr-00	32	3.9	6		7.4	162
	May-00	30	5.9	3.8		6.9	60
	Jun-00	30	6.1	3.2		6.9	52
	Jul-00	68	7.5	0.7		6.98	54
	Aug-00	60	7.6	0.9		7.1	46
	Sep-00	30	5.6	1		6.9	54
	Oct-00	32	6.7	1.8		6.82	56
	Nov-00	30	6	2.1		7.1	74
	Dec-00	25	5.2	2		7.18	86
	Jan-01	28	5.4	2.2	7	7.18	140
	Feb-01	30	1.8	15	72	7.5	140
	Mar-01	9.6	3.8	12		7.25	70
	Apr-01	10.5	4	10		7.2	76
	May-01	9.6	3.8	12		7.3	70
	Jul-01	10	6.6	4		7.2	76
	Aug-01	16	6.9	4		7.1	42
	Sep-01	6	6.8	4		7.13	50
	Oct-01	8	6.4	3.7		7.2	50
	Nov-01	3.5	6.5	2.6		7.1	24
	Dec-01	6	5.2	2.2		7.1	30
	Jan-02	4.5	1.4	8		7.27	76
	Feb-02	6	1.3	12		7.25	82
	Mar-02	7	2.1	10		7.2	70
	Apr-02	10	2.8	8		7.2	76
	May-02	7.5	6.4	3.8		7.1	66
	Jun-02	10	6.3	3.7		7.1	50
	Jul-02	10	6.7	3.7		7.1	48
	Aug-02	10.5	6.8	3.5		7.12	56
	Sep-02	10.5	6.8	3.3		7.13	52
	Oct-02	8	6.2	3		7.14	56
	Dec-02	6	5	2.8		7.15	70
	Jan-03	5	2.4	8		7.26	80
	Feb-03	4	2.2	10		7.2	78
	Mar-03	4.5	2	16		7.25	88

Table A5: Continued

Station/River	Month/Year	Terbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Chandnighat	Jan-00	30	5.1	2.1	6	7.2	142
Buriganga	Feb-00	32	3.5	24		7.4	180
	Mar-00	30	3.4	18		7.45	182
	Apr-00	30	4	10		7.38	160
	May-00	32	6.1	4.9		6.95	66
	Jun-00	28	6.2	3.4		6.98	54
	Jul-00	67	5.5	0.7		7.05	52
	Aug-00	65	7	0.9		7.12	50
	Sep-00	32	5.5	1.8		6.92	56
	Oct-00	30	6	1.4		6.8	54
	Nov-00	28	6.1	2.2		6.98	72
	Dec-00	25	5.1	2		7.1	85
	Jan-01	30	5.1	2.1	6	7.2	142
	Feb-01	28	2	12	68	7.39	110
	Mar-01	9.7	6	4		7.1	74
	Apr-01	12	5	3.8		7.1	80
	May-01	9.7	6	4		7.2	72
	Jul-01	9	6.8	4		7.1	80
	Aug-01	15	7	4.5		6.98	44
	Sep-01	10	6.9	4.1		7.1	52
	Oct-01	12	6	3.5		7.2	54
	Nov-01	40	6.4	3.4		7.2	26
	Dec-01	6	5.8	2		7.15	28
	Jan-02	6.5	1.2	10		7.25	74
	Feb-02	10	1.1	10		7.2	74
	Mar-02	8	1.4	12		7.25	72
	Apr-02	10.5	2.4	12		7.2	74
	May-02	8	6.3	3.8		7.1	64
	Jun-02	12	6.4	3.7		6.95	52
	Jul-02	10	6.8	3.8		6.95	46
	Aug-02	105	6.7	3.5		6.92	54
	Sep-02	10	6.8	3.4		7.12	50
	Oct-02	8.5	6.4	3.1		7.12	54
	Dec-02	6	6	2.8		7.15	72
	Jan-03	5	2.6	6		7.2	76
	Feb-03	4.5	2.4	10		7.2	76
	Mar-03	4	2.2	14		7.25	88

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Sadarghat	Jan-00	28	5.3	2.4	8	7.2	146
Buriganga	Feb-00	30	3.2	23		7.4	178
	Mar-00	32	3.1	18.5		7.4	169
	Apr-00	30	4	16		7.3	162
	May-00	30	5.5	4.2		6.8	64
	Jun-00	28	6.2	3.2		6.98	54
	Jul-00	95	7.5	2.1		7.08	56
	Aug-00	90	7.2	2.4		7.1	49
	Sep-00	36	5.7	1.7		6.95	54
	Oct-00	38	5.8	1		6.95	54
	Nov-00	30	6	2		7.12	74
	Dec-00	25	5.2	2.1		7.15	86
	Jan-01	28	5.3	2.4	8	7.2	146
	Feb-01	28	2.1	10	74	7.35	100
	Mar-01	9.8	5.8	3		7.13	72
	Apr-01	11	5.2	4		7.1	72
	May-01	9.8	5.8	3		7.2	70
	Jul-01	10	6.1	4.1		7	74
	Aug-01	12	7	4.6		6.95	46
	Sep-01	8	7	4.2		7.15	56
	Oct-01	8	5.5	2.8		7.2	60
	Nov-01	5	6.1	3.4		7.2	24
	Dec-01	8	4.6	6		7.25	30
	Jan-02	6.5	1.6	10		7.18	74
	Feb-02	4.9	1.1	12		7.15	72
	Mar-02	8	1.1	14		7.2	72
	Apr-02	10	2.6	12		7.28	76
	May-02	8.5	6.4	3.8		7.12	66
	Jun-02	12.5	6.1	3.5		6.98	52
	Jul-02	12	6.9	3.8		6.96	46
	Aug-02	10	6.8	3.6		6.95	54
	Sep-02	10	6.8	3.4		7.14	52
	Oct-02	8.5	6.4	3.1		7.14	56
	Dec-02	6	6	2.8		7.14	72
	Jan-03	4.5	2.8	8		7.18	74
	Feb-03	4.5	2.6	8		7.21	78
	Mar-03	4	2.4	14		7.26	90

