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Research Article

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Assessment of the Seasonal Variations of Lakes Water Quality in Bangladesh

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Abstract

The study was conducted to assess the seasonal variations of water quality in Hatirjheel Lake and Dhanmondi Lake during the period from August, 2019 to January, 2020. The water samples were collected monthly during the monsoon and post-monsoon seasons from five sampling stations of both lakes. Comparative analysis revealed that mean pH was near the standard level in both lakes where DO concentration was much lower in Hatirjheel Lake than Dhanmondi Lake which could be due to the direct dumping of nearby residential and commercial waste, and domestic sewages from the city drainage system as well. The BOD concentration in Hairjheel Lake water exceeded the standard in both seasons and there was no significant change over seasons. In contrast, the Dhanmondi Lake water showed relatively lower BOD concentrations in both seasons where mean concentration slightly exceeded the standard in some stations. The EC and TDS contents showed positive relations but exceeded the standard limit throughout seasons in both lakes. The nutrient contents (NO_3-, NO_2- and NH_4+) of Hatirjheel Lake water highly exceeded the standard during the study that tends the lake water prone to eutrophication. The study revealed that the physicochemical parameters and nutrient status of Dhanmondi Lake water were within the standard limit except EC indicating a rich habitat for aquatic organisms and sounds for recreational activities than Hatirjheel Lake which should be monitored throughout the year to maintain the productivity of lake water systems.

Keywords: Water Quality, Hatirjheel Lake, Dhanmondi Lake, Seasonal Variation

Statements and Declarations

The authors had conducted the research by their own interest and didn't receive any kind of fund from any institution or organization. There is no human and/or animals were used in the research and primary data were collected and analyzed by the authors. The authors also declared that they have no known competing financial interests as well as personal relationships that could have conveyed influence to the research findings.

1. Introduction

Lakes are one of the most potential water bodies which act as water retention basins during the monsoon and besides being the sources of biodiversity of the area even they are an important part of the scenic beauty [1]. The sources of these lakes flow through the middle of Dhaka, becoming polluted with industrial effluents, municipal wastes, surface run-off, sewage and other hazardous substances with many human health and economic implications, particularly regarding the poor and slum dwellers [2]. Hatirjheel Lake, Gulshan Lake, Banani Lake, Ramna Lake and Dhanmondi Lake are the popular relaxation spot in the city which is being polluted by slums and sewages, the business firms and industries operating in the area, locals and environmentalists alleged [1]. Haitrjheel is a prominent depression within Dhaka metropolitan area. It is located in the centre of Dhaka and is a crucial element in the city's drainage system. The lake ecology system being contiously destroyed for excessive waste water. As a result a greater changes happening in bio-diversity [3]. This present situation is getting worse due to the lack of adequate entertainment spots in the capital. Lake and its adjacent area become crowded during the weekends. Residents of the area also alleged that liquid wastes from sewages are dumped into the lake. Garbage and human waste have made the water of the lake greenish [4]. Dhanmondi is the biggest residential area of Dhaka city. It has always been very important to keep the Dhanmondi Lake healthy and attractive because it serves many environmental and recreational purposes for the people of Dhaka city. Dhanmondi Lake is a popular area for visiting where many interesting activities and events take place on a regular mode [5]. But in the era of urbanization and industrialization it is very pathetic to observe that all our natural resources including the lake, river water degrade its quality day by day and posing more threats to our existence. Since urbanization process involves the pollution cycle with the speedy growth of population the condition becoming worse. The water quality management foundation is related to water quality monitoring and assessment. There has been an increasing demand for monitoring water quality by regular measurements of various water quality variables [6]. Both organic and inorganic

waste effluents adversely interact with the river system and deteriorating the water quality of these rivers. For this reason, water causes the adverse effect on surrounding land and aquatic ecosystem as well as subsequent impact on the livelihood of the local community. So a continuous monitoring of water quality is very essential to determine the status of pollution. To keep these points in consideration the research was designed and carried out with the following objectives:

1. To investigate the physicochemical parameters and nutrient status of Hatirjheel Lake and Dhanmondi Lake water of Dhaka city.
2. To compare the water quality parameters of both lakes to understand the seasonal variation and their impacts throughout the year.

2. Materials and Methods

2.1 Study Area

The study was conducted for a period of six months from August 2019 to January 2020 at Hatirjheel Lake and Dhanmondi Lake in Dhaka city, Bangladesh. Dhanmondi Lake is situated in the middle of Dhaka City having 23043'N latitude and 90026'E longitude. It is 3 km in length where width varies from 35 m to 100 m with a maximum depth of 4.77 m and the total area of the water body is approximately 37.37 ha. The lake is one of the most visiting places in Dhaka city and surrounded by residential area, shops, commercial area, and in the middle of the lake has restaurant and cafeteria. Over the lake there has some walking bridge and beside the lake have footpath, main road and sub-road, all which are the source of pollution [7]. Hatirjheel Lake is located at the centre of the capital, Dhaka with latitude of 23°44′58.47″N and longitude of 90°23′48.35″W. The place is surrounded by Tejgaon, Gulshan, Badda, Rampura, Niketon, Maghbazar, etc. [8]. The length of the Hatirjheel Lake is 3.8 km which covers an area of 0.0160 km2 with an average depth of 2.5 m and subjected to pollution due to direct discharge of effluent, dumping of solid waste from surrounding residential areas, small shops and commercial activities. Washing clothes, bathing, dumping of unusable construction materials is very common in the Hatirjheel Lake [9].

