ASSESSMENT OF SELECTED PHYSICO-CHEMICAL PARAMETERS OF THE BURIGANGA RIVER, BANGLADESH

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ABSTRACT: A study was conducted on the physico-chemical parameters in the Buriganga River at Wise Ghat and Postogola Bridge, Dhaka, Bangladesh, on a monthly basis from October 2023 to September 2024. The purpose of this study is to evaluate the present water quality status based on six selected physico-chemical properties of water including water temperature, transparency, total dissolved solids (TDS), electrical conductivity (EC), pH and dissolved oxygen (DO). Minimum average temperature was observed 19.4 °C in January while maximum average temperature was 33.6 °C in November. The Minimum and the maximum value of average transparency of the river water was determined as 21.8 cm in May and 52.6 cm in October, respectively. Minimum average TDS was 85 ppm in July and maximum average TDS was 403 ppm in May. Minimum average EC was 150 µS/cm in October and maximum average was 589.5 µS/cm in May. pH of the water found more stable round the year which ranged from 7.4 to 7.8 and annual mean pH value was 7.62. DO of the water showed a greater fluctuation, which ranged from 0.9 ppm in May to 7.25 ppm in September. Some parameters were not within the standard limit for aquatic life. A regular monitoring system could be developed to prevent further deterioration of water condition and restoration of the ecosystem of the Buriganga River.

Key Words: Physico-chemical parameters, Buriganga River, Sucker fish.

INTRODUCTION

A river, contributing a country's economy in many ways including agriculture, tourism, transportation etc. and also playing vital role in ecosystem by supporting biodiversity. Bangladesh, a South Asian country, blessed with around seven hundred rivers, the total length of its waterways is about 13,000 km (Banglapedia, 2023) and her landscape is provided by the rivers. Rivers play crucial role in counteracting adverse climatic condition such as flash flood,

salinity intrusion and contributing to the country's economy by holding abundant fish and other aquatic resources, thus became an integral part of life of the citizens of Bangladesh. Agricultural sector of the country heavily depends on the river system and one of the most important transportation means of the country relies on waterbodies, that's why seasonal and regional availability of river water greatly dominate the country's economy and environment. However, unplanned urbanization, industrialization, pollution, changes in hydrological system, dumping of solid waste, oil spill from aquatic vehicles etc. overshadowing the past pride of Bangladesh rivers. The capital city of Bangladesh which is Dhaka, also known as world's largest megacity was established on the northern bank of the Buriganga River. It is one of the most important rivers around Dhaka city in terms of irrigation, transportation, sewage and industrial waste disposal etc. One of the courses of Ganges renamed as Buriganga after losing its connection with Ganges, which was previously connected with the Bay of Bengal through Dhaleswari. Average depth of the Buriganga River is about 10 meters and the length is 27 km (Banglapedia, 2023). The Buriganga River meets the Turag River in upstream and junction with the Dhaleswari River in downstream and receives its main water flows from the Turag River. This river is economically important to Dhaka and majority the people of the country rely on this river for transportation (Salman *et al.* 2018). Local people use this river for their domestic purpose as well. At present, this river is significantly polluted because of discharging of industrial effluents, urban sewage as well as solid waste caused by human activities in the area (Ahammed *et al.*, 2016). Industrial effluents mainly originated from textile and dyeing factories situated along its bank which rarely have wastewater treatment facilities. Approximately 21,600 square meters of liquid wastes discharged previously everyday into the Buriganga from the tanneries of Hazaribagh area (Kamal *et al.*, 1999). These harmful effluents are severely polluting the Buriganga River. 627 dyeing industries were located beside the Buriganga River near Zinzira, Keraniganj areas (Kamal *et al.*, 1999). Effluents of these industries comprised epoxy, polyurethane, enamel, ductile silvery white metal, hydrochloric acid, alkalis, lime, caustic soda, aluminum, zinc chromate, zinc phosphate, asbestos etc. (Rahman and Bakri, 2010). These pollutants from industries significantly deteriorate not only the aquatic ecosystem but also the human health through process of biomagnification (Ray, 1994). Additionally, man-made activities such as cleaning, washing, bathing etc. also pollutes the water of Buriganga river (Ahammed *et al.* 2016). However, this river provided with specific attention from government through enacting various policies including National Environmental Policy 1992, Industrial Policy 1999 and National Water Policy 1999. In Environmental Conservation Act 1997 and Environmental

