WATER QUALITY ASSESSMENT OF THE RIVER BURIGANGA, BANGLADESH

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Abstract

The present investigation was conducted to assess the water quality status of the river Buriganga. Water samples were collected from three selected stations in wet (June-August) and dry (November-January) seasons during the years 2017 and 2018. Temperature and Dissolved Oxygen (DO) of water varied from 22.80 to 31.40 °C and 0.22 to 2.74 mg/L, respectively. Electrical conductivity of water varied from 180 to 598 μS/cm while pH ranged from 7.61 to 8.97. This study showed that temperature, DO and Fe were higher in wet season than in the dry season, whereas pH, conductivity and phosphate were higher in dry season than in the wet season. But manganese did not vary in different seasons. It is found that the differences of water quality parameters were significant in seasons ($p<0.05$) except for Fe and insignificant for stations ($p>0.05$) except for DO. The results reveal that there were significant differences between sampling seasons (wet and dry) ($p<0.05$) except for temperature and manganese. A significant correlation ($p<0.01$) was also found among temperature and other parameters viz. DO, conductivity, pH, phosphate. According to the result obtained in the present study, it may be said that the water quality of the river Buriganga is not acceptable to declare the river-ecosystem as a sound one ecologically.

***Key words**:* Buriganga River, Water quality, Dry and wet seasons.

INTRODUCTION

Water is absolutely vital not only for survival of human beings, but also for plants, animals and all other living organisms (Razo *et al.* 2004). Water bodies, such as, lakes, rivers, ponds and estuaries are the source of water supply in domestic, industrial, agriculture and aquaculture purposes. The Buriganga River flows through south and west of Dhaka city. The water quality of this river has become a matter of concern due to anthropogenic intervention of vital pollutants such as industrial effluents, urban sewage and solid wastes in this area. Buriganga River is at risk to the contamination from untreated municipal wastes, industrial discharges, runoff from organic and inorganic fertilizers, pesticides, insecticides, and oil emission around the river (Kamal *et al.* 1999, Ahmad *et al.* 2010, Islam 2015 and Sikder 2016). The residential and commercial establishments along the river Buriganga cause discharge of wastewater either directly into the river or into drains and canals which subsequently find their way into the river. In recent years, the river has become a dumping ground of all kinds of solid, liquid and chemical wastes which are generated by the activities in and around the river. However, several regulatory measures and policies have been enforced by the Government to protect the river Buriganga from pollution, improvement has not yet been taken place. These reports lack updated and quantitative information on river water quality parameters, which has created confusions on the state of water quality of the river Buriganga. Therefore, it was needed to assess the water quality of Buriganga River. So, this study was conducted to analyze some physico-chemical parameters including temperature, EC, pH, DO, salinity and the PO_4^-, Pb, Fe, Cd and Mn of the River Buriganga for both wet and dry seasons to assess the water quality status of the river.

MATERIAL AND METHODS

Study area and sampling station

The river Buriganga (23° 37' 42'' N, 90° 26' 30'' E) is located in the south and west of the Dhaka city. The length of the river is about 18 km. The average breadth and depth of the river are 14 m and 265 m, respectively (BBS 2005). The average flow of the river fluctuates between 700 cubic m/s in wet (June to October) season and 140 cubic m/s in dry season (November to May) (BBS 2005). Samples were collected at three sampling stations, namely station 1 (St1) (Faridabad, N23.69° E90.42°), station 2 (St2) (Chandnighat, N23.70° E90.42°) and station 3(St3) (Hazaribagh, N23.73° E90.35°), in this study. The location of the study stations has been shown in Fig.1. There are 104 fertilizer industries situated in Faridabad, Fatulla, Bosilla, Damra on the bank of Buriganga river. From these industries, approximately 9000 square meters of effluents are discharged everyday into this river. There are 627 dyeing industries situated beside this river opposite to Chandnighat area (Kamal *et al.* 1999). From these indrustries, 5000 square meters of effluents are discharged daily into the river. There are also 343 tannery industries situated in Hazaribagh on the bank of this river. These tanneries discharge some 21600 square meters of liquid wastes everyday into the river (Kamal *et al.* 1999).

Fig.1. The map showing the study area (1= Faridabad, 2= Chandni Ghat, 3= Hazaribagh).

