COMPARISON OF LAKE ECOLOGY IN KUET CAMPUS

R. ISLAM*[1], and Q. H. Bari[2]

[1]*Undergraduate student, Khulna University of Engineering & Technology, Bangladesh, e-mail:* rikhan11235@gmail.com

[2] *Professor, Department of Civil Engineering, Khulna University of Engineering & Technology, Bangladesh, e-mail:* qhbari@ce.kuet.ac.bd

***Corresponding Author**

ABSTRACT

Rapid campus development and human activities can subtly alter lake ecosystems, influencing both water quality and the surrounding biodiversity. Campus lakes also undergo changes in the physicochemical properties of their soil and water with the seasons, resulting in alterations to the biodiversity patterns, but are often overlooked in scientific research because of their limited spatial scale. This study aims to investigate the variations in physicochemical properties of water and soil in KUET campus lakes across seasons and to examine differences in biodiversity patterns between the lakes to assess how season, lake age, and basic maintenance practices affect overall ecosystem status, and to understand the driving parameters behind water quality. To assess water quality, physicochemical parameters were measured in four windows, and the CCME water quality index was computed and compared. Marginal biodiversity was documented through a complete walk-through, and a 2m*2m quadrat, placed in the densest patch, and summarized with indices. To combine the interrelationship, soil was collected and tested for physicochemical characteristics. A two-way ANOVA and a paired T-test were conducted for the water parameters. CCME WQI placed the old lake at approximately 44.3 and the newer lake at approximately 48.2, indicating marginal to poor conditions of water for both lakes. Paired ANOVA revealed significant seasonal variations for some of the parameters, such as COD, Cl^-, DO, EC, TS, and Hardness, indicating driving parameters behind water chemistry. Biodiversity indices favored the old lake, indicating a diverse and overall balanced situation at the edge of the old lake. These findings suggest that driving parameters are to be kept in check for improvement of overall water quality, providing a repeatable baseline for KUET lakes and pointing to low-cost actions. Overall, the combined data from water, soil, and biodiversity assessments present a practical development for guiding better management and conservation of KUET campus lakes.

Keywords: *ANOVA; water quality; CCME WQI; biodiversity;*

1. INTRODUCTION

Though mainly created to serve an aesthetic view, campus lakes serve as a piece of tranquillity in nature for the students, creating an ecosystem in and around the water body. Urbanization and weather conditions, especially rainfall intensity, create a significant impact on the physicochemical properties of soil and water, ultimately affecting the surrounding ecological pattern of a water body, making it an important aspect to understand the changes brought by seasonal variations. Lake age and maintenance plays crucial role in the ecological patterns (Mayer, 2005), making it important in order to accomplish a healthy lake.

In Bangladesh, seasonality sets the rhythm. Most rainfall arrives with the Southwest Monsoon, while the cooler months are much drier. Analyses by the Bangladesh Meteorological Department (1992-2021) and National climate summaries (1991–2020) show monsoon rain intensity in a short, intense window (Baten et al., 2023). What this means for campus lakes is straightforward: storms deliver short, powerful pulses of runoff that carry fine sediment and nutrients from paths, lawns, and nearby drains. Heavy rain makes the water cloudier and saltier, while in calmer situations, these pressures often ease (Wei et al., 2020). Local case studies underline these points. Assessments of Dhanmondi lake (Hossain & Hossain, 2017) and Hatirjheel lake (Pasha et al., 2023) report exceedances of common urban indicators: cloudiness (TSS/turbidity), salts (EC, hardness, chloride), nutrient and organic loads (PO_4^{3-}, BOD, COD), and occasional low dissolved oxygen often linked to storm-drain inputs and catchment pressures. During monsoon, fine soil particles, ions, and nutrients from the lake edge moved due to runoff, resulting raise in turbidity, EC, BOD, COD, and stress DO (Yang & Lusk, 2018). Soil properties are tightly connected with minerals; an increase or decrease in a soil property causes a significant effect on the solubility of minerals, which are finally washed down to the lake, affecting the water chemistry (Withers & Jarvie, 2008). That is why simple soil measurements at the water's edge can help explain water results (Bilotta & Brazier, 2008).

To understand how living communities are coping with multiple stressors at once (nutrients, sediment, temperature, human activity), water measurements are paired with biological indicators as freshwater biodiversity is declining faster, and integrated monitoring is needed to track change and guide practical action (Tickner et al., 2020).

Though numerous studies have been conducted on water quality or biodiversity of lakes, small-scale campus lakes such as KUET lakes are ignored, and most studies lacks of the interrelation among water, soil, and ecological components.

