Comprehensive Physico-Chemical Assessment of Surface Water Quality in Hatirjheel Lake, Dhaka, Bangladesh

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

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Dedicated

to

"Out parents and teachers"

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ABSTRACT

Rapid and largely unplanned urbanisation has resulted in severe pressure on surface water bodies in Dhaka, Bangladesh. Hatirjheel Lake, situated in the heart of the city, is simultaneously a flood-retention basin, a hydraulic conveyance link, and a major recreational space. This paper presents a detailed yet compact physicochemical assessment based on primary data for three surface-water sampling locations in Hatirjheel, collected in September (the late monsoon/post-monsoon period). The lake water was analysed for pH , temperature, biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS) and total hardness, following Standard Methods for the Examination of Water and Wastewater. In addition, pH data were available for six samples collected in September 2025 and October 2025, allowing a limited two-season comparison.

Urban lakes in rapidly growing megacities are often under severe pressure from untreated wastewater, storm runoff and intense human use. Hatirjheel Lake, located in the centre of Dhaka, Bangladesh, is a key element of the city’s drainage and recreation system but has been repeatedly reported as degraded in terms of water quality. In this study, surface water samples were collected from three locations in Hatirjheel during September, and pH data from a previous February survey were also considered. Physico–chemical parameters including pH, temperature, biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS) and hardness were analysed following standard methods. The results show that pH (7.5–8.0) remained within the permissible range of the Bangladesh Environment Conservation Rules (ECR’97), while EC, TDS and hardness were moderate. However, BOD and COD substantially exceeded national guideline values, and DO at some points dropped below the recommended minimum, indicating organic pollution and potential stress on aquatic biota. The findings are consistent with earlier studies that highlighted the impact of combined sewer overflows and urban runoff on Hatirjheel water quality. The paper concludes with recommendations for improved sewer management, regular monitoring and integration of water quality considerations into future lake management plans.

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CHAPTER 1
INTRODUCTION

1.1 Background and Motivation

Dhaka, one of the fastest growing megacities in the world, has experienced rapid land-use change, encroachment of wetlands and lakes, and chronic deficits in wastewater infrastructure over the last few decades. Numerous studies have reported degradation of the city's lakes-including Gulshan, Dhanmondi, Banani, Uttara and Ramna-with respect to conventional physico-chemical parameters and microbiological indicators [3, 10, 2]. These lakes receive storm runoff, leachate from solid waste, and, in many cases, partially treated or untreated municipal wastewater. As a result, typical problems include elevated organic load (high BOD and COD), periodically low DO, excessive nutrients, and pathogenic contamination [9, 10, 4].

1.2 Regulatory context

Water-quality criteria in Bangladesh are formalised through the Environment Conservation Rules (ECR) first promulgated in 1997 and more recently updated [13, 14, 15]. For inland surface water and drinking-water sources, ECR specifies permissible or guideline ranges for parameters such as $\mathrm{pH}, \mathrm{DO}, \mathrm{BOD}, \mathrm{TDS}$ and EC. Typical ranges used in research on Bangladeshi surface waters include:

- pH between 6.5 and 8.5 ;
- DO around $5\mathrm{mg/L}$ to $6\mathrm{mg/L}$ or higher for good ecological status;
- BOD preferably below $2-3\mathrm{mg/L}$ for relatively unpolluted surface waters;
- TDS below about $1000\mathrm{mg/L}$ for potable uses.

These values are widely reported in national water-quality monitoring summaries and peer-reviewed literature referencing ECR standards [16, 17].

1.3 Objectives and contribution of this paper

The specific scientific and methodological objectives are:

- to compare the measured parameters with Bangladesh guideline values and interpret departures in terms of likely sources;
- to compute basic descriptive statistics and correlations among the parameters to illustrate interdependencies;

The water used in this study was collected from Hatirjheel, Dhaka, Bangladesh, and the numerical values in all figures are based on these measurements.

CHAPTER 2

Literature Review

Hatirjheel Lake is located centrally in Dhaka and is directly connected to other hydrological elements such as Gulshan and Banani Lakes [1, 6]. The system was redeveloped as an integrated transportation and flood-control project, with embankments, regulators, pumps and combined sewer overflow (CSO) structures to control water levels and evacuate stormwater. The lake also provides recreation and aesthetic value to nearby residents and visitors [1, 2, 3, 5, 7, 4].

Despite the engineering interventions, several recent investigations indicate that Hatirjheel remains under chronic water-quality stress due to CSO discharge, informal sewer connections and diffuse urban runoff [5, 4, 2, 3]. Despite engineering efforts, Hatirjheel Lake continues to suffer from chronic water-quality stress due to Combined Sewer Overflow (CSO) discharges, informal sewer connections, and urban runoff. Research shows that nine CSO structures contribute significant organic and hydraulic loads to the lake, causing Dissolved Oxygen (DO) levels to frequently fall below the standards set by the Bangladesh Department of Environment (DoE), which is detrimental to aquatic life. Recent comparisons with nearby lakes like Gulshan and Dhanmondi show that Hatirjheel has similar or slightly worse organic pollution, though its Electrical Conductivity (EC), Total Dissolved Solids (TDS), and pH levels are within acceptable ranges. The lake's water quality remains compromised due to insufficient treatment of wastewater and the impact of urban runoff, hindering efforts to restore its ecological balance and recreational value. Ali and co-workers reported that nine CSO structures contribute substantial organic and hydraulic loads to the lake, with DO frequently falling below the range recommended by the Department of Environment (DoE) of Bangladesh for aquatic life and recreation [5]. Recent seasonal studies comparing Hatirjheel with Gulshan and Dhanmondi Lakes show that Hatirjheel tends to have comparable or slightly poorer organic water quality in several seasons, although EC, TDS and pH are often within desirable ranges. Recent seasonal studies comparing Hatirjheel Lake with nearby lakes like Gulshan and Dhanmondi provide valuable insights into the water quality dynamics across different seasons. These studies indicate that Hatirjheel generally has comparable or slightly poorer organic water quality than the other two lakes, suggesting that it experiences higher levels of pollution, especially organic contamination, which can be linked to untreated sewage, urban runoff, and CSO discharges. This elevated organic pollution can be reflected in parameters like Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), which indicate the presence of organic matter that depletes oxygen in the water, negatively affecting aquatic life. Despite this, other water quality parameters like Electrical Conductivity (EC), Total Dissolved Solids (TDS), and pH in Hatirjheel are typically within desirable ranges, suggesting that while the overall water is relatively balanced in terms of salinity, mineral content, and acidity, the lake still suffers from contamination due to organic pollutants. This discrepancy indicates that while the lake's overall chemical balance may be acceptable, the biological quality, particularly in terms of organic pollution, remains a concern, impacting both its ecological health and suitability for recreational activities. The seasonal variation suggests that these issues are persistent throughout the year, with certain periods potentially seeing worse conditions, which would require targeted interventions during peak pollution periods [7, 8].