Sampling and analytical methods

The water samples of the Buriganga river were collected from three different locations (three replicates) in two seasons (wet and dry) during the period from June 2017 to January 2018. The samples were collected from the bank (around 5 meters) in 500 ml non-transparent plastic bottles and were carefully carried to laboratory by ice carrier and preserved in a refrigerator to prevent microbial decomposition of organic and inorganic materials. Water temperature, dissolved oxygen (DO), electrical conductivity and pH were measured by using digital thermometer, DO meter, EC meter and pH meter, respectively in accordance with the standard methods (APHA 2005). Heavy metals (Mn, Fe, Pb and Cd) were estimated by using atomic absorption Spectrophotometry and Colorimetric estimation of phosphate was done by ascorbic acid reductant method (Whatanabe and Olsen 1965). AAS follows the principle that elements in the gas phase absorb light at very specific wavelengths which gives the technique excellent specificity and detection limits. The light of a specific wavelength, appropriate to the element, being analyzed is shown through the flame, the absorption is proportional to the concentration of the element. Quantification is achieved by preparing standards of the element. Data were analyzed by one way ANOVA to show the significant differences among the months and stations. T test were performed to observe the differences between sampling seasons (wet and dry). Pearson correlation analysis was used to study the relationship among the variables.

RESULTS AND DISCUSSION

Water is absolutely vital not only for the survival of human beings, but also for plants, animals and all other living organisms (Razo *et al.* 2004). To assess the water quality status of the river Buriganga the present study was conducted. Sampling areas were divided into three sampling stations. In all the three stations, physico-chemical parameters were recorded and analyzed. Records are tabulated in the Table 1.

Temperature

The mean water temperature was fluctuated from 22.80 to 31.40°C. If there should arise an occurrence of river water temperature, the DOE standard for maintaining aquatic life is within 20 to 30°C. The mean water temperature for all the sampling stations for both dry and wet season complies with the standard. The highest temperature was recorded during the month of August at Station 3 and the lowest water temperature was recorded in December at station1. Physico-chemical parameters were significantly affected by water temperature (Bellos and Sawidis 2005). The cause of higher temperature is a result of atmospheric fact and solar radiation. Beside this, in the both bank of Buriganga river there are many mills and factories constructed and they use Buriganga's water for chilling purposes in various steps of manufacturing of their goods. They are draining out their wastes into the Buriganga river, after cooling operations, which rises the temperature.

Statistical analysis results found that the differences of temperature were significant among the sampling months ($p<0.05$) whereas, the difference was not significant among the stations ($p>0.05$). T test result observed that the difference of temperature was significant between dry and wet seasons ($p<0.05$).

Table 1. Some physico-chemical parameters of Buriganga river at three sampling stations.

Stations	Parameters (Mean ± SEM)							
	Temperature (°C)	**DO (mg/L)**	**pH**	**Conductivity (µS/cm)**	**Phosphate (mg/L)**	**Mn (mg/L)**	**Fe (mg/L)**	**Pb (mg/L)**	**Cd (mg/L)**
St-1	26.70± 0.85	1.01±0.17	8.47±0.07	315.26±29.70	0.33± 0.48	0.18± 0.05	0.84± 0.10	BDL	BDL
St-2	27.09± 0.82	0.45±0.05	8.50±0.08	391.38±46.29	0.56± 0.10	0.12± 0.03	1.24± 0.31	BDL	BDL
St-3	27.44± 0.74	1.21±0.24	8.46±0.11	357.48±41.11	0.38± 0.06	0.19± 0.07	1.41± 0.43	BDL	BDL
Total	27.08± 0.46	0.89±0.11	8.47±0.05	354.71±22.86	0.42± 0.43	0.16± 0.03	1.16± 0.18		

BDL: Below Detection level

Dissolved oxygen (DO)

The mean of DO concentration for six months sampling ranged from 0.22 to 2.74 mg/L. The maximum DO was recorded during July at Station 3 and the minimum during August at Station 2. The DO of all sites was very low. This indicates that the decrease in DO in Buriganga is mainly due to its location beside the urban areas of Dhaka. This diminishment in value is because of the high release of organic material, e.g. from sewage treatment works, storm floods, farming slurry, silage alcohol. Such low values do not bolster the survival of aquatic life. As per the environmental quality standard (EQS), the accompanying requirements for DO are endorsed: 6 mg/L for drinking, 4 to 5 mg/L for entertainment, 4 to 6 mg/L for fish and domesticated animals and 5 mg/L for industrial application. It was found that the difference in DO was significant among the sampling months and stations ($p<0.05$). t-test result showed that the difference in DO was significant between dry and wet season.

