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Investigation of Some Selected Water Quality Parameters of the Buriganga River

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A study was conducted to investigate the impact of the wastewater received from numerous sources along the Buriganga river through present state of water quality and pollution level. The water samples were collected from five different points namely Wise Ghat, Badamtoli Ghat, Babubazar Ghat, Lalkuthi Ghat and Postogola Ghat during monsoon from May to September in 2016 and analyzed for various physicochemical parameters. The observed values of temperature, pH, EC, DO, BOD, TDS and turbidity were spatially and temporally varied from 27-34ºC, 6.02-7.79, 136-285 µS/cm, 0.6-2.4 mg/l, 6.7-20 mg/l, 68.2-145 mg/l and 13.06-52 NTU respectively. The result showed that the river water was not suitable for aquatic organisms living therein.

Key Words: Buriganga river, Water quality, River pollution, Temporal variation

Field of Research: Environmental Engineering

1. Introduction

Water is essential for drinking, for growing food, for washing and it is also important for many of the pleasant recreational aspects of life (Reeve 2002).The Buriganga is one of the largest rivers in Bangladesh and flows through west and south of Dhaka (Rahman, Rabbani and Tooheen 2011). This river is considered the lifeline of Dhaka city because it is a source of water used by the city residents for bathing, drinking, irrigation and industrial purposes. The Buriganga, which is a part of the Ganges in Bangladesh, is a tide-influenced river. The river, approximately 18 km long, is significantly polluted due to the addition of industrial effluents, urban sewage and solid waste generated from human activities in the surrounding area. There were also 343 tannery industries, 627 dyeing industries and 104 fertilizer industries situated on the bank of Buriganga river (Ahmed 2005). Thousands of industrial units and sewerage lines dumping huge volumes of toxic wastes into Buriganga river increasingly pollute the water (Islam, Akhtar and Masud 2006). The degradation of water quality due to rapid industrialization and urbanization are creating an unfavorable environment for aquatic lives. The pollution that is occurring may cause harm to the aquatic lives as well as agricultural and domestic uses (Saifullah et al. 2012). For these reasons, a study is needed to assess the current water quality scenario of this river. The aim of the present study was to investigate several water quality parameters of the Buriganga river and to determine their suitability for fisheries and other aquatic flora and fauna by providing an updated report on the state of water quality.

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The paper has been organized as follows: Section 1 deals with introduction focusing on the background of the study and justification behind adopting the concept. Section 2 highlights the previous studies that were carried out on the water quality of the Buriganga and their findings. Section 3 describes the major steps comprising the methodology of the study and section 4 deals with the statistical analyses and comparison of several parameters on spatio-temporal pattern of water quality of the Buriganga. Conclusion and specific recommendations are provided in Section 5.

2. Literature Review

The Buriganga is considered the lifeline of Dhaka city. This city, being over populated, produces an over estimated load of pollutants every year which directly goes into the river without or insufficient treatment. The Department of Environment (2007) conducted a survey and found that the Buriganga is one of the major polluted rivers in the country, with Hazaribagh being the most polluting station. Hasan et al. (2009) analyzed various water quality parameters of the Buriganga and found out the river was subject to severe pollution while comparing with another rural river Panguchi. Their study showed that the degree of river pollution was quite alarming for urban population. Rahman and Bakri (2010) conducted a study where data analyses showed that the water quality of the Buriganga was not acceptable from aquatic ecosystem point of view for parameters such as DO, BOD_5, COD and EC during dry season. However, they concluded that the river water was still acceptable for pH and temperature in dry season. Saifullah et al. (2012) investigated the water quality of the Buringanga river during wet (monsoon) and dry (winter) season to determine the spatial distribution and temporal variation of various water quality parameters. The river was found to be highly turbid both in dry and wet season. The values of BOD, EC and TDS were found higher in dry season while DO was found higher in wet season.