Conservation Rules 1995, the Government's interest for protecting rivers from pollution has been reflected and specific measures were implemented to increase water quality standards of Buriganga River, which includes transferring the 148 tannery industries from Hazaribagh area to Savar in March 2017. Upon enforcing several policies, yet significant improvement has not been observed, according to various report on the quality of water of the Buriganga River. These reports lack detailed updated information. So, an investigation on the Buriganga river was needed to assess its present condition. For this purpose, this study was undertaken to provide updated information on several water quality parameters including temperature, transparency, total dissolved solids (TDS), electrical conductivity (EC), pH as well as dissolved oxygen (DO).

MATERIAL AND METHODS

Study area: The samples of water were collected from the Buriganga River, passing through west and south of Dhaka which is the capital of Bangladesh. For this study two points of the river were selected namely Wise Ghat (site 1: 23.707483 N, 90.405848 E) and another point is Postogola Bridge (23.687080 N, 90.427027 E), also known as Bangladesh China Friendship Buriganga Bridge 1. (Fig 1).
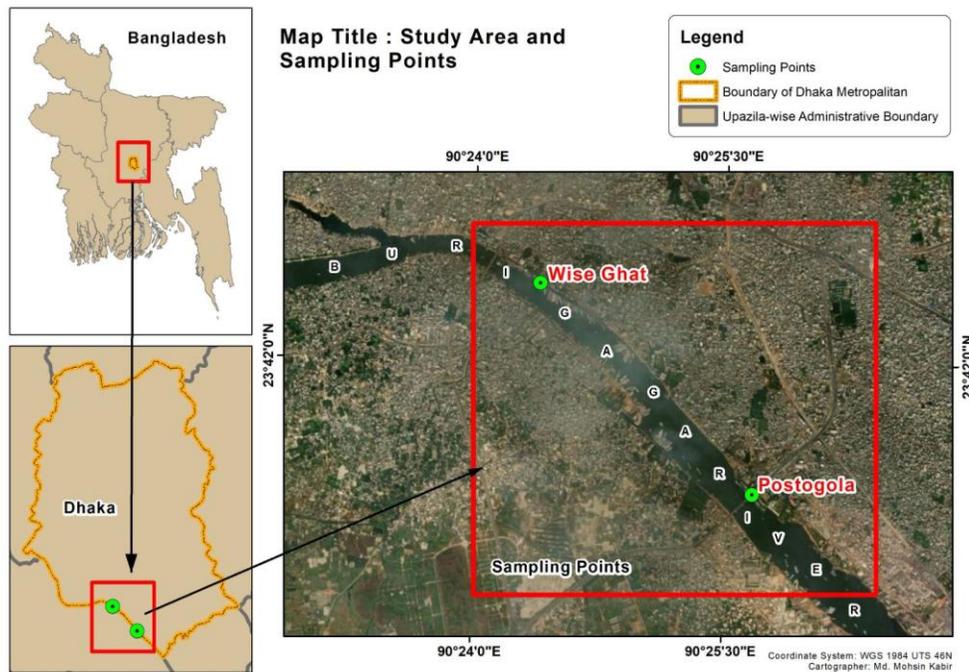

Fig. 1. Map of the study area denoting the sampling sites (Green circle).

Sample collection: The sampling of water was carried out once in a month from October 2023 to September 2024. A total of 12 months' samples were collected and all those collections were made at early in the morning. After collecting surface water samples with high density PVC bottle, samples were immediately taken into laboratory for analysis and these were collected from sampling area to laboratory by black bag. Two physical parameters including temperature and water transparency was examined at the sampling site. One chemical parameter, DO also measured at the sampling site.

