

ASSESSMENT OF WATER QUALITY OF BAMUN SHAHI CANAL OF CHITTAGONG CITY

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ABSTRACT

The water quality of Bamunshahi Canal of Chittagong city, the busiest seaport in southern Bangladesh has been assessed in the study. The canal water is being used for irrigation, fishing, recreation etc. by the local community living alongside the river. However, the canal receives industrial toxic wastes as well as human sewage and carries these pollutants to the tidal river Karnaphully. Hence the physical, chemical and biological quality of the canal water has been analysed in the study. The values of pH, dissolved oxygen (DO), faecal coliform(FC), total hardness, alkalinity, phosphate are within the allowable limit of Bangladesh Standard (BDS). However, the values of biological oxygen demand (BOD₅), chemical oxygen demand (COD), turbidity, nitrate, color, total solid (TS), electrical conductivity(EC) exceed the standard limit prescribed for Bangladesh. The study indicates that the water is not suitable for irrigation or fishing purpose. Hence industrial effluent must be treated before discharging into the canal like any other natural water systems to sustain the ecological balance of the river and canal as well.

Keywords: Water quality; canal water; biological oxygen demand; chemical oxygen demand; dissolved oxygen

INTRODUCTION

Surface water, one of the major water sources used for all water-related purposes, is obviously highly susceptible to contamination, and it has historically been the most convenient sewer for industry and municipalities alike (Masters, 2004). The quality of surface water is being degraded day by day due to the unplanned urbanization and consequent speedy economic growth through intensified industrial activities in developing countries. Like other developing countries, the quality of surface water in Bangladesh is also at high risk, and the problems are acute especially in the urban areas. Chittagong, the busiest coastal seaport city in the southern Bangladesh, is located on the banks of the tidal river Karnaphuli, and the river has major contributions to the national economy through import-export activity, hydropower generation, drinking water supply for Chittagong city dwellers, navigation for waterways, employment of many fishermen, boatmen etc. and a significant prospect of tourism in its 88 kilometers of course in Bangladeshi border (Haider et al., 2014). However, the industrial effluents which may contain highly toxic substances from various industries situated throughout the city corporation area as well as a large amount of municipal waste are being discharged into the Karnaphully river directly or through almost twenty tributary canals flowing across the city to dispose city's wastewater and stormwater. Although the pollution level of the river water may be minimized by its self-cleaning capacity and the diurnal tidal cycle of the river, its quality is being deteriorated day by day. A significant number of studies have found that the water quality of the river has been exceeded its tolerable limit such as for fisheries, irrigation etc. (Haider et al., 2014; Ahmed et al., 2010; Sarwar et al. 2010; Hossain et al., 2006). Many studies have been conducted to assess the water quality of the river of the city but the study on water quality assessment of its tributary canals are limited.

In this backdrop the study has been conducted to assess the water quality of Bamunshahi canal, one of the tributary canals of the Karnaphully river, which receives pollutant both from point and non-point sources such as the industrial effluents from heavy industrial area of the city, as well as the municipal waste from the surrounding areas. Few suggestions are also made at the end of the study which might help minimize the potential risk from the disposal of untreated effluent to the environment.

METHODOLOGY

The study was conducted on a canal which is originated from Oxygen area, a heavy industrial area of Chittagong city, and ended up into the Karnaphuly river. The Shitaljharna Khal is flowing from Oxygen area to Dhalipara which is about 5 Km long, and the name of the canal has been changed as Bamun Shahi Khal from Dhalipara to the Karnaphuly confluence. Therefore, the two canals are named here as Bamunshahi Khal in later section of the paper for the convenience. The details of the 11 Km long study area and sampling locations are shown in Fig. 1. Water samples were collected from 21 locations along the length of Baminshahi Khal at approximately equal distances (500 m interval) to analyse its physical, chemical and biological parameters during the period of August 2014 - August 2015. Necessary precautions were taken during sample collection, and the samples were analysed in the environmental engineering laboratory of Chittagong University of Engineering and Technology following standard procedure of water analysis. Table 1 presents sample identification and sample location.