pH

The mean of pH value for six months sampling varied from 7.61 to 8.97. The maximum value of pH was noted during September at Station 1and the minimum pH value was recorded during January at Station 3. The optimum limit of pH for fish culture is from 6.5 to 8.0 (ECR 1997, Meade 1998, ADB 1994). The pH acceptable limit for inland surface water is from 6.5 to 8.5 (EQS 1997). This study observed that the pH of all sampling locations was within the optimum range. It also met the DoE standard (6.5 to 8.5). pH significantly influences biological activity. It additionally influences a few properties of water body, activity of creature and viability of poisonous substances exhibit in the aquatic environment. The estimation of alkalinity and pH is expected to decide the corrosiveness of the water.

Statistical analysis results found that the difference of pH value was significant among the sampling months ($p<0.05$) whereas, the difference was insignificant among the stations ($p>0.05$). t-test result showed that the difference of pH value was significant between dry and wet season ($p<0.05$).

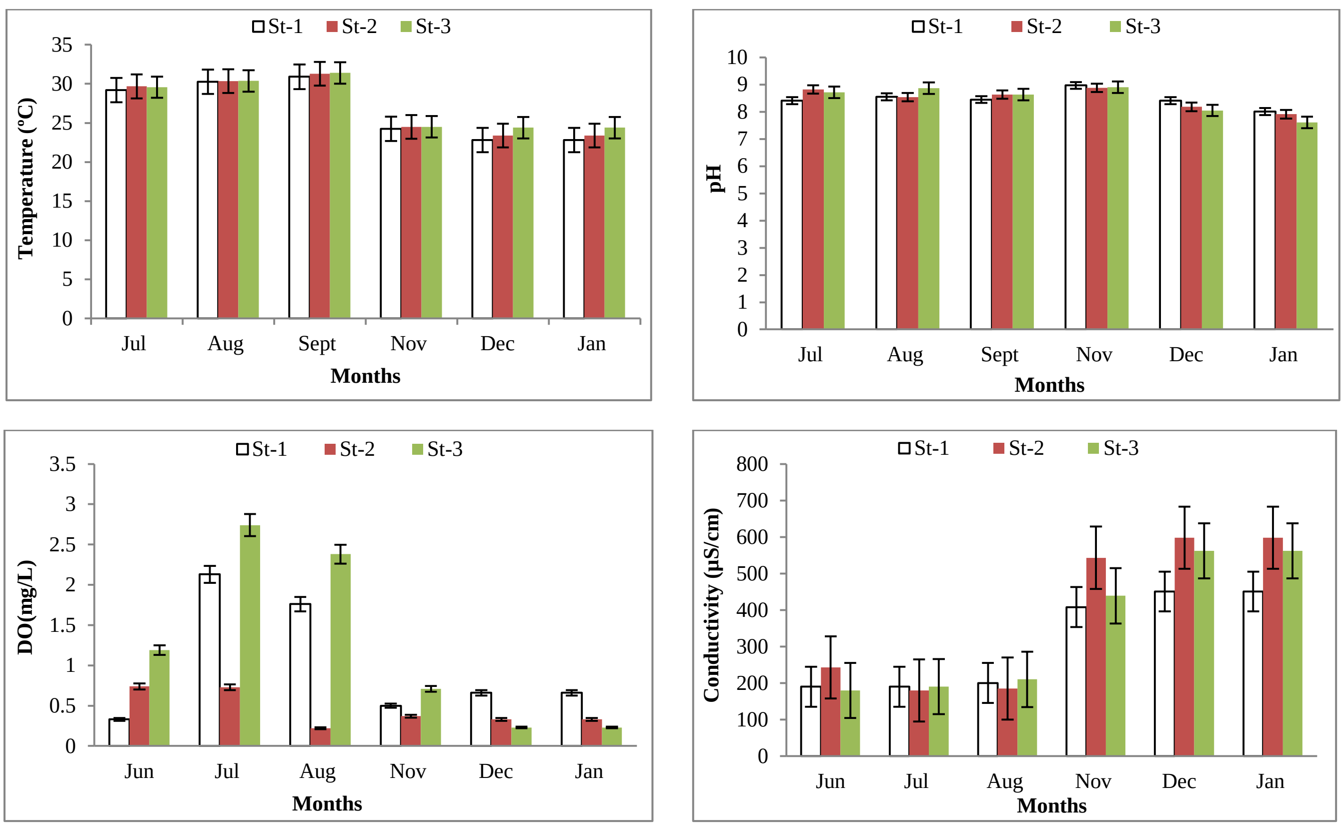

Fig. 2a. Spatial variation of physico-chemical parameters in different months in experimental stations.

