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Trophic State and Water Quality Dynamics of Banani Lake in Bangladesh: Insights from Physicochemical and Biological Indicators

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Abstract: This study evaluated the water quality and trophic status of Banani Lake, an urban freshwater body in Dhaka, Bangladesh, by analyzing key physicochemical parameters, chlorophyll-a concentration, and the Trophic State Index (TSI) during both the wet (July-2023) and dry (January-2024) seasons. Water samples were collected from five stations (St-1 to St-5), and a total of nine physicochemical parameters were measured, including transparency, temperature, dissolved oxygen (DO), pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity, total hardness, and chlorophyll-a. The TSI was calculated using both chlorophyll-a concentration (TSI-CA) and Secchi disk depth (TSI-SD). During the wet season, observed values ranged as follows: transparency (15.17–19.13 cm), temperature (27.2–28.47°C), DO (1.97–3.13 mg/L), pH (5.22–5.9), EC (497–607 μS/cm), TDS (243–267 mg/L), alkalinity (33–38.3 mg/L), hardness (122–204 mg/L), and chlorophyll-a (9.303–13.559 μg/L). In the dry season, corresponding values were: transparency (12.5–17.5 cm), temperature (22.93–23.8°C), DO (2.1–2.87 mg/L), pH (5.343–5.93), EC (673–723 μS/cm), TDS (327–357 mg/L), alkalinity (69.7–97.3 mg/L), hardness (126.6–152 mg/L), and chlorophyll-a (9.41–10.733 μg/L). Assessment revealed that temperature, EC, and alkalinity remained within acceptable limits for aquaculture, while transparency, DO, and pH fell below recommended levels. TDS, hardness, and chlorophyll-a concentrations exceeded standard values, indicating nutrient enrichment. TSI values ranged from 56.175 to 89.965, suggesting that Banani Lake falls within the light to hyper-eutrophic category. These findings highlight the progressive eutrophication and ecological stress in Banani Lake, emphasizing the urgent need for intervention by Dhaka North City Corporation. Regular monitoring, pollution control measures, and public awareness are critical to restoring and maintaining the ecological integrity of this vital urban water body.

1. Introduction

Water is a fundamental natural resource for all life forms and sustaining ecological and socio-economic systems. It plays a vital role in domestic consumption and sectors such as agriculture, industry, hydropower generation, fisheries, and the maintenance of ecosystem health (Aazami *et al.*, 2021; Poonam *et al.*, 2013; Tyagi *et al.*, 2013). Despite its significance, the quality of freshwater resources is under increasing threat due to rapid urbanization, population growth, and industrial expansion, especially in developing countries like Bangladesh (Usha *et al*., 2025; Mamun *et al*., 2025). Urban centers are mostly vulnerable to surface and groundwater degradation, driven by untreated waste discharge, poor drainage infrastructure, and encroachment on natural water bodies (Vasistha and Ganguly, 2020).

Water pollution due to the discharge of untreated communal, industrial effluents containing heavy metals and rain effluents into bodies of water is a major global problem. The most recent research on climate change impacts and on smarter solutions to manage surface waters. The protection of the water quality of lakes and their management is highly complex, and requires a great deal of coordination between the involved stakeholders (Grochowska, 2020; Errich *et al*., 2021; Ciampittiello *et al*., 2024).

Dhaka, the capital of Bangladesh, has been one of the fastest-growing megacities in the world. This rapid urban growth has placed enormous stress on the city's freshwater resources, particularly its lakes, which are critical for ecological balance, stormwater management, and urban aesthetics (Alam and Rabbani, 2012; UN, 2007). Urban lakes, like Banani Lake in Dhaka, offer numerous ecosystem services including groundwater recharge, flood mitigation, microclimate regulation, recreational amenities, and biodiversity conservation (Schallenberg *et al*., 2013; Martínez-Arroyo and Jáuregui, 2000). These lakes also serve as vital green spaces that enhance the quality of urban life by providing open areas for leisure, education, and aesthetic pleasure. However, many of these lakes face severe environmental degradation due to unregulated urban sprawl, illegal encroachments, inadequate waste management, and industrial discharge. Like several other urban lakes in Dhaka, Banani Lake has transitioned from a clean and functional ecosystem to a polluted and eutrophic one, affected by heavy sedimentation, nutrient loading, and sewage contamination. The inflow of untreated domestic wastewater, storm-water runoff, and solid waste has resulted in the accumulation of organic matter and nutrients, leading to algal blooms, bad odour, oxygen depletion, and significant biodiversity loss (Rahman and Hossain, 2019; Alam, 2014).

