



Assessment of Water Quality Parameters of The Kohelia River at Cox's Bazar of Bangladesh

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Abstract

The study was conducted to explore the physicochemical parameters of surface water from the construction work involving the bridge over the river Kohelia and road along the bank of Kohelia for the construction of access road for Matarbari Coal Fired Power Plant is under construction area of Bangladesh starting from September 2020 to September 2021. The surface water samples were collected from three sampling stations in the Kohelia for the construction of access road for Matarbari. The result of the study showed that pH, Temperature (T), Dissolved Oxygen (DO), Total Suspended Solids (TSS), Turbidity, Electric Conductivity (EC), Total Dissolved Solids (TDS), Total Coliform (TC) and Fecal Coliform (FC) were ranged from 6.6 to 8.2, 24.8 to 31.6°C, 4.3 to 6.1 mg/L, 4.0 to 15.0 mg/L, 7.4 to 117.0 NTU, 24.3 to 725.0 µS/cm, 200.0 to 2721.0 mg/L, 23.6 to 644.0 N/100 ML and 11.0 to 312.0 N/100 ML respectively. Some parameters showed no significant change with the time period. This might happen due to periodic changes per day or month due to tidal effects as the study area of Kohelia River is very close estuary of the Bay of Bengal. Except pH and Temperature (T), all others physicochemical parameters were across the acceptable range of standard limits. The Comparative study showed Total and Fecal coliform is higher than the Standard might be happen due to piling slurry, concrete debris, wastewater, unhygienic sanitary waste, soil & silt dumping, surface runoff, oil and grease littering, solid waste created by workers, encroachment etc.

Key words: Contamination, Construction, Environment, Physiochemical, Water Quality

Introduction

Water is essential to all forms of life and makes up 50-97% of the weight of all plants and animals and about 70% of human body (Buchholz, 1998; Phiri *et al.*, 2005). Matarbari Island under Moheshkhali Upazilla of Cox's Bazar district is surrounded by the Kohelia river. Water quality parameters provide current information about the concentration of various solutes at the river. Besides these, the degree of pollution is generally assessed by studying physicochemical characteristics of the water bodies (Duran and Suicmez, 2007). Pollution of the aquatic environment is a global issue that has reached an alarming level (Mahfuza *et al.*, 2012). Construction pollution is reducing the availability of fresh surface water for agriculture, fisheries, and other purposes around the world (Ipeaiyeda and Obaje, 2017). The vulnerability of rivers to pollution, particularly for developing work, is unprecedentedly great due to its unrestricted accessibility for garbage disposal (Bartley *et al.*, 2012). Because of development around the world, rivers have become dumping basins for solid wastes and effluents from engineering (Ipeaiyeda and Obaje, 2017). Due to construction of coal fired power plant project and associated facilities, huge area has been developed through land filling and hydrological dimension of the proposed project and surrounding likely to be affected. For the demand of the local people, public land that is

falling on this and for the protection of the Matarbari project, the project authority has rehabilitated the east part of existing embankment for use as a road and a bridge over the river construction work ongoing for the local inhabitants. Proposed 7.35 km long embankment from Rajghat, Matarbari to Mohoriguna, Dhalghata and 860m bridge over the Kohelia River. The main rationale of the project is connecting two unions from Rajghat point, Matarbari to Mohoriguna, Dhalghata by constructing embankment cum road.

The main of goal the study was to assess the alteration of water quality in the Kohelia River due to construction of access road along with the bridge over the river. The specific objectives of this study were: (i) to make an assessment of water quality parameters, (ii) to evaluate the impacts of water parameters produced due to construction activities, and (iii) to identify the mitigation measures to minimize the consequence.

Materials and Methods

Study area

The study area is Kohelia river is situated Moheshkhali Upozila under Cox's bazar District in Chittagong region. The Kohelia River is around 17 Km length with on an average width of 350 m. The study area is situated at 21.728800°N, 91.905381°E to 21.681456°N, 91.876293°E.

