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Evaluation of Surface Water Quality Using Water Quality Index in Phewa Lake, Nepal

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ABSTRACT

Phewa Lake, the second largest lake of Nepal receives untreated wastewater from surrounding restaurants, hotels and urban areas. As the lifeline for the economic progress of that region, the water quality of Phewa Lake is of great concern. Therefore, this study was conducted to assess the water quality of Phewa Lake using the water quality index (WQI). WQI is a widely used evaluation tool that display the overall water quality status in a single number. Water samples were collected from sixteen sampling locations of Phewa Lake covering an area of 5.726 km^2. Ten physicochemical parameters namely electrical conductivity (EC), pH, turbidity, total dissolved solids (TDS), alkalinity, biological oxygen demand (BOD), chloride, dissolved oxygen (DO), hardness and nitrate were analyzed for the computation of WQI. The calculated WQI ranges from 20.74 to 70.65, indicating excellent water quality on average which may be attributed to limited anthropogenic activities due to COVID-19 pandemic. 87.5% of the sampling site, the water quality was excellent and 12.5% was of good category. Except for turbidity, all the physicochemical parameters were within the permissible limit. The findings of this study are fundamentally important to concern authorities which may aid in decision making for effective lake management.

Keywords: *Water quality index, physicochemical parameters, Phewa Lake, water quality*

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INTRODUCTION

For life to exist on Earth, water is essential (Dalakoti et al., 2018).Half of the world's renewable freshwater is provided by lakes (Johnson et al., 2001) which plays a crucial role in the socio- economic development for human wellbeing (Anthonj et al., 2019). Lakes are considered to be ecological indicator of a city's health since they control the microclimate of urban settings (Ravikumar et al., 2013). However, the lakes are vulnerable to water pollution due to the stagnant water. Discharge of municipal wastewater, industrial effluent, agricultural runoff along with weathering of rocks and overuse of chemicals are responsible for the contamination of surface water (Maansi et al., 2022). Monitoring of water quality has become a prerequisite to safeguard public health and to treasure valuable freshwater resources. Therefore, it is vital to check the quality status of this precious natural resource by evaluating the physicochemical parameters of water (Venkatesharaju et al., 2010). Stating each water quality parameter to outline water quality is difficult to understand (Akoteyon et al., 2011). So, data records of water quality can be efficiently summarized by using the water quality index (Reza & Singh, 2010) which was first proposed by Horton in 1965 (Horton, 1965). Phewa Lake, the second largest lake in Nepal is one of the most attractive tourist destinations and has experienced rapid urbanization. Phewa Lake is under pressure of siltation resulting in shrinkage of lake area, water pollution, eutrophication, and catchment area encroachment (Watson et al., 2019). Periodic analyzing of water chemistry of the lake is vital as many factors are accountable for the deterioration of water quality within a particular

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water body. Therefore, the objective of this study was to assess the water quality of Phewa Lake using water quality index (WQI) and to examine the status of physicochemical parameters of water with respect to National Drinking Water Quality Standards (NDWQS), 2005.

METHOD

The study was conducted on Lake Phewa which is an urban lake in the Pokhara valley with an altitude of 742 m above sea level. The lake has an area of 5.726 km^2 and average depth of the lake is about 8.5 m (Watson et al., 2019).

The subsurface water samples were collected from sixteen sampling locations of the study area (Fig. 1). The guidelines provided by American Public Health Association (APHA) were followed for water sample collection. Parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), and dissolved oxygen (DO) were measured immediately on site. While the remaining parameters were analyzed based on the Standard Methods for the Examination of Water and Wastewater. Lab analysis were carried out at Nepal Academy of Science and Technology (NAST), Khumaltar, Nepal.

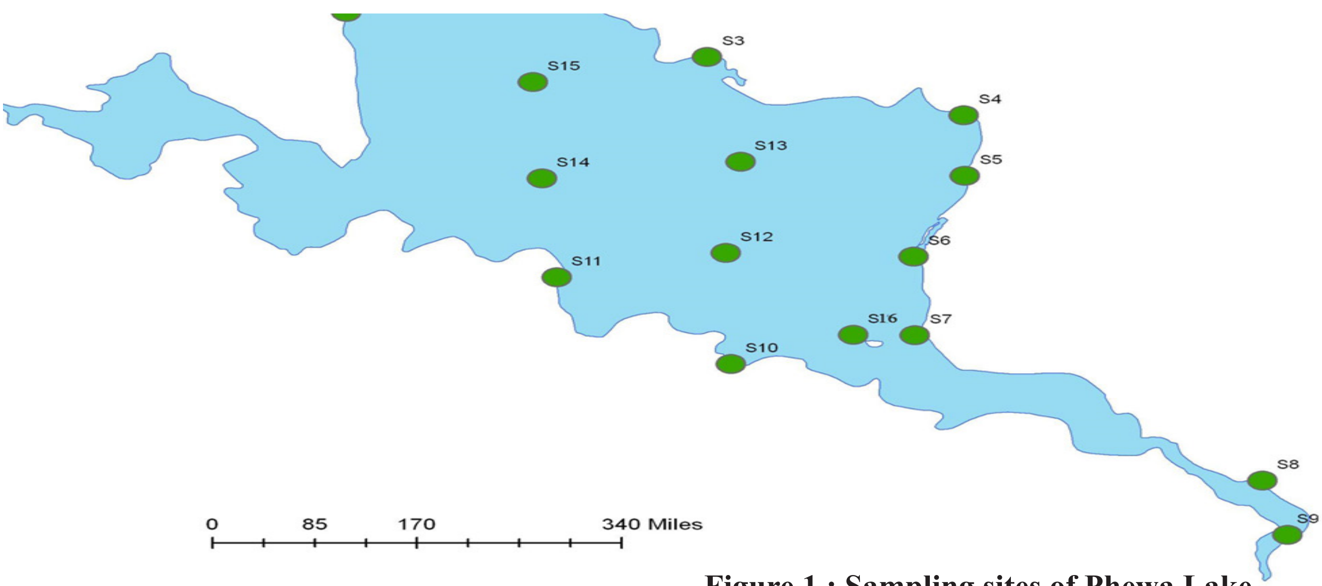

Figure 1 : Sampling sites of Phewa Lake

Table 1. Analytical methods applied for the measurement of physico-chemical parameters

