Proceedings of the 5th International Conference on Civil Engineering for Sustainable Development (ICCESD 2020), 7~9 February 2020, KUET, Khulna, Bangladesh (ISBN-978-984-34-8764-3)

IMPACTS OF RELOCATION OF TANNERY INDUSTRIES ON THE RIVER SYSTEM OF DHAKA

Rodoshi Ahmed*[1], Ishraq Faruk[2], Sadia Marjia Ferdous[3], Muhtashim Rafiq Chowdhury[4] and Rowshan Mamtaz[5]

[1]Student, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: rodoshiahmed06@gmail.com
[2]Student, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: ishraqfaruk@gmail.com
[3]Student, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: ontora.ava@gmail.com
[4]Student, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: rahat_r181t@yahoo.com
[5]Professor, Department of Civil Engineering, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: mamtaz@ce.buet.ac.bd

***Corresponding Author**

ABSTRACT

Bangladesh is a low lying riverine country located in South Asia. Buriganga and Dhaleshwari are two of the major rivers for Dhaka, the capital of Bangladesh. Buriganga has become a dying river due to the indiscriminate disposal of effluents from various industries, especially from tannery industries situated at Hazaribagh, which is close to Buriganga. To improve the water quality of Buriganga, the tannery industries along with a new Common Effluent Treatment Plant (CETP), were established at Savar in 2016, on the bank of Dhaleshwari River. The main objective of this study is to assess the impacts on the water quality of the selected sample locations for these two rivers due to the relocation of tannery industries from Hazaribagh to Savar, by comparing with previous data. For Buriganga river sampling locations were Rayerbazar, Chadnighat and Bangladesh China Friendship Bridge (B.C.F.B) and for Dhaleshwari, three points namely upstream, downstream and mixing point were selected as sampling locations. The water quality parameters which were studied during different seasons were - pH, BOD_5, COD, Colour, TDS, Chloride, Chromium, EC, Phosphate, Nitrate, Hydrogen sulfide, Ammonia. The analysis showed that except the Rayerbazar (where tannery industries used to discharge the wastewater previously) location, water quality parameters haven't improved in other two locations of Buriganga. The reason is the presence of other industries on the bank of Buriganga River that are polluting the river on a regular basis. For Dhaleshwari River, present study result shows overall degradation of water quality in comparison with the previous data, especially Chloride, TDS, Chromium were at alarming level. The data from wet season was better for both the rivers as expected.

Keywords: *Tannery, Relocation, Pollution, River, Analysis.*

1. INTRODUCTION

Bangladesh, located in South Asia, is blessed with about 700 rivers including tributaries flowing through the country constituting a waterway of total length around 24,140 kilometers. Dhaka, the capital of Bangladesh, is located on the northern bank of the river Buriganga and surrounded by other rivers, namely, the Turag to the west, the Tongi Khal to the north and the Balu to the east. The rivers surrounding Dhaka are giving advantage to it and essential for the survival of the mega city as these provide drainage system, drinking water, different kinds of fishes and also waterways for traveling. The city has many industries, built with limited planning, that discharge large amounts of untreated effluent into the adjacent rivers (Turag, Buriganga, and Balu). The water quality of these rivers is in a very critical condition (Akbor et al.2017; Hadiuzzaman et al. 2006). Monsoon flood caused by the overflow of rivers inundates about one-third of Bangladesh (Bala et al. 2009). The pollution levels showed a seasonal pattern of change with high pollution during dry season and low pollution during wet season (Islam et al. 2015; Mohiuddin et al. 2011).