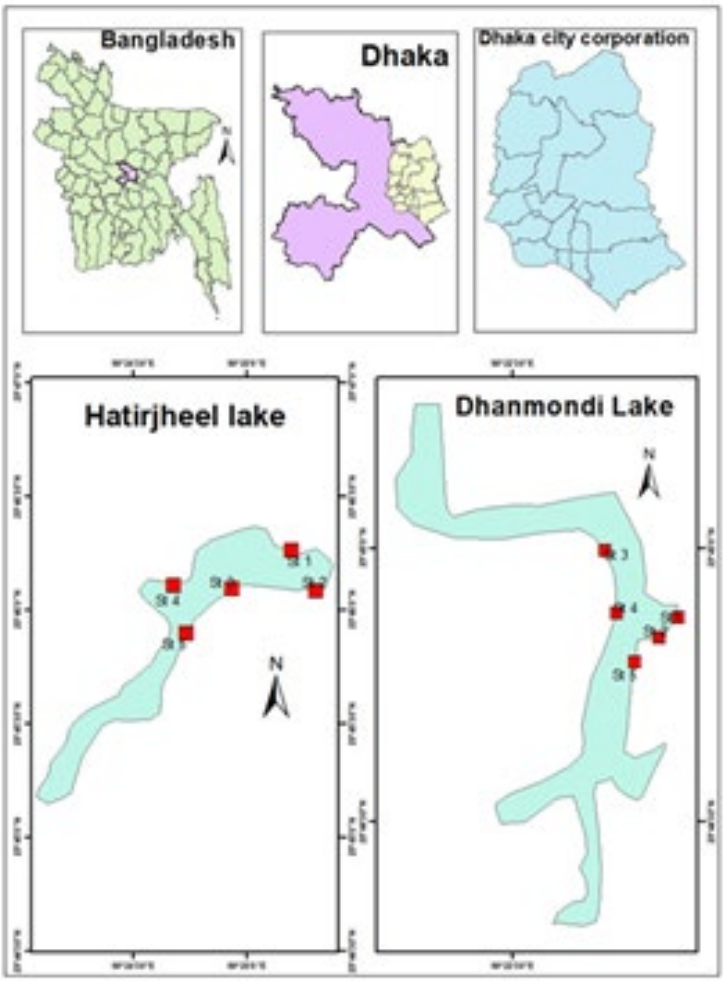

Figure 1: Map showing the study area

Lakes	Sampling stations	Latitude	longitude
Hatirjheel Lake	1	23º46′06.2″N	90º 25′15.4″E
	2	23º46′05.2″N	90º 25′14.9″E
	3	23º46′06.4″N	90º 25′04.3″E
	4	23º460′6.7″N	90º 24′45.7″E
	5	23º45′45.0″N	90º24′40.4″E
Dhanmondi Lake	1	23º44′40.5″N	90º22′39.5″E
	2	23º44′44.5″N	90º22′39.1″E
	3	23º44′45.4″N	90º22′40.0″E
	4	23º44′41.5″N	90º22′42.0″E
	5	23º44′40.2″N	90º22′43.2″E

Table 1: Sampling stations of Hatirjheel Lake and Dhanmondi Lake

3. Sample Collection

The water samples were collected from 5 sampling stations of both Hatirjheel Lake and Dhanmondi Lake of Dhaka city during monsoon (Aug-Oct, 2019), and post-monsoon (Nov. 2019- Jan. 2020) seasons, respectively. (Table 1) Seasons were designed according to Banglapedia, 2015 [10]. To analyze the physiochemical parameters and nutritional status of lake water, 1000 ml water from each sampling station was collected by plastic bottles with double stoppers monthly and immediately preserved with 0.1N KOH+KI solution.

4. Sample Analysis

The physiochemical parameters of water such as transparency, temperature, pH, electric conductivity (EC) and total dissolved solids (TDS) and DO were determined by Secchi Disc method, thermometer, digital pH meter, digital EC meter, digital TDS meter and digital DO meter, respectively. The biological oxygen demand (BOD) was measured by two steps where initial BOD (BOD_1) was measured immediately after water sample collection and BOD_5 was measured after incubation in the dark condition at 20°C for 5 days. Then the total BOD (BOD_1- BOD_5) concentration was measured. The nutrients (NO_3-, NO_2- and NH_4+) were measured according [11, 12]. to semimicro kjeldahl method (a wet oxidation process).

5. Statistical Analysis

The statistical analysis of physicochemical parameters was carried out by the Microsoft Excel 2010 and SPSS was used to plot graphs for dissemination of the results.