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Farasgang	Jan-00	30	4.9	1.9	4	7.18	142
Buriganga	Feb-00	30	3.1	22		7.3	172
	Mar-00	30	3	16		7.32	170
	Apr-00	32	3.6	14		7.38	162
	May-00	30	5.4	4		7.15	64
	Jun-00	30	6	2.9		7.1	56
	Jul-00	97	7.5	2.1		7.15	54
	Aug-00	92	7.2	2.8		7.2	52
	Sep-00	35	5.7	1.3		7.09	52
	Oct-00	32	6.8	1.4		6.89	52
	Nov-00	28	5.8	1.8		7.15	78
	Dec-00	25	5	1.9		7.18	88
	Jan-01	30	4.9	1.9	4	7.18	142
	Feb-01	26	1.9	16	78	7.4	98
	Mar-01	9.4	5	2.8		7.15	76
	Apr-01	10	4.8	8		7.2	70
	May-01	9.4	5	2.8		6.9	74
	Jul-01	12	6.2	3.8		7.1	72
	Aug-01	16	6.7	3.8		7.1	44
	Sep-01	8.5	6.8	3.8		7.2	58
	Oct-01	9	5.5	2.7		7.9	62
	Nov-01	3	5.5	2.7		7.8	28
	Dec-01	8.5	4.2	8		7.38	32
	Jan-02	7	1	10.5		7.11	80
	Feb-02	4.8	1.2	10		7.11	82
	Mar-02	6	1.2	12		7.3	76
	Apr-02	9.5	2	14		7.3	78
	May-02	8.5	6	3.6		7.15	68
	Jun-02	10	5.3	2.9		7.1	54
	Jul-02	10	6.8	3.8		6.98	44
	Aug-02	2	6.7	3.4		6.95	58
	Sep-02	10	6.7	3.2		7.18	54
	Oct-02	9	6.3	3		7.15	58
	Dec-02	6.5	5.9	2.7		7.16	70
	Jan-03	10	2.2	10		7.2	76
	Feb-03	4.8	2.2	10		7.25	80
	Mar-03	5	2.1	16		7.3	96

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO (mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Dholaikhal	Jan-00	35	4.1	6	18	7.2	168
Buriganga	Feb-00	35	2	14		8	184
	Mar-00	38	2.1	12		8	185
	Apr-00	32	3.6	14		7.5	168
	May-00	38	4	10		7.3	120
	Jun-00	38	4.9	8		7.3	105
	Jul-00	85	6	0.7		6.95	54
	Aug-00	110	7.2	0.9		7.2	52
	Sep-00	34	5.4	0.8		7.1	60
	Oct-00	30	5.5	0.9		6.88	58
	Nov-00	32	5.6	1.6		7.2	82
	Dec-00	25	4.8	1.4		7.3	96
	Jan-01	35	4.1	6	18	7.2	168
	Feb-01	30	1.5	20	100	7.5	150
	Mar-01	16	3.2	10		7.2	86
	Apr-01	12	2.8	18		7.3	92
	May-01	16	3.3	10		7	78
	Jul-01	12.5	6.1	3.6		7.3	90
	Aug-01	18	6.2	3.7		7.3	50
	Sep-01	10	6.5	3.2		7.3	62
	Oct-01	11	5.5	2		7.8	65
	Nov-01	6	5.6	2.8		7.7	24
	Dec-01	6	5.2	1.6		7.2	28
	Jan-02	8	1	16		6.96	92
	Feb-02	10	1	12		6.98	94
	Mar-02	8.5	0.8	18		7.35	82
	Apr-02	12	1.8	18		7.35	80
	May-02	9.5	5.1	2.8		7.25	70
	Jun-02	12	6.3	3.3		7.15	56
	Jul-02	12.5	5.8	2.1		7.25	60
	Aug-02	15	5.8	2.8		7.15	62
	Sep-02	15.5	5.9	2.8		7.22	65
	Oct-02	12	6	3		7.23	64
	Dec-02	10	5.8	2.4		7.25	86
	Jan-03	6.5	1.8	12		7.28	90
	Feb-03	10.5	1.6	12		7.28	84
	Mar-03	6.5	1.6	18		7.36	120

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
BD China Bridge Buriganga	Jan-00	30	5	2	7	7.18	130
	Feb-00	28	2.6	14		7.7	170
	Mar-00	30	2.5	12		7.6	169
	Apr-00	30	4	10		7.35	160
	May-00	30	5.6	3.8		7.1	64
	Jun-00	28	6.2	3.1		7.1	54
	Jul-00	100	7.3	1.6		6.98	55
	Aug-00	50	7.4	2.8		6.9	48
	Sep-00	29	5.6	1.3		6.9	52
	Oct-00	28	5.8	1.2		6.82	50
	Nov-00	28	5.9	2		7.2	70
	Dec-00	25	5.2	2		7.22	82
	Jan-01	30	5	2	7	7.18	130
	Feb-01	26	4.6	28	70	7.3	94
	Mar-01	12	4.2	8		7.1	78
	Apr-01	10	5.5	3.9		7.2	74
	May-01	12	4.4	8		7.1	86
	Jul-01	12	6.5	3.2		7.2	72
	Aug-01	16.5	6.3	3.8		7.15	40
	Sep-01	12	6.7	3.4		7.1	52
	Oct-01	12	5	3		7.4	54
	Nov-01	5	6	2.9		7.3	24
	Dec-01	6.5	5.1	1.4		7.25	32
	Jan-02	4.5	1.4	8.5		7.17	76
	Feb-02	4.9	1.1	12		7.15	78
	Mar-02	6	1	14		7.18	74
	Apr-02	10	2.2	14		7.2	78
	May-02	6.5	6.2	3.4		7.1	60
	Jun-02	10	6.2	3.1		6.9	50
	Jul-02	12.5	6.7	3.6		6.9	44
	Aug-02	10	6.8	3.6		6.92	58
	Sep-02	10.5	6.9	3.6		7.1	50
	Oct-02	9	6.4	3.2		7.11	52
	Dec-02	6	6	3		7.1	72
	Jan-03	5	2.6	8		7.25	82
	Feb-03	4.5	2.4	10		7.21	76
	Mar-03	4.5	2.4	12		7.28	92

