River Water Quality Report 2015

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

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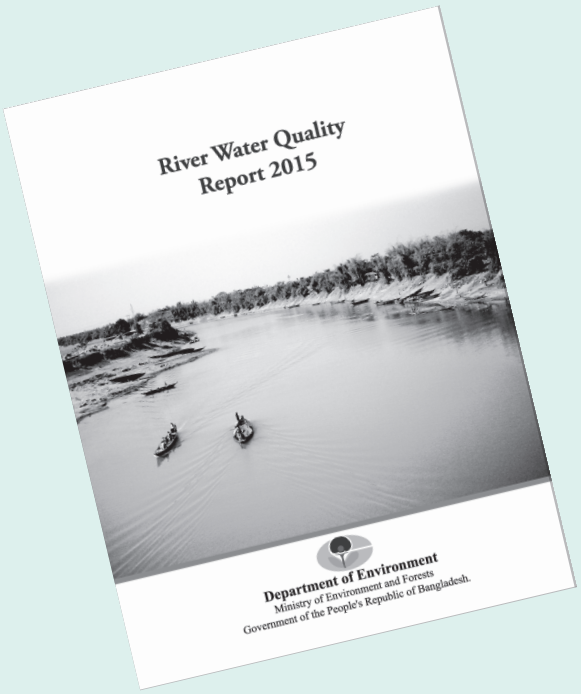

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Message

Water is an essential element for industrial as well as agricultural development. Water is absolutely essential not only for survival of human-beings, but also for animals, plants and all other living beings. Water is also crucial for the quality of life. River water quality is a key concern as it is used for drinking and domestic purpose, irrigation and aquatic life including fish and fisheries.

To evaluate the quality of river water for the purpose of irrigation, health, domestic and fisheries, we set Environmental Quality Standard (EQS). Considering importance of water quality the Department of Environment (DoE) has been monitoring surface water quality since its origin in 1973. DoE monitors surface water quality following its monitoring network that includes major rivers and lakes. Monitoring information provide water resource quality of major rivers of Bangladesh.

"River Water Quality Report 2015" is the sixth of its kind that shed light on overall status of river water quality in Bangladesh. Dumping of city and industrial wastes into rivers highly polluting rivers surrounding cities. To halt further degradation of water quality of rivers government has declared Buriganga, Turag, Balu and Sitalakhy river as Ecologically Critical Area (ECA) in 2009. Water quality of big rivers such as Padma, Megna, Jamuna, Brahmmputra is still good and within water quality standards set in the Environment Conservation Rules, 1997. Water quality of rivers in southern region degraded due to high salinity and turbidity and thus, water of those rivers often unfit for domestic use.

This report also highlighted the necessary steps to be taken for sustainable management of aquatic ecosystems. Hopefully this document will be useful in the decision making process for conservation of degraded riverine ecosystems of Bangladesh.

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

Md. Raisul Alam Mondal
Director General

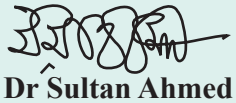
Foreword

Water is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Water is a universal solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Because of water's very characteristic of high solubility, it is very much vulnerable to getting polluted. That is why we need effective management of solid and liquid wastes to avoid water pollution. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving. A river is defined as a large natural stream of water emptying into an ocean, lake, or other body of water and usually fed along its course by converging tributaries.

The quality of natural water in rivers, lakes and reservoirs and below the ground surface depends on a number of interrelated factors. In its movement on and through the surface of the earth, water has the ability to react with the minerals that occur in the soil and rocks and to dissolve a wide range of materials, so that its natural state is never pure. It always contains a variety of soluble inorganic, soluble organic and organic compounds. In addition to these, water can carry large amounts of insoluble materials that are held in suspension. Both the amounts and type of impurities found in natural water vary from place to place and by time of year and depends on a number of factors. These factors include geology, climate, topography, biological processes and land use. The impurities determine the characteristics of a water body.

River water quality is a key concern as it is used for drinking and domestic purpose, irrigation and aquatic life including fish and fisheries. The river can play a vital role to contribute social and economic structure of development as a developing country like Bangladesh. The river water quality report 2015 contains statistical analyses of various water quality parameters of different rivers of the country for the period from January to December 2015. A number of physiochemical water quality parameters including Temperature, pH, EC, TDS, DO, BOD, COD, SS, Chloride, Turbidity, Total Alkalinity and Salinity were measured in laboratory base analysis. The mean value of such respective parameters in both seasons were compared with the water quality standards as set by the EQS guideline of Department of Environment (DoE). This report also gives a comparative statement of river water quality for the period of 2010-2015. It offers a clear view of present situation and recommends ways and means for conservation and sustainable use of water.

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)
Director (NRM and Research)

Editorial Notes

Water quality and quantity greatly affects ecosystems productivity and services they provide. To provide with necessary information for sustainable services especially of aquatic ecosystem, continuous monitoring of water quality is essential. Despite discontinuous sampling and measurement of a few parameters, this report would shed some light on water quality of major rivers of the country. Water quality parameters like pH, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Turbidity, Total Dissolve Solis (TDS), Suspended Solid (SS), Total Alkalinity, Electrical Conductivity (EC) and Chloride presented in this report were measured more or less round the year of 2015. There was spatiotemporal variation in water quality. From the analyses, impact of seasons, industrialization and urbanization 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 improved, 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 huge 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 season. Long dry period and reduced upstream flow are the proximate causes of high salinity of surface water in southern region. Sometimes salinity becomes exceptionally high. High salinity together with high turbidity are making river ecosystem in the southern region fragile. Soil erosion from catchment area, dumping of solid wastes into rivers are the main causes of high turbidity. Water salinity comes down near to EQS during wet season. Summer rainfall and increased flow from upstream are proximate cause of salinity decrease. To get clearer picture on water quality, more intense and systematic monitoring is essential. However, current condition of surface water quality finds discharge of untreated wastes into rivers by the industries as well as domestic and other wastes. Hence, this is a need to escalate monitoring and enforcement activities as well as awareness building in all walks of life to improve surface water quality.

Dr. Md. Sohrab Ali
Director (IT)

Acknowledgement

The River Water Quality Report 2015 is an effort of series of water quality data analysis result that were conducted by the Laboratories of Department of Environment (DoE). At the outset, I would like to express my gratitude to Mr. Md Raisul Alam Mondal, Director General, Department of Environment, for the supervision and guidance during preparation of this report. Our sincere gratitude to the DoE laboratories (Dhaka Lab, Chittagong Lab, Rajshahi Lab, Khulna Lab, Barisal Lab, Sylhet Lab) and laboratories personnel such as Directors, Deputy Directors, Senior Chemists, Junior Chemists, Assistant Biochemists and Sample Collectors for doing the troublesome work of river water collection in month interval and provide us the analysis report in due time. Without their perdurable support it cannot be end with the eventual outcome. I would like to extend my sincerest thanks and appreciation to the editors Dr. Sultan Ahmed, Director (Natural Resources Management & Research) and Dr. Sohrab Ali, Director (IT) for their patient souls with excellent guidance to accomplish this study report. A special thanks is also extended to Mr. Md. Abubakar Ahmed, Junior Consultant, for compiling data for this report.

Farhana Mustari
Assistant Director (Water & Bio.)

Executive Summary

Rivers are important features of Bangladesh's landscape where hundreds of rivers are crisscrossing the landmass and playing role of artery and veins for the maintenance of the ecosystem of the country. 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 66 stations of the 28 rivers in Bangladesh. 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, Jamuna, Dhaleshwari, Surma, Korotoa etc. was within the limit of Environmental Quality Standards (EQS) in 2015 while rivers around greater Dhaka were highly polluted specially in the first five months of 2015 in terms of DO, BOD and COD value. DO was almost zero from January to May at different location of Buriganga, Shitalakhya and Turag River. High levels of Chloride (135.6 mg/l), TDS (639 mg/l), BOD (35 mg/l) and COD (124.3 mg/l) were found in Buriganga river from January to December in 2015. In Meghna DO and BOD level were found within the EQS which varied from 4.7 to 8.1 mg/l and 1.0 to 7.0 mg/l, respectively. In Jamuna DO and BOD levels were found from 5.0 to 7.6 mg/l and 0.3 to 5.2 mg/l, respectively.

High levels of Chloride, TDS and Turbidity were found in Moyuri, Rupsha, Pashur and Kakshiali River. Highest level of Chloride (12692 mg/l) and TDS (16376 mg/l) were found in Pashur river. Highest value of Turbidity (134.3 NTU) was found in Kakshiali river. High COD (489 mg/l) was found in Karnaphuli river.

Impact of seasonality on water quality surfaced up while analyzing data. During dry seasons water quality become worse. On the contrary, river water quality improved greatly during the wet seasons indicating clear relationship between increased flow of river and river water quality.

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ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
TDS	-	Total Dissolved Oxygen
EC	-	Electrical Conductivity
ECA	-	Ecologically Critical Area
ECR	-	Environmental Conservation Rules
SS	-	Suspended Solids
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. Monitoring of surface water quality is one of the vital work of the Department of Environment (DoE). To evaluate water quality for human consumption and other uses the Government has set EQS for inland surface water in the Environmental Conservation Rules (ECR), 1997. 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.

Out of 57 transboundary rivers, 54 shared with India and three shared with Myanmar. The flows in the rivers varies greatly depending on seasons, rainfall intensity and upstream diversion of transboundary rivers. Following fluctuation in flow river water quality varies significantly. Dumping of industrial untreated waters, household and municipal wastes, medical wastes, naval waste 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.

The Department of Environment (DoE) has established 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 2015, the monitoring program covered 66 sampling locations in 28 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 2015. The following are the limitations of the report:

- In some cases, 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 Meghna, 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 (BOD_5), Chemical Oxygen Demand (COD) measured to assess the inland surface water quality in Bangladesh.

3.2 Methods of Analysis

Modified Winkler's Method was used to analyze DO, Dilution Method for BOD_5, Closed Reflux Colorimetric Method for COD, Argentometric Methods for Chloride and Gravimetric Methods for TDS and SS. Nephelometric Methods for Turbidity. Standard method for the examination of water and Wastewater for pH, EC and Total Alkalinity. Hydrometric and Argentomentric Method for Salinity.

3.3 Comparison with standards for inland surface water

River water quality was compared with the Environmental Quality Standard (EQS) set in the Environmental Conservation Rules 1997 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 2015

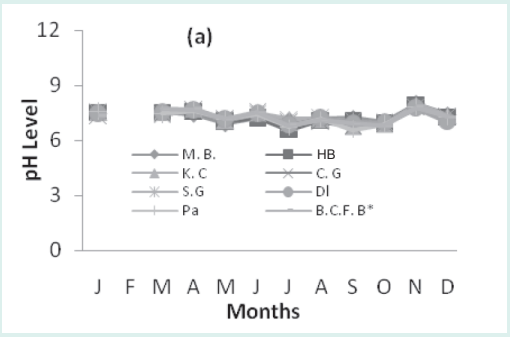
4.1 Buriganga River

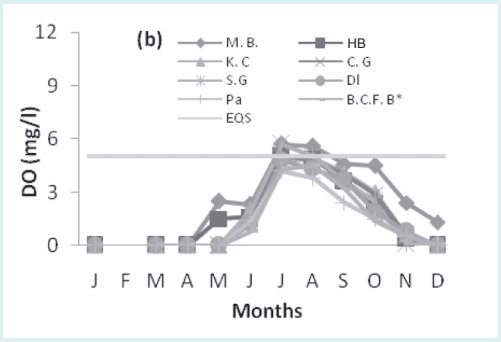
To monitor water quality of Buriganga river, samples were collected from eight different locations viz. Mirpur Bridge (M B), Hazaribag (H B), Kamrangir Char (K C), Chandni Ghat (C G), Sadar Ghat (S G), Dholaikhal (DL), Bangladesh China Friendship Bridge (BCFB) and Pagla (Pa) along the river.

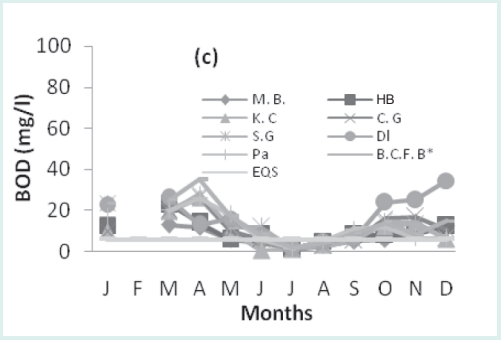
In 2015, pH among different locations varied from 6.58 to 7.98 (Fig.1a) while standard pH range for inland surface water for fisheries is 6.5 to 8.5. In 2014, pH range varied from 6.66 to 7.79. Dissolved oxygen (DO) content in Buriganga river water was very low (0.0 mg/l) in 2015. In 2015, DO of Buriganga river was lower than EQS (≥5 mg/l). The maximum DO (5.70 mg/l) was found at Mirpur Bridge in July and the minimum (0.0 mg/l) was at all locations from January to April (Fig.1b). Reduced flow of water, direct discharge of untreated effluent from industries, domestic wastes, tannery wastes into the river and are the proximate causes for depletion of DO in dry season. DO level was slightly increased in wet season (June to October) at all locations of the river. In 2014, DO level varied from 0.0 mg/l to 5.48 mg/l.

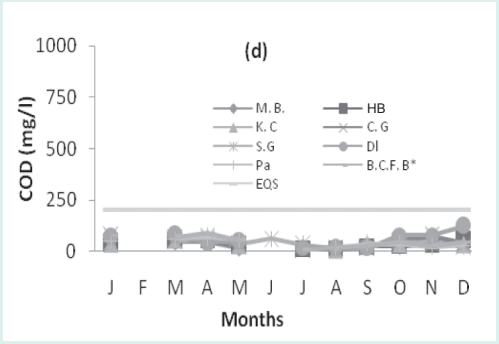
In 2015, BOD of Buriganga river was higher than EQS limit (≤6 mg/l). At Hazaribag point BOD level was much higher than EQS round the year (Fig.1c). This was mainly because of discharge of untreated tannery wastewater into the river. The maximum BOD (35 mg/l) was found at B.C.F Bridge in April and the minimum (0.6 mg/l) was at Kamrangir Char in June. In 2014, BOD range was 0.0 to 132 mg/l. In 2015, 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 124.3 mg/l at Dholaikhal in December and 4.83 mg/l at Chadni Ghat in July (Fig.1d). In 2014, COD varied from 5.0 mg/l to 219 mg/l.

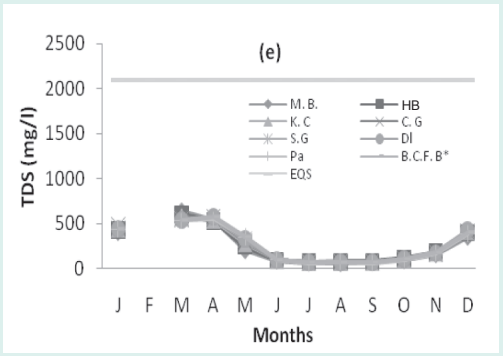
TDS of Buriganga river varied from 60.9 to 639 mg/l (Fig.1e) and the EQS of TDS is 2100 mg/l for industrial wastewater after treatment. In 2014, TDS concentration varied from 72.1 to 782 mg/l. Chloride concentration of the Buriganga river was below the EQS for industrial wastewater after treatment. The maximum concentration was 135.6 mg/l at Mirpur Bridge point in March and the minimum 5.9 mg/l at Sadar Ghat in August (Fig.1f). In 2014, Chloride concentration varied from 2.1 mg/l to 400 mg/l. Turbidity range varied from 4.9 to 250 NTU against the EQS (10 NTU) (Fig.1g). In 2014, Turbidity range varied from 15.4 to 24.6 NTU.

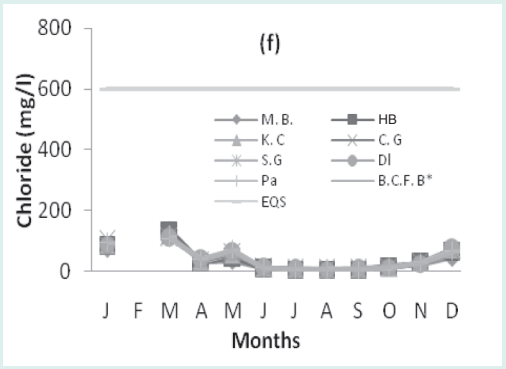












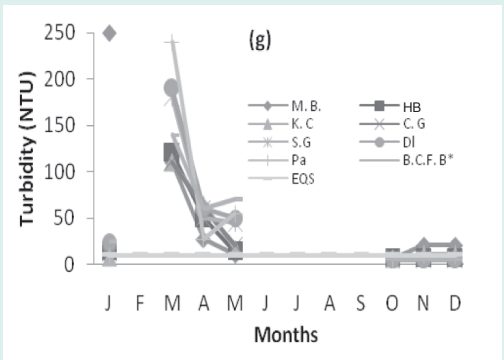


Fig.1. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Buriganga River in 2015

Table-1. Total Alkalinity of Buriganga River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	202	-	244	110	108	52	42	47	50	48	54	140
Hazaribag	204	-	284	120	150	48	40	48	48	54	50	154
Kamrangir Char	208	-	300	130	164	54	50	48	52	58	52	154
Chandni Ghat	226	-	**344**	170	190	48	46	52	54	54	54	160
Sadar Ghat	210	-	314	180	180	54	**44**	50	56	56	54	156
Dholaikhal	226	-	298	155	210	50	48	51	54	58	60	178
Pagla	220	-	284	170	240	54	50	54	54	56	58	160
B.C.F. Bridge	210	-	292	160	226	58	46	50	54	54	50	164
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Total Alkalinity of Buriganga river was 344 mg/l at Chandni Ghat in March and 44 mg/l at Sadar Ghat in July (Table-1). T. Alkalinity was very high during dry season.

Table-2. Electrical Conductivity (EC) of Buriganga river water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	638	-	**1238**	1109	419	194.1	133.6	**125.1**	150	201.9	311	673
Hazaribag	663	-	1193	1070	508	191.7	142.3	143.1	165.7	255	344	746
Kamrangir Char	701	-	1163	1104	565	193	135.7	142	152	222	321	778
Chandni Ghat	771	-	1122	1156	616	150	134	160.4	156.7	233	317	769
Sadar Ghat	684	-	1101	1157	665	197.2	135.3	144.2	154.1	223	311	754
Dholaikhal	683	-	1079	1174	678	208.6	139.3	149.6	157.6	238	331	811
Pagla	682	-	1068	1107	730	224	136.4	159.4	151.3	235	310	743
B.C.F. Bridge	642	-	1075	1161	719	211.6	143.8	152.6	151.6	229	328	748
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

The maximum and the minimum EC of Buriganga river was 1238 mg/l in March and 125.10 mg/l in August at Mirpur Bridge (Table-2). During March-April, EC was high.

Table-3. Suspended Solid (SS) of Buriganga River Water in 2015

Sampling Locations	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	31	-	60	45	46	31	18	34	12	50	21	29
Hazaribag	28	-	60	55	51	38	35	28	18	48	22	36
Kamrangir Char	27	-	55	40	53	34	30	25	18	43	14	28
Chandni Ghat	25	-	60	43	57	34	28	18	18	47	14	22
Sadar Ghat	21	-	90	47	57	34	24	23	17	45	**12**	28
Dholaikhal	22	-	80	44	60	33	24	25	16	41	20	61
Pagla	27	-	**100**	51	85	29	25	28	14	40	20	24
B.C.F. Bridge	28	-	75	80	63	35	26	29	16	40	16	41
EQS for wastewater after treatment from industrial units 150 mg/l												

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 100 mg/l in March at Dholaikhal and 12 mg/l in November at Sadar Ghat (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.

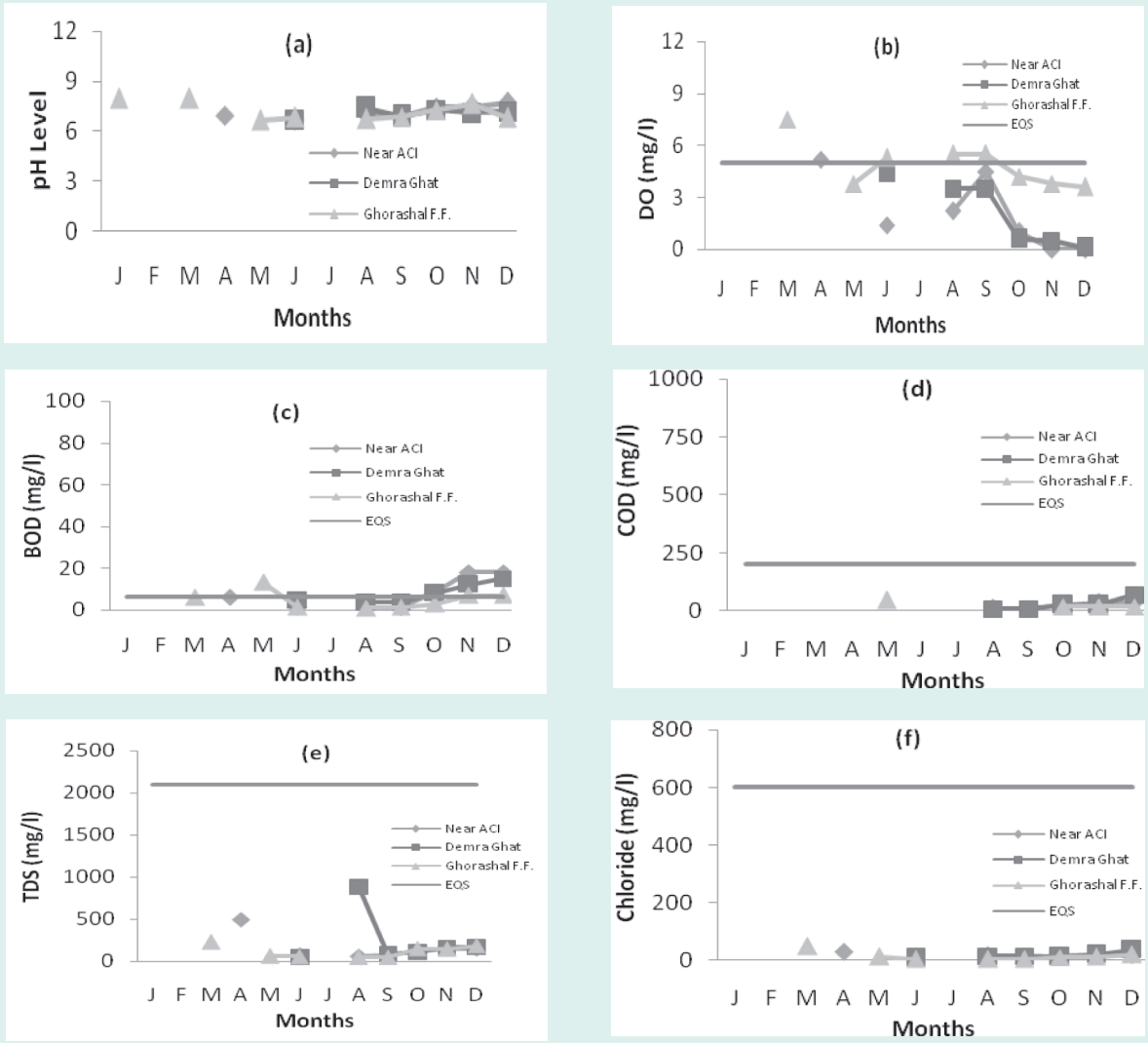


Fig.2. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Shitalakhya River in 2015

In 2015, pH of Shitalakhya river water was within the EQS (6.5-8.5) range for inland surface water. The maximum pH was 7.97 in March and the minimum PH was 6.66 in May at Ghorasal Fertilizer Factory (G.F.F) respectively (Fig.2a). In 2014, pH varied from 6.8 to 7.8. In 2015, the maximum DO (5.5 mg/l) was found at G.F.F in August and the minimum (0.0 mg/l) was found near ACI factory in November and December (Fig.2b). In 2014, DO varied from 0.0 to 5.6 mg/l.