Islam et al. (2015) conducted a study on the physicochemical parameters and dissolved metals levels from main rivers around Dhaka city in order to determine the present pollution status and their alteration trends with the seasonal change of discharge amount. Physicochemical analyses revealed that most of the water quality parameters exceeded the recommended levels set by the DoE during both dry and monsoon seasons. The dry season had significantly higher contamination loads, which were decreased during the monsoon season. Anthropogenic activities, as well as the variation in river water flow during different months were the main reasons for this high degree of water pollution. Ahammed et al. (2016) studied several water quality parameters from the selected sampling sites along the bank of the Buriganga river during different seasons. The results indicated that the water quality of the Buriganga was very poor and the values of DO, BOD, COD, TDS and turbidity were at an alarming level.

Considering the significance of the Buriganga, these findings lack updated information on water quality parameters which could create confusions on the state of water quality of the Buriganga river. Thus, a detailed study was needed to assess the present water quality situation of the river. This study aims to analyze several important physicochemical water quality parameters along this river in wet season.

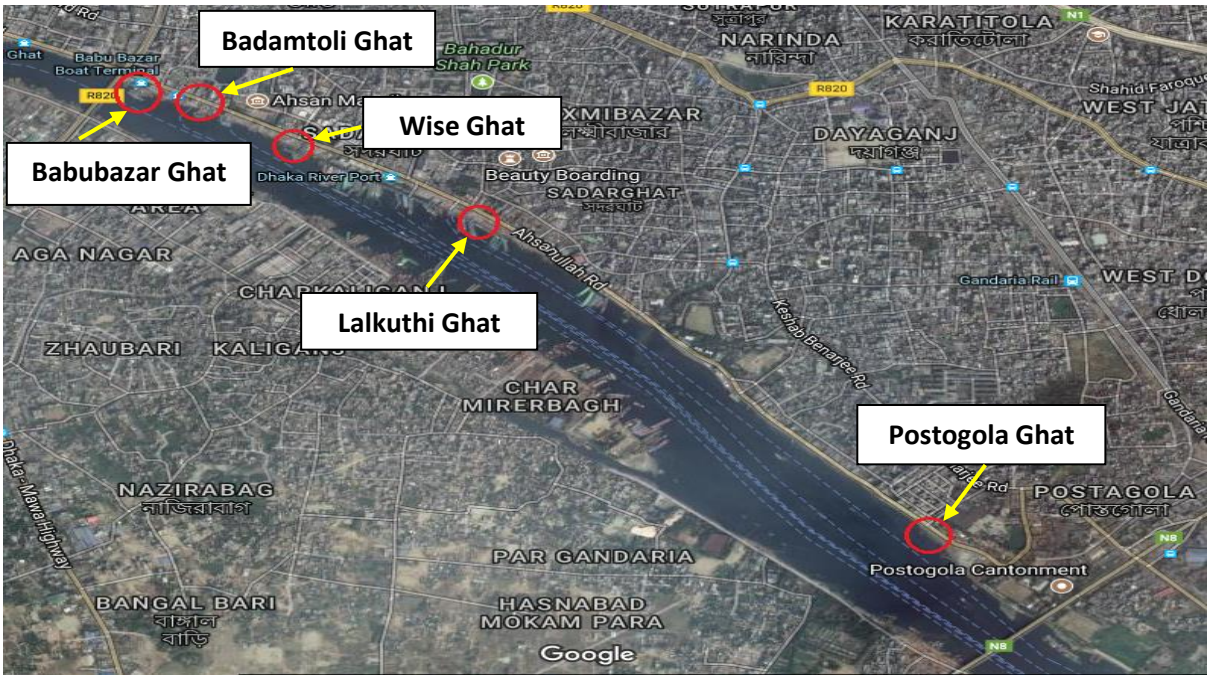
3. Materials and Methods

Water samples were collected during wet season in 2016 to test for physical qualities and chemical contents in the Buriganga river.

3.1 Sampling sites

Water samples were collected from different locations of the Buriganga river at industrial and sewage disposal points. Five sampling sites were selected for the collection of water samples in this study. The sampling sites were Wise Ghat, Badamtoli Ghat, Babubazar Ghat, Lalkuthi Ghat and Postogola Ghat. These sites were chosen because they had been heavily polluted by different kinds of waste discharged from tannery industry, commercial sectors and households. The location of the sampling sites is given in Figure 1.

