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An investigation of pH, TDS and trace elements of water in Buriganga river, Bangladesh

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Abstract

In the present work, water samples were collected from some specific sampling spots in River of Buriganga, Bangladesh. Using flame atomic absorption spectrophotometer (FAAS), concentration of trace elements namely Pb, Cd, Cr, Cu, Fe, Mn and Zn in Buriganga river water were determined which ranged as < 0.02 mg/l, < 0.0015 mg/l, 0.0041 to 0.00507 mg/l, 0.00460 to 0.0092 mg/l, 0.230 to 0.299 mg/l, 0.170 to 0.178 mg/l, and 0.0088 to 0.0273 mg/l respectively. The observed pH and TDS ranged as 7.19-7.55, and 128-186 mg/l respectively. pH and TDS of river water is lower than the recommended value of World Health Organization (WHO) and Bangladeshi standard but P_H is slightly alkaline than pure water. Low TDS means that other toxic trace elements except seven determined elements may be present in low concentration in the river water. The concentration of lead (Pb) and cadmium (Cd) could not be traced in any of the water samples. The concentration of manganese (Mn) is higher than the recommended value of WHO and Bangladeshi standards.

Keywords: pH, TDS, FAAS, Trace elements, Toxicity, Aquatic lives

Introduction

The environment, development and economic growth are all highly influenced by water. River is the main water source of surface water supply which is used for irrigation, fisheries, industries as well as human health. Environment and development are highly interrelated with each other. Rivers are severely contaminated with the rapid development of society and economy. Development activities cause degradation and drastic changes (Anwar 2006) in every component of environment and utilization of the river pose a great threat to the health of the existing natural environmental system, particularly for the important river Buriganga of the capital city, Dhaka, due to the pollution of the river water. The Buriganga River, whose length is 27 km, is situated (Majumdar 1971) in the southern region of the north central part of Bangladesh and close to the confluence of the Padma and upper Meghna river. In ancient times one course of the Ganges used to reach the Bay of Bengal through Dhaleshwari. The Buriganga (Ahmad *et al* 2010), whose average width and depth are 400m and 10m respectively, originated from the Dhaleshwari. The flow of this river is controlled by some upstream rivers like Jamuna, Turag, Karnatali, Dhaleswari and canals like Tongi khal. Buriganga River is not only important for providing vital ecological function but also for many other purposes like ground water recharge, drinking water supply, transportation, recreation, flood control, cleaning, washing that means social and economical functions (Huang *et al.* 2015). The chemical effluent of mills and factories, household wastes, medical wastes, sewage, dead animals, plastics, and oil are some of the Buriganga's pollutants (Ali *et al*. 2008) which may pose a direct or indirect threat to aquatic organisms, humans, and other creatures because of resistance degradation, toxicity, bio-accumulation, and persistence (Yi *et al.* 2016). Most of the industrial units especially dyeing and textile industries have been established in this area which has no sewage treatment or effluent treatment plant. Textile industries (Islam *et al.* 2015) annually discharge 56 million tons (approximate.) of waste and 0.5 million tons (approximate.) of sludge and most of these are released into the river (DoE 2001). When factories and manufacturers pour their chemicals and livestock wastes directly into streams and rivers, the water becomes poisonous and oxygen levels are depleted causing many aquatic organisms to die. Most of the wastes are not biodegradable which may causes very harmful environmental pollution (Kamal *et al.* 1999) due biodegradability of trace metals. Trace metal ions have important roles in our life functioning in a wide spectrum. Thus, the determination of trace metals is becoming increasingly important because of the increased interest in water. To ensure sound health and quality of life, identification and regular monitoring of pollution sources are essential. It could be a fruitful attempt to understand the environment pollution and increase the awareness of the people to restore traditional heritage for the conservation of natural sources and to estimate the pH, TDS and trace metal concentration of water we drink and their effects on our health.