Table A5: Continued

Station/River	Month/Year	Turbidity(NTU)	DO(mg/l)	BOD5 at 20 oC(mg/l)	COD (mg/l)	pH	T .Alkalinity
Pagla Buriganga	Jan-00	30	5.2	2.1	8	7.2	136
	Feb-00	30	3.2	10		7.8	160
	Mar-00	30	3.1	8		7.75	164
	Apr-00	32	4.1	8		7.35	162
	May-00	32	5.4	3.6		7.18	68
	Jun-00	30	6.2	3.2		7.1	56
	Jul-00	95	8.5	3.6		6.92	59
	Aug-00	52	7.4	4.2		6.99	50
	Sep-00	28	5.5	1.5		6.99	54
	Oct-00	28	6	1.4		6.8	54
	Nov-00	30	5.8	1.8		7.71	75
	Dec-00	25	5.1	1.9		7.25	84
	Jan-01	30	5.2	2.1	8 60	7.2	136
	Feb-01	26	3.2	8.5		7.35	96
	Mar-01	9.8	5.8	2.4		7.2	80
	Apr-01	10.5	5.9	4.2		7.1	78
	May-01	9.8	5.9	2.3		7.2	80
	Jul-01	10.5	6.4	4.1		7.1	78
	Aug-01	15	6.7	4		7.1	46
	Sep-01	8	6.6	3.5		7.15	56
	Oct-01	9	4.6	3.9		7.4	60
	Nov-01	5	5.8	3.8		7.4	32
	Dec-01	6.5	5.1	1.4		7.25	32
	Jan-02	4.5	1.2	10		7.13	80
	Feb-02	4.8	1.5	10		7.12	82
	Mar-02	6	1.2	12		7.18	74
	Apr-02	10	2.4	12		7.18	72
	May-02	7.5	6	3		7.15	62
	Jun-02	10.5	6.5	1.1		6.95	54
	Jul-02	10	6.8	3.8		6.98	46
	Aug-02	10.5	6.7	3.5		6.94	60
	Sep-02	12	6.7	3.2		7.15	54
	Oct-02	8.5	6.2	3.1		7.15	56
	Dec-02	6.5	5.8	2.8		7.15	76
	Jan-03	6	2.8	8		7.18	76
	Feb-03	4	2.6	8		7.2	76
	Mar-03	4.5	2.2	14		7.28	94

Table A .6: Water Quality Data of the Buriganga River (Source: WSP International, 1998; IWM, 2005)

River/Khal	Location Name	Station ID	Date	Parameters Tested (mg/l)						
				BOD5	COD	NH3-N	NH4-N	PO4	Cr	Pb
Buriganga	Kamrangir Char	Buri-3	18-12-97	38					0.019	
			20-01-98	1.8					0.009	
			18-02-98	29.2				1.14		
			26-04-03	29	39	0.19	7.09		0.007	0.231
			9/12/2003	2.8	8	0.029	2.671		0.005	<0.001
			16-03-04	56	92	0.36	16.64		0.005	
			5/4/2004	20	44	10.68	0.07	0.42	0.27	<0.001
	Hazaribagh	Buri-4	18-12-97	34					0.21	
			20-01-98	21.3					0.015	
			18-02-98	31.6				4.45		
			26-04-03	27	85	0.21	11.29		0.008	0.234
Buriganga	Keranigang	Buri-5	18-12-97	33					0.021	
			20-01-98	3.9					0.019	
			18-02-98	30				1.53		
			27-04-03	8	53	0.25	9		0.007	0.111
			9/12/2003	1.8	3	0.048	4.021		<0.001	<0.001
			16-03-04	35	58	0.28	17.72		0.006	
			5/4/2004	12	29	8.36	0.04	0.48	<0.001	<0.001
	Pagla	Buri-6	19-12-97	28					0.027	
			21-01-98	15.3					0	
			19-02-98	30				1.7		
			26-04-03	12	24	0.31	10.84		0.002	0.23
			10/12/2003	3.2	17	0.017	2.463		<0.001	<0.001
			17-03-04	10	16	0.19	9.21		0.004	
			6/4/2004	4	10	0.55	0	0.4	<0.001	<0.001
Buriganga	Fatulla	Buri-7	19-12-97	27					0.016	
			21-01-98	16.2					0.02	
			19-02-98	29.2				1.55		
			26-04-03	12	18	0.23	7.72		0.002	0.095
			10/12/2003	2.4	4	0.017	1.573		<0.001	<0.001
			17-03-04	8	14	0.08	4.22		1E-05	
			6/4/2004	3	10	0.44	0.01	2.4	<0.001	<0.001
	Hariharpara	Buri-8	19-12-97	29					0.009	
			21-01-98	14.7					0.012	
			19-02-98	31.2				2.1	0.004	0.034
			27-04-03	16.5	29	0.06	3.09		<0.001	0.058

All parameters are in mg/l except pH

BOD5 at 20 °C

COD in K₂Cr₂O₇ value

Table A.7: Dhaka Water Works (Chandnighat Water Treatment Plant)

Water Quality Data of the raw and Treated Water (tested carried out at the plant laboratory)