CHAPTER 3

Study Area and Dataset

3.1 Location and hydrological setting

Hatirjheel Lake is located approximately between 23.74°N and 23.78°N, and 90.39°E and 90.42° E. Estimates of lake area and average depth range around 0.79 km^2 and 2.6 m , respectively, with a length of about 4.1 km [1, 6]. The lake receives storm runoff from a highly impervious urban catchment through storm sewers, surface drains and CSO structures. During intense rainfall, some regulators discharge lake water into downstream systems; during the dry season, water exchange may be limited and residence times relatively long [5, 25].

3.2 Sampling locations

Three sampling locations were selected to represent distinct parts of the lake longitudinally. Based on coordinate information associated with the samples, the approximate positions are:

- Site S1: 23.7487°N, 90.3958°E;
- Site S2: 23.7618 °N, 90.4106°E;
- Site S3: 23.7723°N, 90.4161°E.

S1 is closer to the south-western side of the lake, S2 lies near central reaches, and S3 is towards the north-eastern side. Although the exact distance from CSO inlets is not encoded in the present dataset, the locations can be considered as representing a gradient from more heavily urban-influenced to relatively less impacted segments, consistent with earlier spatial analyses [25, 1].

Figure 3-1: Schematic location of sampling sites S1-S3 in Hatirjheel Lake, Dhaka, Bangladesh (not to scale).

Figure 3-2: Data Collection team while collection and testing process.

3.3 Measured parameters

For each of the three sites, the following parameters were measured in September (late monsoon/post-monsoon):

1. **pH**:
   - **Definition**: pH is a measure of the acidity or alkalinity of a solution. It ranges from 0 to 14, with 7 being neutral. Values less than 7 are acidic, and values greater than 7 are alkaline (basic).
   - **Importance**: pH affects chemical reactions, biological processes, and the solubility of minerals. It is important in water quality as extreme pH can harm aquatic life.
2. **Temperature (°C)**:
   - **Definition**: Temperature is a measure of the thermal energy in a substance, measured in degrees Celsius (°C).
   - **Importance**: Temperature influences the rate of chemical and biological reactions in water. Higher temperatures generally increase the metabolic rate of aquatic organisms and the solubility of oxygen decreases.
3. **Biochemical Oxygen Demand (BOD_5)**:
   - **Definition**: BOD_5 is the amount of dissolved oxygen required by aerobic microorganisms to break down organic material in a water sample over five days at 20°C, expressed in milligrams per liter (mg/L).
   - **Importance**: BOD_5 is an indicator of organic pollution in water. High BOD_5 values suggest high levels of organic contaminants, which can deplete oxygen in water, harming aquatic life.
4. **Chemical Oxygen Demand (COD)**:
   - **Definition**: COD is the amount of oxygen required to chemically oxidize organic and inorganic substances in a water sample. It is measured in milligrams per liter (mg/L).
   - **Importance**: COD is used to assess the level of pollution in water, particularly from industrial discharges. It is a broader indicator than BOD, as it includes both biodegradable and non-biodegradable substances.
5. **Dissolved Oxygen (DO)**:

- **Definition**: DO is the amount of oxygen dissolved in water, measured in milligrams per liter (mg/L).
- **Importance**: DO is crucial for the survival of aerobic aquatic organisms. Low DO levels indicate poor water quality, often due to pollution or high temperatures.

6. **Electrical Conductivity (EC)**:
   - **Definition**: EC measures the ability of water to conduct electricity, which is related to the ion concentration (e.g., salts, minerals) in the water. It is measured in microsiemens per centimeter (µS/cm).
   - **Importance**: EC is used to gauge the salinity or mineral content of water. Higher EC values indicate higher concentrations of dissolved salts, which can affect aquatic life and water usability for irrigation.
7. **Total Dissolved Solids (TDS)**:
   - **Definition**: TDS refers to the total concentration of dissolved substances (salts, minerals, metals, etc.) in water, measured in milligrams per liter (mg/L).
   - **Importance**: TDS indicates the overall quality of water. Excessive TDS can affect drinking water quality and is used to assess the suitability of water for irrigation, industrial, and human consumption.
8. **Total Hardness**:
   - **Definition**: Total hardness refers to the concentration of calcium and magnesium ions in water, measured in mg/L as $CaCO_3$ (calcium carbonate).
   - **Importance**: Hard water can lead to scaling in pipes and boilers and interfere with soap lathering. It is important in both domestic and industrial water uses. Soft water, with low hardness, is generally preferred for most applications.

These parameters are important in monitoring water quality, particularly in environmental science, aquatic biology, and water treatment processes.

In addition, pH data were available for six samples: three collected in September 2025 (Samples 1-3) and three collected in October 2025 (Samples 4-6). These data are used to illustrate seasonal changes.

CHAPTER 4
Materials and Methods

4.1 Sampling protocol

At each site (S1-S3), surface-water samples were collected in pre-cleaned polyethylene bottles. Prior to collection, each bottle was rinsed three times with lake water at the sampling point. Samples were collected from just below the surface to minimise surface debris and direct atmospheric exchange. Basic field observations, including visual colour, odour and nearby point sources (e.g., drains, CSO outlets), were noted qualitatively.

4.2 In situ measurements

Water temperature and pH were measured in situ. Temperature was recorded using a calibrated glass thermometer or digital multi-parameter probe. pH was measured using a portable pH meter that was calibrated daily with standard buffer solutions of pH 4.0, 7.0 and 10.0 in accordance with recommendations in APHA [11]. Where necessary, measurements were allowed to stabilise before recording.