6. Result and Discussion

6.1 Physiochemical Parameters

The mean transparency of the Hatirjheel Lake water was ranged from 11.5 to 21.1cm when mean highest transparency was measured in October and lowest was measured in September. The mean transparency of the Dhanmondi Lake was ranged from 26.1 to 45.0 cm with mean highest transparency in September and lowest in January (Table 2). Transparency of Dhanmondi Lake showed a significant positive relationship with water temperature ($r = 0.898$, $p < 0.01$) in Table (5). The comparative study showed that the Dhanmondi Lake water was more transparent than Hatirjheel Lake water which is supported [14]. Water transparency ranging from 36 to 40 cm is suitable for aquatic life [15]. Thus, in case of suitability for aquatic Transparency ranging from 36 to 40 cm is suitable for aquatic life [15]. Thus, in case of suitability for aquatic life, Dhanmondi Lake was suitable than Hatirjheel Lake. The monthly average temperature of Hatirjheel Lake was ranged from 20.2±3.34 to 30.8±0.72ºC where maximum average temperature was recorded in November and the lowest in January as well. Dhanmondi Lake showed the range of monthly average water temperature from 18.0±0.13 to 33.1±1.09°C with mean maximum temperature in September and mean lowest in January.

The both lakes were experienced highest pH in monsoon indicating monsoon rain and post-monsoon have influence on pH fluctuation. The Hatirjheel Lake water pH showed lower limit of the standard level [16, 17] in the entire study period and in December it exceeded the standard which could be due to open disposal of household drainage wastewater, industrial waste effluents and city wastes The average pH of the Dhanmondi Lake water was within the acceptable limit and showed significant positive relationship with water temperature ($r = 0.877$, $p < 0.01$), ($r = 0.754$, $p < 0.01$) with transparency and with DO ($r = 0.910$, P<0.01), (Table 5). The Ramna Lake water pH ranging from 6.53 to 6.72 [17] which were almost similar to the Hatirjheel Lake where Dhanmondi Lake showed better result.

The high EC content shows a large amount of ionic substances present in water [18]. The acceptable range of EC for recreational water is 500 µS/cm where for irrigation and aquaculture, the contents are 750 and 800-1000 µS/cm, respectively [19]. But the streams supporting for good mixed fisheries have EC range between 150 and 500 µS/cm [19]. where the EC content outside this range could indicate that the water is not suitable for certain species of fish or micro-invertebrates [1]. The results of the study showed that the mean EC contents of both lakes exceeded the recreational standard as well as good mixed fisheries standard but lower than the aquaculture standard i.e. fisheries activities can be performed at limited scale but recreational activities will be hampered which is the crying need of the city dwellers. The water quality of Hatirjheel Lake is degrading gradually that supported by [17]. and EC of Hatirjheel Lake water show the negative correlation with the TDS ($r = -0.141$, $p < 0.05$) (Table 4). The mean EC content of Ramna Lake in Dhaka city was found 179.5µs/cm [17] which was much better than the Hatirjheel and Dhanmondi Lake.

The monthly mean TDS content of Hatirjheel Lake water was measured 288±11.77, 293±0.6.22, 300±2.34, 313.2±6.90, 400.6±7.76 and 397.2±3.34 mg/l, respectively (Table 2) where in Dhanmondi Lake, the mean content was 152.6±1.34, 175±8.54, 173.5±4.21, 171.4 ±2.40, 177.6±1.51 and 198.8±6.30 mg/l, respectively from August, 2019 to January, 2020. (Table 3)The TDS content of Dhanmondi Lake water showed the significant negative relationship (r = –0.784, p < 0.01) with water temperature, (r = –0.479, $p < 0.05$) with transparency and (r = –0.871, $p < 0.01$) with pH while showed the significant negative relationship (r = –0.740, $p < 0.01$) with water temperature and (r = –0.722, $p < 0.01$) with pH in Hatirjheel Lake water (Table 4 and 5). The TDS content was much higher in Hatirjheel Lake water than Dhanmondi Lake i.e. almost two times, although both lakes were within the standard limit [20]. Previous studies showed that Hatirjheel Lake experienced 339.9±31.9 mg/l in 2015 [21] which was similar to the present study. The Dhanmondi Lake experienced 189±7.211 mg/l in 2014 [1] which was also similar to the present study.

High temperature (29.3±2.03°C) was recorded in monsoon at St-4 and low temperature (21.75±5.30°C) was recorded at St-1 in post-monsoon (Table 2). The pH ranged from 7.75±0.17 to 7.41±0.34 with the highest in monsoon and the lowest in post-monsoon at the St-5. Variation in temperature (CV = 9.75–6.90%) and pH (CV = 0.03–9.29%) were significant between seasons and at all sampling station. Higher values of EC were recorded in monsoon (763±20.8 μS/cm) at the St-5 and lower in post-monsoon (630±2.12 μS/cm) at St-4. The higher EC is attributed to the high degree of anthropogenic activities such as waste disposal and runoff. The highest TDS content (387±12.72 μS/cm) in monsoon and lowest (294.25±18.66 µS/cm) in post-monsoon season were recorded at both edge sites i.e., St-5 and St-1 and the range of CV was 8.34-2.16%. The DO concentration showed highest at St-1 and the lowest at St-3 in monsoon.The DO showed positive covariance which was significant (CV= 1.83–18.5%) between seasons and at all sampling station. The BOD concentration ranged from 3.5±0.14 to 4.00±0.14 mg/l in monsoon where St-4 showed highest and St-5 showed lowest, and the concentration ranged from 3.8±0.70 to 4.5±0.42 mg/l in post-monsoon, respectively where St-3 showed lowest and St-1 showed highest.

