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Research Article

A Phytosociological Assessment on Aquatic Macrophytes Diversity in Two Selected Wetlands of Kishanganj District, Bihar

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Abstract

Macrophytes play a very significant role to stabilize a wetland ecosystem. The present research was conducted for quantitative investigation of aquatic macrophytes in Mahanadi and Harapukhur Beel in Bihar from November 2021 to May 2023. The survey documented 16 macrophytes species belonging to 11 families among which Poaceae is the most dominant family. Besides that some ecological parameters such as density, frequency, abundance and IVI were also calculated. Computational analyze of different diversity indices of macrophytes also have been done which revealed the highest value for Shannon Weiner's index by Mahanadi(W1) and highest value for Simpson Dominance index by Harapukhur Beel (W2).

Keywords: *Macrophytes, Quantitative, Frequency, Diversity indices.*

Introduction

Wetlands are considered to be the most productive and critical part of our natural environment that play a vital role in supporting a wide range of biodiversity (Slathia and Sheikh, 2019). Wetlands can be defined as the transitional zone between terrestrial and aquatic ecosystem which is saturated with water near the soil surface either seasonally or permanently(Anil. *et al*., 2023). Wetlands functions as natural sponges by purifying and replenishing water. Along with they also provide many societal benefits like shelter of various aquatic organisms, food and habitat for fishes and wildlife, improvement of water quality,flood storage,shoreline erosion control etc. (Chaudhary and Devkota, 2021). Wetlands of India are facing tremendous anthropogenic pressure and degradation through drainage and landfill, discharge of domestic and industrial effluents, disposal of solid waste, hydrological alternation,deforestation and over exploitation of natural resources(Chaibasa. *et al*., 2021). Aquatic macrophytes are the macroscopic form of angiosperms including some pteridophyes, mosses, fern and large macroscopic algae which are the key component of aquatic ecosystem. Ecologically, macrophytes has a significant impact as they not only serve as habitat for aquatic organism but also acts as bioindicator of the overall water body health (Chaudhary and Devkota, 2021;Mukherjee and Mandal, 2023). Macrophytes also show phenotypic plasticity by changing morphological and physiological behavior in response to adapt in a particular environment. Aquatic macrophytes are no doubtly the basic parameter for the documentation of particular wetland ecosystem. So the present study aimed to analyze the floristic composition and dynamics of vegetation which provides the indication of the nature of the biological and physical environment (Levis. *et al*., 2020; Mjelde. *et al*., 2023) along with it also include

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life form analysis, growth form classification and analysis of diversity index.

Materials and Methods

Study Area

The two selected study areas, Mahanadi and Harapukhur Beel are located at Kishanganj district of Bihar. Kishanganj district lies between 25°20′ N to 26° 30′ N latitude and 87° 70′ E to 88 °19′ N longitudes which covers the total area of 1884 sq.km. The district is surrounded by Araria district in the west, Purnia in the south-west, Uttar Dinajpur of West Bengal on the east and Darjeeling district of West Bengal and Nepal on the north. Mahananda, Donk, Kankai and Ratua are the major rivers of the district. For analysing the diversity index of macrophytes, Mahanadi and Harapukhur Beel of Pothia block of Kishanganj district has been selected.

Mahanadi:

It is a natural and perennial wetland. It is located at 88.06° E longitude and 26.23° N latitude. The wetland is under government ownership and covers about 16.5 acres of land. Some of the neighbouring villages of the wetland are Dhamalbari, Paharkata, Bansbari, Barabari and Chagalia.

Harapukhur Beel:

