SURFACE AND GROUND WATER QUALITY REPORT 2016

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

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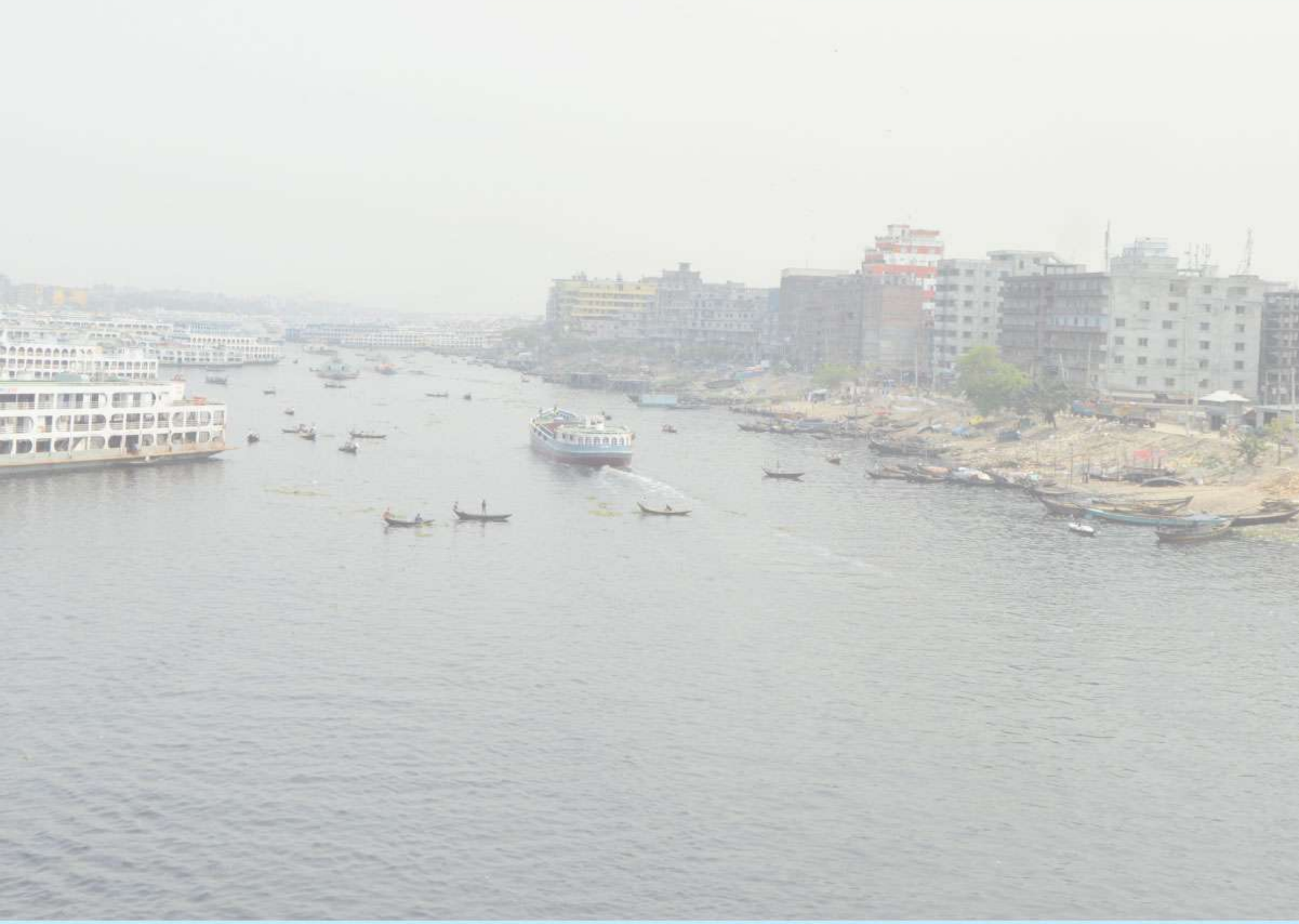

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Surface and Ground Water Quality Report 2016

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MESSAGE

Water is widely used in industrial processes, agriculture, cooking and washing. It is the main constituent of earth's streams, lakes, and oceans, and the fluids of most living organisms. There fore need effective management of solid and liquid wastes to avoid water pollution.

We set Environmental Quality Standard (EQS) for the purpose of irrigation, health, domestic and fisheries. Considering importance of water quality the Department of Environment (DoE) has been monitoring surface water quality since its establishment in 1973. DoE's surface water quality monitoring network includes major rivers and lakes. Monitoring information provide water resource quality of major rivers of Bangladesh.

"River and Ground Water Quality Report 2016" is the sixth of its kind that gives overall status of river and ground water quality in Bangladesh. Dumping of municipal and industrial wastes into rivers is highly polluting rivers surrounding cities. To halt further degradation of water quality of rivers government has declared Buriganga, Turag, Balu and Sitalakhya rivers as Ecologically Critical Areas (ECA) in 2009. Water quality of big rivers such as Padma, Megna, Jamuna, Brahmmputra is still good and within water quality standards as 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 and agricultural use specially in the dry and winter season.

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

Thank Natural Resource Management and Research wing and other officials involved in preparing this report.

Md. Raisul Alam Mondal
Director General

FOREWORD

In Bangladesh, during the dry season groundwater has become an increasingly important source of water for irrigation, municipal and industrial purposes. Some environmental hazards have been encountered in many areas and a number of adverse effects have emerged as a result of the over-abstraction of groundwater, such as lowering of water tables, reduction in dry season flows of rivers and streams, groundwater pollution, intrusion of saline water in coastal areas, ecological imbalance and possible land subsidence. There has been evidence of permanent lowering of groundwater levels in some locations, particularly in the Dhaka metropolitan area where the average annual decline in the groundwater level is about 3 m (BADC, 2006) and in the northwest region of the country.

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 occurs 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 2016 contains statistical analyses of various water quality parameters of different rivers of the country for the period from January to December 2016. 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 on groundwater, lake and hotel/restaurant's water quality. 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
(Additional Secretary)
Director (NRM and Research)

EDITORIAL NOTES

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact, and drinking water. 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 2016. 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 (Dhaka Lab)

ACKNOWLEDGEMENT

Water pollution affects the entire biosphere of plants and organisms living in these water bodies, as well as organisms and plants that might be exposed to the water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

The River Water Quality Report 2016 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 could not be done 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 (Dhaka Lab) 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

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. 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.

The Department of Environment (DoE) has been monitoring surface and ground water quality since 1973. The surface water quality-monitoring programme of DoE is supposed to include 66 stations of 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, Jumuna, Dhaleshwari, Surma, Korotoa etc. was found within the limit of Environmental Quality Standards (EQS) in 2016 while rivers around greater Dhaka were highly polluted specially in the first four months of 2016 in terms of DO, BOD and COD value. DO was almost zero from January to April at different location of Buriganga, Shitalakhya and Turag River. High levels of Turbidity (120 mg/l), TDS (586 mg/l), BOD (50.20 mg/l) and COD (212.62 mg/l) were found in Buriganga river from January to December in 2016. In Meghna DO and BOD level were found within the EQS which varied from 0.8 to 7.1 mg/l and 0.2 to 8.4 mg/l, respectively. In Jamuna DO and BOD levels were found from 4.6 to 8.5 mg/l and 1.2 to 4.2 mg/l, respectively.

High levels of Chloride, TDS and Turbidity were found in Moyuri, Rupsha, Pashur and Kakshiali River. Highest level of Chloride (7228 mg/l) and TDS (11521 mg/l) were found in Pashur river. Highest value of Turbidity (124.46 NTU) was found in Kakshiali river. High COD (516 mg/l) was found in Karnapuli river.

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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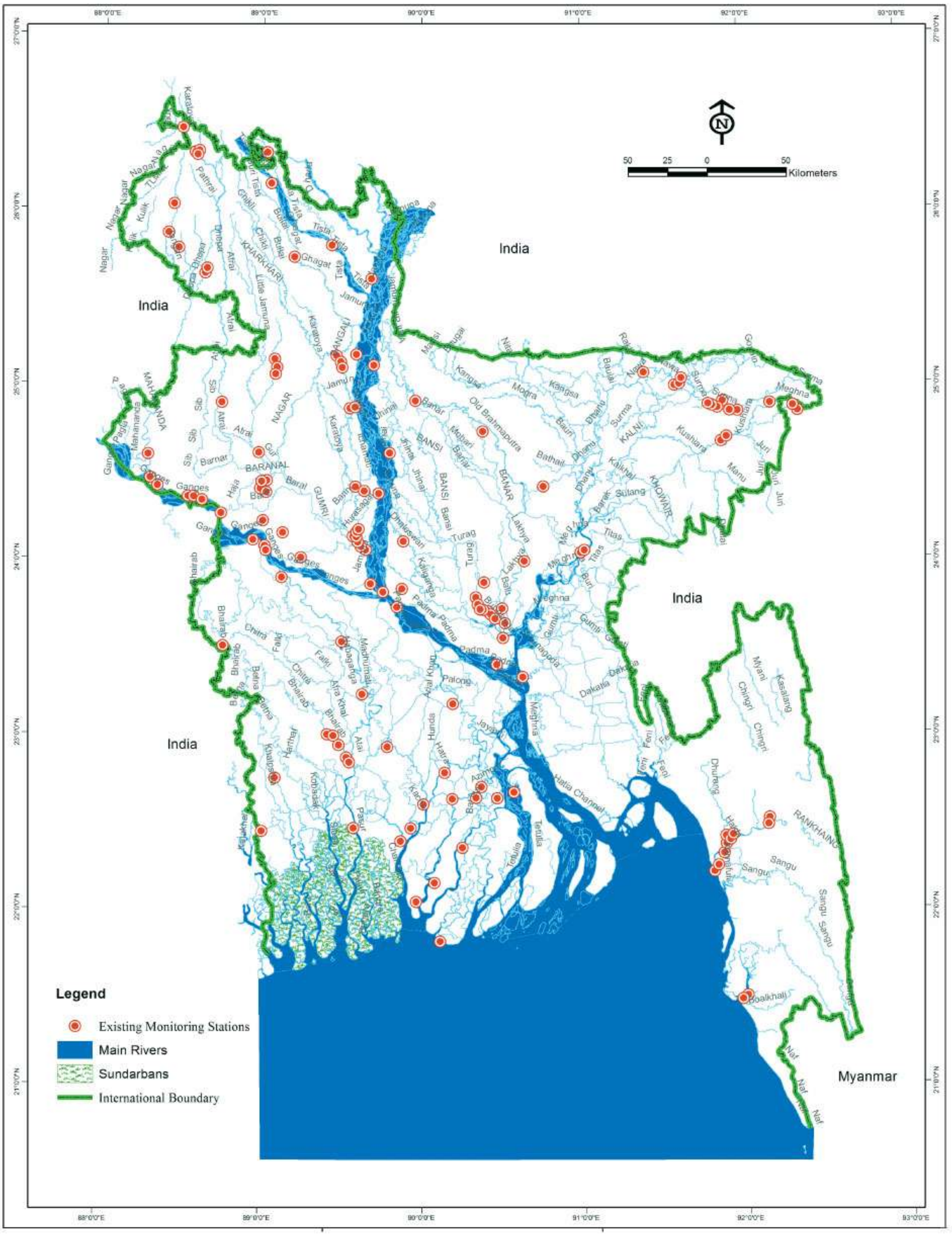
ABBREVIATIONS

BOD-	Biochemical Oxygen Demand
COD-	Chemical Oxygen Demand
TDS-	Total Dissolved Oxygen
EC-	Electrical Conductivity
ECA-	Ecologically Critical Area
ECR-	Environmental Conservation Rules
DO-	Dissolved Oxygen
SS-	Suspended Solids
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

Map of Existing Monitoring Station of DoE



CHAPTER 1: INTRODUCTION

1.1 Background

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. Monitoring 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 Environmental Quality Standerd (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.

Threr are about 700 rivers in Bangladesh. 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 wastes, 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.

DoE has established a monitoring network. Following this network for surface water quality, 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 2016, 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 information for research/study in the relevant field.
- 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.
- To provide water quality data to Global Environment Monitoring System (GEMS).
- Sensitization and awareness building among the stakeholders and public in general
- Information sharing and preparation of State of the Environment (SoE) Report.

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 from January to December 2016. The following are the limitations of the report:

- In some cases, data on all the parameters as per ECR 1997, for the entire period of the year 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 unavail able.

CHAPTER 2: AN OVERVIEW OF BANGLADESH'S RIVERS

Rivers of Bangladesh

The rivers of Bangladesh greatly linked with the lives and livelihood of the people and their culture. They are part of our heritage. They generally flow from north to south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overexploting soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and cause hardship to the people.

Rivers are the most important elements of physiographic features of Bangladesh and play a crutial role in the economy. 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 number and size from the northwest to the southeastern region.

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

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

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

The rivers of Bangladesh greatly linked with the lives and livelihood of the people and their culture. They are part of our heritage. They generally flow from north to south. The large rivers serve as the main source of water for cultivation and as the principle arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overexploited soil. The rivers also drain excess monsoon rainfall in the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and cause hardship to the people.

The profusion of rivers can be divided into five major networks. The Jamuna-Brahmaputra system is 292 kilometres long and extends from northern Bangladesh to its confluence with the Padma.

Originating as the Yarlung Tsangpo River in China's Xizang Autonomous Region (Tibet) and flowing through India's state of Arunachal Pradesh, where it becomes known as the Brahmaputra ("Son of Brahma"), it receives waters from five major tributaries that total is some 740 kilometres in length. At the point where the Brahmaputra meets the Tista River in Bangladesh, it becomes known as the Jamuna. The Jamuna is notorious for its shifting subchannels and for the formation of fertile silt islands (chars). No permanent settlements can exist along its banks.

The second system is the Padma-Ganges, which is divided into two sections: a 258 kilometres segment, the Ganges, which extends from the western border with India to its confluence with the Jamuna some 72 kilometres west of Dhaka, and a 126 kilometres segment, the Padma, which runs from the Ganges-Jamuna confluence to where it joins with the Meghna River at Chandpur. The Padma-Ganges is the central part of a deltaic river system with hundreds of rivers and streams-some 2,100 kilometres in length-flowing generally east or west into the Padma.

The third network is the Surma-Meghna River System, which courses from the northeastern border with India to Chandpur, where it joins with the Padma. The Surma-Meghna, at 669 kilometres by itself the longest river in Bangladesh, is formed by the union of six smaller rivers. Down the city of Kalipur, it is known as the Meghna. When the Padma and Meghna join together, they form the fourth river system-the Padma-Meghna-which flows 145 kilometres to the Bay of Bengal.

This mighty network of four river systems flowing through the Bangladesh Plain drains an area of some 1.5 million square kilometres. The numerous channels of the Padma-Meghna, its distributaries, and smaller parallel rivers that flow into the Bay of Bengal are referred to as the Mouths of the Ganges. Like the Jamuna, the Padma-Meghna and other estuaries on the Bay of Bengal are also known for their many chars.

A fifth river system, unconnected to the other four, is the Karnaphuli. Flowing through the region of Chittagong and the Chittagong Hills, it cuts across the hills and runs rapidly downhill to the west and southwest and then to the sea. The Feni, Karnaphuli, Sangu, and Matamuhari-an aggregate of some 420 kilometres- are the main rivers in the region. The port of Chittagong is situated on the banks of the Karnaphuli.

CHAPTER 3: MEASUREMENT OF RIVER WATER QUALITY

3.1 Water Quality Parameters

Water quality testing is an important part of environmental monitoring. When water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well.

These sections detail all of the parameters that affect the quality of water in the environment. These properties can be physical, chemical or biological factors. Physical properties of water quality include temperature and turbidity. Chemical characteristics involve parameters such as pH and dissolved oxygen. Biological indicators of water quality include algae and phytoplankton. These parameters are relevant not only to surface water studies of the ocean, lakes and rivers, but to groundwater and industrial processes as well.

Water quality monitoring can help researchers predict and learn from natural processes in the environment and determine human impacts on an ecosystem. These measurement efforts can also assist in restoration projects or ensure environmental standards are being met.

A comprehensive range of physico-chemical parameters like Temperature, Electrical Conductivity (EC), Dissolved Oxygen (DO), pH, Total Alkalinity, Turbidity, Total Dissolved Solid (TDS), Suspended Solid (SS), Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD) measured to assess the inland surface water quality in Bangladesh.

3.2 Methods of Analysis

While the details of sampling, testing and analysis are beyond the scope of this handbook, what follows is a general description of the significance of water quality tests usually made. Testing procedures and parameters may be grouped into physical, chemical, bacteriological and microscopic categories.

- Physical tests indicate properties detectable by the senses.
- Chemical tests determine the amounts of mineral and organic substances that affect water quality.
- Bacteriological tests show the presence of bacteria, characteristic of faecal pollution.

3.2.1 Physical tests

Colour, turbidity, total solids, dissolved solids, suspended solids, odour and taste are recorded. Colour in water may be caused by the presence of minerals such as iron and manganese or by substances of vegetable origin such as algae and weeds. Colour tests indicate the efficacy of the water treatment system.

Turbidity in water is because of suspended solids and colloidal matter. It may be due to eroded soil caused by dredging or due to the growth of micro-organisms. High turbidity makes filtration expensive. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection. Odour and taste are associated with the presence of living microscopic organisms; or decaying organic matter including weeds, algae; or industrial wastes containing ammonia, phenols, halogens, hydrocarbons. This taste is imparted to fish, rendering them unpalatable. While chlorination dilutes odour and taste caused by some contaminants,

it generates a foul odour itself when added to waters polluted with detergents, algae and some other wastes.

3.2.2 Chemical tests

pH, hardness, presence of a selected group of chemical parameters, biocides, highly toxic chemicals, and B.O.D are estimated.

pH is a measure of hydrogen ion concentration. It is an indicator of relative acidity or alkalinity of water. Values of 9.5 and above indicate high alkalinity while values of 3 and below indicate acidity. Low pH values help in effective chlorination but cause problems with corrosion. Values below 4 generally do not support living organisms in the marine environment. Drinking water should have a pH between 6.5 and 8.5.

BOD.: It denotes the amount of oxygen needed by micro-organisms for stabilization of decomposable organic matter under aerobic conditions. High B.O.D. means that there is less of oxygen to support life and indicates organic pollution.

3.2.3 Bacteriological tests

For technical and economic reasons, analytical procedures for the detection of harmful organisms are impractical for routine water quality surveillance. It must be appreciated that all that bacteriological analysis can prove is that, at the time of examination, contamination or bacteria indicative of faecal pollution, could or could not be demonstrated in a given sample of water using specified culture methods. In addition, the results of routine bacteriological examination must always be interpreted in the light of a thorough knowledge of the water supplies, including their source, treatment, and distribution.

Modified Winkler's Method was used to analyze DO, Dilution Method for BOD5, Closed Reflux Colorimetric Method for COD, Argentometric Methods for Chloride and Gravimetric Methods for TDS 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 2016

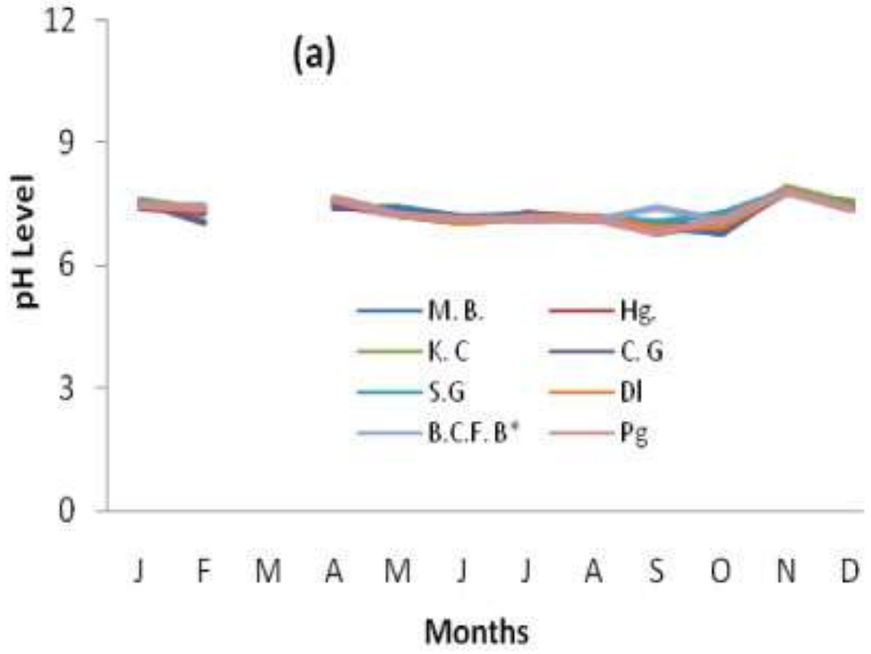
4.1 Buriganga River

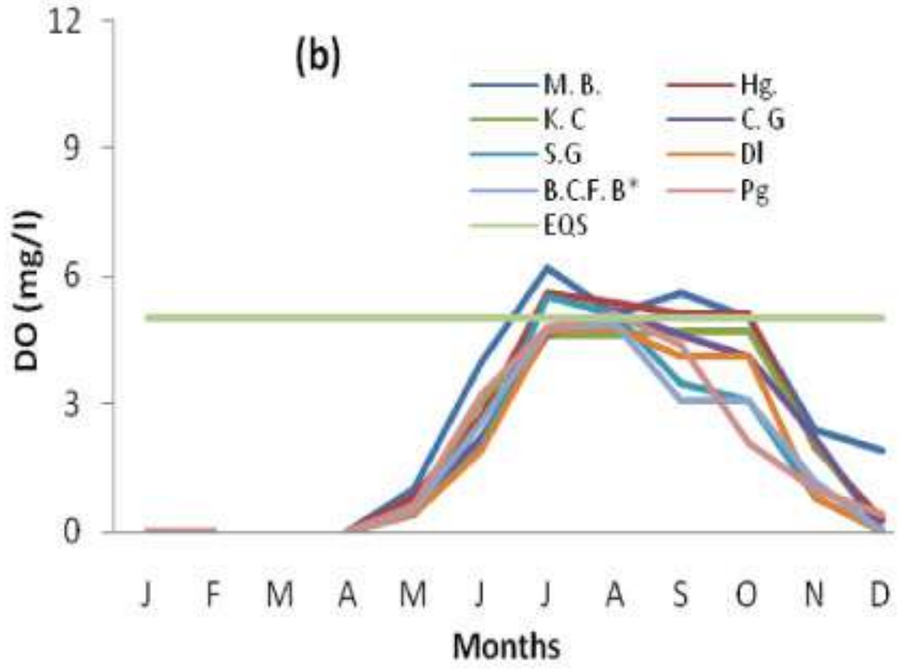
To monitor water quality of Buriganga river, samples were collected from eight different locations viz. Mirpur Bridge (M B), Hazaribag (Hg), Kamrangir Char (K C), Chandni Ghat (C G), Sadar Ghat (S G), Dholaikhal (DL), Bangladesh China Friendship Bridge (BCFB) and Pagla (Pa) along the river.

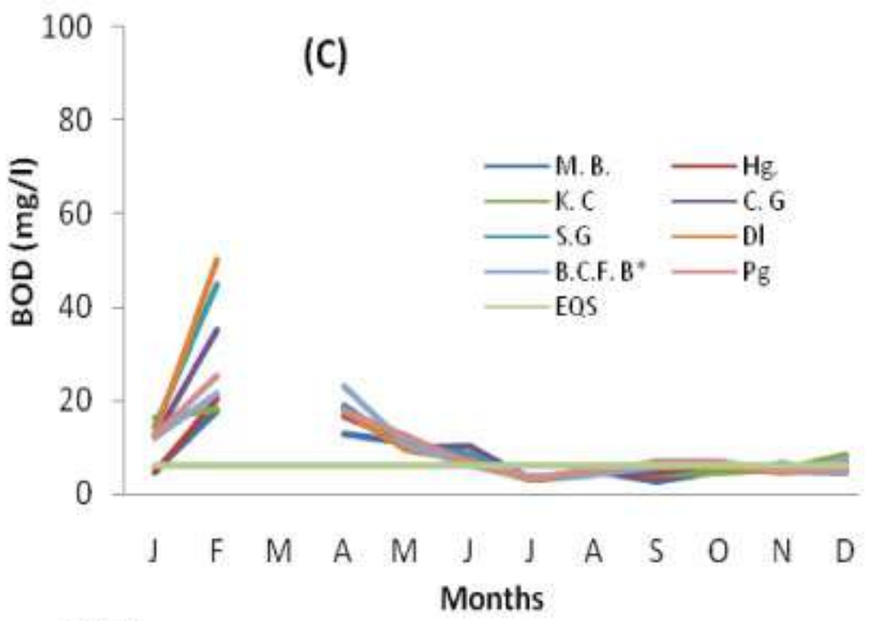
In 2016, pH among different locations varied from 6.78 to 7.89 (Fig.1a) while standard pH range for inland surface water for fisheries is 6.5 to 8.5. In 2015, pH range varied from 6.58 to 7.98. In 2016. the maximum DO (6.2 mg/l) was found at Mirpur Bridge in July and the minimum (0.0 mg/l) was at all locations from January to April (Fig.1b). Direct discharge of untreated effluent from industries, reduced flow of river water, municipal wastes and tannery wastes into the river 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 2015, DO level varied from 0.0 mg/l to 5.7 mg/l.

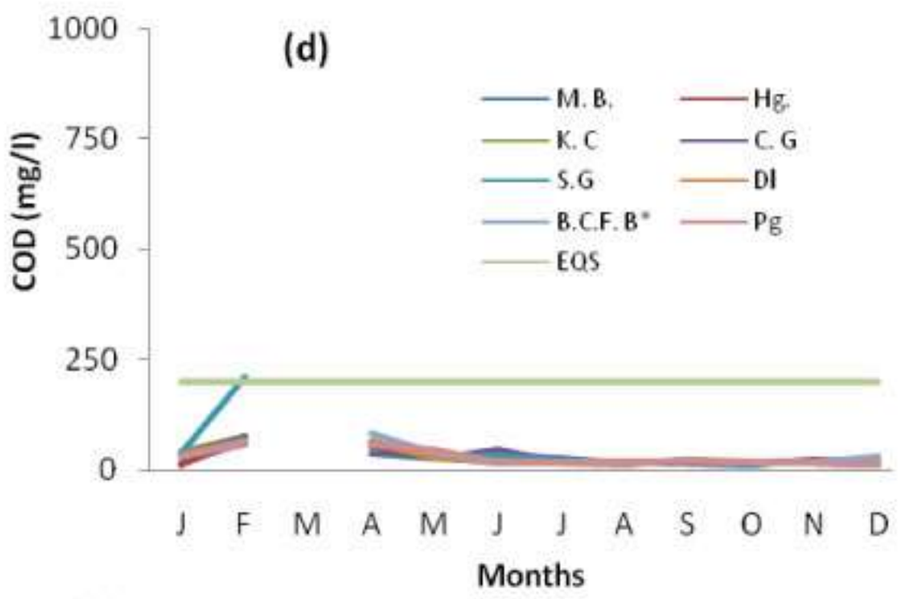
In 2016, BOD of Buriganga river water was higher than EQS ($\leq$6 mg/l). The maximum BOD (50.2 mg/l) was found at Dholaikhal Point in Fabruary and the minimum (2.6 mg/l) was at Mirpur Bridge in September (Fig.1c). In 2015, BOD range was 0.6 to 35 mg/l. In 2016, COD level was mostly below the EQS (200 mg/l) set for industrial wastewater after treatment. The maximum and the minimum COD concentration of Buriganga river was 212.62 mg/l at Sadar Ghat in February and 10 mg/l at Pagla point in December (Fig.1d). In 2015, COD varied from 4.83 mg/l to 124.3 mg/l.

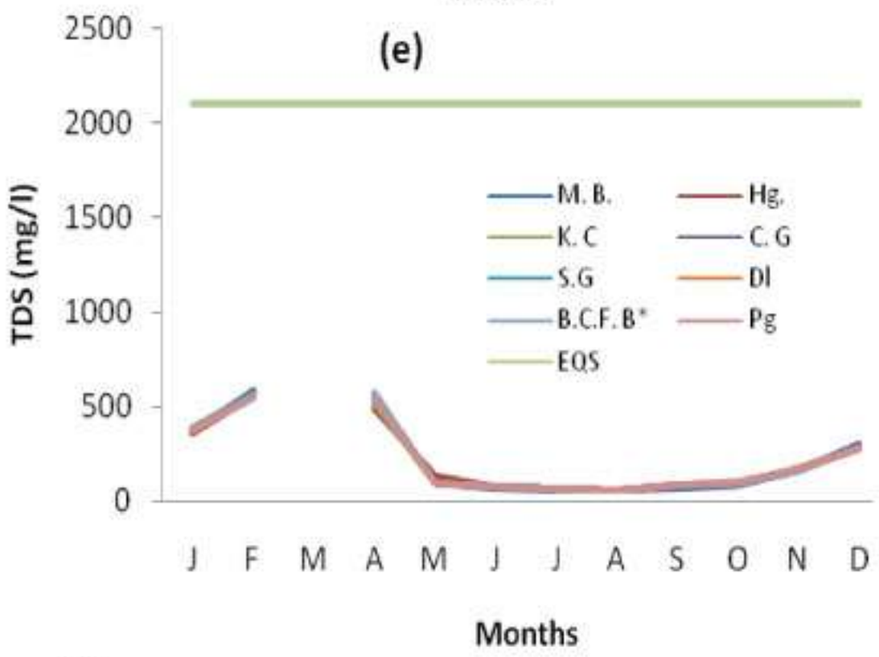
In 2016, TDS of Buriganga river varied from 56.2 to 586 mg/l (Fig.1e) against the EQS of 2100 mg/l for industrial wastewater after treatment. In 2015, TDS concentration varied from 60.9 to 639 mg/l. In 2016, Chloride concentration of the Buriganga river was below the EQS for industrial wastewater after treatment. The maximum concentration was 56.98 mg/l at Sadar Ghat point in February and the minimum 5.98 mg/l at Kamrangir Char in June (Fig.1f). In 2015, Chloride concentration varied from 5.9 mg/l to 135.6 mg/l. In 2016, the maximum and the minimum Turbidity of Buriganga river water was 120 mg/l at Mirpur Bridge in February and 3.6 mg/l at Pagla point in December while EQS is 10 NTU (Fig.1g). In 2015, Turbidity range varied from 4.9 to 250 NTU.

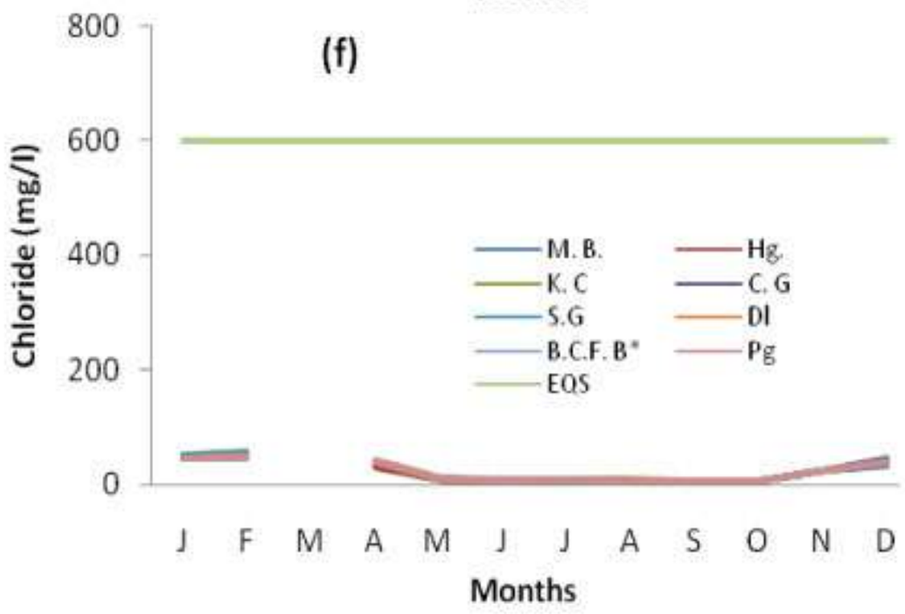












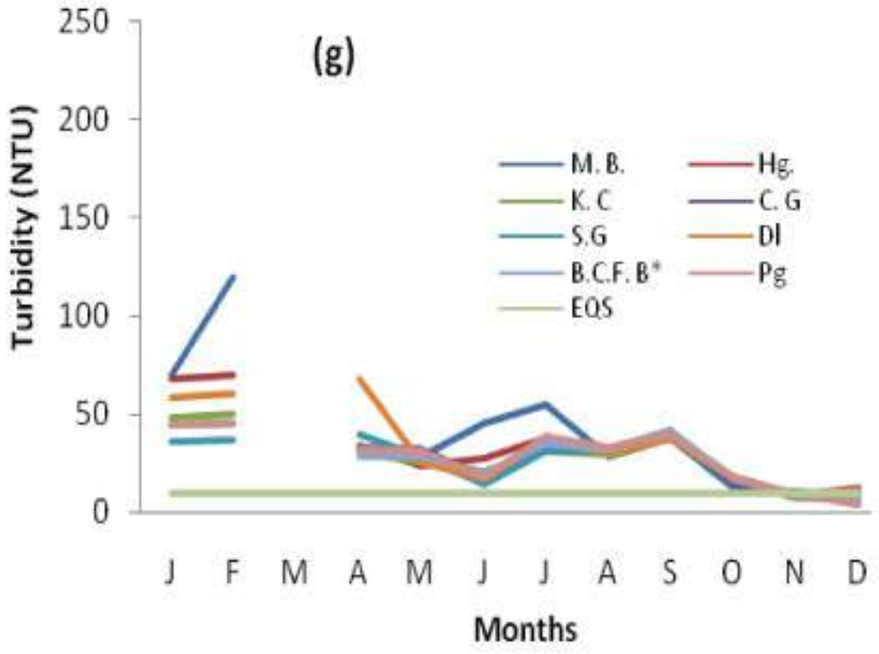


Fig.1. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Buriganga River in 2016

Table-1. Total Alkalinity of Buriganga River Water in 2016

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	144	148	-	108	52	**40**	42	44	50	70	140	104
Hazaribag	142	146	-	114	50	48	40	46	48	72	148	158
Kamrangir Char	154	57.33	-	124	64	46	44	44	52	68	152	162
Chandni Ghat	148	77.06	-	168	48	44	46	42	54	58	160	180
Sadar Ghat	150	76.44	-	178	52	42	48	40	56	62	158	168
Dholaikhal	146	**212.62**	-	160	58	48	46	42	54	64	152	164
Pagla	144	64.5	-	166	54	44	48	48	54	72	154	166
B.C.F. Bridge	148	66.89	-	150	56	48	46	44	54	68	154	170
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, the maximum and the minimum Total Alkalinity of Buriganga river water was 212.62 mg/l at Dholaikhal in February and 40 mg/l at Mirpur Bridge in June (Table-1). In 2015, Total Alkalinity varied from 44 mg/l to 344 mg/l.

Table-2. Electrical Conductivity (EC) of Buriganga river water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	720	1156	-	1078	176.4	123.8	**107.5**	110.8	162.8	182.2	324	530
Hazaribag	712	1109	-	980	250	141.4	116.6	114.4	178.2	187.3	314	552
Kamrangir Char	748	1096	-	1020	183	142.8	118	116	168.4	177.5	321	549
Chandni Ghat	740	**1182**	-	1100	188	143.2	119.2	121	152.4	188.2	317	585
Sadar Ghat	750	1130	-	1120	198	140.9	116.6	118.2	166.2	194.2	324	550
Dholaikhal	746	1104	-	1130	190	142.5	123.5	122.3	172.8	189.4	328	550
Pagla	746	1110		1080	188	151	117.5	114.8	172	225	320	562
B.C.F. Bridge	748	1101	-	1150	184	146.1	121.1	112.4	176.2	187.9	310	562
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC of Buriganga river water was 1182 µmhos/cm in February at Chandni Ghat and 107.50 µmhos/cm in July at Mirpur Bridge (Table-2). In 2015, EC varied from 125.10 µmhos/cm to 1238 µmhos/cm.

Table-3. Suspended Solid (SS) of Buriganga River Water in 2016

Sampling Locations	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mirpur Bridge	34	26	-	45	25	34	61	45	46	22	25	13
Hazaribag	32	25	-	55	27	20	40	60	52	25	18	38
Kamrangir Char	40	17	-	40	28	12	44	58	44	23	22	37
Chandni Ghat	42	14	-	43	32	42	42	48	46	27	24	47
Sadar Ghat	40	23	-	47	34	**4**	39	48	48	28	28	15
Dholaikhal	38	32	-	**80**	32	19	42	46	46	22	30	46
Pagla	36	18	-	51	38	13	41	48	48	27	28	42
B.C.F. Bridge	36	26	-	44	36	12	46	48	48	25	24	41
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, SS of Buriganga river water at different locations was below the EQS (150 mg/l) for wastewater after treatment from industrial units. The maximum and the minimum SS was 80 mg/l in April at Dholaikhal and 4 mg/l in June at Sadar Ghat (Table-3). In 2015, SS varied from 12 mg/l to 100 mg/l.

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 (DG), Ghorasal Fertilizer Factory (GFF) and near ACI factory at Narayanganj.

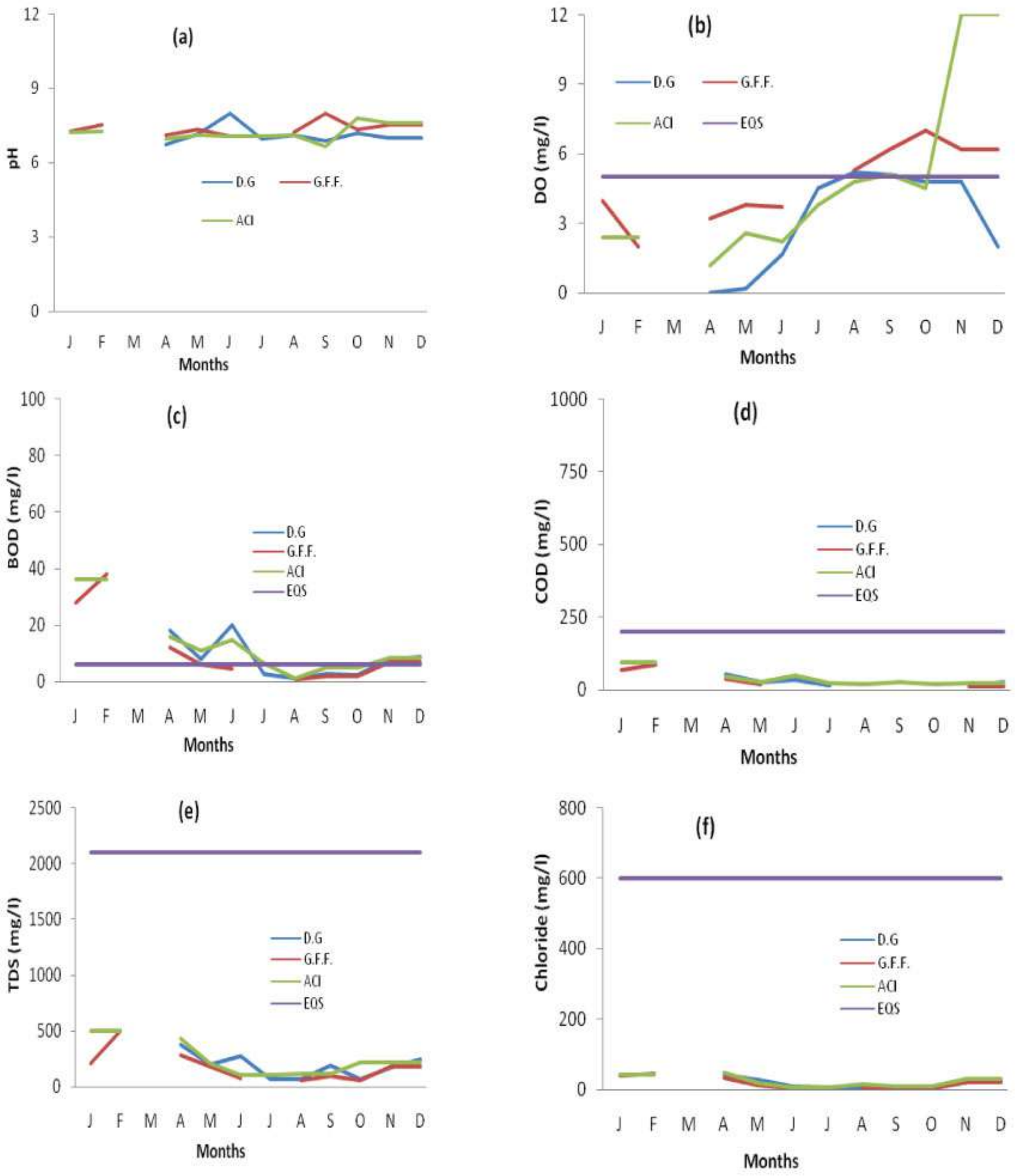


Fig.2. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Shitalakhya River in 2016

In 2016, pH of Shitalakhya river water was within the EQS (6.5-8.5) range for inland surface water. The maximum pH was 7.98 in June at Dhamra Ghat and the minimum PH was 6.66 in September near ACI Factory (Fig.2a). In 2015, pH varied from 6.66 to 7.97. In 2016, the maximum DO (12.0 mg/l) was found at near ACI Factory in November and the minimum (0.0 mg/l) was found at Demra Ghat in April (Fig.2b). In 2015, DO varied from 0.0 to 5.5 mg/l.

In 2016, BOD at Demra Ghat was very high during dry period and was above the EQS ($\leq$6 mg/l) for fisheries. Highest value of BOD (38 mg/l) was found near Ghorasal Fertilizer Factory in February and lowest (0.8 mg/l) was in August respectively (Fig.2c). In 2015, BOD concentration varied from 0.8 mg/l to 18 mg/l. In 2016, 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 (94 mg/l) was at near ACI Factory in January and the minimum COD (10 mg/l) was at near Ghorasal Fertilizer Factory in November (Fig.2d). In 2015, COD level varied from 7.25 mg/l to 69.28 mg/l. In 2016, TDS of Shitalakhya river water varied from 107.90 to 498 mg/l against the EQS (2100 mg/l) for wastewater after treatment from industrial units. In dry season maximum TDS (498 mg/l) was at near ACI Factory and the minimum (107.9 mg/l) in June at near ACI Factory (Fig.2e). In 2015, TDS range was from 48.5 to 484.2 mg/l. In 2016, Chloride concentration of the Shitalakhya river water was below the EQS (600 mg/l) for wastewater after treatment from industrial units. The maximum Chloride (48.9 mg/l) was found at near ACI Factory in April and the minimum was 4.0 mg/l at near G.F.F in October (Fig.-2f). In 2015, Chloride concentration varied from 4.0 mg/l to 35.98 mg/l.