Parameters	Seasons	St-1	St-2	St-3	St-4	St-5
Water temperature (∘C)	Monsoon Cvar.%	27.17±2.66 9.78	28.12±2.57 9.15	28.22±2.80 9.95	29.3±2.03 6.9	28.97±2.45 8.45
	Post-monsoon Cvar.%	21.75±5.30 24.38	21.2±4.66 22.03	27.82±2.57 9.25	21.95±5.72 26.09	22.35±6.29 28.15
pH	Monsoon Cvar.%	6.42±0.35 5.59	6.91±0.68 9.97	6.77±0.49 7.36	6.87±0.38 5.61	7.05±0.50 7.18
	Post-monsoon Cvar.%	6.30±0.28 4.48	6.40±0.14 2.20	6.25±0.21 3.39	6.20±2.28 4.57	6.75±0.07 1.03
EC (µS/cm)	Monsoon Cvar.%	748.75±34.65 44.62	762.25±6.07 0.79	761±21.02 2.76	759.25±21.94 2.89	763.5±20.80 2.72
	Post-monsoon Cvar.%	725.5±7.77 1.07	729±7.07 0.96	630.5±2.12 0.29	734.5±4.94 0.67	723.5±3.53 0.4
TDS (mg/l)	Monsoon Cvar.%	294.25±18.66 6.34	297.5±6.45 2.16	299±9.12 3.05	300.25±14.90 4.96	303.75±10.14 3.33
	Post-monsoon Cvar.%	373±31.11 8.34	376±29.69 7.89	387±12.72 3.28	384.5±26.16 6.80	382.5±17.67 4.62
DO (mg/l)	Monsoon Cvar.%	5.19±0.57 11.16	5.02±0.77 15.36	4.4±0.55 12.72	4.82±0.82 17.03	5.15±0.55 10.69
	Post-monsoon Cvar.%	4.5±0.42 9.42	4.3±0.14 3.28	3.8±0.70 18.60	4.3±0.28 6.57	3.85±0.07 1.83
BOD (mg/l)	Monsoon Cvar.%	3.30±0.36 11.06	3.30±0.29 8.92	3.17±0.35 11.31	2.90±0.62 21.62	2.57±0.66 25.83
	Post-monsoon Cvar.%	3.95±0.07 1.7	3.9±0.14 3.62	3.7±0.14 3.82	4.00±0.14 3.53	3.5±0.14 4.06
Cvar.%: Percentage Co-variance.						

Table 2: Physicochemical characteristics of Hatirjheel Lake water during monsoon and post-monsoon season

