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Original Article

Seasonal assessment of Water Quality Index of Upper Lake Bhopal

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Abstract

Upper Lake (Bhojtal) in Bhopal, Madhya Pradesh, is one of the largest man-made lakes in India and serves as a major source of drinking water for the city. Rapid urbanization, sewage inflow, anthropogenic pressure, and climate variability have significantly affected the lake's water quality. The present study evaluates the Water Quality Index (WQI) of Upper Lake using physicochemical parameters such as pH, dissolved oxygen (DO), total dissolved solids (TDS), total hardness, alkalinity, and nitrate were considered for WQI assessment. The findings revealed significant seasonal fluctuations in water quality. The highest WQI values were observed during summer, indicating comparatively poor water quality due to evaporation, concentration of dissolved solids, and anthropogenic stress. Monsoon season showed comparatively improved water quality because of dilution effects caused by rainfall. The overall WQI values indicated that the lake water ranged from low to medium polluted across different seasons. The study highlights the growing environmental pressure on Upper Lake and emphasizes the need for continuous monitoring, sustainable management practices, and pollution control measures.

Keywords: *Water Quality Index, Upper Lake, Bhojtal, Bhopal, physicochemical parameters, lake pollution, seasonal variation*

Introduction

Water quality assessment is an important aspect of environmental monitoring and sustainable water resource management. Lakes situated within urban areas are particularly vulnerable to pollution caused by sewage discharge, industrial runoff, agricultural activities and anthropogenic disturbances. Upper Lake, locally known as Bhojtal, is a Ramsar wetland site and provides approximately 40% of Bhopal city's drinking water supply.

Upper Lake has experienced increasing environmental stress due to urban expansion, domestic sewage inflow, tourism activities, idol immersion and climate-induced hydrological changes. Recent studies have reported deterioration in water quality parameters and elevated nutrient concentrations contributing to eutrophication.

Water Quality Index (WQI) is widely used to simplify complex water quality data into a single numerical expression representing the suitability of water for human use. This study aims to assess the seasonal WQI status of Upper Lake Bhopal in various sampling sites from present experimental study.

Study Area

Upper Lake is located in Bhopal, Madhya Pradesh, India, between latitude 23°12′N and longitude 77°18′E. It was constructed during the 11th century by Raja Bhoj, the lake covers approximately 31 km² and forms a crucial freshwater ecosystem for central India. The lake supports drinking water supply, fisheries, recreation, irrigation, and biodiversity conservation.

Twenty sampling sites were selected for the study. These locations represent different ecological and anthropogenic zones of the lake including recreational areas, domestic influence zones, and comparatively less disturbed regions. The sampling stations are selected in such the way so that the whole lake may be covered for proper sampling and better data analysis.

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A total of 20 sites have been selected for the study

The observations were categorized into four seasons:

- Summer
- Monsoon
- Post-monsoon
- Winter

Sampling Sites details				
S.No.	Name of Sampling Sites	Sample Sites Code	Location	
			Latitude	Longitude
1	Sair Sapata, Upper Lake, Bhopal	BUL1	23°21'62.5"N	77°37'54.5"E
2	Van vihar National Park, Upper Lake, Bhopal	BUL2	23°14'18.6"N	77°21'26.8"E
3	Beside Shamala Hills, Upper Lake, Bhopal	BUL3	23°14'30.6"N	77°22'38.2"E
4	Krishna Nagar, Upper Lake, Bhopal	BUL4	23°14'52.2"N	77°23'31.1"E
5	Ginnori Road, Upper Lake, Bhopal	BUL5	23°15'02.0"N	77°23'56.4"E
6	VIP Road, Street View, Upper Lake, Bhopal	BUL6	23°15'18.0"N	77°23'49.3"E
7	VIP Road, Nakkar Khana, Upper Lake, Bhopal	BUL7	23°15'35.2"N	77°23'10.0"E
8	IPC College Road, Upper Lake, Bhopal	BUL8	23°15'25.0"N	77°21'41.2"E
9	Near Panchmukhai Hanumam Temple, Upper Lake, Bhopal	BUL9	23°16'05.3"N	77°21'31.1"E
10	Boor Van, Upper Lake, Bhopal	BUL10	23°15'29.7"N	77°20'54.6"E
11	Sant Hirdaramdas Nagar, Upper Lake, Bhopal	BUL11	23°16'01.5"N	77°19'46.0"E
12	Chirayu Madical College, Upper Lake, Bhopal	BUL12	23°15'39.6"N	77°18'53.4"E
13	Near Playotel Resort, Upper Lake, Bhopal	BUL13	23°15'33.8"N	77°18'12.4"E
14	Jamoniyachhir, Upper Lake, Bhopal	BUL14	23°15'03.6"N	77°17'14.6"E
15	Khetlakhedi, Upper Lake, Bhopal	BUL15	23°14'34.9"N	77°15'56.5"E
16	Inhkhedichhap, Upper Lake, Bhopal	BUL16	23°13'58.4"N	77°15'48.5"E
17	Huzur, Upper Lake, Bhopal	BUL17	23°14'11.9"N	77°16'48.5"E
18	Mugaliya Chhap, Upper Lake, Bhopal	BUL18	23°14'42.4"N	77°17'50.2"E
19	Bhoj wetland, Upper Lake, Bhopal	BUL19	23°13'57.1"N	77°19'59.2"E
20	Bisankhedi, Upper Lake, Bhopal	BUL20	23°14'34.5"N	77°20'47.2"E
	Note : BUL01- BUL20 corresponds to Bhopal Upper lake sample stations 01-20			