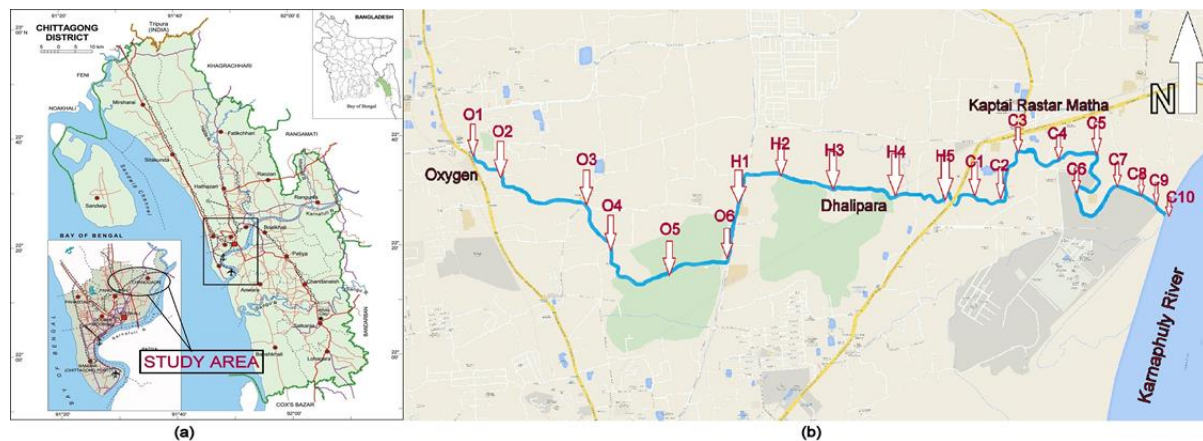


Fig. 1: (a) Map of the study area; (b) Sampling Location

RESULTS AND DISCUSSION

Physical, chemical and biological parameters of the water samples collected from the studied area were analysed to assess their quality for the intended uses. The obtained results were also compared with the Bangladesh Standards (BECR'1997) of water quality parameters for various water related purposes. The key findings of different parameters of water samples are discussed in the following sections.

Evaluation of Physical Properties of Water

The pH of the canal water was found between 6.4-7.9 which is within the allowable value suggested in the Bangladesh standard. Although there is no direct effect of pH on aquatic environment, there may be a gradual decrease in fish population with the decrease in pH. The toxicity of several common pollutants is markedly affected by pH changes, and increasing acidity or alkalinity may take those poisons more toxic (Russel et al, 1979). The temperature of water is a very important parameter because it has effects on chemical reactions and reaction rates, aquatic life, and the suitability of the water for beneficial uses. Optimum temperatures for bacterial activity are in the range 25- 35 °C, the temperature of the canal water was 26-29°C. There is no standard value of color for fishing and agriculture but for drinking the BDS standard is 15PCU. The PCU value of the water was very high from Chandgaon to Raillarpore area and Mohra ward area which may be due to the colored wastewater discharges from various garments situated in the area. The water collected from all the locations were found very turbid and the turbidity values are higher (maximum 106 NTU) than those of the Bangladesh standard (10NTU) except Hazipara area. Turbid water interferes the recreational use, and turbid water can be dangerous for swimming, because of the possibility of unseen submerged hazards and the difficulty in locating swimmers in danger of drowning. (Russel et al, 1979). There is frequent dredging work found along the length of the canal which might be one of the reasons of being highly turbid water. The gradual increase in turbidity in 5 no. Mohra Ward is ascribed to the industrial disposal in the area. All the physical parameters of water samples analysed in the study are graphically presented in Fig. 1.

Table 1: Different sample location and their identification in the study at different distances

Sampling location	Sample ID	Distance from base point (Km)	Sampling location	Sample ID	Distance from base point (Km)
Oxygen moore*	O1	0	4 no Chandgaon ward	C1	6
Shahid nagar	O2	0.5	4 no Chandgaon ward	C2	6.5
Jomader pol	O3	1.5	4 no Chandgaon ward	C3	7
Hazipara	O4	2	5 no Mohra ward	C4	7.5
Chadgaon	O5	2.5	5 no Mohra ward	C5	8
Chadmia road	O6	3	5 no Mohra ward	C6	8.5
Hazirpul	H1	3.5	5 no Mohra ward	C7	9
Dhalipara	H2	4	5 no Mohra ward	C8	9.5
Dhalipara	H3	4.5	5 no Mohra ward	C9	10
Tekbazar	H4	5	Karnaphuly river	C10	10.5
Raillarpul	H5	5.5			