Analyses: The surface water temperature was measured using a standard mercury thermometer. To determine temperature, thermometer was dipped into the water and wait for 1-2 minutes before taking final reading. The transparency of water was determined using Secchi disc of about 20 cm diameter and final measurement was taken applying following formula:

$$Zs = (d_1 + d_2)/2$$

Where, Zs indicates transparency of water, d_1 is the invisibility point of Secchi disc and d_2 is the last visibility point of Secchi disc. And during transparency measurement technique of Alzaman and Boyd (1978) was followed. Total dissolved solids (TDS) along with electrical conductivity (EC) was evaluated with the help of TDS and EC meter, (Adwa kft, Romania). After measuring TDS and pressing the mode button allowed to measure EC. The concentration of hydrogen ion or pH of water sample was determined using a pH meter (model HANNA H196107). Before measuring pH instrument was calibrated using buffer solution in which pH value was 7.0 in accordance with standard method. Dissolved oxygen (DO) was measured with a DO meter (Lutron, DO-5509).

RESULTS AND DISCUSSION

The average weather parameter including day length, temperature, humidity and average monthly rainfall in Dhaka over 12-month period from October 2023 to September 2024 presented in the Table 1. Daylight duration varied slightly throughout the year, ranging from 11 hours 1 minutes in November to a peak of 13 hours 35 minutes in June. Longer day lengths were observed during the pre-monsoon as well as monsoon seasons, consistent with the region's subtropical climate. The average monthly temperature represented seasonal variation, with the lowest temperature in January i.e. 18 °C and highest in April i.e. 32 °C. Temperature remained relatively high from April to September, then gradually declined. Humidity was higher during the monsoon months, peaking at 82% in August and lowest in February i.e. 57% and remained low from February to April. Among the water quality parameters, the DO showed positive relationship with the humidity. The DO level increased

during the monsoon season when the humidity was also increased, whereas, it declined in the winter season along with the humidity. Rainfall was markedly seasonal. The monsoon recorded the highest monthly rainfall, with a maximum of 426.97 mm was recorded in July. In contrast, the winter recorded minimal rainfall, with amounts below 30 mm per month. Lowest was observed in February as 7.62 mm. The DO level steadily declined with decreasing average rainfall from November to April. Then, it started to increase along with the rainfall during the monsoon season. Similarly, transparency increased along with the rainfall and gradually declined in winter. In contrast, other water quality parameter i.e. TDS, EC showed inverse relationship with rainfall (Table 3). These parameters decreased during the monsoon and increased in the winter season. Whereas, rainfall had no significant impact on pH value throughout experimental period.

Table 1. Meteorological parameters of research area during the experimental period.

Month	Day Length	Temperature (°C)	Humidity (%)	Rainfall (mm)
October-23	11 hours 40 min	29	73	150
November-23	11 hours 1 min	26	65	27
December-23	11 hours 41 min	22	74	11
January-24	11 hours 50 min	18	75	9.85
February-24	11 hours 21 min	23	57	7.62
March-24	12 hours 1 min	27	60	23.11
April-24	12 hours 43 min	32	59	144.53
May-24	13 hours 20 min	31	68	241.55
June-24	13 hours 35 min	31	78	324.61
July-24	13 hours 28 min	30	78	426.97
August-24	13 hours	29	82	347.22
September-24	12 hours 18 min	30	78	215.14

