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Contiguous reaction of manufacturing effluent on Buriganga river of Bangladesh

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ABSTRACT

The present assessment was carried out to explore the amount of heavy metals and physico-chemical properties in Buriganga river in Dhaka Bangladesh from February to March, 2017. Heavy metals are the main health hazard pollutants which contaminate aquatic life. In the current research three sampling sites (Upstream, Mid Point and Downstream) were selected from Sadarghat sampling point to Sowarighat which were away from one another 0m, 100m, 200m, 300m and 400m distances from the bank side of manufacturing effluent discharging points in river Buriganga. The main goal of the current investigation was find out health hazardous heavy metals such as Zn, Cu, Cd, Pb, Cr, Mn and physico-chemical properties in the Buriganga river. Heavy metals recorded in the present research were in the range of Zn 1.18-1.84 ppm; Cu 1.04-1.28 ppm; Cd 2.9-4 ppm; Pb 45.9 to 33.65 ppm; Cr 0.05-0.20 ppm; Mn 0.04-0.12 ppm; Ni 6.17 to 9.42 ppm and the physico-chemical properties pH 6.7-9.98, EC 556.7-106.03 µs/cm^{-1}, OS 6.78-2.98 %, N 0.153-0.107 ppm, P 25.10-7.82 ppm, K 0.465-0.212 ppm, S 275.3-163.24 ppm, Na 863.32-443.2 ppm respectively. The present study reviled that Zn, Cu, Cd, Pb and Cr was found exceeded the permissible limits while Mn, Zn was within the permissible range and the water is not better for any use like irrigation and biotic life.

INTRODUCTION

Heavy metals contamination in river is one of the major quality issues in many fast growing cities like Dhaka, because maintenance of water quality and sanitation infrastructure did not increased along with population and urbanization growth especially for the developing countries (Sundaray et al., 2006). Effluent is an out flowing of water from a natural body of water, or from a human made structure. Effluent is defined by the United States Environmental Protection Agency (USEPA, 2010) as "waste water treated or untreated that flows out of a treatment plant, sewer or industrial outfall generally discharged into surface waters". There has been an increasing interest in the utilization of fishes as bio-indicators of the integrity of aquatic environmental systems in recent years (Tawari and Ekaye, 2007). Heavy metals influence cellular organelles and various enzymes involved in metabolic process, detoxification, and damage repair (Wong and Shi, 2001). Manufactured effluent is any waste water generated by an industrial activity. Industrial effluents consist of many trace and heavy metals like Zn, Cu, Ni, Cd, Cr, Pb, As, Fe, N, P, K, S, Na etc which may beneficial at minute amount and harmful at large amount. The general symptoms of humans related to heavy metal (Cd, Pb, Hg, Zn, Cu) poisoning, include vomiting, convulsions, paralysis, ataxia, diarrhoea, depression and pneumonia (McCluggage, 1991).

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Accumulation of Pb, Zn, Ni, Cu, Fe, and as were high in smelting and metal production industries, textile effluents are high in BOD due to fiber residues suspended solids (EPA, 1998). Continuous route of mechanized engine oil vessel with several types of industrial units including textile, dyeing, pharmaceuticals, cosmetics, aluminum, leather, glass, garments, packaging industry in near bank side of Buriganga river. The discharges waste material from those industrial activities causes severe adverse effects on river pollution.

Toxic heavy metals entering into river ecosystem may lead to geo-accumulation, bioaccumulation and bio-magnifications. Keeping these facts in mind, the aim of the current study was to evaluate the contiguous reaction of manufacturing effluent on Buriganga river in Bangladesh.

MATERIALS AND METHOD

Buriganga River a tide-influenced river passing through west and south of Dhaka city. In ancient times one course of the Ganges used to reach the Bay of Bengal through Dhaleshwari. Its average width and depth are 400m and 10m respectively. This river is only 27 km long and located approximately within latitude at 23° 38′ 0″ N, and longitude at 90° 26′ 0″ E (Figure 1) (Chowdhury et al., 2012).

Figure 1: Map showing the experimental area.

River sample collection

River samples were collected from 3 selected sites at 0m, 100m, 200m, 300m and 400m distances area between Sadarghat to Sowaright point. And this water samples were collected by glass bottle tight with rope from 0-10m depth and kept into the individual clean and dry plastic bottles with screw caps and labeled with definite marking and tagging. After collection, the samples were carried to the laboratory for physical and chemical analysis.