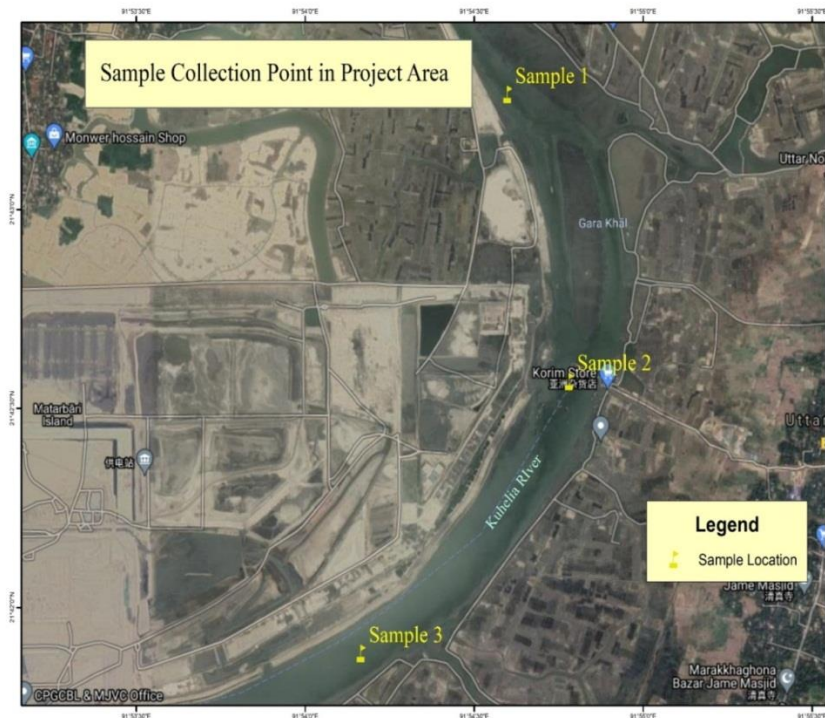


Fig. 1. Location of the study area.

Study design

The study was conducted through following mixed method approach: a combination of qualitative and quantitative approach. In the first stage, review of secondary literature was done in the case of impacts of construction change on water quality, aquatic resources and health of people. In second stage, collection of qualitative and quantitative data. To identify the impact on water, base line data were collected prior to start the construction work from three locations such as one was at upstream of the construction work (S1), second one was within the construction area (S2) and third one was at downstream of the construction zone (S3) as shown on the map. After that, periodically three times sample were collected and sent to the laboratories for test and gotten the parameters. Base line sample and periodic sample of river water were collected and tested within four-month interval. The baseline data were collected in September’ 2020 before the construction work was started. The periodic sample were collected in January’ 2021, May’2021 and September 2021. The period completed a while cycle of year as well as all the seasonal variation such as monsoon, rainy, dry and winter seasons.

Sample collection

The water samples were collected from 3 sampling stations denoted as St-1, St-2, and St-3, of the Kohelia river is situated Moheshkhali Upazila during September 2020 to September 2021. The samples were collected by 500 ml plastic bottles with double stoppers from each sampling points. The bottles was cleaned and washed with detergent solution and treated with 5% nitric acid (HNO₃) over night before sampling. Finally the bottles

will be rinsed with deionized water and dried. After sampling the bottles will be screwed carefully and labeled properly for identification. Some of the parameters are tested on-site by the on-site field kit and rest of the parameters was tested from the Central Laboratory of Department of Public Health Engineering (DPHE). The samples were filtered through 0.45 μm micro-pore membrane filter and were kept at freeze to avoid further contamination until analysis.

Sample analysis

The water quality parameters such as Temperature, EC, TDS, pH, DO, Turbidity, and TSS were measured by thermometer (Celsius scale), EC meter (Model: HM digital, Germany), TDS meter (Model: HM digital, Germany), pH meter (Model: pH scan WP 1, 2, Malaysia), DO meter (Model-D, 46974, Taiwan), Turbidity meter (Model: Hanna-HI9829, USA), and Filtration and drying method (Standard Method 20th Edition, 1997) respectively.

Membrane filter method (MFM)

Instruments used

Membrane filter (pore size 0.45μm), Incubators (35°C), Hot air Oven, Autoclave.

Media preparation

a) Total coliform

In 100mL sterile distilled water, dissolve 5.1 gram M Endo agar and 1 mL ethyl alcohol. To dissolve Agar,

heat to near boiling temperature, then remove from heat and cool to 45°C to 50°C. Fill sterile petridishes with 10 to 20 milliliters of liquid and let completely aside to solidify. pH was 7.2 (Method APHA 9222B, 2012).

b) Fecal streptococci

100 mL sterile distilled water, 4.2 gram ME Agar. Heat until the agar is dissolved, then withdraw from the heat and cool to 45-50°C. Allow to solidify the agar by pouring it into sterile petridishes to a depth of 4 to 5mm (Method APHA 9230, 2012).

