ASSESSMENT OF SURFACE AND GROUNDWATER CONTAMINATION AND SEASONAL VARIATION AT THE TANNERY AREA IN DHAKA, BANGLADESH

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ABSTRACT

Hazaribagh in Dhaka is home to about 150 footwear factories and is known as a contamination hub. Although some tanneries have relocated to new industrial parks, it has been seen that many are still running. In the present study, 42 water samples, including surface and groundwater, from six different sampling points of the Hazaribag tannery complex were examined for one year (December 2019–August 2020; dry and rainy seasons respectively). This research aimed to assess the surface and groundwater quality of the sampling area and the seasonal variation on different parameters. During sampling, a sequence was maintained, from the tannery source points to the downstream Buriganga River, the ultimate destination of tannery effluents. Chemical and physicochemical properties pH, DO, BOD, NO_3^-, C^{2+}, Mg^{2+}, K^+, Na^+, Cl^-, TDS, TSS, EC, Eh, and turbidity of wastewater were evaluated using the standard method. However, our primary attention was on heavy metal contamination. Trace metals were analyzed by atomic absorption spectrophotometer. The excessively higher concentration of heavy metals was observed in the first three sampling sites. It was also found that heavy metal concentrations decreased significantly from the source point to the downstream Buriganga River. Such variations in metal content with the location may have occurred due to increasing distance from the source point and percolation of wastewater to downward groundwater by soil. Comparatively lower concentrations of heavy metals were observed in the rainy season than dry season due to dilution with rainwater but still was above the maximum allowable concentration. Concentrations of all investigated heavy metals and some physicochemical parameters such as pH, DO, BOD, TDS, TSS, EC, Cl^-, and Na^+ of all the surface and groundwater samples were found above the national (DoE) and international (WHO) standards.

Keywords: tannery industries, heavy metal pollution, surface water, groundwater water pollution, tannery effluents.

1 INTRODUCTION

Leather processing is one of the most promising sectors of Bangladesh. Among 220 tanneries in Bangladesh, about 90–95% of all tanneries are located in Hazaribagh, Dhaka [1]. Twenty-five hectares of tannery complex are in Dhaka municipality's western part and inside the flood protection dam. About 60,000 tons of raw hides and skins are processed here per year [2] and generate 7.7 and 88 million tons of liquid and solid waste [3]. These wastes are not managed in efficient ways. As a result, this area has now become a chemically contaminated hub. An average of 30–35 m^3 of wastewater is produced per rawhide processing per ton [4]. Wastewater is discharged into nearby open drains, ponds, and lagoons. It makes its way to the other side of the dam and ultimately flows into the river Buriganga, which is considered Dhaka's lifeline. People in and around the city, directly and indirectly, depend on Buriganga for a different purposes. Tannery wastewater and effluents are the main culprits of extreme biodiversity loss in the river, and the color of river water turns black. After decades of discussion on the topic, the government launched a relocation project to move the tannery from Hazaribag to the north of Dhakar near Savar, where all the tanneries would share a central effluents treatment plant (CETP). Many tanneries have been relocated in the newly

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formed leather industry [5]. The main goal of relocating this industry was to make rivers safe from pollution. However, the goal is not attained in the newly formed industrial area [6]. As the Central effluent treatment plant has not been built, the same hazard will achieve in the area. They are now discharging non-treated effluent near the Dhaleshawri River [7]. Tanning is a process by which rawhide and skin turn into soft and durable leather. It is time-consuming, and many chemicals and mechanisms are involved here. About 40 heavy metals and acids are used during the soaking, tanning, and post tanning processing of hides and skins [8], including sodium sulfite, basic chromium sulfate, various painting agents, bactericides, soda ash, CaO, ammonium sulfide, ammonium chloride, sodium bisulfate, Cl, H_2SO_4, formic acid, sodium formate, sodium bicarbonate, vegetable tannins, system, resins, polyurethane, dyes, fat emulsions, pigments, binders, waxes, lacquers and formaldehyde and enzymes [9]. Only 20% of chemicals used in the tanning process are absorbed by leather rest are released as waste [10]. In the future area of Hazaribag will be used for commercial and residential purposes. However, soil and water, including groundwater, will suffer from tannery wastes [11]. A recent study observed a very high concentration of heavy metals in the surrounding area's soil and plant samples [12]. There is an urgent need to evaluate surface and groundwater in Hazaribag.

