



Assessment of Macrophyte Diversity and Seasonal Variations in Two Freshwater Lakes of Jaipur District, Rajasthan

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KEYWORDS

Fresh water,
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ABSTRACT:

Introduction: Macrophytes play a crucial role in maintaining freshwater ecosystem health and are effective indicators of water quality. Mansagar Lake (urban) and Chandlai Lake (peri-urban), located in Jaipur District, Rajasthan, offer contrasting environmental and trophic conditions suitable for ecological comparison.

Objectives: The study aimed to evaluate the diversity and ecological role of macrophyte communities in the two lakes and assess their potential as bioindicators for water quality monitoring.

Methods: A year-long field investigation was conducted across the summer, monsoon, and winter seasons. Macrophytes from littoral and sub-littoral zones were sampled and categorized into four ecological groups: free-floating, submerged, marginal, and emergent.

Results: A year-long field investigation was conducted across summer, monsoon, and winter seasons. Macrophytes from littoral and sub-littoral zones were sampled and categorized into four ecological groups: free-floating, submerged, marginal, and emergent.

Conclusions: The study confirms the utility of macrophytes as reliable bioindicators for freshwater quality. Their diversity patterns offer a nature-based, cost-effective approach for monitoring aquatic health in semi-arid environments.

1. Introduction-

Aquatic macrophytes, the macroscopic vegetation found in freshwater ecosystems, play a critical ecological role in maintaining ecosystem balance and water quality. These plants are instrumental in removing both toxic and non-toxic substances from water and sediments through natural purification processes. (Bashir et al., 2022) By absorbing excess nutrients such as nitrogen and phosphorus, macrophytes help control eutrophication and support the functioning of aquatic ecosystems. (Muskute & Chavan, 2016). In addition to their role in nutrient cycling, macrophytes trap sediments, support the growth of beneficial microbial communities, and contribute to the degradation of organic pollutants. (Yunxiao et al., 2013). Structurally, dense macrophyte beds create complex habitats that enhance species richness by providing spawning grounds, refuge, and food sources for fish, amphibians, invertebrates, and avian fauna. Furthermore, they help stabilize sediments, reduce shoreline erosion, and contribute to carbon

sequestration, thereby enhancing climate resilience (Fernández & Zilli, 2019). Macrophytes are also recognized as effective bioindicators of aquatic ecosystem health. The presence, abundance, and distribution of specific species can reflect the trophic status of a water body and indicate pollution levels or ecological imbalance. As such, monitoring macrophyte diversity serves as a cost-effective and reliable approach to assessing water quality and ecosystem changes due to anthropogenic pressure or climatic variation (Bashir et al., 2021). The ecological habitats of aquatic macrophytes vary widely, including free-floating, submerged, rooted submerged, rooted with floating leaves, and emergent types. Understanding their distribution and diversity is essential for effective water management, especially in semi-arid regions where water bodies face environmental stress. (Chaurasia, 2022) This study focuses on the floristic composition and seasonal dynamics of macrophytes in two freshwater lakes, Mansagar (urban) and Chandlai (peri-urban),



located in Jaipur District, Rajasthan. By analyzing macrophyte diversity across seasons and lake types, this research aims to evaluate their potential as ecological indicators of water quality and trophic status in a semi-arid climatic zone

2. Objectives-

The primary objective of this study is to evaluate the diversity, composition, and ecological significance of aquatic macrophyte communities in two contrasting freshwater ecosystems—Mansagar Lake (urban) and Chandlai Lake (peri-urban)—located in the semi-arid region of Jaipur District, Rajasthan. By conducting seasonal assessments over a year, the research aims to understand how macrophyte diversity responds to varying trophic statuses and environmental conditions. Specifically, the study investigates the spatial and temporal distribution of macrophyte species, categorizes them into ecological groups, and analyzes their potential as bioindicators of water quality. This comparative analysis is intended to support the use of macrophyte-based monitoring as a cost-effective and reliable approach for assessing ecological health in freshwater bodies exposed to different levels of anthropogenic pressure.

