# ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF BURIGANGA AND TURAG RIVER WATER

**BY**


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**DEPARTMENT OF AGRICULTURAL CHEMISTRY**

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# CERTIFICATE

This is to certify that the thesis entitled, **"ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF BURIGANGA AND TURAG RIVER WATER"** submitted to the Department of **Agricultural Chemistry**, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURAL CHEMISTRY,** embodies the result of a piece of bona fide research work carried out by **AMIT BAGCHI** bearing **Registration No. 10-03783** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

**Dated: 27.08.2017**
**Place: Dhaka, Bangladesh**

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**ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF BURIGANGA AND TURAG RIVER WATER**

**By**

**AMIT BAGCHI**

## ABSTRACT

This investigation was conducted to assess the physico-chemical properties of different point of Buriganga and Turag Rivers for agricultural purpose. Total twenty samples were collected from each of the rivers to analyze some physico-chemical properties which are available within the research facility of the department of Agricultural Chemistry in Sher-e-Bangla Agricultural University. The analytical parameters were -Color, Odor, pH, Total Dissolved Solids (TDS), Salinity, Sodium (Na), Potassium (K), Calcium (Ca), Carbonate ($CO_3$) and Bicarbonate ($HCO_3$). The obtained results of the present study shows that most of the parameters were not exceed the maximum permissible limit for irrigation, livestock and aquaculture except Bicarbonate in both rivers. Bicarbonate was found the ranges of 31 to 91.5 mg/L, whereas the standard limit of Bicarbonate is 1.50 mg/L for irrigation. From the statistical point of view, though there were some parameters showed the positive correlation but most of the parameters were negatively correlated with other parameters. From the findings, we may conclude that the quality of rivers water was not so serious problematic for agriculture.

## Some commonly used Abbreviations

| Full word | Abbreviations |
|---|---|
| Calcium | Ca |
| Potassium | K |
| Phosphorus | P |
| Boron | B |
| Carbonate | $CO_3$ |
| Bi-Carbonate | $HCO_3$ |
| Total Dissolved Soilds | TDS |
| Total Solids | TS |
| Total Suspended Solids | TSS |
| Total Hardness | TH |
| Dissolved Oxygen | DO |
| Carbon Dioxide | $CO_2$ |
| Sulfer Dioxide | $SO_2$ |
| Sulphate | $SO_4$ |
| Carbon Monoxide | CO |
| Electrical Conductivity | EC |
| Diological Oxygen Demand | BOD |
| Chemical Oxygen Demand | COD |
| Water Quality Index | WQI |
| And Others | *et al.* |
| World Health Organization | WHO |
| Asian Development Board | ADB |
| United Nations Development Programme Financial Initiative | UNEPFI |
| Water Quality Management | WQM |
| Pakistan Standard Quality Control Authority | PSQCA |
| Factor Analysis | FA |
| Cluster Analysis | CA |
| Discriminant Analysis | DA |
| Geographic Information System | GIS |

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# CHAPTER I

# INTRODUCTION

Water is undoubtedly the most precious natural resource that exists in our universe. It is the most valuable and vital resource for the sustenance of life and also for any developmental activities (Kumar *et al*., 2011). Bangladesh is a low lying flat country with big inland water bodies, including some of the biggest rivers in the world and is extremely vulnerable because of its geographical characteristics (Matin and Kamal, 2010). Besides, the increasing urbanization and industrialization of Bangladesh have negative implications for water quality where the industrial effluents directly discharge into the rivers without any consideration of the environmental effects. Surface water of Bangladesh is polluted in various ways such as; industrial wastes, agricultural inputs including fertilizers and pesticides, sewage slugs and domestic wastes etc. (De, 2005; Dara, 2002). This polluted water cannot be used for drinking, domestic and agricultural purposes because it has inherent health risk (Goel, 2006).

The water is a scarce resource that requires utmost protection. It is estimated that 40 % of the world population will live in water scarce regions by the year 2025 (UNEP, 2004). Rapid population growth, urbanization, consumption and the desire for better living has placed great strain on fresh drinking water supply, especially in urban centres, with attendant health and environmental issues (Pruss-Ustun and Corvalan, 2006). The water quality monitoring is essential to determine the physical, chemical and biological characteristics of water. These characteristics provide basis as to how and for what water can be used and the species and ecosystem processes it can support.

Monitoring is also the foundation on which water quality management is based. It provides the information that permits the rational decision to be made on describing water resources, identifying actual and emerging problems of water pollution, use and abstraction of water, and land use; formulating plans; and in evaluating the effectiveness of management actions (UNEP/WHO, 1996).

Dhaka is one of the most densely populated cities in the world which is surrounded by number of rivers such as; the Buriganga, Turag, Shitalakhya, Balu, Bongshi, Karnatali etc. (GOB, 1997). Unfortunately, most of them are biologically dead or about to die (Karn and Harada, 2001; Bangladesh River System, 2004). Huge quantities of industrial effluents, solid waste from river-side settlements, petroleum products from ships, launches, cargoes, boats, untreated sewage etc. regularly get dumped into these rivers (Khan *et al*., 2007). The major polluting industries are tanneries, textiles, dying, pulp and paper and steel re-rolling mills, which are located besides the Buriganga, Turag and Shitalakhya rivers. These industries are discharging heavy metals like; Fe, Zn, Pb, Al, Co, Mo, Cd, Ni, Cr, As and Hg and some acids and solvents like; sulfuric acid, hydrochloric acid, Carboxilic acids, Phenol, Organic acids etc. (Ahmed and Reazuddin, 2000).

Buriganga river is one of the most important rivers in the country in respect to irrigation, fisheries, transportation, recreational uses and so on. The water of Buriganga river is undergoing continuous changes in terms of quality. The degradation of water quality of Buriganga has aggravated at an alarming rate as a result of increasing industrialization, urbanization and development activities. Buriganga river receives millions of litter of sewage, domestic waste, industrial and agricultural effluents.

The Buriganga river is choked with industrial effluent and untreated sewage through numerous outfalls. Thousands of industrial units and sewerage lines dumping huge volumes of toxic wastes into Buriganga river increasingly polluting the water (Islam *et al.*, 2006). These changes in water quality by industrial effluents, agricultural pollution and human waste are creating the environment unfavorable for aquatic lives. The pollution decreases the water quality of Buriganga that may cause harm to the aquatic lives as well as agricultural and domestic uses.

The Turag River is the upper tributary of the Buriganga, a major river in Bangladesh. Both organic and inorganic waste effluents that are discharged into the Turag River water adversely interacting with the river system and deteriorating the water quality of the river. For this reason, water causes the adverse effect of surrounding land and aquatic ecosystem as well as subsequent impact on the livelihood of the local community (Meghla *et al.*, 2013; Rahman *et al.,* 2012). The major pollution sources of Turag River water are various consumer goods industries (soap and detergent), garments industries, pharmaceuticals industries, dyeing industries, aluminum industries, battery manufacturing, match industries, ink manufacturing industries, textile, paint, iron industries, pulp and paper factories, chemical factories, frozen food factories and steel workshop etc. (Rahman *et al.*, 2012).

Turag River has been declared as ecologically critical areas (ECA) by the Department of Environment. Study on Turag River water quality was carried out in different time by Department of Environment (DoE, 2001). But the various industries besides the Turag River are continuously discharging their effluents and waste water into the Turag River and seriously polluting the river water. As a result, the values of different physicochemical parameters are continuously changing at an alarming rate in this river water.

To assess whether the water body is fit for various human activities and could support aquatic species and ecosystem processes, various physical, chemical and microbiological parameters are determined through laboratory analyses. With hundreds of parameters available to assess the water quality, the challenge remains on providing a single statement that would sum up several water quality parameters into one holistic description. Like any other environmental monitoring program, there is a problem on the reporting of water quality monitoring results to both managers and the general public because of the complexity associated with analyzing a large number of measured variables.

The present research work was conducted for the assessments of Physico-Chemical properties of waters in Buriganga and Turag rivers of Bangladesh with the following objectives –

1. To assess the concentration of different water quality parameters of Buriganga and Turag Rivers.
2. To explore the Buriganga and Turag Rivers water quality for agriculture.

# CHAPTER II

# REVIEW AND LITERATURE

Sikder *et al.* (2016) carried out to investigate the air, water and sediment quality which are degraded due to pollution load at Turag River. Gastec technique (Japanese origin) is used to determine the CO, $CO_2$, $NO_x$ and $SO_2$ concentration and the concentration range for CO: 2425-7635 μg/m 3, 82-652 μg/m 3 for $NO_x$, 151.93-553.56 μg/m 3 for $PM_{10}$ and 395-510 μg/m 3 for CO2. Air temperature, Water temperature, $p^H$, EC, Chloride, Turbidity, TS, TDS, DO, $BOD_5$, and COD concentration in water samples were found to range from 26-36°c, 29-34°c, 7.5-7.9, 1850-1900(μScm-1), 32-42(mg/L), 13.5-14.4cm, 902-970(mg/L), 810-850(mg/L), 0-0(mg/L), 21-24(mg/L), 106-141(mg/L).

Flura *et al.* (2016) conducted a research to assess the physico-chemical and biological parameters of Meghna Rivers water in three spots during the period of January, 2014 to December, 2014.Nineteen (ten were physical and nine were chemical) physico-chemical parameters of water *viz* Waterdepth, Water temperature, Air temperature, Water colour, Odour of water, Bottom type, Transparency,Conductivity, Turbidity, Total Dissolve Solids (TDS), Dissolve Oxygen (DO), Free carbon dioxide, pH, $NH_3$, Total alkalinity, Total hardness, Biological Oxygen Demand (BOD), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), plankton community of both phytoplankton and Zooplankton were studied in aforesaid sampling spots of Meghna river. Maximum water depth was recorded from Meghna ghat area. Among these sampling spots highest transparency was recorded from Bhairab region. Dissolve oxygen concentration was found highest 7.5 mg/L in Chandpur. Free carbon dioxide was found maximum in Meghna ghat area 3.7 mg/L.

Nahar *et al.* (2016) conducted a research to assess the physic chemical properties of the water from the Gorai river in Kushtia, Bangladesh. To conduct this research, six samples from six points were collected from surface water of this river that covered only the Kushtia town. Samples were collected from Charulia, Barokhada, Jugia, Kamlapur, Thanapara and Ghoshpara at 1km interval. Another three samples were collected from Jagati sugar mill area and two domestic effluents those were discharged to the main river flow to evaluate the impact of these effluents on the river water quality. Different water quality parameters such as temperature, pH, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Alkalinity, Hardness, Sodium, Potassium, Phosphate, Sulphate, Chloride, were examined. From this study it was observed that most of the parameters exceeded the permissible limits.

Bhasin *et al.* (2016) studied for the assessment of water quality of Kshipra river by use of control chart, water quality index (WQI), physic chemical and microbiological analysis. Samples were collected from five sites of the river for a period of one year. The main purpose of the study is to provide a baseline data regarding pollution control, management and improvement of water quality of this river before Mahakumbh 2016. Analysis of various parameters like dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand (BOD), total coliform (TC), fecal coliform (FC), turbidity, transparency, total alkalinity, total hardness, chloride, calcium was performed. WQI values ranged from 284.0-1112.34 and shows all study site to be under pollution stress. Results of the present investigation showed that water quality of the river is more deteriorated during summer followed by monsoon and winter season. The sample mean values in control chart cross lower and upper limits consistently in all seasons and at all study site, indicating very poor water quality. Higher pollution load was observed in Ramghat followed by Managalnath, Triveni, Mahidpur and Kshipra village study sites. According to CPCB water of Kshipra river is found to be of D class and river is observed to be under great pollution stress. Immediate remedial measures are recommended to control pollution and improve water quality of the river which is important for proper management and conservation of this holy river.

Narayane *et al.* (2016) described the Increasing population demands more water for consumption due to industrialization, urbanization, agricultural activities, change in lifestyle, etc. which produces more waste water. Water is a finite resource on earth and fresh water is important for human existence. Due to contamination of fresh water we are leading towards water scarcity. Now-a-days water quality is a global issue and river Krishna is no escape to this. The physico-chemical parameters of Krishna river water at Wai Taluka were studied in November 2015-March 2016. For the study three samples were collected on different dates from Bhuinj in Wai taluka and parameters like pH, BOD, COD, DO, TDS, Hardness and Phosphates were determined in the laboratory. M.I.D.C, waste water from households, city sewage, bathing and washing at the ghats, human activities along the river length, agricultural activities, etc. are the sources of river water contamination in Wai taluka.

Karthick *et al.* (2015) presented the era brings more threat to the environment. The scenario of the environmental hazard majorly concerned with the water and waste water contamination. This paper deals with the cluster of literatures for the scrutiny of various physico chemical parameters of water and wastewater. From the suggestions and results of the authors the paper concludes that the contamination of water and wastewater was almost higher than permissible limits and the presence of heavy metal was also abundant.