Table-4. Suspended Solid (SS) of Shitalakhya River Water in 2016

Sampling Locations	SS (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demra Ghat	-	-	-	42	22	1.4	41	**89**	40	34	18	28
Ghorashal F.F.	10	**4**	-	38	24	28	-	38	38	40	22	22
Near ACI Factory	18	18	-	58	32	8	46	47	42	48	30	30
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, SS of Shitalakhya river water at different sampling locations was within the EQS (150 mg/l). Maximum SS concentration of Shitalakhya river was 89 mg/l Demra Ghat in August and the minimum was 4.0 mg/l in February at Ghorasal Fertilizer Factory (Table-4). In 2015, SS varied from 12 mg/l to 76 mg/l.

Table-5. Electrical Conductivity (EC) of Shitalakhya River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demra Ghat	-	-	-	741	385	581	**6147**	142	373	141	326	470
Ghorashal F.F.	480	990	-	560	362	143.4	-	**116.8**	185	120	359	359
Near ACI Fty.	990	990	-	864	423	234	237	236	238	468	406	406
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, 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 (6147 µmhoms/cm) was at Demra Ghat in July and the minimum EC (116.8 µmho/cm) was at Ghorasal Fertilizer Factory in August. In 2015, EC varied from 108.40 µmhos/cm to 930 µmhos/cm.

Table-6. Total alkalinity of Shitalakhya River Water in 2016

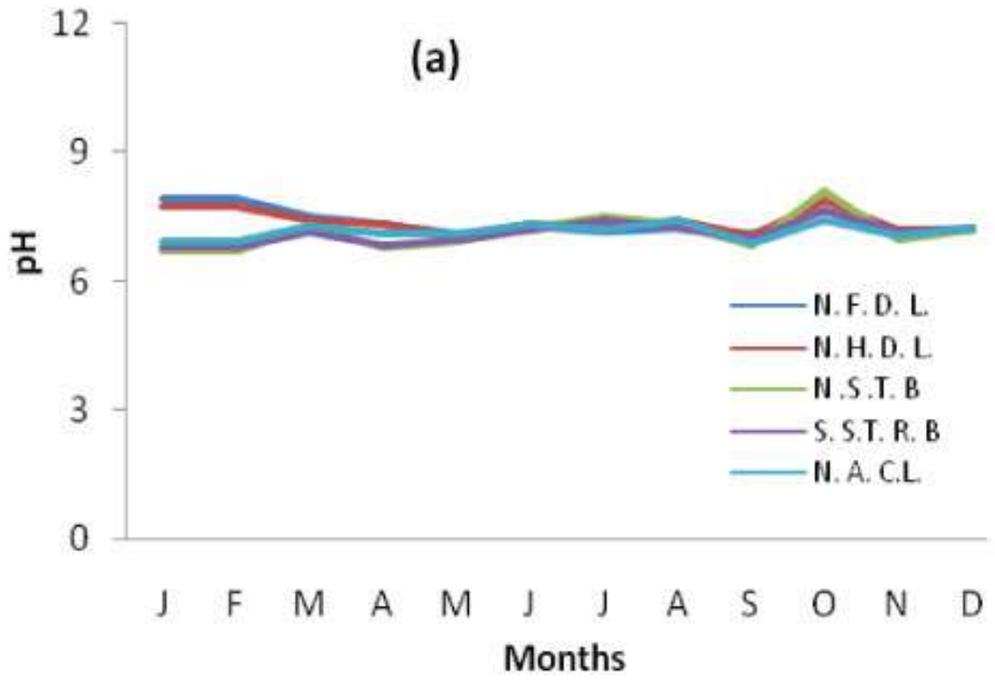
Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demra Ghat	-	-	-	160	120	38	80	**22**	58	70	60	120
Ghorashal F.F.	124	142	-	80	108	41	-	38	44	50	70	70
Near ACI Factory	138	138	-	**164**	130	60	80	42	52	78	110	110
EQS for wastewater after treatment from industrial units 150 mg/l												

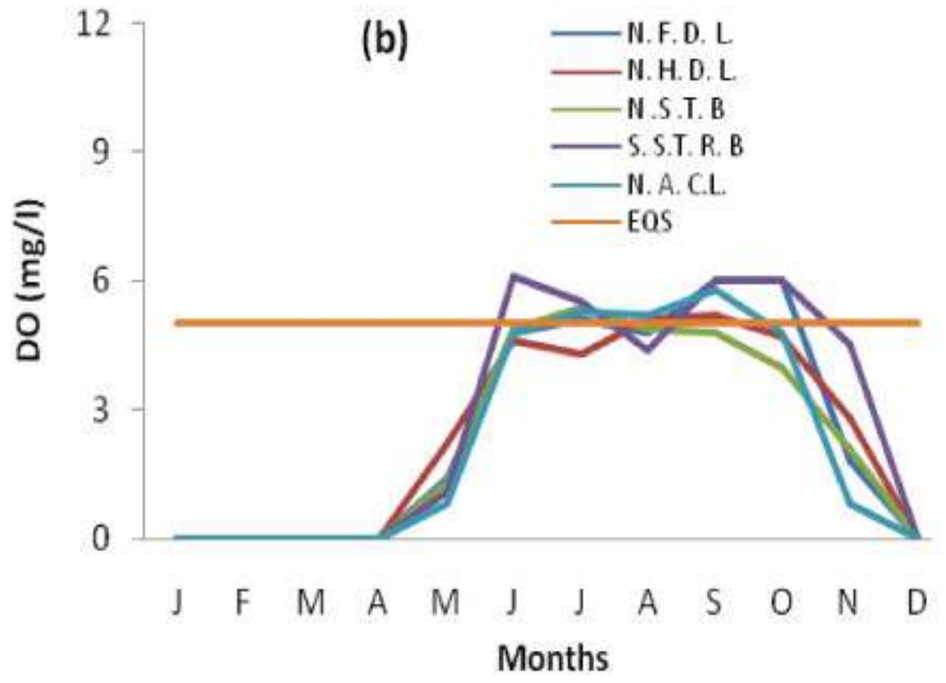
In 2016, Maximum Total Alkalinity (164 mg/l) was at near ACI Factory in April and that of minimum was (22 mg/l) at Demra Ghat in August (Table-6). In 2015, Total Alkalinity varied from 32 mg/l to 170 mg/l.

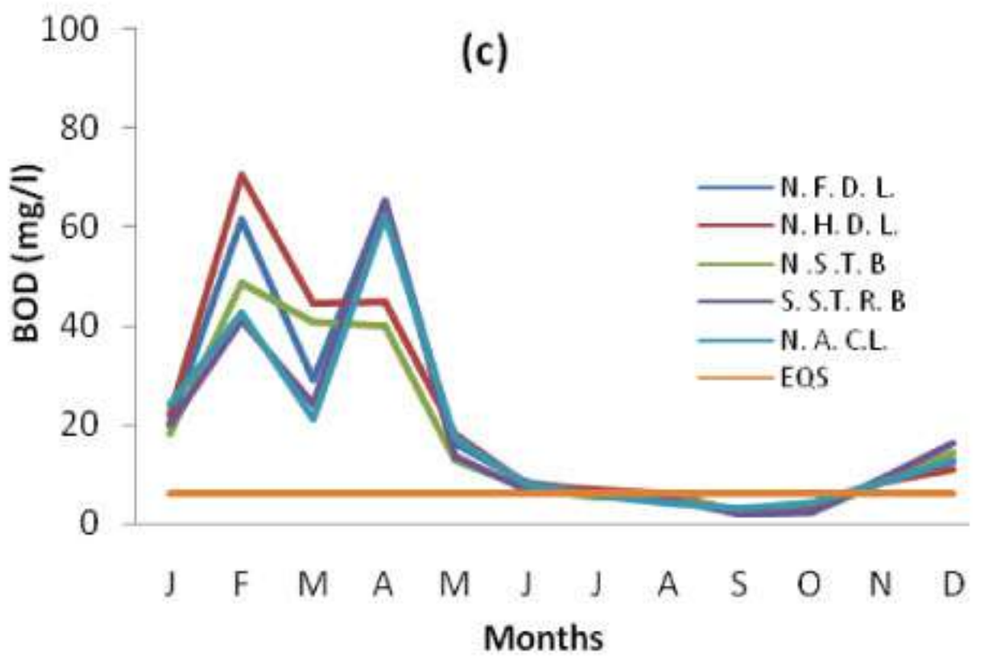
4.3 Turag River

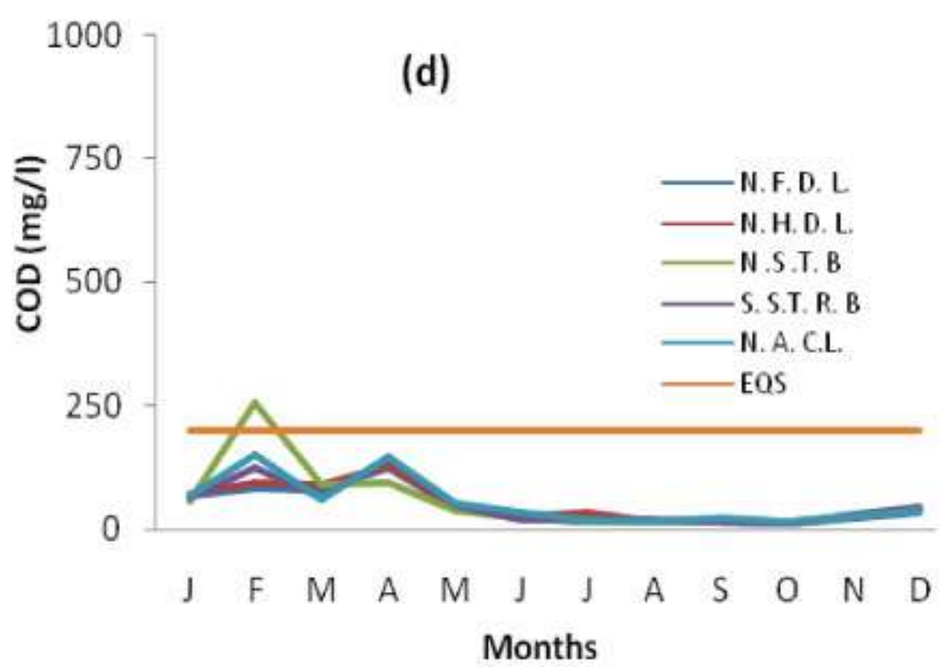
The Turag river is the upper tributary of the Buriganga. To monitor water quality in 2016, water samples were collected from five locations such as near Fulpukuria Dyeing Ltd. (FDL), near Hossain Dyeing Ltd. (HDL), North Side of Tongi Rail Bridge (NSTRB), South Side of Tongi Rail Bridge (SSTRB) and near Azmeri Composite Ltd. (ACL).

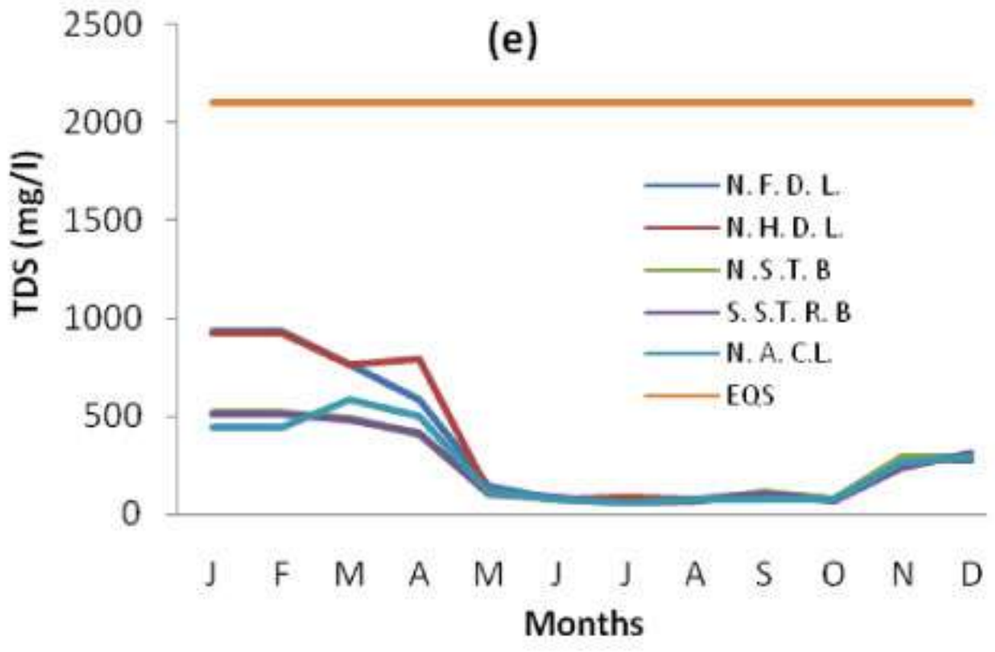
In 2016, the pH range (6.68- 8.11) (Fig.3a) of Turag river was within EQS (6.5 -8.5). The maximum pH 8.11 NSTRB was found in Octaber and the minimum pH 6.68 was found in February at the same location. In 2015, pH range was 6.14- 8.79. In 2016, DO concentration of Turag river water was very low during dry season. The maximum DO (6.1 mg/l) found at SSTRB in June and the minimum DO (0.0) mg/l was found in December to April at the all locations. (Fig.3b). In 2015, DO was varied from 0.0 to 5.9. In 2016, BOD of Turag river water was beyond the EQS ($\leq$6 mg/l) for all sampling locations. The maximum BOD was 70.3 mg/l in February at HDL and the minimum was 1.8 mg/l in September at FDL (Fig.-3c). In 2015, BOD varied from 1.0 mg/l to 86 mg/l. In 2016, COD at almost 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 258.01 mg/l at NSTRB in February and 10 mg/l at FDL in October (Fig.-3d). In 2015, COD range was from 17 mg/l to 233 mg/l. In 2016, TDS was below the EQS (2100 mg/l) for wastewater after treatment from industrial units (Fig.-3e) at all the sampling points. The maximum TDS was 930 mg/l in February at HDL while that of minimum was 56 in July at ACL In 2015, TDS varied from 52.6 mg/l to 804 mg/l. In 2016, Chloride content of Turag river water was below the EQS (600 mg/l). The maximum Chloride was (119.7 mg/l) found in April at HDL and the minimum Chloride was (6.0 mg/l) in October at all sampling locations (Fig.-3f). In 2015, Chloride varied from 7.86 mg/l to 129.7 mg/l.











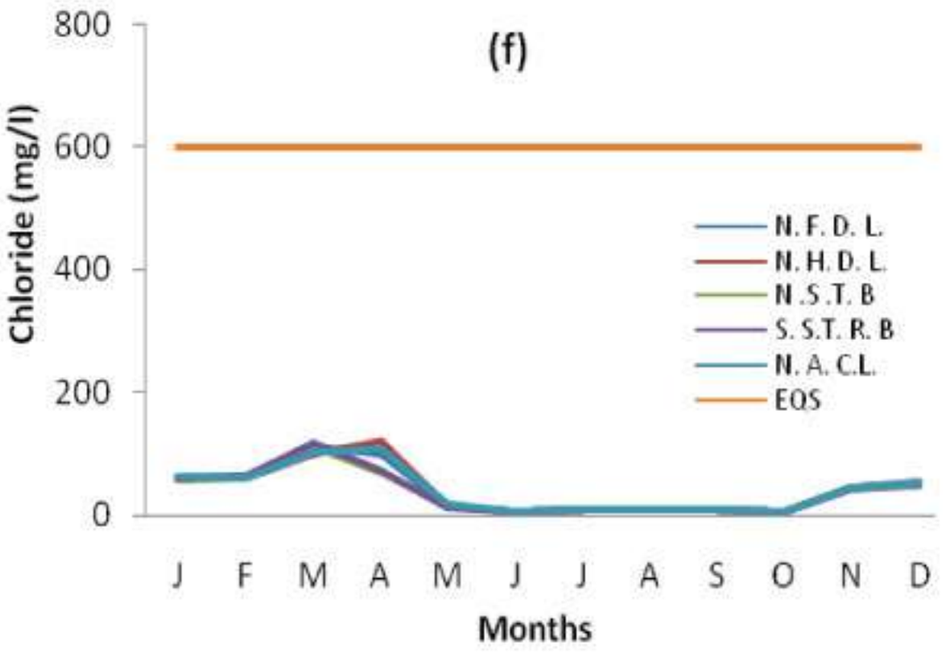


Fig.3. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Turag River in 2016

Table-7. Total Alkalinity of Turag River Water in 2016

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fulpukuria Dyeing Ltd. (FDL)	140	142	**450**	270	76	42	**38**	40	82	62	170	110
Hossain Dyeing Ltd. (HDL)	104	108	410	276	74	44	40	42	80	64	172	110
North Side Tongi Rail Bridge (NSTRB)	120	118	350	266	68	46	42	44	78	68	168	120
South Side Tongi Rail Bridge (SSTRB)	116	120	340	260	78	42	40	44	78	64	178	100
Azmeri Composite Ltd. (ACL)	108	110	380	268	76	44	42	46	80	62	172	110
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, the maximum Total Alkalinity (450 mg/l) was at FDL in March and the minimum (38 mg/l) in July respectively (Table-7). In 2015, Total Alkalinity varied from 42 mg/l to 280 mg/l.

Table-8. EC of Turag River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fulpukuria Dyeing Ltd. (FDL)	**1767**	1767	1425	1172	274	156	148	146.2	202.5	153.7	540	540
Hossain Dyeing Ltd. (HDL)	1750	1750	1424	1582	224	154	160	148.2	156.1	154	530	560
North Side Tongi Rail Bridge (NSTRB)	1007	1007	920	803	208.4	155.4	119	144.8	229	152	552	580
South Side Tongi Rail Bridge (SSTRB)	993	993	918	853	214	171. 9	120	142.3	224	153	492	310
Azmeri Composite Ltd. (ACL)	857	857	1091	1002	218	168.4	**118**	144.8	159.2	173	499	580
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum EC (1767 µmhos/cm) was in January at FDL and the minimum (118 µmhos/cm) was in July (Table-8) at ACL. In 2015, EC varied from 100 µmhos/cm to 1682 µmhos/cm.

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 2016, Dhaleshwari river water was almost neutral and pH varied from 7.0 to 7.86 (Fig.-4a). In 2015, pH level varied from 6.7 to 8.78. In 2016, the maximum DO concentration (7.5 mg/l) was at Harindhara in May and the minimum (0.8 mg/l) at Muktarpur Ghat in February (Fig.4b). In 2015, DO concentration varied from 0.0 to 20.4 mg/l.

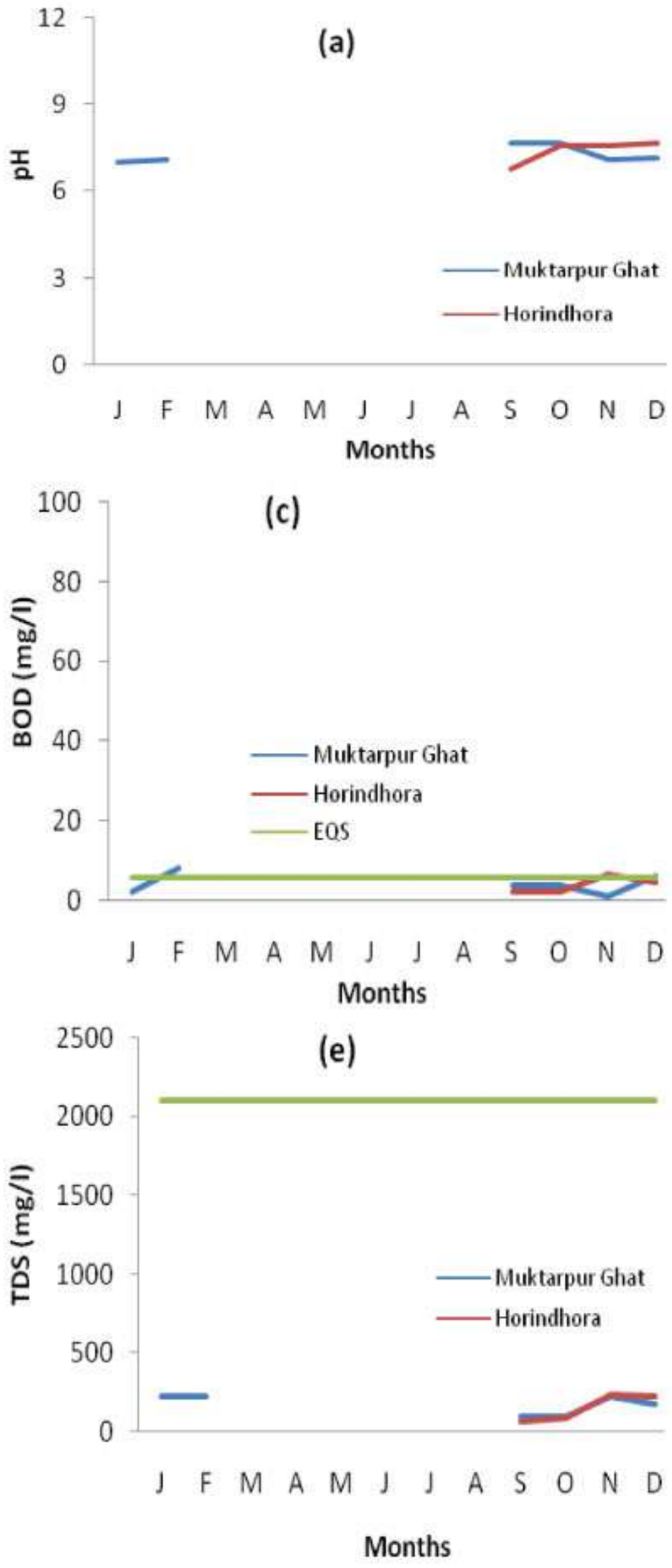


Fig.4. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Dhaleshwari River in 2016

In 2016, BOD varied from 1.2 to 8.4 mg/l (Fig.4c) while EQS for fisheries is ≤6 mg/l. In 2015, BOD varied from 0.8 to 17.0 mg/l. Level of COD of Dhaleshwari river water was within the EQS. The maximum COD of Dhaleshwari river water was 30 mg/l in November at Muktarpur Ghat and the minimum was 14 mg/l in December at the same location (Fig.4d) against the EQS (200 mg/l) for wastewater after treatment from industrial units. In 2015, COD varied from 24.15 to 53 mg/l. In 2016, TDS concentration varied from 64.2 to 234 mg/l (Fig.4e) while standard TDS level is 2100 mg/l for wastewater after treatment from industrial units. In 2015, TDS varied from 64.80 to 476 mg/l. In 2016, Chloride concentration ranged from 5 to 38 mg/l (Fig.4f), which is far below the EQS (600 mg/l) for wastewater after treatment from industrial units. In 2015, Chloride concentration range of Dhaleshwari river water was from 5 to 238 mg/l.

Table-9. Total alkalinity of Dhaleshwari River Water in 2016

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshigonj	80	84	-	-	-	-	-	-	60	60	50	**110**
Horindhora, Hemayetpur, Saver, Dhaka	-	-	-	-	**22**	-	-	-	48	40	70	80
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, the maximum Total Alkalinity of Dhaleshwari river water was 110 mg/l in December at Muktarpur Ghat and the minimum was 22 mg/l in May at Horindhora (Table-9). In 2015, Total Alkalinity of Dhaleshwari river water was from 38 to 476 mg/l.

Table-10. EC of Dhaleshwari River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Muktarpur Ghat, Munshiganj	443	**452**	-	-	-	-	-	-	183.1	183.1	224	306
Harindhara, Hemayetpur, Saver, Dhaka	-	-	-	-	181.2	-	-	-	**143.3**	170	234	431
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, Electrical Conductivity (EC) of Dhaleshwari river water at different locations was mostly within the EQS (1200 µmhos/cm). The maximum and the minimum EC of Dhaleshwari river water was 452 µmhos/cm in February and 143.3 µmhos/cm in September at Harindhara (Table-10). In 2015, EC of Dhaleshwari river water was from 150.90 µmhos/cm to 992 µmhos/cm.

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 2016, pH level of Brahmaputra river water varied from 7.18 to 7.78 (Fig.5a), while standard range for fisheries is 6.5 to 8.5. In 2015, pH level varied from 7.08 to 7.95. In 2016, DO concentration varied from 5.8 to 7.6 mg/l (Fig.5b). The highest and the lowest DO was found in January and September respectively, while EQS for DO for fisheries is $\geq$5 mg/l. In 2015, DO varied from 6.4 to 7.5 mg/l. In 2016, BOD concentration varied from 1.0 to 2.2 mg/l (Fig.5c) while EQS for fisheries is $\leq$6 mg/l. In 2015, BOD varied from 2.2 to 8 mg/l. In 2016, TDS level ranged from 52.2 to 168 mg/l (Fig.5d) and was within the EQS (2100 mg/l). In 2015, TDS level varied from 42.6 to 183mg/l. In 2016, SS was varied from 10 to 45 mg/l (Fig.5e). In 2015, SS was 13 to 56 mg/l. In 2016, Chloride level was from 4.0 to 12.0 mg/l (Fig.5f) and which is less than EQS (600 mg/l) for treated wastewater from industrial units. In 2015, Chloride concentration varied from 2.95 to 7.99 mg/l.

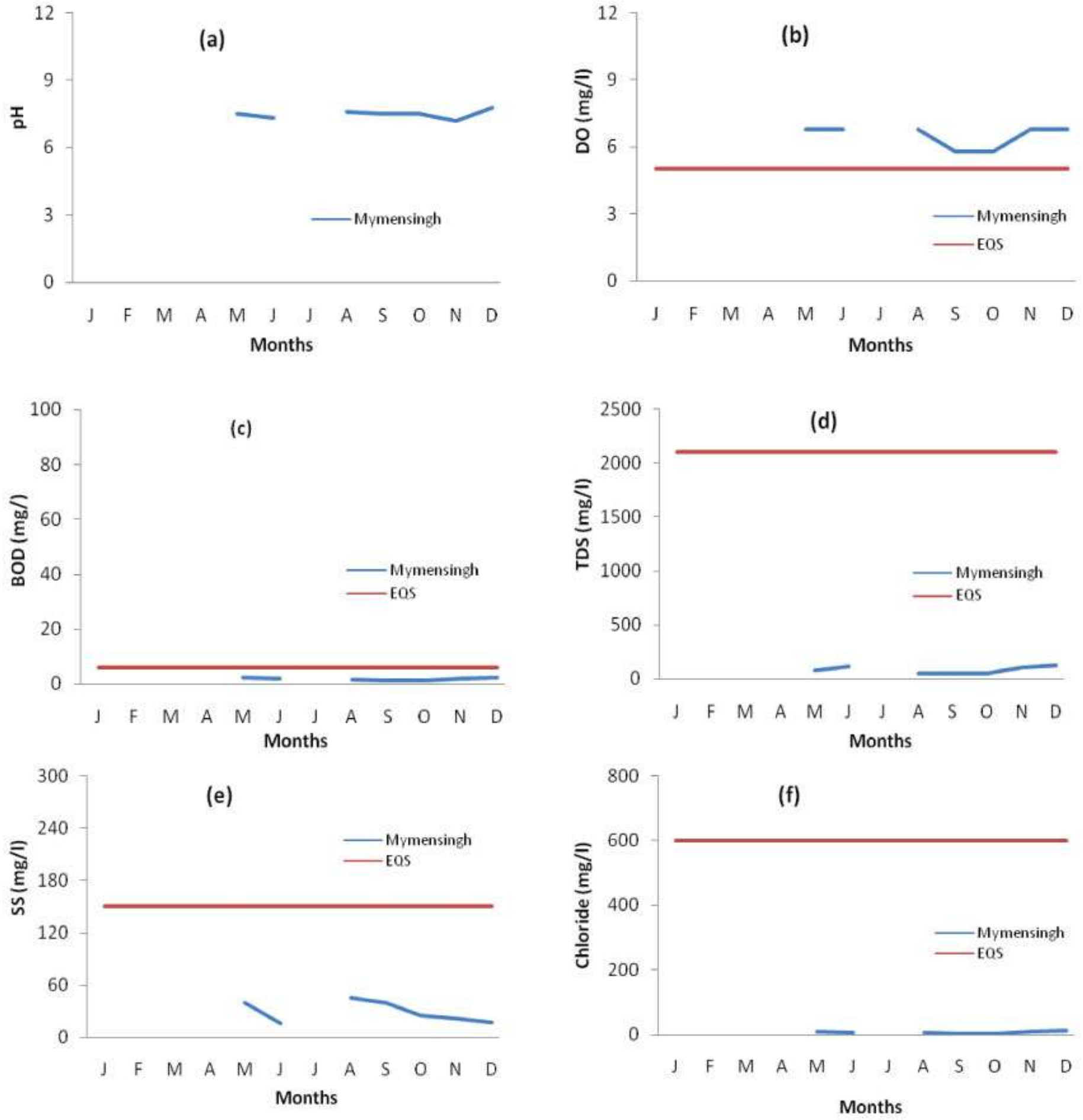


Fig.5. Graphical presentation of pH, DO, BOD, SS, Chloride and TDS of Brahmaputra River in 2016

Table-11. Total alkalinity of Brahmaputra River Water in 2016

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	48	-	-	-	32	32	-	**24**	46	46	40	**48**
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, the maximum and the minimum Total alkalinity of Brahmaputra river water was 48 mg/l in December and 24 mg/l in August (Table-11). In 2015, Total alkalinity concentration varied from 36 to 70 mg/l.

Table-12. EC of Brahmaputra River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mymensingh	**320**	-	-	-	150	219.2	-	108.7	107	**107**	210	240
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC of Brahmaputra river water was 170 µmhos/cm in October and 107 µmhos/cm in January (Table-12). In 2015, EC varied from 96.90 to 363 µmhos/cm.

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. Bheutha Ghat, Manikganj) of the river.

In 2016, pH of Kaliganga river varied from 6.36 to 7.69 (Fig.6a). The maximum and the minimum pH was found in March and May, respectively. In 2015, pH level varied from 7.01 to 7.34. In 2016, DO range was from 6.2 to 7.7 mg/l (Fig.6b). In 2015, DO was from 3.3 to 7.5 mg/l. In 2016, BOD varied within a range of 1.2 to 3.2 mg/l (Fig.6c). In 2015, BOD varied from 1.2 to 5.0 mg/l.

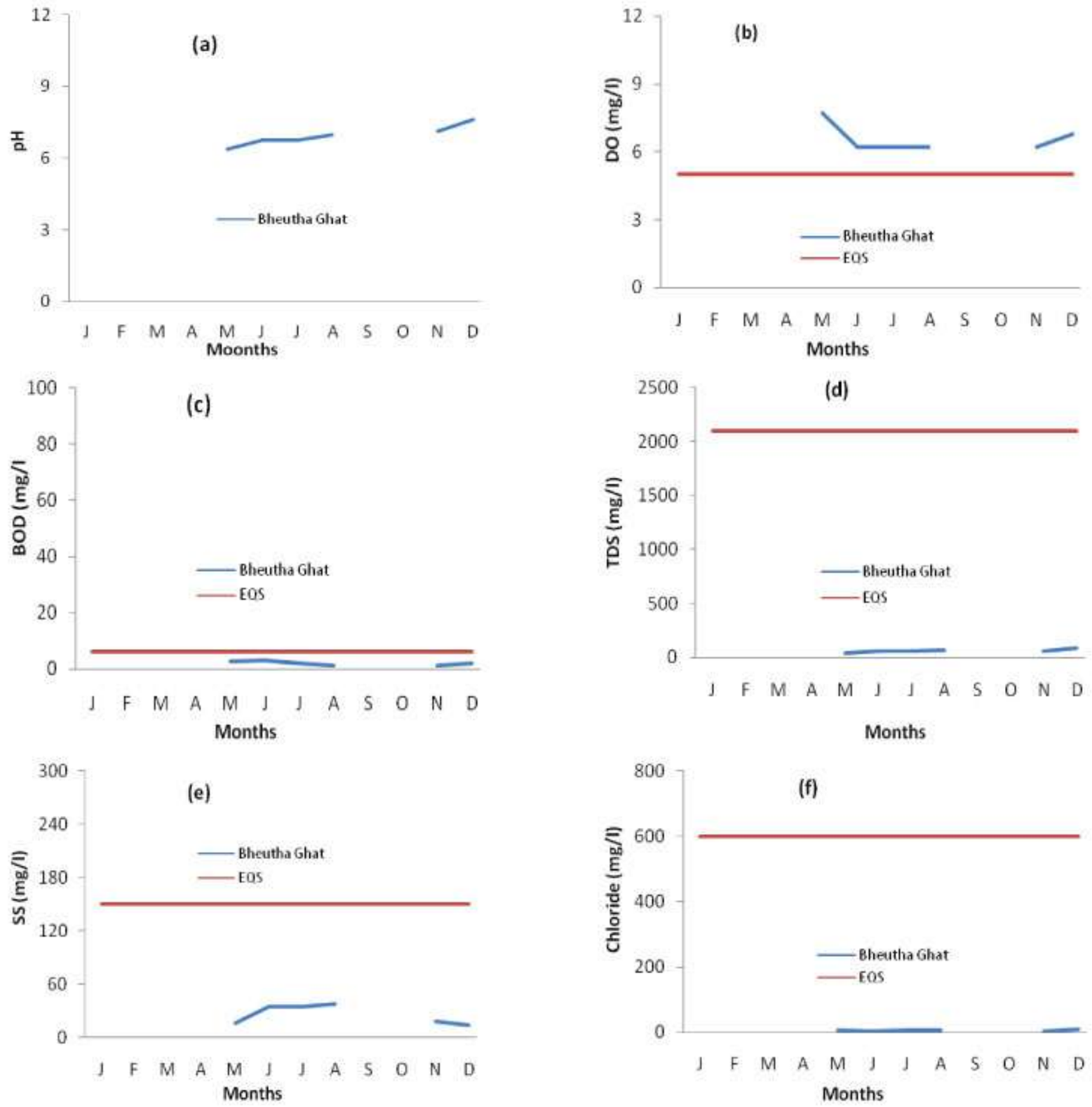


Fig.6. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Kaliganga Rriver in 2016

In 2016, TDS concentration was within the limit of EQS (2100 mg/l) for wastewater after treatment from industrial units. The maximum TDS was 276 mg/l in March and the minimum TDS was 42 mg/l in May (Fig.6d). In 2015, TDS concentration varied from 57.1 to 250 mg/l. In 2016, SS of Kaliganga river water was within the EQS (150 mg/l). The maximum and the minimum SS was 38.0 mg/l and 8.0 mg/l, respectively (Fig.6e). In 2015, SS varied from 6.0 to 22.0 mg/l. In 2016, Chloride level was lower than the EQS (600 mg/l). Highest Chloride was (8.99 mg/l) in March and the lowest was (4.0 mg/l) in November (Fig.6f). In 2015, Chloride varied from 1.06 to 12.7 mg/l.

Table-13. Total Alkalinity of Kaligonga River Water in 2016

Sampling Locations	Total Alkalinity (mg/l)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikganj	-	-	**56**	-	24	32	**18**	28	-	-	48	48
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, the maximum and the minimum Total alkalinity of Kaligonga River water was 56 mg/l in August and 18 mg/l in March (Table-13). In 2015, Total alkalinity concentration varied from 16.6 to 58 mg/l.

Table-14. Level of EC of Kaligonga River Water in 2016

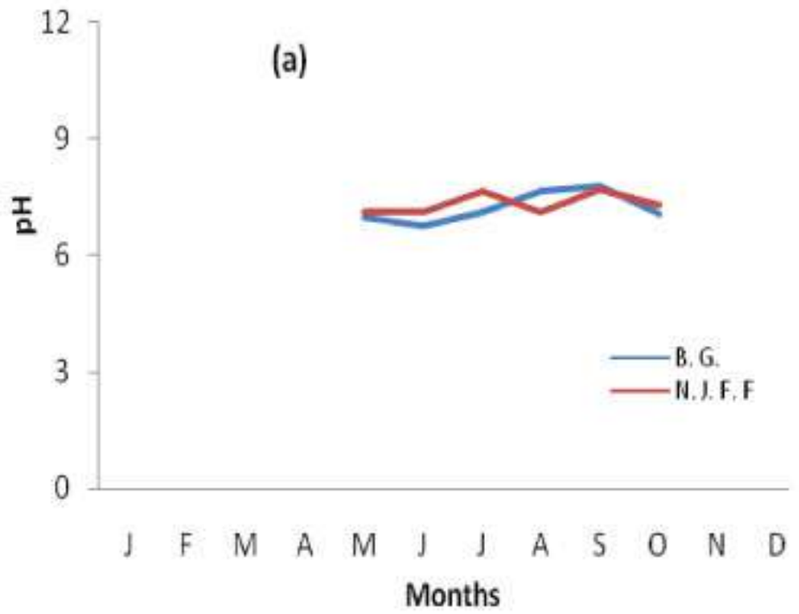
Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Veuta Ghat, Manikgonj	-	-	**513**	-	**84**	123.6	123.6	116.1	-	-	123.6	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

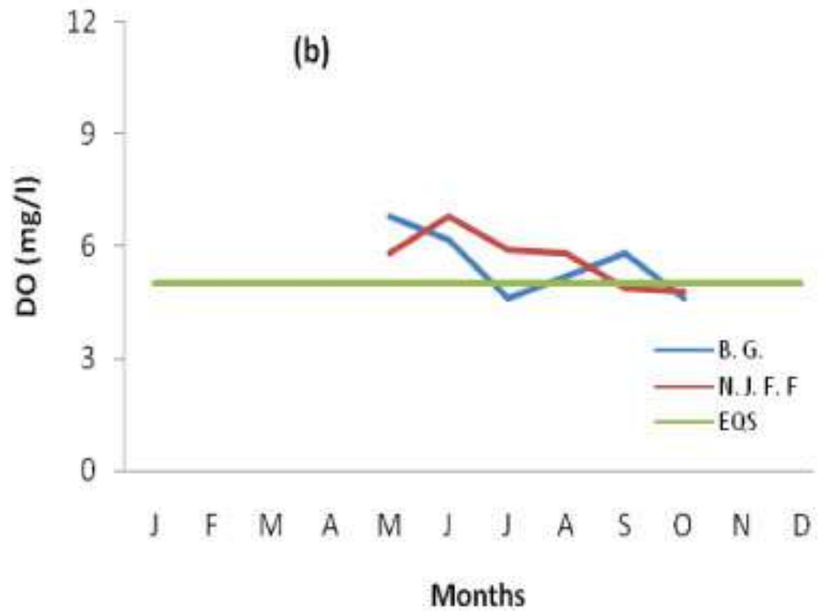
In 2016, the maximum and the minimum EC of Kaligonga River water was 84 µmhos/cm in August and 513 µmhos/cm in March (Table-14). In 2015, EC varied from 135.4 to 480 µmhos/cm.

