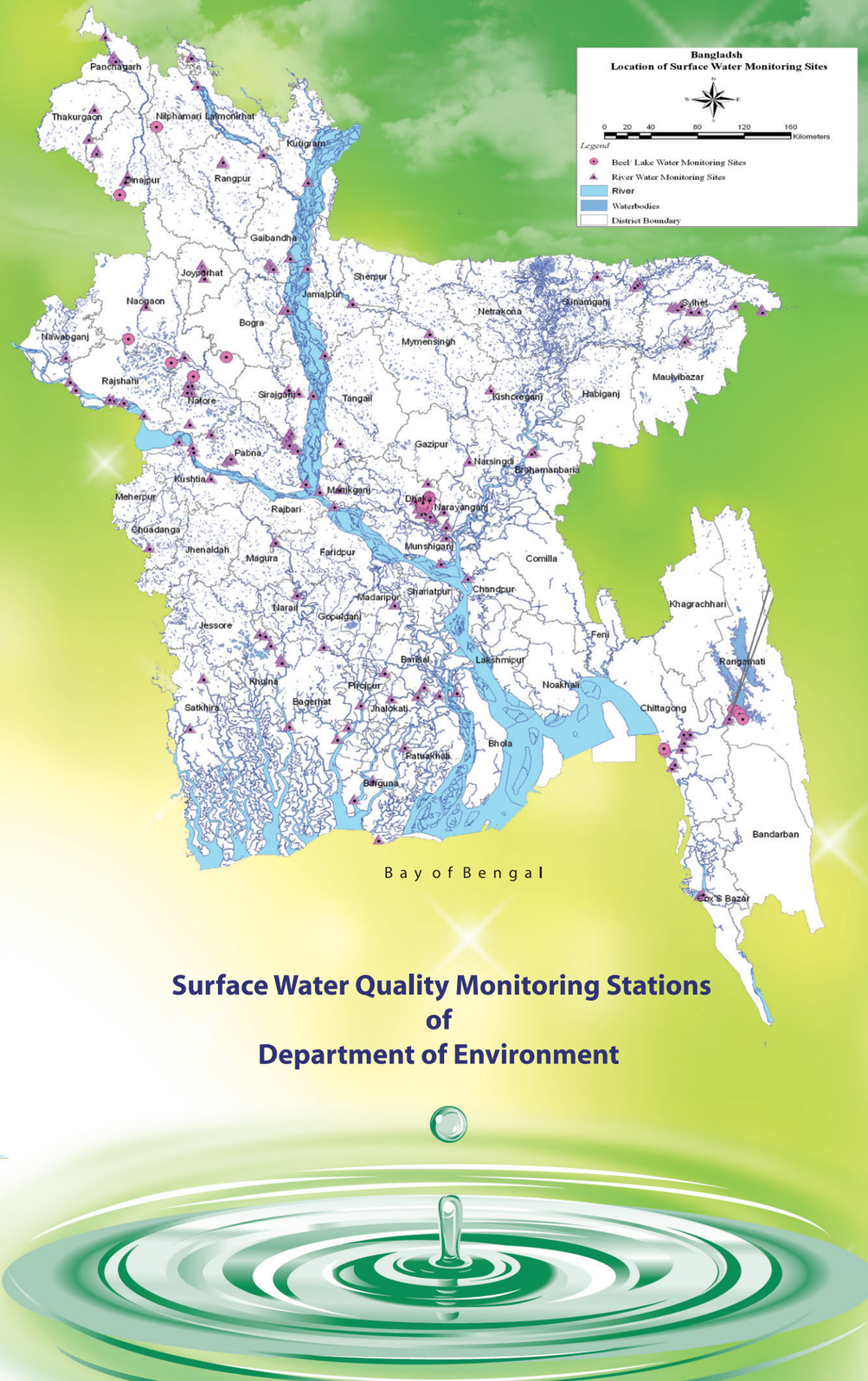


**Surface Water Quality Monitoring Stations**
**of**
**Department of Environment**

# River Water Quality Report 2011


**পরিবেশ অধিদপ্তর**

পরিবেশ ও বন মন্ত্রণালয়, গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

# RIVER WATER QUALITY REPORT 2011

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## MESSAGE

Water is the central gem of all production activities where quantity and quality matters much. In riverine Bangladesh water greatly occupies most avenues of lives and livelihoods. The Department of Environment has been monitoring surface water quality since its origin in 1973. It has successfully translated monitoring information into development of policy and legislative framework for environmental protection.

Bangladesh is criss-crossed by hundreds of rivers, streams, canals and creeks with a total length of at least 24,000 km and an area of 4,600 sq.km. The combined total catchments area of the Ganges--the Brahmaputra-the Meghna (GBM) river systems is about 1.74 million sq. km of which seven percent lies within Bangladesh.

“River Water Quality Report, 2011” is the second of this kind that shed light on present status of river water quality in Bangladesh and also highlight the necessary steps to be taken for sustainable management of aquatic ecosystems.

I express my sincere thanks to the Natural Resource Management Section, Department of Environment for preparing this report.

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

Md. Golam Rabbani
Director General

# FOREWORD

Being a country of rivers, Bangladesh needs to adopt adequate measures to halt further degradation of our precious water resources. The river water quality report 2011 contains statistical analyses of various water quality parameters of different rivers of the country for the period from January to December 2011. It offers a clear view of present situation and recommends ways and means for conservation and sustainable use of water.

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

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

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



# TECHNICAL NOTE

Water is life where quality and quantity matter most. It is a single most important constituent of environment that can exists as liquid, gaseous and solid forms under natural condition. Because of its nature of high mobility, can come into contact with various pollutants and easily get polluted. To track changes in water quality continuous monitoring is essential. Despite continual monitoring of surface water quality considering spatio-temporal context and partial measurement of parameters in terms of number of water quality parameters, this report would shed some light on water resource quality of the country. In this report efforts have been made to analyze parameters like pH, DO, BOD, COD, Turbidity, TDS, SS, Total Alkalinity, EC and Chloride those were measured more or less round the year of 2011. From the analyses, seasonality aspect of water quality and impact of industrialization on water quality surfaced up especially for the rivers surrounding Dhaka city. During the rainy season water quality of most rivers (under the monitoring programme) was good while comparing with the Environmental Quality Standard (EQS) set in the ECR. Water quality of rivers around Dhaka city and the environs, Chittagong and Khulna failed to comply EQS in the dry season indicating the most probable effect of dense industrialization in those areas followed by increased human pressure on rivers. The difference in pollution level among the sampling points along a single river was also evident. Monitoring and enforcements reports revealed the fact that discharging of industrial untreated wastes mostly responsible for river pollution. All the above situations fingering to noncompliance of rules by the industries and thus, need to escalate monitoring & enforcement activities as well as awareness building in all walks of life to achieve sustainable management of water resources.

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

# ACKNOWLEDGEMENT

We would like to thank all divisional offices of the Department of Environment, for providing with water quality data. We greatly acknowledge kind support and guidance of Md. Golam Rabbani, Director General, Department of Environment for preparation of this report. Special thanks go to Dr Sultan Ahmed, Director (NRM and Research) at present for critical review of this report.




# EXECUTIVE SUMMERY


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

The Department of Environment (DoE) has been monitoring surface and ground water quality since 1973. The surface water quality monitoring programme of DoE supposed to include 63 stations of the 27 rivers in Bangladesh. But divisional offices monitoring water quality only at 28 stations of 12 rivers at monthly interval. The monitoring involved making field measurements (only pH at some stations) and collecting water samples for laboratory analyses. Six divisional offices measured 12 parameters (physical and chemical) of collected samples. Depending on continuity of measurements in the spatio-temporal context, we took ten parameters [e.g. pH, Chloride, Turbidity, Total Dissolved Solid (TDS), Suspended Solid (SS), Electrical Conductivity (EC), Total Alkalinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)] for our analyses.

Based on the parameters mentioned above water quality of the major rivers e.g. Padma, Meghna, Jumuna, Dhaleshwari, Surma, Korotoa etc. was within the limit of Environmental Quality Standards (EQS) in 2011 while rivers around greater Dhaka were highly polluted in the first five or four months of 2011 in terms of DO, BOD and COD value. No dissolved oxygen was found from January to May at different location of Buriganga, Shitalakhya and Turag River. High level of Chloride (48 mg/l), TDS (1188 mg/l), BOD (87 mg/l) and COD (226 mg/l) were found in Buriganga river from January to May in 2011 . In Meghna and Jamuna DO and BOD level was found within the national standard which varied from 5.2 to 7.2 mg/l and 0.3 to 3.4 mg/l respectively in Meghna and from 4.5 to 7.8 mg/l and 2.0 to 3.8 mg/l respectively in Jamuna.

High level of chloride, TDS, turbidity was found higher in Moyuri, Rupsha, Pashur and Kakshiali River. Highest level of chloride (11,390 mg/l) and TDS (17,750 mg/l) were found in Pashur River. Heigh value of turbidity (188.4 JTU) was found in Kakshiali River (Fig.20). More than 500 mg/l COD were found in Karnaphuli, Bakkhali Mathavanga River and Moyuri .

Lack of continuous monitoring is one of the major problems for analysis river water quality data. Establishment of detail inland surface water standard and water quality index is essential to assess water quality of rivers.

## TABLE OF CONTENTS



## TABLE OF CONTENTS

# LIST OF TABLES



# LIST OF FIGURES

# ABBREVIATIONS

| | | |
|---|---|---|
| **BOD** | - | **Biochemical Oxygen Demand** |
| **COD** | - | **Chemical Oxygen Demand** |
| **EC** | - | **Electrical Conductivity** |
| **ECA** | - | **Ecologically Critical Area** |
| **ECR** | - | **Environmental Conservation Rules** |
| **DO** | - | **Dissolved Oxygen** |
| **DoE** | - | **Department of Environment** |
| **EQS** | - | **Environmental Quality Standard** |
| **GPS** | - | **Global Positioning System** |
| **IWM** | - | **Integrated Watershed Management** |
| **NTU** | - | **Nephelometric Turbidity Unit** |
| **SS** | - | **Suspended Solid** |
| **SoE** | - | **State of the Environment** |
| **T. Alkalinity** | - | **Total Alkalinity** |
| **TDS** | - | **Total Dissolved Solid** |
| **TS** | - | **Total Solid** |
| **WQI** | - | **Water Quality Index** |
| **WCZ** | - | **Water Control Zone** |

# CHAPTER 1: INTRODUCTION

## 1.1 Background

In Bangladesh, rivers, their tributaries and distributaries are the principal sources of fresh water for all forms of lives. To ensure quality of water for human consumption and other uses the Government has set specific standards for inland surface water in the Environmental Conservation Rules (ECR), 1997.

The flows in the rivers varies greatly by responding to seasons and fluctuation of flow. Following fluctuation in flow river water quality varies significantly. A significant portion of the river's base flow in the country is abstracted for potable use. This can greatly reduce the river's flow volume, and its natural flushing and purification capacity. Dumping of industrial untreated waters, household and municipal wastes etc. into water courses is the prime reason for surface water pollution. Government has already declared four rivers (Buriganga, Shitalakhya, Turag and Balu) as Ecologically Critical Area (ECA) to protect from further pollution.

To monitor surface water quality and to devise ways and means for pollution control, DoE has setup a monitoring network. To maintain quality of water effective control and management of pollutants at source as well as regional cooperation is essential.

## 1.2 Major objectives of the report

i. To provide updated information on the rivers water quality to help information based decision-making process for sustainable development and management of water resources.
ii. Sensitization and awareness building among the stakeholders.
iii. To provide information for research/study in the relevant field.
iv. 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 the Department of Environment (DoE) for the period of January to December 2011. The following may be the limitations of the report:

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

### 1.4 River water quality monitoring

Monitoring of river water resources quality is a vital work of DoE. The information obtained from monitoring would constitute part of diagnosis of functionality of aquatic ecosystem. Also it would help evaluating effectiveness of the pollution abatement measures and would provide necessary input for development of water resource management strategies.

Following countrywide monitoring network water samples have been collected for laboratory analyses. In 2011, the monitoring program covered 63 sampling locations in 27 rivers. About 50% of these locations were monitored on monthly basis.



# CHAPTER 2: AN OVERVIEW OF BANGLADESH'S RIVERS

### Rivers of Bangladesh

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

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

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

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

# CHAPTER 3: MEASUREMENT OF RIVER WATER QUALITY

### 3.1 Water quality parameters

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

### 3.2 Comparison with standards for inland surface water

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



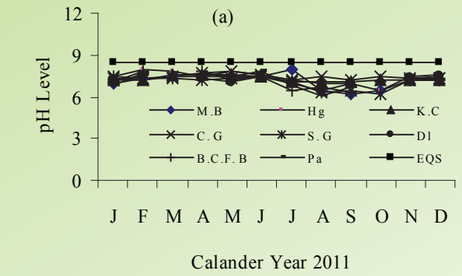
# CHAPTER 4: RIVER WATER QUALITY IN 2011

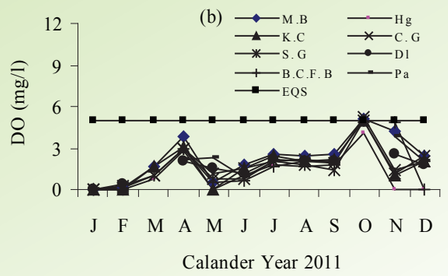
### 4.1 Buriganga river

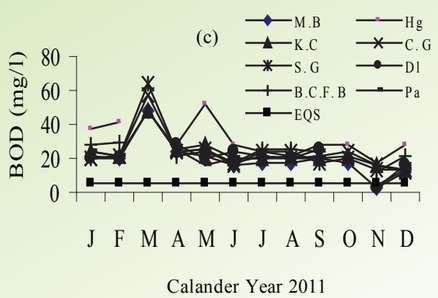
To monitor water quality of Buriganga river samples were collected from eight different locations viz. Mirpur Bridge, Hazaribag, Kamrangir Char, Chandni Char, Sadar ghat, Dholaikhal, Bangladesh China Friendship Bridge (BCFB) and Pagla along the river.

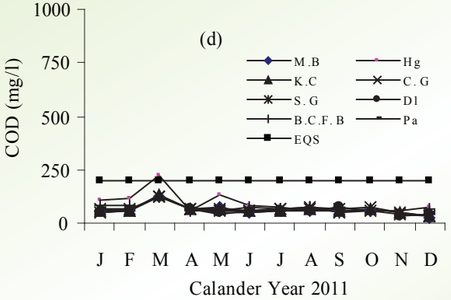
In 2011, pH at different locations varied from 6.2 to 7.88 (Fig.-2a) while standard pH range for inland surface water for fisheries is 6.5 to 8.5. In 2012, pH level varied from 6.5 to 7.9. Dissolved oxygen (DO) in Buriganga river water was very low in 2011. During the first four months, DO level was almost nil at all locations of the river (Fig.-2b). Direct discharge of untreated effluent from industry, domestic wastes, tannery waste into the river and reduced flow of water are the proximate causes for depletion of DO in dry season. DO level was relatively higher in wet season (June to November) at all locations of the river. In 2012, DO level varied from 0.45 to 5.08. In 2011, BOD of Buriganga river was higher than EQS (≤6 mg/l). At Hazaribag point BOD level was much higher than EQS for fisheries round the year (Fig.-2c). This was mainly because of discharge of untreated tannery wastewater into the river. The maximum BOD (87 mg/l) was found at Hazaribag in March and the minimum (3.1 mg/l) was at Dholaikhal in November. In 2012, the maximum BOD (48 mg/l) was recorded at Kamrangir Char in May and the minimum was nil at Mirpur Bridge in September. In 2011, 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 226 mg/l at Hazaribag in March and 28 mg/l at Mirpur Bridge respectively in December (Fig.-2d). In 2012, the maximum COD concentration was recorded 283 mg/l at Kamrangir Char in November and the minimum 5 mg/l at Kamrangir Char in June.

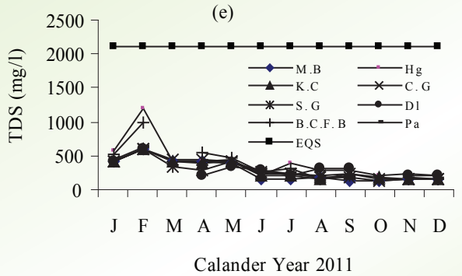
TDS of Buriganga river varied from 120 to 1188 mg/l (Fig.-2e) against the EQS of 2100 mg/l for industrial wastewater after treatment. In 2012, TDS concentration varied from 70 to 432 mg/l. Turbidity range was from 6 to 16.6 NTU and was mostly within the EQS (10 NTU) (Fig.-2f). But from January to May turbidity level exceeded the EQS at Hazaribag and Mirpur Bridge points. In 2012, Turbidity range varied from 0.97 to 1.41 NTU. Chloride concentration of the Buriganga river was below the EQS for wastewater after treatment from industrial units. The maximum and the minimum concentration was 48 and 6 mg/l respectively. Fig. 2g represents Chloride level at various location of Buriganga river. In 2012, Chloride concentration varied from 3.5 mg/l to 133.96 mg/l.

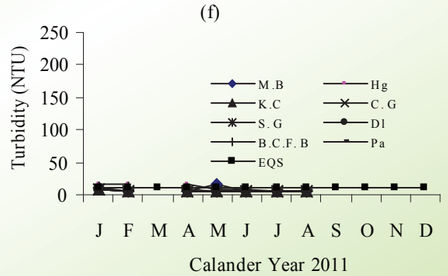


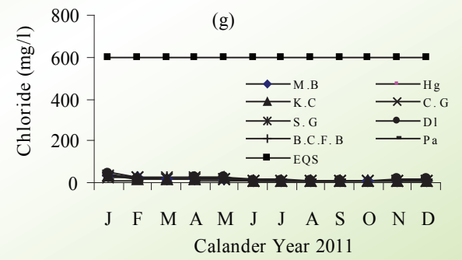




Note: Highest BOD was recorded 87 mg/l at Hazaribag in March 2011.

**Fig.1.Graphical presentation of pH, DO, BOD, COD, TDS, Turbidity and Chloride of Buriganga River in 2011**

Note: M.B=Mirpur Bridge, Hg=Hazaribag, K.C=Kamrangir Char, C.G= Chandni Ghat, S.G=Sadar Ghat, DL=Dholaikhal, Pa=Pagla, B.C.F.B=Bangladesh China Friendship Bridge.



**Table 1. Level of Total Alkalinity at different sampling locations of Buriganga River in 2011.**

| Locations of Buriganga River | Total Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Mirpur Bridge (MB) | 180 | 281 | 220 | 224 | 212 | 148 | 208 | 210 | 90 | 210 | 78 | 78 |
| Hazaribag (Hg) | 280 | 284 | 300 | 320 | 335 | 280 | 250 | 220 | 200 | 200 | 132 | 124 |
| Kamrangir Char (KC) | 201 | 214 | 194 | 220 | 240 | 144 | 208 | 180 | 95 | 90 | 74 | 78 |
| Chandni Ghat (CG) | 208 | 216 | 200 | 222 | 224 | 148 | 192 | 200 | 80 | 95 | 76 | 76 |
| Sadar Ghat (SG) | 204 | 220 | 230 | 228 | 246 | 152 | 190 | 190 | 190 | 160 | 78 | 74 |
| Dholaikhal (Dl) | 150 | 200 | - | 280 | 228 | 150 | 204 | 206 | 180 | - | 120 | 112 |
| B.C.F. B* | 250 | 230 | - | 224 | 216 | 146 | 220 | 170 | 160 | - | 82 | 86 |
| Pagla (Pg) | 230 | 224 | - | 228 | 238 | 160 | 220 | 240 | 160 | - | 78 | 80 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

The maximum and the minimum Total Alkalinity of Buriganga river was 335 mg/l at Hazaribag in May and 74 mg/l at Sadar Ghat in December (Table-1).

**Table 2. Level of EC at different sampling locations of Buriganga River in 2011.**

| Locations of Buriganga River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Mirpur Bridge (MB) | 830 | 1192 | 839 | 814 | 775 | 312 | 354 | 340 | 240 | 270 | 300 | 292 |
| Hazaribag (Hg) | 1200 | 2360 | 850 | 836 | 870 | 412 | 628 | 560 | 490 | 430 | 480 | 410 |
| Kamrangir Char (KC) | 900 | 1184 | 844 | 800 | 830 | 395 | 350 | 320 | 340 | 370 | 320 | 300 |
| Chandni Ghat (CG) | 800 | 1190 | 862 | 790 | 815 | 470 | 372 | 330 | 290 | 270 | 328 | 312 |
| Sadar Ghat (SG) | 830 | 1198 | 702 | 570 | 790 | 475 | 394 | 420 | 380 | 320 | 336 | 316 |
| Dholaikhal (Dl) | 812 | 1180 | - | 408 | 640 | 530 | 340 | 610 | 580 | - | 420 | 398 |
| B.C.F. B* | 930 | 1980 | - | 994 | 918 | 525 | 470 | 300 | 310 | - | 340 | 298 |
| Pagla (Pg) | 840 | 1230 | - | 812 | 785 | 565 | 378 | 370 | 340 | - | 322 | 296 |
| EQS for wastewater after treatment f rom industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

Electrical Conductivity (EC) at different locations of Buriganga was below the EQS (1200 µmhoms/cm) for wastewater after treatment from industrial unit (Table-2). EC was above the EQS at Hazaribag, B.C.F.B & Pagla points in February.