Materials and methods

Sampling

The water samples were collected for physicochemical parameters and heavy metals from three different sampling spots of the Buriganga River. Each spots are divided into three different parts on the basis of the depth i.e. 0.01 meter (surface water), 1 meter and 2 meter. For collecting samples from different selected spots, 2L polyethylene white bottles were used and then filtered through the filter paper (Whatman filter paper). After cleaning and washing, filtered water samples were taken into 1 liter polyethylene white bottles. For cationic species experiment, 1 bottle was acidified with 4 ml 69-70% Analar Nitric Acid (E. Merck, Germany) to make the pH $<$ 2 of the water samples. The acidified samples were kept in refrigerators at 4^0C for further analysis. The samples were taken to the normal temperature before analysis. The rest of the water samples were stored at room temperature (25^0 C) for determining TDS and pH.

Sampling Stations

Sampling spots were at least 0.25 km (approximate) distance from the bank of the river which covers the Sadarghat to Keranigonj area.

Samples analysis

For measuring pH, a calibration curve was made and the concentration of water sample was determined using the calibration curve. Now the calibration procedures for two buffers (pH= 7, 4 or 10) were followed according to the instruction manual of the handy pH meter. The sample and buffer were measured measured in the same temperature. If the sample pH <7, the meter was calibrated with buffer 4 and 7. If sample pH >7 then buffer 7and 10 were used for calibration.

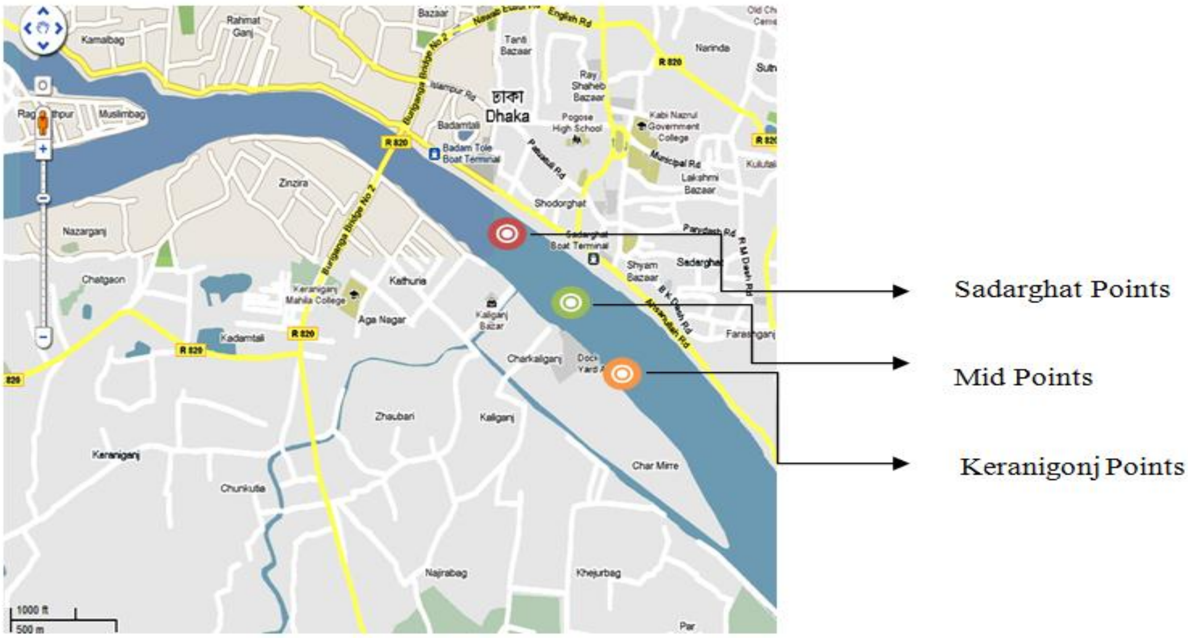


Figure 1: Google view of the three sampling spots of Buriganga river.