Slight differences in temperature was recorded at both of the experimental sites of the Buriganga River throughout the year. The annual mean temperature of the River Buriganga was 26.58 °C (Table 2). Minimum average temperature was 19.4 °C while maximum average temperature was 33.6 °C (Table 2). Minimum seasonal mean temperature was 24.2 °C in winter and maximum seasonal mean temperature measured in monsoon, which was 29.94 °C (Table 3). Minimum and maximum temperature of Wise Ghat was 19.5 °C in January and 33.8 °C in November. Minimum and maximum temperature of Postogola Bridge was 19.3 °C in January and 33.4 °C in November (Fig. 2). Monthly fluctuations of temperature of both sites presented in Fig. 2. Mustari *et al.* (2021) reported that temperature fluctuations of the Buriganga River between 21.4 °C to 30.0 °C, that is quite similar to the current study. Previous study by Uddin *et al.* (2016) reported temperature, ranged from 18 °C to 24 °C. In water the solubility of gases are controlled by temperature (Habib *et al.*, 2020). Along with solar radiation, waste dumped by factories are responsible for rises in temperature by

chemical breakdown. The rate of chemical reaction generally increases higher temperature (Alam *et al.*, 2007).

Annual mean transparency of water of the Buriganga River was 33.29 cm and minimum and maximum average transparency was measured as 21.8 cm and 52.6 cm, respectively (Table 2). The seasonal mean transparency was lowest during summer period, which was 25.21 cm and highest seasonal mean transparency was 40.01 cm in Monsoon (Table 3). During the study period transparency of water found ranged from 21.7 cm in Wise Ghat in May to 54.3 cm in Postogola Bridge in October (Fig. 3). Saifullah *et al.* (2012) found a fluctuation of transparency of the Buriganga River water fluctuated between 18 and 29 cm. In contrast, present study observed different transparency level, indicating a variation in water clarity that may be attributed to temporal or environmental differences between the sites. Hossain *et al.* (2012) reported that transparency of productive fresh water body usually varied from 35 cm to 45 cm. Result of investigation highlighted that Buriganga River water was not within this tolerable limit and not appropriate for aquatic organisms.

Assessed annual mean TDS of water of the river was 241.71 ppm (Table 2). Minimum average TDS was 85 ppm and maximum average TDS value was 403 ppm (Table 2). Lowest seasonal mean TDS was 91.63 ppm in monsoon and highest seasonal mean TDS was 349.13 ppm, measured in summer (Table 3). Through the year-round, minimum TDS was recorded as 75 ppm in July at Postogola Bridge and maximum TDS was recorded as 406 ppm at Wise Ghat in the month of May (Fig. 4). Monthly fluctuation of TDS shown in Fig. 4. Saifullah *et al.* (2012) reported that the fluctuations of TDS value of the water of Buriganga River ranged from 471 to 692 ppm. Mustari *et al.* (2021) observed that the TDS value of all examined samples of the Buriganga River was within the range of 60 to 639 ppm during their investigation period. Water with excess TDS is toxic to aquatic animals (Peng *et al.*, 2020). Removal of TDS from waste water can be done by physical adsorption, bacteria based bioremediation (Pinto *et al.*, 2015). Removal of TDS from water can also be done by microalgae because they absorb organic and inorganic nutrients. As per the USEPA standard the acceptance limit of TDS is 500 ppm (Krishnamoorthy *et al.*, 2019).

Annual mean value of EC was measured as 378.58 µS/cm and minimum average EC was 150 µS/cm and maximum average EC was 589.5 µS/cm (Table 2). In case of seasonal EC value, lowest EC was 172.25 µS/cm in monsoon and highest was 516.88 µS/cm, measured in summer (Table 3). Monthly fluctuations of EC of the water sample from both sites shown in Fig. 5. A previous study by Saifullah *et al.* in 2012 found EC fluctuations of the Buriganga River water from 1559 to 1780 µS/cm. Mustari *et al.* (2021) observed the EC fluctuations of water

of the Buriganga River from 125 µS/cm to 1238µS/cm. Conductivity of water relies on several parameters including water temperature, salinity, TDS, flow of water, changes of water level. Usually water inflow decreases conductivity values but highly mineralized ground water inflow of clay soil increased conductivity because minerals in clay soil will ionized when they dissolved. For 1°C increase in temperature, conductivity value increased 2-4%. Rain itself can contribute to increase in higher conductivity in comparison with pure water because of incorporation of gases along with dust particles. Although heavy rainfall declines the conductivity of water body because it dilutes total dissolved solids.

