DAFFODIL INTERNATIONAL UNIVERSITY JOURNAL OF SCIENCE AND TECHNOLOGY, VOLUME 16, ISSUE 1, JANUARY 2021
ISSN 1818-5878 (Print) 2408-8498 (Online)

A COMPARATIVE STUDY ON WATER QUALITY OF THE DHALESHWARI RIVER NEAR SAVAR TANNERY INDUSTRIAL ESTATE

*Md. Sultanul Islam[1], Anik Chandra Sarker[2], Tasnuva Tanin Meem[1]
[1]Department of Civil Engineering, Presidency University, Bangladesh
[2]Graduate Student, Department of Civil Engineering, Daffodil International University, Bangladesh
Email: sultanuli@pu.edu.bd

Abstract: The present study was conducted to investigate the impact of wastewater received from Savar Tannery Industrial Estate into the Dhaleshwari river through the present status of water quality and pollution level. The water samples were collected from five different points, outfalls of the wastewater generated in the industrial estate, during post-monsoon and dry season from October 2019 to February 2020 and analyzed for six physico-chemical parameters. The observed values of pH, electric conductivity (EC), total dissolved solids (TDS), turbidity, dissolved oxygen (DO) and biochemical oxygen demand (BOD) were temporally varied from 6.8-8.06, 505.44-1544.4 µS/cm, 162-495 mg/l, 10.06-27.12 NTU, 1.3-3.96 mg/l and 8.20-13.432 mg/l respectively. The results were compared with guideline values and previous studies that were performed on this river of late. The river water was found to be significantly polluted and unsuitable for aquatic organisms living in the water body due to the occurrence of high level of BOD. The necessity for long-term monitoring combined with further investigation involving other parameters is highlighted.

Keywords: *physico-chemical parameter, water quality, Dhaleshwari river, river pollution, temporal variation.*

1. INTRODUCTION

Rivers play an important role in shaping the civilizations around the world through socio-economic development. It is a significant source of water for different applications such as drinking, domestic, industrial, agricultural etc. and act as a receiver of wastewater, stormwater and agricultural runoffs [1]. Bangladesh, known as a riverine country, is crisscrossed by innumerable rivers including tributaries and distributaries. The Dhaleshwari is one of the most prominent rivers that flows through central part of Bangladesh. The river, an important distributary of the Jamuna river, is 160 km long with an average depth of about 37 m [2]. The river water has been used for irrigation as the surrounding land was used for agricultural purposes [3]. Water level of the river becomes very high during monsoon period and drastically reduces during pre- and post-monsoon due to lack of rain [4].

The rivers surrounding Dhaka, the capital of Bangladesh, have been significantly polluted due to rapid industrialization and urbanization of the city. Extreme pollution of the Buriganga river in Dhaka from the Hazaribagh tannery effluents is a widely known environmental disaster [5]. In response to the mounting criticisms and pressures from the environmental activists to save the river, the High Court of Bangladesh directed the Government to relocate the leather industry to the Savar Tannery Industrial Estate. This industrial park is located on the banks of the Dhaleshwari river at Jhauchar village in Tetuljhara union of Savar upazila, Dhaka. However, the physical condition of water of the Dhaleshwari river has been deteriorated since the relocation of the tannery industries. According to the Bangladesh Environment Conservation Rules (1997), it is mandatory to install Effluent Treatment Plant (ETP) to treat tannery waste before discharging into the environment. A total of 111 tanneries have already started their production at Savar Tannery Industrial Estate, before the Central Effluent Treatment Plant (CETP) has become fully operational [6]. The tanneries were currently discharging approximately 20,000 m^3 of untreated effluents every day into the Dhaleshwari river and nearby wetlands [5].

There has been a growing concern on the increasing level of pollution of the Dhaleshwari river, that were confirmed by the local inhabitants and reported in several online and print news portal [7-9]. Previously, Real et al. [10] conducted a study on several water quality parameters, anion concentrations and the availability of some selected microorganisms in the Dhaleshwari river during April to June 2015. They concluded that the microbial pollution of the river was very high, and the usage of the water could be hazardous to human health and aquatic organisms. Recently, Hasan et al. [1] studied thirty physico-chemical parameters to determine different water quality indices for any spatio-temporal variations of the Dhaleshwari river. The quality of river water was found to be poor, especially near the industrial area,

deteriorated further in winter and unsuitable for drinking purposes.