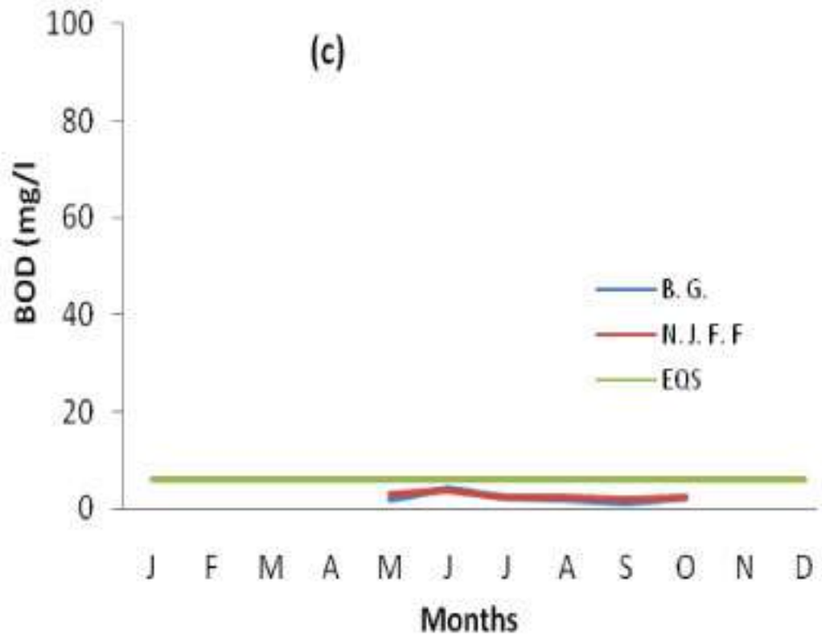
4.7 Jamuna River

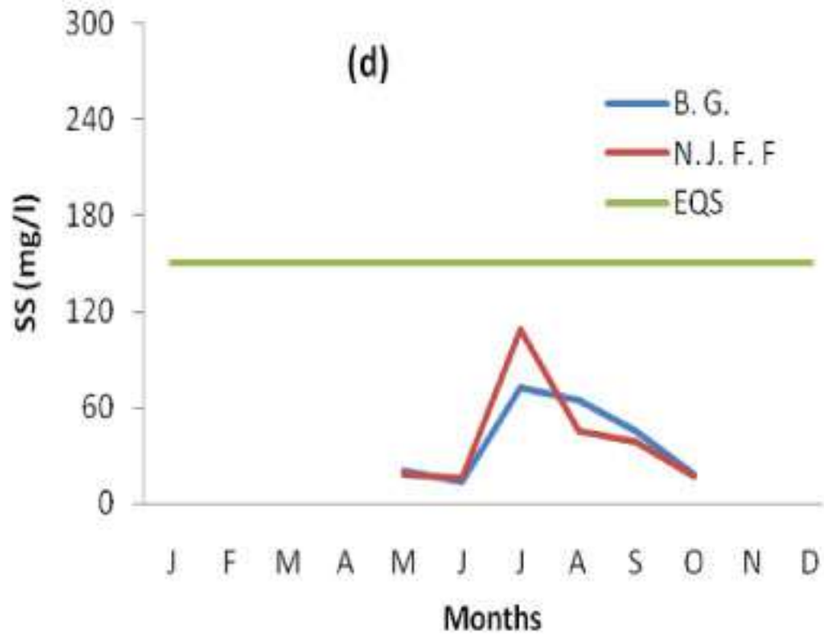
The Jamuna river is one of the three main rivers of Bangladesh. It is the main distributary channel of the Brahmaputra river that flows out of India into Bangladesh. To monitor water quality, samples were collected only from two locations e.g. Bahadurabad Ghat (B.G) and near Jamuna Fertilizer Factory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

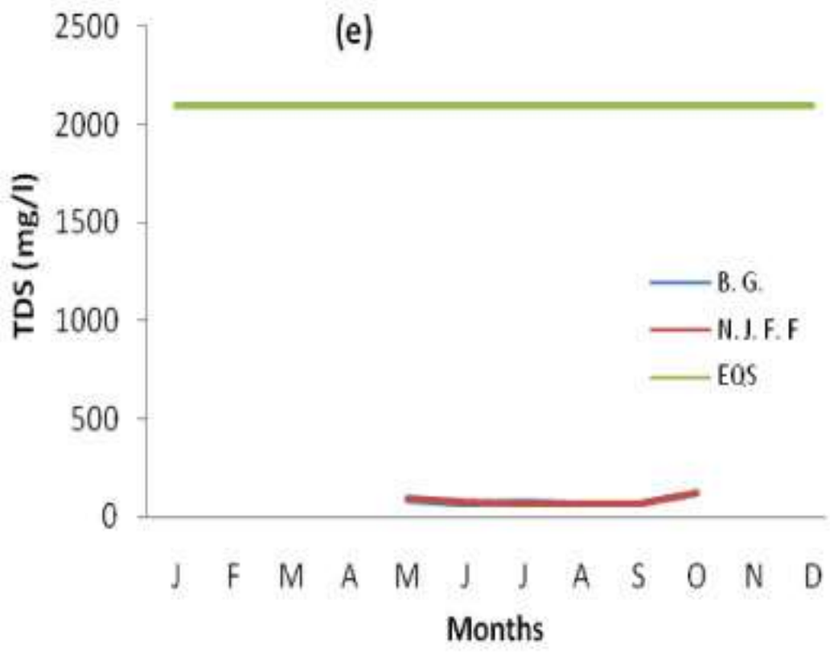
In 2016, pH varied from 6.76 to 8.19 and it was within the EQS limits (6.5 to 8.5) (Fig.7a). In 2015, pH was varied from 6.5 to 7.84. In 2016, DO concentrations ranged from 6.4 to 8.5 mg/l (Fig.7b) and it was within the EQS ($\geq$5 mg/l) for fisheries. In 2015, DO concentration varied from 5.0 to 7.6 mg/l. In 2016, the maximum BOD level was 4.2 mg/l in June at Bahadurabad Ghat and the minimum BOD level was 1.2 mg/l in September at the same location (Fig.7c). BOD was below the EQS ($\leq$6 mg/l) for fisheries (Fig.7c). In 2015, BOD concentration varied from 0.3 to 5.2 mg/l in December. In 2016, SS concentration varied 14-108 mg/l and was below the EQS (150 mg/l) ((Fig.7d). In 2015, SS was from 6.0 mg/l to 50 mg/l. In 2016, level of TDS of Jamuna river water varied from 62.2 to 125.3 mg/l (Fig.7e), while EQS for TDS is 2100 mg/l. In 2015, TDS level varied from 54 to 276 mg/l. In 2016, Chloride content was varied from 4.0 mg/l to 10.0 mg/l (Fig.7f). In 2015, Chloride concentration varied from 2.95 mg/l to 12.18 mg/l.











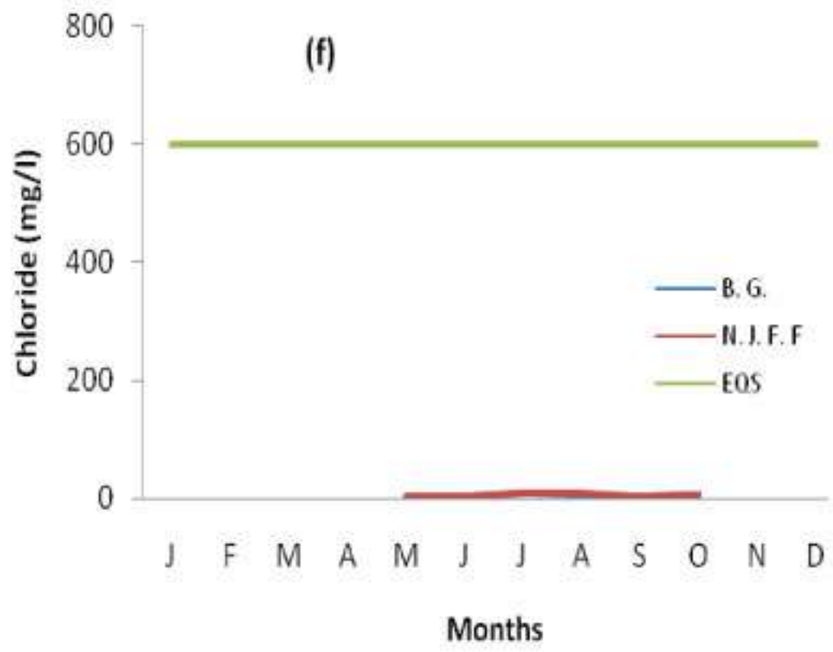


Fig.7. Graphical presentation of pH, DO, BOD, SS, TDS and Chloride of Jamuna Rriver in 2016

Table-15. Level of EC of Jamuna River Water in 2016

Sampling Locations of Jamuna River	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
B. G.	-	-	-	-	162	142.8	139.3	126.6	132.1	251	-	228
N. J. F. F	-	-	-	-	180	**120.2**	137.6	129.3	128.2	**263**	-	232
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC of Jamuna River water was 263 µmhos/cm in June and 120.2 µmhos/cm in October (Table-15). In 2015, EC varied from 108.2 to 580 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 (B.B), Meghna Ghat (M.G), Shahjalal Paper Mills (S.P.M) of the Meghna river.

In 2016, the highest pH was 7.09 in July at Bhairab Bazar and the minimum pH was 6.08 at Meghna Ghat in May (Fig.8a). In 2015, pH level varied from 6.5 to 7.47. In 2016, DO level of Meghna river was varied 0.8 mg/l to 7.1 mg/l and was often higher than the EQS ($\geq$5 mg/l) for fisheries (Fig.8b). In 2015, DO level varied from 4.7 mg/l to 8.1 mg/l. In 2016, at all the sampling locations of the river, BOD was below the EQS ($\leq$6 mg/l) for fisheries round the year. The maximum and the minimum BOD load was 8.4 mg/l in February at Bhairab Bazar and 0.2 mg/l in July at the same location (Fig.8c). In 2015, BOD concentration varied from 1.0 to 7.0 mg/l. In 2016, TDS of Meghna river water was very low and the range was from 28.1 to 228 mg/l (Fig.8d). In 2015, TDS concentration varied from 30.8 to 101.5 mg/l. In 2016, SS of Meghna river varied from 10.0 to 60.0 mg/l (Fig.7e). In 2015, SS was varied from 5.0 to 47.0 mg/l. In 2016, 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 (30.99 mg/l) was found in February at Bhairab Bazar and the minimum (2.0 mg/l) was in October at the same location (Fig.8f). In 2015, Chloride concentration varied from 4.91 to 22.71 mg/l.

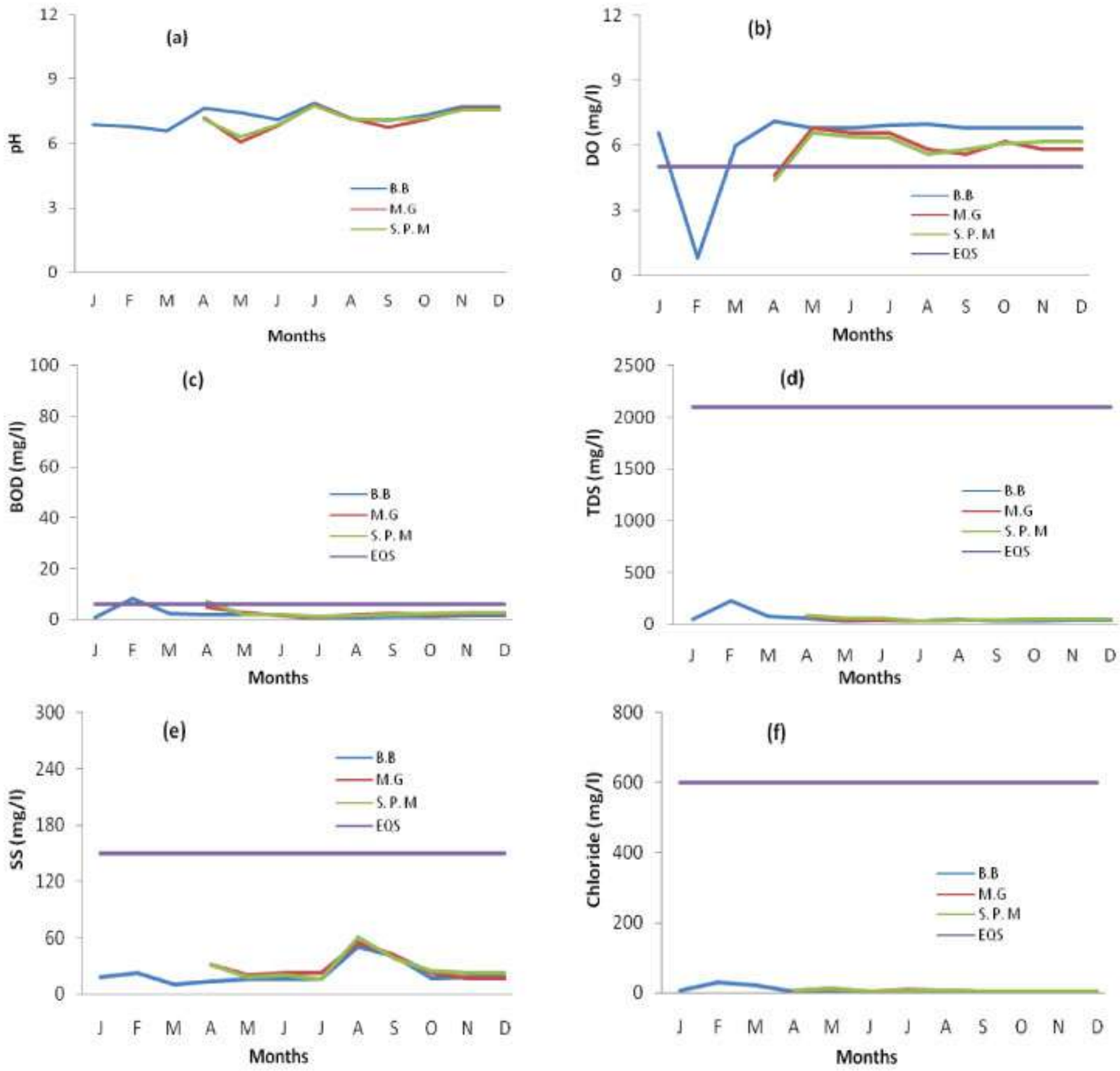


Fig.8. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Meghna River in 2016

Table-16. EC at different locations of Meghna River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bhairob Bazar	98.4	**452**	136	112	68.3	70.4	63.4	101.4	61	62	78	78
Meghna Ghat	102.6	-	-	145	75.5	75	**58.1**	80.8	75.8	88	84	84
N. S. P. M	105.8	-	-	165	107.7	107.7	67.4	84.2	78.2	89	88	88
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, EC of Meghna river water at different locations was within the EQS (µmhos/cm). The maximum and the minimum EC of Meghna river was 452 µmhos/cm in February at Bhairob Bazar and 58.1 µmhos/cm in July at Meghna Ghat (Table-16). In 2015, EC varied from 73.3 to 216.9 µmhos/cm.

4.9 Padma River

The Padma is a major transboundary river of Bangladesh. Water samples were collected from three locations of the river namely Mawa Ghat, 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.

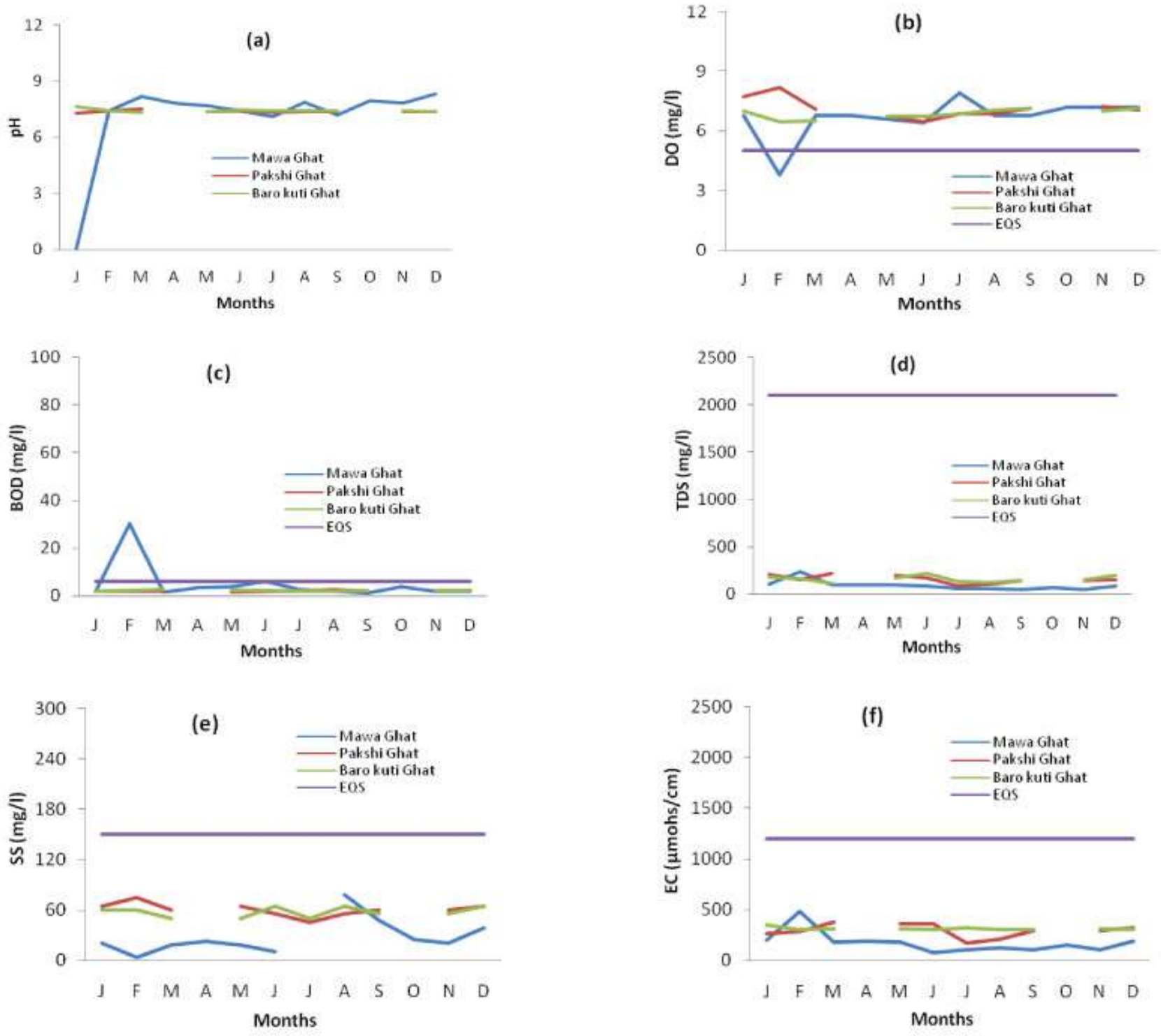


Fig.9. Graphical presentation of pH, DO, BOD, TDS, SS and EC of Padma River in 2016

In 2016, pH of Padma river water was mostly neutral and varied from 7.08 to 8.32 (Fig.9a) while standard pH for fisheries 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 2015, pH level varied from 6.89 to 7.69. In 2016, DO level of Padma river was above EQS (≥5 mg/l) for fisheries at almost all the locations and it varied from 3.8 to 8.2 mg/l (Fig.9b). In 2015, DO concentration ranged from 5.25 to 8.5 mg/l. In 2016, BOD load was within the EQS (≤6 mg/l) for fisheries at all locations. The maximum BOD was found 30 mg/l in February at Mawa Ghat and the minimum was 1.0 mg/l in September at the same location (Fig.9c). In 2015, BOD load varied from 1.7 to 2.65 mg/l. In 2016, TDS level of Padma river water was within EQS throughout the year and it varied from 51 to 240 mg/l (Fig.9d). In 2015, TDS concentration varied from 140 to 295 mg/l. In 2016, SS level of Padma river water was within EQS throughout the year and it varied from 4.0 to 78 mg/l (Fig.9e). In 2015, SS varied from 35 to 135 mg/l. In 2016, the maximum and the minimum EC of Padma river water was 480 µmhos/cm in February at Mawa Ghat and 75 µmhos/cm in June at the same Location (Fig.9f), while EQS is 1200 µmhos/cm wastewater after treatment from industrial units. In 2015, EC varied from 285 µmhos/cm to 532 µmhos/cm.

Table-17. Total Alkalinity at different sampling locations of Padma River Water in 2016

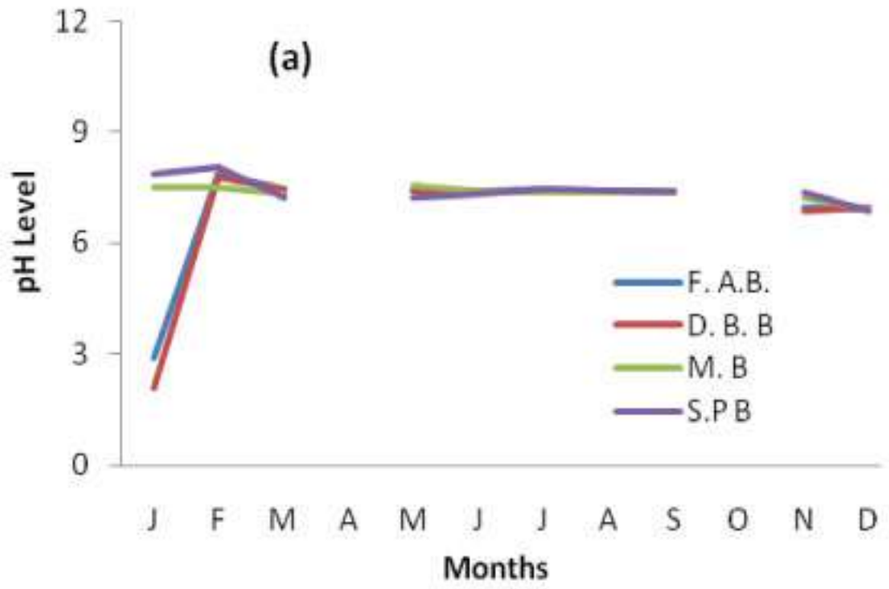
Sampling Locations	Total Alkalinity (mg/l)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mawa Ghat	48	**128**	48	38	38	20	**18**	32	60	40	70	40
EQS for wastewater after treatment from industrial units 150 mg/l												

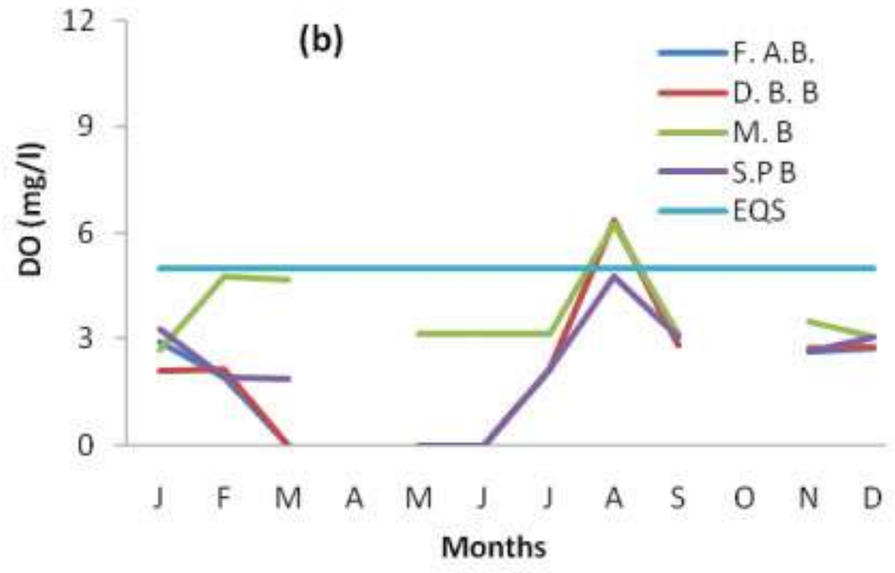
In 2016, the maximum and the minimum Total Alkalinity of Padma river water was 128 mg/l in February and 18 mg/l in July at mawa Ghat (Table-17).

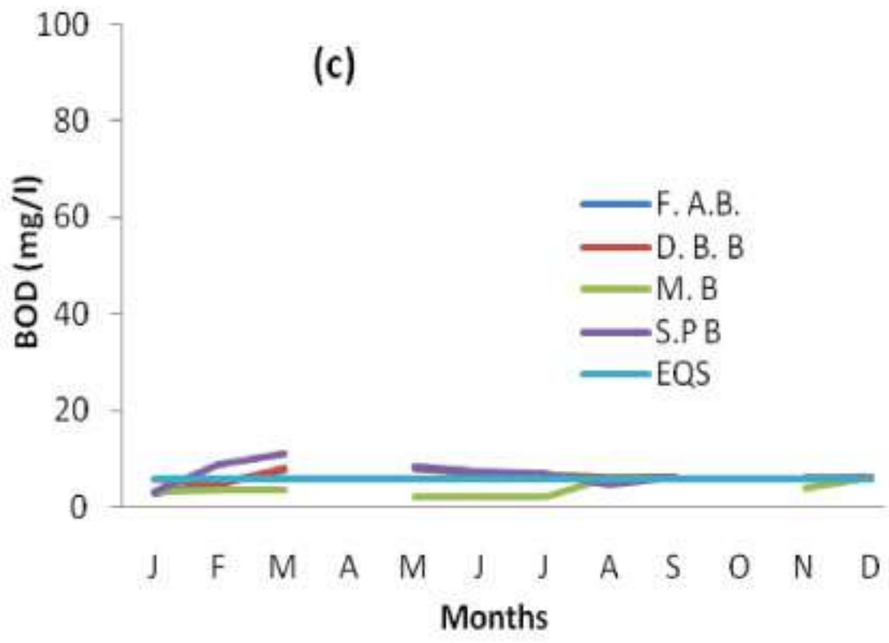
4.10 Korotoa River

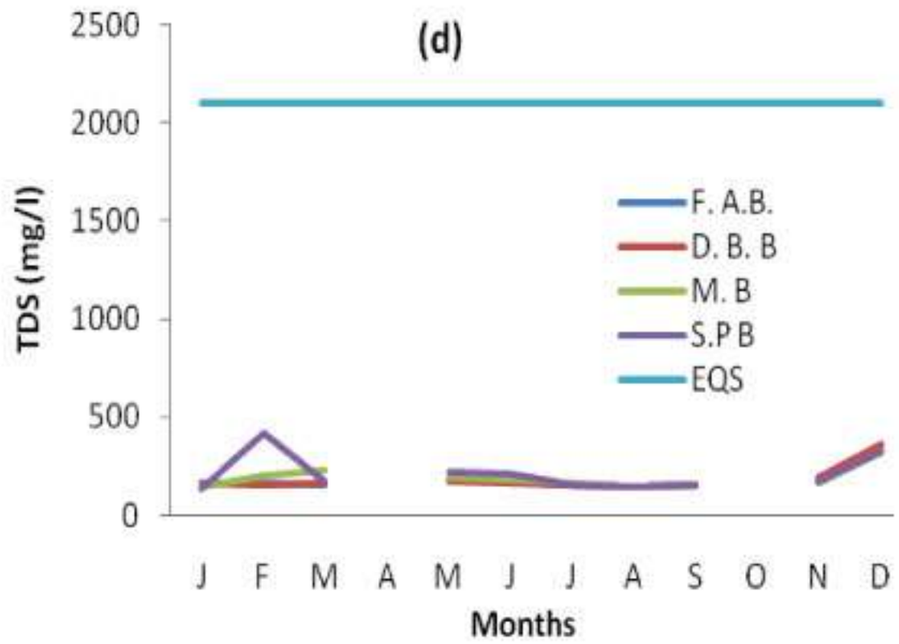
To monitor water quality of Korotoa river in 2016, water samples were collected from four locations of the river e.g. Fateh Ali Bridge (FAB), Dutta Bari Bridge (DBB), Matidali Bridge (MB) and S.P Bridge (SPB).

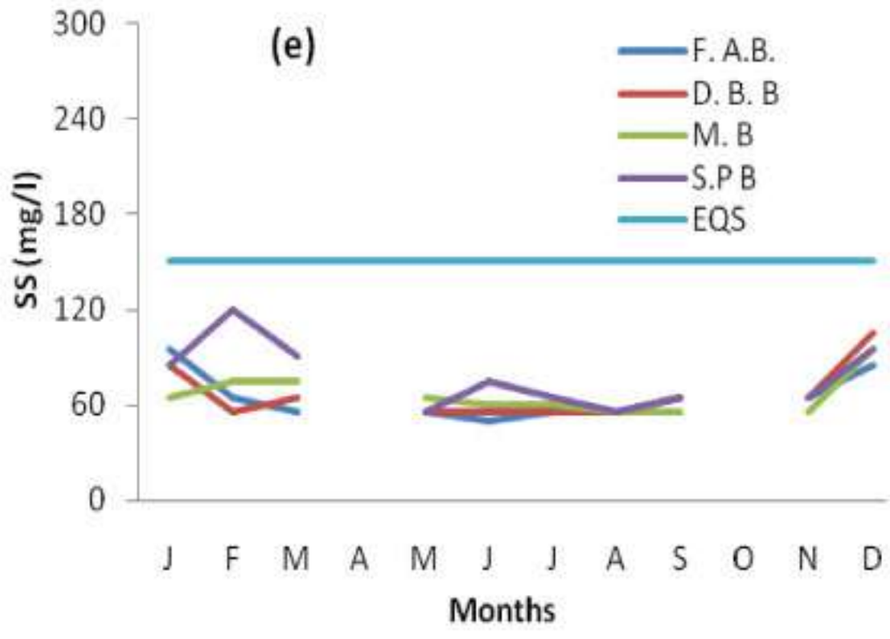
In 2016, pH level of Korotoa river water varied from slightly acidic to slightly alkaline (2.1 to 8.04) (Fig.10a) and was within EQS limit. In 2015, pH level varied from 6.19 to 8.18. In 2016, DO level of Korotoa river water was lower than EQS (≥5 mg/l) for fisheries except the month of August. DO varied from 0.0 to 6.35 mg/l (Fig.10b). In 2015, DO concentration varied from 0.0 to 8.18 mg/l. In 2016, the minimum BOD was 2.15 in July at near Matidali Bridge and the maximum BOD was 11.1 mg/l in March at S.P Bridge (Fig.10c). In 2015, BOD concentration varied from 2.1 to 37.5 mg/l. In 2016, TDS varied from 140 mg/l to 420 mg/l (Fig.10d). In 2015, TDS range was from 90 mg/l to 270 mg/l. In 2016, level of SS of Korotoa river water at different locations was within the EQS. The maximum and the minimum SS was 120 mg/l in February at at S.P Bridge and 50 mg/l in June at Fateh Ali Bridge (Fig.10e). In 2015, SS concentration varied from 40 mg/l to 125 mg/l. In 2016, average EC varied from 279.50 µmhos/cm to 809.5 µmhos/cm (Fig.10f) and was within the EQS limit. In 2015, EC concentration varied from 171 µmhos/cm to 471 µmhos/cm.











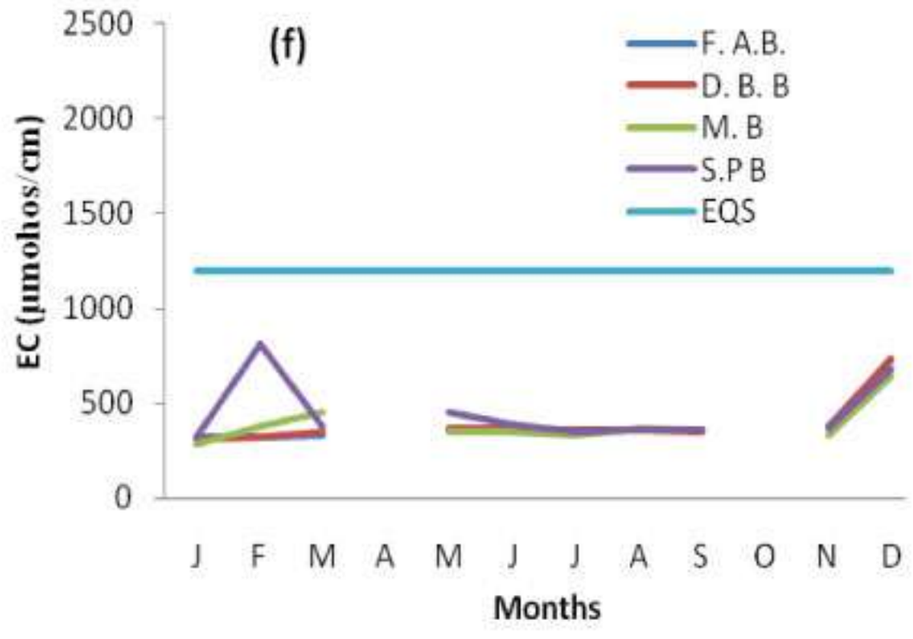
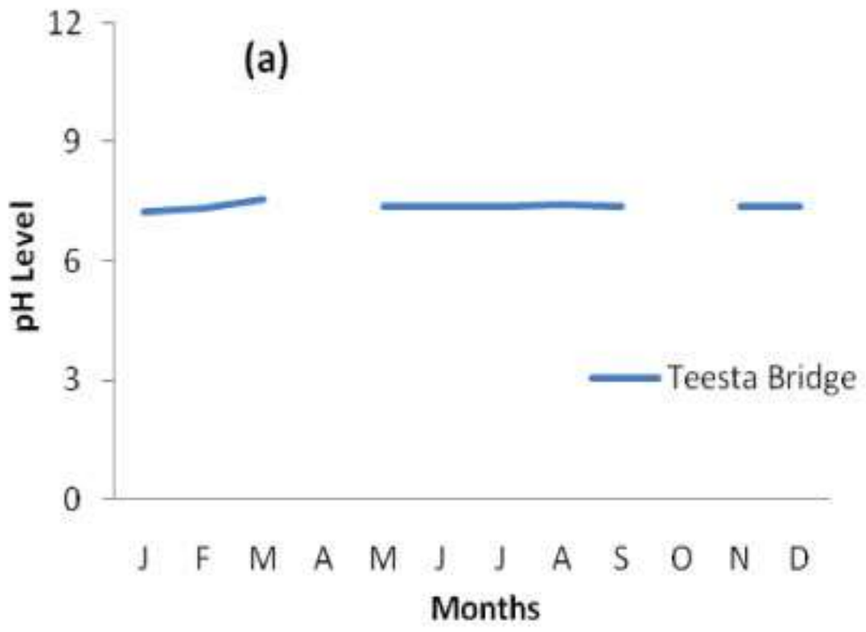


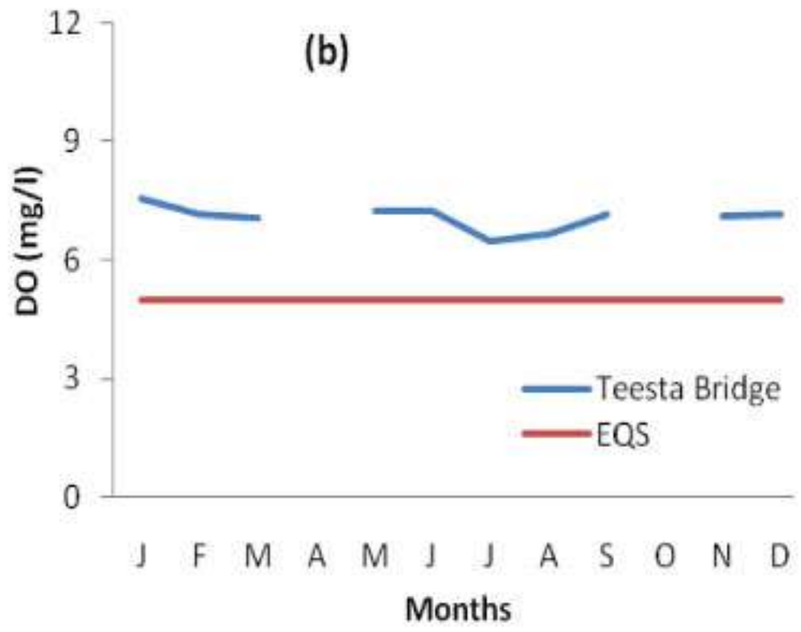
Fig.10. Graphical presentation of pH, DO, BOD, COD, TDS, SS and EC of Korotoa River in 2016

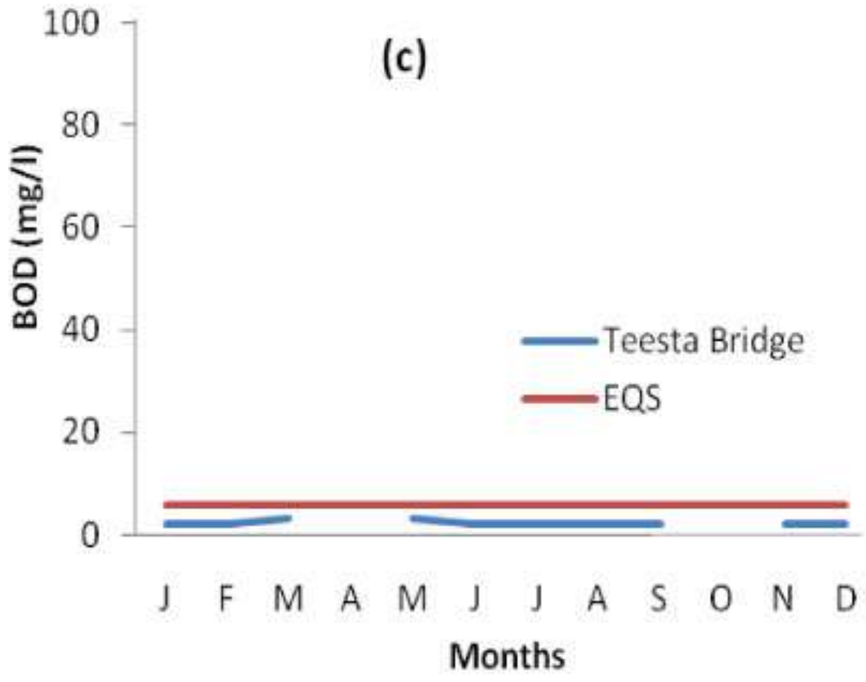
4.11 Teesta River

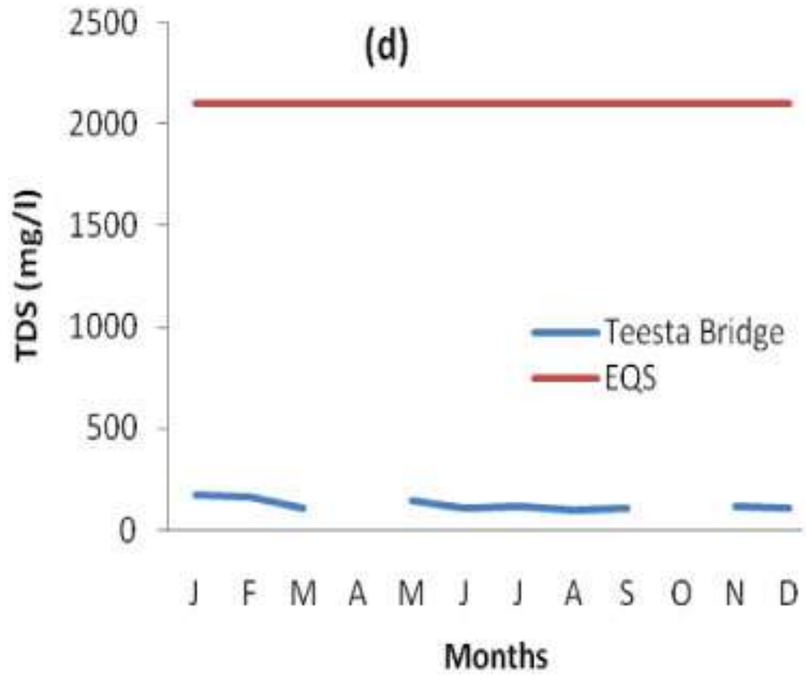
The Teesta river is a 309 km long flowing through the Indian state of Sikkim. It carves out from the verdant Himalayas in temperate and tropical river valleys and forms the border between Sikkim and West Bengal and flows through the cities of Rangpo (Sikkim) and Jalpaiguri & Kalimpong (West Bengal) before 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 2016.

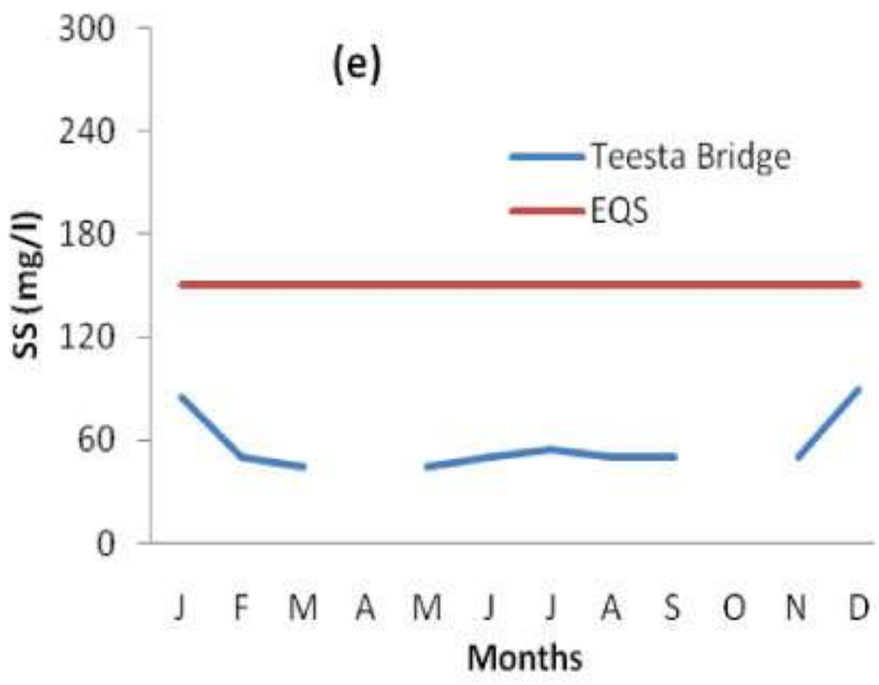
In 2016, pH level of Teesta river water varied from 7.24 to 7.54 (Fig.11a) and was within the EQS limit. In 2015, pH level varied from 7.04 to 7.45. In 2016, DO level of Teesta river water was above the EQS (≥5 mg/l) for fisheries. DO varied from 6.45 to 7.55 mg/l (Fig.11b). In 2015, DO level varied from 5.25 to 7.75 mg/l.











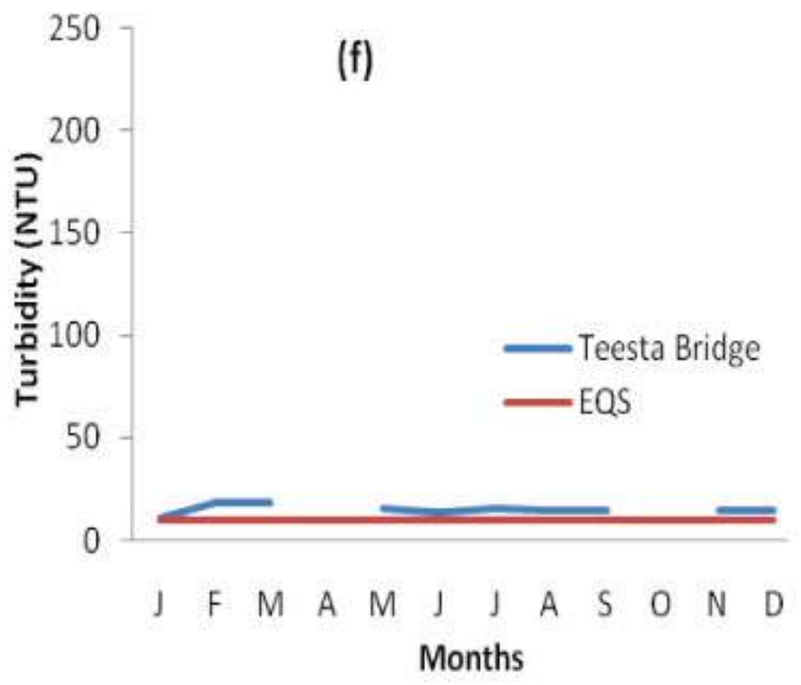


Fig.11. Graphical presentation of pH, DO, BOD, COD, SS and Turbidity of Teesta River in 2016

In 2016, the maximum BOD was 3.2 mg/l in May and the minimum BOD was 1.9 mg/l in February (Fig.11c). In 2015, BOD level varied from 1.95 to 7.5 mg/l. In 2016, TDS varied from 95 mg/l to 170 mg/l (Fig.10d). In 2015, TDS level varied from 65 mg/l to 255 mg/l. In 2016, Level of SS of Teesta river at different locations was within the EQS. The maximum and the minimum SS was 90 mg/l in December and 45 mg/l in March (Fig.11e). In 2015, SS level varied from 30 to 128 mg/l. In 2016, the maximum and the minimum Turbidity was 18.75 mg/l in February and 10.5 mg/l in January (Fig.11f). In 2015, Turbidity level varied from 10.5 to 36.75 mg/l.