Table 2. Annual average values of physico-chemical parameters in the Buriganga River

Parameters	Unit	Minimum	Maximum	Mean
Temperature	(°C)	19.4	33.6	26.58
Transparency	(cm)	21.8	52.6	33.29
Total dissolved solids (TDS)	(ppm)	85	403	241.71
Electrical conductivity (EC)	(µS/cm)	150	589.5	378.58
pH	-	7.4	7.8	7.62
Dissolved oxygen (DO)	(ppm)	0.9	7.25	3.6

Table 3. Seasonal average value of physico-chemical parameters of two selected sites in the Buriganga River

Season	Month	Temperature (°C)	Transparency (cm)	TDS (ppm)	EC (µS/cm)	pH	DO (ppm)
Summer	Mar-24	22.65	25.3	389.5	576	7.75	1.15
	Apr-24	25.9	22.75	400	586	7.65	0.9
	May-24	26.9	21.8	403	589.5	7.7	1.05
	Jun-24	26.9	31	204	316	7.4	2.35
Average		25.59	25.21	349.13	516.88	7.63	1.36
Monsoon	Jul-24	29.3	39.75	85	174	7.6	4.9
	Aug-24	29.45	38.75	91.5	176	7.55	6.7
	Sep-24	30.4	28.95	100	189	7.65	7.25
	Oct-23	30.6	52.6	90	150	7.4	6.15
Average		29.94	40.01	91.63	172.25	7.55	6.25
Winter	Nov-23	33.6	47.2	156	288	7.6	5.3
	Dec-23	24	36.1	252.5	407	7.65	3.5
	Jan-24	19.4	28.9	352	539	7.8	2.6
	Feb-24	19.8	26.35	377	552.5	7.7	1.3
Average		24.2	34.64	284.38	446.63	7.69	3.18

Annual mean pH was 7.62, which is slightly alkaline (Table 2). Minimum average pH was 7.4 and maximum average pH was 7.8 (Table 2). Lowest seasonal mean pH recorded in monsoon, which was 7.55 and highest seasonal mean pH was 7.69 in winter (Table 3). pH value was more or less similar with little fluctuations in both sites, which ranged from 7.3 to 7.8 (Fig. 6). Saifullah *et al.* (2012) found pH value of Buriganga River water ranged from 6.63 to 7.83.