The blot dry electrode was immersed in the first buffer in which pH = 7 until the reading was stabilized. Then electrode was removed from the first buffer, rinsed thoroughly, dried with tissue paper and immersed in the second buffer until the reading was stabilized. After completing calibration procedure the machine was ready to measure the sample pH of a desired sample. Total Dissolved Solids (TDS) meters measure the strength of a nutrient solution by measuring the flow of electrical current between two metallic probes. The higher the salt concentration in the nutrient solution the better it conducts electricity; therefore the higher the reading on the meter. It is extremely important that the batteries are in good, strong condition and the probes must always be clean from salt deposits. Weak and dirty probes will affect the accuracy of the reading and are the biggest causes of inaccurate readings. pH was determined by pH meter (Model-Ecodcon) in the Department of Environmental Science, Jahangirnagar University, Savar, Dhaka and TDS (Total Dissolved Solids) was measured by a TDS meter (Model 4510, JENWAY) in the Ministry of Water Resources, River Resource Institute, Faridpur, Dhaka, Bangladesh. Heavy metal concentrations were analyzed in the Chemistry Division, Bangladesh Atomic Energy Commission, Atomic Energy Centre, Dhaka. All chemicals used were to analytical-reagent grade. Seven individual standard solutions i.e. Pb, Cd, Cr, Cu, Fe, Mn and Zn and concentrated nitric acid were purchased from E. Merck (Germany). FAAS (Varian SpectrAA-240) was used to determine the concentrations of the trace metals. The trace metals of water samples were pre-concentrated by evaporating the sample to low volume on a hot plate, 2 ml Analar grade Nitric acid was added before heating the organic matter. Where water are relatively clean with low total dissolved solids content water can be used directly into the instrument. After concentrated the sample is filtered by Whatman 41 filter paper. A volume of 250 ml of the acidified sample was taken into a 300 mL beaker and then heated on a hotplate with 4 mL of conc. HNO_3 until the total volume was reduced to approximately 10 ml. The concentrated sample was then transferred to a 25mL volumetric flask and made up to volume for metal analysis by FAAS.

Results and discussions

pH and TDS

Physicochemical parameters of the Buriganga River water were measured during our study period. Maximum, minimum, mean and standard deviations of all the physicochemical parameters namely pH and TDS in the Buriganga River water are shown in Table 1.

Fig. 2 demonstrates the maximum value of pH is obtained in the depth 0.01 meter (surface water) in the Sadarghat points of the Buriganga River and the minimum value is in the in the depth 1 meter in the Sadarghat points of the Buriganga River. Table 1 shows the maximum value is 7.55 and the minimum value is 7.19. The higher pH at Sadarghat points at 0.01 meter (surface water) depth is due to the tanneries and pharmaceuticals industries effluent discharge here. It indicates that pH value of all the collected samples fall within safer limit of Buriganga River water as prescribed in WHO guideline and Bangladeshi standard. pH is one of the most important and frequently used water quality parameter which measures the corrosive characteristics of water (Patil *et al.* 2012). pH can have a great impact (Nasr *et. al.* 2014) on our internal environment and ultimately our health. During the study period the water was dark and smell is basic because water contains a higher concentration of [OH^-]. Fig. 3 shows the maximum value of TDS is in the depth 0.01 meter (surface water) in the Sadarghat points of the Buriganga River and the minimum value is in the depth 2 meter in the Sadarghat points of the Buriganga River.

Higher temperature is harmful for aquatic life (Bhuyan *et al.* 2017). Metabolic activities of aquatic life can malfunction. Cold water has more oxygen than warm water which is very important for aquatic life. Drastic change of water temperature is harmful for fish.