Monitoring and managing the health of such lakes requires a comprehensive understanding of their water quality and ecological dynamics. Physicochemical parameters such as transparency, temperature, dissolved oxygen (DO), pH, electrical conductivity (EC), total dissolved solids (TDS), alkalinity, hardness, and chlorophyll-a concentration are widely used to assess aquatic ecosystem health (Gorde and Jadhav, 2013; Kane *et al*., 2015). Among these, chlorophyll-*a* is particularly important as a proxy for phytoplankton biomass and nutrient enrichment, which are indicative of eutrophication (Versari *et al*., 2002). Variations in these parameters especially DO and pH, can significantly influence aquatic organism survival and biogeochemical processes (WHO, 2007; Sheldon *et al*., 2019). A key tool for assessing the ecological condition of lakes is the Trophic State Index (TSI), developed by Carlson (1977), which categorizes lakes based on nutrient concentrations and biological productivity. The TSI integrates three variables-chlorophyll-a, Secchi disk transparency, and total phosphorus-to classify lakes as oligotrophic (low productivity), mesotrophic (moderate productivity), or eutrophic/hypereutrophic (high productivity). Although phosphorus data are often lacking in developing country studies, the use of chlorophyll-a and Secchi depth alone can still offer valuable insight into trophic status. The TSI has proven effective in predicting oxygen depletion, algal biomass, and changes in aquatic community structure, making it an important tool for lake management worldwide (Mishra et al., 2015; Mukhtar *et al*., 2014; Saluja and Garg, 2017).

Despite the growing relevance of the TSI and its successful application in North America, Europe, and parts of Asia, its use in Bangladesh remains limited. In cities like Dhaka, where freshwater bodies are increasingly under threat, there is a pressing need to adopt such tools for ecosystem assessment and restoration planning. In particular, Banani Lake has seen a rapid decline in water quality due to unchecked urbanization, increasing exploitation of its shores, and pollution from hotels, commercial establishments, and residential areas. Climate change, population growth, and conflicting demands between conservation and development have further exacerbated its ecological vulnerability. Given these challenges, a comprehensive seasonal assessment of Banani Lake's water quality is essential for understanding its ecological trajectory and identifying intervention strategies. Evaluating physicochemical parameters and the lake's trophic condition over time provides insights into the extent of nutrient loading and ecological degradation, thereby informing sustainable management and conservation actions. Therefore, the specific objectives of this study were to: (i) assess the water quality of Banani Lake by measuring key physicochemical parameters, (ii) determine the trophic status of the lake using TSI; and (iii) identify potential sources of pollution contributing to the lake's ecological deterioration.

2. Methodology

2.1 Study area

Banani Lake is a prominent urban water body located in the Banani neighborhood, a well-developed residential and commercial area in the northern part of Dhaka, Bangladesh (**Fig. 1**). Geographically, the lake lies at approximately 90°25′ E longitude (Rahaman *et al*., 2017). It spans a total surface area of 80.81 acres and has an average depth of 2.0 meters. The lake extends over a length of 3.43 kilometers, with its width varying from a minimum of 21.89 meters to a maximum of 116.54 meters (Rahaman *et al*., 2017). Despite its location in a bustling metropolis, the lake provides aesthetic and environmental value, making it a vital component of the city's urban ecosystem.