*considered as base point for convenience

Regarding the solid concentration of the canal water, the TS values was higher in the upstream of the canal which might be due to the channel scouring phenomena and having lower depth. However, a comparatively lower TS value was found at the confluence point of the canal and the Karnaphully river due to the dilution process., TS values decreased rapidly due to dilution of the canal water. Electrical conductivity indicates the presence of ions, salt within the water. The water contains higher conductivity (maximum 1685 $\mu\text{mhos/cm}$) than that of BDS (1200 $\mu\text{mhos/cm}$) for irrigation purpose and hence it can be concluded that the water is unsuitable for irrigation. Also according to Indian Standard, EC value ranges from 750-2250 micro mhos/cm at 25 °C which should not be used on soils with restricted drainage because it hampers crop yielding. Unrestricted and untreated disposal of industrial effluent contributes various ions in the water which may help to increase EC value of water.

Evaluation of chemical properties of water

The results found from the chemical analysis of water samples from different areas are shown in Fig. 2. The study shows that the canal water is alkaline having the alkalinity value of 20-55 mg/L but it is below the Bangladesh standard for the water to be used for drinking and fishing purposes. Hardness analysis of all the samples shows that the values of most of the samples are within the BD standard. A spatial variation in hardness value along the canal length has been observed in the study and have slight variation throughout the canal. As the water is soft the water may be used for irrigation.

The DO value is the most important parameter considered for a healthy aquatic life. Hence the level of DO value of the studied canal was determined, and the DO values of the tested samples are within limit ($\geq 6\text{mg/L}$) for most of the cases except 4 no. Chandgaon Ward, 5 no. Mohora Ward and the confluence point with Karnaphuly River. A comparatively DO value can adversely affect aquatic life and other animals which live on fish. However, many other invertebrates are less sensitive to a lower DO concentration and may be equally suitable for fish food. The water had a BOD₅ value of 10-50 mg/L. Excessive discharge of industrial and tannery waste to the canal and disposal of

