RIVER WATER QUALITY REPORT 2013

Department of Environment
Ministry of Environment and Forests
Government of the People's Republic of Bangladesh

River Water Quality Report 2013

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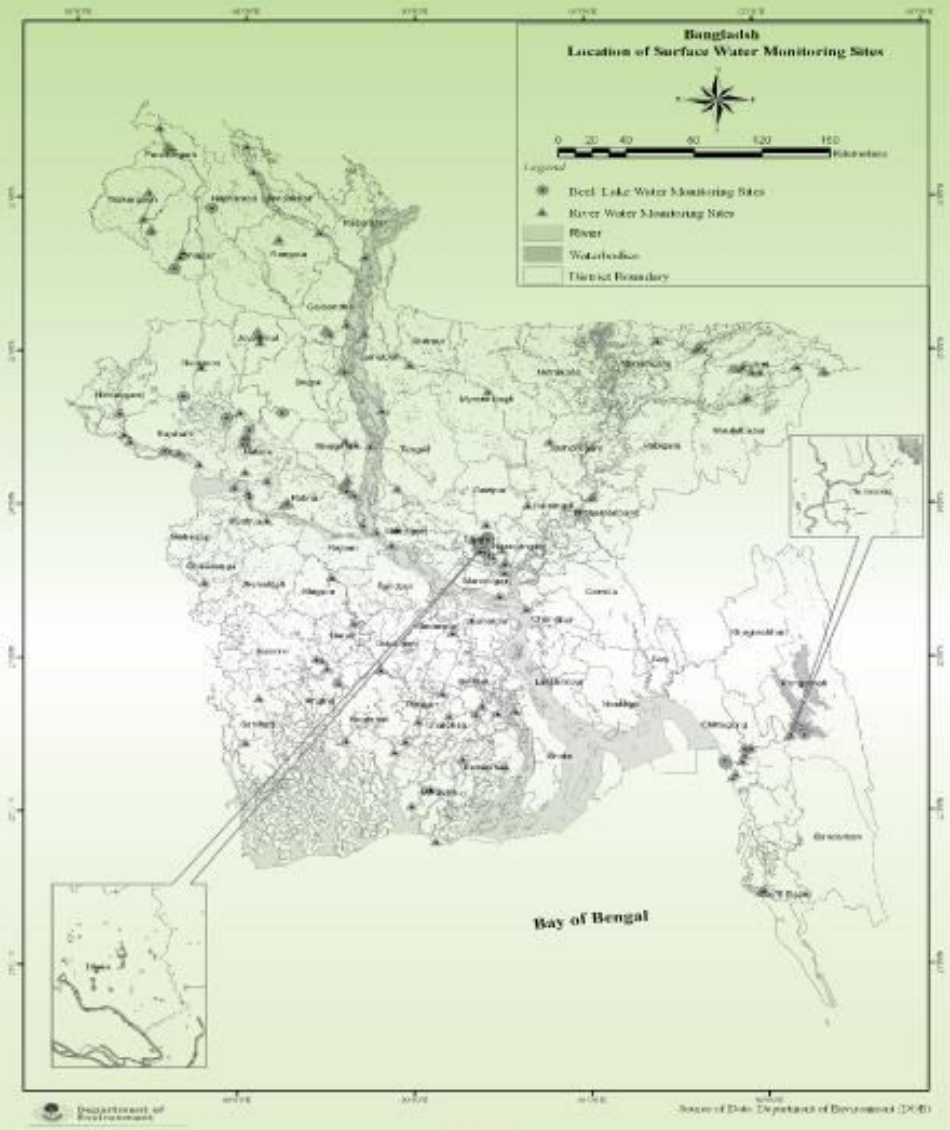

Department of Environment
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MESSAGE

Water is life where quality and quantity of water really matters. The Department of Environment (DoE) has been monitoring surface water quality since its origin in 1973. DoE monitor surface water quality following its monitoring network that includes major rivers and lakes. Monitoring information reprint water resource quality of major rivers of Bangladesh.

Bangladesh is criss-crossed by hundreds of rivers, streams, canals and creeks with a total length of at least 24,000 km and an area of 4,600 sq.km. The combined total catchment area of the Ganges the Brahmaputra-the Meghna (GBM) river systems is about 1.74 million sq. km of which seven percent lies within Bangladesh. In this riverine Bangladesh water greatly occupies most avenues of lives and livelihoods. Water is the central gem of all production activities where quantity and quality matters most.

"River Water Quality Report 2013" is the fourth of its kind that shed light on present status of river water quality in Bangladesh and also highlighted the necessary steps to be taken for sustainable management of aquatic ecosystems.

I express my sincere gratitude to the Natural Resource Management and Research section, DoE for preparing this report.

I hope this document will be useful in the decision making process for conservation of degraded riverine ecosystems of Bangladesh.

Md. Raisul Alam Mondal
Director General

FOREWORD

Being a country of rivers, Bangladesh needs to adopt adequate measures to halt further degradation of our precious water resources. The river water quality report 2013 contains statistical analyses of various water quality parameters of different rivers of the country for the period from January to December 2013. It offers a clear view of present situation and recommends ways and means for conservation and sustainable use of water.

Population pressure, release of untreated waste and effluent from urban areas and industrial units, and encroachment are the main causes for deterioration of water quality. Upstream withdrawal of water and salinity intrusion due to sea level rise are also responsible for degradation of river water quality. River water resources will always serve as the basis for securing lives and livelihoods for millions of people by providing different ecosystem services in this river-floodplain country.

The report suggests future programme of actions for conservation of river water resources. We have to implement these activities recommended in this report to pave the way of conservation and sustainable use of water resources at various levels of our development agenda.

Dr Sultan Ahmed
Joint Secretary
and
Director (NRM and Research)

TECHNICAL NOTE

Productivity of aquatic ecosystem greatly depends on quality of water. To maintain quality of water resources monitoring of water resources is essential. Despite discontinuous and measurement of fewer parameters, this report would shed some light on river water quality of the country. Water quality parameters like P^H, DO, BOD, COD, Turbidity, TDS, SS, Total Alkalinity, EC and Chloride presented in this report were measured more or less round the year of 2013. River water quality varied in spatiotemporal contest. From the analyses, impact of seasons and industrialization on water quality surfaced up especially for the rivers surrounding Dhaka city. During the rainy season water quality of most rivers (under the monitoring programme) was good while comparing with the Environmental Quality Standard (EQS) set in the ECR, 1997. Water quality of rivers around Dhaka city, Chittagong and Khulna did not comply with EQS in the dry season indicating the most probable effect of dense industrialization in those areas followed by increased human pressure on rivers. The difference in pollution level among the sampling points along a single river was also evident. Salinity level of rivers in southern Bangladesh greatly increases during dry seasons while salinity comes down to EQS during wet season. Sometimes salinity became exceptionally high. Long dry period may be the proximate cause of high salinity of surface water in southern region. To get clearer picture on water quality, more intense and systematic monitoring is essential. However, current condition of surface water quality fingers to noncompliance of rules by the industries as well as intuitions responsible for domestic and other wastes management. Hence, this is a need to escalate monitoring and enforcement activities as well as awareness building in all walks of life to achieve sustainable management of water resources.

Dr. Md. Sohrab Ali
Deputy Director (Water & Bio.)

EXECUTIVE SUMMARY

Rivers are important features of Bangladesh's landscape where hundreds of rivers crisscrossed the landmass and playing role of artery and veins. Rivers are mainly used for irrigation, fisheries, drinking water, navigation and industrial purposes. Bangladesh's streams and rivers are also the home to a wide variety of aquatic flora and fauna. The volumes of water they carry vary widely depending on the season, heavy summer rainstorms, upstream diversion of water flow and dry winter months.

The Department of Environment (DoE) has been monitoring surface and ground water quality since 1973. The surface water quality-monitoring programme of DoE supposed to include 63 stations of the 27 rivers in Bangladesh. But divisional offices monitored water quality only 27 rivers at monthly interval. The monitoring involved making field measurements (only pH at some stations) and collecting water samples for laboratory analyses. Six divisional offices measured 12 parameters (physical and chemical) of collected samples. Depending on continuity of measurements and spatio-temporal context, we took ten parameters (viz. pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solid (SS), Total Dissolved Solid (TDS), Electrical Conductivity (EC), Chloride, Turbidity and Total Alkalinity for analyses.

Based on the parameters mentioned above water quality of the major rivers viz. Padma, Meghna, Jumuna, Dhaleshwari, Surma, Korotoa etc. was within the limit of Environmental Quality Standards (EQS) in 2013 while rivers around greater Dhaka were highly polluted spicially in the first five months of 2013 in terms of DO, BOD and COD value. No dissolved oxygen was found from January to May at different location of Buriganga, Shitalakhya and Turag River. High levels of Chloride (144.5 mg/l), TDS (714 mg/l), BOD (57 mg/l) and COD (157 mg/l) were found in Buriganga river from January to December in 2013. In Meghna DO and BOD levesl were found within the EQS which varied from 1.8 to 6.7 mg/l and 0.0 to 35 mg/l, respectively. In Jamuna DO and BOD levels were found from 5.2 to 8.3 mg/l and 5.2 to 9.0 mg/l, respectively.

High levels of Chloride, TDS and Turbidity were found higher in Moyuri, Rupsha, Pashur and Kakshiali River. Highest level of Chloride (8357.39 mg/l) and TDS (13,000 mg/l) were found in Pashur river. Highest value of Turbidity (129 NTU) was found in Kakshiali river. More than 400 mg/l COD was found in Karnapuli river.

ACKNOWLEDGEMENT

We would like to thank all divisional offices of the Department of Environment for providing with water quality data. We sincerely acknowledge the kind support and guidance of Mr. Md. Raisul Alam Mondal, Director General, Department of Environment for preparation of this report. We express our sincere thanks to the reviewers for their suggestions and comment in preparing this report. Special thanks go to six divisional offices and their laboratory personnel for their kind contribution in terms of collecting and providing us with river water quality data.

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ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
ECA	-	Ecologically Critical Area
ECR	-	Environmental Conservation Rules
DO	-	Dissolved Oxygen
DoE	-	Department of Environment
EQS	-	Environmental Quality Standard
GEMS	-	Global Environment Monitoring System
GPS	-	Global Positioning System
IWM	-	Integrated Watershed Management
NTU	-	Nephelometric Turbidity Unit
SoE	-	State of the Environment
TDS	-	Total Dissolved Solid
WQI	-	Water Quality Index
WCZ	-	Water Control Zone

CHAPTER 1: INTRODUCTION

1.1 Background

In Bangladesh, rivers, their tributaries and distributaries are the main source of fresh water for all forms of lives. To evaluate water quality for human consumption and other uses the Government has set specific standards for inland surface water in the Environmental Conservation Rules (ECR), 1997.
Monitoring surface water quality is one of the vital work of the Department of Environment (DoE). The information obtained from monitoring would constitute part of diagnosis of functionality of aquatic ecosystem. Also it would help evaluating effectiveness of the pollution control measures and would provide necessary input for development of water resource management plan.

The flows in the rivers varies greatly depending on seasons, rainfall intensity and upstream diversion of trans-boundary rivers. Following fluctuation in flow river water quality varies significantly. A significant portion of the river's base flow in the country is obstructed for potable use. This together with dry winter and diversion of upstream flow greatly reduce the river's flow volume, and its natural flushing and purification capacity. Dumping of industrial untreated waters, household and municipal wastes etc. into water courses further degrade surface water quality. Because of severe pollution, Government has already declared four rivers (Buriganga, Shitalakhya, Turag and Balu) as Ecologically Critical Area (ECA) to protect from further pollution.

To monitor surface water quality the Department of Environment (DoE) has setup a monitoring network. Following this network, DoE collect surface water samples for laboratory analyses. Samples are collected on monthly basis from selected sampling points of rivers under the monitoring network. In 2013, the monitoring program covered 63 sampling locations in 27 rivers. About 50% of these locations were monitored on monthly basis.

1.2 Major objectives of the report

- To provide updated information on the river's water quality to help information based decision-making process for sustainable development and management of water resources.
- Sensitization and awareness building among the stakeholders.
- To provide information for research/study in the relevant field.
- Information sharing and preparation of State of the Environment (SoE) Report.
- To provide water quality data to Global Environment Monitoring System (GEMS).

1.3 Limitation of the report

This report has been prepared based on primary data and information collected from six divisional offices of DoE for the period of January to December 2013. The following are the limitations of the report:

- Data on all the parameters as per ECR 1997, for the entire period could not be furnished with this report due to lack of irregular sampling and laboratory analyses.
- This report lacks of information on microbiological parameters.
- Data on weather conditions of the sampling locations, at the time of sampling were unavailable.

CHAPTER 2: AN OVERVIEW OF BANGLADESH'S RIVERS

Rivers of Bangladesh

Rivers are the most important elements of physiographic features of Bangladesh. The Padma, the Jamuna and the lower Meghna are the widest rivers, with the latter expanding to around eight kilometers across in the wet season, and even more during the floods. The pride of Bangladesh is its rivers with one of the largest networks in the world with a total number of about 700 rivers including tributaries and distributaries having total length of about 24,140 km (Banglapedia, 2006). These all together cover about 7 percent of country's surface area. The watercourses of the country are unevenly distributed. They increase in numbers and size from the northwest to the southeastern region.

The river system of Bangladesh is extremely dynamic. The discharge carried by those rivers has a wide seasonal fluctuation peaking at the monsoon (July to September). Bangladesh has predominantly four major river systems. They are –

- The Brahmaputra-Jamuna,
- The Ganges-Padma,
- The Surma-Meghna, and
- The Chittagong Region river system.

The principal rivers of Bangladesh are the Padma, the Megna, the Jamuna, the Brahamaputra, the Dhaleswari and the Karnafuli. Besides those rivers, there are many small rivers like the Buriganga, the Sitalakhya, the Gumti, the Tista, the Atrai, the Korotoa, the Mohananda, the Madhumati and many others.

CHAPTER 3: MEASUREMENT OF RIVER WATER QUALITY

3.1 Water quality parameters

A comprehensive range of physico-chemical parameters like Temperature, Electrical Conductivity (EC), Dissolved Oxygen (DO), pH, Total alkalinity, Turbidity, Total Dissolved Solid (TDS), Suspended Solid (SS), Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD) were set in the ECR'97 to assess the inland water quality in Bangladesh. But only a few of them commonly analyzed by the divisional offices. Modified Winkler's Method was used to analyze DO, Dilution Method for BOD5, Closed Reflux Colorimetric Method for COD, Argentometric Methods for Chloride and Gravimetric Methods for TDS.

3.2 Comparison with standards for inland surface water

River water quality was compared with the Environmental Quality Standard (EQS) set in the rules for inland surface water to get insight about the state of the river ecosystems in Bangladesh. This is essentially helpful for development planning and management of aquatic ecosystems.

CHAPTER 4: RIVER WATER QUALITY IN 2013

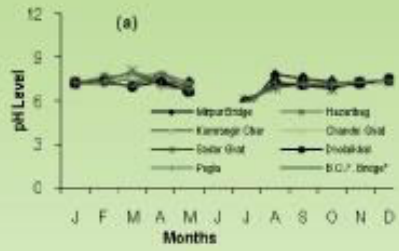
4.1 Buriganga River

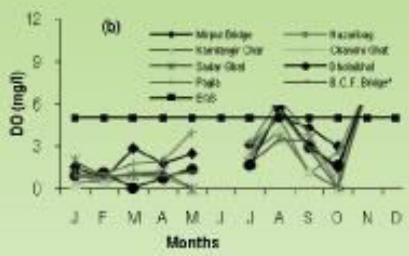
To monitor water quality of Buriganga river samples were collected from eight different locations viz. Mirpur Bridge, Hazaribag, Kamrangir Char, Chandni Char, Sadar ghat, Dholaikhal, Bangladesh China Friendship Bridge (BCFB) and Pagla along the river.

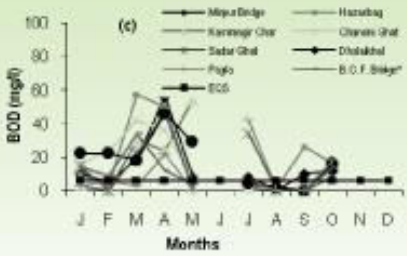
In 2013, pH among different locations varied from 5.36 to 8.03 (Fig.1a) while standard pH range for inland surface water for fisheries is 6.5 to 8.5. In 2012, pH level varied from 6.4 to 7.9. Dissolved oxygen (DO) in Buriganga river water was very low in 2013. In 2013, DO of Buriganga river was lower than EQS (≤5 mg/l). The maximum DO (7.3 mg/l) was found at B.C.F. Bridge in November and the minimum (0.0 mg/l) was at Hazaribag in May (Fig.1b). Direct discharge of untreated effluent from industries, domestic wastes, tannery wastes into the river and reduced flow of water are the proximate causes for depletion of DO in dry season. DO level was slightly increased in wet season (June to November) at all locations of the river. In 2012, DO level varied from 0.45 mg/l to 5.08 mg/l.

In 2013, BOD of Buriganga river was higher than EQS (≤6 mg/l). At Hazaribag point BOD level was much higher than EQS for fisheries round the year (Fig.1c). This was mainly because of discharge of untreated tannery wastewater into the river. The maximum BOD (57 mg/l) was found at Hazaribag in March and the minimum (0.0 mg/l) was at Kamrangir Char in February. In 2012, BOD range was 1.01-48 mg/l. In 2013, COD level was mostly below the EQS (200 mg/l) set for industrial wastewater after treatment. The maximum and the minimum COD concentration of Buriganga river was 152 mg/l at Kamrangir Char in May and 1.0 mg/l at Hazaribag point in July (Fig.1d). In 2012, COD varied from 5.0 mg/l to 283 mg/l.

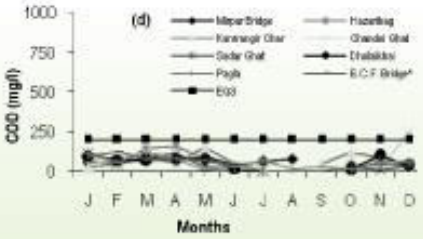
TDS of Buriganga river varied from 14 to 714 mg/l (Fig.1e) against the EQS of 2100 mg/l for industrial wastewater after treatment. In 2012, TDS concentration varied from 70 to 432 mg/l. Chloride concentration of the Buriganga river was below the EQS for industrial wastewater after treatment. The maximum concentration was 144.5 mg/l at Hazaribah point in May and the minimum 1.25 mg/l at Kamrangir Char in February (Fig.1f). In 2012, Chloride concentration varied from 3.5 mg/l to 133.96 mg/l. Turbidity range varied from 1.25 to 62.7 NTU against the EQS (10 NTU) (Fig.1g). In 2012, Turbidity range varied from 0.97 to 1.41 NTU.

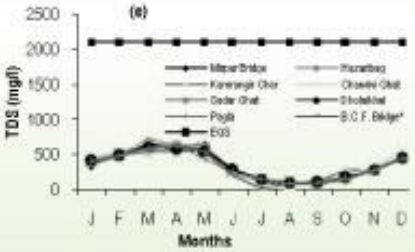


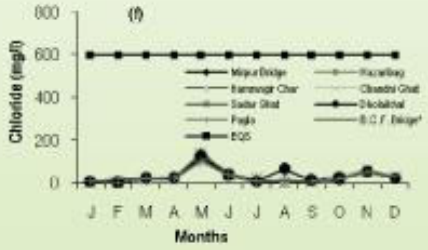




Note: Highest BOD was recorded 57 mg/l at Hazaribag in March 2013.







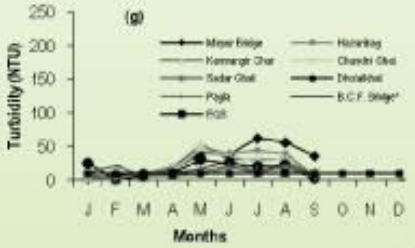


Fig.1. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Buriganga river in 2013

Table-1. Level of Total alkalinity at different sampling locations of Buriganga river in 2013

Sampling Locations of Buriganga River	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	142	150	190	212	300	50	55	42	80	108	-	-
Hazaribag	130	145	305	299	330	60	59	44	100	138	140	230
Kamrangir Char	130	143	290	285	320	120	60	55	110	198	156	235
Chandni Ghat	170	163	295	302	300	90	79	50	70	128	190	220
Sadar Ghat	150	172	252	287	310	100	80	52	80	118	185	230
Dholaikhal	160	142	282	300	270	110	90	42	60	173	175	190
B.C.F. B*	140	145	290	292	250	90	68	48	70	100	159	200
Pagla	135	140	161	182	200	50	110	50	70	118	192	215
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Total Alkalinity of Buriganga river was 302 mg/l at Chandni Ghat in April and 42 mg/l at Dholaikhal in August (Table-1).

Table-2. Level of EC at different sampling locations of Buriganga river in 2013

Sampling Locations of Buriganga River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	737	995	1338	1288	1235	542	203	161.4	176.1	339	-	-
Hazaribag	857	1023	1453	1297	1273	520	261	151.2	285	355	580	920
Kamrangir Char	830	1008	1099	1188	1120	512	260	155.1	251	602	582	916
Chandni Ghat	942	1093	1306	1252	1236	458	275	253	214.2	426	702	1134
Sadar Ghat	822	1005	1264	1296	1172	536	278	212	187.2	353	587	936
Dholaikhal	829	980	1207	1195	1090	561	290	164.1	210.9	255	583	893
B.C.F. B*	834	1004	1104	1252	1081	412	28	170.8	211.4	277	589	906
Pagla	803	969	1028	1286	878	498	292	157.4	194.5	245	544	903
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

Electrical Conductivity at different locations of Buriganga was below the EQS (1200 µmhos/cm) except the month of February to May for treated wastewater from indusial units (Table-2). The maximum and the minimum EC of Buriganga river was 1453 mg/l at Hazaibag in March and 28 mg/l at B.C.F.B in July.