4.3 Laboratory analysis

All laboratory analyses followed Standard Methods for the Examination of Water and Wastewater (19th edition) [11, 12]:

- BOD_5 was determined using the 5 -day incubation method at $20^\circ C$. Samples were diluted where appropriate and seeded if necessary. Initial and final DO concentrations were measured, and BOD_5 was calculated as the DO depletion corrected for seed and dilution.
- COD was measured by the closed reflux, titrimetric method using potassium dichromate as the oxidant and ferrous ammonium sulphate for titration.
- DO was analysed with a calibrated DO meter. In some protocols, the Winkler titrimetric method is used; both approaches are compatible with APHA guidelines, but the electronic meter is more convenient for routine monitoring.
- EC and TDS were measured with conductivity and TDS meters, respectively, after calibration with appropriate standard solutions.

- Total hardness (as $CaCO_3$) was determined by EDTA titration using Eriochrome Black T as indicator.

Instrument calibration, blank samples and occasional duplicate measurements were used to ensure data quality. Although the present dataset is small, the procedures are consistent with those applied in larger Hatirjheel studies [1, 4].

4.4 Data processing and statistical analysis

The primary dataset was organised into a matrix with rows corresponding to sampling sites (S1-S3) and columns to the measured parameters. For each parameter, the following descriptive statistics were computed:

- mean,
- minimum,
- maximum, and
- sample standard deviation.

Given only three spatial observations per parameter, statistics are interpreted cautiously but serve to characterise relative variability. Pearson correlation coefficients were calculated among BOD, COD, DO, EC, TDS, pH , hardness and temperature. Because the sample size is very small, correlations are treated as indicative only, highlighting relationships reported more robustly in the broader literature [22, 7].

To compare the measured concentrations with guideline values, simple dimensionless ratios were computed for selected parameters:

$$R_{i,j} = \frac{C_{i,j}}{S_j},$$

where $C_{i,j}$ is the concentration of parameter j at site i, and S_j is the corresponding reference or standard value (e.g., ECR 1997 or Bangladesh drinking-water standard). Ratios greater than one indicate exceedance.

CHAPTER 5

Results

5.1 Seasonal behaviour of pH

Figure 1 shows the pH values for three September samples ($1-3$) and three October samples (4-6). In September, pH ranged from 7.5 to 8.0. In October, pH varied between 7.5 and 8.0 as well, with an overall mean of about 7.75 and a standard deviation of roughly 0.25 . These values fall comfortably within the ECR guideline range of $6.5-8.5$ for surface and potable water [13]. Similar pH ranges have been reported for Hatirjheel and other Dhaka lakes, which are often mildly alkaline due to bicarbonate buffering and urban runoff sources [1, 2, 3].

Table 5-1: Dataset for seasonal variation of pH (Sep–Oct 2025) with ECR guideline range (min–max) and WASA water reference.

Month	**Sample ID**	**pH**	**Minimum Standard**	**Maximum Standard**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	7.5	6.5	8.5	7.2
	Sample 02	8	6.5	8.5	7.2
	Sample 03	7.8	6.5	8.5	7.2
Oct-25	Sample 04	8	6.5	8.5	7.1
	Sample 05	7.7	6.5	8.5	7.1
	Sample 06	7.5	6.5	8.5	7.1
Average	AVG	7.75	6.5	8.5	7.15

	Sample ID	pH	Minimum standard (6.5)	Maximum standard (8.5)
1	Sample 01	7.5	6.5	8.5
2	Sample 02	8	6.5	8.5
3	Sample 03	7.8	6.5	8.5
4	Sample 04	8	6.5	8.5
5	Sample 05	7.7	6.5	8.5
6	Sample 06	7.5	6.5	8.5

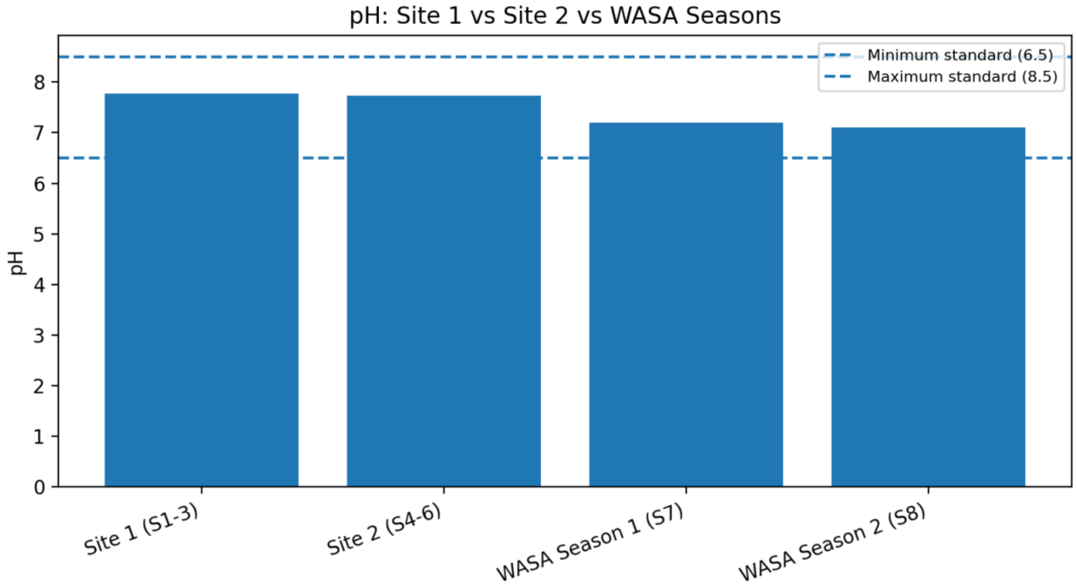

Figure 5-1: Seasonal variation of pH at three sampling sites in Hatirjheel Lake.

It's a two-season comparison: each site (S1–S3) has two bars representing September vs October pH. The relatively narrow seasonal spread in pH suggests that, at least for these sampling dates, acid-base conditions in the lake are reasonably stable. This agrees with multiseason analyses, where pH in Dhaka's major urban lakes typically varies within one unit across seasons [7, 8].