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Materials and Methods

Data Collection

The present assessment is based on recent local studies conducted for seasonal physicochemical analyses of water reported for Upper Lake, Bhopal. Early morning samples were collected from all 20 the sampling sites during all four seasons i.e. Summer, Monsoon, Post Monsoon and Winter. Parameters commonly used in WQI estimation include:

- pH
- Total Dissolved Solids (TDS)
- Dissolved Oxygen (DO)
- Total Hardness
- Total Alkalinity
- Nitrate

Water Quality Index Method

Calculate Unit Weight (Wi)

The unit weight is inversely proportional to the standard value.

Formula:

$Wi=K/Si$

Where:

- Wi = Unit weight of parameter
- Si = Standard permissible value
- K = Constant of proportionality

Calculate Constant (K)

Formula:

$K=1/\sum(1/Si)$

Calculate Quality Rating Scale (Qi)

Formula:

$Qi=(Vi-Videal)/(Si-Videal)\times100$

Where:

- Qi = Quality rating
- Vi = Observed value from water sample
- Si = Standard permissible value
- Videal = Ideal value

Calculate Sub-Index (SIi)

Formula:

$SIi=Wi\times Qi$

Where:

- SIi = Sub index
- Wi = Unit weight
- Qi = Quality rating

Calculate Final WQI

Formula:

$WQI=\sum SIi / \sum Wi$

Based on the above formula the Water Quality Index of all water samples of all 04 seasons was obtained.

The WQI classification used in the study is as follows:

WQI Range	Water Quality Status
0–25	Excellent
26–50	Good
51–75	Poor
76–100	Very Poor
>100	Unsuitable for Drinking

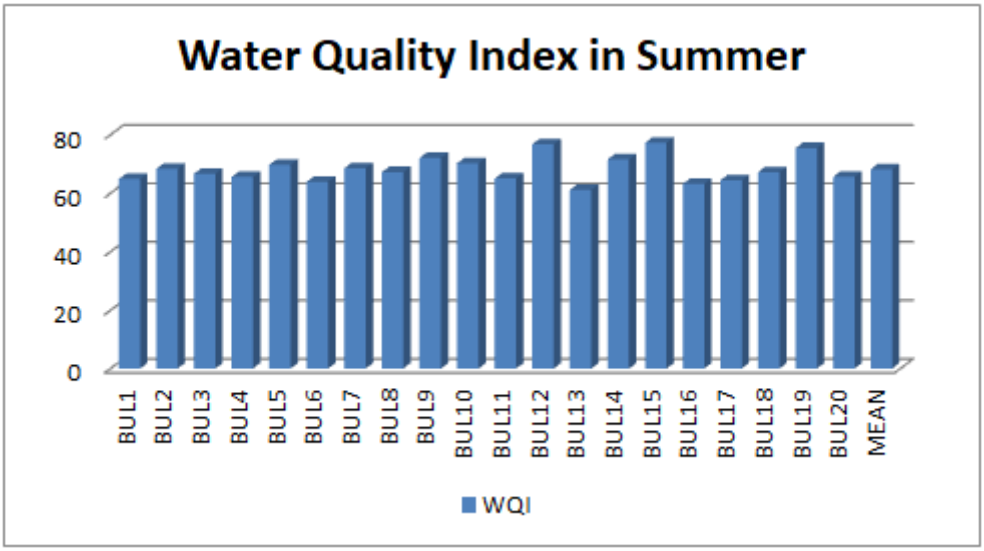
Results and Discussion

Seasonal Variation in Water Quality Index

Summer Season

The summer season recorded the highest WQI values among all seasons. WQI values ranged from 77.24 to 61.15 across all twenty sampling stations (BUL01-BUL20).