Considering the significance of the Dhaleshwari, the severity of the pollution is of great concern to the public health and environment. Thus, a detailed study was needed to assess the present water quality situation of the river. The objective of the present study is to investigate several physico-chemical water quality parameters of the Dhaleshwari river to find out the pollution level due to relocation of tanneries and compare the findings with similar works that were carried out previously on this river. Finally, comments will be made on the impact of shifting the tanneries through the observed values.

2. MATERIALS AND METHODS

A. Study Area

The study was conducted on specific segment of the Dhaleshwari river in the vicinity of Tannery Industrial Estate. Five sampling sites were selected for the collection of water samples in this study. Fig. 1 shows the map of the study area with sampling locations. The locations were chosen based on the major effluent discharge points of the industrial estate. The discharge points were selected through a reconnaissance survey.

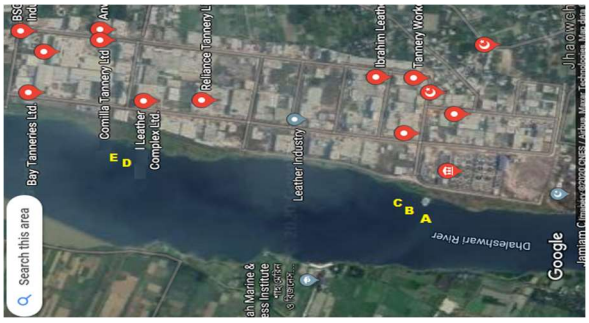

Fig. 1. Map showing the locations of sampling points (A, B, C, D, E)

B. Sample Collection

Water samples were collected during post-monsoon and dry season (October 2019 to February 2020) due to high possibility of identifying the pollution sources. The locations of the sample points including GPS co-ordinates are shown in Table I. The sampling was carried out once in every month during daytime. Approximately 1000 ml of water samples were collected in polypropylene bottles. Water samples from all five locations were collected at least 15 to 20 ft from the discharge point and at a depth of about 2 ft from river surface to avoid floating surface scum and turbulence. At each point, three set of samples were collected to obtain the average value of each parameter. Thus, a total of 75 water samples were collected in five consecutive months for this study. The sample bottles were immediately labeled with required information such as sample number, date, time and location. Then they were carefully sealed and transported to the laboratory as soon as possible. Standard methods were adopted for laboratory analysis.

Table I: GPS co-ordinates and distances of the sample points

Name of the Points	GPS co-ordinates	Distances in m (measured from point A)
A	23°46'34.3"N 90°14'19.8"E	0
B	23°46'35.4"N 90°14'20.6"E	41
C	23°46'36.1"N 90°14'20.7"E	61
D	23°46'52.8"N 90°14'25.6"E	595
E	23°46'53.5"N 90°14'25.7"E	615

C. Sample Analysis

The methods and instruments that were used to observe the water quality parameters of the samples are given in Table II. Six different parameters were considered for this study. The value of each sample was taken using probe for all the parameters except BOD. Accurate measurement of DO values, at the beginning and end of a five-day period in which the samples were held in dark incubated conditions at 20^0C, were employed to calculate BOD. Data analyses were performed using standard statistical tools.

Table II: Methods and instruments used for the analysis of different parameters

Sl No.	Water quality parameter	Method/Instrument (Model)
1	pH	pH Meter (Hanna HI-98107)
2	Turbidity	Turbidity Meter (Lutron TU-2016)
3	DO	DO Meter (Lutron DO-5509)
4	EC	EC Meter (Hanna HI-98302)
5	TDS	EC Meter (Hanna HI-98302)
6	BOD	Five days incubation

3. RESULTS AND DISCUSSION

A. Statistical Analysis

The values of pH, EC, TDS, turbidity, DO and BOD of sampling water were measured. The measured values

of the test results were summarized to perform basic descriptive statistical analyses (Table III).