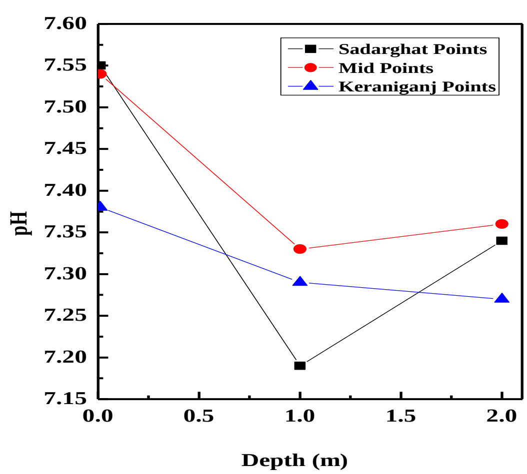


Figure 2: Variation of pH with depth.

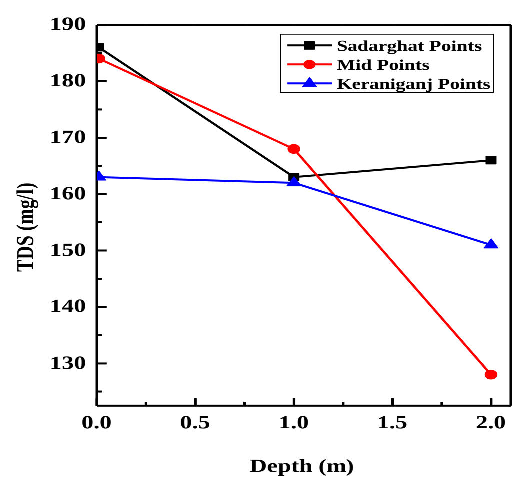


Figure 3: Variation of TDS with depth.

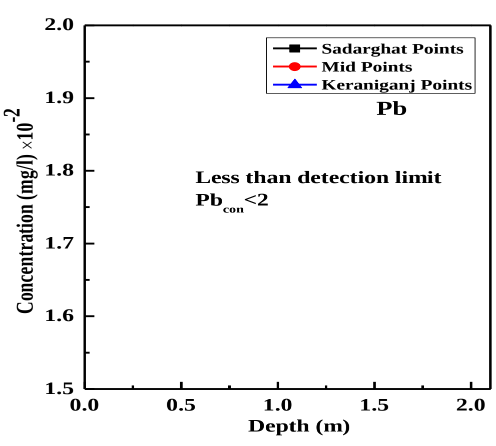
Table 1: Descriptive statistics of the physicochemical parameter of the Buriganga river.

Parameters	N	Min.	Max.	Mean	SD
pH	9	7.19	7.55	7.36	0.118
TDS	9	128	186	163.44	17.22
**Min. = Minimum, Max. = Maximum , SD= Standard Deviation					

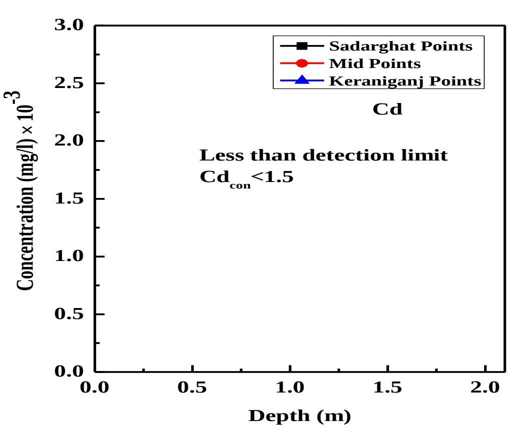
Table 1 shows the maximum value is 186 mg/l and the minimum value is 151 mg/l. The higher TDS is observed in Sadarghat points at 0.01 meter (surface water) depth due to the tanneries and pharmaceuticals industries effluent discharge here. The total concentration of dissolved materials in water supplies originates from natural sources, sewage, urban and agricultural runoff and industrial wastewater. Mineral springs contain water with high levels of dissolved solids, because the water has flowed through a region where the rocks have a high salt content. These minerals can also come from human activities. Concentrations of TDS from (WHO 1996) natural sources have been found to vary from less than 30 mg/l to as much as 6000 mg/l. In our study period the TDS varied from 128 to 186 mg/l in Buriganga River water. Low TDS means that other toxic trace elements except seven determined elements may be present in low concentration in the river water. High TDS interferes with the taste of foods and beverages and makes them less desirable to consume. Some of the individual's mineral salts that make up TDS pose a variety of health hazards. Boiled water with high TDS is not recommended for drinking purposes. TDS also helps to determine the suitability of water for drinking and irrigation. In addition with pH and TDS, water temperature is another important parameter to justify water environment.