Table-3. Level of SS at different sampling locations of Buriganga river in 2013

Sampling Locations of Buriganga River	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	41	312	3738	-	155	62	11	52	67	26	-	-
Hazaribag	61	292	7486	-	117	37	9	38	08	11	13	11
Kamrangir Char	84	305	859	-	104	21	8	28	20	57	6	10
Chandni Ghat	238	1062	112	-	105	33	23	32	31	22	7	143
Sadar Ghat	1498	405	766	-	55	20	10	22	11	13	8	10
Dholaikhal	595	81	590	-	21	15	16	18	24	12	02	6
B.C.F. B*	192	510	10	-	22	24	13	24	08	5	10	16
Pagla	208	125	443	-	9	16	11	15	22	7	04	15
EQS for wastewater after treatment from industrial units 150 mg/l												

Suspended Solid (SS) of Buriganga river at different locations was below the EQS (150 mg/l) for wastewater after treatment from industrial units. The maximum and the minimum SS was 7486 mg/l at Hazaribag in March and 2 mg/l at Dholaikhal in November (Table-3)

4.2 Shitalakhya River

Shitalakhya river is a distributary of the Brahmaputra river. It remains navigable round the year. For monitoring water quality, samples were colleted from three different locations viz. Demra Ghat, Ghorasal Fertilizer Factory (GFF) and near ACI factory at Narayanganj.

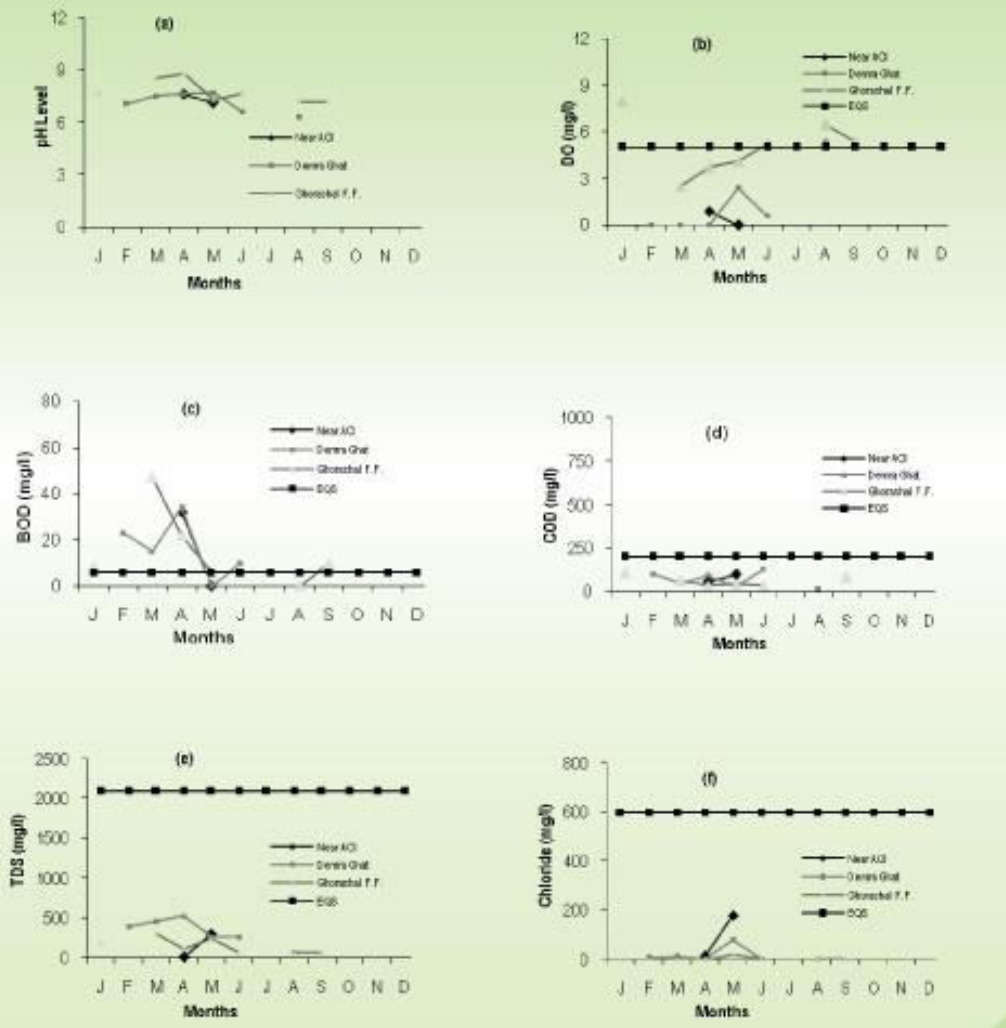


Fig.2. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Shitalakhya river in 2013

In 2013, pH level of Shitalakhya river water was within the EQS (6.5-8.5) for inland surface water. The maximum pH was 8.8 in April at Ghorasal F.F and the minimum PH was 6.31 in August at Damra Ghat (Fig.2a). In 2012, pH varied from 6.7 to 8.64. In 2013, the maximum DO (6.5 mg/l) was found at Ghorasal F.F in August and the minimum (0.6 mg/l) was found at Demra Ghat in March (Fig.2b). In 2012, DO varied from 0.6 to 6.2 mg/l.

In 2013, BOD at Demra Ghat was very high during dry period. At Ghorasal F.F BOD was within the EQS (≤6 mg/l) for fisheries in May and June. Highest value of BOD (47 mg/l) was found at Ghorasal F.F in March and that of lowest (0.0 mg/l) was in August respectively (Fig.2c). BOD concentration was higher at all locations in April. In 2012, BOD concentration varied from 2.0 mg/l to 16 mg/l. In 2013, COD level was within the EQS (200 mg/l) for wastewater after treatment from industrial units at all locations of Shitalakhya river. Among all the locations of the Shitalakhya river COD was lowest at Damra Ghat (Fig.2d). The maximum COD (130 mg/l) at Damra Ghat in June and the minimum COD (16 mg/l) was in August, respectively. In 2012, COD level varied from 14 mg/l to 73 mg/l. TDS of Shitalakhya river varied from 5.0 to 523 mg/l against the EQS (2100 mg/l) for wastewater after treatment from industrial units. In dry season TDS (523 mg/l) was high at Damra Ghat sampling location (Fig.2e). In 2012, TDS range was 52 to 392 mg/l. Chloride concentration of the Shitalakhya river in 2012 was below the EQS (600 mg/l) for wastewater after treatment from industrial units. The maximum Chloride (179.5 mg/l) was found at ACI point in May and the minimum was 0.7 mg/l at Ghorasal F.F in January, 2012 (Fig.-2f). In 2012, Chloride concentration varied from 1.3 mg/l to 110 mg/l.

Table-4. Level of SS at different sampling locations of Shitalakhya river in 2013

Sampling Locations of Shitalakhya River	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	-	19	-	-	-	-	-	-	-
Demra Ghat	-	5210	1143	-	36	18	-	36	37	-	-	-
Ghorashal Fertilizer Factory (GFF)	422.8	-	598	-	3	17	-	42	-	-	-	-
EQS for wastewater after treatment from industrial units 150 mg/l												

SS of Shitalakhya river water at different locations was within the EQS (150 mg/l) except the month of February. Maximum SS concentration of Shitalakhya River was 5210 mg/l in February and minimum 3 mg/l in May (Table-4).

Table-5. Level of EC at different sampling locations of Shitalakhya river in 2013

Sampling Locations of Shitalakhya River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	1044	598	-	-	-	-	-	-	-
Demra Ghat	-	798	933	1064	514	519	-	127.4	-	-	-	-
Ghorashal Fertilizer Factory (GFF)	376	-	622	-	469	136.4	-	139.1	139.1	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC of Shitalakhya river at different locations was within the EQS (1200 µmhoms/cm) for treated wastewater from industrial units (Table-5) except in the month of April. The maximum EC (1064 µmhoms/cm) was at Demra Ghat in April and the minimum EC (127.4 µmho/cm) was at Demra Ghat in August.

Table-6. Level of Total alkalinity at different sampling locations of Shitalakhya river in 2013

Sampling Locations of Shitalakhya River	Total alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	220	142	-	-	-	-	-	-	-
Demra Ghat	-	190	650	285	200	39	-	0	-	-	-	-
Ghorashal Fertilizer Factory (GFF)	100	-	250	-	130	29	-	-	60	-	-	-
EQS for wastewater after treatment from industrial units 150 mg/l												

Maximum T. alkalinity (650 mg/l) was at Demra Ghat in March and that of minimum (0.0 mg/l) was at sampling point in August (Table-6).

4.3 Turag River

The Turag river is the upper tributary of the Buriganga. To monitor water quality in 2012, water samples were collected from near Fulpukuria Dyeing Ltd., near Hossain Dyeing Ltd., near Tongi Rail Bridge and near Azmeri Composite Ltd.

In 2013, the pH range (7.1- 8.03) (Fig.-3a) of Turag river was within EQS (6.5 -8.5). The maximum pH 8.03 (near Azmeri Composite Ltd.) was found in March and the minimum pH 7.1 was found in August at near Azmeri Composite Ltd. In 2012, pH range was 6.7 to 8.4. DO concentration of Turag river was very low during dry season of 2013 and it varied 0 to 4.6 (Fig.-3b). In 2012, DO was varied 0.6 to 6.1. BOD of Turag river water was beyond the EQS (≤6 mg/l) for all locations. The maximum BOD was 65 mg/l in January at near north side of Tongi Bridge and the minimum was 0.0 mg/l in August at near Fulpukuria Dyeing Ltd. (Fig.-3c). In 2012, BOD varied from 5.0 mg/l to 38 mg/l. In 2013, COD at all locations of Turag river was below the EQS (200 mg/l) for wastewater after treatment from industrial units. The maximum and the minimum COD content of Turag river water

was 303 mg/l in march and 4 mg/l in August (Fig.-3d). In 2012, COD range was from 9 mg/l to 290 mg/l. TDS was below the EQS (2100 mg/l) for wastewater after treatment from industrial units (Fig.-3e) at all the sampling points. The maximum TDS was 1049 mg/l in April while that of the minimum was 98.4 in July. In 2012, TDS varied from 60 mg/l to 1020 mg/l. Chloride content of Turag river water was below the EQS (600 mg/l). The maximum Chloride was (133.8 mg/l) found in May at near Azmeri Composite Ltd. and the minimum Chloride was (8.0 mg/l) in August at near Hossain Dyeing Ltd. (Fig.-3f). In 2012, Chloride varied from 3.5 mg/l to 135 mg/l.

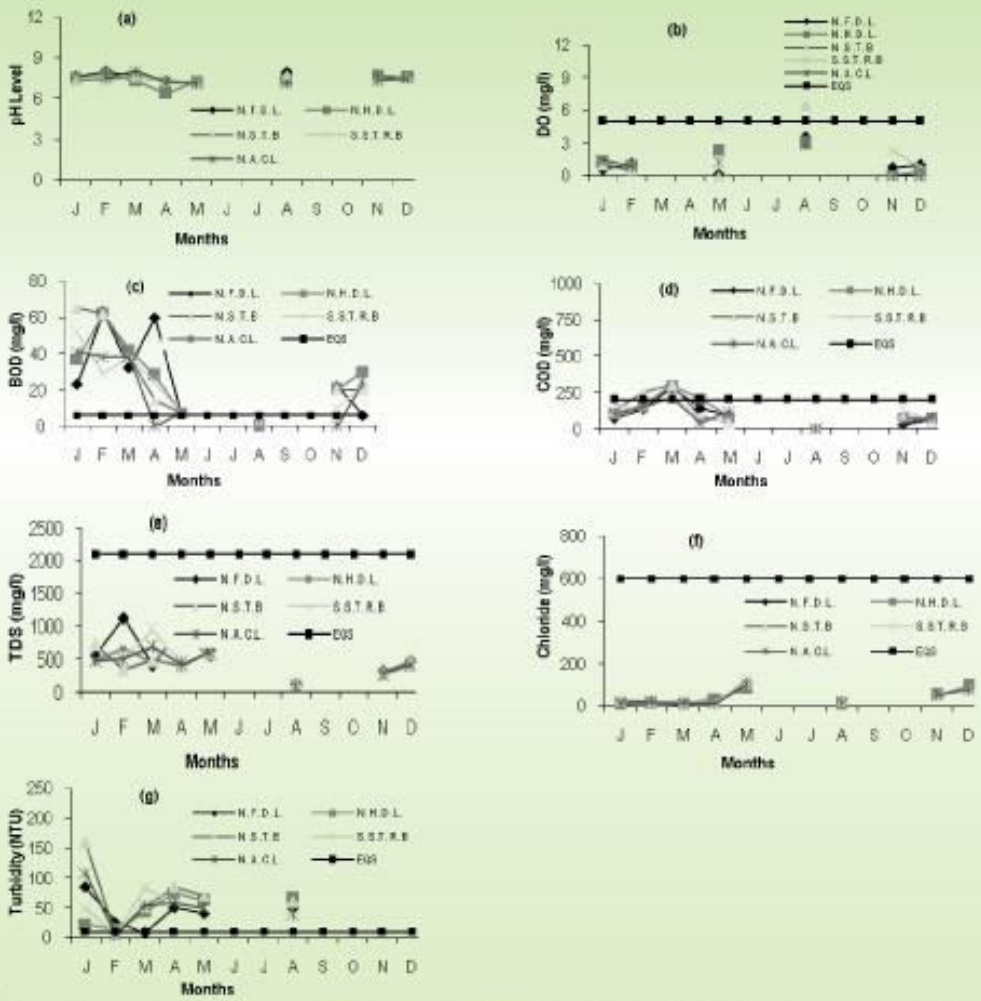


Fig.3. Graphical presentation of pH, DO, BOD, COD, TDS, Turbidity and Chloride of Turag river in 2013

Note: N.F.D.L = Near Fulpukuria Dyeing Ltd., N.H.D.L = Near Hossain Dyeing Ltd., N.S. T.B = North side of Tongi Bridge, S.S. T.R.B = South side of Tongi Rail Bridge, N.A.C.L = Near Azmeri Composite Ltd.

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Table-7. Level of Total Alkalinity at different sampling locations of Turag river in 2013

Locations of Turag River	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Near Fulpukuria Dyeing Ltd.	167	200	770	750	258	-	--	80	-	73	156	230
Near Hossain Dyeing Ltd.	179	161	840	820	222	-	-	78	-	93	190	210
North side of Tongi Rail Bridge	175	170	1070	1150	267	-	-	97	-	78	151	215
Near Istema field Tongi	220	206	965	850	275	-	-	85	-	68	162	210
Near Indigo Washing Plant Ltd.Tongi	184	304	1120	570	267	-	-	79	-	65	146	205
EQS for wastewater after treatment from industrial units 150 mg/l												

Total alkalinity at different locations of Turag river was mostly above the EQS. The maximum T. alkalinity (1150 mg/l) was near north side of Tongi Rail Bridge, Tongi, in April and the minimum (65 mg/l) in October Near Indigo Washing Plant Ltd.,Tongi (Table-7).

Table-7. Level of Total Alkalinity at different sampling locations of Turag river in 2013

Locations of Turag River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Near Fulpukuria Dyeing Ltd.	1114	2240	838	2070	1275	-	-	245	-	277	648	891
Near Hossain Dyeing Ltd.	965	1356	905	1912	1031	-	-	206	-	255	652	880
North side of Tongi Bridge	1474	715	1004	817	1216	-	-	280	-	245.0	606	910
Near Istema field Tongi	966	1040	1886	866	1183	-	-	219	-	217.4	539	781
Near Indigo Washing Plant Ltd.Tongi	991	1039	1414	836	1225	-	-	208	-	215.6	581	797
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

At different locations EC of Turag river water was within the EQS (1200 µmhos/cm). The maximum EC (2240 µmhos/cm) was in February at near Fulkpukuria Dyeing Ltd. and the minimum (208 µmhos/cm) was in August Near Indigo Washing Plant Ltd., Tongi (Table-8).

4.4 Dhaleshwari River

The Dhaleshwari river is a 160 km long distributary of the Jamuna river flowing through central part of Bangladesh. It starts off the Jamuna near the northwestern tip of Tangail. Then it branched into two: the north branch retains the name Dhaleshwari and the other branch flows as Kaliganga. The both branches merged at the southern part of Manikganj district. Finally the merged flow meets the Shitalakhya River near Narayanganj district. In 2013, water samples were collected from two locations namely Muktarpur Ghat, Munshiganj and Harindhara, Hemayetpur, Savar, Dhaka for analyses.

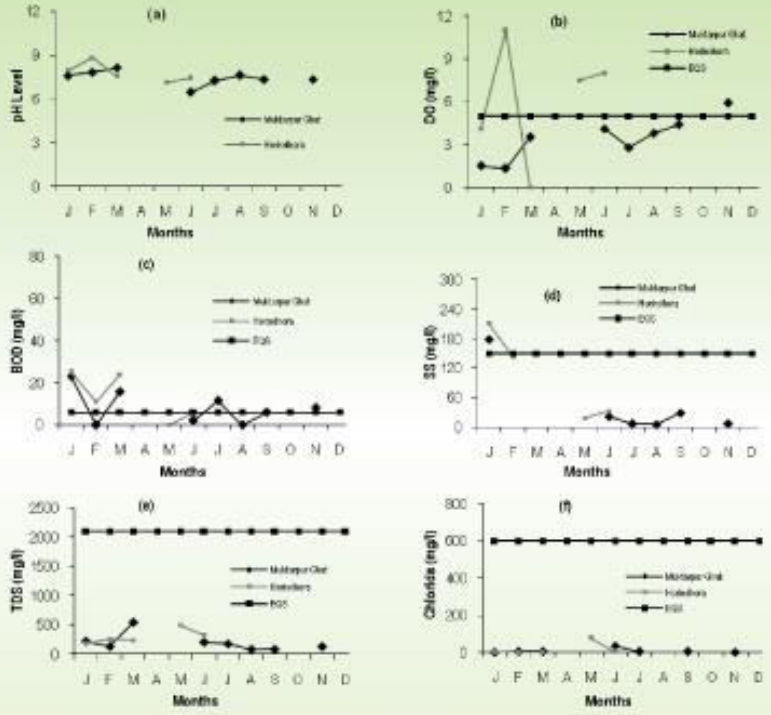


Fig.4. Graphical presentation of pH, DO,BOD, SS, TDS and Chloride of Dhaleshwari river in 2013

In 2013, pH of Dhaleshwari river water varied from 6.44 to 8.8 (Fig.-4a). In 2012, pH level varied from 6.4 to 8.46. In 2013, the maximum DO concentration (11 mg/l) was at Harindhara in February and the minimum (0.0 mg/l) in March, respectively (Fig.4b). In 2012, DO concentration varied from 1.0 to 10.9 mg/l. In 2013, BOD varied from 0.0 to 25 mg/l (Fig.4c) while EQS for fisheries is ≤6 mg/l. In 2012, BOD varied from 2.2 to 31 mg/l. Level of SS of Dhaleshwari river water was within the EQS. The maximum SS of Dhaleshwari river water was 1469 mg/l in February and the minimum was 5.0 mg/l in August (Fig.4d) against EQS (150 mg/l) for wastewater after treatment from industrial units. In 2012, SS varied from 18 to 4023.1 mg/l. TDS concentration varied from 79.1 to 552 mg/l (Fig.4e) while standard TDS level is 2100 mg/l for wastewater after treatment from industrial units. In 2012, TDS concentration varied from 92 to 217 mg/l. Chloride concentration ranged from 1.8 to 76.5 mg/l (Fig.4f), which is far below the EQS (600 mg/l) for wastewater after treatment from industrial units. In 2012, Chloride concentration range of Dhaleshwari river water was from 0.5 to 10.0 mg/l.

Table-9. Level of Total alkalinity at different sampling locations of Dhaleshwari river in 2013

Sampling Locations of Dhaleshwari River	Total alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshigonj	93	104	105	-	-	110	80	-	70	-	95	-
Horindhora,Hemayetpur Saver, Dhaka	75	110	222	210	180	30	-	30	-	83	-	-
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum Total Alkalinity of Dhaleshwari river water was 222 mg/l in March and the minimum was 30 mg/l in August (Table-9) at Hemayetpur.

Table-10. Level of EC at different sampling locations of Dhaleshwari river in 2013

Sampling Locations of Dhaleshwari River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshigonj	457	271	1121	-	-	412	354	165.8	183.7	-	216	-
Horindhora,Hemayetpur Saver, Dhaka	392	529	501	882	995	652	-	150.5	-	206.8	-	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

Electrical Conductivity of Dhaleshwari river at different locations was mostly within the EQS (1200 µmhos/cm) except the month of March. The maximum and the minimum EC of Dhaleshwari river water was 1121 µmhos/cm in March and 150.5 µmho/cm in August at Muktarpur Ghat (Table-10) respectively.

4.5 Brahmaputra River

The Brahmaputra, a trans-boundary river that originates from Manossavovar near Mount Kailash in the Himalayas and flows via Tibbet, China, India and Bangladesh to Bay of Bengal. The total length it travels from Himalayans to the Bay of Bangal is 2900 km (Chowdhury, 2006).

