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Physicochemical Parameters and Heavy Metal Concentration in Water at the Mokesh Beel of Bangladesh

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Abstract

The study investigated physicochemical parameters and heavy metal concentrations in water of the Mokesh beel during January to June 2016. Samples were collected from 3 different locations and analyzed in the laboratory of the Department of Environmental Science and Resource Management, MBSTU, Tangail and BINA, Mymensingh. Results showed that EC and TDS were varied from 645-688µS/cm and 541-586mg/l, respectively indicated high ionic concentration, whereas DO of all stations ranged from 4.1-5.5mg/l represents low organic waste, and pH (7.25-7.55) of all stations showed alkaline nature. In case of heavy metal concentration Pb, Cd, Cu, Zn and Cr were within the standard level. The result concludes that the water can be used for different purposes but heavy metals can be accumulated in fish flesh, consequently affect the human health. To maintain the water quality and conserve the aquatic life, proper measures should be taken to prevent pollutants intrusion into the beel.

Key words: Aquatic environment, Heavy metal, Mokesh beel, Physicochemical parameter

Introduction

The surface water quality of the beel of Bangladesh is getting highly polluted day by day (Alam *et al*., 2007) with the rapid population growth, urbanization, haphazard agricultural and industrial production, all gives rise to increased levels of emissions of organic and inorganic pollutants into the aquatic environment (DoE, 1992). Industrial wastes are known to adversely affect natural life by direct toxic action or indirectly through qualitative alterations in the character of the water (Ahmed and Reazuddin, 2000). Recently, contamination of water with heavy metals is a major environmental concern; various anthropogenic activities continuously increase the amount of heavy metals in the water bodies especially in the beel, lakes, canals and rivers (Malik *et al.*, 2010). Aquatic organisms such as fish and shell fish accumulate metals to concentrations many times higher than present in water or sediment (Olaifa *et al.*, 2004). They can take up metals concentrated at different levels in their different body organs (Khaled, 2004). Certain environmental conditions such as salinity, pH, and hardness can play an important role in heavy metals accumulation in the living organisms up to toxic concentrations and cause ecological damage (Guven *et al.*, 1999). There are over 24000 registered small-scale industrial units in Bangladesh and it is generally accepted there were an equivalent number unregistered, furthermore, industrial growth has continued rapidly in the past decade, many of these industries are highly polluting and as a consequence of their unregulated development, many ecosystems are now under threat (SEHD, 1998).

The Mokesh beel is one of the biggest wetlands in the area covering approximately 1100 ha in the wet season, but holding only 40 ha of water in the dry season, when it receives most of its water from Ratanpur Khal, which is fed almost entirely by industrial effluent (BCAS, 2009). As a result, water quality has gradually deteriorated to a level which was reportedly unsuitable for certain types of aquatic life (IWRB, 1992).Dominant industries in the Mokesh beel area include textile production (dyeing, printing, and washing), large-scale commercial poultry farming, and pharmaceutical manufacturing. Industrial development in Mokesh beel, however, is not well managed. Most industries do not have an effluent treatment plan, and many that do have a plan have not implemented it because of cost (Akter, 2011). Moreover, the water quality in the Gazipur watershed exceeds one hundred percent due to industrial effluent and the daily effluent load is 37844 kg (IWM, 2007). This pollution was found to be a serious problem affecting the aquatic ecosystem and the local people reported that the fish they caught had a bad smell and were difficult to sell or eat (Akter, 2011). The aquatic environment for living organisms can be affected and bioaccumulation of harmful substances in the water-

dependent food chain can occur. For this reason, the investigation of physicochemical parameters of water and heavy metal contamination in water of the Mokesh beel is essential since even slight changes in their concentration above the acceptable levels can result in serious environmental and subsequent human health problems.