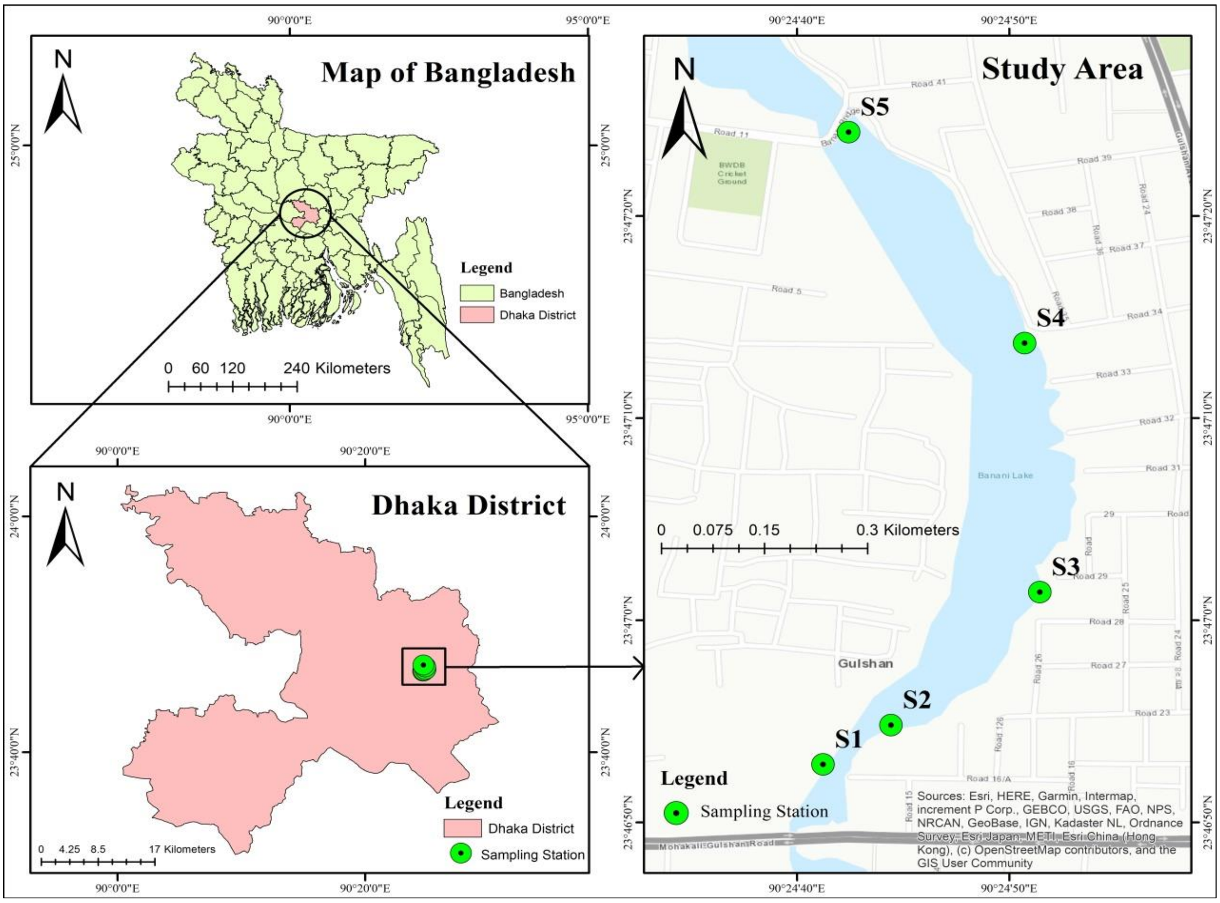

Figure 1. Map showing the study area with sampling stations in Banani Lake, Dhaka

2.2 Sample collection, processing and analysis

Water sampling was carried out at five selected sites along Banani Lake during the wet season (July 2023) and dry season (January 2024) to evaluate seasonal variations in water quality. Each site was chosen based on spatial distribution and lake accessibility (Kabir *et al.*, 2020). At each location, 500 mL of surface water was collected using pre-cleaned, double-capped plastic bottles. The containers were thoroughly washed with detergent, soaked overnight in 5% nitric acid (HNO_3), rinsed with deionized water, and air-dried before sampling. After collection, bottles were sealed, labeled, and kept at 4 °C to preserve sample integrity until laboratory analysis. Field measurements included temperature, pH, electrical conductivity (EC), and total dissolved solids (TDS). A portable pH meter (Model: pH Scan WP 1) was calibrated with a pH 7.0 buffer solution prior to use. EC and TDS were recorded using HM Digital meters. Dissolved oxygen (DO) was determined using a digital DO meter (Model: D.46974, Taiwan), with sodium thiosulfate (0.025N) as a titrant where necessary. Total alkalinity was assessed by titration with 0.1 N HCl using methyl orange as an indicator. Total hardness was measured via EDTA titration, employing Eriochrome Black T as the indicator. Chlorophyll-a concentration was analyzed using a UV-Vis spectrophotometer (Model: T-60). A 100 mL water sample was filtered through a cellulose nitrate membrane, and the filter was soaked in 10 mL of 90% acetone for 18–24 hours. The extract was centrifuged, and absorbance was recorded at 630, 645, and 665 nm to calculate chlorophyll-a levels (Islam *et al.*, 2021; Islam *et al.*, 2022). All analyses followed standard protocols, and data were used to compute the Trophic State Index (TSI) to assess the lake's ecological status.