2 MATERIALS AND METHOD

2.1 Surface and groundwater sampling

Six sampling points were chosen based on the assumption of pollution intensity. The first three spots were located inside, and the rest three were outside the flood protection embankment of Dhaka. Spot I was considered the main disposal point of tanneries, and the increasing numbers of the spots indicant ate increasing distance from the main disposal point. Water samples were collected from the study area in two phases, December 2019 (dry season) to August 2020 (rainy season). The sampling spots were kept fixed throughout the whole sampling period. The sampling points were geo-referenced with GPS (global positioning system) and marked on the map. GPS locations of sampling points are given in Table 1. The location map of the study area and sampling location is shown in Figs 1 and 2. Water samples of 500 ml (with three replications) were collected from each site in sterilized plastic bottles fitted with a liquid-tight stopper. Groundwater samples were collected from deep tube well (DTW) (>150 m), located at sampling point IV. The water samples were immediately acidified with 4 ml of concentrated hydrochloric acid (HCl) per liter and analyzed within seven days of collection.

Table 1: GPS location of sampling point (both dry and rainy seasons).

I	23044.013'N	90021.807'E
II	23041.156'N	90021742'E
III	23044.552'N	90021.604'E
IV + GW	23044.673'N	90021.549'E
V	23044.600'N	90021.279'E
VI	23044.501'N	90021.109'E

Figure 1: Location map of study area [16].

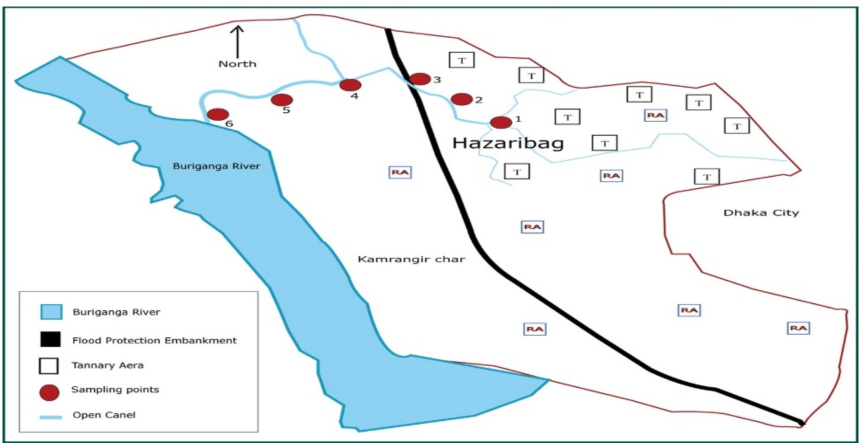

Figure 2: Sampling site at Hazaribag tannery area.