Ogendi *et al. (*2015) conducted a study to assess the water quality parameters assessed were dissolved oxygen concentration, pH, conductivity, turbidity, chlorophyll-a, total and soluble phosphate and nitrate concentrations and coliform counts. Nutrient concentrations generally increased from the source of the Nyanchwa -Riana River towards the lower reaches of the river. Soluble nutrient concentrations exhibited the same trend. The total phosphorous to total nitrogen ratio of 1:3 varied from the Redfield ratio of 1:16 commonly found in natural habitats. Total coliform counts exceeded those recommended in the international water quality standards of less than 10 coliform cells/100ml of water. Observations on the physical and chemical parameters showed levels stressful to aquatic life, with dissolved oxygen concentrations less than 5 $mgL^{-1}$ in some sampling points.

Miah *et al.* (2015) analysed the water quality assessment of different sources (surface water and ground water) in the coastal belt region of Noakhali was conducted. Physical parameters of the supplied samples like Color, Odor, Temperature, and Taste were identified. Beside this pH, Conductivity, Total dissolved solid (TDS), Hardness, Alkalinity, Chloride, cations, Dissolved Oxygen were measured to understand the physicochemical parameters, salinity and the presence of toxic metal ions in water. pH values for surface water were 6.3-7.49 and those of ground water were 7.33-8.5; Total hardness for surface water was 70-132 ppm and ground water was 180-296 ppm as $CaCO_3$; Electrical conductivity (EC) for surface water was 576-1040μs and that of ground water was 5210-8170 μs. Ground water (deep) source contains highest level of Chloride and TDS which is 1683ppm and 1152ppm respectively. The alkalinity of the underground water was 2115 ppm & 518ppm which was higher than the surface water which was 68.5 ppm 112.5 respectively.

Singh (2014) stated to focus on the seasonal variations in the physico-chemical parameters of the river Gomti, district Lucknow. A total 8 parameters were analysed and their seasonal variation is discussed to assess the impact of effluents on water quality. Results of present study are indicative of deteriorating life sustaining quality of river water as well as its non suitability for domestic consumption. Possible effects of water quality on aquatic life as well as possible remedial measures have also been discussed.

Gulzar and Nanda (2015) studied to determine the physico-chemical properties (moisture content, reducing sugars, proline content, electrical conductivity, ash content, pH, titrable acidity, HMF, water activity, total soluble solids and total solids) of three different varieties of honeys from Kashmir valley of India (acacia honey, pine honeydew and multiflow oral honey). Of the honey samples analysed, only pine honeydew were grouped in dark category of honey (L*50) and possessed both red and yellow components. The concentrations of mineral content were found highest in pine honeydew followed by multi floral and least in acacia honey. All the physico-chemical properties and enzymatic activity indicated that all the three analysed varieties of honey met the criteria set by the International Honey Commission and revised codex standards for honey. The source of honey had a significant effect.

Muralidharan et al. (2015) revealed that pHvaluewas 8.5 while dissolved oxygen was 0.67 mg/l increased. Carbondioxide content, salinity, phosphate ,turbidity and total hardness level increased. Study showed that water was not found to be suitable for aquatic animals due to high salinity content in the water.

Tewari et al. (2014) investigated five sewage sampling sites were selected before they mixed with river water for analysis of physico- chemical properties like temperature, turbidity, conductivity, pH, total alkalinity, free carbon dioxide, total acidity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, total hardness, nitrate nitrogen, nitrite nitrogen and total phosphate. The average value of various parameters observed as temperature range 23.54 to 25°C and the pH value ranged between 7.72 to 7.78.The others physicochemical parameters namely turbidity 20-36.17 N.T.U., conductivity 0.64-1.08 mhos.$cm^{-1}$,total alkalinity 594.75- 969.41$mL^{-1}$,free CO 37.35-60.42$mL^{-1}$, total acidity42.45-64.91 $mL^{-1}$, dissolve oxygen 0.33-1.85 $mL^{-1}$, BOD 58.77- 112.42 $mL^{-1}$, COD 420.62-547.25 $mL^{-1}$, chloride 36.97-104.60 $mL^{-1}$, total hardness 259.43-384 $mL^{-1}$, nitrate nitrogen 0.111- 0.184 $mL^{-1}$,nitrite nitrogen 0.017-0.02 $mL^{-1}$,and total phosphate within 0.85-1.03 $mL^{-1}$ range.

Akter *et al.* (2014) evaluated the water quality in the aquatic body of Dhaka Export Processing Zone (DEPZ) area was studied on the basis of some physiochemical parameters and heavy metal concentrations. The range of pH for all of the samples was found from 7.1 to 8.17 and 120 to 450 mg/L for TDS. The Values of EC were found from 90 to 300 µs cm-1. For pH, EC and TDS, though the ranges were within the limits but there was an increasing trend of the values was observed in every case which is highly alarming. The range of COD values was estimated from 90 to 300 mg/L and in most of the samples the values exceeded the standard range. Stated environmental condition is highly vulnerable for human being, that's why this is the time to take proper steps for remediation and preventing the pollution around DEPZ water body which is directly related to the industrial emission of DEPZ.

Smitha *et al.* (2013) conducted a research on the banks of the river Kapila (Kabini) and water analysis carried out for the parameters like odor, turbidity, temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), chloride, total hardness, calcium hardness, magnesium hardness, nitrate and sulphate for testing the quality of water during the month of March, April and May. The results suggested that the level of organic load increased in the month of May, indicating pollution of the river.

Shanti *et al.* (2013) carried out to assess the physico-chemical parameters with reference to seasons in Irukkankudi Dam, Virudhunagar district, Tamil Nadu. The various water parameters such as temperature (TEM), Total dissolved solids (TDS), Electrical conductivity (EC) and chemical parameters such as pH, Alkalinity and total hardness (TH) were carried out. In addition, the ions such as, sodium (Na), potassium (k), iron (Fe), magnisium (Mg), nitrate and nitrite were also analysed. From this we understand that the condition of this dam showed fluctuation in water qualities

Kotadiya *et al.* (2013) ascertained the "Water Quality Index" (WQI) of a Ghuma Lake, supplying fresh water in a rural area of Ghuma village in Ahmadabad district. The WQI was determined by studying 12 physicochemical characteristics like pH, electrical conductivity, hardness, D.O, BOD, TDS, alkalinity, Mg hardness, Ca hardness, Nitrate, Sulphate and Chloride. The water samples were collected every morning at an interval of 30 days. It was observed that the water from the lake is not suitable for drinking. As a result of saturation of water by evaporation, it was observed that the pollution levels were higher in summer than in the winter and rainy seasons.

Sowmyashree *et al.* (2013) carried out a study near the origin of Tungabhadra River in the Western Ghats of India. The objective was to review the pollution levels with special reference to seasonal variations in the physiochemical properties of the river waters. The period covered was 12 months commencing from December 2009. Physiochemical parameters like temperature, conductivity, dissolved solids, pH, Hardness, D.O, total alkalinity, chlorides, Ca & Mn showed seasonal variations due to local climatic conditions. Analysis of the physiochemical parameters, for the area which was selected for the collection of sample, revealed low levels of concentration of the parameters amalysed. These were within the permissible limits set by various agencies such as WHO and the water was 'safe' for drinking purposes.

Rahman *et al.* (2012) assessed the degree of pollution of Turag river water by determining various physico-chemical parameters. Water samples were collected six times per year during wet and dry season at the following three locations: Tongi Railway Bridge, Bishwa Ijtema field and Ashulia. Most of the measured physicochemical parameters exceeded permissible limit of drinking water. The recorded pH ranged from 6.6 to 7.98 and Electrical Conductivity (EC) from 160 to 1107 μs/cm. The recorded dissolve oxygen (DO) varied from 0.11 to 6.8 mg/L and biological oxygen demand (BOD) ranged from 10 to 180 mg/L while chemical oxygen demand ranged from 21 to 220 mg/L and free CO2 value from 5 to 22 mg/L. Due to the increased values of the parameters pH, DO, BOD, COD and free CO2 water from these locations was not suitable for human consumption without appropriate treatment.

Aggarwal *et al.* (2012) studied in the Kaushalya River in Parwanoo. The study includes an analysis of two types of parameters, viz. physicochemical and bacteriological. For this purpose, two sites were selected near the origin of the River and two sites were selected near the end point of the river. The process of sample collection was conducted in four specific months of 2011, namely, January, April, July and October. It was observed that except for some parameters, all others were within the permissible limits prescribed by various “Authorities”. However, it was concluded that water was unsafe for domestic use unless purified, since major physicochemical parameters like COD, alkalinity, hardness and major bacteriological parameters - total coliform and fecal coliform were in excess of the limits. The existence of a water treatment Plant at Kamli became necessary to purify the waters before consumption.

Ombaka *et al.* (2012) conducted a study on the “Irigu” River in the Meru province of the Southern part of Kenya. In order assess the quality of the River “Irigu” both physicochemical and bacteriological parameters were evaluated. The sample collection and analysis was done both in the summer and rainy season. Certain parameters like pH, turbidity, NH3 were high during the dry seasons due to anaerobic decomposition of organic matter. The phosphorous levels were beyond the limit which was likely to trigger periodic bloom and eutrophication. It was therefore concluded that the river waters could not be used for drinking and other allied domestic purposes

Hema *et al.* (2012) performed evaluation of surface water quality using multivariate statistical studies of the Cauvery River in Erode district, Tamil Nadu. The river carries the effluents of a large number of tanneries and textile industries established in this region. In order to draw samples for examination, 50 locations were selected along the course of the river. Multivariate statistical methods like FA, CA, PCA and data interpretation were used to identify low, moderate and high pollutant groups.

Jeena *et al.* (2012) studied the impact of municipal sewage of the Cauvery River in Tiruchirapalli city, Tamil Nadu. Various parameters like pH, Electrical Conductivity, COD, BOD etc. were considered and it was observed that the Uyyakodan canal, which is a tributary of the Cauvery River, was more polluted than the river itself. The reason for this was stated as the dumping of domestic waste and municipal sewage into the canal as it passes through the city.

Khan *et al.* (2012) revealed the physiochemical properties of Jhelum River, Kashmir to find out the variation in properties due to the location of sites from where the water samples are drawn. Variation in the parameters with the change in geographical location of the sample site and season were observed. In some cases, some parameters have crossed the maximum permissible limits set by World Health Organization (WHO). The author's review indicated degradation in the quality of water and threat to all kinds of life.

Jindal *et al.* (2011) performed a study of physicochemical parameters of Sutlej River around Ludhiana. For the purpose, water samples were taken from three locations along the course of the river. A period of 12 months from November 2006 was considered for this purpose. The concentration levels of some of the physicochemical parameters were assessed. In addition some heavy metal levels were also reviewed. The water was found to be unacceptable for drinking at two out of the three sites.

Shankar *et al.* (2011) investigated a reports the results of a monitoring study focusing on groundwater quality of Paravanar River Sub-basin, Cuddalore District of Tamil nadu. Since, remediation of groundwater is very difficult, knowledge of the existing nature, magnitude, and sources of the various pollution loads is a prerequisite to assessing groundwater quality. Thirty five ground water samples were collected randomly from Bore wells and analyzed for various chemical parameters. Geologically, the study area comprises Quaternary alluvium made up of an alternating succession of clay, silt and sandstone deposits. An attempt has been made to study on the quality of ground water for the Villages falling in the Paravanar Sub Basin to interpolate major ions concentration in groundwater. Highest concentration of hardness in groundwater is observed in Kulakudi. Abundance of $CaCO_3$ hardness may be attributed due to dissolution of aragonite bearing minerals by the way of pedological differenceaction in the preceding sedimentary cycle of deposition. Maximum concentration of $NO_3$ above 100 ppm which is more than European drinking water standard is found to occur in SE and E part of the study area which comprises of recent alluvium.

Venkatesharaju *et al.* (2010) observed a physicochemical and bacteriological investigation on Cauvery River, Karnataka. The study was conducted during a period of 3 years from 2006 to 2008. The objective of the study was to investigate into both physicochemical and bacteriological parameters. Six sampling stations were selected along the Kollegal region of the river to draw appropriate samples. The samples were anlaysed for nineteen physicochemical and two bacteriological parameters. It was found based on the physicochemical parameters that the river is not polluted and all the parameters are within the permissible limits specified by the “Bureau of Indian Standards”. The high values bacteriological parameter however means that the water is not safe for drinking.

Verma *et al.* (2010) reported a study on the “Kalpi River” at Gwalior in Madhya Pradesh. The objective was to investigate into water quality of the river. They reported the values of various pollution parameters such as transparency, electrical conductivity, BOD, COD etc. at six different locations. It was concluded that to achieve a reduction in the level of pollution, it was essential to have an organsised approach to the problem of “Water Quality Management” incorporating both aspects of quality and adequacy.