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 2016. To simplify analysis average value of upstream and downstream point of both locations were used.

In 2016, pH level at the sampling points of the Karnaphuli river varied from 6.8 to 8.5 (Fig.12a), while standard pH for inland surface water for fisheries is 6.5 to 8.5. In 2015, pH level varied from 7.0 to 8.20. DO level of Karnaphuli river was within the EQS althrough the year of 2016 and met the standard of DO for fisheries ($\geq$5 mg/l). DO varied from 5.1 to 6.7 mg/l (Fig.12b). In 2015, DO concentration varied from 5.1 to 5.8 mg/l. In 2016, COD value varied from 108 to 516 mg/l (fig.11c), while EQS for wastewater after treatment from industrial units is 200 mg/l. COD value was high at TSP points compare to KUFL points. In 2015, COD value varied from 109 to 489 mg/l. In 2016, the maximum TDS was 20296 mg/l in February at KUFL and the minimum was 1175 mg/l in July at the same location (Fig.12d). In 2015, TDS concentration varied from 852 to 20416mg/l. In 2016, level of SS of Karnaphuli river water at different points was beyond the EQS (150 mg/l). The maximum and the minimum SS was 517 mg/l in October at KUFL and 143 mg/l in July at TSP location (Fig.12e). In 2015, SS value varied from 64 to 312 mg/l. In 2016, EC concentration was relatively higher during high tide at all locations of the river. The maximum EC concentration was 40587 µmohs/cm in February at KUFL and the minimum EC concentration was 2300 µmohs/cm in July at same location (Fig.12f). In 2015, EC concentration varied from 2100 to 40832 µmohs/cm.

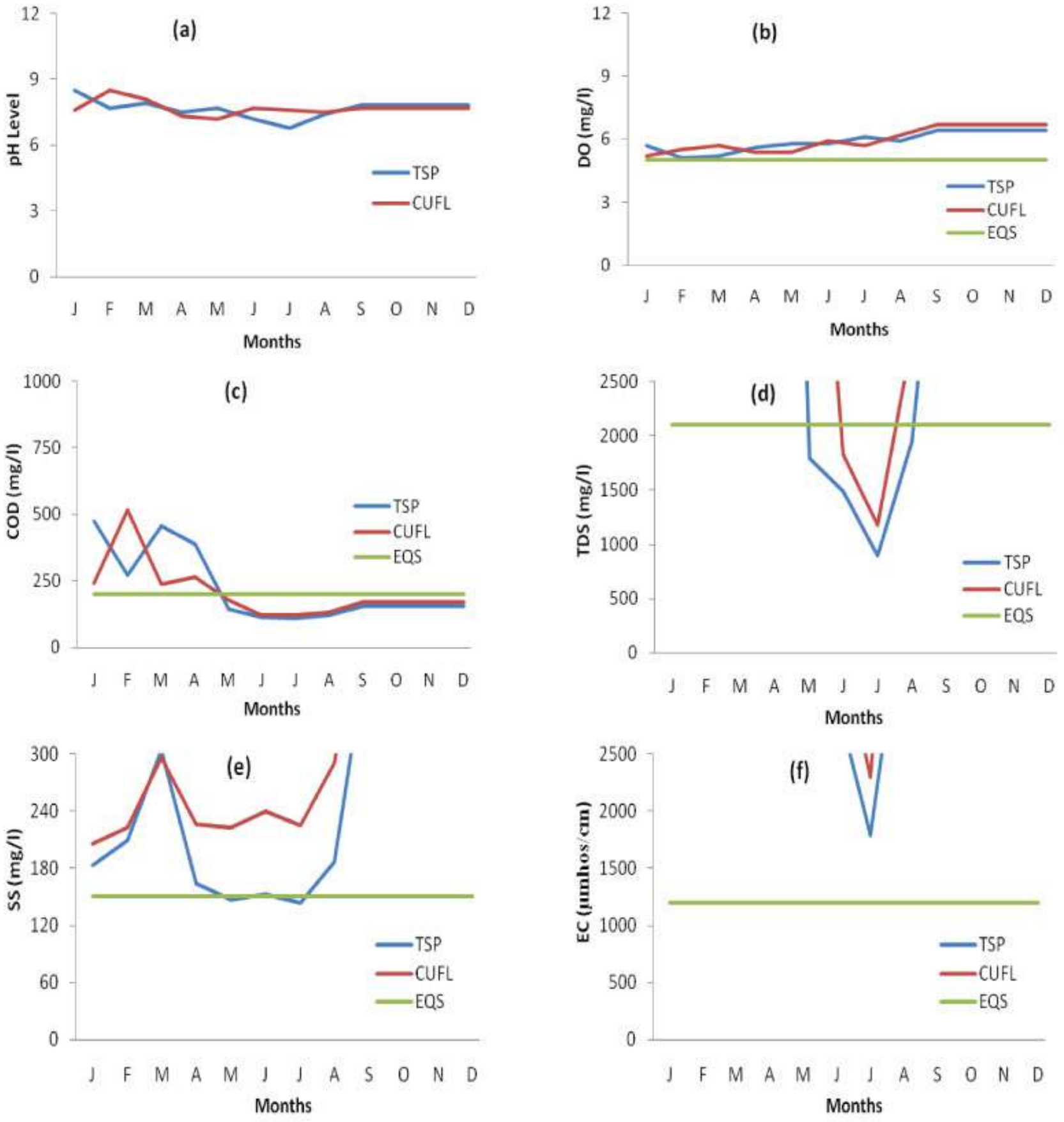


Fig.12. Graphical presentation of pH, DO, COD, SS, TDS and EC of Karnaphuli River in 2016

4.13 Halda River

Halda river passes through the South-Eastern part of Bangladesh. Water sampling locations were WASA intake upstream and downstream, Maduna Ghat (MG) (Bank and 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–low tide variation for the sampling locations were considered. Because no significant variation was found between upstream and downstream (WASA Intake Point) and river bank- middle (Maduna Ghat).

In 2016, pH of Halda river water was within EQS limit and varied from 6.8 to 7.8 (Fig.13a). In 2015, pH level varied from 6.92 to 7.9. DO level of Halda river was above the EQS limit throughout the monitoring period of 2016. DO varied from 5.9 to 7.8 mg/l (Fig.13b). In 2015, DO range was from 5.3 to 7.2 mg/l. In 2016, COD at the sampling locations of Halda river during high and low tide was varied 13.0 mg/l to 115 mg/l (Fig.13c). In 2015, COD range was from 8.0 mg/l to 105 mg/l. TDS level of Halda River in 2016 was within the EQS (2100 mg/l) for treated wastewater from industrial units. TDS varied from 62 to 230 mg/l (Fig.13d). In 2015, TDS

concentration varied from 48 to 234 mg/l. In 2016, the maximum and the minimum SS content of Halda river water was 218 mg/l in August and 22 mg/l in January at Maduna Ghat (Fig.13e). In 2015, SS value varied from 19.0 to 219 mg/l. In 2016, the maximum and the minimum EC was 398 µmohos/cm in January at WASA intake point and 132 µmohos/cm in July at the same location (fig.13f). In 2015, EC concentration varied 94 and 474 µmohos/cm.

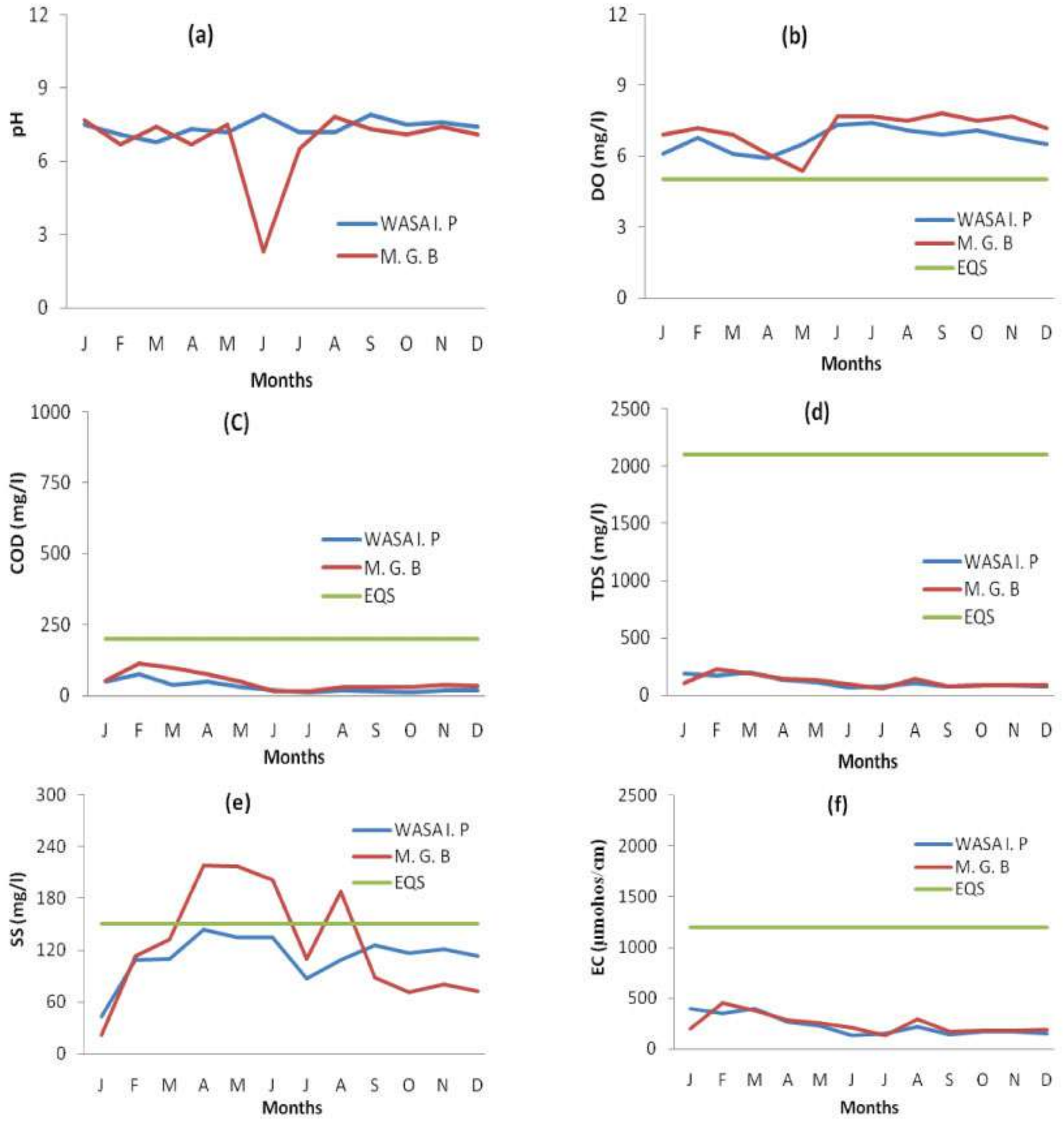


Fig.13. Graphical presentation of pH, DO, COD, SS,TDS and EC of Halda River in 2016

4.14 Moyuri River

The Mayuri River is situated at the back swamp of the Bhairab-Rupsha River. Khulna City Corporation (KCC) is situated on the bank of this river basin and the Mayuri River borders the west bound 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 2016, 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 2016, pH level of Moyuri river water varied from 7.62 to 7.81 (Fig.14a) and was within the EQS limit. In 2015, pH level varied from 7.52 to 8.0. In 2016, DO concentration of Moyuri river water varied from 0.5 to 2.9 (Fig.14b) and was lower than the EQS (≥ 5 mg/l) for fisheries. In 2015, DO varied from 0.4 to 3.8. In 2016, TDS level of the Moyuri river water varied from 348 to 1282 mg/l (Fig.14c) while EQS is 2100 mg/l. In 2015, TDS range was from 516 to 1305 mg/l. In 2016, Chloride range was from 122 to 602 mg/l (Fig.14d) while EQS is 600 mg/l. Highest Chloride was found in April. In 2015, Chloride level varied from 228 to 878.92 mg/l.

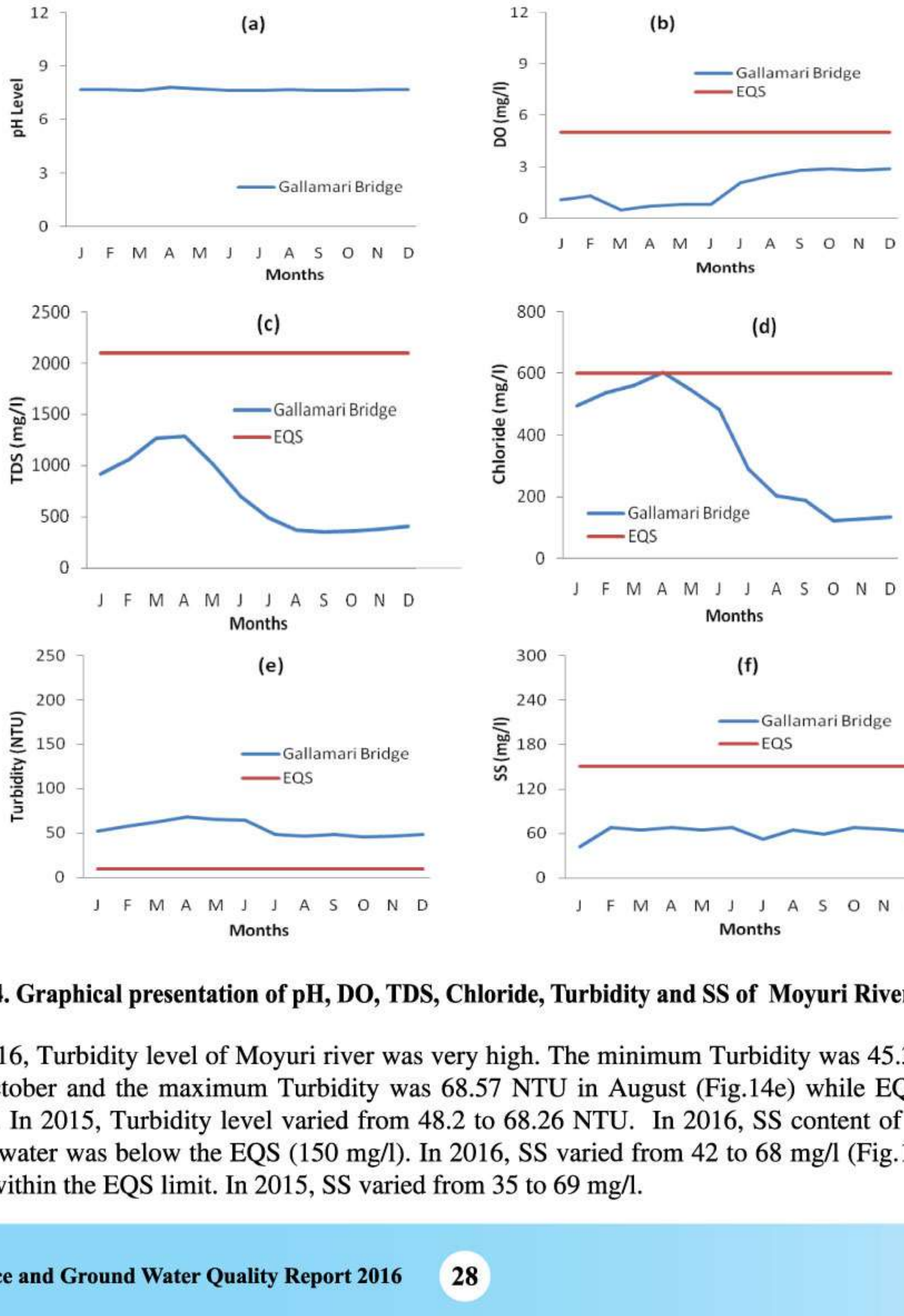


Fig.14. Graphical presentation of pH, DO, TDS, Chloride, Turbidity and SS of Moyuri River in 2016

In 2016, Turbidity level of Moyuri river was very high. The minimum Turbidity was 45.30 NTU in October and the maximum Turbidity was 68.57 NTU in August (Fig.14e) while EQS is 10 NTU. In 2015, Turbidity level varied from 48.2 to 68.26 NTU. In 2016, SS content of Moyuri river water was below the EQS (150 mg/l). In 2016, SS varied from 42 to 68 mg/l (Fig.14f) and was within the EQS limit. In 2015, SS varied from 35 to 69 mg/l.

Table-18. EC of Moyuri River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge (Avg.)	1824	2120	2524	**2564**	2042	1398	976	726	-	**724**	760	812
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC was 2564 µmhos/cm in April and 724 µmhos/cm in Octoberrespectively (Table-18) while standard for treated wastewater from industrial unit EC is 1200 µmhos/cm. In 2015, EC was from 1080 µmhos/cm to 2608 µmhos/cm.

Table-19. Salinity of Moyuri River Water in 2016

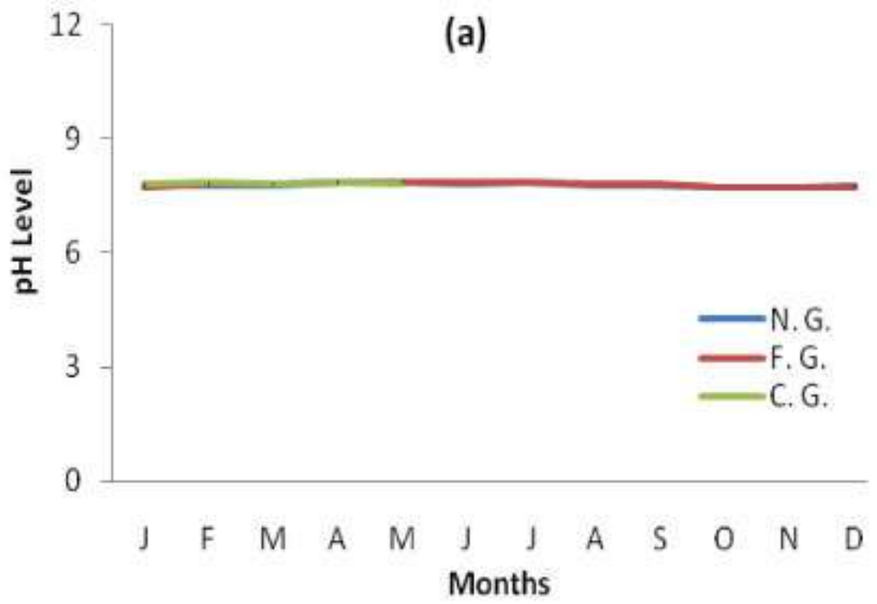
Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gallamari Bridge (Avg.)	1	1.3	1.4	**1.5**	1.3	1.2	0.4	**0.3**	0.3	0.3	0.4	0.6
EQS for wastewater after treatment from industrial units 400 ppt												

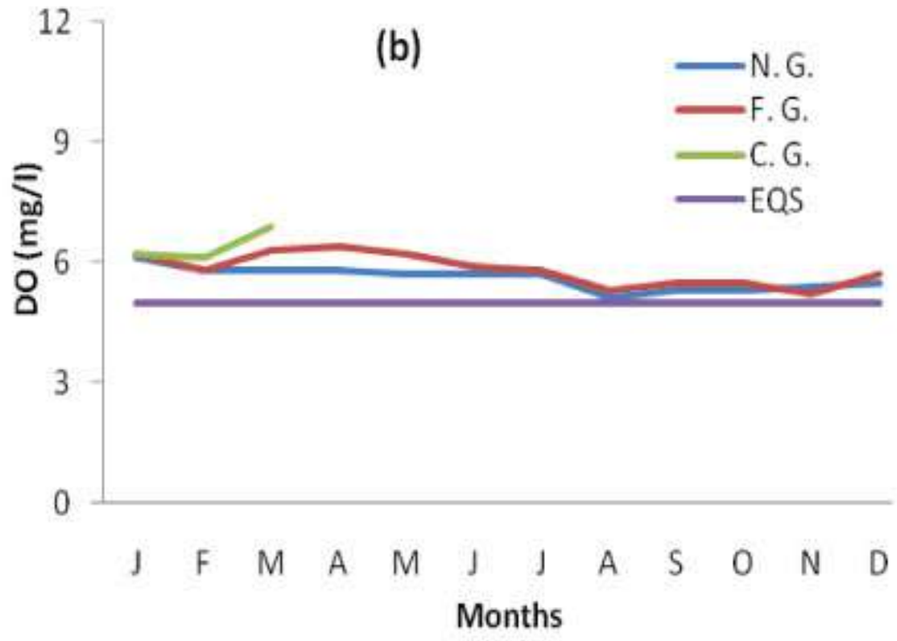
In 2016, the maximum and the minimum salinity was 1.5 and 0.3 ppt respectively while standard salinity is 400 ppt for treated wastewater from industry (Table-19). In 2015, Salinity was varied from 0.3 ppt to 1.7 ppt.

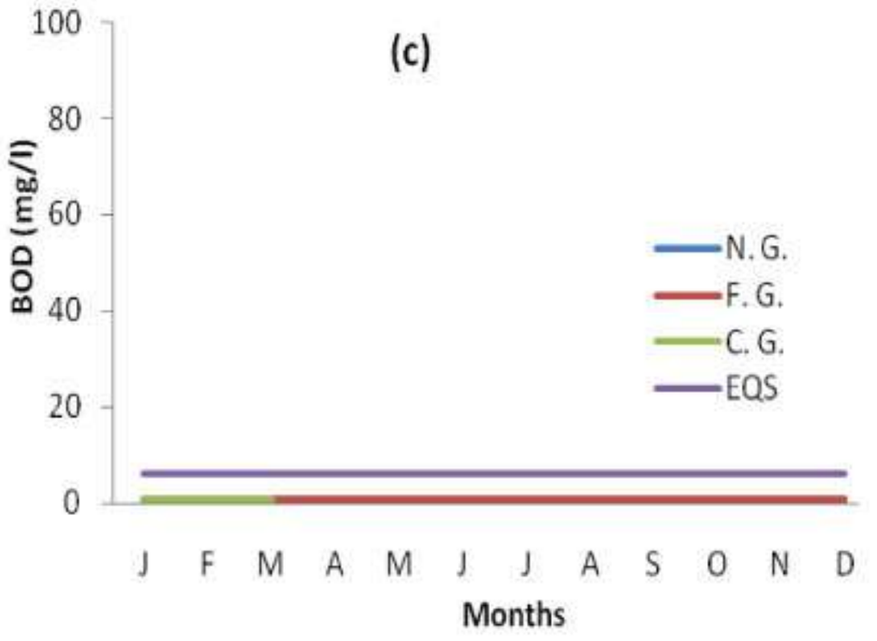
4.15 Bhairab River

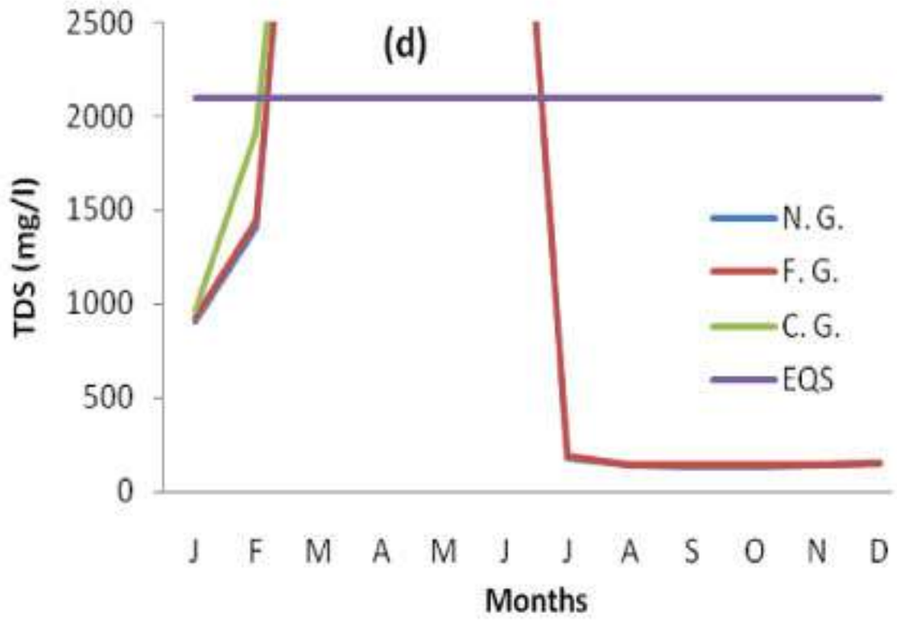
Bhairab river flows in the south of Bangladesh. The river is approximately 62 Km long. Its water carries plenty of silt. Water samples were collected from three locations comprising nine different points [e.g. Noapara Ghat Bank (NG), Middle and Opposite bank, Fultala Ghat (FG) Side, Middle and Opposite bank and Charerhat Ghat (CG) Side Middle and Opposite bank of Bhairab River for monitoring water quality in 2016. 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.

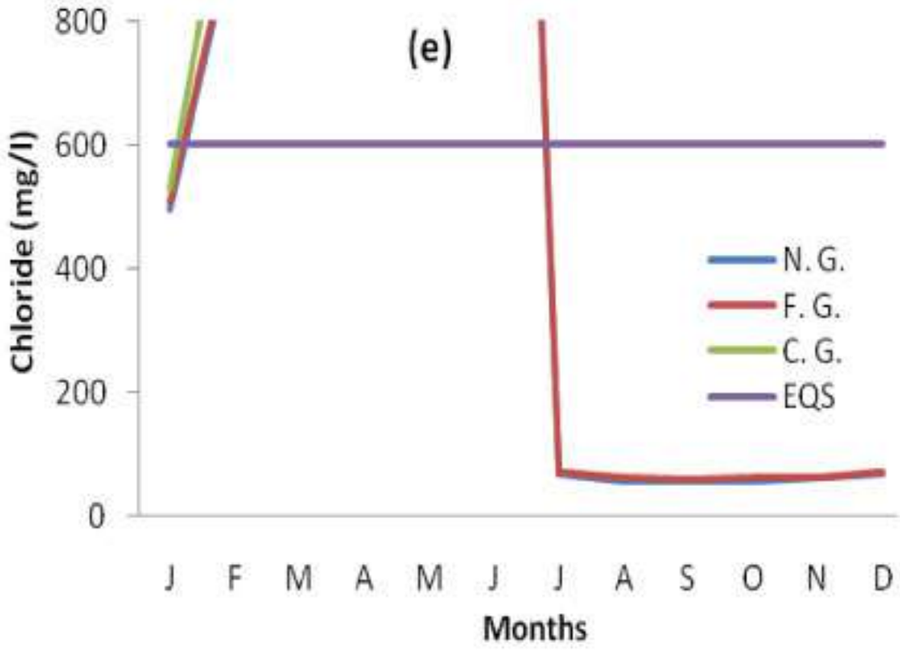
In 2016, pH at different locations of the Bhairab river varied from 7.68 to 8.4 (Fig.15a) while EQS for inland surface water is 6.5 to 8.5. In 2015, pH varied from 7.68 to 8.4. DO was around the EQS (($\geq$5 mg/l) for fisheries. In 2016, DO was from 3.8 to 6.5 mg/l (Fig.15b). In 2015, DO varied from3.8 to 6.5 mg/l. In 2016, BOD level of Bhairab river water was below the EQS ($\leq$6 mg/l) for fisheries round the year of 2016. BOD varied from 0.8 to 0.9 mg/l (Fig.15c). In 2015, BOD level varied from 0.8 to 1.2 mg/l. In 2016, at all locations TDS level of Bhairab river waterwas very high during March to June. The maximum and the minimum TDS was 5311 and 132 mg/l (Fig.15d) respectively while EQS is 2100 mg/l. In 2015, TDS was from 115 to 12060 mg/l. In 2016, Chloride was varied from 32 to 7884 mg/l (Fig.15e) while EQS for Chloride is 600 mg/l. Highest Chloride (3008 mg/l) was found in March at Charerhat Ghat and lowest was 56mg/l in September at Noapara Ghat. In 2015, Chloride level varied from 32 to 7884 mg/l. Turbidity of Bhairab river water at all locations was very high in 2016. It varied from 34.26 to 96.67 NTU while the EQS for drinking water is 10 NTU (Fig.15f). The prime reason may be of carrying huge silt by the river throughout the year. In 2015, Turbidity level varied from 18.26 to 96.66 NTU.











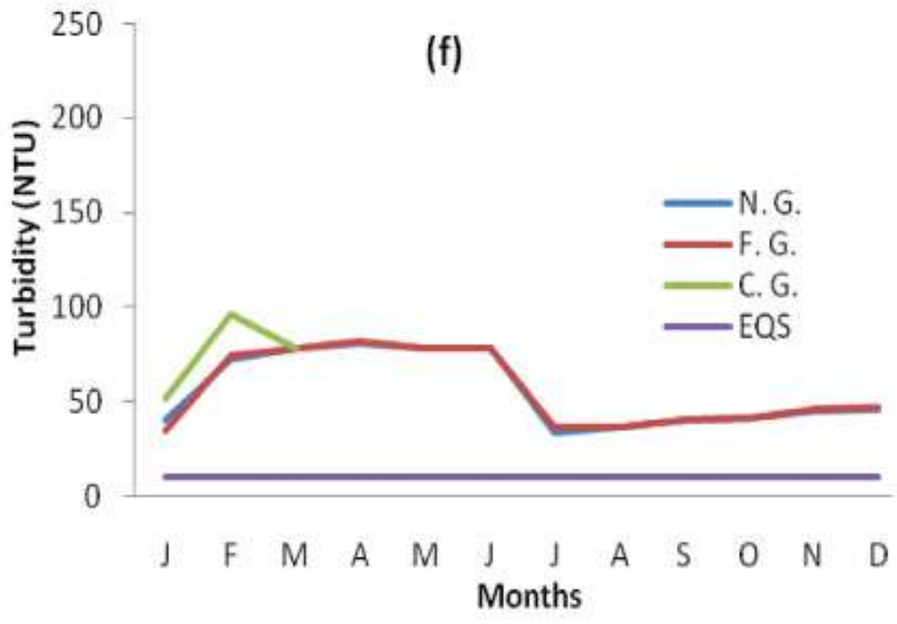


Fig.15. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Bhairab River in 2016

Table-20. Salinity of Bhairab River Water in 2016

Sampling Locations	Salinity (ppt)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Noapara Ghat (Avg)	1.2	1.4	5.9	5.8	5.6	5.6	0.3	0.1	0.1	0.1	0.1	0.1
Fultala Ghat (Avg)	1.2	1.4	5.1	6	5.8	5.7	0.3	**0.1**	0.1	0.1	0.1	0.1
Charerhat Ghat (Avg)	1.2	2.6	**6.4**	-	-	-	-	-	-	-	-	-
EQS for wastewater after treatment from industrial units 400 ppt												

In 2016, the maximum and the minimum salinity was 6.4 ppt in March and 0.1 ppm in August to December (Table-20). In 2015, Salinity varied from 0.1 ppt to 16.3 ppt

Table-21. EC of Bhairab River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Noapara Ghat (Avg)	1822	2820	10552	10574	9342	9302	372	280	**262**	268	280	308
Fultala Ghat (Avg)	1856	2892	10578	10582	9384	9342	378	286	276	284	286	312
Charerhat Ghat (Avg)	1930	3840	**10622**	-	-	-	-	-	-	-	-	-
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC was 10622 µmhos/cm in March and 262 µmhos/cm in September respectively (Table-21) while EQS for EC is 1200 µmhos/cm. In 2015, EC varied from 230 µmhos/cm to 24153.33µmhos/cm.

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 2016. For analysis, average of three points of a location were considered.

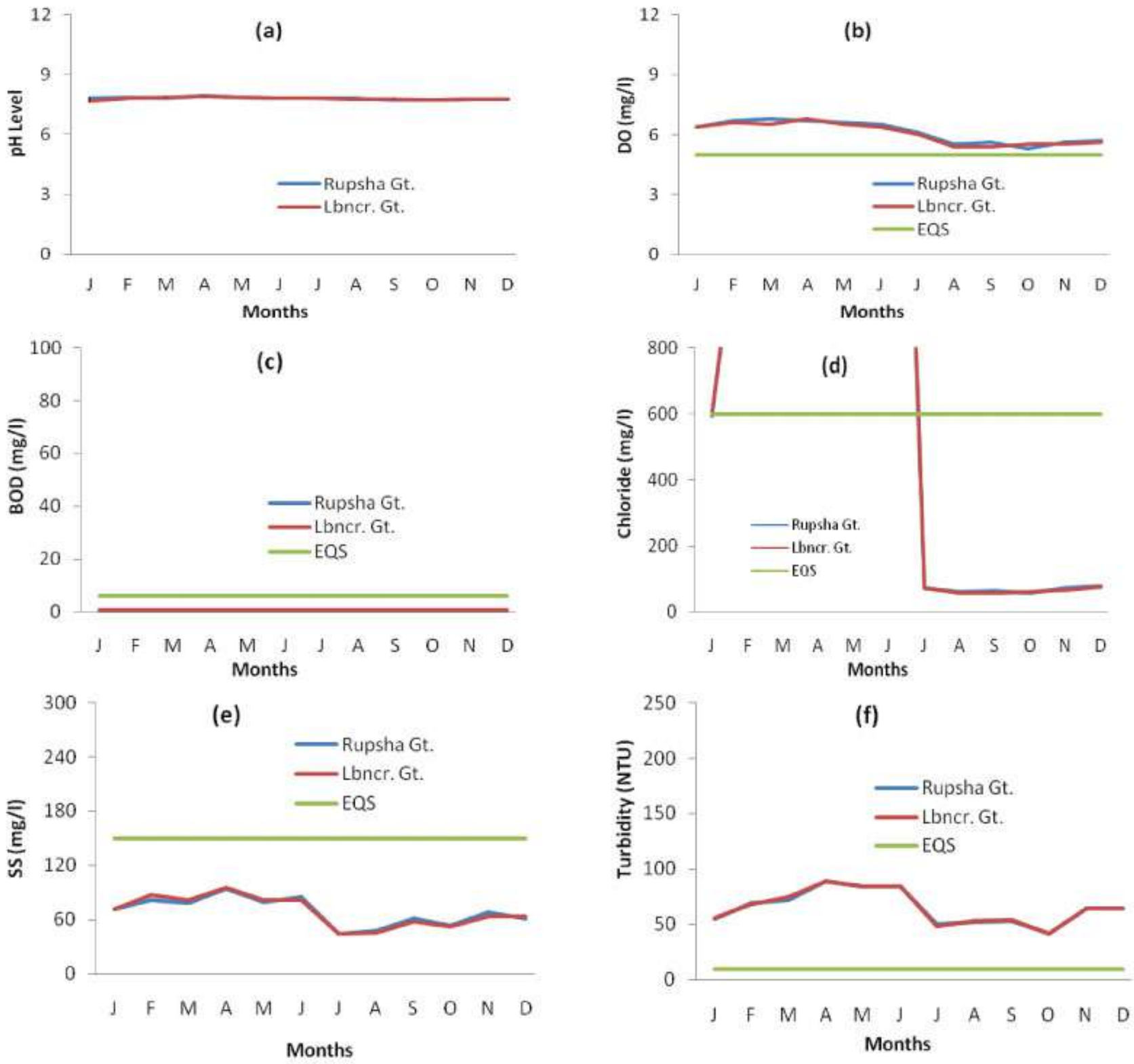


Fig.16. Graphical presentation of pH, DO, BOD, Chloride, SS and Turbidity of Rupsha River in 2016

In 2016, pH varied from 7.66 to 7.92 (Fig.16a) while standard pH for inland surface water is 6.5 to 8.5. In 2015, pH level varied from 7.72 to 8.5. In 2016, DO level was above the EQS (≥5 mg/l) for fisheries. The maximum and the minimum DO content was 6.8 in march and 5.3 mg/l in October at Rupsha ghat respectively (Fig.16b). In 2015, DO level was varied from 5.1 to 6.7 mg/l. In 2016, the maximum and the minimum BOD was 0.7 and 0.9 mg/l respectively (Fig.16c). In 2015, BOD level was from 0.7 to 1.2 mg/l. In 2016, 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 58 to 3910 mg/l (Fig.16d). In 2015, Chloride varied from 32 to 10082 mg/l. In 2016, SS varied from 44 to 96 mg/l (Fig.16e) and was within the EQS limit. In 2015, SS varied from 35 to 94 mg/l. In 2016, Turbidity level at both locations of Rupsha river was very high in 2016. Turbidity was highest in May and varied from 41.40 to 88.60 NTU (Fig.15f) while EQS for drinking water is 10 NTU. In 2015, Turbidity range was from 15.23 to 88.63 NTU.

Table-22. EC of Rupsha River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Rupsha Ghat	2230	7420	12134	12142	10236	10112	386	298	286	**268**	304	324
Labanchara Ghat	2296	7460	**12482**	12148	10240	10109	382	294	282	284	302	322
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, EC was high from January to June in 2016. EC level varied from 268 to 12482 mg/l (Table-22) while standard EC for treated wastewater from industrial units is 1200 µmhos/cm. In 2015, EC level varied from 282 to 27828 mg/l

Table-23. Salinity of Rupsha River Water in 2016

Sampling Locations	Salinity (ppt)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Rupsha Ghat	1.8	4.1	7.6	7.7	6.4	6	0.2	0.1	0.1	0.1	0.1	0.1
Labanchara Ghat	1.6	4.1	**7.9**	7.8	6.3	6	0.2	**0.1**	0.1	0.1	0.1	0.1
EQS for wastewater after treatment from industrial units 400 ppt												

In 2016, Salinity level varied 0.1 ppt to 7.9 ppt. The maximum and the minimum salinity was 7.9 ppt in March and 0.1 ppt August to December (Table-23). In 2015, Salinity level varied from 0.1 ppt to 18.7 ppt.

4.17 Mathavanga River

Mathavanga river 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 2016, pH varied from 6.62 to 7.79 (Fig.17a) while standard pH for inland surface water is 6.5 to 8.5. In 2015, pH range was from 7.52 to 8.0. In 2016, DO level varied from 4.9 to 5.3 mg/l (Fig.17b) while standard DO for fisheries is ≥5 mg/l. In 2015, DO level varied from 4.8 to 6.2 mg/l. In 2016, BOD was 0.8 mg/l all over the year (Fig.17c). In 2015, BOD range was from 0.7 to 0.8 mg/l. In 2016, TDS varied from 134 to 316 mg/l (Fig.17d). In 2015, TDS range was from 144

to 315 mg/l. Chloride of Mathavanga river water varied from 32 to 36 mg/l (Fig.17e) while EQS for Chloride is 600 mg/l. In 2015, Chloride content varied from 25 to 52 mg/l. In 2016, Turbidity level was higher than EQS (10 NTU) for drinking water and varied from 36.2 to 46.2 NTU (Fig.17f). In 2015, Turbidity range was from 10.3 to 48.26 NTU.

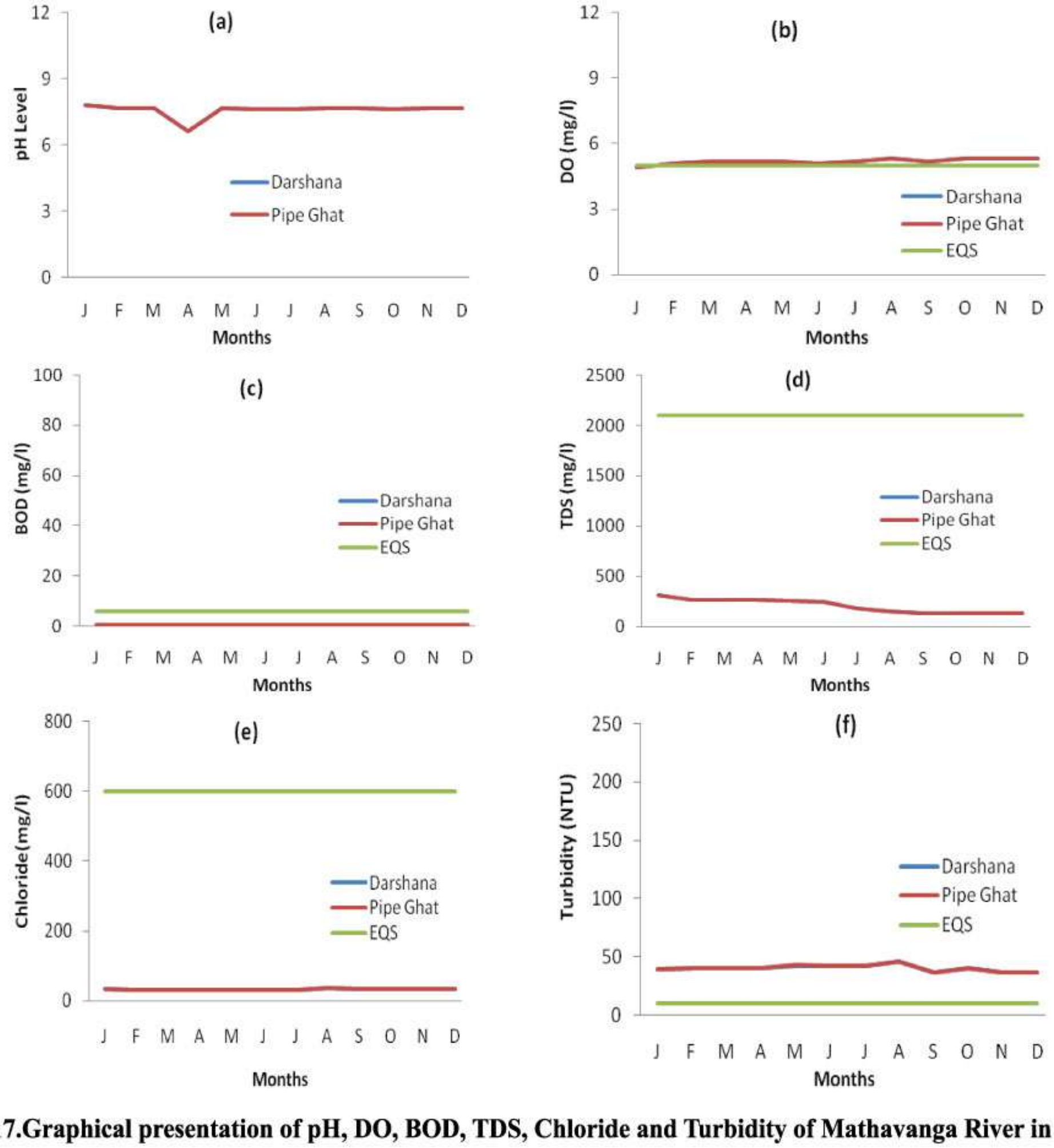


Fig.17.Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Mathavanga River in 2016

4.18 Pashur River

The Pashur river is in southwestern Bangladesh and a distributary of the Ganges. It continues as the Rupsa River. All its distributaries are tidal. It meets the Shibsa River within the Sundarbans and Near the sea the river named as 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 2016, pH level varied from 7.54 to 8.2 (Fig.18a) and was within the EQS (6.5 to 8.5) though slightly alkaline. In 2015, pH level varied from 7.54 to 8.2. In 2016, DO level was above the EQS (≥5 mg/l) for fisheries all over the year. The maximum and the minimum concentration of DO was 6.9 and 5.6 mg/l respectively (Fig/18b). In 2015, DO varied from 5.0 and 6.8 mg/l. In 2016, BOD level was within the EQS (≤6 mg/l) for fisheries during the sampling period. The maximum and the minimum value of BOD was 1.1 and 0.7 mg/l respectively (Fig.18c). In 2015, BOD level varied from 0.8 and 1.2 mg/l. In 2016, High level of TDS was found at Pipeghat compare to other points of the river. TDS varied from 254 to 11521 mg/l (Fig.17d). In 2015, TDS level varied from 144 to 16376 mg/l.