Figure 1: Map Showing the Location of Study Area



Source: Google Map

3.2 Sample Collection

Water samples were collected during monsoon (wet season) from May to September in 2016. Sampling was carried out once in every month and sampling time was chosen randomly. Approximately 1000 ml of water samples were collected in polypropylene bottles during day time of each location. At each point, three sets of sample were collected from different depths to obtain the average value of the parameter. Thus for this study, a total of 75 water samples were collected for analyzing seven water quality parameters. The sample bottles were immediately labeled with date and sampling location. Then they were carefully sealed and transported to the laboratory as soon as possible. Standard methods were adopted for laboratory analysis.

3.3 Sample Analysis

Different methods and instruments that were used for the determination of several physicochemical properties of water samples are given in Table 1. All these experiments were conducted in accordance with the procedure endorsed by the manufacturers of the equipment.

Table 1: Methods and Instruments used for the Analysis of Different Parameters

Sl No	Parameter	Method/Instrument (Model)
1	pH	pH meter (PHS-2C)
2	Dissolved Oxygen (DO)	DO meter (Lutron DO-5509)
3	Biochemical Oxygen Demand (BOD)	Five days incubation
4	Total Dissolved Solids (TDS)	TDS meter (Cyberscan 510)
5	Electric Conductivity (EC)	TDS meter (Cyberscan 510)
6	Temperature	Thermometer
7	Turbidity	Turbidity meter (Lutron TU-2016)