Generally, rivers surrounding Dhaka are being polluted by the discharge of untreated industrial effluent, urban wastewater, agrochemicals, sewage water, storm runoff, solid waste dumping, oil spillage, sedimentation and also encroachment. Although there are certain laws and regulations to control industrial pollution, its monitoring system is generally weak (Islam et al. 2017). Estimation reveals that there are over 7,000 industries in Dhaka metropolitan area located mostly in three clusters, namely, Hazaribagh, Tejgaon, and Dhaka- Narayanganj- Demra dam area (Roy, 2009). However, among all these industries the tannery industries situated at Hazaribagh and Rayerbazar were one of the main polluters of the Buriganga. As the tanneries were located on the bank of the Buriganga, this river has been the disposal point of effluent all along from the beginning of the operation of these industries, where both liquid and solid wastes were produced.

Several regulatory measures and policies are being considered and implemented by the government to protect the river Buriganga from pollution. One of the most significant initiatives is relocating the tannery industries from Hazaribagh to the Savar Tannery Industrial Estate on the bank of Dhaleshwari river. Almost 115 tanneries are now operating at Savar Tannery Estate. As wastewater from the tannery industries was of the major sources of Buriganga river water pollution, it was expected that with the relocation of the tannery industries the water quality of Buriganga River would improve to some extent. In Savar, the effluent from new tannery estate is discharging into Dhaleshwari River. Though the effluent is to be treated before being discharged into the Dhaleshwari, but it can be postulated that the water quality of the river will degrade to some extent than previous.

Before the relocation of tannery industries, many studies were carried out to assess the water quality of these two rivers, specially of Buriganga river. But after the relocation there were very few studies on the water quality of Buriganga and almost no elaborate study with proper data on the water quality of Dhaleshwari. Islam (2018) found that the DO level has not improved to a large extent in 2018, even after relocation of many tannery industries from Hazaribagh. Islam (2018) also predicted only minor increase (about 0.2 mg/L) in DO, even if all the BOD load from tannery industries have been removed. So, this research was conducted not only to document the current water quality scenario of these rivers but also to assess the impact of relocation on the water quality of these major two rivers.

The main objective of this study was to assess the impacts on the water quality of Buriganga and Dhaleshwari rivers due to the relocation of tannery industries from Hazaribagh to Savar. Some specific objectives were also set for this study. The specific objectives are noted as below:

- To assess the water quality of Buriganga river over a considerable time.
- To study the impacts on water quality of Dhaleshwari river due to disposal of treated wastewater from CETP of Savar Tannery Estate.

- To study the seasonal and temporal variation of water quality parameters of both the rivers Dhaleshwari and Buriganga.

Keeping the objectives of this research in mind, at first field surveys were conducted at locations (Hazaribagh and Savar CETP area) to assess the present situation of the tannery estate, their wastewater disposal location, the surrounding environment etc. This survey facilitated in selecting the sampling locations also. Sampling of water from the rivers were performed on monthly basis. Laboratory analysis of the collected samples was carried out to characterize the river water quality.

2. METHODOLOGY

2.1 Sample Collection

There were total six sampling locations – three in Buriganga River and three in Dhaleshwari River. All but one location was regularly sampled. Sample collection, at the mixing point of the Rayerbazar canal and Buriganga River, was done only for two months, one during dry season and the other during wet.

2.1.1 Buriganga River Sample Location

Three locations were selected for the Buriganga river. The sampling locations were Rayerbazar (RB), Chadnighat (CG) and Bangladesh China Friendship Bridge (B.C.F.B). The Rayerbazar (RB) location was the mixing point of the Rayerbazar canal and Buriganga River. Table 1 shows the geographical co-ordinates of the Buriganga river sampling locations.

Table 1: Information on the sampling locations of Buriganga River

ID	Sampling Location	Latitude	Longitude
RB	Rayerbazar	23° 44' 26.7" N	90° 21' 6.84" E
CG	Chadnighat	23° 42' 35.64" N	90° 23' 29.58" E
BCFB	Bangladesh-China Friendship Bridge	23° 41' 21.696" N	23° 41' 21.696" E

2.1.2 Dhaleshwari River Sample Location

Three locations were selected as sampling locations for the Dhaleshwari river. The sampling locations were Mixing point-where the treated effluent of CETP was discharged in the river (MIX), Downstream of mixing point (DW) and Upstream of mixing point (UP). Table 2 shows the geographic co-ordinates of the Dhaleshwari river sampling locations.