KUET's two campus lakes are used every day, yet decisions about care (bank repair, vegetation, desilting, litter control) are still made with limited, scattered information. Studies on urban ponds show that shoreline design and day-to-day care strongly influence biodiversity and overall ecological health, small ponds also act as stepping stones that help wildlife move across urban areas (Hassall, 2014).

This study keeps the approach simple and fair: the same fixed point on each lake was sampled in four seasons for water quality, with one practical snapshot of shoreline soils and a straightforward check of biodiversity. By pairing clear measurements with easy-to-read indices and simple statistics, the work aims to show how season, lake age, and basic maintenance shape real conditions and to point to actions KUET can take to keep its lakes healthier.

2. METHODOLOGY

2.1 Study Area

The old lake of KUET campus is on the east side of KUET campus, behind the KUET Shaheed Minar (Figure 1-a), and the new lake of KUET resides at the mid-west side of the campus behind the IT park (Figure 1-b) of KUET, which is located in Khulna, a city in the southwestern part of Bangladesh.

Figure 1: Maps of the study area. (a) KUET old lake. (b) KUET new lake.

2.2 Water Collection and Quality Assessment

Sample collection point was kept simple and consistent for each lake by choosing one fixed sampling point (the same bank spot for every visit, marked by GPS and a clear land mark (For old lake: 22° 53′ 58.584″N latitude, 89° 30′ 18.394″E longitude and for the new lake: 22°54'03.3"N latitude, 89°29'53.9"E longitude) and water sample was collected from there in each season at the same local time of the day. The first samples were taken in June 2024, which were considered as early monsoon samples. Later from the same location and at the same time of the day, three more samples were taken, which were considered as post monsoon (October 2024), dry season (February 2025), and mid-monsoon (July 2025). Samples were preserved and tested for physical properties (Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, and Color) and chemical properties (pH, DO, BOD, COD, Phosphate, Sulphate, Total Hardness, Electrical Conductivity, and Chloride content).

Indices are used to help to understand the situation without losing the underlying data (Balasubramanian, 2010). In this study, CCME-WQI is used because it fits a seasonal design and is easy to explain. In CCMEWQI, three factors are assimilated from designated water quality goals (Mostafaei, 2014). They are scope (F_1), frequency (F_2), and amplitude (F_3). They provide an arithmetic range of CCMEWQI water quality status classified in six descriptive classes between 0(poor) and 100 (excellent) (Boyacioglu, 2010) (Table 1).

Table 1: The classification of the scores of the Canadian Council of Ministries of the Environment Water Quality Index (Boyacioglu, 2010)

Rating	CCMEWQI Score	Description
Excellent	95–100	Water quality is at pristine levels.
Very good	89–94	Water quality is very close to pristine levels.
Good	80–88	Water quality rarely departs from desirable levels.
Fair	65–79	Water quality sometimes departs from desirable levels.
Marginal	45–64	Water quality often departs from desirable levels.
Poor	0–44	Water quality usually departs from desirable levels.

F_1 (scope) denotes the number of water quality parameters that failed the standard (equation 1)

$$F_1 = \frac{number\ of\ failed\ variables}{total\ number\ of\ variables} \times 100 \quad (1)$$

F_2 (frequency) represents the percentage of each test that does not meet the guideline values ("failed tests") (equation 2)

$$F_2 = \frac{number\ of\ failed\ tests}{total\ number\ of\ tests} \times 100 \tag{2}$$

F3 is calculated in three steps. i) The number of times by which an individual concentration is greater than the guideline is termed as excursion (equation 3).

$$excursion_i = \left(\frac{Failed\ test\ value_i}{Objective_j}\right) - 1 \tag{3}$$

ii) By summing the excursions of individual tests from their guidelines and dividing by the total number of tests, the normalized sum of excursions (nse) is calculated (equation 4).

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{number\ of\ tests} \tag{4}$$

F_3 (amplitude) represents the extent to which failed test values do not agree with their standards (equation 5).

$$F_3 = \left(\frac{nse}{0.01nse + 0.01}\right) \tag{5}$$

Finally, the CCME WQI is calculated (equation 6).

$$CCMEWQI = 100 - \frac{\sqrt{(F_1^2 + F_2^2 + F_3^2)}}{173.2} \tag{6}$$

2.2.1 Statistical Analysis

For each parameter, four paired observations were formed by aligning old lake and new lake values within the same four seasons. Differences were computed. The mean difference and its standard deviation) were obtained, and to separate Lake and Season effects, a two-way ANOVA without replication was conducted on the 2 × 4 table (2 lakes × 4 seasons).