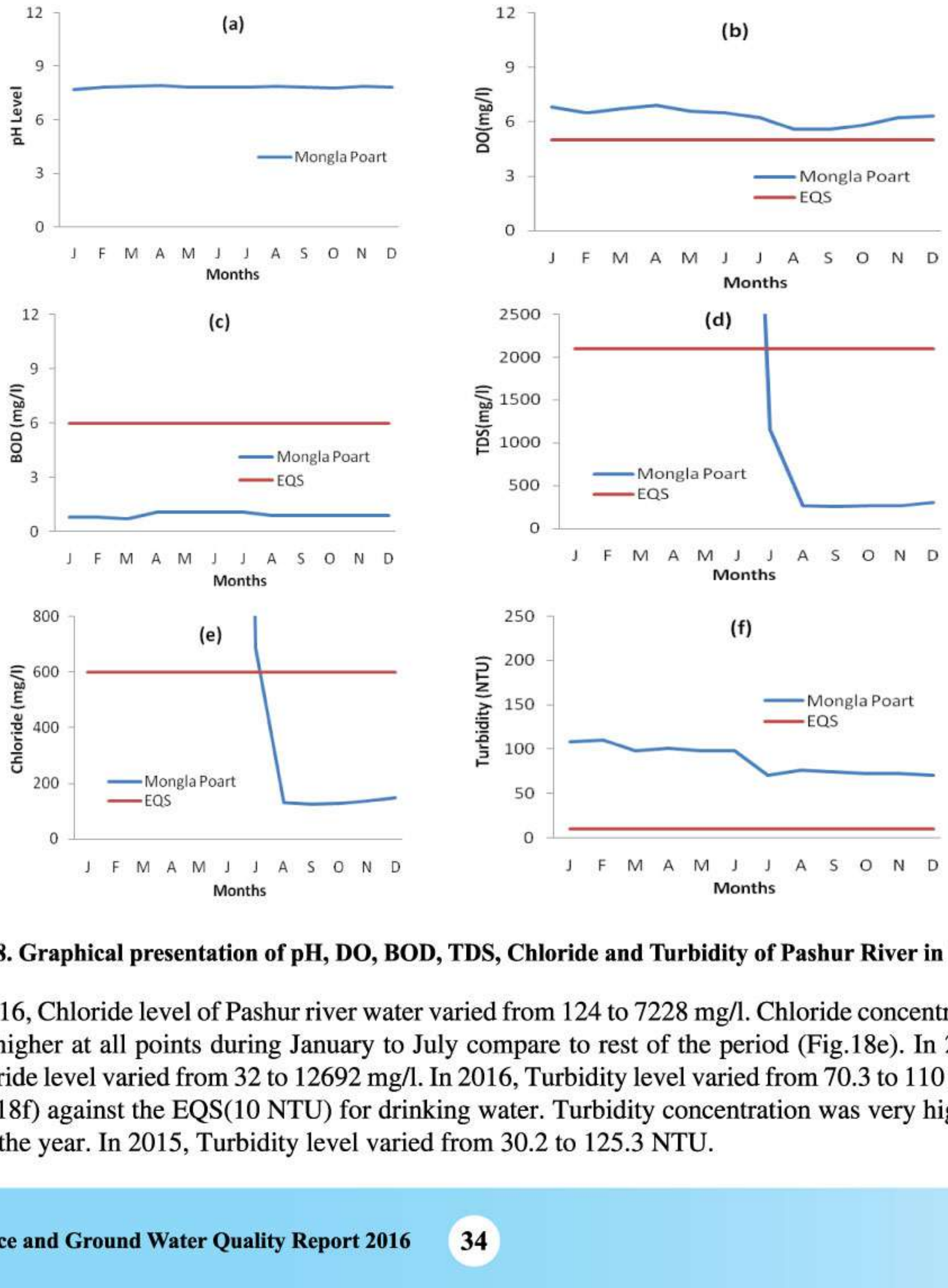


Fig.18. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Pashur River in 2016

In 2016, Chloride level of Pashur river water varied from 124 to 7228 mg/l. Chloride concentration was higher at all points during January to July compare to rest of the period (Fig.18e). In 2015, Chloride level varied from 32 to 12692 mg/l. In 2016, Turbidity level varied from 70.3 to 110 NTU (Fig.18f) against the EQS(10 NTU) for drinking water. Turbidity concentration was very high all over the year. In 2015, Turbidity level varied from 30.2 to 125.3 NTU.

Table-24. EC of Pashur River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mongla Poart	5810	10260	22080	**23042**	19642	19204	2302	526	**508**	526	546	604
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum salinity was 23042 µmhos/cm in April and 508 µmhos/cm in September while EQS for EC is 1200 µmhos/cm (Table-24). In 2015, EC varied from 288 to 32752 µmhos/cm.

Table-25. Salinity of Pashur River Water in 2016

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mongla Poart	3.1	5.8	12.8	**13.1**	10.2	9.9	1.6	0.8	**0.6**	0.6	0.6	0.8
EQS for wastewater after treatment from industrial units 400 ppt												

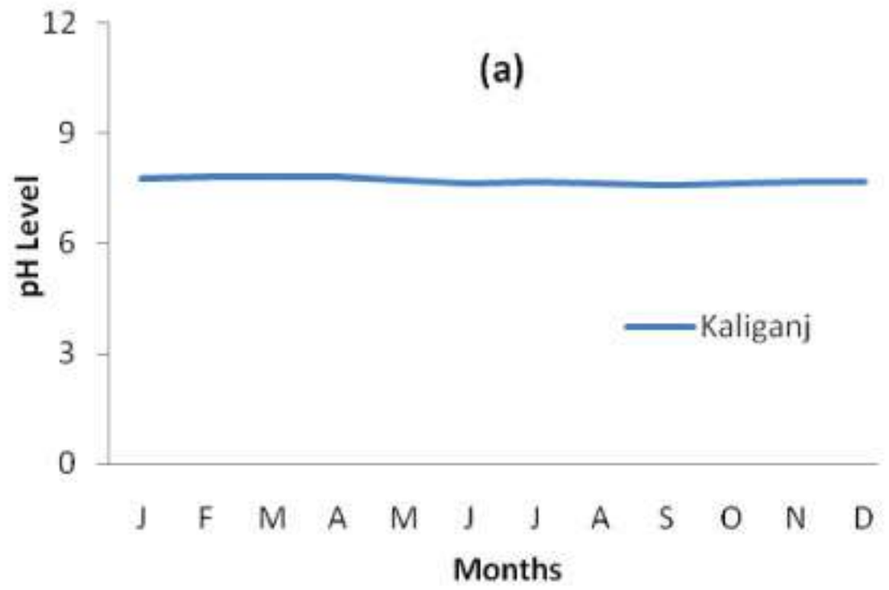
In 2016, the maximum and the minimum salinity was 13.1 ppt in April and 0.6 ppt in September to November while EQS for Salinity is 400 ppt (Table-25). In 2015, Salinity varied from 0.3 ppt to 21.3 ppt.

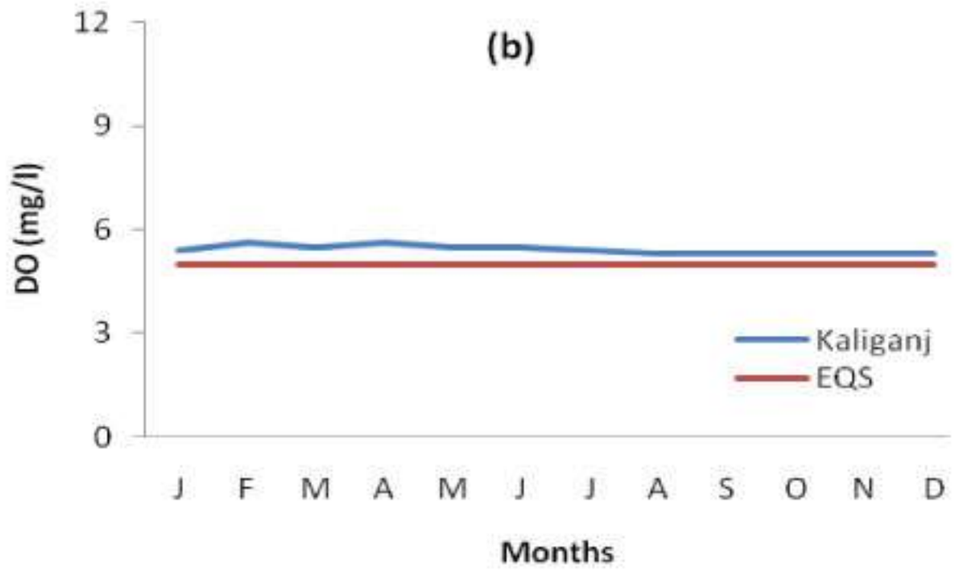
4.19 Khakshiali River

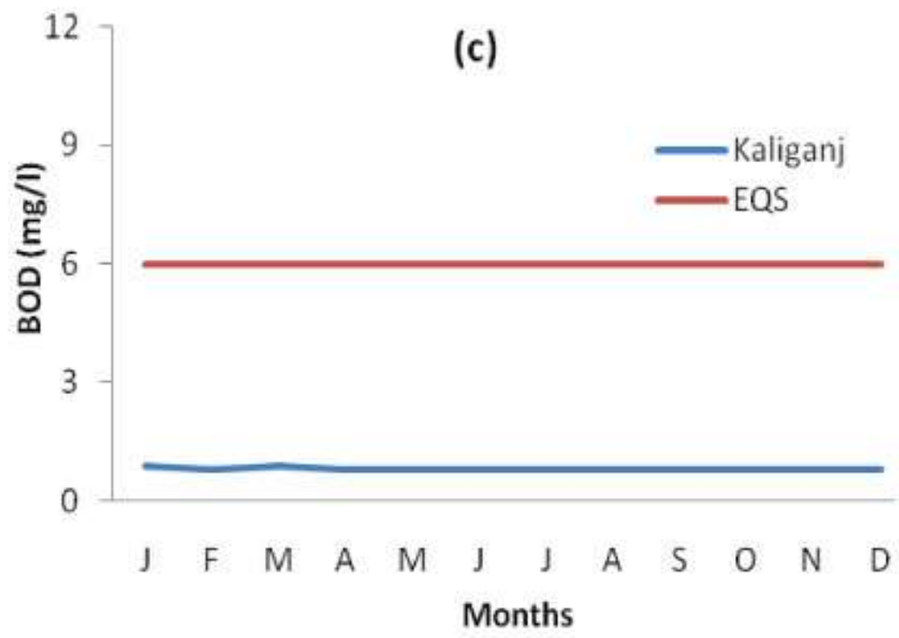
Khakshiali river is located in Satkhira district in Khulna division. To monitor water quality of Kakshiali river, water samples were collected from three different points of Kaligonj location e.g. Kaliganj Bank, Middle and Opposite bank at Shatkhira in 2016. For analysis, average values of three points were considered.

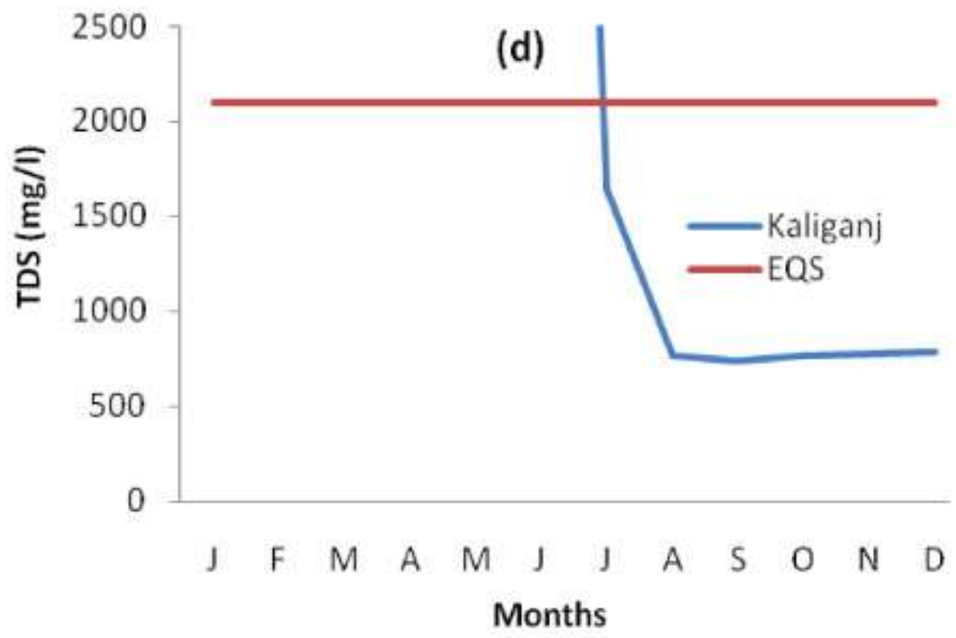
In 2016, pH level was within the EQS (6.5-8.5) for inland surface water and was varied from 7.58 to 7.79 (Fig.18a). In 2015, pH was from 7.54 to 7.9. In 2016, DO level varied from 5.3 to 5. 6mg/l (Fig.18b) throughout the year while EQS for fisheries is $\geq$5 mg/l. In 2015, DO level varied from 5.0 to 6.1 mg/l. In 2016, BOD was far below the EQS ($\leq$6 mg/l). It varied from 0.8 to 0.9 mg/l (Fig.18c). In 2015, BOD level varied from 0.7 to 1.1 mg/l. In 2016, TDS level was very high all January to June. The minimum TDS was 742 mg/l in September and the maximum TDS was 11641 mg/l in Aujust (Fig.18d). In 2015, TDS level varied from 144 to 17614 mg/l.

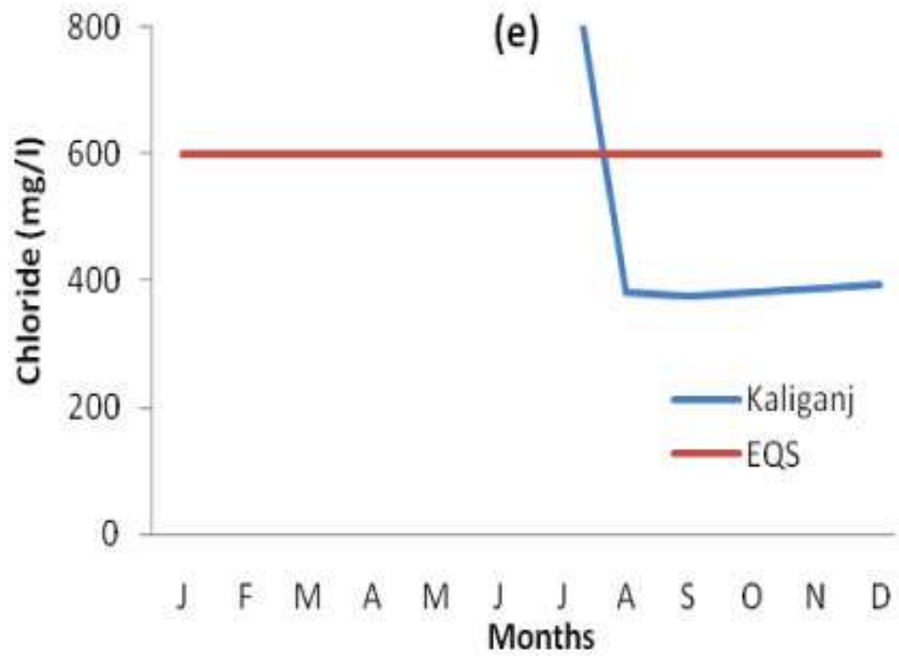
In 2016, Chloride concentration was very high all over the year and varied from 376 to 7322 mg/l (Fig.18e) while standard for treated wastewater from industrial units is 600 mg/l. The highest Chloride was found in April and the lowest value was in September. In 2015, Chloride level varied from 32 to 13124 mg/l. Turbidity level was above the EQS (10 NTU) limit for drinking water all the year that varied from 65.3 to 124.47 NTU (Fig.18f). In 2015, Turbidity level varied from 28.3 to 134.3 NTU.











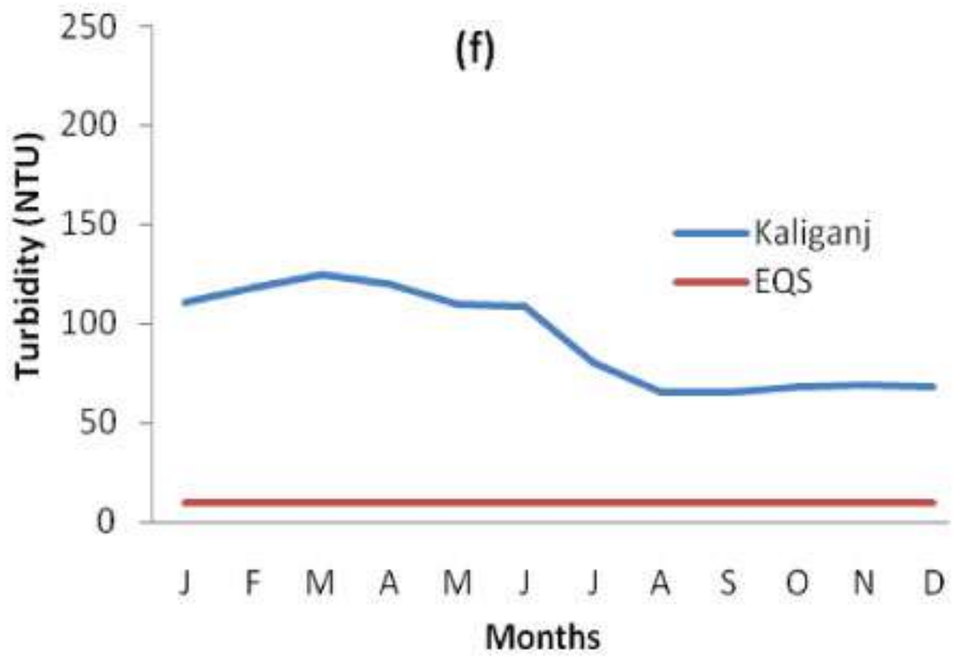


Fig.19. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Kakshiali River in 2016

Table-26. EC of Kakshiali River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kaliganj (Avg)	10500	12920	23028	**23038**	20122	20198	3280	1526	**1482**	1526	1542	1564
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, the maximum and the minimum EC was 23038 µmhos/cm in April and 1482 µmhos/cm in September while EQS for EC is 1200 µmhos/cm (Table-26). In 2015, EC varied from 288 to 35228 µmhos/cm.

Table-27. Salinity of Kakshiali River Water in 2016

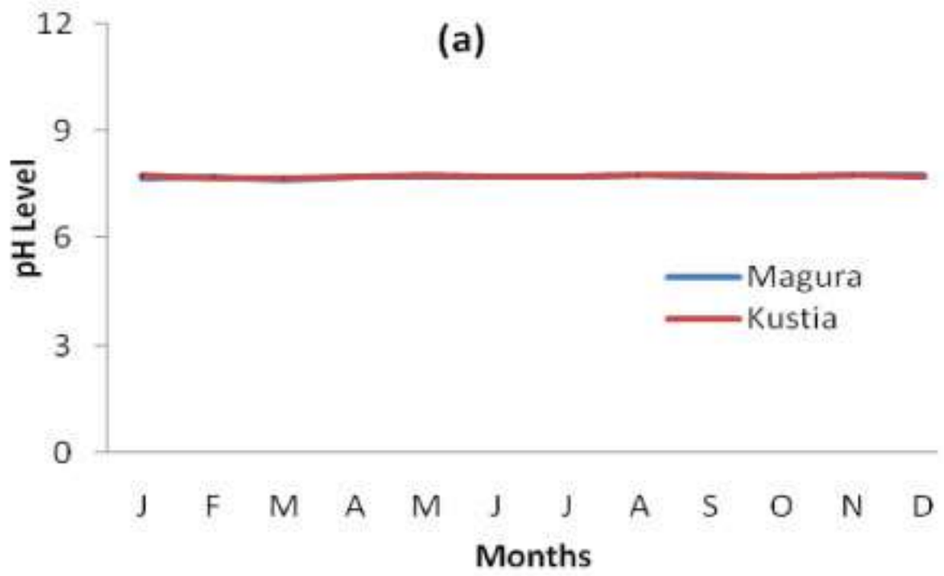
Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kaliganj (Avg)	6.5	8.2	14.3	**14.5**	10.8	10.2	1.2	0.9	**0.8**	1.1	1.3	1.4
EQS for wastewater after treatment from industrial units 400 ppt												

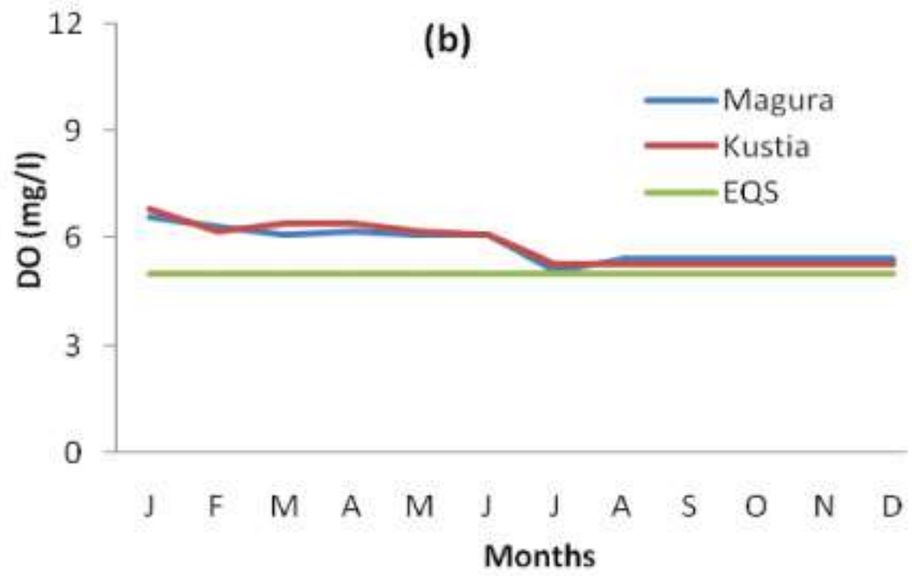
In 2016, the maximum and the minimum Salinity was 14.5 ppt in April and 0.8 ppt in September (Table-27). In 2015, Salinity varied from 0.1 ppt to 23.1 ppt.

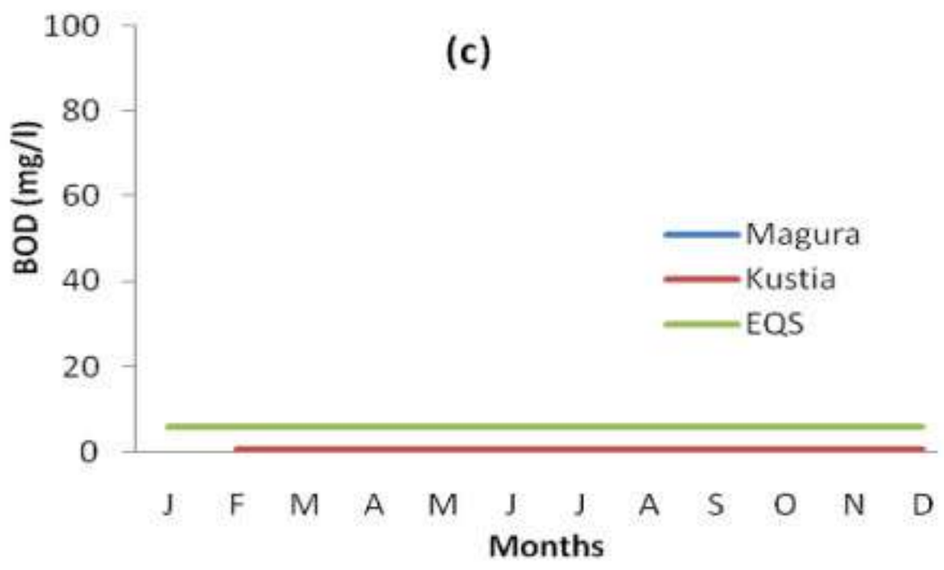
4.20 Gorai River

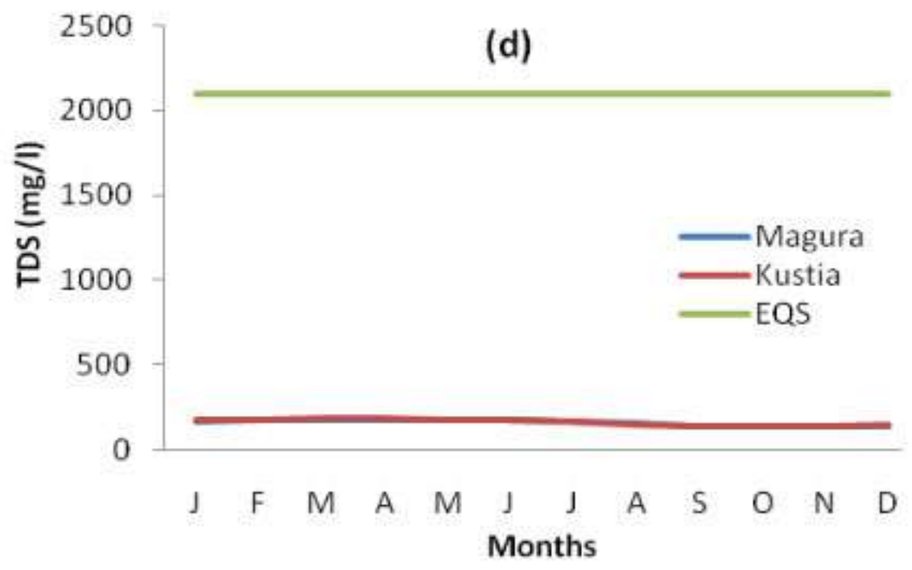
Gorai river is located in Kushtia district in Khulna division. Water samples were collected from two locations viz. Magura and Kustia comprising three points each. Average values of three points of a location were used for graphical representation.

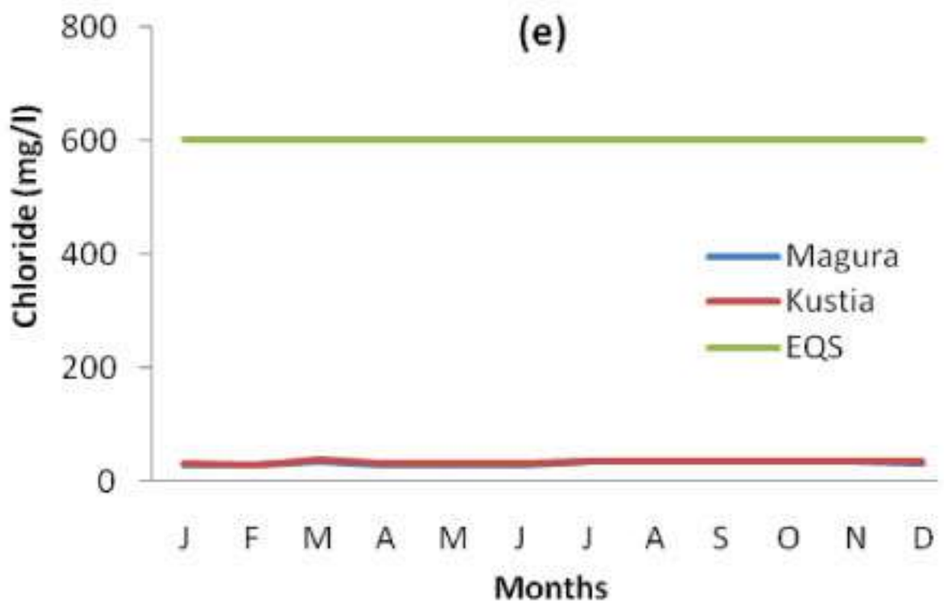
In 2016, pH of Gorai river water was varied from 7.65 to 7.79 (Fig.20a) and was within the EQS (6.5-8.5) for inland surface water. In 2015, pH level varied from 7.58 to 8.5. In 2016, DO was above the EQS ($\geq$5 mg/l) limit for fisheries at both locations. Level of DO varied from 5.1 to 6.8 mg/l (Fig.20b). In 2015, DO level varied from 5.1 to 6.8 mg/l. In 2016, BOD level was within the EQS ($\leq$6 mg/l) and varied from 0.7 to 0.8 mg/l (Fig.20c). In 2015, BOD range was from 0.7 to 0.9 mg/l. In 2016, 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 134 to 184 mg/l (Fig.20d). In 2015, TDS level varied from 130 to 206 mg/l. In 2016, 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 28 mg/l (Fig.20e). In 2015, Chloride level was from 21and 38mg/l. In 2016, Turbidity level was relatively higher throughout the year than the EQS (10 NTU) for drinking water. It varied from 24.33 to 36.26 NTU (Fig.20f). In 2015, Turbidity level varied from 15.7 to 38.3 NTU.











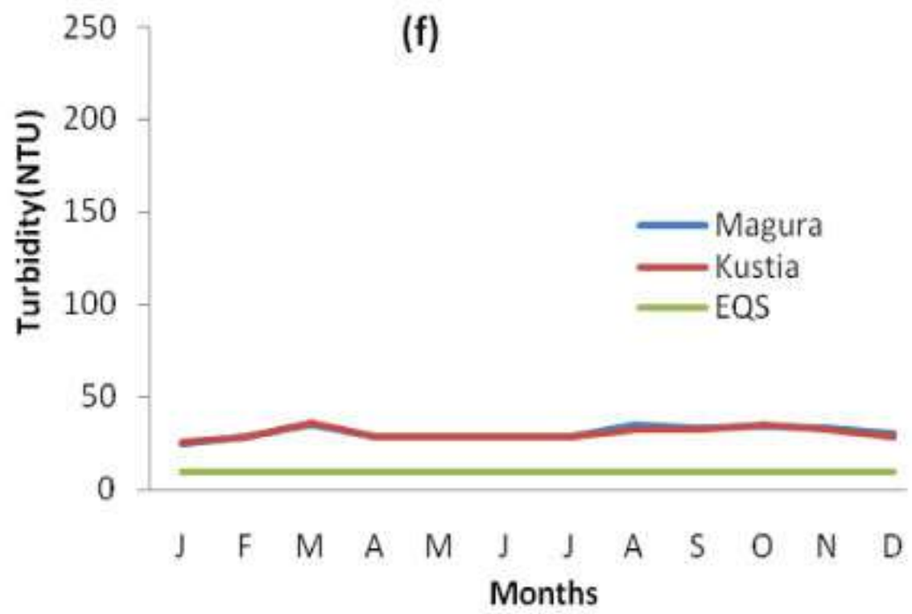


Fig.20. Graphical presentation of pH, DO BOD, TDS, Chloride and Turbidity of Gorai River in 2016

4. 21 Modhumoti River

Madhumati river, distributary of the upper Padma River flowing through southwestern Bangladesh. It leaves the Padma just north of Kushtia and flows 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 2016, 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 considered.

In 2016, pH level of Modhumoti river was within the EQS and varied from 7.52 to 7.86 (Fig.21a). In 2015, pH level varied from 7.51 to 7.86. In 2016, DO was varied from 5.1 to 5.8 mg/l while EQS is $\geq$5 mg/l for fisheries (Fig.21b). In 2015, DO level was varied from 5.1 to 5.8 mg/l. In 2016, BOD of the river was also in the EQS ($\leq$6 mg/l) for fisheries. BOD was 0.8 mg/l all over the year

(Fig.21c). In 2015, BOD varied from 0.7 mg/l to 0.9 mg/l. In 2016, TDS of Modhumoti river water was within EQS (2100 mg/l). The maximum and the minimum value was 176 mg/l and 134 mg/l respectively (Fig.21d). In 2015, TDS level varied from 114 to 193 mg/l. In 2016, Chloride level varied from 52 to 72 mg/l while EQS for treated wastewater from industrial units is 600 mg/l (Fig.20e). In 2015, Chloride level varied from 0.0 to 72 mg/l. In 2016, Turbidity varied from 42.2 to 79.06 NTU (Fig.21f). In 2015, Turbidity varied from 38.13 to 78.30 NTU.

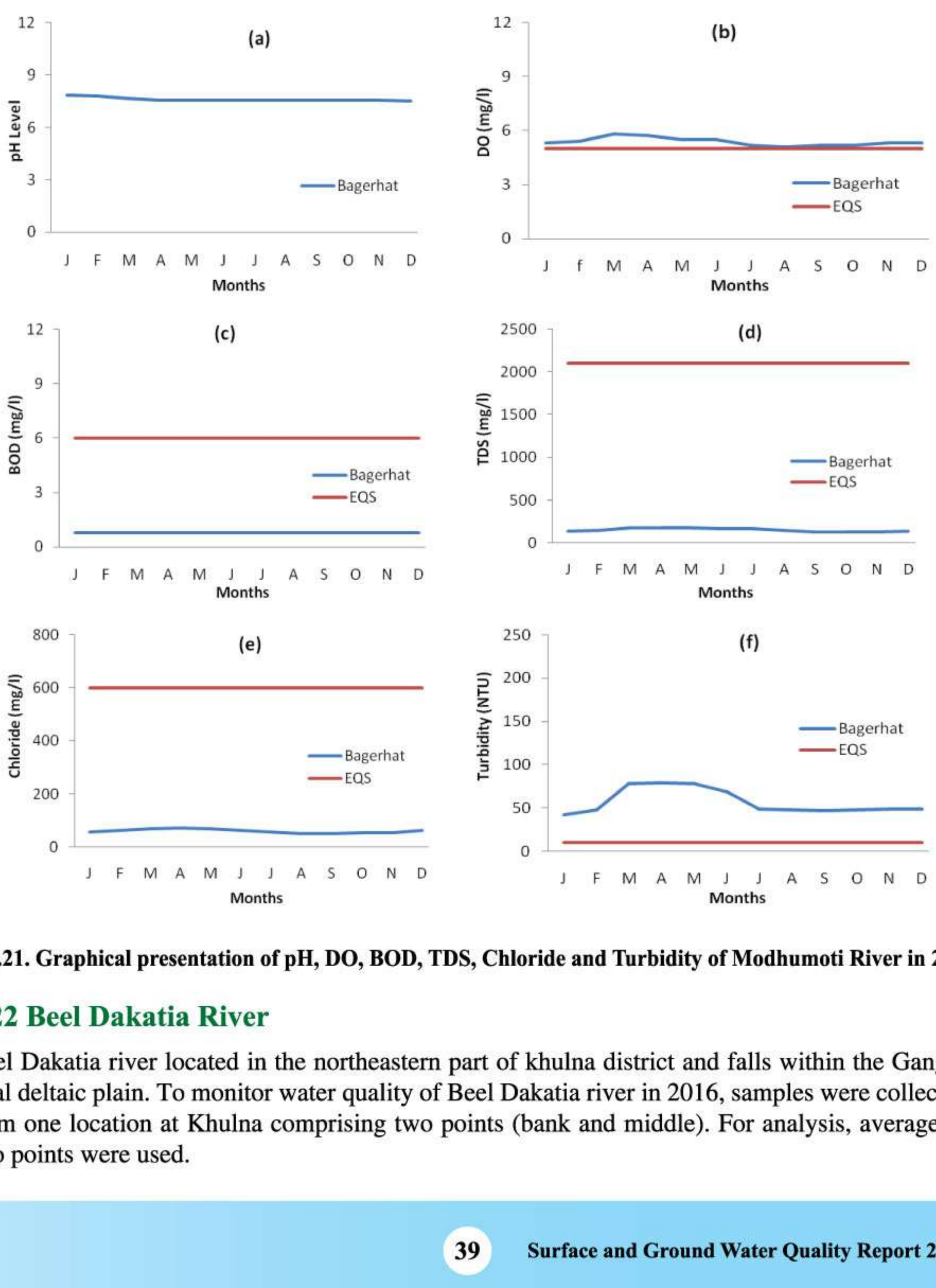
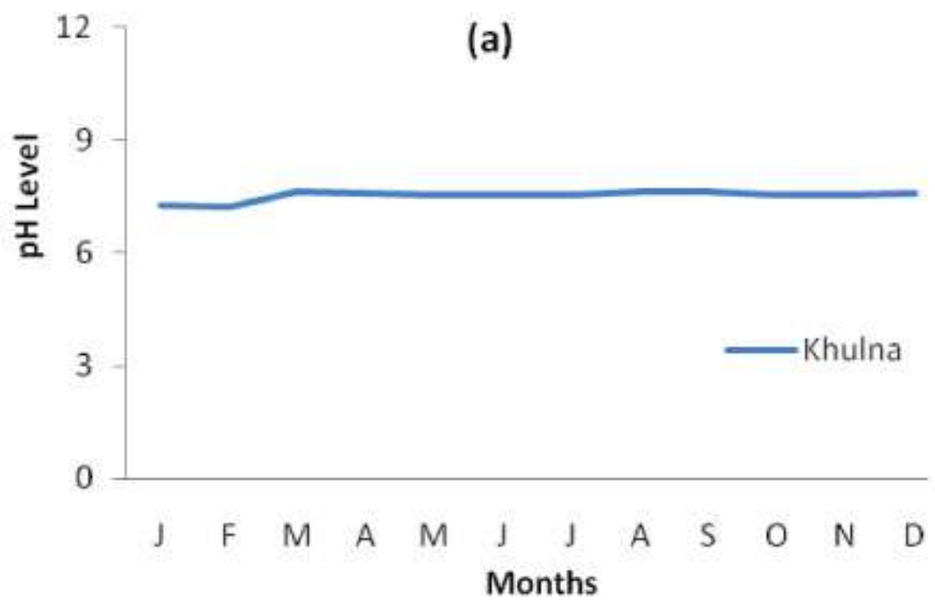


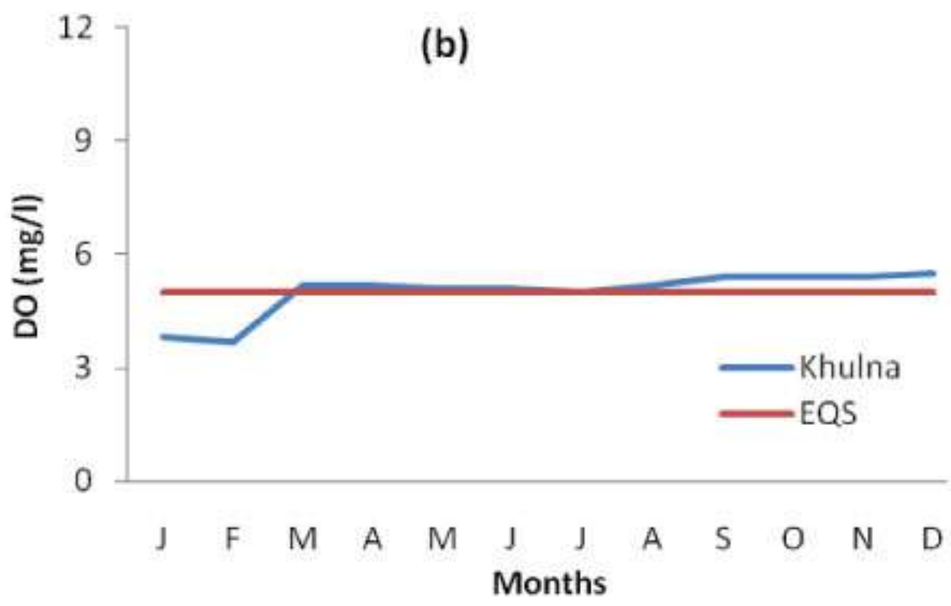
Fig.21. Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Modhumoti River in 2016

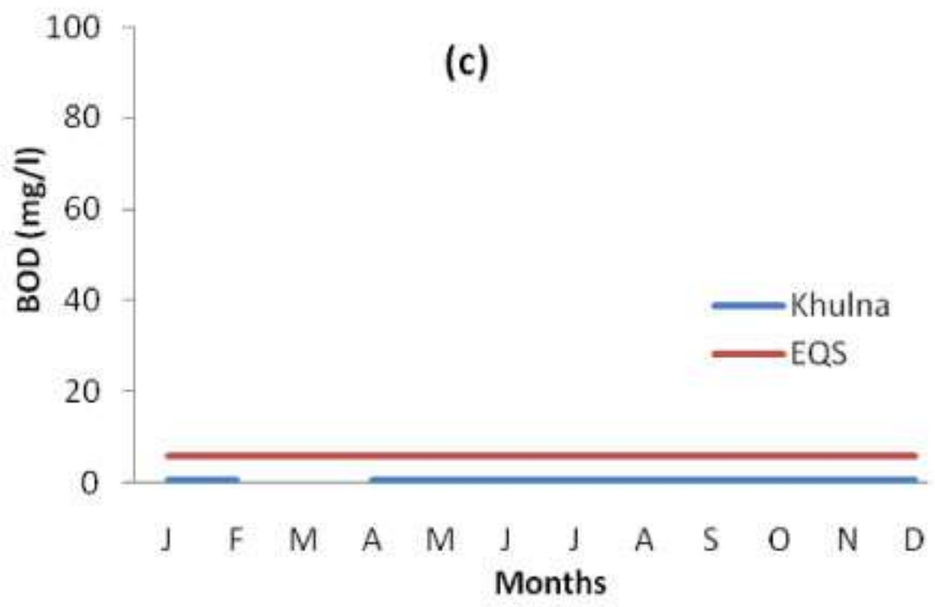
4.22 Beel Dakatia River

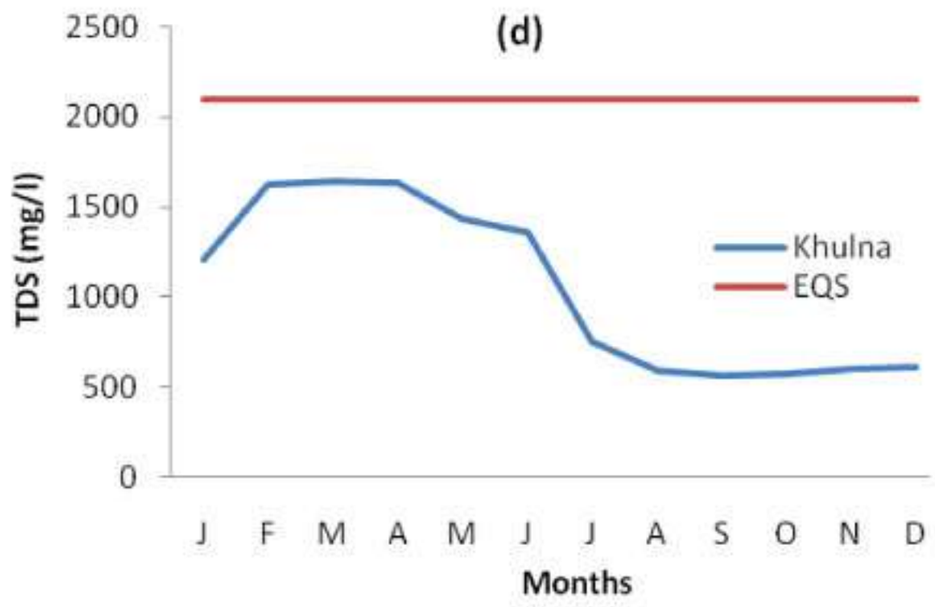
Beel Dakatia river located in the northeastern part of khulna district and falls within the Ganges tidal deltaic plain. To monitor water quality of Beel Dakatia river in 2016, samples were collected from one location at Khulna comprising two points (bank and middle). For analysis, average of two points were used.