The mean summer WQI was approximately 68.20, indicating poor water quality. Increased evaporation, reduced inflow, and concentration of dissolved pollutants during summer may be responsible for this deterioration.



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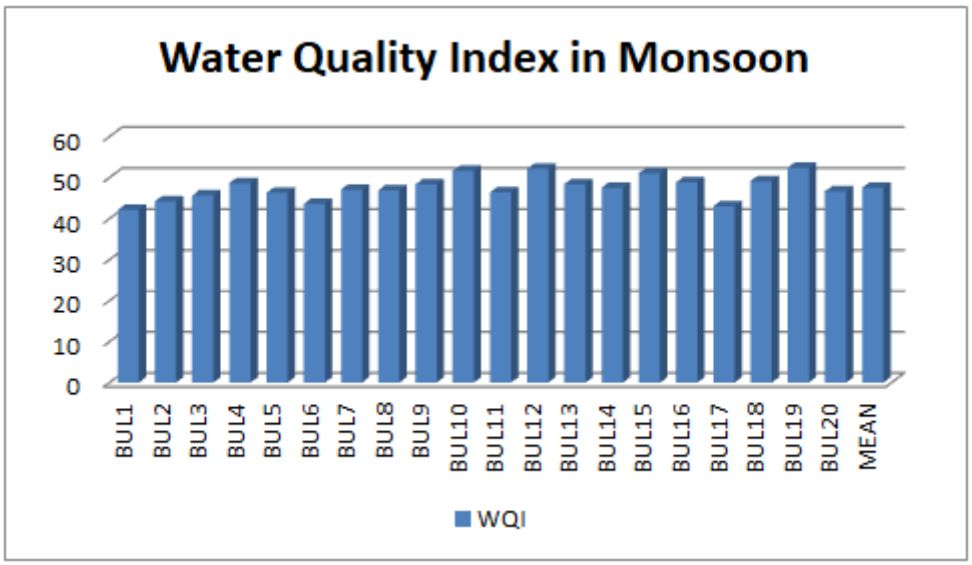
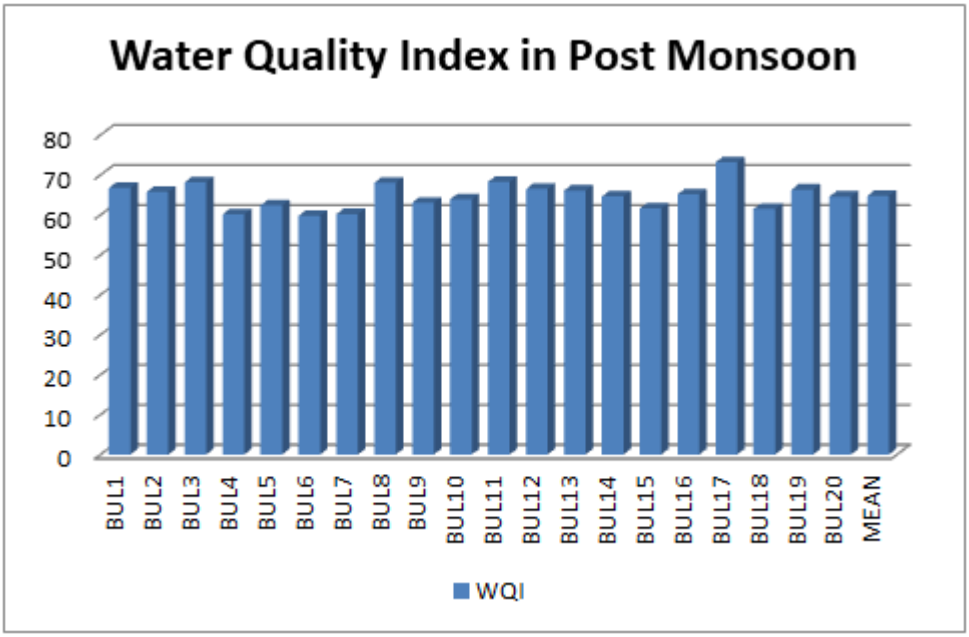
Monsoon Season

The monsoon season exhibited comparatively lower WQI values due to the dilution effect of rainwater. The average monsoon WQI was approximately 47.5, which falls under the good water quality category. WQI values ranged from 52.4 to 42.11 across all twenty sampling stations (BUL01-BUL20).