In 2015, BOD at Demra Ghat was very high during dry period. Near Ghorasal Fertilizer Factory BOD was within the EQS (≤6 mg/l) for fisheries in May and June. Highest value of BOD (18 mg/l) was found near ACI Factory in December and lowest (0.8 mg/l) was in August near G.F.F point (Fig.2c). In 2014, BOD concentration varied from 0.0 mg/l to 32 mg/l. In 2015, COD level was within the EQS (200 mg/l) for wastewater after treatment from industrial units at all locations of Shitalakhya river. The maximum COD (69.28 mg/l) was at Demra Ghat in December and the minimum COD (7.25 mg/l) was at Damra Ghat in September (Fig.2d). In 2014, COD level varied from 4.0 mg/l to 141 mg/l. TDS of Shitalakhya river

varied from 48.5 to 484.2 mg/l against the EQS (2100 mg/l) for wastewater after treatment from industrial units. In dry season maximum TDS (484.2 mg/l) was at Damra Ghat and the minimum (48.5 mg/l) in September near G.F.F (Fig.2e). In 2014, TDS range was 70.6 to 668 mg/l. Chloride concentration of the Shitalakhya river in 2015 was below the EQS (600 mg/l) for wastewater after treatment from industrial units. The maximum Chloride (35.98 mg/l) was found at Damra Ghat in December and the minimum was 4.0 mg/l near G.F.F in September, 2015 (Fig.-2f). In 2014, Chloride concentration varied from 3.1 mg/l to 44 mg/l.

Table-4. Suspended Solid (SS) of Shitalakhya River Water in 2015

Sampling Locations	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	32	-	**76**	-	36	10	48	24	24
Demra Ghat	-	-	-	-	-	34	-	27	27	24	36	18
Ghorashal Fertilizer Factory (GFF)	-	-	12	-	32	47	-	26	**12**	54	33	28
EQS for wastewater after treatment from industrial units 150 mg/l												

SS of Shitalakhya river water at different sampling locations was within the EQS (150 mg/l). Maximum SS concentration of Shitalakhya river was 76 mg/l near ACI Factory in June and minimum 12 mg/l in September at the same location (Table-4).

Table-5. Electrical Conductivity (EC) of Shitalakhya River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	**930**	-	175.9	-	135	112.9	254	288	288
Demra Ghat	-	-	-	-	-	**108.4**	-	190.7	190.7	241	304	310
Ghorashal Fertilizer Factory (GFF)	-	-	434	-	142.4	127.6	-	118.2	161.1	301	296	374
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC of Shitalakhya river at different locations was mostly within the EQS (1200 µmhoms/cm) for treated wastewater from industrial units (Table-5) except in the month of April. The maximum EC (930 µmhoms/cm) was near ACI factory in April and the minimum EC (108.4 µmho/cm) was at Demra Ghat in June.

Table-6. Total Alkalinity of Shitalakhya River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Narayanganj (Near ACI)	-	-	-	80	-	36	-	64	52	60	100	100
Demra Ghat	-	-	-	-	-	**32**	-	60	60	72	140	120
Ghorashal Fertilizer Factory (GFF)	-	-	**170**	-	40	40	-	38	44	84	70	70
EQS for wastewater after treatment from industrial units 150 mg/l												

Maximum T. Alkalinity (170 mg/l) was near Ghorasal Fertilizer Factory in March and that of minimum was (32 mg/l) at Demra Ghat in June (Table-6).

4.3 Turag River

The Turag river is the upper tributary of the Buriganga. To monitor water quality in 2015, water samples were collected from five locations such as near Fulpukuria Dyeing Ltd. (FDL), near Hossain Dyeing Ltd. (HDL), North Side Tongi Rail Bridge (NSTRB), South Side of Tongi Rail Bridge (SSTRB) and near Azmeri Composite Ltd. (ACL). In 2015, pH varied (6.14- 8.79) (Fig.3a) of Turag river was within EQS (6.5 -8.5). The maximum pH 8.79 (near Fulpukuria Dyeing Ltd) was found in January and the minimum pH 6.14 was found in July near Azmeri Composite Ltd. In 2014, pH range was 7.01- 8.4. DO concentration of Turag river was very low during dry season of 2015 and it varied from 0.0 to 5.9 (Fig.3b). In 2014, DO was varied from 0.0 to 4.5. BOD of Turag river water was beyond the EQS (≤6 mg/l) for all sampling locations. The maximum BOD was 86 mg/l in March near Hossain Dyeing Ltd. and the minimum was 1.0 mg/l in July at south side of Tongi Rail Bridge. (Fig.-3c). In 2014, BOD varied from 2.0 mg/l to 154 mg/l. In 2015, COD at all locations of Turag river was below the EQS (200 mg/l) for waste water after treatment from industrial units. The maximum and the minimum COD content of Turag river water was 233 mg/l near Hossain Dyeing Ltd. in March and 17 mg/l near Azmeri Composite Ltd. in August (Fig.-3d). In 2014, COD range was from 5 mg/l to 475 mg/l. TDS was below the EQS (2100 mg/l) for waste water after treatment from industrial units (Fig.-3e) at all the sampling points. The maximum TDS was 804 mg/l in August near Hossain Dyeing Ltd. while that of minimum was 52.6 in July at South Side of Tongi Rail Bridge. In 2014, TDS varied from 76.2 mg/l to 959 mg/l. Chloride content of Turag river water was below the EQS (600 mg/l). The maximum Chloride was (129.7 mg/l) found in April near Hossain Dyeing Ltd. and the minimum Chloride was (7.86 mg/l) in July at Tongi Rail Bridge (Fig.-3f). In 2014, Chloride varied from 3.0 mg/l to 141 mg/l.

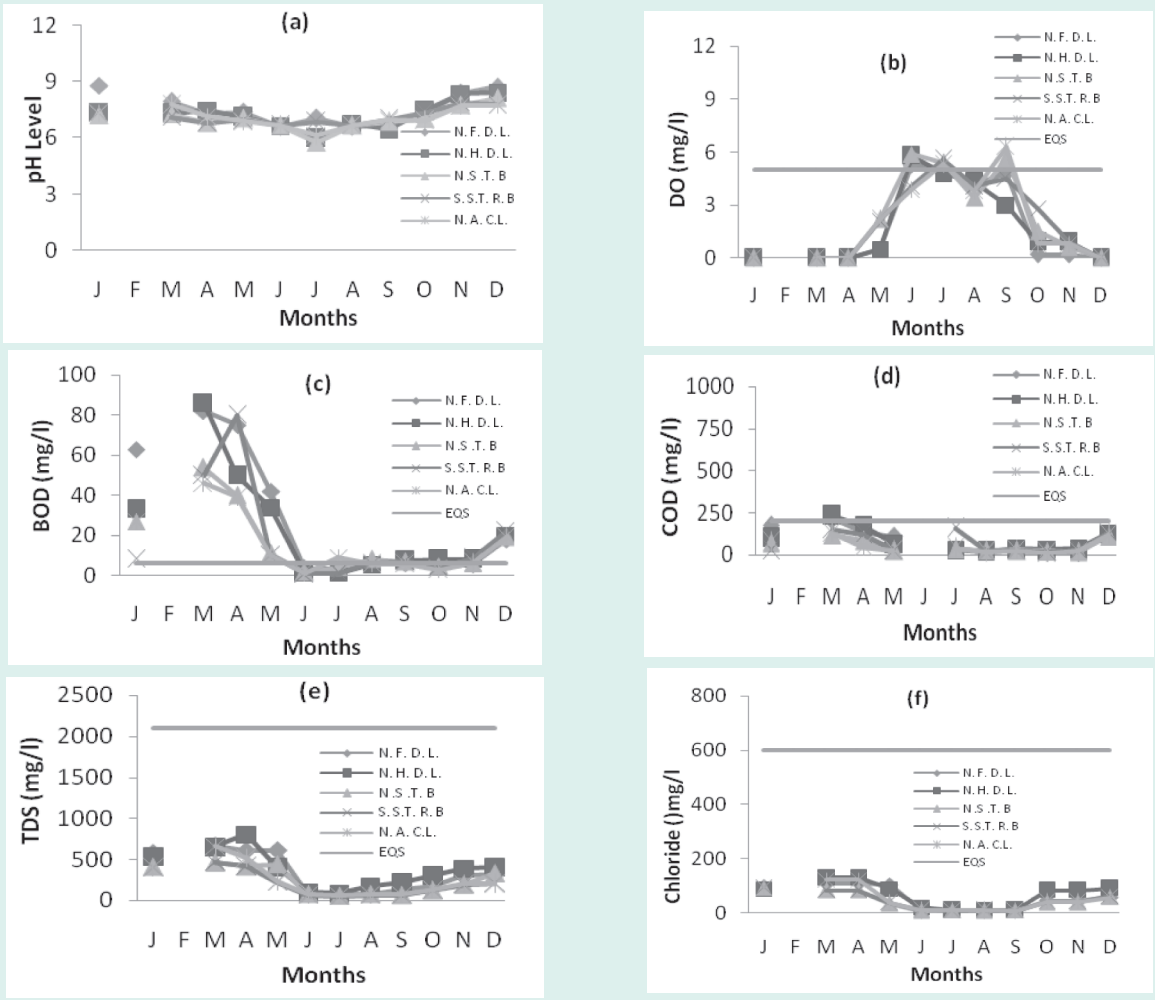


Fig.3. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Turag River in 2015

Table-7. Total Alkalinity of Turag River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fulpukuria Dyeing Ltd.	266	-	274	274	190	50	42	50	84	74	78	138
Hossain Dyeing Ltd.	190	-	**280**	280	152	56	44	80	88	72	76	98
North Side Tongi Rail Bridge	186	-	272	272	106	58	52	58	44	72	76	112
South Side Tongi Rail Bridge	150	-	270	270	110	46	40	46	48	58	64	102
Azmeri Composite Ltd.	200	-	268	268	116	**42**	42	42	52	64	72	114
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 Total alkalinity (280 mg/l) was near Hossain Dyeing Ltd. in March and the minimum (42 mg/l) in June near Azmeri Composite Ltd. (Table-7).

Table-8. EC of Turag River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fulpukuria Dyeing Ltd.	1066	-	1106	1272	1206	181.8	127.5	181.8	302	357	638	640
Hossain Dyeing Ltd.	**100**	-	1051	**1682**	745	210.2	194.9	387	503	619	792	796
North Side Tongi Rail Bridge	764	-	753	883	428	185.2	138.6	185.2	161.2	262	399	650
South Side Tongi Rail Bridge	753	-	765	893	409	152.4	117.5	152.4	143.2	271	401	398
Azmeri Composite Ltd.	760	-	1087	1102	419	148.9	124	148.9	144.4	270	415	420
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC of Turag river water was within the EQS (1200 µmhos/cm). The maximum EC (1682 µmhos/cm) was in April near Hossain Dyeing Ltd. and the minimum (100 µmhos/cm) was in January (Table-8) at the same location.

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 divided 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 2015, water samples were collected from two locations namely Muktarpur Ghat, Munshiganj and Harindhara, Hemayetpur, Savar, Dhaka for analyses.

In 2015, Dhaleshwari river water was almost neutral and pH varied from 6.7 to 8.78 (Fig.-4a). In 2014, pH level varied from 6.91 to 7.72. In 2015, the maximum DO concentration (20.4 mg/l) was at Harindhara in May and the minimum (0.0 mg/l) at Muktarpur Ghat in January (Fig.4b). In 2014, DO concentration varied from 0.3 to 6.2 mg/l.

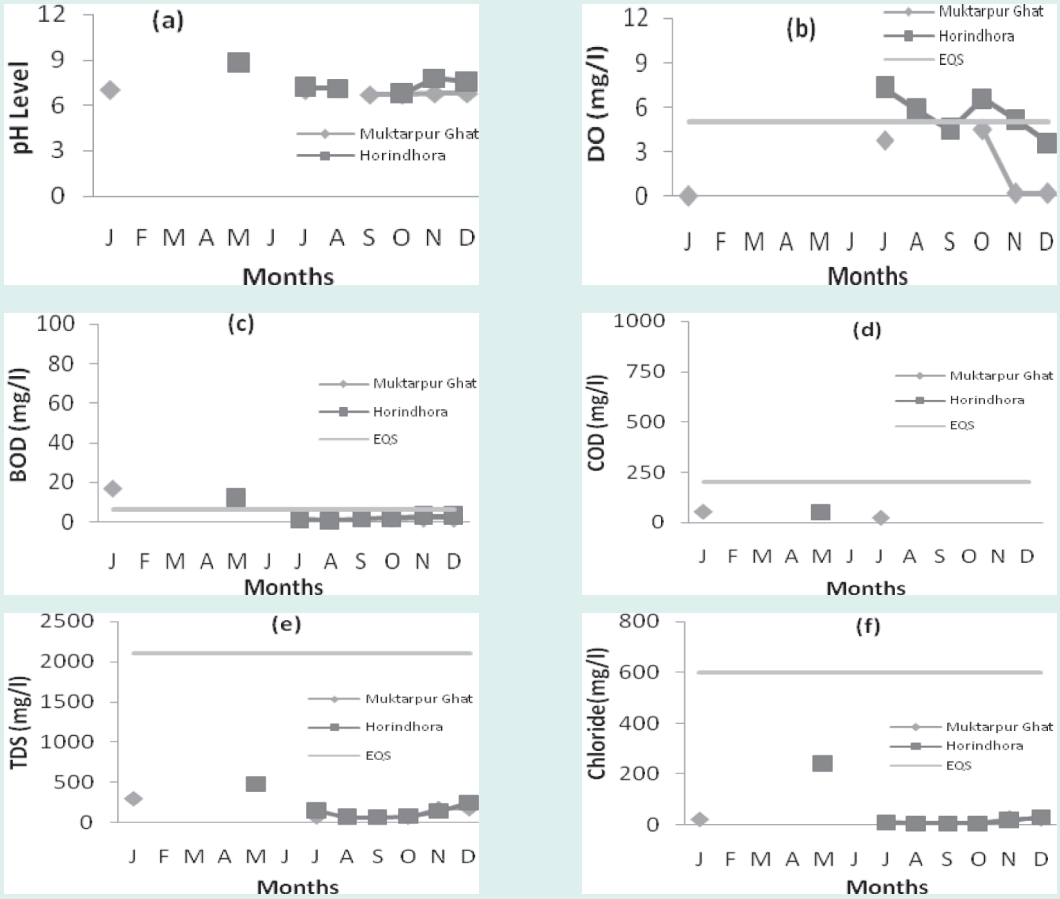


Fig.4. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Dhaleshwari River in 2015

In 2015, BOD varied from 0.8 to 17.0 mg/l (Fig.4c) while EQS for fisheries is ≤6 mg/l. In 2014, BOD varied from 0.0 to 17.8 mg/l. Level of COD of Dhaleshwari river water was within the EQS. The maximum COD of Dhaleshwari river water was 53 mg/l in January at Muktarpur Ghat and the minimum was 24.15 mg/l in July (Fig.4d) against EQS (200 mg/l) for waste water after treatment from industrial units. In 2014, COD varied from 25 to 230 mg/l. In 2015, TDS concentration varied from 64.80 to 476 mg/l (Fig.4e) while standard TDS level is 2100 mg/l for waste water after treatment from industrial units. In 2014, TDS varied from 71.9 to 287 mg/l. In 2015, Chloride concentration ranged from 5 to 238 mg/l (Fig.4f), which is far below the EQS (600 mg/l) for waste water after treatment from industrial units. In 2014, Chloride concentration range of Dhaleshwari river water was from 5 to 21 mg/l.

Table-9. Total alkalinity of Dhaleshwari River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshigonj	170	-	-	-	-	-	50	-	-	60	76	76
Horindhora, Hemayetpur, Saver, Dhaka	-	-	-	-	**476**	-	80	56	60	**38**	52	150
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum Total Alkalinity of Dhaleshwari river water was 476 mg/l in May at Horindhora and the minimum was 38 mg/l in October (Table-9).

Table-10. EC of Dhaleshwari River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshiganj	614	-	-	-	-	-	156.3	-	-	150.9	351	351
Harindhara, Hemayetpur, Saver, Dhaka	-	-	-	-	**992**	-	325	159	**150.9**	163.5	294	485
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

Electrical Conductivity (EC) of Dhaleshwari river at different locations was mostly within the EQS (1200 µmhos/cm). The maximum and the minimum EC of Dhaleshwari river water was 992 µmhos/cm in May and 150.9 µmhos/cm in September at Harindhara (Table-10).

4.5 Brahmaputra River

The Brahmaputra, a trans-boundary river that originates from Manossarobar 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 2015, pH level of Brahmaputra river varied from 7.08 to 7.95 (Fig.5a), while standard range for fisheries is 6.5 to 8.5. In 2014, pH level varied from 7.73 to 8.06. In 2015, DO concentration varied from 6.4 to 7.5 mg/l (Fig.5b). The highest and the lowest DO was found in November and August respectively, while EQS of DO for fisheries is ≥5 mg/l. In 2014, DO varied from 8.4 to 11 mg/l. In 2015, BOD concentration varied from 2.2 to 8 mg/l (Fig.5c) while EQS for fisheries is ≤6 mg/l. In 2014, BOD varied from 0.4 to 1.5 mg/l. In 2015, SS concentration varied from 13 to 56 mg/l (Fig.5d). In 2014, SS was 15 mg/l in December. In 2015, Chloride level was from 2.95 to 7.99 mg/l (Fig.5e) and which is less than EQS (600 mg/l) for treated wastewater from industrial units. In 2014, Chloride concentration varied from 1.7 to 7.71 mg/l. In 2015, TDS level ranged from 42.6 to 183 mg/l (Fig.5f) and was within the EQS (2100 mg/l). In 2014, TDS level varied from 147.1 to 180.1 mg/l.

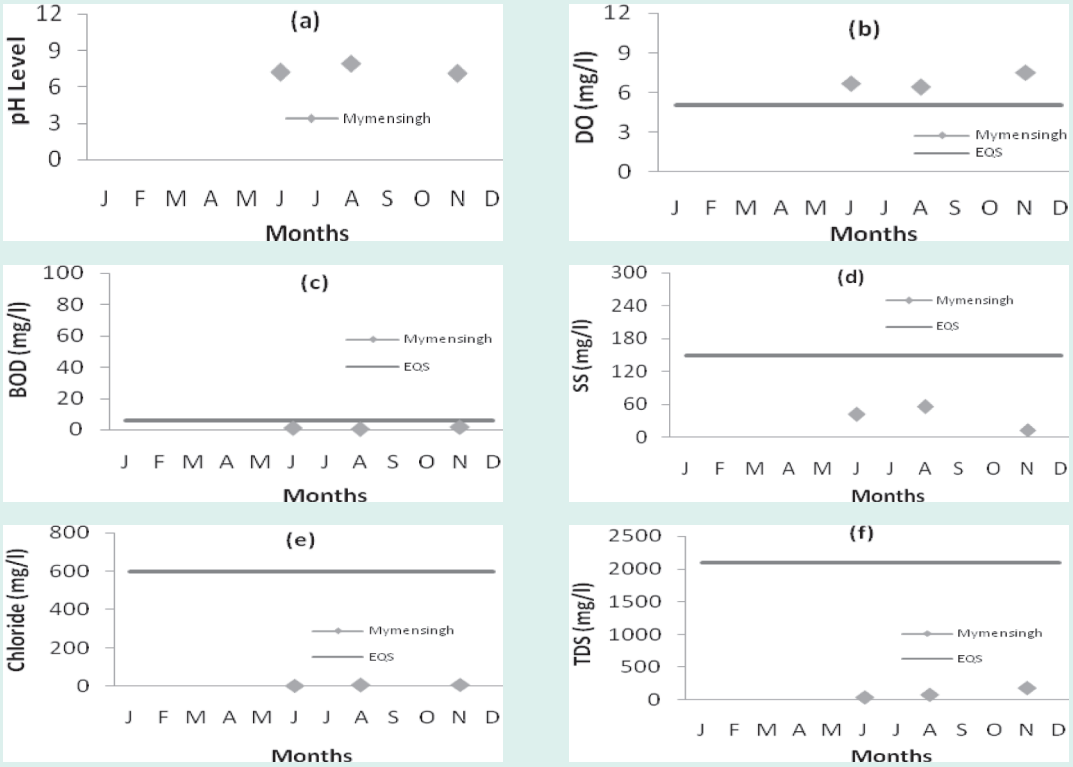


Fig.5. Graphical presentation of pH, DO, BOD, SS, Chloride and TDS of Brahmaputra River in 2015

Table-11. Total Alkalinity of Brahmaputra River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	-	-	-	-	-	**36**	-	**70**	-	-	70	-
EQS for wastewater after treatment from industrial units 150 mg/l												

T. Alkalinity was below the EQS (Table-11).

Table-12. EC of Brahmaputra River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	-	-	-	-	-	**96.9**	-	180.7	-	-	**366**	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC was far below EQS (Table-12).

4.6 Kaliganga River

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

In 2015, pH of Kaliganga river varied from 7.01 to 7.34 (Fig.6a). The maximum and the minimum pH was found in December and August, respectively. In 2014, pH level varied from 7.35 to 7.98. In 2015, DO range was from 3.3 to 7.5 mg/l (Fig.6b). In 2014, DO was from 4.3 to 7.2 mg/l. In 2015, BOD varied within a range of 1.2 to 5.0 mg/l (Fig.6c). In 2014, BOD varied from 5.1 to 26.0 mg/l.