**Table 3. Level of SS. at different sampling locations of Buriganga River in 2011.**

| Locations of Buriganga River | SS (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Mirpur Bridge (MB) | 50 | 28 | 80 | 22 | 27 | 24 | 28 | 80 | 30 | 80 | 28 | 40 |
| Hazaribag (Hg) | 110 | 60 | 140 | 24 | 34 | 30 | 76 | 26 | 70 | 20 | 48 | 38 |
| Kamrangir Char (KC) | 68 | 30 | 50 | 20 | 26 | 20 | 28 | 30 | 40 | 40 | 30 | 22 |
| Chandni Ghat (CG) | 66 | 30 | 58 | 26 | 28 | 24 | 30 | 30 | 32 | 30 | 28 | 20 |
| Sadar Ghat (SG) | 60 | 32 | 52 | 24 | 30 | 22 | 30 | 32 | 34 | 50 | 28 | 22 |
| Dholaikhal (Dl) | 54 | 28 | - | 36 | 23 | 20 | 24 | 22 | 60 | - | 40 | 30 |
| B.C.F. B* | 100 | 50 | - | 28 | 32 | 23 | 58 | 54 | 42 | - | 28 | 20 |
| Pagla (Pg) | 50 | 34 | - | 24 | 28 | 24 | 30 | 28 | 26 | - | 30 | 20 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

Suspended Solid (SS) of Buriganga river at different locations exceeded the EQS (150 mg/l) limit for industrial wastewater after treatment from January to September. The maximum and the minimum SS was 140 mg/l at Hazaribag in March and 20 mg/l at Chandni Ghat in December (Table-3).

## 4.2 Shitalakhya River

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

pH level of Shitalakhya was within the EQS (6.5-8.5) for inland surface water. Maximum pH was 7.96 in October and the minimum pH was 6.42 in December at the GFF (Fig.-3a). In 2012, pH varied from 6.7 to 8.04. No Dissolved Oxygen (DO) was found at Demra Ghat from February to April. Also at ACI point, DO was found very low from February to April and then began to invrease towards May to December. DO level was good at all locations from June to December. The maximum DO (6.5 mg/l) was found at GFF in August (Fig.-3b). In 2012, DO varied from 0.0 to 6.2 mg/l.

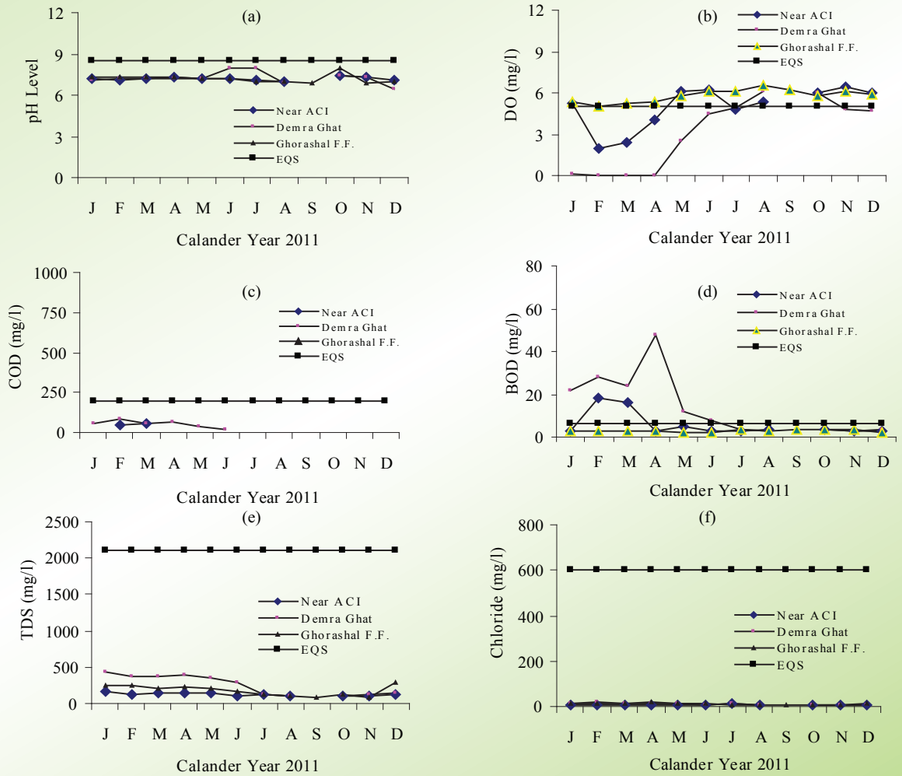



**Fig.2. Graphical presentation of pH, DO, BOD, COD, TDS and Chloride of Shitalakhya River in 2011.**

BOD at Demra Ghat and ACI points was very high during dry period of 2011. At Ghorasal BOD was within the EQS (≤6 mg/l) for fisheries throughout the year. Highest value of BOD (48 mg/l) was found at Demra Ghat in April and that of lowest (2.3 mg/l) was at Ghorashal F.F in May (Fig.-3c). BOD concentration was higher at Demra Ghat compare to other two locations. In 2012, BOD concentration varied from 2.0 mg/l to 28 mg/l. COD level was very high in 2011 at all locations of Shitalakhya river. Among all the locations of the Shitalakhya river COD was lowest at Demra Ghat point (Fig.-3d). The maximum COD (84 mg/l) was at Demra Ghat in February and the minimum COD (22 mg/l) was in June. In 2012, COD concentration varied from 14 mg/l to 73 mg/l. TDS of Shitalakhya river



varied from 80 to 430 mg/l against the EQS (2100 mg/l) for wastewater after treatment from industrial units. In dry season TDS (430 mg/l) limit was high at Demra Ghat and Ghorashal F.F. sampling locations (Fig.-3e). In 2012, TDS range was 52 to 392 mg/l. Chloride concentration of the Shitalakhya river in 2011 was below the EQS (600 mg/l) for wastewater after treatment from industrial units. In 2011, the maximum Chloride (18 mg/l) was found at Ghorasal F.F in February and the minimum was 4.5 mg/l at Demra Ghat in November and December (Fig.-3f). In 2012, Chloride concentration varied from 1.3 mg/l to 134 mg/l.

**Table 4. Level of Turbidity at different sampling locations of Shitalakhya River in 2011.**

| Locations of Shitalakhya River | Turbidity (NTU) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Narayangonj (Near ACI) | 6.5 | 6.0 | 6.0 | 6.0 | 6.0 | 6.5 | 6.0 | 6.0 | - | 6.0 | - | - |
| Demra Ghat | 6.5 | 6.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.0 | 6.0 | - | 6.0 | - | - |
| Ghorashal Fertilizer Factory (GFF) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.5 | 6.5 | 6.5 | 6.0 | - | - |
| EQS for drinking water 10 NTU | | | | | | | | | | | | |

Turbidity range was 6.0 - 6.5 JTU and was within the EQS (10 NTU) for drinking water (Table-4).

**Table 5. Level of EC at different sampling locations of Shitalakhya River in 2011.**

| Locations of Shitalakhya River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Narayangonj (Near ACI) | 286 | 250 | 246 | 254 | 248 | 182 | 228 | 184 | - | 200 | 212 | 242 |
| Demra Ghat | 740 | 750 | 740 | 762 | 684 | 562 | 224 | 186 | - | 200 | 244 | 284 |
| Ghorashal Fertilizer Factory (GFF) | 430 | 440 | 436 | 448 | 384 | 324 | 238 | 184 | 160 | 224 | 170 | 580 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Shitalakhya river at different locations was within the EQS (1200 µmhoms/cm) for wastewater after treatment from industrial units (Table-5). Maximum EC (762 µmhoms/cm) was at Demra Ghat in April and the minimum EC (160 µmhoms/cm) was at Ghorashal F.F. in November.

**Table 6. Level of Total Alkalinity at different sampling locations of Shitalakhya River in 2011.**

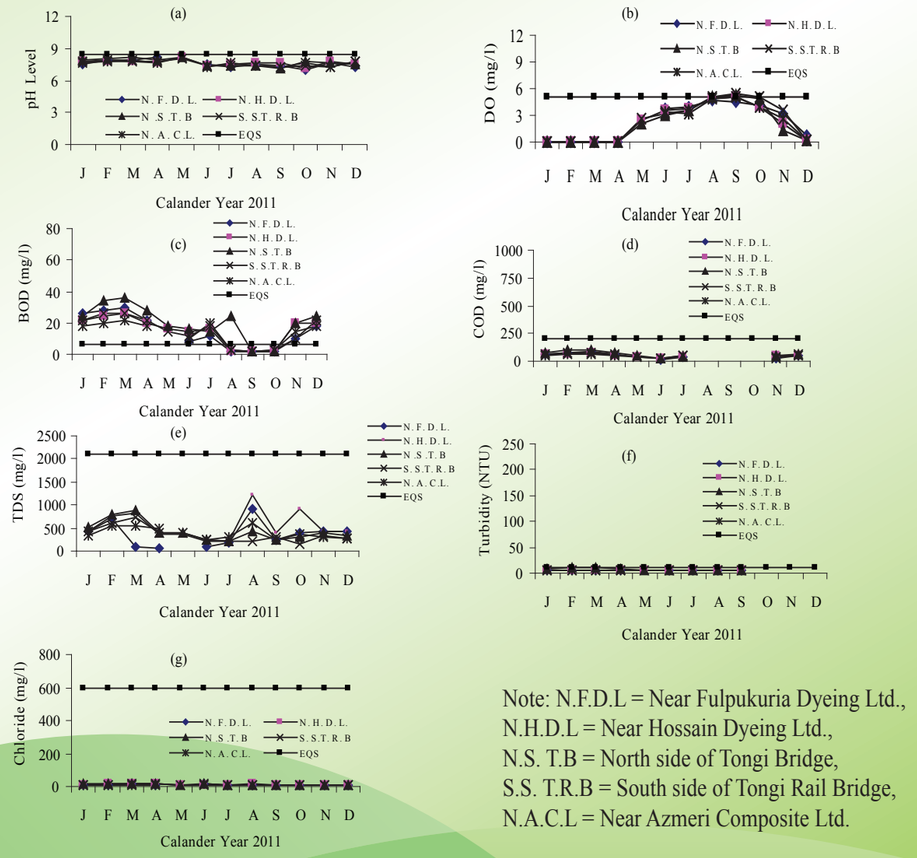
| Locations of Shitalakhya River | Total Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Narayangonj (Near ACI) | 96 | 132 | 138 | 142 | 138 | 84 | 142 | 124 | - | 74 | 78 | 120 |
| Demra Ghat | 150 | 146 | 144 | 148 | 142 | 134 | 118 | 84 | - | 74 | 142 | 150 |
| Ghorashal Fertilizer Factory (GFF) | 150 | 170 | 170 | 168 | 154 | 142 | 138 | 114 | 110 | 124 | 104 | 130 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

Total Alkalinity (170 mg/l) was maximum at Ghorashal F.F. in January to May and was above the EQS (150 mg/l) for waste water after treatment from industrial units while the minimum (74 mg/l) was at ACI & Demra Ghat in October (Table-6).

### 4.3 Turag river

The Turag River is the upper tributary of the Buriganga. To monitor water quality in 2011, water samples were collected from four different sites.

In 2011, pH range (7.18 to 8.24) (Fig.-4a) of Turag river was within EQS (6.5 to 8.5). The maximum pH (8.24) was found in April and the minimum pH (7.18) was found in September at Pagar, Tongi (North side of Tongi Bridge). In 2012, pH range was 6.7 to 8.4. DO concentration of Turag river was very low during dry season of 2011 and it was nil in January and April (Fig.-4b). In 2012, DO was nil in March to May. BOD of Turag river water was within the EQS (6 mg/l). Maximum BOD (36 mg/l) was in March at Pagar, Tongi and minimum (1.4 mg/l) was found in October near Fulpukuria Dyeing Ltd. (Gudara Ghat), Pagar, Tongi. (Fig.-4c). In 2012, BOD varied from 5.0 mg/l to 36 mg/l. COD at all location of Turag river was below the EQS (200 mg/l) for wastewater after treatment from industrial units in 2011. Maximum and minimum COD content of Turag river water was 102 mg/l and 18 mg/l respectively in June (Fig.-4d). In 2012, COD range was from 9.0 mg/l to 290 mg/l.




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

**Fig.3. Graphical presentation of pH, DO, BOD, COD, TDS, Turbidity and Chloride of Turag River in 2011**



TDS was below the EQS (2100 mg/l) for wastewater after treatment from industrial units (Fig.-4e) at all the sampling points. The maximum TDS was (924 mg/l) in August while that of minimum was (66 mg/l) in April at Near Fulpukuria Dyeing Ltd., Pagar, Tongi. In 2012, TDS range varied from 60 mg/l to 1020 mg/l. Turbidity range was from 6.0 to 12.0 NTU (Fig.4f). Turbidity sometimes exceeded the EQS (10 NTU). The maximum Turbidity (12 NTU) was Near Hossain Dyeing ltd. in February and March. In 2012, Turbidity varied from 3.59 –7.77 NTU. Chloride content in Turag river water was below the EQS (600 mg/l). The maximum Chloride (18.5 mg/l) was found at Pagar, Tongi in March and April, and the minimum Chloride (6.0 mg/l) was found in December at Near Azmeri Composite Ltd., Faydabad, Dakshinkhan, Uttara, Dhaka (Fig.-4g). In 2012, Chloride varied from 3.5 mg/l to 135 mg/l.

**Table 7. Level of Total Alkalinity at different sampling locations of Turag River in 2011.**

| Locations of Turag River | T. Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Near Fulpukuria Dyeing Ltd. | 148 | 150 | 158 | 142 | - | 154 | 124 | 142 | 138 | 160 | 144 | 138 |
| Near Hossain Dyeing Ltd. | 152 | 158 | 162 | 164 | 184 | 181 | 138 | 178 | 146 | 240 | 162 | 140 |
| North side of Tongi Bridge | 158 | 166 | 168 | 158 | 188 | 192 | 128 | 124 | 112 | 100 | 124 | 154 |
| South side of Tongi RailBridge | 156 | 152 | 162 | 148 | 180 | 174 | 134 | 88 | 84 | 78 | 92 | 156 |
| Near Azmeri Composite Ltd. Dakshinkhan | 150 | 148 | 154 | 140 | - | 178 | 118 | 134 | 128 | 180 | 110 | 150 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

T. Alkalinity at different locations of Turag river was mostly over the EQS. The maximum T. Alkalinity (240 mg/l) was near Hossain Dyeing Ltd. Pagar, Tongi, in October and the minimum (178 mg/l) at south side of Tongi Rail Bridge, Pagar, Tongi, in October (Table-7).

**Table 8. Level of EC at different sampling locations of Turag River in 2011.**

| Locations of Turag River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Near Fulpukuria Dyeing Ltd. | 856 | 140 | 180 | 132 | - | 484 | 372 | 1848 | 518 | 814 | 872 | 842 |
| Near Hossain Dyeing Ltd. | 834 | 1520 | 1620 | 712 | 696 | 426 | 414 | 2412 | 812 | 1800 | 840 | 832 |
| North side of Tongi Bridge | 910 | 1600 | 1764 | 760 | 742 | 496 | 426 | 884 | 514 | 610 | 810 | 648 |
| South side of Tongi RailBridge | 870 | 1218 | 1428 | 798 | 710 | 437 | 406 | 412 | 312 | 320 | 686 | 532 |
| Near Azmeri Composite Ltd. | 690 | 1062 | 1094 | 962 | - | 456 | 614 | 1240 | 486 | 720 | 640 | 524 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Turag river water was within the EQS (1200 µmhoms/cm). The maximum EC (1848 µmhoms/cm) was in August and the minimum (132 µmohos/cm) was in April near Fulpukuria Dyeing Ltd. (Gudara Ghat), Pagar, Tongi (Table-8).

### 4.4 Dhaleshwari River

The Dhaleshwari river is a 160 km long distributary of the Jamuna river flowing through central part of Bangladesh. It starts off the Jamuna near the northwestern tip of Tangail. Then it branched into two: the north branch retains the name Dhaleshwari and the other branch flows as Kaliganga. The both branches merged at the southern part of Manikganj District. Finally the merged flow meets the Shitalakshya River near Narayanganj District. In 2011, Water samples were collected from two locations namely Muktarpur Ghat, Munshigonj and Horindhora, Hemayetpur,saver, Dhaka for analyses.

In 2011, pH of Dhaleshwari river water varied from 6.2 to 7.42 (Fig.-5a). In 2012, pH level varied from 6.4 to 8.46. In 2011, DO varied from 4.8 to 6.8 mg/l (Fig.-5b). DO concentration of Dhaleshwari river critically met EQS (≥5 mg/l) for fisheries during January to May. Then DO level went up from June towards December. In 2012, DO concentration varied from 1.0 to 10.9 mg/l. BOD in 2011 varied from 2.2 to 3.8 mg/l (Fig.-5c). In 2012, BOD varied from 2.2 to 31 mg/l. Level of SS of Dhaleshwari river water was within the EQS (150 mg/l) for wastewater from industrial units. The maximum SS of Dhaleshwari river water was 34 mg/l in January and the minimum was 16 mg/l in September (Fig.5d). In 2012, SS varied from 18 to 4023.1 mg/l. TDS concentration varied from 60 to 420 mg/l (Fig.-5e) while standard TDS level is 2100 mg/l for wastewater after treatment from industrial units. In 2012, TDS concentration varied from 9.2 to 217 mg/l. Chloride concentration ranged from 3.5 to 9.0 mg/l (Fig.-5f), which is far below the EQS (600 mg/l) for wastewater after treatment from industrial units. In 2012, Chloride concentration range of Dhaleshwari river water was from 0.5 to 10 mg/l.



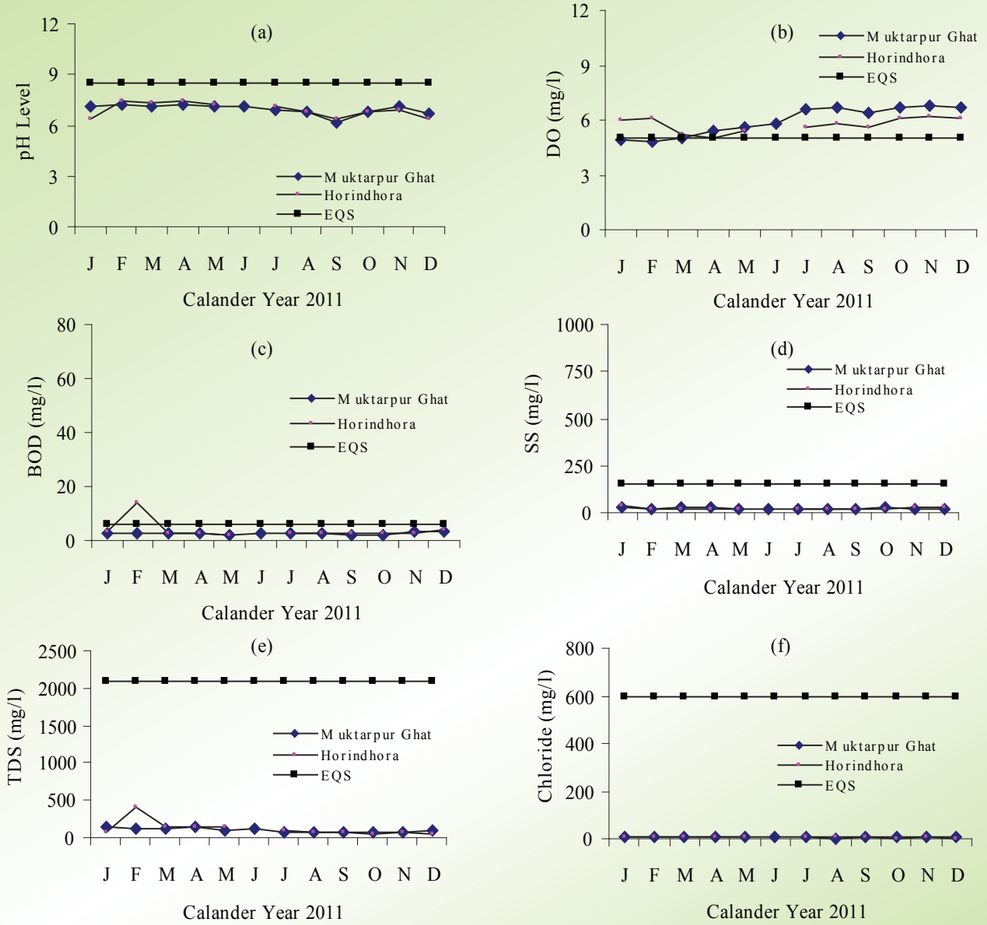



**Fig.4. Graphical presentation of pH, DO,BOD, SS, TDS and Chloride of Dhaleshwari River in 2011**

**Table-9. Level of Total Alkalinity at different sampling locations of Dhaleshwari River in 2011.**

| Sampling Locations of Dhaleshwari River | Total Alkalinity(mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | Feb | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Muktarpur Ghat, Munshigonj | 134 | 80 | 140 | 148 | 144 | 134 | 88 | 64 | 92 | 80 | 84 | 74 |
| Horindhora, Hemayetpur , Saver, Dhaka | 44 | 78 | 48 | 74 | 78 | - | 78 | 78 | 80 | 48 | 72 | 64 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

The maximum and the minimum T. Alkalnity concentration of Dhaleshwari river water was 148 mg/l in April and 64 mg/l in December respectively (Table-9) .