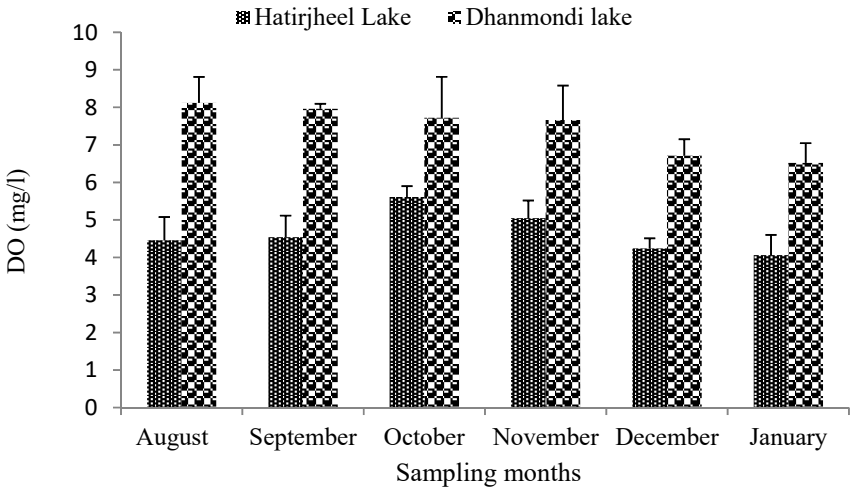

Figure 2: The DO concentrations in Hatirjheel Lake and Dhanmondi Lake water

The monthly mean DO concentration of Hatirjheel Lake water was measured 4.46±0.61, 4.54±0.57, 5.61±0.29, 5.05±0.46, 4.24±0.27 and 4.06±0.54 mg/l, respectively where the monthly mean DO concentration of Dhanmondi Lake water was 8.12±0.69, 7.96±0.13, 7.72±1.09, 7.66 ±0.52, 6.71±0.44 and 6.52±0.91 mg/l, respectively from August 2019 to January 2020 (Figure 2). In October the maximum DO concentration was recorded in Hatirjheel Lake and the lowest was in January. The maximum DO concentration was recorded in Dhanmondi Lake in August and the lowest value was recorded in the month of January. The DO concentration of Hatirjheel Lake showed the significant positive relationship ($r = 0.804$, $p < 0.01$) with water temperature but showed the significant negative relationship ($r = –0.604$, $p < 0.01$) with TDS (Table 5) while the DO concentration of Dhanmondi Lake showed the significant positive relationship ($r = 0.910$, $p < 0.01$) with water temperature, ($r = 0.847$, $p < 0.01$) with transparency, ($r = 0.926$, $p < 0.01$) with pH and ($r = 0.516$, $p < 0.05$) with EC but showed the significant negative relationship ($r = –0.812$, $p < 0.01$) with TDS (Table 5). The result revealed that the mean DO concentration was highest in monsoon season as well as lowest in post-monsoon season that supports the temporal variation of surface water quality. The Dhanmondi Lake water quality was more suitable than Hatirjheel Lake water quality although the mean DO concentration of both lakes had the resemblance with national standard [22]. for aquaculture (4-6 mg/l) and recreational activities (4-5 mg/l) such as swimming, fishing, boat riding, walking beside the lake.

The mean BOD concentration of Hatirjheel Lake water was measured 3.22±0.38, 3.18±0.51, 2.8±0.47, 3.0±0.36, 3.86±0.8 and 3.76±0.32 mg/l, respectively and 2.26±0.33, 2.31±0.69, 1.92±0.95, 1.62 ±0.57, 1.86±0.11 and 2.0±0.32 mg/l, respectively was measured in Dhanmondi Lake water from August 2019 to January 2020 (Figure 3). The Hatirjheel Lake experienced maximum BOD in December and the lowest in the month of October. The maximum BOD concentration was recorded in Dhanmondi Lake in August and lowest in November. The results showed that the Dhanmondi Lake water quality was in almost good condition where Hatirjheel Lake water quality was ineligible to serve the purpose of recreational activities. The mean BOD concentration of Ramna Lake was 1.47 mg/l, ranging from 1.32 to 2.43 mg/l, respectively [21]. A negative relation exists between DO and BOD. Though the DO concentration was favourable in both Lakes, the lower BOD contents were observed throughout the study period in Dhanmondi Lake than Hatirjheel Lake.

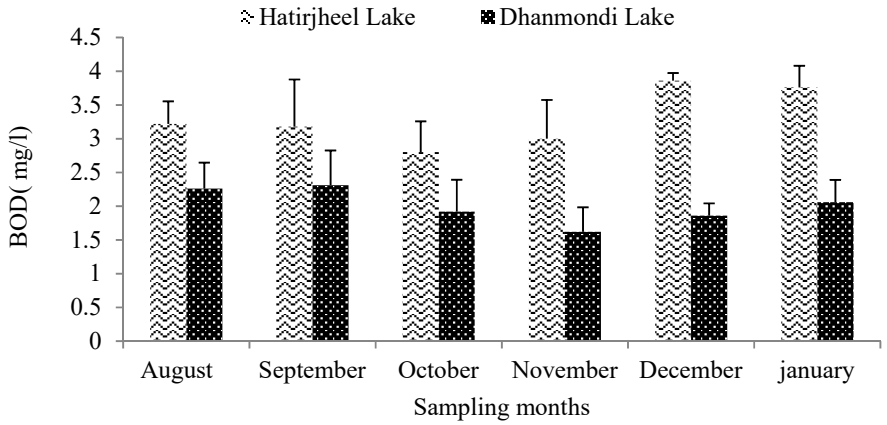

Figure 3: The BOD concentrations of Hatirjheel Lake and Dhanmondi Lake water

The BOD of Hatirjheel Lake water showed the negative significant correlation with the pH at (r = –-0.814 p<0.01) and (r = –-0.888, p<0.01) with DO (Table 4). The BOD also showed negative significant correlation with nitrate (r = –-0.806, p<0.01) (Table 4) in Hatirjheel Lake.

High temperature was recorded in Dhanmondi Lake water (31±2.62°C) in monsoon at St-2 and low temperature (21.20±5.79°C) was recorded in post-monsoon at St-4. The pH was within the standard limit in both seasons. Variation in temperature (CV = 26.11-2.44%) and pH ((CV = 0.00–9.29%)) were significant between the seasons and in all sampling station. Higher EC content was recorded in monsoon (775±26.72 μS/cm) at St-2 and lower (740±11.31 μS/cm) in post-monsoon at St-5. The higher EC is attributed to the high degree of anthropogenic activities such as waste disposal and runoff. The St-1 and St-5 showed the highest and lowest TDS content in both seasons, respectively where TDS content was higher in post-monsoon than monsoon that supported by [23]. and the CV showed positive relationship between variables.