In 2013, pH level of Brahmaputra river varied from 7.69 to 8.67 (Fig.5a), while standard range for fisheries is from 6.0 to 8.5. In 2012, pH level varied from 6.63 to 8.1. DO concentrations varied from 5.9 to 13.5 mg/l (Fig.5b). The highest and the lowest DO was found in January and July respectively, while EQS of DO for fisheries is ≥5 mg/l. In 2012, DO varied from 5.4 to 9.4 mg/l. BOD concentration varied from 0.0 to 25 mg/l (Fig.5c) while EQS for fisheries is ≤6 mg/l. In 2012, BOD varied from 2.0 to 4.2 mg/l. The maximum and the minimum SS of Brahmaputra river water was 834.5 mg/l in March and 25 mg/l in January (Fig.5d), where EQS for treated wastewater from industrial units is 150 mg/l. In 2012, SS varied from 18 to 22 mg/l. Chloride level varied from 1.7 to 6.0 mg/l (Fig.5e) and was less than EQS (600 mg/l) for treated wastewater from industrial units. In 2012, Chloride concentration varied from 2.0 to 8.5 mg/l. TDS level ranged from 75.1 to 225 mg/l (Fig.5f) and was much below the EQS (2100 mg/l). In 2012, TDS level varied from 71 to 163 mg/l.

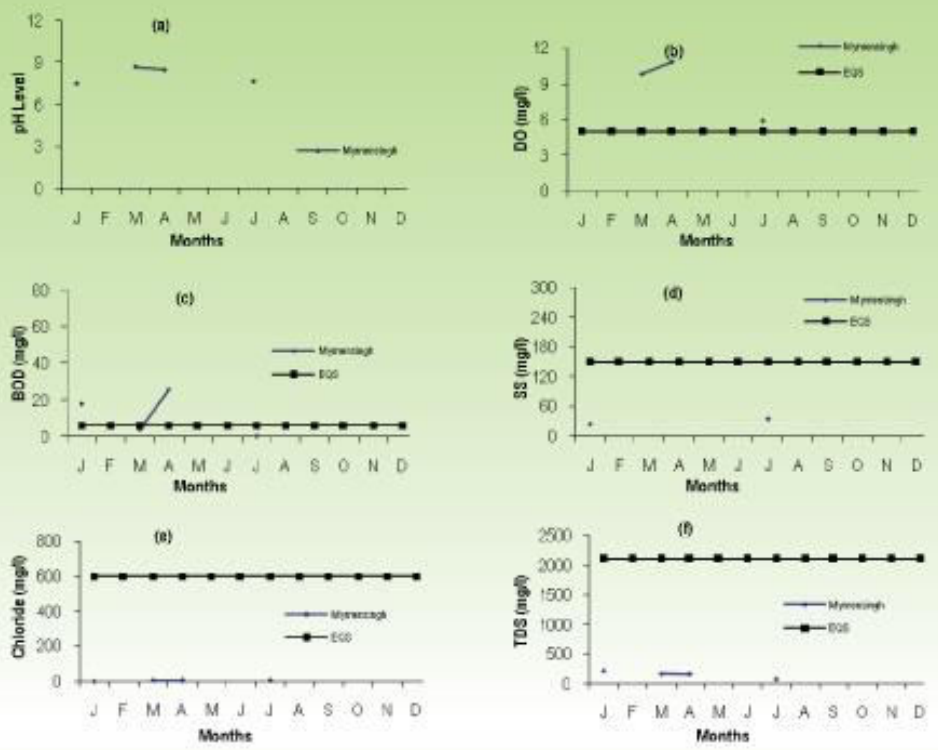


Fig.5. Graphical presentation of pH, DO, BOD, SS, Chloride, and TDS of Brahmaputra river in 2013

Table-11. Level of Total alkalinity of Brahmaputra river in 2013

Sampling Locations of Brahmaputra River	Total alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	118	-	400	250	-	-	52	-	-	-	-	-
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Total alkalinity of Brahmaputra river water was (400 mg/l) in March and 52 mg/l in July (Table-11) respectively.

Table-11. Level of Total alkalinity of Brahmaputra river in 2013

Sampling Locations of Brahmaputra River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	465	-	343	337	-	-	150.3	-	-	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

Level of EC of Brahmaputra river water was within the EQS (1200 µmhos/cm). The maximum and the minimum EC was 465 µmhos/cm in January and 150.3 µmhos/cm in July (Table-12).

4.6 Kaliganga River

The Kaliganga river flows by Manikganj district. For analysis of water quality water samples were collected from one location (e.g. Manikganj) of the river .

In 2013, pH of Kaliganga river varied from 7.2 to 7.86 (Fig.6a). The maximum and the minimum pH was found in January and September, respectively. In 2012, pH level varied from 6.9 to 7.4. DO level varied from 5.8 to 6.9 mg/l (Fig.6b) and met the EQS for fisheries (≥5 mg/l). In 2012, DO varied from 5.5 to 14.5 mg/l. BOD varied from 2.0 to 10.0 mg/l (Fig.6c). BOD level was within the EQS limit for fisheries throughout the year. In 2012, BOD varied from 2.2 to 5.0 mg/l. COD varied from 4.0 to 134 mg/l (Fig.6d). In 2012, COD range was 5.0 to 25 mg/l.

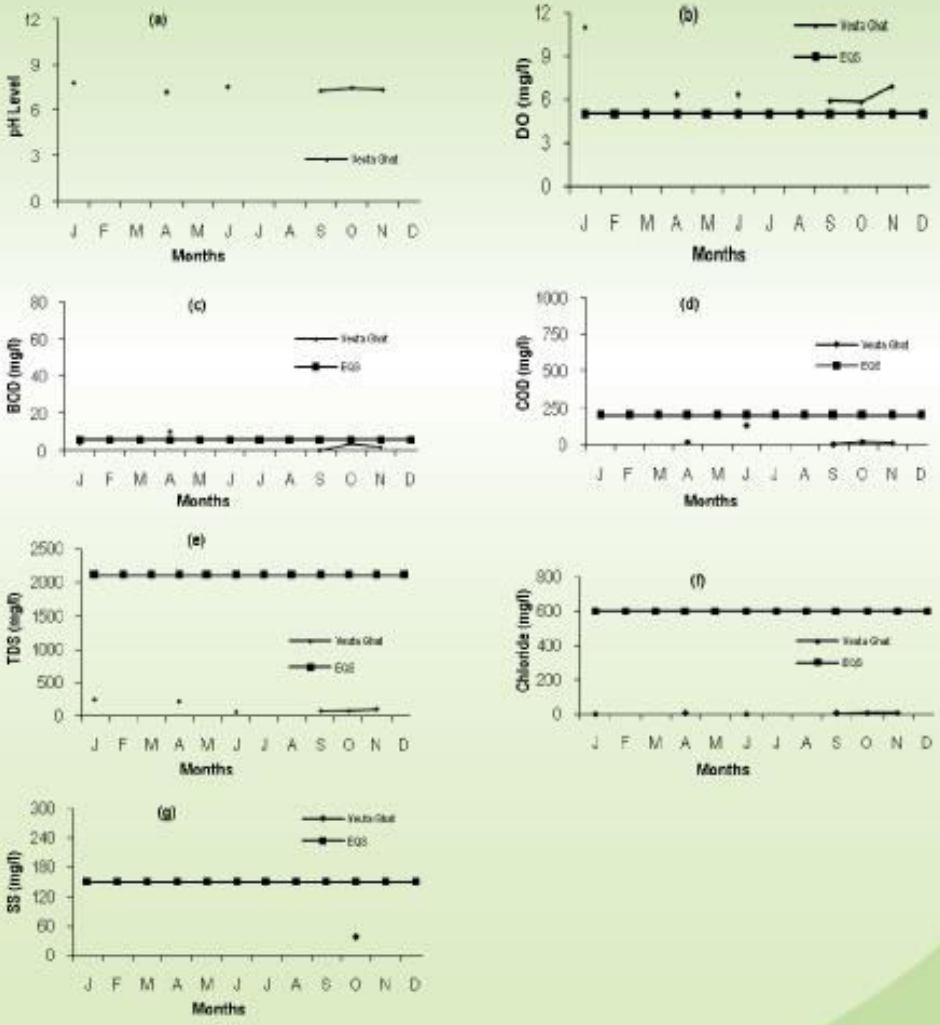


Fig.6. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Kaliganga river in 2013

In 2013, TDS concentration was very low compared to the EQS (2100 mg/l) for wastewater after treatment from industrial units. The maximum TDS was 249 mg/l in January and the minimum TDS was 61.1 mg/l in June (Fig.6e). In 2012, TDS concentration varied from 41.4 to 178.3 mg/l. Chloride level was lower than the EQS (600 mg/l). Highest Chloride concentration (6.0 mg/l) was in October and the lowest Chloride level (0.5 mg/l) was in January (Fig.6f). In 2012, Chloride varied from 0.5 to 30 mg/l. SS of Kaliganga river was within the EQS (150 mg/l). The maximum and the minimum SS was 351 mg/l and 37 mg/l, respectively (Fig.6g).). In 2012, SS varied from 18 to 22 mg/l.

Table-13. Level of Total alkalinity of Kaligonga river in 2013

Locations of Kaliganga River	Total alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikganj	115	-	-	110	-	60	-	-	64	64	92	-
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Total alkalinity of Kaliganga river water was 115 mg/l in January and 60 mg/l in June (Table-13).

Table-14. Level of EC of Kaligonga river in 2013

Locations of Kaliganga River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikgonj	514	-	-	457	-	122.9	-	-	154.9	182.9	227	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC of Kaligonga river water at different locations was within the EQS (1200 µmhos/cm). The maximum and the minimum EC was 514 µmhos/cm in January and 122.9 µmhos/cm in June (Table-14).

4.7 Jamuna River

The Jamuna river is one of the three main rivers of Bangladesh. It is the main distributary channel of the Brahmaputra river that flows out of India into Bangladesh. To monitor water quality, samples were collected only from two locations e.g. Bahadurabad Ghat (B. Ghat) and near Jamuna Fertilizer Factory (JFF) in 2013.

In 2013, pH 8.38 was found at Jamuna Fertilizer Factory in February. pH level was within the EQS limits (Table-15). In 2012, pH level varied from 7.2 to 8.46. At JFF, DO varied from 5.2 to 8.3 mg/l (Table-15). DO level was higher than the EQS (≥5 mg/l) for fisheries. In 2012, DO concentration varied from 5.9 to 8.5 mg/l. In 2013, the maximum BOD level was 9. 0 mg/l and the minimum BOD level was 5.3 mg/l in the month of February and March while the EQS is ≤6 mg/l for fisheries (Table-15). In 2012, BOD concentration varied from 2.8 to 11.0 mg/l. Level of SS of Jamuna river water was within the EQS (150 mg/l). SS was 70.2 mg/l in February (Table-15). In 2012, SS concentration varied from 20 to 24 mg/l. Level of TDS of Jamuna river water was 129.8 mg/l (Table-15), while EQS for

TDS is 2100 mg/l. In 2012, TDS level varied from 63.1 to 165.6 mg/l. Chloride of Jamuna river water was 1.1 mg/l in JFF (Table-15). In 2012, Chloride concentration varied from 1.5 to 8.5 mg/l. The maximum Total alkalinity of Jamuna river water was 104 mg/l in January and and the minimum was 79 mg/l in February, respectively (Table-15). Level of EC of Jamuna river water at sampling locations was within the EQS (1200 µmhos/cm). The maximum and the minimum EC of Jamuna river was 366 µmhos/cm in January and 236 µmhos/cm in February (Table-15).

Table-15. Level of different parameters at different locations of Jamuna river in 2013

Sampling Locations of Jamuna River	Month	pH	DO	BOD	COD	SS	TDS	Chloride	T.alkalinity	EC
Bahadurabad Ghat (B.G)	Jan	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	104	366
Bahadurabad Ghat (B.G)	Feb	-	-	-	-	-	-	-	79	236
Near Jamuna Fertilizer Factory (NJFF)		8.38	8.3	9	-	70.2	129.8	1.1	85	271
Bahadurabad Ghat (B.G)	Mar	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	5.2	5.2	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Apr	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	May	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Jun	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Jul	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Aug	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Sep	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Oct	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Nov	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
Bahadurabad Ghat (B.G)	Dec	-	-	-	-	-	-	-	-	-
Near Jamuna Fertilizer Factory (NJFF)		-	-	-	-	-	-	-	-	-
EQS		**6-9**	**5 mg/l**	**6 mg/l**	**200 mg/l**	**150 mg/l**	**2100 mg/l**	**600 mg/l**	**150 mg/l**	**1200 µmhos/cm**

4.8 Meghna River

The Meghna is an important river in Bangladesh and one of the three that forms the Ganges Delta, the largest on earth fanning out to the Bay of Bengal. To monitor water quality, water samples were collected from Bhairab Bazar, Meghna Ghat, near Shahjalal Paper Mills (NSPM), Chandpur (side), Chandpur (middle), Zia Fertilizer (up stream), Zia Fertilizer (down stream), AFCL (up stream) and AFCL (down stream) of the Meghna river.
Throughout the year pH level was within the standard limit for inland surface water. The maximum pH was 8.4 at NSPM and the minimum pH was 6.4 Meghna Ghat in January respectively (Fig.7a). In 2012, pH level varied from 6.24 to 7.6. DO level of Meghna river was varied 1.8 mg/l to 6.7 mg/l below the EQS (≥5 mg/l) for fisheries (Fig.7b). In 2012, DO level varied from 5.2 mg/l to 7.2 mg/l. At all sampling locations of the river BOD level was below the EQS (≤6 mg/l) for fisheries round the year. The maximum and the minimum BOD load was 35 mg/l in March and 0.0 mg/l in May at Meghna Ghat respectively (Fig.7c). In 2012, BOD concentration varied from 0.3 to 3.4 mg/l. COD varied from 3.0 to 82 mg/l (Fig.7d). COD level was below the EQS (200 mg/l) for wastewater from industrial units round the year. In 2012, COD concentration varied from 1.5 to 3.5 mg/l. TDS of Meghna river was very low in 2013 and ranged from 28.2 to 335 mg/l (Fig.7e). In 2012, TDS concentration varied from 45 to 150 mg/l.

In 2013, Chloride concentration at all the sampling locations was also within the EQS (600 mg/l) for wastewater after treatment from industrial units. The maximum Chloride (25.1 mg/l) was found in May at Meghna Ghat and the minimum (1.1 mg/l) was in March at Bhairab Bazar (Fig.7f). In 2012, Chloride concentration varied from 3.0 to 11 mg/l.

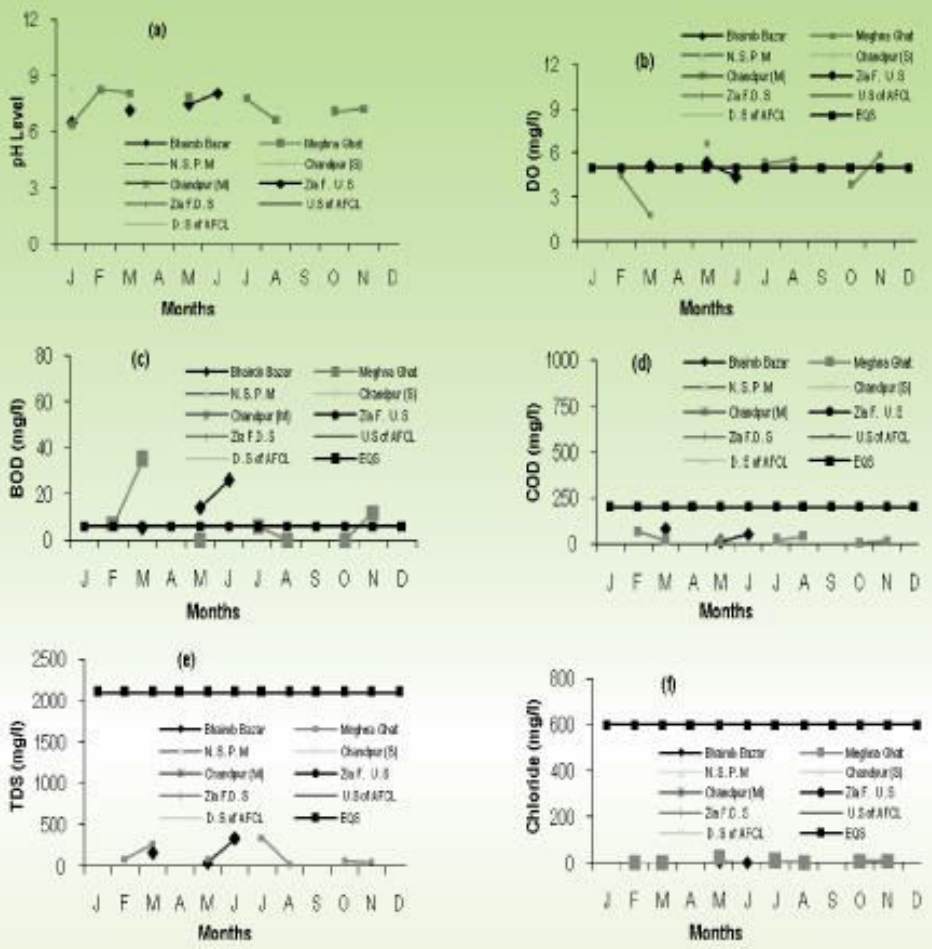


Fig.7. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Meghna river in 2013

Note: N.S.P.M = Near Shajalal Paper Mill, Zia F.D.S = Zia Fertilizer Factory Down Stream,
Zia F.U.S = Zia Fertilizer Factory Up Stream, AFCL U.S= AFCL up stream, AFCL D.S= AFCL Down Stream

Table-16. Level of EC at different locations of Meghna river in 2013

Sampling Locations of Meghna River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bhairob Bazar	137.1		161.3		79.1	669						
Meghna Ghat	132.4	178.8	273	230	184.9	-	689	57.2	-	147.3	106.6	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC of Meghna river water at different locations was within the EQS (µmhos/cm). The maximum and the minimum EC of Meghna river was 689 µmhos/cm in July and 57.2 µmhos/cm in August, respectively at Maghna Ghat (Table-16).

4.9 Padma River

The Padma is a major trans-boundary river of Bangladesh. Water samples were collected from three locations of the river namely Mawa Ghat, Pakshi Ghat (Bank and Middle) of Pabna, Iswardi and Baro Kuti Ghat (Bank and Middle) of Rajshahi only middle points were used in the analysis.

In 2013, pH level of Padma river varied from 3.3 to 8.0 (Fig.8a) while standard pH for inland surface water is 6.5 to 8.5. The maximum pH was found at Baro Kuti Ghat bank in January and the minimum pH level was at in October respectively. In 2012, pH level varied from 6.0 to 7.8. DO level of Padma river was above EQS (≥5 mg/l) for fisheries at all the locations and it varied from 5.8 to 7.8 mg/l (Fig.8b). In 2012, DO concentration ranged from 5.4 to 8.26 mg/l. BOD load was within the EQS (≤6 mg/l) for fisheries at all locations. The maximum BOD was found 1.92 mg/l in December and that of the minimum was 1.1 mg/l in January (Fig.8c). In 2012, BOD load varied from 1.15 to 2.8 mg/l. TDS level of Padma river was within EQS throughout the year of 2013 and it varied from 170 to 280 mg/l (Fig.8d). In 2012, TDS concentration varied from 90 to 370 mg/l.The maximum and the minimum EC of Padma river water was 530 µmhos/cm in August and 320 µmhos/cm in March (Fig.8e), while EQS is 1200 µmhos/cm waste from industrial units. In 2012, EC varied from 138.3 to 699 mg/l. Level of SS was within the EQS (150 mg/l). The maximum and the minimum SS concentration of Padma river was 90 mg/l in July and 60 mg/l in January (Fig.8f). In 2012, SS concentration varied from 26 to 90mg/l.

Table-17. Level of Total alkalinity at different sampling locations of Padma river in 2013

Sampling Locations of Padma River	Total alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mawa Ghat												
Pakshi (E), Ishurdi	32	27	25	22	29	28	23	23	24	26	23	37
Pakshi (M),Ishurdi	33	29	28	25	32	39	21	21	24	25	24	38
Baro kuti (E), Raj.	-	24	26	28	23	25	23	19	26	26	24	34
Baro kuti (M), Raj.	-	22	24	27	25	26	23	20	25	24	25	36
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Total alkalinity of Padma river water was 39 mg/l in june and 19 mg/l in August (Table-17).