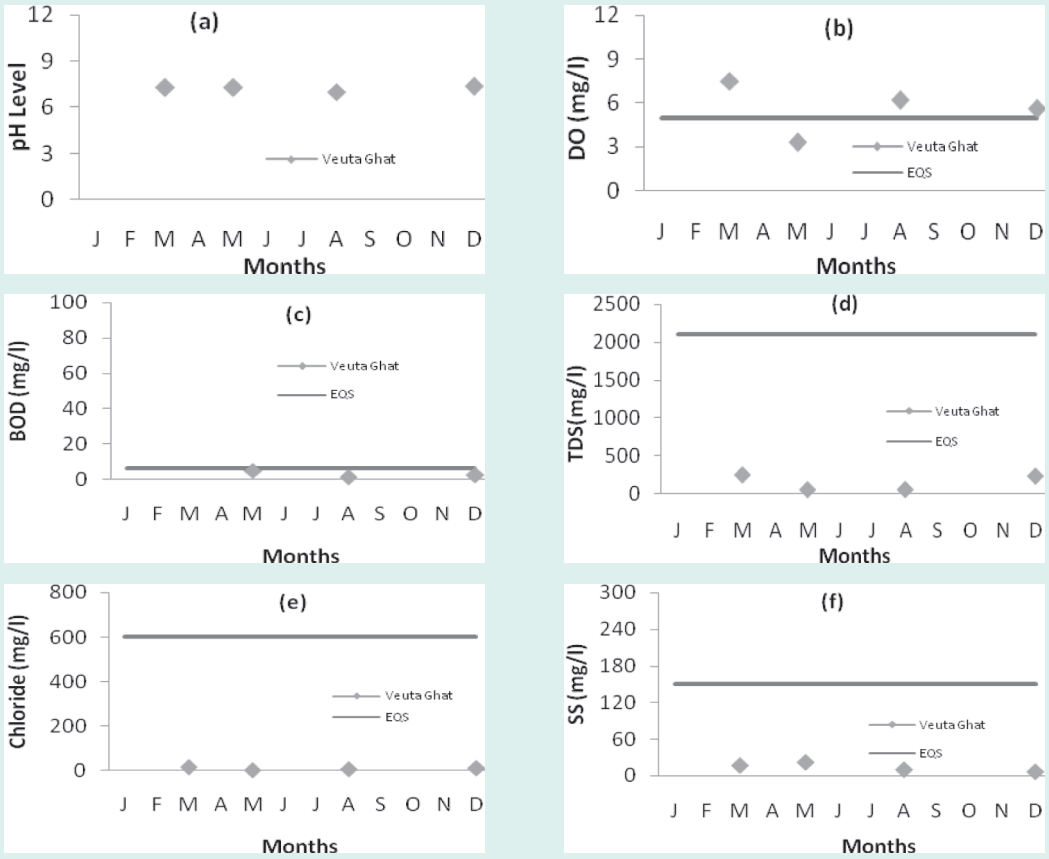


Fig.6. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of KaligangaRriver in 2015

In 2015, TDS concentration was within the limit of EQS (2100 mg/l) for wastewater after treatment from industrial units. The maximum TDS was 250 mg/l in March and the minimum TDS was 57.1 mg/l in May (Fig.6e). In 2014, TDS concentration varied from 66.1 to 267 mg/l. In 2015, Chloride level was lower than the EQS (600 mg/l). Highest Chloride was (12.7 mg/l) in March and that of lowest was (1.06 mg/l) in May (Fig.6f). In 2014, Chloride varied from 5.0 to 8.0 mg/l. In 2015, SS of Kaliganga river was within the EQS (150 mg/l). The maximum and the minimum SS were 6.0 mg/l and 22 mg/l, respectively (Fig.6g).). In 2014, SS varied from 8 to 61 mg/l.

Table-13. Total Alkalinity of Kaligonga River Water in 2015

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikganj	-	-	**16.6**	-	40	-	-	58	-	-	-	52
EQS for wastewater after treatment from industrial units 150 mg/l												

Total alkalinity of Kaliganga river water was within the EQS (Table-13).

Table-14. Level of EC of Kaligonga River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikgonj	-	-	**480**	-	136.9	-	-	**135.4**	-	-	-	471
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). However, EC in wet season was much lesser than in dry season (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 2015. samples were collected in January, April, June, July and September.

In 2015, pH varied from 6.5 to 7.84 and it was within the EQS limits (6.5 to 8.5) (Table-15). In 2014, pH was varied from 7.88 to 7.93. DO concentrations ranged from 5.0 to 7.6 mg/l (Table-15) and it was within the EQS (≥5 mg/l) for fisheries. In 2014, DO concentration varied from 8.45 to 8.5 mg/l. In 2015, the maximum BOD level was 5.2 mg/l and, the minimum BOD level was 0.3 mg/l which is below the EQS (≤6 mg/l) for fisheries (Table-15). In 2014, BOD concentration varied from 2.0 to 2.2 mg/l in December. In 2015, Average SS (25 mg/l) was far below the EQS (150 mg/l) (Table-15). In 2014, SS concentration varied from 6.0 to 50 mg/l. In 2015, Level of TDS of Jamuna river water varied 54 to 276 mg/l (Table-15), while EQS for TDS is 2100 mg/l. In 2014, TDS level varied from 98.6 to 263 mg/l. In 2015, Chloride varied from 2.95 mg/l to 12.18 mg/l (Table-15). In 2014, Chloride concentration varied from 6.0 mg/l to 1.1 mg/l. In 2015, High Total alkalinity 140 mg/l (Table-15) was in January near Jamuna Fertilizer Factory may be due to discharge of untreated waste by the Jamuna Fertilizer Factory into the river. In 2015, Level of EC of Jamuna river water at sampling locations was within the EQS (1200 µmhos/cm) (Table-15). In 2014, maximum EC concentration was 488 µmhos/cm in December.

Table-15. Level of different parameters at different locations of Jamuna River in 2015

Sampling Locations	Month	pH	DO	BOD	SS	TDS	Chloride	T.alkalinity	EC
Bahadurabad Ghat (B.G)	January	7.6	7.1	5.2	30	248	6.8	120	433
Near Jamuna Fertilizer Factory (NJFF)		7.62	7.6	1.9	25	242	11.12	140	440
Bahadurabad Ghat (B.G)	April	7.84	6.2	3.1	22	129	12.18	80	276
Near Jamuna Fertilizer Factory (NJFF)		7.79	6.4	1.8	25	276	16.1	70	580
Bahadurabad Ghat (B.G)	June	7.53	6.7	0.3	46	68	8.84	44	140
Near Jamuna Fertilizer Factory (NJFF)		7.54	6.4	1.4	50	54	4.91	46	120
Bahadurabad Ghat (B.G)	July	6.5	6.5	0.4	6	78	2.95	54	173
Near Jamuna Fertilizer Factory (NJFF)		6.69	6.2	1.2	21	59	2.95	5l	131.2
Bahadurabad Ghat (B.G)	September	7.19	5	1.2	21	58.9	6.86	70	108.2
Near Jamuna Fertilizer Factory (NJFF)		7.03	5.4	0.4	36	65.2	7.86	58	115.8
EQS		**6.5-8.5**	**≥5 mg/l**	**≤6 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 the earth ended up the Bay of Bengal. To monitor water quality, water samples were collected from Bhairab Bazar, Meghna Ghat, Shahjalal Paper Mills (SPM) of the Meghna river.

In 2015, the highest pH (7.47) in June at Bhairab Bazar and the minimum pH was 6.5 at near Shahjalal Paper Mills in May (Fig.7a). In 2014, pH level varied from 6.92 to 9.56. In 2015, DO level of Meghna river was varied 4.7 mg/l to 8.1 mg/l that was often higher than the EQS (≥5 mg/l) for fisheries (Fig.7b). In 2014, DO level varied from 0.0 mg/l to 6.7 mg/l. In 2015, at all the sampling locations of the river, BOD was below the EQS (≤6 mg/l) for fisheries round the year. The maximum and the minimum BOD load was 7.0 mg/l in May near Shahjalal Paper Mills and 1.0 mg/l in July at Meghna Ghat (Fig.7c). In 2014, BOD concentration varied from 2.3 to 17 mg/l. TDS of Meghna river was very low in 2015 and ranged from 30.8 to 101.5 mg/l (Fig.7d). In 2014, TDS concentration varied from 27.6 to 138 mg/l.

In 2015, Chloride concentration at all the sampling locations was within the EQS (600 mg/l) for waste water after treatment from industrial units. The maximum Chloride (22.71 mg/l) was found in January near Shahjalal Paper Mills and the minimum (4.91 mg/l) was in July at Mehna Ghat (Fig.7e). In 2014, Chloride concentration varied from 3.5 to 77.7 mg/l. SS of Meghna river varied from 5.0 to 47.0 mg/l (Fig.7f). In 2014, SS concentration varied from 0.0 to 47 mg/l.

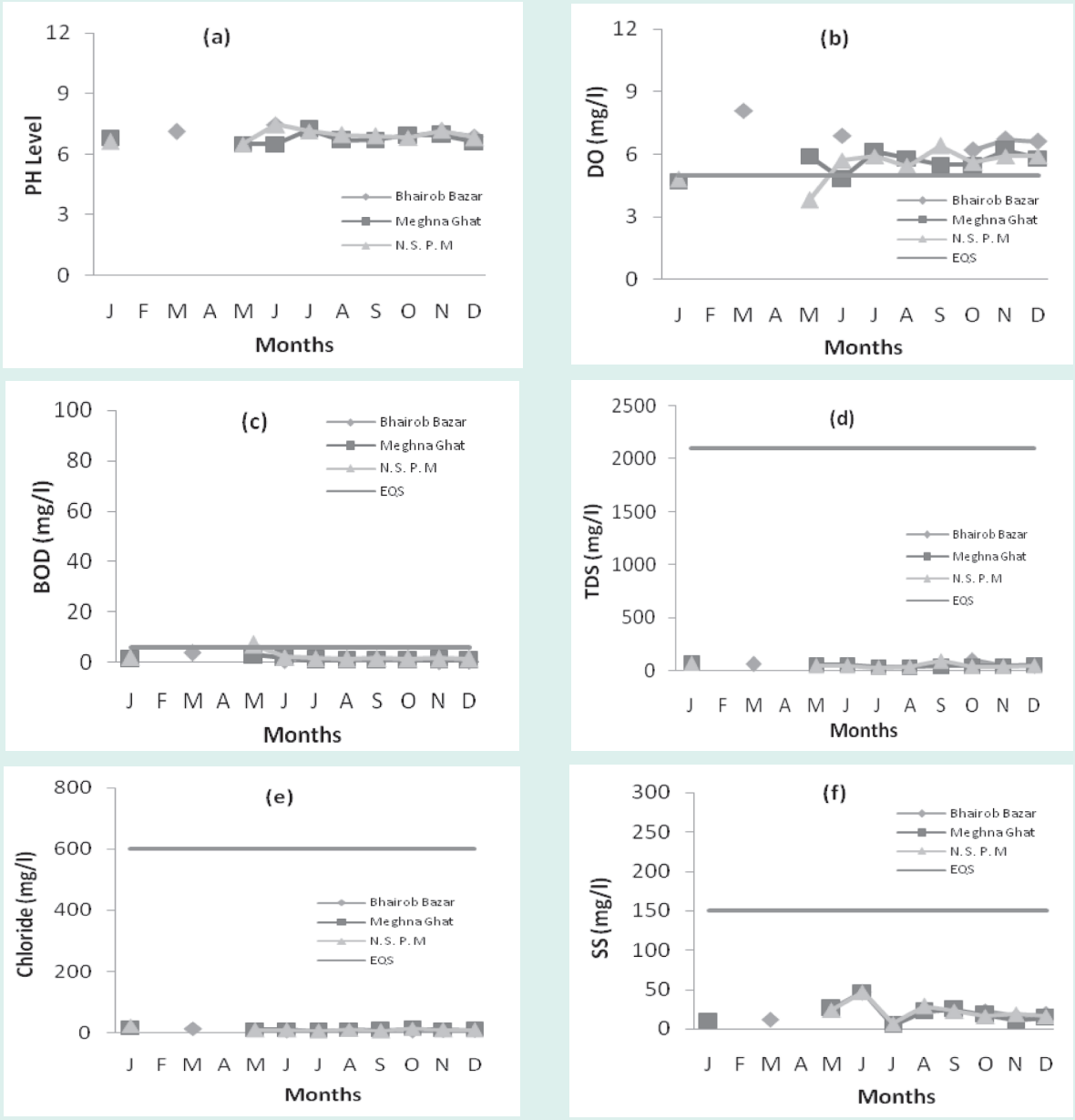


Fig.7. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Meghna River in 2015

Table-16. EC at different locations of Meghna River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bhairob Bazar	-	-	126.3	-	-	121	-	-	-	**216.9**	90.4	98.4
Meghna Ghat	38.2	-	-	-	115.7	115.7	**73.3**	79.2	89.2	87.1	85.9	102.6
Shajalal Paper Mill	136.2	-	-	-	121.7	121	69.8	82.9	206.9	91.2	85.6	105.8
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 216.9 µmhos/cm in October at Bhairob Bazar and 73.3 µmhos/cm in July at Meghna Ghat (Table-16).

4.9 Padma River

The Padma is a major transboundary river of Bangladesh. Water samples were collected from three locations of the river namely Pakshi Ghat (Bank and Middle) of Pabna and Baro Kuti Ghat (Bank and Middle) of Rajshahi only middle points were used in the analysis. For analysis, average values of two points were considered.

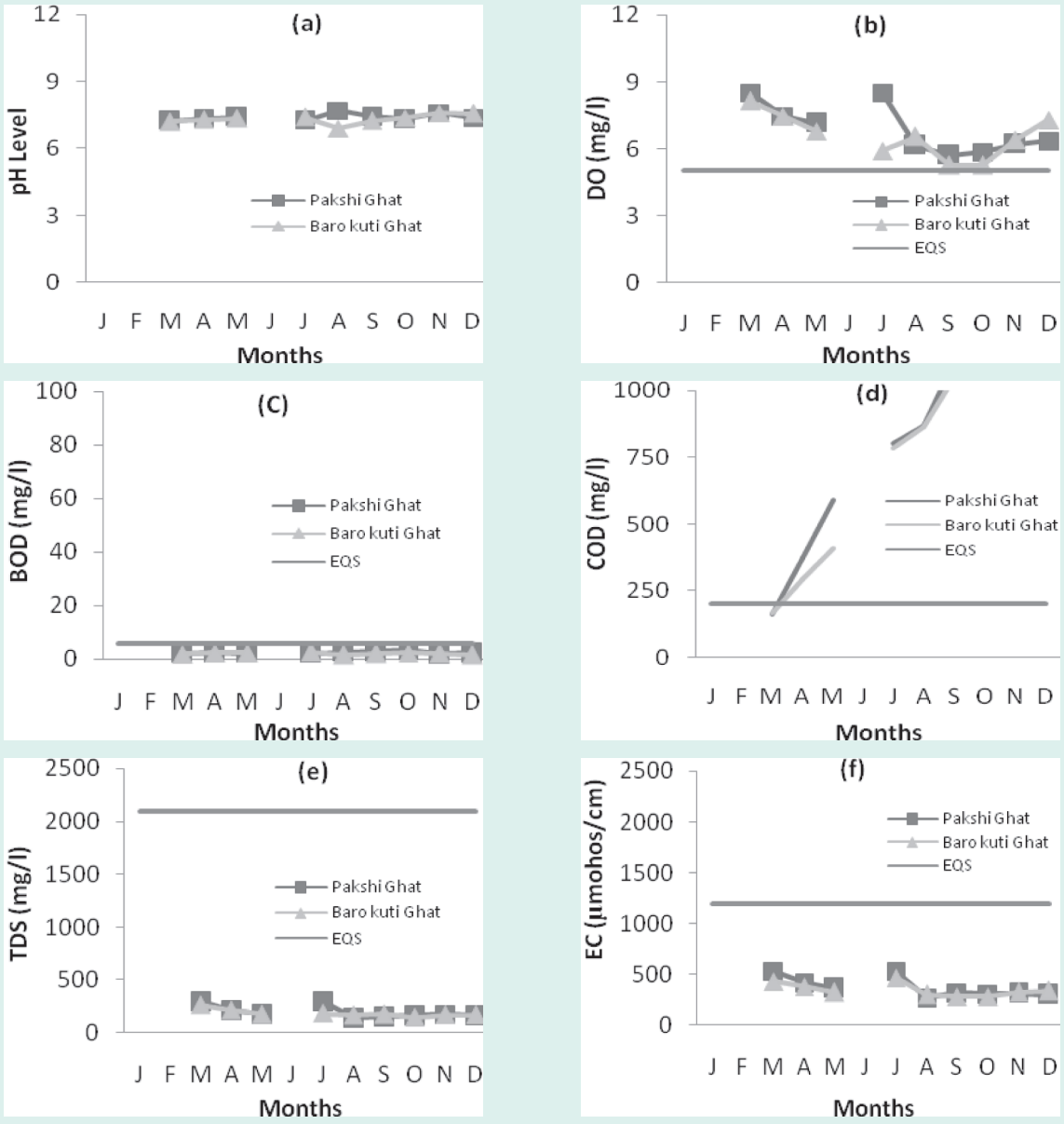


Fig.8. Graphical presentation of pH, DO, BOD, COD, TDS and EC of Padma River in 2015

In 2015, pH of Padma river was mostly neutral and varied from 6.89 to 7.69 (Fig.8a) while standard pH for inland surface water is 6.5 to 8.5. The maximum pH was found at Paksi Ghat (bank) in August and the minimum pH level was at Baro Kuti in August. In 2014, pH level varied from 5.3 to 8.6. DO level of Padma river was above EQS (>5 mg/l) for fisheries at all the locations and it varied from 5.25 to 8.5 mg/l (Fig.8b). In 2014, DO concentration ranged from 5.1 to 8.3 mg/l. BOD load was within the EQS (<6 mg/l) for fisheries at all locations. The maximum BOD was found 2.65 mg/l in July and that of the minimum was 1.7 mg/l in August at Boro Kuti Ghat (Fig.8c). In 2014, BOD load varied from 0.8 to 2.9 mg/l. Level of COD was within the EQS (200 mg/l). The maximum and the minimum COD

concentration of Padma river was 1569.5 mg/l in December at Pakshi Ghat and 163.5 mg/l in March respectively (Fig.8d). TDS level of Padma river was within the EQS throughout the year of 2015 and it varied from 140 to 295 mg/l (Fig.8e). In 2014, TDS concentration varied from 110 to 270 mg/l. The maximum and the minimum EC of Padma river water was 532 µmhos/cm in March at Pakshi Ghat and 285 µmhos/cm in September at Boro Kuti Ghat (Fig.8f), while EQS is 1200 µmhos/cm wastewater after treatment from industrial units. In 2014, EC varied from 214 µmhos/cm to 561 µmhos/cm.

Table-17. Chloride at different sampling locations of Padma River Water in 2015

Sampling Locations	Chloride (mg/l)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mawa Ghat	-	-	-	-	-	-	-	-	-	-	-	-
Pakshi (E), Ishurdi	-	-	20	14	-	-	**35**	-	-	-	30	24.75
Pakshi (M),Ishurdi	-	-	20	14	-	-	20	-	-	-	30	21
Baro kuti (E), Raj.	-	--	20	**13**	-	-	20	-	-	-	25	19.5
Baro kuti (M), Raj.	-	-	20	14	-	-	35	-	-	-	25	23.5
EQS for wastewater after treatment from industrial units 150 mg/l												

The maximum and the minimum Chloride of Padma river water was 35 mg/l in July at Pakshi and 13 mg/l in April at Boro Kuti Ghat (Table-17).

4.10 Korotoa River

To monitor water quality of Korotoa river in 2015, water samples were collected from four locations of the river e.g. Fateh Ali Bridge (FAB), Dutta Bari Bridge (DBB), Matidali Bridge (MB) and S.P Bridge (SPB).

In 2015, pH level of Korotoa river water varied from slight acidic to slight alkaline (6.19 to 8.18) (Fig.9a) and was within EQS limit. In 2014, pH level varied from 6.18 to 8.2. In 2015, DO level of Korotoa river water was within the EQS (≥5 mg/l) for fisheries. DO varied from 0.0 to 8.18 mg/l (Fig.9b). In 2014, DO concentration varied from 2.0 to 6.8 mg/l. In 2015, the minimum BOD was 2.1 in August at Dutta Bari Bridge and the maximum BOD was 37.5 mg/l in January at Fateh Ali Bridge (Fig.9c). In 2014, BOD concentration varied from 1.5 to 6.4 mg/l. In 2015, COD level of Korotoa river was lower than EQS (200 mg/l) for wastewater after treatment from industrial units. Average COD varied from 1.5 to1532.5 mg/l (Fig.9d). The maximum COD concentration was 1532.5 mg/l in December at downstream of S.P Bridge, and need to identify source of pollution. In 2014, COD concentration varied from 36 to1681 mg/l. In 2015, TDS varied from 90 mg/l to 270 mg/l (Fig.9e). In 2014, TDS range was from 110 mg/l to 370 mg/l. In 2015, level of SS of Korotoa river at different locations was within the EQS. The maximum and the minimum SS was 125 mg/l in June at Fateh Ali Bridge and 40 mg/l in October at S.P Bridge (Fig.9f). In 2014, SS concentration varied from 50 mg/l to 130 mg/l. Average EC varied from 171 mg/l to 471 mg/l (Fig.9g) and was within the EQS limit. In 2014, EC concentration varied from 107 mg/l to 729 mg/l.