Mustari *et al.* (2021) found that pH value of Buriganga River water fluctuated between 6.88 and 7.98. It was reported by Bhatia (2006) that aquatic biota is sensitive to pH. Toxic algal bloom such as *Microcystic aeruginosa,* which is harmful to fish, allowed to grow at higher rate by higher pH value of water (Nasar and Munsi, 1974).For the culture of fish, optimum level of pH ranged from 6.5-8.0 (ECR, 1997). Acceptable limit pH for inland surface water is ranged from 6.5-8.5 (EQS, 1997). From this view it can be said that water from both site is suitable for aquatic organism but during study period aquatic organism rarely seen except Suckermouth Catfish. It also met DoE standard (6.5-8.5).
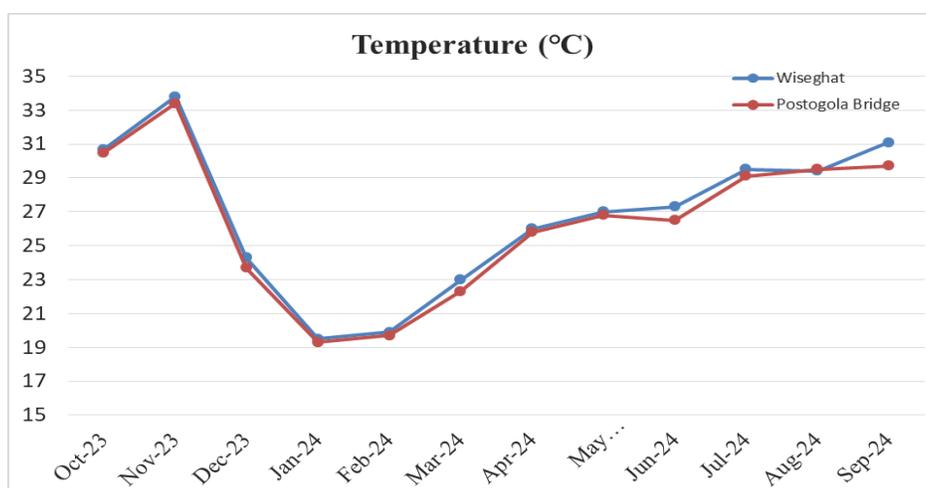
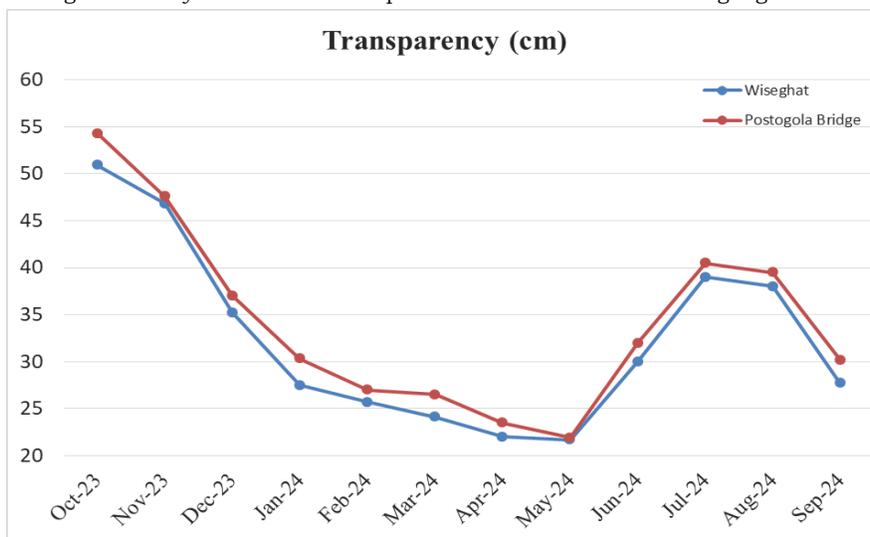Fig 2. Monthly fluctuation of temperature at two sites of the Buriganga River.