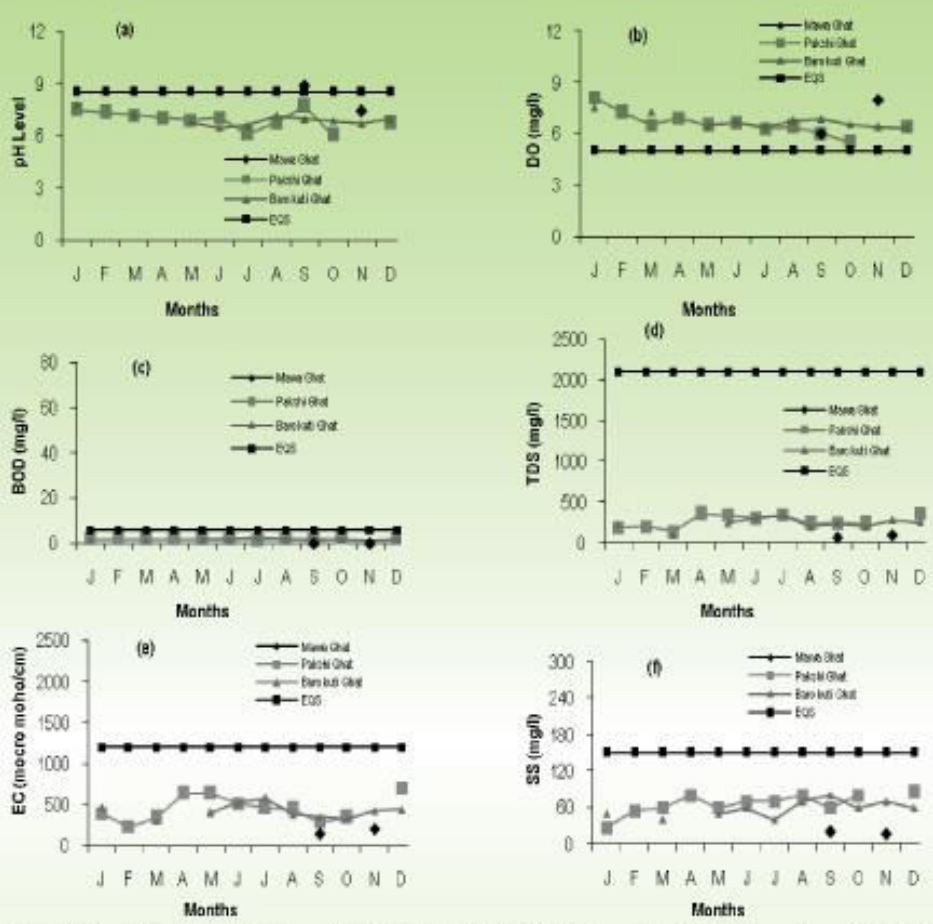


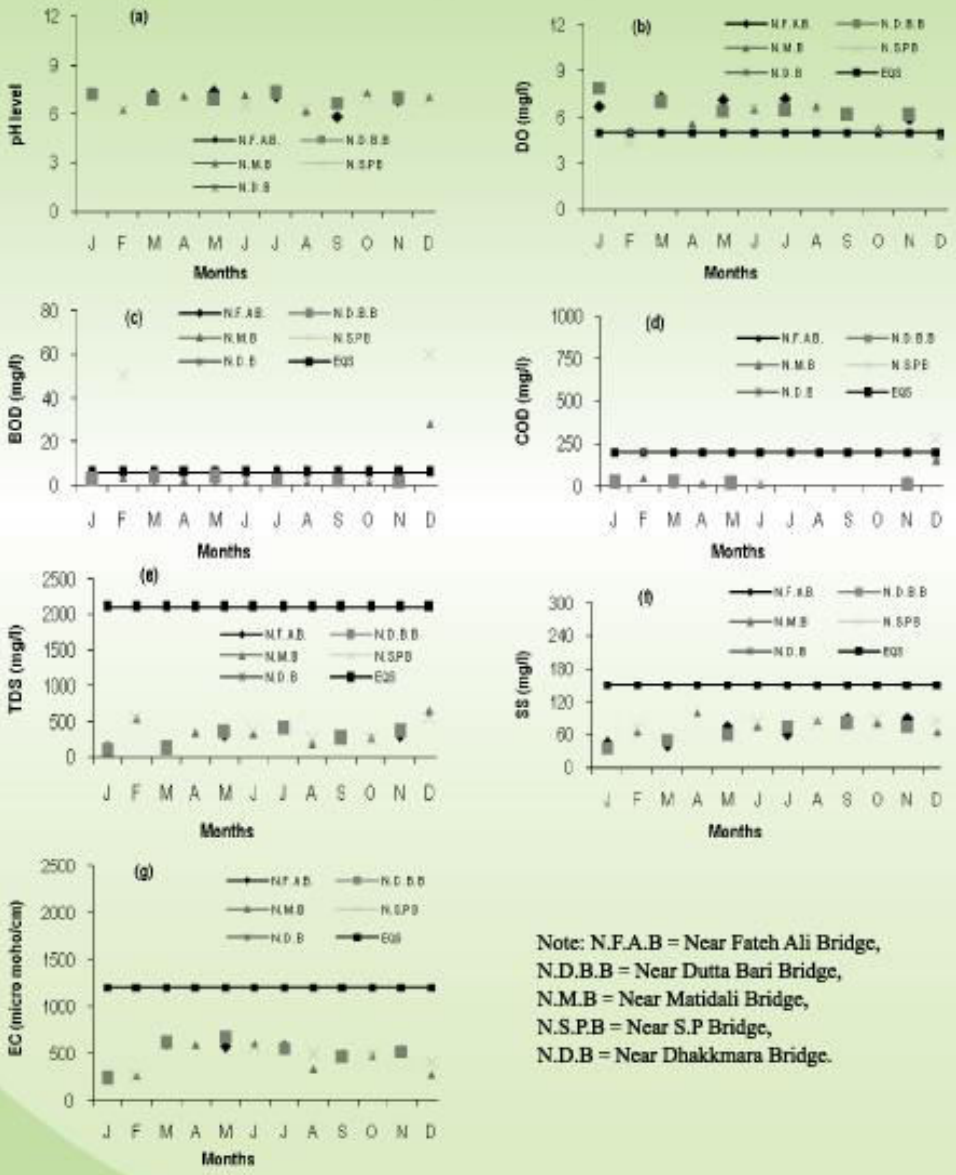
Fig.8. Graphical presentation of pH, DO, BOD, TDS, EC and SS of Padma river in 2013
Note: E= End, M=Middle.Raj=Rajshahi.

4.10 Korotoa River

To analyse water quality of Korotoa river in 2013, water samples were collected from five locations of the river e.g. near Fateh Ali Bridge, near Dutta Bari Bridge, near Matidali Bridge, near S.P Bridge, near Dhakkmara Bridge.

pH level of Korotoa river water varied from 4.7 to 8.35 (Fig.9a) and was within EQS limit. In 2012, pH level varied from 5.8 to 7.42. DO level of Korotoa river water was within the EQS (≥5 mg/l) for fisheries. DO varied from 2.0 to 6.8 mg/l (Fig.9b). In 2012, DO concentration varied from 3.0 to 8 mg/l. In 2013, BOD varied from 1.5 to 6.4 mg/l (Fig.9c). In 2012, BOD concentration varied from 2.0 to 65 mg/l. In 2013, COD level of Korotoa river was low compare to EQS (200 mg/l) for wastewater after treatment from industrial units. COD varied from 9.0 to 25 mg/l (Fig.9d). The maximum COD concentration was 25 mg/l in Korotoa river the Down stream, N.D.B.B. In 2012, COD concentration

varied from 8.0 to 308 mg/l. TDS varied from 170 mg/l to 1260 mg/l (Fig.9e). In 2012, TDS range was from 110 mg/l to 670 mg/l. Level of SS of Korotoa river at different locations was within the EQS. The maximum and the minimum SS was 110 mg/l in July and 70 mg/l in February at N.M.B (U.S) respectively (Fig.9f). In 2012, SS concentration varied from 30 mg/l to 110 mg/l. EC varied from 401 mg/l to 1440 mg/l (Fig.9g) and was within the EQS limit. In 2012, EC concentration varied from 228 mg/l to 686.6 mg/l.



Note: N.F.A.B = Near Fateh Ali Bridge,
N.D.B.B = Near Dutta Bari Bridge,
N.M.B = Near Matidali Bridge,
N.S.P.B = Near S.P Bridge,
N.D.B = Near Dhakkmara Bridge.

Fig.9. Graphical presentation of pH, DO, BOD, COD, TDS, SS and EC of Korotoa river in 2013

4.11 Karnaphuli River

Karnaphuli river is in the south-eastern part of Bangladesh that flows through Chittagong Hill Tracts and Chittagong into the Bay of Bengal. Water samples were collected from two locations comprising four points (e.g. Triple Super Phosphate (TSP) industry Upstream, TSP industry Downstream, Karnaphuli Urea Fertilizer Limited (CUFL) Upstream and CUFL Downstream of Karnaphuli river for monitoring of water quality in 2013.

In 2013, pH level at the sampling points of the Karnaphuli river varied from 6.1 to 8.2 (Fig.10a), while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH level varied from 6.4 to 7.98 mg/l. DO level of Karnaphuli river was high althrough the year of 2013 and met the standard of DO for fisheries (≥5 mg/l). DO varied from 1.0 to 5.6 mg/l (Fig.10b). In 2012, DO concentration varied from 4.4 to 5.5 mg/l. BOD level was below the EQS limit (≤6 mg/l) for fisheries throughout the year. It varied from 4.8 to 5.7 mg/l (Fig.10c). In 2012, BOD concentration varied from 0.8 to 2.6 mg/l. COD value varied from 1.0 to 626 mg/l (fig.10d), while EQS for wastewater after treatment from industrial units is 200 mg/l. COD value was high at CUFL upstream and downstream compare to TSP upstream and downstream. In 2012, COD value varied from 4.0 to 441 mg/l. Level of SS of Karnaphuli river water at different points was beyond the EQS (150 mg/l). The maximum and the minimum SS was 1132 mg/l in August and 96 mg/l in January (Fig.10e). In 2013, SS value varied from 161 to 1207 mg/l. In 2013, Chloride concentration of Karnaphuli river was higher especially at CUFL upstream and downstream and varied from 13 to 13203 mg/l (Fig.10f) where standard for Chloride is 600 mg/l for wastewater after treatment from industrial units. The maximum (13203 mg/l) level was found at CUFL downstream in February and the minimum (13 mg/l) level at TSP upstream in August. In 2012, Chloride concentration varied from 54 to 12390 mg/l.

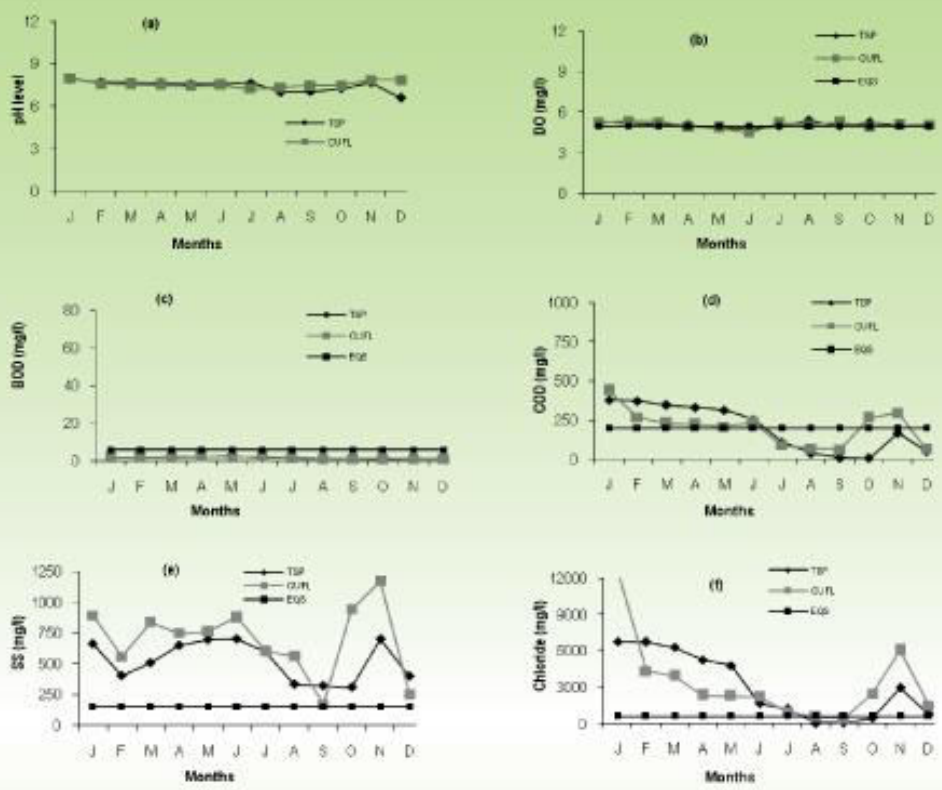


Fig.10. Graphical presentation of pH, DO, BOD, COD, SS and Chloride of Karnaphuli river in 2013

T.S.P (US) = Triple Super Phosphate (Up stream), T.S.P (DS) = Triple Super Phosphate (Down stream),
C.U.F.L (UP) = Carnaphuli Urea Fertilizer Limited Up Stream, C.U.F.L(DS) = Carnaphuli Urea Fertilizer Limited Down Stream,

4.12 Halda River

Halda river passes through the South-Eastern part of Bangladesh. Water sampling points were WASA intake Point (upstream), WASA intake Point (downstream), Maduna Ghat (Bank) and Maduna Ghat (Middle) of Halda River. Samples were collected during high tide and low tide at all locations of the river. To simplify the analysis, only high tide and low tide variation for the sampling points were considered. Because no significant variation was found between upstream and downstream (WASA intake Point) and river bank- middle (Maduna Ghat).

pH of Halda river water was within EQS limit in 2013 and varied from 7.0 to 7.51 (Fig.11a). In 2012, pH level varied from 7.0 to 8.0. DO level of Halda river was well above the EQS limit throughout the monitoring period of 2013 and met the standard of DO level for fisheries (≥5 mg/l) at all sampling locations of the river during high tide and low tide. DO varied from 5.0 to 5.7 mg/l (Fig.11b). In 2012, DO range was from 1.0 to 5.65 mg/l. The maximum and the minimum BOD was 0.2 and 0.8 mg/l

respectively (fig.11c). In 2012, BOD concentration varied 1.8 and 0.3 mg/l. In 2013, COD at the sampling locations of Halda river during high and low tide was around 1.0 mg/l throughout the year (Fig.11d). In 2012, COD varied from 1.0 to 4.0 mg/l. The maximum and the minimum SS content of Halda river water was 174 mg/l in November and 11 mg/l in September (Fig.-11e). In 2012, SS value varied from 13 to 211 mg/l. Chloride level of Halda River in 2013 was well below the EQS (600 mg/l) for treated wastewater from industrial units. Chloride varied from 8 to 148 mg/l (Fig-11f). Chloride concentration was relatively higher during high tide compare to the low tide concentration of at all locations of the river. In 2012, Chloride concentration varied from 8 to 47 mg/l.

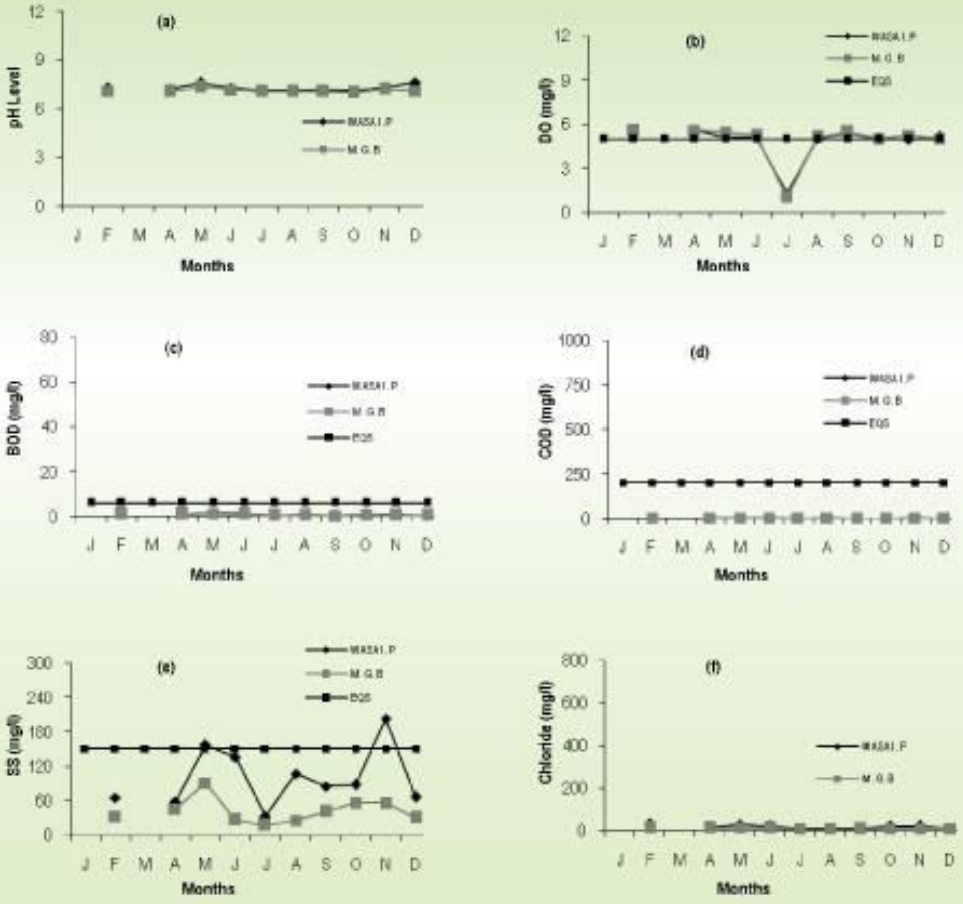


Fig.11. Graphical presentation of pH, DO, BOD, COD, SS and Chlorideof Halda river in 2013

Note: WASA I.P (HT)= WASA Intake Point High Tide, WASA I.P (LT)= WASA Intake Point Low Tide
M.G.B (S) = Maduna Ghat Bank Side, M.G.B (M) = Maduna Ghat Bank Middle

4.13 Titas River

Titas river is situated in Brahmanbaria district. In 3013, water samples were collected from one location e.g. Bakail Bridge, Brahmanbaria.

In 2013, pH level varied from 6.6 to 8.7 (Fig.12a) and was within the standard limit (6.5-8.5) of inland surface water. In 2013, DO concentration varied from 3.3 to 4.3 mg/l (Fig.12b). DO was below the EQS for fisheries (≥5 mg/l). BOD level of Titas river water was below the EQS (≤6 mg/l) for fisheries throughout the sampling period. The maximum and the minimum BOD was 0.3 and 0.6 mg/l (Fig.12c). COD was 1.0 mg/l throughout the sampling period (Fig.12d). SS of Titas river water was within the EQS. The maximum and the minimum SS concentration of Titas river was 63 mg/l in March and 16 mg/l in April (Fig.12e).

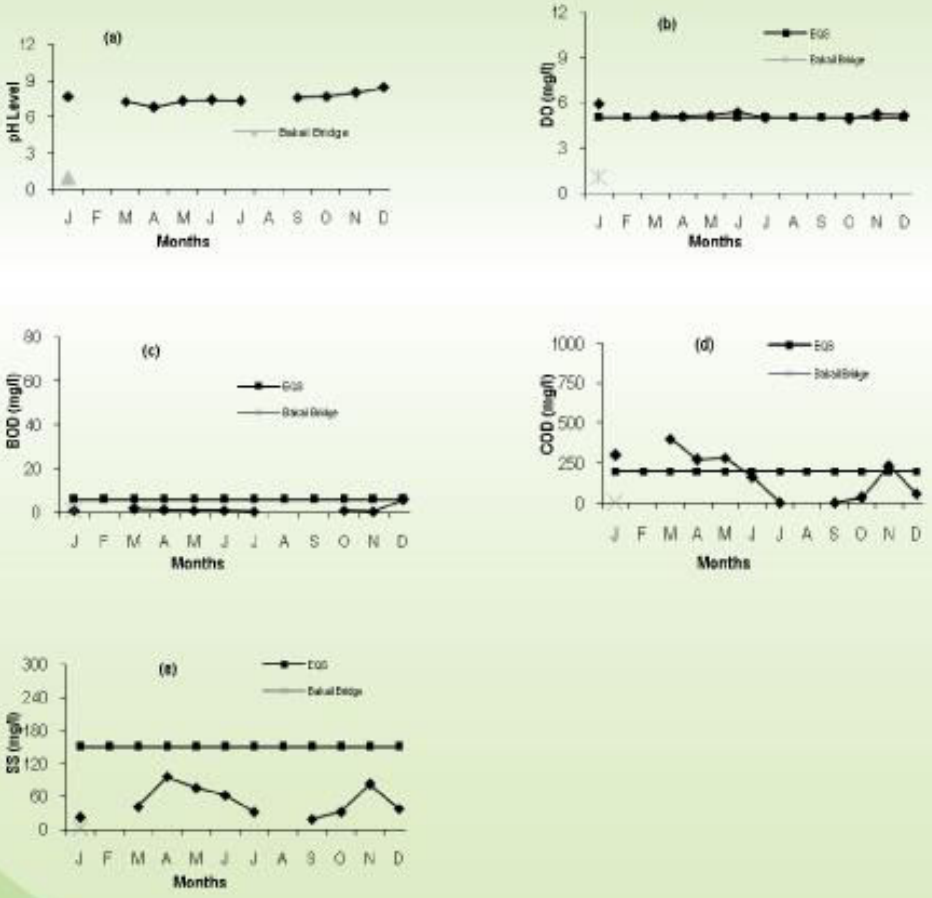


Fig.12. Graphical presentation of pH, DO, BOD, COD and SS of Titas river in 2013

Table-18. Level of Chloride at Bakail Bridge, B.Baria of Titas river in 2013

Sampling Locations of Titas River	Chloride (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bakail Bridge, B-Baria	-	-	221	166	8	7	8	-	-	-	-	-
EQS for wastewater after treatment from industrial units 600 mg/l												

Chloride concentration varied from 7.0 to 221 mg/l (Table-18) against the EQS (600 mg/l) for treated wastewater from industrial units.

4.14 Moyuri River

For monitoring water quality of Moyuri River in 2013, water samples were collected from one location named Gallamari Bridge comprising both of the bank and middle point of the river.