Preparation of river sample

The stock solution was prepared as 1000 ppm = 1000 mg/l. Then 100 ppm solution was prepared from stock solution using serial dilution equation of $C_1V_1 = C_2V_2$

Determination of heavy metals in water

The water samples were first filtered with the help of filter paper and then taken in 250 ml of glass bottles and subjected to the atomic absorption spectrophotometer (Zn, Cu, Ni, Cd, Cr, Pb, N, P, K, S, Na) at Bangladesh Institute of Nuclear Agriculture lab.

Physicochemical parameter

The samples were analyzed for physico-chemical parameters viz. River pH, electrical conductivity (EC), organic substances (OS), nitrogen (N), phosphorus (P), potassium (K), sulphur (S), sodium (Na), Zinc (Zn), cupper (Cu), chromium (Cr), manganese (Mn), lead (Pb) and cadmium (Cd). River pH was determined by glass electrode pH meter (WTW pH 522; Germany) as described by Jackson (1988); EC of collected river samples were determined electrometrically (river water ratio was 1:5) by a conductivity meter (WTW LF 521; Germany) as described by Anderson and Ingram (1996); the organic substances was calculated by multiplying the content of organic carbon by van Bemmelen factor, 1.73 and formula is as follows -Organic matter (%) = OC (%) x 1.73 (Ghosh et al., 1983); nitrogen of the river samples was determined by Kjeldahl method as described by Bremner (1996); available phosphorus present in river was determined by Olsen's method (Olsen et al., 1954) colorimetrically, where $SnCl_2$ was used as a reductant; available sulfur (S) was determined by extracting the river samples by calcium chloride solution (0.15%) by Page al (1982); available sodium and potassium was determined by ammonium acetate extraction method by flame photometer; to determine Pb and Cd, Cr, Zn, Mn, Cu river samples were extracted by following procedure described by Tam and Yao (1999) where total accumulations of Pb and Cd, Cr, Zn, Mn, Cu in river samples were determined using atomic absorption spectrophotometer (AAS), equipped with single elements hollow cathode lamps at the wave lengths of 283.3 and 228.8 nm, respectively.

RESULTS and DISCUSSION

River water pH

The lowest pH value 6.7 was found at 0m distance (Table 1) which was slightly acidic and the highest value 9.98 was observed at 400m which was buffer condition (Figure 2).

Electrical conductivity (EC)

The maximum value of electrical conductivity (556.7 $\mu s/cm^{-1}$) was found at 0m and minimum value (106.03 $\mu s/cm^{-1}$) was at 300m distance. Like p^H values of the collected samples, EC values also decreased with the increase of distance from contaminated water near bank side of river (Figure 3).

Organic substances concentration

The organic substances was higher 6.78% at 0m distance and it decreased gradually up to 100m (Table 1) and after that the value was constant (Figure 4).

Nitrogen (N) concentration

Total N content decreased from river Bank edge to distant (Table 1) places and the variation in N content with distance followed the variation with organic substances (Figure 5).

Phosphorus (P) concentration

The maximum value 25.10 ppm was found at 0m distance and minimum value 7.82 ppm was at 400m distance (Figure 6).

Potassium (K) concentration

The mean K content decreased gradually with the increase of distance from bank side of the river (Figure 7).

Sulphur (S) concentration

The gradual decrease of S content with the increase of distance from river bank side indicating the load of S at 0m sites, preferably from industrial effluent (Figure 8).

Sodium (Na) concentration

A significant variation in Na content was found with distance. There was a decreasing trend in Na accumulation with increasing distance from river bank side (Figure 9).

Lead (Pb) concentration

The higher lead content at 0m caused by smelting and metal production industries and Pb content was significantly decreased at 100m distance and remained same up to 400m distance (Figure 10). Ahmed et al. (2010) reported that the concentration of Pb ranged from 0.058 ppm during pre-monsoon to 0.072 ppm during monsoon in the Buriganga river.

Cadmium (Cd) concentration

The Variation in Cd content values was very less with distance. The Cd content of all testing samples was higher than the standard limit (0.5 ppm) (Figure 11). Ahmed et al. (2010) studied that the concentration of Cd ranged from 0.007 ppm during monsoon to 0.012 ppm during post-monsoon in the Buriganga river.

Zinc (Zn) concentration

The higher Zinc content at 0m occured by metal industries and Zn content was significantly decreased at 100m distance and remained same up to 300m distance (Figure 12). Ahmed et al. (2010) studied that the amount of heavy metals recorded were Zn 1.19-1.7ppm.