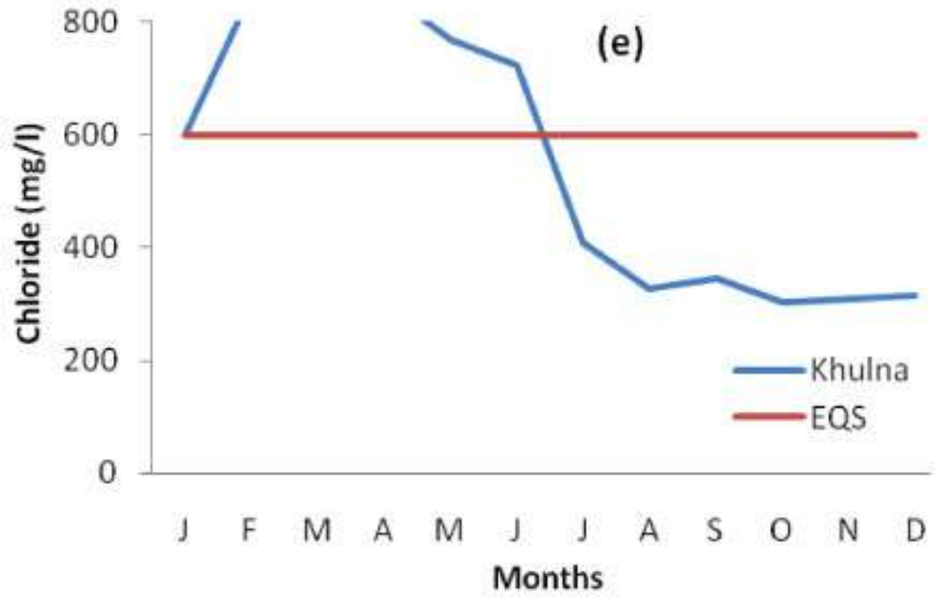
In 2016, pH level was within the EQS and varied from 7.22 to 7.64 (Fig.22a). In 2015, pH level varied from 7.22 to 7.73. In 2016, DO varied from 3.7 to 5.5 mg/l (Fig.22b) and was closer to the EQS for fisheries (≥5 mg/l). In 2015, DO level varied from 3.7 to 5.9 mg/l. In 2016, BOD Concentration varied from 0.6 to 0.8 mg/l (Fig.22c). In 2015, BOD Concentration varied from 0.6 to 0.9 mg/l. In 2016, the maximum and the minimum TDS was 1643 mg/l in March and 562 mg/l in September (Fig.22d). In 2015, TDS level varied from 590 to 6310 mg/l. In 2016, Chloride level varied from 302 mg/l to 860 mg/l while EQS for treated wastewater from industrial units is 600 mg/l. The maximum value was found in March and the minimum was in October (Fig.22e). In 2015, Chloride level varied from 272 mg/l to 38578 mg/l. In 2016, Turbidity varied from 40.8 to 66.85 NTU (Fig.22f) and was higher than EQS (10 NTU) for dirking water. In 2015, Turbidity range was from 40.8 to 68.25 NTU.











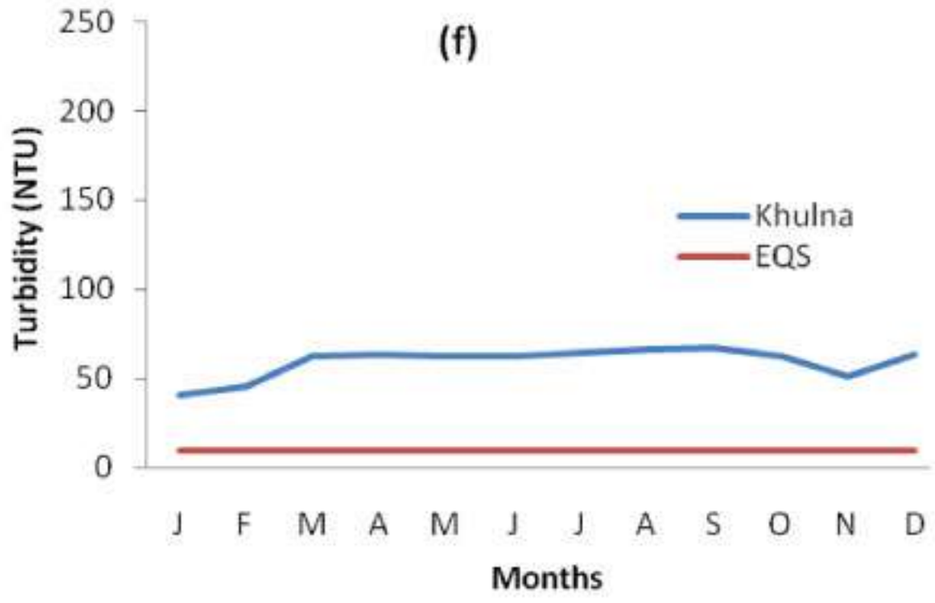


Fig.22.Graphical presentation of pH, DO, BOD, TDS, Chloride and Turbidity of Beel Dakatia River in 2016

Table-28. Salinity of Beel Dakatia River Water in 2016

Sampling Locations	Salinity (ppt)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Khulna (Avg)	1.2	1.8	1.8	**1.9**	1.7	1.7	1.1	1	**0.8**	1	1.1	1.2
EQS for wastewater after treatment from industrial units 400 ppt												

In 2016, Salinity varied 0.8 ppt to 1.9 ppt. The maximum and the minimum salinity was 1.9 ppt in April and 0.8 ppt in September (Table-28). In 2015, Salinity varied from 0.1 ppt to 7.2 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 2016, pH level of Kirtankhola river water varied from 7.1 to 7.3 (Fig.23a) and was within the EQS. In 2015, pH range was from 7.0 to 7.9. In 2016, DO level of Kirtankhola rive was above the EQS ($\geq$5 mg/l) for fisheries. DO varied from 7.1 mg/l to 6.9 mg/l (Fig.23b). In 2015, DO level varied from 6.5 mg/l to 7.1 mg/l. In 2016, BOD was 2.0 mg/l round the year. (Fig.23c). In 2015,BOD level varied from 2.0 mg/l and 4.75 mg/l. In 2016, 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.23d). In 2015, TDS level varied from 59 to 102 mg/l. In 2016, Chloride content varied from 130 to 140 mg/l (Fig.23e). In 2015, Chloride level varied from 39 to 135 mg/l. In 2016, T. Alkalinity of Kirtankhola river water was within EQS. The maximum and the minimum T. alkalinity was 147 mg/l in July and 131 mg/l in March (Fig.23f). In 2015, T. alkalinity was 54 mg/l to 147 mg/l.

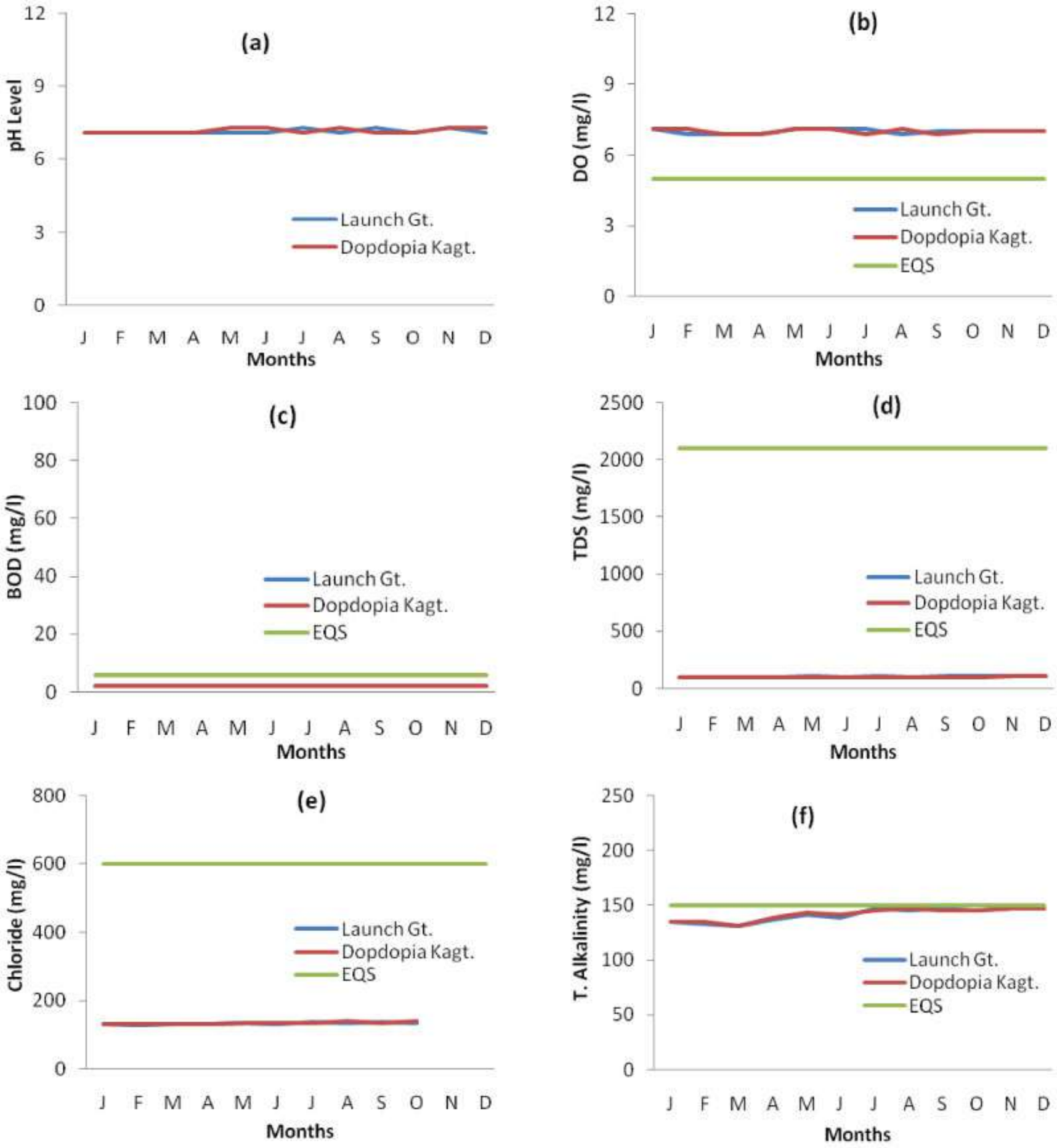


Fig.23.Graphical presentation of pH, DO, BOD, TDS, Chloride and T. Alkalinity of Kirtankhola River in 2016

Table-29. EC of Kirtankhola River Water in 2016

Sampling Locations	EC (µmhos/cm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barisal Launch Ghat	171	169	169	**167**	169	167	171	169	173	171	173	171
Dopdopia Kheya ghat	171	171	169	167	171	171	169	173	171	171	173	**173**
EQS for wastewater after treatment from industrial units 1200 µmhos/cm												

In 2016, EC level of the Kirtankhola river varied from 167 to 173 µmhos/cm against the EQS for treated wastewater from industrial units is 1200 µmhos/cm (Table-29). In 2015, EC varied from 161 to 901 µmhos/cm

4.24 Tetulia River

Tatulia river is a flow of the lower Meghna river originated 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 Tentulia 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 2016, pH level of the Tetulia river water ranged from 6.9 to 7.35 mg/l (Fig.24a) while in 2015, the range was from 7.1 to 7.3. In 2016, DO varied from 6.9 to 7.1 mg/l (Fig.24b) while standard limit for fisheries is (≥5 mg/l). In 2015, DO level varied from 6.3 to 7.2 mg/l. In 2016, BOD level of the Tetulia river was 2.0 round the year (Fig.23c) against corresponding EQS (≤6 mg/l) for fisheries. In 2015, BOD level of the Tetulia river water was varied 2.0 to 2.2 mg/l. In 2016, TDS range varied from 97 to 109 mg/l (Fig.23d). In 2015, TDS range was 91.4 to 97.0 mg/l. In 2016, Chloride level varied from 143 to 163 mg/l (Fig.24e) while EQS for treated wastewater from industrial units is 600 mg/l. In 2015, Chloride level varied from 53 to 161 mg/l. In 2016, EC level was 155-173 µmohos/cm (Fig.24f) and was below the EQS (1200 mg/l). In 2015, EC level varied from 141 to 173 mg/l.

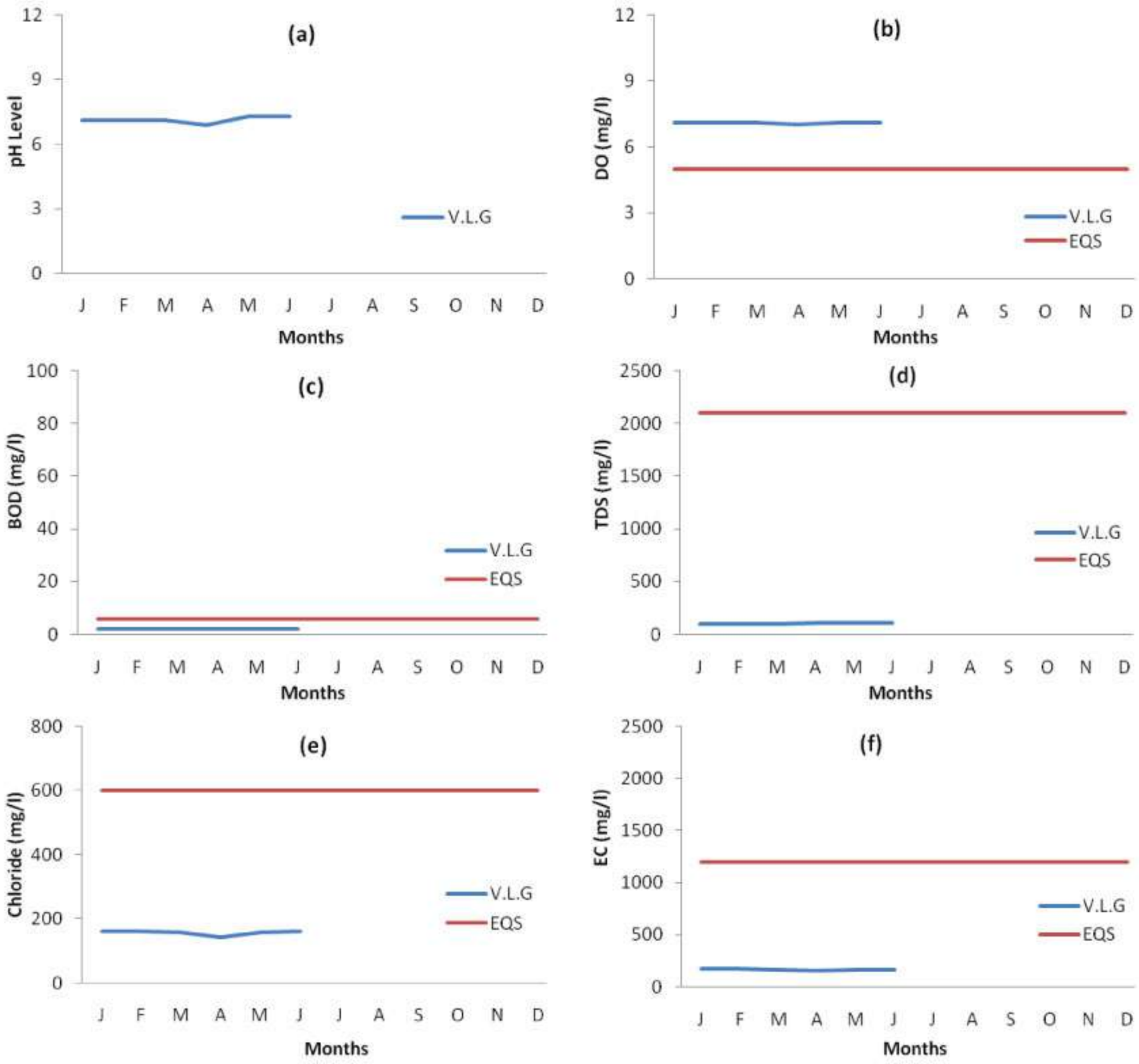
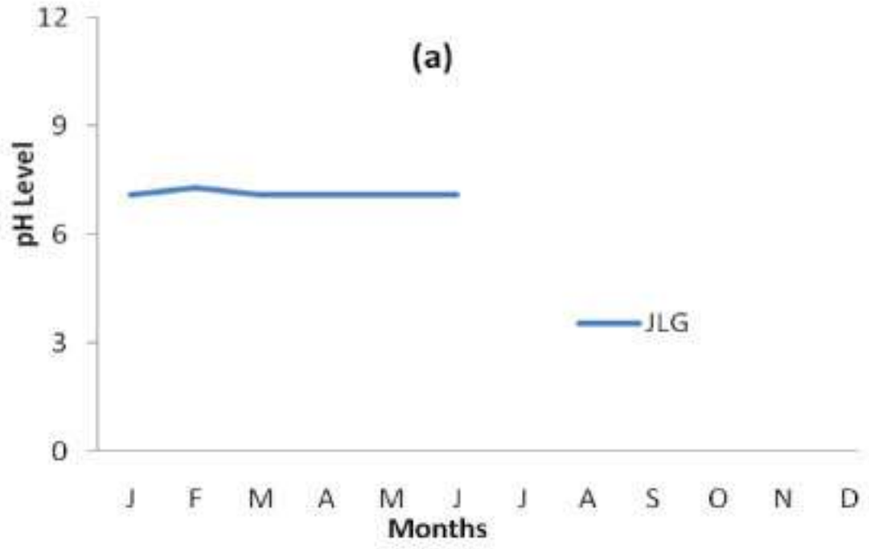


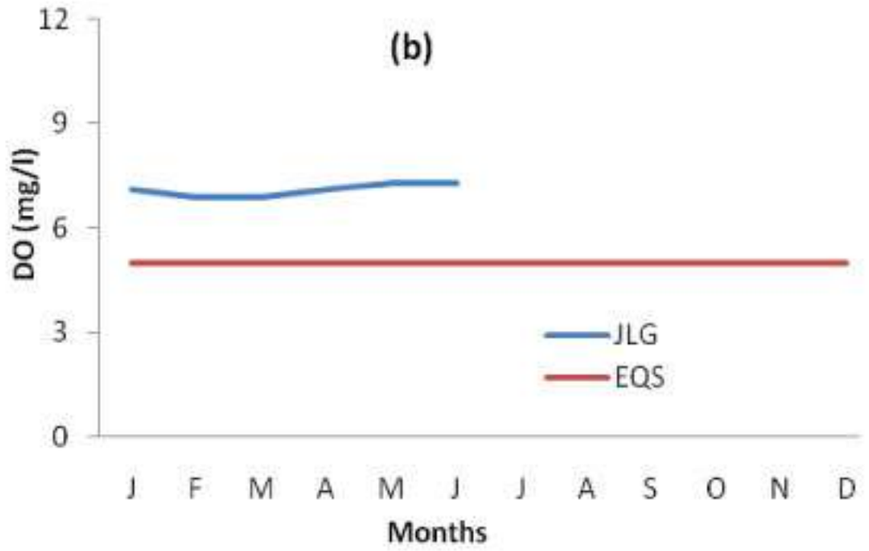
Fig.24.Graphical presentation of pH, DO, BOD, TDS, Chloride and EC of Tetulia River in 2016

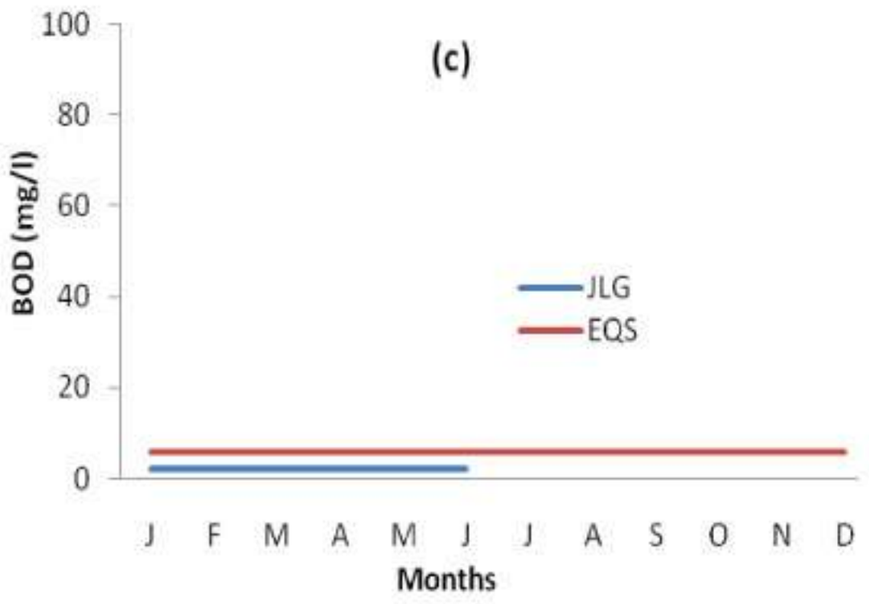
4.25 Sugandha River

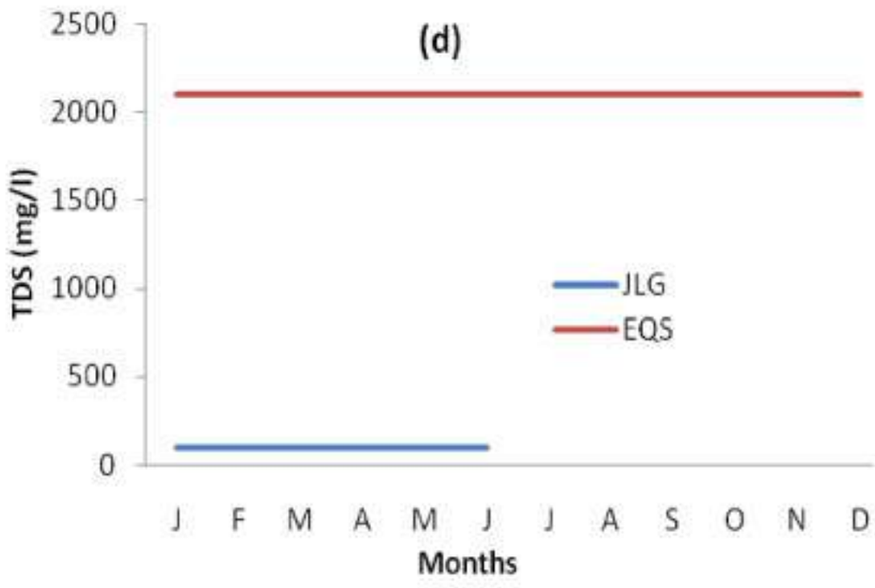
The Sugandha river flows by eastern side of Shayestabd and falls into the Bay of Bengal after meeting with the Megna river at Sahbazpur in Bhola. Another offshoots of the Sugandha river flows south-southwest as the Kirtankhola upto Nalchity keeping the Barisal town on its west bank.The length of this river is 30 km,the width is 1000 m and the depth is 10m.The deltaic branches of the Sugandha river gradually disappeared making various Islands locally knows as in many part of the greater Barisal district. To monitor water quality of Sugandha River water samples were colleted for analysis from Jhalkathi Launch Ghat (JLG) (e.g. Side and middle high tide) of the river.

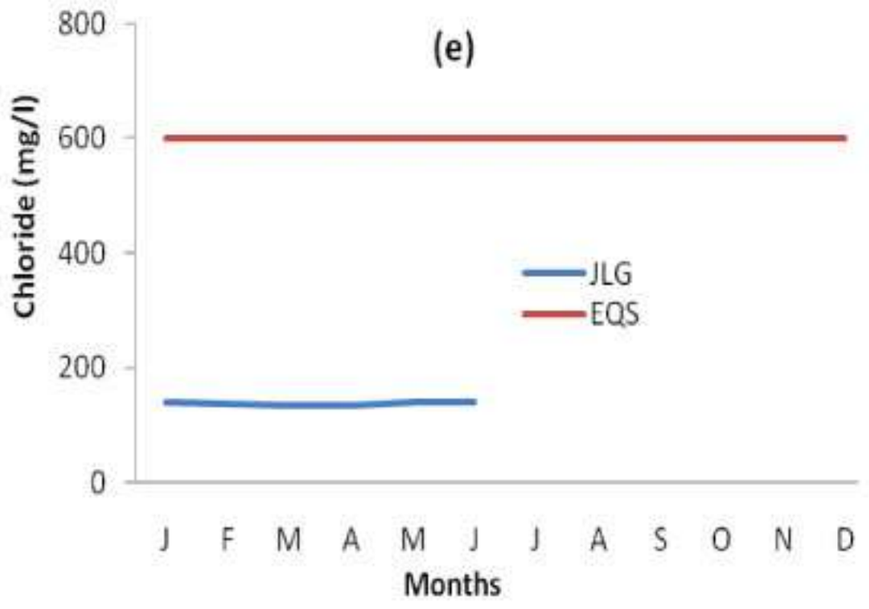
In 2016, pH level of the Sugandha river water varied from 7.1 to 7.3. (Fig.25a) while EQS for fisheries is 6.5 to 8.5. In 2015, pH level varied from 7.1 to 7.5. In 2016, DO level varied from 6.9 to 7.3 mg/l (Fig.25b) and was above the EQS ($\geq$5 mg/l) for fisheries. In 2015, DO level varied from 7.1 to 7.3 mg/l. In 2016, BOD range was 2.0 mg/l round the year (Fig.25c) while EQS for fisheries is $\leq$6 mg/l. In 2015, BOD level varied from 2.0 to 2.1mg/l. In 2016, TDS level of the Sugandha river water was from 97 to 107 mg/l (Fig.25d) while corresponding EQS is 2100 mg/l for treated wastewater from industrial units. In 2015, TDS level varied from 91 to 103 mg/l. In 2016, Chloride level of the Sugandha river water was from 135 to 143 mg/l (Fig.25e) while corresponding EQS is 600 mg/l for treated wastewater from industrial units. In 2015, Chloride level varied from 131 to 141 mg/l. In 2016, EC level of the Sugandha river water was 163 µmohos/cm-159µmohos/cm (Fig.25f) against EQS (150 mg/l) for treated wastewater from industrial units. In 2015, EC was 161 to 165 µmohos/cm.











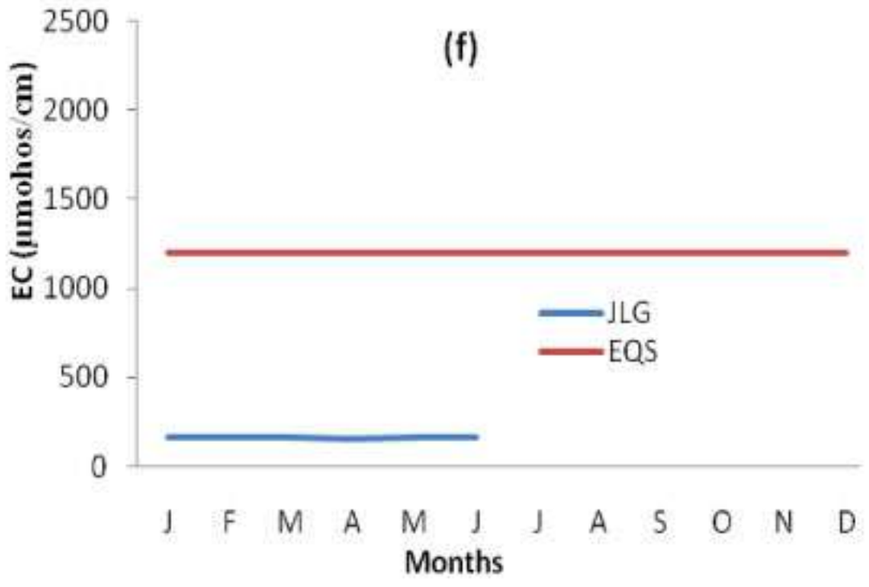


Fig.25.Graphical presentation of pH, DO, BOD, TDS, Chloride and EC of Sugandha River in 2016

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 2016, pH level of the Lohalia river water varied from 7.1 to 7.3. (Fig.26a) while EQS for fisheries is 6.5 to 8.5. In 2015, pH was varied from 7.1 to 7.7. In 2016, DO level varied from 6.9 to 7.1 mg/l (Fig.25b) and was above the EQS ($\geq$5 mg/l) for fisheries. In 2015, DO was varied from 6.3 to 7.1 mg/l. In 2016, BOD range was 2.0 mg/l round the year (Fig.25c) while EQS for fisheries is $\leq$6 mg/l. In 2015, BOD was varied from 2.0 to 2.05 mg/l. In 2016, TDS level of the Lohalia river water was

from 99 to 107 mg/l (Fig.25d) EQS is 2100 mg/l. In 2015, TDS was varied from 71 to 103 mg/l. In 2016, Chloride level of the Lohalia river water was from 157 to 163 mg/l (Fig.25e) EQS is 600 mg/l. In 2015, Chloride was varied from 137 to 163 mg/l. In 2016, EC level of the Lohalia river was varied from 163 to 173 µmhos/cm (Fig.24f) against EQS (1200 µmhos/cm) for treated wastewater from industrial units. In 2015, EC was varied from 141 to 171 µmhos/cm.

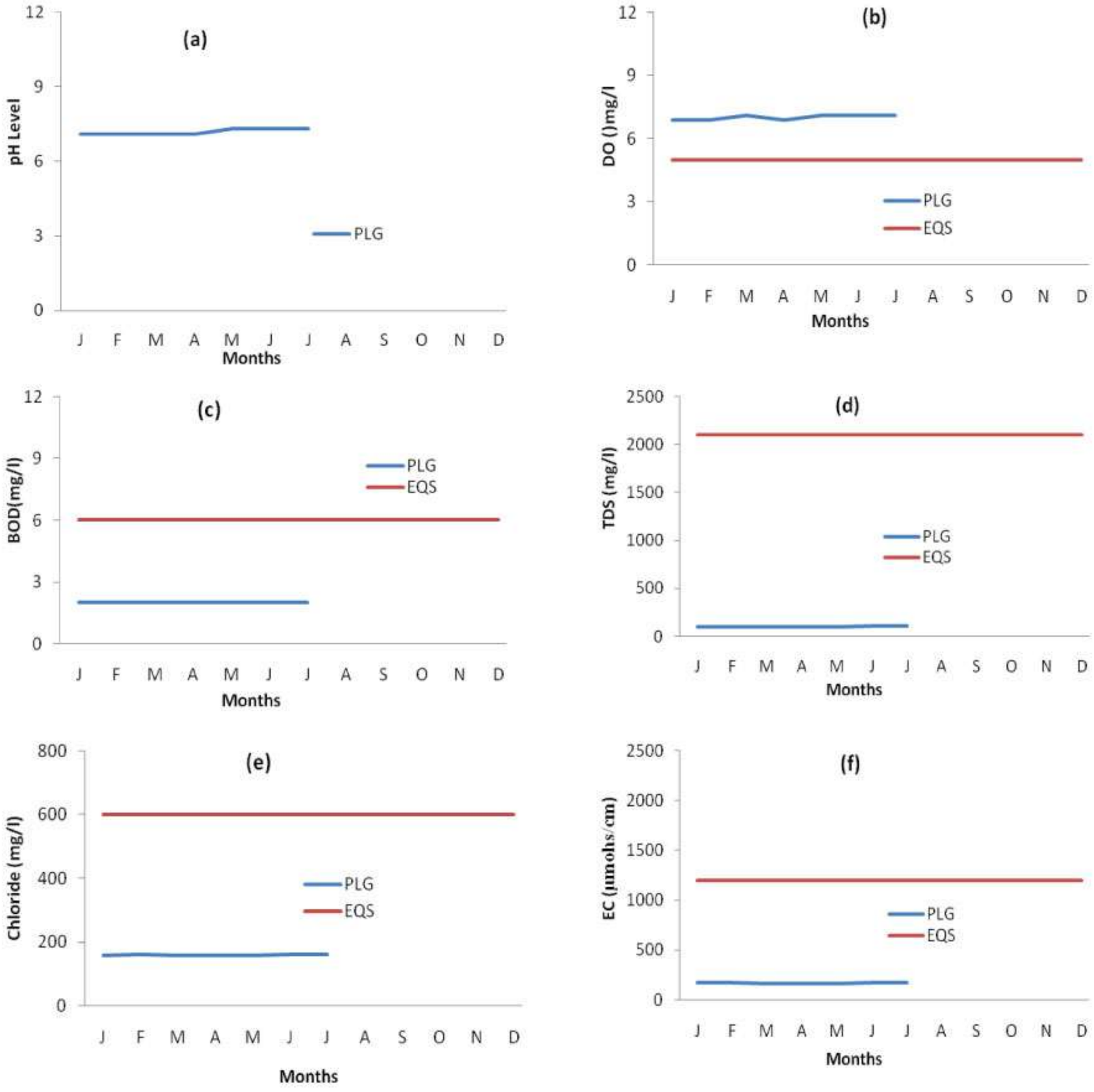


Fig.26.Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Lohalia River in 2016

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 2016, pH level of the Surma river water varied from 6.9 to 7.4 (Fig. 27a) while in 2015, pH was from 6.4 to 7.6. In 2016, DO content was mostly above the EQS (≥5 mg/l). It varied from 5.03 to 7.2 mg/l (Fig. 27b). In 2015, DO level varied from 5.2 to 6.7 mg/l.

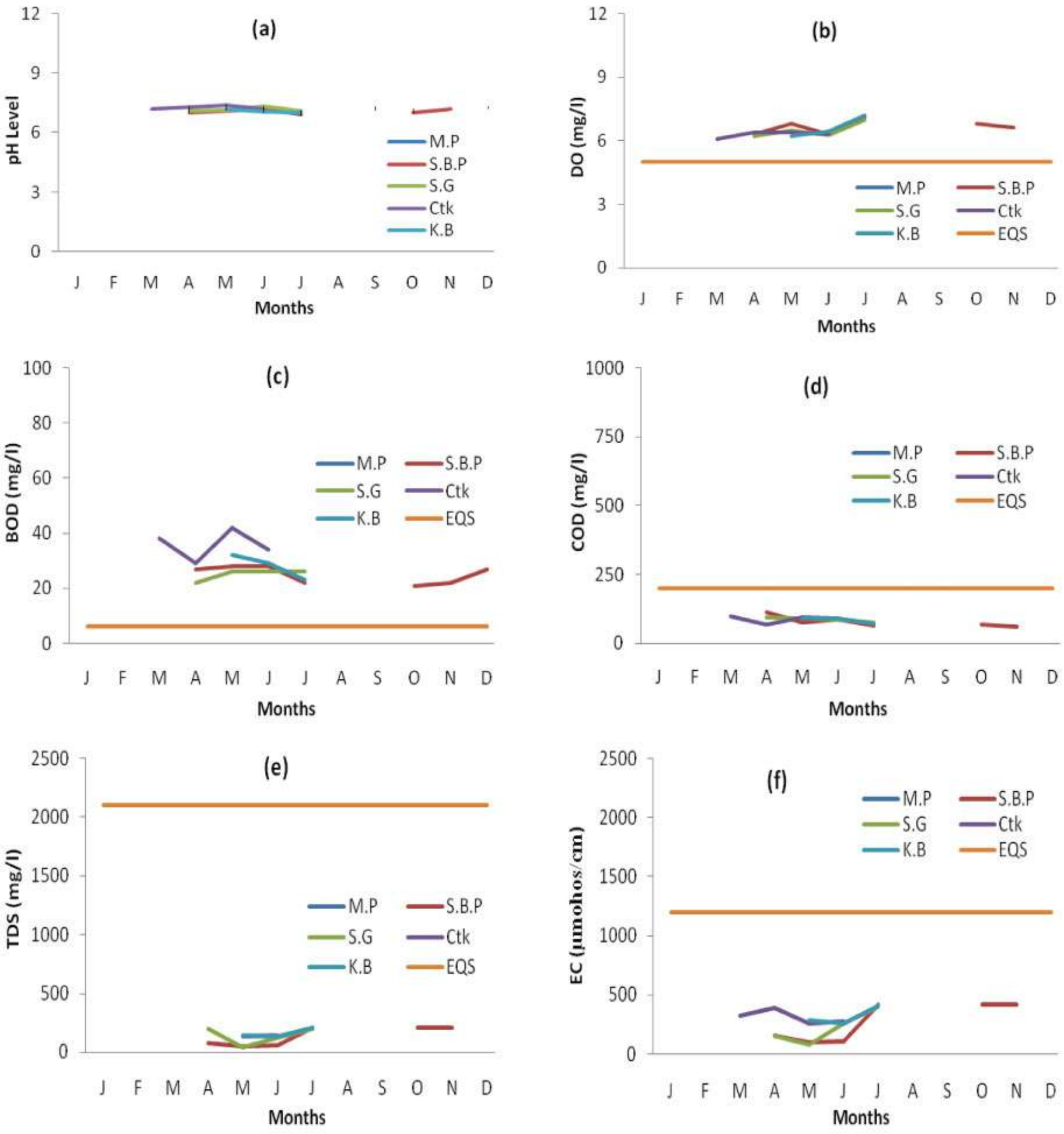


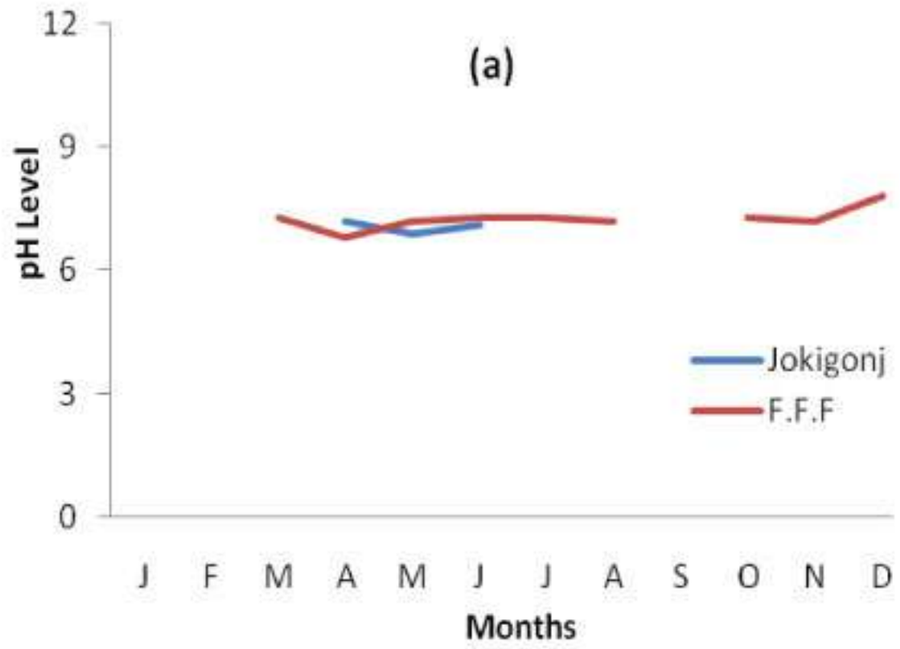
Fig.27. Graphical presentation of pH, DO, BOD, COD, TDS and EC of Surma River in 2016

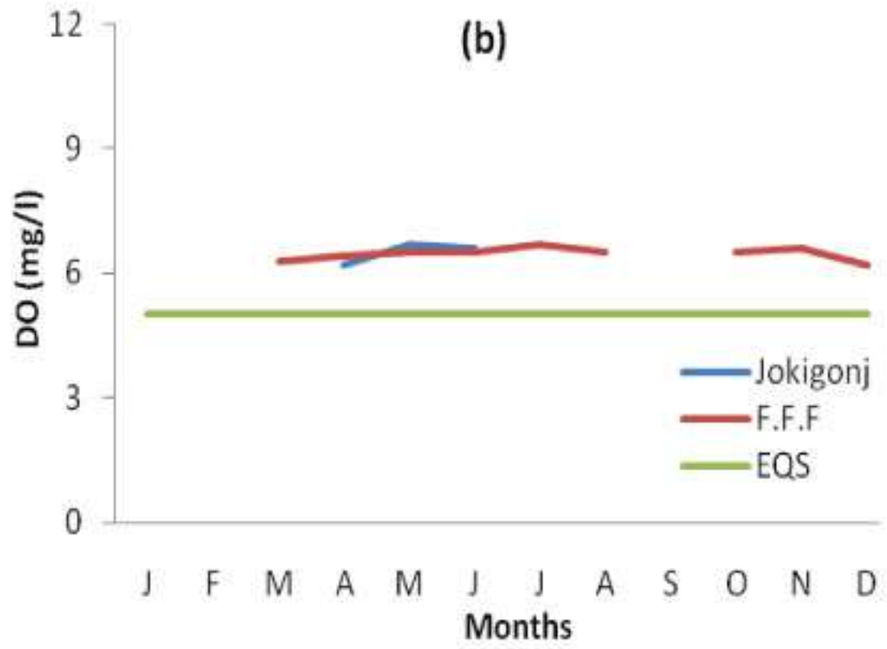
In 2016, BOD value was also within the EQS at all locations. The maximum and the minimum BOD was 42 mg/l in May at Chattak and 21 mg/l in February at Shak Ghat location (Fig. 27c). In 2015, BOD level varied from 1.6 to 32 mg/l. In 2016, COD content was within the EQS (200 mg/l) and varied from 62 to 118 mg/l (Fig. 27d). In 2015, COD level varied from 32 to 138 mg/l. In 2016, TDS range was from 41 to 209 mg/l (Fig. 27e) where EQS for TDS is 2100 mg/l for treated wastewater from industrial units. In 2015, TDS level was varied from 63.5 to 166.3 mg/l. In 2016, EC level of Surma river water was within the EQS limit for treated wastewater from industrial unit. It varied from 82 to 418 µmohos/cm (Fig. 27f). In 2015, EC was varied from 132 to 295 µmohos/cm.