Table III: Statistical analyses of data of the samples

Parameter	Range (Min-Max)	Mean	Median	Standard Deviation
pH	6.7-8.2	7.272	6.9	0.069
TDS (mg/l)	110-600	256.6	175	67.263
EC (µS/cm)	343.2-1872	800.592	546	209.860
Turbidity (NTU)	5.57-38.87	16.9212	15.46	5.512
DO (mg/l)	0.9-4.3	2.944	3	0.234
BOD (mg/l)	7.33-18.33	11.04	10	1.023

B. Analysis of Physico-chemical Parameters

i) pH

pH is a basic water quality parameter which represents whether a solution is acidic or alkaline. The range of pH from 6-9 is suitable for the existence of most biological life [11]. Extremely high or low values of pH can reduce the palatability of water, as well as increase the corrosive effect on water distribution systems [12]. The Department of Environment (DoE), Bangladesh standard for pH is 6.5 to 8.5. The mean pH values of all locations in dry season were found within this range, indicating the river water was characterized as neutral from acidity or alkalinity point of view.

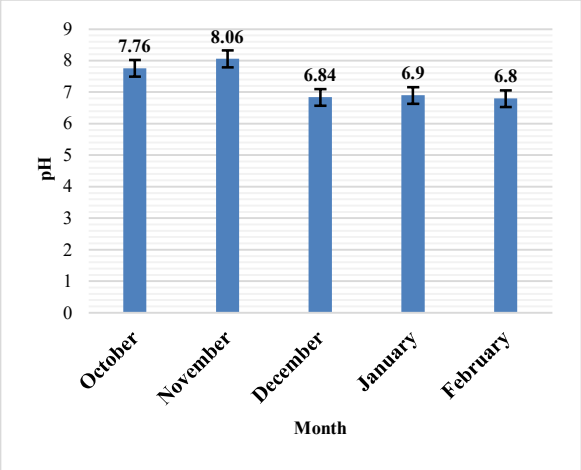

Fig. 2: Temporal variation of pH

ii) EC

Electric conductivity is a measure of the ability of an aqueous solution to carry an electric current. Presence of inorganic positive and negative ions such as sodium, magnesium, chloride, nitrate, sulphates etc. as well as temperature affects the conductivity in water [13]. The mean values of EC in the Dhaleshwari River for five months (October 2019 to February 2020) at five different sampling stations were found higher than the DoE standard. The EC values can generally be higher in dry season than wet season as increased volume of water can dilute the concentrations of ions. The value in October was more than double the value of other months in dry season. The significantly higher value of EC in this month could be due to increased alkalinity and calcium concentrations from weathering; elevated chloride concentrations from sources such as discharges of various substances containing chlorides and runoff of fertilizers; and increased sulfate concentrations [14].

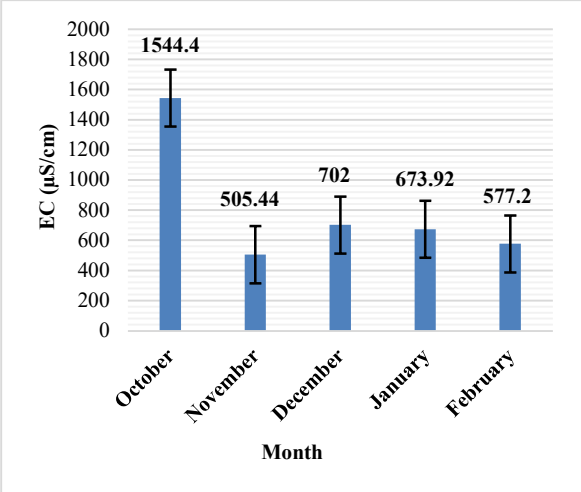

Fig. 3: Temporal variation of EC

iii) TDS

TDS is an important parameter which is derived from EC. For this reason, the study showed exactly same pattern for TDS and EC throughout the months. All the values of TDS except November exceeded the DoE standard. High dissolved solids can make the water corrosive which leads to lower efficiency in boilers and pipe scaling [15]. TDS can also affect the palatability of water. Water containing high quantity of dissolved solids is reported to have a poor taste but low dissolved solids in water can also taste flat [16, 17]. As the mean value of EC was found to be very high in October, TDS followed the same pattern in that month.

