Bangladesh J. Bot. **53**(3): 589-596, 2024 (September) DOI: https://doi.org/10.3329/bjb.v53i3.76279

IMPACT OF INDUSTRIAL EFFLUENTS ON BURINGANGA RIVER AND ITS TRIBUTARIES

SHAHREAR AHMAD*, MD EUNUS MIA, MD JANNATUL HASAN JIHAD, SHARMIN AFROZ, MOHAMMAD MONIRUZZAMAN[1] AND BADHAN SAHA[1]

Department of Botany, Faculty of Life and Earth Sciences, Jagannath University, Dhaka-1100, Bangladesh

Keywords: Buriganga river, Contamination, Water quality, Industrial effluents, Heavy metals

Abstract

Many rivers throughout Bangladesh are now under threat due to both human-made and natural causes. In this context, we described the Buriganga river system, its uses of the river, its level of pollution, and its sources of pollution. The present condition of the Buriganga water and its surrounding areas soils and plants might not be suitable for fisheries and irrigation; it has been observed that sampling points of 9,10,11 were highly polluted, with sampling point 7 with the highest water pH value (7.19), in sampling point 11 EC value was found (799 µS/cm) with other physicochemical parameters and Fe, Cd, Cr and Zn content in plant and soil samples were comparatively high at sampling point 9 and 11. In the studied area, the correlation coefficient of heavy metal content among soil and water, the Cr concentration (0.0289mg/l), was highly significant; it has been indicated that heavy metals were uptake by soil.

Introduction

Many rivers flowing through Bangladesh carry heavy loads of sediments and other debris, including domestic wastes, agrochemicals, and industrial waste, from local and far places. Thus, making the water body saturated and times over-saturated with organic and inorganic pollutants which affect the environment. So, pollution is getting aggravated in Bangladesh. The Buriganga river has been the central artery to economic life in Dhaka for centuries. But nowadays, it has become heavily polluted by sources such as waste flowing into the river, oil spills from boats, and building structures appearing on the river banks. Metals enter into river water from mining areas through various ways such as mine discharge, run-off, chemical weathering of rocks and soils, and wet and dry fallout of atmospheric particulate matter (Singh *et al*. 2008, Venugopal *et al*. 2009). Most tanneries in Hazaribagh discharge their effluent directly into the Buriganga river. The primary anthropogenic sources of heavy metal contamination are mining, the disposal of untreated and partially treated effluents containing toxic metals, as well as metal chelates from various industries, and the indiscriminate use of heavy metal-containing fertilizer and pesticides in agricultural fields (Amman *et al*. 2002, Nouri *et al*. 2008). Dhaka discharges about 4,500 tons of solid waste every day, and most of it is released into the Buriganga. According to the Department of the Environment (DoE 2003), 20,000 tons of tannery waste are released into the river daily. Textile industries annually discharge as much as 56 million tons of waste and 0.5 million tons of sludge. Sewage is also released into the Buriganga. Nearly 4 million people in the city are exposed to the consequences of water pollution daily. The acuteness of toxicity and devasting effects of cadmium (Cd) on animals was amply proved by Itai-Itai disease in human beings. Time is not so far when Bangladesh may be exposed to the same problem if unconscious discharges are not to be prohibited (Sarker 2005). The objectives of the present research are to determine the water quality parameters and to recognize the specific heavy metals in the nearby environment of the Buriganga river.

*Author for correspondence: <shahrear01@yahoo.com>. [1]Bangladesh Council of Scientific and Industrial Research, Dhaka-1205, Bangladesh.

Materials and Methods

The Buriganga river encompasses the southwestern periphery of Dhaka City. It originates from Dhaleswari, which is north of Dhaka, and meets it again south of Dhaka City. The Dhaleswari turns into the Bangshe River at 23º55'N and 90º13'30"E and then joins the Turag River at 23º47'N and 90º20'30"E. From this point downward, it is named the Buriganga river. It runs for more than 27 kilometres southeast to turn sharply (hairpin bend) westward to run into the Dhaleswari River again. The location was confirmed by GPS (*Model:* Magellan GPS 320). Water samples were collected at each point with a water sampler (*Model:* UWITEC, A-3510) in the midstream at a depth of 1 to 2 meters to avoid the interference of the floating substances. Sample collection was conducted three times. The high-density 1-liter PVC bottles were used for sample collection and preservation. Each bottle was cleaned thoroughly by rinsing with dilute HNO_3 followed by washing with distilled water (De 1990). Another 500 ml air-tight water samples for each sampling point were also collected in a sterilized bottle for microbial analysis and kept in an icebox to maintain 4ºC.