**Table-10. Level of EC at different sampling locations of Dhaleshwari River in 2011.**

| Sampling Locations of Dhaleshwari River | EC(µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Muktarpur Ghat, Munshigonj | 230 | 185 | 238 | 242 | 184 | 148 | 130 | 112 | 134 | 140 | 144 | 180 |
| Horindhora,Hemayetpur, Saver, Dhaka | 118 | 740 | 284 | 292 | 264 | - | 189 | 146 | 160 | 120 | 138 | 120 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Dhaleshwari River at different locations was within the EQS (1200 µmho/cm). Maximum and minimum EC of Dhaleshwari river water was 740 µmhoms/cm in February and 112 µmhoms/cm in August (Table-10).

### 4.5 Brahmaputra river

The Brahmaputra, a trans-boundary river that originates from Manossarovar 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 is 2900 Km (Chowdhury, 2006).Water sample collected from a single location which is insufficient to evaluate water quality of Brahmaputra.

In 2011, pH level of Brahmaputra river varied from 6.0 to 7.4 mg/l (Fig.6a), while standard range for fisheries is from 6.0 to 8.5. In 2012, pH level varied from 6.63 to 8.1. DO concentrations varied from 5.1 to 6.9 mg/l (Fig.6b). The highest and the lowest DO was found in December and February respectively. However standard of DO for fisheries is ≥5 mg/l. In 2012, DO concentrations varied from 5.4 to 9.4 mg/l. BOD concentration varied from 2.0 to 3.6 mg/l (Fig.6c) while EQS for fisheries is ≤6 mg/l. In 2012, BOD varied from 2.0 to 4.2 mg/l. The maximum and the minimum SS concentration of Bhramaputra river water was 30 mg/l in February and 16 mg/l in August (Fig.6d), where EQS for wastewater after treatment from industrial units is 150 mg/l. In 2012, SS varied from 2.0 to 4.2 mg/l. Chloride level varied from 18 to 22 mg/l (Fig.6e) and was less than EQS (600 mg/l) for wastewater from industrial units. In 2012, Chloride concentration varied from 2 to 8.5 mg/l. TDS level varied from 60 to 138 mg/l (Fig.6f) and was much below the EQS (2100 mg/l). In 2012, TDS level varied from 71 to 163 mg/l.



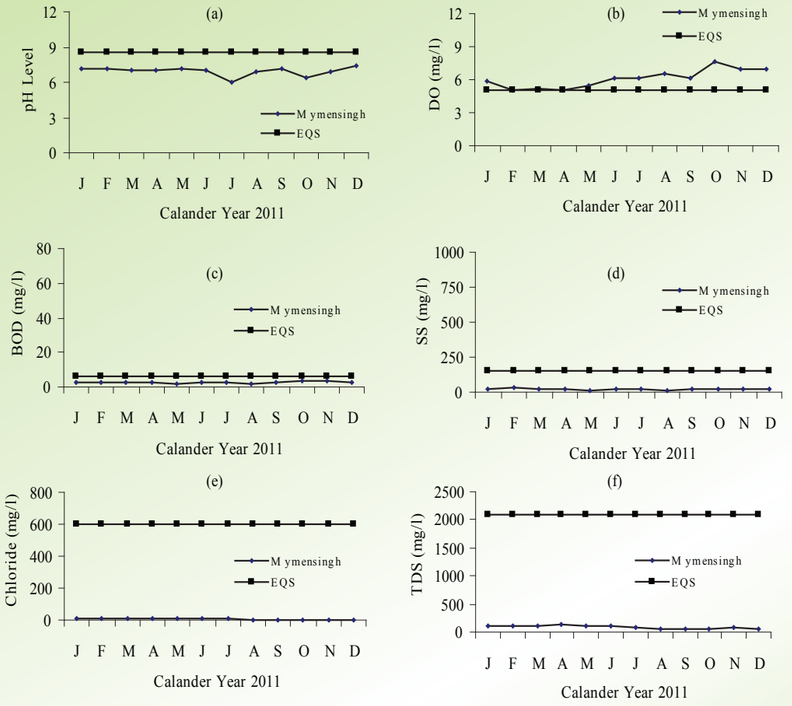



**Fig.5. Graphical presentation of pH, DO, BOD, SS, Chloride, and TDS of Brahmaputra River in 2011**

**Table-11. Level of Turbidity of Bhramaputra River in 2011.**

| Sampling Locations of Bhramaputra River | Turbidity (NTU) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mymensingh | 6.5 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.5 | 6.5 | - | - |
| EQS for drinking water 10 NTU | | | | | | | | | | | | |

Turbidity level of Brahmaputra river water was varied from 6 to 6.5 NTU (Table-11) and was lower than the EQS (10 NTU) for drinking water.

**Table-12. Level of Total Alkalinity of Bhramaputra River in 2011.**

| Sampling Locations of Bhramaputra River | Total Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mymensingh | 76 | 144 | 140 | 144 | 114 | 94 | 96 | 84 | 88 | 60 | 64 | 134 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

The maximum and the minimum T. Alkalinity concentration of Bhramaputra river water was 144 mg/l in February and 60 mg/l in October (Table-12) respectively.

**Table-13. Level of EC of Bhramaputra River in 2011.**

| Sampling Locations of Bhramaputra River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mymensingh | 174 | 240 | 240 | 258 | 210 | 174 | 144 | 118 | 120 | 130 | 138 | 164 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Bhramaputra river water was within the EQS (1200 µmhoms/cm). The maximum and the minimum EC was 258 µmhoms/cm in April and 118 µmhos/cm in August (Table-13).

### 4.6 Kaliganga river

The Kaliganga river flows by Manikganj district. Water samples were collected from one location of the river (e.g.Manikganj) for analysis of water quality. Data was unavailable for the month of October.

pH of Kaliganga river varied from 6.28 to 7.16 (Fig.7a). The maximum and the minimum pH was found in February and November respectively. In 2012, pH level varied from 6.9 to 7.4. DO level varied from 5 to 6.6 mg/l (Fig.7b) and met the EQS for fisheries (≥5 mg/l). In 2012, DO varied from 5.2 to 14.5 mg/l. BOD varied from 2.2 to 22 mg/l (Fig.7c). BOD level was within the EQS limit for fisheries throughout the year except in the month of March and December. In 2012, BOD varied from 2.2 to 5.0 mg/l. COD range was 54 mg/l and 60 mg/l (Fig.7d). In 2012, COD range was 5.0 and 25 mg/l. TDS concentration was very low compare to EQS (2100 mg/l) for waste water after treatment from industrial units. The maximum TDS was 340 mg/l in April and the minimum TDS was 74 mg/l in November (Fig.7e). In 2012, TDS concentration varied from 41.4 to 178.3 mg/l. Chloride level was lower than the EQS (600 mg/l). Highest Chloride concentration (14.0 mg/l) was found in March and the lowest Chloride level (4.0 mg/l) was in August (Fig.7f). In 2012, Chloride varied from 0.5 to 30 mg/l. SS of Kaligonga river was within the EQS (150 mg/l). The maximum and the minimum SS was 34 mg/l and 28 mg/l respectively (Fig.7g). ). In 2012, SS varied from 18 to 22 mg/l.



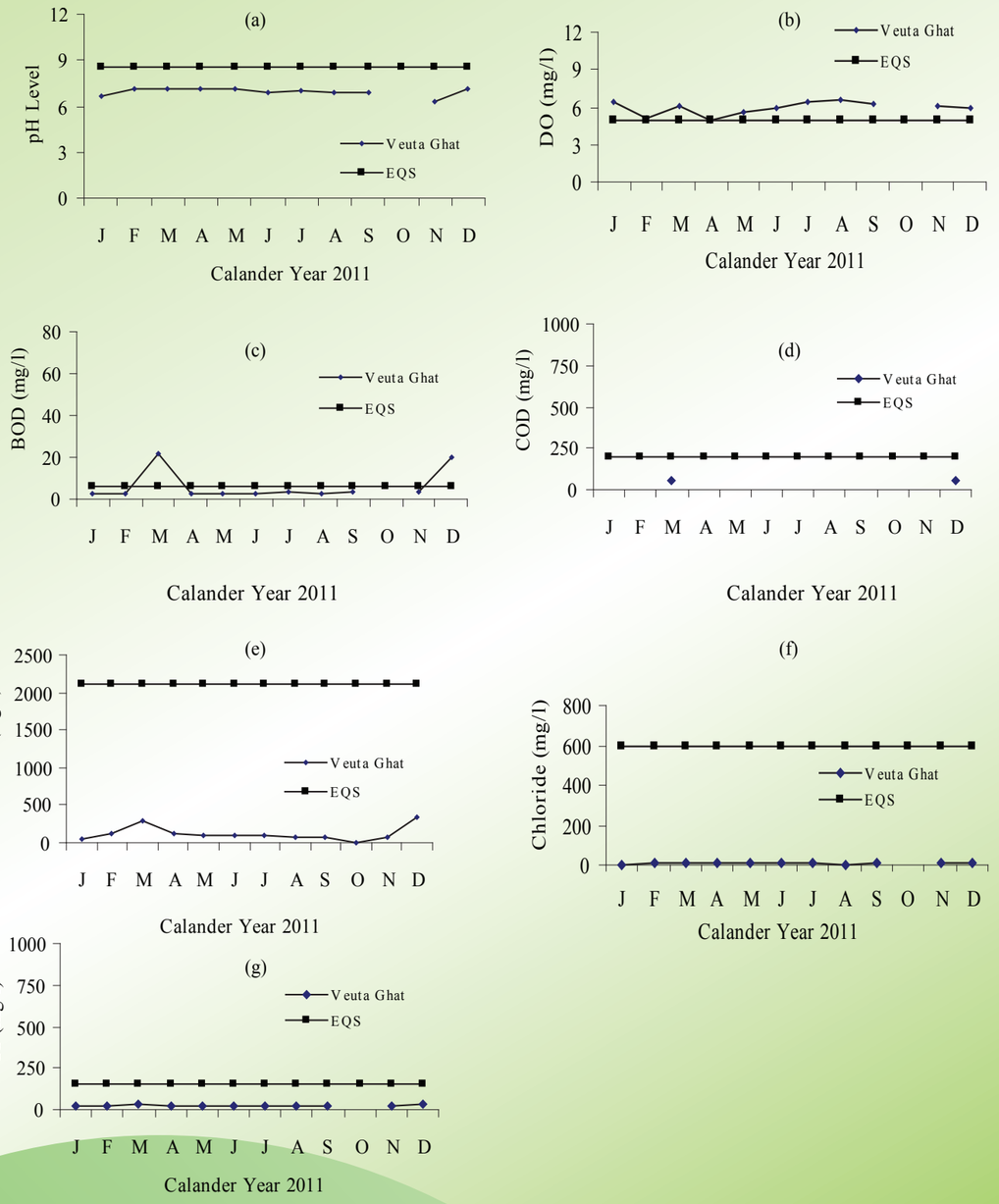



**Fig.6. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Kaliganga River in 2011**

**Table-14. Level of T.alkalinity of Kaligonga River in 2011.**

| Locations of Kaligonga River | Total Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Veuta Ghat, Manikgonj. | 76 | 140 | 152 | 114 | 110 | 92 | 94 | 84 | 98 | - | 112 | 160 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

The maximum and the minimum Total Alkalinity of Kaligonga River water was 160 mg/l in February and 74 mg/l in October (Table-14).

**Table-15. Level of Turbidity of Kaligonga River in 2011.**

| Locations of Kaligonga River | Turbidity (NTU) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Veuta Ghat, Manikgonj. | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | - | - | - |
| EQS for drinking water 10 NTU | | | | | | | | | | | | |

Turbidity was 6.0 NTU throughout sampling period while drinking water standard for turbidity is 10 NTU (Table-15).

**Table-16. Level of EC of Kaligonga River in 2011.**

| Locations of Kaligonga River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Veuta Ghat, Manikgonj. | 110 | 240 | 610 | 248 | 194 | 168 | 184 | 134 | 150 | - | 164 | 680 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Kaligonga river water at different locations was within the EQS (1200 µmhoms/cm). The maximum and the minimum EC was 680µmhos/cm in December and 110 µmhoms/cm in January (Table-16).

### 4.7 Jamuna River

The Jamuna river is one of the three main rivers of Bangladesh. It is the main distributary channel of the Brahmaputra river that flows out of India into Bangladesh. To monitor water quality, samples were collected only from two locations e.g. Bahadurabad Ghat (B. Ghat) and near Jamuna Fertilizer Factory (JFF) in 2011.

The maximum pH 7.6 was found at near Jamuna Fertilizer factory in January and the minimum 6.4 was found at Bahadurabad Ghat in September. Besides above exception, pH level was within the EQS limits throughout the year (Fig.8a). In 2012, pH level varied 7.2 to 8.46. At JFF, DO varied from 4.5 to 7.8 mg/l (Fig.8b). DO level was lower than EQS (≥5 mg/l) for fisheries from February to May. In 2012, DO concentration varied from 5.9 to 8.5 mg/l. BOD level was within the EQS (≤6 mg/l) for fisheries round the year (Fig.8c). In 2012, BOD concentration varied from 2.8 to 11.0 mg/l. Level of SS of Jamuna river water was within the EQS (150 mg/l). The maximum and the minimum SS was 28 mg/l in July-August and 16 mg/l in February (Fig.8d) respectively. In 2012, SS concentration varied from 20 to 24 mg/l. TDS ranged from 60 to 160 mg/l (Fig.8e), while EQS for TDS is 2100 mg/l. In 2012, TDS level varied from 63.1 to 165.6 mg/l. Chloride content varied from 3 to 16 mg/l (Fig.8f). The maximum chloride (16 mg/l) was found at JFF in March, and the minimum (3 mg/l) was found in August respectively. In 2012, Chloride concentration varied from 1.5 to 8.5 mg/l.



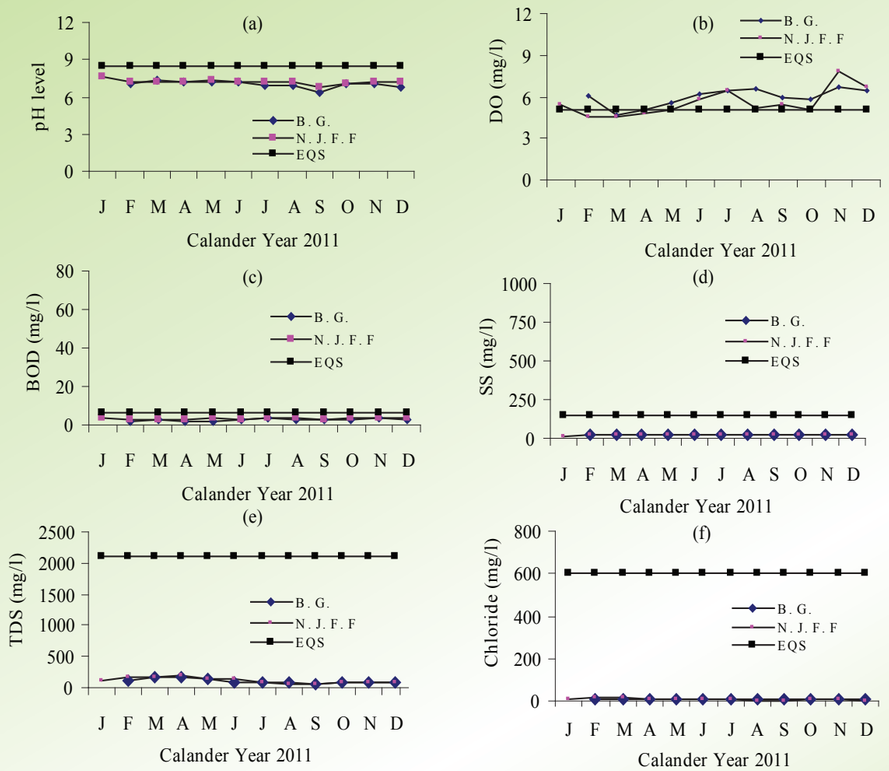



**Fig.7. Graphical presentation of pH, DO, BOD, SS, TDS and Chloride of Jamuna River in 2011**

Note : B.G = Bahadurabad Ghat, N.J.F.F = Near Jamuna Fertilizer Factory

**Table-17. Level of Turbidity at different sampling locations of Jamuna River in 2011**

| Sampling Locations of Jamuna River | Turbidity (NTU) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Bahadurabad Ghat (B.G) | - | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | - | - |
| Near Jamuna Fertilizer Factory (NJFF) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.5 | 6.5 | 6.5 | 6.5 | - | - |
| Standard limit for drinking water 10 JTU | | | | | | | | | | | | |

Turbidity varied within the range of 6 to 6.5 NTU (Table-17) round the year.

**Table-18. Level of Total Alkalinity at different sampling locations of Jamuna River in 2011.**

| Sampling Locations of Jamuna River | Total Alkalinity (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Bahadurabad Ghat (B.G) | - | 128 | 184 | 186 | 138 | 116 | 112 | 94 | 110 | 114 | 118 | 72 |
| Near Jamuna Fertilizer Factory (NJFF) | 120 | 170 | 198 | 176 | 138 | 142 | 122 | 42 | 40 | 78 | 118 | 124 |
| EQS for wastewater after treatmen t from industrial units 150 mg/l | | | | | | | | | | | | |

The maximum and the minimum Total Alkalinity of Jamuna river water was 198 mg/l in March and 40 mg/l in September (Table-18) respectively.

**Table-19. Level of EC at different sampling locations of Jamuna River in 2011.**

| Sampling Locations of Jamuna River | EC(µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Bahadurabad Ghat (B.G) | - | 208 | 328 | 310 | 254 | 224 | 172 | 160 | 140 | 148 | 180 | 190 |
| Near Jamuna Fertilizer Factory (NJFF) | 200 | 312 | 358 | 342 | 284 | 242 | 168 | 120 | 108 | 138 | 160 | 180 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Jamuna river water at sampling locations was within the EQS (1200 µmhoms/cm). The maximum and the minimum EC of Jamuna river was 358 µmhoms/cm in March and 108 µmhos/cm in September (Table-19).

### 4.8 Meghna river

The Meghna is an important river in Bangladesh and one of the three that forms the Ganges Delta, the largest on earth fanning out to the Bay of Bengal. To monitor water quality, water samples were collected from five locations (e.g. Meghna Ghat, Near Shahjalal Paper Mills, Near Bhairab Bazar, Chandpur and Zia Fertilizer) of the Meghna river.

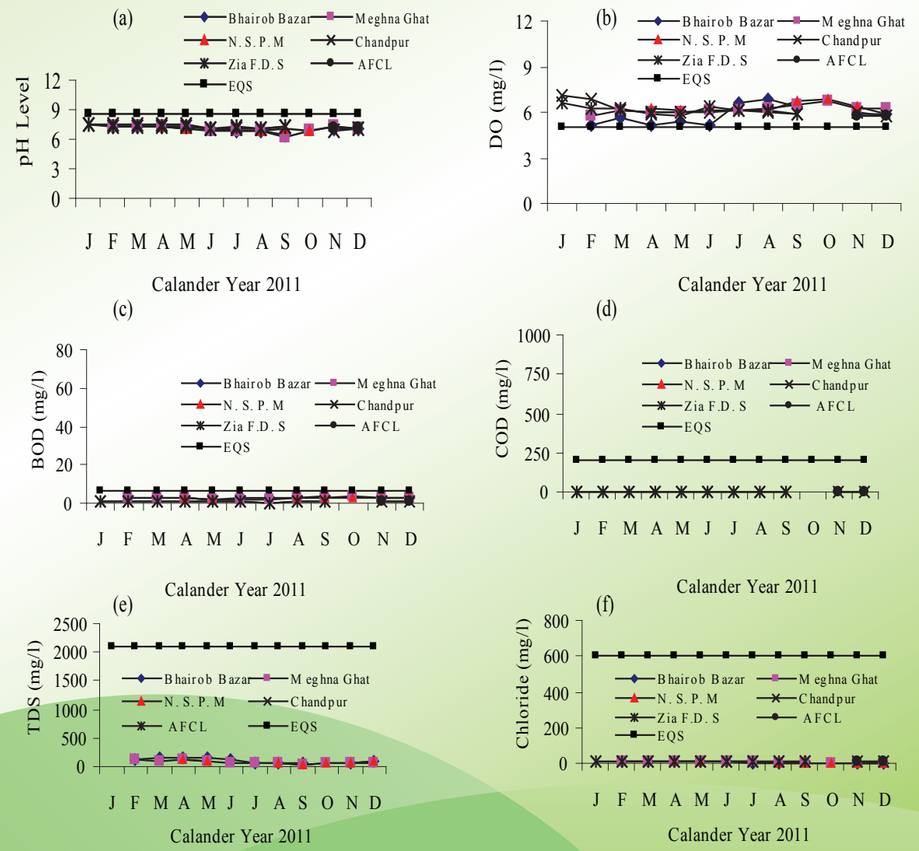



**Fig.8. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Meghna River in 2011**

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



Throughout the year pH level was within the standard limit of inland surface water. The maximum pH was 7.6 in November at Chandpur and the minimum pH was 6.24 in September near Bhairab Bazar (Fig.9a). In 2012, pH level varied from 6.24 to 7.6. DO level of Meghna river was above the EQS (≥5 mg/l) for fisheries all through the year (Fig.9b). In 2012, DO level varied from 5.2 mg/l to 7.1 mg/l. At all locations of the river BOD level was below the EQS (≤6 mg/l) for fisheries round the year. The maximum and the minimum BOD load were 3.4 mg/l in October and 0.3 mg/l in July (Fig.9c). In 2012, BOD load from 0.3 to 3.4 mg/l. COD varied from 2 to 3 mg/l (Fig.9d). At all locations COD level was below the EQS (200 mg/l) for wastewater after treatment from industrial units round the year. In 2012, COD concentration varied from 1.5 to 3.5 mg/l. TDS of Meghna river was very low in 2011 and ranged from 45 to 150 mg/l (Fig.9e). In 2012, TDS concentration varied from 45 to 150 mg/l. In 2011, Chloride concentration at all the locations in 2011 was also under the EQS (600 mg/l) for wastewater after treatment from industrial units. The maximum chloride (11.0 mg/l) was found in April and the minimum (3.0 mg/l) was in October (Fig.9f). In 2012, Chloride concentration varied from 3.0 mg/l to 11 mg/l.