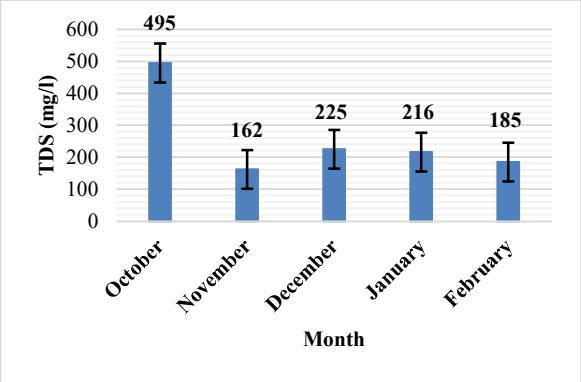

Fig. 4: Temporal variation of TDS

iv) Turbidity

Turbidity is the presence of fine solids matter in water which cannot be filtrated by routine methods [12]. The solids causing turbidity can be clay, silt, plankton, microscopic organisms, inorganic, or organic matters. Turbidity can affect the disinfection process by masking the pathogens [12]; thus, high turbid water can be an indicator of microbial pollution. The average values of turbidity ranged from 10.06 to 27.12 NTU. No guideline value for turbidity is provided by the DoE. The values fell within the range recommended by the United States Environmental Protection Agency which is between 5 to 50 NTU for designated stream [18]. According to WHO, turbidity equal to or above 4 NTU can affect the appearance and acceptability to people [19].

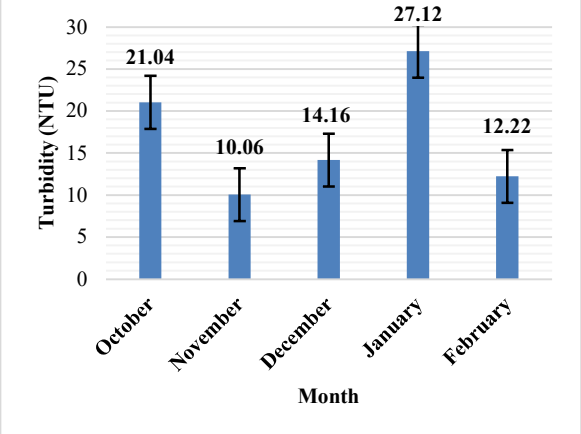

Fig. 5: Temporal variation of turbidity

v) DO

Dissolved oxygen is the measure of the amount of oxygen dissolved in the water. It is the most important parameter for survival of aquatic lives in rivers, as well as an indicator of presence of organic pollutants in the water [20]. The mean values of five months were found below both the DoE standards (5 mg/l for sustaining aquatic life and 6 mg/l for using river water as the source for drinking water supply). The dissolved oxygen level of the Dhaleshwari river has been depleted due to disposal of untreated and easily oxidized tannery wastes.

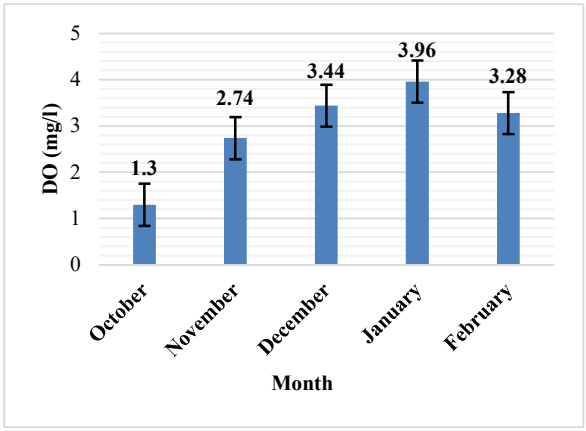

Fig. 6: Temporal variation of DO

vi) BOD

The amount of oxygen required by microorganisms to decompose biodegradable organic matter is called BOD. Oxygen required during first five days is usually considered as standard BOD. BOD_5 of the samples were varied from 7.33 to 18.33 mg/l in the sampling stations, which were significantly higher compared to the standard values. Unpolluted waters, in general, have BOD values of 2 mg/l or less [21].