Cupper (Cu) concentration

The fluctuation in Cu content values was very less with distance (Table 2). The Cd content of all testing samples was higher than the standard limit (0.5 ppm) (Figure 13). Ahmed et al. (2010) studied that the concentration of Cu ranged from 0.11 ppm during monsoon to 0.2 ppm during post-monsoon in the Buriganga river.

Cromium (Cr) concentration

A significant variation in Cr content was found with distance. It was a decreasing trend in Cr accumulation with increasing distance from river Bank side to middle part of the river (Figure 14). Ahmed et al. (2010) studied that the concentration of Cr ranged from 0.13 ppm during monsoon to 0.04 ppm in the Buriganga river.

Manganese (Mn) concentration

The higher Mn content at 0m occurred by metal industries which concentration was significantly decreased at 100m distance and remained same up to 400m distance (Figure 15, Table 2). Ahmed et al. (2010) studied that the amount of Mn were 0.01-0.03ppm.

Nickel (Ni) concentration

The fluctuation in Ni content values was very less with distance (Table 2). The Ni content of all testing samples was higher than the standard limit (0.02 ppm) (Figure 16).

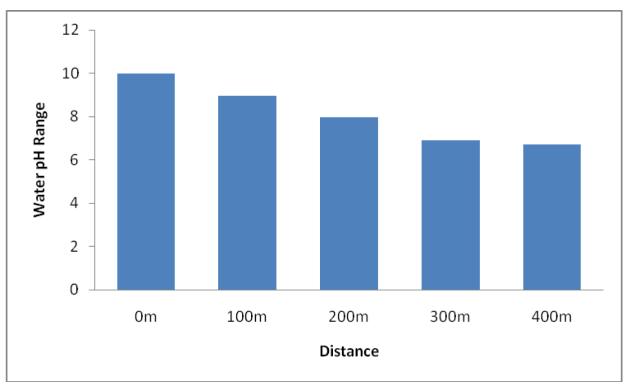

Figure 2: p^H values of river at different distance

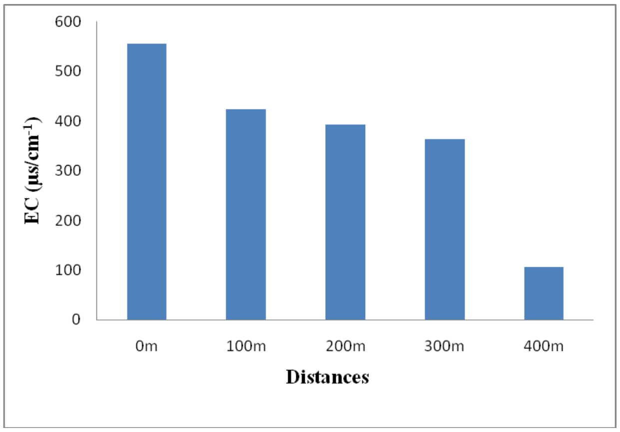

Figure 3: EC values of river at different distances

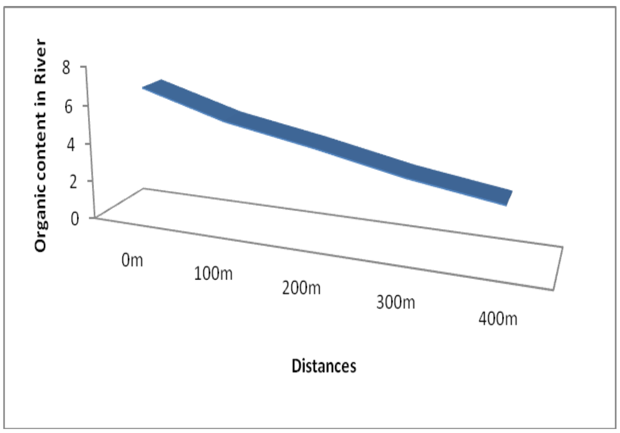

Figure 4: Organic substances content of river at different distances

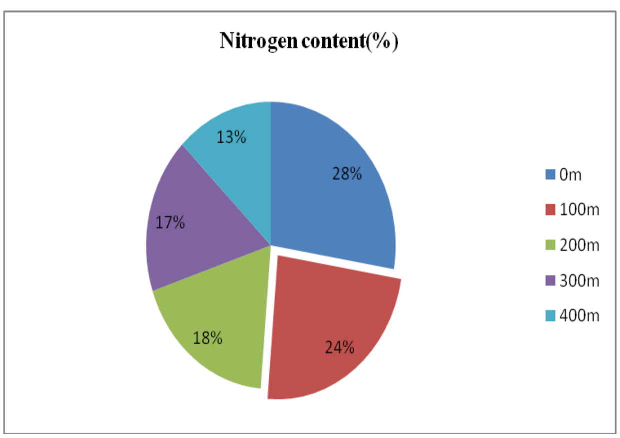

Figure 5: Accumulation of nitrogen at different distances

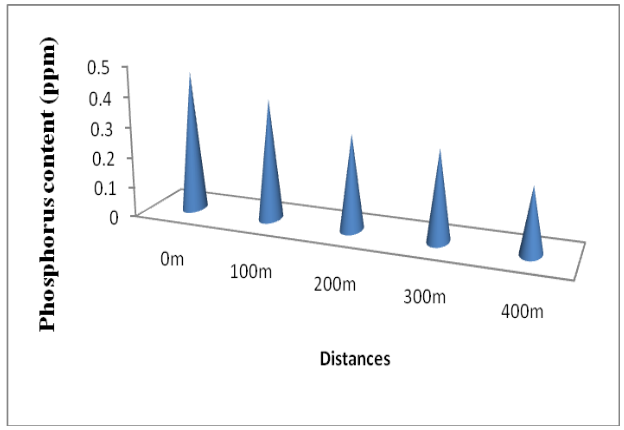

Figure 6: Accumulation of phosphorus at different distances

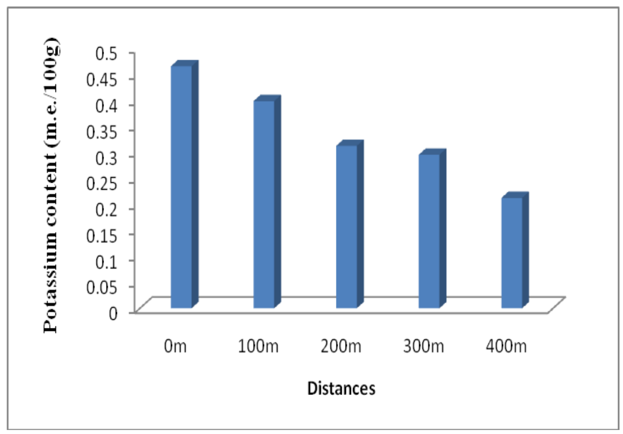

Figure 7: accumulation of potassium at different distances

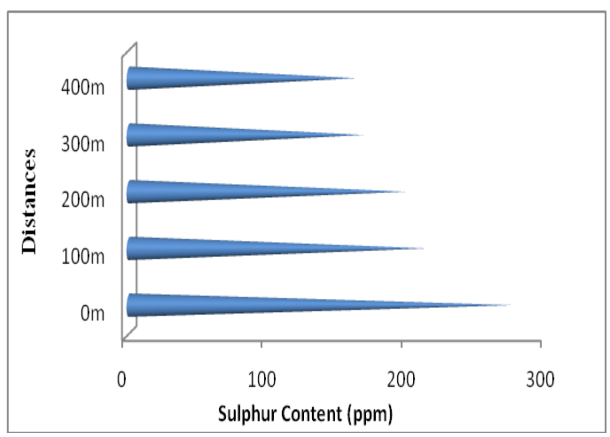

Figure 8: Accumulation of sulphur at different distances

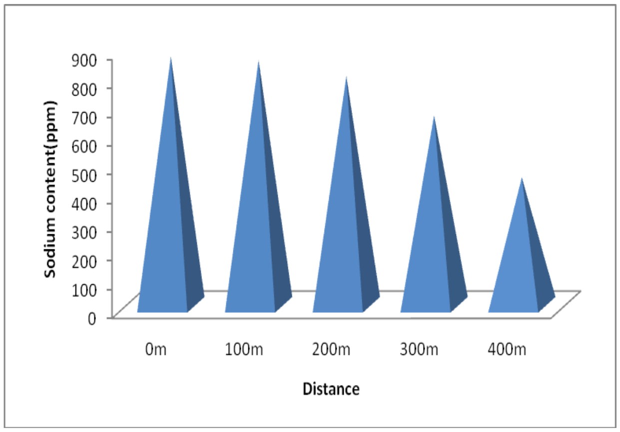

Figure 9: Accumulation of sodium at different distances

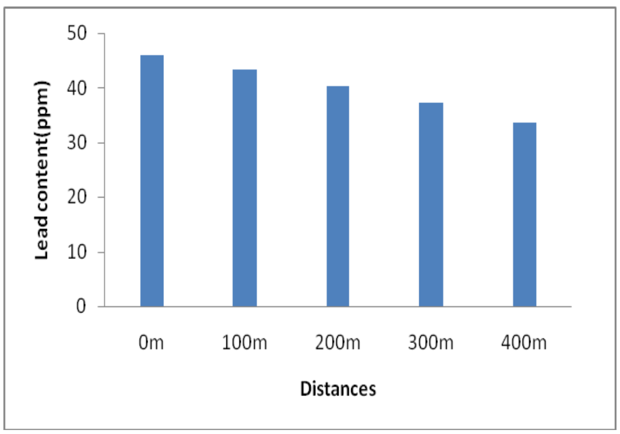

Figure 10: Accumulation of lead at different distances

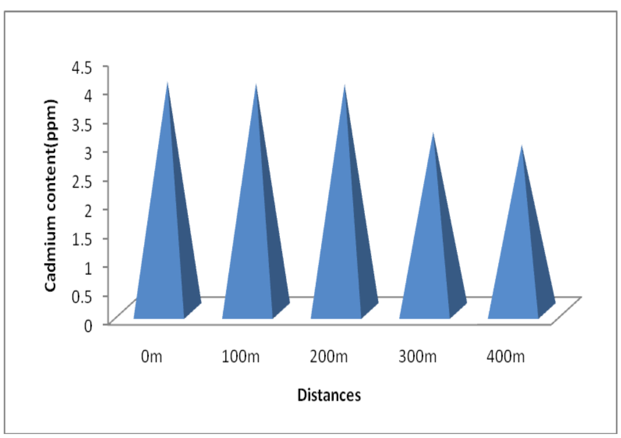

Figure 11: Accumulation of cadmium at different distances