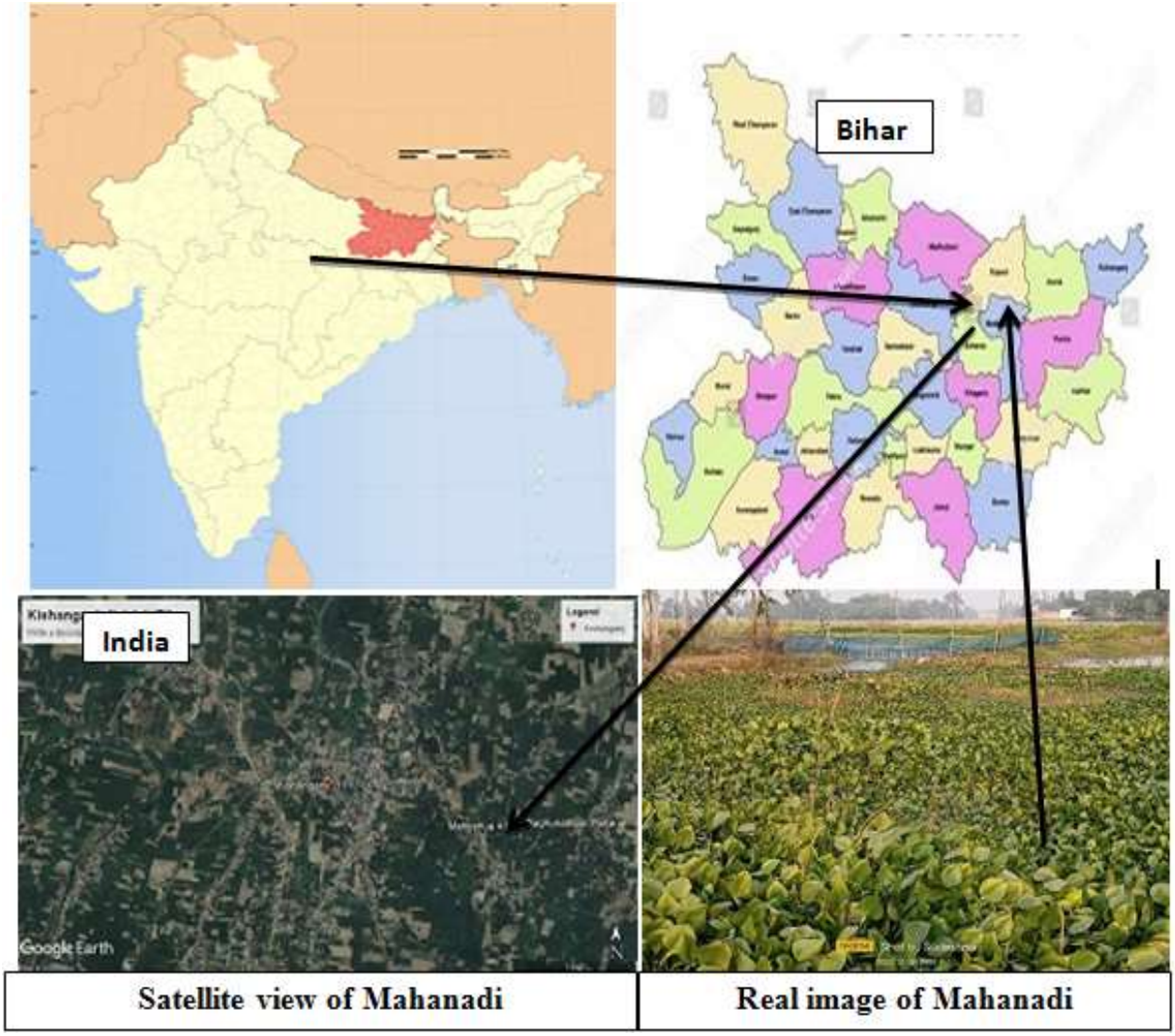
It is a manmade, perennial wetland which is located between 88.05° E Longitude and 26.20° N latitude. It covers about 5 acres of land. Harapukhur, Goagbasti, etc are the neighbouring villages of the wetland.

Macrophytes Collection and Identification

The two selected wetlands were surveyed thoroughly and visited for documenting the seasonal variation of macrophytes diversity at regular intervals,specially from November, 2021 to May, 2023. Macrophytes were randomly collected from the study sites and kept primarily in polythene bag. After that for drying properly the macrophytes were kept in paper by changing the paper at regular intervals. Work out of the preserved macrophytes were done in the laboratory. Specimens were identified with the aid of standard literatures(Cook,1996; Mandal and Mukherjee, 2007; 2010; 2012; 2016; 2017; Jambhulkar. *et al*., 2021; Salam. *et al*., 2021; Yadav, 2022; Patil, 2022; Ahmed and Dhiman, 2022; Agbogidi. *et al*.,2022a; 2022b; Chowdhury and Chowdhury, 2022; Shelekar. *et al*., 2022; Ashrafuzzaman. *et al*., 2023; Awo. *et al*.,2023;Bhanja. *et al*.,2023; Edo. *et al*.,2023; Mukherjee and Mandal, 2023; Patel and Patel, 2023; Radhanpur, 2023; Troia, 2023; Vukov. *et al*., 2023). Besides this for the identification of the flora and to check their valid scientific names POWO (Plants of the World Online, 2023) and WFO (World Flora Online, 2023) were used. Identified macrophytes were classified into different life form (LF) according to **Raunkiaer's, (1934)** and growth form(GF) accodfing to **Cook, (1996).**

Sampling of Macrophytes

Quadrat **s**ampling method is a classical tool that is used to mark an exact area for ecological study so that plant species of that particular area can be easily identified and counted. Quadrats of definite size (1m x 1m) were laid down randomly at each wetland. A total of 10 quadrats in each were plotted to analyze the phytosociological attributes like frequency, density,dominance which were calculated following Curtis (1956), Philips, (1959) and Misra, (1968). IVI (Importance Value Index) of a species community reflects the idea of relative importance of the species as compared to other species (Curtis, 1959) which is obtained by adding up the relative abundance (RA), relative frequency(RF) and relative dominanace (RD).