3. Methods

3.1 Study Area

The present study was conducted in two freshwater lakes located in Jaipur District, Rajasthan, India, (mentioned in Figures 2 and 3), which falls within a semi-arid climatic zone. Jaipur receives an average annual rainfall of approximately 603 mm, with nearly 90% of precipitation occurring during the monsoon months (June to September). The region exhibits significant interannual variability in rainfall patterns and experiences around 34 rainy days per year on average.

3.2 Mansagar Lake (Urban Water Body)

Mansagar Lake, also known as Jal Mahal Lake, is a prominent artificial freshwater reservoir situated on the northern outskirts of Jaipur city (26.959°N, 75.845°E). Originally constructed in the 18th century, the lake serves both ornamental and ecological functions. The eastern boundary of the lake is lined by a dam measuring approximately 300 meters in length and 28.5–34 meters in width, equipped with three sluice gates that regulate

water discharge downstream. As an urban water body, Mansagar Lake receives runoff from surrounding densely populated areas and is subject to anthropogenic stress, making it a suitable site for studying urban aquatic ecology. (Dadupanthi, 2023)

3.3 Chandlai Lake (Peri-Urban/Rural Water Body)

Chandlai Lake is a small freshwater lake located near the Jaipur-Kota Highway, approximately 30 kilometers southeast of Jaipur city center (26.665°N, 75.876°E). Historically, a natural wetland, the lake has gradually evolved into a semi-permanent water body and plays a critical role in maintaining regional biodiversity. It receives seasonal inflows of both wastewater and agricultural runoff. Despite pollution pressures, Chandlai Lake remains a vital habitat for aquatic vegetation (macrophytes), fish, amphibians, and a wide variety of avifauna. The site is especially noted for attracting migratory bird species such as flamingos and pelicans during the winter season, establishing its importance as a birdwatching hotspot and ecological conservation zone. (Sharma *et al.*, 2008)

These two lakes, one urban and one rural, were selected for comparative analysis to evaluate differences in macrophyte diversity and ecological health under contrasting land-use and environmental conditions.



Figure 1-Location map- Jaipur (Raj)

Source - <https://sl.bing.net/hb2yMMq1PMq>



Figure 2 – Mansagar Lake

Source- <https://www.google.com/maps/place/Mansagar+Lake/@26.9535,75.8462,15z>

Figure 3 – Chandlai Lake

Source-<https://maps.app.goo.gl/Ce4VHZmHemMvUvMx5Z>

3.4 Sampling -

Macrophyte sampling was conducted seasonally—during summer, monsoon, and winter—from April 2023 to June 2024 in two freshwater lakes of Jaipur District. In shallow water zones, macrophytes were collected manually, while deeper water samples were obtained using a long-handled hook. Three replicate samples were collected from each of two stations in both lakes using a 50 cm × 50 cm hand net within the littoral zone. A 1 m × 1 m wooden quadrat was employed for random sampling across shoreline areas. Submerged plants were collected using tubs from a boat, and hand plucking was used for species counting. All specimens were thoroughly washed in the field to remove sediment and fauna, wrapped in filter paper, and transported to the laboratory in polythene bags placed in iceboxes. Upon arrival, samples were preserved in 10% formalin for identification and analysis. Macrophyte species were identified to the species level using standard literature, including APHA (2024), and morphometric characteristics were recorded. Taxonomic validation of scientific names was performed using online databases such as Plants of the World Online (POWO, 2024), World Flora Online (WFO, 2024), and the Global Biodiversity Information Facility (GBIF, 2024). Collected macrophytes were classified into four ecological categories: free-floating, submerged, marginal, and emergent, based on their growth forms and habitat preferences.

4. Results

A total of 15 macrophyte species belonging to 12 families were recorded from the two freshwater lakes

studied—Mansagar Lake (urban) and Chandlai Lake (peri-urban).