Parameters	Seasons	St 1	St 2	St 3	St 4	St 5
Water temperature (∘C)	Monsoon Cvar.%	31.8±1.02 3.21	31.62±15.14 3.60	31.77±2.62 8.25	30.52±2.21 7.08	31.02±0.74 2.44
	Post-monsoon Cvar.%	21.95±5.30 24.16	21.3±4.52 21.24	21.9±5.79 26.47	22.2±5.79 26.11	21.6±5.09 23.57
pH	Monsoon Cvar.%	7.58±0.42 5.65	7.75±0.17 2.23	7.41±0.34 4.58	7.45±0.31 4.17	7.72±0.29 3.86
	Post-monsoon Cvar.%	6.70±00 00	6.84±0.07 1.03	6.60±0.42 6.40	6.85±0.63 9.29	7.20±0.14 1.96
EC (µS/cm)	Monsoon Cvar.%	762.75±28.33 3.71	775±26.72 3.44	764±27.12 3.55	756.75±25.34 3.34	761±28.01 3.68
	Post-monsoon Cvar.%	743.5±7.77 1.04	746±14.14 1.89	756±15.55 2.05	741±15.55 2.09	740±11.31 1.52
TDS (mg/l)	Monsoon Cvar.%	172.5±14.54 8.43	171.5±13.4 7.81	166.75±7.93 4.75	165±8.71 5.28	164.75±8.61 5.23
	Post-monsoon Cvar.%	195±21.21 10.87	187.5±13.43 7.16	186.5±13.43 7.20	186±14.14 7.60	186±12.72 6.84
DO (mg/l)	Monsoon Cvar.%	8.17±0.60 7.43	8.22±0.65 7.96	7.32±0.55 7.59	7.95±1.18 14.86	7.65±0.58 7.5
	Post-monsoon Cvar.%	6.55±0.07 1.06	6.75±0.07 1.04	6.45±0.49 7.67	6.2±0.84 13.68	7.10±0.28 3.98
BOD (mg/l)	Monsoon Cvar.%	2.05±0.52 25.65	2.6±0.47 18.31	1.85±0.44 23.97	1.65±0.36 22.40	1.97±0.15 7.95
	Post-monsoon Cvar.%	1.85±0.35 19.11	1.7±0.28 16.63	2.05±0.35 17.24	2.00±0.14 7.07	2.2±0.14 6.42

Cvar.%: Percentage Co-variance.

Table 3: Physicochemical characteristics of Dhanmondi Lake water during monsoon and post-monsoon season

Highest DO concentration (8.22±0.65 mg/l) and lowest (7.32.90±0.55 mg/l) were measured in monsoon where CV was 7.43-14.86%. In post-monsoon, DO concentration ranged from 6.20±0.84 to 7.10±0.28 mg/l with CV (13.08-1.04%) which was within the standard limit of all purposes. Highest BOD concentration (2.20±0.14 mg/l) and lowest (1.70±0.28mg/l) were recorded at St-5 and St-2, respectively in post-monsoon and where St-2 and St-4 showed the highest and lowest concentration, respectively in monsoon (Table 3).

	WT	*Trans.*	*pH*	*EC*	*TDS*	*DO*	*BOD*	*Nitrate*	*Nitrite*
WT	1								
Trans.	-0.22142	1							
pH	0.470482	-0.41813	1						
EC	0.478282	0.016131	-0.49817	1					
TDS	-0.74057	0.498257	-0.72216	-0.14198	1				
DO	0.804838	0.284224	0.490202	0.21536	-0.60423	1			
BOD	-0.77068	0.07949	-0.81472	0.050076	0.82528	-0.88888	1		
NO_3^-	0.802105	-0.10862	0.579519	0.211817	-0.58392	0.778081	-0.80675	1	
NO_2^-	-0.22316	0.375227	0.02466	-0.14365	0.118791	0.146999	-0.14747	0.333333	1
NH_4^+	-0.15431	0.604988	-0.22333	-0.18401	0.35691	0.100877	0.143539	-0.44721	-0.44721

Table 4: Pearson's correlation matrix of water quality parameters in Hatirtjheel Lake

** Correlation is significant at the 0.01 level (2- tailed)
*Correlation is significant at the 0.05 level (2- tailed)
WT=Water Temperature; TDS=Total Dissolved Solid; EC= Electric Conductivity; Trans.=Transparency; DO=Dissolved Oxygen; BOD =Biological Oxygen Demand; NO_3-= Nitrate; NO_2- = Nitrite; NH_4+ =Ammonium.

	WT	*Trans.*	*pH*	*EC*	*TDS*	*DO*	*BOD*	*Nitrate*	*Nitrite*
WT	1								
Trans.	0.898885	1							
pH	0.877183	0.754415	1						
EC	0.316325	0.279401	0.247383	1					
TDS	-0.78438	-0.47948	-0.87127	-0.34791	1				
DO	0.910831	0.847809	0.926755	0.516042	-0.81275	1			
BOD	0.138455	0.181976	0.095616	0.265299	-0.17147	0.318245	1		
NO_3^-	0.652929	0.858349	0.486164	0.167971	-0.11375	0.543928	-0.24107	1	
NO_2^-	-0.71068	-0.73966	-0.73316	-0.10718	0.578641	-0.79414	-0.66648	-0.33333	1
NH_4^+	0.559132	0.801767	0.375133	-0.17873	-0.03147	0.453846	0.320868	0.707107	-0.70711

Table 5: Pearson's correlation matrix of water quality parameters in Dhanmondi Lake

** Correlation is significant at the 0.01 level (2- tailed) *Correlation is significant at the 0.05 level (2- tailed)

WT=Water Temperature; TDS=Total Dissolved Solid; EC= Electric Conductivity; Trans. =Transparency; DO=Dissolved Oxygen; BOD =Biological Oxygen Demand; NO_3-= Nitrate; NO_2- = Nitrite; NH_4+ =Ammonium.

