Uttar Pradesh Journal of Zoology

Volume 45, Issue 19, Page 10-16, 2024; Article no.UPJOZ.4127
ISSN: 0256-971X (P)

Checklist of Aquatic Macrophytes and Water Quality Assessment of Kakarikata Beel, Majuli District, Assam

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2024/v45i194493

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/4127

Original Research Article

Received: 21/07/2024
Accepted: 24/09/2024
Published: 26/09/2024

ABSTRACT

This study investigates the list of aquatic macrophytes and evaluates key water quality parameters in Kakarikata Beel, Assam. Wetlands like Kakarikata Beel are highly productive ecosystems, yet they face growing threats from human activities, resulting in the degradation of water quality and biodiversity. The objective of this research is to document the macrophyte species present and analyse water quality indicators such as pH, dissolved oxygen, and temperature, providing crucial baseline data on the beel's ecological health. A total of 20 species belonging to 19 genera were

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Cite as: *Doimari, Rituporna, Surajeet Konwar, Ankur Jyoti Dutta, Darshita Sinha, Krishna Devi Daflari, and Manash Jyoti Das. 2024. "Checklist of Aquatic Macrophytes and Water Quality Assessment of Kakarikata Beel, Majuli District, Assam". UTTAR PRADESH JOURNAL OF ZOOLOGY 45 (19):10-16. https://doi.org/10.56557/upjoz/2024/v45i194493.*

recorded during the study. Despite numerous studies on Assam's wetlands, there has been limited focus on the relationship between aquatic macrophytes and water quality in this particular beel. The results of this study reveal a diverse assemblage of macrophytes, with notable species including *Eichhornia crassipes, Nelumbo nucifera, and Hydrilla verticillata*. The water quality parameters measured were generally stable, indicating a functioning ecosystem. However, the study also highlights challenges such as eutrophication and ongoing anthropogenic disturbances, which threaten the long-term sustainability of this wetland. These findings underscore the importance of implementing conservation strategies to preserve the biodiversity and ecological services of Kakarikata Beel, which hold significant socio-economic value for local communities.

Keywords: Macrophytes; feedstock; Kakarikata Beel; conservation.

1. INTRODUCTION

Inland waters are the focus of limnology, which is often considered a branch of environmental science or ecology [1]. Limnology is closely associated with aquatic ecology and hydrobiology, which study aquatic organisms in relation to their hydrological environments [2]. While freshwater science is commonly conflated with limnology, this is a misconception, as limnology also includes the study of inland salt lakes [3]. Biological diversity refers to the variation among living organisms. This diversity spans species and ecosystems, originating from various sources, including terrestrial, marine, and aquatic habitats and the ecological complexes they form Gopal, [4]. Wetlands have traditionally been undervalued in terms of social development and land use, often being drained or filled for human purposes [5,6]. However, over time, their importance has been recognized. Wetlands are now regarded as some of the most biodiverse and productive ecosystems on the planet, where aquatic and terrestrial habitats intersect [7]. These ecosystems provide critical services to humans, including clean water, food, construction materials, flood and erosion control, and biodiversity conservation [8]. Macrophytes are a key component of the biological diversity found in wetlands. These are macroscopic plants that thrive in wet environments, including angiosperms, ferns, mosses, liverworts, and certain freshwater macroalgae [9]. Due to their abundance and diversity, macrophytes in wetlands serve as an essential food and fodder source for aquatic ecosystems. In Assam, these macrophytes are found in large, lentic, perennial freshwater lakes, locally referred to as "beel" [10]. Beels are highly productive ecosystems, capable of efficiently converting solar energy into organic carbon, especially when nutrients are abundant from natural sources [11]. The Central Inland Fisheries Research Institute (CIFRI) has reported that primary productivity from macrophytes and plankton stages in floodplain wetlands is considerably higher than in other inland open-water systems [12]. Consequently, utilizing beels for fish farming has become an effective means of harnessing natural resources for human benefit.The ecology of beels is highly complex, marked by temporal and spatial variations in key characteristics such as depth, catchment area type, precipitation, and river connectivity. Assamese beels, in particular, are known for their abundant sunlight, warm water regimes, and high nutrient content, making them exceptionally productive environments. However, many of these beels face episodes of eutrophication, leading to excessive weed growth [13]. .macrophytes play a crucial role in controlling water pollution by absorbing nutrients through their root systems, thus improving water quality. These wetlands also serve as suitable habitats for migratory birds. Numerous studies, such as those by Das and Sharma, [14], have documented the macrophytes in various regions of Assam.