**Table-20. Level of EC at different locations of Meghna River in 2011.**

| Locations of Meghna River | EC(µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Bhairob Bazar | - | 265 | 280 | 294 | 240 | 224 | 152 | 124 | 120 | - | 128 | 180 |
| Meghna Ghat | - | 224 | 184 | 198 | 168 | 124 | 114 | 96 | 94 | 104 | 134 | 140 |
| Near Shajalal Paper Mill | - | - | - | 210 | 170 | - | - | 98 | 90 | 108 | 128 | 160 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC of Meghna river water at different locations was within the EQS. The maximum and the minimum EC of Meghna river was 280 µmhmos/cm in March and 90 µmhoms/cm in September (Table-20).

### 4.9 Padma river

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

pH level of Padma river varied from 6.4 to 8.3 (Fig.10a) while standard pH for inland surface water is 6.4 to 8.3. Maximum pH was found at Baro Kuti Ghat Bank in september and minimum pH level was at Mawa Ghat in December. In 2012, pH level varied from 6.0 to 8.87. DO level of Padma River was above EQS (≥5 mg/l) for fisheries at all the locations and it varied from 5.0 to 10.5 mg/l (Fig.10b). In 2012, DO concentration ranged from 5.4 to 8.26 mg/l. BOD load was lower than EQS (≤6 mg/l) for fisheries at all locations. The maximum BOD was found 3.5 mg/l and that of the minimum was 1.5 mg/l in the month of December (Fig.10c).

In 2012, BOD load varied from 1.15 to 2.8 mg/l. TDS level of Padma river was within EQS throughout the year of 2011 and it varied from 47 to 280 mg/l (Fig.10d). In 2012, TDS concentration varied from 90 to 370 mg/l.The maximum and the minimum EC concentration of Padma river water was 461 µmhoms/cm in May and 64 µmhoms/cm in November (Fig.10e), while EQS is 1200 µmhoms/cm. In 2012, EC concentration varied from 202 to 699 mg/l. Level of SS was within the EQS (150 mg/l). The maximum and the minimum SS concentration of Padma river was 74 mg/l in September and 15 mg/l in February (Fig.10f). In 2012, SS concentration varied from 26 to 90 mg/l.

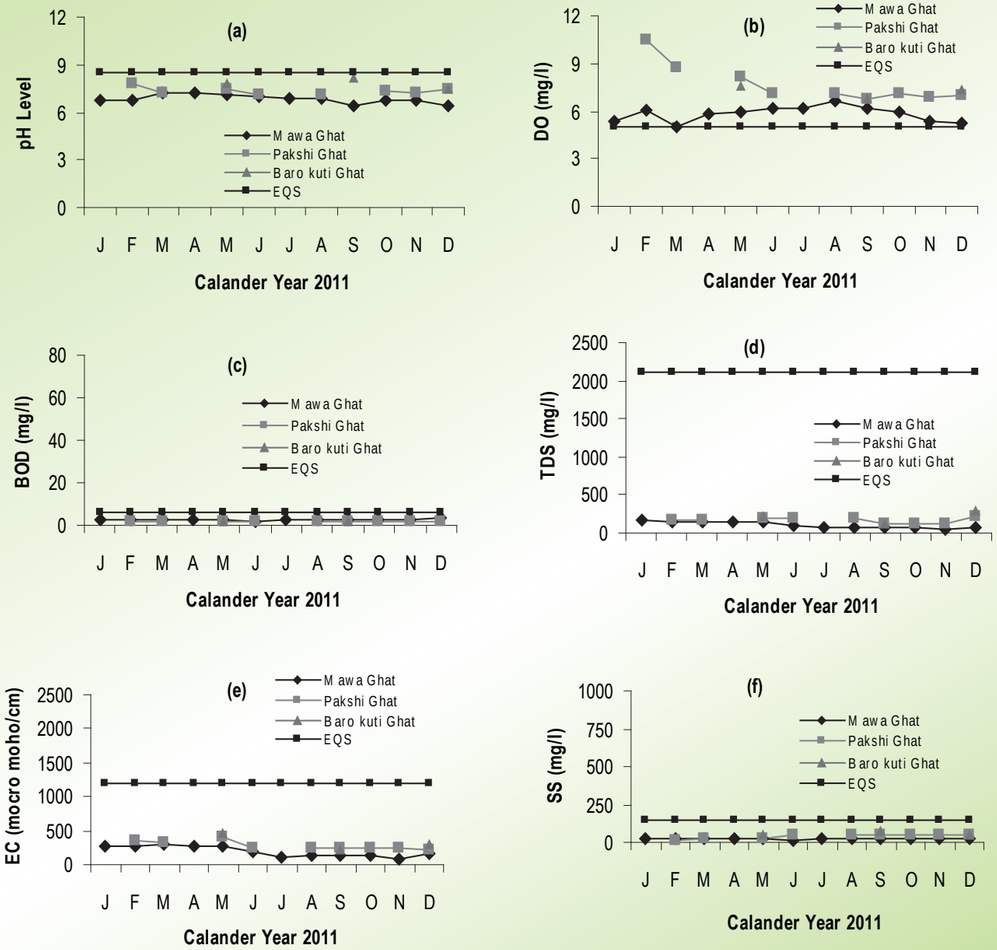



**Fig.9. Graphical presentation of pH, DO, BOD, TDS, EC and SS of Padma River in 2011**



**Table-21. Level of Total Alkalinity at different sampling locations of Padma River in 2011.**

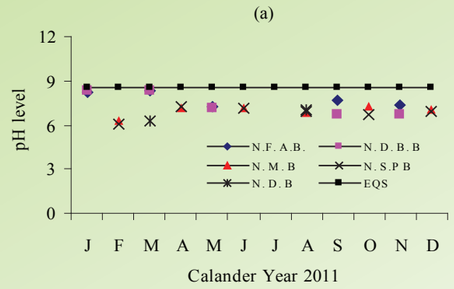
| Sampling Locations of Padma River | Total Alkalinity(mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mawa Ghat | 110 | 130 | 148 | 134 | 124 | 112 | 56 | 78 | 72 | 78 | 74 | 80 |
| Pakshi (E), Iswardi | - | 38 | 40 | - | 42 | 40 | - | 48 | 48 | 44 | 48 | 44 |
| Pakshi (M),Iswardi | - | 36 | 38 | - | 42 | 42 | - | 52 | 46 | 46 | 46 | 46 |
| Baro kuti (E), Raj. | - | - | - | - | 48 | - | - | - | 52 | - | - | 54 |
| Baro kuti (M), Raj. | - | - | - | - | 46 | - | - | - | 52 | - | - | 52 |
| EQS for wastewater after treatment from industrial units 150 mg/l | | | | | | | | | | | | |

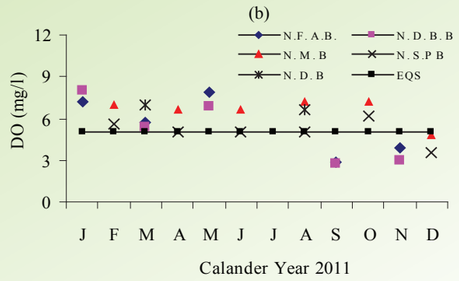
The maximum and the minimum Total Alkalinity concentration of Padma river water was 148 mg/l in March and 36 mg/l in February (Table-21).

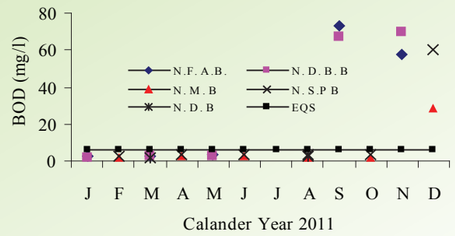
### 4.10 Korotoa river

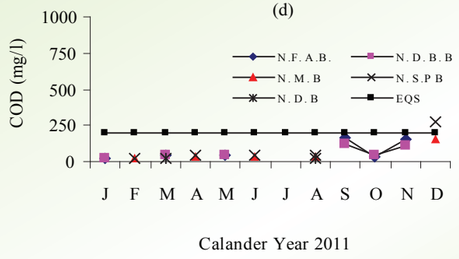
For analysis of water quality of Korotoa river in 2011, water samples were collected from four locations of the river e.g. Near Fateh Ali Bridge Upstream and Downstream and Near Dutta Bari Bridge Upstream and Downstream.

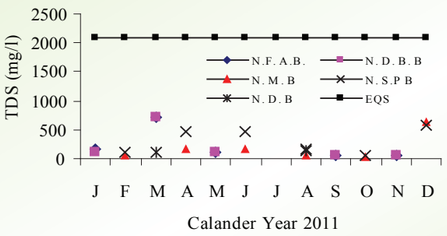
pH level of Korotoa river water varied from 6.0 to 8.38 (Fig.11a) and was within EQS limit. In 2012, pH level varied from 5.8 to 7.42. DO level of was above the EQS (≥5 mg/l) for fisheries at all location throughout the year except in the month of September, November and December. DO varied from 2.2 to 8.0 mg/l (Fig.11b). In 2012, DO concentration varied from 3.0 to 8 mg/l. BOD was also within the EQS (≤6 mg/l) limit for fisheries except in the month of September, November and December. BOD varied from 2.1 to 74 mg/l (Fig.11c). In 2012, BOD concentration varied from 2.0 to 65 mg/l. COD level of Korotoa river was low compare to EQS (200 mg/l) for wastewater after treatment from industrial units. It varied from 20 to 308 mg/l (Fig.11d). The maximum COD concentration was 308 mg/l in Korotoa river down stream, Near S.P Bridge, Bogra. In 2012, COD concentration varied from 8.0 to 308 mg/l. TDS varied from 29 mg/l to 723 mg/l (Fig.11e). In 2012, TDS range was from 110 mg/l to 670 mg/l. Level of SS of Korotoa river at different locations was within the EQS. The maximum and the minimum SS was 90 mg/l in December and 26 mg/l in October (Fig.11f) respectively. In 2012, SS varied from 30 mg/l to110 mg/l. EC varied from 64 mg/l to 960.6 mg/l (Fig.11g) and was within the EQS limit. In 2012, EC concentration varied from 228 mg/l to 686 mg/l.

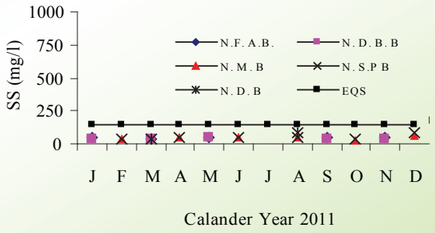


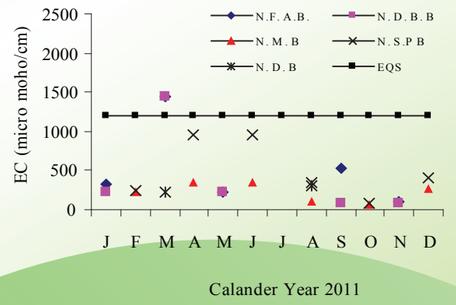




Note:
N.F.A.B = Near Fateh Ali Bridge,
N.D.B.B = Near Dutta Bari Bridge,
N.M.B = Near Matidali Bridge,
N.S.P.B = Near S.P Bridge,
N.D.B = Near Dhakkmara Bridge,

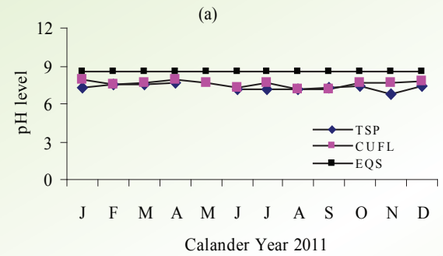
**Fig.10. Graphical presentation of pH, DO, BOD, COD, TDS, SS and EC of Korotoa River in 2011**

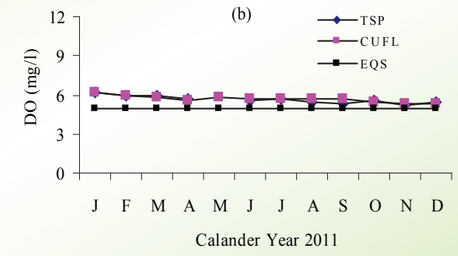


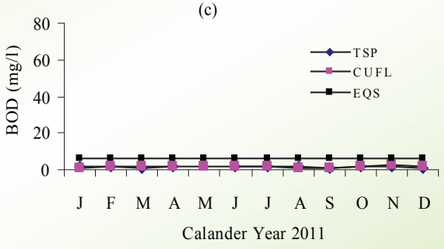
### 4.11 Karnaphuli river

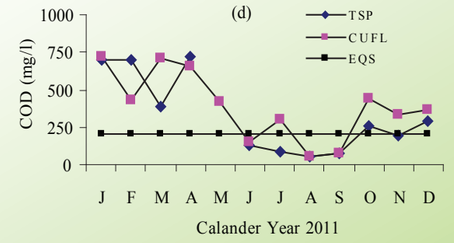
Karnaphuli is in the south-eastern part of Bangladesh that flows through Chittagong Hill Tracts and Chittangong into the Bay of Bengal. Water samples were collected from four locations [e.g. Triple Super Phosphate (TSP) industry Upstream, TSP industry Downstream, Carnaphuli Urea Fertilizer Limited (CUFL)] Upstream and CUFL Downstream of Karnaphuli river for analyses of water quality in 2011.

pH level among the sampling locations of the Karnaphuli river varied from 6.8 to 8.0 (Fig.12a), while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH level varied from 6.4 to 7.98 mg/l. DO level of Karnaphuli river was high throughout the year of 2011 and met the standard of DO for fisheries (≥5 mg/l). DO varied from 5.2 to 6.8 mg/l (Fig.12b). In 2012, DO concentration varied from 4.4 to 5.5 mg/l. BOD level was lower than EQS limit (≤6 mg/l) for fisheries throughout the year. It varied from 1.0 to 2.4 mg/l (Fig.12c). In 2012, BOD concentration varied from 0.8 to 2.6 mg/l. COD varied from 53 to 923 mg/l (fig.12d), while EQS for wastewater after treatment from industrial units is 200 mg/l. COD value was high at CUFL upstream and downstream compare to TSP upstream and downstream. In 2012, COD value varied from 4.0 to 441 mg/l. Level of SS of Karnaphuli river water at different locations beyond the EQS (150 mg/l). The maximum and the minimum SS was 953 mg/l in December and 219 mg/l in March (Fig.12e). In 2012, SS value varied from 161 to 1207 mg/l.



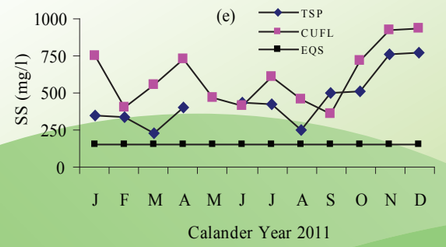




**Fig.11. Graphical presentation of pH, DO, BOD, COD and SS of Karnaphuli River in 2011**

Note: T.S.P = Triple Super Phosphate, C.U.F.L = Carnaphuli Urea Fertilizer Limited

**Table-22. Level of Chloride at different sampling locations of Karnaphuli River in 2011.**

| Locations of Karnafully River | Chloride (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| TSP Up Stream | 6670 | 7113 | 5002 | 5706 | - | 570 | 360 | 130 | 310 | 1640 | 2980 | 6000 |
| TSP Down Stream | 6675 | 1115 | 5020 | 5713 | - | 572 | 363 | 135 | 312 | 1645 | 3000 | 6040 |
| CUFL Up Stream | 9150 | 4600 | 5530 | 8280 | 4380 | 1520 | 1730 | 270 | 230 | 3870 | 8100 | 10567 |
| CUFL Down Stream | 9200 | 4670 | 5335 | 8320 | 4390 | 1530 | 1740 | 272 | 232 | 3890 | 8160 | 10700 |
| EQS for wastewater after treatment from industrial units 600 mg/l | | | | | | | | | | | | |

Chloride concentration of Karnaphuli river was higher in 2011 especially at CUFL upstream and downstream and it varied from 130 to 10,700 mg/l (Table-22) where standard for wastewater after treatment for industrial unit is 600 mg/l. The maximum (10,700 mg/l) level was found at CUFL downstream in December and the minimum (130 mg/l) at TSP upstream in August. In 2012, Chloride concentration varied from 54 to 12,390 mg/l.

### 4.12 Halda river

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

pH of Halda river water was within EQS limit in 2011 and it varied from 6.8 to 7.6 (Fig.13a). In 2012, pH level varied from 7 to 8. DO level was well above the EQS limit throughout the monitoring period of 2011 and met the standard of DO level for fisheries (≥5 mg/l) at all locations of the river during high tide and low tide. DO varied from 5.2 to 6.4 mg/l (Fig.13b). In 2012, DO range was from 1.0 to 5.65 mg/l. BOD level of Halda River was below the EQS limit (≤6 mg/l) for fisheries throughout the year of 2011. The maximum and the minimum BOD was 1.8 and 1.0 mg/l respectively (fig.13c). In 2012, BOD concentration varied 0.3 and 1.8 mg/l. COD at the sampling locations of Halda river during high and low tide varied from 2 to 7 mg/l (Fig.13d). In 2012, COD varied from 1.0 to 4.0 mg/l. SS of Halda river water at different locations was within the EQS except in the month of March and August. The maximum and the minimum SS content of Halda river water was 213 mg/l in March and 10 mg/l in February (Fig.-13e). In 2012, SS value varied from 13 to 211 mg/l. Chloride level of Halda river in 2011 was well below the EQS (600 mg/l) for treated wastewater from industrial units. Chloride varied from 6 to 55 mg/l (Fig.-13f). Chloride concentration was relatively higher during high tide compare to the low tide at all locations of the river. In 2012, Chloride concentration varied from 8 to 47 mg/l.



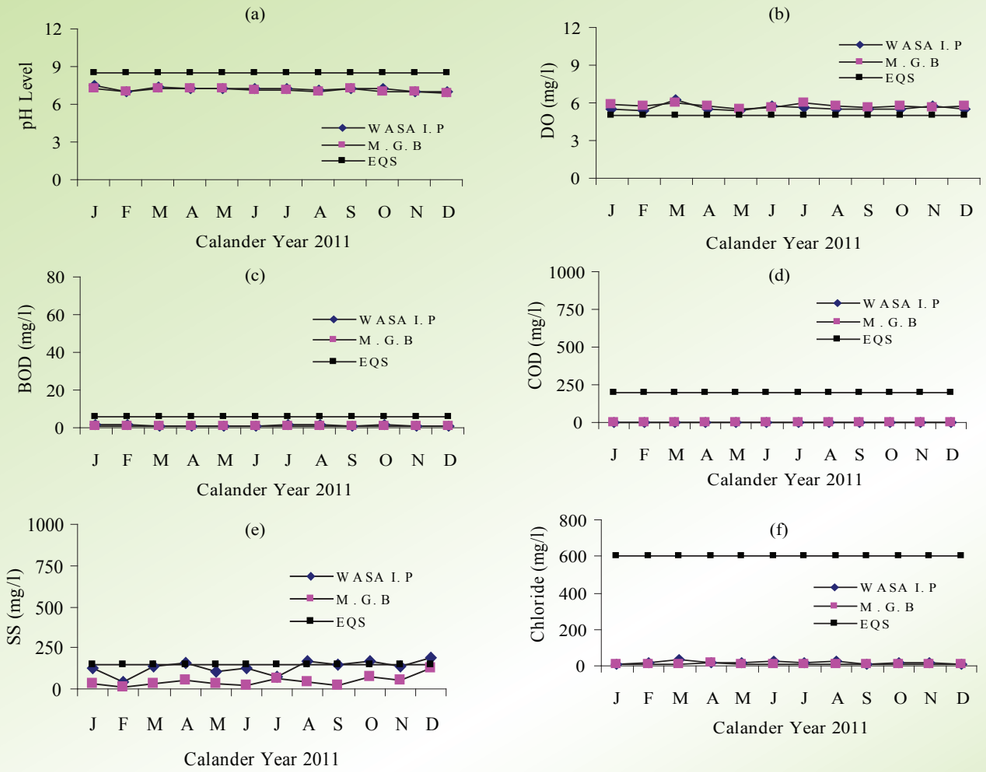



**Fig.12. Graphical presentation of pH, DO, BOD, COD, SS and Chlorideof Halda River in 2011**

Note: WASE I.P = WASA Intake Point, M.G.B = Maduna Ghat Bank

### 4.13 Bakkhali river

Bakkhali river, the only river in Cox's Bazar district. It rises from the ranges that divided Chittagong from Arakan and flows north, then turning to the west and flows passes Ramu, Cox's Bazar towns and falls into the Maheshkhali channel. Water samples were collected from two locations e.g. Mazer Ghat and Fishery Ghat of Cox's Bazar of Bakkhali river in 2011.

pH level varied from 7.2 to 7.9 (Fig.14a) and it was within the standard limit (6.5-8.5) for inland surface water at all the locations during sampling period. In 2012, pH level varied from 6.8 to 8.45. DO concentration varied from 5.4 to 6.4 mg/l (Fig.14b). DO at all the sampling points was above the EQS for fisheries (≥5 mg/l). In 2012, DO content varied from 4.8 to 5.9 mg/l. BOD level of Bakkhali river water was below the EQS (≤6 mg/l) for fisheries throughout the sampling period. The maximum and the minimum BOD was 0.6 and 1.4 mg/l (Fig.14c) respectively. In 2012, BOD varied from 0.6 to 1.9 mg/l. COD level of Bakkhali river was much higher than the EQS (200 mg/l) for treated wastewater from industrial units. COD varied from 1.0 to 735 mg/l throughout the sampling period (Fig.14d). In 2012, COD level varied from 1 to 413 mg/l. SS of Bakkhali river water at different locations was within the EQS. The maximum and the minimum SS concentration of Bakkhali river was 123 mg/l in November and 13 mg/l in January (Fig.14e). In 2012, SS value varied from 22 to 152 mg/l.