2.3 Soil Sampling and Testing

For each lake, four points were fixed on the bank marked by GPS and landmarks (Table 2).

Table 2: Details of sampling location along with their latitude and longitude

Name of Lake	Location	
	Latitude	Longitude
Old Lake	22° 53′ 58.584″N	89° 30′ 18.394″ E
	22°54'00.9"N	89°30'16.4"E
	22°54'01.4"N	89°30'17.0"E
	22°54'03.7"N	89°30'15.3"E
New Lake	22°54'00.1"N	89°29'54.0"E
	22°54'03.4"N	89°29'54.1"E
	22°54'00.0"N	89°29'53.9"E
	22°54'03.2"N	89°29'53.4"E

At each point, soil was taken from a depth of 40 cm. Equal-mass subsamples from the four points were placed in a clean bucket and thoroughly mixed to create one composite sample per lake. Each composite soil was air-dried, gently disaggregated, and sieved to ≤2 mm. pH, Organic matter (%), and some other parameters (Al, B, Ba, K, Ca, Mg, Na, and Zn) were measured.

2.4 Biodiversity Assessment

Five biodiversity Indices were calculated for each lake from a whole-edge survey and a 2m*2m quadrat of a visible densest patch survey of the taxon for both of the lakes to compare between them.

2.4.1 Richness/Diversity Indices

Shannon - Wiener's Diversity Index H' (Shannon, 1948) is a commonly used diversity index that takes into account both the abundance and evenness of taxa present in the community (equation 7). The H' increases with the number of taxa in the community.

$$H' = -\Sigma p_i * \ln p_i \tag{7}$$

Where pi is the proportion of individuals in species i.
Simpson's Diversity Index (S') is a measure of diversity based on the probability that any two individuals drawn at random from an infinitely large community belong to the same taxon (equation 8).

$$D = 1 - \Sigma p_i^2 \tag{8}$$

(Values closer to 1 indicate higher diversity).
Margalef's Diversity Index M' (Ulanowicz, 2001) explains the relationship between the number of taxa detected (R') and a transformation of the total number of individuals counted (N) (equation 9).

$$Dmg = (S-1)/\ln N \tag{9}$$

Where $N=\sum n_i$ is the total number of individuals.

2.4.2 Evenness/Dominance Indices

Berger-Parker's Dominance Index BP' (Berger & Parker, 1970) is the simplest measure for the numerical significance of the first most abundant species (equation 10).

$$d = N_{max}/N \tag{10}$$

Where N_{max} is the count of the most abundant species.
Pielou's Evenness Index J' expresses the ratio between the realized Shannon-Wiener diversity of a sample (H') and its maximum possible value (as a logarithm of R'), i.e., the expected value of H' if all taxa had an identical number of individuals (Pielou, 1966). Evenness was expressed with Pielou's index (equation 11).

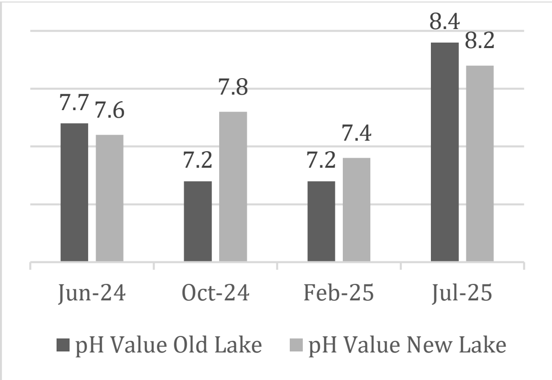
$$J' = H'/\ln S \tag{11}$$

Where S is the total number of species.