Date	Turbidity (NTU)		pH		Colour(NTU)		Residual Chlorine (mg/l)
	Raw Water	Treated Water	Raw Water	Treated Water	Raw Water	Treated Water	
05 Aug,98	20	0.5		6.5	20	10	0.5
15 Aug,98	18	0.5		6.7	20	6	0.2
30 Aug,98	15	1		6.7	15	12	0.2
07 Sep,98	14	0.5		6.6	25	10	0.3
14 Sep,98	16	1		6.8	22	9	0.4
21 Sep,98	15	1		6.7	18	10	0.4
04 Oct,98	8	2		6.7	22	10	0.3
14 Oct,98	8	0.5		6.6	20	8	0.3
25 Oct,98	10	0.5		6.5	20	10	0.3
01 Nov,98	10	0.5		6.6	20	8	0.4
08 Nov,98	3	0.5		6.6	20	12	0.2
24 Nov,98	3	0.5		6.6	20	10	0.3
14 Dec,98	7	0.5		6.5	20	8	0.1
20 Dec,98	8	0.5		6.7	20	7	0.3
31 Dec,98	8	0.4		6.7	20	10	0.4
04 Jan,99	8	0.5		6.8	20	10	0.3
03 Feb,99	10	0.5		7.1	15	10	0.4
04 Mar,99	7	10		7.1	100	20	0.1
05 Apr,99	36	1.5		7.2	60	20	0.5
03 May,99	8	0.5	7.4	7	30	15	0.5
06 Jun,99	10	0.5		6.8	40	15	0.5
04 Jul,99	75	1		6.8	160	10	1.3
02 Aug,99	12	0.1	6.8	6.8	30	15	0.5
06 Sep,99	12	0.5		6.8	25	12	0.5
18 Oct,99	8	1	7.78	7.68	30	8	0.02
04 Nov,99	8	0.5		7.27	35	8	0.3
08 Dec,99	10	0.5	7.5	7.4	30	12	0
06 Jan,00	6	1	8.4	8.5	15	6	0.05
07 Feb,00	8	2.5	7.2	7.2	15	15	0.1
04 Mar,00	20	4	8.3	8.1	35	10	0.2
08 Apr,00	10	0.5	8.3	7.5	16	4	0.05
06 May,00	10	2	8.5	8	15	6	0.4
05 Jun,00	8	0.5	7.4	7.1	16	3	0.5
05 Jul,00	35	1.5	7.6	7.6	40	4	0.4
05 Aug,00	32	0.5	8	7.6	40	2	0.4
05 Sep,00	20	0.5	7.6	7.7	24	2	0.05
05 Oct,00	30	0.5	7.1	7.4	35	2	0.05
05 Nov,00	30	1.5	7.4	7.2	35	3	0.5
05 Dec,00	20	1	7.6	7.5	25	3	0.1
05 Jan,01	12	1.5	8	7.6	16	3	0.05
05 Feb,01	45	20	8	7.6	50	24	0.05
05 Mar,01	40	18	8.2	8	48	24	0.1
05 Apr,01	45	8	7.4	7.4	55	12	0.3
05 May,01	25	4	7.6	7.4	35	10	0.15
02 Jun,01	25	2	7.6	7.4	35	5	0.3
06 Jul,01	16	1.5	7.2	7	30	4	0.15
13 Aug,01	18	1.5	7.2	6.9	30	4	0.3
06 Sep,01	16	1	6.6	6.4	30	3	0.5
23 Oct,01	16	0.5	6.6	6.5	30	2	0.3
07 Dec,01	22	1	7.2	6.9	34	2.5	0.4

Source: Md. Moazzem, 2005

Table A.7:Dhaka Water Works (Chandnighat Water Treatment Plant)

Water Quality Data of the raw and Treated Water (tested carried out at the plant laboratory)

Date	Turbidity (NTU)		pH		Colour(NTU)		Residual Chlorine (mg/l)
	Raw Water	Treated Water	Raw Water	Treated Water	Raw Water	Treated Wa	
27 Jan,02	30	7	7.2	6.9	40	15	0.4
17 Feb,02	35	2.5	7	6.7	48	5	0.6
19 Mar,02	55	6	7	7	64	12	0.3
05 Apr,02	45	3	6.8	7.1	35	12	0.2
05 May,02	30	2	7.1	7	35	8	0.1
05 Jun,02	35	4	6.8	6.9	30	14	0.2
10 Oct,02	14	1	7.2	7.4	20	2.5	0.6
16 Nov,02	24	1	7.1	6.7	35	2.5	0.3
11 Dec,02	22	1.5	6.8	7	25	3	0.3
05 Jan,03	25	1	6.8	7	30	2	0.2
06 Feb,03	68	7	7.4	6.9	84	14	0.6
05 Mar,03	72	6	7.3	6.9	95	16	0.5
05 Apr,03	55	3.5	7.5	7.1	70	10	0.4
10 May,03	40	3.5	7.5	7.3	55	6	0.5
06 Jun,03	36	6	7.2	7.3	55	14	0.35
05 Jul,03	32	1	7.2	6.8	40	2	0.3
10 Aug,03	30	1	7.3	7.1	42	3	0.2
10 Sep,03	42	1	7.4	7.1	50	4	0.25
05 Oct,03	45	1	7.3	7.1	58	3	0.5
06 Nov,03	60	2	7.3	6.8	70	3	0.15
10 Dec,03	76	1.5	7.4	6.9	84	4	0.15
11 Jan,04	84	3.5	7.4	7.1	100	7	0.3
08 Feb,04	84	3	7.4	6.9	94	7	0.3
04 Mar,04	78	5.5	7.3	7	86	10	0.3
25 Apr,04	48	4	7.5	7.1	65	8	0.15
07 May,04	54	4	7.5	7.1	70	8	0.4
08 Jun,04	54	1.5	7.6	7.3	68	3	0.4
10 Jul,04	48	1.5	7	6.9	60	3	0.4
18 Aug,04	54	1	7.3	7.2	68	3	0.3
24 Sep,04	60	1	7.2	7	74	3	0.3
09 Oct,04	50	1	7.1	6.8	64	2	0.2
04 Nov,04	55	1.5	7.1	7.3	70	5	0.3
21 Dec,04	80	3.5	7.5	7.1	95	8	0.3
05 Jan,05	96	4	7.5	7.2	115	8	0.05
15 Jan,05	96	4	7.6	7.3	115	8	0.15
25 Jan,05	100	4	7.5	7.2	120	9	0.2
10 Feb,05	110	12	7.6	7	150	20	0.15
15Feb,05	115	12	7.5	7.1	160	20	0.4
20 Feb,05	115	10.5	7.5	6.9	160	20	0.2
27 Mar,05	110	18	7.5	7	150	30	0.05
28 Mar,05	110	20	7.6	7.1	150	35	0.05
29 Mar,05	115	20	7.6	6.9	155	37	0.05
05 Apr,05	100	12	7.5	7.1	150	20	0.35
15 Apr,05	100	12	7.6	6.9	148	20	0.3
25 Apr,05	96	10	7.6	7.1	140	18	0.35

Source: Md. Moazzem, 2005

Table A .8:Water Quality Data around Dhaka (Source: DOE)