Parameters	Analytical methods	Units	NDWQS
EC	EC/TDS meter Milwaukee E (59, Europe	µS/cm	1500
pH	HANNA pH meter pHep®, Romania		6.5 – 8.5
Turbidity	Nephelometer (HANNA)	NTU	5
TDS	EC/TDS meter Milwaukee E (59, Europe)	mg/L	1000
Chloride	Argentometric titration	mg/L	250
Hardness	EDTA titration	mg/L as $CaCO_3$	500
Nitrate	Colorimetric kit method (Visocolor® alpha, Germany)	mg/L	50
Alkalinity	Titrimetric	mg/L	-
BOD	Winkler's method	mg/L	-
DO	Winkler's method	mg/L	-

Calculation of WQI

WQI is a widely used evaluation tool that displays the overall water quality status in a single number (Ravikumar et al., 2013). Ten physicochemical parameters namely EC, pH, turbidity, TDS, alkalinity, biological oxygen demand (BOD), chloride, DO, hardness and nitrate were analyzed for the calculation of WQI. The computed WQI values were categorized into different classes.

Table 2. Classification of water quality index value (Sahu & Sikdar, 2008)

WQI value	Type of water
< 50	Excellent water
50 -100	Good water
100 – 200	Poor water
200 – 300	Very poor water
>300	Unsuitable

RESULTS and DISCUSSION

Spatial variation of water quality index

Except for two sampling sites (S3, S4), WQI values for remaining sites were excellent. The calculated WQI value ranges from 20.4 to 70.65, indicating excellent water quality on average. As the recreation activities, hotels and restaurants around the lake was shut down during COVID –19 pandemic, it may have upgraded the quality of water (Malla-Pradhan et al.,2022; Malla-Pradhan et al., 2024). Khan et al. (2021) also mentioned the improvement in water quality during COVID -19 in his review paper. The water quality of 87.5 % of the sampling sites was excellent and 12.5 % fall under the good category.

Physicochemical water quality parameters.

The physicochemical parameters of water are key factors as they have significant impact on water quality. The mean, maximum and minimum values of the selected physicochemical parameters of the sampling sites are presented in Table 3.

Electrical conductivity is the capacity of the water to conduct an electrical current and is an indirect measure of the ion concentration (APHA, 2005).

The value of EC ranged from 50 µS/cm to 123 µS/cm which is well within the permissible limit but relatively higher EC value noted in Lake Mallathahalli of Karnataka, India (Ravikumar et al., 2013). pH is a numerical expression that indicates the degree to which water is acidic or alkaline in nature. The pH ranges from 7.5 to 8.8 with a mean of 7.95 indicating slightly alkaline state of water. Water becomes corrosive with low pH value while high pH value has harmful effects on skin and eyes (Rao & Nageswararao, 2010). Turbidity is the cloudiness of water (WHO, 2017). The mean value of turbidity 6.36 NTU exceeded the permissible limit of 5 NTU. Total dissolved solids consist of inorganic salts and little amount of organic matter dissolved in water. The average concentration of TDS was 41.94 mg/L which is below the NDWQS permissible limit of 1000 mg/L. Lower TDS value (< 100mg/L) was reported by Manzoor et al. (2017) in Lake Sukhana. Chloride is the major inorganic anions naturally occurring in all freshwater in low concentration. The value of chloride in Phewa Lake ranges from 8.52 mg/L to 11.36 mg/L which is low in comparison to the permissible limit of 250 mg/L. Chloride is a prime barometer of water pollution (Podhade et al., 2020). Hardness represents the concentration of calcium and magnesium ions present in water. The mean total hardness value 38.50 mg/L in the study area was below the permissible limit of 500 mg/L (NDWQS, 2005) and water can be classified as soft water (WHO, 2004). Nitrate value was found to be 1.13 mg/L which was within the standard value. High nitrate concentration stimulates phytoplankton productivity which causes eutrophication, loss of biodiversity, leads to toxic algal bloom that can destroy fisheries (Bartley et al., 2003).

Table 3. Physicochemical water quality variables of Phewa Lake

Parameters	Mean	SD	Min	Max
EC	83.56	14.57	50	123
pH	7.95	0.32	7.5	8.8
Turbidity	6.36	6.84	1.83	25.6
TDS	41.94	7.57	25	63
Chloride	10.03	1.21	8.52	11.36
Hardness	38.5	4.29	32	50
Nitrate	1.13	0.5	0.5	2

CONCLUSION

This study used WQI and physicochemical water parameters to evaluate the water quality status of Phewa Lake from sixteen different sampling locations. The concentrations of the studied physicochemical parameters such as EC, pH, TDS, chloride, hardness and nitrate were within the prescribed limit of national standard except turbidity which slightly exceeded the limit. Based on WQI, we can conclude that during the sampling period, the water quality of Phewa Lake was excellent. This may be due to the self-purification mechanism of the lake water as the sample was taken just a few days after the restriction was lifted due to COVID-19 pandemic. Regular monitoring of lake water is necessary to maintain the quality of water to protect them from contamination.

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Conflict of interest: None

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