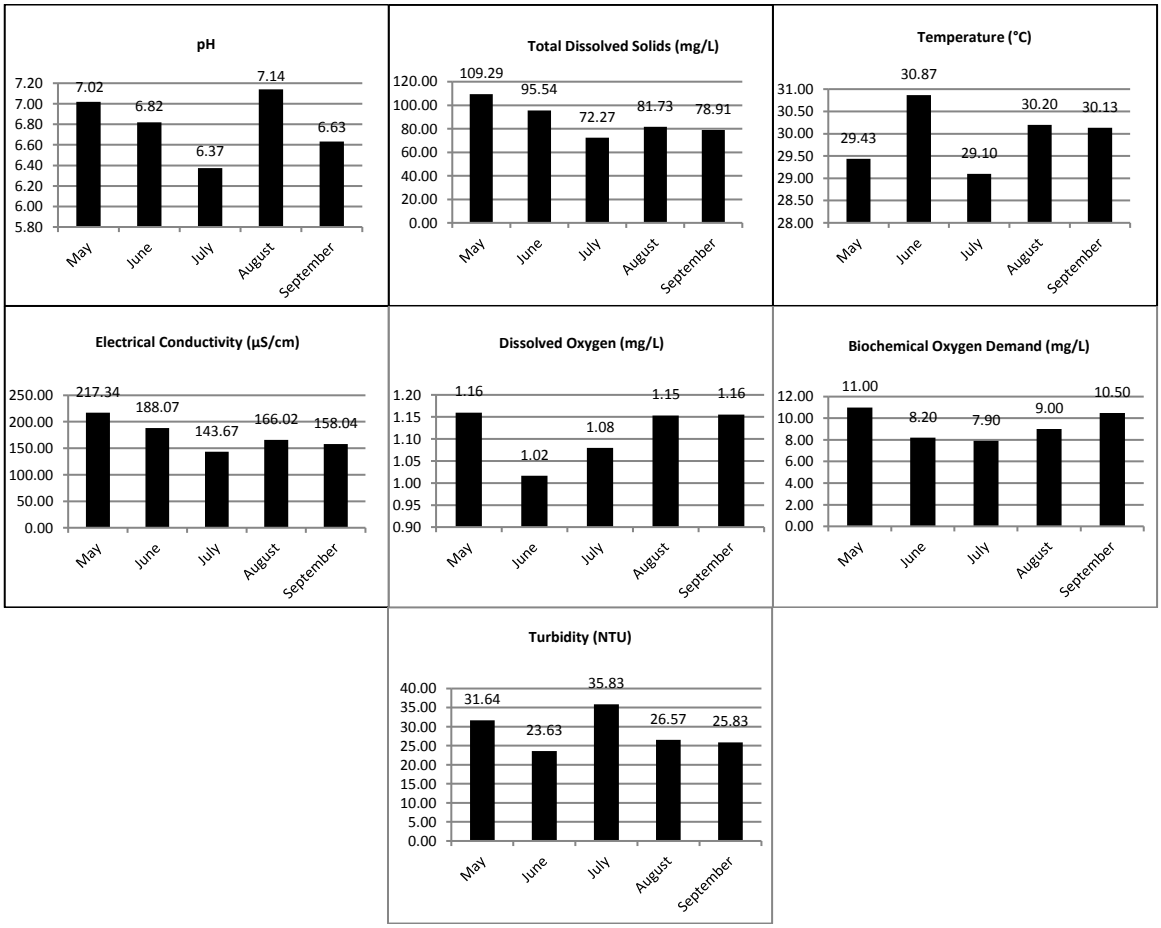
4. Results and Discussion

The values of pH, temperature, TDS, EC, turbidity, DO and BOD of sampling water were measured. The measured values of the test results were summarized to perform statistical analyses and the mean values were compared with the standards set out by the DoE and previous literature available on this subject.

Table 2: Statistical Analyses of Data of the Studied Samples

Parameter	Range (Min-Max)	Mean	Median	Standard Deviation
pH	6.02-7.79	6.84	6.85	0.408
TDS (mg/l)	68.2-145	87.55	79.7	17.849
EC (µS/cm)	136-285	174.63	161	34.342
Temperature (°C)	27-34	29.95	30	1.572
DO (mg/l)	0.6-2.4	1.11	1.0	0.349
BOD (mg/l)	6.7-20	11.79	10.7	3.286
Turbidity (NTU)	13.06-52	28.22	25.9	8.301

Figure 2: Temporal Variation of Different Parameters from May to September in 2016



4.1 Temperature

In case of river water temperature, the DoE standard for sustaining aquatic life is in the range of 20 to 30^{0}C. The mean water temperature (Table 3) for all the sampling stations during five months complies almost with the standard. In a previous study conducted by Saha et al. (2009) found highest temperature of 30^{0}C during rainy season. The higher temperature in the Buriganga river water might suggest having fewer amounts of insoluble pollutants in wet season.

4.2 pH

The acidic or alkaline condition of the water is expressed by pH and the DoE standard of this parameter is 6.5 to 8.5. pH is a major water quality parameter but we did not observe any significant variation in these five study areas. The mean values for all the sampling stations during five months were found within this limit except in the month July, indicating the river water is characterized as neutral from acidity or alkalinity point of view. The pH ranging from 6-9 is suitable for the existence of most biological life (Metcalf and Eddy 2003). We can comment that pollutants in the Buriganga have less influence on pH.

Table 3: Comparison of Investigated Data with the DoE Guidelines and Standard Values for Fisheries

Parameter	DoE standard to maintain the aquatic ecosystem	Bangladesh Standard for Fisheries (EQS,1997)	Investigated Water Quality (mean value)				
			May	June	July	August	Sept
pH	6.5 to 8.5	6.5-8.5	7.02	6.82	6.37	7.14	6.63
DO (mg/l)	5	4.0-6.0	1.16	1.02	1.08	1.15	1.16
BOD (mg/l)	2	(-) or below 2	11.0	8.2	7.9	9.0	10.5
TDS (mg/l)	175	500	109.29	95.54	72.27	81.73	78.91
EC(µS/cm)	350	800-1000	217.34	188.07	143.67	166.02	158.04
Temp (°C)	20 to 30	25	29.43	30.87	29.10	30.20	30.13
Turbidity (NTU)	5 to 50*	5 to 50*	31.64	23.63	35.83	26.57	25.83

*United States Environmental Protection Agency, as no DoE guideline values are available