Fig 3. Monthly changes of transparency at two sites of the Buriganga River.
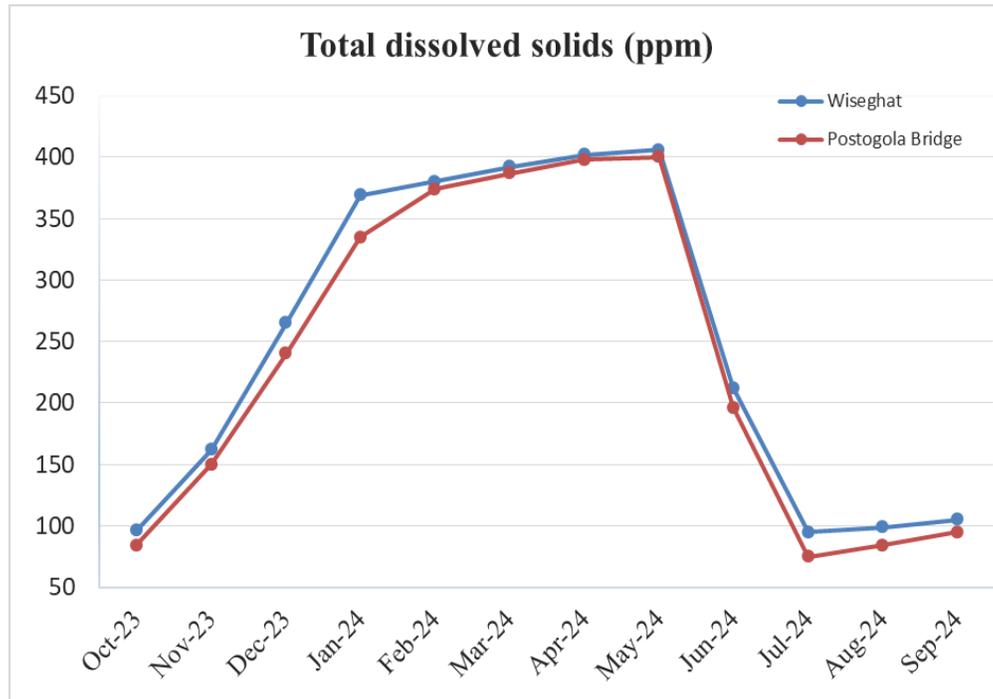
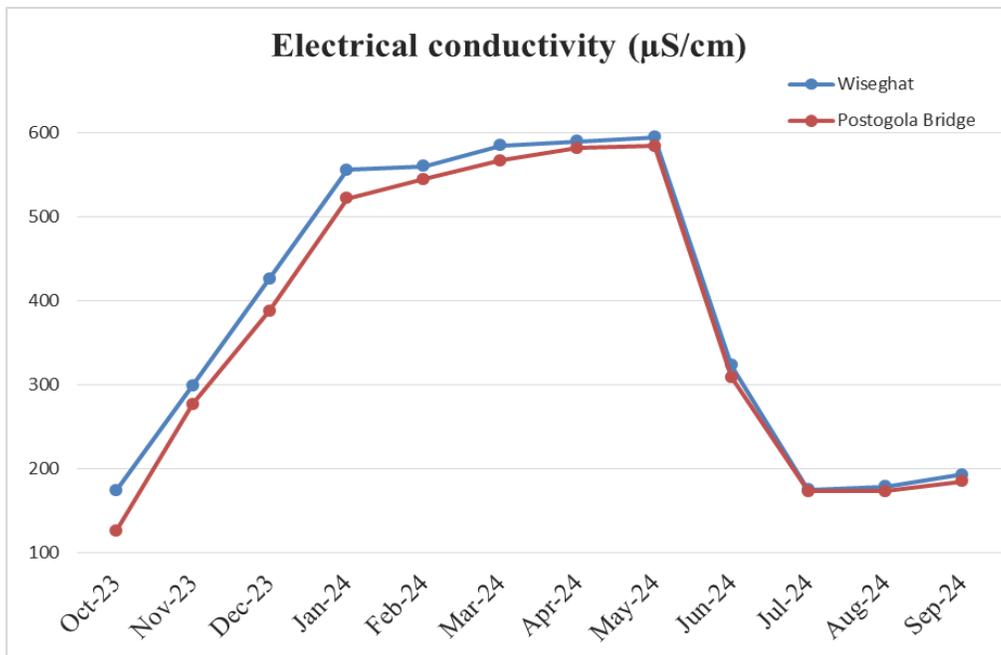Fig 4. Monthly total dissolved solids at two sites of the Buriganga River.

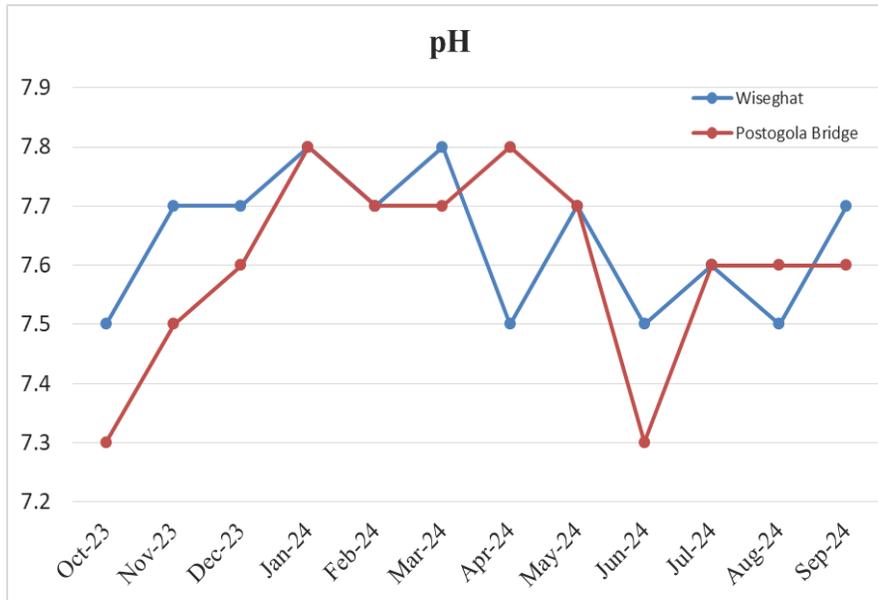Fig 5. Monthly fluctuation of electrical conductivity at two sites of the Buriganga River.