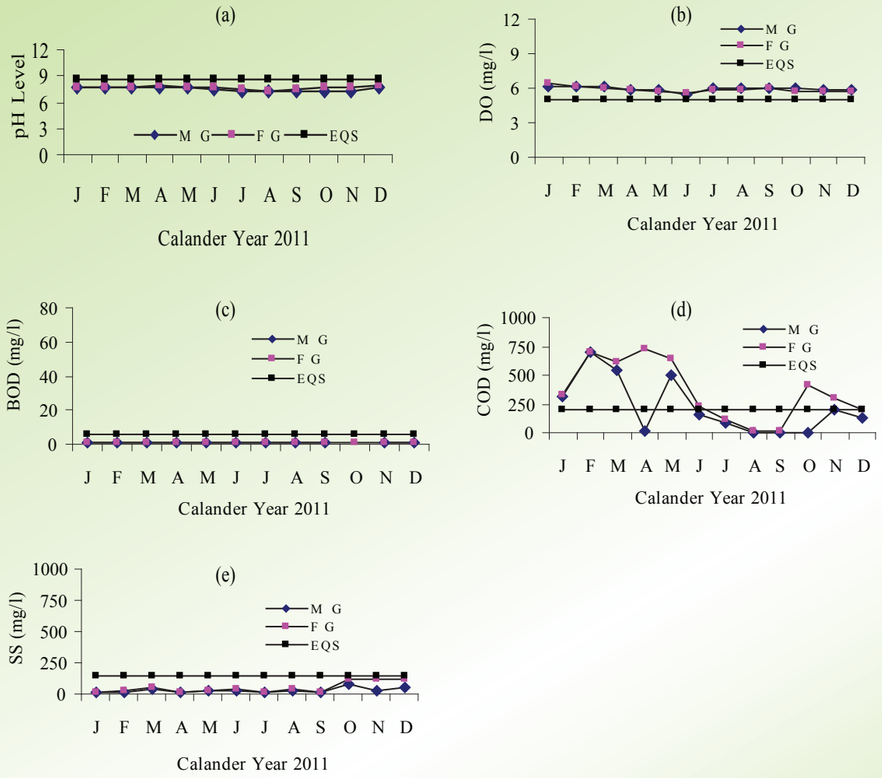



**Fig.13. Graphical presentation of pH, DO, BOD, COD and SS of Bakkhali River in 2011.**

**Table-23. Level of Chloride at different locations of Bakkhali River in 2011.**

| Locations of Bakkhali River | Chloride (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Mazer Ghat at Cox's Bazar | 4286 | 4390 | 6930 | 7110 | 6810 | 1920 | 910 | 342 | 450 | 5266 | 3820 | 4300 |
| Fishery Ghat at Cox's Bazar | 4796 | 5610 | 7600 | 7480 | 9100 | 3540 | 1120 | 468 | 512 | 8621 | 8100 | 9010 |
| EQS for wastewater after treatmen t from industrial units 600 mg/l | | | | | | | | | | | | |

Chloride concentration varied from 342 to 9100 mg/l (Table-23) against the EQS (600 mg/l) for treated wastewater from industrial units. In 2012, Chloride concentration varied from 45 to 14,222 mg/l.

### 4.14 Moyuri river

For monitoring water quality of Moyuri river in 2011, water samples were collected from three different points of Gallamari Bridge location (Bank, Middle and Opposite Bank) of the river.

pH level of Moyuri river water varied from 6.93 to 7.72 (Fig.15a) and was within the EQS limit. In 2012, pH level varied from 6.35 to 7.68.



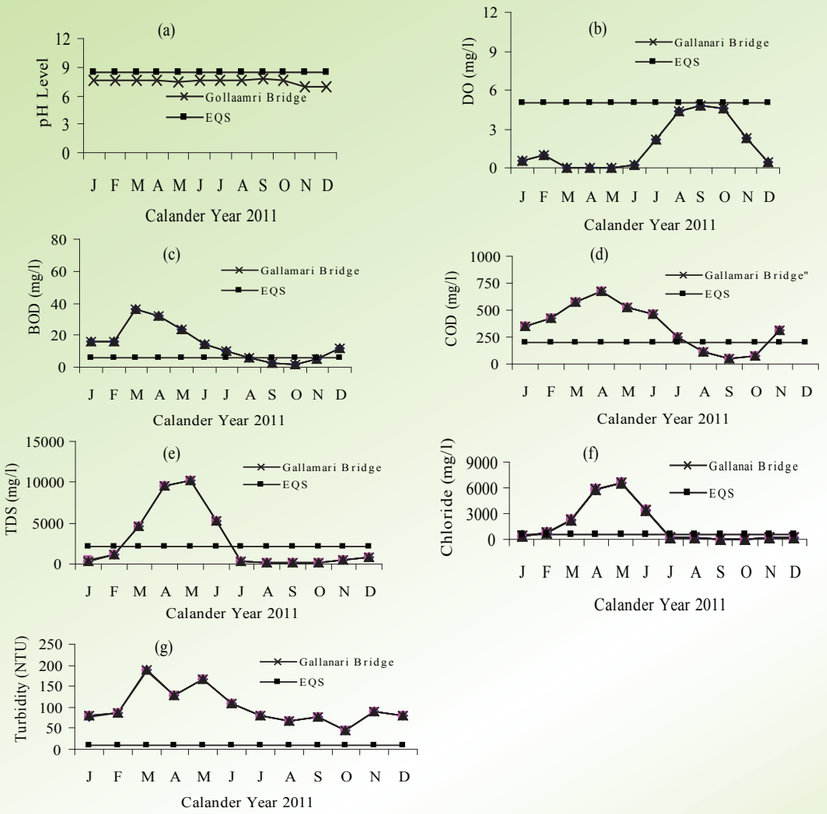



**Fig.14.Graphical presentation of pH,DO,BOD,COD,TDS,Chloride and Turbidity of Moyuri River in 2011**

DO content of Moyuri river water was below the EQS (≥5 mg/l) for fisheries. DO level varied from 0 to 4.8 mg/l (Fig.15b). No dissolved oxygen was found from March to May. In 2012, DO concentration varied from 0.4 to 2.0 mg/l. BOD level of the Moyuri river water varied from 1.8 to 36 mg/l while EQS for fisheries is ≤6 mg/l (Fig.15c). In 2012, BOD level varied from 6 to 20 mg/l. COD concentration of Moyuri river was very high in 2011. The maximum and the minimum concentration was 672 and 46 mg/l respectively (Fig.15d). TDS range was from 190 to 10300 mg/l (Fig.15e) while EQS is 2100 mg/l. Highest TDS value was found from February to June and lowest was found from July to December. In 2012, TDS concentration varied from 547 to 1015 mg/l. Chloride level was much higher (March-June) compare to rest of the period and it varied from 21 to 6483 mg/l (Fig.15g). In 2012, Chloride level varied from 680 to135.65 mg/l. Turbidity level of Moyuri river at all points was very high. It varied from 44.6 to 166.8 NTU while Turbidity for drinking water is 10 NTU (Fig.15f). In 2012, Turbidity level varied from 40.1 to 79.6 NTU.

**Table-24. Level of EC at different sampling points of Moyuri River in 2011.**

| Sampling Locations of Moyuri River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Gallamari Bridge (Side point) | 1120 | 2150 | 9200 | 18960 | 20600 | 10600 | 610 | 420 | 380 | 380 | 839 | 1488 |
| Gallamari Bridge, (Middle point) | 1130 | 2150 | 9100 | 18960 | 20600 | 10600 | 610 | 420 | 380 | 380 | 834 | 1488 |
| Gallamari Bridge, (Opposite point) | 1120 | 2150 | 9200 | 18960 | 20600 | 10600 | 610 | 420 | 380 | 380 | 839 | 1488 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC varied from 380 µmhoms/cm to 20600 µmhoms/cm. The maximum and the minimum concentration was 20600 µmhoms/cm in May and 380 µmhoms/cm (Table-24) in September respectively while standard EC is 1200 µmhoms/cm. for treated wastewater from industrial unit EC is 1200 µmhoms/cm.

**Table-25. Level of Salinity at different sampling points of Moyuri River in 2011.**

| Sampling Locations of Moyuri River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Gallamari Bridge, (Side point) | 0.6 | 1.2 | - | 11.1 | 11.8 | 6.1 | - | - | - | - | - | 0.7 |
| Gallamari Bridge, (Middle point) | 0.6 | 1.2 | - | 11.1 | 11.8 | 6.1 | - | - | - | - | - | 0.7 |
| Gallamari Bridge, (Opposite point) | 0.6 | 1.2 | - | 11.1 | 11.8 | 6.1 | - | - | - | - | - | 0.7 |
| EQS for wastewater after tr eatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity level varied from 0.6 ppt to 11.8 ppt. The maximum and the minimum salinity was 11.8 and 0.6 ppz respectively while standard salinity is 400 ppt for treated wastewater from industry (Table-25).

### 4.15 Bhairab River

Bhairab river flows in the south of Bangladesh. The river is approximately 100 miles long and 300 feet wide. Its average depth is 4 to 5 feet and with minimal water flow with plenty of silt. Water samples were collected from three locations comprising nine different points (e.g. Noapara Ghat Side, middle and opposite side, Fultala Ghat side, middle and opposite side and Charerhat Ghat side middle and opposite side) of Bhairab River for analyses water quality in 2011. To simplify data analysis only middle point of all locations was considered. Because, no significant variation was found between side, middle and opposite side of a location of the river.

pH at different locations of the Bhairab river varied from 7.11 to 7.78 (Fig.16a) while standard pH for inland surface water is 6.5 to 8.5. In 2012, pH level varied from 7.42 to 7.87. BOD level of Bhairab river water was below the EQS (≤6 mg/l) for fisheries round the year of 2011. BOD varied from 0.5 to 1.1 mg/l (Fig.16b). In 2012, BOD level varied from 0.5 to 0.8 mg/l. COD was relatively low in 2011. The maximum and the minimum COD was 210 and 20 mg/l (Fig.16c) respectively while EQS for COD is 200 mg/l. In 2012, COD varied from 20 to 22 mg/l. DO was below the EQS ((≥5 mg/l) for fisheries. The maximum and the minimum DO was 6.4 and 4.4 mg/l (Fig.16d) respectively. In 2012, DO varied from 5.3 to 7.8 mg/l. TDS level of Bhairab river was very high during February to June at all locations. The maximum and the minimum was 15000 and 130 mg/l (Fig.16e) respectively while EQS is 2100 mg/l. TDS was high in March to June. In 2012, TDS varied from 116 to 2180 mg/l. High level of Chloride was found from March to June in Bhairab river water. It varied from 9.6 to 9340 mg/l (Fig.16f) while EQS for Chloride is 600 mg/l. Highest Chloride (9340 mg/l) was found in May and lowest value was 9.6 mg/l in September. In 2012, Chloride level varied from 16.78 to 1060 mg/l. Turbidity of Bhairab river water at all locations was very high in 2011. It varied from 38.4 to 188.8 NTU while the EQS for drinking water is 10 NTU (Fig.16g). The prime reason may be of carrying huge silt by the river throughout the year. In 2012, Turbidity level varied from 20.7 to 108 NTU.



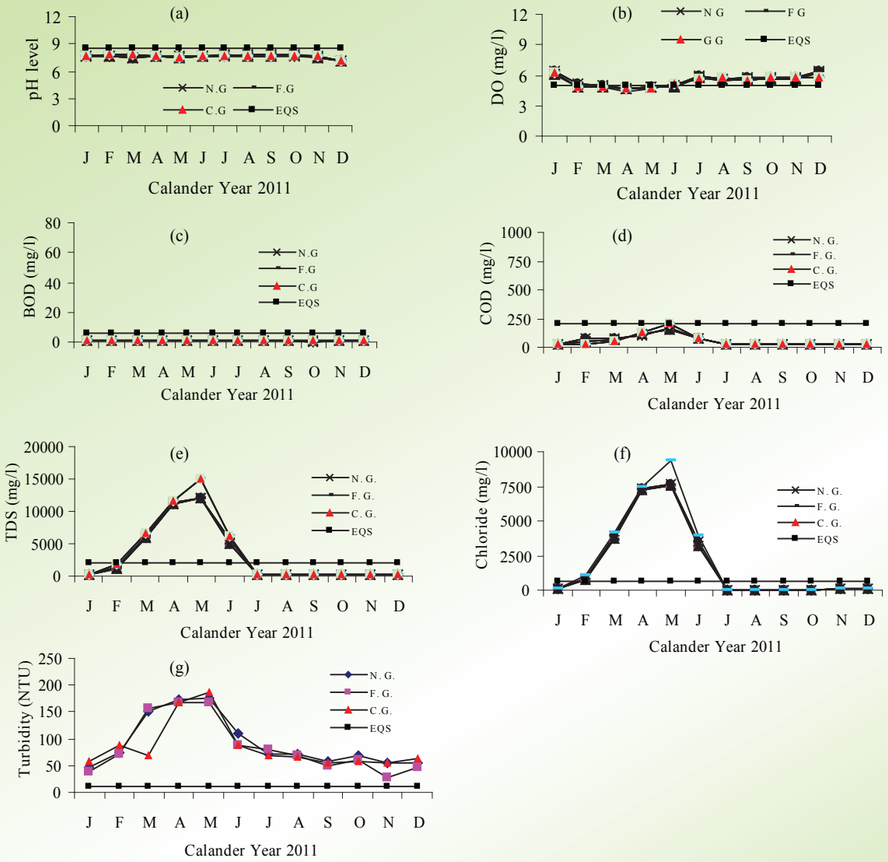



**Fig.15. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and Turbidityof Bhairab River in 2011**

Note: N.G = Noapara Ghat, F.G = Fultala Ghat, C.G = Charerhat Ghat

**Table-26. Level of Salinity at different locations of Bhairab River in 2011.**

| Sampling Locations of Bhairab River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Noapara Ghat (Side) | 0.2 | 1.3 | 6.8 | 13.4 | 13.7 | 5.8 | - | - | - | - | - | 0.2 |
| Noapara Ghat ( Middle) | 0.2 | 1.3 | 6.8 | 13.4 | 13.7 | 5.8 | - | - | - | - | - | 0.2 |
| Noapara Ghat (Opposite) Side | 0.2 | 1.3 | 6.8 | 13.4 | 13.7 | 5.8 | - | - | - | - | - | 0.2 |
| Fultala Ghat (Side) | 0.2 | 1.5 | 7.1 | 13.8 | 13.8 | 6.4 | - | - | - | - | - | 0.2 |
| Fultala Ghat (Middle) | 0.2 | 1.5 | 7.1 | 13.8 | 13.8 | 6.4 | - | - | - | - | - | 0.2 |
| Fultala Ghat (Opposite) Side | 0.2 | 1.5 | 7.1 | 13.8 | 13.8 | 6.4 | - | - | - | - | - | 0.2 |
| Charerhat Ghat (Side) | 0.2 | 2.1 | 7.6 | 14.0 | 17.1 | 7.1 | - | - | - | - | - | 0.2 |
| Charerhat Ghat(Middle) | 0.2 | 2.1 | 7.6 | 14.0 | 17.1 | 7.1 | - | - | - | - | - | 0.2 |
| Charerhat Ghat (Opposite) Side | 0.2 | 2.1 | 7.6 | 14.0 | 17.1 | 7.1 | - | - | - | - | - | 0.2 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity varied from 0.2 ppt to 17.1 ppt. The maximum and the minimum salinity was 17.1 ppt in May and 0.2 ppm in January and December respectively (Table-26).

## 4.16 Rupsha River

Rupsha is one of the most famous and important river of Bangladesh that flows by the port city Khulna, and falls to the Bay of Bengal through Poshur River at Mongla channel. Water samples were collected from two locations comprising six points (e.g. Rupsha Ghat Bank, Middle and Opposite and Labanchara Ghat side, middle and opposite side) of Rupsha River for monitoring water quality in 2011. To facilitate analysis, only the middle points of two locations were considered. Because, no significant variation was found between banks and middle points of both locations.

In 2011, pH varied from 7.13 to 7.73 (Fig.17a) while in 2012, pH level varied from 7.44 to 7.88. It has been observed that DO level was lower during February to June than EQS (≥5 mg/l) for fisheries. The maximum and the minimum DO content was 6.8 and 4.5 mg/l respectively (Fig.17b). In 2012, DO level varied from 5.7 to 6.8 mg/l. In 2011, the maximum and the minimum BOD was 8.0 and 0.6 mg/l respectively (Fig.17c). In 2012, BOD varied from 0.4 to 0.8 mg/l. COD was slightly higher in May 2011. The maximum and the minimum COD was 225 and 22 mg/l respectively (Fig.17d) while the EQS is 200 mg/l. In 2012, COD concentration varied from 20 and 22 mg/l. Chloride level was much higher (February-June) than the EQS (600 mg/l) for treated wastewater from industrial units. Chloride content varied from 15.6 to 9720 mg/l (Fig.17e). In 2012, Chloride varied from 16 to 2609 mg/l. Turbidity level at both location of Rupsha river was very high during dry period of 2011. Turbidity level was relatively higher throughout the year and it varied from 52.2 to 210.6 NTU (Fig.17f) while EQS for drinking water is 10 NTU. In 2012, Turbidity varied from 10.22 to 89.20 NTU.

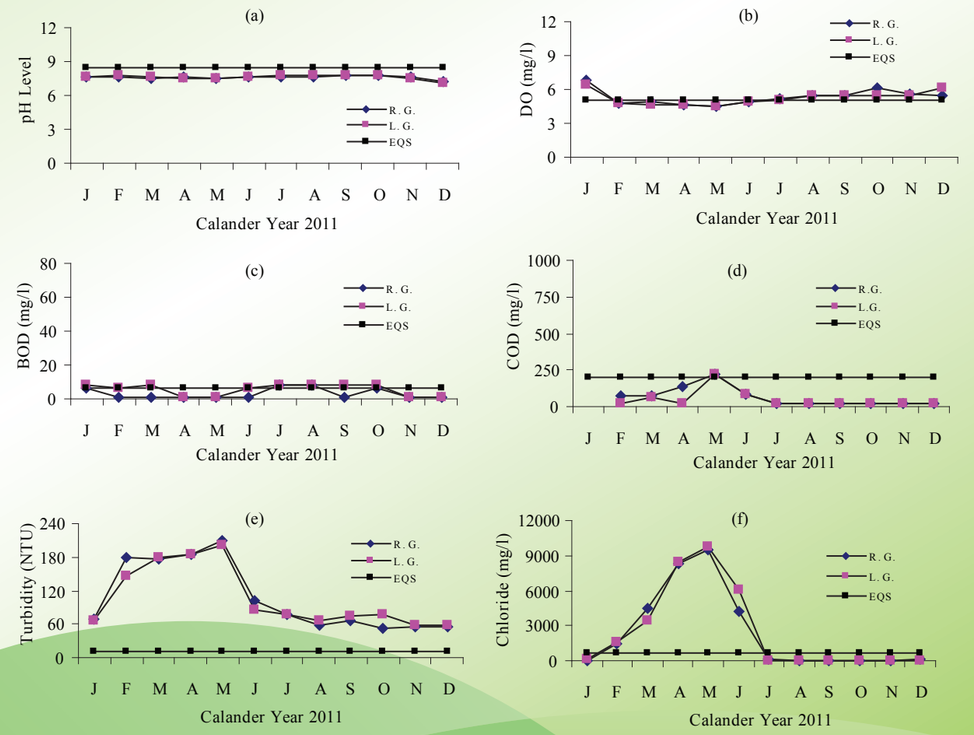



**Fig.16.Graphical presentation of pH, DO, BOD, COD, Chloride and Turbidity of Rupsha River in 2011**

Note : R.G = Rupsha Ghat, L.G = Labanchara Ghat



**Table-27. Level of Salinity at different sampling locations of Rupsha River in 2011.**

| Sampling Locations of Rupsha River | TDS (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Rupsha Ghat (Side) | 0.2 | 2.5 | 8.1 | 15.5 | 17.5 | 7.6 | - | - | - | - | - | 0.2 |
| Rupsha Ghat (Middle) | 0.2 | 2.5 | 8.1 | 15.5 | 17.5 | 7.6 | - | - | - | - | - | 0.2 |
| Rupsha Ghat (Opposite) | 0.2 | 2.5 | 8.1 | 15.5 | 17.5 | 7.6 | - | - | - | - | - | 0.2 |
| Labanchara Ghat (Side) | | 2.5 | 8.4 | 15.8 | 17.7 | 8.1 | - | - | - | - | - | 0.2 |
| Labanchara Ghat (Middle) | | 2.5 | 8.4 | 15.8 | 17.7 | 8.1 | - | - | - | - | - | 0.2 |
| Labanchara Ghat (Other) | | 2.5 | 8.4 | 15.8 | 17.7 | 8.1 | - | - | - | - | - | 0.2 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity level varied 0.2 ppt to 17.7 ppt. The maximum and the minimum salinity was 17.7 ppt in May and 0.2 ppt in January and December respectively (Table-27).