2.3 Determination of trophic status

The trophic status of Banani Lake was assessed using Carlson's Trophic State Index (TSI), which provides a numerical estimate of nutrient enrichment and algal productivity. TSI values were derived from chlorophyll-a concentrations and Secchi disk transparency using the following equations (Carlson, 1977): *TSI (Chlorophyll-a) = 9.81 × ln(Chlorophyll-a [µg/L]) + 30.6; TSI (Secchi Depth) = 60-14.41 × ln(Secchi Depth [m])*. These calculations yield TSI values on a scale from 0 to 100, reflecting different trophic conditions. According to Carlson's classification (Carlson, 1977): Oligotrophic: TSI $\leq$ 30; Oligo-mesotrophic: 30 < TSI $\leq$ 40; Mesotrophic: 40 < TSI $\leq$ 50; Lightly eutrophic: 50 < TSI $\leq$ 60; Moderately eutrophic: 60 < TSI $\leq$ 70; Hypereutrophic: TSI > 70. These indices were used to interpret the lake's ecological condition and nutrient status during both wet and dry seasons.

2.4 Statistical analysis

Collected data were organized and analyzed using Microsoft Excel and SPSS software. Results were presented through tables and charts to facilitate clear interpretation. Pearson's correlation analysis was employed to assess the relationships between different water quality parameters (Islam *et al.*, 2022). This statistical method quantifies the strength and direction of associations between paired variables, with correlation coefficients (r) ranging from +1 (perfect positive relationship) to –1 (perfect negative relationship), and 0 indicating no correlation. Values of $r \geq 0.7$ denote strong correlation, $0.5 \leq r < 0.7$ indicate moderate correlation, and values below 0.5 suggest weak or no significant association (Shil *et al.*, 2019). The correlation matrix helped illustrate the interdependence among key physicochemical parameters of the lake water.

3. Results and Discussion

3.1 Physicochemical Water Quality

Transparency levels in Banani Lake varied seasonally, averaging 16.53 cm during the wet season and 14.23 cm in the dry season (**Table 1**). Maximum transparency was observed at St-1 (19.13 cm) during the wet season, while the lowest was at St-4 (15.17 cm). In contrast, dry season values ranged from 17.5 cm (St-5) to 12.5 cm (St-1) (**Table 1**).

The higher transparency in the wet season may result from increased water volume due to rainfall, which reduces suspended particles through dilution. In comparison, Islam *et al*. (2021) reported greater seasonal variation in Kaptai Lake, with transparency ranging from 17 cm in the wet season to 303 cm in the dry season. Average water temperatures were 21.71°C in wet and 23.31°C in dry seasons, with minor spatial variation (**Table 1**). The highest wet-season temperature was 21.97°C at St-2, while the lowest was 21.13°C at St-1. In the dry season, temperatures ranged from 23.8°C (St-1) to 22.93°C (St-5) (**Table 1**). Warmer temperatures in the dry season likely stem from increased solar exposure and lower cloud cover. All values were within the EQS (1997) surface water guideline of 30.5°C. Bashar *et al*. (2015) observed a similar pattern in Kaptai Lake, where temperatures ranged from 21.04°C in January to 31.52°C in September. DO concentrations were slightly higher in the wet season (2.55 mg/L) than in the dry season (2.42 mg/L) (**Table 1**). The highest DO was recorded at St-3 (3.13 mg/L) and the lowest at St-1 (1.97 mg/L) during the wet season. In the dry season, DO ranged from 2.87 mg/L (St-1) to 2.1 mg/L (St-5) (**Table 1**). Lower DO in the dry season may reflect reduced aeration and solubility due to higher temperatures and limited mixing. All values fell below the EQS (1997) guideline of 5 mg/L for surface waters. Similar low DO levels (<2 mg/L) were reported in Gulshan Lake by Sabit and Ali (2015). pH values were consistently acidic, averaging 5.47 in the wet season and 5.69 in the dry season (**Table 1**). Wet season pH ranged from 5.22 (St-3) to 5.9 (St-5), while dry season values spanned from 5.34 (St-1) to 5.93 (St-5) (**Table 1**). Acidic conditions may be linked to acid rain and organic matter runoff from surrounding urban areas. All readings were below the DoE (2011) recommended pH range (6.5–8.5) for surface water. In contrast, Islam *et al*. (2010) reported near-neutral to slightly alkaline pH in Ashulia Beel, with values between 7.1 and 8.4.