Counting and calculation

TC = (Coliform Colonies Counted ÷ Volume of sample filtered) × 100

FC= (Streptococci colonies Counted ÷ Volume of Sample Filtered) × 100

Statistical analysis: The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. The Microsoft Excel 2016 software was used to present and interpret the collected data.

Results and Discussion

The water samples of the Kohelia River were collected and tested from reputed laboratories. The laboratory tested results are tabulated:

Table 1. Seasonal variation of surface water quality in Kohelia river of Moheshkhali Upazila

Parameter	Sampling Station	Measured Value				Standard
		September-2020	January-2021	May-2021	September-2021	
pH	St ₁	6.6	7.4	7.4	8.2	6.5-8.5 (ECR 1997)
	St ₂	6.7	7.2	7.7	8.2	
	St ₃	6.6	6.6	6.6	7.9	
	Mean	6.6	7.1	7.6	8.1	
Temperature (°C)	St ₁	27.8	24.9	29.8	31.6	25-31 (WQG and GES, 2016)
	St ₂	28	24.8	28.8	31.5	
	St ₃	27	28.7	30.1	29.1	
	Mean	27.6	26.1	29.6	30.7	
DO (mg/l)	St ₁	5.1	5.3	5.8	4.7	5 (WHO 2011)
	St ₂	5.6	5.5	6.1	4.8	
	St ₃	5.0	5.1	4.8	4.3	
	Mean	5.2	5.3	5.6	4.6	
TSS (mg/l)	St ₁	8.0	11.0	4.0	6.0	10(ECR 1997)
	St ₂	9.0	15.0	13.0	5.3	
	St ₃	8.5	8.0	4.0	6.0	
	Mean	8.5	11.3	7.0	5.8	
Turbidity (NTU)	St ₁	14.0	48.2	15.0	14.2	<5(WEPA, 2017)
	St ₂	13.5	117.0	14.5	7.4	
	St ₃	13.0	25.0	18.0	14.2	
	Mean	13.5	63.4	15.8	11.9	
EC (µS/cm)	St ₁	24.3	544.0	647.0	38.5	300(ICMR 1975)
	St ₂	24.9	249.8	725.0	39.2	
	St ₃	24.6	243.0	581.0	89.7	
	Mean	24.6	345.6	651.0	55.8	
TDS (mg/l)	St ₁	201.7	2277.0	2714.0	253.0	500(WHO 2011)
	St ₂	201.2	2498.0	2448.0	244.0	
	St ₃	200.0	2019.0	2721.0	325.0	
	Mean	201.0	2264.7	2627.7	274.0	
Total Coliform (N/100 ML)	St ₁	24.0	256.0	200.0	96.0	Zero (ECR 1997)
	St ₂	23.6	644.0	253.0	248.0	
	St ₃	24.9	244.0	225.0	96.0	
	Mean	24.2	381.3	226.0	146.7	
Faecal Coliform (N/100 ML)	St ₁	12.0	124.0	120.0	48.0	Zero (ECR 1997)
	St ₂	11.0	312.0	112.0	120.0	
	St ₃	12.5	122.0	124.0	48.0	
	Mean	11.8	186.0	118.7	72.0	

Physicochemical properties of water**Temperature**

The result of the study showed that the highest temperature of the river was 31.6 °C at St-1 during the September-2021 whereas lowest was found at 24.8 °C St-2 in January-2021 (Table 1) which was found within the standard 25-31 °C (WQG and GES, 2016) and the study revealed that temperature was suitable for aquatic environment. It was observed that the temperature were decreased in January'2021 to an average value 26.1 °C and then raised again to become maximum in September'2021. This may happened due to the seasonal temperature change as well as activity in water body. This temperature is little bit more in September' 2021 with respect to ECR (20 to 30 °C) for aquatic environment as well as fish production established by Bangladesh Environmental Conservation Rules (ECR 1997).