River	Sample Location	Date	pH	E.Conductivity	Chloride	T. Alkalinity	Turbidity	DO	BOD
Buriganga River	Mirpur Bridge	7/1/2007	7.18	720	22	200	6.5	1.5	12
	Hazaribagh	7/1/2007	7.8	812	42	252	12	0	28
	Kamrangir Char	7/1/2007	7.17	740	24	196	6.5	1.2	12.4
	Chandni Ghat	7/1/2007	7.16	746	26	198	6.5	0.6	16.8
	Sadar Ghat	7/1/2007	7.18	748	26	206	6.5	0.4	18
	Farashgonj	7/1/2007	7.5	750	28	232	6.5	0	20.4
	Dholaikhal	7/1/2007	7.62	792	32	244	10	0	24
	BCFB	7/1/2007	7.1	710	20.5	190	6	1.8	10.2
	Pagla	7/1/2007	7.16	750	28	240	6.5	0	22
Buriganga River	Mirpur Bridge	11/2/2007	7.2	760	26	210	6	0.4	16.8
	Hazaribagh	11/2/2007	7.83	920	46	264	16	0	36.2
	Kamrangir Char	11/2/2007	7.22	764	26.5	212	6	0	18.6
	Chandni Ghat	11/2/2007	7.22	768	28	214	6	0	22
	Sadar Ghat	11/2/2007	7.3	768	28.5	224	6	0	24
	Farashgonj	11/2/2007	7.58	770	30	234	6	0	26.2
	Dholaikhal	11/2/2007	7.62	782	32	248	6	0	28.4
	BCFB	11/2/2007	7.2	766	26	204	6	0.8	12.8

Note: All units in mg/l, except EC micro S/cm, Turbidity NTU, BOD at 20° C and 5 days.

Table A.9 Water Quality Data Of the Buriganga River (Source : BWDB)

RiverName	StationName	StationID	DateTime	T	pH	DO	Salinity	TDS	EC
Buriganga	Dhaka_Mill Barrack	SW42	4/22/2001	31.40	6.80	7.00			495.00
Buriganga	Dhaka_Mill Barrack	SW42	4/23/2001	29.10	7.49	7.60			393.00
Buriganga	Dhaka_Mill Barrack	SW42	8/9/2002	29.80	8.37	5.30	0.05	0.08	124.70
Buriganga	Dhaka_Mill Barrack	SW42	9/10/2002	28.50	8.15	4.30	0.06	0.11	170.29
Buriganga	Dhaka_Mill Barrack	SW42	10/8/2002	25.01	8.44	4.21	0.11	0.13	203.58
Buriganga	Dhaka_Mill Barrack	SW42	11/7/2002	21.60	8.04	4.93	0.12	0.16	243.50
Buriganga	Dhaka_Mill Barrack	SW42	12/9/2002	16.59	8.09	5.16	0.12	0.17	260.19
Buriganga	Dhaka_Mill Barrack	SW42	1/8/2003	20.33	7.94	1.93	0.12	0.16	250.10
Buriganga	Dhaka_Mill Barrack	SW42	2/10/2003	29.44	8.03	2.29	0.14	0.18	287.63
Buriganga	Dhaka_Mill Barrack	SW42	2/22/2003	24.64	0.19	3.59	0.19		384.70
Buriganga	Dhaka_Mill Barrack	SW42	3/9/2003	29.41	8.18	3.23	0.15	0.17	272.00
Buriganga	Dhaka_Mill Barrack	SW42	4/10/2003	29.87	8.30	3.68	0.14	0.16	248.06
Buriganga	Dhaka_Mill Barrack	SW42	5/11/2003	29.40	8.52	0.91	0.11	0.13	208.29
Buriganga	Dhaka_Mill Barrack	SW42	6/10/2003	31.30	8.63	1.03	0.10	0.12	179.58
Buriganga	Dhaka_Mill Barrack	SW42	7/12/2003	30.45	8.59	2.99	0.10	0.11	175.98
Buriganga	Dhaka_Mill Barrack	SW42	8/10/2003	29.91	8.49	5.00	0.05	0.08	126.80
Buriganga	Dhaka_Mill Barrack	SW42	9/9/2003	29.39	7.09	3.31	0.10	0.11	176.09
Buriganga	Dhaka_Mill Barrack	SW42	10/10/2003	26.43	7.58	4.13	0.12	0.14	224.00
Buriganga	Dhaka_Mill Barrack	SW42	11/9/2003	20.51	8.53	3.98	0.13	0.17	264.45
Buriganga	Dhaka_Mill Barrack	SW42	12/10/2003	16.43	8.13	3.32	0.13	0.17	259.48
Buriganga	Dhaka_Mill Barrack	SW42	1/9/2004	14.23	7.22	3.54	1.15	0.19	291.41
Buriganga	Dhaka_Mill Barrack	SW42	2/10/2004	25.44	6.95	2.95	0.14	0.17	259.14
Buriganga	Dhaka_Mill Barrack	SW42	3/12/2004	29.19	6.88	4.91	0.14	0.16	252.61
Buriganga	Dhaka_Mill Barrack	SW42	4/12/2004	30.48	7.07	5.23	0.09	0.10	163.00
Buriganga	Dhaka_Mill Barrack	SW42	5/10/2004	31.49	8.08	4.23	0.10	0.12	189.25
Buriganga	Dhaka_Mill Barrack	SW42	6/9/2004	30.48	7.86	5.78	0.10	0.11	172.15
Buriganga	Dhaka_Mill Barrack	SW42	7/8/2004	30.48	7.73	3.45	0.06	0.10	149.45
Buriganga	Dhaka_Mill Barrack	SW42	8/10/2004	30.29	8.53	4.59	0.05	0.08	125.30
Buriganga	Dhaka_Mill Barrack	SW42	9/12/2004	30.54	8.21	4.01	0.05	0.09	135.95
Buriganga	Dhaka_Mill Barrack	SW42	10/4/2004	29.51	8.01	2.89	0.06	0.10	160.53
Buriganga	Dhaka_Mill Barrack	SW42	11/10/2004	25.49	7.46	3.95	0.11	0.13	209.41
Buriganga	Dhaka_Mill Barrack	SW42	12/10/2004	17.15	7.03	1.63	0.14	0.17	258.80
Buriganga	Dhaka_Mill Barrack	SW42	1/10/2005	20.34	7.38	1.74	0.29	0.37	154.40
Buriganga	Dhaka_Mill Barrack	SW42	2/1/2005	20.89	6.29	1.98	0.33	0.41	194.20
Buriganga	Dhaka_Mill Barrack	SW42	3/5/2005	28.59	5.57	3.57	0.39	0.49	213.20
Buriganga	Dhaka_Mill Barrack	SW42	4/9/2005	29.32	6.30	4.12	0.42	0.08	168.30
Buriganga	Dhaka_Mill Barrack	SW42	5/1/2005	30.80	6.85	4.52	0.48	0.10	165.20
Buriganga	Dhaka_Mill Barrack	SW42	6/1/2005	31.50	7.20	4.85	0.35	0.11	175.50