Materials and Methods

Study area

The study was conducted in the Mokesh beel of the Gazipur district, Bangladesh, during the period from January to June 2016, covering the two villages namely Korolsurichala and Mediasulai, within the Turag-Bangshi wetland area of the Kaliakoir upazila (BBS, 2012). The study area was approximately located at 24.0750°N - 90.2167°E, and bounded by the Turag river to the north and east, Ratanpur khal to the south, and the Gazipur-square-Chandra-Kaliakor highway to the south and west (Akter, 2011).

Sample collection

The water samples were collected from 3different sampling stations of the Mokesh beel indicated as St-1 (Korolsurichala), St-2 (Mediasulai) and St-3 (Turag-Bangshi wetland area)during the dry season January to June 2016.To analyze the water quality, 500ml water was collected by plastic bottles with double stoppers from each sampling points. Before sampling, the bottle were cleaned and washed with detergent solution and treated with 5% nitric acid (HNO_3) over night. The bottles were finally rinsed with deionized water and dried. At each sampling station, the sampling bottles were rinsed at least three times before sampling was done. Pre-prepared sampling bottles were immersed about 10cm below the surface water. After sampling, the bottles were screwed carefully and marked with the respective identification number. The samples were acidified with 10% nitric acid (HNO_3), were placed in an ice bath and were brought to the laboratory. The samples were filtered through 0.45µm micro-pore membrane filter and were kept at freeze to avoid further contamination until analysis.

Sample analysis

The physicochemical parameters of water samples were analyzed in the laboratory of the Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Tangail. The water temperature and pH were determined by the thermometer and digital pH meter (pH Scan WP 1, 2; Malaysia), respectively. Digital EC and TDS meter (HM digital; Germany) was used to determine EC and TDS, respectively. The DO was determined by digital DO meter (D.46974; Taiwan). For analysis of heavy metal in water the prepared sample was taken in a vial and analyzed for Pb, Cu, Cr, Zn and Cd by Atomic Absorption Spectrometer (AAS:AA-7000, Shimadzu, Japan) in the laboratory of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh

Statistical analysis

The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. The Microsoft Office Excel software was used to present and interpret the collected data. The results of the study were presented in charts and tabular forms.

Results and Discussion

Physicochemical water quality parameters

The highest temperature of the beel was 30.8ºC at St-3 in April and the lowest was 23.3ºC at St-2 in February, whereas the mean temperature of the Mokesh beel water was 27.36ºC (Table 1). The standard limit of water temperature is 20-30ºC (EQS, 1997) and the study showed that all the temperature was within the standard limit. The temperature ranged from 22.9-36.0ºC along the Shitalakhya river in dry season during the sampling period where higher temperature was April, compared to February and March due to high air temperature (Alam *et al.*, 2006), which is almost similar to the present study. The temperature ranged from 24.6-28.2ºC at Ashulia point in the Turag river during the period from July to October (Khan *et al.*, 2007).

The highest electrical conductivity (EC) of the beel water was 688µS/cm at St-3 in February while the lowest was 645µS/cm at St-1 in April with the mean temperature of the beel was 663µS/cm (Table 1). The standard limit of EC in water is 700µS/cm (EQS, 1997) and the study showed that all the EC contents were within the standard limit. According to DWASA (2011) the content of EC was ranged from 108-991µS/cm at Kanchan and from 110-581 µS/cm at Kaligonj Kheyaghat in Shitalakhya River. According to Das *et al.* (2011), the EC of tannery effluent was 10455ε S/cm and in Buriganga and Karnatoli River were 614.5 and 175.6ε S/cm, respectively. All these studies are relatively similar to the present study.

The mean TDS content of the Mokesh beel water was 562mg/l, whereas the highest TDS content was 586mg/l at Station-1 in February and the lowest was 541mg/lat Station-2 in March. The standard limit of TDS in water is 1000mg/l (ADB, 1994) and the study showed that all the TDS contents were within the standard limit. The TDS contents of different sampling points of Turag River were ranged from 100-580mg/l (Rahman *et al*., 2012). The TDS concentrations of the Padma river water ranged from 129-166, 118-140 and 147-178mg/l over the pre-monsoon, monsoon and post-monsoon, respectively (Islam *et al*., 2014), and all these studies are similar to the present study.