2.2 Analytical procedure

Determination of pH for all samples was done using the HI-2211 (Hanna Instrument). DO and BOD were measured with the electrolytic method by using an electric probe (Hanna HI 98193). Determination of chloride was done by the titration method. The micro Kjeldahl distillation method measured nitrates ($NO3^-$) in water [13]. Potassium (K) was determined turbidimetrically after digesting the water sample with the $HNO_3^-HClO_4$ (1:3) mixture by a spectrophotometer at 769 nm [14]. Sodium (Na) and potassium (K) were determined by atomic absorption spectrophotometer (AAS). Calcium (Ca) and magnesium (Mg) were measured titrimetrically by EDTA (ethylenediaminetetraacetic acid) method. Determination of chloride was done by the titration method [15]. Total dissolved solids (TDS) were measured using a portable TDS (HI98301 DiST1) meter. Total soluble salts (TSS) in water were measured gravimetrically by evaporating 20 ml of water sample at 1100°C and expressing it in mg kg^{-1}. Electrical conductivity (EC) was measured using an EC meter (HI98301 DiST1). The redox potential (Eh) of water samples was determined redox meter (PCE PH-30). The Turbidity of the water sample was determined by using a turbidity meter (LUTRON TU-2016). Heavy metals (Cr, Zn, Pb, Cd, Mn, Fe, and Ni) were analyzed by using an atomic absorption spectrophotometer (model no AA421) following the method prescribed by APHA [15].

2.3 Statistical analyses

Data analysis was done using the Microsoft Office Excel 2007 and SPSS software. The tests of significance of different sampling points were calculated by DMRT at a 5% level.

3 RESULT AND DISCUSSION

3.1 Chemical and physicochemical parameters

The chemical and physicochemical properties of wastewater are analyzed and presented in Table 2. The pH of the water sample was found to be in the range of 6.23 to 7.83 and 6.77 to 8.15 for dry and rainy seasons respectively and, was within the standard regulatory limits [17], [18]. There was no significant variation in pH values during the dry and rainy seasons. This also conforms to previous works [3]. A maximum of 8.15 pH was recorded during the rainy phase at sampling point III. The pH of water is greatly influenced by the concentration of CO_2 [19]. A very low value of DO was observed at various sampling points of the Hazaribag tannery area. The DO across multiple sampling points ranged from 0.00 to 0.45 and 0.65 to 0.96 mg/L in the dry season and rainy season respectively and in the dry season lowest DO was observed at the sampling point, I (0.00 mg/L), and 0.65 was observed at the same sampling point in the rainy season. The groundwater had a higher DO level in both seasons; 3.90 and 1.2 mg/L in two consecutive seasons. The study of the wastewater quality at the different sampling spots during the dry and rainy seasons revealed that tannery wastes heavily polluted the water and the Buriganga river water, so much, so that the DO of the wastewater samples was found to be nil during the dry season and no fish and other aquatic life were found living, up to 500 m downstream of the sluice gate. DO in all samples was detected below the standard limit [17], [18].

BOD values were higher in the rainy season 217 mg/L in relation to the dry season 150 mg/L. This might be due to warmer temperatures in that season enhanced microbial activities, consuming more oxygen to decompose industrial and tannery effluents and domestic wastes, which are drained out into the river by monsoon rain and surface run-off. The inversely proportional relationship between BOD and DO was also observed throughout this study. However, the important fact is that the BOD values were high, which reduced the amount of oxygen (DO) available to fish and rendered the water body unsuitable for the fishery. Similar works were also reported earlier [20]. BOD in all sampling points exceeds the recommended maximum allowable concentration [17], [18].

NO_3^- in the sample, a ranged from 96 to 189 and 12 to 185 mg/L for the dry and rainy seasons, respectively. Compare to the dry season a lower value of NO_3^- was observed in the

Table 2: Wastewater's chemical and physicochemical properties in dry and rainy phases.