The primary motivation behind this research is to fill the gap in the current understanding of the aquatic macrophytes in Kakarikata beel, a relatively understudied wetland system in Assam. By cataloguing the diversity of these macrophytes and assessing the water quality, this study seeks to provide a comprehensive overview of the health and ecological functioning of this beel. A survey of the aquatic macrophyte diversity and water quality assessment of Kakarikata Beel is essential for documenting the biodiversity of this wetland, evaluating its ecological health, and understanding the interactions between aquatic vegetation and water quality. As key bioindicators, macrophytes provide insights into the beel's environmental condition, while water quality parameters like pH, dissolved oxygen, and turbidity help assess its capacity to sustain aquatic life and support local livelihoods. The research highlights the socio-economic significance of the beel, which supports fisheries and other community activities, while also identifying challenges such as eutrophication and human-induced disturbances that threaten its long-term sustainability. By offering crucial baseline data, your study not only informs future conservation efforts but also emphasizes the need for sustainable management practices to preserve the ecological and economic functions of Kakarikata Beel.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Kakarikata Beel, a perennial freshwater wetland located in the Majuli Island district of Assam, India. Geographically, Kakarikata Beel lies between 26°45'27.04"N and 26°46'15.00"N latitude, and 94°12'11.02"E and 94°13'05.00"E longitude. This wetland is ecologically significant, supporting a rich diversity of aquatic macrophytes, fauna, and migratory birds. It plays a crucial role in sustaining local biodiversity, acting as a natural habitat and breeding ground for various species. The surrounding area has been subjected to increasing human activities such as agriculture, fishing, and urban expansion, which have begun to degrade the wetland's water quality and affect its biodiversity. Kakarikata Beel, due to its unique ecosystem and increasing anthropogenic pressure, was chosen as an ideal site for studying the interrelationship between aquatic macrophytes and water quality. The wetland's water remains stable year-round, with seasonal variations in hydrology influencing species distribution and abundance. Sampling sites were strategically selected throughout the beel to capture a comprehensive view of its ecological health.

2.2 Sample Collection

Aquatic macrophyte samples were collected from different locations within Kakarikata Beel using a random sampling technique. Plant species were identified using state flora references, including *Flora of Assam* (Volumes 1-5). Water samples were also collected simultaneously to assess water quality parameters. Water was collected in sterilized bottles and immediately transported to the laboratory for analysis.

The sampling of aquatic macrophytes in Kakarikata Beel was conducted using a systematic transect method, ensuring a representative collection of species across different areas of the wetland. Five transects, each 100 meters in length, were laid out perpendicular to the shoreline, covering a diverse range of habitat types, including submerged, emergent, and floating vegetation zones. Along each transect, sampling plots of 1 m^2 were established at 10-meter intervals, making for a total of 50 plots. This approach ensured comprehensive coverage of the wetland, allowing for an accurate assessment of species composition and abundance.

2.3 Water Quality Analysis

Several physicochemical parameters were measured to evaluate the water quality in Kakarikata Beel. The following methods were employed and explained by the U.S. Environmental Protection Agency [15].

2.3.1 pH

Measured using a calibrated digital pH meter directly at the sampling sites.

2.3.2 Temperature

Recorded on-site using a mercury thermometer.

2.3.3 Dissolved Oxygen (DO)

Determined by Winkler’s method, with readings expressed in parts per million (ppm).

2.3.4 Turbidity

Assessed using a turbidity meter, and values were recorded in NTU (Nephelometric Turbidity Units).

2.3.5 Total alkalinity

Measured using titration with sulfuric acid, with results expressed in ppm.

2.3.6 Arsenic and fluoride

Tested using a field-testing kit approved by the Bureau of Indian Standards, with results recorded in ppm.

All data were recorded seasonally to account for temporal variations in water quality. The results were analyzed to assess the overall ecological health of the beel.

Fig. 1. Map showing Kakari Kata Beel located in Majuli Island District
(Source: Google earth)

3. RESULTS

The following is a list of all 20 species of aquatic macrophytes that have been identified and found in the Kakarikata beel of the Majuli Island district in Assam. Table 1 provides details of the macrophytes from waterways that have been sampled and confirmed so far for Kakarikata beel.