In 2013, pH level of Moyuri river water varied from 7.59 to 7.68 (Fig.13a) and was within the EQS limit. In 2012, pH level varied from 6.35 to 7.73. DO content of Moyuri river water was below the EQS (≥5 mg/l) for fisheries. DO level varied from 0.0 to 0.2 mg/l (Fig.13b). In 2012, DO concentration varied from 0.4 to 2.0 mg/l. BOD level of the Moyuri river water varied from 10 to 36 mg/l while EQS for fisheries is ≤6 mg/l (Fig.13c). In 2012, BOD level varied from 6.0 to 20 mg/l. TDS range was from 382 to 1653 mg/l (Fig.13d) while EQS is 2100 mg/l. Highest TDS value was found from February to May and lowest was found from June to December. In 2012, TDS concentration varied from 547 to 1015 mg/l. Chloride level was much higher (March-June) compared to rest of the period and varied from 122.73 to 910.98 mg/l (Fig.13e). In 2012, Chloride level varied from 135.65 to 680mg/l. Turbidity level of Moyuri river was very high. It varied from 42.8 to 58.6 NTU while Turbidity for drinking water is 10 NTU (Fig.13f). In 2012, Turbidity level varied from 40.1 to 79.6 NTU.

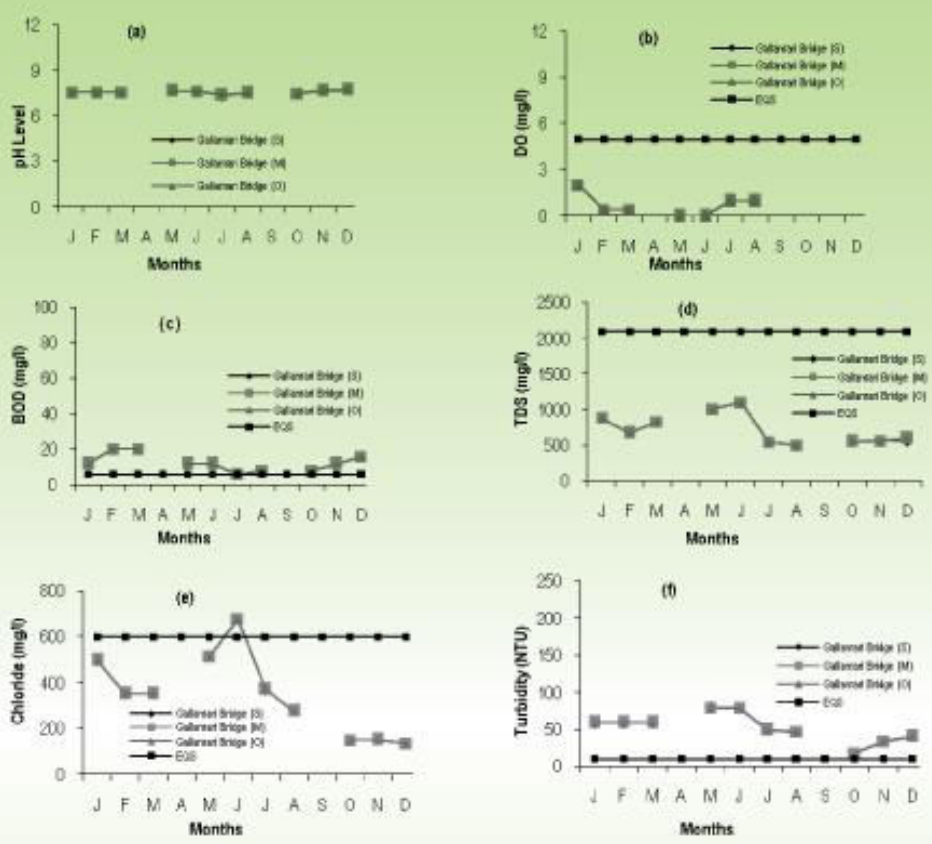


Fig.13. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Moyuri river in 2013

Table-19. Level of EC at different sampling points of Moyuri river in 2013

Sampling Locations of Moyuri River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge (Side point)	1491	2090	14081	3310	3310	1158	1130	730	752	764	1042	1235
Gallamari Bridge, (Middle point)	1491	2090	14081	3310	3310	1158	1130	730	752	764	1042	1235
Gallamari Bridge, (Opposite point)	1491	2090	14081	3310	3310	1158	1130	730	752	764	1042	1235
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC varied from 730 µmhos/cm to 3310 µmhos/cm. The maximum and the minimum concentration was 3310 µmhos/cm in April and 730 µmhos/cm (Table-19) in August, respectively while standard for treated wastewater from industrial unit EC is 1200 µmhos/cm.

Note: S=Side, M= Middle, O= Opposite side

Table-20. Level of Salinity at different sampling points of Moyuri river in 2013

Sampling Locations of Moyuri River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge, (Side point)	0.7	1	8.6	1.7	1.7	0.5	0.4	0	0.3	0.3	0.5	0.6
Gallamari Bridge, (Middle point)	0.7	1	8.6	1.7	1.7	0.5	0.4	0	0.3	0.3	0.5	0.6
Gallamari Bridge, (Opposite point)	0.7	1	8.6	1.7	1.7	0.5	0.4	0	0.3	0.3	0.5	0.6
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity level varied from 0.0 ppt to 8.6 ppt. The maximum and the minimum salinity was 8.6 and 0.0 mg/l respectively while standard salinity is 400 ppt for treated wastewater from industry (Table-20).

4.15 Bhairab River

Bhairab river flows in the south of Bangladesh. The river is approximately 62 Km long and 100 m wide. Its average depth is 1.22m to 1.53m and with minimal water flow with plenty of silt. Water samples were collected from three locations comprising nine different points (e.g. Noapara Ghat Bank, Middle and Opposite, Fultala Ghat Side, Middle and Opposite and Char-erhat Ghat Side Middle and Opposite) of Bhairab River for monitoring water quality in 2013. To simplify data analysis only middle point of all locations was considered. Because, no significant variation was found between side, middle and opposite point of a location of the river.

In 2013, pH at different locations of the Bhairab river varied from 7.56 to 7.72 (Fig.14a) while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH level varied from 7.42 to 7.87. DO was around the EQS (($\geq$5 mg/l) for fisheries. In 2013, the maximum and the minimum DO was 4.8 to 7.2 mg/l (Fig.14b) respectively. In 2012, DO varied from 5.3 to 7.8 mg/l. BOD level of Bhairab river water was below the EQS ($\leq$6 mg/l) for fisheries round the year of 2013. BOD varied from 0.4 to 5.3 mg/l (Fig.14c). In 2012, BOD level varied from 0.5 to 0.8 mg/l. In 2013, TDS level of Bhairab river was very high during April to May at all locations. The maximum and the minimum was 4880 and 114 mg/l (Fig.14d) respectively while EQS is 2100 mg/l. TDS was high in March to June. In 2012, TDS varied from 116 to 2180 mg/l. In 2013, High level of Chloride was found from March to June in Bhairab river water. It varied from 18.23 to 2910.98 mg/l (Fig.14e) while EQS for Chloride is 600 mg/l. Highest Chloride (2910.98 mg/l) was found in April and lowest was (18.23 mg/l) in January. In 2012, Chloride level varied from 16.78 to 1290 mg/l. Turbidity of Bhairab river water at all locations was very high in 2013. It varied from 28.1 to 75.28 NTU while the EQS for drinking water is 10 NTU (Fig.14f). The prime reason may be of carrying huge silt by the river throughout the year. In 2012, Turbidity level varied from 20.7 to 108 NTU.

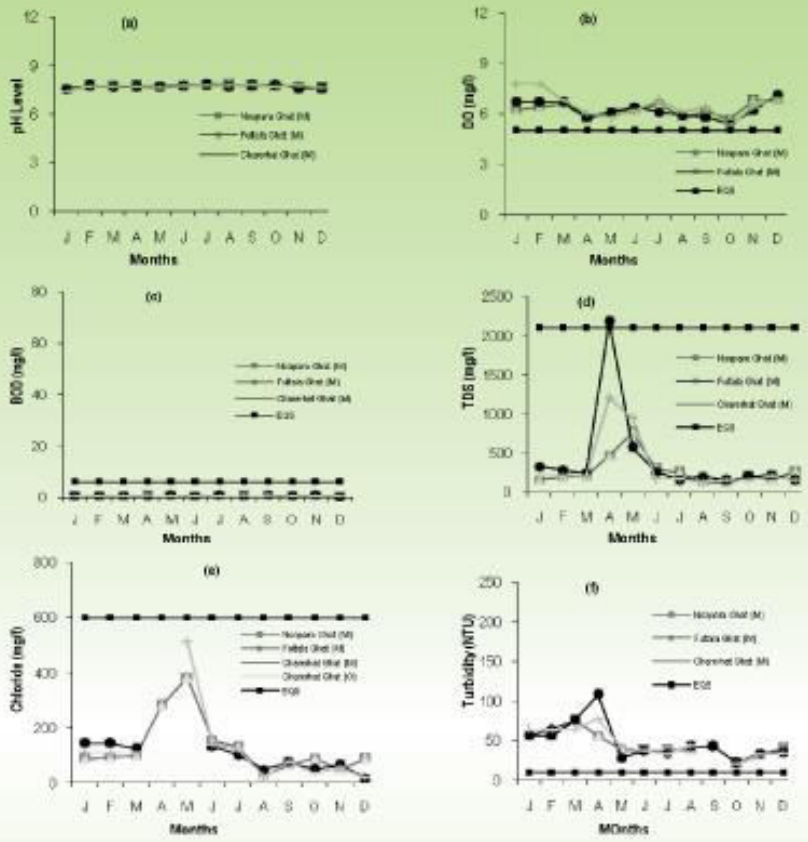


Fig.14. Graphical presentation of pH,DO,BOD,COD,TDS,Chloride and Turbidityof Bhairab river in 2013

Table-21. Level of Salinity at different locations of Bhairab river in 2013

Sampling Locations of Bhairab River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Noapara Ghat (Side)	0.3	0.3	0.4	3.5	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Noapara Ghat (Middle)	0.3	0.3	0.4	3.5	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Noapara Ghat (Opposite)	0.3	0.3	0.4	3.5	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Fultala Ghat (Side)	0.2	0.3	0.6	3.9	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Fultala Ghat (Middle)	0.2	0.3	0.6	3.9	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Fultala Ghat (Opposite)	0.2	0.3	0.6	3.9	2.7	0.3	0.1	0	0.1	0.1	0.1	0.2
Charerhat Ghat (Side)	0.1	0.2	0.8	3.5	2.9	0.3	0.1	0	0.1	0.1	0.1	0.2
Charerhat Ghat(Middle)	0.1	0.2	0.8	3.5	2.9	0.3	0.1	0	0.1	0.1	0.1	0.2
Charerhat Ghat (Opposite)	0.1	0.2	0.8	3.5	2.9	0.3	0.1	0	0.1	0.1	0.1	0.2
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied from 0.0 ppt to 3.9 ppt. The maximum and the minimum salinity was 3.9 ppt in April and 0.0 ppm in August respectively (Table-21). In 2012, salinity varied from 0.0 ppt to 2.3 ppt.

4.16 Rupsha River

Rupsha is one of the most famous and important river of Bangladesh that flows by the port city Khulna, and falls to the Bay of Bengal through Pashur River at Mongla channel. Water samples were collected from two different locations comprising six points (e.g. Rupsha Ghat Bank, Middle and Opposite and Labanchara Ghat Bank, Middle and Opposite) of Rupsha River for monitoring water quality in 2013. To facilitate analysis, only the middle point value of two locations were considered. Because, no significant variation was found among banks and middle points of both locations.

In 2013, pH varied from 7.61 to 7.72 (Fig.15a) while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH level varied from 7.44 to 7.88.

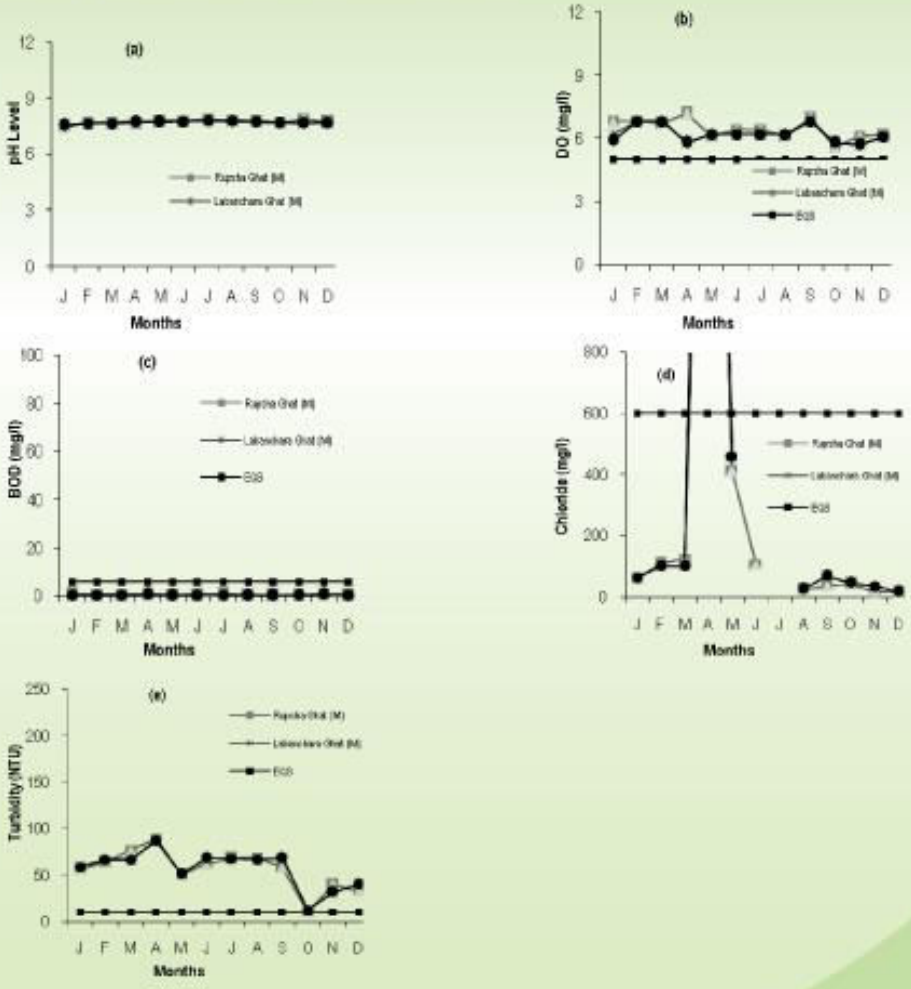


Fig.15. Graphical presentation of pH, DO, BOD, Chloride and Turbidity of Rupsha River in 2013

In 2013, DO level was higher than EQS (≥5 mg/l) for fisheries except the Labaonchara Ghat in March. The maximum and the minimum DO content was 3.8 and 8.0 mg/l respectively (Fig.15b). In 2012, DO level varied from 5.7 and 6.8 mg/l. In 2013, the maximum and the minimum BOD was 0.9 and 0.4 mg/l respectively (Fig.15c). In 2012, BOD level was from 0.4 to 0.8 mg/l. Chloride level was much higher in April and May than the EQS (600 mg/l) for treated wastewater from industrial units. Chloride content varied from 43.98 to 3598.57 mg/l (Fig.15d). In 2012, Chloride varied from 16 to 2609 mg/l. Turbidity level at both locations of Rupsha river was very high during dry period of 2013. Turbidity level was relatively higher throughout the year and varied from 42.8 to 86.21 NTU (Fig.15e) while EQS for drinking water is 10 NTU. In 2012, Turbidity varied from 10.22 to 89.20 NTU.

Table-22. Level of TDS at different sampling locations of Rupsha river in 2013

Sampling Locations of Rupsha River	TDS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rupsha Ghat (Side)	234	1030	2080	3450	3030	468	106	119	148	178	146	215
Rupsha Ghat (Middle)	234	1030	2080	3450	3030	468	106	119	148	178	146	215
Rupsha Ghat (Opposite)	234	1030	2080	3450	3030	468	106	119	148	178	146	215
Labanchara Ghat (Side)	234	1105	2900	5150	3060	472	113	120	115	182	149	213
Labanchara Ghat (Middle)	234	1105	2900	5150	3060	472	113	120	115	182	149	213
Labanchara Ghat (Other)	234	1105	2900	5150	3060	472	113	120	115	182	149	213
EQS for wastewater after treatment from industrial units 2100 mg/l												

TDS was high during April in 2013 at Labanchara Ghat. TDS level varied from 119 to 5150 mg/l (Table-22) while standard for treated wastewater from industrial units Turbidity is 2100 mg/l.

Table-23. Level of Salinity at different sampling locations of Rupsha river in 2013

Sampling Locations of Rupsha River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rupsha Ghat (Side)	0.2	1	2.2	3.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
Rupsha Ghat (Middle)	0.2	1	2.2	3.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
Rupsha Ghat (Opposite)	0.2	1	2.2	3.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
Labanchara Ghat (Side)	0.2	1.1	3.1	5.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
Labanchara Ghat (Middle)	0.2	1.1	3.1	5.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
Labanchara Ghat (Other)	0.2	1.1	3.1	5.8	0.6	0.4	0.1	0	0.1	0.1	0.1	0.2
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity level varied 0.0 ppt to 5.8 ppt. The maximum and the minimum salinity was 5.8 ppt in April and 0.0 ppt August respectively (Table-23).

4.17 Mathavanga River

For monitoring water quality of Mathavanga river, water samples were collected from a single location comprising three diffeent points, Pipeghat, Pipeghat 200m upstream and Pipeghat 200m downstream of Darshana, Chuadanga.

In 2013, pH varied from 6.61 to 7.68 (Fig.16a) while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH range was from 6.9 to 7.91. In 2013, DO level varied from 5.2 to 8.5 mg/l (Fig.16b) while standard DO for fisheries is ≥5 mg/l. In 2012, DO level varied from 4.4 to 7.8 mg/l. In 2013, BOD varied from 0.6 to 20 mg/l (Fig.16c). In 2012, BOD range was from 0.5 to 143 mg/l. Chloride of Mathavanga river water varied from 19.99 to 173 mg/l (Fig.16d) while EQS for Chloride is 600 mg/l. In 2012, Chloride content varied from 11.0 to 16.8 mg/l. Turbidity level was higher then EQS (10 NTU) for drinking water and varied from 14 to 27.1 NTU (Fig.16e). In 2012, Turbidity level varied from 20.0 to 78.6 NTU.

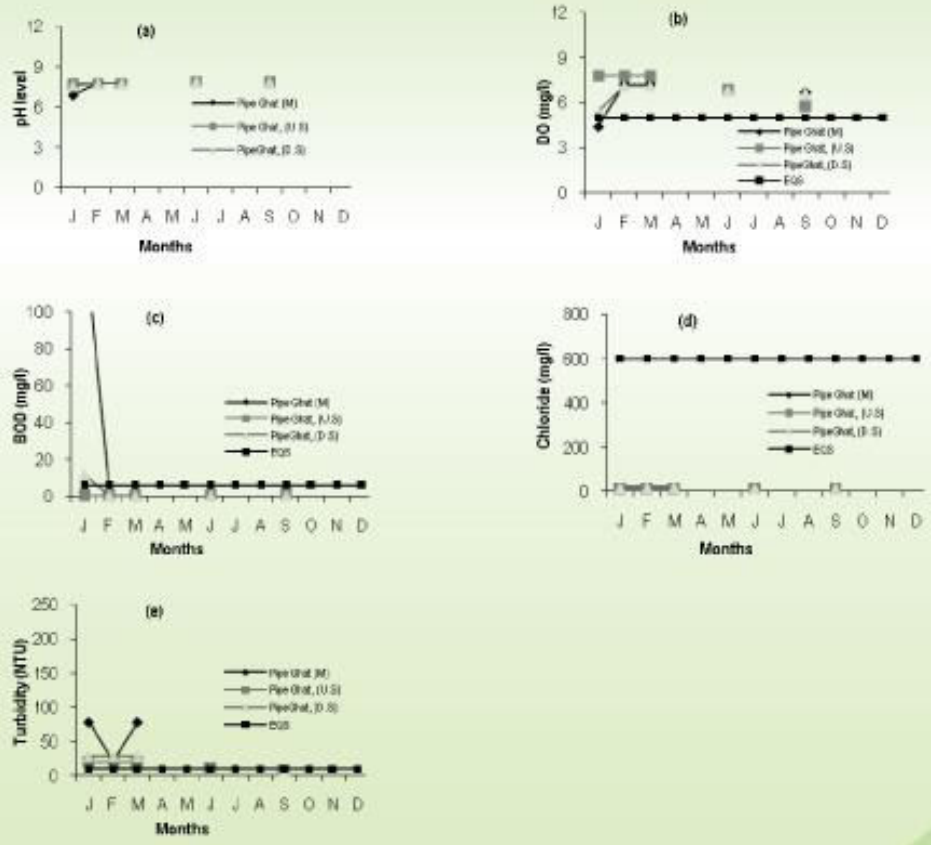


Fig.16.Graphical presentation of pH, DO, BOD, Chloride and Turbidity of Mathavanga river in 2013

Note: M=Middde, US =Upstream, DS= Downstream

4.18 Pashur River

For monitoring of water quality, water samples were collected from one location of Pashur river comprising three different points e.g. Monglaport Bank, Middle and Opposite bank. For analysis, only middle point was considered as there was no difference among banks and middlepoint.