EC levels showed seasonal variation, averaging 534.2 µS/cm in the wet season and rising to 699.8 µS/cm in the dry season (**Table 1**). Wet season values ranged from 497 µS/cm (St-3 & St-5) to 607 µS/cm (St-4), whereas in the dry season, EC values were highest at St-1 (723 µS/cm) and lowest at St-5 (673 µS/cm) (**Table 1**). The increased EC during the dry season may result from evaporation and reduced dilution. All readings were within EQS (1997) surface water guideline of 700 µS/cm. Islam *et al*. (2021) reported a much lower EC range in Kaptai Lake, from 82.5 µS/cm (wet) to 141.24 µS/cm (dry). TDS concentrations averaged 254.8 mg/L in the wet season and 343.4 mg/L in the dry season (**Table 1**). The highest wet season value was 267 mg/L (St-1 & St-2), while the lowest was 243 mg/L (St-4). In the dry season, values ranged from 357 mg/L (St-1) to 327 mg/L (St-5) (**Table 1**). Higher TDS in the dry season likely reflects water volume reduction through evaporation. All values remained below the WHO (2007) and EPA (2017) thresholds of 500 mg/L. In comparison, TDS levels in Bogakain Lake and Kaptai Lake were considerably lower, ranging from 39–42 mg/L and 52–54 mg/L respectively (Barua *et al*., 2016; Khondker *et al*., 2010). Alkalinity averaged 34.98 mg/L during the wet season and increased to 84.32 mg/L in the dry season (**Table 1**). Wet season readings ranged from 33 mg/L (St-3) to 38.3 mg/L (St-2), whereas dry season values spanned from 69.7 mg/L (St-3) to 99 mg/L (St-4) (**Table 1**).

Table 1. Physiochemical and biological water quality parameters of Banani Lake, Dhaka

Parameter	Sampling Stations	Wet Season		Dry Season		Standard
		Average	Range	Average	Range	
Transparency (cm)	St-1	19.13	15.17-19.13	12.5	12.5-17.5	≥400 (Carlson, 1977)
	St-2	16		13.17		
	St-3	17		12.67		
	St-4	15.17		15.33		
	St-5	15.33		17.5		
	Mean±SD	**16.52±1.62**		**14.23±2.15**		
Temperature (◦C)	St-1	27.97	27.2-28.47	23.8	22.93-23.8	20-30 (EQS, 1997)
	St-2	27.2		23.63		
	St-3	28.47		23.2		
	St-4	28.03		22.97		
	St-5	27.4		22.93		
	Mean±SD	**27.81±0.51**		**23.31±0.39**		
DO (mg/L)	St-1	1.97	1.97-3.13	2.87	2.1-2.87	5.0 (EQS, 1997)
	St-2	3		2.57		
	St-3	3.13		2.37		
	St-4	2.57		2.2		
	St-5	2.07		2.1		
	Mean±SD	**2.55±0.53**		**2.42±0.31**		
pH	St-1	5.42	5.22-5.9	5.343	5.343-5.93	6.5-8.5 (DoE, 2011)
	St-2	5.51		5.67		
	St-3	5.22		5.707		
	St-4	5.31		5.797		
	St-5	5.9		5.93		
	Mean±SD	**5.47±0.26**		**5.69±0.22**		
EC (mg/L)	St-1	527	497-607	723	673-723	700 (EQS, 1997)
	St-2	543		707		
	St-3	497		703		
	St-4	607		693		
	St-5	497		673		
	Mean±SD	**534.2±45.27**		**699.8±18.47**		
TDS (mg/L)	St-1	267	243-267	357	327-357	165 (Huq and Alam, 2005)
	St-2	267		350		
	St-3	247		343		
	St-4	243		340		
	St-5	250		327		
	Mean±SD	**254.8±11.41**		**343.4±11.28**		
Alkalinity (mg/L)	St-1	35.3	33-38.3	85.3	69.7-97.3	>100 (Rahman, 1992)
	St-2	38.3		97.3		
	St-3	33		69.7		
	St-4	34		99		
	St-5	34.3		70.3		
	Mean±SD	**34.98±2.03**		**84.32±14.1**		
Hardness (mg/L)	St-1	204	122-204	152	126.6-152	123 (Huq and Alam, 2005)
	St-2	148		131.4		
	St-3	122		147.4		
	St-4	180.6		126.6		
	St-5	135.4		151.4		
	Mean±SD	**158±33.67**		**141.76±11.9**		
Chl-a (ug/L)	St-1	9.606	9.303-13.559	9.516	9.41-10.733	≥5 (Carlson, 1997)
	St-2	13.559		10.316		
	St-3	9.764		10.259		
	St-4	12.916		10.733		
	St-5	9.303		9.41		
	Mean±SD	**11.03±2.04**		**10.05±0.56**		