Shankar *et al.* (2010) carried out a study in Nagpur Municipality region. The main objectives of this work were to evaluate the quality of water in lakes, well, bore wells etc. The geochemical effect on the physiochemical properties of water was reviewed. Various factors such as the presence of fluorides, chlorides, the pH of water, EC, D.O were analysed. The analysis of different samples revealed that though the lake water was suitable for drinking, the well/bore well water was not of an adequate quality for human consumption.

Joseph *et al.* (2010) reviewed an analysis of the physicochemical characteristic of Pennar River water in Kerela. The physical characterics of water, such as, colour, odor, temperature ane EC were considered. Addtionally, the purity of water was assessed by reviewing total suspended solids (TSS), total dissolved substances (TDS) and Total Solids(TS) in water samples taken. The  physicochemical parameters, such as, turbidity, pH, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, salinity, fluoride, phosphate and nitrate were also studied. For the purpose of analysis, samples were extracted from 4 different locations in all seasons of the year, viz. rainy, winter and summer. The results indicated that the river is highly polluted and the water is unsuitable for drinking.

Ullah *et al.* (2009) studied on Assessment of groundwater contamination in an industrial city, Sialkot, Pakistan. This study had been designed to assess the groundwater quality in relation with heavy metal pollution and its implication to human health. The groundwater water samples were collected from 25 localities during October-November 2005in the industrial city of Pakistan. Nearly 22 physiochemical parameters including pH, Temperature, Electric Conductivity (EC), Salinity, Total Dissolved Solids (TDS), Turbidity, Chloride (Cl), Sulfate ($SO_4$), Total Hardness, Alkalinity were recorded. These results were compared with standard guidelines from WHO and Pakistan Standard Quality Control Authority (PSQCA) for groundwater quality. The Cluster Analysis (CA) were used, it grouped all sites into four zones based on their spatial similarities and dissimilarities of physiochemical properties. Zone 1 were highly contaminated with high level of turbidity, TDS, EC, $SO_4$, Cl, Zn, total hardiness, Pb and Fe concentrations were above the permissible levels of both WHO and PSQCA. in nineteen sampling sites Cr+6 was detected. Factor Analysis (FA) and Discriminant Analysis (DA) revealed significant variables including pH, EC, $SO_4$, $NO_3$, Cl, TDS, Total Hardness, Fluoride, Iodide, Total Chlorine, alkalinity, Pb, Fe and Mn which were responsible for variations in the quality of groundwater and affect water chemistry. The results proved that the groundwater of the study area cannot be as considered good quality as it is highly turbid (57% of total sites). Using Geographic Information System (GIS) the spatial distribution maps of water quality parameters were produced.

Adeyemo *et al.* (2008) evaluated a review of certain geographic parameters to determine the pollution levels of the rivers in Ibadan, in Nigeria. To achieve this, the process of sample collection was done at different points, throughout the length of the rivers, from its origin to its destination, in all the major regions of Ibadan. The period covered was from October 2003 to March 2004 and again from August 2004 to September 2004. The parameters that were assessed were D.O, BOD, pH, chlorides, nitrates and phosphates. Varying levels of pollution from unpolluted to exceptionally-polluted levels was observed during the different seasons, posing a threat to the fish health and biodiversity.

Hema and Suneel (2008) carried out a study in the River of 'Tamiraparni River' which flows throughout the year. The objective was to analyse the pollution levels. The study was with special reference to discharges of sewage water and the presence of Coliform Bacteria in the river water. There were many industrial units on both the banks of the river, which discharged industrial wastes, thereby affecting the quality of the river water. Examination of the samples collected, revealed that the existence of Coliform Bacteria in river water was maximum in December – post monsoon, while it was minimum in May –ie. Pre monsoon.

Begum and Harikrishna (2008) carried out from four streams designated as station 1 (upstream of effluent discharge point), station 2 (effluent discharge point) and station 3 (downstream of effluent discharge) station 4 (fresh water stream) to assess the impact of effluent on the water quality. The river water composition is increasingly dominated by Na and Cl in the downstream region of the river, indicating the influence of airborne salts with oceanic affinities. Significant spatial variation was observed in water level, transparency, turbidity, depth, dissolved oxygen, colour, biochemical oxygen demand, nitrate, nitrite and total hydrocarbon among the physiochemical parameters of the study stations. *A posteriori* test revealed that station 2 & 3 were the cause of the significant difference. The dissolved oxygen level in stations 2 & 3 was lower than 5.0mg/L, which is recommended minimum allowable limit for aquatic life. About 7 rotifer species in large amount recorded in this study were encountered in station 1, 7 in station 2 & 3 while 12 species in station 4. The overall density of rotifers in the four stations was significantly different. *A posteriori* comparison revealed that station 2 & 3 are the cause of the significant difference. The Branchionus angularis rotifers, which dominated the community, were found to tolerate the effluent effect in station 2&3, and showed remarkable recovery in the downstream station 4. Low faunal diversity and negative impact on the biotic and abiotic environment was experienced in station 2 & 3 throughout the duration of sampling because of the brewery effluent discharged directly into these two Streams.

Geetha *et al.* (2008) performed a research to assess the underground water contamination and the effect of textile effluents on Noyyal River basin in and around Tiruppur Town. Twenty six sampling locations were selected at random and the ground water samples were collected mostly from tube wells at Noyyal River basin in and around Tiruppur area. The samples were analyzed for major physical and chemical water quality parameters like pH, alkalinity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), Ca, Mg, Na, K, $Cl^-$ & $SO4^{2-}$. It was found that the underground water quality was contaminated at few sampling sites due to the industrial discharge of the effluents on to the river or land from the Tiruppur town. The sampling sites namely Orathupalayam, Karuvapalayam, Kulathupalayam, Uttukuli and Kodumanalpudur showed high deviations in total alkalinity, total hardness, Ca, Mg and chloride concentrations. Hence our study concludes that the underground water quality study in this region shows a constant variation in different parameters in different periods (before and after monsoon). So it is highly important to take periodical monitoring of the underground water quality in this region for our future sustainability.

Smitha *et al.* (2007) assessed the Physico-chemical characteristics of water samples of Bantwal Taluk, south-western Karnataka, India.This present study analyzed of water samples collected from different sources like open wells, bore wells, streams, rivers and farm ponds of 20 villages of Bantwal taluk of Dakshina Kannada district, SW Karnataka had been carried out. The physical and chemical characteristics of this water showed that it were suitable for agricultural and irrigational purposes.

# CHAPTER III

# MATERIALS AND METHODS

All natural waters contain various types of dissolved constituents as well as the heavy metals which are originated from the environment by spontaneous natural process and also from the waste product of human activities. The chemical analyses of freshwater samples include the measurement of pH, Total Dissolved Solids (TDS), Salinity, Sodium (Na), Potassium (K), Calcium (Ca), Carbonate ($CO_3$) and Bicarbonate ($HCO_3$).

## 3.1 Study area

The site of freshwater sampling from different sources of Buriganga and Turag have been shown in Figure 1. The detailed information regarding freshwater sampling has been reported in Table (1 & 2).

## 3.2 Collection of freshwater samples

The freshwater samples were collected to study the extent of physicochemical contamination of the Buriganga and Turag river of Dhaka. To obtain a general information regarding sampling, exactly 20 number of places/point were selected. Freshwater samples were collected randomly from selected rivers. In each river, 20 samples were collected from different point of Buriganga and Turag river.

| Table 1. Detailed information regarding freshwater sampling | | | | |
|---|---|---|---|---|
| **SL. No.** | **Sample Name** | **River Name** | **Location** | **Date** |
| 1. | $B_1$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 2. | $B_2$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 3. | $B_3$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 4. | $B_4$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 5. | $B_5$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 6. | $B_6$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 7. | $B_7$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 8. | $B_8$ | Buriganga | Below Aminbajar Bridge | 25.07.2016 |
| 9. | $B_9$ | Buriganga | Sadarghat | 27.07.2016 |
| 10. | $B_{10}$ | Buriganga | Sadarghat | 27.07.2016 |
| 11. | $B_{11}$ | Buriganga | Sadarghat | 27.07.2016 |
| 12. | $B_{12}$ | Buriganga | Sadarghat | 27.07.2016 |
| 13. | $B_{13}$ | Buriganga | Midfort Ghat | 29.07.2016 |
| 14. | $B_{14}$ | Buriganga | Midfort Ghat | 29.07.2016 |
| 15. | $B_{15}$ | Buriganga | Midfort Ghat | 29.07.2016 |
| 16. | $B_{16}$ | Buriganga | Midfort Ghat | 29.07.2016 |
| 17. | $B_{17}$ | Buriganga | Ginjira Ferri Ghat | 31.07.2016 |
| 18. | $B_{18}$ | Buriganga | Ginjira Ferri Ghat | 31.07.2016 |
| 19. | $B_{19}$ | Buriganga | Ginjira Ferri Ghat | 31.07.2016 |
| 20. | $B_{20}$ | Buriganga | Ginjira Ferri Ghat | 31.07.2016 |

| Table 2. Detailed information regarding freshwater sampling | | | | |
|---|---|---|---|---|
| **SL. No.** | **Sample Name** | **River Name** | **Location** | **Date** |
| 1. | $T_1$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 2. | $T_2$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 3. | $T_3$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 4. | $T_4$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 5. | $T_5$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 6. | $T_6$ | Turag | Below Abdullahpur Bridge | 05.08.2016 |
| 7. | $T_7$ | Turag | Near Ijtema Moidan | 07.08.2016 |
| 8. | $T_8$ | Turag | Near Ijtema Moidan | 07.08.2016 |
| 9. | $T_9$ | Turag | Near Ijtema Moidan | 07.08.2016 |
| 10. | $T_{10}$ | Turag | Near Ijtema Moidan | 07.08.2016 |
| 11. | $T_{11}$ | Turag | Near Ijtema Moidan | 07.08.2016 |
| 12. | $T_{12}$ | Turag | Boat Mooring | 09.08.2016 |
| 13. | $T_{13}$ | Turag | Boat Mooring | 09.08.2016 |
| 14. | $T_{14}$ | Turag | Boat Mooring | 09.08.2016 |
| 15. | $T_{15}$ | Turag | Boat Mooring | 09.08.2016 |
| 16. | $T_{16}$ | Turag | Boat Mooring | 09.08.2016 |
| 17. | $T_{17}$ | Turag | Coatbari Bazar Ghat | 11.08.2016 |
| 18. | $T_{18}$ | Turag | Coatbari Bazar Ghat | 11.08.2016 |
| 19. | $T_{19}$ | Turag | Coatbari Bazar Ghat | 11.08.2016 |
| 20. | $T_{20}$ | Turag | Coatbari Bazar Ghat | 11.08.2016 |

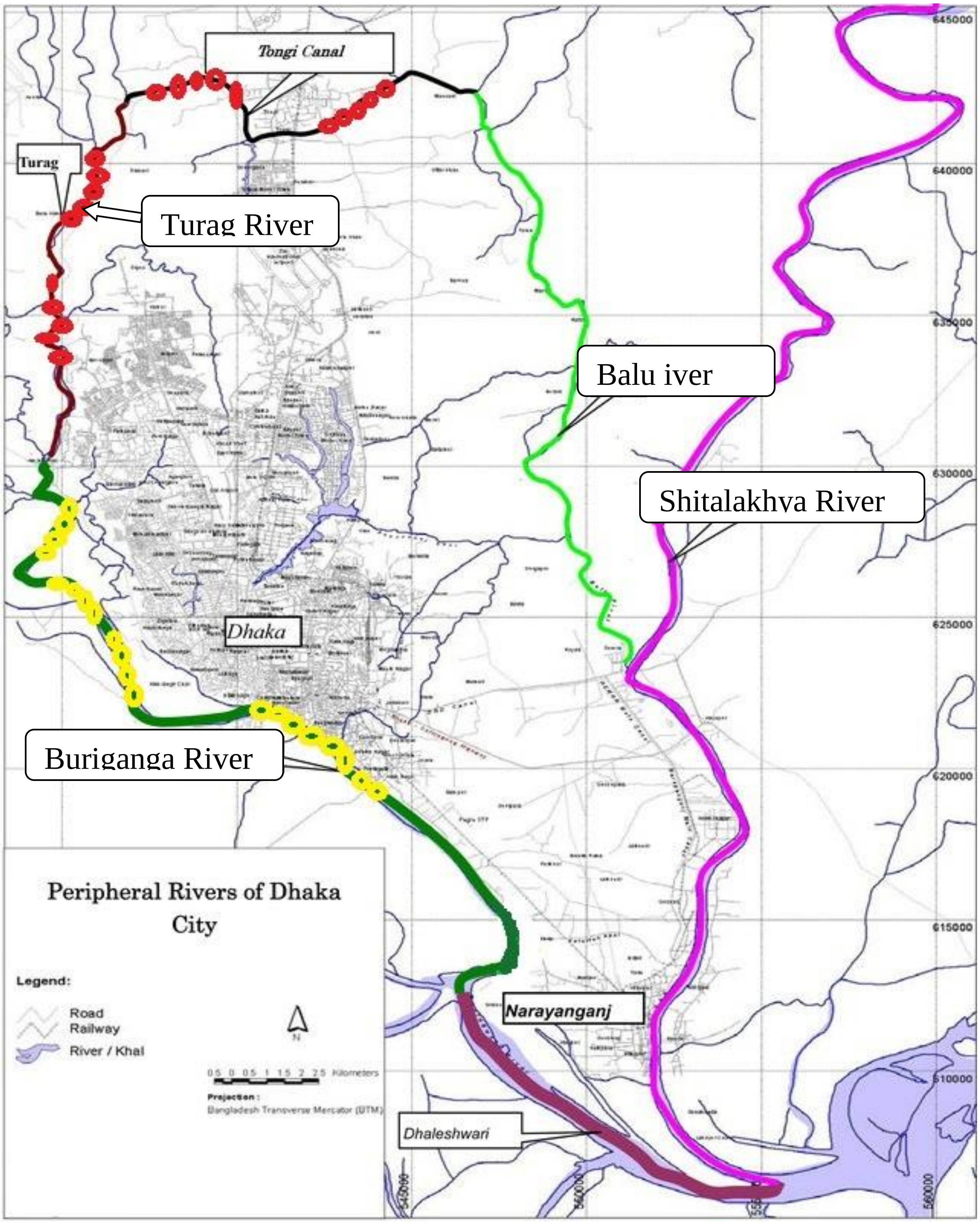


**Figure 1:** Four major rivers around Dhaka city and sampling points of the current study from the Buriganga and Turag River

