IUBAT Review
A Multidisciplinary Academic Journal

Md Tarekh Rasul, Md Monirul Islam, Saiful Islam Sajjad & Md Zihad Islam. 2021. **"Impact on Wastewater Discharge to the River Turag: A Case Study Adjacent to the IUBAT"** *IUBAT Review* 4 (1): 48-54. iubat.net/journal/

Impact of Wastewater Discharge to the River Turag: A Case Study Adjacent to the IUBAT

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ABSTRACT: *The Turag, one of the major peripheral rivers of Dhaka city, has become highly polluted due to the discharge of effluent from some point and non-point sources. To identify the impact of the point source for the river pollution, wastewater has been tested from a discharge point adjacent to the International University of Business Agriculture and Technology (IUBAT) campus, and at the same time, water samples from the river Turag have been tested for consecutive seven months. The test results of the present study and the test results of other studies show that the different point sources are significantly polluting the Turag. It has been found that the point-source adjacent to IUBAT does not satisfy wastewater quality standards to discharge into inland waterbody as per the guideline of the Department of Environment (DoE), Bangladesh. Total suspended solids (TSS), biochemical oxygen demand (BOD), dissolved oxygen (DO), and chemical oxygen demand (COD) level of the wastewater sample was found as 209.57±122.25 mg/l, 394.66±34.75 mg/l, 0.00 mg/l and 736.8 ±239.65 mg/l, respectively, which were beyond the water quality standard. On the other hand, quality of water of the river Turag itself does not satisfy the standards of DoE. The water pollution indicating parameters like TSS, BOD5, DO, and COD levels of the Turag water were found as 189.97±98.21 mg/l, 53.49±12.33 mg/l, 0.26±0.56 mg/l and 84.8 ±11.75 mg/l, respectively, which is beyond the standard to use as feed water in water supply systems both in domestic and industrial, to use for recreational activities, fisheries, or irrigation purposes. Proper treatment of effluent before discharging can save the Turag from pollution. There is scope for resource recovery from wastewater if a holistic approach to waste management is adopted.*

KEYWORDS: *Wastewater, Turag, Pollution, Biogas, Ecosystem*

1. Introduction

The major three peripheral rivers system Turag-Tongi Khal-Balu has surrounded the entire Dhaka city (Whitehead et al., 2018). The Turag river is a tributary of the Buriganga river in the upper reaches. It originates in the Bangshi river and flows through the Gazipur district before joining the Buriganga near Mirpur in the Dhaka district (Rahman et al., 2013). In addition, the Turag is connected to the Balu River through the Tongi Khal (Choudhury and Choudhury, 2004; Rahman et al., 2013; Mobin et al., 2014). The Turag water has been excessively polluted from discharging of industrial effluents, sewage, agricultural wastage, and city run-off and anthropogenic activities. The pollution level is slightly higher in the dry season compared to the wet season (Begum et al., 2018).

Bangladesh holds 1176 industries on the bank of rivers that discharge about 0.4 million m^3 of raw wastewater daily into the river (Rabbani and Sharif, 2005, as cited in Rabbi et al., 2016). One hundred fifty-two polluter industries include 56 dyeing and textile industries, 50 chemicals and pharmaceuticals, 9 food processing, and 37 other engineering industries surrounding the Turag. The river water is polluted by industrial effluents, solid waste from river-side settlements, vehicles' petroleum products, untreated sewage, etc. (Khan et al., 1970). The Turag river water had a deep black color with a putrid odor, indicating that the water is contaminated and hazardous to the aquatic environment and human health (Mobin et al., 2014). The Ministry of Environment and Forestry has designated rivers in Greater Dhaka as Ecologically Critical Areas (MoEF, 2010; Rahman et al., 2013; Whitehead et al., 2018).

The present study has been conducted to identify a particular point source's contribution to river water pollution. Sufficient literature has not yet been found regarding the contribution and extent of individual point sources to pollute this river water. There are some outfalls identified from different sources like educational institutions, hospitals, and residential buildings. The pollution impact of an individual source will help to determine the effects of other sources to pollute the river. This research will open scope for further work to develop a model for river reclamation and protect river pollution from point sources.