In 2013, pH level varied from 7.65 to 7.78 (Fig.17a) and was within the EQS (6.5 to 8.5). In 2012, pH level varied from 7.71 to 7.88. DO level was above the EQS (≥5 mg/l) for fisheries all over the year. The maximum and the minimum concentration of DO was 8.1 and 5.5 mg/l respectively (Fig/17b). In 2012, DO varied from 6.8 and 4.8 mg/l. In 2013, BOD level was within the EQS (≤6 mg/l) for fisheries during the sampling period. The maximum and the minimum value of BOD was 0.8 and 0.4 mg/l respectively (Fig.17c). In 2012, BOD level varied from 0.5 and 0.9 mg/l. High level of TDS was found at Pipeghat compare to other points of the river. TDS varied from 149 to 13000 mg/l (Fig.17d). In 2012, TDS level varied from 151 to 11200 mg/l. Chloride level of Pashur river water varied from 72.28 to 8397.39 mg/l. Chloride concentration was higher at all points during March to June compare to rest of the period (Fig.17e). In 2012, Chloride level varied from 30 to 5451 mg/l. Turbidity level varied from 66.6 to 136 NTU (Fig.17f) against the EQS(10 NTU) for drinking water. Turbidity concentration was very high all over the year. In 2012, Turbidity level varied from 22.4 to 110 NTU.

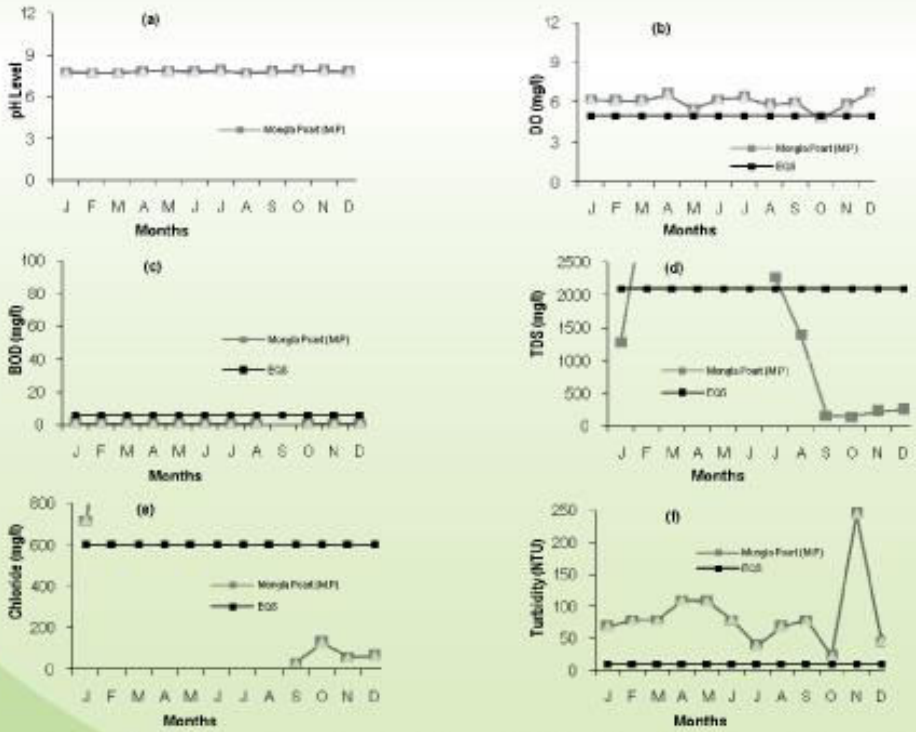


Fig.17. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Pashur river in 2013

Table-24. Level of Salinity at different sampling locations of Pashur river in 2013

Sampling Locations of Pashur River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mongla Poart (Side)	4	4.44	8.6	15.2	15.9	3.7	0.2	0.1	0.1	0.1	0.1	-
Mongla Poart (Middle)	4	4.44	8.6	15.2	15.9	3.7	0.2	0.1	0.1	0.1	0.1	-
Mongla Poart(Opposite)	4	4.44	8.6	15.2	15.9	3.7	0.2	0.1	0.1	0.1	0.1	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied from 0.1 ppt to 15.9 ppt. The maximum and the minimum salinity was 15.9 ppt in May and 0.1 ppt in September to November respectively while EQS for Salinity is 400 ppt (Table-24). In 2012, salinity varied from 0.2 ppt to 13.4 ppt.

4.19 Kakshiali River

To monitor water quality of Kakshiali river, water samples were collected from three different points e.g. Kaliganj Bank, Middle and Opposite bank at Shatkhira location in 2013. For analysis, only middle point was considered as there were insignificant differences among banks and middle point.

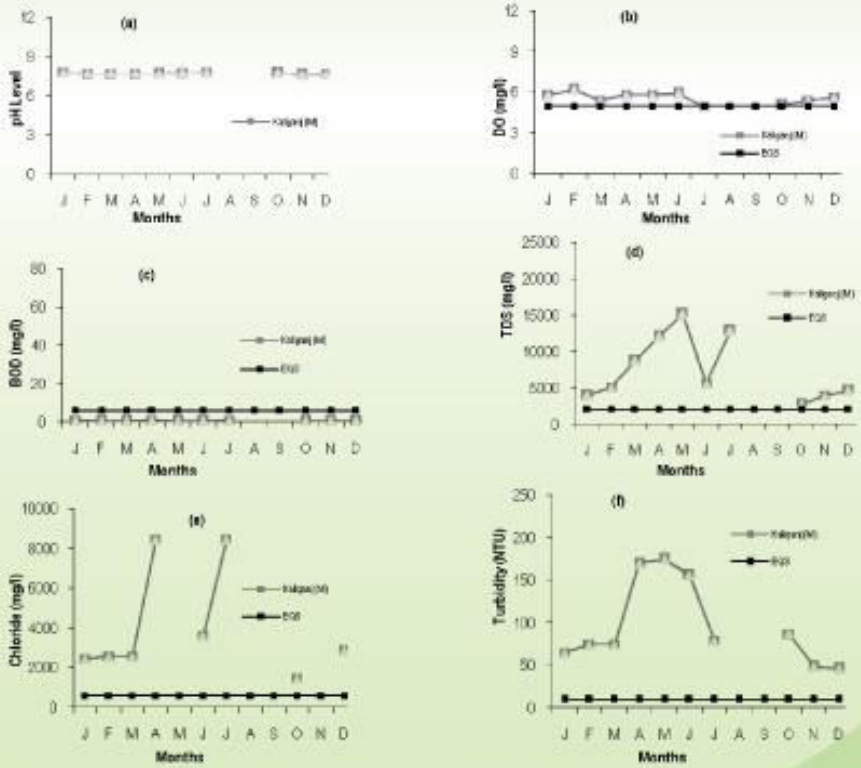


Fig.18. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Kakshiali river in 2013

In 2013, pH level was within the EQS (6.5-8.5) for inland surface water and was varied from 7.65 to 7.75 (Fig.18a). In 2012, pH varied from 7.65 to 7.79. DO level varied from 4.8 to 8.5 mg/l (Fig.18b) throughout the year while EQS for fisheries is ≥5 mg/l. In 2012, DO level varied from 5.1 to 5.9 mg/l. BOD was far below the EQS (≤6 mg/l) for fisheries. It varied from 0.6 to 0.8 mg/l (Fig.18c). In 2012, BOD level varied from 0.5 to 0.8 mg/l. TDS level was very high all over the year of 2013. It varied from 2200 to 14000 mg/l (Fig.18d). In 2012, TDS level varied from 3910 to 15,200 mg/l.

In 2013, Chloride concentration was very high during January to June and varied from 862.78 to 9546.72 mg/l (Fig.18e) while standard for treated wastewater from industrial units Chloride is 600 mg/l. The highest Chloride was found in June and the lowest value was in August. In 2012, Chloride level varied from 1439 to 8440 mg/l. Turbidity level was above the EQS (10 NTU) limit for drinking all over the year that varied from 76.2 to 129 NTU (Fig.18f). In 2012, Turbidity level varied from 46.1 to 87.2 NTU.

Table-25. Level of Salinity at different sampling locations of Kakshiali river in 2013

Sampling Locations of Kakshiali River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kaliganj (Side)	6.4	10.9	12.6	-	-	17.2	-	1.8	2.9	3.2	-	-
Kaliganj (Middle)	6.4	10.9	12.6	-	-	17.2	-	1.8	2.9	3.2	-	-
Kaliganj (Opposite)	6.4	10..9	12.6	-	-	17.2	-	1.8	2.9	3.2	-	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied 1.8 ppt to 17.2 ppt. The maximum and the minimum salinity was 18.8 ppt in May and 2.9 ppt in October (Table-25) respectively. In 2012, Salinity varied from 0.2 ppt to 20.8 ppt. In 2012, salinity varied from 2.9 ppt to 18.8 ppt.

4.20 Gorai River

Water samples were collected from two locations viz. Kamarkhali ghat, Magura and G K ghat, Kustia comprising three points each. Only middle point of both locations was considered for analyses because there was no significant difference between bank, middle and opposite bank of both locations.

In 2013, pH of Gorai river water was varied from 7.61 to 7.82 (Fig.19a) and was within the EQS (6.5-8.5) for inland surface water. In 2012, pH level varied from 7.252 to 7.88. In 2013, DO was above the EQS (≥5 mg/l) limit for fisheries at both locations. Level of DO varied from 6.3 to 8.5 mg/l (Fig.19b). In 2012, DO level varied from 5.8 to 7.2 mg/l. In 2013, BOD level was far below the EQS (≤6 mg/l) for fisheries. It varied from 0.2 to 0.8 mg/l (Fig.19c). In 2012, BOD level varied from 0.4 to 0.60.3 to 0.6 mg/l. TDS level of Gorai river water was very low throughout the year while comparing to the

EQS (2100 mg/l) for treated wastewater from industrial units. It varied from 115 to 226 mg/l (Fig.19d). In 2012, TDS level varied from 63.7 to 210 mg/l. Chloride level was also within the EQS (600 mg/l) for treated wastewater from industrial units. The maximum and the minimum chloride value was 125.58 and 10.8 mg/l (Fig.19e). In 2012, Chloride level varied from 8.1 to 22.5 mg/l. Turbidity level was relatively higher throughout the year than the EQS (10 NTU) for drinking water. It varied from 10.2 to 22.5 NTU (Fig.19f). In 2012, Turbidity level varied from 10.1 to 21.6 NTU.

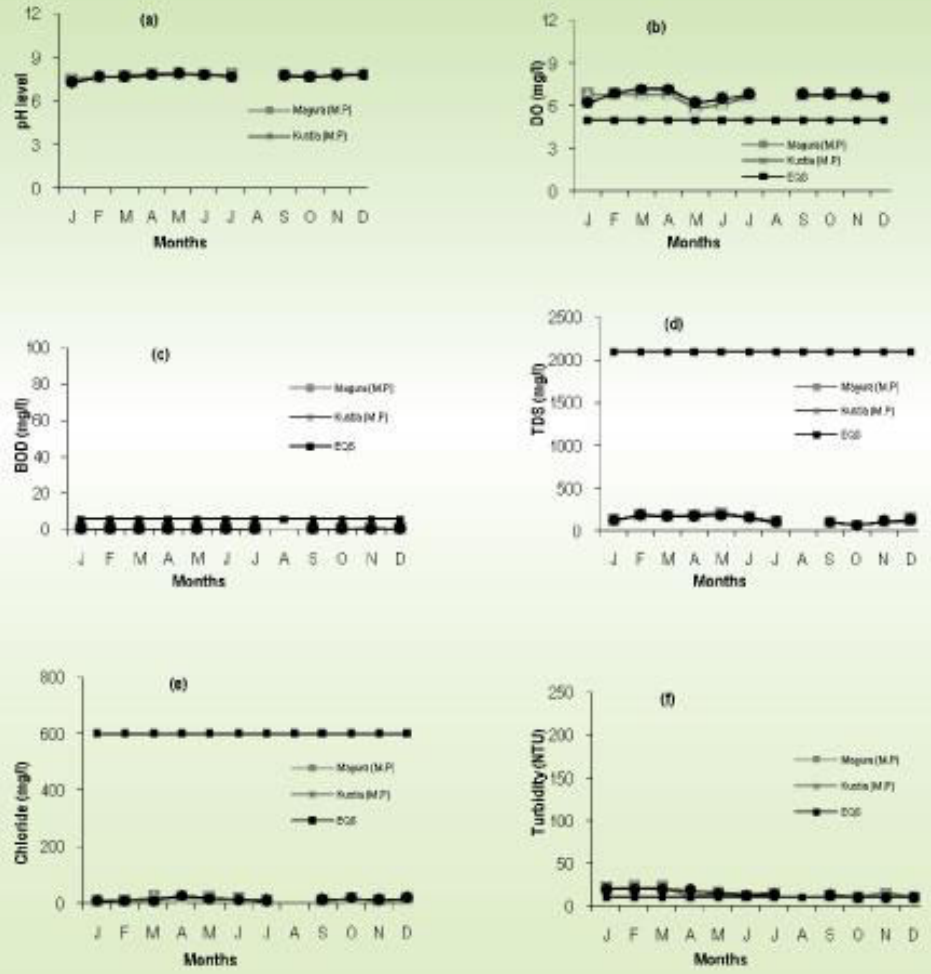


Fig.19. Graphical presentation of pH, DO BOD, COD, TDS, Chloride, Turbidity of Gorai river in 2013

4. 21 Modhumoti River

To monitor water quality of Modhumoti river in 2013, samples were collected from one location comprising three different points (Mollarhat side, middle and opposite) of Bagerhat. For analysis, only middle point was considered.

In 2013, pH level of Modhumoti river was within the EQS and varied from 6.68 to 7.74 (Fig.20a). In 2012, pH level varied from 6.88 to 7.88. DO was varied from 5.2 to 7.3 mg/l while EQS is ≥5 mg/l for fisheries (Fig.20b). In 2012, DO level was varied from 5.8 to 6.8 mg/l. BOD of the river was below the EQS (≤6 mg/l) for fisheries. BOD varied from 0.4 to 1.0 mg/l (Fig.20c). In 2012, BOD varied from 0.4 to 0.6 mg/l. TDS of Modhumoti river water was within EQS (2100 mg/l). The maximum and the minimum value was 150 mg/l and 94 mg/l respectively (Fig.20d). In 2012, TDS level varied from 113 to 183 mg/l. In 2013, Chloride level varied from 22 to 99.96 mg/l while EQS for treated wastewater from industrial units is 600 mg/l (Fig.20e). In 2012, Chloride level varied from 8.13 to 45.6 mg/l. In 2013, EC varied from 188 to 347 µmohos/cm (Fig.20f).

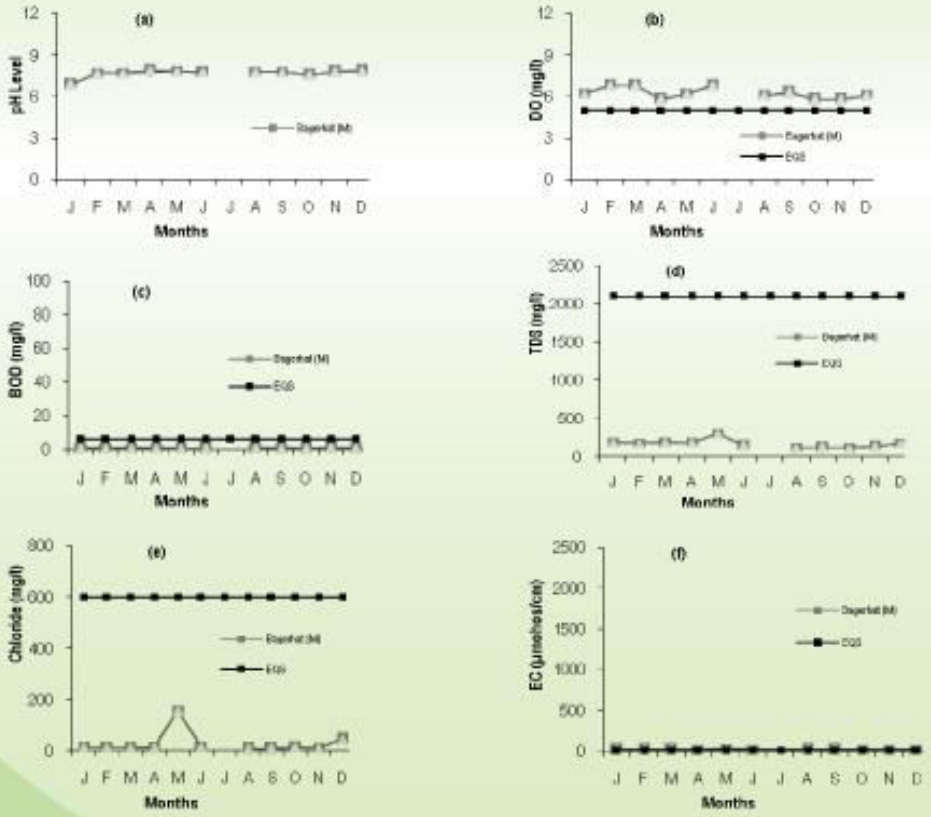


Fig.20. Graphical presentation of pH, DO, BOD COD, TDS, Chloride and EC of Modhumoti river in 2013

4.22 Beel Dakatia River

To monitor water quality of Beel Dakatia river in 2013, samples were collected from one location at Khulna comprising two points (bank and middle). For analysis, only the middle point was considered as there was no difference between bank and middle point.

In 2013, pH level was within the EQS and varied from 7.61 to 7.72 (Fig.21a). In 2012, pH level varied from 7.72 to 7.48. DO varied from 2.1 to 6.3 mg/l (Fig.21b) and was closer to the EQS for fisheries (≥5 mg/l). In 2012, DO level varied from 3.2 to 6.1 mg/l. In 2013, BOD was below the EQS (≤6 mg/l) for fisheries that varied from 1.1 to 13 mg/l (Fig.21c). In 2012, BOD level varied from 0.5 to 2 mg/l. TDS of Beel Dakatia river water was within the EQS (2100 mg/l). The maximum and the minimum TDS was 1283 and 323 mg/l respectively (Fig.21d). In 2012, TDS level varied from 135 to 2880 mg/l. In 2013, Chloride level varied from 135.68 mg/l to 1258.82 mg/l while EQS for treated wastewater from industrial units is 600 mg/l. The maximum value was found in May and the minimum was in November (Fig.21e). In 2012, Chloride level varied from 29.6 mg/l to 845 mg/l. Turbidity varied from 41.8 to 78.1 NTU (Fig.21f) and was higher than EQS (10 NTU) for dirking water. In 2012, Turbidity level varied from 12.25 to 68.10 NTU.

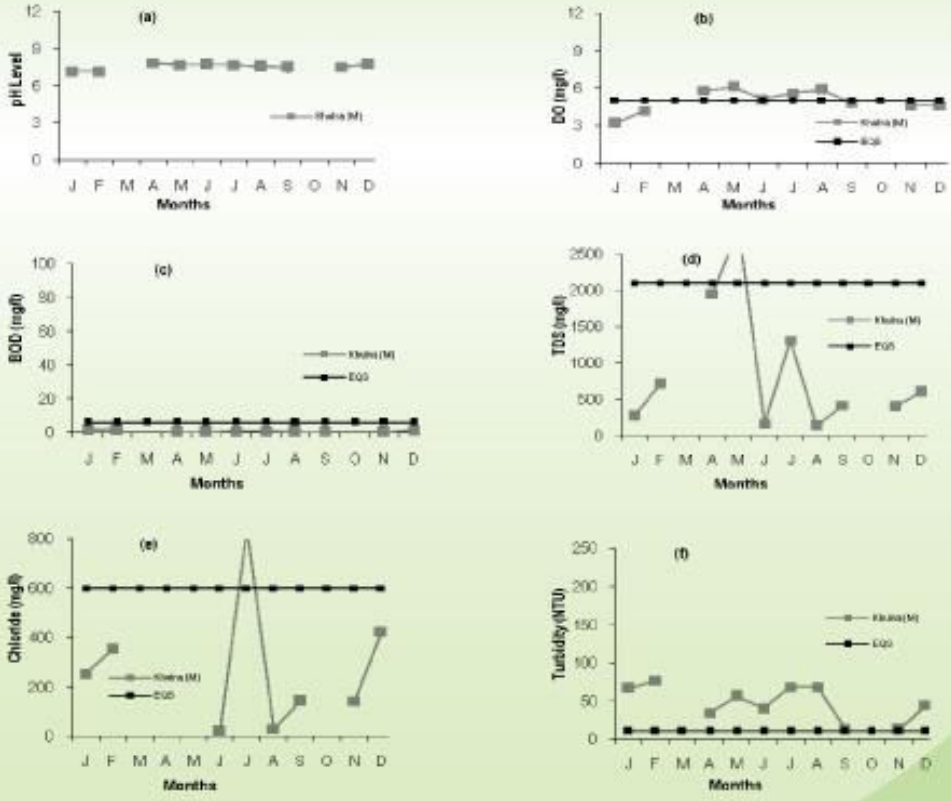


Fig.21.Graphical presentation of pH, DO, BOD, COD, TDS, Turbidity of Beel Dakatia river in 2013

Table-26. Level of Salinity of Beel Dakatia river water in 2013

Locations of Beel Dakatia River	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beel Dakatia (Side)	0.5	0.8	1.3	--	0.8	0.6	0.7	0.4	0.3	0.3	0.3	-
Beel Dakatia (Middle)	0.5	0.8	1.3	-	0.8	0.6	0.7	0.4	0.3	0.3	0.3	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied 0.3 ppt to 0.8 ppt. The maximum and the minimum salinity was 0.8 ppt in May and 0.3 ppt in September respectively (Table-26). In 2012, salinity varied from 0.0 ppt to 3.1 ppt.