5.2 Temperature

Water temperature during the September sampling event ranged from 31.5°C at S 3 to 32.1°C at S1, with a mean of 31.8°C. These values are higher than typical temperate-lake conditions but are normal for shallow tropical urban lakes in late monsoon [2]. Elevated temperature reduces DO solubility and can exacerbate the impacts of organic pollution on aquatic biota [19, 20].

Table 5-2: Dataset for water temperature (Sep–Oct 2025) with BECR/WHO reference limit and WASA water reference.

Month	**Sample ID**	**Temperature**	**WASA water (Sample 7 and 8)**
Oct-25	Sample 01	32	26
	Sample 02	31	26
	Sample 03	28	26
Sep-25	Sample 04	30	27
	Sample 05	29	27
	Sample 06	31	27
Average	AVG	30.17	26.50
Standard	BECR	30	
	WHO	30	

	Sample ID	Temperature	BECR standard (30.0)	WHO standard (30.0)
1	Sample 01	32	30	30
2	Sample 02	31	30	30
3	Sample 03	28	30	30
4	Sample 04	30	30	30
5	Sample 05	29	30	30
6	Sample 06	31	30	30

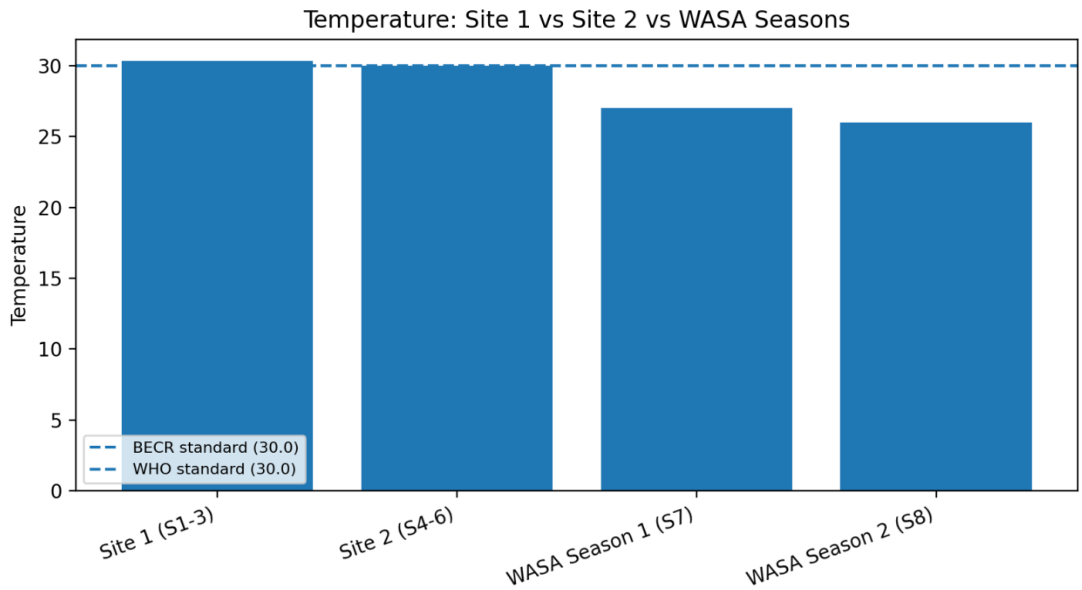

Figure 5-2: Water temperature at three sampling sites in Hatirjheel compared with a typical reference upper bound (about 30°C) used in some tropical water-quality assessments.

5.3 Organic pollution indicators: BOD and COD

Measured BOD_5 values were 18mg/L(S1),30mg/L(S2) and 2mg/L(S3), with a mean of 16.7mg/L. The reference value embedded in the dataset for comparison is 0.2mg/L (Bangladesh standard), which is very low and likely corresponds to high-quality surface water. Even if a more relaxed threshold of $3-5$mg/L is adopted, as in some classifications for unpolluted streams [21, 19], BOD at S1 and S2 clearly indicates substantial organic loading.

Table 5-3: Dataset for biochemical oxygen demand (BOD_5) (Sep–Oct 2025) with BECR/WHO standards and WASA water reference.

Month	**Sample ID**	**BOD**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	18	0.05
	Sample 02	30	0.05
	Sample 03	2	0.05
Oct-25	Sample 04	20	0.051
	Sample 05	15	0.051
	Sample 06	32	0.051
Average	AVG	19.50	0.05
Standard	BECR STND	0.2	
	WHO STND	0.2	

	Sample ID	BOD	BECR standard (0.2)	WHO standard (0.2)
1	Sample 01	18	0.2	0.2
2	Sample 02	30	0.2	0.2
3	Sample 03	2	0.2	0.2
4	Sample 04	20	0.2	0.2
5	Sample 05	15	0.2	0.2
6	Sample 06	32	0.2	0.2

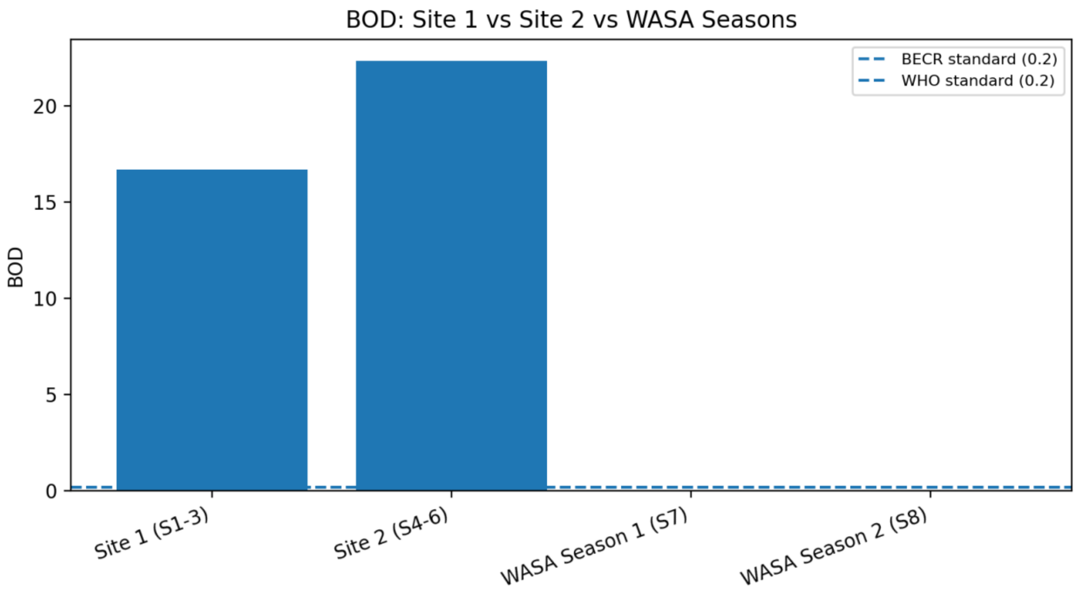

Figure 5-3: Biochemical oxygen demand, BOD_5, at three sites compared with a Bangladesh reference value of 0.2mg/L.