Total dissolved solids (TDS)

The TDS contents were within the range of 200 to 2721 mg/l. The minimum TDS was found as 200 mg/l in base line data at S3 in September 2021 and the maximum value counted in May 2021 at S3 downstream. From the observation, drastically increased the value January 2021 and May'2021 with the base line data but sharply fall again in September'2020. Soil leaching and agricultural runoff might be cause of increased TDS and after rainy season TDS decreased. TDS levels of 1000 ppm, 1500 ppm, 5000 ppm, and 2000 ppm are suitable for drinking, industrial, livestock, and irrigation water respectively (Mobin *et al.*, 2014). From the study, it was observed that the concentration of TDS were higher than the limit of standard (TDS>1000 ppm).

pH

The PH is an important aspect of water quality because it affects both the water and the people who use it (Kabir *et al.*, 2020a). The PH of all collected water samples from exploring areas were within increased gradually with the base line. The base line average value was 6.6 whereas the value increased to 7.1, 7.6 & 8.1 when collected sample during construction works in progress. Construction activity like piling works produced bentonite-cement- admixture effluent, earth filling concrete works polluted water. Rise of PH might be happened due to alkaline cement concrete debris effluent to river and also detergent used by the project workers which added the alkaline to the river Kohelia. In general, chemicals, minerals, pollutants, soil or bedrock composition, and any other contaminants that interact with a water will create an imbalance in the water's natural PH of 7. The acceptable range of PH for drinking water is 6.5 to 8.5 (WHO, 2011). The study found that the pH values of all sampling sites were within the standard limit.

Dissolve oxygen (DO)

The DO of all collected water samples from investigated regions were within the Average range 4.3 to 6.1 mg/l. From the study, the parameter is seem to be slightly up till May 2021 and in September'21 looks down that other three times even with base line data. The acceptable range of DO for domestic water supplies is 4.0 to 6.0 ppm by United State Public Health (USPH) standard (Mobin *et al.*, 2014). On the basis of the study, the measured values of DO of all water samples were within the acceptable range (ECR, 1997), may be because of the greater temperature and higher pace of deterioration of natural matter as mechanical exercises are significantly contributed for the diminishing of DO level (Kabir *et al.*, 2020a).

Electric conductivity (EC)

The EC of all collected water samples from Kohelia river at three locations were within the range of minimum September 2021 was 24.3 µS/cm to in May 2021 was 725.0 µS/cm. The Electric Conductivity increased continuously in January 2021 and May 2021 sharply and again decreased in September 2021 little more than the base line data. This changes which might be the consequence of anthropogenic activities such as industrial release and agricultural runoff (Kabir *et al.*, 2020c). The standard of electric conductivity is 1200 µS/cm for inland surface water (ECR 1997). The acceptable range of EC for recreational water, irrigation and aquaculture are 500µS/cm, 750µS/cm and 800 to 1000 µS/cm, respectively (Mobin *et al.*, 2014). Hence, it seems to within the limit though the magnitude raised.

Turbidity

From the above study we can show that the turbidity was found the average 11.9 NTU to 63.4 NTU. The turbidity in January 2021 raised more and in May 2021 & September 2021, the values close to the base line of September 2021. This might be happened due to massive activities was done in the dry season like January caused flows to the Kohelia river and increased the dimension and reverse was in rainy season as less activities. According to Environmental Conservation Rules (ECR, 1997) the suitable temperature range of Turbidity is 10 NTU (ECR, 1997). So from the above discussion we can tell that the amount of turbidity is not within the national standard.

Imran *et al.* (2020) revealed that the highest turbidity content 890 NTU was found at monsoon and lowest content of 720 NTU was found at post-monsoon season in Moheskhal fishing zone. The water turbidity standard is <5 (WEPA, 2017), hence the projected Turbidity values were greater than the standard limit (Table 1).

Total suspended solids (TSS)

The total suspended solids (TSS) found minimum in September'2021 was 4.0 mg/l and maximum in

January'2021 15.0 mg/l. The results indicated that the average value increased from 8.5 mg/l to 11.3 mg/l in the dry season and again decreased in rainy season to 7.0 mg/l & 5.8 mg/l. Average maximum values reported in the present study during monsoon months at all study sites were due to increased polluted surface runoff from nearby construction area and catchments.

Imran *et al.* (2020) revealed that the highest TSS content 38 mg/L was found at pre-monsoon and lowest content 17 mg/L was found at post-monsoon in Moheskhal fishing zone. For marine surface water, the mean TSS content is 50 mg/L, according to the Malaysian standard WQSC (2004). All the observed TSS contents in the present study within the standard level.