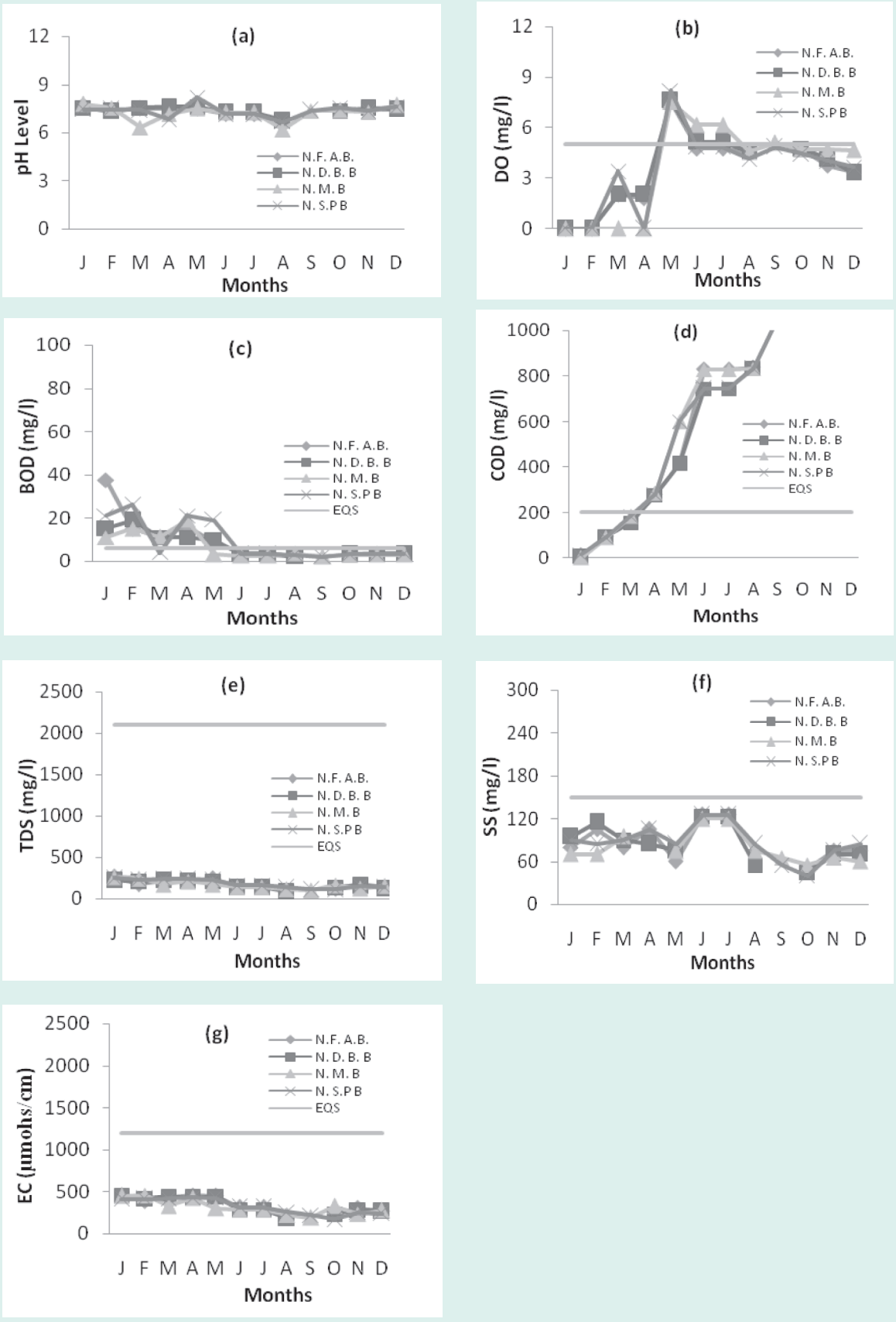


Fig.9. Graphical presentation of pH, DO, BOD, COD, TDS, SS and EC of Korotoa River in 2015

4.11 Teesta River

The Teesta River is a 309 km long river flowing through the Indian state of Sikkim. It carves out from the verdant Himalayas in temperate and tropical river valleys and forms the border between Sikkim and West Bengal and flows through the cities of Rangpo (Sikkim) and Jalpaiguri & Kalimpong (West Bengal) before joining the Jamuna, a distributary channel of the Brahmaputra through Bogra in Bangladesh. It drains an area of 12,540 km2. (Ref. Wikipedia, the free encyclopedia). Water samples were collected from near Tista Bridge (up Stream and down stream) of Teesta river for monitoring of water quality in 2015.

pH level of Teesta river water varied from 7.04 to 7.45 (Fig.10a) and was within the EQS limit. DO level of Teesta river water was within the EQS (≥5 mg/l) for fisheries. DO varied from 5.25 to 7.75 mg/l (Fig.10b).

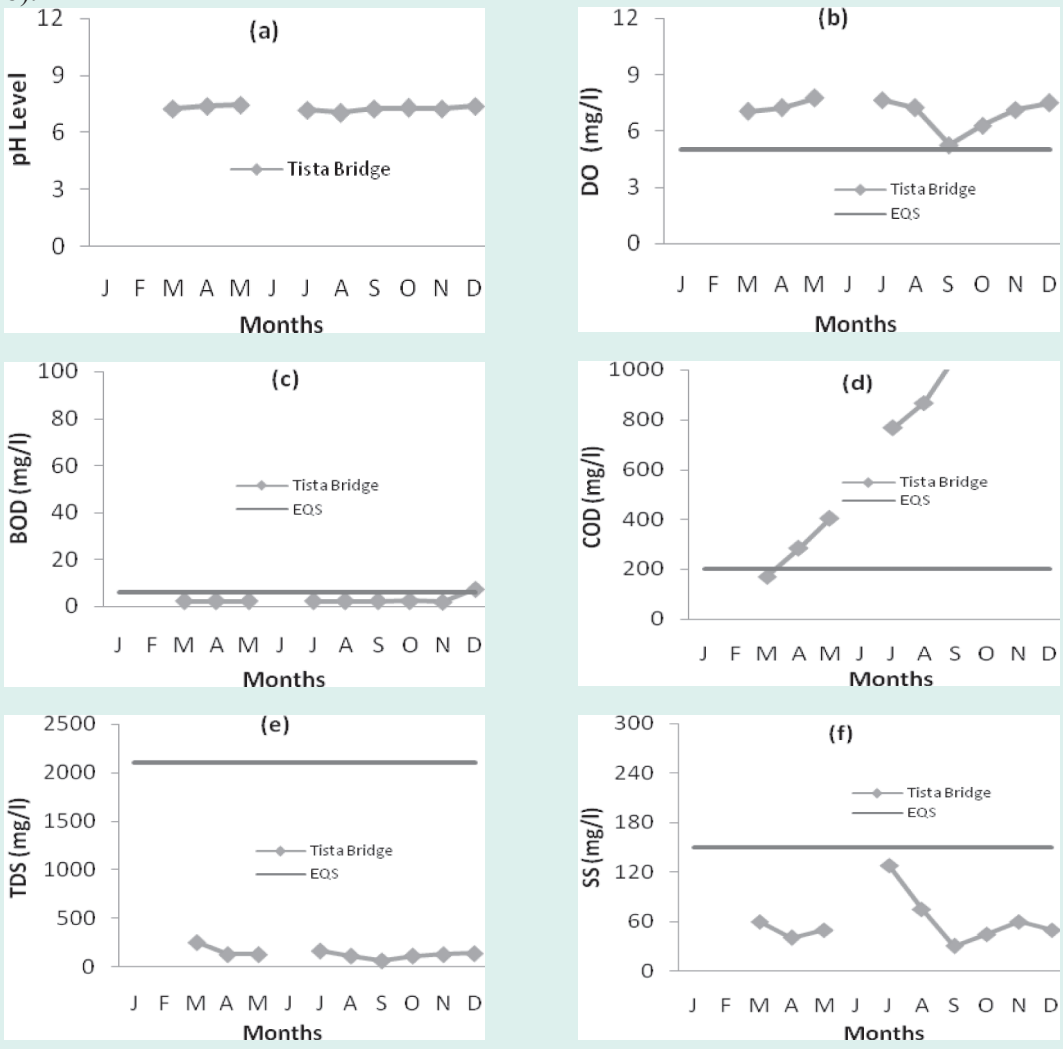


Fig.10. Graphical presentation of pH, DO, BOD, COD, SS and Chloride of Teesta River in 2015

In 2015, the maximum BOD was 7.5 mg/l in December and the minimum BOD was 1.95 mg/l in November (Fig.10c). The maximum COD level of Teesta river was 1534.5 in December and is higher than EQS (200 mg/l) for wastewater after treatment from industrial units. The minimum COD was 169.5 mg/l in March (Fig.10d). TDS varied from 65 mg/l to 255 mg/l (Fig.10e). Level of SS of Teesta river at different locations was within the EQS. The maximum and the minimum SS was 128 mg/l in July and 30 mg/l in September (Fig.10f).

4.12 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 (KUFL) Upstream and KUFL Downstream of Karnaphuli river for monitoring of water quality in 2015.

In 2015, pH level at the sampling points of the Karnaphuli river varied from 7.0 to 8.20 (Fig.11a), while standard pH for inland surface water is 6.5 to 8.5. In 2014, pH level varied from 7.27 to 8.05. DO level of Karnaphuli river was within the EQS althrough the year of 2015 and met the standard of DO for fisheries (≥5 mg/l). In 2015, DO varied from 5.1 to 5.8 mg/l (Fig.11b). In 2014, DO concentration varied from 4.5 to 5.7 mg/l. In 2015, COD value varied from 109 to 489 mg/l (fig.11c), while EQS for wastewater after treatment from industrial units is 200 mg/l. COD value was high at TSP upstream and downstream compare to KUFL upstream and downstream. In 2014, COD value varied from 9.0 to 144.5 mg/l. In 2015, level of SS of Karnaphuli river water at different points was beyond the EQS (150 mg/l). The maximum and the minimum SS was 312 mg/l in March and 64 mg/l in April at TSP point (Fig.11d). In 2014, SS value varied from 130.5 to 1053.5 mg/l. In 2015, TDS level was higher than the EQS limit (2100 mg/l) for wastewater after treatment from industrial units. It varied from 852 to 20416 mg/l (Fig.11e). In 2014, TDS concentration varied from 506.5 to 16125.5 mg/l. In 2015, EC concentration was relatively higher during high tide at all locations of the river. The maximum EC concentration was 40832 µmohs/cm in February at KUFL and the minimum EC concentration was 2100 µmohs/cm in July at KUFL point (Fig.11f). In 2014, EC concentration varied from 1013 to 38194 µmohs/cm.

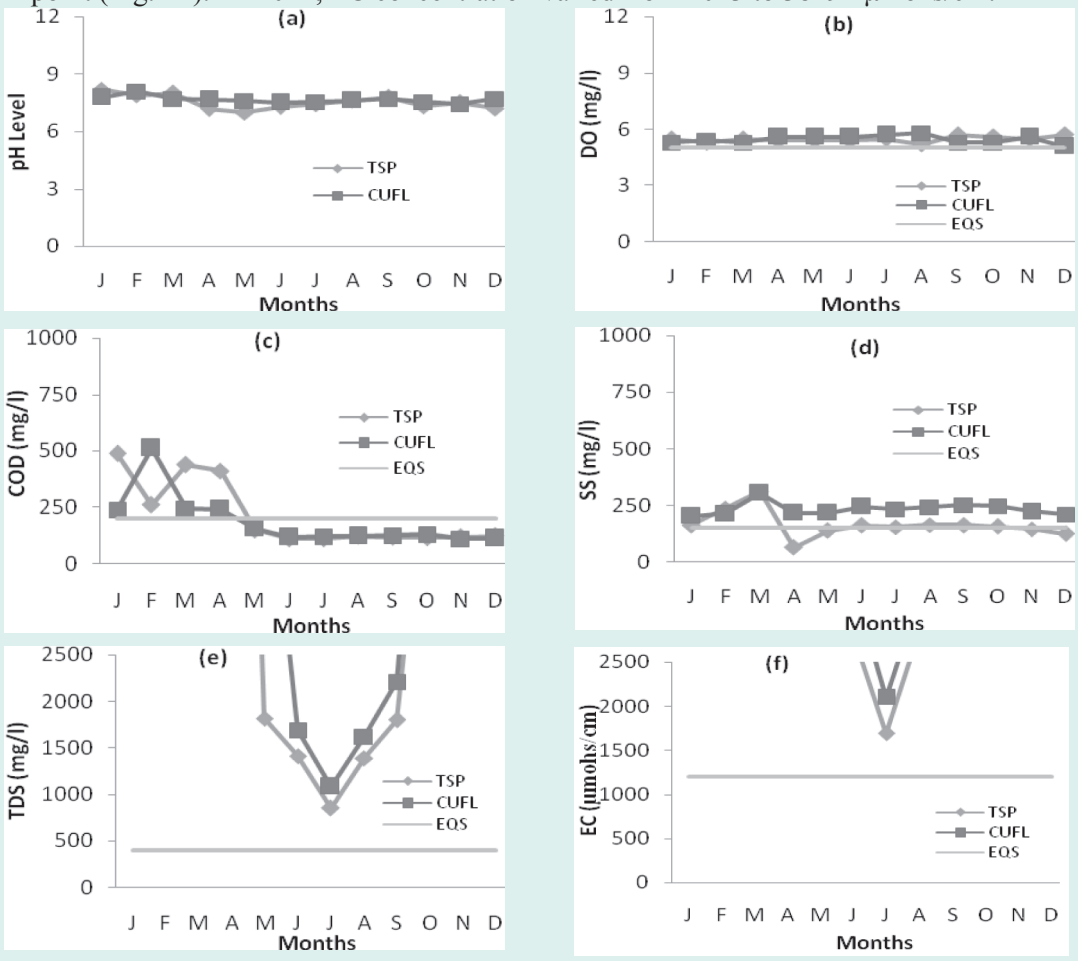


Fig.11. Graphical presentation of pH, DO, COD, SS, TDS and EC of Karnaphuli River in 2015

4.13 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 (MG) (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 2015 and varied from 6.92 to 7.9 (Fig.12a). In 2014, pH level varied from 7.0 to 7.315. In 2015, DO level of Halda river was above the EQS limit throughout the monitoring period. In 2015, DO varied from 5.3 to 7.2 mg/l (Fig.11b). In 2014, DO range was from 5.0 to 5.7 mg/l. In 2015, COD at the sampling locations of Halda river during high and low tide was varied 8.0 mg/l to 105 mg/l (Fig.12c). In 2015, The maximum and the minimum SS content of Halda river water was 219 mg/l in November at Maduna Ghat and 19 mg/l in January at Maduna Ghat respectably (Fig.-12d). In 2014, SS value varied from 17.5 to 313 mg/l. TDS level of Halda River in 2015 was within the EQS (2100 mg/l) for treated wastewater from industrial units. TDS varied from 48 to 234 mg/l (Fig-12e). In 2014, TDS concentration varied from 48 to 1389.5 mg/l. The maximum and the minimum EC was 474 µmohos/cm in February at Maduna Ghat and 94 µmohos/cm in December at Maduna Ghat respectively (fig.12f). In 2014, EC concentration varied 96 and 2779 µmohos/cm.

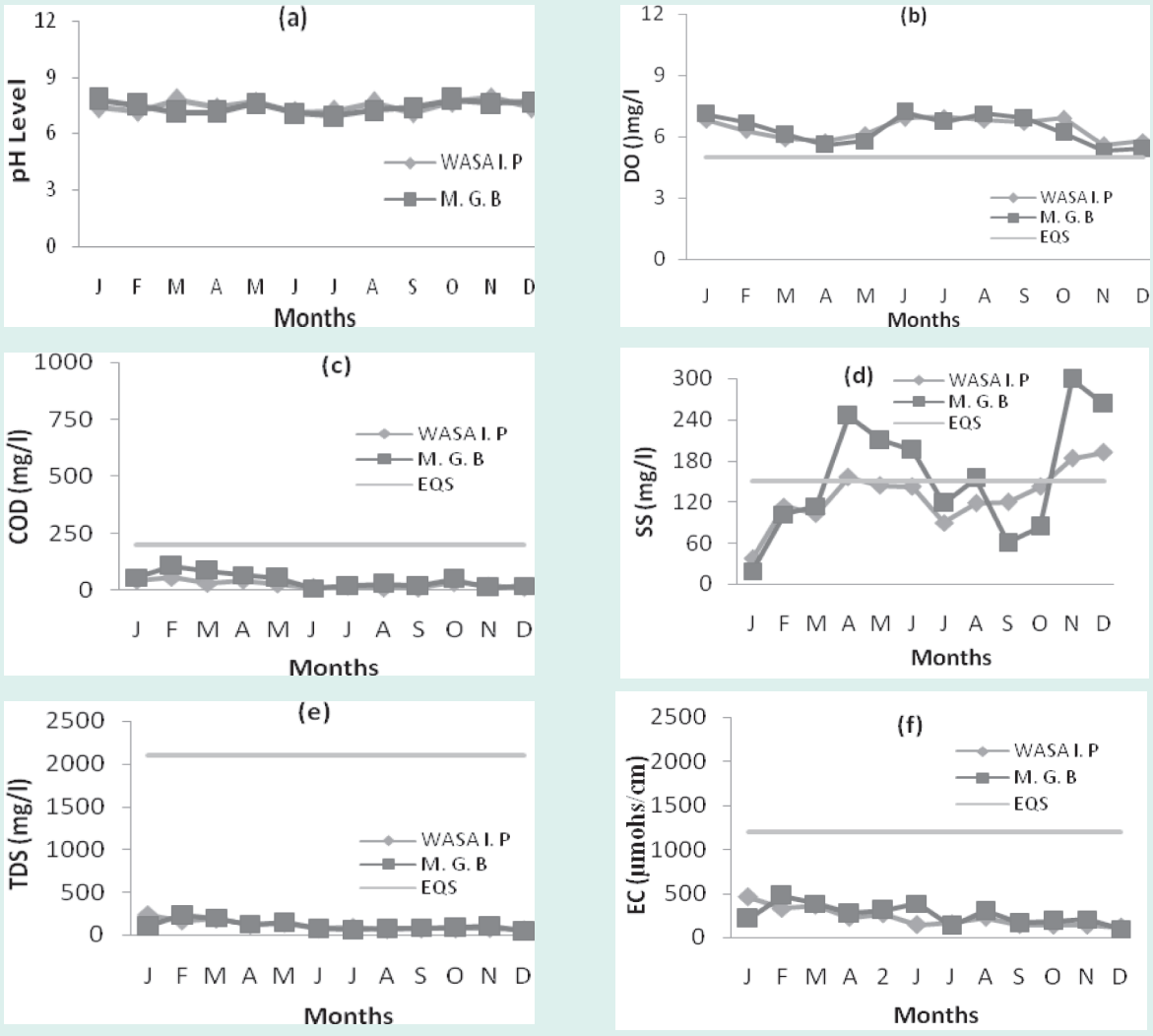


Fig.12. Graphical presentation of pH, DO, COD, SS,TDS and EC of Halda River in 2015

4.14 Moyuri River

The Mayuri River is situated at the back swamp of the Bhairab-Rupsha River. Khulna City Corporation (KCC) is situatedon the bank of this river basin and the Mayuri River borders the westbound of the city. The river is about 11.69 km long and varies by width widely at different chains. For monitoring water quality of Moyuri River in 2015, water samples were collected from one location named Gallamari Bridge (G.B) comprising both of the banks and middle point of the river. Average value of those three points was used in the analysis.

In 2015, pH level of Moyuri river water varied from 7.52 to 8.0 (Fig.13a) and was within the EQS limit. In 2014, pH level varied from 7.53 to 8.0. In 2015, DO concentration of Moyuri river water varied from 0.4 to 3.8 (Fig.13b) and was lower than the EQS (≥5 mg/l) for fisheries. SS content of Moyuri river water was below the EQS (150 mg/l). TDS level of the Moyuri river water varied from 516 to 1305 mg/l while EQS is 2100 mg/l (Fig.13c). In 2014, TDS range was from 633 to 1197 mg/l. Chloride range was from 228 to 878.92 mg/l (Fig.13d) while EQS is 600 mg/l. Highest Chloride value was found in April. In 2014, Chloride level varied from 232 to 832.68 mg/l.

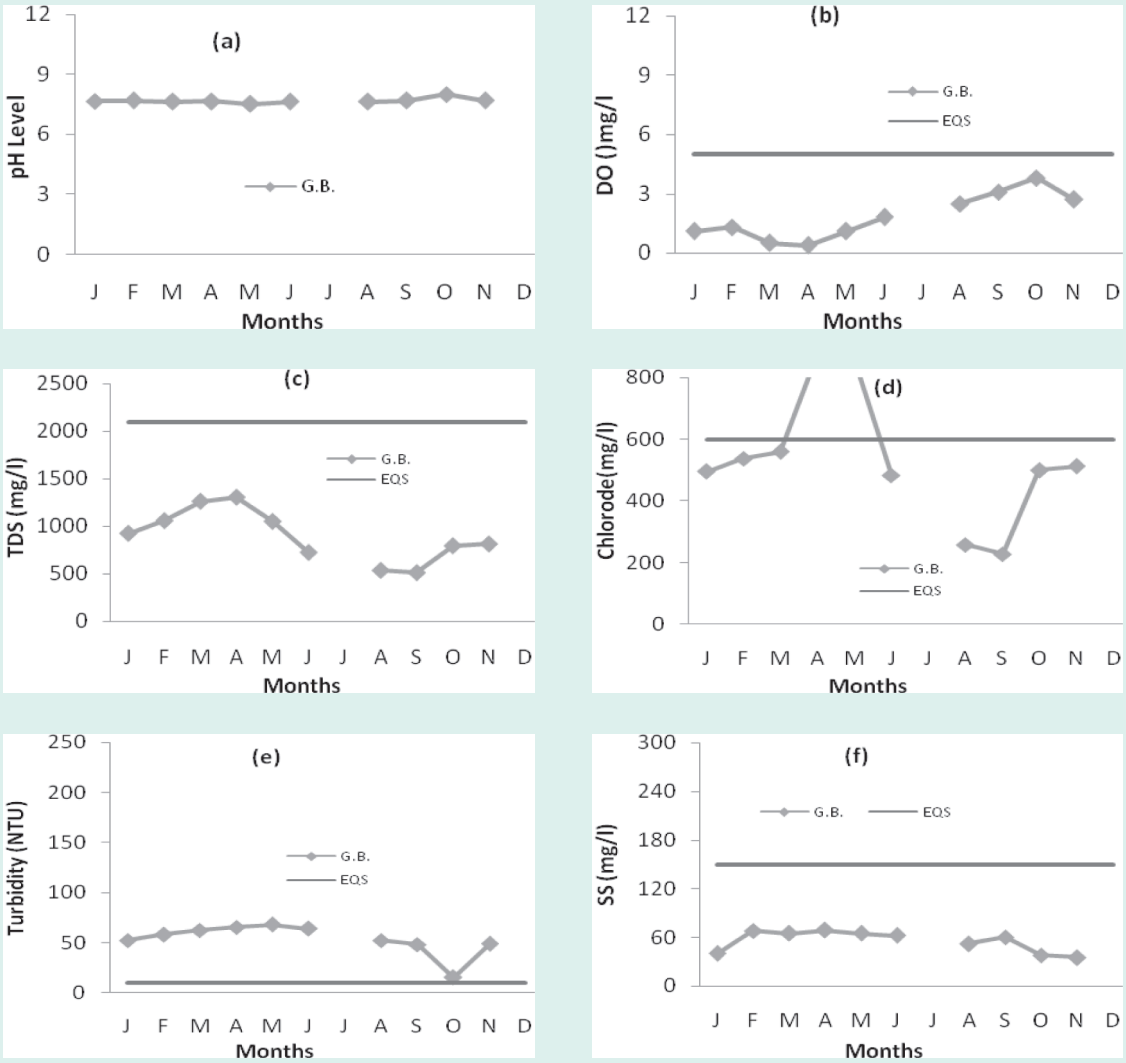


Fig.13. Graphical presentation of pH, DO, TDS, Chloride, Turbidity and SS of Moyuri River in 2015

Turbidity level of Moyuri river was very high. The minimum Turbidity was 48.2 NTU in September and the maximum Turbidity was 68.26 NTU in May while Turbidity for drinking water is 10 NTU (Fig.13e). In 2014, Turbidity level varied from 12.3 to 68.5 NTU. In 2015, SS varied from 35 to 69 mg/l (Fig.13f) and was within the EQS limit. In 2014, SS varied from 32 to 72.0 mg/l (Fig.13f) and was within the EQS.