## 4.17 Mathavanga river

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

In 2011, pH varied from 7.19 to 7.71 (Fig.18a) while in 2012, pH range was from 6.9 to 7.91. DO level was high at Upstream but no dissolved oxygen was found at Pipeghate in the month of April (Fig.18b). DO varied from 0 to 7.2 mg/l while DO standard for fisheries is ≥5 mg/l. In 2012, DO level varied from 4.4 to 7.8 mg/l. In 2011, BOD level varied from 0.5 to 187 mg/l (Fig.18c) and in 2012, BOD range was from 0.5 to 143 mg/l. COD was very high at Pipeghat during February to May, because Keru & Co. Factory discharges their wastewater in the Mathavanga river without treatment. COD varied from 20 to 5460 mg/l (Fig.18d) while EQS for treated wastewater from industrial unit is 200 mg/l. No data was collected in the month of December. TDS was below the EQS (2100 mg/l) at all the locations in 2011. High level of TDS was found at Pipeghat compare to other points of the river. It varied from 105 to 555 mg/l (Fig.18e). In 2012, TDS level varied from 115to 410 mg/l. Chloride level of Mathavanga river water varied from 6.9 to 121.8 mg/l (Fig.18f) while EQS for Chloride is 600 mg/l. In 2012, Chloride content varied from 11.0 to 16.8 mg/l. Turbidity that level was above the EQS (10 NTU) for drinking water and varied from 20.2 to 210.7 NTU (Fig.18g). In 2012, Turbidity level varied from 20.0 to 78.6 NTU.

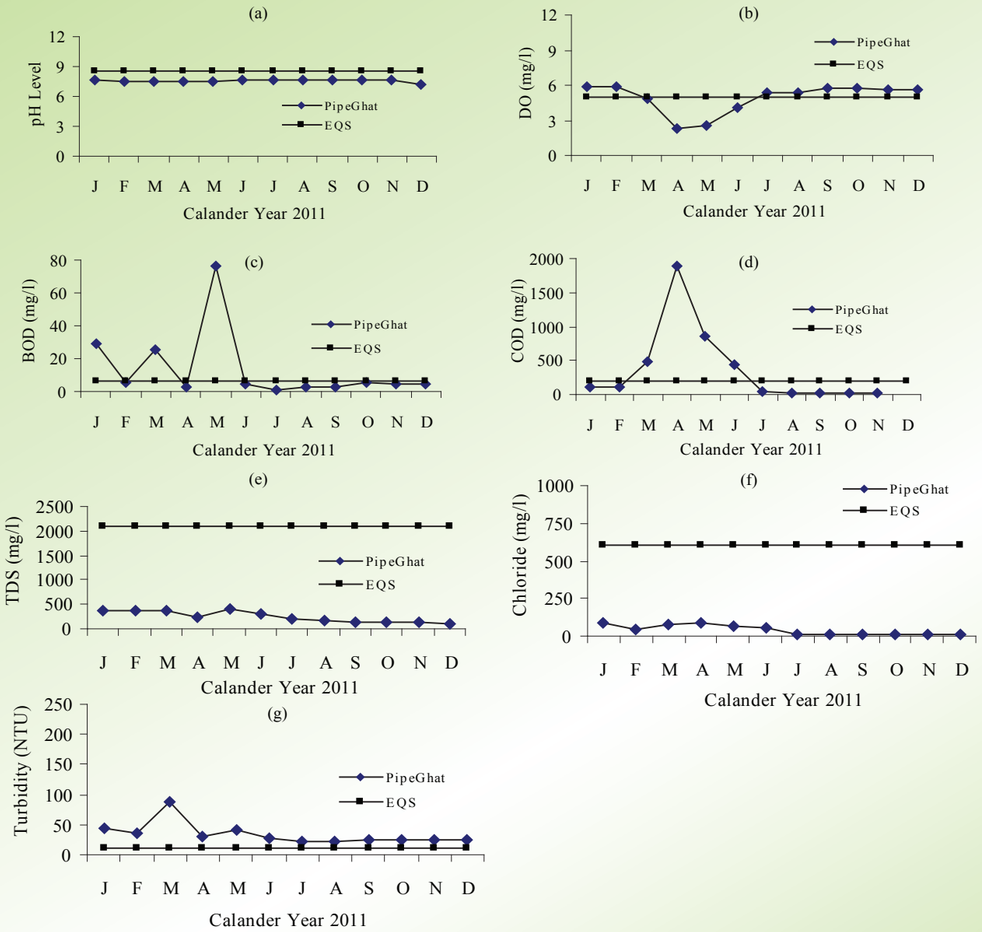



**Fig.17.Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Mathavanga River in 2011**

### 4.18 Pashur river

For analysis of water quality, water samples were collected from one location of Pashur river comprising three different points e.g. Monglaport site, middle and opposite side of Bagherhat.

In 2011, pH level varied from 7.16 to 7.74 (Fig.19a) and was within the EQS (6.5 to 8.5). In 2012, pH level varied from 7.71 to 7.88. DO level was below the EQS (≥5 mg/l) for fisheries from February to July. The maximum and the minimum concentration of DO was 6.8 and 4.6 mg/l respectively (Fig/19b). In 2012, DO varied from 4.8 to 6.8 mg/l. BOD level was within the EQS (≤6 mg/l) for fisheries during the sampling period. the maximum and the minimum value of BOD was 1.2 and 0.8 mg/l respectively (Fig.19c). In 2012, BOD level varied from 0.5 to 0.9 mg/l. COD level was within the EQS (200 mg/l) for treated wastewater from industrial units except in May. the maximum and the minimum value of COD was 210 and 22 mg/l respectively (Fig.19d). High level of TDS was found at Pipeghat compare to other points of the river. TDS varied from 205 to 17,750 mg/l (Fig.19e). In 2012, TDS level varied from 151 to 11200 mg/l. Chloride level of Pashur river water ranged from 76 to 11,390 mg/l. Chloride concentration was higher at all points during January to July compare to rest of the period (Fig.19f). In 2012, Chloride level varied from 30 to 5451 mg/l. Turbidity level varied from 58.7 to 178.6 NTU (Fig.19g) against the EQS for drinking water (10 NTU). Turbidity concentration was very high round the year. In 2012, Turbidity Turbidity level varied from 22.4 to 110 NTU.



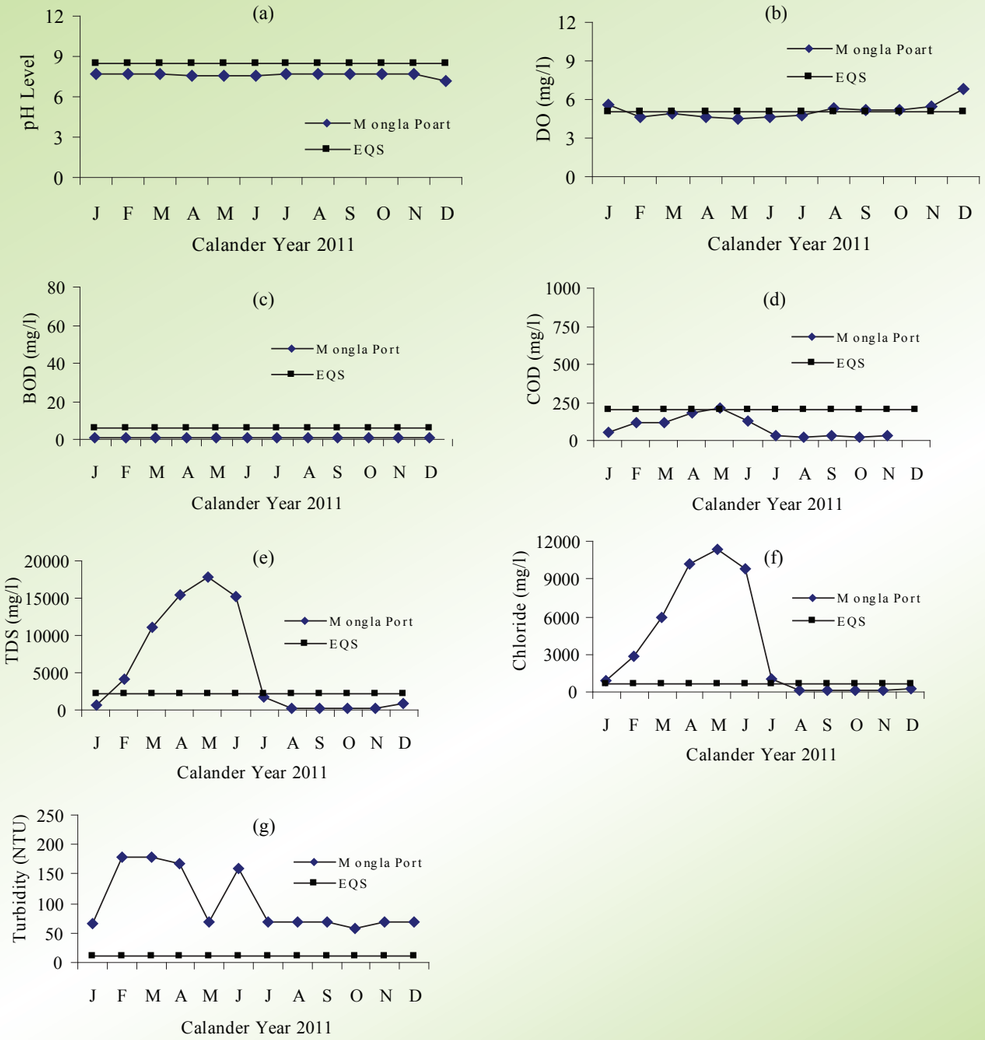



**Fig.18.Graphical presentation of pH,DO,BOD,COD,TDS,Chloride, Turbidity of Pashur River in 2011**

**Table-28. Level of Salinity at different sampling locations of Pashur River in 2011.**

| Sampling Locations of Pashur River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Mongla Poart (Side) | 0.8 | 8.3 | 12.7 | 18.6 | 20.8 | 18.3 | 1.8 | 0.2 | - | 0.3 | - | 0.7 |
| Mongla Poart (Middle) | 0.8 | 8.3 | 12.7 | 18.6 | 20.8 | 18.3 | 1.8 | 0.2 | - | 0.1 | - | 0.7 |
| Mongla Poart(Opposite) | 0.8 | 8.3 | 12.7 | 18.6 | 20.8 | 18.3 | 1.8 | 0.2 | - | 0.1 | - | 0.7 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity varied 0.1 ppt to 20.8 ppt. the maximum and minimum salinity was 20.8 ppt in May and 0.1 ppt in August respectively while EQS for Salinity is 400 ppt (Table-28).

### 4.19 Kakshiali River

To monitor water quality of Kakshiali river, water samples were collected from three different points e.g. Kaliganj site, middle and opposite side at Shatkhira location in 2011.

In 2011, pH level was within the EQS (6.5-8.5) for inland surface water and was varied from 7.11 to 7.74 (Fig.20a). In 2012, pH varied from 7.65 to 7.79. DO level varied from 4.6 to 5.8 mg/l (Fig.20b) throughout the year while EQS for fisheries is ≥5 mg/l. In 2012, DO level varied from 5.1 to 5.9 mg/l. BOD was far below the EQS (≤6 mg/l) for fisheries. It varied from 0.4 to 1.0 mg/l (Fig.20c). In 2012, BOD level varied from 0.5 to 0.8 mg/l.

COD concentration was below the EQS (200 mg/l) for treated wastewater from industrial units and varied from 20 to 198 mg/l (Fig.20d). TDS level was very high in the first seventh months of 2011 and it varied from 212 to 18,200 mg/l (Fig.20e). In 2012, TDS level varied from 3910 to 15,200 mg/l.

Chloride concentration was very high during January to June and varied from 72.4 to 9811 mg/l (Fig.20f) while standard for Chloride is 600 mg/l wastewater from industrial units. The highest Chloride was found in April and the lowest value was in September. In 2012, Chloride level varied from 1439 to 8440 mg/l. Turbidity level was above the EQS (10 NTU) limit for drinking all over the year that varied from 46.8 to 188.4 NTU (Fig.20g). In 2012, Turbidity level varied from 46.1 to 87.2 NTU.

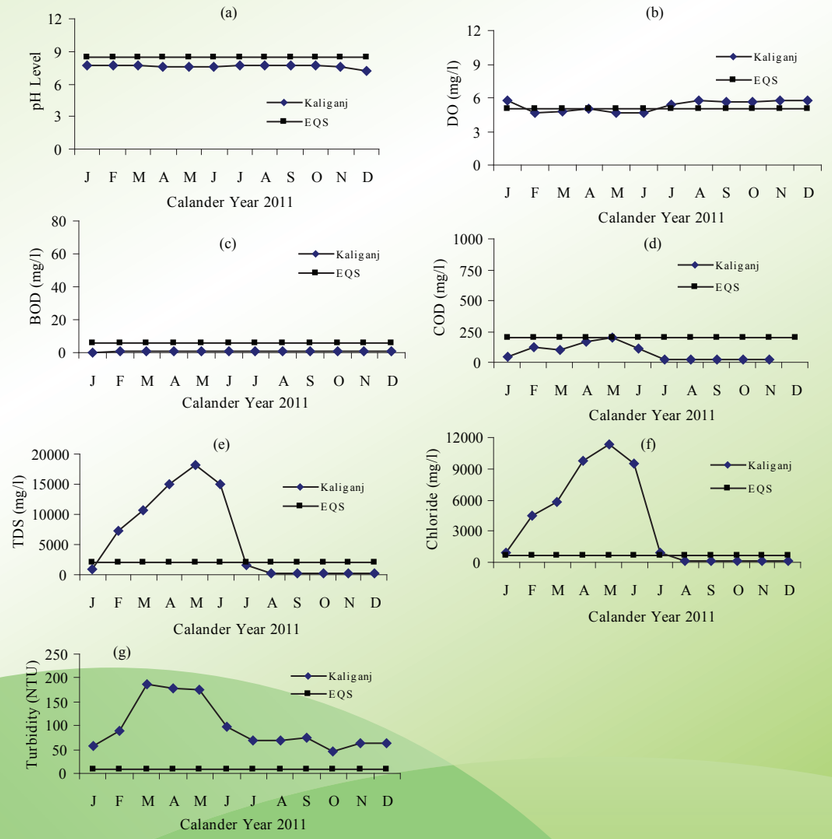



**Fig.19. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride,Turbidity of Kakshiali River in 2011**



**Table-29. Level of Salinity at different sampling locations of Kakshiali River in 2011.**

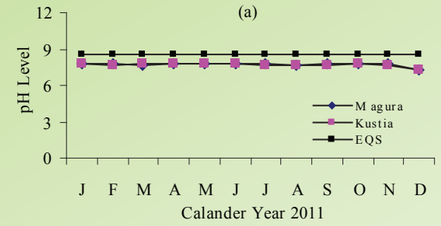
| Sampling Locations of Kakshiali River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Kaliganj (Side) | 1.0 | 8.1 | 12.1 | 18.2 | 20.8 | 17.8 | 1.6 | 0.2 | - | 0.3 | - | 0.3 |
| Kaliganj (Middle) | 1.0 | 8.1 | 12.1 | 18.2 | 20.8 | 17.8 | 1.6 | 0.2 | - | 0.3 | - | 0.3 |
| Kaliganj(Opposite) | 1.0 | 8.1 | 12.1 | 18.2 | 20.8 | 17.8 | 1.6 | 0.2 | - | 0.3 | - | 0.3 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

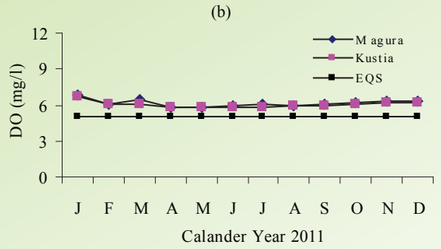
Salinity varied 0.2 ppt to 20.8 ppt. The maximum and the minimum salinity was 20.8 ppt in May and 0.2 ppt in August (Table-29) respectively while EQS for Salinity is 400 ppt.

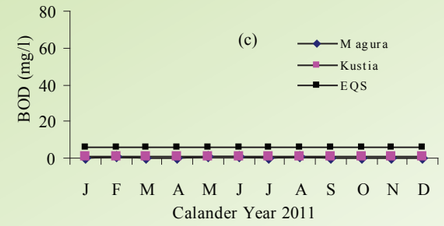
### 4.20 Gorai River

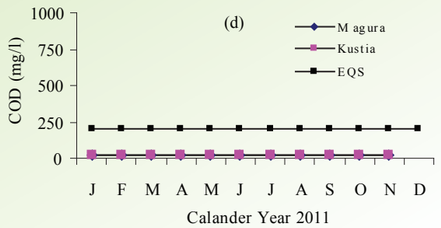
Water samples were collected from two locations viz Kamarkhali ghat, Magura and G K ghat, Kustia, comprising three points each. Only middle point of both locations was considered for analyses because there was no significant difference between bank, middle and opposite bank of both locations.

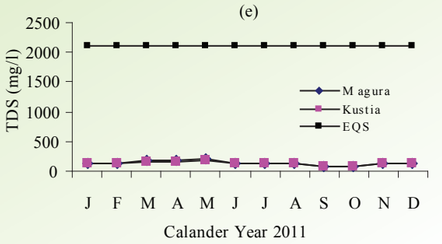
In 2011, pH of Gorai river water was varied from 7.22 to 7.81 (Fig.21a) and was within the EQS (6.5-8.5) for inland surface water. In 2012, pH level varied from 7.28 to 7.88. DO was above the EQS (≥5 mg/l) for fisheries at both locations of the river. Level of DO varied from 5.7 to 6.8 mg/l (Fig.21b). In 2012, DO level varied from 5.8 to 7.2 mg/l. BOD level was far below the EQS (≤6 mg/l) for fisheries. It varied from 0.4 to 0.6 mg/l (Fig.21c). In 2012, BOD level varied from 0.3 to 0.6 mg/l. COD was around 20 mg/l throughout the year at both locations except in May (Fig.21d). TDS level of Gorai river water was very low throughout the year compare to the EQS (2100 mg/l) for treated wastewater from industrial units. It varied from 85 to 220 mg/l (Fig.21e). In 212, TDS level varied from 63.7 to 210 mg/l.

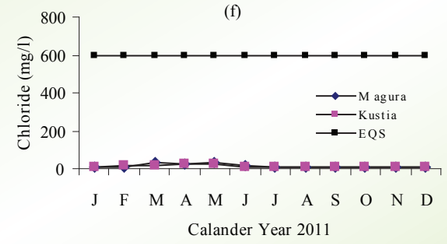


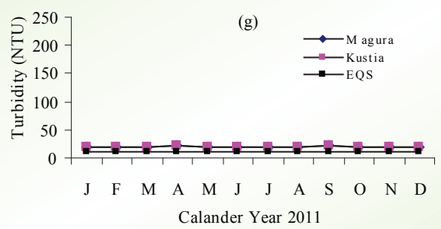




**Fig.20.Graphical presentation of pH,DO,BOD,COD,TDS,Chloride ,Turbidity of Gorai River in 2011**

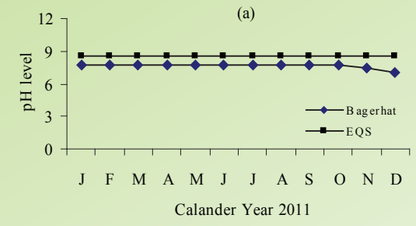
Chloride level was also within the EQS (600 mg/l) for waste from industrial units. The maximum and the minimum chloride value was 35.5 and 6.5 mg/l (Fig.21f). In 2012, Chloride level varied from 8.1 to 22.5 mg/l. Turbidity level was relatively higher throughout the year than the EQS (10 NTU) for drinking water. It varied from 17.6 to 22.6 NTU (Fig.21g). In 2012, Turbidity level varied from 10.1 to 21.6 NTU.