2. Methodology

The water sample was collected from a discharge point adjacent to the IUBAT boundary (Figure-1). Precisely, the sample was collected from both the wastewater pit and the Turag river near the sewage discharge point. A significant amount of wastewater enters this point from the IUBAT campus, where approximately ten thousand people use toilets from morning to evening. The amount of discharge was estimated from the daily water consumption. The sample was collected twice a week for consecutive seven months. Plastic bottles of 500ml were used for collecting samples. All samples were collected by grab sampling, labeled, and preserved by following the standard procedures to avoid contamination or deterioration of the property of the collected water samples. Standard Methods for the Examination of Water and Wastewater were followed for sample collection and analysis (APHA,1995).

Seven water quality parameters, e.g., pH, TDS, TSS, TS, DO, BOD, and COD were examined between November-2018 and May-2019 (each of the sources 46 wastewater samples were collected). Each parameter was tested twice for the accuracy of the result. If any deviation was detected from the two results, a further test was conducted. The parameters, i.e., pH, TDS, TSS, TS, and DO were tested twice a week, whereas BOD and COD were tested once a month. The wastewater flow was counted from the point source for 12 h in a day.

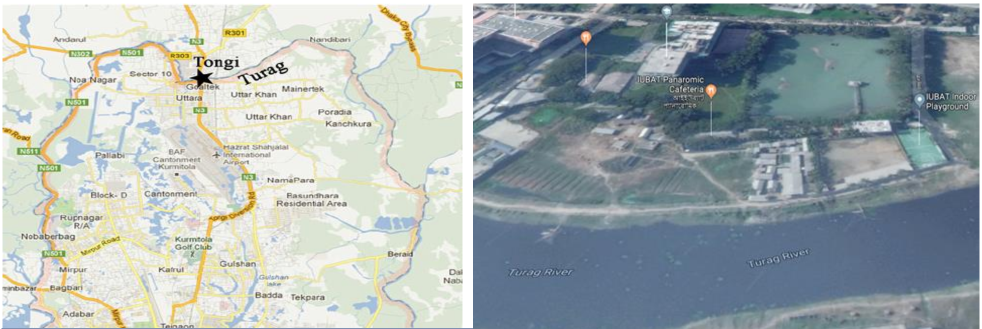

Figure 1. Sampling point (point source) adjacent to the IUBAT Boundary

Table 1: Average value of water quality permeants of point source and the Turag river

Parameters		**Value, Mean ± SD**		**Quality Standard of Effluent to Discharge Inland Surface water**
Name	**Unit**	**Point-source**	**The Turag Water**	
pH	*	7.09 ± 0.32	7.22 ± 0.27	6 – 9
TDS	mg/l	540.43 ± 78.60	577.93 ± 75.87	2100
TSS	mg/l	209.57 ± 122.25	189.97 ± 98.21	150
TS	mg/l	745.65 ± 142.02	767.90 ± 120.58	-
DO	mg/l	0	0.26 ± 0.56	4.5 – 8
BOD_5	mg/l	394.66 ± 34.75	53.49 ± 12.33	50
COD	mg/l	736.83 ± 239.65	84.83 ± 11.75	200

Pollution load = Concentration of pollutants × Flow × Flow time = Load (g/day).

The biogas production rate was calculated from the average COD load of the wastewater as stated in Metcalf & Eddy (2003). One mole of methane (CH4) could be produced by 64g of COD under anaerobic conditions. Under standard temperature and pressure, 0.35L of CH4 could be produced by 1g of COD. If the average anaerobic digestion temperature is considered as 250C, the production of methane could be calculated by the following equation.

The volume of 1-mole methane gas,

$$V = \frac{nRT}{P}$$

$$= \frac{\left(1\ mole\ x\ 0.082057\ atm.\frac{L}{mole}.K\right)[(273.15+25)K]}{1.0\ atm}$$

$$V = 24.465L$$

The methane equivalent to COD converted under anaerobic condition

$$= \frac{24.465LMethene/mole}{(64\text{g}\ COD\ /mole)}$$

$$= 0.382\ L\ Methane/\text{g}\ COD$$

So, Methane production rate

$$= COD\ (\text{g}/m3)/day \times 0.382$$

= L /day

The results obtained from the laboratory analysis were tabulated and analyzed with computer software. Finally, different inferences were drawn from the analytical results.