Table-18. EC of Moyuri River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge (Avg.)	1854	2120	2524	**2608**	2102	1456	-	**1080**	1032	1594	1632	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC varied from 1080 µmhos/cm to 2608 µmhos/cm. The maximum and the minimum concentration was 2608 µmhos/cm in April and 1080 µmhos/cm in August respectively (Table-18) while standard for treated wastewater from industrial unit EC is 1200 µmhos/cm. In 2014, EC was from 925 µmhos/cm to 2390 µmhos/cm.

Table-19. Salinity of Moyuri River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge (Avg.)	1	1.3	1.5	**1.7**	1.6	1.1	-	**0.3**	0.3	0.8	0.8	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity level varied from 0.3 ppt to 1.7 ppt. The maximum and the minimum salinity was 1.7 and 0.3 ppt respectively while standard salinity is 400 ppt for treated wastewater from industry (Table-19). In 2014, Salinity was varied from 0.3 ppt to1.2 ppt.

4.15 Bhairab River

Bhairab river flows in the south of Bangladesh. The river is approximately 62 Km long. Its water carries plenty of silt. Water samples were collected from three locations comprising nine different points [e.g. Noapara Ghat Bank (NG), Middle and Opposite bank, Fultala Ghat (FG) Side, Middle and Opposite bank and Charerhat Ghat (CG) Side Middle and Opposite bank of Bhairab River for monitoring water quality in 2015. To simplify data analysis only middle point of all locations were considered. Because, no significant variation was found between side, middle and opposite bank point of a location of the river.

In 2015, pH at different locations of the Bhairab river varied from 7.68 to 8.4 (Fig.14a) while EQS for inland surface water is 6.5 to 8.5. In 2014, pH varied from 7.63 to 8.3. DO was around the EQS (($\geq$5 mg/l) for fisheries. In 2015, DO varied from 3.8 to 6.5 mg/l (Fig.14b). In 2014, DO varied from 5.2 to 6.6 mg/l. BOD level of Bhairab river water was below the EQS ($\leq$6 mg/l) for fisheries round the year of 2015. BOD varied from 0.8 to 1.2 mg/l (Fig.14c). In 2014, BOD level varied from 0.8 to 1.1 mg/l. In 2015, at all locations TDS level of Bhairab river was very high during March to June. The maximum and the minimum was 12060 and 115 mg/l (Fig.14d) respectively while EQS is 2100 mg/l. In 2014, TDS was from 119 to 11850 mg/l. In 2015, Chloride was varied from 32 to 7884 mg/l (Fig.14e) while EQS for Chloride is 600 mg/l. Highest Chloride (7884 mg/l) was found in May at Fatulla Ghat and lowest was 32 mg/l in October at Charerhat Ghat . In 2014, Chloride level varied from 18.23 to 2910.98 mg/l. Turbidity of Bhairab river water at all locations was very high in 2015. It varied from 18.26 to 96.66 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 2014, Turbidity level varied from 16.2 to 89.5 NTU.

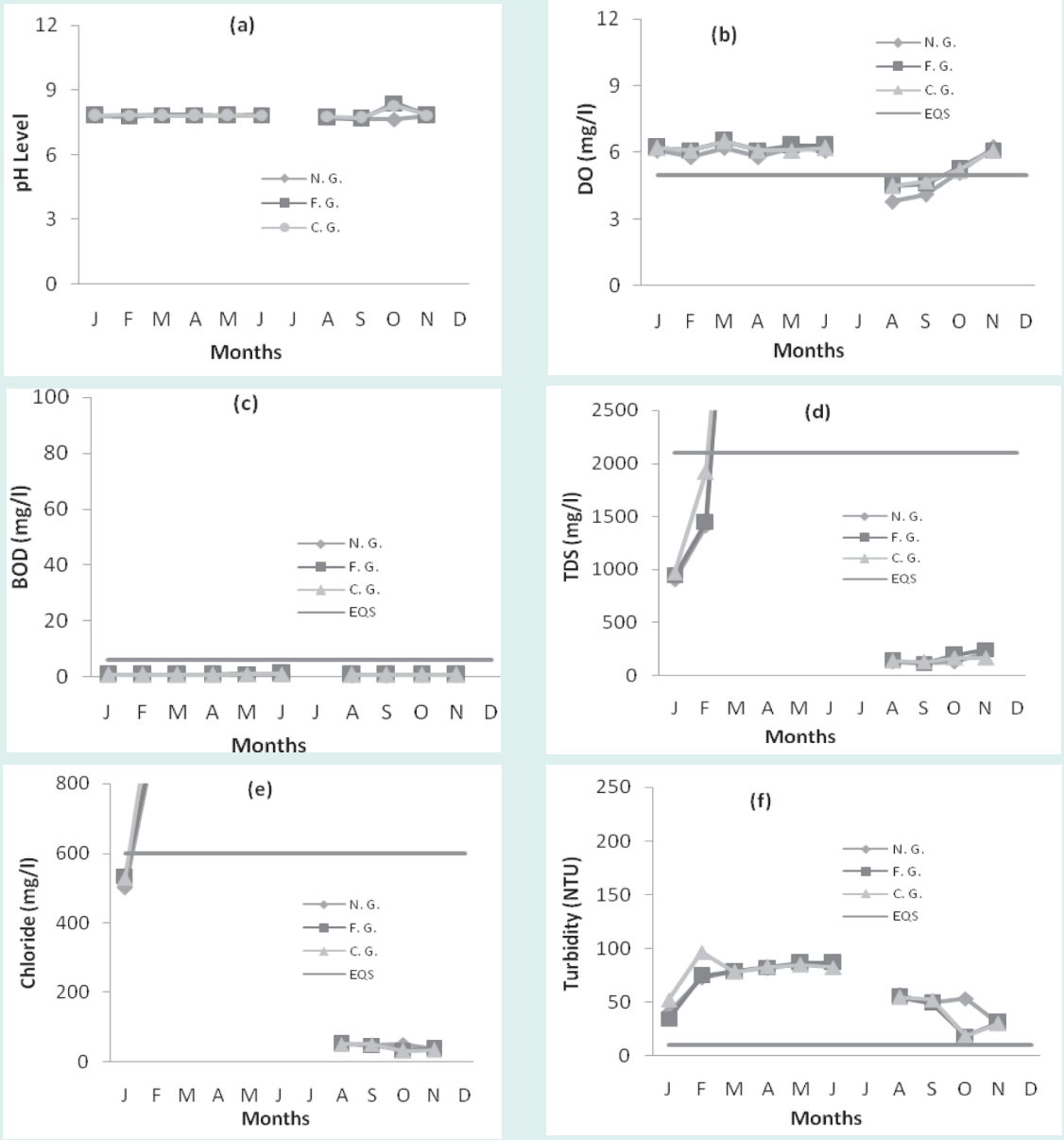


Fig.14. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Bhairab River in 2015

Table-20. Salinity of Bhairab River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Noapara Ghat (Avg)	40.3	72.3	78.7	81.2	85.2	86.3	-	56.2	49.3	53.1	30.2	-
Fultala Ghat (Avg)	34.4	74.2	78.3	82.2	86.4	86.6	-	54.5	48.66	18.3	31.1	-
Charerhat Ghat (Avg)	52.1	**96.6**	78.2	82.7	84.6	82.2	-	54.6	52.3	**18.26**	30.1	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied from 18.26 ppt to 96.6 ppt. The maximum and the minimum salinity was 96.6 ppt in February and 18.26 ppm in October respectively (Table-20)

4.16 Rupsha River

Rupsha is an 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 (RG) Bank, Middle and Opposite and Labanchara Ghat (LG) Bank, Middle and Opposite] of Rupsha river for monitoring water quality in 2015. For analysis, average of three points of a location were considered.

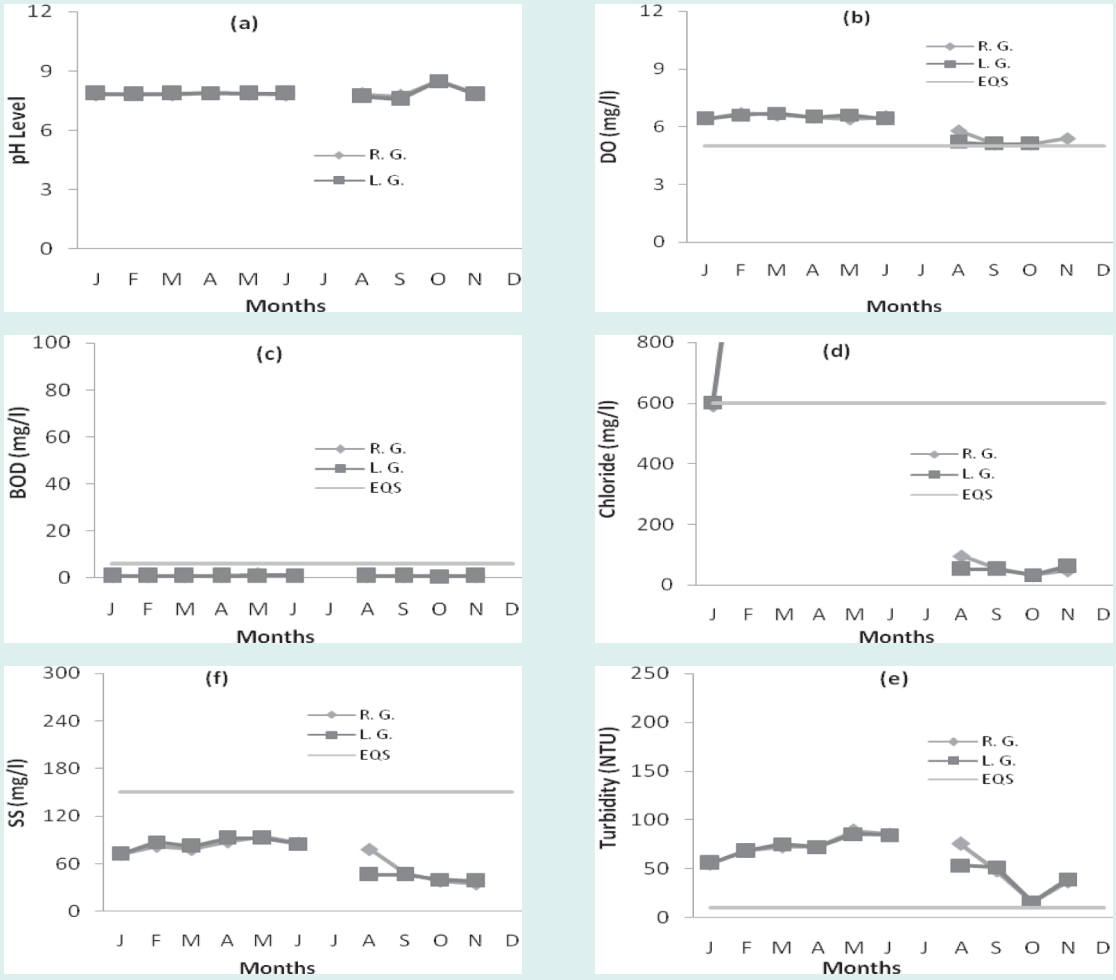


Fig.15. Graphical presentation of pH, DO, BOD, Chloride, Turbidity and SS of Rupsha River in 2015

In 2015, pH varied from 7.72 to 8.5 (Fig.15a) while standard pH for inland surface water is 6.5 to 8.5. In 2014, pH level varied from 7.62 to 7.84. In 2015, DO level was within the EQS (>5 mg/l) for fisheries. The maximum and the minimum DO content was 6.7 and 5.1 mg/l respectively (Fig.15b). In 2014, DO level varied from 5.1 to 6.7 mg/l. In 2015, the maximum and the minimum BOD was 1.2 and 0.7 mg/l respectively (Fig.15c). In 2014, BOD level was from 0.7 to 0.1 mg/l. Chloride level was much higher from March to June than the EQS (600 mg/l) for treated wastewater from industrial units. Chloride content varied from 32 to 10082 mg/l (Fig.15d). In 2014, Chloride varied from 32 to 10159.70 mg/l. Turbidity level at both locations of Rupsha river was very high in 2015. Turbidity was highest in May and varied from 15.23 to 88.63 NTU (Fig.15e) while EQS for drinking water is 10 NTU. In 2014, Turbidity range was from 12.7 to 90.55 NTU.

Table-21. EC of Rupsha River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rupsha Ghat	2230	7420	12134	21018	**27828**	24062	-	488	282	331	366	-
Labanchara Ghat	2296	7460	12482	21032	27674	24108	-	**282**	260	342	455	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

EC was high from January to June in 2015. EC level varied from 282 to 27828 mg/l (Table-21) while standard EC for treated wastewater from industrial units is 1200 µmhos/cm. In 2014, EC level varied from 212 to 27600 mg/l

Table-22. Salinity of Rupsha River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rupsha Ghat	1.8	4.1	7.6	12.8	**18.7**	16.5	-	0.6	**0.1**	0.1	0.1	-
Labanchara Ghat	1.8	4.1	8.1	12.9	18.5	16.8	-	0.1	0.1	0.1	0.4	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity level varied 0.1 ppt to 18.7 ppt. The maximum and the minimum salinity was 18.7 ppt in May and 0.1 ppt September (Table-22). In 2014, Salinity level varied from 0.1 ppt to 17 ppt.

4.17 Mathavanga River

Mathavanga river, Chuadanga, Bangladesh is next to Daulatdia and is located in Khulna, Bangladesh. 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. Average values of three points were taken while analysis carried out.

In 2015, pH varied from 7.52 to 8.0 (Fig.16a) while standard of pH for inland surface water is 6.5 to 8.5. In 2014, pH range was from 7.04 to 8.0. In 2015, DO level varied from 4.8 to 6.2 mg/l (Fig.16b) while standard DO for fisheries is ⩾5 mg/l. In 2014, DO level varied from 5.2 to 6.2 mg/l. In 2015, BOD varied from 0.7 to 0.8 mg/l (Fig.16c). In 2014, BOD range was from 0.6 to 0.7 mg/l. In 2015, TDS varied from 144 to 315 mg/l (Fig.16d). In 2014, TDS range was from 120 to 339 mg/l. Chloride of Mathavanga river water varied from 25 to 52 mg/l (Fig.16e) while EQS for Chloride is 600 mg/l. In 2014, Chloride content varied from 12 to 120.28 mg/l. Turbidity level was higher than EQS (10 NTU) for drinking water and varied from 10.3 to 48.26 NTU (Fig.16f). In 2014, Turbidity range was from 10.3 to 20.4 NTU.

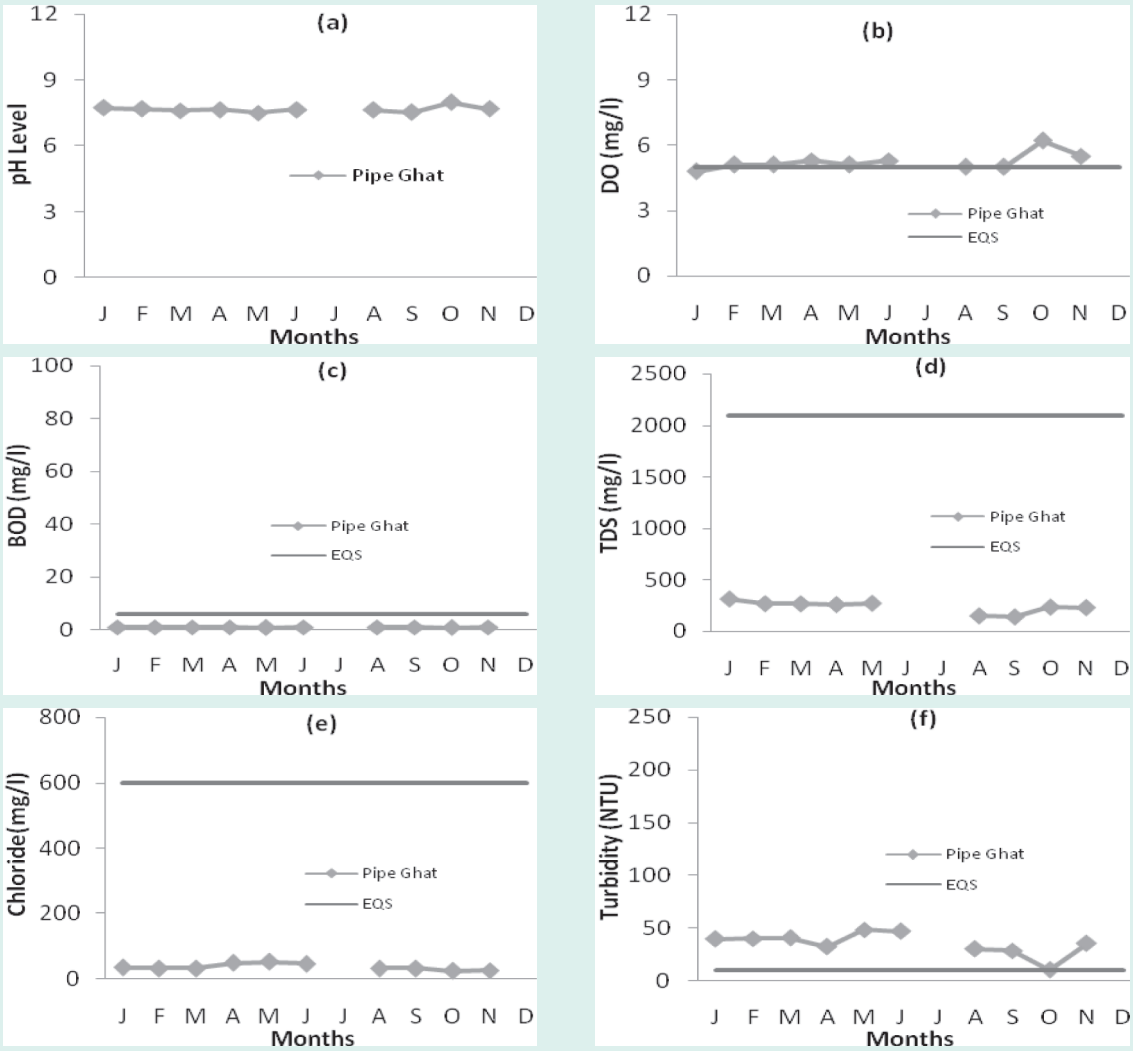


Fig.16.Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Mathavanga River in 2015

4.18 Pashur River

The Pashur river is a river in southwestern Bangladesh and a distributary of the Ganges. It continues the Rupsa River. All its distributaries are tidal. It meets the Shibsa River within the Sundarbans and near to the sea the river becomes the Kunga 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, average values of three points were taken.

In 2015, pH level varied from 7.54 to 8.2 (Fig.17a) and was within the EQS (6.5 to 8.5) though slightly alkaline. In 2014, pH level varied from 7.62 to 8.2. DO level was above the EQS ($\bar{>}$5 mg/l) for fisheries all over the year. The maximum and the minimum concentration of DO was 6.8 and 5.0 mg/l respectively (Fig/17b). In 2014, DO varied from 5.2 and 6.7 mg/l. In 2015, BOD level was within the EQS ($\bar{<}$6 mg/l) for fisheries during the sampling period. The maximum and the minimum value of BOD was 1.2 and 0.8 mg/l respectively (Fig.17c). In 2014, BOD level varied from 0.8 and 1.1 mg/l. High level of TDS was found at Pipeghat compare to other points of the river. TDS varied from 144 to 16376 mg/l (Fig.17d). In 2014, TDS level varied from 256 to 15500 mg/l.

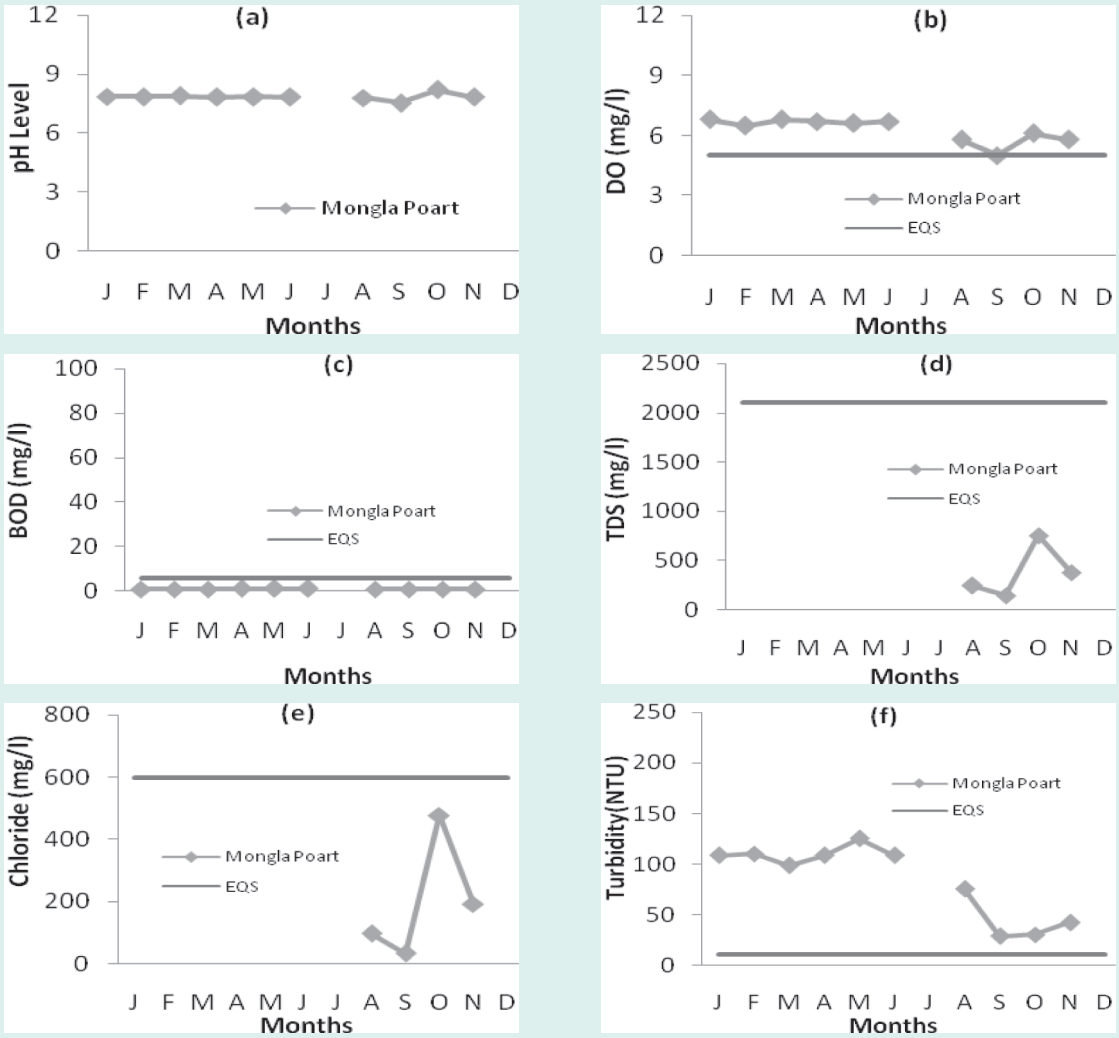


Fig.17. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Pashur River in 2015

Chloride level of Pashur river water varied from 32 to 12692 mg/l. Chloride concentration was higher at all points during March to June compare to rest of the period (Fig.17e) where EQS of chloride is 600 mg/l. In 2014, Chloride level varied from 124 to 12646 mg/l. Turbidity level varied from 30.2 to 125.3 NTU (Fig.17f) against the EQS(10 NTU) for drinking water. Turbidity concentration was very high all over the year. In 2014, Turbidity level varied from 28.3 to 128.3 NTU.