Table 1. List of major aquatic macrophytes found in Kakarikata beel, Majuli Island

Serial no.	Scientific Name	Family	Growth habitat	Common Name
1	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Floating	Water hyacinth
2	*Vallisneria spiralis* L.	Hydrocharitaceae	Submerged	Tape grass
3	*Hygrophila schulli* (Buch.-Ham.) M.R. & S.M. Almeida	Acanthaceae	Emerged	Hamilt
4	*Ceratophyllum demersum* L.	Ceratophyllaceae	Submerged	Coon tail hornwort
5	*Nymphoides hydrophylla* (Lour.) Kuntze	Menyanthaceae	Floating	Loureiro
6	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	Submerged	Water-thyme
7	*Colocasia esculenta* (L.) Schott	Araceae	Emerged	Kola kochu
8	*Trapa natans* L.	Lythraceae	Floating	Buffalo nut
9	*Xanthium strumarium* L.	Asteraceae	Emerged	Agora
10	*Salvinia molesta* D.S. Mitchell	Salviniaceae	Floating	Puni
11	*Alpinia allughas* Roscoe	Zingiberaceae	Emerged	Tora
12	*Ceratopteris thalictroides* (L.) Brongn.	Pteridaceae	Emerged	Pani Dhekia
13	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Emerged	Helesi hak
14	*Pistia stratiotes* L.	Araceae	Floating	Borpuni
15	*Polygonum hydropiper* L.	Polygonaceae	Emerged	Pothura bihlongni
16	*Nymphaea nouchali* Burm. f.	Nymphaeaceae	Floating	Rongabhet
17	*Nelumbo nucifera* Gaertn.	Nelumbonaceae	Floating	Sacred lotus
18	*Marsilea minuta* L.	Marsileaceae	Emerged	Dwarf water-clover
19	*Ludwigia adscendens* (L.) H. Hara	Onagraceae	Emerged	Water primrose
20	*Ipomoea aquatica* Forssk.	Pontederiaceae	Emerged	Water spinach

Table 2. Water quality parameters of Kakarikata beel, Majuli Island

Serial Number	Parameters	Concentration
1.	Temperature	16-27ºC
2.	pH	6- 8.2 scale
3.	Turbidity	7-22 NTU
4.	Dissolved oxygen (DO)	4-10 mg/l
5.	Total alkalinity	19-200 mg/l
6.	Arsenic	0.00 ppm
7.	Flouride	0.00 ppm