## 3.4 Sample Preparation

The freshwater samples were collected in 500 mL previously cleaned plastic bottles. Before, water sampling, all bottles were rinsed again 3 to 4 times with water to be sampled. Freshwater samples were taken from the midstream and few centimeters below the surface. After collection of freshwater of samples, all bottles were sealed immediately to avoid exposure to air or any kinds of dust. The prepared water samples were carried to the departmental laboratory of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka. After bringing to the laboratory, all samples were kept in clean, cool and dry place. All samples were then filtered with filter paper (Whatman no.42) to remove the unwanted solid and suspended materials before analysis. The samples were analysed as quickly as possible on arrival at the laboratory.

## 3.5 Analytical methods of fresh water samples

The major chemical constituents or salient features of freshwaters related to water toxicity were considered for analysis as follows:

### 3.5.1 Physical characteristics

i. Color

ii. Odor

## 3.6 Chemical characteristics

i. pH

ii. Total Dissolved Solids (TDS)

iii. Salinity

## 3.7 Ionic Constituents

i. Sodium (Na)

ii. Potassium (K)

iii. Calcium (Ca)

iv. Carbonate ($CO_3$) and

v. Bicarbonate ($HCO_3$)

All chemical analyses were performed at the departmental Laboratory of Sher-e-Bangla Agricultural University, Dhaka-1207

**Physical characteristics**

**Color**

Color is a qualitative characteristic of waste water. With the help of its general condition, the waste water contamination can be assumed. If the color is dark grey or black, the waste water is typically septic, having undergone extensive bacterial decomposition under anaerobic conditions. The color of the sample was compared with the glass comparator and colorless distilled water.

**Odor**

The determination of odor has become increasingly important, as the odor may give a hint about the presence of various organic unwanted components in the waste water samples. Odor is measured by successive dilutions of the sample with odor-free water until the odor is no longer detectable.

**pH**

The pH is considered to be the most important wastewater parameter. The pH value of freshwater samples was determined electrometrically by taking 100 mL of sample in 200 mL beaker and immersing the electrode of the pH meter (Model senslON$^{PM}$ + PH1) into the water as stated by APHA (1995).

**Total Dissolved Solids (TDS)**

The suspended and dissolved solids in waste water are considered as total solids. Solids that are able to settle can be removed by sedimentation. The unit of solids that are able to settle is milligrams per liter (ppm). Usually, about 60% of the suspended solids in an industrial wastewater have solids that are able to settle. The TDS value of freshwater samples was determined electrometrically by taking 100 mL of sample in 200 mL beaker and immersing the electrode of Flame Photometer (Model Jenway PFP7).

**Calcium (Ca)**

Calcium (Ca) was determined from the fresh water separately with the help of Flame Photometer (Model: Jenway PFP7) using appropriate filters (Calcium filter). About 100mL of filtered sample was taken in a 250mL beaker and then aspirated in a natural gas flame of light emitted by Calcium which were directly proportional to the concentration of these ions present in water sample, respectively.

**Potassium (K) and Sodium (Na)**

Potassium (K) and Sodium (Na) were determined from the fresh water separately with the help of Flame Photometer (Model Jenway PFP7) using appropriate filters (Potassium filter and Sodium filter). About 100mL of filtered sample was taken in a 250 mL beaker and then aspirated in a natural gas flame of light emitted by sodium and potassium which were directly proportional to the concentration of these ions present in water sample, respectively.

### Carbonate ($CO_3$) and Bicarbonate ($HCO_3$)

Carbonate ($CO_3$) and Bicarbonate ($HCO_3$) contents of water samples were determined by acidimetric method of titration using phenolphathalein and methyl orange indicators (Tandon, 1995 and Singh *et al.*, 1999). Exactly 10 ml of water samples was taken in a porcelain dish by addition of 5 drops of phenolphthalein indicator. If pink colour indicated the presence of carbonate, then it was titrated with 0.05N sulphuric acid ($H_2SO_4$) until the solution became colorless. After the addition of 2 to 3 drops of methyl orange indicator, it was titrated with 0.05 N $H_2SO_4$ till the color changed from yellow to rosy red.

## 3.8 Statistical Analysis

Statistical analysis of data generated out of the chemical analyses of freshwater samples were done and establish the association among the parameters by using the software MS Excel 2007. And comparison was also calculated with the help of scientific calculator (CASIO super FX-991).

# CHAPTER IV

# RESULT AND DISCUSSION

In the experimental samples, the major physical and ionic constituents such as pH, Total Dissolved Solids (TDS), Salinity, Sodium (Na), Potassium (K), Calcium (Ca), Carbonate ($CO_3$) and Bicarbonate ($HCO_3$). The obtained analytical results have been represented in Tables (3-8). The salient features of the experimental findings presented in this chapter and discussed under appropriate headings and support he relevant available research findings wherever applicable.

## 4.1 Physical characteristics

The color and odor of the samples ensure us that the samples collected were contaminated. The results of various physical tests are given below and discuss about them briefly.

### 4.1.1 Color

Accurate documentation of water color is important as it indicates source of water and pollutants. Water color is referred as apparent color and true color based on the type of solid material present in it (Table -3&4). Apparent color is the color of the whole water sample, and consists of color due to both dissolved and suspended components. True color is measured by filtering the water sample to remove all suspended material, and measuring the color of the filtered water, which represents color due to dissolved components. Suspended and dissolved particles in water influence color. Suspended material in water bodies may be a result of natural causes and/or human activity.

Transparent water with a low accumulation of dissolved materials appears blue and indicates low productivity. Dissolved organic matter, such as humus, peat or decaying plant matter, can produce a yellow or brown color. The collected samples were light brown and slightly blackish in Buriganga river and normal to slightly blackish in Turag river. The color of the most of the samples was yellow, pale yellow or ash, which enhances the probability of presence of various inorganic and organic pollutants (Islam *et al.*, 2016).

### 4.1.2 Odor

The odor rises off the polluted rivers nearby factories dump their wastewater. Most of the factories are garment operations, textile mills and dyeing plants in the supply chain that exports clothing to earn foreign currencies. The rapid increasing number of industries are involved to emit their waste material into the rivers and these rotten waste materials causes the foul or Slightly foul odor in the river water (Table 3 & 4). But it also often means ignoring costly environmental regulations. Bangladesh's garment and textile industries have contributed heavily to what experts describe as a water pollution disaster, especially in the large industrial areas of Dhaka, the capital. The odor of the samples were moderately foul to foul in Buriganga river and slightly foul to moderately foul in Turag rivers. The odor of the samples was also very pungent or low pungent which also informs the existence of the unwanted contaminants (Islam *et al.*, 2016).

**Table 3. The water color and odor of Buriganga river**

| Sample | Odor | Color |
|---|---|---|
| $B_1$ | Moderately Foul | Light Brown |
| $B_2$ | Moderately Foul | Light Brown |
| $B_3$ | Moderately Foul | Light Brown |
| $B_4$ | Moderately Foul | Light Brown |
| $B_5$ | Moderately Foul | Light Brown |
| $B_6$ | Moderately Foul | Light Brown |
| $B_7$ | Moderately Foul | Light Brown |
| $B_8$ | Moderately Foul | Light Brown |
| $B_9$ | Foul | Light Brown |
| $B_{10}$ | Foul | Light Brown |
| $B_{11}$ | Foul | Slightly Blackish |
| $B_{12}$ | Foul | Slightly Blackish |
| $B_{13}$ | Foul | Slightly Blackish |
| $B_{14}$ | Foul | Slightly Blackish |
| $B_{15}$ | Foul | Slightly Blackish |
| $B_{16}$ | Foul | Slightly Blackish |
| $B_{17}$ | Foul | Slightly Blackish |
| $B_{18}$ | Foul | Slightly Blackish |
| $B_{19}$ | Foul | Slightly Blackish |
| $B_{20}$ | Foul | Slightly Blackish |

**Table 4. The water color and odor of Turag river**

| Sample | Odor | Color |
|---|---|---|
| $T_1$ | Slightly foul | Normal |
| $T_2$ | Slightly foul | Normal |
| $T_3$ | Slightly foul | Normal |
| $T_4$ | Slightly foul | Normal |
| $T_5$ | Slightly foul | Normal |
| $T_6$ | Slightly foul | Normal |
| $T_7$ | Slightly foul | Normal |
| $T_8$ | Slightly foul | Normal |
| $T_9$ | Moderately Foul | Normal |
| $T_{10}$ | Moderately Foul | Normal |
| $T_{11}$ | Moderately Foul | Slightly Blackish |
| $T_{12}$ | Moderately Foul | Slightly Blackish |
| $T_{13}$ | Moderately Foul | Slightly Blackish |
| $T_{14}$ | Moderately Foul | Slightly Blackish |
| $T_{15}$ | Moderately Foul | Slightly Blackish |
| $T_{16}$ | Moderately Foul | Slightly Blackish |
| $T_{17}$ | Moderately Foul | Slightly Blackish |
| $T_{18}$ | Moderately Foul | Slightly Blackish |
| $T_{19}$ | Moderately Foul | Slightly Blackish |
| $T_{20}$ | Moderately Foul | Slightly Blackish |

## 4.2 Chemical characteristics

### 4.2.1 pH

Aquatic organisms are affected by pH because most of their metabolic activities are dependent on it. pH of an aquatic system is an important indicator of the water quality and the extent pollution in the watershed areas (Kumar *et al.*, 2011). The minimum pH value of Buriganga river was recorded 6.86 where the maximum pH value was 7.17. The average value of Buriganga was 6.99. On the other hand, the minimum and maximum pH value of Turag river were recorded 6.79 and 7.2 respectively. The average value of Turag was 7.01. The result showed that, pH values are within the permissible limit in Buriganga and Turag river. The acceptable range of pH for irrigation water quality is from 6.0 to 8.5 (Ayers and Westcot, 1985). Even the optimal range of pH for sustainable aquatic life is 6.5-8 (ECR, 1997). The pH values ranged from 5.87 to 8.21 in Buriganga (Mohiuddin *et al.,* 2015). A research was conducted for water quality assessment of an industrial zone polluted aquatic body in Dhaka and the pH values recorded as 7.10-8.17 (Akter *et al.*, 2014). The average values of the pH of Buriganga and Turag river in three distinct seasons were 6.08, 7.22 (pre-monsoon); 7.18, 7.28 (monsoon) and 4.05, 5.86 (post-monsoon) respectively (Islam and Azam, 2015).

According to the water quality standard for aquaculture, the recommended pH value ranges from 6.5 to 8.0 (Meade, 1989). On the basis of their comments, all the water samples in both rivers were not problematic for irrigating agricultural crops and any other activities rather than drinking water.