Table 1. GIS location of the sampling points near Dhaka city.

Sampling points	Latitude	Longitude	Location
1	23º41’23”N	90º25’35”E	Shutrapur
2	23º41’54”N	90º25’56”E	Shutrapur
3	23º42’11”N	90º25’12”E	Sadarghat
4	23º42’32”N	90º24’44” E	Sadarghat
5	23º42’56”N	90º24’09”E	Kotouali
6	23º42’07”N	90º23’34”E	Kotouali
7	23º42’48”N	90º22’17”E	Lalbagh
8	23º42’22”N	90º22’02”E	Kamrangirchar
9	23º42’57”N	90º21’18”E	Kamrangirchar
10	23º43’05”N	90º21’12”E	Hazaribagh
11	23º43’53”N	90º21’32”E	Hazaribagh

The bottles were kept airtight and labelled properly for identification. The water samples were brought to the Department of Botany, Jagannath University and the Department of Soil, Water and Environment of BCSIR Laboratory of Dhaka and preserved in a refrigerator until analysis. In this experiment, single-point sampling was carried out. PH, DO, EC, TDS, BOD, and COD of water were determined according to the standard methods described in different literatures (Ahmed 2004, Ahmed *et al*. 2010, Das *et al*. 2024).

A suitable site was selected for the collection of a sample, and a soil auger was inserted into the soil up to a suitable depth, usually 0-15 cm. The soil was collected in a polythene bag labelled properly and tied securely. The soil and plant samples were digested by HNO_3 and $HClO_4$ acid mixture. After completion of digestion, the digested samples were volume up to 100ml into a volumetric flask and then these were filtered into plastic bottles. This extract was used to determine the Cd, Cr, Fe, and Zn content of samples (Alloway *et al*. 1986, Sarker *et al.* 2005).

The distribution pattern of various chemical properties was determined by analyzing their average, maximum, and minimum values and standard deviation (SD) among the samples. Correlation analyses between the different combinations of quality indicators, such as SAR versus

SSP and SSP versus RSBC, were done to establish a relationship between them. This statistical analysis was performed by Windows SPSS (version 10).

Results and Discussion

In the study area, pH of water at different points of the Buriganga River ranged from 6.7 to 7.19 (Fig.1). The highest pH (7.19) was found in sampling point 7 near the Kamrangirchar area during November, the lowest in the sampling point 1 (pH = 6.70) (Fig. 1). It might be runoff the industrial effluents through heavy rain from the bypass canal. A similar result was observed by Shivkumar and Biksham (1995). Excessive pH harms aquatic life like fish, microorganisms and aquatic plants, and sometimes it influences the other properties of water bodies, the activity of organisms and the potency of toxic substances present in the aquatic environment (Yusuff and Sonibare 2004).

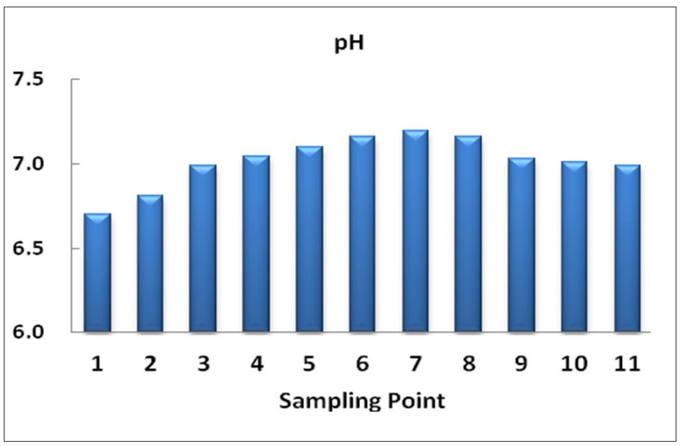

Fig. 1. pH of the Buriganga river water at different sampling points.