Table 2: Information on the sampling locations of Dhaleshwari River

ID	Sampling Location	Latitude	Longitude
UP	Upstream of mixing point	23° 46' 58.2996" N	90° 14' 24.9" E
MIX	Mixing point of CETP outlet and Dhaleshwari River	23° 46' 34.104" N	90° 14' 18.06" E
DW	Downstream of the mixing point	23° 46' 17.904" N	90° 14' 13.668" E

2.1.3 Sampling Frequency

It was decided to collect water samples once a month from the selected sites to observe the monthly variation of water quality (October-July) and seasonal variation of water quality (Dry Season- and Wet Season). The water samples were usually collected from 10AM to 1PM. The date of collection was randomly chosen.

2.2 Parameter Selection

Water quality parameters were chosen based on tannery wastewater characteristics (Mahmood, 2008). Total 17 parameters were tested of the collected water samples. 10 of them were tested on every month as the samples were collected. 4 extra parameters were tested only on two months-February and July. Remaining 3 were tested once only on February.

The following Tables 3, 4 and 5 show which parameters were tested and the frequency of each parameter tested.

Table 3: Parameters tested regularly

1. pH	2. Colour	3. Chloride (Cl^-)	4. Chromium (Cr)
5.Chemical Oxygen Demand (COD)	6.Bio-chemical Oxygen Demand (BOD)	7.Total Dissolved Solids (TDS)	8.Electrical Conductivity (EC)

Table 4: Parameters tested on two months only

1.Ammonia as $NH_3 – N$	2.Nitrate as $NO_3 – N$
3.Hydrogen Sulphide (H_2S)	4.Phosphate as $PO_4 – P$

Table 5: Parameters tested only on February

1.Cadmium (Cd)	2. Lead (Pb)	3.Copper (Cu)

3. RESULT

An extensive sample collection campaign including river water sampling and collection from point sources were conducted to analyze surface water quality parameters of Buriganga and Dhaleswari rivers. Sampling of Dhaleshwari river was done from October 2017 to July 2018. Sampling of Buriganga river was done from November 2017 to July 2018. Temporal variation was determined using the dataset throughout the whole sampling time. Seasonal variation was measured using dataset of dry season (October 2017 to April 2018) and wet season (May 2018 to July 2018). This Chapter presents an assessment of the water quality of Buriganga and Dhaleswari rivers based on the test result of parameters, with particular focus on the possible impact of tannery industry relocation.

3.1 Buriganga River Seasonal Variation

In Figure 1 it can be seen that the COD value in respective sampling location is higher in dry season than in wet season. In Figure 2 it can be inferred that the BOD value is also higher in dry season than wet season as it is correlated to COD values. Figure 3 also shows the same result that dry season values are higher for Chloride than wet season. The only anomaly in these four graphs can be seen in Figure 4 which shows the seasonal variation for Chromium. Unlike the other parameters the value of chromium is not always higher in dry season. Only Rayerbazar sampling location has a higher dry season value than wet season, and the other two sampling points has rather unusual higher wet season values than dry season.