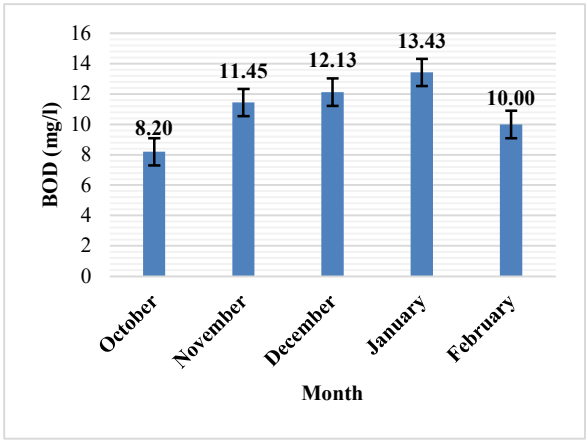

Fig. 7: Temporal variation of BOD

Table IV: Comparison of investigated data with the DoE guidelines and standard values for fisheries

Parameter	DoE standard to maintain the aquatic ecosystem	Bangladesh Standard For Fisheries (EQS, 1997)	Investigated Water Quality (Average value)				
			October	November	December	January	February
pH	6.5 to 8.5	6.5 to 8.5	7.76	8.06	6.84	6.9	6.8
EC (µs/cm)	350	800-1000	1544.4	505.44	702	673.92	577.2
TDS (mg/l)	175	500	495	162	225	216	185
Turbidity (NTU)	5-50*	5-50*	21.04	10.06	14.16	27.12	12.22
DO (mg/l)	5	4.0-6.0	1.3	2.74	3.44	3.96	3.84
BOD (mg/l)	2	(-) or below 2	8.20	11.45	12.13	13.43	10.00

*United States Environmental Protection Agency, as no DoE guideline values are available.

Except pH and turbidity, all the parameters exceeded the guidelines of DoE. The BOD and DO values were not within any of the standards which is alarming for aquatic organisms as these are the most important parameters affecting their lives.

C. Comparison with Previous Studies

Dhaleshwari is one of the most important rivers of Bangladesh. For recent developments on the bank of this river, it is evident that the water quality of the river needs to be assessed regularly. There have been several studies performed on assessing the water quality of the Dhaleshwari river.

Rikta et al. [22] investigated the physico-chemical status of the Dhaleshwari river during monsoon season (July to August). The pH values (7.27 - 8.31) were found to be slightly higher than the range found in this study (6.7 – 8.2). The DO values were much higher and EC values were lower than that of present studies. It indicates the increasing pollution levels in recent years, especially in dry season. The turbidity values are also higher than the previous study as heavy rain brings high amount of sediment which contributes to turbidity. Though the pollution is low in wet season, the study found significant amount of microbial pollution in water (total coliform ranges from 260 to 1880 CFU/100 ml).

DoE [23] reported the water quality of the Dhaleshwari river in two locations - Harindhora and Muktarpur ghat in dry season, 2016. The EC values ranged from 143.3 to 452 µS/cm which was lower than the range found in this study (343.2-1872 µS/cm). The BOD values varied from 1.2 to 8.4 mg/l which was significantly lower than observed values in the present study (7.33-18.33 mg/l). The TDS concentrations were also lower than that of present study. The increasing values of EC, BOD and TDS in dry season showed that the pollution is increasing in the river.