Table A .9 :Continued

RiverName	StationName	StationID	DateTime	T	pH	DO	Salinity	TDS	EC
Buriganga	Hariharpara	SW43	4/18/2001	30.70	7.83	7.80		0.80	180.00
Buriganga	Hariharpara	SW43	8/9/2002	29.93	8.30	5.32	0.05	0.08	125.10
Buriganga	Hariharpara	SW43	9/10/2002	28.55	8.15	4.28	0.05	0.10	145.10
Buriganga	Hariharpara	SW43	10/8/2002	25.11	8.44	4.29	0.06	0.11	170.29
Buriganga	Hariharpara	SW43	11/7/2002	21.64	8.14	4.90	0.07	0.13	203.85
Buriganga	Hariharpara	SW43	12/9/2002	16.52	8.09	5.13	0.08	0.15	234.15
Buriganga	Hariharpara	SW43	1/8/2003	20.37	7.94	1.91	0.07	0.14	201.85
Buriganga	Hariharpara	SW43	2/10/2003	29.49	8.03	2.18	0.06	0.13	198.45
Buriganga	Hariharpara	SW43	3/9/2003	29.45	8.18	3.29	0.06	0.11	170.25
Buriganga	Hariharpara	SW43	4/10/2003	29.90	8.25	3.58	0.05	0.10	160.15
Buriganga	Hariharpara	SW43	5/11/2003	29.45	8.48	0.88	0.05	0.10	150.91
Buriganga	Hariharpara	SW43	6/10/2003	31.35	8.53	0.98	0.05	0.10	145.41
Buriganga	Hariharpara	SW43	7/12/2003	30.51	8.55	2.87	0.05	0.08	130.25
Buriganga	Hariharpara	SW43	8/10/2003	29.68	8.13	5.21	0.05	0.08	125.00
Buriganga	Hariharpara	SW43	9/9/2003	29.39	7.19	3.23	0.05	0.09	134.91
Buriganga	Hariharpara	SW43	10/10/2003	26.47	7.68	4.03	0.05	0.08	124.30
Buriganga	Hariharpara	SW43	11/9/2003	20.54	8.43	3.87	0.06	0.10	158.94
Buriganga	Hariharpara	SW43	12/10/2003	16.64	8.23	3.23	0.05	0.08	123.15
Buriganga	Hariharpara	SW43	1/9/2004	14.25	7.42	3.54	0.07	0.13	201.00
Buriganga	Hariharpara	SW43	2/10/2004	25.49	6.98	2.85	0.05	0.08	126.19
Buriganga	Hariharpara	SW43	3/12/2004	29.34	6.95	4.89	0.08	0.16	248.95
Buriganga	Hariharpara	SW43	4/11/2004	30.52	7.11	5.14	0.08	0.16	251.94
Buriganga	Hariharpara	SW43	5/10/2004	31.50	8.18	4.19	0.09	0.17	260.13
Buriganga	Hariharpara	SW43	7/8/2004	30.53	7.84	3.44	0.10	0.15	239.25
Buriganga	Hariharpara	SW43	8/10/2004	29.88	8.05	5.05	0.05	0.08	125.04
Buriganga	Hariharpara	SW43	9/12/2004	30.50	8.25	4.51	0.05	0.08	129.41
Buriganga	Hariharpara	SW43	10/11/2004	29.48	8.11	3.95	0.08	0.13	201.15
Buriganga	Hariharpara	SW43	11/10/2004	25.53	7.53	2.78	0.05	0.08	125.51
Buriganga	Hariharpara	SW43	12/10/2004	17.05	7.24	3.81	0.05	0.08	125.30

Table A. 10 :Water quality data of SWMC of Buriganga river(1997-98)

Nature of Sample	Sample ID	Date of Collection	Parameter Tested (mg/l)					
			BOD	NO3-N	PO4	Cr	Pb	Zn
River Water	Buri-1	17-Dec	37	NA	NA	0.032	NA	NA
River Water	Buri-1	19-Jan	3.6	NA	NA	0.033	NA	NA
River Water	Buri-1	17-Feb	26	0.2	2.16	Nil	0.084	1.867
River Water	Buri-2	17-Dec	34	NA	NA	0.029	NA	NA
River Water	Buri-2	19-Jan	3.3	NA	NA	0.029	NA	NA
River Water	Buri-2	17-Feb	18.4	0.1	2.57	Nil	Nil	0.753
River Water	Buri-3	18-Dec	38	NA	NA	0.019	NA	NA
River Water	Buri-3	20-Jan	1.8	NA	NA	0.009	NA	NA
River Water	Buri-3	18-Feb	29.2	0.1	1.14	Nil	Nil	1.566
River Water	Buri-4	18-Dec	34	NA	NA	0.021	NA	NA
River Water	Buri-4	20-Jan	21.3	NA	NA	0.015	NA	NA
River Water	Buri-4	18-Feb	31.6	0.1	4.45	Nil	Nil	4.34
River Water	Buri-5	18-Dec	33	NA	NA	0.021	NA	NA
River Water	Buri-5	20-Jan	3.9	NA	NA	0.019	NA	NA
River Water	Buri-5	18-Feb	30	0.4	1.53	Nil	Nil	4.569
River Water	Buri-6	19-Dec	28	NA	NA	0.027	NA	NA
River Water	Buri-6	21-Jan	15.3	NA	NA	0	NA	NA
River Water	Buri-6	19-Feb	30	0.1	1.7	Nil	Nil	2.263
River Water	Buri-7	19-Dec	27	NA	NA	0.016	NA	NA
River Water	Buri-7	21-Jan	10.2	NA	NA	0.02	NA	NA
River Water	Buri-7	19-Feb	29.2	0.1	1.55	Nil	Nil	1.075
River Water	Buri-8	19-Dec	29	NA	NA	0.009	NA	NA
River Water	Buri-8	21-Jan	14.7	NA	NA	0.012	NA	NA
River Water	Buri-8	19-Feb	31.2	2.1	1.09	0.004	0.034	2.007
River Water	Buri-9	21-Dec	27	NA	NA	0.023	NA	NA
River Water	Buri-9	22-Jan	6.9	NA	NA	0	NA	NA
River Water	Buri-9	21-Feb	22	2.4	0.554	Nil	0.031	1.777
River Water	Buri-10	21-Dec	38	NA	NA	Nil	NA	NA
River Water	Buri-10	22-Jan	7.8	NA	NA	0.027	NA	NA
River Water	Buri-10	21-Feb	20	2.2	0.509	Nil	0.014	0.0475
River Water	Buri-11	22-Dec	6	NA	NA	0.006	NA	NA
River Water	Buri-11	23-Jan	6.6	NA	NA	0.025	NA	NA
River Water	Buri-11	22-Feb	22.4	0.2	0.566	0.002	Nil	0.67