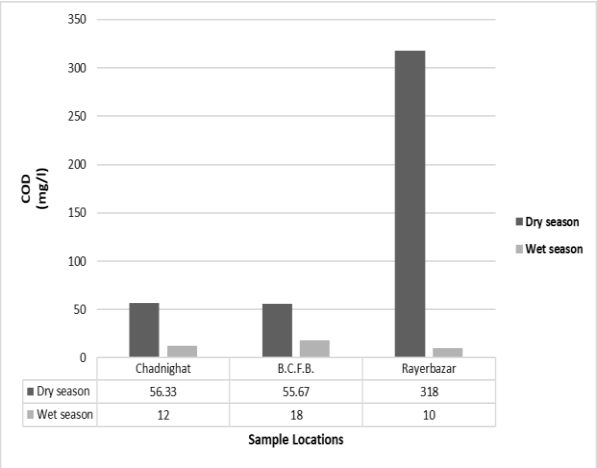

Figure 1: Seasonal Variation of COD Buriganga

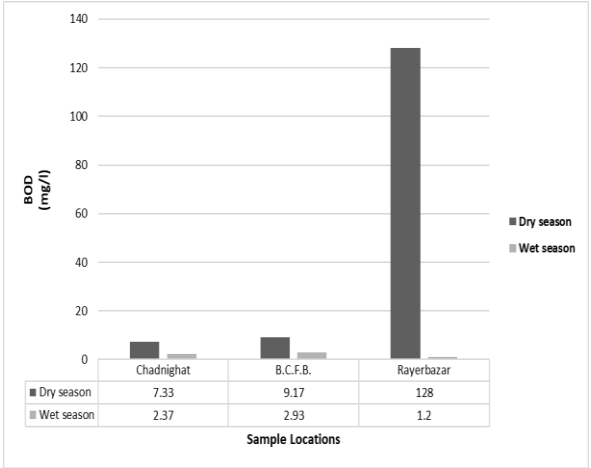

Figure 2: Seasonal Variation of BOD_5 Buriganga

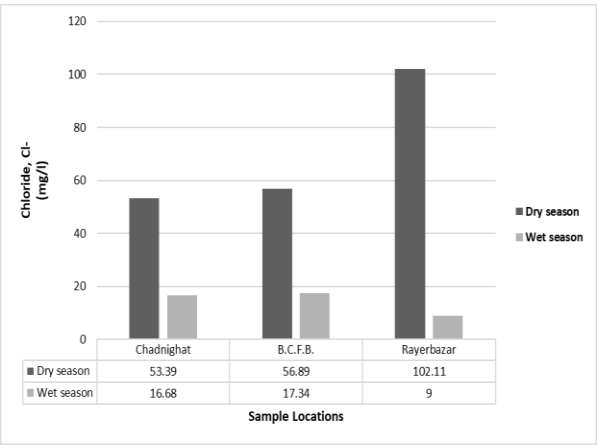

Figure 3: Seasonal Variation of Chloride Buriganga

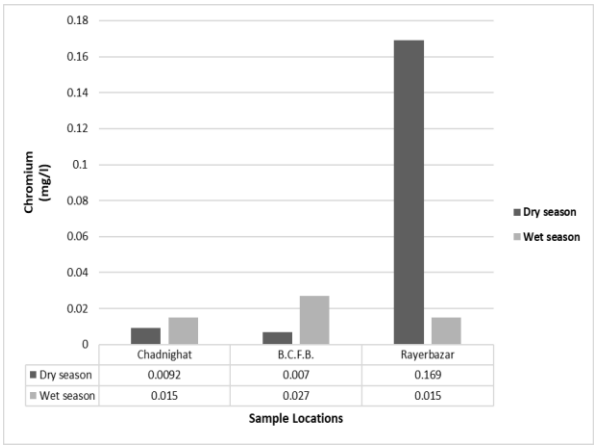

Figure 4: Seasonal Variation of Chromium Buriganga

3.2 Dhaleshwari River Seasonal Variation

In figure 5 the analysis of COD value was usual for Upstream and Downstream sampling points. On the other hand, the COD value for mixing point was higher in wet season than dry season which is unusual. Figure 6 shows the seasonal variation of BOD value, which also exhibits the same discrepancy in mixing point sampling location as COD value. The BOD value in dry season for mixing point sampling location was lower than the value in wet season, which is very unusual. In Figure 7 and Figure 8 it can also be seen that the same anomaly is present for both the parameters Chloride and Chromium, where the value in wet season of Mixing point sampling location is higher than the value in dry season.