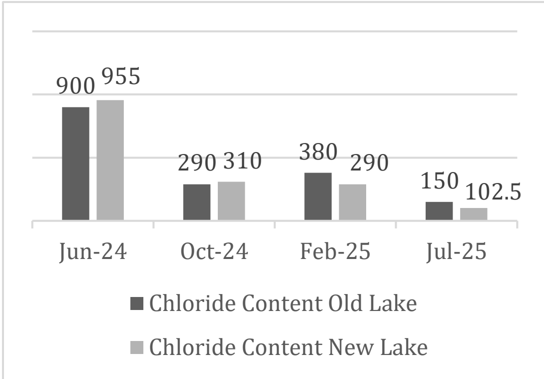
3. RESULTS AND DISCUSSION

3.1 Water Quality Parameters

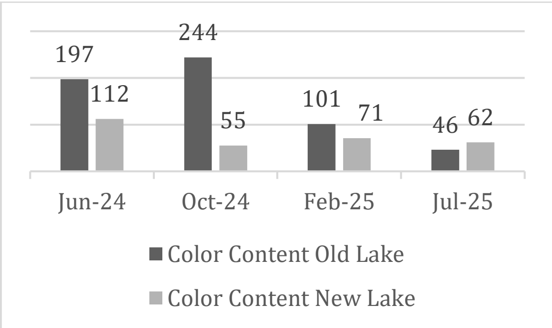
Figure 2 shows the comparison of water quality parameters of the old lake and new lake of KUET, which were measured during June 2024, October 2024, February 2025, and July 2025. Additionally, by comparing the measured values with the BIS standard (Rao et al., 2020), it can be seen that among the parameters for the new lake, the pH value was above the standard limit in the months of June-24, October-24, and July 26, 25, as for the old lake pH value was above the standard limit in the months of June-24 and July 25. While electrical conductivity was always below the standard limit for both lakes, Turbidity and Hardness values were almost always above the limit except for the month of October-24 in the new lake and July-25 and October-24 for the old lake. While Sulphate and COD values were always below the limit, other parameter fluctuates from time to time. Phosphate value crossed the standard limit in the months of February-25 and July-25 in the new lake, as for the old lake, in addition to these two months, it also crosses the limit in June-24. As for BOD, it was higher in the months of June-24 and October-24 for the new lake, and for the old lake, BOD was higher in February-25, June-24, and October-24. Chloride value was above the standard limit every time except in the month of July 2025 for both lakes.



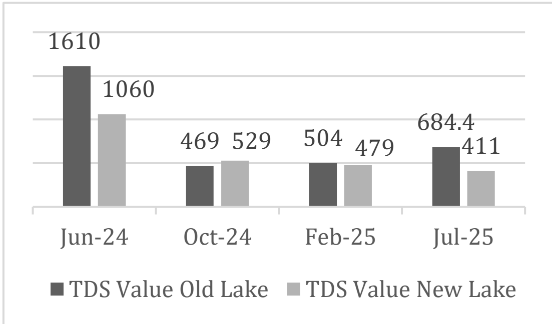
(a)



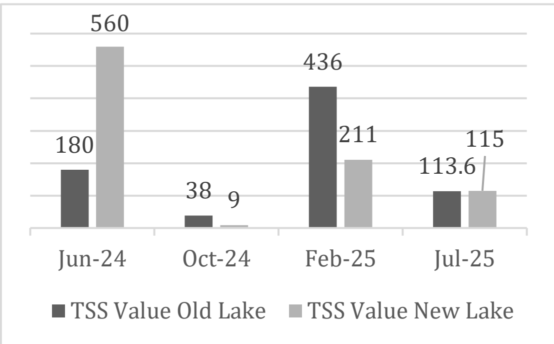
(b)



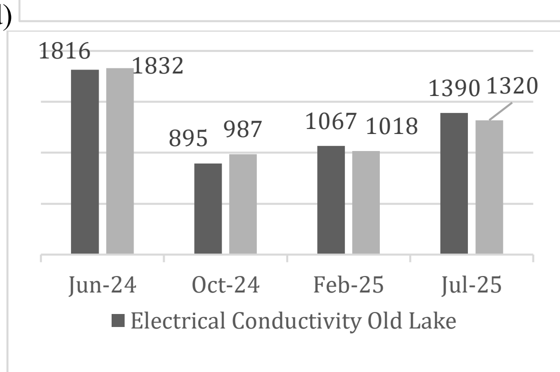
(c)



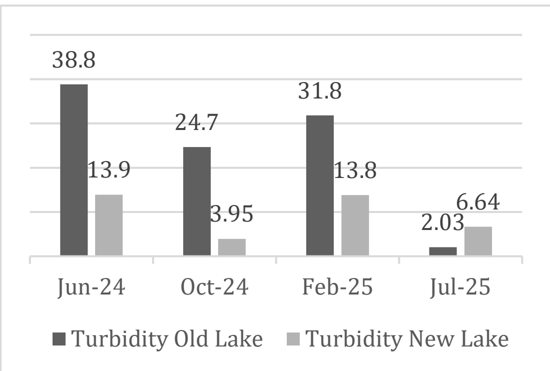
(d)



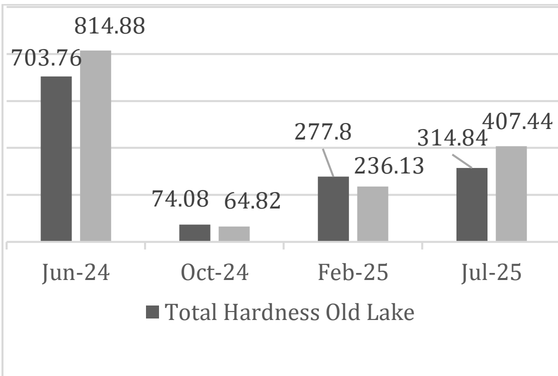
(e)