These species were classified into four ecological categories based on their growth forms: free-floating (4 species), submerged (2 species), marginal (7 species), and emergent (2 species). A detailed breakdown of seasonal abundance and distribution is provided in Table 1

Marginal plants constituted the largest group in both lakes, particularly in Chandlai Lake, where they were observed in higher abundance across all seasons. *Typha sp.*, *Cyperus rotundus*, and *Parthenium hysterophorus* were among the most dominant marginal species. In contrast, free-floating macrophytes such as *Pontederia crassipes* and *Azolla sp.* were most abundant during the monsoon season, especially in Mansagar Lake, indicating favorable conditions for floating vegetation during periods of higher nutrient inflow. Submerged species like *Hydrilla verticillata* and *Ceratophyllum sp.* showed higher presence in Chandlai Lake, particularly during the monsoon. Species such as *Marsilea quadrifolia* and *Lemna aequinoctialis* were found to be seasonally restricted and location-specific, occurring only during the monsoon and winter seasons in Chandlai Lake. Emergent species, including *Nymphoides sp.* and *Nymphaea nouchali*, were less frequently encountered and showed limited distribution.



Table 1. Seasonal variation in abundance of macrophyte species (April 2023 – June 2024) in Mansagar Lake and

Name of Plant	Family	Category	Mansagar (Summer)	Mansagar (Monsoon)	Mansagar (Winter)	Chandlai (Summer)	Chandlai (Monsoon)	Chandlai (Winter)
<i>Pistia stratiotes</i>	<i>Araceae</i>	Free-floating	5	75	5	0	30	5
<i>Pontederia crassipes</i>	<i>Pontederiaceae</i>	Free-floating	30	75	30	5	75	5
<i>Lemna aequinoctialis</i>	<i>Lemnaceae</i>	Free-floating	0	5	0	30	0	0
<i>Azolla</i> sp.	<i>Salvinaceae</i>	Free-floating	5	75	30	5	30	5
<i>Ceratophyllum</i> sp.	<i>Hydrocharitaceae</i>	Submerged	0	30	5	0	30	0
<i>Hydrilla verticillata</i>	<i>Hydrocharitaceae</i>	Submerged	0	15	5	0	30	0
<i>Phragmites australis</i>	<i>Poaceae</i>	Marginal	0	5	5	5	30	5
<i>Typha</i> sp.	<i>Typhaceae</i>	Marginal	5	75	5	5	50	5
<i>Parthenium hysterophorus</i>	<i>Asteraceae</i>	Marginal	5	30	5	5	75	5
<i>Arundo donax</i>	<i>Poaceae</i>	Marginal	0	5	0	5	30	0
<i>Cyperus rotundus</i>	<i>Cyperaceae</i>	Marginal	5	30	5	0	75	30
<i>Marsilea quadrifolia</i>	<i>Marsileaceae</i>	Marginal	0	0	0	0	30	15
<i>Cyperus laevigatus</i>	<i>Cyperaceae</i>	Marginal	5	30	5	0	75	30
<i>Nymphaea</i> sp.	<i>Nymphaeaceae</i>	Emergent	5	5	5	30	30	5
<i>Nymphaea nouchali</i>	<i>Nymphaeaceae</i>	Emergent	5	30	0	0	0	0

Chandlai Lake, Jaipur District, Rajasthan. Species and family names are italicized. Abundance values are estimated counts per sampling period

Location - <https://www.google.com/maps/place/Mansagar+Lake/@26.9535,75.8462,15z>