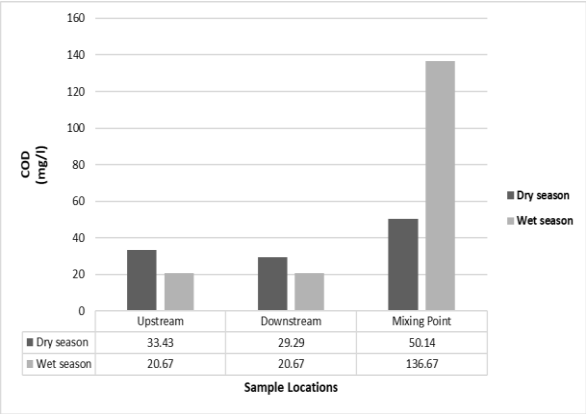

Figure 5: Seasonal Variation of COD Dhaleshwari

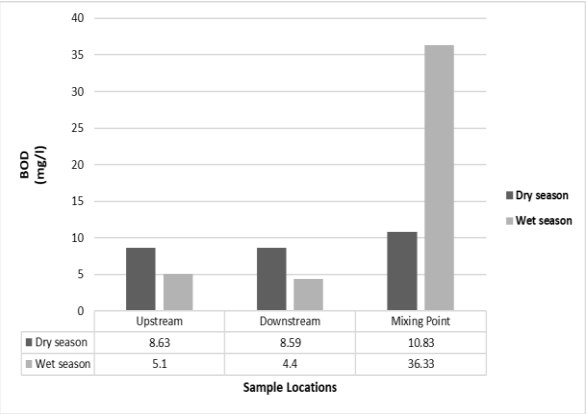

Figure 6: Seasonal Variation of BOD_5 Dhaleshwari

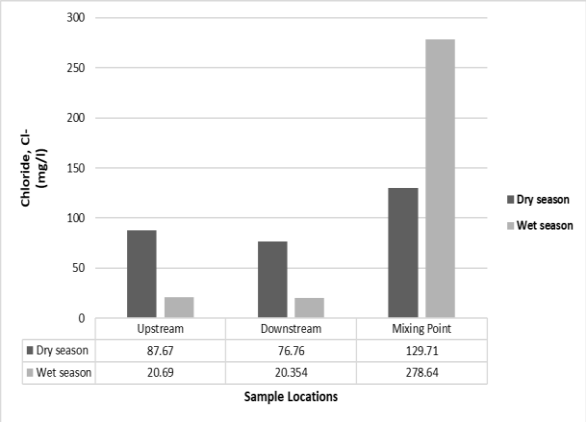

Figure 7: Seasonal Variation of Chloride Dhaleshwari

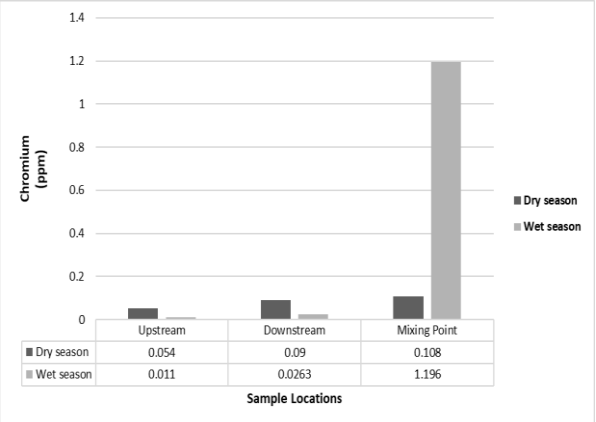

Figure 8: Seasonal Variation of Chromium Dhaleshwari

3.3 Findings

3.3.1 Comparison of Water Qualities with Different Standards

The following table 6 shows the comparision of Buriganga and Dhaleshwari river water quality with USEPA Surface Water Parameter Quality, Surface Water Standard (ECR, 1997) and EU Directive or National Regulations (2001).