The monthly mean NO_3- concentration in the Hatirjheel Lake water were measured 5.0, 10.0, 10.0, 10.0, 5.0 and 5.0 mg/l, respectively (Figure 4) where the Dhanmondi Lake showed uniform results (5.0 mg/l). Dhanmondi Lake showed (Table 5) significant correlationship with both transparency ($r = 0.858$, $p<0.01$), and BOD ($r = -- 0.241$, $p<0.01$). The excess levels of nitrates in water can create difficulties for aquatic insects or fish to survive. The NO_3- concentration in water should not exceed 0.5 mg/l [24]. where <0.2 mg/l [25]. the fresh water.

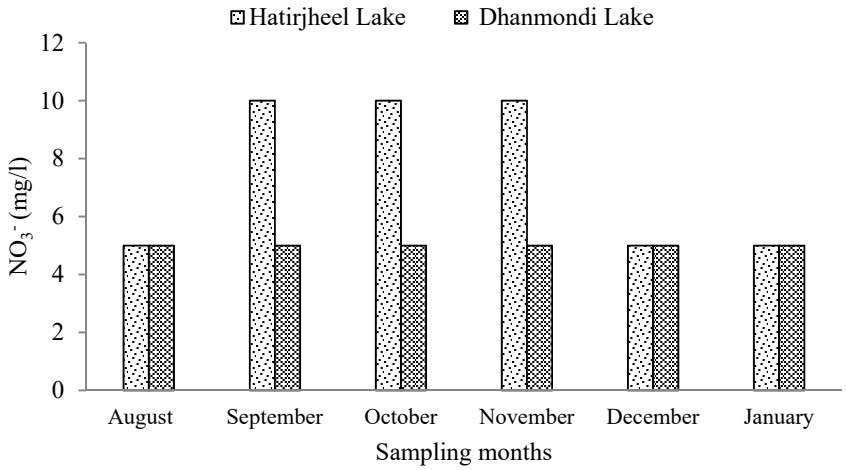

Figure 4: The NO3- concentrations in Hatirjheel Lake and Dhanmondi Lake water

The mean nitrate (NO_3-) concentration of both lakes exceeded the recommended value where the condition of Hatirjheel Lake water is getting worse than Dhanmondi Lake water which could be due to the surface runoff of excess nitrate from domestic and industrial wastewater. Since both lakes are subjected to fish culture along with recreational purposes, NO_3- concentration should be controlled in regular basis alongside cut off of untreated and/or less treated domestic and industrial wastewater entrance.