Table 1. Water quality parameters of the Mokesh beel

Parameters	Sampling stations	Months			Mean	Standard
		February	March	April		
Temp. (°C)	St-1	23.5	27.8	30.5	27.26	20.0-30.0 (EQS, 1997)
	St-2	23.3	28.1	30.7	27.37	
	St-3	23.6	27.9	30.8	27.43	
EC (ε S/cm)	St-1	684	653	645	660	700 (EQS, 1997)
	St-2	687	657	655	666	
	St-3	688	656	649	664	
TDS (mg/l)	St-1	586	543	557	562	1000 (ADB, 1994)
	St-2	580	541	562	562	
	St-3	578	544	568	563	
DO (mg/l)	St-1	4.6	5.3	4.1	4.7	5.0 (EQS, 1997)
	St-2	4.3	5.4	4.8	4.8	
	St-3	4.8	5.5	4.7	5.0	
pH	St-1	7.25	7.53	7.41	7.40	6.50-8.50 (ECR, 1997)
	St-2	7.43	7.54	7.48	7.48	
	St-3	7.48	7.55	7.47	7.50	

The highest DO content of the beel water was observed 5.5mg/l at St-3 in March while the lowest was 4.1mg/l at St-1 in April, whereas the mean DO content was 4.8mg/l (Table 1). The standard limit of DO is 5.0mg/l (EQS, 1997) and the study showed that most of the DO contents were lower than the standard might be due to the presence of organic waste into the water (Islam *et al*., 2014). The DWASA (2011) reported that the contents of DO ranged from 1.5-6.2mg/l at Kanchan and 4.0-7.4mg/l at Kaligonj Kheyaghat in Shitalakhya river, which is almost similar to the present study. The mean DO content of the Padma river water were found 7.31, 7.59 and 6.82 mg/l over pre-monsoon, monsoon and post-monsoon, respectively (Islam *et al*., 2014).

The highest pH was 7.55 at St-3 in March and the lowest was 7.25at St-1 in February, with the mean pH was 7.46 (Table 1). The standard limit of pH is 6.5-8.5 (ECR, 1997) and the study showed that almost all recorded pH was within the standard limit. The result of the study revealed that the beel water tends to be alkaline, this may be due to the alkali contain waste and effluent into the water and heavy rainfall. Alam *et al.* (2004) found that the pH was 7.5 in rainy season and 7.4 in dry season at Demraghat in Shitalakhya River. The pH of Padma river water were ranged from 7.0-7.6, 7.61-8.20 and 7.5-7.8 over the pre-monsoon, monsoon and post- monsoon, respectively (Islam *et al*., 2014), all these studies are almost similar to the present study.

Heavy metals concentration in water

The study showed that the highest concentration of lead (Pb) of the Mokesh beel water was 0.0019 mg/l at sampling St-1in April and the lowest was 0.0010mg/l at St-1 in March (Fig. 1), whereas the standard of Pb in water is 0.05mg/l (ECR, 1997) and all the investigated concentrations were lower than the standard indicated that the water was not polluted by Pb containing

compounds. The concentration of Pb ranged from 0.00269-0.00589mg/l at Ashulia point in the Turag river (Rahman *et al*., 2012) which is almost similar to the present study.

The study stated that the highest concentration of cadmium (Cd) of the beel water was 0.0019mg/l at sampling St-3in April and the lowest was 0.0012mg/l at St-1and St-2 in March and February (Fig. 2), respectively. The standard of Cd in water is 0.005mg/l (ECR, 1997) and all the recorded concentrations were lower than the standard indicated that the water was not highly polluted by Cd containing compounds. Ahmad *et al.* (2010) studied that the concentration of Cd ranged from 0.007-0.012mg/l during monsoon and post-monsoon season in Buriganga River. The concentration of Cd was below detection level in Gulshan lake, Bangladesh (Quraishi *et al.*, 2010); all these studies are almost similar to the present study.