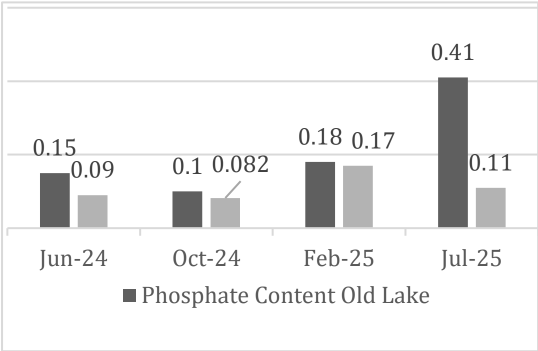
(f)

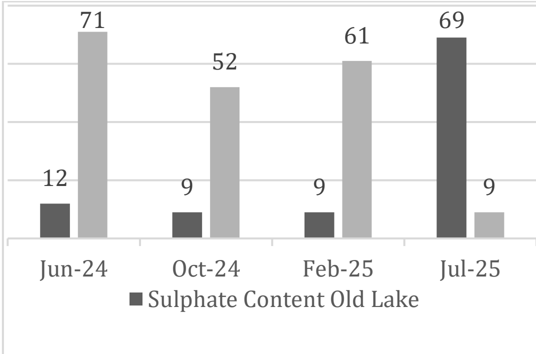


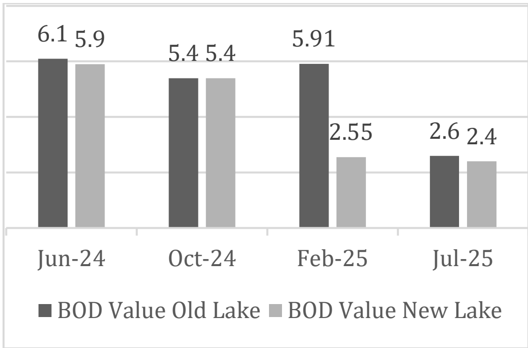
(g)

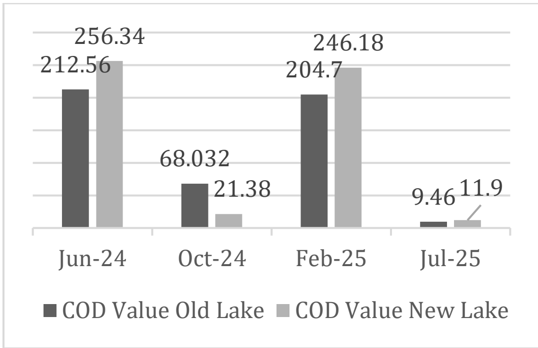


(h)

(i)


(j)


(k)


(l)


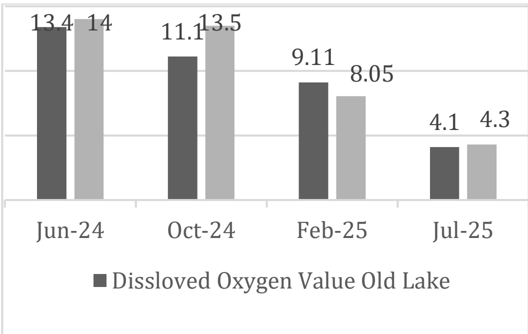
(m)


Figure 2: Comparison between the lakes, (a) pH value, (b) Chloride content, (c) Color, (d)Total Dissolved Solids, (e) Total Suspended Solids, (f) Electrical Conductivity, (g) Turbidity, (h) Total Hardness, (i) Phosphate content, (j) Sulphate content, (k) BOD value, (l) COD value, (m) DO value.

3.2 Water Quality Index

Old lake scored 44.27 and new lake 48.22 on the CCME-WQI, putting old lake on the Poor/Marginal boundary and new lake in the marginal class. In plain terms, water quality often departs from the chosen limits, and in the old lake, departures are a bit more severe. Table 3 shows the values of CCME WQI and its factors.

Table 3: Water Quality Index and its Factors

Factors	Old Lake	New Lake
F1-Scope (%)	72.7	72.7
F2-Frequency (%)	47.7	45.5
F3-Magnitude (%)	41.82	26.22
CCME WQI	44.27	48.22

• F1 — Scope (how many different variables failed at least once): both lakes had 8 of 11 variables fail, so F1 = 72.7%. That tells us the problem set is broad (solids/clarity, salts, nutrient/oxygen demand).