Spot No	pH	DO	BOD	NO^{3-}	Ca	Mg	K	Na	Cl	TDS	TSS	EC	Eh	Turbidity
	mg/L										mg/50 mL	dS/cm	mV	FTU
Dry season														
I	6.23	0.00	150	156	4.3	1.2	0.3	98	789	3,160	0.16	2.1	378	4,096
II	7.83	0.45	138	163	4.1	2.1	0.6	100.2	895	2,860	0.09	7.4	365	674
III	7.73	0.35	128	125	4.5	2.6	0.2	95	789	2,580	0.09	6.10	363	563
IV	7.61	0.33	124	147	4.9	1.9	0.2	79	656	2,320	0.03	3.87	353	800
V	7.35	0.25	112	96	3.6	1.3	0.6	16.2	548	643	0.04	2.64	344	347
VI	7.02	0.38	168	189	3.8	1.9	0.1	23.2	458	592	0.02	6.74	197	60
GW	7.36	3.9	0	121	0.2	0.03	0.01	9	18	125	0.01	0.228	110	3.68
Rainy season														
I	8.07	0.65	212	125	4.5	2.3	0.2	126	568	486	1.2	7.23	325	530
II	7.59	0.96	206	185	4.6	2.1	0.2	158	698	430	0.23	8.01	125	442
III	8.15	0.89	194	163	5.6	2.03	0.2	63	456	329	0.56	7	389	166
IV	7.11	0.69	154	73	6.2	2.56	0.2	48	678	226	0.48	3.72	321	41.5
V	7.24	0.85	114	45	4.2	1.3	0.3	69	458	116	0.12	2.85	378	27.4
VI	7.16	0.74	217	184	3.8	1.8	0.6	128	325	223	0.45	6.42	296	13.6
GW	6.77	1.2	0	12	0.34	0.05	0.01	2	11	105	0.00	0.84	241	2.4
FAO [17]	6–9		30	50						2,100	30			550
DoE [18]	6–9	4.5	50	50						2,100	50	1.2		550

rainy season. The highest value in the dry season might be due to the continuous accumulation of tannery effluents. All NO_3^- values of DTW during the rainy season were obtained were within regulatory limits of 50 mg/L [18].

Ca^{2+} in wastewater at different sampling points of the Hazaribag tannery is ranged from 0.2 to 4.9 and 0.34 to 6.2 mg/L for the dry and rainy seasons, respectively. Mg^{2+} ranged from 0.03 to 2.6 and 0.05 to 2.56 mg/L for the dry and rainy seasons. Na^+ in wastewater at various sampling points ranged from 9 to 100.2 and 2 to 158 mg/L for the dry and rainy seasons. Compared to the dry season a higher value of Ca^{2+}, Mg^{2+} and Na^+ were observed in the rainy season. However, potassium, calcium, and magnesium values recorded in this study were found within the recommended regulatory limit in water <10 mg/L [17], [18]. Very high Sodium concentration was recorded in different samples of this study except for the groundwater. Similar findings were also reported in a previous article [9]. Chloride in the investigated wastewater varied from 18 to 895 and 11 to 698 mg/L in dry and rainy seasons respectively. However, chloride, except for DTW values (18 and 11 mg/L) recorded in this study, was found to be above the recommended regulatory limit in water >250 mg/L [21]. Tannery effluents and municipal sewage waste might be responsible for this contamination. The sharp fall of Chloride concentration in the rainy season in the wastewater was due to dilution of rainwater by monsoon rain or less discharge of tannery effluents from industries at the time of sampling. The effect of chloride in an aquatic environment does not seem to have received much attention. However, a certain high concentration of any ion is bound to affect overall biota drastically. TDS in wastewater at different samples ranged from 125 to 3,160 and 2.4 to 530 mg/L for dry and rainy seasons. However, the TDS of the first three sampling points in the dry phase exceeds the regulatory value of 2,100 mg/L [18]. The variations in TDS concentrations in wastewater are due to the discharge of effluents and wastes from the tannery industries. Comparative higher values were in the dry season than the rainy season. Lower TDS values obtained during the rainy season could result from several physicochemical reactions such as sedimentation, coagulation, fixation, oxidation, and precipitation [22]. The number of solids present in a water body can be used to estimate the pollution load due to both organic and inorganic contaminants present.