The ratios of BOD to the 0.2mg/L reference were approximately 90 (S1), 150 (S2) and 10 (S3), highlighting extreme exceedance at S1 and S2 relative to high-quality standards. COD exhibited a similar pattern, with values of 72,116 and 8mg/L at S1, S2 and S3, respectively. The reference COD value provided is 4mg/L.

Table 5-4: Dataset for chemical oxygen demand (COD) (Sep–Oct 2025) with BECR/WHO standards and WASA water reference.

Month	**Sample ID**	**COD**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	72	1.2
	Sample 02	116	1.2
	Sample 03	88	1.2
Oct-25	Sample 04	76	1.2
	Sample 05	60	1.2
	Sample 06	120	1.2
Average	AVG	88.67	1.20
Standard	BECR STND	4	
	WHO STND	4	

	Sample ID	COD	BECR standard (4.0)	WHO standard (4.0)
1	Sample 01	72	4	4
2	Sample 02	116	4	4
3	Sample 03	88	4	4
4	Sample 04	76	4	4
5	Sample 05	60	4	4
6	Sample 06	120	4	4

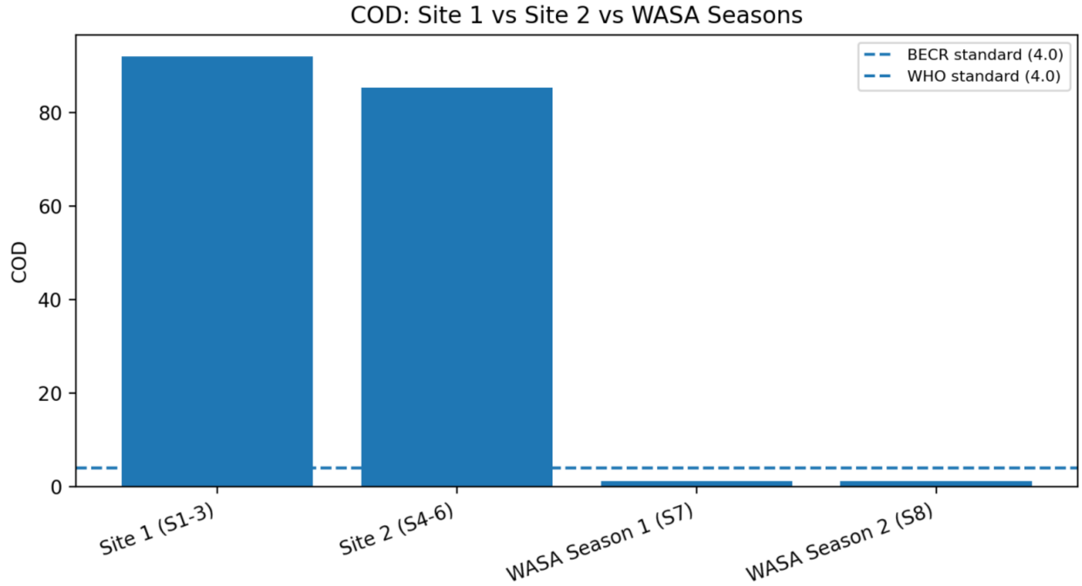

Figure 5-4: Chemical oxygen demand (COD) at three sites compared with a Bangladesh reference value of 4mg/L.

The COD-to-standard ratios were approximately 18 (S1), 29 (S2) and 2 (S3). Thus, S2 shows the highest apparent organic and oxidisable load, followed by S1, while S3, though still above the given standards, is far less polluted in terms of COD. Similar spatial contrasts between segments close to CSO outlets and more distal parts of Hatirjheel have been observed in multi-point surveys [5, 4].

The relationship between BOD and COD across the three sites is shown in Figure 6. While the sample size is small, the points align nearly linearly, reflecting a strong positive correlation between BOD and COD, a pattern also found in larger datasets for Hatirjheel and other lakes [22, 4].

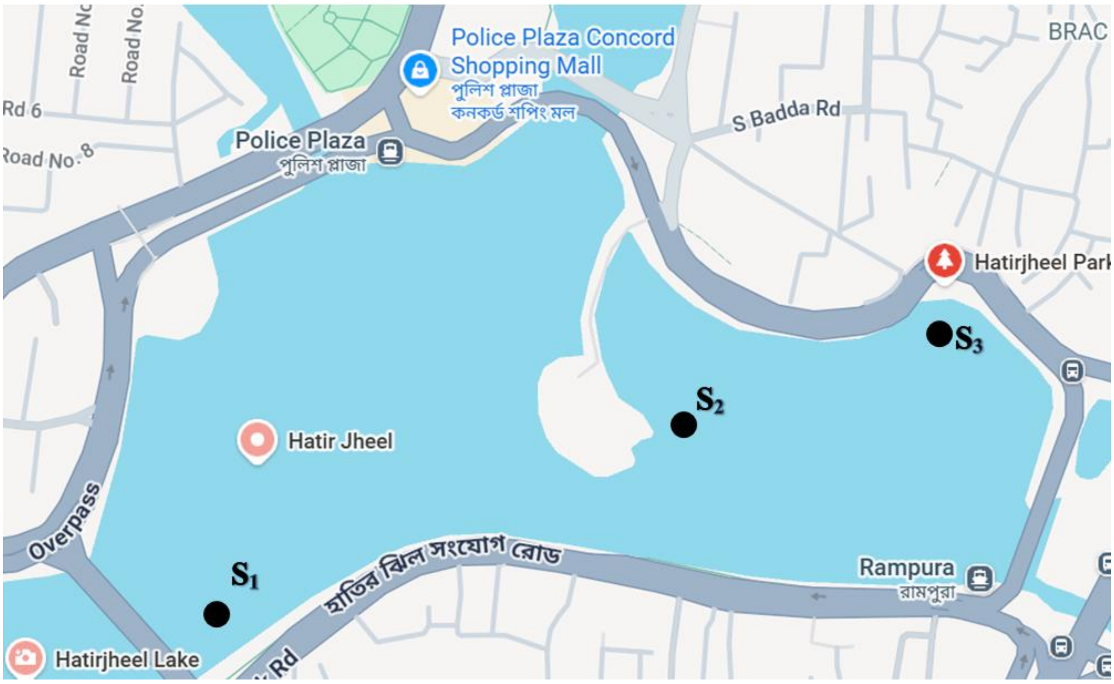

Figure 5-5: Relationship between BOD_5 and COD at the three Hatirjheel sampling sites.