A very low dissolved oxygen concentration of water (0.78 mg/l) was observed in sample point 10 and high at sampling point 1 (2.47 mg/l) (Fig. 2). This may be due to the high amount of organic wastes discharged from tannery, textile, and dying industries into the river from those areas. Biodegradable organic wastes are dumped into the river from fruits and vegetables wholesale depot near Sadarghat. This suggested that the industries were releasing a lot of organic substances, most likely the dyes that were high oxygen-demanding wastes (Lellis *et al.* 2019).

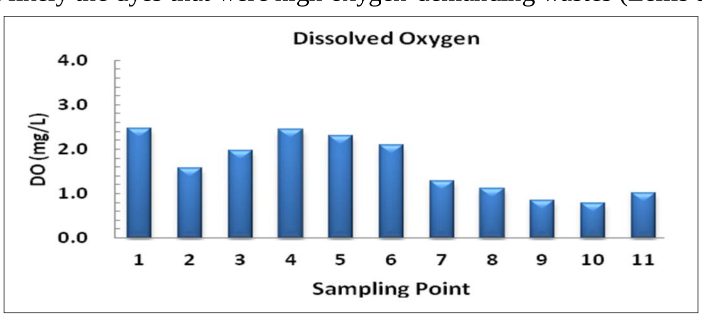

Fig. 2. DO of the Buriganga river water at different sampling points.

EC of water of Buriganga river was within the range from 391 to 799 μS/cm. The highest EC value was found in sampling point 11 during November (799 μS/cm), and lowest in sampling point 4 (391 μS/cm) (Fig. 3). Sources of dissolved ions include soil and rocks in the watershed, wastewater from sewage treatment plants, and urban runoff from roads. So, there was no harmful effect of salt concentration or salinity hazards concerning EC. As per DoE (2003), the high value of EC is unsuitable for aquatic life and irrigation purposes.

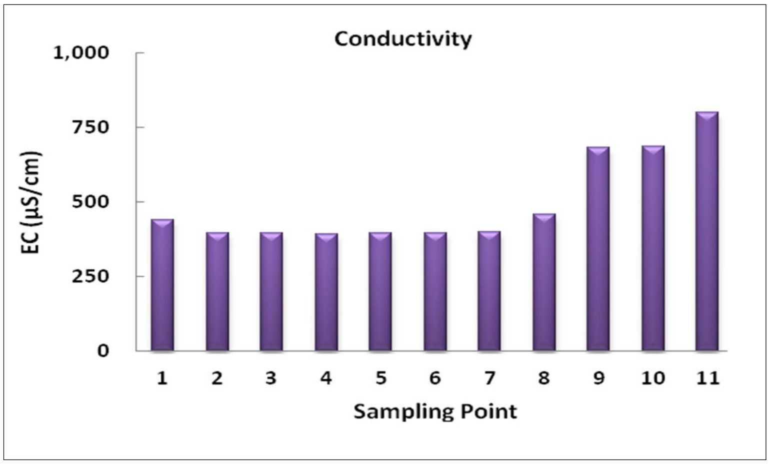

Fig. 3. EC of the Buriganga river water at different sampling points.

TDS concentration of collected water at different points and at different times of year ranged from 189.4 to 382 mg/l (Fig. 4). Wokeh *et al.* (2023) observed that the high amount of dissolved solids in water increases the water density; it influences osmoregulation of freshwater organisms and reduces the solubility of gases.

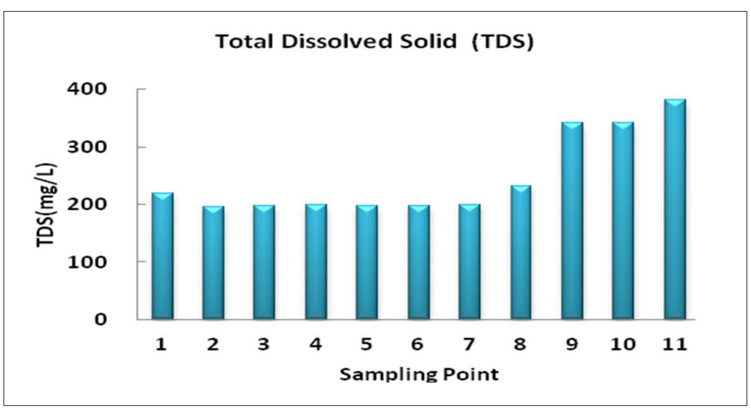

Fig. 4. TDS of the Buriganga river water at different sampling points.