The study depicted that the highest concentration of copper (Cu) was 0.08mg/l at St-2 in April and the lowest was 0.02mg/l at St-2 in February (Fig. 3), whereas the standard of Cu in water is 1.00 mg/l (ECR, 1997) and all the concentrations were lower than the standard. The collected surface water samples from the Turag river contained significant amount of Cu and ranged from 0.01-0.02, 0.02-0.03 and 0.21-0.27mg/l during post-monsoon, pre-monsoon and monsoon season, respectively (Meghla *et al*., 2013) which is almost similar to the present study. The concentration of Cu ranged from 0.028-0.043mg/l at Ashulia point in the Turag River during the period from July to October (Khan *et al*., 2007).

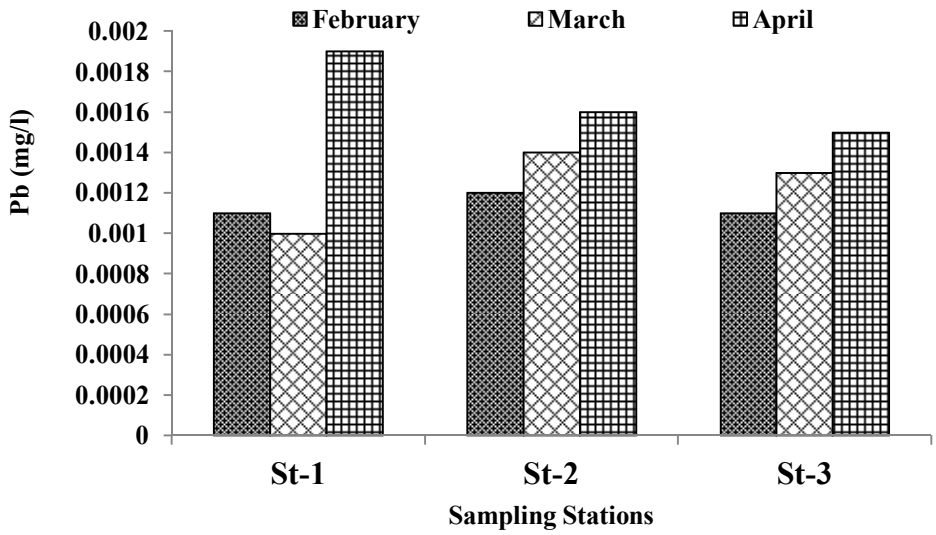

Fig. 1. Lead concentration (mg/l) in water of the Mokesh beel

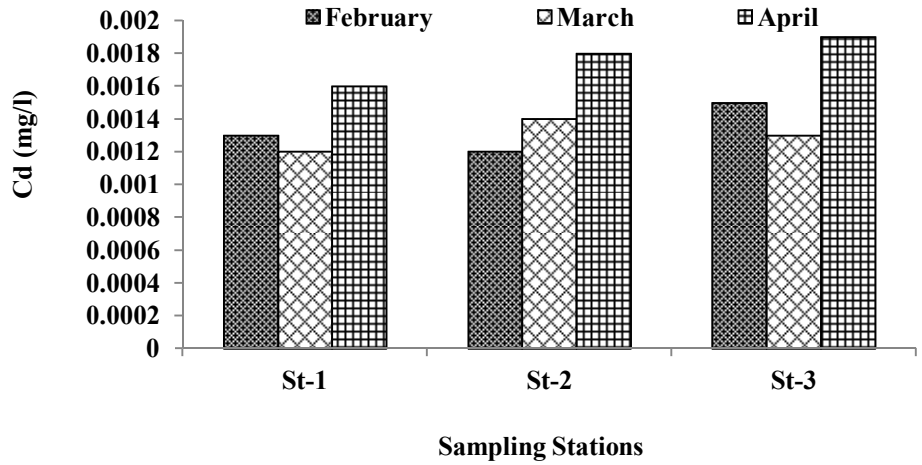

Fig. 2. Cadmium concentrations (mg/l) in water of the Mokesh beel