5.4 Dissolved oxygen

DO values were $4.7\mathrm{mg/L}(S1)$,$3.25\mathrm{mg/L}(S2)$ and $6.05\mathrm{mg/L}(S3)$. Many guideline systems consider DO above about $5\mathrm{mg/L}$ as desirable for most sensitive life stages of aquatic organisms, whereas DO below about $3\mathrm{mg/L}$ can be stressful or lethal for extended exposure [20, 19]. In this context, S1 and especially S2 exhibit sub-optimal DO conditions, while S3 is just above a typical target threshold.

Table 5-6: Dataset for dissolved oxygen (DO) (Sep–Oct 2025) with BECR/WHO standards and WASA water reference.

Month	**Sample ID**	**DO**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	4.75	6.2
	Sample 02	3.25	6.2
	Sample 03	6.05	6.2
Oct-25	Sample 04	3.48	6.3
	Sample 05	4.1	6.3
	Sample 06	2.72	6.3
Average	AVG	4.06	6.25
Standard	BECR	6	
	WHO	5	

	Sample ID	DO	BECR standard (6.0)	WHO standard (5.0)
1	Sample 01	4.75	6	5
2	Sample 02	3.25	6	5
3	Sample 03	6.05	6	5
4	Sample 04	3.48	6	5
5	Sample 05	4.1	6	5
6	Sample 06	2.72	6	5

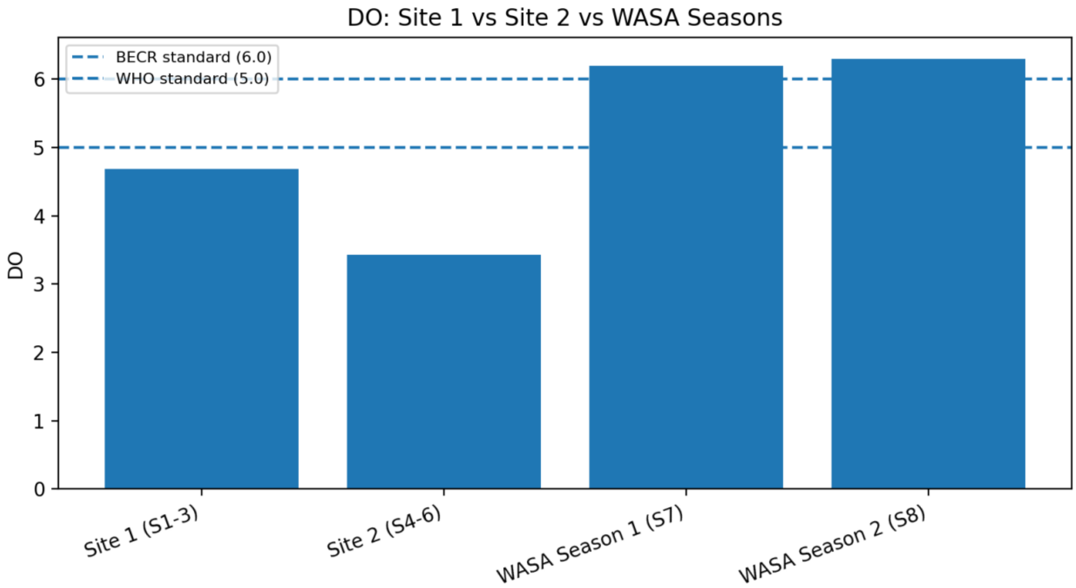

Figure 5-6: Dissolved oxygen (DO) at three sampling sites compared with a reference value of 6mg/L.

Considering the high BOD and COD, the depressed DO at S 1 and S 2 is consistent with oxygen consumption due to microbial degradation of organic matter and other reduced constituents. This situation mirrors findings in other years, where DO in parts of Hatirjheel has been reported as low as $2.7 - 3.7 \text{mg/L}$ in some seasons [4].

5.5 EC, TDS and hardness

EC values were $620 \mu \text{ S cm}^{-1}$ (S1), $570 \mu \text{ S cm}^{-1}$ (S2) and $550 \mu \text{ S cm}^{-1}$ (S3). These values are moderate and below several EC thresholds used for irrigation and aquatic life in Bangladesh surface water assessments [18]. TDS values of 310,285 and 275mg/L are well below the 1000mg/L limit commonly used for drinking water and comparable to those reported in previous Hatirjheel surveys [1, 4]. Hardness ranged from 153 to 171mg/L as $CaCO_3$, falling into a moderately hard category typical of urban lakes with mixed geological and anthropogenic inputs.

Table 5-7: Dataset for electrical conductivity (EC) (Sep–Oct 2025) with WHO standard and WASA water reference.