• F2 — Frequency (how often tests failed): old lake had 21 of 44 tests fail (F2 = 47.7%); new lake had 20 of 44 (F2 = 45.5%). Nearly half of all checks were over the objective in each lake.
• F3 — Magnitude (by how much the failed values exceeded the limit): old lake had F3 ≈ 41.82 with NSE ≈ 0.719; new lake had F3 ≈ 26.22 with NSE ≈ 0.355. On average, when the old lake failed, it was about 72% over the limit, and when the new lake failed, it was about 36% over. This is the main reason the old lake's final score is lower.

3.3 Statistical Analysis

From the two-tailed paired T-test, there is no significant difference seen between the parameters of the lake water. All tests were evaluated for $\alpha = 0.05$. P values from the T-test are well above the value of α.
As for ANOVA tests, considering the difference between the lakes, all the P values are well above the limit ($\alpha = 0.05$), which suggests that there is no significant difference, echoing the results from paired T-tests. The ANOVA test, considering the four seasons, shows that for some parameters, season brings significant differences in their presence. COD, Chloride, Dissolved Oxygen, Electrical Conductivity, Total Solids, and Hardness values change significantly with seasons. Other parameters don't get significantly affected by seasons. Table 4 shows the results of the paired T-test and ANOVA test computed in Microsoft Excel.

Table 4: Results from statistical analysis

Parameters	Unit	ANOVA P (based on lake)	ANOVA P (based on season)
BOD	mg/L	0.3288	0.1584
COD	mg/L	0.6616	0.0094
Chloride	mg/L	0.6651	0.0014
Color	Pt-Co unit	0.2013	0.4317
DO	mg/L	0.5088	0.0077
EC	µS/cm	0.9447	0.0013
Phosphate	mg/L	0.252	0.4486
Sulphate	mg/L	0.4633	0.9918
TDS	mg/L	0.2465	0.052
TS	mg/L	0.0963	0.0036
TSS	mg/L	0.8174	0.3337
Hardness	mg/L	0.3838	0.0035
Turbidity	NTU	0.1117	0.2668
pH	-	0.5367	0.0914

3.4 Shoreline Soils

New lake soil was more acidic (pH 4.5) than old lake (pH 5.5), and it held more organic matter (6.8% vs 5.0%). In simple terms, new lake soil is richer and more acidic, which can lock up some nutrients but also fuel oxygen demand when bits of that organic matter wash into the lake. These contrasts are shown in Table 5.
Old lake soil contained more sodium and potassium (Na 0.754 mg/L vs 0 mg/L; K 16.4 mg/L vs 14.8 mg/L) and slightly more magnesium (17.3 mg/L vs 16.3 mg/L), while the new lake had more calcium (64.5 mg/L vs 50.0 mg/L). This pattern lines up with the water chemistry previously observed: the old lake repeatedly showed higher chloride and TDS in several seasons (June and February), while the new lake often showed higher hardness (especially in June and July), consistent with its higher soil calcium. Together, these suggest that the older lake's edge has accumulated more soluble salts over time, whereas the newer lake's edge is more calcium-hard.
Old lake had higher boron and barium (B 0.116 mg/L vs 0.0762 mg/L; Ba 16.0 µg/L vs 8.60 µg/L) and was slightly higher in aluminum and zinc (Al 32.2 mg/L vs 30.5 mg/L; Zn 373 µg/L vs 368 µg/L).

These are not interpreted as hazards here; they simply mark a more mineralized bank in the older basin and give KUET a baseline to watch over time.

Table 5: Tested Parameters of Shoreline Soil

Parameter	Unit	Old Lake	New Lake
pH	-	5.5	4.5
Organic Matter (%)	-	5.0	6.8
Al	mg/L	32.2	30.5
B	mg/L	0.116	0.0762
Ba	μg/L	16.0	8.60
K	mg/L	16.4	14.8
Ca	mg/L	50	64.5
Mg	mg/L	17.3	16.3
Na	mg/L	0.754	0
Zn	μg/L	373	368

3.5 Biodiversity of Lake Margins

3.5.1 Diversity and Richness

Across all indices, the old lake consistently supported a richer community than the new lake. For the small 2×2 m snapshot, Shannon diversity (H′) was 2.346 in old lake versus 2.037 in new lake; when the whole edge was considered, H′ rose for both lakes to 3.188 (old lake) and 2.747 (new lake), and the gap widened, indicating that old lake's greater variety becomes clearer when more habitat is included. Margalef richness (Dmg) showed the same pattern: 2.695 and 9.40 (old lake: quadrat and whole edge) versus 1.988 and 8.004 (new lake), confirming that the mature lake holds a larger species pool around its full perimeter. Figure 3 shows the diversity and richness indices of two lakes. The upward shift from quadrat to full-edge values shows that both edges are heterogeneous, but the old lake offers more distinct micro-habitats (vegetated patches, shaded edges, different substrates), which accumulate more species when walking the entire rim.