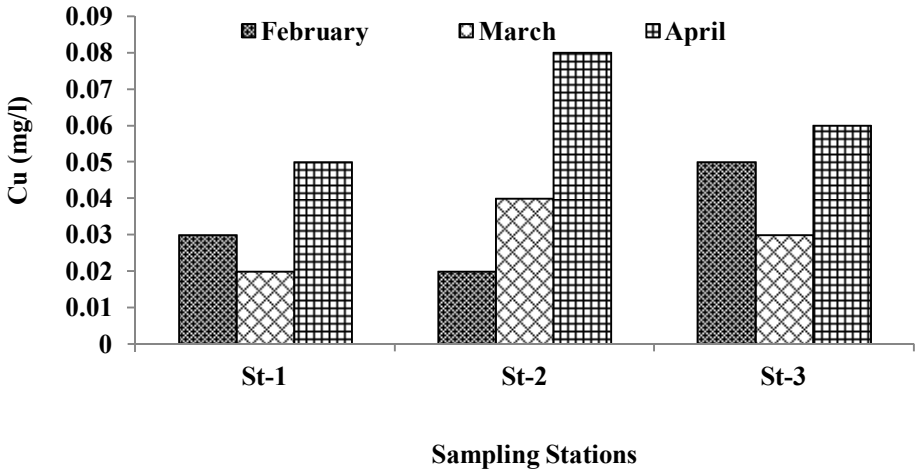

Fig. 3. Copper concentrations (mg/l) in water of the Mokesh beel

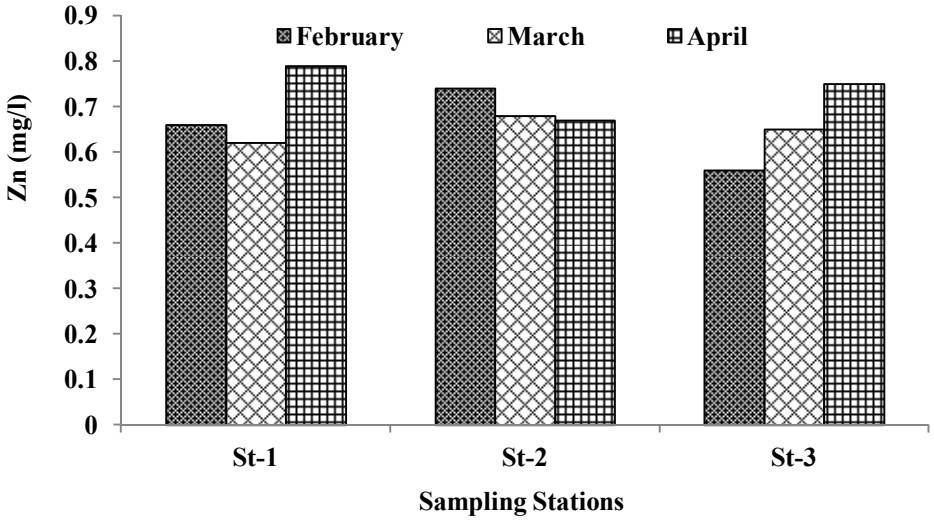

Fig. 4. Zinc concentrations (mg/l) in water of the Mokesh beel

The study revealed that the highest concentration of zinc (Zn) in beel water was 0.79mg/l at sampling St-1 in April while the lowest was 0.56mg/l at St-3 in February (Fig. 4). The standard of Zn in water is 5.00mg/l (ECR, 1997) and the all investigated concentrations were lower than the standard levels indicated that the water was not highly polluted by Zn containing compounds. The status of Zn contaminations of river water of Dhaka Metropolitan City was 0.021mg/l (Mokaddes *et al.*, 2013). Begum (2005) investigated the water pollution of Mauna and Mouchak industrial areas of Gazipur district and reported that the concentration of Zn in industrial effluents was within the range of 0.01-3.60mg/l.