The elevated alkalinity during the dry season may be attributed to concentration of carbonates due to evaporation and limited rainfall. Rubel *et al*. (2019) reported similar findings in Kaptai Lake, where carbonates and bicarbonates were the dominant contributors to alkalinity (42.90–51.00 mg/L). Total hardness averaged 158 mg/L in the wet season and declined to 141.76 mg/L during the dry season (**Table 1**). The highest wet season value was 204 mg/L at St-1, while the lowest was 122 mg/L at St-3. In the dry season, hardness ranged from 152 mg/L (St-1) to 126.6 mg/L (St-4) (**Table 1**). Higher hardness during the wet season may result from mineral-rich runoff entering the lake. Similar observations were made by Islam *et al*. (2010), who reported that hardness in Ashulia Beel was below the standard limit in the wet season (123 mg/L) and slightly higher in the dry season.

3.2 Biological water quality

Chlorophyll-a: Chlorophyll-a concentrations averaged 11.03 µg/L during the wet season and 10.05 µg/L in the dry season across all sampling stations (**Table 1**). In the wet season, the highest level was recorded at St-2 (13.56 µg/L) and the lowest at St-5 (9.30 µg/L). In the dry season, values ranged from 10.73 µg/L at St-4 to 9.41 µg/L at St-5 (**Table 1**). The marginally elevated chlorophyll a in the wet season may be attributed to enhanced nutrient influx from surface runoff, which can stimulate phytoplankton growth. Comparatively, Nion *et al*. (2020) reported higher seasonal ranges of chlorophyll a in coastal waters, varying from 0.217 to 1.168 mg/L during the monsoon at high tide and up to 1.88 mg/L in the post-monsoon at low tide, indicating site-specific hydrological and nutrient dynamics.

3.3 Estimation of trophic state index (TSI)

Secchi Depth TSI: The Trophic State Index based on Secchi depth (TSI-SD) ranged from 83.83 to 87.18 during the wet season and from 85.12 to 89.97 in the dry season across all sampling sites (**Fig. 2**). Mean values were 85.99 and 88.21 for the wet and dry seasons, respectively. The highest TSI-SD was observed at St-4 (87.18) in the wet season and at St-1 (89.97) in the dry season, while the lowest values were recorded at St-1 (83.83) and St-5 (85.12), respectively (**Fig. 2**). These values indicate a consistent hyper-eutrophic condition throughout the year. The higher dry-season TSI is likely due to improved water clarity, as reduced rainfall limits the influx of suspended particles. In comparison, Kaptai Lake showed significantly lower TSI-SD values of 48.19 (pre-monsoon) and 53.00 (post-monsoon) (Rahman *et al*., 2014). According to Yang *et al*. (2012), TSI-SD values above 70 denote hyper-eutrophic status, consistent with current findings (Islam *et al*., 2021).

Chlorophyll-a TSI: The Trophic State Index based on chlorophyll a (TSI-Chl a) ranged from 52.48 to 56.18 in the wet season and 52.59 to 53.88 in the dry season (**Fig. 2**), with seasonal means of 54.02 and 53.22, respectively. The highest value was found at St-2 (56.18) in the wet season and at St-4 (53.88) in the dry season, while the lowest values occurred at St-4 (52.48) and St-5 (52.59), respectively (**Fig. 2**). These results suggest the lake generally exhibits light eutrophic conditions. Yang *et al*. (2012) categorized TSI-Chl values between 50 and 60 as indicative of light eutrophy, which aligns with the present findings. For comparison, Khondker *et al*. (2010) reported a TSI-Chl a of 41.24 for Bogakain Lake, indicating mesotrophic conditions, while Kaptai Lake showed even lower values (27.43–37.79), suggesting oligo-mesotrophic status.