BOD of water collected at different points ranged from 245 to 438 mg/l (Fig. 5). The BOD of water was low at sampling point 1 (BOD = 245 mg/l) and high at sampling point 10 (BOD = 43 mg/l) Khan and Noor (2002) reported that TSS, BOD and COD in industrial effluents were above the permissible limits set by National Environmental Quality Standards (NEQS).

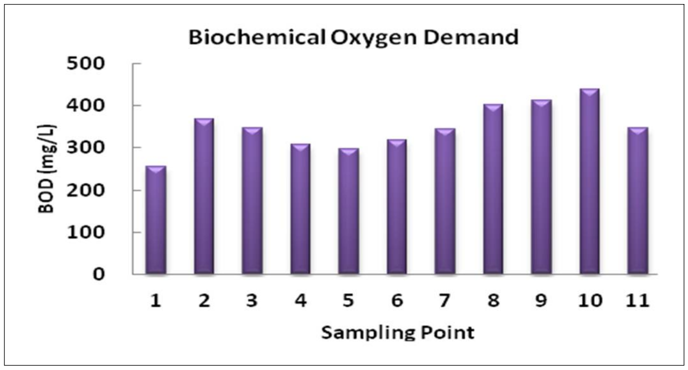

Fig. 5. BOD of the Buriganga river water at different sampling points.

COD of water collected at different points from 308 to 627 mg/l (Fig. 6). The COD of water was low at sampling point 1 (COD = 308) and on the other hand, high at sampling point 10 (COD = 627 mg/l). This may be due to the dilution effect of water. According to the BEC (2023), the discharge quality standard of COD for industrial Effluents is not more than 120 mg/l depending on the receiving water of the type of industry under consideration of PCC but does not exceed 400 mg/l. All industrial effluents are above permissible limits, so there could be a direct effect of these untreated effluent discharges. We have observed a strong correlation between EC, TDS, BOD and COD (Table 2). These metal content were also found in high concentrations in river water and surrounding soils. So, there must be a clear indication of metal uptake by plant parts from effluents and soil.

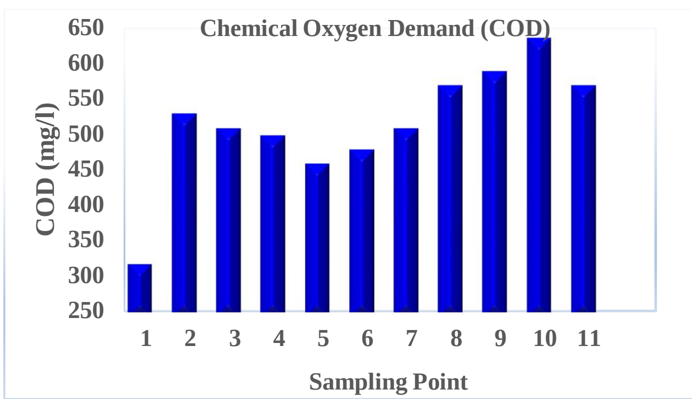

Fig. 6. COD of the Buriganga river water at different sampling points.

The average Fe concentration of water collected from different sampling points ranged was (0.486 mg/l). The Fe concentration of water was relatively high (2.36 mg/l) at sampling point 1 (near Shutrapur). On the other hand, the Fe concentration of water was relatively low at sampling point 7 (0.329 mg/l). The average cadmium concentration of river water collected at different points was 0.0029 mg/l. Among sampling points, it was observed that sampling point 11 near Hazaribagh, Kamrangirchar areas showed a high Cd concentration of around (0.0052 mg/l). On the other hand, the Cd concentration of water was comparatively low at sampling point 9 (0.0015 mg/l). Dadebo and Gelaw (2024) waste discharge quality standard of Fe and Cd for industrial units and projects is respectively 5.0 and 0.05 ppm of Cd for irrigation water, and here, the content of