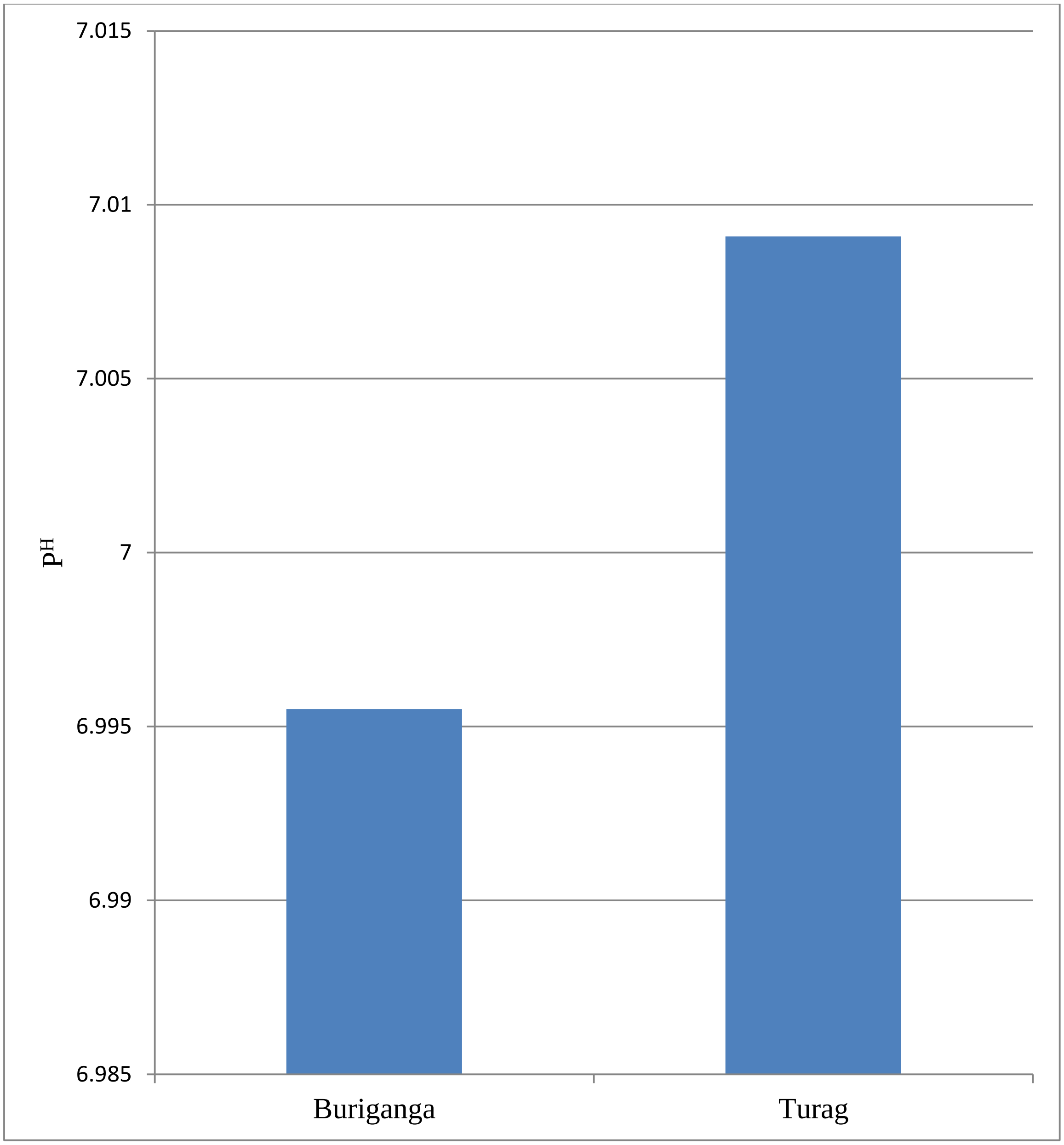


**Figure 2.** Comparison of pH value of Buriganga and Turag River water

| **Table 5: Parameter and concentration of fresh water in Buriganga river** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sample** | pH | TDS (mg/L) | Salinity (dS/m) | Carbonate( mg/L) | Bi-carbonate (mg/L) | Calcium (mg/L) | Potassium (mg/L) | Sodium (mg/L) |
| $B_1$ | 7.05 | 73 | 0.1 | trace | 30.5 | 5 | 2.9 | 6.24 |
| $B_2$ | 7.17 | 73.8 | 0.1 | trace | 61 | 5 | 2.9 | 6.44 |
| $B_3$ | 7.01 | 75.9 | 0.1 | trace | 91.5 | 5 | 2.96 | 6.44 |
| $B_4$ | 6.95 | 75.1 | 0.1 | trace | 61 | 5 | 2.85 | 6.44 |
| $B_5$ | 7.1 | 72.1 | 0.1 | trace | 61 | 5 | 2.6 | 6.52 |
| $B_6$ | 6.96 | 80.2 | 0.1 | trace | 61 | 5 | 3.25 | 7 |
| $B_7$ | 7.05 | 70.5 | 0.1 | trace | 91.5 | 5 | 2.45 | 6.36 |
| $B_8$ | 6.94 | 76.1 | 0.1 | trace | 61 | 5 | 2.9 | 6.68 |
| $B_9$ | 7.06 | 81.9 | 0.1 | trace | 61 | 5 | 2.9 | 7.32 |
| $B_{10}$ | 6.88 | 76.9 | 0.1 | trace | 61 | 5 | 3.05 | 6.64 |
| $B_{11}$ | 6.99 | 76.4 | 0.1 | trace | 61 | 5 | 2.9 | 6.4 |
| $B_{12}$ | 6.94 | 77.3 | 0.1 | trace | 61 | 5 | 2.75 | 6.68 |
| $B_{13}$ | 6.86 | 80.1 | 0.1 | trace | 30.5 | 5 | 2.9 | 7.32 |
| $B_{14}$ | 6.93 | 81.3 | 0.1 | trace | 61 | 5 | 2.9 | 7.28 |
| $B_{15}$ | 6.89 | 80.1 | 0.1 | trace | 91.5 | 5 | 2.85 | 7.16 |
| $B_{16}$ | 6.99 | 77.2 | 0.1 | trace | 61 | 5 | 2.75 | 7.12 |
| $B_{17}$ | 7.02 | 77.7 | 0.1 | trace | 61 | 5 | 2.7 | 6.96 |
| $B_{18}$ | 7.04 | 78.1 | 0.1 | trace | 61 | 5 | 3.09 | 6.84 |
| $B_{19}$ | 7.16 | 78.3 | 0.1 | trace | 91.5 | 5 | 2.7 | 6.84 |
| $B_{20}$ | 6.92 | 77.8 | 0.1 | trace | 61 | 5 | 2.6 | 6.68 |
| Min. | 6.86 | 70.5 | 0.1 | trace | 30.5 | 5 | 2.45 | 6.24 |
| Max. | 7.17 | 81.9 | 0.1 | trace | 91.5 | 5 | 3.25 | 7.32 |
| Average | 6.9955 | 76.99 | 0.1 | trace | 64.05 | 5 | 2.845 | 6.768 |
| SD | 0.086965 | 3.031571 | 1.42383E-17 | trace | 16.85144 | 0 | 0.183059 | 0.344484 |
| CV (%) | 0.012432 | 0.039376 | 1.42383E-16 | Trace | 0.263098 | 0 | 0.064344 | 0.050899 |

| Table 6: Parameter and concentration of fresh water in Turag river | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sample** | pH | TDS (mg/L) | Salinity (dS/m) | Carbonate (mg/L) | Bi-carbonate (mg/L) | Calcium (mg/L) | Potassium (mg/L) | Sodium (mg/L) |
| $T_1$ | 7.07 | 74.8 | 0.1 | trace | 91.5 | 7 | 2.7 | 5.55 |
| $T_2$ | 7.07 | 74.2 | 0.1 | trace | 61 | 7 | 2.8 | 5.95 |
| $T_3$ | 7.14 | 75.1 | 0.1 | trace | 61 | 7 | 2.9 | 6.05 |
| $T_4$ | 7.19 | 75.8 | 0.1 | trace | 91.5 | 7 | 2.95 | 6.1 |
| $T_5$ | 7.09 | 75.2 | 0.1 | trace | 61 | 7 | 2.9 | 5.6 |
| $T_6$ | 7.02 | 83.3 | 0.1 | trace | 91.5 | 7 | 3.25 | 8.16 |
| $T_7$ | 6.88 | 85 | 0.1 | trace | 61 | 7 | 3.3 | 8.48 |
| $T_8$ | 7.2 | 73.8 | 0.1 | trace | 91.5 | 7 | 2.9 | 5.55 |
| $T_9$ | 6.91 | 79.8 | 0.1 | trace | 91.5 | 7 | 3.05 | 7.16 |
| $T_{10}$ | 7.05 | 79.4 | 0.1 | trace | 61 | 7 | 3.07 | 7 |
| $T_{11}$ | 7.18 | 78.5 | 0.1 | trace | 91.5 | 7 | 3 | 6.76 |
| $T_{12}$ | 7.05 | 77.9 | 0.1 | trace | 61 | 7 | 3 | 6.68 |
| $T_{13}$ | 6.99 | 77.7 | 0.1 | trace | 61 | 7 | 2.95 | 6.28 |
| $T_{14}$ | 6.94 | 76.7 | 0.1 | trace | 61 | 7 | 2.95 | 6.2 |
| $T_{15}$ | 6.79 | 80.8 | 0.1 | trace | 61 | 7 | 3.04 | 7.28 |
| $T_{16}$ | 7 | 82.4 | 0.1 | trace | 61 | 7 | 3.04 | 7.44 |
| $T_{17}$ | 6.97 | 97.5 | 0.1 | trace | 61 | 7 | 3.04 | 12.64 |
| $T_{18}$ | 6.93 | 94.9 | 0.1 | trace | 61 | 7 | 3.01 | 12.96 |
| $T_{19}$ | 6.88 | 82.6 | 0.1 | trace | 61 | 7 | 3.05 | 8.84 |
| $T_{20}$ | 6.86 | 83.2 | 0.1 | trace | 61 | 7 | 3.07 | 8.72 |
| Min. | 6.79 | 73.8 | 0.1 | trace | 61 | 7 | 2.7 | 5.55 |
| Max. | 7.2 | 97.5 | 0.1 | trace | 91.5 | 7 | 3.3 | 12.96 |
| Average | 7.009091 | 80.90455 | 0.1 | trace | 70.70455 | 7 | 2.998636 | 7.632273 |
| SD | 0.116821 | 6.369756 | 1.42383E-17 | trace | 14.33995 | 0 | 0.133703 | 2.094971 |
| CV (%) | 0.016667 | 0.078732 | 1.42383E-16 | Trace | 0.202815 | 0 | 0.044588 | 0.274489 |

### 4.2.2 Total Dissolved Solids (TDS)

The TDS of all collected water samples from 20 locations under the two rivers were within the ranges of 70.5 to 81.9 mg/L in Buriganga and 73.8 to 97.5 mg/L in Turag river. The average TDS values of Buriganga and Turag were 76.99 and 80.90 mg/L, respectively. The lowest TDS value of 70.5 mg/L was observed in Buriganga river from the area of Amin Bazar bridge (sample no.7), but the highest TDS value of 81.9 mg/L was recorded in Buriganga river water (sample no.9). Where, the lowest TDS value of 73.8 mg/L was observed in Turag river from the Coatbari Bazar Ghat area (sample no.8), but the highest TDS value of 97.5 mg/L was recorded in Turag river water (sample no.17). From the result, it was found that TDS values were higher in Turag than Buriganga river water. The standard of TDS for domestic water supplies is 500 mg/L by USPH (De, 2005). The acceptable standard of TDS for drinking water is 1000 mg/L, livestock is 5000 mg/L, and irrigation is 2000 mg/L (ADB, 1994). A similar observation was reported by Meghla *et al.* (2013) for the assessment of physicochemical properties of water from Turag River in Dhaka City, Bangladesh. High TDS values indicate the presence of an appreciable quantities of bicarbonates, sulphates and chlorides of Ca, Mg and Na (Karanth, 1994).

According to Freeze and Cherry (1979), all the water samples containing TDS les then 1000 mg/L were graded as freshwater in quality. Therefore, these waters might safely be used for irrigation and also were suitable for crop production in respect of TDS. On the basis of water quality standard for aquaculture as cited in Appendices 2, 3 and 4. No other samples were found as unsuitable for aquaculture and livestock consumption, because the collected surface water containing less than 1000mg/L TDS.