TSS ranged from 0.0 to 0.16 and 0.00 to 1.2 mg/50 mL, respectively, in the dry and rainy seasons. In the dry season, maximum TSS was observed at sampling point I (0.16 mg/50 ml). Gradually decreasing values were observed from sources point to downstream, outside the barrier. The lowest turbidity value was observed in tube well water (0.00 mg/50 ml). Similar findings were observed in the rainy season. TSS value of the wastewater samples at different spots decreased in the dry season. The subsequent increase was observed in the rainy season, indicating a large amount of waste discharged from tannery industries and heavy monsoon rainfall causing surface runoff from the surrounding area during the investigation period. EC indicates the total concentration of the ionized constituents of water and is usually correlated closely with TDS [19]. EC in wastewater at various sampling points ranged from 0.228 to 7.4 and 0.84 to 8.01 dS/m, respectively, in the dry and rainy seasons. EC of all samples was found within the regulatory limit of 1,200 dS/cm [17].

The redox potential characterizes the oxidation-reduction state of water. Eh, the value of the water sample in two seasons was determined on the 28th day after sampling and ranged from –436 to –110 and –389 to –241 mV in dry and rainy seasons, respectively. The lowest redox potential was recorded in the rainy season at –389 mV. The highest one was recorded during the dry season at –110 mV from samplings point I and groundwater, respectively. A low redox potential in the rainy season might be due to changes in the composition of organic matter and metal complexes in the overlying water and higher redox values in the dry season, probably due to the continuous turnover and movement of the waters. Values of EC, Na, Ca, K, Mg and Eh indicate high wastewater pollution even in the Buriganga River (sampling point VI), where water is not stagnant. Many authors also reported similar findings [23], [24].

The turbidity in various sampling points ranged from 3.68 to 4096 and 2.4 to 530 FTU, respectively, in the dry and rainy seasons. Turbidity is the opposite phenomenon of transparency and has an inverse relationship. Turbidity is essential because of the aesthetic consideration and the organism's pathogenicity that can be hidden on tiny colloidal particles [25]. In the dry season, maximum values were observed at sampling point I, 4096 FTU, and gradually decreasing values from the source point to downstream, outside the barrier. The lowest value of turbidity was observed in groundwater (3.68 FTU). Similar findings were observed in the rainy season, where the highest turbidity value was honored at the source point, i.e., the sampling point I, 530 FTU. Turbidity above the regulatory limit was observed at sampling spots II, III, IV, and I in the dry season [17].

3.2 Heavy metals

Cr in wastewater samples ranged from 4,609.8 to 8,995.0 mg/L and 17.86 to 863.03 mg/L in dry and rainy seasons, respectively (Table 3). In the dry season, highest 8,995.0 mg/L was observed at sampling point I, i.e., the main disposal point of tanneries. Various chromium salts used in tannery industries, or vast amounts of wastewater may contaminate spot I and effluents are now continuously added from other sectors [23]. Significant differences were found between sampling points II, III, IV, and V, VI. DMRT calculated the significance tests of different samples at the 5% level. In the rainy season, a comparatively lower concentration of Cr was observed at the same points. 17.48 and 863.03 mg/L was the lowest and highest observation of Cr at sampling points V and I. This downfall may be due to the dilution of water by rainfall. Imamul-Huq [9] reported 0.28 ppm Cr in wastewater in the Hazaribag area. Similar findings were also reported by Nuruzzaman et al. [26]. Cr in all samples, both dry and rainy seasons across the MAC (maximum allowable concentration) for inland water d 0.5 mg/kg [18] and drinking water of WHO 0.05 mg/kg [21].

Table 3: Chromium (mg/L) in wastewater at sampling points of study area both in dry and the rainy season.