4.23 Kirtankhola River

Kirtankhola river starts from Sayeshtabad in Barisal and ends into the Gajalia near Gabkhan khal (Canal). This old river is now known as the Barisal river. The total length of the river is about 160 km (Murshed, 2006). For monitoring purpose water samples were collated from the different locations of the river e.g. Launch ghat bank, Launch ghat middle. Samples were collected during low tide and high tide.

In 2013, pH level of Kirtankhola river water varied from 7.0 to 7.9 (Fig.22a) and was within the EQS. In 2012, pH level varied from 6.0 to 8.2. DO level of Kirtankhola rive was above the EQS (≥5 mg/l) for fisheries. DO varied from 6.0 mg/l to 6.4 mg/l (Fig.22b). In 2012, DO level varied from 5.7 mg/l to 7.3 mg/l. In 2013, BOD was low round the year. The maximum and the minimum BOD was 2.4 mg/l and 1.8 mg/l respectively (Fig.22c). In 2012, BOD level varied from 1.1to 2.5 mg/l.

In 2013, TDS of Kirtankhola rive water was also within the EQS (2100 mg/l) throughout the year while it ranged from 34.5 to 72 mg/l (Fig.22d). In 2012, TDS level varied from 20 to 75.8 mg/l. Chloride content of the Kirtankhola river water varied from 20 to 30 mg/l (Fig.22e). In 2012, Chloride level varied from 13 to 45 mg/l. SS of Kirtankhola river water was within EQS. The maximum and the minimum SS was 21.8 mg/l in June and 10.2 mg/l in May (Fig.22f). In 2012, the maximum and the minimum SS was 30.3 mg/l in March and 6.72 mg/l in July.

Table-27. Level of EC at different sampling locations of Kirtankhola river water in 2013

Locations of Kirtankhola River	EC(µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Launch Ghat (S), L.T	74.5	-	-	-	-	-	-	-	-	-	-	-
Launch Ghat (M), L.T	70.6	-	-	-	-	-	-	-	-	-	-	-
Launch Ghat (S), H.T	61.1	-	78.5	134.5	134.8	136.8	134.8	136.8	138.2	140.0	142	122
Launch Ghat (M), H.T	60.5	-	75.6	134.8	134.2	138.2	132.2	134.6	138.2	138.2	140	120
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC level of the Kirtankhola river varied from 60.5 to 142 µmhos/cm against the EQS for treated wastewater from industrial units is 1200 µmhos/cm (Table-27).

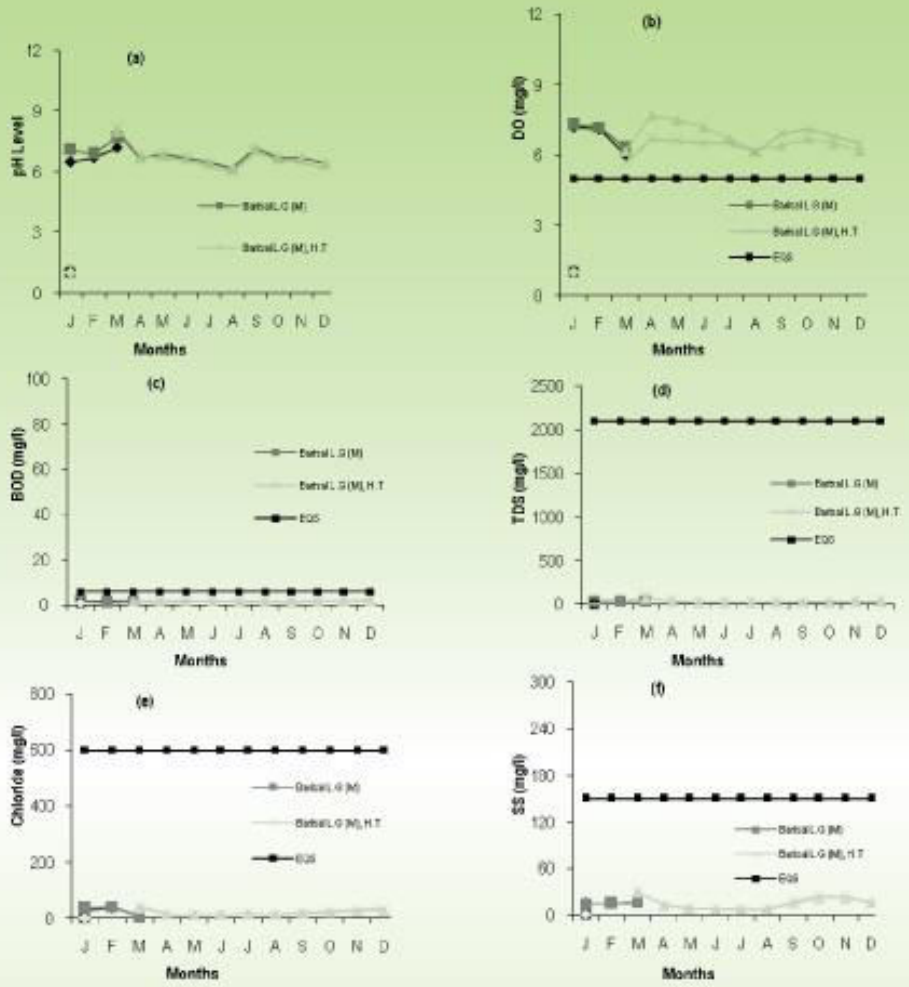


Fig.22.Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Kirtankhola river in 2013

Note: B.L.G = Barisal Lanch Ghat, L.T=low Tide, H.T= High Tide, M=Middle, S=Side.

4.24 Tetulia River

For monitoring of water quality of Tetulia river water samples was colleted from Vedhoria Feri Ghat location (bank and middle point). Samples collected during High Tide.

In 2013, pH level of the Tetulia river water ranged from 6.5 to 7.7 mg/l (Table-28) while in 2012, it varied from 6.2 to 6.9. DO varied from 6.2 to 7.2 mg/l (Table-28) while standard limit for fisheries is (≥5 mg/l). In 2012, DO level varied from 5.85 to 7.6 mg/l. BOD level of the Tetulia river varied from 2.0 to 2.4 mg/l (Table-28) against corresponding EQS (≤6 mg/l) for fisheries. In 2012, BOD level varied from 1.2 to 2.6 mg/l. TDS range was from 32.2 to 90 mg/l (Table-28). In 2012, TDS level varied from 20 to 38 mg/l. Chloride level varied from 30 to 132 mg/l (Table-28) while EQS for treated wastewater from industrial units is 600 mg/l. In 2012, Chloride level varied from 11 to 51 mg/l. SS

level varied from 14.2 to 34 mg/l (Table-28) and was below the EQS (150 mg/l). In 2012, SS level varied from 5 to 15.24 mg/l. EC level of the Tetulia river varied from 68.8 to 138.2 µmhos/cm against the EQS for treated wastewater from industrial units is 1200 µmhos/cm (Table-28).

Table-28. Level of different parameters at different sampling locations of Tetulia river in 2013

Sampling Locations of Tatulia River	Months	pH	DO	BOD	COD	SS	TDS	Chloride	T.alka linity	EC
V. F. G (S), H.T	Jan	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Feb	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Mar	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Apr	6.5	6.4	2.1		14.2	32.4	54		68.8
V. F. G (M), H.T		6.6	6.2	2		16	32.2	52		69.8
V. F. G (S), H.T	May	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Jun	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Jul	7.6	7.2	2.4		34	78.4	130		136.8
V. F. G (M), H.T		7.7	7	2.2		30.2	86.6	132		138.2
V. F. G (S), H.T	Aug	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Sep	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S), H.T	Oct	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
V. F. G (S),H.T	Nov	7.6	7	2.2		26	88	30		136
V. F. G (M), H.T		7.4	7.2	2		26	90	32		138
V. F. G (S), H.T	Dec	-	-	-	-	-	-	-	-	-
V. F. G (M), H.T		-	-	-	-	-	-	-	-	-
EQS		**6-9**	**5 mg/l**	**6 mg/l**	**200 mg/l**	**150 mg/l**	**2100 mg/l**	**600 mg/l**	**150 mg/l**	**1200 µmhos/cm**

Note: V.F.G= Vedhoria Feri Ghat, S=Side, M=Middle, H.T= High Tide

4.25 Lohalia River

To monitor water quality of Lohalia River water samples were colleted for analysis from Launch Ghat, Patuakhali (e.g. Side and middle high tide) of the river.
In 2013, pH level of the Lohalia river water varied from 7.4 to 7.8 mg/l (Table-29) while EQS for fisheries is 6.5 to 8.5. In 2012, pH level varied from 7.4 to 8.2. In 2013, DO level varied from 5.7 to 7.9 mg/l (Table-29) and was above the EQS (≥5 mg/l) for fisheries. In 2012,

DO level varied from 5.7 to 7.9 mg/l. In 2013, BOD range was from 1.5 to 2.7 mg/l (Table-29) while EQS for fisheries is ≤6 mg/l. In 2012, BOD level varied from 1.5 to 2.7 mg/l. Chloride level of the Lohalia river was from 130 to 132 mg/l (Table-29) while corresponding EQS is 600 mg/l for treated wastewater from industrial units. In 2012, Chloride level varied from 45 to 156 mg/l. SS level of the Lohalia river varied from 20 to 30 mg/l (Table-29) against EQS (150 mg/l) for treated wastewater from industrial units. In 2012, SS level varied from 29.7 to 35.4 mg/l. Salinity level of the Lohalia river water varied from 11.0 ppt to 138.6 ppt (Table-29). In 2012, salinity varied from 3.8 ppt to 12.1 ppt. EC level of the Lohalia river was much below the EQS for waste from industrial units is 1200 µmhos/cm (Table-29).

Table-29. Level of different parameters at different sampling locations of Lohalia river in 2013

Sampling Locations of Lohalia River	Months	pH	DO	BOD	COD	SS	TDS	Chloride	T.alkalinity	EC
Patuakhali L.G (S)	Jan	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Feb	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Mar	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Apr	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	May	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Jun	7.8	7.2	2.2		34		130	11.0	164
Patuakhali (M)		7.6	7.4	2.4		30.2		132	12.2	166
Patuakhali L.G (S)	Jul	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Aug	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Sep	7.6	7	2.2		20		132	138.6	
Patuakhali (M)		7.4	7.2	2.4		20		130	136.4	
Patuakhali L.G (S)	Oct	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Nov	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
Patuakhali L.G (S)	Dec	-	-	-	-	-	-	-	-	-
Patuakhali (M)		-	-	-	-	-	-	-	-	-
EQS		**6-9**	**5 mg/l**	**6 mg/l**	**200 mg/l**	**150 mg/l**	**2100 mg/l**	**600 mg/l**	**150 mg/l**	**1200 µmhos/cm**

4.26 Surma River

The Surma river is a part of the Surma-Meghna river System. The average depth of this river is 86m and maximum depth is 170m. For monitoring purpose water samples were collected from six different locations of the river namely Mehendipaka Bridge, Knee Bridge, Kazi bazaar, Chattak, Shajalal Bridge and Shak Ghat.

In 2013, pH level of the Surma river varied from 6.2 to 7.8 (Fig. 23a). In 2012, pH level varied from 6.5 to 7.79. In 2013, DO content of Surma river water was mostly above the EQS (≥5 mg/l) for fisheries except January at Shak Ghat. It varied from 4.2 to 10.4 mg/l (Fig. 23b). In 2012, DO level varied from 4.2 to 6.8 mg/l. BOD value was also within the EQS at all locations. The maximum and the minimum BOD was 3.9 and 0.3 mg/l respectively (Fig. 23c). In 2012, BOD level varied from 1.0 to 1.3 mg/l. TDS level was varied from 32 to 558 mg/l (Fig. 23d) where EQS for TDS is 2100 mg/l for treated wastewater from industrial units. In 2012, TDS level was varied from 57.5 to 750 mg/l. In 2013, Chloride content of Surma river water was within the EQS (600 mg/l) and varied from 20 to 42 mg/l (Fig. 23e). In 2012, Chloride level varied from 70 to 220 mg/l. SS level of Surma river was within the EQS the limit for treated wastewater from industrial units. It varied from 13.2 to 102 mg/l (Fig. 23f). In 2012, SS level varied from 100 to 120 mg/l.

Table-30. Level of EC at different sampling locations of Surma river in 2013

Sampling Locations of Surma River	E.C (µmhos/cm /cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shajalal Bridge (S)	232	-	-	-	-	-	-	-	-	-	-	-
Shajalal Bridge (M)	-	-	-	-	-	-	-	-	-	-	-	-
Shajalal Bridge (O)	-	-	-	-	-	-	-	-	-	-	-	-
Keen Bridge (S)	-	257	-	-	-	-	-	-	-	-	-	-
Keen Bridge (M)	-	260	-	-	-	-	-	-	-	-	-	-
Keen Bridge (O)	-	-	-	-	-	-	-	-	-	-	-	-
Shak Ghat (S)	327	268	248	252	252	248	-	-	273	253	-	-
Shak Ghat (M)	325	-	264	266	269	254	-	-	268	258	-	-
Shak Ghat (O)	-	-	-	-	-	-	-	69.9	-	-	-	-
Chattak (S)	-	-	-	-	-	-	-	75.8	-	-	-	-
Chattak (M)	-	-	-	-	-	-	-	-	-	-	-	-
Chattak (O)	-	-	-	-	-	-	-	-	-	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmohos/cm												

EC level of Surma river was within the EQS limit. It varied from 69.9 to 327 µmhos/cm(Table-30).

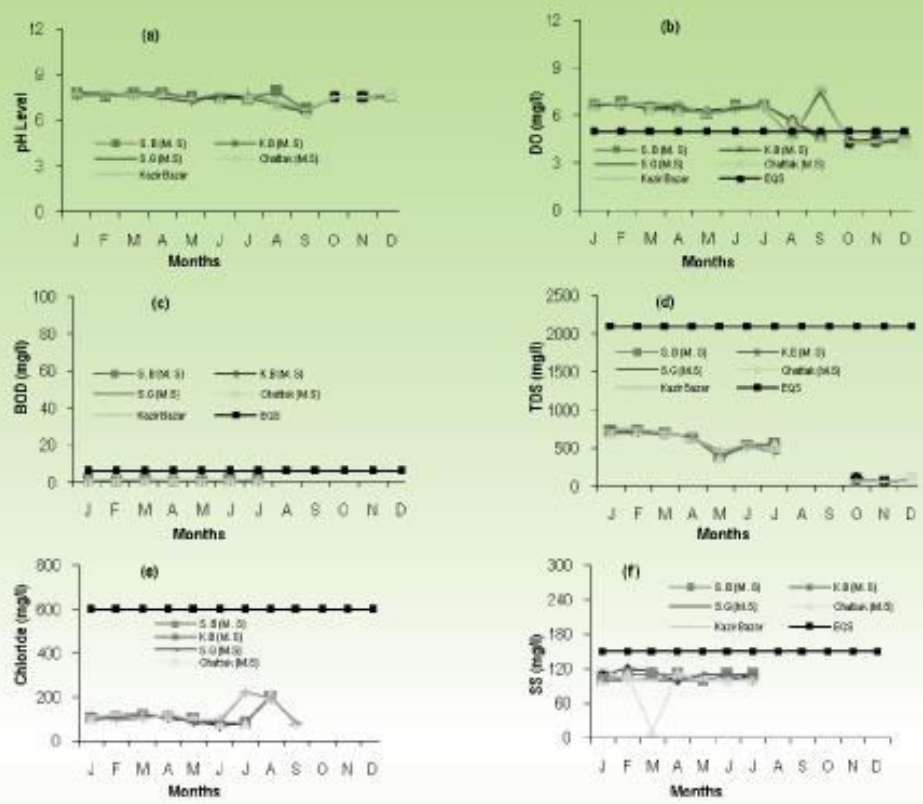


Fig.23. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Surma river in 2013

Note: MB= Mehendipaka Bridge,KB= Knee Bridge, SB= Shajalal Bridge, SG= Shak Ghat, S=Side/Bank, M=Middle, R= Opposite/Bank

4.27 Kushiara River

Kushiara river is one of the Trans-boundary rivers of Bangladesh. The total length of the Kushiara is about 161 km. The average width of the river is 250 m and in the rainy season the mean depth of the Kushiyara reaches upto 10m (Ahmed, 2006). Water samples were collected from two locations (e.g. Jokigonj and Fenchugonj Fertilizer Industry) of the river in 2013 for analysis of water quality. Sample was collected only the month of November.

In 2013, pH level of Kushiara river was within EQS (6.5-8.5) for inland surface water. It varied from 7.2 to 7.3 (Fig. 24a). In 2012, pH level varied from 7.0 to 7.9. DO was above the EQS (≥ 5 mg/l) for fisheries and varied from 5.8 to 5.9 mg/l (Fig. 24b). In 2012, DO level varied from 4.2 to 6.8 mg/l. BOD level was from 1.0 to 1.2 mg/l while EQS for fisheries is ≤6 mg/l (Fig. 24c). In 2012, BOD level varied from 1.0 to 1.3 mg/l. In 2013, TDS level of Kushiara river water was below the EQS for treated wastewater from industrial units and varied from 450 to 560 mg/l (Fig. 24d). In 2012, TDS level varied from 41.6 to 720 mg/l. SS level of Kushiara River was within the EQS limit for treated wastewater from industrial units. It varied from 130 to 150 mg/l (Fig. 24e). In 2012, SS level varied

from 100 to 120 mg/l. Chloride was also within the EQS (600 mg/l) limit for drinking water. The maximum Chloride was found (220 mg/l) and the minimum concentration (186 mg/l) was in November at Fenchugonj Fertilizer Industry (Fig. 24f). In 2012, Chloride concentration varied from 70 to 290 mg/l.

Table-31. Level of EC at different sampling locations of Kushiara River in 2013

Sampling locations of Kushiara River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jokigong B.S.F Ghat (S)	-	-	-	-	-	-	-	-	-	-	-	-
Jokigong B.S.F Ghat (M)	-	-	-	-	-	-	-	-	-	-	-	-
Jokigong B.S.F Ghat (O)	-	-	-	-	-	-	-	-	-	-	-	-
Fenchugonj Fertilizer (S)	-	-	-	-	-	-	-	-	-	-	640	-
Fenchugonj Fertilizer (M)	-	-	-	-	-	-	-	-	-	-	590	-
Fenchugonj Fertilizer (O)	-	-	-	-	-	-	-	-	-	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC level of Kushiara river was within the EQS for treated wastewater from industrial units. It varied from 590 to 640 µmhos/cm (Table-31).

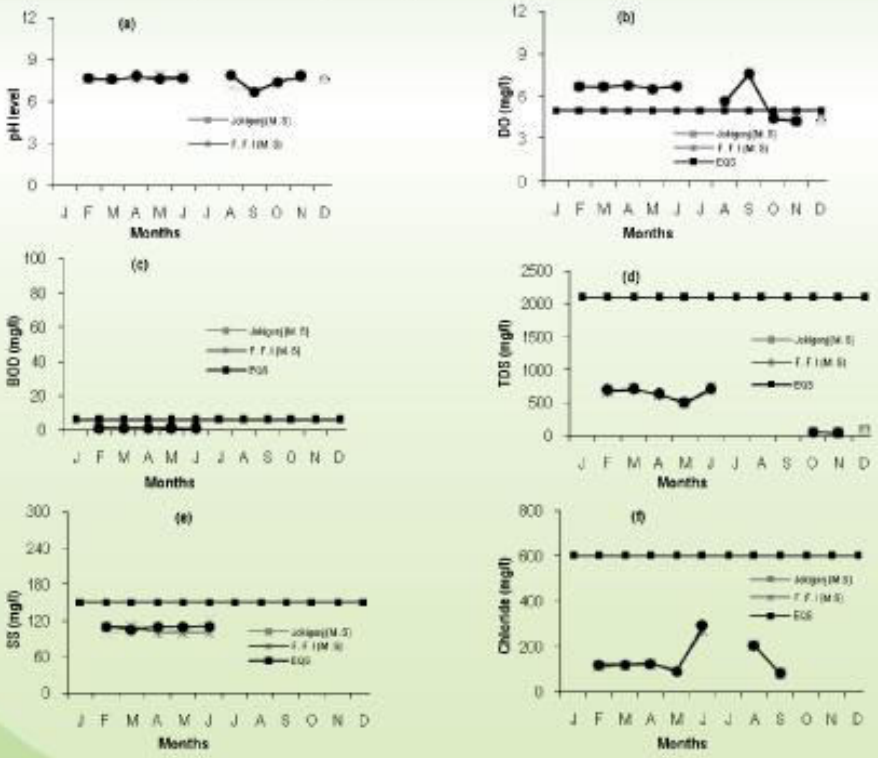
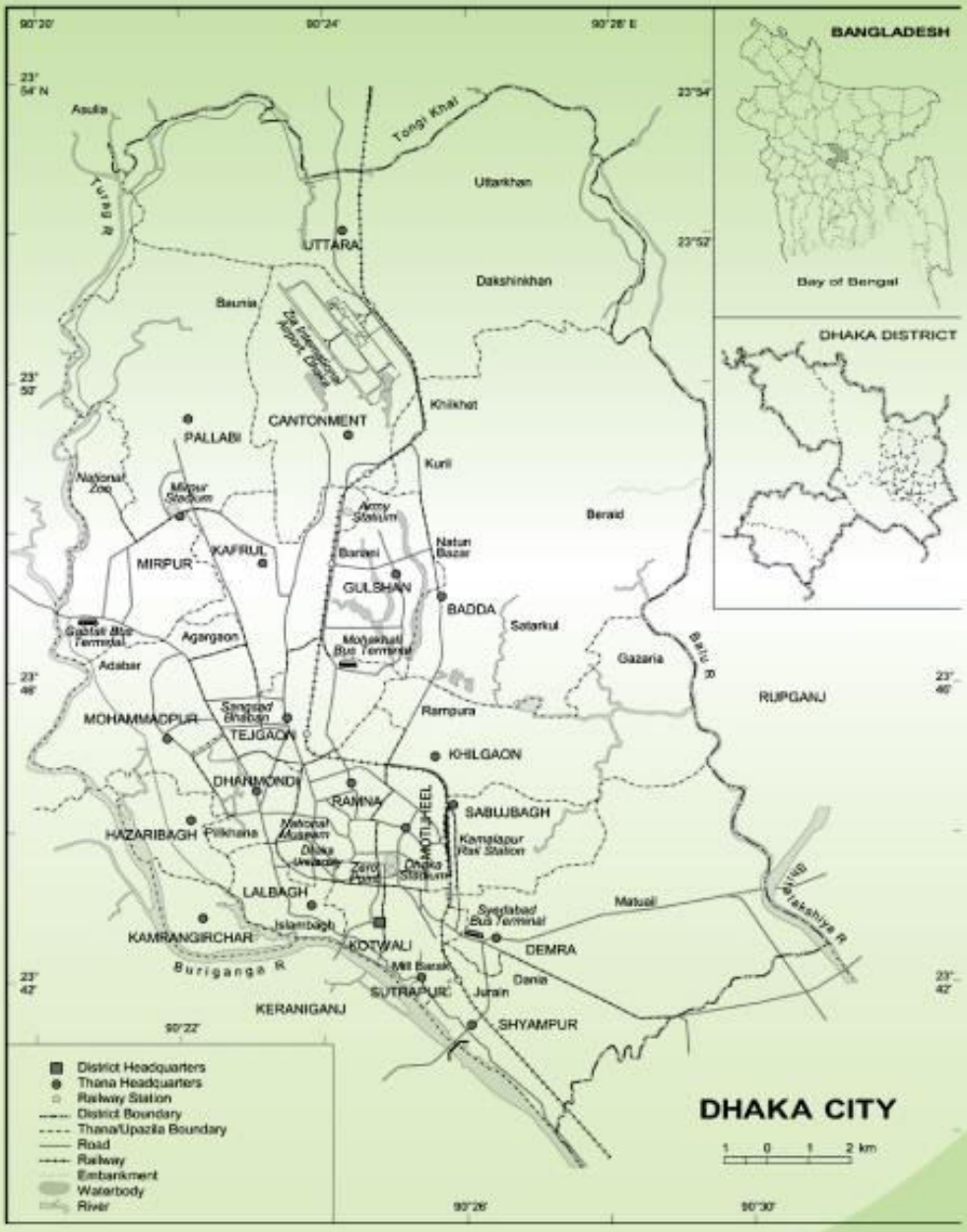


Fig 24. Graphical presentation of pH, DO, BOD, TDS, SS and Chloride of Kushiara River in 2013

Note : F.FI = Fenchugonj Fertilizer Industry.