3. Result and Discussion:

The seven-month (November-2018 to May-2019) water quality assessment is presented in Table-1. The quality of the Turag and the wastewater has been compared with the Bangladesh Water Quality Standard of the DoE guideline (ECR 1997, Schedule-10).

The tested results show that effluent from the point source discharging to the Turag near the IUBAT does not meet all water quality standards of the DoE. The parameters like pH and TDS are within the limit of water quality standard, but TSS, DO, BOD, and COD does not meet the standards. Too much presence of such parameters indicates that water is biologically polluted. Since the primary source of effluent is toilet discharge, it must contain fecal coliform bacteria, which is pathogenic. In addition, results show that toilet discharge has been either partially treated or untreated before discharge. Bashar & Fung (2020) had conducted a similar study in Dhaka city. They had accumulated municipal wastewater pollution data from major four outlets provided by the Institute of Water Modelling. It was reported that BOD levels in different outlets like Katasur, Hazaribagh, Islampur, and Lalbagh were 425, 60, 150 and 140 mg/l, COD levels were 2134, 205, 585 and 565 mg/l, respectively. The present study shows that the BOD level is 394.66 ± 34.75 mg/l and the COD level is 736.83 ± 239.65 mg/l. The ratio of BOD and COD in the present study is about 0.536, whereas Bashar & Fung (2020) shows BOD: COD as 0.199, 0.293, 0.256 and 0.248 in different outfalls. The inconsistency of the BOD and COD ratio is caused due to variations of the property of wastewater in different places. The high ratio of BOD and COD in the study point indicates that the wastewater contained a high concentration of biodegradable organic matter. On the other hand, the concentration of DO level 0.0 indicates that a completely anaerobic environment prevails in the wastewater and is suitable for anaerobic treatment.

The laboratory test results of the river Turag water quality reveal that other sources have polluted it before reaching the sampling point. TSS and DO of the Turag do not satisfy inland surface water quality (ECR 1997, Schedule-10). The present study results could be compared to the surface water standard shown in Table-3 to evaluate the utility of the river Turag water.

As per the ECR 1997, Schedule-3 (Table-02), the BOD and DO level of the Turag water does not satisfy inland surface water standard for use as the source of drinking water with conventional treatment, water use for recreational purpose, industrial use or

Table 3: Standard for Inland Surface Water (Schedule-3, ECR-1997)

Best Practice-Based Classification	Water Quality Parameters		
	pH	BOD, mg/l	DO, mg/l
a. Source of drinking water for supply only after disinfecting	6.5 – 8.5	2 or less	6 or above
b. Water usable for recreational activity:	6.5 – 8.5	3 or less	5 or above
c. Source of drinking water for supply after conventional treatment:	6.5 – 8.5	6 or less	6 or above
d. Water usable by fisheries:	6.5 – 8.5	6 or less	5 or above
e. Water usable by various process and cooling industries:	6.5 – 8.5	10 or less	5 or above
f. Water usable for irrigation:	6.5 – 8.5	10 or less	5 or above

irrigation purpose. Majed et al. (2018) also found that the Turag River is polluted by 15-point sources, including industrial effluent and municipal sewage. They have also identified major outfalls included storm sewer pipes, open channels, and small/big private outfalls. According to their research, DO was found below 4 mg/l, the levels of BOD and TSS were obtained beyond the standard water quality ranges, especially during the dry season in most instances. The present study also identified that the level of DO is very low. Furthermore, the level of BOD and TSS is beyond the standard water quality ranges. Those results indicate that the Turag water is not suitable for water treatment plants, irrigation, and aquaculture. A good number of studies have been done on the water pollution of the river Turag. Some researchers worked on the source of river pollution and others worked on characteristics of river water quality. The present study was conducted on river water quality and a particular point source of pollution. A comparative study of different researchers is shown in Table-4.