Table-23. Salinity of Pashur River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mongla Poart	3.3	5.8	13.3	17.6	**21.3**	17.9	-	0.6	0.1	1.1	**0.3**	--
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied from 0.3 ppt to 21.3 ppt. The maximum and the minimum salinity was 21.3 ppt in May and 0.3 ppt in November while EQS for Salinity is 400 ppt (Table-23).

4.19 Kakshiali River

Khakshiali river is located in Satkhira district in Khulna division. To monitor water quality of Kakshiali river, water samples were collected from three different points of Kaligonj location e.g. Kaliganj Bank, Middle and Opposite bank at Shatkhira in 2015. For analysis, average values of three points were considered.

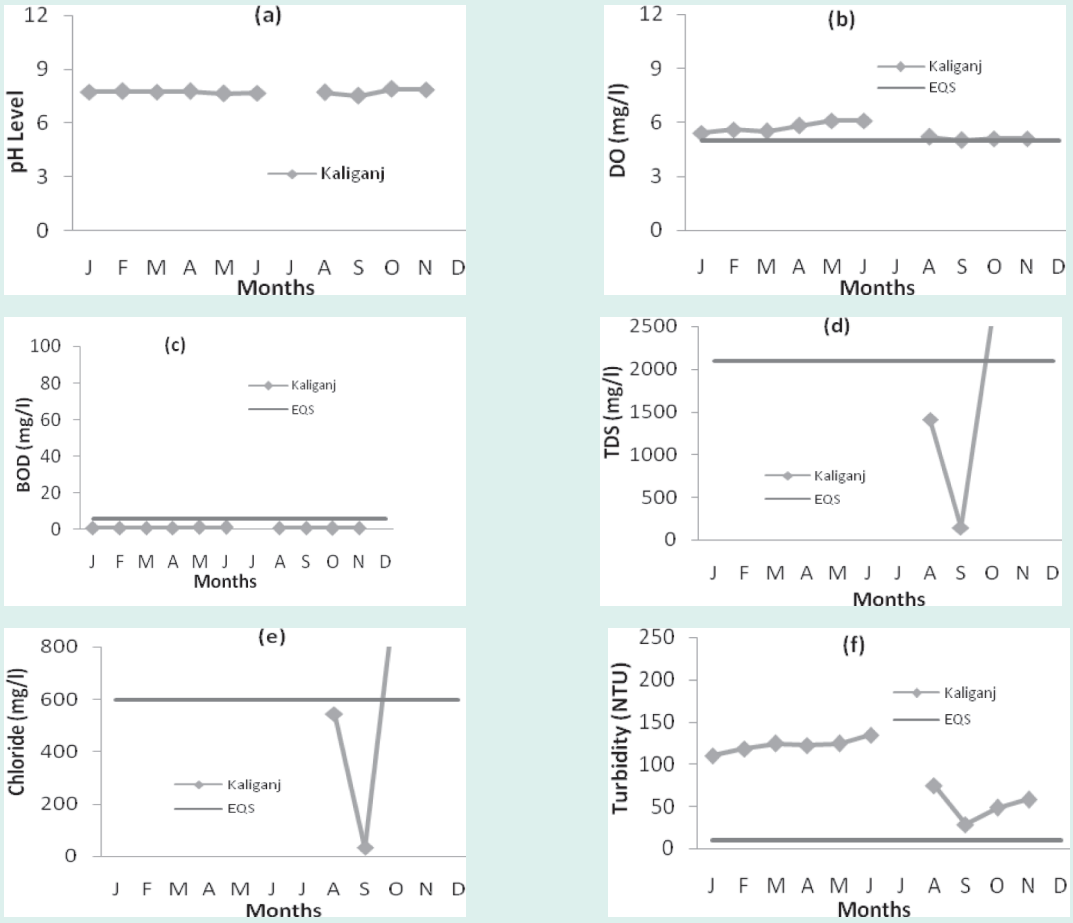


Fig.18. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Kakshiali River in 2015

In 2015, pH level was within the EQS (6.5-8.5) for inland surface water and was varied from 7.54 to 7.9 (Fig.18a). In 2014, pH was from 7.65 to 7.9. DO level varied from 5.0 to 6.1 mg/l (Fig.18b) throughout the year while EQS for fisheries is ≥5 mg/l. In 2014, DO level varied from 5.1 to 7.85 mg/l. BOD was far below the EQS (≤6 mg/l). It varied from 0.7 to 1.1 mg/l (Fig.18c). In 2014, BOD level varied from 0.7 to 1.2 mg/l. TDS level was very high all over the year of 2015. The minimum TDS was 144 mg/l in September and the maximum TDS was 17614 mg/l in May (Fig.18d). In 2014, TDS level varied from 514 to 16700 mg/l.

In 2015, Chloride concentration was very high all over the year and varied from 32 to 13124 mg/l (Fig.18e) while standard for treated wastewater from industrial units is 600 mg/l. The highest Chloride was found in May and the lowest value was in September. In 2014, Chloride level varied from 692 to 13045.95 mg/l. Turbidity level was above the EQS (10 NTU) limit for drinking water all the year that varied from 28.3 to 134.3 NTU (Fig.18f). In 2014, Turbidity level varied from 48.2 to 136.3 NTU.

Table-24. Salinity of Kakshiali River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Kaliganj (Avg)	6.5	8.2	14.3	18.6	**23.1**	19.2	-	1.0	**0.1**	2.8	3.8	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied from 0.1 ppt to 23.1 ppt. The maximum and the minimum salinity was 23.1 ppt in May and 0.1 ppt in September (Table-24) respectively.

4.20 Gorai River

Gorai river is located in Kushtia district in Khulna division. Water samples were collected from two locations viz. Magura and Kustia comprising three points each. Average values of three points of a location were used for graphical representation.

In 2015, pH of Gorai river water was varied from 7.58 to 8.5 (Fig.19a) and was within the EQS (6.5-8.5) for inland surface water. In 2014, pH level varied from 7.41 to 8.4. In 2015, DO was above the EQS (>5 mg/l) limit for fisheries at both locations. Level of DO varied from 5.1 to 6.8 mg/l (Fig.19b). In 2014, DO level varied from 5.0 to 5.8 mg/l. In 2015, BOD level was within the EQS (≤6 mg/l) and varied from 0.7 to 0.9 mg/l (Fig.19c). In 2014, BOD range was from 0.6 to 0.7 mg/l. TDS level of Gorai river water was within the limit throughout the year while comparing to the EQS (2100 mg/l) for treated wastewater from industrial units. It varied from 130 to 206 mg/l (Fig.19d). In 2014, TDS level varied from 130 to 219 mg/l. Chloride level was also within the EQS (600 mg/l) for treated wastewater from industrial units. The maximum and the minimum chloride values were 38 and 21 mg/l (Fig.19e). In 2014, Chloride level was from 21.0 to 108.35 mg/l. Turbidity level was relatively higher throughout the year than the EQS (10 NTU) for drinking water. It varied from 15.7 to 38.3 NTU (Fig.19f). In 2014, Turbidity level varied from 14.3 to 32.8 NTU.

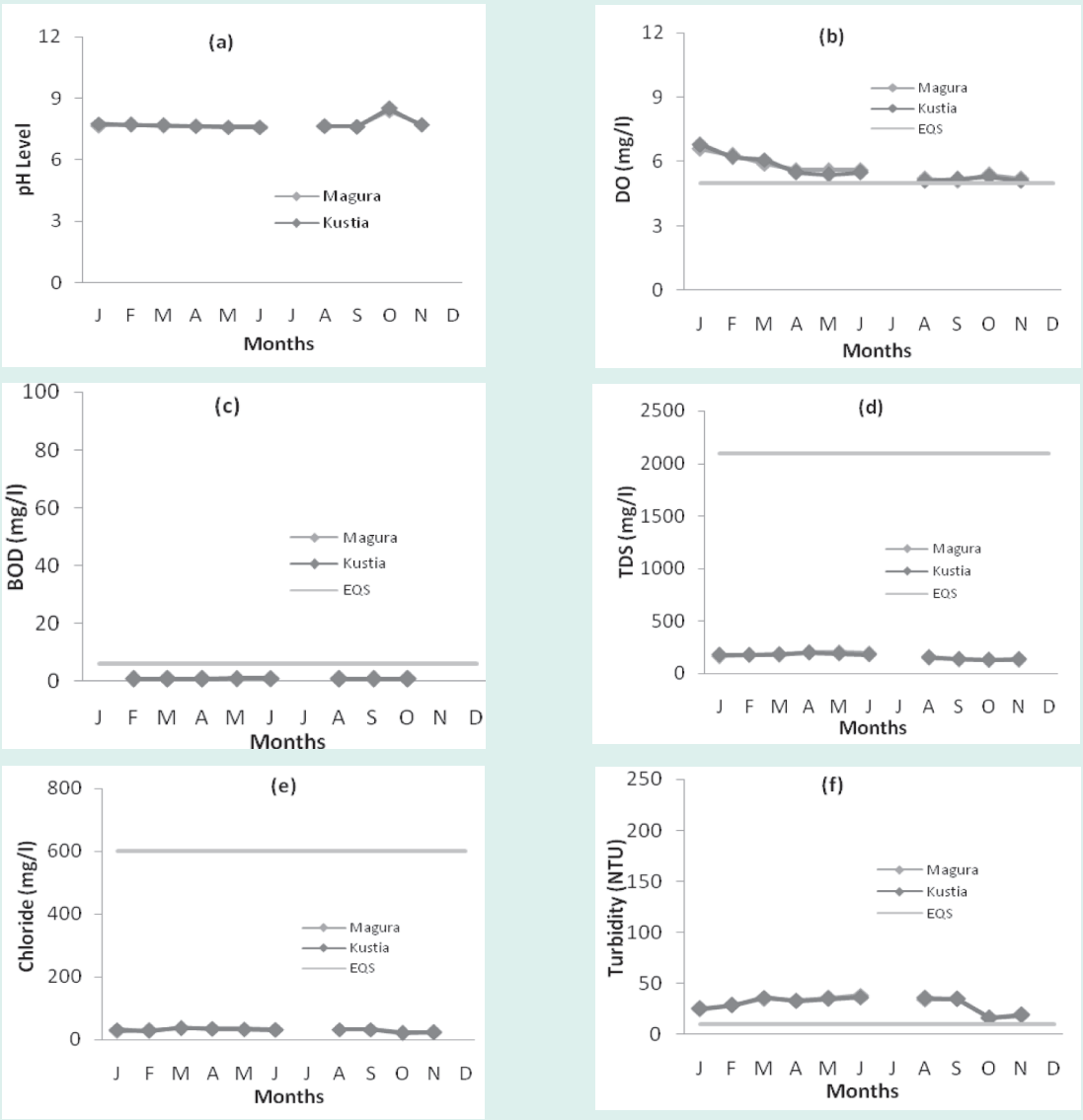


Fig.19. Graphical presentation of pH, DO BOD, TDS, Chloride and Turbidity of Gorai River in 2015

4. 21 Modhumoti River

Madhumati river, distributary of the upper Padma River (Ganges [Ganga] River), flowing through southwestern Bangladesh. It leaves the Padma just north of Kushtia and flows 190 miles (306 km) southeast before turning south across the swampy Sundarbans region to empty into the Bay of Bengal. To monitor water quality of Modhumoti river in 2015, samples were collected from one location comprising three different points (Mollarhat side, middle and opposite) of Bagerhat. For analysis, average values of three points were condidered.

In 2015, pH level of Modhumoti river was within the EQS and varied from 7.51 to 7.86 (Fig.20a). In 2014, pH level varied from 7.21 to 7.82. DO was varied from 5.1 to 5.8 mg/l while EQS is ≥5 mg/l for fisheries (Fig.20b). In 2014, DO level was varied from 4.5 to 5.6 mg/l. BOD of the river was also in the EQS (≤6 mg/l) for fisheries. BOD varied from 0.7 mg/l to 0.9 mg/l (Fig.20c). In 2014, BOD was 0.8 mg/l all over the year. TDS of Modhumoti river water was within EQS (2100 mg/l). The maximum and the minimum value was 184 mg/l and 124 mg/l respectively (Fig.20d). In 2014, TDS level varied from 114 to 193 mg/l. In 2015, Chloride level varied from 0.0 to 72 mg/l while EQS for treated wastewater from industrial units is 600 mg/l (Fig.20e). In 2014, Chloride level varied from 58 to 102.25 mg/l. In 2015, Turbidity varied from 38.13 to 78.30 NTU (Fig.20f). In 2014, Turbidity varied from 12.2 to 79.4 NTU.

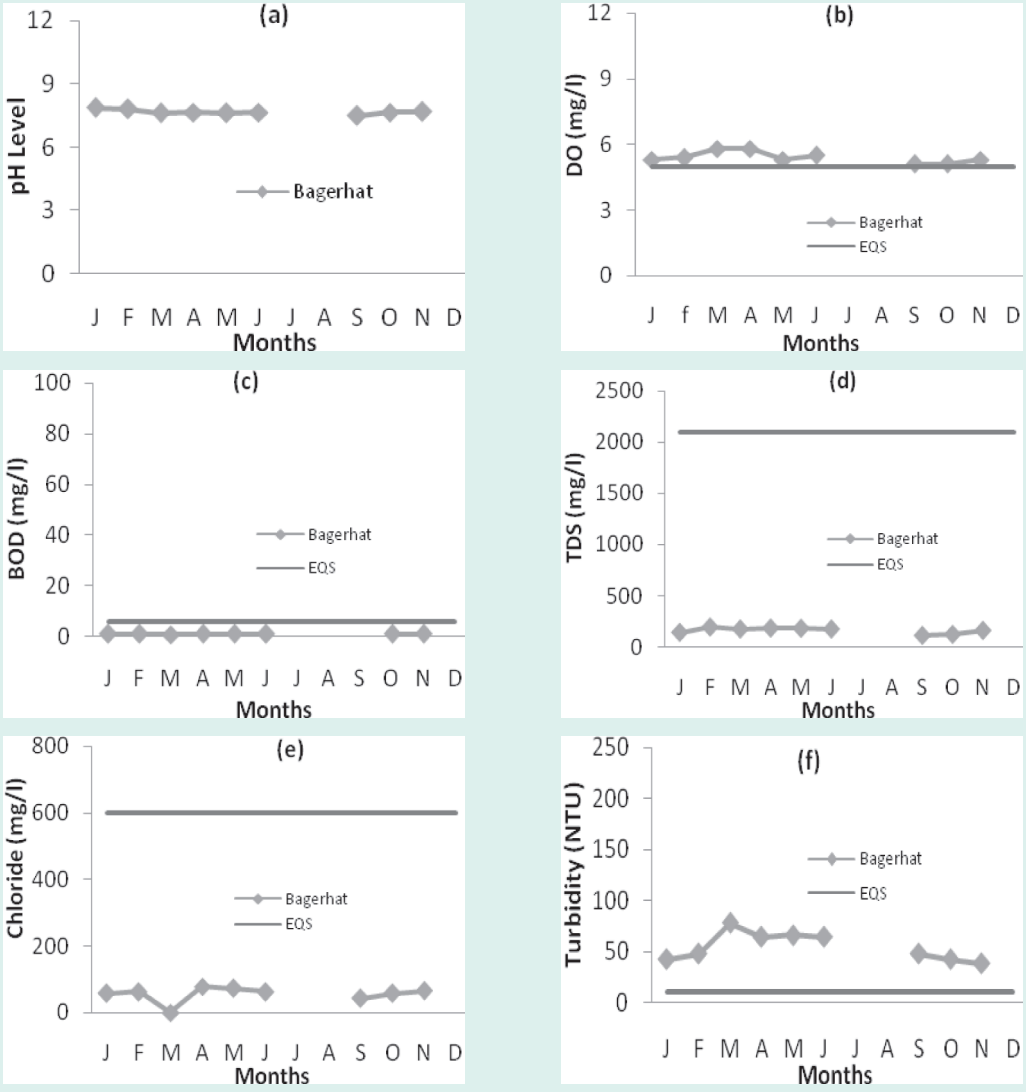


Fig.20. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Modhumoti River in 2015

4.22 Beel Dakatia River

To monitor water quality of Beel Dakatia river in 2015, samples were collected from one location at Khulna comprising two points (bank and middle). For analysis, average of two points were used.

In 2015, pH level was within the EQS and varied from 7.22 to 7.73 (Fig.21a). In 2014, pH level varied from 7.48 to 7.75. DO varied from 3.7 to 5.9 mg/l (Fig.21b) and was closer to the EQS for fisheries (≥5 mg/l). In 2014, DO level varied from 3.4 to 5.6 mg/l. In 2015, BOD Concentration varied from 0.6 to 0.9 (Fig.21c). TDS was within the EQS (2100 mg/l) except the month of April and May. The maximum and the minimum TDS was 6310 mg/l in May and 590 mg/l in September respectively (Fig.21d). In 2014, TDS level varied from 115 to 6155 mg/l. In 2015, Chloride level varied from 272 mg/l to 38578 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 September (Fig.21e). In 2014, Chloride level varied from 52 mg/l to 3425 mg/l. Turbidity varied from 40.8 to 68.25 NTU (Fig.21f) and was higher than EQS (10 NTU) for dirking water. In 2014, Turbidity range was from 15.3 to 67.35 NTU.

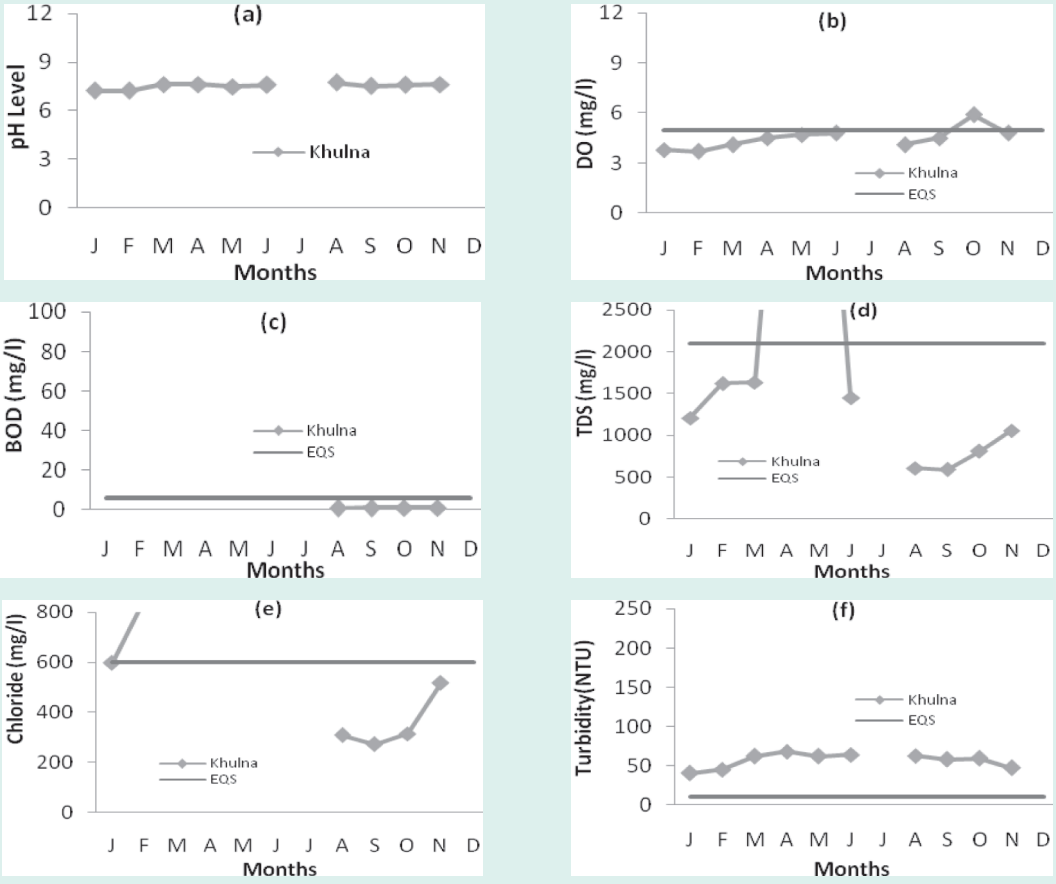


Fig.21.Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Beel Dakatia River in 2015

Table-25. Salinity of Beel Dakatia River Water in 2015

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Khulna (Avg)	1.2	1.8	1.9	6.9	**7.2**	5.2	-	3.1	2.6	2.8	**1.0**	-
EQS for wastewater after treatment from industrial units 400 ppt												

Salinity varied 1.0 ppt to 7.2 ppt. The maximum and the minimum salinity was 7.2 ppt in May and 1.0 ppt in November (Table-25). In 2014, salinity varied from 0.1 ppt to 6.8 ppt.

4.23 Kirtankhola River

Kirtankhola river starts from Sayeshtabad in Barisal and ends at 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 one location of the river at Launch ghat (at bank and in the middle). Samples were collected during low tide and high tide.

In 2015, pH level of Kirtankhola river water varied from 7.0 to 7.9 (Fig.22a) and was within the EQS. In 2014, pH range was from 7.1 to 7.5. DO level of Kirtankhola rive was above the EQS (≥5 mg/l) for fisheries. DO varied from 6.5 mg/l to 7.1 mg/l (Fig.22b). In 2014, DO level varied from 6.0 mg/l to 6.4 mg/l. In 2015, BOD was low round the year. The maximum and the minimum BOD was 2.0 mg/l and 4.75 mg/l respectively (Fig.22c). In 2014, BOD level varied from 1.8 mg/l to 2.4 mg/l. In 2015, TDS of Kirtankhola rive water was also within the EQS (2100 mg/l) throughout the year and the range was from 59 to 102 mg/l (Fig.22d). In 2014, TDS level varied from 34.5 to 72 mg/l. Chloride content varied from 39 to 135 mg/l (Fig.22e). In 2014, Chloride level varied from 20 to 30 mg/l. SS of Kirtankhola river water was within EQS. The maximum and the minimum SS was 171 mg/l in February and 20 mg/l in August (Fig.22f). In 2014, the maximum and the minimum SS was 21.8 mg/l in June and 10.2 mg/l in May respectively.