Heavy Metals

Heavy metal concentrations in the Buriganga River water were measured during rainy seasons. Descriptive statistics of heavy metals including the maximum, minimum, mean and standard deviation values for the Buriganga River water is shown in Table 2. Toxic metals are significant threating source on ecosystem. Chemical factories such as Batteries, colors, pharmaceuticals are responsible for contamination of Buriganga River water by releasing Pb which is especially toxic for children below 6 years**.** The effect of Pb poisoning is irreversible and may lead to Pallor, anemia, drawn look, Constipation, loss of appetite, metallic taste pain in abdomen, Loss of co-ordination, loss of strength tiring, Peripheral motor paralysis, atrophy of most used muscles, headache insomnia, tremor, dizziness, encephalopathy condition, Diminished hemoglobin, arteriosclerosis hypertension, Lead line in gums, miscarriages (repeated) loss of vision, joints painful.



(a)



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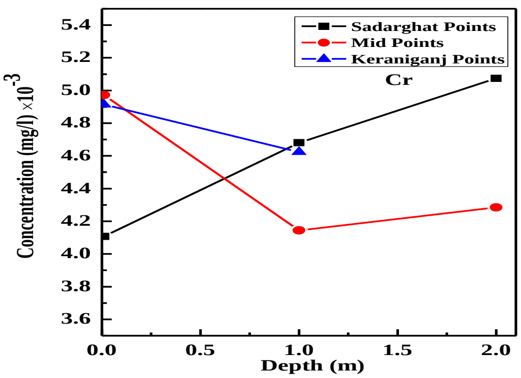

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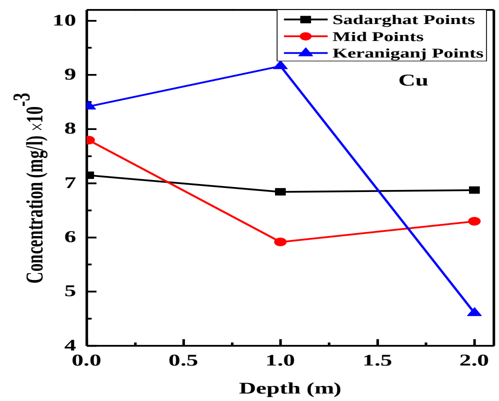

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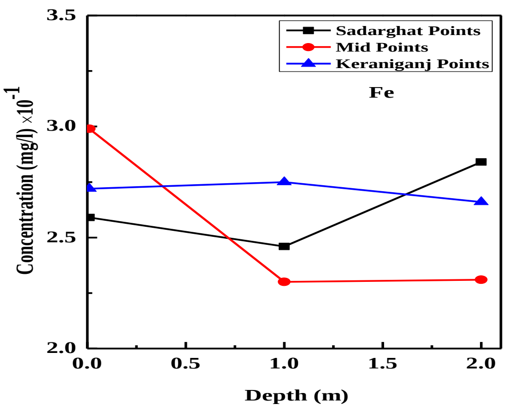