Bhuiyan et al. (2011) identified seasonal and special variations from a 12-month study period at different points. They found that water pollution indicator parameters increase in the low flow period due to evaporative effects. In contrast, lower values are observed in the high flow period when the surface water is diluted by rainwater. The comparative analysis of different studies has shown that the pH value is within the acceptable limit, except Tamanna Meghla et al. (2013). In comparison, the TDS level is found within the acceptable limit in all the studies. Banu et al. (2013) and Bhuiyan et al. (2011) found TSS within the acceptable limit, but the present study does not satisfy it. To use the Turag water as the source of water supply, irrigation, fishery or recreational activity, dissolved oxygen (DO) level and Biochemical oxygen demand (BOD) level does not satisfy the standard, but Bhuiyan et al. (2011) found DO level within the limit.

Rahman et al. (2013) identified that the mean environmental flow of the Turag is 192.72 cumec. The study reveals that, in more recent times, the environmental flow is

Table 4: The mean value of different physicochemical parameters of the Turag water by different studies

Sl No	Study	Period	pH	TDS mg/l	TSS mg/l	DO mg/l	BOD5 mg/l	COD mg/l
01	Bhuiyan et al. (2011)	May 2007 to May 2008	7.48	784.33	31.05	4.83	0.90	72.50
02	Banu et al. (2013)	2006	7.10	342	38.00	6.00	2.80	58.00
03	Banu et al. (2013)	2010	7.5 0	812	84.00	0.00	22.00	102.00
04	Tamanna Meghla et al. (2013)	October 2011 to September 2012	5.69	398.9	-	1.12	4.38	-
05	Islam et al.	2012	7.40	748.60	-	2.36	-0.98	-
06	Mobin et al. (2014)	April 2013 to July 2013	6.83	340.86	-	2.25	1.15	-
07	Rabbi et al. (2016)	September 2015 to February 2016	7.06	281.23	-	3.50	13.35	-
08	Present Study, (2019)	November 2018 to May 2019	7.22	577.93	189.97	0.26	53.49	84.83

not maintained during the low flow season in the river and the overall flow rate is reduced. During the low flow season in the same period, the flow flowed below the required environmental flow. Securing the ecological health status of a river is necessary to ensure environmental flow.

Another study was done by Mitul and Sheikh (2020) on water consumption in the IUBAT campus in the year 2018. According to their study per day average consumption and discharge were found to be about 40 m3. Based on this flow rate, the annual pollution contribution by the study point source to the Turag had been calculated and presented in Table-5.

Table 5: Annual Pollution Contribution by Sewage to the River Turag

Water Polluting Parameters	The amount, g/day	The amount, Ton/year
TDS	21617	8
TSS	8383	3
TS	29826	11
BOD	15786	6
COD	29473	11

The above result shows that the biological load intruding into the river must affect aquatic life and imbalance the river ecosystem. If this wastewater is treated in a holistic environmental protection approach, there will be a scope created for resource recovery through energy production and pollution control. Anaerobic wastewater treatment system could be a suitable core technology for sustainable wastewater management and resource recovery (Lettinga et al. 1997 as cited in Noyola et al., 2006). Since the discharge from point-source is highly polluted with biological pollutants, through the anaerobic effluent treatment process, the wastewater could be treated and biogas produced as a byproduct, which could be one of the sources of green energy. If wastewater of the point-source is completely anaerobically digested daily about 11m3 of methane could be produced for the plant. That amount of methane can produce 144 x 103 MJ heat energy, equivalent to 40 MW electric power at 100% efficiency

4. Conclusion

The Turag is being polluted by different point and non-point sources. It has been identified that the point source nearby IUBAT has a significant role in polluting the river water. BOD, COD, and TSS levels have been found above the acceptable limit to discharge into the inland waterbody. On the other hand, the Turag water is already polluted by different sources. The pollution level of the Turag varies seasonally due to variations of flow and weather. The different studies have shown that the Turag water is not fit for feed in water supply systems both for domestic and industrial purposes. The water is also unfit to use for recreational activities, fisheries, or irrigation purposes. Ensuring proper environmental flow and pollution control can only revive the ecology and navigation of the Turag. The treatment of effluent before discharging into the river can prevent pollution. There is also scope to recover resources from the effluent if waste management proceeds sustainably.

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