Table A. 10 :Continued Water Quality Monitoring Data of SWMC on Buriganga River(1997-98)

Nature of Sample	Sample ID	Date of Collection	Parameter Tested (mg/l)				
			BOD	NH3-N	Cr	Pb	Zn
Waste Water	S-3	5-Jan	11	NA	Nil	Nil	1.102
Waste Water	S-3	9-Feb	95	NA	0.015	Nil	2.399
Waste Water	S-4	24-Feb	155	4.42	0.016	0.022	0.103
Waste Water	S-4	5-Jan	27	NA	0.017	0.057	0.21
Waste Water	S-4	15-Feb	90	10.53	0.014	0.066	2.392
Waste Water	S-5	4-Feb	42	NA	0.022	0.016	2.986
Waste Water	S-5	5-Jan	51	NA	0.013	0.049	0.265
Waste Water	S-5	15-Feb	240	27.63	0.024	0.057	0.521
Waste Water	S-6	4-Feb	230	NA	0.027	0.068	3.555
Waste Water	S-6	5-Jan	52	NA	0.017	0.016	0.23
Waste Water	S-6	15-Feb	390	33.43	0.018	0.058	0.621
Waste Water	S-7	4-Feb	85	NA	0.031	0.114	4.941
Waste Water	S-7	20-Dec	400	NA	10.08	NA	NA
Waste Water	S-7	11-Jan	580	NA	31.083	NA	NA
Waste Water	S-8	11-Feb	470	98.9	17.246	0.151	2.654
Waste Water	S-8	29-Dec	110	NA	0.058	NA	NA
Waste Water	S-8	11-Jan	155	NA	0.125	NA	NA
Waste Water	S-9	11-Feb	580	40.88	0.27	0.111	2.161
Waste Water	S-9	11-Jan	305	NA	0.039	NA	NA
Waste Water	S-9	9-Feb	240	50.45	0.02	0.129	2.46
Waste Water	S-10	11-Jan	510	NA	0.11	NA	NA
Waste Water	S-10	9-Feb	520	43.23	0.091	0.144	4.489
Waste Water	Majhee-K	30-Dec	200	NA	0.052	NA	NA
Waste Water	Majhee-K	13-Jan	180	NA	0.031	NA	NA
Waste Water	Majhee-K	10-Feb	520	14.85	0.011	0.113	3.414
Waste Water	Killar-K	30-Dec	112	NA	NA	NA	NA
Waste Water	Killar-K	13-Jan	72	NA	0.027	NA	NA
Waste Water	Killar-K	10-Feb	250	27.6	0.007	0.076	3.105
Waste Water	Kalib-K	30-Dec	205	NA	0.023	NA	NA
Waste Water	Kalib-K	13-Jan	212	NA	0.03	NA	NA
Waste Water	Kalib-K	10-Feb	230	56.55	0.021	0.049	2.16
Waste Water	Tanbaz-K	30-Dec	356	NA	NA	NA	NA
Waste Water	Tanbaz-K	13-Jan	430	NA	0.039	NA	NA
Waste Water	Tanbaz-K	10-Feb	460	82.25	0.023	0.073	1.027
Waste Water	BKRD-K	30-Dec	110	NA	NA	NA	NA
Waste Water	BKRD-K	13-Jan	35	NA	0.018	NA	NA
Waste Water	BKRD-K	10-Feb	110	64.76	0.021	0.076	1.226
Waste Water	Dholai-K	31-Dec	280	NA	NA	NA	NA
Waste Water	Dholai-K	12-Jan	210	NA	0.117	NA	NA
Waste Water	Dholai-K	12-Feb	480	50.18	0.066	0.14	2.281
Waste Water	Narai-K	6-Jan	40	NA	0.018	0.068	0.072
Waste Water	Narai-K	5-Feb	140	NA	0.014	0.07	1.802
Waste Water	Narai-K	26-Feb	270	27.54	0.043	0.06	1.964
Waste Water	DND-K	14-Jan	105	NA	0.052	NA	NA
Waste Water	DND-K	8-Feb	80	NA	0.03	0.039	4.418
Waste Water	DND-K	28-Feb	58	2.73	0.025	0.02	3.55

Table A. 11 :Wastewater Quality Data in the Wastewater Outlets located in the periphery of Dhaka