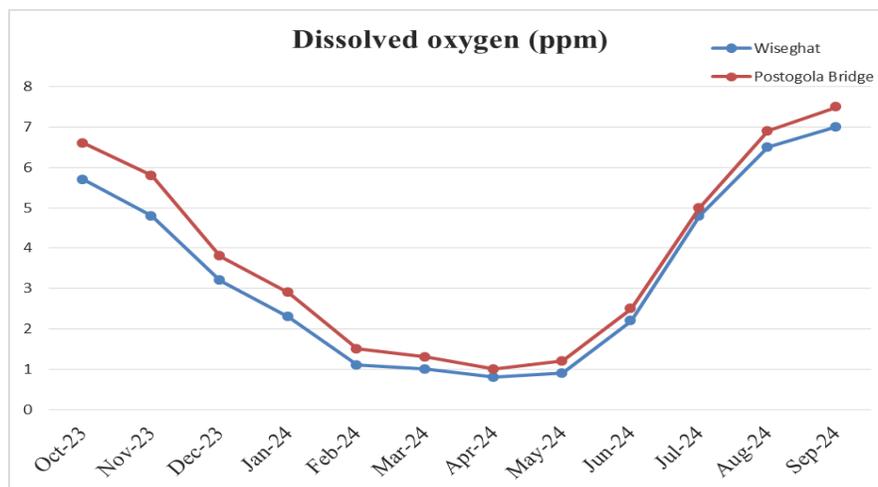Fig 6. Monthly fluctuation of pH at two sites of the Buriganga River.

Fig 7. Monthly fluctuation of dissolved oxygen at two sites of the Buriganga River.

Annual mean DO was 3.6 ppm (Table 2). Minimum average DO was 0.9 ppm and maximum average DO was 7.25 ppm (Table 2). Seasonal mean DO was lowest in summer, which was 1.36 ppm and highest in monsoon, which was 6.25 ppm (Table 3). DO level of the Buriganga River water showed a greater monthly fluctuation, which ranged from 0.8 ppm in April in Wise Ghat to 7.5 ppm in September in Postogola Bridge (Fig. 7). Mustari *et al.* (2021) observed

DO value of the water Buriganga River ranged from 0 to 4.9 ppm. It is a major water quality parameter for the survival of aquatic organisms in an aquatic ecosystem (Kumar *et al.*, 2011). Highest concentration of dissolved oxygen was recorded by Shaikh *et al.* (2016) from Buriganga River in Rainy season. It was stated by Shaikh *et al.* (2016) that, 8 ppm of Dissolved Oxygen value is standard for river water. The standard amount of DO in water of river should not be below 5 ppm, stated by Boyd in 2015. Estimated DO value from present study was not within this limit and not satisfactory for aquatic organisms.

CONCLUSION

The continuous discharge of industrial effluents along with household waste, fruit waste and textile waste has significantly deteriorated the status of the river water. The findings of the study clearly indicate that the river is not suitable for aquatic life. During the study period a limited number of freshwater fish or other aquatic organism were observed with the exception of the suckermouth catfish.

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