Statistical Analysis

Species diversity of aquatic macrophytes was calculated by using following formula:

Shannon and Weiner diversity index (H) calculated using the Shannon and Weiner formula (1949)

$$H' = -\sum_{i=1}^{i=s} \left(\frac{ni}{N}\right) log e \left(\frac{ni}{N}\right)$$

H'= Index of species diversity
ni= Density of one species
N= Density of all species
e= Base of natural logarithm (ni/N)= $2.303 log 10(ni/N)$
$\Sigma(ni/N)$= Addition of the expression for the values of i=1 to i=s

Simpson's Diversity Index (D)

It provides the measure of diversity, taking into account the dominant species as well as its abundance.

$D = 1 - \sum_{i=1}^{s} (pi)^2$ Where, "pi" is the proportion of individuals in the "ith" taxon of the community and "s" is the total number of taxa in the community (Simpson, 1949).

Results and Discussion

During investigation(November 2021-May 2023) a total of 16 macrophytes species belonging to 11 angiosperms families were documented in Table 1.Among which Poaceae was found the most dominant family.In study area collected macrophytes were also classified according to their growth form(Cook1996) and life form(Raunkiaer 1934).Among the 16 macrophytes species 14 were therophytes and 1 each were hemicryptophytes and hydrophytes.Overall macrophytes investigation revealed that helophytes were dominant(0 9 species) followed by pleustophytes(05 species) and hyperhydrates(02 species).

Table 1: Macrophytes of Mahanadi and Harapukhur Beel.

Sl. No.	Scientific Names	Family	Life form (LF)	Growth form(GF)	W_1	W_2
1	*Acmella uliginosa*(Sw.) Cass.	Asteraceae	TH	Hel	+	+
2	*Alternanthera sessilis*(L.)DC.	Amaranthaceae	TH	Hel	+	
3	*Centella asiatica*(L.)Urb.	Apiaceae	TH	Ple		+
4	*Cyperus sphacelatus* Rottb.	Cyperaceae	TH	Hel	+	
5	*Hygroryza aristata*(Retz.) Nees ex Wight &Arn.	Poaceae	TH	Ple		+
6	*Ipomoea aquatica* Forssk.	Convolvulaceae	HCP	Hyp	+	+
7	*Ischaemum sayajiraoi* Raole &R.J. Desai	Poaceae	TH	Hel		+
8	*Leersia oryzoides* (L.)Sw.	Poaceae	TH	Hel		+
9	*Ludwigia perennis* L.	Onagraceae	TH	Hel	+	
10	*Marsilea.quadrifolia* L.	Marsileaceae	TH	Ple	+	+
11	*Phleum pratense* L.	Poaceae	TH	Hel	+	
12	*Pistia stratiotes* L.	Araceae	TH	Ple	+	
13	*Pontederia crassipes* Mart.	Pontederiaceae	HY	Ple	+	+
14	*Sporobolus indicus*(L.) R.Br.	Poaceae	TH	Hel	+	
15	*Sporobolus maritimus*(Curtis) P.M. Peterson & Saarela	Poaceae	TH	Hel	+	
16	*Torenia crustacea*(L.) Cham. & Schltdl.	Linderniaceae	TH	Hyp	+	+

LF(Life form):HCP=Hemicryptophytes,HY=Hydrophytes,TH =Therophytes:GF(Growth form): Hel=Helophyte,Hyp=Hyperhydrate, Ple=Pleustophyte.W1:Mahanadi;W2:Harapukhur Beel.

Table 2: Wetland wise statistical analysis of the aquatic macrophytes

Name of the wetlands	No. of macrophyte species reported in wetland	No. of the sites	No. of the Quadrats	Dominance_ D	Shannon_H
Mahanadi (W1)	12	5	10	0.18	0.66
Harapukhur Beel(W2)	9	3	10	0.33	0.44

Figure 4 showing the overall density, frequency, abundanc and IVI of the macrophytes inhabiting Mahanadi and Harapukhur Beel of Bihar. It denotes that the maximum overall frequency was exhibited by *Pontederia crassipes* (90%) followed by *Pistia statiotes*(60%) and *Marsilea quadrifolia*(40 %) where as least was shown by *Sporobolus indicus*, *Ischaemum sayajiraoi* and *Cyperus sphacelatus(*5% each). *Pontederia* spp. showed the highest overall dominance in terms of density, frequency, abundance and IVI.Lower IVI was shown by *Cyperus sphacelatus* and *Ischaemum sayajiraoi* (6.16 each) followed by *Sporobolus indicus* (11.05).