Conductivity

The mean conductivity of water for six months sampling varied from 180 to 598 µS/cm. The minimum conductivity was found during the months of June and July at Station 3 and 2, respectively and maximum was recorded during the months December and January at Station 2. The dilution of salinity of the water may occur because of the flow of river increases in the wet season, while EC increases in the dry season because of the flow of river decreases. The mean values for EC in the Buriganga river at all three different sampling stations (Table 1) were nearly compiled with the DOE standard, which is 350 µs/cm. One way ANOVA analysis results showed that the difference in water conductivity among the sampling months was significant ($p<0.05$) whereas, the difference was not significant among the stations (p>0.05). t-test result showed that the difference of conductivity was significant (p<0.05) between dry and wet season.

Dissolved phosphate

The mean dissolved phosphate concentration for six month samplings ranged from 0.102 to 1.019 mg/L. The maximum dissolved phosphate concentration was found during the month of January at Station 2 and the minimum was found during the month of June at Station 3. All the observed values for phosphate were found below the standard value of DOE during both dry and wet seasons which are suitable for aquatic life. So, it can be said that the water of the Buriganga river is somewhat harmless in terms of phosphate pollution.

Results found that difference in phosphate concentration was significant (p<0.05) among the sampling months whereas, difference was not significant (p<0.05) among the stations. t-test result showed that difference was significant (p<0.05) between dry and wet season.