CHAPTER 5: DESCRIPTION OF SAMPLING POINT AROUND DHAKA CITY



1.0 Buriganga River

The Buriganga River (Buṛigônga "Old Ganges") flows pass the southwest outskirts of Dhaka city. Its average depth is 7.6 metres and its maximum depth is 18 metres.

In the distant past, a course of the Padma river used to reach the Bay of Bengal through the Dhaleshwari river. This course gradually shifted and ultimately lost its link with the main channel of the Ganges and it was renamed as Buriganga.

The Buriganga is economically very important for Dhaka. Launches and country boats provide communication with other parts of Bangladesh. When the Mughals made Dhaka their capital in 1610, as Dhaka was a prime location for trade. The river was also the city's main source of drinking water.

Today, the Buriganga river is afflicted by the noisome problem of pollution. The chemical waste of mills and factories, household waste, medical waste, sewage, dead animals, plastics, and oil are some of the Buriganga's pollutants. Experts identified nine industrial areas in and around the capital city as the primary sources of river pollution : Tongi, Tejgaon, Hazaribagh, Tarabo, Narayanganj, Savar, Gazipur, Dhaka Export Processing Zone and Ghorashal. Most of the industrial units of these areas have no sewage treatment plant (STP) or effluent treatment plants (ETPs) of their own.

More than 60,000 cubic metres of toxic waste, including textile dying, printing, washing and pharmaceuticals are released into the main water bodies of Dhaka every day .(Ref. Majumdar, Dr. R.C., History of Ancient Bengal, First published 1971, Reprint 2005, pp. 3-4, Tulshi Prakashani, Kolkata, ISBN 81-89118-01-3). Textile industries annually discharge nearly 56 million tonnes of waste and 0.5 million tonnes of sludge. Sewage is also released into the Buriganga. The Buriganga receives high amount of food waste including rotten fruits, vegetables, and fish.

To monitor water quality of Buriganga river samples were collected from eight different locations viz. Mirpur Bridge, Hazaribag, Kamrangir Char, Chandni Ghat, Sadar Ghat, Dholaikhal, Bangladesh China Friendship Bridge (BCFB) and Pagla along the river.

Mirpur Bridge Sampling Point:

This sampling point is near Gabtoli bus stand and close to Gabtoli Bridge, beside the Gabtoli Launch Ghat. A lot of commercial activates e.g. loading/unloading of sand, stone, coal, bricks take place around this point. Also wastes from Gabtoli bus terminal, households and commercials installations go to the river. So, this point is still valid for sampling to monitor water quality of Buriganga river.

Hazaribag Sampling Point:

Hazaribagh is a part of old Dhaka since Mughal period. At present, it has become an industrial area. Bangladesh's largest leather processing zone is situated here. This area is situated near the Buriganga river. All the untreated wastes from this industrial zone go to the Buriganga river. So, Hazaribag as a sampling location for monitoring Buriganga river water quality is very important.

Kamrangir Char Sampling Point:

Total area of is Kamrangirchar 2.87 km². It has a population of 25827. Sanitation is very poor. All the sewage line of this area is connected near the sampling point. Besides that industrial enterprises discharge their wastes into the Buriganga river. This location is suitable for sampling in order to monitor river water quality.

Chandni Ghat Sampling Point:

This sampling point is near old town of Dhaka (Lalbagh). In this area many small and medium industries are located those discharge their waste in Buriganga river. Besides that city sewage system ends up in the river. Further dumping of municipal and industrial wastes polluting river water. So, this location is elegible for monitoring water quality of Buriganga river.

Sadar Ghat Sampling Point:

Sadarghat river port is located in the southern part of Dhaka, on the river Buriganga. The Sadarghat port is one of the largest river ports in the world. About 200 large and small passenger vessels depart and arrive at the terminal every day. According to the officials at the terminal, on averages 50,000 people, use the port every day. Hundreds of country boats (mechanized and non-mechanized) on the river surrounding port area.

All the vessels and boats discharge bilge water, food and other solid wastes into the river. Human excreta also discharged directly to the river water. So, this location is very important for sampling to monitor river water quality.

Dholaikhal Sampling Point:

This sampling point is in Sadarghat Launch ghat and China Friendship Bridge (BCFB) point. Distance between Sadarghat Launch ghat and BCFB is 0.3 km. There a sluice gate (through which sewage is being discharged to the river) down to the sampling point. Sampling at this point cannot capture polluting scenario due sewage discharge. This pollution can be captured by sampling at BCFB.

So, Dholaikhal sampling point could be dropped from the sampling network of Buriganga river.

Bangladesh China Friendship Bridge (BCFB) Sampling Point:

With the growing population in the Dhaka city, it becames imperative to connect the surrounding areas by an integrated transportation network. Construction of the 6th China-Bangladesh Bridge at Mukterpur over the river Dhaleswari on Dhaka-Munshigonj road was completed in January 2008. The length of the Bridge is 152 m and width is 10 m. The project impact area covers the district of Dhaka, Narayangonj and Munshigonj. Many industries located on both side of Burigonga river around the sampling location. Besides that municipal and human wastes pollute river water. This location is eligible for sampling for monitor water quality of Buriganga river.

Pagla Sampling Point:

This sampling point is near Pagla bazaar in Dhaka. Pagla sewage treatment facility of Dhaka Water Supply and Sewerage Authority (DWSSA) is located near this point. Treated wastewater from the Pagla sewage treatment facility is being discharged slighty up of this sampling point. River water quality monitoring at the point will enable to monitor effectively of Pagla sewage treatment plant. So, sampling should continue at this location.

2.0 Turag River

The Turag River is the upper tributary of the Buriganga. The Turag originates from the Bangshi River, which is an important tributary of the Dhaleshwari River. Turag river flows through Gazipur and meet the Buriganga river at Mirpur in Dhaka District. It remains navigable by boat all year round. Earlier this river was called as (Bengali: "Kohor Doriya"), "Kohor river". There are many industries dotting the banks of this river those dispose their wastes into the river. These waste materials pollute the water of the river to a dangerous level. During the Bishwa Ijtema, Muslims pilgrims coming from all over the world stay at the riverside for days. Unfortunately they lack proper accommodation and an adequate sanitation system. As a result, human waste and garbage generated are disposed into the river. This also pollutes the river heavily.

Fulpukuria Dyeing Ltd. Sampling Point:

Fulpukuria Dyeing Ltd. is situated on Gudara Ghat, Pagar, Tongi. Some other textile dyeing industries are located around this sampling location and all of those industries discharge waste (may be after treatment) into river water. To monitor river water quality as well as effectively of ETP of those industries, sampling at this location plays significant role. So, sampling should continue at this location.

Hossain Dyeing Ltd. Sampling Point:

Hossain Dyeing Ltd. is situated at Pagar (East side of Tongi, BSCIC), Tongi. This location is not suitable for sampling. Because it is the discharge point of Hossain Dyeing Ltd. It should be move about 200 m west side (down) which near Tongi Rail Bridge.

Tongi Rail Bridge Sampling Point:

Tongi Rail Bridge is situated about 2 km east side form Abdullahpur bus stand. It is between Hossain Dyeing Ltd. and the Tongi bridge. This location is not suitable for sampling because two sampling point e.g near near Fulpukuria Dyeing Ltd., and near Hossain Dyeing Ltd. are adjacent (within 500 m). It should move to Dhour, Ashulia Bridge, Ashulia. It is a intersection point of tongi river and tongi canal. Many industries located on both side of Turag river around the

sampling location. Besides those loading/unloading construction materials, municipal and human wastes pollute river water. Some textile dyeing industries viz. Itafill (BD) Ltd., Tamisna Yarn Dyeing, Cross line knit Composite, Annantex Ltd, Orbit Processing etc are located around this sampling location and all of those industries discharge wastes (may be after treatment) into river water. To monitor the river water quality as well as to evaluate effectively of ETP of those industries, sampling at this location plays significant role. **So, sampling point could be fix at Dhour, Ashulia Bridge, Ashulia.**

Tongi Bridge Sampling Point:

This sampling point is near Tongi BSCIC industrial area. Many industries and bazaar discharge their treated/untreated wastes (solid and liquid) in to the Turag river. Many textile dyeing industries are located around this sampling location and all of those industries discharge waste into river water. To monitor river water quality as well as effectively of ETP of those industries, sampling at this location ply significant role. So, this point is suitable sampling to monitor water quality is Turag river.

Azmeri Composite Ltd. Sampling Point:

It is situated near Tongi Istema field and Kamarpara bus stand. Azmeri Composite Ltd. together with other industries located surroubdibg this location discharge their wastes into the river. Further wastes from nearby bus stand also mix with water and degrade water quality. So, this point is suitable for sampling to monitor water quality is of Turag river.

3.0 Shitalakhya River

Shitalakshya River: This is also known as **Lakhya River**, is a distributary of the Brahmaputra. In its initial stages it flows in a southwest direction and then to east side of Narayanganj city until it merges with the Dhaleswari near Kalagachhiya. A portion of its upper course is known as Banar River. The river is about 110 kilometres long and its width 300 metres near Narayanganj. It remains navigable year round. The river's maximum depth is 21 metres and average depth is 10 metres. The Shitalakhya is a branch of the Brahmaputra which has changed its course at least twice in the Bangladesh part in the fairly recent past. In the 21st century, the main flow of the Brahmaputra waters is through the Jamuna channel. Earlier, after tracing a curve round the Garo Hills on the west, it took a sharp turn in the south-east direction near Dewanganj, and then passing by Jamalpur and Mymensingh, threw off the Shitalakhya branch and flowed through the eastern part of Dhaka district and fell into the Dhaleshwari. The Shitalakhya ran almost parallel to the Brahmaputra and joined with the Dhaleswari after passing by Narayanganj. There is a river port in Narayanganj. Numerous launches and mechanized vessels ply on this river. A lot of large, medium and small sized industries located on both banks of the river.

For monitoring water quality samples are being colleted from three different locations viz. Demra Ghat, Ghorasal Fertilizer Factory (GFF) and near ACI factory at Narayanganj.

Demra Ghat Sampling Point:

Many industries located on both side of Shitalakhya river around the sampling location. Besides that loading/unloading construction materials, municipal and human wastes pollute river water. Some textile dyeing industries, consumer item producing industries and jute mills are located around this sampling location and all of those industries discharge wastes into river water. To monitor the river water quality as well as to evaluate effectively of ETP of those industries, sampling at this location plays significant role. So, sampling should continue at this location.

Ghorasal Fertilizer Factory (GFF) Sampling Point:

Ghorashal fertilizer factory is located Narsingdi District.

Ghorashal fertilizer factory together with other industries located surrounding this location and discharge their wastes into the river. So, this point is suitable sampling to monitor water quality is Shitalakhya river. This location is suitable for sampling.

ACI factory at Narayanganj Sampling Point:

This is located at Narayanganj, on the bank of Shitalakkhya river.

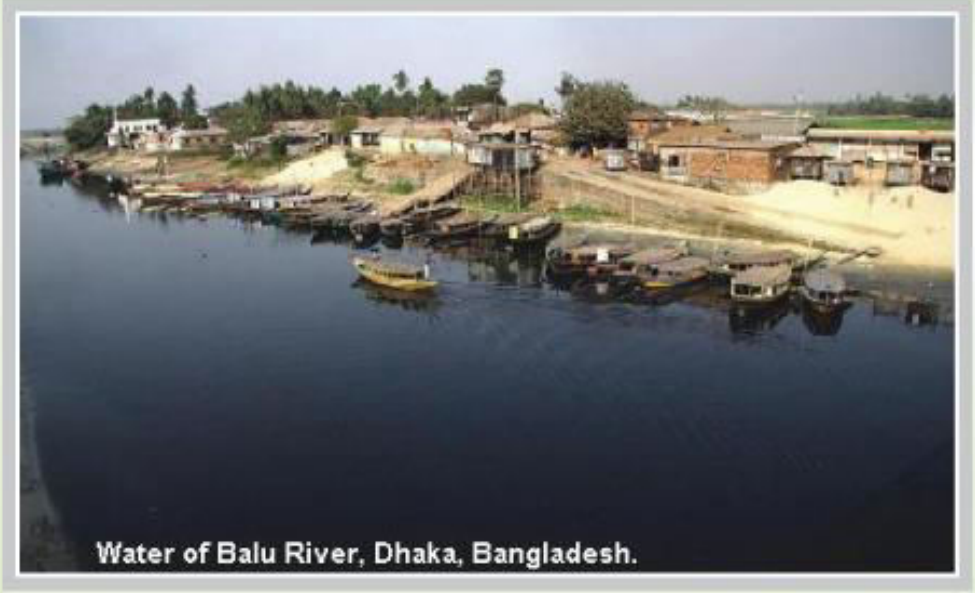
This location is not suitable for sampling because it is the discharge point of near ACI factory. It should be move about 200 m down steam from the existing location.

4.0 Balu River:

The Balu River, is a tributary of the Shitalakhya River. It passes through the wetlands of Beel Belai and Dhaka before it met with the Shitalakshya at Demra.

It has a narrow connection with the Shitalakha through Suti Nadi near Kapasia on the end and with the turag river, Tongi khal on the other end there is also a link with the Shitalaksha near Kaliganj. Although it carries floodwater from the Shitalakhya and the Turag during the monsoon season, the Balu is of importance mainly for local drainage. This is also important for establishing circular water way around the Dhaka city.

Water of Balu river is polluted due to discharge of sewage and industrial wastes. At present, there is no sampling points in the Balu River. However, two sampling locations could be established. One east side of Bashundhara residential area near Purbachal project near Rupganj and another is at Gazaria (Back side of Saterkul, Badda) near Damra/Sultana Kamal bridge.



Water of Balu River, Dhaka, Bangladesh.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Despite discontinuity of monitoring data in some cases, this report would shed some light on overall surface water quality status of Bangladesh and provide food for thought of how to plan for proper monitoring. Because water quality monitoring information shall provide the basis for water resource development plans.

6.2 Recommendations

To provide with concrete useful information for policy feedback a continuous monitoring of a comprehensive set of parameters is essential. The following actions are recommended to get comprehensive data set trough better monitoring and analyses of the rivers water of Bangladesh.

- Judicious selection of sampling locations.
- Collection of water samples and analyses must be in a consistent way and on regular basis for assessment of water quality.
- Increase skilled manpower at all level of water quality analysis including sample collec tion.
- Microbial test (Fecal Coliform, E-Coli etc) of river water is essential to analysis water quality of rivers.
- Use Global Positioning System (GPS) to represent monitoring results in global context.
- Establish Water Quality Index (WQI) to assess water quality analysis.
- Undertake capacity building programme of the laboratory (both human and logistics capacity).
- Review and update surface water monitoring network.
- Need to collect supporting weather information while sampling.
- Need to collect data on river flow.
- Need to collect data every month through the year.
- Strengthening regional cooperation for the sustainable management of trans-boundary rivers, Integrated Watershed Management (IWM) approach can be implemented in this regard.
- For each river, sampling must be done from more than one location.

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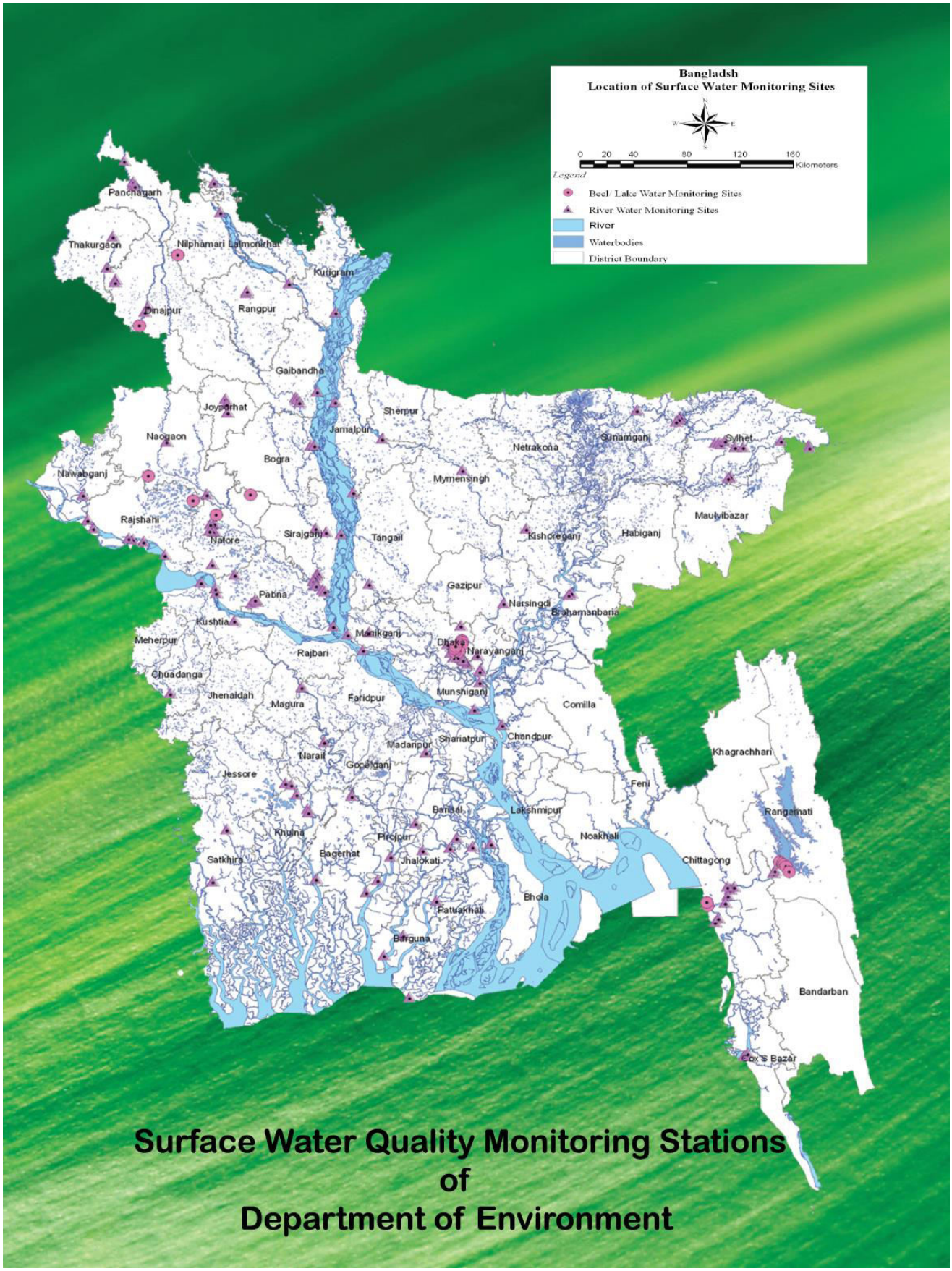

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