Post-Monsoon Season

Post-monsoon water quality remained relatively stable. Moderate WQI values were observed due to gradual settlement of suspended particles and improvement in dissolved oxygen.WQI values ranged from 73.15 to 59.72 across all twenty sampling stations (BUL01-BUL20).
The average post monsoon WQI was approximately 64.78, indicating transition toward poor water quality.



Winter Season

Winter season showed moderate water quality conditions with comparatively stable physicochemical parameters.WQI values ranged from 55.63 to 45.3 across all twenty sampling stations (BUL01-BUL20).
The average post monsoon WQI was approximately 49.73, indicating good water quality.

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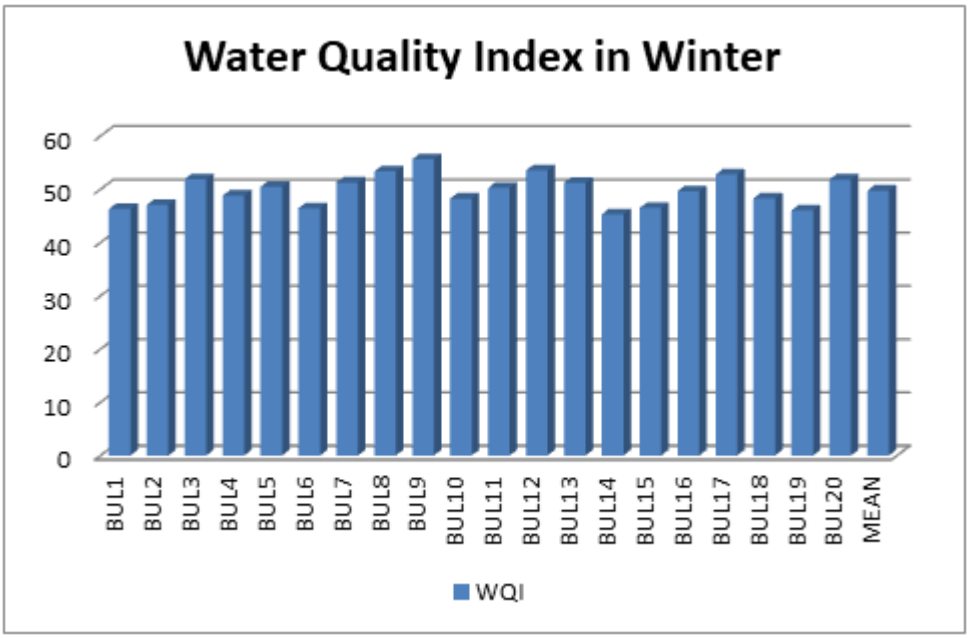

Observed Mean values of WQI and status across twenty sampling sites in four seasons of Upper Lake Bhopal

Season	Observed Mean	Water Quality Status
Summer	68.2	Poor
Monsoon	47.5	Good
Post-Monsoon	64.56	Poor
Winter	49.73	Good

The summer season exhibited the highest WQI values due to reduced water volume, increased evaporation and concentration of dissolved pollutants. Monsoon season showed lowest WQI values because rainfall diluted pollutant concentration and improved dissolved oxygen levels.

Recent environmental monitoring by the Madhya Pradesh Pollution Control Board reported elevated total coliform concentrations in several locations of Upper Lake, categorizing portions of the lake under Class-B water quality suitable primarily for outdoor bathing rather than direct drinking purposes.

Physicochemical Characteristics

Studies reported that most physicochemical parameters remained within permissible limits during monsoon and winter seasons, whereas alkalinity, turbidity and nutrient loading increased significantly during summer.

Heavy metal accumulation and bacteriological contamination have also been observed due to urban sewage discharge and catchment degradation. Earlier bacteriological investigations indicated substantial seasonal coliform variation in lake water.

Anthropogenic and Climatic Influence

Upper Lake is increasingly threatened by:

- Untreated sewage inflow
- Encroachment around catchment areas
- Religious waste disposal
- Tourism-related littering
- Climate change and declining water levels

Recent climate-based studies predict that Upper Lake may shrink substantially by 2050 if current climatic trends continue.

Community observations and local environmental concerns further highlight growing pollution pressure on the lake ecosystem.