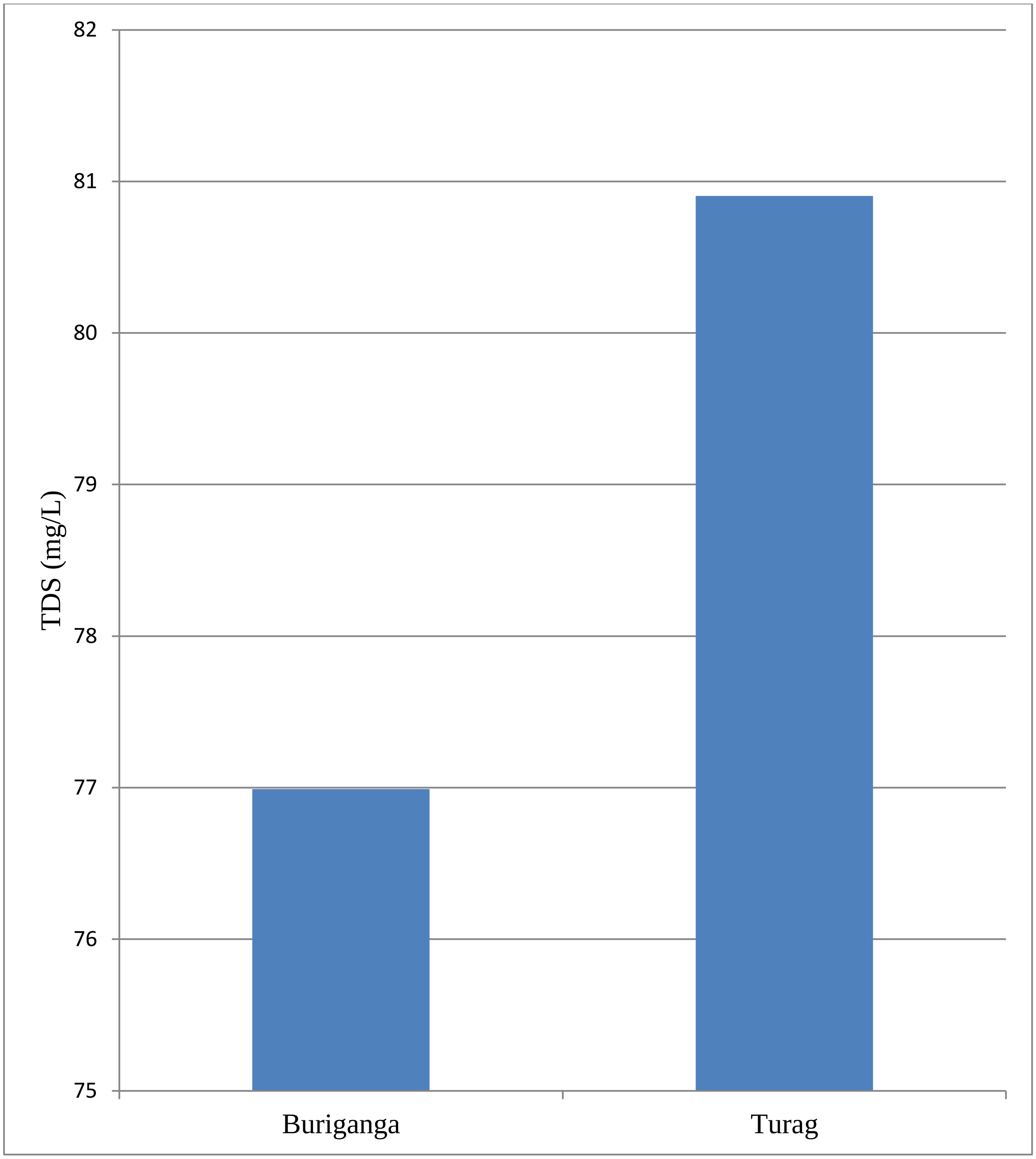


**Figure 3.** Comparison of TDS (mg/L) of Buriganga and Turag River water

### 4.2.3 Salinity

Salinity is a current problem which is expected to exacerbate by climate change and sea level rise. Salinity intrusion due to reduction of freshwater flow from upstream, salinisation of groundwater and fluctuation of soil salinity are major concern of Bangladesh. As sea level continues to raise the associated effects of permanent inundation is likely to increase the salinity near coastal areas. The average salinity was recorded 0.1 dS/m for both Buriganga and Turag river. Even the lowest and the highest value of salinity were 0.1 and 0.1 dS/m for both the rivers. No samples contained more than 0.1 dS/m in the rivers. SRDI (1997) reported that, soil salinity levels south of Khulna and Bagerhat towns ranged between 8 to 15 dS/m during the low flow season. It is also reported that, several sub-districts (such as Kachua, Mollahat, and Fultali) south of the Sundarbans known to be non-saline in the pre-Farakka period have began to develop soil salinity during the low flow seasons of 1980s. The anticipated sea level rise would produce salinity impacts in three fronts: surface water, groundwater and soil. Increased soil salinity due to climate change would significantly reduce food grain production. Even at present, some parts of coastal lands are not being utilized for crop production, mostly due to soil salinity; and this situation would aggravate further under a climate change scenario. A modeling exercise has indicated that, under the changed climate conditions, the index of aridity would increase in winter (Huq, *et al.*, 2002). According to them, it can be concluded that the Buriganga and Turag river's water might safely be used for irrigation and also were suitable for crop production in respect of salinity (Appendix 5).

## 4.3 Ionic Constituents

### 4.3.1 Sodium (Na)

The concentration of Na in freshwater samples of the study area varied from 6.24 to 7.32 mg/L with an average value of 6.77 mg/L (Table 5) in Buriganga river. Where in Turag river, the minimum and the maximum concentration of Na were 5.55 and 12.96 mg/L (sample no. $T_{18}$) with a mean value of 7.63 mg/L (Table 6). In the study, it is showed that, the lowest concentration of Na was observed as 5.55 mg/L in Turag river  and highest was found 12.96 mg/L in Turag river. That is why the mean value of Na was also higher than the Buriganga river. Maximum concentration of Sodium (28.320 mg/L) was found in rainy season and minimum (6.720 mg/L) in summer season (Joshi *et al.*, 2009).

Irrigation water containing less than 40 mg/L Na was suitable for raising crop plants (Ayers and Westcot, 1985). The recorded Na content test was far below this specific limit from all the river water samples. The acceptable content of Na in water samples for aquaculture is 75.00 mg/L (Meade, 1989). All rivers water under test contained less than 75.00 mg/ L Na.

According to the Appendices 3 and 4, the upper limit for the livestock use of drinking water and aquaculture for 300 mg/L and 75 mg/L respectively. There were no samples which contained such concentration of Sodium. From this result, it is concluded that the water of Burigana and Turag rivers are safe for the consumption of Livestock, agricultural production as well as for the aquaculture.

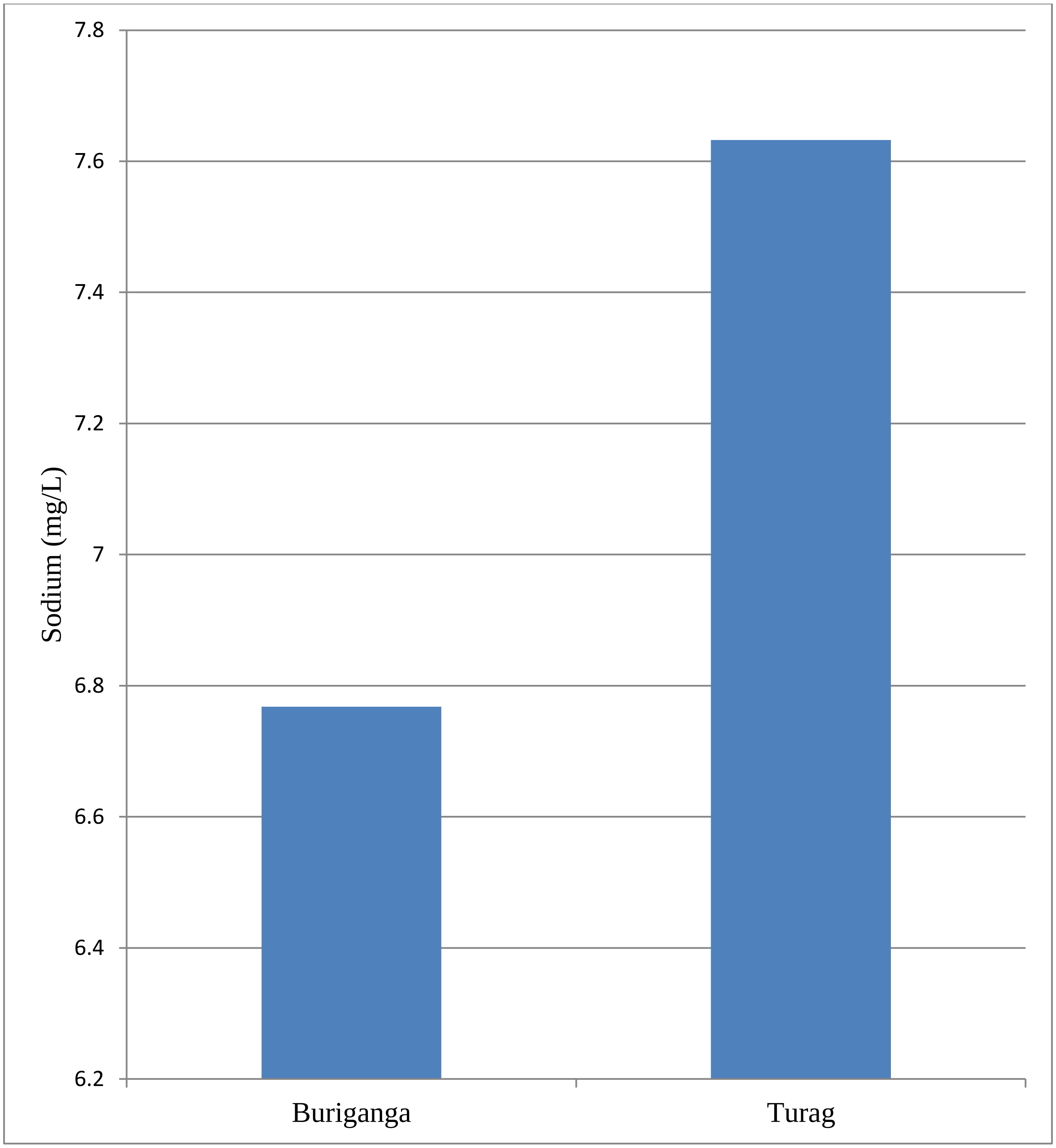


**Figure 4.** Comparison of Sodium (mg/L) of Buriganga and Turag River water

### 4.3.2 Potassium (K)

The status of Potassium (K) in the collected water samples in Buriganga river which was varied from 2.45 to 3.25 mg/L and the mean value was 2.845 mg/L. In case of Turag river, the lowest value was 2.70 mg/L and the highest value was found 3.3 mg/L. The mean value of K content in Turag river was greater than the Buriganga river because of dilution of various industrial waste materials. The similar concentration of river water of K content was also observed by Gupta (1999) and Zaman *et al.* (2001). This might due to be run off of K 'Bearing fertilizer from the adjacent crop field, garments industries, leaching domestic effluents and decomposition of organic matter, which contaminated the river water (Tapas *et al.* 2000). The maximum concentration of potassium (3.425 mg/L) was found in rainy season and minimum (1.216 mg/L) in summer season.

The acceptable content of K for aquaculture is less than 5.0 mg/L (Meade, 1989) as shown in Appendix 4. And the upper limit for the livestock use of water is 20 mg/L. From the above information, no samples were found within this range. So, it can be concluded that the water use for the livestock, aquaculture and for the irrigation is suitable.