Station	Date of collection	Flow (m³/s)	Parameters Tested(mg/l)								Coliform (1000/100)	
			BOD	COD	NH3-N	NO3-N	PO4	Cr	Pb	Zn	T.coli	F.coli
S3	Jan-98		11							1.102	3.8	3.1
S3	Feb-98		95					0.015		2.399	0.56	0.42
S3	Feb-98		155		4.42		0.37	0.016	0.022	0.163		10.8
S4	Jan-98		27					0.017	0.057	0.21	102	82
S4	Feb-98		90		10.53		1.89	0.014	0.066	2.392	640	520
S4	Feb-98		42.5					0.022	0.016	2.986		1200
S4	Mar ,04	0.3	54	89	0.605	1.7		0.218	0.022			
S5	Jan-98		51					0.013	0.049	0.265	987	836
S5	Feb-98		240		27.63		7.15	0.024	0.057	0.521	54000	32000
S5	Feb-98		230					0.027	0.068	3.555		9200
S5	Mar ,04	0.1	52		0.325	0.8		0.185	0.107			
S5	Apr,04	0.1	30		0.26	1.7	5.15	0.00083	<0.001			
S6	Jan-98		52	86				0.017	0.016	0.23	667	525
S6	Feb-98		390	69	33.43		8.01	0.018	0.058	0.621	3920	3000
S6	Feb-98		85					0.031	0.114	4.941		2000
S6	Mar ,04	1.4	175	291	0.121	1.6		0.0045	0.0048			
S6	Apr,04	1.4	45	138	0.286	2.1	9.4	0.00043	<0.001			
S7	Dec-97		400					10.08				
S7	Jan-98		580					31.083				
S7	Feb-98		420		98.9		8.82	17.24	0.151	2.654		3200
S7	Apr,03	1.3	460	886	1.19			1.49	0.143			
S7	Dec-03	0.385	1450	2402	25.6	2.5		22.42	4.83			
S7	Mar ,04	0.64	1280	2130	1.875	5.8		7.28	0.0056			
S7	Apr,04	0.82	425	2134	1.396	8.9	6.25	1.746	<0.001			
S8	Dec-97		110					0.058				
S8	Jan-98		155					0.125				
S8	Feb-98		580		40.88		13.3	0.27	0.111	2.161		17600
S8	Apr,03	0.45	28	154	0.46			0.042	0.131			
S8	Dec-03	0.36	123	240	0.37	1		0.17	<0.001			
S8	Mar ,04	0.1	1425	2374	2.48	2.8		26.45	0.01			
S8	Apr,04	0.3	60	205	0.289	1.2	1.55	0.048	<0.001			
S9	Jan-98		305					0.039				
S9	Feb-98		240		50.45		12.79	0.029	0.129	2.46		24800
S9	Apr,03		130	419	0.04			0.038	0.146			

Table A. 11 Continued : Wastewater Quality Data in the Wastewater Outlets located in the periphery of Dhaka

Station	Date of collection	Flow (m³/s)	Parameters Tested(mg/l)								Coliform (1000/100)	
			BOD	COD	NH3-N	NO3-N	PO4	Cr	Pb	Zn	T.coli	F.coli
S9	Dec-03		170	380	0.28	1.7		0.075	<0.001			
S9	Mar ,04		625	1042	0.055	0.3		0.085	0.112			
S9	Apr,04		150	585	0.157	5	9.45	0.014	<0.001			
S10	Jan-98		510					0.119				
S10	Feb-98		520		43.23		14.94	0.091	0.144	4.489		20000
S10	Apr,03	1	125	535	0.05			0.034	0.146			
S10	Dec-03	0.5	480	825	0.24	2.2		0.082	<0.001			
S10	Mar ,04	0.6	450	739	0.05	1.5		0.033	0.027			
S10	Apr,04	0.32	140	565	0.085	5.7	7.65	0.01128	<0.001			
S11	Dec-03	0.8	68	139	0.17	0.8		0.057	<0.001			
S11	Mar ,04	0.1	115	188	0.226	1		0.0047	0.012			
Dholai Kha	Dec-97		280					nill				
Dholai Kha	Jan-98		210					0.117				
Dholai Kha	Feb-98		480		50.18		16.62	0.066	0.14	0.14		20000
Dholai Kha	Apr,03	5	65	425	0.1			0.022	0.142			
Dholai Kha	Dec-03	4	420	735	0.19	1.2		0.4	<0.001			
Dholai Kha	Mar ,04	3.1	125	510	0.13	0.9		0.0048				
Dholai Kha	Apr,04	4	380	652	0.04	5.4	2.07	0.016	<0.001			<0.002
Norai khal	Jan-98		40					0.018	0.068	0.072	3200	2000
Norai khal	Feb-98		140					0.014	0.07	1.802	2400	800
Norai khal	Feb-98		270		27.54		8.04	0.043	0.06	1.964		74
Norai khal	Apr,03	7.29	27.5	126	0.14			0.0015	0.114			
Norai khal	Feb-04	5.93	60	116	0.43	1.5		0.02	<0.001			
Norai khal	Mar ,04	15.16	32	100	0.11	1.4		0.00371	0.00124			
Norai khal	Apr,04	16.32	30	88	18.84	9.5	6.85	<0.001	<0.001			
K. Road Kh	Dec-97		110									
K. Road Kh	Jan-98		35					0.016				
K. Road Kh	Feb-98		110		64.76		25.95	0.021	0.076	1.226		960
K. Road Kh	Feb-04	0.2	150	178	0.66	0.4		0.004	0.002			
K. Road Kh	Mar ,04	0.15	50	154	0.62	0.2						
K. Road Kh	Apr,04	0.2	450	756	0.21	2.9	6.75	0.002	<0.001			

APPENDIX- B

Pollution scenario of the Buriganga River



Figure B-1: Dholai khal out fall contains sewage and polluted water



Figure B-2: One of the canals emptying highly toxic effluents into the Buriganga River.
PHOTO Syed Zakir Hossain (The Daily Star, 27/12/06)



Figure B-3: Buriganga not only encroaching but also effluent from different factories and houses are being discharge into without treatment



Figure B-4: Liquid waste and solid waste from factories and tanneries dumped into the Buriganga



Figure B-5: Encroachment of the Buriganga River at Kamrangir Char



A dyeing factory worker dumps wastes into the River Buriganga on Thursday despite repeated drives against pollution of the river.
— New Age photo

Figure B-6: A dyeing factory worker dumps wastes into the Buriganga River.



Figure B-7: Solid waste dumped into the river side and changes its cross section



Figure B-8: Sewage disposal at Buriganga



Figure B-9: Polythene bags hazard for deteriorating quality in the Buriganga River



Figure B-10: Untreated sewage disposal into the Buriganga



Figure B-11: Industrial effluent discharge point at Kaliganj Bazar



Figure B-12: Solid waste along the Buriganga River