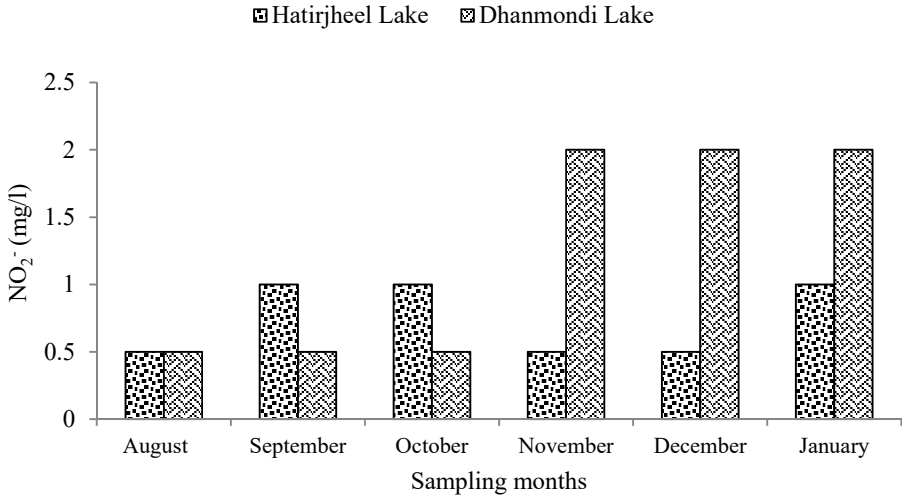

Figure 5: The NO_2- concentrations of Hatirjheel Lake and Dhanmondi Lake water

Nitrite (NO_2-) is the ionized form of nitrous acid (HNO_2), and it is lethal as ammonia (NH3) and may be a significant limiting factor in fish production ponds [26]. The monthly mean NO_2- concentration of Hatirjheel Lake water was recorded 0.5, 1.0, 1.0, 0.5, 0.5 and 1.0 mg/l, respectively and the Dhanmondi Lake water showed 0.5, 0.5, 0.5, 2.0, 2.0 and 2.0 mg/l, respectively from August 2019 to January 2020 (Figure 5). Dhanmondi Lake showed negative correlation ($r = -0.739$, $p < 0.01$) with transparency. The standard NO_2- concentration is 0.50 mg/l [27]. At 2 mg/l and above, nitrites are toxic (injurious or lethal) to many fish and shrimp where the recommended NO_2- concentration for fish farming is <0.3 mg/l [28]. which does not support fish culture in both studied lake. For untreated and/or less treated domestic and industrial wastewater, open dumping of wastes from nearby commercial shops, both lakes were experienced excess nitrites (NO_2-) which supports eutrophication and is alarming for fish culture.

The monthly average ammonium (NH_4+) concentration of Hatirjheel Lake water showed uniform condition i.e.3.0 mg/l where in Dhanmondi Lake, the concentrations were 0.5, 1.0, 1.0, 0.5, 0.5 and 0.5 mg/l, respectively (Figure 6) from August 2019 to January 2020. Dhanmondi Lake showed the positive seignificant correlation ($r = 0.375$, $p < 0.01$) with pH Table (5). In Hatirjheel Lake, NH_4+ showed negative correlation ($r = -0.233$, $p < 0.05$) with pH Table (4). The study revealed that mean NH_4+ contents were higher in Hatirjheel Lake than Dhanmondi Lake.

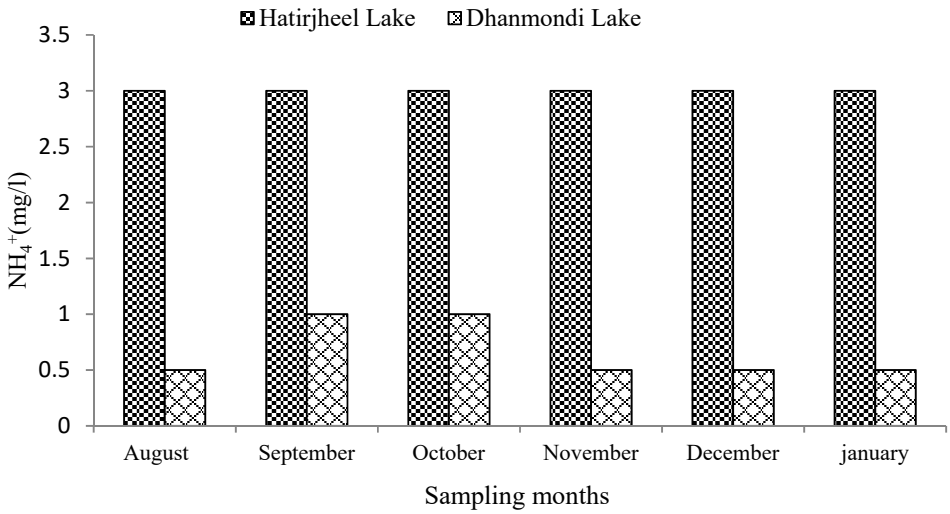

Figure 6: The NH4+ contents of Hatirjheel Lake and Dhanmondi Lake water

The higher concentration of NH_4+ contents could be partially due to the death and subsequent decomposition of phytoplankton or other detritus matter which is similar to the present study. >0.4 ppm to be lethal and < 0.05 ppm is safe for many tropical fish species [24]. high concentration of ammonium (12 ppm or more) in water could be due to the organic pollution, gas work pollution and high decomposition that may lethal to fish and other aquatic organisms [28]. The both Hatirjheel Lake and Dhanmondi Lake faced nutrient toxicity in case of NH_4+ contents and is lethal for many tropical fish species that supported by [24, 29].

The Hatirjheel and Dhanmondi Lake are situated in the heart point of Dhaka city. Both lakes are very important for residential people of Dhaka. Two lakes are very attractive for their scenic beauty, recreational activities as well as aquaculture practices. So it is very essential to maintain the water quality in a good condition around the year. But due to the anthropogenic and industrial activities lake water quality is going to be worsening condition day by day. The investigated physicochemical parameters of Hatirjheel Lake water except DO content represented its non suitability for aquaculture and recreational activities like swimming, boat riding etc. The presence of high nutrient contents could meke the lake tends to eutrophication. The study depicted that Dhanmondi Lake water quality was within standard limit as the transparency, TDS, temperature, pH, DO, BOD, nitrite, were suitable for aquatic ecosystem. The season based comparison between two lakes revealed that the Hatirjheel Lake water quality was degraded than the Dhanmondi Lake which should be kept in mind while running monitoring program to maintain sound freshwater environment.

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Authors Contribution

Nowara Tamanna Meghla: Conceptualization, Methodology, post-data analysis, original draft writing, review and editing, supervision.

Sabina Yeasmin Urmi: Pre-data analysis, data compilation, writing- original draft, drafts editing.

Md. Rubel Mahamud: Pre-data analysis, data compilation, writing- original draft, drafts editing.

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