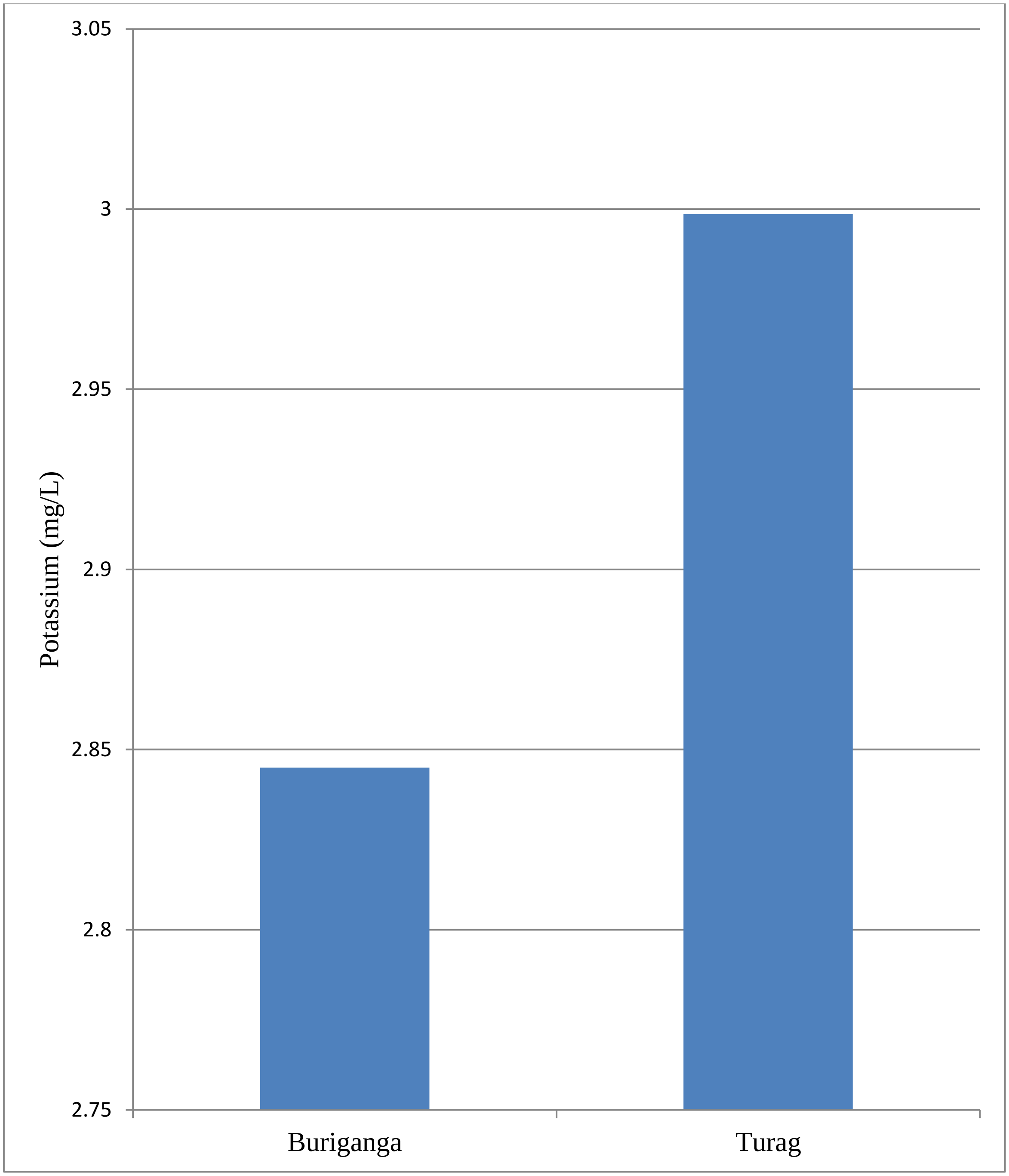


**Figure 5.** Comparison of Potassium (mg/L) of Buriganga and Turag River water

### 4.3.3 Calcium (Ca)

The concentration of Ca in freshwater samples of the study area were 5.0 mg/L with an average value of 5.0 mg/L in the Buriganga river. On the other hand, the concentration of Ca was 7.0 mg/L in Turag river. From the result, the concentration of Ca was higher in Turag river as compared to the Buriganga river due to heavy dilution by rain water and application of TSP from fertilizer industries. A water samples collection survey was conducted by Islam *et al.* (1996) and found the similar result. Irrigation water containing less than 20 mg/L Ca was suitable for raising crop plants (Ayers and Westcot, 1985). The values of calcium were registered with a minimum (63.3 mg/L) at Mahidpur during winter season and maximum (92.18 mg/lit) at Ramghat during summer season (Bhasin *et al.*, 2016).

In the study area, all the collected water samples were suitable based on the estimated Ca content. Considering freshwater quality for aquaculture, the detected amount of Ca was suitable where acceptable limit of Ca for this aspect is 4 to 160 mg/L (Meade, 1989) as mentioned in Appendix 4.

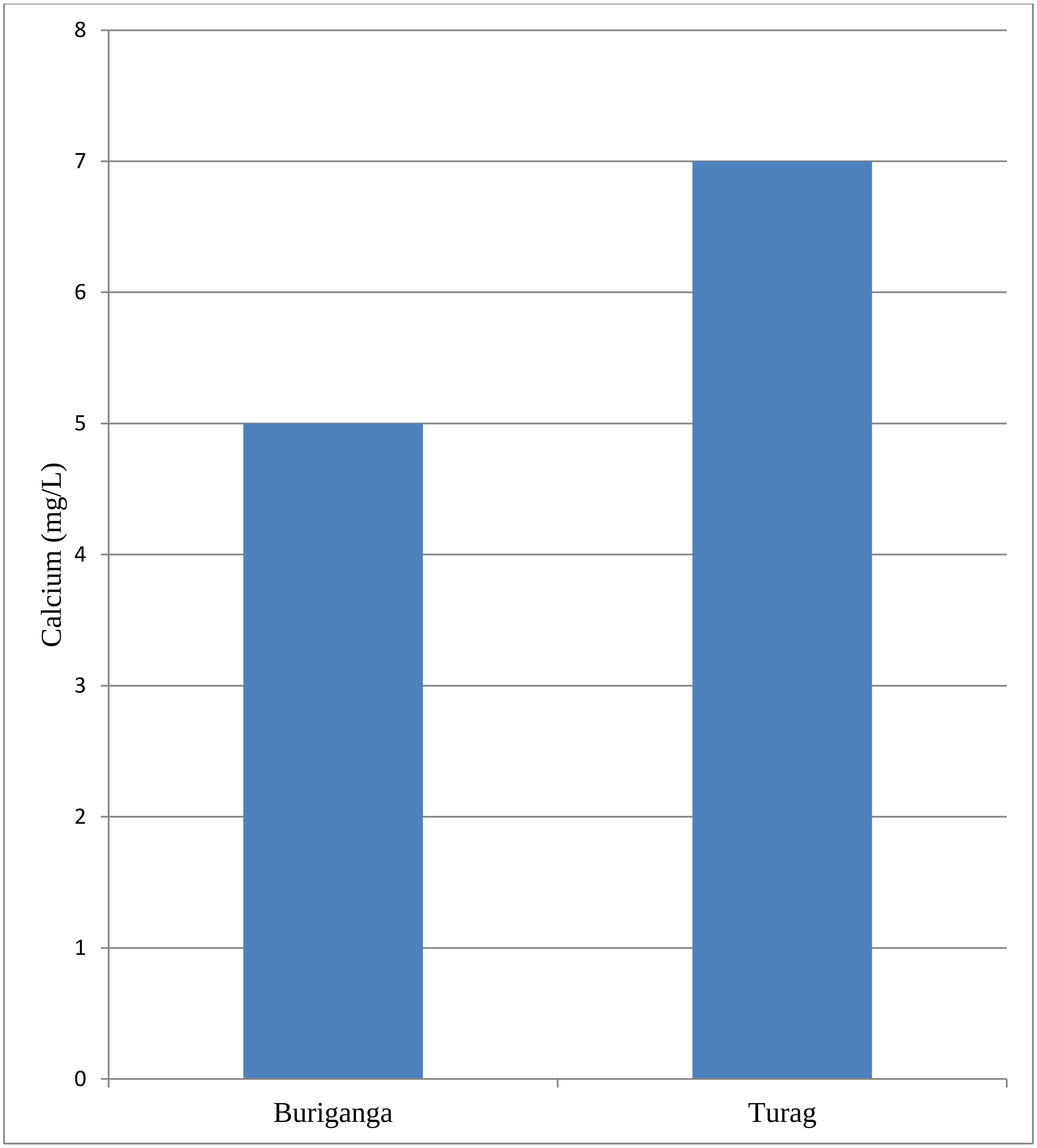


**Figure 6.** Comparison of Calcium (mg/L) of Buriganga and Turag River river

### 4.3.4 Carbonate ($CO_3$)

All the water samples did not contain any trace amount of $CO_3$ for both Buriganga and Turag river. The detected concentration of all the water samples was found in very trace amounts which indicated that all the water samples were free from carbonate. The concentration of $CO_3$ was similar as observed by Bharambe *et al.* (1992). So, the detected concentration of $CO_3$ had no any remarkable influence based on the effect of river as well as the environment even for the usage of agricultural purposes.

### 4.3.5 Bicarbonate ($HCO_3$)

The concentration of $HCO_3$ in the collected water samples fluctuated between 30.5 to 91.5 mg/L with the mean value of 64.0 mg/L in respect of Buriganga river. On the other hand, the minimum and maximum values of $HCO_3$ were 61 and 91.5 mg/L, respectively with the mean value of 70.70 mg/L in Turag river.

The maximum recommended concentration of $HCO_3$ in irrigation is 1.50 mg/L (Ayers and Westcot, 1985). Depending on this $HCO_3$ contents, all the collected samples in both rivers were highly toxic and for any sorts of agricultural activities in respect of $HCO_3$. According to the findings, Buriganga and Turag rivers are highly unsuitable and it would be considered as problematic for aquaculture and livestock usage as well as the environment.

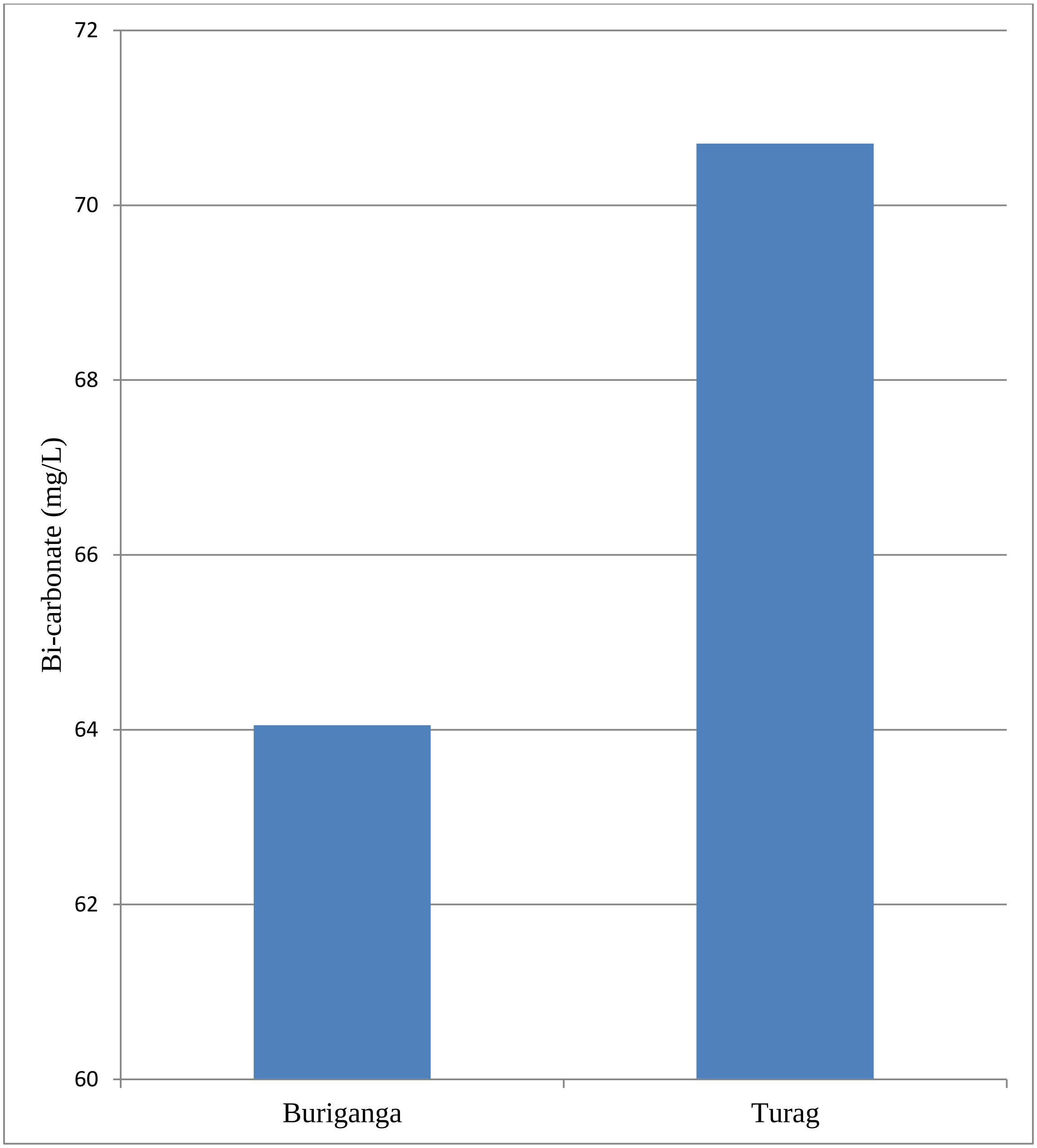


**Figure 7.** Comparison of Bicarbonate (mg/L) of Buriganga and Turag River water

## 4.4 Correlation matrix of Buriganga and Turag River

The correlation matrix presented that in Tables (7&8) shows both positive and negative significant correlations among physico-chemical parameters.

In case of Buriganga river, Potassium (K) shows the positive correlation with TDS (r=0.460634) and Sodium (Na) also shows positive correlation with TDS (r=0.86591), whereas a negative significant correlation existed between Bi-carbonate, TDS and Salinity (= -6.3E-15).