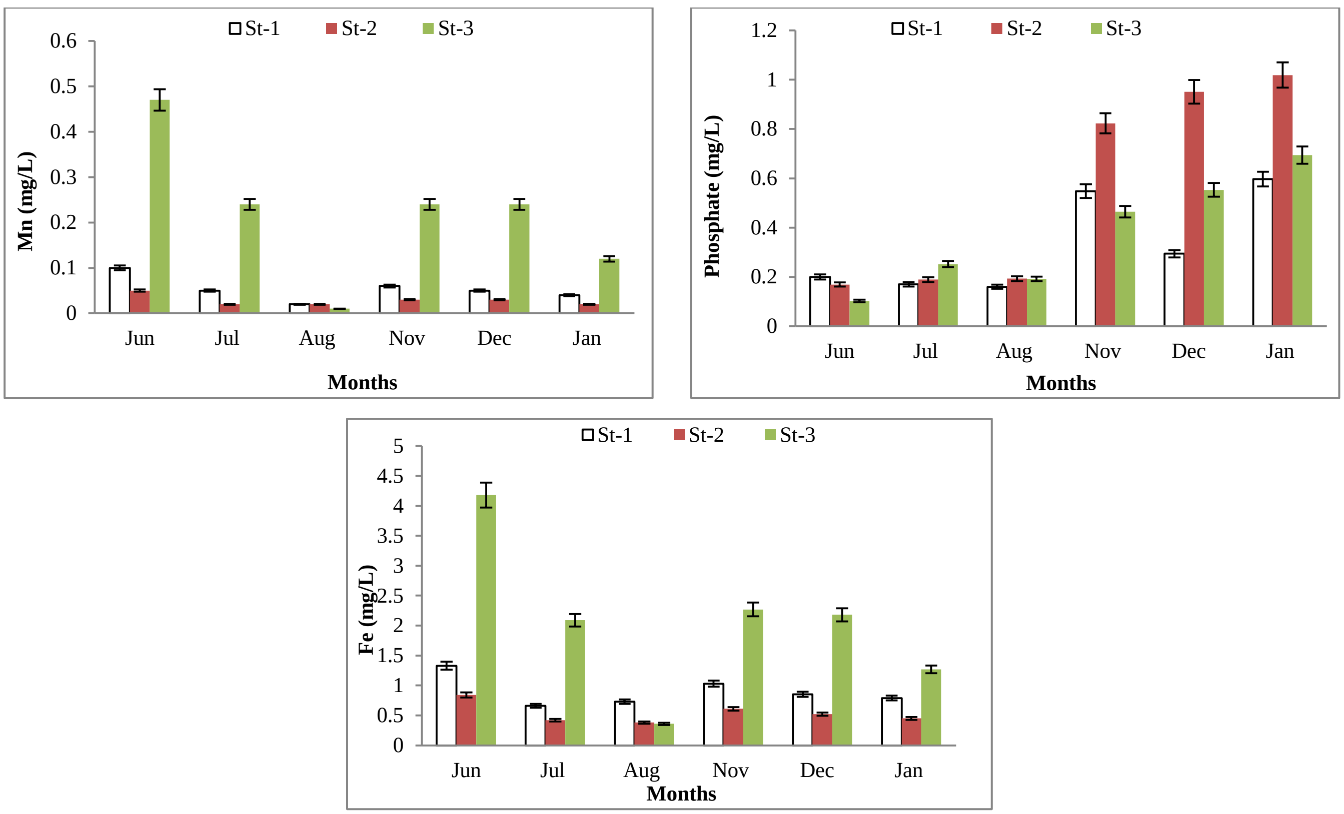

Fig. 2b. Spatial variation of physico-chemical parameters in different months in experimental stations.

Manganese

Results showed that mean concentration of manganese for six month samplings varied from 0.01 to 0.47 (mg/L). The minimum concentration of manganese was recorded during August at Station 3 and maximum was found during June at Station 3. According to FAO, the maximum permissible concentration of manganese for irrigation water is 200 µg/L and for drinking water purposes is 50 µg/L. The concentration of manganese found in this study is higher than that of the optimum acceptable range of drinking water. So, it is necessary to treat the water of the Buriganga river before using for drinking or irrigation purposes.

One way ANOVA analysis results found that manganese was significantly ($p<0.05$) different among the sampling months whereas, manganese was not significant ($p<0.05$) among the stations. t-test result showed that manganese was not significant ($p<0.05$) between dry and wet season.

Iron

The mean concentration of iron for six month samplings ranged from 0.36 to 4.18 (mg/L). The lowest concentration of iron was found during August at Station 3 and highest was found during June at Station 3. Iron was insignificant ($p<0.05$) among the sampling months and stations whereas, phosphate was not significant ($p<0.05$) among the stations. t-test result showed that difference in phosphate concentration in water was significant ($p<0.05$) between dry and wet season.

Lead and Cadmium

Pb and Cd were not found within the detection limit (0.02 mg/L for Pb and 0.01 mg/L for Cd). Alam *et al.* (2003) found that in the Buriganga river Pb concentration varied between 0.1 and 0.7 μg/L in rainy season, and 5-14.4 μg/L in dry season, which are much lower than the present study. Khan *et al.* (1998) found that the concentration of Pb ranged from 0.012 to 0.43 μg/mL, which are much lower than the current study.The lead concentration for all the samplings were below the optimum concentration (0.05mg/L) of DOE which is suitable for aquatic life during both dry and wet seasons. Alam *et al.* (2003) found that in Buriganga river the Cd concentration varied between BDL (beyond detection limit-0.2 μg/ L) and 1.0 μg/L in rainy season and 1.7-10.60 μg/L in dry season. So, it can be said that the water of the Buriganga river is not contaminated in perspective of Pb and the current value of its concentration caused no matter of concern.

Pearson correlation analysis showed that correlations exist among temperature and other parameters, such as DO, conductivity, pH, phosphate at significant level ($p<0.01$). Correlations also present among DO and other parameters, such as conductivity, pH, phosphate and Fe at significant level ($p<0.01$). Correlations exist among conductivity and other parameters, such as pH, phosphate at significant level ($p<0.01$). Correlation also exists between pH and phosphate (Table 2).

Table 2. Correlation matrices of water quality parameter of the Buriganga river.

	Temperature	DO	Conductivity	pH	Phosphate	Mn	Fe
Temperature	1						
DO	0.573**	1					
Conductivity	-0.923**	-0.568**	1				
pH	0.428**	0.354**	-.525**	1			
Phosphate	-0.749**	-0.458**	0.851**	-0.442**	1		
Mn	-0.090	-0.178	0.066	-0.055	0.081	1	
Fe	-0.215	-0.272*	0.224	-0.119	0.153	0.087	1

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

The results from data analysis showed that the water of the Buriganga river is not safe as shown in the values obtained in the parameters, such as DO, EC, phosphate, Pb during both dry and wet seasons. On the other hand, the study has also revealed that the river water is still acceptable in both dry and wet seasons from parameters, such as pH and temperature perspectives. This study shows that the water quality of the river Buriganga is being contaminated from its adjacent point and non-point sources including municipal wastewater and effluents from different industries. Continuous monitoring of water quality is necessary to save the Buriganga river.

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