3.4 Pearson's correlation analysis

Based on measured values of transparency, temperature, DO, pH, EC, TDS, total alkalinity, hardness, chlorophyll a, and TSI indices, Pearson correlation matrix analysis revealed distinct relationships among parameters in both seasons (**Table 2**). In the wet season, strong positive correlations were observed among chlorophyll *a* and EC, total alkalinity and TDS, chlorophyll *a* and total alkalinity, and between TSI (Chl-a) with both EC and chlorophyll-*a*. Moderate positive correlations were noted between total hardness and EC; and between TDS and transparency. A significant negative correlation was found between TSI(SD) and transparency, indicating that as turbidity increases, TSI(SD) also rises (Islam *et al*., 2021; Nion *et al*., 2020).

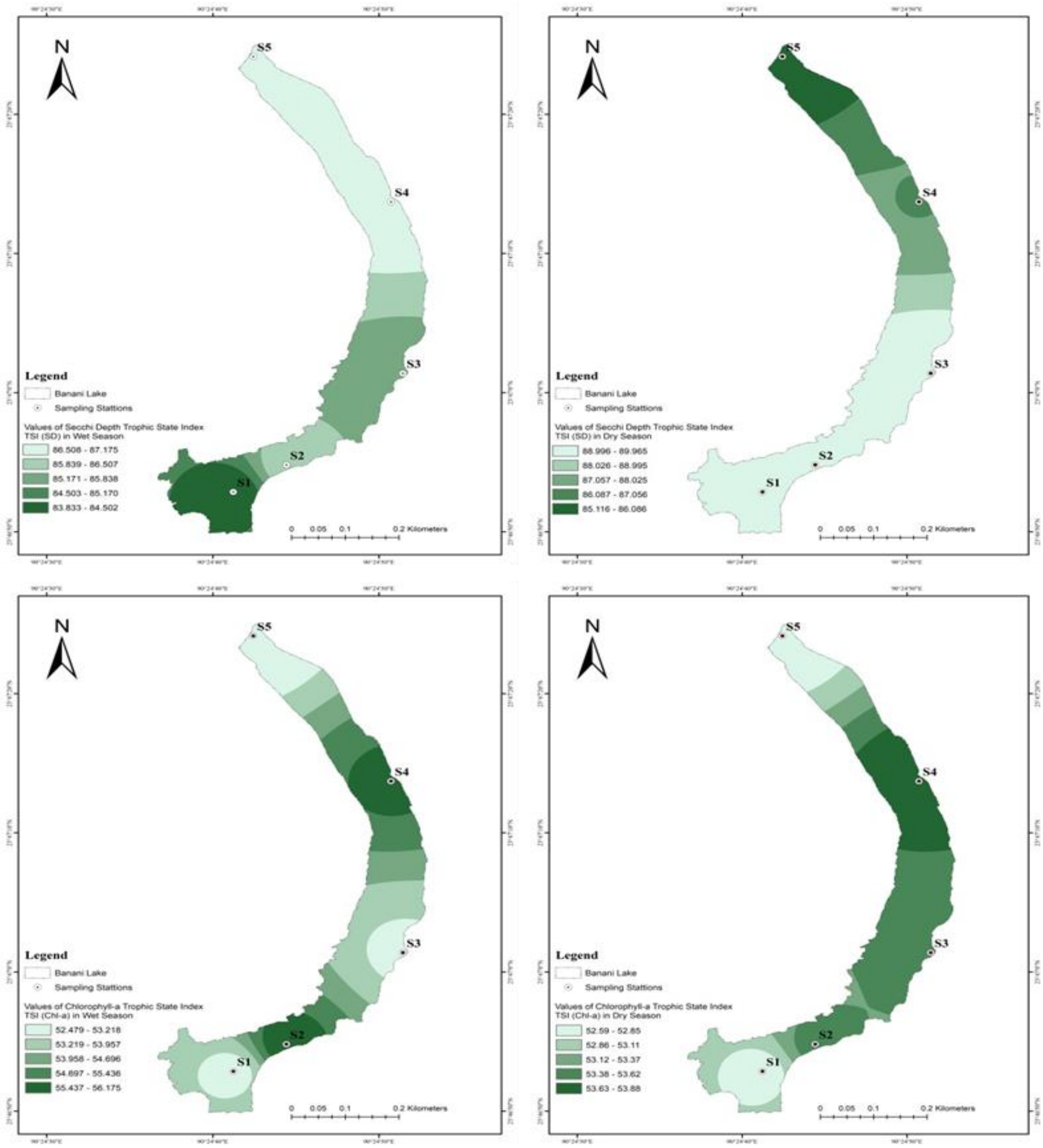

Figure 2. Spatial distribution of TSI in the Banani lake, Dhaka, Bangladesh

In the dry season, strong positive associations emerged among pH and transparency, DO and temperature, and between temperature with EC and TDS. TSI(SD) showed strong positive correlations with temperature, EC, TDS, and DO. Moderate positive correlations appeared between chlorophyll-*a* and total alkalinity, as well as TSI(Chl-a) and total alkalinity. Negative correlations were found between TSI(SD) and transparency, as well as between DO and pH, EC and transparency, and TDS and both pH and transparency. These patterns suggest that several parameters vary proportionally or inversely depending on seasonal influences. Similar trends in correlation among water quality indicators have been reported by Shil *et al*. (2019), supporting the interconnected nature of physicochemical and biological parameters in aquatic systems.

Table 2. Pearson correlation coefficients (r) among water quality parameters of the Banani Lake

Parameters	Trans.	Temp.	DO	pH	EC	TDS	TA	TH	Chl-a	TSI (SD)	TSI (Chl-a)
Wet Season											
Trans.	1										
Temp.	0.373	1									
DO	-0.271	0.201	1								
pH	-0.332	-0.758	-0.556	1							
EC	-0.324	0.002	0.062	-0.370	1						