Turag river, A significant positive correlation existed between Sodium (Na) with TDS (r=0.983373). Potassium also shows the positive significant correlation with TDS (r=0.520156). And a negative signification correlation existed in pH (r=-0.51013).

| Parameters | pH | TDS (mg/L) | Salinity (ds/m) | Bi-carbonate (mg/L) | Potassium (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|---|
| pH | 1 | | | | | |
| TDS | -0.4256 | 1 | | | | |
| Salinity | -2.3E-14 | -6.3E-15 | 1 | | | |
| Bi-carbonate | 0.228935 | -0.07164 | -1.7E-16 | 1 | | |
| Potassium | -0.24713 | 0.460634 | -1.4E-15 | -0.2758 | 1 | |
| Sodium | -0.34308 | 0.86591 | -3.4E-15 | -0.08185 | 0.204314 | 1 |

**Table 7:** Correlation matrix among the parameters in Buriganga River

**Table 8:** Correlation matrix of among the parameters in Turag River

| Parameters | pH | TDS (mg/L) | Bi-carbonate (mg/L) | Potassium (mg/L) | Sodium (mg/L) |
|---|---|---|---|---|---|
| pH | 1 | | | | |
| TDS | -0.51013 | 1 | | | |
| Bi-carbonate | 0.485832 | -0.29138 | 1 | | |
| Potassium | -0.47776 | 0.520156 | -0.11805 | 1 | |
| Sodium | -0.48888 | 0.983373 | -0.29603 | 0.456314 | 1 |

# CHAPTER V

# SUMMARY AND CONCLUSION

The study was conducted at the Agricultural Chemistry laboratory at Sher-e-Bangla Agricultural University to assess the physico-chemical parameters in Briganga and Turag river of Bangladesh for agricultural purpose. For this purpose, 20 samples were collected from different locations of each river to analyze the physical (TDS, Salinity and pH) and chemical content or ionic constituents like Sodium (Na), Potassium (K), Calcium (Ca), Carbonate ($CO_3$) and Bicarbonate ($HCO_3$).

The pH values of Buriganga river varied from 6.86 to 7.17 and most of the pH values were belonged around to the same range. The highest and lowest value of pH were not far from each value. So most of the cases the water of Buriganga was alkaline. On the other hand, in case of Turag river the pH values ranged from 6.79 to 7.2 and the pH value was greater than the Buriganga river.

The highest concentration Total Dissolve Solid (TDS) was 81.97 mg/L in Buriganga river whereas 97.57 mg/L in Turag river. And the mean value of TDS was greater (80.907 mg/L) than the Buriganga river (76.997 mg/L). Most of the cases the concentrations of TDS were below 80.7 mg/L in Buriganga river but maximum concentrations were above the ranges 80 in Turag river.

The salinity of Buriganga and Turag river were same (0.1 dS/m) in both cases. Even the samples were collected from different location of two rivers.

Though Buriganga is more contaminated than Turag river. But during the salinity analysis the concentrations of salt were same.

The trace element namely Carbonate ($CO_3$) was not found from the Buriganga and Turag rivers. But in case of Bicarbonate ($HCO_3$), the lowest (30.57 mg/L) concentration was found in Buriganga river, whereas the highest (91.57mg/L) concentration was found in both of the rivers. The mean value of Bicarbonate (70.707 mg/L) observed in Turag river was greater than Buriganga river. The lowest (64.057 mg/L) mean value was found in Buriganga river.

The Calcium (Ca) concentration was found 5 mg/L in Buriganga and 7 mg/L in Turag river. So, it is clear that the concentration of Ca was greater in Turag than Buriganga river.Though, the water samples were collected from different places of two rivers. The concentration of Sodium (Na) varied from 6.24 to 7.327 mg/L in Buriganga river, whereas the ranges of Na were 5.55 to 12.96 mg/L in Turag river. Even the mean value (7.63 mg/L) in Turag was higher than the highest mean value (6.772 mg/L) in Buriganga river. And the concentration of Potassium (K) was slightly higher (3.3 mg/L) in Turag than the highest value (3.252.99 mg/L) in Burigana river. The mean value was higher (2.99 mg/L) in case of Turag than Buriganga river (2.85 mg/L).

Considering all the criteria, the collected freshwater samples of the study areas were not problematic for irrigation, aquaculture and livestock consumption. Some water samples were problematic in respect of specific ion. All the freshwaters can safely be used for specific purpose after proper treatment. Regarding this issue, sustainable and appropriate technology should be developed for the remediation of contaminated freshwaters. In addition to the chemical quality of freshwater ecosystems, the biological and radiological qualities of water should be assessed for the efficient water management.

## RECOMMENDATION

- As we do not able to determine many other quality parameters especially heavy metals due to lack of lab facilities, so further analysis of different heavy metals should be done.
- The assessment of water quality should be done at regular interval and as well as season wise.

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# APPENDICES

**Appendix 1:** Recommended maximum concentration of different ions in water

| Elements name | Symbol | Concentration for water used (mg/L) |
|---|---|---|
| Calcium | Ca | 4 - 160 |
| Potassium | K | 2.0 |
| Phosphorus | P | 2.0 |
| Boron | B | 0.75 |
| Carbonate | $CO_3$ | 1.50 |
| Bicarbonate | $HCO_3$ | 0.10 |

**Source :** Ayers, R.S. and Wescot, D.W. (1985). Water Quality for Agriculture, FAO Irrigation and Drainage Paper 29 (Rev. 1):40-96, Meade (1989).

**Appendix 2:** Water Classification as per TDS

| Water Clsss | TDS (mg/L) |
|---|---|
| Fresh water | 0-1000 |
| Brackish water | 1000-10000 |
| Saline water | 10000-100000 |
| Brine water | >100000 |

**Source :** Freeze, A.R. and Cherry, J.A. 1979. Groundwater.Prentice Hall Inc. Englewood Cliffs, New Jersey 07632,p. 84

**Appendix 3:** Recommendation limit of toxic constituents in drinking water for livestock use

| Constituents | Symbol | Upper limit (mg/L) |
|---|---|---|
| Boron | B | 5.00 |
| TDS | - | 10000.0 |
| Calcium | Ca | 150 |
| Sodium | Na | 300 |
| Potassium | K | >20 |
| Carbonate | $CO_3$ | 2000 |
| Bicarbonate | $HCO_3$ | 2000 |

**Source :** ESB (Environmental Studies Board) 1972. National Academy of Sciences. National Academy of Engineering, and Agricultural Waste Management Field Handbook, page 1 to 17.University of Missouri. USA.

**Appendix 4:** Water quality standards for aquaculture

| Parameters | Symbol | Concentration (mg/L) |
|---|---|---|
| Calcium | Ca | 4.0-160 |
| Magnesium | Mg | <15.0 |
| Potassium | K | <5.0 |
| Sodium | Na | 75.0 |
| Carbonate | $CO_3$ | |
| Bicarbonate | $HCO_3$ | |
| pH | - | 6.5-8.5 |
| Salinity | - | |
| Total Dissolve Solid | TDS | <400.0 |

**Source :** Meade, J.W.1989.Aquaculture Management. New York.Van Nostrand Reinhold.

**Appendix 5:** Effect of salinity of drinking water on livestock and poultry (Water Quality Criteria, 1972).

| Soluble salt (mg/L) | Effect |
|---|---|
| <1,000 | Low level of salinity; present no serious burden to any class of livestock or poultry |
| 1,000 to 2,999 | Satisfactory for all classes of livestock and poultry; may cause temporary, mild diarrhea in livestock; and water droppings in poultry at higher levels; no effect on health or performance |
| 3,000 to 4,999 | Satisfactory for livestock; may cause temporary diarrhea or be refused by animals no accustomed to it; poor water for poultry causing watery feces and, at high levels, increased mortality and decreased growth (especially in turkeys). |
| 5,000 to 6,999 | Reasonable safety for dairy and beef cattle, sheep, swine, and horses; avoid use for pregnant or lactating animals; not acceptable for poultry, causes decreased growth and production or increased mortality. |
| 7,000 to 10,000 | Unfit for poultry and swine; risk in using for pregnant or lactating cows, horses, sheep, the young of these species, or animals subjected to heavy heat stress or water loss; use should be avoided, although older ruminants, horses, poultry, and swine may subsist for long periods under conditions of low stress. |
| >10,000 | Risks are great; cannot be recommended for use under any conditions. |

**Source :** Agricultural Waste Management Field Handbook, page 1 to 17.University of Missouri. USA.

**Appendix 6:** Reporting the concentrations of ions and molecules (Anonymous, 2017).

| Equivalent weights of selected ions and Equations | |
|---|---|
| **Constituent** | **Equivalent weight** |
| Sodium ($Na^+$) | 23 |
| Calcium ($Ca^{2+}$) | 20 |
| Magnesium ($Mg^{2+}$) | 12 |
| Ammonium ($NH_4^+$) | 18 |
| Potassium ($K^+$) | 39 |
| Bicarbonate ($HCO3^-$) | 61 |
| Carbonate ($CO_3^{2-)}$ | 30 |
| Chloride ($Cl^-$) | 35 |
| Sulfate ($SO4_2$-) | 48 |
| Nitrate ($NO_3^-$) | 62 |
| Phosphate ($H_2PO_4^-$) | 97 |
| ppm = mg solute / $10^6$ milligrams solution = mg/liter<br>= mg solute / kg solution<br>ppb = μg solute / $10^9$ micrograms solution=μg/liter<br>= μg solute / kg solution<br>mg/L = meq/L × equivalent weight<br>meq/L = mg/L ÷ equiv. wt. | |

**Source**: Salinity Management Guide at http://www.salinitymanagement.org/Salinity%20Management%20Guide/ls/ls_3c.html


**Figure 8:** pH meter (A), EC meter (B).

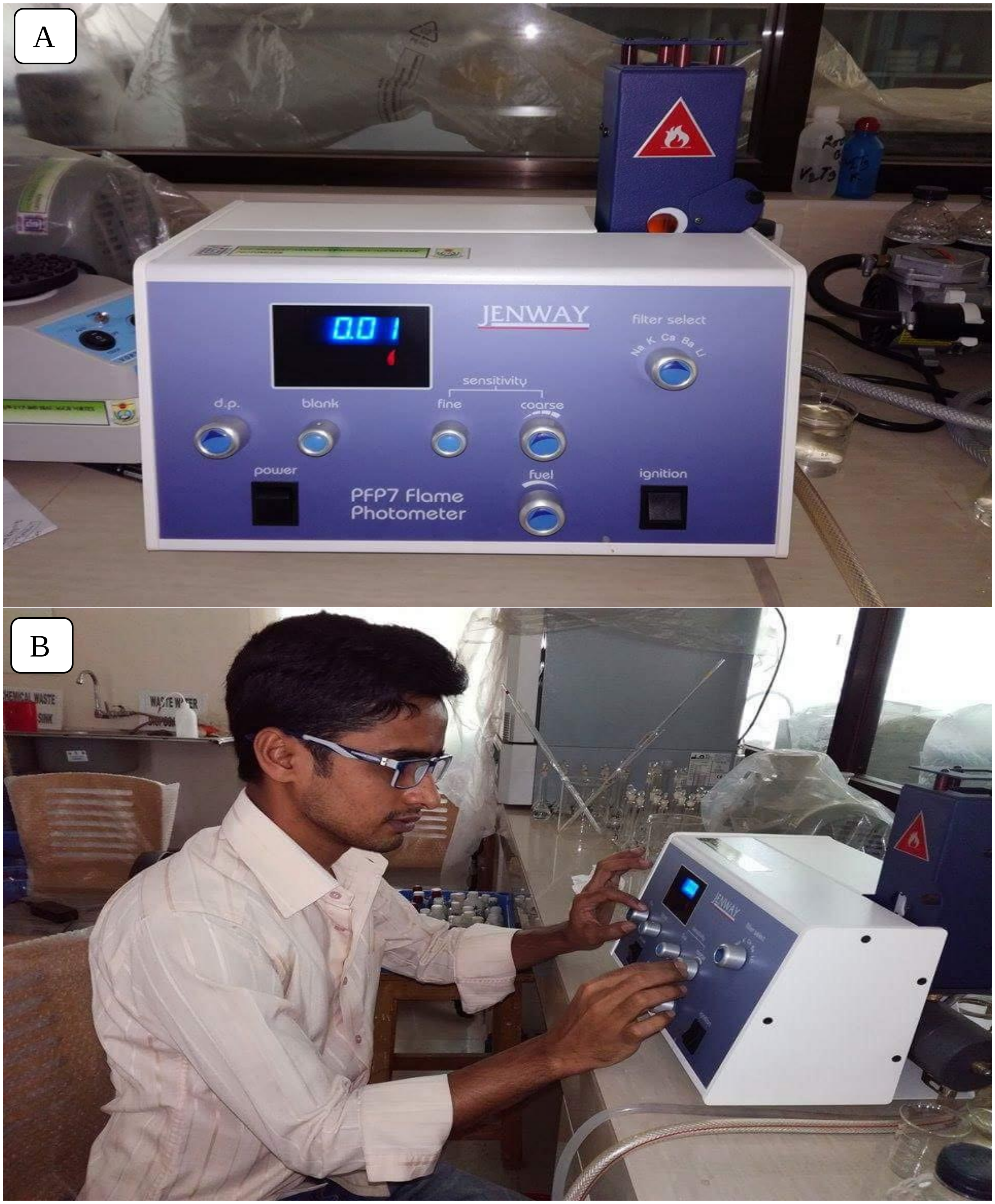


**Figure 9**: Flame Photometer (A), Handling of Flame Photometer (B)

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