Month	**Sample ID**	**EC**	**WHO Standard**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	620	1000	207
	Sample 02	570	1000	207
	Sample 03	550	1000	207
Oct-25	Sample 04	740	1000	208
	Sample 05	573	1000	208
	Sample 06	645	1000	208
Average	AVG	616.33	1000	207.50

	Sample ID	EC	WHO standard (1000.0)
1	Sample 01	620	1000
2	Sample 02	570	1000
3	Sample 03	550	1000
4	Sample 04	740	1000
5	Sample 05	573	1000
6	Sample 06	645	1000

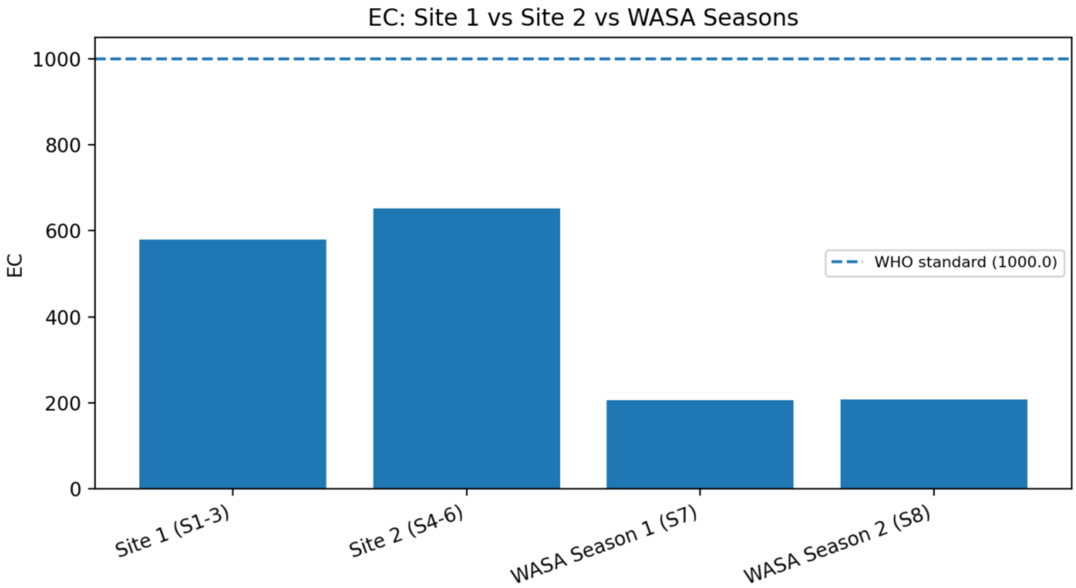

Figure 5-7: Electrical conductivity (EC) at the three Hatirjheel sampling sites.

Table 5-8: Dataset for total dissolved solids (TDS) (Sep–Oct 2025) with BECR/WHO standards and WASA water reference.

Month	**Sample ID**	**TDS**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	310	140
	Sample 02	285	140
	Sample 03	275	140
Oct-25	Sample 04	370	160
	Sample 05	286	160
	Sample 06	325	160
Average	AVG	308.50	150.00
Standard	BECR	1000	
	WHO	1000	

	Sample ID	TDS	BECR standard (1000.0)	WHO standard (1000.0)
1	Sample 01	310	1000	1000
2	Sample 02	285	1000	1000
3	Sample 03	275	1000	1000
4	Sample 04	370	1000	1000
5	Sample 05	286	1000	1000
6	Sample 06	325	1000	1000

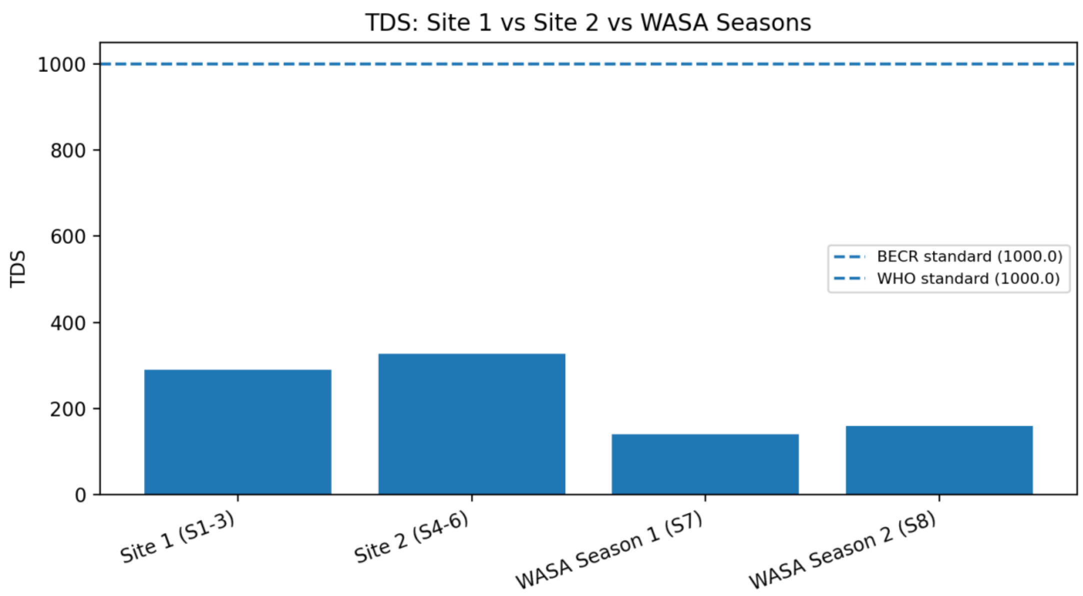

Figure 5-8: Total dissolved solids (TDS) at three sites compared with a Bangladesh drinking-water standard of 1000mg/L.

Table 5-9: Dataset for total hardness (as $CaCO_3$) (Sep–Oct 2025) with BECR/WHO standards and WASA water reference.

Month	**Sample ID**	**Hardness**	BECR Standard	**WHO Standard**	**WASA water (Sample 7 and 8)**
Sep-25	Sample 01	165	500	425	90
	Sample 02	171	500	425	90
	Sample 03	153	500	425	90
Oct-25	Sample 04	165	500	425	88
	Sample 05	171	500	425	88
	Sample 06	153	500	425	88
Average	AVG	163.00	500	425	89.00

	Sample ID	Hardness Value	Average hardness (163.0)
1	Sample -1	165	163
2	Sample -2	171	163
3	Sample -3	153	163
4	Sample -4	165	163
5	Sample -5	171	163
6	Sample -6	153	163