Ahsan et al. [3] found the water quality of the Dhaleshwari river in Tangail region was suitable for irrigation and domestic purposes during the pre-monsoon period (March - May) of 2016. The DO values for all the sample locations were higher than 4 mg/l and the BOD values were also lower than 2 mg/l which indicated enough oxygen were available in water for aquatic lives. In a recent study conducted by Hasan et al. [1], several water quality parameters were analyzed from October 2018 to February 2019 near the vicinity of Savar tannery industrial park. It was found that the river water had lower BOD level and higher DO levels than the present study.

Comparisons of the mean values of selected parameters between previous research findings and current investigation are presented in Fig. 8. It is obvious that the present study has the lowest DO and significantly higher BOD and EC values, thereby revealing the river water was polluted with organic and chemical pollutants.

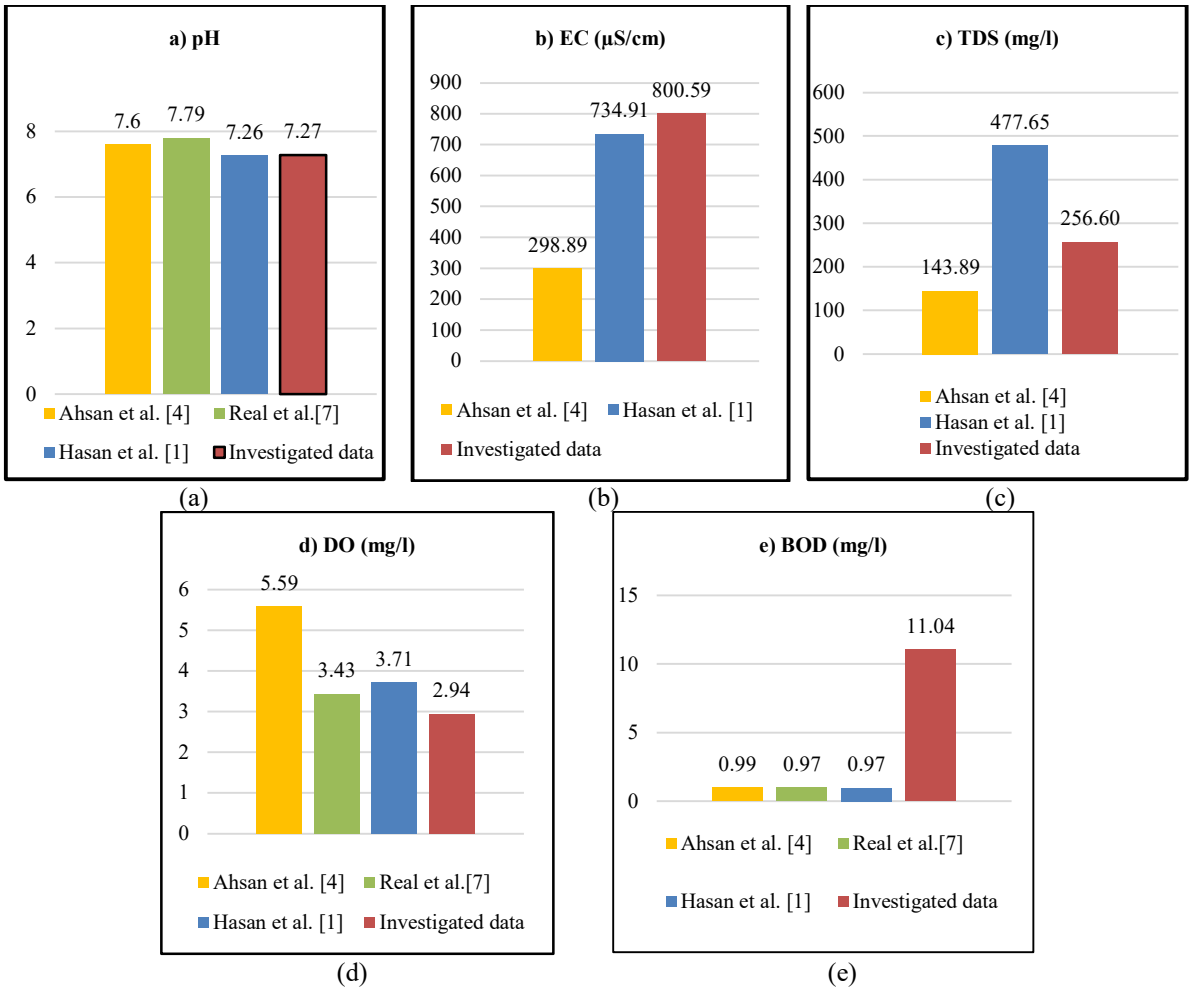

Fig. 8: Comparison with previous studies performed on physico-chemical parameters of the Dhaleshwari river