Fig 3: Diversity and Richness Indices Comparison

3.5.2 Evenness and Dominance

Evenness (Pielou's J′) was higher in the old lake in both views: quadrat 0.6832 vs 0.6328 (new lake) and whole edge 0.6922 vs 0.6218. In other words, old lakes' species tend to share space and resources more evenly, while new lake shows slightly patchier distributions when you look around the entire lake. Simpson's D and Berger–Parker (BP) help read dominance: from the quadrat to the whole edge, dominance increased in both lakes, but the old lake became less dominated than the new lake at the whole-edge scale (BP: Old lake - 0.2950 vs new lake - 0.4266). This implies that the new lake's rim includes sections where one or two species take over, while the old lake's rim stays better balanced overall. Figure 4 shows evenness and dominance indices.

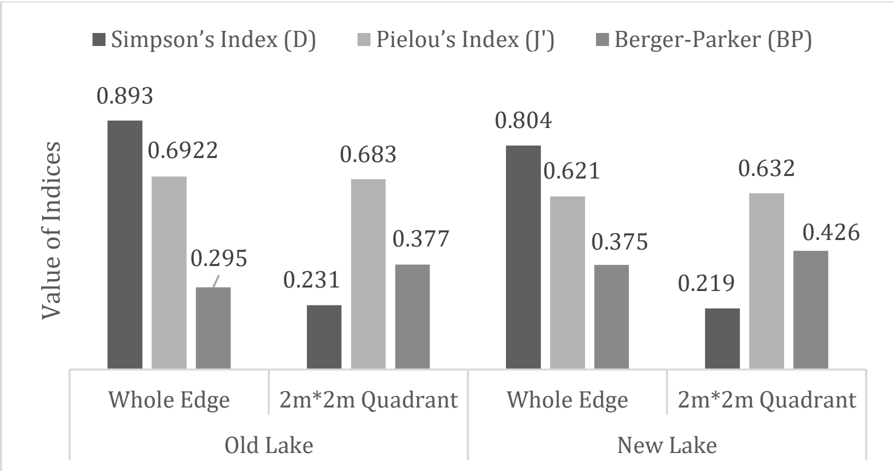


Fig 4: Evenness and Dominance indices comparison

5. CONCLUSIONS

This study compared two KUET campus lakes: one older and regularly maintained (~15 years) and one newly created (~2 years), across four seasons at fixed points of edges and at the same time of day. The results are consistent and easy to read.

Season set the baseline. Parameters tied to rain, heat, and mixing showed the clearest swings. Turbidity and suspended solids pulsed in early monsoon and again in the dry season for at least one lake; dissolved salts (chloride, TDS, hardness) were highest in June and then diluted; phosphate showed a marked July peak in the older lake; and dissolved oxygen declined stepwise toward July in both lakes, reaching about 4 mg/L at peak monsoon.

Lake identity then fine-tuned the pattern. The older lake generally carried more color and, in several windows, more salts and solids, reflecting a larger legacy pool of material built up over time. The newer lake tended to be clearer but showed higher hardness at times and local pockets of dominance along the edge.

Soils help explain the water. New lake bank soils were more acidic and organic (pH ~4.5; OM ~6.8%), while old lake soils contained more soluble salts and several trace elements (higher Na, K, Mg, B, Ba). These differences line up with the water picture: higher hardness in the new lake matches higher soil calcium; higher chloride/TDS at the old lake matches its saltier soils.

Life at the margin mirrored these conditions. The older lake supported higher richness and more even communities at both the small plot and whole-edge scales (higher Shannon and Margalef; lower Berger–Parker), while the newer lake showed patchier sections where a few species dominated.

The most consistent constraints on condition were clarity/solids (turbidity, TSS), salts (chloride, TDS, hardness), and nutrient–oxygen balance (phosphate, BOD). These are the parameters most likely to improve with targeted, low-cost actions on banks and runoff. Limitations to remember are practical sample size (one value per lake per season for some parameters), one-time soil and biodiversity snapshots, and the use of selected guideline objectives; even so, the patterns are strong and coherent.

ACKNOWLEDGEMENTS

I would like to convey my gratitude to Md. Al Amin, a postgraduate student of KUET, and my friend Engr. Jannatul Akmum for their immense support. I also want to thank Sayed Ahsan Ali and Md. Raju

Sheikh, technicians from the Environmental Engineering Laboratory, Department of Civil Engineering, KUET, for their assistance.