TDS	0.585*	-0.482	-0.168	0.138	-0.179	1					
TA	0.022	-0.774	0.109	0.223	0.148	0.806**	1				
TH	0.477	0.057	-0.576	-0.198	0.559*	0.366	0.168	1			
Chl-a	-0.464	-0.356	0.490	-0.259	0.763**	0.101	0.592*	0.133	1		
TSI (SD)	-0.999**	-0.379	0.243	0.342	0.338	-0.586	-0.024	-0.453	0.462	1	
TSI (Chl-a)	-0.459	-0.335	0.494	-0.278	0.772**	0.090	0.577	0.140	1.000**	0.457	1
Dry Season											
Trans.	1										
Temp.	-0.782	1									
DO	-0.813	0.976**	1								
pH	0.799**	-0.895*	-0.971**	1							
EC	-0.932*	0.891**	0.943**	-0.950*	1						
TDS	-0.900*	0.916**	0.946**	-0.931*	0.989**	1					
TA	-0.184	0.298	0.252	-0.215	0.331	0.448	1				
TH	-0.007	0.138	0.206	-0.246	0.029	-0.071	-0.841	1			
Chl-a	-0.211	-0.213	-0.225	0.209	0.065	0.101	0.593*	-.0877	1		
TSI (SD)	-0.999**	0.789**	0.821**	-0.807	0.931**	0.897**	0.152	0.046	0.175	1	
TSI (Chl-a)	-0.223	-0.204	-0.217	0.203	0.073	0.109	0.589*	-0.873	1.000**	0.187	1

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

Conclusion

This study reveals significant seasonal degradation in Banani Lake's water quality, driven by anthropogenic impacts. Key parameters-including dissolved oxygen, pH, TDS, total hardness, and chlorophyll a-often deviated from standard limits for surface water and aquaculture, indicating ecological stress. The lake ranged from light eutrophic to hypereutrophic conditions, reflecting ongoing nutrient loading and imbalance. Although temperature and EC remained within acceptable ranges, persistently low DO and elevated TDS and chlorophyll levels suggest poor suitability for fisheries. Correlation analysis highlighted complex seasonal interactions, with stronger negative relationships during the dry season. These findings call for immediate, science-based management strategies. Long-term restoration should involve routine monitoring, pollution control, stakeholder engagement, and public awareness to ensure the sustainable preservation of Banani Lake.

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Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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