Table 6 : Comparison of water quality of Buriganga and Dhaleshwari with different standards

Water Quality Parameter	Range		USEPA Surface Water Parameters	Surface Water Standard (ECR, 1997)	EU Directive or National Regulations (2001)
	BURIGANGA	DHALESHWARI			
Ammonia (mg/L)	5.37-5.92	4.17-10.45	-	-	4
BOD_5 (mg/L)	4.9-64.6	6.50-23.58	-	≤3	7

Water Quality Parameter	Range		USEPA Surface Water Parameters	Surface Water Standard (ECR, 1997)	EU Directive or National Regulations (2001)
	BURIGANGA	DHALESHWARI			
Cadmium (ppm)	<MDL*	<MDL*	0.0018	-	0.005
COD (mg/L)	34.17-164	24.98-93.41	-	-	40
Chloride (mg/L)	35.04-55.6	54.18-204.18	860	-	250
Chromium (ppm)	0.012-0.092	0.03-0.65	0.57	-	0.05
Color (Pt.Co)	108.92-192.5	46.25-121.75	-	-	150
Copper (ppm)	0.012	0.08	-	-	1
Electric Conductivity (mS/cm)	0.51-0.58	0.76-1.43	-	-	1
Lead (Pb) (ppm)	<MDL*	<MDL*	0.065	-	0.05
Nitrate (mg/L)	0.5-0.85	0.35-6.85	-	-	50
pH	7.14-7.2	7.35-7.48	-	6.5-8.5	5.5-9
Phosphate (mg/L)	0.53-3.14	0.96-1.3	-	-	0.7

*MDL= Minimum Detection Level, for Cadmium=0.001 ppm, for Lead=0.01 ppm

From this table 6 it can be noticed that COD and BOD value of both rivers exceed the standard in a considerable extent. This signifies that river health of both Buriganga and Dhaleshwari is poor. Chromium in Buriganga River satisfies the standard but in Dhaleshwari River it exceeds the limit which indicates the presence of tannery effluent in Dhaleshwari river. Other heavy metals Pb, Cu, Cd and pH, Chloride, Nitrate do not cross the standard limit. Ammonia and Phosphate value exceed the limit to some extent. EC value exceeds the limit in Dhaleshwari river in non significant amount but does not exceed in Buriganga River. Colour exceeds the standard in Buriganga but is within limit in Dhaleshwari river.

3.3.2 Buriganga River Water Quality

The following table 7 shows the comparison between Buriganga River water quality parameters studied in this research and previous study by DoE.

Table 7: Comparison of Present Studies of Buriganga River with Previous Studies

Concentration at different Sampling Location	B.C.F.B		Chadnighat		Rayerbazar	
	Present Study	Findings from previous studies (DoE,2014)	Present Study	Findings from previous studies (DoE,2014)	Present Study	Findings from previous studies (Chakraborty et al, 2013)
Parameters						
pH	7.14	7.22	7.2	7.25	7.15	8.6
EC (mS/cm)	0.58	0.73	0.56	0.75	0.51	3.28

Concentration at different Sampling Location	B.C.F.B		Chadnighat		Rayerbazar	
	Present Study	Findings from previous studies (DoE,2014)	Present Study	Findings from previous studies (DoE,2014)	Present Study	Findings from previous studies (Chakraborty et al, 2013)
TDS (mg/l)	300	363.5	300.25	372.58	291.5	2200
COD (mg/l)	36.84	57.35	34.17	59.55	164	3470
BOD (mg/l)	6.05	13.64	4.85	18.86	64.6	750
Chloride (mg/l)	37.12	34.04	35.04	36.06	55.56	800
Chromium (ppm)	0.02	-	0.01	-	0.09	8.34
NO_3-N (mg/L)	0.85	-	0.5	-	0.53	8
PO_4 (mg/L)	1.3	-	1.19	-	0.96	2.01