4.3 EC

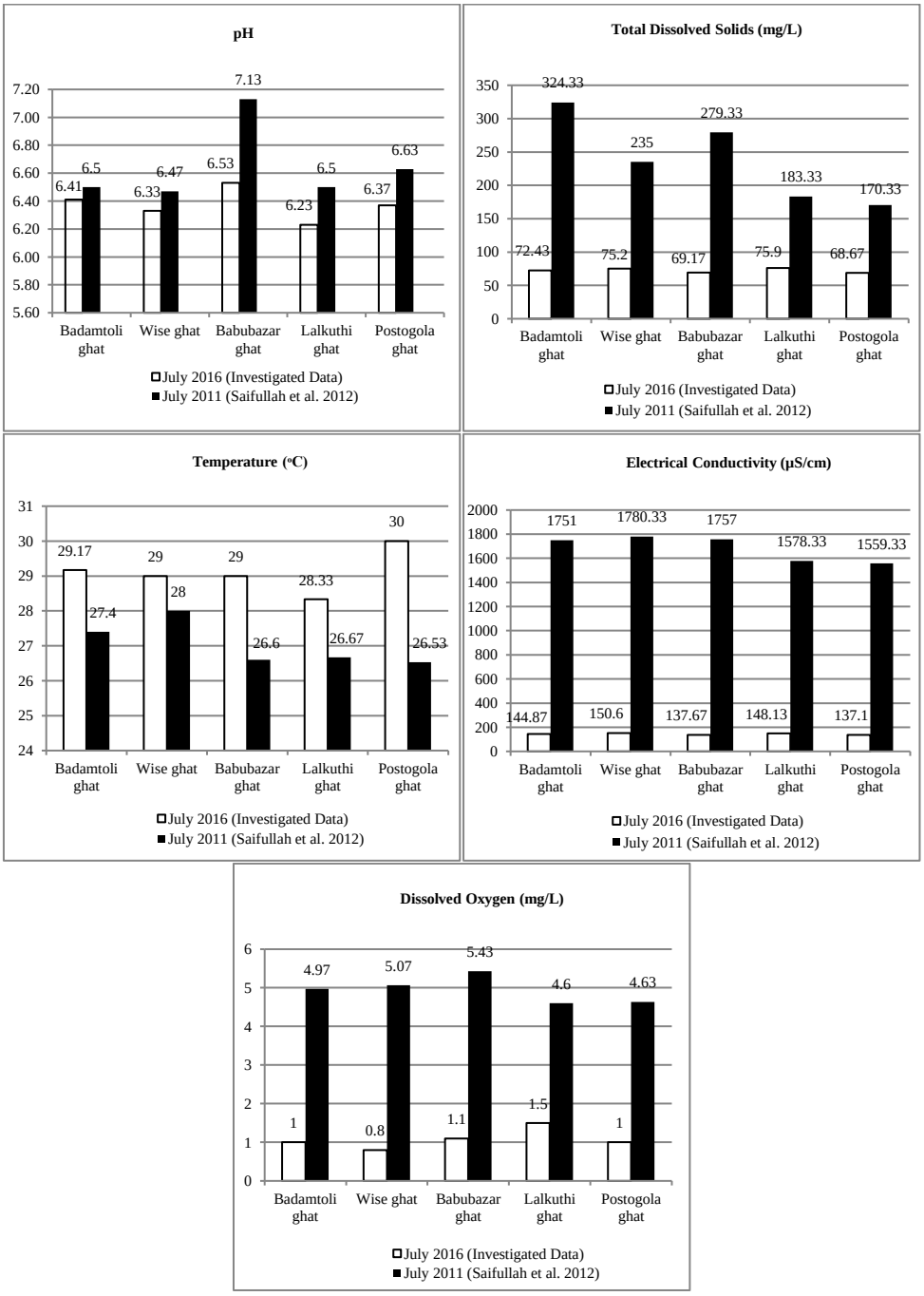
The EC measures the salinity of water and depends on the ions present in water (Alam et al. 2007). The mean values for EC (Table 3) in the Buriganga river during five months (May to September) at five different sampling stations were found much below than the DoE standard, which is 350 µS/cm. Alam et al. (2007) found higher EC in dry season (805 µS/cm) compared to wet season (84 µS/cm). In the dry season, the total volume of water decreases, as a result the conductivity increases. On the other hand in the wet season, as the flow of the river increases which may cause the dilution of the salinity of the water.