Chromium (mg/L)				
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	8,995.0 a	863.03 a		
II	5,967.50 b	674.56 ab		
III	5,619.17 b	62.90 b		
IV	6,232.66 b	275.18 ab		
V	3,644.08 d	39.51 b	0.5	0.05
VI	4,609.8 c	17.86 b		
GW	28.33	2.14 b		

Zinc in water samples in the dry season was 3.10 mg/L at sampling points I, 2.6, 2.21, 1.76, 1.74, 1.73, and 0.601 mg/L in sampling points II, III, IV, V, VI, and groundwater, respectively (Table 4). There were significant differences among different sampling spots except for points II and III. In the case of the rainy season, 2.46 and 0.25 ppm was the highest and lowest observation of Zn that was found at sampling point VI, and I. Ullah et al. [23] reported 0.12 ppm of Zn in wastewater at the Hazaribag area. Similar findings were also reported [26]. All samples crossed the MAC for inland and drinking water 5 mg/kg [18], [21].

Table 4: Zinc (mg/L) in wastewater at sampling points of the study area both in dry and rainy seasons.

		Zinc (mg/L)		
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	17.38 a	16.91 a		
II	17.33 b	12.82 b		
III	17.67 b	13.76 b		
IV	22.16 c	16.91 b		
V	26.03 c	14.49 bc	5	5
VI	31.01c	24.63 bc		
GW	6.1 d	2.51 c		

In the dry season, 1.53 and 3.15 mg/L was the lowest and highest observation of Pb at sampling points I and III (Table 5). No Significant differences were found among different sampling spots. 0.366 to 0.94 mg/L was the lowest and highest findings of Pb that were observed at sampling points I and II. Pb in all samples was cross the traditional value of effluents for inland surface water, 0.1 mg/kg [18].

Table 5: Lead (mg/L) in wastewater at sampling points of study area both in dry and rainy season.

		Lead (mg/L)		
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	3.15 a	0.70 b		
II	3.04 a	0.94 a		
III	2.39 a	0.44 c		
IV	2.23 a	0.51 c		
V	1.53 a	0.36 c	0.1	0.01
VI	1.59 a	0.51 c		
GW	1.63 a	0.78 ab		

Cd in wastewater samples ranged from 0.007 to 0.035 and 0.005 to 0.035 mg/L, respectively, in dry and rainy seasons (Table 6). Groundwater and VI samples were significantly different from other spots. A comparative lower concentration of Cd was observed at the same sampling point in the rainy season. Maybe rainfall was responsible for this mitigation. Cd in all observed samples crosses the national standards for inland 0.05 mg/kg [18], and the maximum allowable drinking water concentration by WHO is 0.005 mg/kg [21].

Mn 1.8 mg/L was the highest observation of Mn found at sampling point I, i.e., the main disposal point of tanneries and located inside the embankment (Table 7). Spot I may contaminate by various manganese salts used in tannery industries. Statically this sample and groundwater were significantly different from other samples. In the rainy season, 0.03 and 1.73 mg/L was the lowest and highest concentration of Mn observed at sampling point I and groundwater. Nuruzzaman et al. [26] reported 0.014 ppm Mn in wastewater at the Hazaribag tannery area. Similar findings were also reported by Ullah et al. [23]. Mn concentration at six sampling points during both dry and rainy seasons across the national and international standards for inland water 5 mg/kg [18] and drinking water (0.05 mg/kg) [21].

Table 6: Cadmium (mg/L) in wastewater at sampling points of study area both in dry and rainy season.

	Cadmium (mg/L)			
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	0.035 a	0.035 a		
II	0.033 a	0.020 bc		
III	0.028 a	0.025 b		
IV	0.030 a	0.005 d		
V	0.026 a	0.015 c	0.05	0.005
VI	0.007 b	0.016 bc		
GW	0.006 b	0.005 d		

Table 7: Manganese (mg/L) in wastewater at sampling points of study area both in dry and rainy season.