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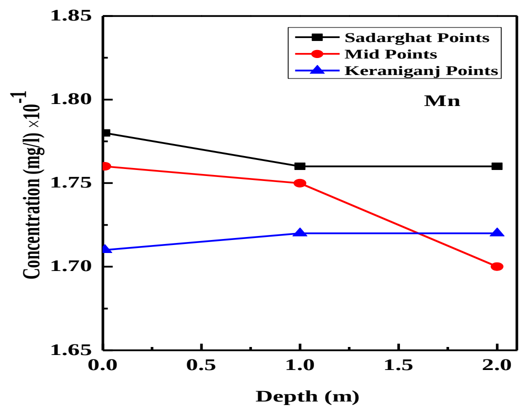
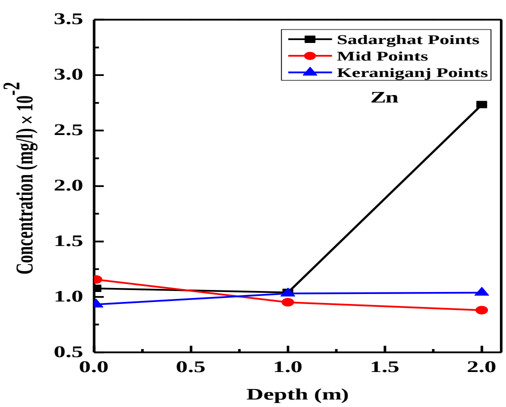


(f)



(g)

Figure 4: Variation of concentration with depth (a) Pb (b) Cd (c) Cr (d) Cu (e) Fe (f) Mn and (g) Zn.

Table 2: Descriptive statistics of the trace elements concentrations in the Buriganga River.

Trace Metals	N	Min.	Max.	Mean	SD
Pb	9	NF	NF	NF	NF
Cd	9	NF	NF	NF	NF
Cr	9	0.0041	0.0051	0.0046	0.3810
Cu	9	0.0046	0.0092	0.0070	0.0014
Fe	9	0.230	0.299	0.2664	0.0234
Mn	9	0.170	0.178	0.2695	0.2555
Zn	9	0.0088	0.0273	0.0120	0.0058
** NF = Not found (less than detection limits). * SD= Standard Deviation					

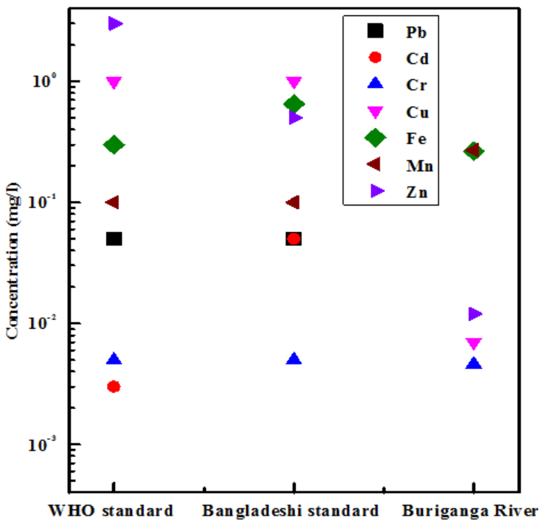


Figure 5: Comparison of Buriganga river water with some drinking water standards.