Cd in all the samples is within the permissible limit. Cr concentration of Buriganga river water was comparatively high at sampling point 1 (0.0289 mg/l), and the concentration exceeded the permissible limit in some points. A significant correlation is observed in Fe and Cr between soil and water (Table 3). On the other hand, there was also a correlation observed in plants and soil for Fe and Cr, but no correlation was observed in Cd and Zn (Table 4). This may be due to longtime untreated industrial effluent discharges in the same canal to the same destination like Buriganga and its tributaries. According to BEC rules (2023), the level of Cr concentration in Buriganga river water was within the safe limit during the wet season, but Cr concentration in river water crossed the safe limit during the dry season. Sampling point 1 near (Shutrapur areas) showed a high Zn concentration of around (0.49 mg/l). In contrast, water from sampling point 3 showed a low Zn concentration of around (0.08 mg/l) due to limited industrial activities. The average chromium concentration of water was (0.0215 mg/l). This may be due to the dilution effect. Our result is supported by BEC rules (2023) for the wet season but not for the dry season.

Table 2. Correlation coefficient of different water quality parameters.

Parameter	pH	EC	TDS	BOD	COD
pH	1				
EC	-0.059 ^{NS}	1			
TDS	-0.048 ^{NS}	0.998 ***	1		
BOD	0.292 ^{NS}	0.527*	0.551*	1	
COD	0.141 ^{NS}	0.688*	0.718**	0.483*	1

NS = non-significant *, **, *** indicate significance at 5, 1 and 0.1%, respectively.

Table 3. Correlation coefficient of heavy metal content among soil and water.

Soil / Water	Fe	Cr	Cd	Zn
Fe	0.904**			
Cr		0.764*		
Cd			0.018^{NS}	
Zn				-0.154^{NS}

NS = non-significant *, ** indicate significance at 5 and 1%, respectively.

Table 4. Correlation coefficient of heavy metal content among plant and soil.

Soil / Plant	Fe	Cr	Cd	Zn
Fe	0.835*			
Cr		0.899**		
Cd			0.562	
Zn				0.532

*, ** indicate significance at 5 and 1%, respectively.

Table 5. P value of heavy metal content among soil and water.

Soil / Water	Fe	Cr	Cd	Zn
Fe	0.001			
Cr		0.002		
Cd			0.845	
Zn				0.651

Table 6. P value of heavy metal content among plant and soil.

Soil / Plant	Fe	Cr	Cd	Zn
Fe	0.05			
Cr		0.03		
Cd			0.693	
Zn				0.620

Trace metal contamination in aquatic environments is of critical concern due to toxicity of metals and their accumulation in aquatic habitats. P value observed significant signs in soil and water for heavy metals of Fe and Cr (Table 5). Trace metals, in contrast to most pollutants, are not biodegradable, and they undergo a global ecological cycle in which natural waters are the main resource. The environmental effects and transport of heavy metals in soil and their plant uptake are governed by their mobility. In this regard, a significant P value was observed in plants and soil for Fe and Cr (Table 6). Metal content in plant samples, especially in Hazaribagh and Kamrangirchar areas, was very high. As a cause, we think all the year round river receives a continuous untreated flow of heavy industrial and small industrial wastewater. This is due to plant metal accumulation from soil and effluents of these industries and river water.

To achieve a suitable quality environment in the Buriganga river some steps and awareness programs should be undertaken; these are given below:

- The industrial waste should not be dumped without proper treatment in the surrounding area.
- Should ensure that the existing laws and regulations are implemented.
- Should have to make people aware of the pollution caused by industries.

If these various recommendations can be obtained, the quality of the surrounding environment may remain in a suitable condition.

Acknowledgements

The authors would like to thanks Chairman of the Department of Botany, Jagannath University Dhaka and the Director of Bangladesh Council of Scientific and Industrial Research, Dhaka for their laboratory support. The authors would like to express their gratitude for the indulgence.

References

Ahmed A n2004. Ecological studies of the river Padma at Mawa Ghat, Munshinganj. I. Physico-chemical properties. Pakistan J. Biol. Sci. **7**(11): 1865-1869.