4. CONCLUSION

Dhaleshwari river is a source of livelihood and offers socio-economic security of the people living around. The water quality of this river has been deteriorating everyday due to the environmental pollution caused by leather industry. The present study indicated that the pollution of the river has been significantly increased in recent years. The result from data analyses showed that the water quality of the Dhaleshwari river was not suitable for human usage or aquatic ecosystem for parameters such as DO, BOD, EC and TDS from October 2019 to February 2020. However, the river water might still be acceptable in terms of pH, EC and TDS for fisheries (Table IV). This study only covered the dry season of the years 2019-2020. All year-round data would be able to provide a thorough representation of the river water quality. Additional parameters like chemical oxygen demand and toxic inorganic substances can be considered for future study which will shed light on this issue. The overall mean values of the studied water quality parameters for the Dhaleshwari river were pH - 7.27, EC - 800.59 µS/cm, TDS - 256.6 mg/l, turbidity - 16.92 NTU, DO - 2.94 mg/l, BOD - 11.04 mg/l. The comparison of several previous reports with this study confirmed that the pollution level of this river is much higher than before.

The ongoing pollution of the Dhaleshwari river has mostly been occurred due to the untreated effluent generated by tannery industries located in Savar. All units of the CETP in the industrial estate need to be fully functional for efficient treatment to prevent the river pollution. However, very little information of the current site is available at present and that is a major challenge for an accurate environmental impact assessment to be conducted. Continuous monitoring of water quality parameters is a necessity to measure the magnitude and reach of the pollution.

ACKNOWLEDGMENT

The authors would like to take this opportunity to express sincere appreciation to Department of Civil

Engineering, Daffodil International University for the technical support provided to laboratory analysis.

REFERENCES

[1] M. M. Hasan, M. S. Ahmed, R. Adnan and M. Shafiquzzaman, "Water quality indices to assess the spatiotemporal variations of Dhaleshwari river in central Bangladesh", Environmental and Sustainability Indicators, vol. 8, 2020. DOI: 10.1016/j.indic.2020.100068.

[2] S. Ahmed, M. S. Ali and F. Mustari, "River Water Quality Report 2015", Department of Environment, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, 2016. http://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/publications/b1ed783d_9b05_4f36_a83e_2173d8698023/River%20Water%20Quality%20Report%202015.pdf. [Accessed November 29, 2020]

[3] M. A. Ahsan, M. A. B. Siddique, M. A. Munni, M. A. Akbor, S. Akter, M. Y. Mia, "Analysis of Physicochemical Parameters, Anions and Major Heavy Metals of the Dhaleshwari River Water, Tangail, Bangladesh", American Journal of Environmental Protection, vol. 7, no. 2, 2018, pp. 29-39. DOI: 10.11648/j.ajep.20180702.12.

[4] M. K. Ahmed, S. Ahamed, S. Rahman, M. R. Haque and M. M. Islam, "Heavy Metals Concentration in Water, Sediments and their Bioaccumulations in Some Freshwater Fishes and Mussel in Dhaleshwari River, Bangladesh", Terrestrial and Aquatic Environmental Toxicology, 2009, pp. 33-41.

[5] S. A. Masum and M. S. Islam, "A Case Study on Predicting the Environmental Impacts of Untreated Effluent Generated From Tannery Industrial Estate In Dhaka, Bangladesh", Geography, Environment, Sustainability, vol. 13, no. 3, 2020, pp. 22-31. DOI: 10.24057/2071-9388-2019-127.