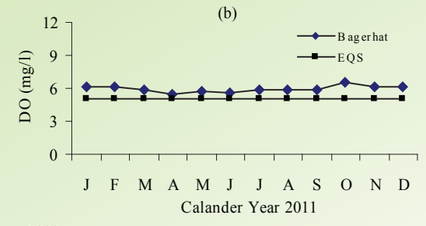
**4. 21 Modhumoti river**

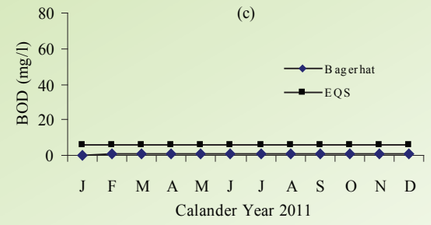
To monitor water quality of Modhumoti river in 2011, samples were collected from one location comprising three different points (Mollarhat side, middle and opposite side) of Bagerhat.

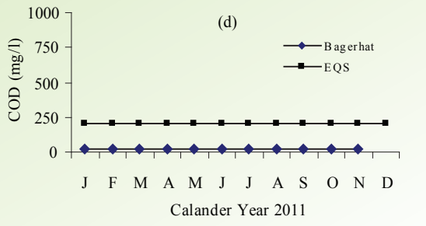
In 2011, pH level of Modhumoti river was within EQS and varied from 6.88 to 7.79 (Fig.22a). In 2012, pH level varied from 6.88 to 7.88. DO was high round the year and was varied from 5.4 to 6.2 mg/l while EQS (≥5 mg/l) for fisheries (Fig.22b). In 2012, DO level was varied from 5.8 to 6.8 mg/l. BOD of the river was below the EQS (≤6 mg/l) for fisheries. BOD varied from 0.4 to 0.8 mg/l (Fig.22c). In 2012, BOD varied from 0.4 to 0.6 mg/l. COD was below 20 mg/l throughout the year (Fig.22d).

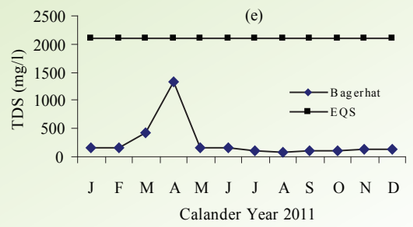


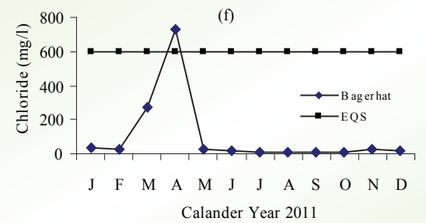


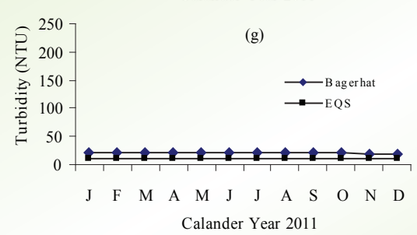




**Fig.21.Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, Turbidity of Modhumoti River in 2011**

TDS of Modhumoti river water was within EQS (2100 mg/l). The maximum and the minimum value was 1315 and 94 mg/l respectively (Fig.22e). In 2012, TDS level varied from 113.9 to183 mg/l. Chloride level varied from 6.2 to 274.5 mg/l while EQS for treated wastewater from industrial units is 600 mg/l. The maximum value was found during March to April and the minimum was in July and August respectively (Fig.22f). In 2012, Chloride level varied from 8.13 to 45.6 mg/l. Turbidity varied from 18.5 to 22.8 NTU (Fig.22g) and was higher than EQS (10 NTU) for dirking water throughout the year. In 2012, Turbidity varied from 10.8 to 12.8 NTU.

**4.22 Beel Dakatia River**

To monitor water quality of Beel Dakatia river in 2011, samples were collected from one location comprising two points (bank and middle) of Khulna.

In 2011, pH level was within EQS and varied from 7.16 to 7.69 (Fig.23a). In 2012, pH level varied from 7.72 to 7.48. DO varied from 3.2 to 5.6 mg/l (Fig.23b) and was slightly below the EQS (≥5 mg/l) for fisheries. In 2012, DO level varied from 3.2 to 6.1 mg/l EQS 5.5 mg/l for surface water. In 2012, Turbidity level varied from 12.25 to 68.10 mg/l.

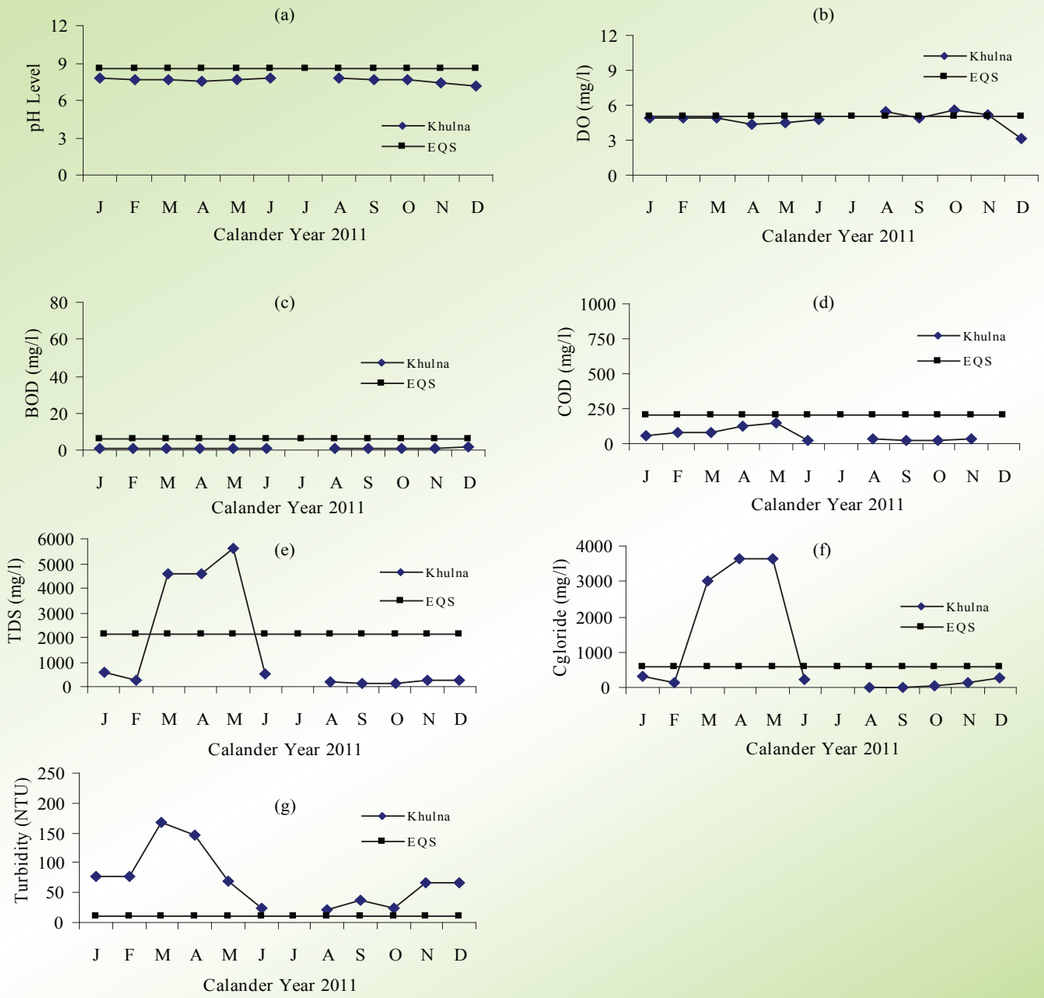



**Fig.22.Graphical presentation of pH, DO, BOD, COD, TDS, Turbidity of Beel Dakatia River in 2011**

In 2011, BOD was below the EQS (≤6 mg/l) for fisheries that varied from 0.8 to 2.0 mg/l (Fig.23c). In 2012, BOD level varied from 0.5 to 2 mg/l. COD varied from 23 to 144 mg/l (Fig.23d). TDS of Beel Dakatia river water was within EQS (2100 mg/l) except from the months March to May. The maximum and the minimum was 5600 and 130 mg/l respectively (Fig.23e). In 2012, TDS level varied from 135 to 2880 mg/l. Turbidity varied from 21.8 to 168.2 NTU (Fig.23g) and was higher han EQS (10 NTU) for drinking water. In 2012, Turbidity level varied from 12.25 to 68.10 mg/l.



**Table-30. Level of Chloride of Beel Dakatia river water in 2011.**

| Locations of Beel Dakatia River | Chloride (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| BeelDakatia(Side) | 329 | 136.0 | 3021.9 | 3634 | 3640 | 210 | - | 12.9 | 12.9 | 26.8 | 128.8 | 252.6 |
| Beel Dakatia (Middle) | 328 | 138.9 | 3022.0 | 3645 | 3640 | 210 | - | 12.9 | 12.8 | 26.8 | 128.8 | 252.8 |
| EQS for wastewater after treatment from industrial units 600 mg/l | | | | | | | | | | | | |

Chloride content varied from 12.9 to 3640 mg/l (Table-31) while EQS (600 mg/l) for treated wastewater from industrial units is 600 mg/l. The maximum Chloride was found during March to May and the minimum was in June to December respectively. In 2012, Chloride level varied from 20 to 843 mg/l.

**Table-31. Level of Salinity of Beel Dakatia river water in 2011.**

| Locations of Beel Dakatia River | Salinit y (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Beel Dakatia (Side) | 0.6 | - | 5.5 | 5.3 | 6.6 | - | - | - | - | - | - | 0.5 |
| Beel Dakatia (Middle) | 0.6 | - | 5.5 | 5.3 | 6.6 | - | - | - | - | - | - | 0.5 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity varied 0.5 ppt to 6.6 ppt. The maximum and the minimum salinity was 6.6 ppt in May and 0.5 ppt in December respectively while standard for Salinity is 400 ppt (Table-31).

### 4.23 Kirtankhola River

Kirtankhola river starts from Sayeshtabad in Barisal and ends into the Gajalia near Gabkhan khal (Canal). This old river is now known as the Barisal river. The total length of the river is about 160 km (Murshed, 2006). For monitoring purpose water samples were collected from different location of the river e.g.Lanch ghat (bank and middle) of Barisal, KDC Ghat. Samples were collected during low tide and high tide. Water sample was not collected in July.

In 2011, pH level of Kirtankhola river water varied from 6.2 to 7.8 (Fig.24a) and was within the EQS. In 2012, pH level varied from 6.0 to 8.2. DO level of Kirtankhola rive was above the EQS (≥5 mg/l) for fisheries at both locations of the river. DO varied from 4.6 mg/l to 9.7 mg/l (Fig.24b). In 2012, DO level varied from 5.7 mg/l to 7.3 mg/l. BOD was low round the year of 2011. The maximum and the minimum was 5.4 and 0.5 mg/l respectively (Fig.24c). In 2012, BOD level varied from 1.1 to 2.5 mg/l. At both locations in February, March and April, COD level was above the EQS (200 mg/l) for treated wastewater from industrial units. It varied from 18 mg/l to 377 mg/l (Fig.24d). In 2012, COD level varied from 36 mg/l to 52 mg/l. TDS was also within the EQS (2100 mg/l) throughout the year while it ranged from 24.4 to 114.5 mg/l (Fig.24e). In 2012, TDS level varied from 20 to 75.8 mg/l. Chloride content of the Kirtankhola river water varied from 15 to 150 mg/l (Fig.24f). In 2012, Chloride level varied from 13 to 45 mg/l. SS was within EQS. The maximum and the minimum SS was 14.63 mg/l in January and 9.59 mg/l in May (Fig.24g). In 2012, SS level varied from 8.15 to 30.3 mg/l. EC at both locations was within the EQS. The maximum and the minimum EC of Kirtankhola river was 73 µmhoms/cm in February and 42 µmhoms/cm in Jun (Fig.24h), where EQS is (1200 µmhoms/cm) for treated wastewater from industrial units.

Salinity varied 0.5 ppt to 6.6 ppt. The maximum and the minimum salinity was 6.6 ppt in May and 0.5 ppt in December respectively while standard for Salinity is 400 ppt (Table-31).

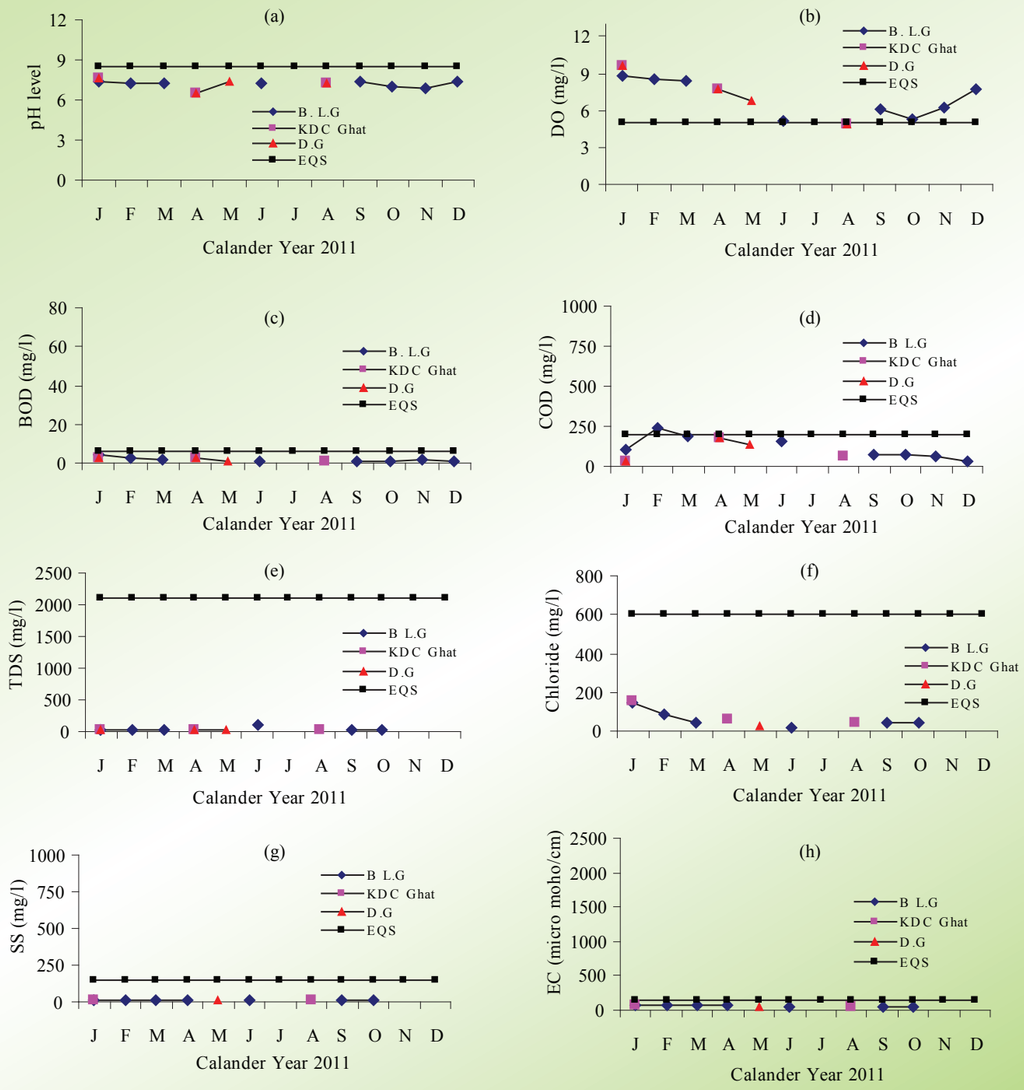



**Fig.23.Graphical presentation of pH, DO, BOD, COD, TDS, Chloride, SS,EC of Kirtankhola River in 2011**

Note: B.L.G = Barisal Lanch Ghat, D.G = Dapdapia Ghat, E.Q.S = Environmental Quality Standard



**Table-32. Level of Salinity at different sampling locations of Kirtankhola River in 2011.**

| Sampling l ocations of Kirtankhola River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Lanch Ghat (S),L.T | 14 | 8.2 | 4.4 | - | - | - | - | - | - | - | 4.8 | ---- |
| Lanch Ghat (M), L.T | 15 | 8.4 | 3.6 | - | - | - | - | - | - | - | - | - |
| Lanch Ghat (S), H.T | - | - | - | 6.0 | - | 1.8 | - | - | 4.2 | 4.4 | - | - |
| Lanch Ghat (M), H.T | - | - | - | 6.2 | - | 1.5 | - | - | 4.6 | 5.0 | - | - |
| KDC Ghat (S), H.T | 14.8 | - | - | - | - | - | - | - | - | - | - | - |
| KDC Ghat (M),H.T | 15.4 | - | - | - | - | - | - | - | - | - | - | - |
| KDC Ghat (S), L. T | - | - | - | - | - | - | - | 4.4 | - | - | - | - |
| KDC Ghat (M), L.T | -- | - | - | - | - | - | - | 4.0 | - | - | - | - |
| Dapdapia Ghat (S), HT | - | - | - | - | 2.1 | - | - | - | - | - | - | - |
| Dapdapia Ghat (M), | - | - | - | - | 2.3 | - | - | - | - | - | - | - |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity concentration varied 0.5 ppt to 6.6 ppt. The maximum and the minimum salinity was 6.6 ppt in May and 0.5 ppt in December respectively while salinity standard for treated wastewater from industrial units is 400 ppt (Table-32).

**Table-33. Level of NH3 at different sampling locations of Kirtankhola River in 2011.**

| Sampling l ocations of Kirtankhola River | $NH_3$ (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Lanch Ghat (S),L.T | 0.18 | 0.62 | 0.03 | - | - | - | - | - | - | - | 0.41 | 0.48 |
| Lanch Ghat (M), L.T | 1.30 | 0.44 | 0.32 | - | - | - | - | - | - | - | 0.39 | 0.47 |
| Lanch Ghat (S), H.T | - | - | - | - | - | 2.6 | - | - | 0.02 | 2.34 | - | - |
| Lanch Ghat (M), H.T | - | - | - | - | - | 2.8 | - | - | 0.01 | 1.82 | - | - |
| KDC Ghat (S), H.T | 0.11 | - | - | 0.05 | - | - | - | - | - | - | - | - |
| KDC Ghat (M),H.T | 1.09 | - | - | 0.34 | - | - | - | - | - | - | - | - |
| KDC Ghat (S), L. T | - | - | - | - | - | - | - | 2.16 | - | - | - | - |
| KDC Ghat (M), L.T | - | - | - | - | - | - | - | 2.55 | - | - | - | - |
| Dapdapia Ghat (S) | - | - | - | - | 0.23 | - | - | - | - | - | - | - |
| Dapdapia Ghat (Mid) | - | - | - | - | 0.17 | - | - | - | - | - | - | - |
| EQS for wastewater after treatment from industrial units 0.5 mg/l | | | | | | | | | | | | |

NH3 level of the river water varied from 0.01 to 2.8 mg/l against the EQS for treated wastewater from industrial units is 0.5 mg/l (Table-33).
(Note: L.T = Low Tide, H.T= High Tide)

### 4.24 Tetulia River

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

In 2011, pH level of the Tetulia river water ranged from 7.2 to 7.6 mg/l (Fig. 25a) while in 2012, pH level varied from 6.2 to 6.9. DO varied from 6.7 to 7.9 mg/l (Fig. 25b). In 2012, DO level varied from 5.85 to 7.6 mg/l. BOD level of the Tetulia river varied from 0.20 to 2.2 mg/l (Fig. 25c) against corresponding EQS (≤6 mg/l) for fisheries. In 2012, BOD level varied from 1.2 to 2.6 mg/l. COD level varied from 36 to 52 mg/l (Fig. 25d). TDS range was from 29.0 to 109.3 mg/l (Fig. 25e). In 2012, TDS level varied from 20 to 38.1 mg/l. Chloride level varied from 62 to 74 mg/l (Fig. 25f) while EQS for treated wastewater from industrial units is 600 mg/l. In 2012, Chloride level varied from 11 to 51 mg/l. SS level varied from 11.60 to 44 mg/l (Fig. 25g) and was below the EQS (150 mg/l). In 2012, SS level varied from 5 to 15.24 mg/l.