Table 2. Correlations among different water quality parameters of Kohelia River at construction zone.

Parameter	pH	TDS	EC	Temperature	DO	TSS	Total Coliform	Fecal Coliform	Turbidity
pH	1								
TDS	-.174	1							
EC	-.161	.718*	1						
Temperature	.445	-.923**	-.694*	1					
DO	-.338	.683*	.198	-.614	1				
TSS	-.378	.390	.299	-.547	.547	1			
Total Coliform	-.391	.447	.634	-.511	.433	.653	1		
Fecal Coliform	-.417	.490	.674*	-.544	.431	.589	.992**	1	
Turbidity	-.376	.379	.575	-.503	.262	.728*	.910**	.901**	1

*, Correlation is significant at the 0.05 level (2-tailed).

**, Correlation is significant at the 0.01 level (2-tailed).

The correlation studies explored that the relationships of fecal coliform vs. total coliform as well as turbidity vs. total and fecal coliform were found strongly positive.

Total coliform and fecal coliform

From all collected water samples from three locations the total coliform (TC) were within the range of 23.6 N/100 ML (September 2020) to 644 N/100 ML (January 2021) and Fecal Coliform (FC) were within the range of 11.0 N/100 ML (September 2020) to 312.0 N/100 ML (January 2021). Comparing with the base line data of September 2020, in January 2021 augmented more and gradually fall though these indicate higher also. The pollution caused due to the presence of fecal coliform bacteria should be by the human activity (Javed *et al.*, 2014). The effluent from workers' unhygienic sanitation could cause the fecal in river water.

Conclusions

Based on the above study it can be summarized that most of the construction connected pollutants are directly or indirectly discharged into the Koherila River. Toxins entering the water body are both in solid and liquid forms. Concerning all measured factors (especially TDS, turbidity, coliform) it could be concluded that pollution of Kohelia water reached critical point with changing tendency seasonally. Consequently, in order to decrease effluence from various sources, apposite paces must be taken immediately. If the necessary preventive measures are not taken, with the construction volume and nature it would be a source danger point for water contamination. This study has exposed that the constructions are encompass in serious environmental hazards. The adverse consequence of construction is severe. Kohelia

as well as other river constitute the major essential source for salt and fisheries for the people around. Pollution is unavoidable part of all developing activities. Rapid growth of the industrial sectors has greatly improved the quality of our life but has also backed largely to pollution. Globally coastal and river areas fisheries are detrimental day by day due to adulteration, which have been stated by researchers. But bearing in mind the economic value, we cannot overlook this sector. Hence, sustainable development is the demand the modern world and mitigation measure is essential to protect the river, water resources for the sake of stake holders. It has now become a vital issue for the concerned authority to commence some inclusive and realistic approaches to save this river.

Recommendations

Water parameters have been identified as a significant potential impact of the access road project during the construction phases. The study highlighted most of the adverse influences on the physicochemical parameters could be equipoise or minimized if the mitigation measures are effectively executed. Now the effect of construction on water quality during activity should be given special consideration. To decrease the impact of construction disturbance on water feature, the following initiatives can be taken:

- a. The detailed environmental assessment required for the access road project to suggest the scale of adverse impacts, which can be reduced to an acceptable level through recommended mitigation measures.
- b. The contractor will be required to submit an Environmental Management Action Plan (EMAP) prior to the start of work. All affected environmental values, all potential impacts on

- environmental values, mitigation strategies, relevant monitoring with appropriate indicators and performance criteria, reporting requirements, and, if an undesirable or unpredicted level of impact occurs, the appropriate corrective actions available should all be specified in the EMAP.
- c. Strengthen the supervision and management at the construction stage, standardize the construction in accordance with the EIA recommendation, and strictly prohibit the discharge of sewage and living garbage from the construction site into the river.
 - d. Solid waste generated during the construction period from excavation and refuse from construction camps, conduct separate waste collection and promote recycling and reuse.
 - e. Protect surface water run-off carries pollutants from the site, such as diesel and oil, toxic chemicals, and building materials like cement. Don't throw any solid waste into the water streams as it leading to pollution. Use pit for any types of debris.
 - f. Large-scale construction machinery should be far away from the reservoir as much as possible. The machinery should be overhauled on time to reduce oil leakage and oil running.

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