[6] Daily-sun.com, "Now tannery wastes polluting Dhaleshwari", [online] The Daily Sun, 2018. Available at: www.daily-sun.com/post/281036/Now-tannery-wastes-polluting-Dhaleshwari [Accessed July 8, 2020].

[7] newagebd.net, "Dumping tannery wastes in Dhaleshwari continues", [online] New Age Bangladesh, 2019. Available at: https://www.newagebd.net/article/69140/dumping-tannery-wastes-in-dhaleswari-continues [Accessed November 21, 2020].

[8] prothomalo.com, "Will tanneries now destroy the river Dhaleswari?" [online] Prothom Alo, 2020. Available at: https://en.prothomalo.com/opinion/Will-tanneries-now-destroy-the-river-Dhaleswari [Accessed November 8, 2020].

[9] thedailystar.net "Tanneries killing the Dhaleshwari River", [online] The Daily Star, 2020. Available at: https://www.thedailystar.net/editorial/news/tanneries-killing-the-dhaleshwari-river-1781302 [Accessed November 24, 2020].

[10] M. K. H. Real, N. Khanam, M. Y. Mia and M. Nasreen, "Assessment of Water Quality and Microbial Load of Dhaleshwari River Tangail", Bangladesh. Advances in Microbiology, vol. 7, 2017, pp. 523-533. DOI: 10.4236/aim.2017.76041

[11] L. Metcalf and H. P. Eddy, *Wastewater Engineering Treatment and Reuse*. 4th Edition, McGraw-Hill, New York, 2003.

[12] Environmental Protection Agency, Parameters of Water Quality - Interpretation and Standards, Ireland, 2001.

[13] USEPA, Monitoring and Assessment: Conductivity, 2012. Available at: https://archive.epa.gov/water/archive/web/html/vms59.html [Accessed October 21, 2020].

[14] T. Mikalsen, "Causes of Increased Total Dissolved Solids And Conductivity Levels in Urban Streams in Georgia", *Proc. of the 2005 Georgia Water Resources Conference,* University of Georgia, Athens, Georgia, April 25-27, 2005.

[15] J. M. Wilson, Y. Wang and J. M. VanBriesen, "Sources of High Total Dissolved Solids to Drinking Water Supply in Southwestern Pennsylvania", Journal of Environmental Engineering, vol. 5, no. 5, 2013. DOI: 10.1061/(ASCE)EE.1943-7870.0000733.

[16] W. H. Bruvold and H. J. Ongerth, "Taste Quality of Mineralized Water", Journal American Water Works Association, vol. 61, no. 4, 1969, pp 170–174.

[17] World Health Organization (WHO), "Guidelines for drinking-water quality", vol. 2, Health criteria and other supporting information, 2nd ed., Geneva, 1996.

[18] M. S. Islam and S. Zaman, "Investigation of some selected water quality parameters of the Buriganaga river", Journal of Modern Science and Technology, vol. 6, no. 1, 2018, pp. 124-133.

[19] World Health Organization (WHO), "Water quality and health - Review of turbidity: Information for regulators and water suppliers", 2017.

[20] B. K. Pramanik and D. C. Sarker, "Evaluation of surface water quality of the Buriganga River", Journal of Water Reuse and Desalination, vol. 3, no. 2, 2013, pp.160–168. DOI: 10.2166/wrd.2013.059.

[21] D. V. Chapman, *Water quality assessments: A guide to the use of biota, sediments and water in environmental monitoring*. 2nd Edition, Published on behalf of UNESCO/WHO/UNEP by E & FN Spon, London, 1996.

[22] S. Y. Rikta, M. S. Rahaman, J. J. Mehjabin, M. K. Uddin, M. M. Kabir and S. M. Tareq, "Evaluation of water quality parameters and Humic substance status of Bangshi, Dhaleshwari and Padma Rivers in Bangladesh", International Journal of Environmental Sciences, vol. 6, no. 6, 2016, pp. 1129-1139. DOI:10.6088/ijes.6018.

[23] Department of Environment, "Surface and Ground Water Quality Report 2016", Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, 2017, pp. 13-15.