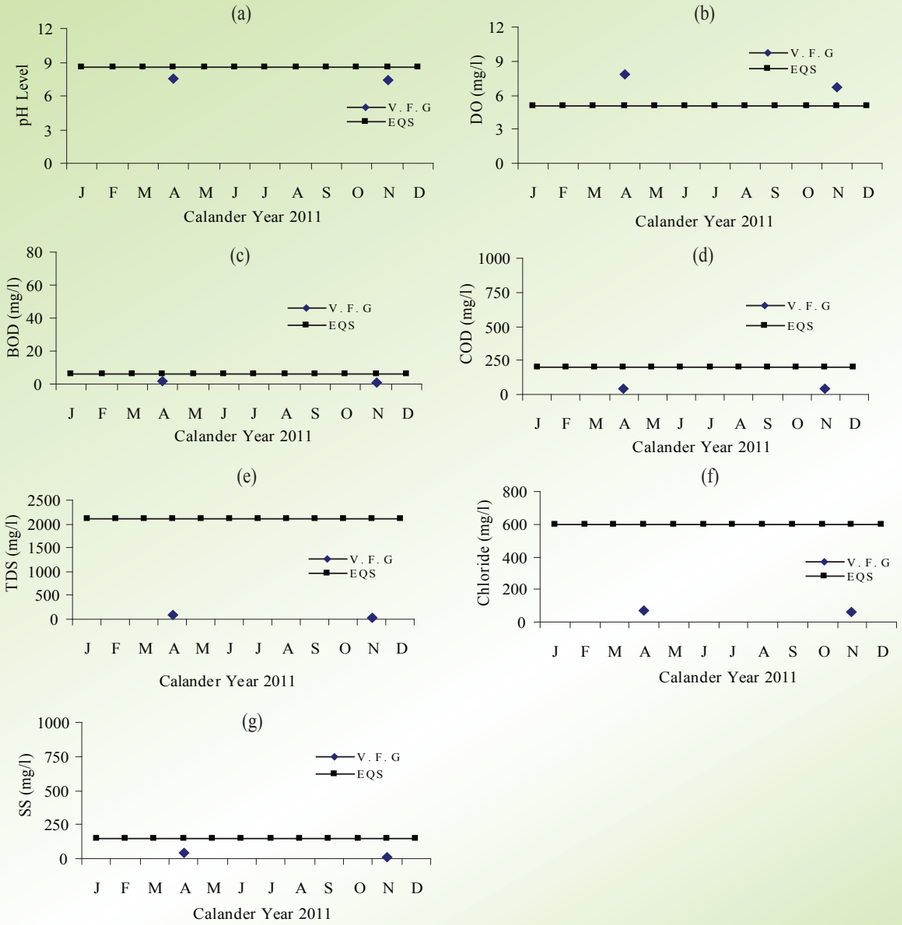



**Fig.24.Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Tatulia River in 2011**

Note: V.F.G=Vedhoria Feri Ghat

**Table-34. Level of NH3 at different sampling points of Tetulia River in 2011.**

| Sampling points of Tetulia River | $NH_3$(mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Vedhoria Feri Ghat (Side), | - | - | - | 0.96 | - | - | - | - | - | - | 0.48 | - |
| Vedhoria Feri Ghat (Middle), | - | - | - | 0.89 | - | - | - | - | - | - | 0.51 | - |
| EQS for wastewater after treatment from industrial units 0.5 mg/l | | | | | | | | | | | | |

NH3 level of the Tetulia river varied from 0.48 to 0.96 mg/l (Table-34) while standard limit for treated wastewater from industrial unit is 0.5 mg/l.



## 4.25 Lohalia River

To monitor water quality of Lohalia river water samples was colleted for analysis from Lanch Ghat, Patuakhali (e.g. Side and middle high tide) of the river.

In 2011, pH level of the Lohalia river water varied from 7.2 to 7.8 (Fig. 26a) while EQS for fisheries is from 6.5 to 8.5. In 2012, pH level varied from 7.4 to 8.2.

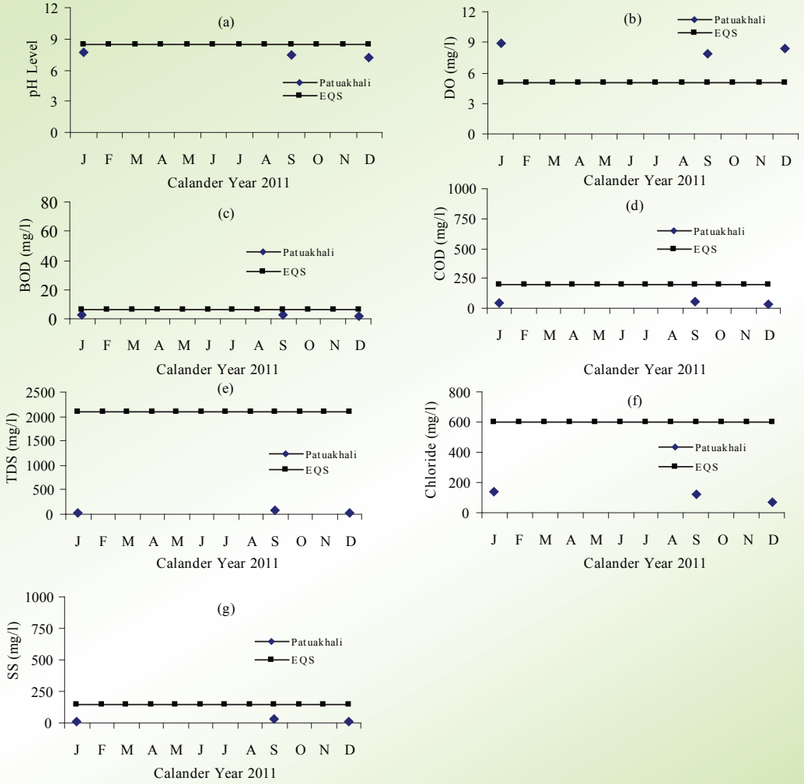



**Fig.25. Graphical presentation of pH, DO, BOD, COD, TDS, Chloride and SS of Lohalia River in 2011**

DO level varied from 7.8 to 8.9 mg/l (Fig. 26b) and was above the EQS (≥5 mg/l) for fisheries. In 2012, DO level varied from 5.7 to 7.9 mg/l. BOD range was from 1.3 to 2.9 mg/l (Fig. 26c) while EQS for fisheries is ≤6 mg/l. In 2012, BOD level varied from 1.5 to 2.7 mg/l. COD level of the Lohalia river water varied from 26 to 52 mg/l (Fig. 26d) where EQS for treated wastewater from industrial units after treatment is 200 mg/l. TDS level varied from 3.3 to 79.0 mg/l (Fig. 26e) while EQS for treated wastewater from industrial unit is 2100 mg/l. In 2012, TDS level varied from 73.3 to 79.5 mg/l. Chloride level of the Lohalia river was from 66 to 156 mg/l (Fig. 26f) while corresponding EQS is 600 mg/l. In 2012, Chloride level varied from 45 to 156 mg/l. SS level of the Lohalia river varied from 13.39 to 31.6 mg/l (Fig. 26g) against EQS (150 mg/l) for treated wastewater from industrial units. In 2012, SS level varied from 29.7 to 35.4 mg/l.

**Table-35. Level of Salinity at different sampling locations of Lohalia River in 2011.**

| Sampling Locations of Lohalia River | Salinity (ppt) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Lanch Ghat (Side), | 12.8 | - | - | - | - | - | - | - | 12.4 | - | - | 6.6 |
| Lanch Ghat (Middle), | 15.6 | - | - | - | - | - | - | - | 12.6 | - | - | 6.8 |
| EQS for wastewater after treatment from industrial units 400 ppt | | | | | | | | | | | | |

Salinity level of the Lohalia river water varied from 6.6 ppt to 15.6 ppt (Table-35).

**Table-36. Level of NH3 at different sampling locations of Lohalia River in 2011.**

| Sampling Locations of Lohal ia River | $NH_3$ (mg/l) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Lanch Ghat (Side), | 1.0 | - | - | - | - | - | - | - | 1.6 | - | - | 0.51 |
| Lanch Ghat (Middle), | 0.61 | - | - | - | - | - | - | - | 0.78 | - | - | 0.39 |
| EQS for wastewater after treatment from industrial units 0.5 mg/l | | | | | | | | | | | | |

$NH_3$ level of the Lohalia river varied from 0.39 to 1.6 mg/l (Table-36) while standard limit for inland surface water is 0.5 mg/l.

### 4.26 Surma river

The Surma river is a part of the Surma-Meghna river System. The average depth of river is 86 m and maximum depth is 170 m. For monitoring purpose samples were collected from six different locations of the river namely Mehendipaka Bridge, Knee Bridge, Kazi bazaar, Chattak, Shajalal Bridge and Shak Ghat. In October water sample was not collected.

In 2011, pH level of the Surma river varied from 7.3 to 7.9 (Fig. 27a). In 2012, pH level varied from 6.5 to 7.79. In 2011, DO content of Surma river water was mostly above the EQS (≥5 mg/l) for fisheries except July at Chattak point. It varied from 6.3 to 7.9 mg/l (Fig. 27b). In 2012, DO level varied from 4.2 to 6.8 mg/l. BOD value was also within the EQS at all locations. The maximum and the minimum BOD was 1.0 and 1.9 mg/l respectively (Fig. 27c). In 2012, BOD level varied from 1.0 to 1.3 mg/l. TDS level was varied from 60 to 880 mg/l (Fig. 27d) where EQS for TDS is 2100 mg/l for wastewater from industrial units after treatment. In 2012, TDS level was varied from 57.5 to 750 mg/l.

Chloride content of Surma river water was within the EQS (600 mg/l) for wastewater after treatment from industrial units. It varied from 70 to 280 mg/l (Fig. 27e). In 2012, Chloride level varied from 70 to 220 mg/l. SS level of Surma river was within the EQS the limit for treated wastewater from industrial units. It varied from 70 to 140 mg/l (Fig. 27f). In 2012, SS level varied from 100 to 120 mg/l.



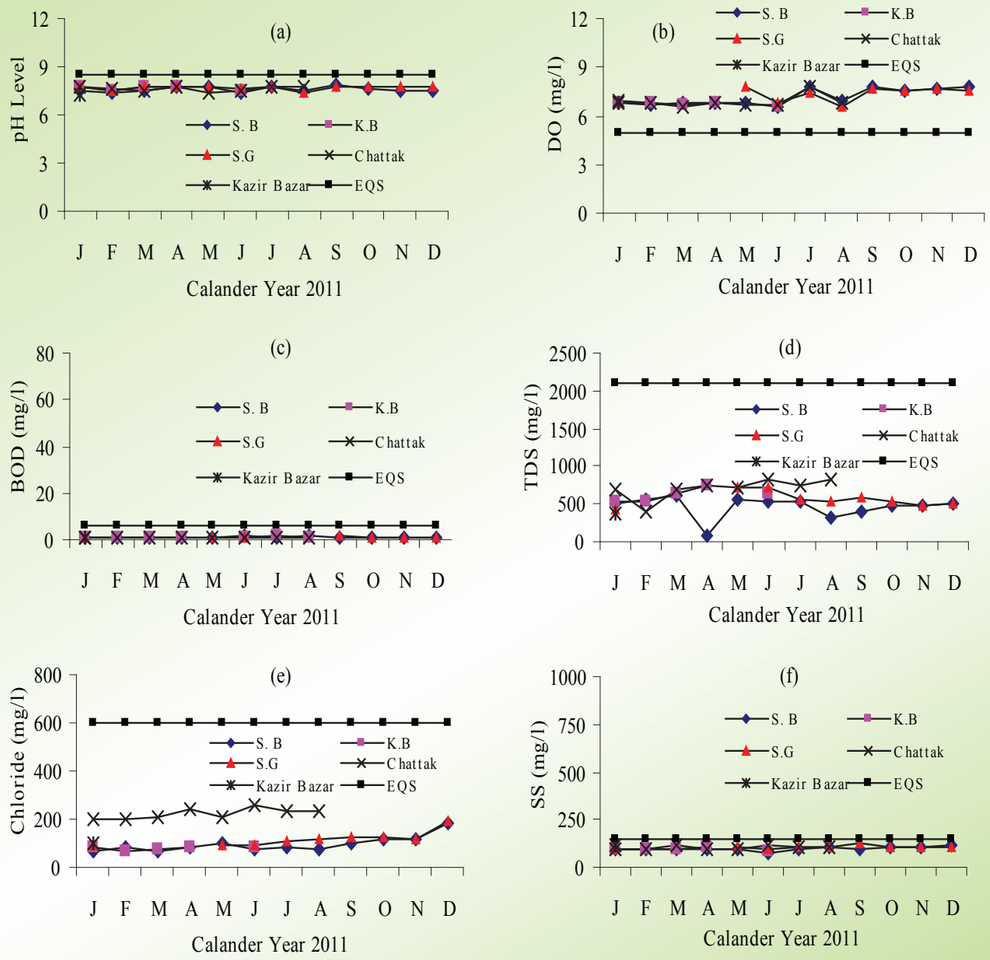



**Fig.26. Graphical presentation of pH, DO, BOD, TDS, Chloride and SS of Surma River in 2011**

Note : S.B = Shajalal Bridge, K.B = Keen Bridge, S.G = Shak Ghat

**Table-37. Level of E.C at different sampling locations of Surma River in 2011.**

| Sampling Locations of Surma River | E.C (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Shajalal Bridge (Left) | 220 | 190 | 200 | 250 | 295 | 240 | 270 | 250 | 310 | 350 | 400 | 560 |
| Shajalal Bridge (Middle) | - | - | - | - | 290 | 250 | 280 | 250 | 320 | 348 | 390 | 580 |
| Shajalal Bridge (Right) | - | - | - | - | 290 | 260 | 280 | 260 | 300 | 350 | 410 | 550 |
| Keen Bridge (Left) | 230 | 180 | 220 | 260 | - | 260 | - | - | - | - | - | - |
| Keen Bridge (Middle) | - | - | - | - | - | 250 | - | - | - | - | - | - |
| Keen Bridge (Right) | - | - | - | - | - | 240 | - | - | - | - | - | - |
| Shak Ghat (Left) | 280 | - | - | - | 280 | 280 | 320 | 340 | 410 | 362 | 395 | 570 |
| Shak Ghat (Middle) | - | - | - | - | 290 | 280 | 320 | 340 | 420 | 358 | 390 | 590 |
| Shak Ghat (Right) | - | - | - | - | 290 | 300 | 300 | 350 | 400 | 360 | 380 | 580 |
| Chattak (Left) | 620 | 620 | 620 | 700 | 630 | 750 | 720 | 740 | - | - | - | - |
| Chattak (Middle) | - | - | - | - | 620 | 760 | 710 | 740 | - | - | - | - |
| Chattak (Right ) | - | - | - | - | 600 | 780 | 700 | 750 | - | - | - | - |
| Kazir Bazar | 300 | - | - | - | - | - | - | - | - | - | - | - |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

EC level of Surma River was within the EQS limit for wastewater after treatment from industrial units. It varied from 180 to 780 µmhoms/cm (Table-37).

### 4.27 Kushiara river

Kushiara river is one of the Trans-boundary rivers of Bangladesh. The total length of the Kushiara is about 161 km. The average width of the river is 250m and in the rainy season the mean depth of the Kushiyara reaches upto 10m (Ahmed, 2006). Water samples were collected from two locations (e.g. Jokigonj and Fenchugonj Fertilizer Industry) of the river in 2011 for analysis water quality. Samples were collected first seven months of 2011.

In 2011, pH level of Kushiara river was within the EQS (6.5-8.5) for inland surface water. It varied from 7.4 to 7.8 (Fig. 28a). In 2012, pH level varied from 7 to 7.9. DO was above the EQS (≥5 mg/l) for fisheries and varied from 6.7 to 7.7 mg/l (Fig. 28b). In 2012, DO level varied from 4.2 to 6.8 mg/l. BOD level was from 1.0 to 1.4 mg/l (Fig 28c) while EQS for fisheries is ≤6 mg/l. In 2012, BOD level varied from 1 to 1.3 mg/l. TDS level of Kushiara river water was below the EQS for treated wastewater from industrial unit and varied from 400 to 900 mg/l (Fig. 28d). In 2012, TDS level varied from 41.6 to 720 mg/l. SS level of was within the EQS limit for treated wastewater from industrial units. It varied from 80 to 120 mg/l (Fig. 28e). In 2012, SS level varied from 100 to 120 mg/l. Chloride was also within the EQS (120-390 mg/l) limit for drinking water. The maximum Chloride (290 mg/l) was found at Jokigonj in January and the minimum concentration (120 mg/l) was in July at Fenchugonj (Fig. 28f). In 2012, Chloride concentration varied from 70 to 290 mg/l.



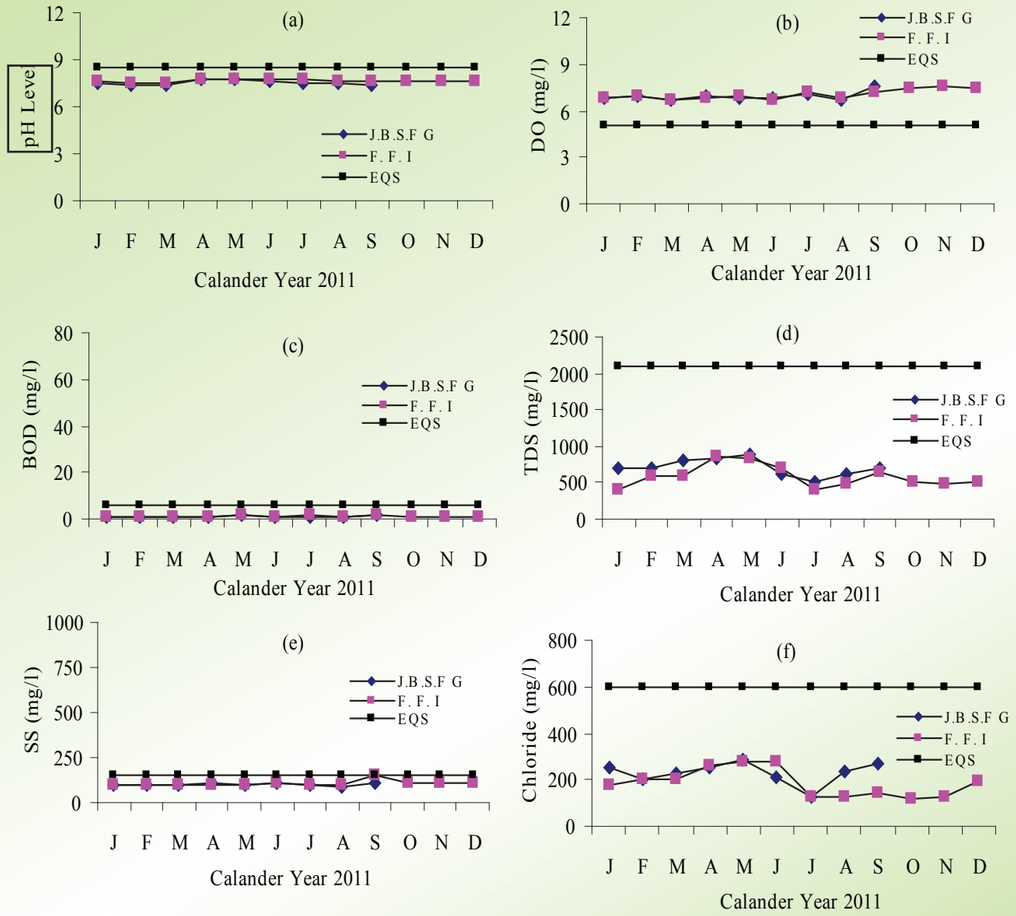



**Fig 27. Graphical presentation of pH, DO, BOD, TDS, SS and Chloride of Kushiara River in 2011**

**Table-38. Level of EC at different sampling locations of Kushiara River in 2011.**

| Sampling locations of Kushiara River | EC (µmhoms/cm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Jokigong B.S.F Ghat(Right) | 750 | 600 | 700 | 800 | 850 | 600 | 520 | 700 | 800 | - | - | - |
| Jokigong B.S.F Ghat(Mid) | - | - | - | - | 850 | 620 | 530 | 720 | 800 | - | - | - |
| Jokigong B.S.F Ghat(Left) | - | - | - | - | 840 | 630 | 520 | 720 | 810 | | | |
| Fenchugonj Fertilizer (Right | 530 | 600 | 600 | 800 | 840 | 800 | 400 | 400 | 140 | 352 | 420 | 590 |
| Fenchugonj Fertilizer (Mid) | - | - | - | - | 840 | 800 | 410 | 410 | 145 | 362 | 422 | 600 |
| Fenchugonj Fertilizer (Left) | - | - | - | - | 830 | 820 | 420 | 410 | 140 | 358 | 410 | 600 |
| EQS for wastewater after treatment from industrial units 1200 µmhoms/cm | | | | | | | | | | | | |

# CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

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

## 5.2 Recommendations

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

- Judicious selection of sampling locations.
- Collection of water samples must be in a consistent way and on regular basis for assessment of water quality.
- Increase skilled manpower at all level of water quality analysis including sample collection.
- Microbial test (Fecal Coliform, E-Coli etc) of river water is essential to evaluate water quality of rivers.
- Use Global Positioning System (GPS) to represent monitoring results in global context.
- Establish Water Quality Index (WQI) to assess water quality.
- Establish standard limit of Fecal Coliform, Temperature, Total Phosphate, Nitrates, Turbidity, SS, COD, TDS, EC, Total Alkalinity and Total Solids for inland surface water.
- Need to develop sampling protocol.
- Undertake capacity building programme of the laboratory (both human and logistics capacity).
- Review redesign current surface water monitoring network of surface water
- Need to collect supporting weather information while sampling.
- Need to collect data on river flow.
- Strengthening regional cooperation for the sustainable management of trans-boundary rivers, Integrated Watershed Management (IWM) approach can be implemented in this regard.



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