EC level of the Kirtankhola river varied from 161 to 901 µmhos/cm against the EQS for treated wastewater from industrial units is 1200 µmhos/cm (Table-26).

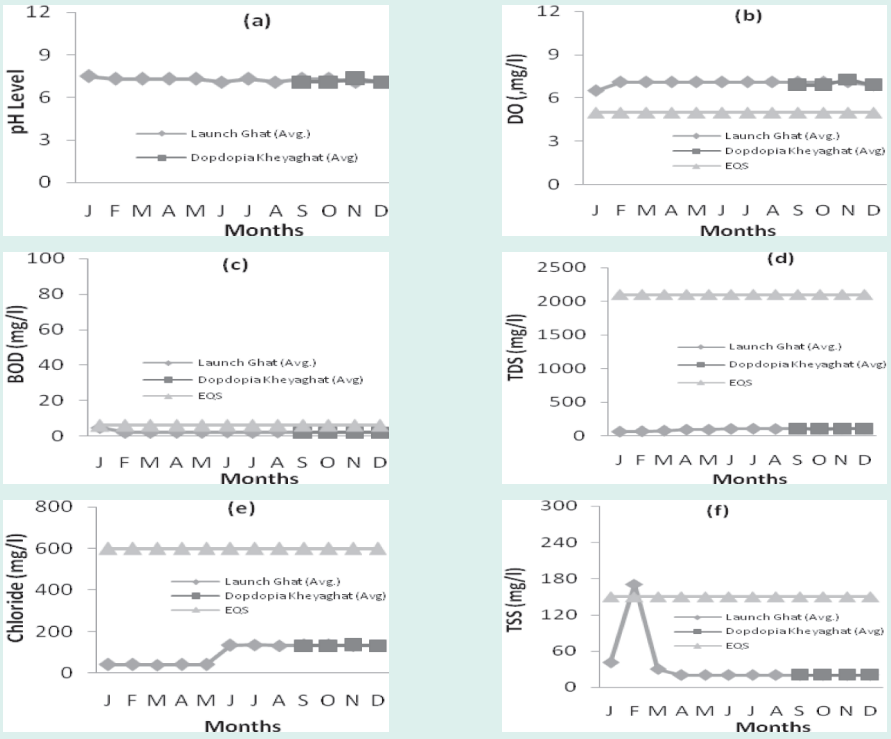


Fig.22.Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Kirtankhola River in 2015

Table-26. EC of Kirtankhola River Water in 2015

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barisal Launch Ghat	169	171	164	173	173	161	901	171	173	173	171	171
Dopdopia Kheya ghat	-	-	-	-	-	-	-	-	169	171	173	171
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

4.24 Tetulia River

Tetulia River a flow of the Lower Meghna River. Originating from the meghna at north of Bhola district. The total length of the river is about 84 km and the average width is 6 km. The Tetulia disconnected the Bhola district from the main land of Barisal. For monitoring of water quality of Tetulia river water samples was colleted from Vedhoria Feri Ghat (VFG) location (bank and middle point).

In 2015, pH level of the Tetulia river water ranged from 7.1 to 7.3 mg/l (Fig.23a) while in 2014, the range was from 7.4 to 7.6. DO varied from 6.3 to 7.2 mg/l (Fig.23b) while standard limit for fisheries is (>5 mg/l). In 2014, DO level varied from 7.0 to 7.2 mg/l. BOD level of the Tetulia river varied from 2.0 tō 2.2 mg/l (Fig.23c) against corresponding EQS (<6 mg/l) for fisheries. In 2014, BOD level of the Tetulia river was 2.0 mg/l. TDS range varied from 9Ꭲ.4 to 97.0 mg/l (Fig.23d). In 2014, TDS range was 90 mg/l. Chloride level varied from 53 to 161 mg/l (Fig.23e) while EQS for treated wastewater from industrial units is 600 mg/l. In 2014, Chloride level varied from 26 to 28 mg/l. SS level was 20 mg/l (Fig.23f) and was below the EQS (150 mg/l). In 2014, SS level varied from 22 to 24 mg/l.

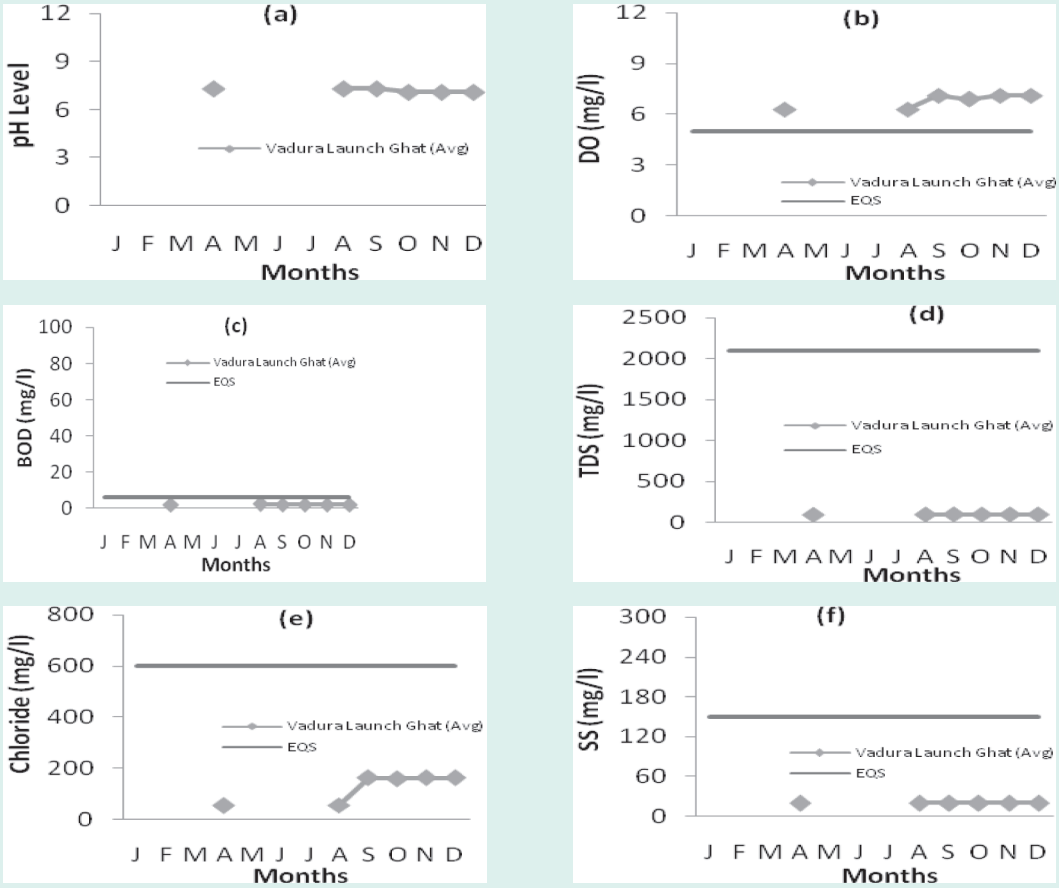


Fig.23.Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Tetulia River in 2015

4.25 Sughanda River

Sugandha river flows south-southwest as the Kirtankhola upto Nalchity keeping the Barisal town on its west bank. To monitor water quality of Sughanda River water samples were colleted for analysis from Launch Ghat, Jhalkathi (e.g. Side and middle high tide) of the river.

In 2015, pH level of the Sughanda river water varied from 7.1 to 7.5. (Fig.24a) while EQS for fisheries is 6.5 to 8.5. In 2014, pH level varied from 7.0 to 7.4. DO level varied from 7.1 to 7.3 mg/l (Fig.24b) and was above the EQS (≥5 mg/l) for fisheries. In 2014, DO level varied from 6.0 to 7.2 mg/l. BOD range was from 2.0 to 2.1 mg/l (Fig.24c) while EQS for fisheries is ≤6 mg/l. In 2014, BOD level varied from 2.0 to 2.2 mg/l. TDS level of the Sughanda river was from 91 to 103 mg/l (Fig.24d) while corresponding EQS is 2100 mg/l for treated wastewater from industrial units. In 2014, TDS level varied

from 66.4 to 94 mg/l. Chloride level of the Sughanda river was from 131 to 141 mg/l (Fig.24e) while corresponding EQS is 600 mg/l for treated wastewater from industrial units. In 2014, Chloride level varied from 130 to 132 mg/l. SS level of the Sughanda river was 20 mg/l (Fig.24f) against EQS (150 mg/l) for treated wastewater from industrial units. In 2014, SS level varied from 20 to 20.2 mg/l.

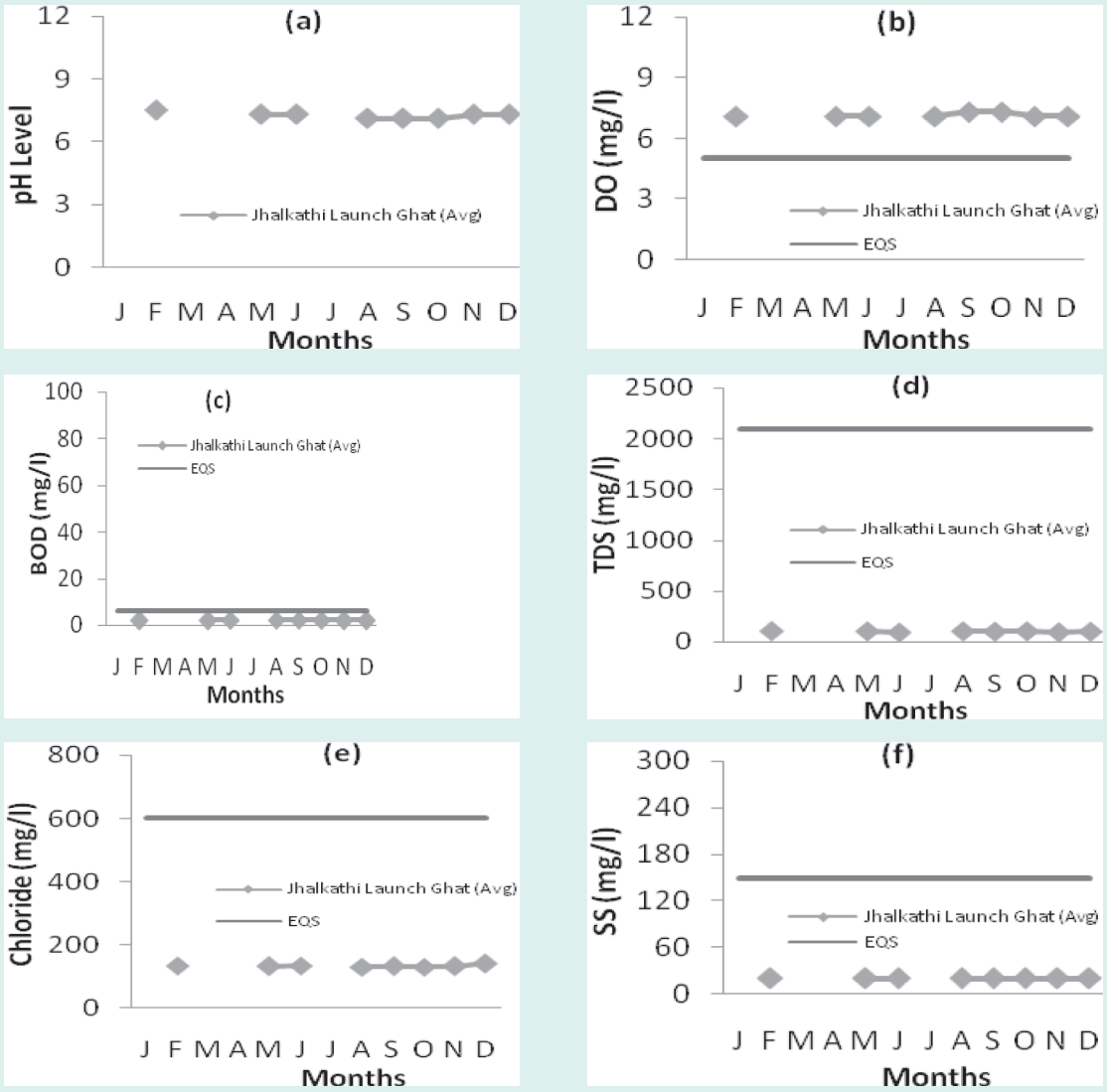


Fig.24.Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Sughanda River in 2015

4.26 Lohalia River

Patuakhali city is surrounded on three sides by two rivers. The two major rivers are Laukathi and Lohalia, which are directly connected with the Bay of Bengal. For monitoring purpose water samples were collected from Patuakhali Launch Ghat (PLG) (side and middle).

In 2015, pH level of the Lohalia river water varied from 7.1 to 7.7. (Fig.25a) while EQS for fisheries is 6.5 to 8.5. DO level varied from 6.3 to 7.1 mg/l (Fig.25b) and was above the EQS (>5 mg/l) for fisheries. BOD range was from 2.0 to 2.05 mg/l (Fig.25c) while EQS for fisheries is <6 mg/l. TDS level of the Lohalia river was from 71 to 103 mg/l (Fig.25d) while corresponding EQS is 2100 mg/l for treated wastewater from industrial units. Chloride level of the Lohalia river was from 137 to 163 mg/l (Fig.25e) while corresponding EQS is 600 mg/l for treated wastewater from industrial units. EC level of the Lohalia river was varied from 141 to 171 µmhos/cm (Fig.24f) against EQS (1200 µmhos/cm) for treated wastewater from industrial units.

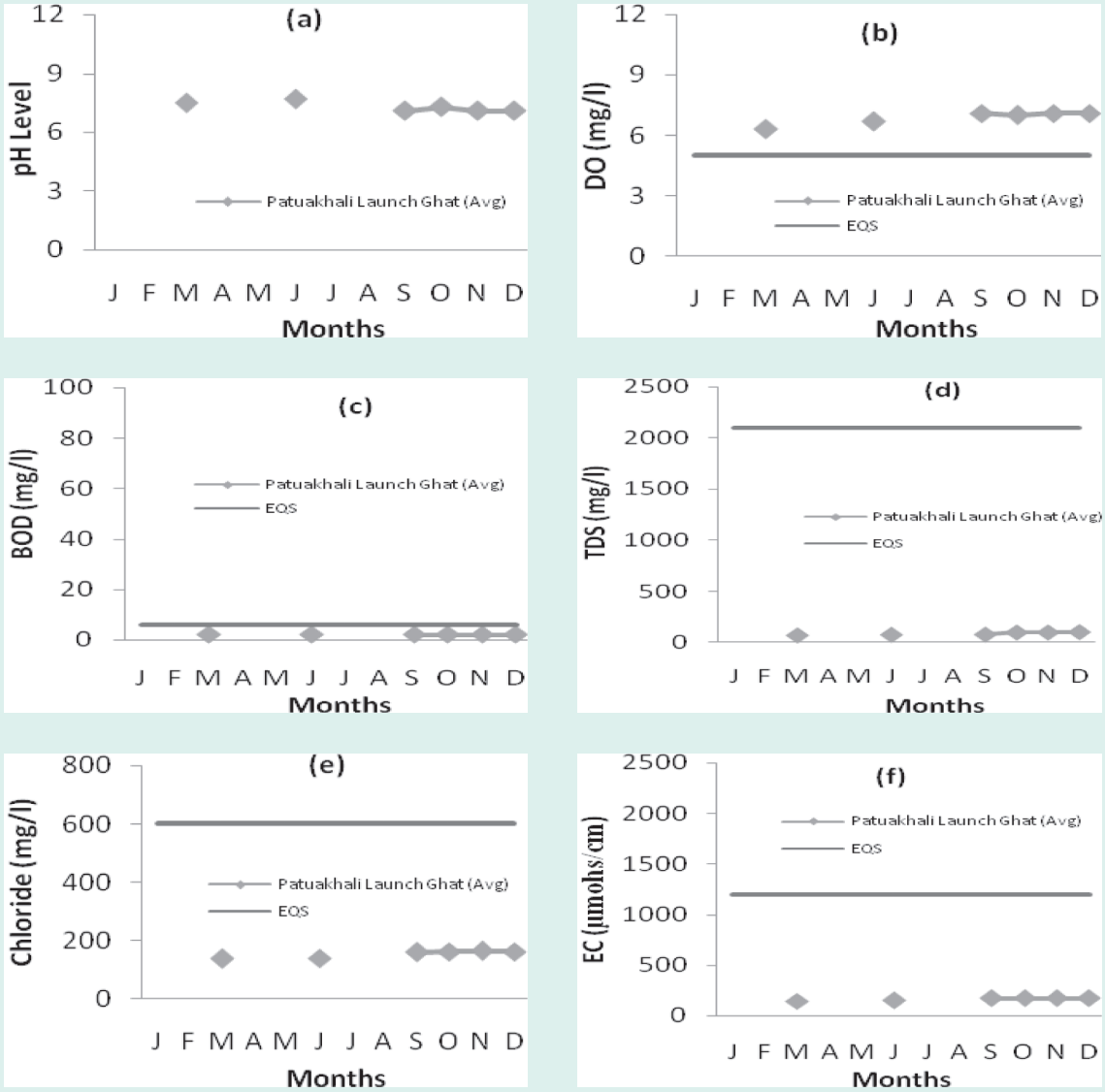


Fig.25.Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Lohalia River in 2015

4.27 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 five different locations of the river namely Mendibag Point (MP), Kin Bridge (KB), Shak Ghat (SG), Chattak and Kazi Bazaar (KB).

In 2015, pH level of the Surma river varied from 6.4 to 7.6 (Fig. 26a). In 2014, pH was from 6.5 to 7.1. In 2015, DO content was mostly above the EQS (>5 mg/l). It varied from 5.2 to 6.7 mg/l (Fig. 26b). In 2014, DO level varied from 4.4 to 7.0 mg/l.

BOD value was also within the EQS at all locations. The maximum and the minimum BOD was 32 mg/l in November and 1.6 mg/l in February at Mendibag location (Fig. 26c). In 2014, BOD level varied from 26 to 48 mg/l. In 2015, COD content was within the EQS (200 mg/l) and varied from 32 to 138 mg/l (Fig. 26d). In 2014, COD level varied from 58 to 188.5 mg/l. TDS range was from 63.5 to 166.3 mg/l (Fig. 26e) where EQS for TDS is 2100 mg/l for treated wastewater from industrial units. In 2014, TDS level was varied from 37.22 to 160 mg/l. SS level of Surma river was within the EQS limit for treated wastewater from industrial unit. It varied from 24.8 to 55.86 mg/l (Fig. 26f). In 2014, SS level varied from 15.04 to 50.2 mg/l.

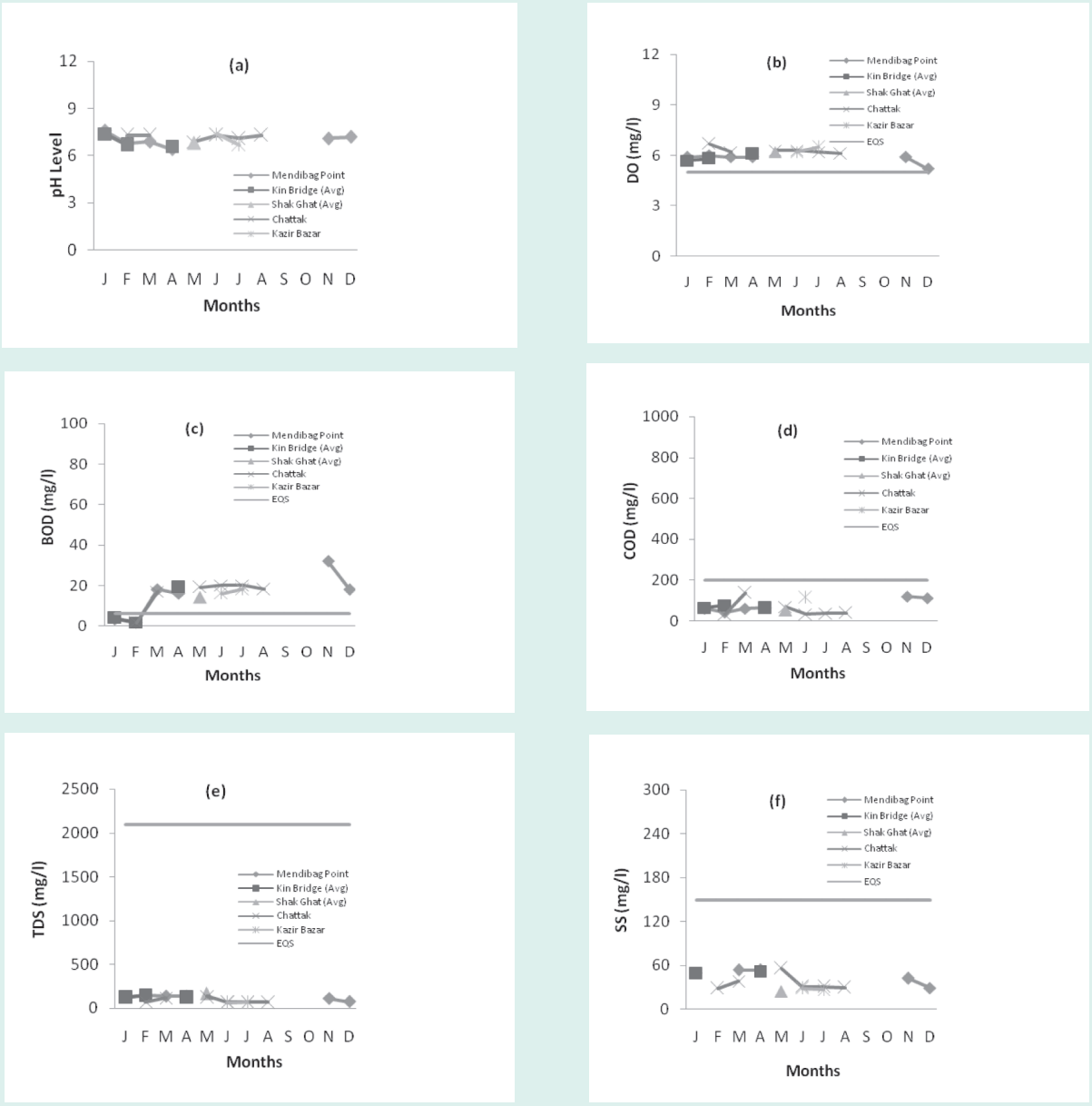


Fig.26. Graphical presentation of pH, DO, BOD, COD, TDS and SS of Surma River in 2015

Table-27. EC of Surma River Water in 2015

Sampling Locations	E.C (µmhos/cm /cm)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mendibag Point	246	**295**	270	270	-	-	-	-	-	-	215	146
Keen Bridge	255	294	-	260	-	-	-	-	-	-	-	-
Shak Ghat	-	-	-	-	273	-	-	-	-	-	-	-
Chattak	-	143	222	-	269.8	145	147	148	-	-	-	-
Kazir Bazar	-	-	-	-	-	**132**	134		-	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmohos/cm												

EC level of Surma river was within the EQS limit. It varied from 132 to 295 µmhos/cm (Table-27).