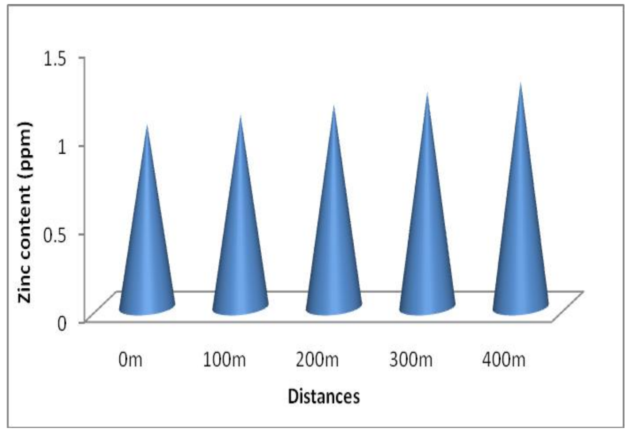

Figure 12: Accumulation of Zinc at different distances

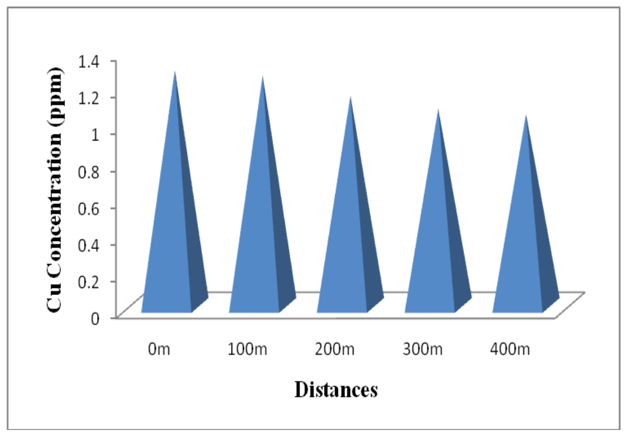

Figure 13: Accumulation of Cupper at different distances

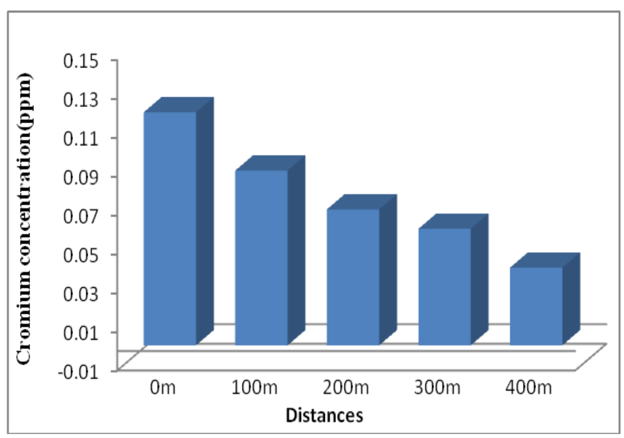

Figure 14: Accumulation of Cromium at different distances of river

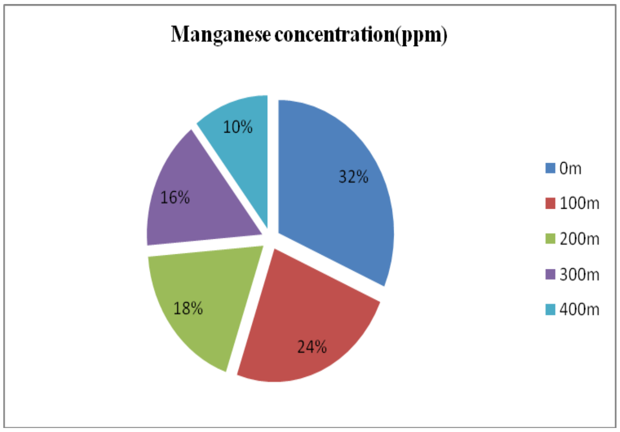

Figure 15: Accumulation of Manganese at different distances of river

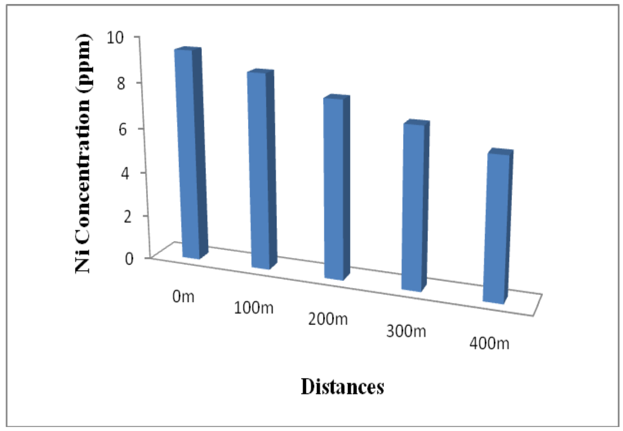

Figure 16: Concentration of Nickel at different distances of river

Table 1
Accumulation of Physico-chemical at different distances

Distances (m)	P	pH	EC	OC	S	K	N	Na
0m	25.1	9.98	556.7	6.78	275.3	0.465	0.153	863.32
100m	21.58	8.97	424.33	5.46	213.25	0.398	0.122	851.25
200m	21.3	7.96	393.23	4.63	198.35	0.312	0.113	795.36
300m	17.38	6.9	363.5	3.68	168.14	0.295	0.112	659.36
400m	7.82	6.7	106.03	2.98	163.24	0.212	0.107	443.2

Table-2
Accumulation of heavy metal (Pb, Cd, Zn, Cr, Mn, Cu) at different distances of river

Heavy Metal	Distance (Meter)					Permissible limits (ppm)
	0	100	200	300	400	
Pb	36.9	30.37	29.07	28.10	24.27	0.05
Cd	4.0	3.97	3.95	3.12	2.9	0.05
Zn	1.18	1.25	1.63	1.72	1.184	5.0
Cr	0.2	0.15	0.11	0.09	0.05	0.05
Mn	0.12	0.09	0.07	0.07	.04	50-70
Cu	1.28	1.25	1.14	1.07	1.04	0.05
Ni	9.42	8.67	7.83	7.05	6.17	0.02

CONCLUSION

All of the parameter was higher at 0m distance and lower at 400m distance. This observation focused that several types of engine oil vessel, industrial units including textile, dyeing, pharmaceuticals, cosmetics, aluminum, leather, glass, garments, packaging and manufacturing industries which restlessly release heavy metel component on the river that deterioate the Limnological and physico-chemical properties. The massive quantities of drainage wastes and sludge discharged from various commercial sources might be liable for enhance of all considered physico-chemical parameters at 0m location. Some of the heavy metals accumulations are higher than the optimum values, which predicted that the Buriganga is considered as a heavy metal contaminated river and the water, sediment and fish are completely unsafe for aquatic and biotic community.

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