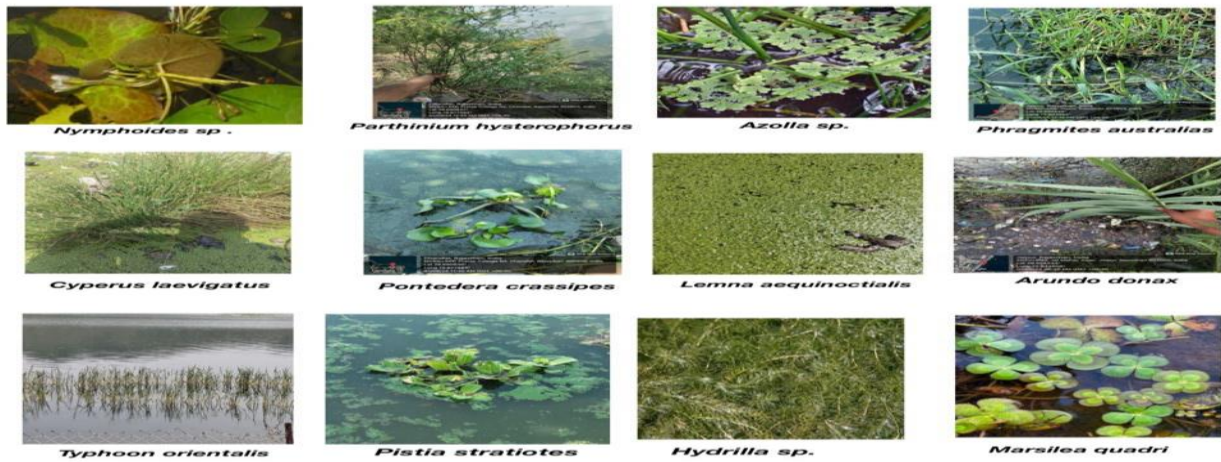


Figure 4– Identified Plant Species

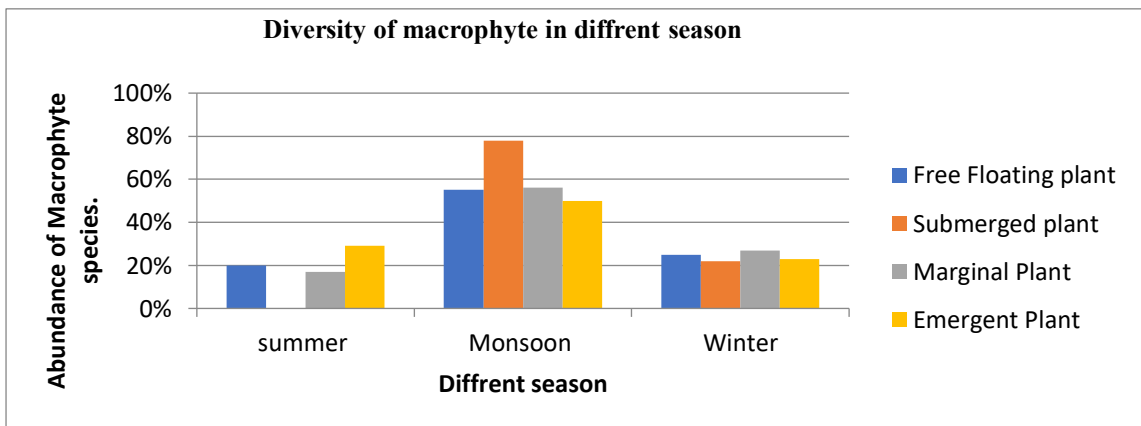
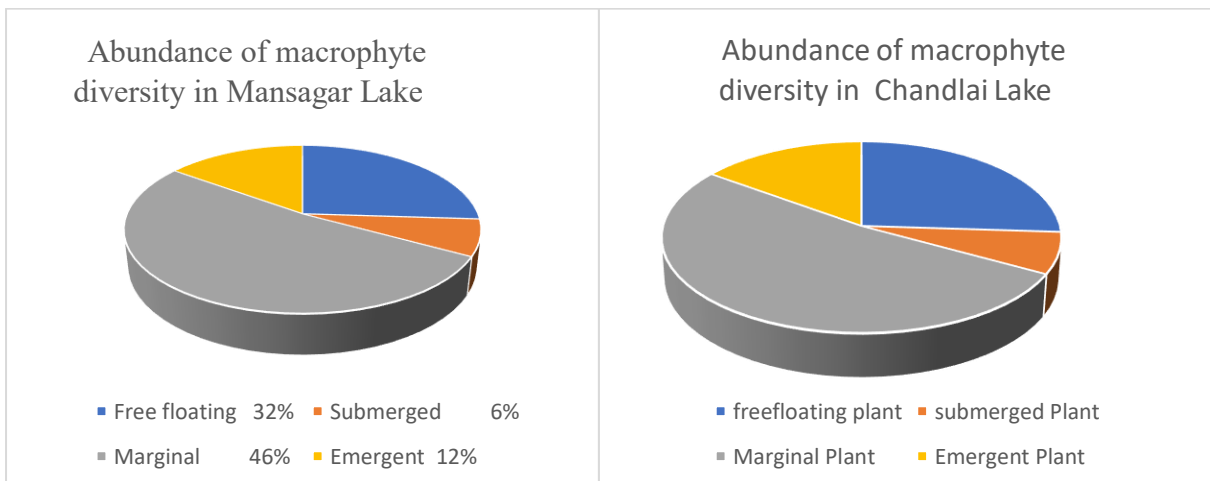