4.28 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 2015 for analysis of water quality.

In 2015, pH level of Kushiara river was within EQS (6.5-8.5) for inland surface water. It varied from 6.8 to 7.3 (Fig. 27a). In 2014, pH level varied from 6.5 to 7.4. DO was above the EQS (≥5 mg/l) for fisheries and varied from 5.2 to 6.2 mg/l (Fig. 27b). In 2014, DO level varied from 4.9 to 5.7 mg/l. BOD level was from 18 to 33 mg/l while EQS for fisheries is ≤6 mg/l (Fig. 27c). In 2014, BOD level varied from 28 to 36 mg/l. In 2015, COD content was within the EQS (200 mg/l) and varied from 58 to 90 mg/l (Fig. 27d). In 2015, TDS level of Kushiara river water was below the EQS for treated wastewater from industrial unit and varied from 72 to 112 mg/l (Fig. 27e). In 2014, TDS level varied from 80.1 to 110 mg/l. SS was within the EQS limit and it varied from 15 to 59 mg/l (Fig. 27f). In 2013, SS level varied from 10 to 37.4 mg/l.

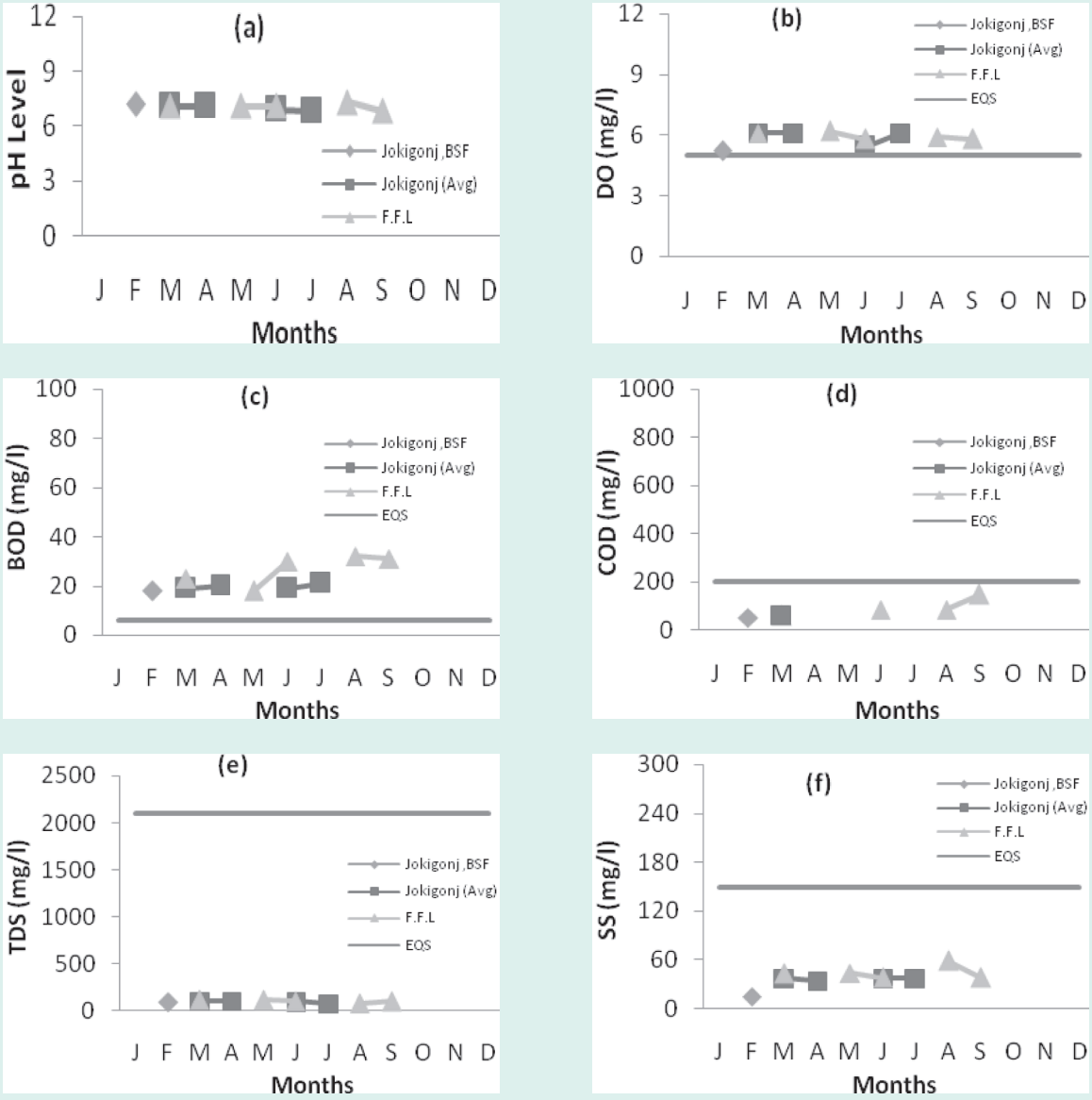


Fig 27. Graphical presentation of pH, DO, BOD, COD, TDS and SS of Kushiara River in 2015
Note : F.FI = Fenchugonj Fertilizer Industry.

Table-28. EC of Kushiara River Water in 2015

Sampling locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jokigong B.S.F Ghat	-	**185**	-	-	-	-	-	-	-	-	-	-
Fenchugonj Fertilizer Inds.	-	-	**221**	-	-	192	-	190	192	-	-	-
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 185 to 221 µmhos/cm (Table-28).

CHAPTER 5: RECOMMENDATIONS

5.1 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 and get water quality improves as well of the rivers water of Bangladesh.

- Review and update surface water monitoring network.
- Need to collect weather information while sampling.
- Need to collect data of river flow.
- 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.
- Intensify monitoring of ETP outlet water of Jamuna Fertilizer Factory at Bahadurpur and KAFCO at Chittagong to improve treatment efficiency.
- Ensure installation of ETP/CETP and their continuous operation to stop disposal of untreated wastewater into the rivers.
- Stop discharging untreated sewage into river water and improve sanitation system in the city areas.
- Stop dumping municipal waste and medical wastes into rivers.
- Increase river flow specially during dry season.
- Water is the most important component of environment. To stop random use of ground water in the industry, environmental tax can be imposed.
- 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 collection.
- A comprehensive set of parameters including microbial test (Fecal Coliform, E-Coli etc) of river water is essential to evaluate 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.

CHAPTER 6: TREND ANALYSIS OF WATER QUALITY OF MAJOR RIVERS

6.1 Buriganga River

The Buriganga River (Burigonga "Old Ganges") flows pass the southwest outskirts of Dhaka city. 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.

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). Currently 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. Different parameters of Buriganga River water are given in the following table.

Table-29. Level of Ddifferent Pparameter of Buriganga River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Buriganga river	2010	Dry	7.25	0.47	26.44
		Wet	7.31	3.83	8.23
	2011	Dry	7.27	1.35	26.06
		Wet	7.03	2.24	22.48
	2012	Dry	7.42	0.54	18.748
		Wet	7.19	2.55	15.90
	2013	Dry	7.38	2.3	21.18
		Wet	6.84	2.56	9.17
	2014	Dry	7.24	0.61	24.97
		Wet	7.27	2.58	10.29
	2015	Dry	7.54	0.14	17.09
		Wet	7.22	2.96	7.42
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD are for fisheries, as per ECR, 1997.

During 2010-2015, pH of Buriganga river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO of Buriganga river was below the EQS. 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 of recent years. BOD content was higher than EQS irrespective of season.

With the passage of time tremendous human pressure on Buriganga river (interms of plying motorized vessels, infrastructural development, encroachment, industrial and sewage waste dumping etc.) and dumping of ever increasing all sorts of wastes turned Buriganga a worst polluted and ecologically dysfunctional river.

6.2 Shitalakhya River:

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. A portion of its upper course is known as Banar River. The Shitalakhya ran almost parallel to the Brahmaputra and joined with the Dhaleswari after passing Narayanganj. There is a river port at 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. Different parameters of Shitalakhya River water are given in the following table.

Table-30. Level of Different Pparameter of Shitalakhya River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Shitalakhya River	2010	Dry	7.22	3.77	9.58
		Wet	7.05	5.53	4.67
	2011	Dry	7.14	3.80	10.62
		Wet	7.22	5.63	3.983
	2012	Dry	7.22	2.18	11.17
		Wet	7.37	3.56	5.21
	2013	Dry	7.7	2.69	22.83
		Wet	7.11	4.10	5.75
	2014	Dry	7.19	0.66	16.8
		Wet	7.43	3.86	6.64
	2015	Dry	7.51	3.84	6.46
		Wet	6.93	3.53	3.78
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations.

During 2010-2015, pH of Shitalakhya river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was below the EQS. BOD was exceeded EQS during 2010-2015 though water quality slightly improved during wet season. This may be due to increase of flow in the river. Direct discharge of untreated effluent from industries, 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 the sampling location and all of those industries discharge wastes into river water.

6.3 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. Earlier this river was called as (Bengali: "Kohor Doriya"), "Kohor river". Different parameters of Turag River water are shown in the table below.

Table-31. Level of Different Parameter of Turag River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Turag River	2010	Dry	7.49	0	30.91
		Wet	6.39	3.73	9.5
	2011	Dry	7.74	0.47	22.33
		Wet	7.52	3.94	9.12
	2012	Dry	7.6	0.65	24.87
		Wet	7.48	2.67	12.95
	2013	Dry	7.46	0.742	31.96
		Wet	7.31	2.93	4.58
	2014	Dry	7.67	0.69	35.44
		Wet	7.36	2.75	7.21
	2015	Dry	7.67	0.11	35.70
		Wet	6.79	3.63	7.45
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Turag river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was below the EQS irrespective of seasons. Sometimes, DO reached to zero especially in dry season. In wet seasons BOD was higher than the EQS in the recent past. Seasons or flow of the river is clearly a factor affecting water quality along with dumping of wastes.

There are many industries dotting the banks of this river those dispose their wastes into the river. During the Bishwa Ijtema, Muslims pilgrims coming from all over the world and stay on the river bank for few days. Unfortunately the site lack of proper accommodation and an adequate sanitation system. As a result, human waste and garbage generated are disposed into the river and pollutes the river heavily. Encroachment, sand/earth filling, dumping of industrial, municipal and medical waste, etc. turned its water pitch black and unfit for any use.

6.4 Padma River:

The Padma enters Bangladesh from India near Chapai Nababganj and meets the near Aricha and retains its name, but finally meets with the Meghna near Chandpur and adopts the name "Meghna" before flowing into the Bay of Bengal. Rajshahi, a major city in western Bangladesh, is situated on the north bank of the Padma.

Table-32. Level of Different Parameter of Padma River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Padma River	2011	Dry	7.15	6.8	2.18
		Wet	7.20	6.78	2.32
	2012	Dry	7.12	6.95	1.75
		Wet	6.72	6.42	1.95
	2013	Dry	7.3	6.85	1.46
		Wet	6.63	6.63	1.68
	2014	Dry	7.70	7.04	1.69
		Wet	6.65	6.36	1.66
	2015	Dry	7.39	7.21	2.15
		Wet	7.33	6.30	2.46
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2011 - 2015, pH of Padma river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS. And BOD content of Padma river water was within the EQS.

6.5 Meghna River

The Meghna is formed inside Bangladesh by the joining of the Surma and Kushiyara rivers originating from the hilly regions of eastern India. Down to Chandpur, Meghna is hydrographically referred to as the Upper Meghna. After the Padma joins, it is referred to as the Lower Meghna. Near Muladhuli in Barisal district, the Safipur River is an offshoot of the Surma that creates one of the main rivers in South Bengal. 1.5 km wide, this river is one of the widest in the country as well. The Meghna is the widest river among those that flow completely inside the boundaries of Bangladesh. At a point near Bhola, Meghna is 12 km wide. In its lower reaches this river follows almost a straight line in its path.

Table-33. Level of Different Parameter of Meghna River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Meghna River	2010	Dry	7.13	5.73	3.44
		Wet	6.91	6.07	3.1
	2011	Dry	7.24	6.14	1.45
		Wet	7.04	6.18	1.76
	2012	Dry	7.25	6.14	1.45
		Wet	7.04	6.18	1.76
	2013	Dry	7.41	4.63	13
		Wet	7.43	5.02	7.8
	2014	Dry	7.09	3.9	7.92
		Wet	7.34	5.18	6.615
	2015	Dry	6.96	6.30	2.07
		Wet	6.88	5.66	2.07
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Meghna river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS except the year of 2013 and 2014 (Dry Season). And BOD content of Meghna river water was higher than the EQS in the year 2013 and 2014 (Dry & Wet Season).

6.6 Jamuna River

The Jamuna River is one of the three main rivers of Bangladesh. It is the main distributary channel of the Brahmaputra River as it flows from India to Bangladesh. The Jamuna flows to south and joins the Padma River, near Goalundo Ghat, before meeting the Meghna River near Chandpur. It then flows into the Bay of Bengal as the Meghna River.

Table-34. Level of Different Parameter of Jamuna River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Jamuna River	2010	Dry	7.24	5.67	3.06
		Wet	7.33	6.37	3.3
	2011	Dry	7.23	5.68	2.86
		Wet	7.06	5.77	2.92
	2012	Dry	7.22	6.02	3.02
		Wet	8.13	7.65	5.5
	2013	Dry	8.38	6.75	7.1
		Wet	-	-	-
	2014	Dry	7.91	8.45	2.1
		Wet	-	-	-
	2015	Dry	7.71	6.82	3
		Wet	7.07	6.03	0.81
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Jamuna river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS. And BOD content of Jamuna river water was within the EQS.

6.7 Karnaphuli River

Karnaphuli the largest and most important river in Chittagong and the Chittagong Hill Tracts, is a 667-metre wide river in the south-eastern part of Bangladesh. Originating from the Lushai hills in Mizoram, India, it flows 270 kilometres southwest through Chittagong Hill Tracts and Chittagong into the Bay of Bengal. A large hydroelectric power plant using Karnaphuli river was built in the Kaptai region during the 1960s. The mouth of the river hosts Chittagong's sea port, the main port of Bangladesh.

Table-35. Level of Different Parameter of Karnaphuli River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Karnafuly River	2010	Dry	7.56	6.77	1.27
		Wet	7.43	6.90	1.08
	2011	Dry	7.55	5.72	1.56
		Wet	7.35	5.64	1.50
	2012	Dry	7.61	5.13	1.61
		Wet	7.37	5.01	1.45
	2013	Dry	7.39	4.95	5.28
		Wet	7.35	5.36	5.36
	2014	Dry	7.582	5.242	0.388
		Wet	7.48	5.47	0.35
	2015	Dry	7.69	5.4	-
		Wet	7.49	5.35	-
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Karnaphuli river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS. And BOD content of Karnaphuli river water was within the EQS. Considering pH, DO and BOD, water quality of Karnaphuli is good.

6.8 Pashur River

The Pashur River flows through southwestern Bangladesh and a distributary of the Ganges. It continues as the Rupsha River. All its distributaries are tidal. It meets the Shibsa River within the Sundarbans, and near to the sea the river becomes the Kunga River. It is the deepest river in Bangladesh. (Ref.Masud Hasan Chowdhury (2012).

Table-36. Level of Different Parameter of Pashur River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Pasur River	2010	Dry	7.65	4.93	0.9
		Wet	7.65	4.9	0.9
	2011	Dry	7.57	5.31	0.96
		Wet	7.64	4.93	0.89
	2012	Dry	7.82	5.78	0.66
		Wet	7.57	5.31	0.96
	2013	Dry	7.70	6.92	0.6
		Wet	7.67	6.1	0.73
	2014	Dry	7.752	6.32	0.82
		Wet	7.85	5.68	0.88
	2015	Dry	7.85	6.52	0.86
		Wet	7.84	6.04	0.96
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Pashur river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was around the EQS. And BOD content of Pasur river water was also in the EQS.

6.9 Rupsha River:

The Rupsha River flows through southwestern Bangladesh and a distributary of the Ganges. It forms from the union of the Bhairab and Atrai rivers, and flows into the Pashur River. It is a tidal river. It flows by Khulna, and connects to the Bay of Bengal through Poshur river at Mongla channel. There is a bridge over the river named Khan Jahan Ali Bridge. This bridge connects Khulna and Bagerhat Districts.

Table-37. Level of Different Parameter of Rupsha River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Rupsa River	2010	Dry	7.66	5.03	-
		Wet	7.66	5.10	-
	2011	Dry	7.53	5.35	3.89
		Wet	7.66	5.20	5.37
	2012	Dry	7.68	6.41	0.6
		Wet	7.77	6.25	0.49
	2013	Dry	7.65	6.62	0.64
		Wet	7.64	5.95	0.64
	2014	Dry	7.77	6.03	0.78
		Wet	7.85	6	0.833
	2015	Dry	7.84	6.37	0.89
		Wet	7.92	5.73	0.92
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Rupsha river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS. And BOD content of Rupsha river water was mostly below the EQS.

6.10 Kirtankhola River:

Kirtankhola-Barisal River, a major river in southern Bangladesh. Kirtonkhola river is about 16 kilometers long 600 meters wide and 15 meters deep. The catchment area is 307.00 km^2. The river flows throughout the year. It is influenced by the tide. The river plays an important role in social and cultural life of the city and its economic well-being. (Ref. visitourbd.blogspot.com/2012/10/kirtanakhola-river_2127.html)

Table-38. Level of Different Parameter of Kirtonkhola River During 2010 - 2015.

Sampling Location	Year	Season	P^H	DO	BOD
Kirtonkhola River	2010	Dry	7.37	7.23	1.81
		Wet	7.45	5.11	1.57
	2011	Dry	7.13	7.95	2.02
		Wet	7.25	5.62	0.86
	2012	Dry	6.84	6.775	1.7
		Wet	6.61	6.7	1.51
	2013	Dry	7.5	6.11	2.06
		Wet	7.32	6.17	2.11
	2014	Dry	7.33	6.18	3
		Wet	7.55	6.30	2.67
	2015	Dry	7.28	6.98	2.45
		Wet	7.2	7.06	2.07
EQS for fisheries			**6.5-8.5**	**5 mg/l**	**6 mg/l**

Note: Value in each cell is seasonal (Dry: November - April, Wet: May-October) as well as average of sampling locations. EQS of pH, DO, BOD is considered for fisheries.

During 2010 - 2015, pH of Kirtonkhola river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was within the EQS. And BOD content of Kirtankhola river water was below the EQS.

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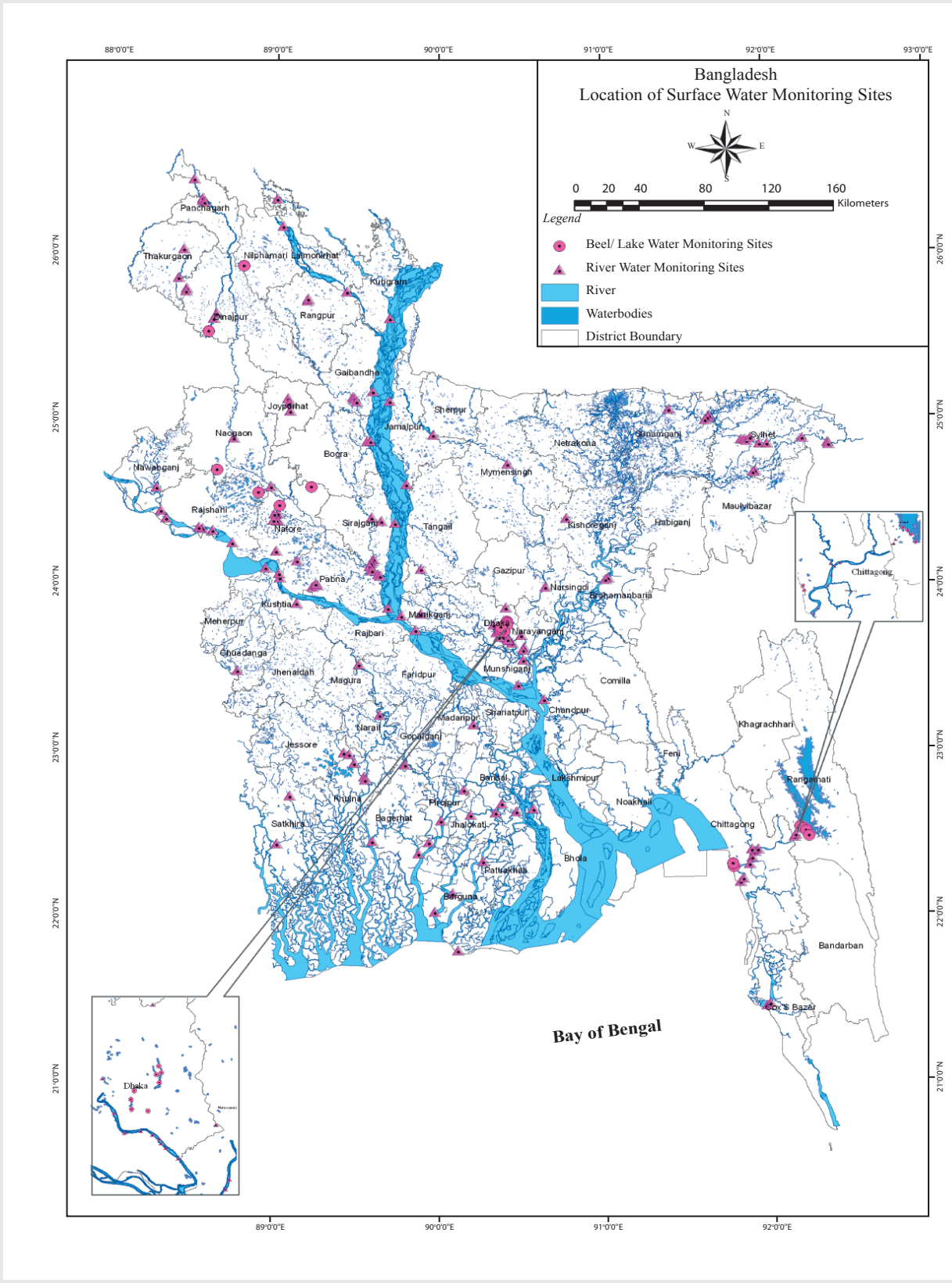

পরিবেশ অধিদপ্তর

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