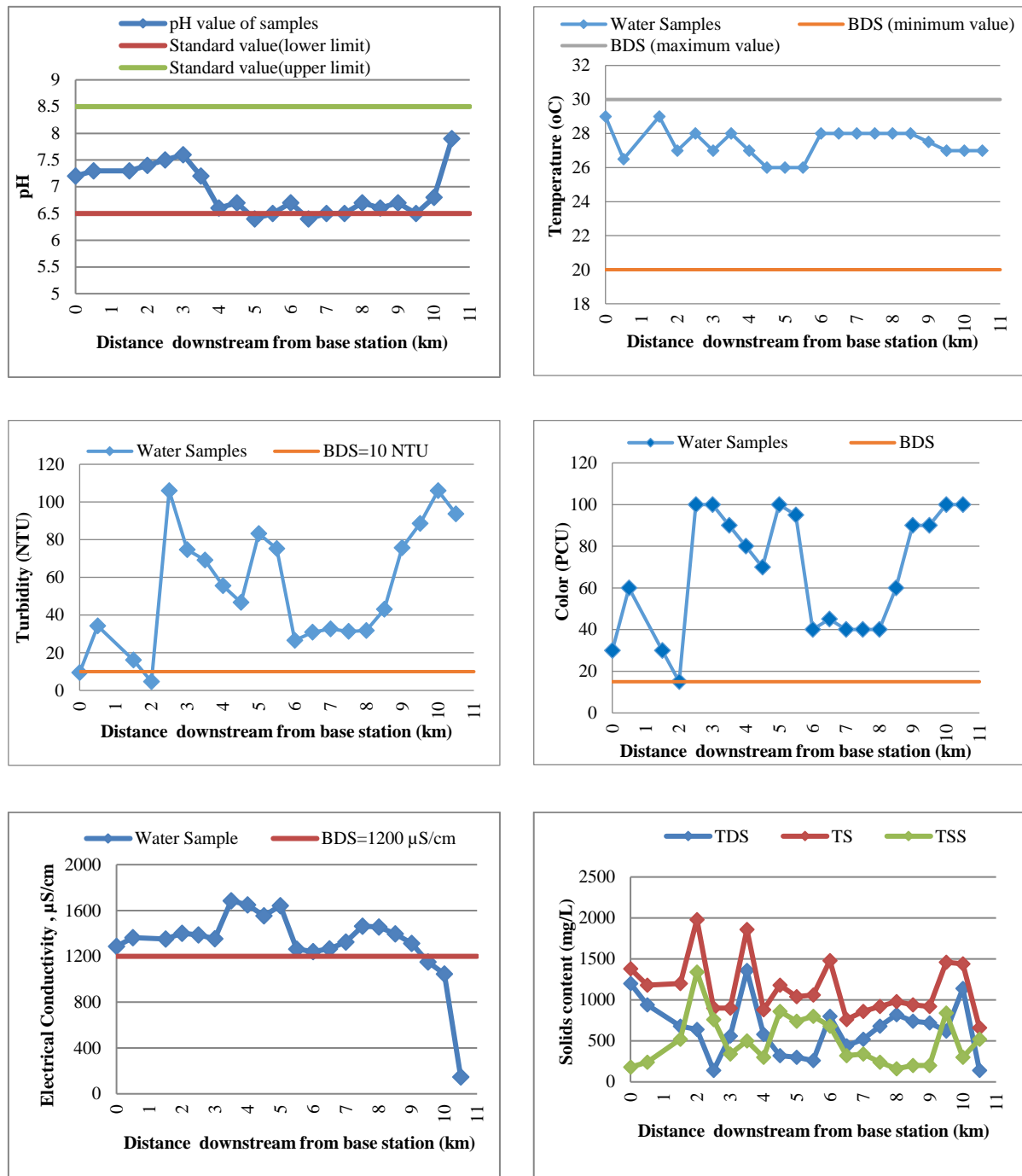


Fig. 2: Results of the physical quality analysis of water samples along the length of the canal

sanitary sewage as well as domestic waste are degrading the water quality and increasing the value of BOD_5 . The water also contains COD concentration with an average value of 168 mg/L (maximum 400 mg/L and minimum 90 mg/L) which is much higher than that of Bangladesh standard for drinking water which may be due to the disposal of industrial effluent from various industries located along the length of the canal especially from the Nasirabad heavy industrial area. However, the results indicate that the water cannot be used for drinking purpose without proper treatment. The findings of the chemical analysis are summarized in Fig. 2. The water quality standards in Bangladesh for various purposes are presented in Table 3.

Table 3: Surface water quality standards for various purposes (BECR, 1997)

Parameters	Units	Bangladesh Standard			
		Irrigation	Drinking water	Recreation	Fishing
pH	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
DO	mg/L	5 or more	6	5 or more	5 or more
BOD ₅	mg/L	<10	0.2	<3	<6
Turbidity	NTU	-	10	-	-
Total solid	mg/L	-	1000	-	-
Temperature	°C	-	-	-	-
TC	N/100 mL	<1000	0	<200	-
Nitrate	mg/L	-	10	-	-
Phosphate	mg/L	-	6	-	-
Alkalinity	mg/L	-	100	-	70-100
COD	mg/L	-	4.0	-	-
Color	PCU	-	15	-	-
Hardness	mg/L	-	250-500	-	80-120
E.C	µmhos/cm	1200	-	-	800-1000

Eutrophication is the process of algal bloom caused by excessive nutrient disposal into the natural systems. If any system gets eutrophied it will affect ultimately the DO value of water and hamper the ecological balance of the system. Hence the regulatory organizations of many countries worldwide put stringent rules and standards on nutrient disposal. Therefore, nutrient (nitrate and phosphate) content of water were analysed in the study. Nitrate values of the water samples were found 120 mg/L and the phosphate content of the water was 5 mg/ L. The nitrate content is much higher than the BDS (10 mg/L) while phosphate content is within the allowable limit (6mg/L).

Evaluation of Biological Parameters

It is noticed during the study that the water of the canal is being used for irrigation, fishing, recreation etc. and there are communities living alongside the canal. Hence there is the possibility of microbial pollution caused by human sewage or other animal's excreta along the length. Therefore, biological analysis (faecal coliform, FC) has been performed in the study to detect the level of microbial pollution. The analysis shows that the water does not contain any FC which comply with the BDS. Therefore, the water is safe to use for irrigation or even for drinking purpose regarding the microbial content of water.