The study showed that the highest concentration of chromium (Cr) in beel water was 0.019mg/l at sampling St-3 in April whereas the lowest value was 0.015mg/l at St-1 in February (Fig. 5), while the standard of Cr in water is 0.05mg/l (ECR, 1997) and all the recorded concentrations were lower than the standard levels indicating that the water was not highly polluted by Cr containing compounds. Mohuya *et al.* (2010) studied on Gulshan-Baridhara lake, Bangladesh, and they found that the mean concentration of Cr in summer was 0.10mg/l and the mean concentration of Cr in monsoon was 0.018mg/l. The minimum Cr concentration was noted from the water sample at Demraghat 0.052mg/l (Sumon, 2012). The concentration of total chromium in water samples in Buriganga river of Bangladesh were greatly exceeded the toxicity reference values in both season (Mohiuddin *et al.*, 2010).

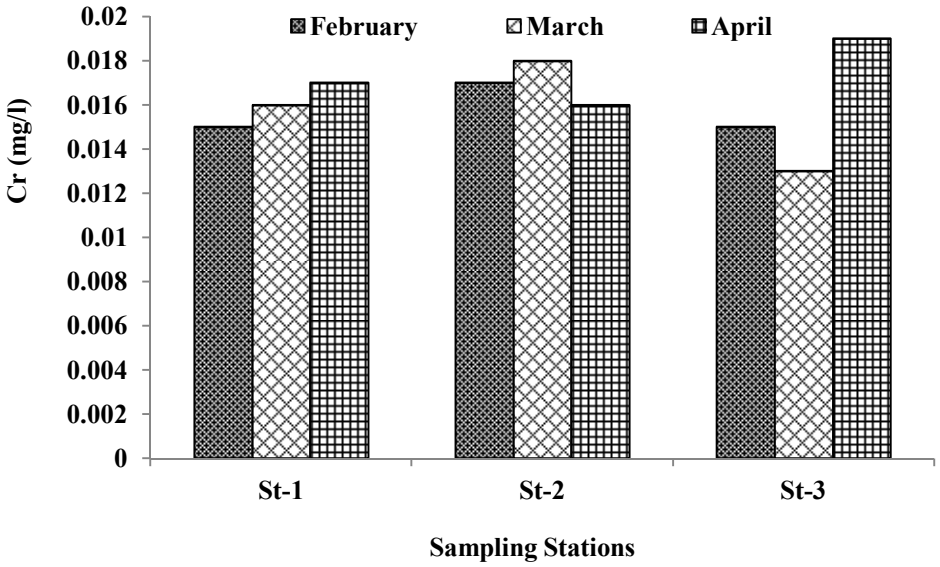

Fig. 5. Chromium concentrations (mg/l) in water of the Mokesh beel

Conclusion

From the overall discussions, it can be concluded that the quality of water in the Mokesh beel is suitable for utilizing in various purposes especially for fisheries. But though it already not hampers the aquatic lives and also the lives of adjacent people, the present status should not let continue that may get critical in near future. In order to achieve the suitable water quality for common uses and for conserving the ecosystem, proper measures should be taken to prevent the water pollution of the beel. To maintain sound environment and healthy ecosystem of the beel and the surrounding areas, identification of illegal industries set up on the bank of the beel, set up of effluent treatment plant (ETP) for all industries, strict legislation for dumping of wastewater into the beel, raising awareness among local people about the water pollution and their adverse effects on public health.

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