	Manganese (mg/L)			
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	12.81 c	7.3 a		
II	18.31 b	3.33 a		
III	21.38 a	0.20 c		
IV	12.98 c	0.59 b		
V	11.81 c	0.05 d	5	5
VI	7.15 d	0.45 b		
GW	4.48 e	0.03 d		

Fe in wastewater samples ranged from 38.93 to 275.01 and 32.11 to 113.27 mg/L in dry and rainy seasons, respectively (Table 8). Spot I was significantly different from other spots except and III. A comparative lower value of Fe was observed at the same sampling point in the rainy season. The previous investigation reported 0.14 ppm Fe in wastewater in the same area [23]. Similar findings were also reported by Nuruzzaman et al. [26]. Fe in all samples was above the national and international standers.

Table 8: Iron Chromium (mg/L) in wastewater at sampling point of study area both in dry and rainy season.

	Iron mg/L			
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	275.01 a	113.27 a		
II	226.43 a	81.6 b		
III	104.76 a	68.27 b		
IV	61.68 b	61.6 b		
V	42.60 b	54.94 c	2	0.3
VI	38.93 b	32.11 bc		
GW	13.60 c	4.61 d		

Ni in wastewater during the dry season was 1.93 at sampling points I, 0.84, 0.51, 0.34, 1.64, 0.84, and 0.51 mg/L in sampling points II, III, IV, V, VI, and groundwater, respectively (Table 9). No significant differences were found among different samples. But the situation was different in the case of the rainy season. Significant differences were found among other sampling spots. 0.341 and 1.57 ppm was the lowest and highest concentration of Ni observed at sampling point V and I. Ni in all samples were above the MAC for drinking water (0.1 mg/kg) [21] and inland water bodies 1 mg/kg [18].

Table 9: Nickel chromium (mg/L) in wastewater at sampling point of study area both in dry and rainy season.

Nickel (mg/L)				
Spot No	Dry season	Rainy season	National Standards DoE [18]	WHO Standards WHO [17]
I	1.93 a	1.57 a		
II	1.64 a	0.80 ab		
III	0.84 a	0.502 ab		
IV	0.51 a	0.341 b		
V	0.34 a	0.65 ab	1	0.1
VI	0.84 a	0.67 ab		
GW	0.51 a	0.11 b		

4 CONCLUSION

In the study, in the area of Hazaribagh, the industrial wastewater is discharged into the river Buriganga via open canals and low lands with extremely high concentrations of Na^+, K, Mg^{2+}, Ca^{2+}, NO_3^- Cl^- and heavy metals, especially Cr, Zn, Pb, Cd, Mn, Fe, and Ni. The high organic matter content was also detected, as evident in high BOD and low DO observe this study's high BOD and low DOD, NO_3^-, Ca^{2+}, Mg^{2+}, K^+, Na^+, Cl^-, TDS, TSS, EC, Eh, and turbidity negatively affect aquatic life and the ecosystem. There was an unusually high concentration of toxic metals in the first three sampling sites. Heavy metal concentrations also decreased dramatically from the source point to the Buriganga River downstream. Such variations in metal content with the location may have occurred due to increasing distance from the source point and percolation of wastewater to downward groundwater by soil. Due to dilution with rainwater, heavy metal concentrations were lower in the rainy season than in the dry season, but they were still above the maximum permitted concentration. The attention of all investigated heavy metals and some physicochemical parameters such as pH, DO, BOD, TDS, TSS, EC, Cl, and Na^+ of all the surface and groundwater samples were found above the DoE and WHO standards. There is the possibility of further contamination of surface and groundwater if untreated tannery wastes and effluents are not considered. It is an emergence to relocate all tanneries to the new industrial sites to reduce pollution. Our last sampling point was the Buriganga River, where concentrations of heavy metals in river water have also exceeded the maximum allowable concentration of DoE and WHO for drinking water due to tanning activities. Surface Water of the study area of Hazaribagh tannery industries is said to be highly polluted, especially with cation, anion, organic matter, and especially with heavy metals, so it is not suitable for the external purposes of human activities such as bathing, washing, irrigation, and ground water is highly polluted, especially with heavy metals, so it is not recommended as a drinking water for human consumption.

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