CONCLUSION

The physical, chemical and biological water quality of Bamushahi Canal, one of the tributary canals of the Kranaphully river, of Chittagong city has been assessed in the study. The results of the water quality analysis indicate that the water is not suitable for irrigation, fishing and recreation. Although DO value of the water are considerably higher than that of Bangladesh standard for fishing, the very high BOD₅ COD content of the water indicates the presence of toxic organic wastes which may hamper the DO content and the ecological system of the canal. The study concludes that treatment of industrial effluent

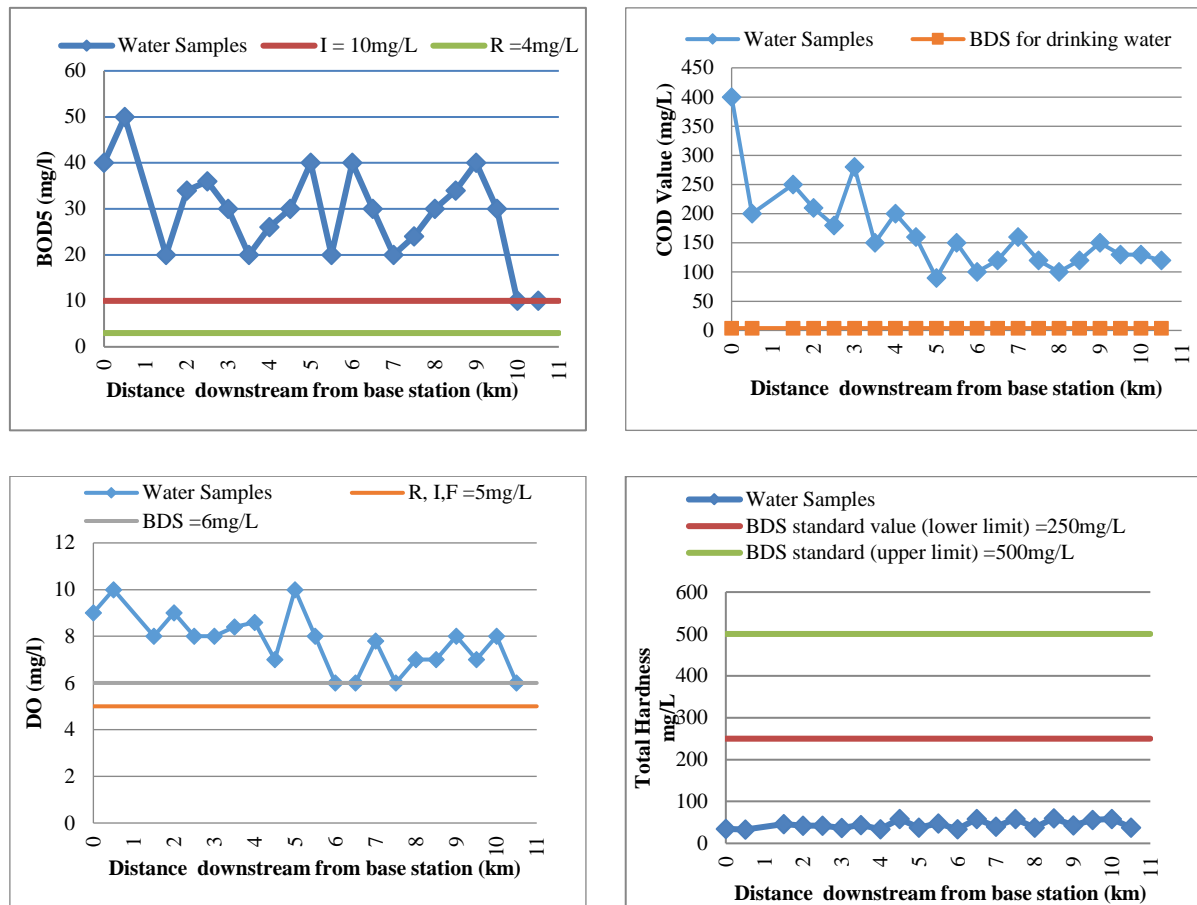


Fig. 3: Results of the chemical quality analysis of water samples along the length of the canal

before discharging it into the canal should be done by the respective authority, and law enforcement and strict monitoring must be maintained on a regular basis to save the canal as well as the Karnaphully river.

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