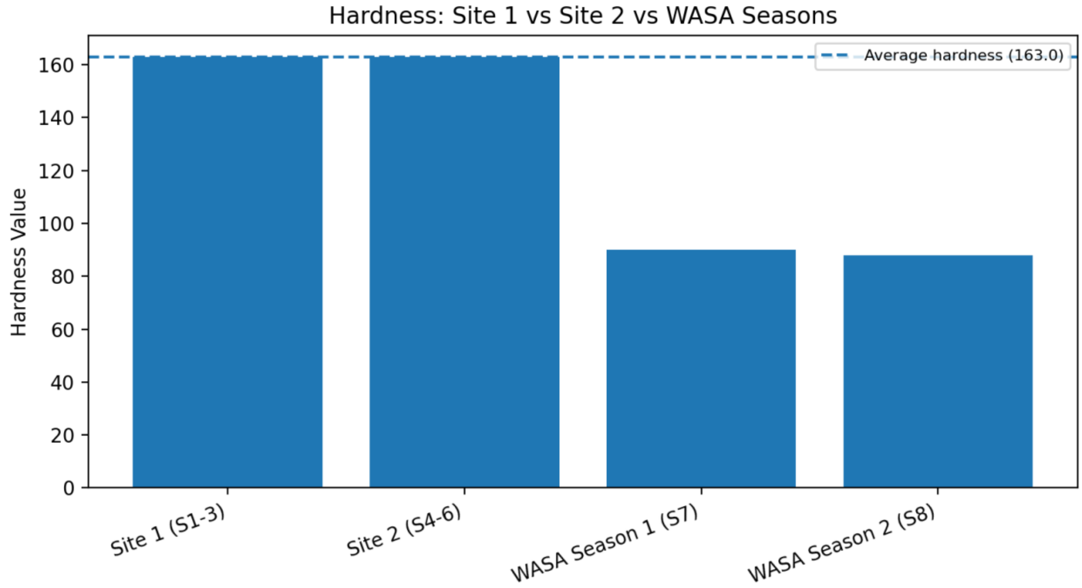

Figure 5-9: Total hardness of Hatirjheel Lake water at three sampling sites.

CHAPTER 6

Discussion

6.1 Correlation patterns and process interpretation

Despite the small sample size, pairwise Pearson correlation coefficients computed among the parameters reveal patterns consistent with those reported in larger urban-lake datasets [22, 7]:

- BOD and COD are almost perfectly positively correlated, as expected for parameters that both represent organic and oxidisable loads.
- EC and TDS are strongly positively correlated by definition, but their correlations with BOD and COD are more modest, indicating that salinity-related parameters are not direct proxies for organic pollution in this setting.
- Hardness shows a strong positive association with BOD and COD in this short dataset, but this should be interpreted cautiously: co-variation may reflect local mixing patterns rather than a direct causal link.

Similar patterns - especially negative DO-BOD correlations - have been documented in rivers and lakes worldwide and are widely used in water quality modelling and index construction [22, 23, 24].

6.2 Context within broader Hatirjheel and Dhaka lake research

Previous studies on Hatirjheel and other Dhaka lakes generally find:

- pH within 6.5-8.5, with mild alkalinity and modest seasonal variation;
- EC and TDS at moderate levels but occasionally elevated near localised discharges;
- BOD and COD frequently exceeding guideline values, especially near CSO outlets or in reaches with slow circulation; and
- DO often below 5mg/L in one or more seasons or locations, indicating chronic oxygen stress [1, 2, 3, 5, 4, 7].

The present dataset is entirely consistent with this pattern: salinity-type parameters (EC, TDS, hardness) and pH are acceptable, while organic pollution indicators (BOD, COD) and DO indicate substantial impairment at certain sites. This dichotomy is typical of urban water bodies dominated by domestic wastewater inputs rather than industrial brines or mining discharges.

6.3 Implications for lake management

From a management perspective, the key message is that organic pollution in Hatirjheel is still high enough at some points to cause oxygen depletion and potential ecological harm, despite past rehabilitation efforts. Likely sources include:

- intermittent and continuous CSO discharges that route combined sewage and stormwater into the lake during rainfall events [5];
- illegal or informal sewer connections directly into drains discharging to Hatirjheel;
- diffuse runoff carrying organic material and nutrients from adjacent residential and commercial areas; and
- resuspension and diagenesis of organic matter in bottom sediments during periods of stratification or mixing.

Mitigation options, discussed extensively in the literature, include:

- upgrading sewer networks to reduce the frequency and load of CSO events;
- improving operation and maintenance of regulators and pumping stations;
- introducing or restoring wetland zones and floating treatment wetlands to enhance in-lake attenuation; and
- strengthening routine water-quality monitoring in line with ECR standards and modern WQI frameworks [5, 7, 23].

6.4 Methodological and data limitations

The primary limitation of the present analysis is the small number of sampling sites and dates. With only three spatial observations and limited seasonal coverage, the statistical results (particularly correlation coefficients) are illustrative rather than definitive. Spatial gradients influenced by local hydrodynamics and point sources may be more complex than suggested here; previous works with more sampling stations have indeed found intricate spatial patterns [25].

Nonetheless, the dataset is measured with standard laboratory methods, and the strong contrast between sites, especially for BOD and COD, is unlikely to be an artefact of sampling error. The main added value of the present paper is therefore the detailed, transparent linkage between measured values, regulatory criteria, and interpretive figures.

CHAPTER 7

Conclusion

This study presented a technically detailed but compact assessment of physico-chemical water quality in Hatirjheel Lake using three September samples and additional two-season pH data. Key findings include:

- pH in both September and October remained within the ECR guideline range of 6.5-8.5, with limited spatial and seasonal variability.
- EC, TDS and hardness were moderate and generally within national guideline values, indicating that ionic strength and salinity alone do not preclude potential uses such as irrigation.
- BOD and COD substantially exceeded reference values, especially at S1 and S2, where BOD_5 reached up to $30 mg/L$ and COD up to $116 mg/L$. These levels are characteristic of moderately to heavily polluted urban waters.
- DO was below a typical $5 mg/L - 6 mg/L$ target at two sites, confirming oxygen stress likely driven by the high organic loading and elevated temperature.
- Simple ratios and correlation analysis, though based on a short dataset, are consistent with more extensive studies that identify CSO inputs and urban runoff as dominant drivers of Hatirjheel water quality.

The overall picture is that Hatirjheel remains an organically polluted urban lake with acceptable salinity-related parameters but compromised oxygen conditions in certain reaches. Priority management actions should therefore focus on reducing organic load, especially from combined sewer systems and informal connections, while maintaining or enhancing hydraulic flushing.

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