Ahmed A, Hoque S, Ohlson M, Akanda MA and Moula MG 2010. Phytoplankton standing crop and its diversity in the Buragauranga River Estuary in relation to chemical environment. Bangladesh J. Bot. **39**(2):143-51.

Alloway BJ, Tills AR and Morgan H 1986. The behavior and availability of Cd, Ni, and Pb in polluted soils. In Assink, J. W. and van den brink, W.J. (eds), Contaminated Soil. Kluwer Academic Press, Dordrect, pp. 101-113. https://doi.org/10.1007/978-94-009-5181-5_9

Ammann AA, Michalke B and Schramel P 2002. Speciation of heavy metals in environmental water by ion chromatography coupled to ICP-MS. Anal. Bioanal. Chem. **372** (3): 448- 452. https://doi.org 10.1007/s00216-001-1115-8

Bangladesh Environmental Conservation (BEC) Rules 2023. https://www.academia.edu/99109146/ Bangladesh_Environmental_ Conservation_Rules_2023

Dadebo TT and Gelaw GT 2024. Determination of metals in water samples within the irrigation area in Telo District, Kaffa Zone, South Western Ethiopia. Heliyon (cell.com) **10** (7): e29003.

Das C, Alfasane MA and Jolly SN 2024. Hydrobiological assessment of two lakes of Jahangirnagar University campus, savar, Bangladesh. Bangladesh J. Bot. **53**(1):159-71.

De AK 1990. Environmental Chemistry. Wiley Eastern Ltd., New Delhi, India. J. Environ Protec. **2**(5): 42-43. https://doi.org/10.4236/sm.2018.83016

DoE (Department of Environment) 2003. A Compilation of Environ. Laws of Bangladesh. 212-214.

Khan S and Noor M 2002. Investigation of pollutants in wastewater of Hayatabad Industrial Estate Peshawar. Pakistan Journal of Agriculture Sciences **2**(4): 457-461. https://doi.org/10.3923/jas.2002.457.461

Lellis B, Polonio CZF, Pamphile JA and Polonio JC 2019. Effects of textile dyes on health and the environment and bioremediation potential of living organisms. Biotechnology Research and Innovation 3(2): 275-290. https://www.sciencedirect.com/science/article/pii/S2452072119300413

Nouri J, Mahvi AH, Jahed GR and Babaei AA 2008. Regional distribution pattern of groundwater heavy metals resulting from agricultural activities. Environ. Geo. **55**(6):1337-1343. http://dx.doi.org/ 10.1007/s00254-007-1081-3

Sarker MAK 2005. Study on the Accumulation and Seasonal Variation of Trace Metals In Water, Sediment and Some Fishes of the Buriganga River. M. Sc thesis (1998-1999), Department of Zoology, Dhaka University, Dhaka, Bangladesh. pp. 1-4.

Shivkumar K and Biksham G 1995. Statistical approach for the assessment of water pollution around the industrial area. Environ Monit. Assess. **36**: 229-249. https://doi.org/10.1007/BF00547904

Singh AK, Mondal GC, Kumar S, Singh TB, Tewary BK and Sinha A 2008. Major ion chemistry, weathering processes and water quality assessment in the upper catchment of Damodar River basin, India. Environ. Geo. **54** (4): 745-758. http://dx.doi.org/10.1007/s00254-007-0860-1

Venugopal T, Giridharan L and Jayaprakash M 2009. Characterization and risk assessment studies of bed sediments of River Adyar-An application of speciation study. Int. J. Environ. Res. **3**(4): 581-598. https://tspace.library.utoronto.ca/bitstream/1807/49477/1/er09064.pdf

Wokeh CGO, Wokeh OK, Orose E, Lananan F and Azra MN 2023. Anthropogenic Impacts on Physicochemical and Heavy Metal Concentrations of Ogbor Hill River Water, Southern Nigeria. Water **15**(7): 1359

Yusuff RO and Sonibare JA 2004. Characterization of textile industrial effluents in Kaduna, Nigeria and pollution implications. Global Nest: The Int. J. **6** (3)**:** 212-221.

(Manuscript received on 10 March, 2024; revised on 18 September, 2024)