The following observations can be inferred from table 7:

- **Rayerbazar**- There is a decrease of TDS by 7 times compared to the findings from previous data. The extent of decrease of Chloride is by 14 times and that of Chromium is by about 90 times. Significant decrease of COD, BOD, NO_3-N and PO_4 is observed. The tannery relocation effect is clearly reflected by the decrease of Chloride and Chromium values, which is supported by the other parameters at this location.
- **Chadnighat and B.C.F.B. –** EC, TDS and Chloride values does not show any remarkable change. COD and BOD values have significantly dropped indicating the improvement of water quality.

So, the water quality of Rayerbazar shows significant improvement due to tannery relocation. But overall water health of Buriganga has not improved much in downstream.

3.3.3 Dhaleshwari River Water Quality

The following observations can be inferred from table 8-

The average value of **BOD** has changed from 13.2 mg/L to 12.31 mg/L. Average **TDS** value has changed to 506.64 mg/L from 310 mg/L. Average **Chloride** value has drastically increased to 102.3 mg/L from 20 mg/L. Average of **EC** value has increased from 0.66 mS/cm to 1.02 mS/cm. The average value of **pH** has changed from 7.78 to 7.43.

These changes in water quality parameters signify the degradation of water quality of the river Dhaleshwari due to the relocation of tannery industries on the bank of this river.
The following table 8 shows the comparison between Dhaleshwari River water quality parameters studied in this research and previous study by DoE.

Table 8 : Comparison of Present Studies of Dhaleshwari River with Previous DoE Studies

Parameters	Concentration at Different Sampling Location (Average of 10 Months)					Findings from previous studies (DoE, 2014)
	Upstream	Mixing	Downstream	Range	Average	
pH	7.48	7.46	7.35	7.35-7.48	7.43	7.78
Colour (pt.Co)	48.92	121.75	46.25	46.25-121.75	72.31	-
EC (mS/cm)	0.87	1.43	0.76	0.76-1.43	1.02	0.66
TDS (mg/L)	372.74	793.77	353.41	353.41-793.77	506.64	310

Parameters	Concentration at Different Sampling Location (Average of 10 Months)					Findings from previous studies (DoE, 2014)
	Upstream	Mixing	Downstream	Range	Average	
COD (mg/L)	27.05	93.41	24.98	24.98-93.41	48.48	-
BOD (mg/L)	6.87	25.58	6.5	6.50-23.58	12.31	13.2
Chloride (mg/L)	54.18	204.18	48.56	54.18-204.18	102.3	20

4. CONCLUSION

The main focus of this study was to assess the impacts on the water quality of river Buriganga and river Dhaleshwari due to the relocation of tannery industry from Hazaribagh to Savar.

4.1 Seasonal Variation

Buriganga River

- **COD**- In **Dry** season, the average COD values were 318 mg/L, 55.67 mg/L and 56.33 mg/L and in **Wet** season, the average COD values were 10 mg/L, 18 mg/L and 12 mg/L at Rayerbazar, B.C.F.B and Chadnighat respectively.
- **BOD_5**- In **Dry** season, the average BOD_5 values were 128 mg/L, 9.17 mg/L and 7.33 mg/L and in **Wet** season, the average BOD_5 values were 1.2 mg/L, 2.93 mg/L and 2.37 mg/L at Rayerbazar, B.C.F.B and Chadnighat respectively.
- **TDS**- In **Dry** season, the average TDS values were 454 mg/L, 424.67 mg/L and 436.5mg/L and in **Wet** season, the average values were 129 mg/L, 175.33 mg/L and 164 mg/L at Rayerbazar, B.C.F.B and Chadnighat respectively.
- **Chloride**- In **Dry** season, the average Chloride values were 102.11 mg/L, 56.89 mg/L and 53.39 mg/L and in **Wet** season, the average values were 9 mg/L, 17.34 mg/L and 16.68 mg/L at Rayerbazar, B.C.F.B and Chadnighat respectively
- **Chromium**- In **Dry** season, the average Chromium values were 0.169 mg/L, 0.007 mg/L and 0.0092 mg/L and in **Wet** season, the average values were 0.015 mg/L, 0.027 mg/L and 0.015 mg/L at Rayerbazar, B.C.F.B and Chadnighat respectively.