Declaration of Use of AI

AI tools (Grammarly, ChatGPT) were used for grammar checking and clarity improvement during manuscript preparation, and Zotero was used for referencing. No AI tool was used to generate research methodology, analysis, results, or ideas presented in this paper. All research ideas, analytical procedures, calculations, and tables were entirely developed by the authors.

REFERENCES

Balasubramanian, A. (2010). Analysis of Water Quality Index (WQI) in Dalvoy Lake, Mysore City, India. *Nature Environment and Pollution Technology*, *9*(4).

Baten, N., Hossain, M. A., Rahman, A., & Khaleque, M. A. (2023). *The Characteristics of Monsoon Rainfall over Bangladesh for the Period of 1992 to 202*. *9*.

Berger, W. H., & Parker, F. L. (1970). Diversity of Planktonic Foraminifera in Deep-Sea Sediments. *Science*, *168*(3937), 1345–1347. https://doi.org/10.1126/science.168.3937.1345

Bilotta, G. S., & Brazier, R. E. (2008). Understanding the influence of suspended solids on water quality and aquatic biota. *Water Research*, *42*(12), 2849–2861. https://doi.org/10.1016/j.watres.2008.03.018

Boyacioglu, H. (2010). Utilization of the water quality index method as a classification tool. *Environmental Monitoring and Assessment*, *167*(1–4), 115–124. https://doi.org/10.1007/s10661-009-1035-1

Hassall, C. (2014). The ecology and biodiversity of urban ponds. *WIREs Water*, *1*(2), 187–206. https://doi.org/10.1002/wat2.1014

Hossain, S., & Hossain, Z. (2017). *Water Quality Assessment of Dhanmondi Lake in Dhaka City*.

Mayer, P. M. (2005). *Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations*.

Mostafaei, A. (2014). Application of Multivariate Statistical Methods and Water-Quality Index to Evaluation of Water Quality in the Kashkan River. *Environmental Management*, *53*(4), 865–881. https://doi.org/10.1007/s00267-014-0238-6

Pasha, A. B. M. K., Mustafa, S. O., Rahman, S. M. M., Abdullah, M., Chowdhury, Md. A. H., & Parveen, M. (2023). Analysis of Water Quality of Hatirjheel Lake, Dhaka, Bangladesh. *Nature Environment and Pollution Technology*, *22*(1), 245–252. https://doi.org/10.46488/NEPT.2023.v22i01.023

Pielou, E. C. (1966). *The Measurement of Diversity in Different Types of Biological Colledions*.

Rao, S., Mogili, N. V., A, P., & A, L. (2020). Aqueous chemistry of anthropogenically contaminated Bengaluru lakes. *Sustainable Environment Research*, *30*(1), 8. https://doi.org/10.1186/s42834-020-00049-5

Shannon, C. E. (1948). *A Mathematical Theory of Communication*.

Tickner, D., Opperman, J. J., Abell, R., Acreman, M., Arthington, A. H., Bunn, S. E., Cooke, S. J., Dalton, J., Darwall, W., Edwards, G., Harrison, I., Hughes, K., Jones, T., Leclère, D., Lynch, A. J., Leonard, P., McClain, M. E., Muruven, D., Olden, J. D., … Young, L. (2020). Bending the Curve of Global Freshwater Biodiversity Loss: An Emergency Recovery Plan. *BioScience*, *70*(4), 330–342. https://doi.org/10.1093/biosci/biaa002

Ulanowicz, R. E. (2001). Information theory in ecology. *Computers & Chemistry*, *25*(4), 393–399. https://doi.org/10.1016/S0097-8485(01)00073-0

Wei, Y., Yuanxi, L., Yu, L., Mingxiang, X., Liping, Z., & Qiuliang, D. (2020). Impacts of rainfall intensity and urbanization on water environment of urban lakes. *Ecohydrology & Hydrobiology*, *20*(4), 513–524. https://doi.org/10.1016/j.ecohyd.2020.06.006

Withers, P. J. A., & Jarvie, H. P. (2008). Delivery and cycling of phosphorus in rivers: A review. *Science of The Total Environment*, *400*(1–3), 379–395. https://doi.org/10.1016/j.scitotenv.2008.08.002

Yang, Y.-Y., & Lusk, M. G. (2018). Nutrients in Urban Stormwater Runoff: Current State of the Science and Potential Mitigation Options. *Current Pollution Reports*, *4*(2), 112–127. https://doi.org/10.1007/s40726-018-0087-7