Figure 5 - Graphical representation of different categories of macrophytes according to seasons (Summer, Monsoon, and Winter)





Data Analysis –

Seasonal Diversity Indices of Macrophytes-

Lake	Season	Total Individual species (N)	Shannon Index (H')	Simpson's Index (D)	Simpson's Diversity (1-D)
Mansagar	Summer	70	1.87	0.27	0.73
	Monsoon	485	2.31	0.14	0.86
Chandlai	Summer	90	1.70	0.27	0.73
	Monsoon	590	2.47	0.10	0.90

Chandlai	Wiener	1.10	1.964	0.182	0.818
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Table 2- Diversity index

To assess the ecological stability and biodiversity of aquatic vegetation, Shannon-Wiener (H') and Simpson's diversity indices were calculated for each season in both Mansagar and Chandlai Lakes. The total abundance of macrophytes varied significantly between seasons and locations, influencing the diversity patterns observed. In Mansagar Lake, the Shannon-Wiener index ranged from 1.87 in summer to 2.31 in monsoon, indicating moderate to high diversity. The lowest diversity in summer is likely due to reduced water availability and high evaporation, limiting macrophyte growth. Conversely, the monsoon season showed the highest diversity, reflecting increased habitat availability and nutrient inflow. The Simpson's diversity (1-D) followed a similar trend, peaking at 0.884 during monsoon, signifying reduced dominance and better species evenness. In Chandlai Lake, diversity was consistently higher than in Mansagar, with the Shannon index reaching 2.47 and Simpson diversity reaching 0.907 during the monsoon. This reflects the relatively better ecological conditions and lower urban stress in Chandlai. Summer values were lowest for both indices in Chandlai (H' = 1.70; 1-D = 0.759), indicating environmental constraints on species richness during dry periods. Overall, the indices demonstrate that monsoon supports maximum macrophyte diversity in both lakes, likely due to optimal hydrological and nutrient conditions. Chandlai Lake, with lower anthropogenic disturbance, maintains a more balanced and diverse macrophyte community across seasons. These findings support the use of macrophyte-based diversity indices as effective tools for ecological monitoring and comparative analysis of freshwater ecosystems. shown in Table 2.



Discussion

The present study revealed marked seasonal and spatial variations in macrophyte diversity between the two freshwater lakes, influenced by environmental conditions and anthropogenic pressures. Overall, Chandlai Lake exhibited greater species richness and diversity, as reflected by higher Shannon-Wiener and Simpson's diversity index values across seasons, particularly during the monsoon. This suggests more favorable ecological conditions and reduced human impact in Chandlai compared to Mansagar Lake, which is subject to urban runoff and pollution. Seasonal analysis indicated that macrophyte diversity peaked during the monsoon season in both lakes, likely due to increased water availability, nutrient inflow, and habitat expansion. The dominance of free-floating species such as *Pontederia crassipes* and *Azolla sp.* during the monsoon highlights the influence of nutrient enrichment and hydrological factors on species proliferation. Conversely, submerged and emergent species were less abundant and more spatially restricted, especially in Mansagar Lake, where urban pressures may limit their growth. The consistent presence of marginal species such as *Typha sp.*, *Cyperus rotundus*, and *Parthenium hysterophorus* in Chandlai Lake across seasons underscores their adaptability to varying conditions and their ecological importance in stabilizing lake shorelines. The diversity indices demonstrate that Chandlai supports a more balanced community with lower species dominance, while Mansagar shows moderate diversity with occasional species dominance during summer, reflecting ecological stress. These findings confirm the utility of macrophytes as bioindicators of lake health and water quality, particularly in semi-arid environments. Integrating macrophyte-based monitoring with other ecological assessments can offer a comprehensive, cost-effective approach for managing freshwater resources and guiding conservation efforts in regions facing water scarcity and environmental degradation.

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