Lead (Pb) is usually classified into a rare element because the Pb content of igneous rocks is about 0.0015 mg/l. During our study period, the concentration of the Pb in the Buriganga River water is < 0.02 mg/l that means below the detection limit. The main sources of cadmium (Cd) in Buriganga river water are different industries which discharge their waste into the river. Pollutant (Stanley 2000) Cd in water may arise from industrial discharges and mining wastes. At high levels, Cd causes kidney problems, anaemia and bone marrow disorders. In Japan, the outbreak of cadmium poisoning occurred in the form of 'Ouch ouch' diseases. A previous important study (El-Ebiary *et al.* 2013) observed that the high dose of cadmium on red tilapia affects the decrease of sperm number. The concentration of the cadmium in the Buriganga river water is < 0.0015 mg/l that means below the detection limit. So it was not harmful during our study period. Fig. 4 (a,b) shows that the concentration of lead (Pb) and cadmium (Cd) was found less than the detection limit which is shown in Fig. 5. Fig. 4 (c) shows the highest concentration of Cr was found in the in the depth 2 meters in the Sadarghat points of the Buriganga river which is lower than WHO but greater than Bangladeshi standards (Fig. 5) due to the industrial effluent (Sultana *et al.* 2009) discharge. The source of Cr may be the electroplating, paper printing and chemical industries (Parween *et al.* 2017). Different types of cooling towers are operating at different industries situated in the bank of the river (Islam *et al.* 2015). From cooling tower additives Cr could be mixed into the river water. Long term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined (De *et al.* 1995). Fig. 4 (d) shows the highest concentration of Cu was found the in the depth 1 meter in the Keraniganj points of the Buriganga river which is lower than WHO and Bangladeshi standards (Fig. 5).Sources of Cu in Buriganga River water are electroplating, paints and dyes, petroleum refining, domestic wastes etc. The absorption of Cu is necessary because it is a trace element that is essential for human health. Although humans can handle proportionally large concentrations of Cu, too much Cu can still cause eminent health problems. Long-term exposure to Cu can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea .Intentionally high uptakes of Cu may cause liver and kidney damage and even death. Fig. 4 (e) shows the highest concentration of Fe was found in the in the depth 0.01 meter (surface water) in the mid-points of the Buriganga River which is lower than WHO and Bangladeshi standards (Fig. 5). Pollutant Fe in Buriganga River water may arise (Yi *et al.* 2016) from power station, pulp and paper industry, ship yard etc. The human body absorbs Fe in animal products faster than iron in plant products. It is an essential part of hemoglobin that the red coloring agent of the blood that transports oxygen through our bodies. A common problem for humans is iron deficiency, which leads to anemia. Inhalation of excessive concentrations of iron oxide may enhance the risk of lung cancer development in workers exposed to pulmonary carcinogens. Fig. 4 (f) shows the highest concentration of Mn was found in the depth 0.01 meter (surface water) in the Sadarghat points of the Buriganga River which is higher than WHO and Bangladeshi standards (Fig. 5) due to the industrial effluent discharge. Manganese substances can cause lung, liver and vascular disturbances, declines in blood pressure, failure in development of animal fetuses and brain damage (De *et al.* 1995). When manganese uptake takes place through the skin it can cause tremors and coordination failures. It can cause both toxicity and deficiency symptoms in plants. It can also cause fatness, glucose intolerance, blood clotting, skin problems, lowered cholesterol levels, skeleton disorders, birth defects, changes of hair color, neurological symptoms, etc. Fig. 4 (g) shows the highest concentration of Zn was found in the depth 2 meters in the Sadarghat points of the Buriganga river which is lower than WHO and Bangladeshi standards (Fig. 5). Pollutant Zn in Buriganga River water may arise from (Krantzberg *et al.* 1988) galvanizing textile, dry cell, alloy, rubber and glass industries etc. Zinc shortages can even cause birth defects. Although humans can handle large concentrations of zinc, too much zinc can still cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anemia. Very high levels of zinc can damage the pancreas and disturb the protein metabolism, and cause arteriosclerosis.

Conclusion

Different aspects of physicochemical parameters namely pH and TDS of Buriganga River were determined and obtained results show that the water in the river is partially toxic during our study period. Since TDS value of the water in Buriganga River is lower than the recommended value of WHO and

Bangladeshi standard, it means that other toxic trace elements except seven determined elements may be present in low concentration in the river water. This river acts as the main dumping site of the wastage of Dhaka city and this made the environment of the river partially degraded. The Buriganga River water is not completely safe for drinking purposes, fisheries, pharmaceuticals industries as well as the irrigation. The concentration of lead and cadmium could not be traced in any the water samples. The concentration of Manganese (Mn) was higher than WHO and Bangladeshi standards which are highly hazardous it may be considered that drinking of this water within the span of 60-70 years may be the cause of different diseases such as stiffness in the joints, hardness of the arteries, kidney stones, gall stones etc. Thus authorities should take necessary steps to prevent the untreated industrial and municipal discharge by installing effluent treatment plant (ETP) and no permission should be given to setup new industries without setting an effluent treatment plant.

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