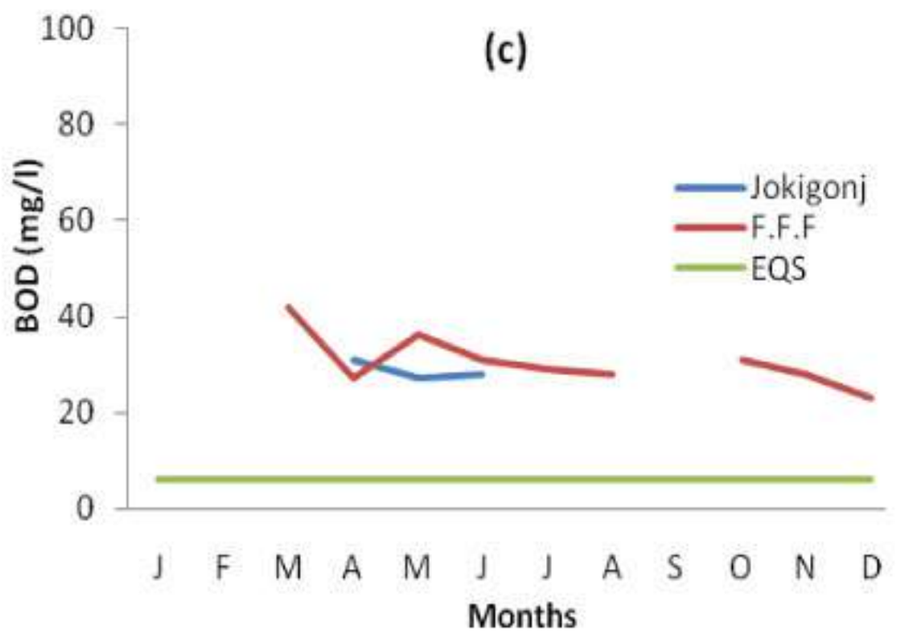
4.28 Kushiara River

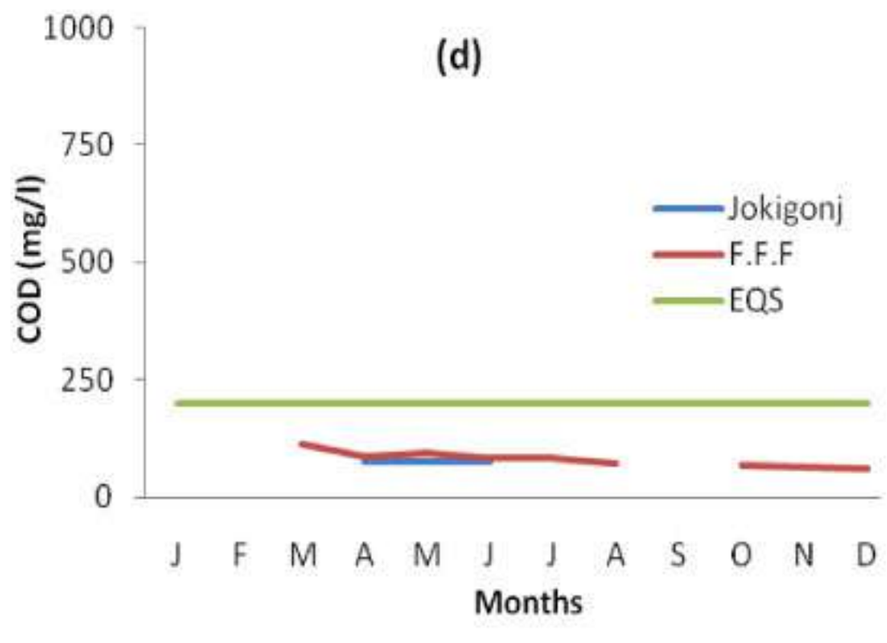
Kushiara river is one of the Trans-boundary rivers of Bangladesh. The total length of the Kushiara is about 161 km. The average width of the river is 250 m and in the rainy season the mean depth of the Kushiyara reaches upto 10m (Ahmed, 2006). Water samples were collected from two locations (e.g. Jokigonj and Fenchugonj Fertilizer Industry (F.F.I) of the river in 2016 for analysis of water quality.

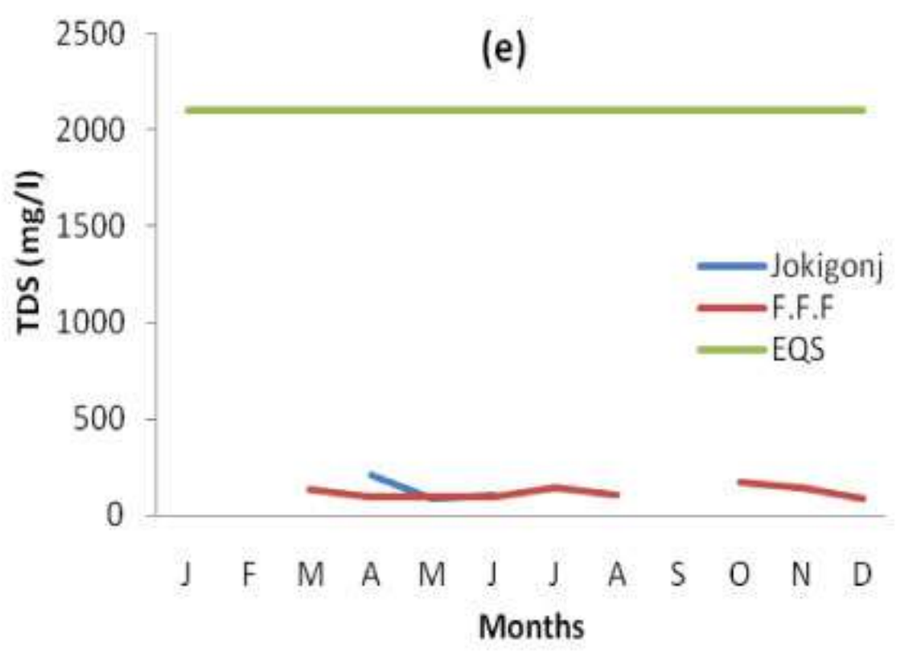
In 2016, pH level of Kushiara river water was within EQS (6.5-8.5) for inland surface water. It varied from 6.9 to 7.8 (Fig. 28a). In 2015, pH level varied from 6.8 to 7.3. In 2016, DO was above the EQS ($\geq$5 mg/l) for fisheries and varied from 6.2 to 6.7 mg/l (Fig. 28b). In 2015, DO level varied from 5.2 to 6.2 mg/l. In 2016, BOD level was from 23 to 42 mg/l while EQS for fisheries is $\leq$6 mg/l (Fig. 28c). In 2015, BOD level varied from 18 to 33 mg/l. In 2016, COD content was within the EQS (200 mg/l) and varied from 59 to 156 mg/l (Fig. 28d). In 2015, COD level varied from 58 to 90 mg/l. In 2016, TDS level of Kushiara river water was below the EQS for treated wastewater from industrial unit and varied from 72 to 206 mg/l (Fig. 28e). In 2015, TDS level varied from 72 to 112 mg/l. In 2016, EC was within the EQS limit and it varied from 140 to 412 µmohos/cm (Fig. 28f). In 2015, EC was from 185 to 221 µmohos/cm.











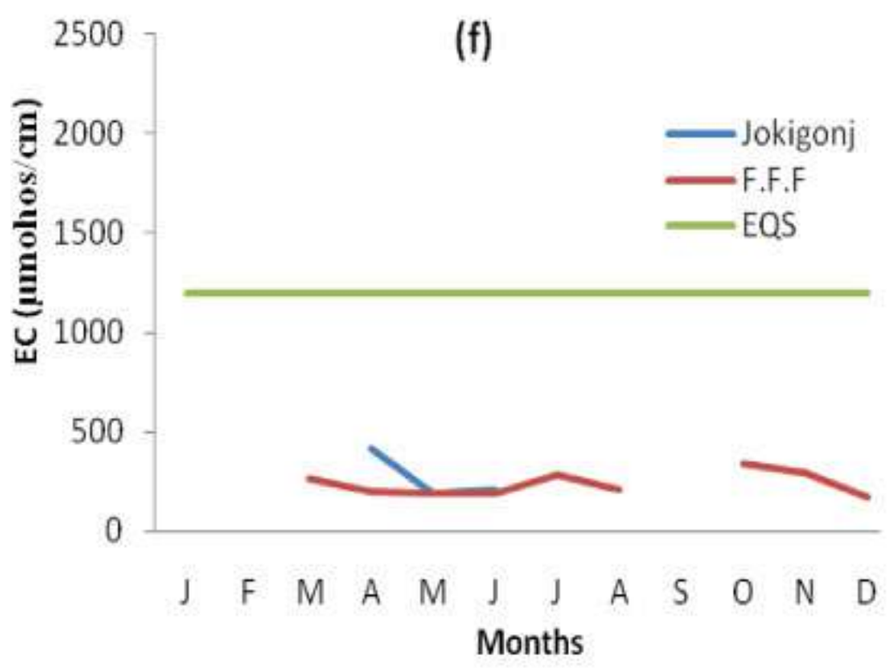


Fig 28. Graphical presentation of pH, DO, BOD, COD, TDS and EC of Kushiara River in 2016

CHAPTER 5: WATER QUALITY OF LAKE AND GROUND WATER

5.1 Gulshan Lake

It is an important urban water body in Dhaka city providing environmental services. However, the lack itself is a victim of environmental pollution. Direct discharge of sewage and dumping of municipal waste into the lake turned it highly polluted. The lake has been declared by the government as "Ecologically Critical Area" in 2001.

Photo-Gulshan Lake

Table-30: pH of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	7.1	7 .2	7.2	6.89	7.31	7.26	7.26	7.28	7.31	7.72	7.21	7.02
Near Housing, South Bridge	7.11	7.3	7.3	7.11	6.93	7.21	7.26	7.22	7.18	7.62	7.38	7.25
Near Lake View Clinic	7.23	7.3	7.4	7.14	7.25	7.44	7.26	7.44	7.13	7.68	7.68	7.24
North Side Gulshan-Baridhara Lake	7.42	7.7	7.8	7.23	8.22	7.38	7.38	7.61	7.14	7.59	7.11	7.26
Taltola Shooting Complex, South Side	7.49	7.5	7.5	7.43	7.58	7.4	7.4	7.81	7.08	7.52	7.67	7.69
North Sideof Gulshan-1, Gudara Ghat	7.37	7.2	7.3	7.11	7.29	7.16	7.16	7.42	6.88	7.465	7.59	7.35
South Side of Gulshan-1, Gudara Ghat	7.68	7.4	7.4	7.18	7.35	7.23	7.23	7.68	7.11	7.4	7.48	7.32
Gulshan-Bonani Connection Bridge	7.71	7.2	7.2	7.21	**8.27**	7.28	7.28	7.61	7.45	7.26	7.12	7.07
Bonani Bridge	7.66	7.2	-	7.23	7.52	7.2	7.2	7.66	7.11	7.42	7.21	**6.85**
EQS for fisheries 6.5-8.5												

In 2016, pH of Gulshan Lake water varied from 6.85 to 8.27. The maximum pH (8.27) was in May at Gulshan-Banani Connection Bridge and the minimum pH (6.85) was in December at Banani Bridge (Table-30).

Table-31: DO (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	9.8	4.1	2.4	11.8	2.9	5.1	1.2	6.8	1.8	10.8	1.2	5
Near Housing, South Bridge	7.8	10.8	14.8	5.6	3.3	5.1	0.4	5.8	0.8	8.2	2.1	10
Near Lake View Clinic	10.8	7.8	8.3	10.6	7.7	5.1	1	8.2	1.8	7.6	7.2	7.1
North Side Gulshan-Baridhara Lake	4.9	8.8	9.4	9.4	**15.3**	5.1	2.9	7.9	2.7	2.9	6.5	6.9
Taltola Shooting Complex, South Side	4.8	10.2	11.4	5.6	7.4	10.9	4.7	0.8	4.8	2.4	0.8	8
North Sideof Gulshan-1, Gudara Ghat	5.9	8.2	8.6	4.8	2.1	10	0.8	1.2	2.8	0.6	1.2	4.7
South Side of Gulshan-1, Gudara Ghat	5.8	7.8	8	4	1.9	10	0.6	1.4	1.6	0.1	**0**	4
Gulshan-Bonani Connection Bridge	12.8	4.1	2.3	6.2	14.6	0.3	1.3	3.2	1.8	0.7	**0**	0.8
Bonani Bridge	7.8	5.6	-	2.1	6.9	1	0.7	6.2	1.7	2.2	2	1.7
EQS for fisheries ≥5 mg/l												

In 2016, DO content of Gulshan lake widely varied among the sampling locations as well as among sampling months. DO of Gulshan Lake water varied from 0 to 15.3 mg/l. The maximum DO (15.3 mg/l) was in May at North Side Gulshan Baridhara Lake and the minimum DO (0.0) mg/l was in November at South Side of Gulshan-1, Gudara Ghat (Table-31).

Table-32: BOD (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	18.4	12.2	12.1	24	18.4	24.2	18.2	18.1	18.8	25.4	22.4	13
Near Housing, South Bridge	24.2	16.4	12.2	28	30.8	20.8	18.6	16.2	17.7	21.8	24.2	16
Near Lake View Clinic	20.4	18.2	16.8	24	22.4	21.8	15.8	15.8	21.8	20.8	32	15
North Side Gulshan-Baridhara Lake	14	22.6	14.3	28	20.8	33.8	13.5	16.2	16.6	22.9	24.2	15
Taltola Shooting Complex, South Side	12	16.8	18.2	24	20.6	17.4	12.6	18.1	18.2	12.2	20.8	10
North Sideof Gulshan-1, Gudara Ghat	8.4	20.4	17.1	28	20.8	17.2	18.2	16.2	18.4	30.1	24	18
South Side of Gulshan-1, Gudara Ghat	18.4	18.6	18.8	24	22	20.4	15.4	18.1	22	**51.7**	28.2	13
Gulshan-Bonani Connection Bridge	**8.1**	22.8	18.3	18	16.6	17.6	11.2	18.1	42	20.4	20.4	14
Bonani Bridge	20.6	18.4	-	26	19.8	19	11.6	16	15	20.2	18.6	21
EQS for fisheries 6≤mg/l												

In 2016, BOD of Gulshan Lake water varied from 8.1 to 51.7 mg/l. The maximum BOD (51.7 mg/l) was in October at South Side of Gulshan-1, Gudara Ghat and the minimum BOD (8.1) was in January at Gulshan-Bonani Connection Bridge (Table-32). BOD was higher than EQS throughout the year of 2016.

Table-33: COD (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	54	50	76	96	103	87	86	64	60	100	72	167.23
Near Housing, South Bridge	72	58	170	75	**303**	86	95	58	72	83	100	217.39
Near Lake View Clinic	61	62	98	112	117	84	64	57	100	76	118	222.17
North Side Gulshan Baridhara Lake	52	87	62	106	105	126	33	62	48	88	102	231.73
Taltola Shooting Complex, South Side	36	52	93	108	93	61	43	71	38	92	82	193.5
North Sideof Gulshan-1, Gudara Ghat	2 4	68	112	98	105	80	76	58	55	86	98	119.45
South Side of Gulshan-1, Gudara Ghat	56	63	166	96	117	76	69	78	70	88	110	152.89
Gulshan-Bonani Connection Bridge	**28**	72	165	68	96	76	32	81	129	79	87	114.67
Bonani Bridge	60	54	-	96	93	49	43	72	45	68	82	172
EQS for wastewater after treatment from industrial units 200 mg/l												

In 2016, COD of Gulshan Lake water varied from 28 to 303 mg/l. The maximum COD (302 mg/l) was in May at Near Housing, South Bridge and the minimum COD (28) mg/l was in January at Gulshan-Bonani Connection Bridge (Table-33). COD was mostly below the EQS.

Table-34: TDS (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	255	302	306	262	231	219	219	162	320	345	270	280
Near Housing, South Bridge	256	352	422	270	**122.5**	310	219	155	262	340	314	309
Near Lake View Clinic	259	256	275	308	231	242	219	165	242	312	295	272
North Side Gulshan Baridhara Lake	311	290	320	310	233	232	232	175	321	283	315	275
Taltola Shooting Complex, South Side	283	244	270	292	222	244	244	195	315	267	275	288
North Sideof Gulshan-1, Gudara Ghat	276	333	370	283	292	276	276	182	282	367	339	349
South Side of Gulshan-1, Gudara Ghat	248	386	350	246	287	287	287	195	310	328	272	342
Gulshan-Bonani Connection Bridge	244	273	407	258	258	213.5	213.5	190	**432**	268	288	326
Bonani Bridge	241	282		272	226	226	226	195	224	272	283	399
EQS for wastewater after treatment from industrial units 2100 mg/l												

In 2016, TDS of Gulshan Lake water varied from 122.5 to 432 mg/l. The maximum TDS (432 mg/l) was in September at Gulshan-Bonani Connection Bridge and the minimum TDS (122.5) was in May at Near Housing, South Bridge (Table-34).

Table-35: Turbidity (NTU) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	76	74	47.2	50	68	67	32	45	52	48	18	50
Near Housing, South Bridge	74	76	76.6	48	67	68	27	41	48	42	**16**	36
Near Lake View Clinic	82	77	77.8	44	67	72	31	40	55	50	17	34
North Side Gulshan Baridhara Lake	78	78	68	50	72	70	38	39	54	48	19	22
Taltola Shooting Complex, South Side	76	72	66	38	71	77	28	42	48	52	22	18
North Sideof Gulshan-1, Gudara Ghat	77	**82**	58	40	66	65	25	42	64	54	18	19
South Side of Gulshan-1, Gudara Ghat	78	79	62	38	68	66	21	44	48	55	20	35
Gulshan-Bonani Connection Bridge	77	82	55	40	71	32	16	43	56	56	21	32
Bonani Bridge	76	81	-	42	78	33	18	42	54	52	25	37
EQS for wastewater after treatment from industrial units 10 NTU												

In 2016, Turbidity of Gulshan Lake water varied from 16 to 82 NTU. The maximum Turbidity (82 NTU) was in February at North Sideof Gulshan-1, Gudara Ghat and the minimum Turbidity (16 NTU) was in November at Near Housing, South Bridge (Table-35). Turbidity was higher than EQS throughout the year of 2016.

Table-36: Chloride (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	39.12	40.98	28.9	33.9	42	31.9	18	16.71	50	22	42	36.98
Near Housing, South Bridge	42.24	41.98	34.9	32.9	40	31.9	19	**15.82**	25	22	44	43.98
Near Lake View Clinic	43.45	38.98	30.9	33.9	35	31.9	18	16.98	22	25	45	45.98
North Side Gulshan Baridhara Lake	40.38	41.98	32.9	38.9	36	33.9	19	15.98	23	26	38	40.98
Taltola Shooting Complex, South Side	41.58	36.98	33.9	38.9	34	37.9	20	16.98	16	25	40	37.98
North Sideof Gulshan-1, Gudara Ghat	43.98	41.98	36.9	38.9	41	35.9	22	17.41	18	23	46	54.98
South Side of Gulshan-1, Gudara Ghat	41.98	44.98	37.9	37.9	38	36.9	23	16.21	21	25	42	60.98
Gulshan-Bonani Connection Bridge	42.98	38.98	30.9	42.9	40	27.9	16	16.22	23	26	42	43.98
Bonani Bridge	44.98	44.98	-	39.9	34	28.9	19	16.41	22	24	38	**76.97**
EQS for wastewater after treatment from industrial units 150-600 mg/l												

In 2016, Chloride of Gulshan Lake water varied from 15.82 to 76.97 mg/l. The maximum Chloride (76.97mg/l) was in December at Bonani Bridge and the minimum Chloride (15.82 mg/l) was in August at Near Housing, South Bridge (Table-36).

Table-37: SS (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	31	76	44	68	70	73	90	42	70	42	**24**	117
Near Housing, South Bridge	29	72	49	55	72	74	79	44	68	47	26	**142**
Near Lake View Clinic	30	78	46	48	68	72	81	48	70	48	32	137
North Side Gulshan Baridhara Lake	28	68	48	44	68	103	57	42	65	46	24	138
Taltola Shooting Complex, South Side	26	82	44	38	66	103	48	38	66	52	28	49
North Sideof Gulshan-1, Gudara Ghat	28	86	46	42	72	71	59	40	67	48	24	96
South Side of Gulshan-1, Gudara Ghat	26	78	48	40	74	67	49	42	72	52	28	87
Gulshan-Bonani Connection Bridge	28	80	40	42	78	35	33	42	70	54	28	42
Bonani Bridge	38	82	-	44	68	34	31	44	68	54	33	44
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, SS of Gulshan Lake water varied from 24 to 142 mg/l. The maximum SS (142mg/l) was in December at Near Housing, South Bridge and the minimum SS (24 mg/l) was in November at Near United Hospital, Kalachadpur (Table-37).

Table-38: Total Alkalinity (mg/l) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	150	160	142	150	168	140	160	120	158	132	180	144
Near Housing, South Bridge	154	158	148	148	170	142	180	124	146	126	182	148
Near Lake View Clinic	152	148	144	124	178	140	140	128	132	128	188	136
North Side Gulshan Baridhara Lake	164	150	142	130	170	156	120	140	154	134	109	144
Taltola Shooting Complex, South Side	160	140	146	148	110	148	140	138	140	132	178	150
North Sideof Gulshan-1, Gudara Ghat	178	144	144	152	190	178	154	144	130	110	182	174
South Side of Gulshan-1, Gudara Ghat	180	148	154	130	198	188	164	148	**104**	138	180	184
Gulshan-Bonani Connection Bridge	150	138	148	138	166	144	144	148	142	140	180	162
Bonani Bridge	160	142	-	148	150	150	132	152	158	138	178	**210**
EQS for wastewater after treatment from industrial units 150 mg/l												

In 2016, Total Alkalinity of Gulshan Lake water varied from 104 to 210 mg/l. The maximum Total Alkalinity (210mg/l) was in December at Bonani Bridge and the minimum Total Alkalinity (104 mg/l) was in September at South Side of Gulshan-1, Gudara Ghat (Table-38).

Table-39: EC (µmohos/cm) of Gulshan Lake Water

Location of Gulshan Lake	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Near United Hospital, Kalachadpur	509	580	590	520	464	420	481	318	630	688	532	554
Near Housing, South Bridge	512	720	803	540	**250**	624	481	305	523	672	621	610
Near Lake View Clinic	517	510	533	610	472	510	481	320	493	620	540	538
North Side Gulshan Baridhara Lake	621	590	618	620	468	513	513	348	642	600	624	544
Taltola Shooting Complex, South Side	574	488	523	590	451	541	541	390	630	577	548	570
North Sideof Gulshan-1, Gudara Ghat	558	664	597	580	591	610	610	360	570	788	678	687
South Side of Gulshan-1, Gudara Ghat	496	771	674	488	582	634	634	389	620	706	548	674
Gulshan-Bonani Connection Bridge	488	554	779	512	526	474	474	372	**869**	582	578	644
Bonani Bridge	482	762	-	540	459	499	499	388	455	588	576	783
EQS for wastewater after treatment from industrial units 1200 µmohos/cm												

In 2016, EC of Gulshan Lake water varied from 250 to 869 µmohos/cm. The maximum EC (869 µmohos/cm) was in September at Gulshan-Bonani Connection Bridge and the minimum EC (250 µmohos/cm) was in May at Near Housing, South Bridge (Table-39).

5.2 Dhanmondi Lake

Dhanmondi Lake is in the Dhanmondi residential area in Dhaka, Bangladesh. The lake was originally a dead channel and was connected to the Turag River. The lake is partially connected with the Begunbari Canal. In 1956, Dhanmondi was developed as a residential area. In the development plan, about 16% of the total area of Dhanmondi was designated for the lake.[3]

The lake has become a well visited tourist spot, with cultural hubs such as the Rabindra-Sarobar located along its side.

Photo-Dhanmondi Lake

Table-40: Level of Different Parameter of Gulshan Lake Water in 2016

Sampling Location	Parameters	Months		EQS
		June	July	
Near Dhanmondi -32	pH	7.44	7.44	6.5-8.5 for fisheries
Near Raifel Square		7.66	7.66	
Near Dhanmondi -32	DO	5.2	6.6	≥5 mg/lfor fisheries
Near Raifel Square		5.5	5.9	
Near Dhanmondi -32	BOD	20	6.2	≤6 mg/l for fisheries
Near Raifel Square		17.6	5.8	
Near Dhanmondi -32	COD	58	16	≤200 mg/l for wastewater after treatment from industrial units
Near Raifel Square		51	18	
Near Dhanmondi -32	TDS	140.1	140.1	≤2100 mg/l for wastewater after treatment from industrial units
Near Raifel Square		139.7	139.7	
Near Dhanmondi -32	SS	13	13	≤150 mg/l for wastewater after treatment from industrial units
Near Raifel Square		16	16	
Near Dhanmondi -32	Chloride	39.9	8	150-600 mg/l for wastewater after treatment from industrial units
Near Raifel Square		31.9	8	
Near Dhanmondi -32	Turbidity	6.4	6.4	10 NTU for wastewater after treatment from industrial units
Near Raifel Square		2.3	2.3	
Near Dhanmondi -32	EC	305	305	1200µmohos/cm for wastewater after treatment from industrial units
Near Raifel Square		305	305	
Near Dhanmondi -32	T. Alkalinity	58	90	150 mg/l for wastewater after treatment from industrial units
Near Raifel Square		51	90	

In 2016, pH level of Dhanmondi Lake water was within the EQS (6.5-8.5) for fisheries. It varied from 7.44 to 7.66 (Table-40). DO was varied from 5.2 to 6.6 mg/l. BOD was varied from 5.8 to 20 mg/l. BOD was higher than EQS in June 2016. COD was varied from 18 to 58 mg/l. COD was within the EQS. TDS was varied from 139.7 to 140.10 mg/l and was within the EQS. SS was varied from 13 to 16 mg/l and was within the EQS. Chloride was varied from 8.0 to 39.9 mg/l and was within the EQS. Turbidity was varied from 2.3 to 6.4 NTU and was within the EQS. EC was within the EQS (1200 µmohos/cm) limit and it was 305 µmohos/cm. Total Alkalinity was within the EQS (150 mg/l) and varied from 51 to 90 mg/l (Table-40). Overall condition of the lake is good.

5.3 Hatir Jheel Lake

Hatir Jheel, the new projects of beautification Dhaka city. It has already become an attractive location to visit in Dhaka City. Direct discharge of sewage, municipal waste and industrial effluent cause water pollution in the lake.

Photo-Hatir Jheel Lake

Table-41: Level of Different Parameter of of Hatir Jheel Lake Water in 2016

Sampling Location	Parameters	Months		EQS
		June	July	
Hatir Jhill-1	pH	7.49	7.49	6.5-8.5 for fisheries
Hatir Jhill-2		7.3	7.3	
Hatir Jhill-1	DO	5.8	5.8	≥5 mg/l for fisheries
Hatir Jhill-2		6.5	6.5	
Hatir Jhill-1	BOD	14.2	14.2	≤6 mg/l for fisheries
Hatir Jhill-2		13.2	13.2	
Hatir Jhill-1	COD	58	58	≤200 mg/l for wastewater after treatment from industrial units
Hatir Jhill-2		41	48	
Hatir Jhill-1	TDS	235	235	≤2100 mg/l for wastewater after treatment from industrial units
Hatir Jhill-2		241	241	
Hatir Jhill-1	SS	55	55	≤150 mg/l for wastewater after treatment from industrial units
Hatir Jhill-2		22	46	
Hatir Jhill-1	Chloride	39.9	19	150-600 mg/l for wastewater after treatment from industrial units
Hatir Jhill-2		40.9	19	
Hatir Jhill-1	Turbidity	60	60	10 NTU for wastewater after treatment from industrial units
Hatir Jhill-2		24	24	
Hatir Jhill-1	EC	516	513	1200µmohos/cm for wastewater after treatment from industrial units
Hatir Jhill-2		529	529	
Hatir Jhill-1	T. Alkalinity	160	120	150 mg/l for wastewater after treatment from industrial units
Hatir Jhill-2		158	120	

In 2016, pH level of Hatir Jheel Lake water was within the EQS (6.5-8.5) for fisheries. It varied from 7.3 to 7.49. DO was varied from 5.8 to 6.5 mg/l. BOD was varied from 13.2 to 14.2 mg/l and was above theEQS. COD of Hatir Jheel water varied from 41 to 58 mg/l. TDS was varied from 235 to 241 mg/l. SS was varied from 22 to 55 mg/l and was below the EQS. Chloride of Hatir Jheel Lake water varied from 19.0 to 40.9 mg/l. Turbidity was varied from 24 to 60 NTU and was above the EQS. EC was within the EQS (1200 µmohos/cm) limit and it varied from 513 to 529 µmohos/cm. Total Alkalinity was within the EQS (150 mg/l) and varied from 120 to 160 mg/l (Table-41).

5.4 Cresent Lake

Cresent lake is near by the Jatio Sangsad Bhaban (National Assembly Building) in Dhaka. It increase the beauty of Jatio Sangsad Bhaban and provides other environmental Service.

Photo-Cresent Lake

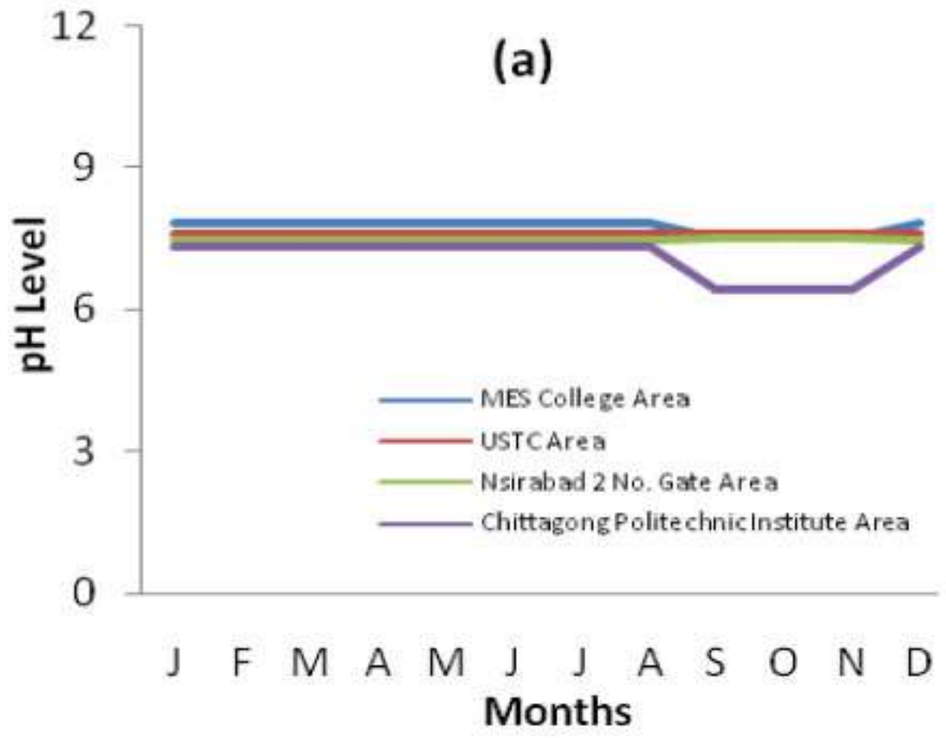
Table-42: Level of Different Parameter of Cresent Lake Water in 2016

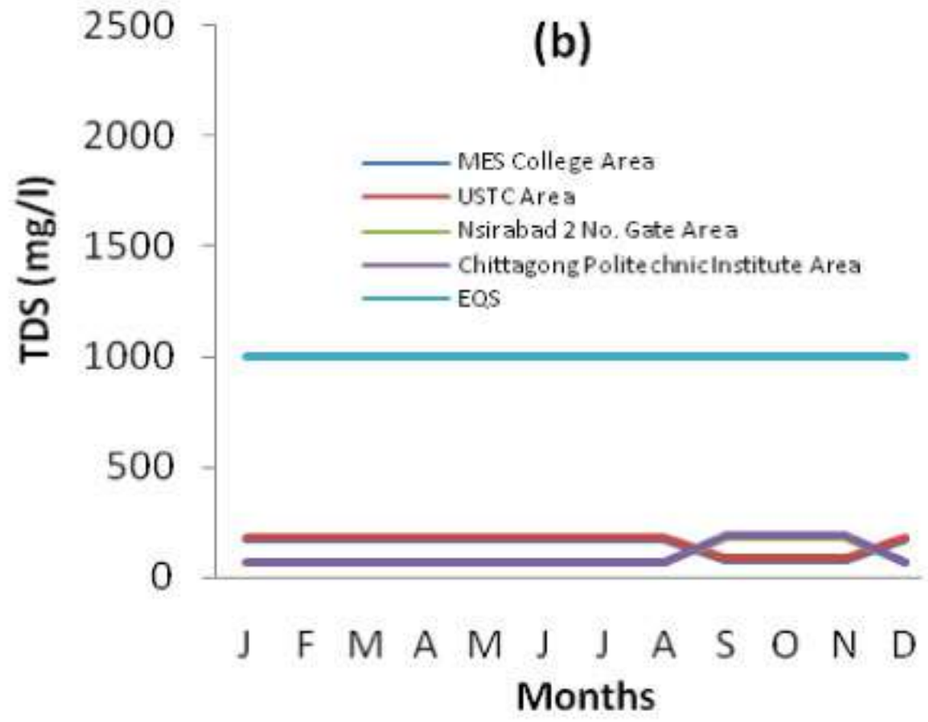
Sampling Location	Parameters	Months		EQS
		June	July	
Near House of Nation	pH	8.66	8.12	6.5-8.5 for fisheries
Near Zia Uddan		8.37	8.4	
Near House of Nation	DO	4	10.3	≥5 mg/l for fisheries
Near Zia Uddan		3.9	8.5	
Near House of Nation	BOD	24.8	5.9	≤6 mg/l for fisheries
Near Zia Uddan		28.4	6.8	
Near House of Nation	COD	78	18	≤200 mg/l for wastewater after treatment from industrial units
Near Zia Uddan		112	20	
Near House of Nation	TDS	110	114.3	≤2100 mg/l for wastewater after treatment from industrial units
Near Zia Uddan		114.8	112.4	
Near House of Nation	SS	24	30	≤150 mg/l for wastewater after treatment from industrial units
Near Zia Uddan		16	11	
Near House of Nation	Chloride	6.99	9	150-600 mg/l for wastewater after treatment from industrial units
Near Zia Uddan		14.9	10	
Near House of Nation	Turbidity	11	8.2	10 NTU for wastewater after treatment from industrial units
Near Zia Uddan		5.5	7.5	
Near House of Nation	EC	240	226	1200µmohos/cm for wastewater after treatment from industrial units
Near Zia Uddan		250	220	
Near House of Nation	T. Alkalinity	112	118	150 mg/l for wastewater after treatment from industrial units
Near Zia Uddan		78	120	

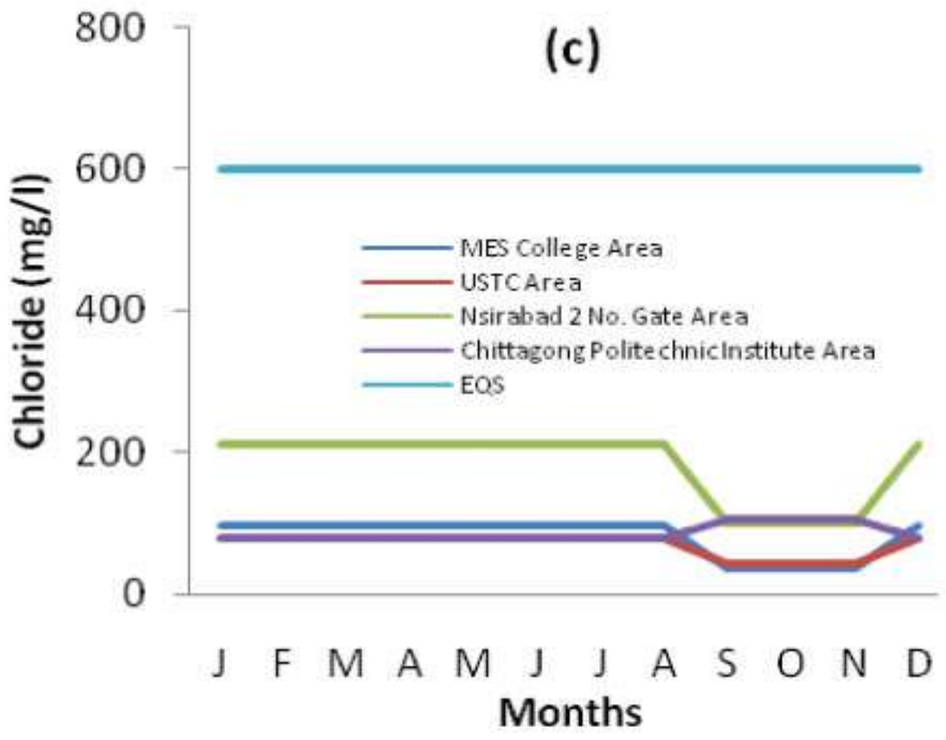
In 2016, pH level of Cresent Lake water was slightly above the EQS (6.5-8.5) for fisheries. It varied from 8.12 to 8.66. DO of Cresent Lake water varied from 3.9 to 10.3 mg/l. BOD of Cresent Lake water varied from 5.9 to 28.4 mg/l. COD of Cresent Lake water varied from 18 to 112mg/l and was below the EQS. TDS of Cresent Lake water varied from 110 to 114.80 mg/l. SS of Cresent Lake water varied from 11 to 30 mg/l (Table-42). Chloride of Cresent Lake water varied from 6.99 to 14.9 mg/l. EC was within the EQS (1200 µmohos/cm) and it varied from 220 to 250 µmohos/cm. Total Alkalinity was also within the EQS (150 mg/l) and varied from 78 to 120 mg/l (Table-42). Overall water quality was better July than June.