From the observation it can be concluded that the overall water quality parameters have improved during the wet season compared to the dry season as expected.

Dhaleshwari River

- **COD**- In **Dry** season, the average COD values was 33.43 mg/L, 29.29 mg/L and 50.14 mg/L and in **Wet** season, the average values were 20.67 mg/L, 20.67 mg/L and 136.67 mg/L at upstream, downstream and mixing point respectively.
- **BOD_5**- In **Dry** season, the average BOD_5 values were 8.63 mg/L, 8.59 mg/L and 10.83 mg/L and in **Wet** season, the average values were 5.1 mg/L, 4.4 mg/L and 36.33 mg/L at upstream, downstream and mixing point respectively.
- **TDS**- In **Dry** season, the average TDS values were 559.14 mg/L, 521.14 mg/L and 353.41 mg/L and in **Wet** season, the average values were 186.33 mg/L, 185.67 mg/L and 913.67 mg/L at upstream, downstream and mixing point respectively.
- **Chloride**- In **Dry** season, the average Chloride values were 87.67 mg/L, 76.76 mg/L and 129.71 mg/L and in **Wet** season, the average values were 20.69 mg/L, 20.35 mg/L and 278.64 mg/L at upstream, downstream and mixing point respectively.
- **Chromium**- In **Dry** season, the average Chromium values were 0.054 mg/L, 0.09 mg/L and 0.108 mg/L and in **Wet** season, the average values were 0.011 mg/L, 0.026 mg/L and 1.19 mg/L at upstream, downstream and mixing point respectively.

From the observation it can be concluded that the overall water quality parameters have improved during the wet season compared to the dry season as expected.

4.2 Comparison with Water Quality Standards

4.2.1 Buriganga River:

- COD & BOD_5 values exceed the standard.
- Colour exceeds the standard.

This signifies that overall health of Buriganga river is not quite satisfactory. It also interprets that there are still many soucres of pollution near buriganga river such as- industries discharging untreated effluent, discharging of municipal waste and many undetected sources.

4.2.2 Dhaleshwari River:

- COD & BOD_5 values exceed the standard.
- Chromium value exceeds the limit.
- EC value exceeds the limit.

These indicate the poor health of river Dhaleshwari.

4.3 Comparison with Previous Studies

4.3.1 Buriganga River:

- **Rayerbazar**- TDS, COD, BOD_5, Chloride, Chromium, NO_3-N and PO_4 values have dropped significantly which clearly shows the positive effect of tannery relocation.
- **Chadnighat and B.C.F.B. –** COD and BOD_5 values have dropped but EC, TDS and Chloride values do not show any remarkable change. So, the water health of Buriganga has not improved much in downstream after the tannery relocation.

These results show that relocation of tannery industries has significant improving effect on Rayerbazar location but has little effect on other part of Buriganga. To effectively improve the overall water health of Buriganga, this only relocation may not work, more adequate steps are necessary as well.

4.3.2 Dhaleshwari River

- BOD_5 value has increased a bit.
- TDS value has increased almost two times.
- Chloride value has increased almost five times.

These major increases clearly indicate the degradation of water quality of Dhaleshwari river. as a result of relocation of tannery industries.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude Dr. Md. Delwar Hossain for his constant help regarding information about CETP. The authors would also like to express their appreciation to Md. Nasir Uddin & Tawsif Ur Rauf for helping to collect samples from Dhaleshwari.

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