Discussion

The study clearly demonstrates the influence of seasonal changes on water quality in Upper Lake Bhopal. Summer season showed maximum WQI values because of higher temperature, evaporation and increased concentration of dissolved solids. Human activities around the lake such as sewage inflow, idol immersion, tourism and surface runoff also contribute to seasonal water quality deterioration.

The monsoon season showed improved water quality due to dilution of pollutants and increased water circulation. However, excessive runoff during heavy rainfall may also introduce nutrients and organic matter into the lake. Winter season maintained comparatively stable conditions because lower temperatures enhance dissolved oxygen retention.

The observed WQI pattern follows the trend:

Summer > Post-Monsoon > Winter > Monsoon

Showing summer as highly polluted, followed by post monsoon and winter, monsoon season being least polluted due to excessive runoff of rain water. This seasonal

trend is consistent with several recent studies conducted on Upper Lake and other urban freshwater lakes in India.

Although most WQI values remained within good to poor categories, continuous anthropogenic pressure may further degrade lake water quality in future years if proper management measures are not implemented.

Conclusion

The assessment of Water Quality Index of Upper Lake indicates moderate seasonal deterioration in water quality, especially during summer months. Although the lake continues to remain an important freshwater source for Bhopal city, increasing anthropogenic pressure and sewage contamination are adversely affecting its ecological health. Seasonal WQI analysis demonstrates that monsoon dilution temporarily improves water quality, whereas pre-monsoon conditions contribute to pollutant concentration and eutrophication risks.

Sustainable management practices including sewage treatment, catchment conservation, strict pollution control, periodic monitoring, and public awareness programs are necessary for long-term protection of Upper Lake.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Gautam, V., Jain, V. K., & Jain, V. (2025). *Water quality assessment of Upper Lake Bhopal (M.P.) India with special reference to removing odour*. Accent Journal of Economics Ecology & Engineering, 10(11), 15–27. Retrieved from https://ajeee.co.in/index.php/ajeee/article/view/5750
2. Gautam, V., & Jain, V. (2022). *Evaluation of the Upper Lake Bhopal's water quality: A basic review*. Accent Journal of Economics Ecology & Engineering, 7(4), 71–76. Retrieved from https://www.ajeee.co.in/index.php/ajeee/article/view/3316
3. Ghadei, P., & Jally, S. K. (2024). *Spatiotemporal analysis of physiochemical properties and trophic state index of Upper Lake, a Ramsar site, Bhopal, India using in-situ observation data*. International Journal of Environmental Sciences. https://doi.org/10.64252/y80mtb88
4. Nisar, Z., Hurra, W. A., & Dar, R. A. (2022). *Determination physico-chemical characteristics of water quality in Upper Lake Bhopal (M.P.)*. Journal of Advanced Zoology, 43(1). https://doi.org/10.53555/jaz.v43i1.4876
5. Singh, N., & Samartha, M. (2021). *Determination of water standards of Upper Lake, Bhopal, India*. Uttar Pradesh Journal of Zoology, 42(7), 75–82. Retrieved from https://mbimph.com/index.php/UPJOZ/article/view/2056
6. Upadhyay, R., Pandey, K. A., & Upadhyay, S. K. (2013). *Assessment of lake water quality by using Palmer and trophic state index: A case study of Upper Lake, Bhopal, India*. International Research Journal of Environmental Sciences, 2(5), 1–8. Retrieved from https://www.isca.me/IJENS/Archive/v2/i5/1.ISCA-IRJEvS-2013-024.php
7. Virha, R., Biswas, A. K., Kakaria, V. K., Qureshi, T. A., Borana, K., & Malik, N. (2011). *Seasonal variation in physicochemical parameters and heavy metals in water of Upper Lake of Bhopal*. Bulletin of Environmental Contamination and Toxicology, 86, 168–174. https://doi.org/10.1007/s00128-010-0172-0
8. Times of India. (2025). *Contamination high in city lakes, water unfit for drinking: PCB*. Retrieved from https://timesofindia.indiatimes.com/city/bhopal/contamination-high-in-city-lakes-water-unfit-for-drinking-pcb/articleshow/122678627.cms
9. Times of India. (2026). *Drying up? Upper Lake could shrink by 40% by 2050: Study*. Retrieved from https://timesofindia.indiatimes.com/city/bhopal/drying-up-upper-lake-could-shrink-by-40-by-2050-study/articleshow/129961196.cms
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