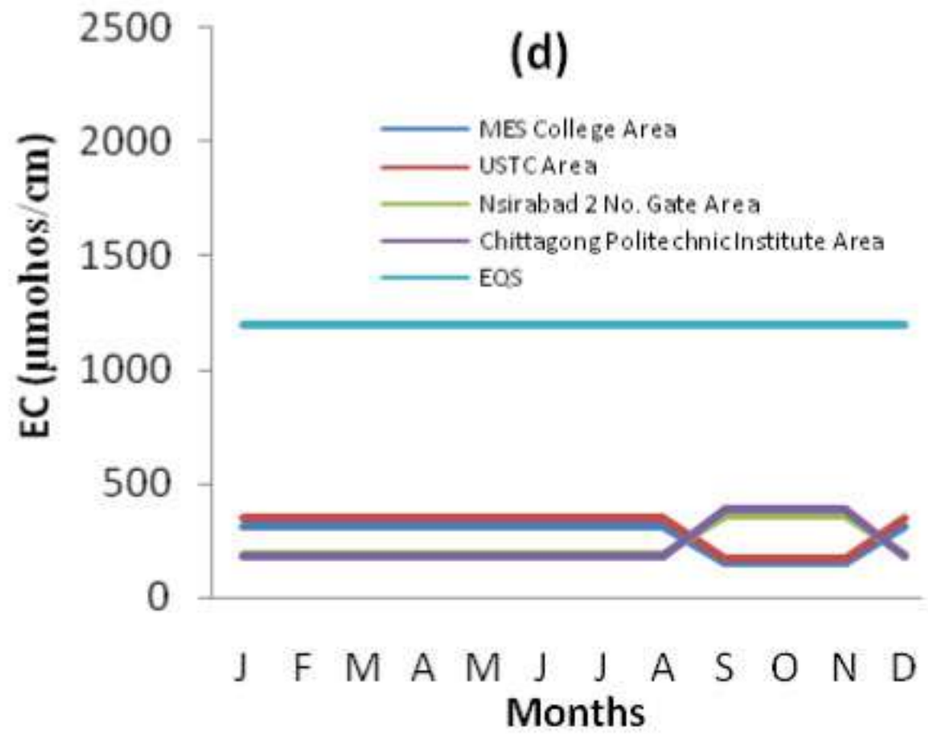
5.5 Ground Water Quality in Chittagong District

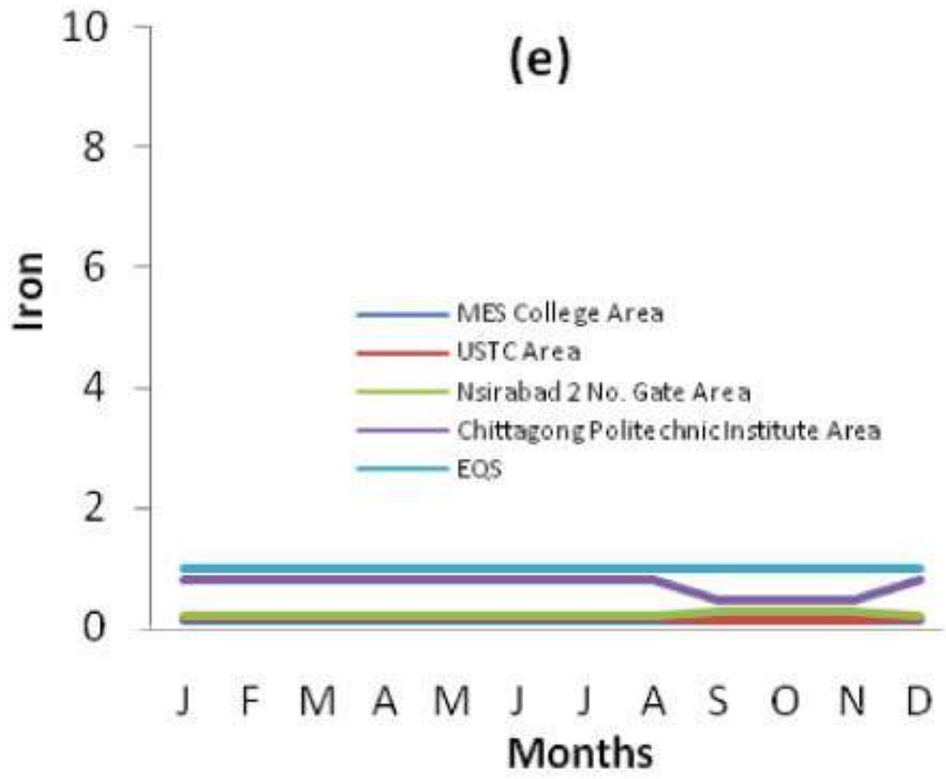
Chittagong is the second largest city of Bangladesh. It is a sea port city and faces various environmental challenges like industrial pollution, land slide, municipal wastes dumping, etc. There is possibility of increasing ground water salinity as the city is on the sea coast. For monitoring ground water quality, samples were colleted from four different locations viz. MES College Area, USTC Area, Nsirabad 2 No. Gate Area, and Chittagong Politechnic Institute Area. In 2016, pH level of ground water of Chittagong District area was within EQS (6.5-8.5) for drinking water. It varied from 6.4 to 7.84 (Fig. 29a). TDS level of Chittagong District area ground water was below the EQS (1000 mg/l) for treated wastewater from industrial unit and varied from 68.8 to 188 mg/l (Fig. 29b). Chloride was within the EQS (150-600 mg/l) limit and it varied from 38 to 212 mg/l (Fig. 29c). EC was within the EQS limit and it varied from 150 to 385 µmohos/cm (Fig.29d). Iron was within the EQS (0.3-1 mg/l) limit and it varied from 0.09 to 08 mg/l (Fig. 29e). Hardness was within the EQS (200 mg/l) limit and it varied from 134 to 176 mg/l (Fig. 29f).











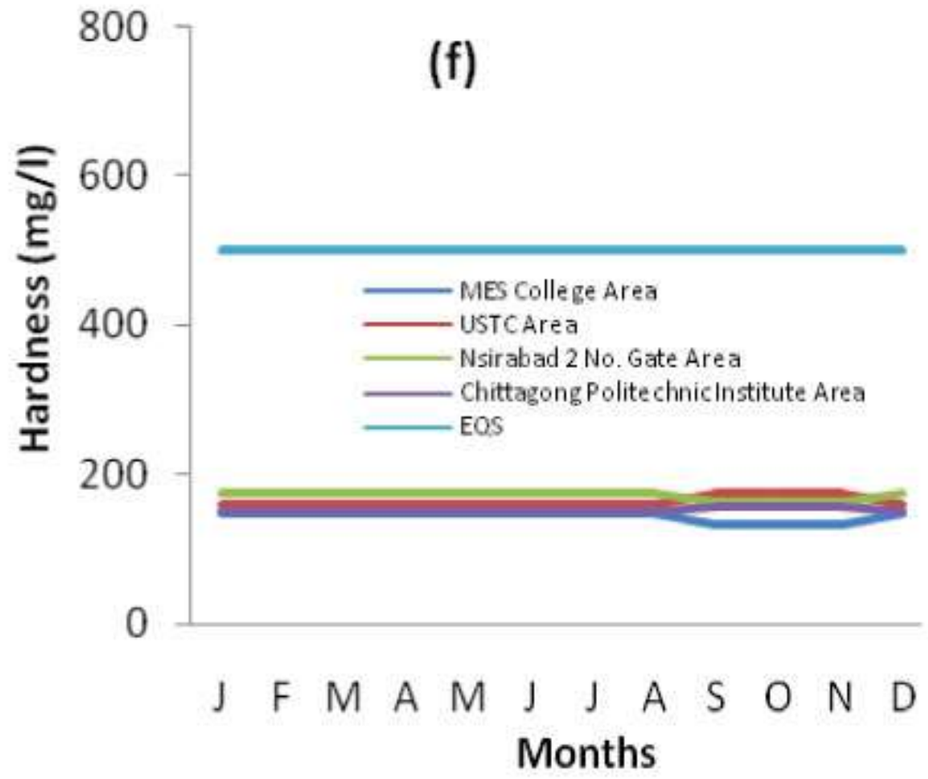


Fig 29. Graphical presentation of pH, TDS, Chloride, EC, Iron and Hardness of Chittagong District area ground water in 2016

5.6 Ground Water Quality in Khulna District

Table-43: pH of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	-	7.68	-	7.62	-	7.62	7.68	7.68	7.59	7.66	-	7.63
Govt. Girls College, Boyra	-	7.57	-	7.56	-	7.56	7.57	7.57	7.67	7.68	-	7.63
Khulna Public College, Boyra	-	7.53	7.45	7.58	7.45	7.58	7.53	7.53	7.73	7.72	-	7.64
Boyra Bazar More, Boyra	-	7.49	7.49	7.44	7.49	7.44	7.59	7.49	7.49	7.49	-	7.62
Aizer More, Boyra	-	7.59	7.59	7.58	7.59	7.58	7.59	7.59	7.59	7.59	-	7.33
Rupsha Bus Stand, Rupsha	-	7.38	7.49	-	7.49	-	7.38	7.38	7.69	7.64	-	7.62
Natun Bazar, Rupsha	-	7.18	7.45	-	7.45	-	**7.18**	7.18	7.74	7.76	-	7.58
Govt. Comercial College, Sonadanga	-	7.55	-	7.58	-	7.58	7.55	7.55	7.55	7.55	-	7.54
Sonadanga Bus Stand, Sonadanga	-	7.45	7.59	7.48	7.59	7.48	7.45	7.45	7.45	7.45	-	7.51
Sarjical Clinic, Sonadanga	-	7.49	7.69	7.52	7.69	7.52	7.49	7.49	7.49	7.49	-	7.54
Govt. B.L College, Daulatpur	-	7.46	-	7.51	-	7.51	7.46	7.46	7.66	7.68	-	7.62
KUET University Main Gate, Fulbari Gate	-	7.56	-	7.55	-	7.55	7.56	7.56	7.76	7.78	-	7.64
Gollamari Bus Stand, Gollamari	7.49	7.69	7.69		7.69		7.69	7.69	7.72	7.74		7.62
Govt. Mohasin College, Khalishpur	-	7.48	-	7.53	-	7.53	7.54	7.54	7.64	7.64	-	7.24
Moylapota More	-	7.59	7.49	7.56	7.49	7.56	7.59	7.59	7.68	7.64	-	7.55
Nirala More	-	7.59	7.59	-	7.59	-	7.59	7.59	7.66	7.62	-	7.44
Islami Bank Hospital, Santidham Mor	-	7.53	7.45	7.52	7.45	7.52	7.53	7.53	7.56	7.52	-	7.52
Seba Clinic, Sher-E-Bangal Road	-	7.52	7.59	7.55	7.59	7.55	7.52	7.52	7.72	7.74	-	7.32
Jia Hall, Sib Bary	-	7.59	7.49	7.52	7.49	7.52	7.59	7.59	7.59	7.59	-	7.42
Khulna University, Vaskarja Chattar	-	7.38	-	-	-	-	7.38	7.38	7.68	7.66	-	7.52
Sarkit House	-	7.28	7.49	-	7.49	-	7.28	7.28	7.76	7.74	-	7.42
Govt. Khulna Gila School	-	7.52	-	-	-	-	7.52	7.52	7.82	**7.84**	-	7.48
D.C Office	-	7.49	-	7.62	-	-	7.49	7.49	7.78	7.76	-	7.42
Dak Banglo More	-	7.52	-	-	-	-	7.52	7.52	7.72	7.74	-	7.33
Govt.Azom Khan Commerce College	-	7.44	7.59	-	7.59	-	7.44	7.44	7.66	7.64	-	7.51
Govt. Majid Memorial City College	-	7.42	-	-	-	-	7.42	7.42	7.49	7.42	-	7.42
EQS (6.5-8.5) for drinking												

In 2016, pH of Khulna district ground water was within the EQS (6.5-8.5). It varied from 7.18 to 7.84 (Table-43).

Table-44: EC (µmohos/cm) of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	-	2120	-	2128	-	1985	2120	1820	1822	1824	-	1830
Govt. Girls College, Boyra	-	1824	-	1830	-	1789	1824	1798	1778	1774	-	1772
Khulna Public College, Boyra	-	1664	2430	1670	2430	1587	1664	1822	1824	1822	-	1830
Boyra Bazar More, Boyra	-	2435	1832	**2444**	1832	2265	2435	1956	1974	1972	-	1854
Aizer More, Boyra	-	1674	1655	1676	1655	1555	1674	1876	1844	1842	-	1852
Rupsha Bus Stand, Rupsha	-	1846	2185	-	2185	-	1846	1774	1776	1774	-	1674
Natun Bazar, Rupsha	-	1868	2430	-	2430	-	1868	1822	1824	1822	-	1822
Govt. Comercial College, Sonadanga	-	1892	-	1896	-	1785	1892	1584	1534	1532	-	1682
Sonadanga Bus Stand, Sonadanga	-	2430	1832	2438	1670	2387	2430	1696	1666	1664	-	1664
Sarjical Clinic, Sonadanga	-	1832	1832	1810	1832	1782	1832	1756	1742	1744	-	1662
Govt. B.L College, Daulatpur	-	1828	-	1834	-	1698	1828	1852	1875	1876	-	1880
KUET University Main Gate, Fulbari Gate	-	1730	-	1744	-	1985	1730	1825	1829	1824	-	1828
Gollamari Bus Stand, Gollamari	1548	**735**	1832	-	1832	-	**735**	1796	1756	1754	-	1755
Govt. Mohasin College, Khalishpur	-	2430	-	2438	-	2385	1648	1788	1744	1754	-	1752
Moylapota More	-	1890	1832	1897	1832	1687	1890	1894	1874	1784	-	1872
Nirala More	-	1368	1670		1670		1368	1686	1644	1872	-	1654
Islami Bank Hospital, Santidham Mor	-	1845	2430	1848	2430	1725	1845	1844	1842	1642	-	1850
Seba Clinic, Sher-E-Bangal Road	-	1578	1655	1582	1655	1495	1578	1784	1762	1844	-	1764
Jia Hall, Sib Bary	-	1670	2185	1676	2185	1589	1670	1554	1534	1764	-	1665
Khulna University, Vaskarja Chattar	-	1846	-	-	-	-	1846	1824	1822	1532	-	1824
Sarkit House	-	1840	1832	-	1832	-	1840	1844	1842	1844	-	1754
Govt. Khulna Gila School	-	1788	-	-	-	-	1788	1786	1782	1784	-	1788
D.C Office	-	1856	-	2128	-	-	1856	1852	1864	1862	-	1862
Dak Banglo More	-	1464	-	-	-	-	1464	1784	1772	1774	-	1748
Govt.Azom Khan Commerce College	-	1674	1655	-	1655	-	1674	1856	1864	1862	-	1768
Govt. Majid Memorial City College	-	1724	-	-	-	-	1724	1794	1766	1764	-	1767
EQS for wastewater after treatment from industrial units 1200 µmohos/cm												

In 2016, EC of Khulna district ground water mostly was above the EQS (1200 µmohos/cm). It varied from 735 to 2444 µmohos/cm. The maximum EC (2444 µmohos/cm) was in April at Boyra Bazar More, Boyra and the minimum Total Alkalinity (735 µmohos/cm) was in February at Gollamari Bus Stand, Gollamari (Table-44).

Table-45: Chloride (mg/l) of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	-	420	-	426	-	374	420	375	379	374	-	402
Govt. Girls College, Boyra	-	455	-	448	-	423	455	396	398	392	-	390
Khulna Public College, Boyra	-	386	520	388	520	342	386	374	375	372	-	382
Boyra Bazar More, Boyra	-	525	462	530	462	518	525	396	384	382	-	396
Aizer More, Boyra	-	396	390	398	390	365	396	374	376	374	-	384
Rupsha Bus Stand, Rupsha	-	484	530	-	530	-	484	344	342	342	-	340
Natun Bazar, Rupsha	-	494	520	-	520	-	494	322	324	322	-	366
Govt. Comercial College, Sonadanga	-	439	-	442	-	432	439	324	322	324	-	336
Sonadanga Bus Stand, Sonadanga	-	520	390	526	390	512	520	322	326	324	-	366
Sarjical Clinic, Sonadanga	-	462	415	468	415	432	462	342	340	342	-	344
Govt. B.L College, Daulatpur	-	324	-	384	-	379	324	328	329	324	-	414
KUET University Main Gate, Fulbari Gate	-	368	-	370	-	374	368	379	382	384	-	392
Gollamari Bus Stand, Gollamari	452	312	415	-	415	-	312	314	328	324	-	334
Govt. Mohasin College, Khalishpur	-	520	-	528	-	497	364	334	332	384	-	368
Moylapota More	-	430	462	436	462	417	430	366	364	362	-	360
Nirala More	-	325	390	-	390	-	325	324	320	322	-	328
Islami Bank Hospital, Santidham Mor	-	432	520	430	520	422	432	374	372	374	-	374
Seba Clinic, Sher-E-Bangal Road	-	421	390	398	390	345	421	344	342	344	-	346
Jia Hall, Sib Bary	--	390	530	394	530	345	390	344	342	344	-	348
Khulna University, Vaskarja Chattar	-	484	-	-	-	-	484	384	364	362	-	362
Sarkit House	-	572	462	-	462	-	572	396	394	396	-	382
Govt. Khulna Gila School	-	508	-	-	-	-	508	366	362	364	-	366
D.C Office		514	-	426	-	-	514	354	334	354	-	356
Dak Banglo More	-	462	-	-	-	-	462	322	324	322	-	324
Govt.Azom Khan Commerce College	-	434	390	-	390	-	**1674**	336	334	332	-	338
Govt. Majid Memorial City College	-	456	-	-	-	-	456	314	**312**	314	-	336
EQS (150-600 mg/l) for Drinking												

In 2016, the maximum Chloride concentration of Khulna district ground water was 1674 mg/l at Govt. Azom Khan Commerce College in July and the minimum Chloride concentration was 312 mg/l at Govt. Majid Memorial City College in September (Table-45) where the EQS is (150-600 mg/l).

Table-46: Hardness (mg/l) of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	-	344	-	348	-	348	344	344	346	344	-	322
Govt. Girls College, Boyra	-	338	-	336	-	336	338	338	336	332	-	336
Khulna Public College, Boyra	-	308	330	312	330	312	308	308	318	314	-	324
Boyra Bazar More, Boyra	-	332	340	330	340	330	332	332	330	332	-	330
Aizer More, Boyra	-	312	330	316	330	316	312	312	314	312	-	326
Rupsha Bus Stand, Rupsha	-	354	390	-	**390**	-	354	354	352	354	-	362
Natun Bazar, Rupsha	-	362	330	-	330	-	362	362	344	342	-	308
Govt. Comercial College, Sonadanga	-	382	-	382	-	382	382	382	374	372	-	372
Sonadanga Bus Stand, Sonadanga	-	330	310	328	310	328	330	330	332	372	-	344
Sarjical Clinic, Sonadanga	-	340	341	336	341	336	340	340	344	342	-	364
Govt. B.L College, Daulatpur	-	228	-	230	-	230	228	228	228	**224**	-	284
KUET University Main Gate, Fulbari Gate	-	228	-	232	-	348	295	228	230	232	-	238
Gollamari Bus Stand, Gollamari	312	295	341	-	341	-	302	295	296	292	-	254
Govt. Mohasin College, Khalishpur	-	328	-	334	-	334	380	302	322	336	-	328
Moylapota More	-	380	340	378	340	378	254	380	384	382	-	363
Nirala More	-	254	310	-	-	-	370	254	252	254	-	256
Islami Bank Hospital, Santidham Mor	-	370	330	362	310	362	312	370	372	374	-	374
Seba Clinic, Sher-E-Bangal Road	-	312	330	310	330	310	310	312	314	312	-	323
Jia Hall, Sib Bary	-	310	390	314	330	314	342	310	314	312	-	310
Khulna University, Vaskarja Chattar	-	342	-	-	390	-	298	342	344	342	-	336
Sarkit House	-	298	340	-	-	-	306	298	302	312	-	308
Govt. Khulna Gila School	-	306	-	-	340	-	302	306	304	314	-	312
D.C Office	-	302	-	348	-	-	302	302	308	310	-	326
Dak Banglo More	-	286	-	-	-	-	286	286	306	312	-	318
Govt.Azom Khan Commerce College	-	318	330	-	330	-	318	318	314	316	-	314
Govt. Majid Memorial City College	-	326	-	-	-	-	326	326	324	322	-	320
EQS (200-500 mg/l) for Drinking												

In 2016, Hardness of Khulna district ground water was above the EQS (200-500 mg/l). It varied from 224 to 390 mg/l (Table-46).

Table-47: Iron (mg/l) of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	`-	0.45	-	0.42	-	0.42	0.45	0.45	0.45	0.46	-	0.42
Govt. Girls College, Boyra	-	0.48	-	0.44	-	0.44	0.48	0.48	0.48	0.42	-	0.46
Khulna Public College, Boyra	-	0.48	0.52	0.42	0.52	0.42	0.48	0.48	0.48	0.44	-	0.44
Boyra Bazar More, Boyra	-	0.54	0.45	0.52	0.45	0.52	0.54	0.54	0.54	0.52	-	0.53
Aizer More, Boyra	-	0.49	0.55	0.44	0.55	0.44	0.49	0.49	0.49	0.44	-	0.44
Rupsha Bus Stand, Rupsha	-	0.36	0.55	-	0.55	-	0.36	0.36	0.34	0.32	-	0.31
Natun Bazar, Rupsha	-	0.52	0.52	-	0.52	-	0.52	0.52	0.52	0.52	-	0.52
Govt. Comercial College, Sonadanga	-	0.56	-	0.58	-	**0.58**	0.56	0.56	0.56	0.52	-	0.53
Sonadanga Bus Stand, Sonadanga	-	0.52	0.52	0.53	0.52	0.53	0.52	0.52	0.52	0.52	-	0.52
Sarjical Clinic, Sonadanga	-	0.45	0.52	0.45	0.52	0.45	0.45	0.45	0.45	0.44	-	0.48
Govt. B.L College, Daulatpur	-	0.44	-	0.48	-	0.48	0.44	0.44	0.44	0.42	-	0.46
KUET University Main Gate, Fulbari Gate	-	0.28	-	0.3	-	0.42	0.28	0.28	0.28	0.24	-	0.38
Gollamari Bus Stand, Gollamari	0.38	0.53	0.52	-	0.52	-	0.53	0.53	0.54	0.52	-	0.52
Govt. Mohasin College, Khalishpur	-	0.52	-	0.56	-	0.56	0.26	0.26	0.24	0.54	-	0.34
Moylapota More	-	0.55	0.45	0.52	0.45	0.52	0.55	0.55	0.52	0.52	-	0.52
Nirala More	-	0.54	0.52	-	0.52	-	0.54	0.54	0.52	0.52	-	0.56
Islami Bank Hospital, Santidham Mor	-	0.35	0.52	0.36	0.52	0.36	0.35	0.35	0.36	0.34	-	0.33
Seba Clinic, Sher-E-Bangal Road	-	0.32	0.55	0.38	0.55	0.38	0.32	0.32	0.34	0.32	-	0.44
Jia Hall, Sib Bary	-	0.52	0.55	0.56	0.55	0.56	0.52	0.52	0.52	0.54	-	0.51
Khulna University, Vaskarja Chattar	-	0.36	-	-	-	-	0.36	0.36	0.34	0.32	-	0.56
Sarkit House	-	0.38	0.45	-	0.45	-	0.38	0.38	0.34	0.32	-	0.32
Govt. Khulna Gila School	-	0.36	-	-	-	-	0.36	0.36	0.32	0.34	-	**0.22**
D.C Office	-	0.48	-	0.42	-	-	0.48	0.48	0.44	0.42	-	0.42
Dak Banglo More	-	0.54	-	-	-	-	0.54	0.54	0.52	0.54	-	0.52
Govt.Azom Khan Commerce College	-	0.46	0.55	-	0.55	-	0.46	0.46	0.42	0.42	-	0.48
Govt. Majid Memorial City College	-	0.56	-	-	-	-	0.56	0.56	0.54	0.52	-	0.55
EQS (0.3-1 mg/l) for Drinking												

In 2016, Iron of Khulna district ground water was within EQS (0.3-1.0 mg/l). It varied from 0.22 to 0.58 mg/l (Table-47). Ground water quality is good throughout the year of 2016.

Table-48: Salinity (ppt) of Khulna District Ground Water

Locations of Khulna	Jan	Feb	Mar	Apl	May	June	July	Aug	Sep	Oct	Nov	Dec
Divisional Comissioner Office, Boyra	-	0	-	0.1	-	0.1	0	0	0	0	-	0.1
Govt. Girls College, Boyra	-	0.1	-	0	-	0	0.1	0.1	0.1	0.1	-	0.1
Khulna Public College, Boyra	-	0.3	0.1	0.2	0.1	0.2	0.3	0.2	0.1	0.1	-	0.2
Boyra Bazar More, Boyra	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	0.1
Aizer More, Boyra	-	0.4	0.2	0.2	0.2	0.2	**0.4**	0.4	0.2	**0**	-	0.1
Rupsha Bus Stand, Rupsha	-	0.1	0.2	-	0.2	-	0.1	0.1	0	0.1	-	0
Natun Bazar, Rupsha	-	0.1	0.1		0.1		0.1	0.1	0	0.1		0.1
Govt. Comercial College, Sonadanga	-	0.2	-	0	-	0	0.2	0.2	0.1	0.1	-	0.1
Sonadanga Bus Stand, Sonadanga	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	0
Sarjical Clinic, Sonadanga	-	0.1	0.1	0	0.1	0	0.1	0.1	0.1	0	-	0.2
Govt. B.L College, Daulatpur	-	0.1	-	0	-	0	0.1	0.1	0.1	0.1	-	0.1
KUET University Main Gate, Fulbari Gate	-	0.1	-	0.1	-	0.1	0.1	0.1	0.1	0.1	-	0
Gollamari Bus Stand, Gollamari	-	0.1	0.1	-	0.1	-	0.1	0.1	0.1	0	-	0
Govt. Mohasin College, Khalishpur	-	0.2	-	0.1	-	0.1	0.2	0.2	0.1	0.2	-	0.1
Moylapota More	-	0	0.1	0	0.1	0	0	0	0.1	0.1	-	0.1
Nirala More	-	0	0.1		0.1		0	0	0.1	0.1	-	0.1
Islami Bank Hospital, Santidham Mor	-	0.1	0.1	0	0.1	0	0.1	0.1	0	0.1	-	0
Seba Clinic, Sher-E-Bangal Road	-	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	-	0
Jia Hall, Sib Bary	-	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.1	-	0
Khulna University, Vaskarja Chattar	-	0.1	-	-	-	-	0.1	0.1	0	0.1	-	0.1
Sarkit House	-	0.1	0.1	-	0.1	-	0.1	0.1	0.1	0.2	-	0.1
Govt. Khulna Gila School	-	0	-	-	-	-	0	0	0	0.1	-	0
D.C Office	-	0.1	-	0.1	-	-	0.1	0.1	0	0	-	0.1
Dak Banglo More	-	0	-	-	-	-	0.1	0	0.1	0.2	-	0.1
Govt.Azom Khan Commerce College	-	0.2	0.2	-	0.2	-	0.2	0.2	0.1	0.1	-	0
Govt. Majid Memorial City College	-	0.2	-	-	-	-	0.2	0.2	0.1	0	-	0.1
EQS for wastewater after treatment from industrial units 400 ppt												

In 2016, Salinity of Khulna district ground water was within EQS (400 ppt). It varied from 0.0 to 0.4 ppt (Table-48).

5.7 Ground Water Quality in Barisal District

Table-49: Ground Water Quality Barisal District in 2016

Locations of Ground Water Parameters in Barisal District	pH			EC			Chloride			T. Alkalinity		
	April	June	Aug	April	June	Aug	April	June	Aug	April	June	Aug
DC Office	7.2	7.0	7.0	218	216	216	124	122	122	120	118	118
Upozila Office	7.4	7.0	7.0	220	216	216	126	122	122	**122**	118	118
Sadar Hospital	7.0	7.2	7.2	216	218	218	**122**	124	124	118	120	120
Sher-E-Bangla Medical College Hospital	7.2	7.4	7.4	218	220	220	124	126	126	120	122	122
BM College, Sadar	7.04	**7.4**	7.4	**220**	220	220	**126**	126	126	122	122	122
Syed Hatim Ali Govt. College	**7.0**	7.2	7.2	**216**	218	218	122	124	124	**118**	120	120
Barisal Zila School	7.2	7.0	7.0	218	216	216	124	122	122	120	118	118
Natullabad Bus Stand	7.4	7.0	7.0	220	216	216	126	122	122	122	118	118
Chowmatha Bazar, Sadar	7.0	7.4	7.4	216	220	220	122	126	126	118	122	122
Battala Bazar, Sadar	7.2	7.2	7.2	218	218	218	124	124	124	120	120	120
EQS	**6.5-8.5**			**1200 µmohos/cm**			**150-600 mg/l**			**150 mg/l**		

In 2016, pH level of Barisal district ground water was within EQS (6.5-8.5) for drinking water. It varied from 7.0 to 7.4. EC was within the EQS (1200 µmohos/cm) limit and it varied from 216 to 220 µmohos/cm. Chloride was within the EQS (150-600 mg/l) and it varied from 122 to 126 mg/l. Total Alkalinity was also within the EQS (150 mg/l) and varied from 118 to 122 mg/l (Table-49).

5.8 Ground Water Quality in Bogra District

Table-50: Ground Water Quality Bogra District in 2016

Locations of Ground Water Parameters in Bogra District	pH			EC			Iron			T. Hardness		
	Feb	Aug	Dec	Feb	Aug	Dec	Feb	Aug	Dec	Feb	Aug	Dec
Bogra Zilla School	**6.78**	7.41	7.42	388	396	374	0.45	0.32	0.28	230	210	230
VM School, Sadar	7.28	7.35	7.46	412	422	359	0.42	0.3	0.34	150	230	220
Zilla Parishad	7.38	7.32	7.35	381	402	420	0.63	0.32	0.42	210	200	210
Office of the Duputy Commissioner	**7.46**	7.24	7.62	396	398	392	0.45	0.36	0.33	190	200	200
Office of the Bogra Municipality	-	7.18	7.78	-	408	390	-	0.34	0.42	-	220	240
Yakubiya Girls High School	-	7.23	-	-	410	-	-	0.38	-	-	230	-
Head Post Office	6.89	6.94	7.38	410	408	354	0.4	0.4	**0.28**	180	**240**	240
Biddut Office	7.31	7.24	7.21	422	412	**320**	0.36	0.38	0.38	**130**	200	220
T & T Office	7.38	6.98	7.38	404	418	368	**0.46**	0.36	0.32	200	210	200
Commercial College	6.96	7.12	7.31	403	402	**422**	0.38	0.3	0.4	140	200	220
Office of the Police Super	6.92	7.26	-	366	414	-	0.55	0.32	-	160	220	-
EQS	**6.5-8.5**			**1200 µmohos/cm**			**0.3-1.0 mg/l**			**200-500 mg/l**		

In 2016, pH level of Bogra district ground water was within EQS (6.5-8.5) for dingking.It varied from 6.78 to 7.46. EC was within the EQS (1200 µmohos/cm) limit and it varied from 320 to 422 µmohos/cm. Iron was within the EQS (0.3-1.0 mg/l) and it varied from 0.28 to 0.46 mg/l. Total Hardness was also within the EQS (200-500 mg/l) and varied from 130 to 240 mg/l (Table-50).

5.9 Ground Water Quality in Sylhet District

Table-51: Ground Water Quality Sylhet District in 2016

Locations of Ground Water Parameters in Sylhet District	pH				EC				Iron				T. Hardness			
	Jan	May	Aug	Dec	Jan	May	Aug	Dec	Jan	May	Aug	Dec	Jan	May	Aug	Dec
MC College, Tilagor	7	7.2	7.1	7.2	286	318	324	332	0.62	0.62	0.65	0.68	12	12	13	13
Kadamtoli Bus Terminal	7.1	7.3	7.2	7.1	288	292	312	316	0.8	0.8	0.75	0.74	**8**	14	12	11
Durgakumar Govt. Primary School, Bandor Bazar	6.9	6.9	7	6.9	325	345	**348**	346	0.5	0.65	0.72	0.78	9	**18**	17	16
Sylhet Govt. Girls High School, Bandor Bazar	7	7	7.2	7.4	284	310	**33**	338	**0.3**	0.3	0.39	0.49	11	13	13	12
Osmani Medical College	6.9	7.4	7.3	7.3	318	296	312	318	**0.85**	0.45	0.55	0.58	12	16	15	14
Shahjalal Darga, Sadar	-	**7.6**	7.1	-	-	256	-	-	-	0.52	-	-	-	9	-	-
Shahporan Darga, Khadinnagar	-	**6.8**	-	-	-	278	-	-	-	0.56	-	-	-	8	-	-
EQS	**6.5-8.5**				**1200 µmohos/cm**				**0.3-1.0 mg/l**				**200-500 mg/l**			

In 2016, pH level of Sylhet district ground water was within EQS (6.5-8.5) for dingking. It varied from 6.8 to 7.6. EC was within the EQS (1200 µmohos/cm) limit and it varied from 33 to 348 µmohos/cm. Iron was within the EQS (0.3-1.0 mg/l) and it varied from 0.3 to 0.85 mg/l. Total Hardness was also within the EQS (200-500 mg/l) and varied from 8.0 to 18 mg/l (Table-51).

CHAPTER 6: TREND ANALYSIS OF WATER QUALITY OF MAJOR RIVERS

6.1 Buriganga River

The Buriganga River 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-52. Level of Different Parameter of Buriganga River During 2010 - 2016.

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
	2016	Dry	7.54	0.17	17.09
		Wet	7.05	2.98	6.53
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 2010-2016, 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 (≤6 mg/l) 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-53. Level of Different Pparameter of Shitalakhya River During 2010 - 2016.

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
	2016	Dry	7.26	4.25	19.99
		Wet	7.22	4.14	5.49
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 2010-2016, 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 (≤5 mg/l). BOD was exceeded EQS during 2010-2016 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 "Kohor river". Different parameters of Turag River water are shown in the table below.

Table-54. Level of Different Parameter of Turag River During 2010 - 2016.

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
	2016	Dry	7.18	0.4	30.48
		Wet	7.31	4.51	4.84
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 - 2016, 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 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.

Table-55. Level of Different Parameter of Dhaleshwari River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Dhaleshwari River	2010	Dry	7.03	5.36	2.85
		Wet	6.86	6.15	3.42
	2011	Dry	7.17	6.01	3.91
		Wet	6.86	6.00	2.52
	2012	Dry	7.57	4.50	6.61
		Wet	7.82	6.0	8.64
	2013	Dry	7.81	4.15	14.37
		Wet	7.25	4.91	4.28
	2014	Dry	7.48	2.87	11.55
		Wet	7.16	4.475	6.65
	2015	Dry	7.15	1.4	7.2
		Wet	6.90	5.35	1.38
	2016	Dry	7.21	2.75	4.98
		Wet	7.56	6.05	2.41
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 2011-2016, pH of Padma river water was within the EQS for inland surface water for fisheries. DO content was within the EQS in the wet season. And BOD content of Dhaleshwari river water was within the EQS.

6.5 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)

Table-56. Level of Different Parameter of Brahmaputra River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Brahmaputra River	2010	Dry	7.14	5.44	4.5
		Wet	6.97	5.62	2.42
	2011	Dry	7.08	5.85	2.86
		Wet	6.74	6.35	2.36
	2012	Dry	7.31	6.9	3.1
		Wet	7.28	6.25	2.6
	2013	Dry	8.22	11.36	16
		Wet	7.69	5.9	0
	2014	Dry	7.89	9.7	5.1
		Wet	-	-	-
	2015	Dry	7.08	7.5	1.5
		Wet	7.56	6.55	0.55
	2016	Dry	7.19	7.06	1.66
		Wet	7.48	6.4	1.58
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 - 2016, pH of Brahmaputra river water was within the EQS for inland surface water for fisheries. DO content was within the EQS in the wet season. BOD content of Brahmaputra river water was higher than the EQS in the year 2013 in Dry Season.

6.6 Halda River

Halda River is a river in south-eastern Bangladesh. It originates at the Badnatali Hill Ranges in Ramgarh Upazila in the Chittagong Hill Tracts, flows through Fatikchhari Upazila, Bhujpur Thana, Hathazari Upazila, Raozan Upazila and Chandgaon Thana of the Chittagong Metropolitan City, and falls into the Karnaphuli River. The 81-kilometre long river has a very turbulent tributary, the Dhurung River, which joins Purba Dhalai about 48 kilometres downstream. The river is navigable by big boats 29 km into it (up to Nazir Hat) and by small boats 16–24 km further (up to Narayanhat). The Halda reaches up 21 feet (6.4 m) in depth and 30 feet (9.1 m) in deepest point. The Halda river is also famous for breeding pure Indian carp. This is the only pure Indian carp breeding field of Bangladesh, perhaps in South Asia.

Table-57. Level of Different Parameter of Halda River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Halda River	2010	Dry	7.13	-	-
		Wet	7	-	-
	2011	Dry	7.13	5.71	1.12
		Wet	7.16	5.65	1.13
	2012	Dry	7.22	5.31	0.77
		Wet	7.15	4.54	0.78
	2013	Dry	7.19	5.34	0.41
		Wet	7.12	5.31	0.32
	2014	Dry	7.22	5.26	0.37
		Wet	7.186	5.44	0.24
	2015	Dry	7.49	6.03	-
		Wet	7.37	6.69	-
	2016	Dry	7.22	6.68	-
		Wet	6.95	7.15	-
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 2010-2016, pH of Halda river water was within the EQS for inland surface water for fisheries. DO and BOD content was within the EQS. Considering pH, DO and BOD, water quality of Halda is good.

6.7 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.

Table-58. Level of Different Parameter of Moyuri River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Moyuri River	2010	Dry	7.6	0.36	26.6
		Wet	7.52	2.33	5.66
	2011	Dry	7.40	0.69	19.5
		Wet	7.59	2.7	9.73
	2012	Dry	7.59	0.93	16.0
		Wet	7.53	0.5	9.2
	2013	Dry	7.63	0.06	21.5
		Wet	7.63	-	13
	2014	Dry	7.67	-	-
		Wet	7.75	-	-
	2015	Dry	7.66	1.2	-
		Wet	7.49	2.46	-
	2016	Dry	7.68	1.55	-
		Wet	7.65	1.98	-
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 - 2016, pH of Moyuri river water was within the EQS for inland surface water for fisheries. DO content was not within the EQS. And BOD content of Moyuri river water was over the EQS.

6.8 Surma River

The Surma River is a major river in Bangladesh, part of the Surma-Meghna River System. It starts when the Barak River from northeast India divides at the Bangladesh border into the Surma and the Kushiyara rivers. It ends in Kishoreganj District, above Bhairab Bazar), where the two rivers rejoin to form the Meghna River. The waters from the river ultimately flow into the Bay of Bengal. The average depth of river is 86 m and maximum depth is 170 m. From its source in the Manipur Hills near Mao Songsang, the river is known as the Barak River. At the border with Bangladesh, the river divides with the northern branch being called the Surma River and the southern the Kushiyara River. This is where the river enters the Sylhet Depression (or trough) which forms the Surma Basin. The Surma is fed by tributaries from the Meghalaya Hills to the north, and is also known as the Baulai River after it is joined by the south-flowing Someshwari River.

Table-59. Level of Different Parameter of Surma River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Surma River	2010	Dry	7.48	6.3	1.2
		Wet	7.45	6.76	1.16
	2011	Dry	7.63	7.39	1.17
		Wet	7.63	7.24	1.23
	2012	Dry	7.66	5.88	1.12
		Wet	7.35	5.8	1.21
	2013	Dry	6.89	6.4	1.30
		Wet	6.63	6.54	0.9
	2014	Dry	6.95	5.02	32.37
		Wet	6.76	5.49	36.12
	2015	Dry	7.055	5.85	15.03
		Wet	7.1	6.23	17.87
	2016	Dry	7.22	6.07	26.54
		Wet	7.14	6.58	26.88
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 - 2016, pH of Surma 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 Surma river water was much over the EQS in the year of 2013 to 2016.

6.9 Korotoa River

Karatoya River, a small stream in Rajshahi Division of Bangladesh, was once a large and sacred river. A channel of it presently flows by the ancient ruins of Mahasthangarh in Bogra District. The Karatoya, known as Phuljhur rises in the Baikunthapur jungles in the extreme north-west of Jalpaiguri district (West Bengal, India) and forms for some distance the boundary between Dinajpur and Rangpur districts. It, then, meanders through Rangpur and Bogra. In the south of Bogra district, it receives the Halhalia and the united stream is then known as Phuljhur. It leaves Bogra at Chanda kona and flowing in a southerly direction past Raiganj and Shujapur is joined by the Ichhamati at Nalka. The Phuljhur then flows south past the important village of Ullapara, a few miles below which it joins the Hurasagar at Narnia after a course of about 64 kilometres in this district. After this junction, it takes the name of Hurasagar and passing close by Shazadpur and Hera joins the Jamuna near Bera.

Table-60. Level of Different Parameter of Korotoa River During 2011- 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Korotoa River	2011	Dry	7.22	5.54	20.70
		Wet	7.07	5.80	16.22
	2012	Dry	6.91	5.74	13.44
		Wet	6.79	6.38	2.51
	2013	Dry	7.27	5.17	2.67
		Wet	7.13	4.87	4.31
	2014	Dry	7.37	4.58	3.57
		Wet	7.33	4.38	2.79
	2015	Dry	7.42	1.78	11.85
		Wet	7.24	5.36	4.05
	2016	Dry	6.77	2.57	5.74
		Wet	7.39	2.56	6.09
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 - 2016, pH of Korotoa river water was within the EQS (6.5-8.5) for inland surface water for fisheries. DO content was almost within the EQS except the year 2014 and 2016. And BOD content of Korotoa river water was over the EQS in the year of 2011, 2012 (Dry season) and 2015 (Dry Season).

6.10 Mathavanga River

The Mathabhanga or Hauli, whose lower reach is called the Haulia, leaves the Padma about ten miles below the point where the Jalangi leaves from it. It flows first in a southeasterly direction as far as Hatboalia, where it bifurcates one branch, which is thereafter known as the Kumar or Pangasi, it then proceeds in the same direction, past Alamdanga, up to the boundary of the district which it forms for a few miles until it passes into Jessore, whilst the other branch pursues a very tortuous course. The general trend of which is to the south, until, after passing Chuadanga it reaches Krishnaganj (in India). There a second bifurcation takes place, the two resulting streams being known as the Churni and the Ichamati, and the name of the parent river being lost. It borderline's between India and Bangladesh.

Table-61. Level of Different Parameter of Mathavanga River During 2010 - 2016.

Sampling Location	Year	Season	P^H	DO	BOD
Mathavanga River	2010	Dry	7.46	2.11	144.08
		Wet	7.62	3.6	82.85
	2011	Dry	7.50	5.03	11.69
		Wet	7.65	4.83	15.40
	2012	Dry	7.71	6.53	17.61
		Wet	7.85	6.7	0.53
	2013	Dry	7.62	6.83	0.9
		Wet	7.62	5.8	0.8
	2014	Dry	7.62	5.4	0.6
		Wet	7.465	5.67	0.69
	2015	Dry	7.67	5.16	0.8
		Wet	7.67	5.32	0.76
	2016	Dry	7.67	5.16	0.8
		Wet	7.47	5.21	0.8
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 2010-2016, pH of Mathavanga 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 Mathavanga river water was over the EQS in the year of 2010, 2011and 2012 (Dry Season).

CHAPTER 7: RECOMMENDATIONS

Recommendations

To provide with 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.

a. Strengthening regional cooperation for the sustainable management of trans-boundary rivers, Integrated Watershed Management (IWM) approach can be implemented in this regard.

b. For each river, sampling must be done from more than one location.

c. Intensify monitoring of ETP outlet water of Jamuna Fertilizer Factory at Bahadurpur and KAFCO at Chittagong to improve treatment efficiency.

d. Stop discharging untreated sewage into river water and improve sanitation system in the city areas.

e. Review and update surface water monitoring network.

f. Need to collect weather information while sampling.

g. Need to collect data of river flow.

h. Stop dumping municipal waste and medical wastes into rivers.

i. Increase river flow specially during dry season.

j. Water is the most important component of environment. To stop random use of ground water in the industry, environmental tax can be imposed.

k. Judicious selection of sampling locations.

l. Collection of water samples and analyses must be in a consistent way and on regular basis for assessment of water quality.

m. Use Global Positioning System (GPS) to represent monitoring results in global context.

n. Establish Water Quality Index (WQI) to assess water quality analysis.

o. A comprehensive set of parameters including microbial test (Fecal Coliform, E-Coli etc) of river water is essential to evaluate water quality of rivers.

p. Increase skilled manpower at all level of water quality analysis including sample collection.

q. Ensure installation of ETP/CETP and their continuous operation to stop disposal of untreated wastewater into the rivers.

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