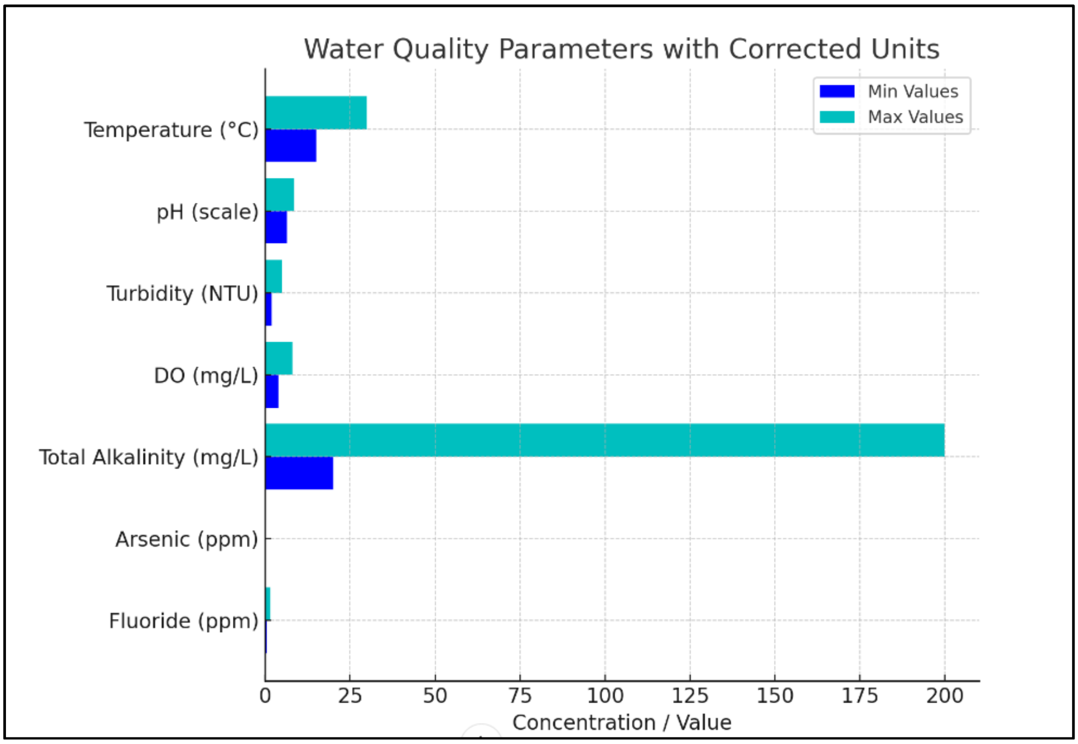

Fig. 2. Graphical presentation of the water quality parameters based on Table 2

4. DISCUSSION

The survey recorded 20 genera belonging to 19 species indicating good water quality, nutrient cycling, and providing habitat for aquatic life. They also help stabilize sediments, support biodiversity, and enhance ecosystem health. The water quality parameters selected for analysis included salinity, Dissolved Oxygen (DO), turbidity, pH, arsenic, fluoride, and temperature. The water temperature was measured using a digital thermometer, while the pH was assessed on-site with a pocket pH meter. The temperature of the water in the beel ranged between 16°C and 27°C. The analysis revealed that the water remained moderately clear throughout the year, except during the monsoon season (June to September), when turbidity increased. The primary contributors to turbidity were silt and organic materials carried by runoff streams during rainfall. The pH of the water samples ranged from 6.0 to 8.2, largely influenced by the aquatic vegetation and the characteristics of the basin soil. Dissolved oxygen levels in Kakarikata Beel ranged from 4.0 to 10.0 Parts Per Million (ppm), which is sufficient to support aquatic life, including fish. The total alkalinity of the water varied between 19 and 200 ppm, indicating fluctuations in water hardness and its buffering capacity over time. One of the most encouraging findings was the absence of arsenic and fluoride in the water samples, a positive indicator of water safety. This is crucial, considering the small number of people who use the beel's water for drinking and other purposes.

In comparison to other wetlands, such as the Koothapar wetland in the Tiruchirapalli district, which Ravichandran and Teneson [16] found to be severely polluted year-round, Kakarikata Beel demonstrates better water quality. While the Koothapar wetland's water is unfit for human consumption, it is still suitable for agricultural and recreational purposes. Similarly, research by Saha [17] on four distinct wetlands showed that Renuka Lake experienced declining DO levels and rising BOD, pH, and COD values. This comparative analysis highlights the relatively good condition of Kakarikata Beel, especially in terms of dissolved oxygen, arsenic, and fluoride levels, indicating its potential for sustaining aquatic life and its safe usage for local populations. Recent studies on wetlands in Assam and neighboring regions have focused on water quality parameters and macrophyte diversity. In Kapla Beel, Assam, dominant macrophytes like Eichhornia crassipes showed high productivity, with positive correlations to temperature, pH, and turbidity, but negative correlation with Dissolved Oxygen (DO) [18]. The Disangmukh wetland study revealed positive correlations between plant diversity and DO, ORP, and TDS (Durlov & Sahariah, 2022). In Sambalpur, Odisha, macrophyte diversity was negatively correlated with most water quality parameters, indicating anthropogenic impacts [19]. Assessment of Sivasagar wetlands used physicochemical parameters and macro-invertebrate diversity as bioindicators to evaluate water quality and pollution status [20]. These studies collectively emphasize the importance of monitoring water quality parameters and biodiversity for effective wetland management and conservation [21].

5. CONCLUSION

Based on the aforementioned findings, it can be said that during the summer, the Kakarikata beel wetland displayed a great diversity of macrophytes. The water hyacinth has now overrun a good portion of the beel. The size of the marsh vegetation and the impact of anthropogenic disturbances such as permanent agriculture, settlements, and intensive fishing operations that are gradually encroaching on the beel have an impact on the species biodiversity of the Kakarikata beel. Assam's biologically rich beel of Majuli Island is home to several aquatic and terrestrial species, some of which are threatened worldwide. The local people depend on this beel for their daily sustenance because it offers fishing along with additional wetland biological resource collection options. As a result, the beel's water quality has significant economic and environmental implications. Thus, in order to ensure this beel's survival and a sustainable means of subsistence, appropriate conservation measures must be adopted.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Grammarly has been used to check the grammar of the paper. Semantic Scholars has been used to find the papers related to this work for references.

Details of the AI usage are given below:

1. Grammarly
2. Semantic Scholars

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/4127