4.4 DO

DO is an important water quality parameter for most chemical and biological processes in the water body. In this study, the mean values during five months (Table3) were found drastically below than the DoE standard (5 mg/l for sustaining aquatic life and 6 mg/l for using river water as the source for drinking water supply). Similarly, DO values in five sampling sites were found much lower in the month of July 2016 when compared to that of July 2011 (Figure 3).

This DO depletion in the Buriganga river had occurred probably due to the release of easily oxidized industrial and municipal organic wastes. These wastes are being discharged from several point and non-point sources along the length of the river. It is obvious that in such a heavily polluted and low DO state, no aquatic life can survive and thus the river reaches to a dying stage (Rahman and Bakri 2010).

Figure 3: Comparison of Selected Water Quality Parameters between July 2011 and July 2016



4.5 BOD

The BOD_5 is a measure of the amount of oxygen that bacteria will consume in five days at 20°C while decomposing organic matter under aerobic conditions (Masters 2004). Unpolluted waters typically have BOD values of 2 mg/l or less (Chapman 1996). For the present study it ranges from 6.7 to 20 mg/L in all the sampling stations. In case of BOD_5 the DoE standard for aquatic life is 2 mg/l, which has been exceeded by a certain extent. The normal range of BOD for good water quality is 5-6 mg/l (Huq and Alam 2005).

4.6 TDS

TDS analysis has great implications in the control of biological wastewater treatment processes. A large amount of total solids makes the river water more turbid and increases its electrical conductivity (Srivastava 1996). Comparative spatial variation is shown in Figure 3 where it is clearly evident that the values of TDS are considerably lower at five sites in July 2016 as compared to the same locations in July 2011.

4.7 Turbidity

Although no guideline value for turbidity is provided by the DoE, a range of 5-50 NTU for designated stream use is suggested by the United States Environmental Protection Agency and it varies from one state to another (USEPA 1980). For example, turbidity shall not exceed 50 JTU for all purposes in Florida where as turbidity in surface waters due to discharge of wastes shall not exceed 50 JTU in warm water fishery streams in Arizona. Majority of our observed values were within this range.

5. Conclusion

Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living things (Razo et al. 2004). In addition to that, agricultural, industrial, domestic and commercial purposes cannot be served properly without fresh water. The Buriganga river is economically very important to Dhaka city. But the water of the Buriganga turned putrefying under the huge load of effluents flowing into it. The present study indicates that the water of the Buriganga is being polluted from its surrounding point and non-point sources which included discharge from industries, sewage and municipal waste. The result from data analyses has shown that the water quality of the Buriganga river is not acceptable to aquatic ecosystem for parameters such as DO and BOD for five consecutive months starting from May to September in 2016. On the other hand, the study has also demonstrated that the river water is still acceptable in terms of parameters such as pH, temperature, EC, TDS and turbidity. Dry season was not covered in this research. Otherwise year-round data analyses would have provided a more in-depth representation of water quality and seasonal effect on water quality parameters. The overall mean values of the studied water quality parameters for the Buriganga river are: pH-6.84; temperature-29.95°C; EC-174.63 µS/cm; TDS-87.55 mg/l; turbidity-28.22 NTU; DO-1.11 mg/l; BOD-11.79 mg/l.

The pollution of the Buriganga that used to be occurred by tanneries at Hazaribagh in the capital can be prevented as a consequence of relocation of tanneries to Savar Tannery Estate. Roughly 60% pollution to the rivers around Dhaka are caused by industrial waste while 30% by Dhaka WASA and two city corporations and 10% by household wastes (Matin 2017). Merely tanneries were responsible for around 30% pollution to the Buriganga. Dyeing factories at Shyampur area have now become the main cause of pollution to the Buriganga after the relocation of tanneries. Strong measures should be taken to move them elsewhere from current location. The capacity of Pagla Sewage Treatment Plant needs to be expanded as the untreated portion is being drained to the river without any treatment. Continuous monitoring of

water quality parameters of the river will provide a better picture of spatial distribution and temporal variation. It is crucial to make provision for protection and restoration of water quality of the Buriganga river to sustain the existing ecosystem and overall environment of Dhaka city.

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