The calculation of diversity indices of macrophytes is tabulated in Table 2 which indicates the maximum value for Shannon Weiner's index and Simpson Dominance index were exhibited by Mahanadi (W1) and Harapukhur Beel(W2). Where as reversely lowest dominance and Shannon Weiner's index were exhibited by Mahanadi(W1) and Harapukhur Beel(W2).

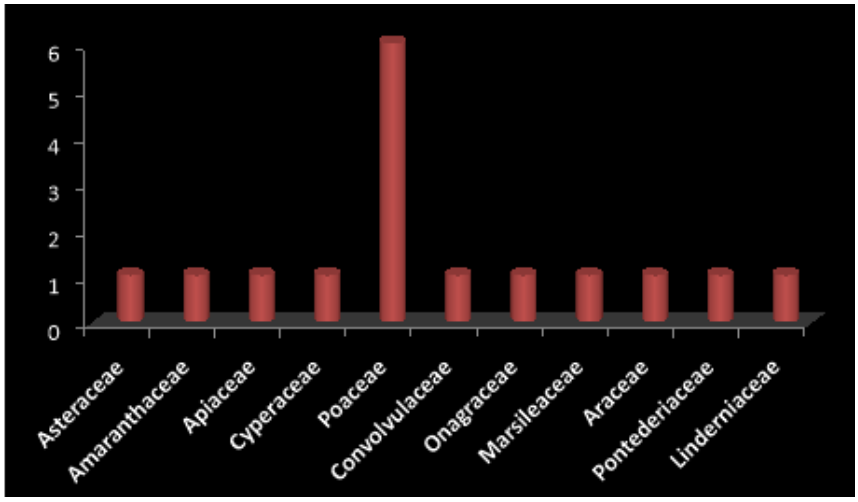


Figure 1: Family wise distribution of collected macrophytes

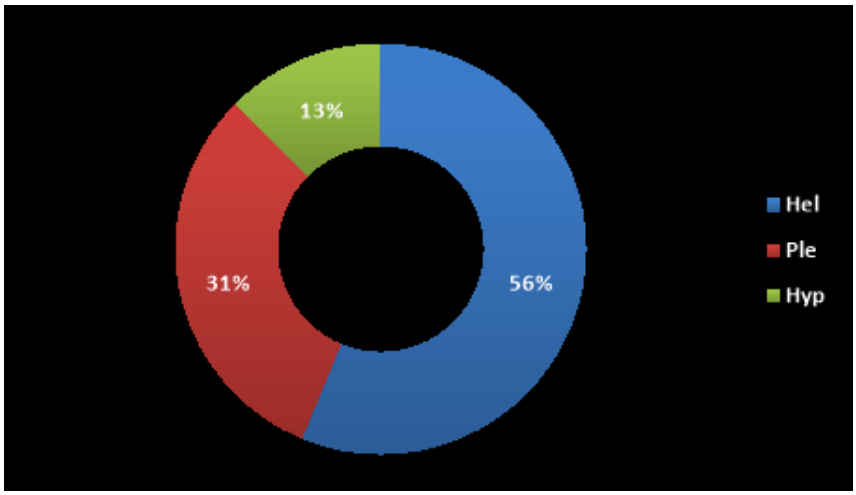


Figure 2: Percentage of macrophytes distribution according to their growth form (Cook 1996)

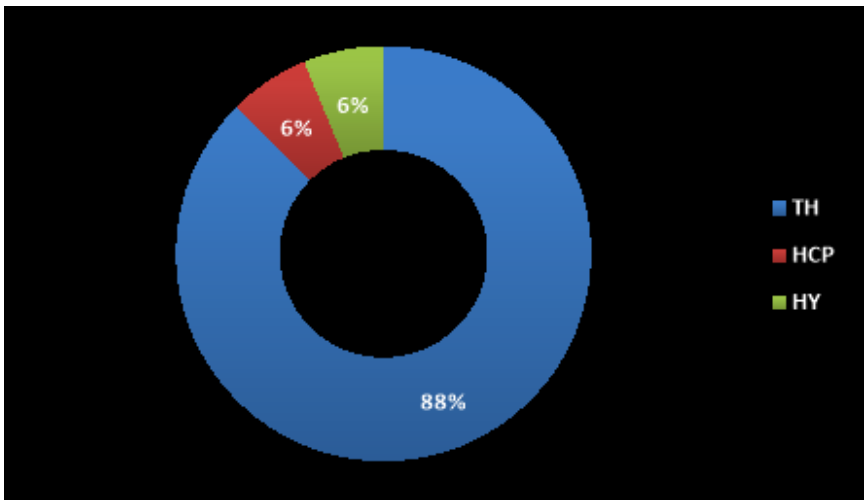


Figure 3: Distribution of macrophytes according to their life form(Raunkiaer 1934)

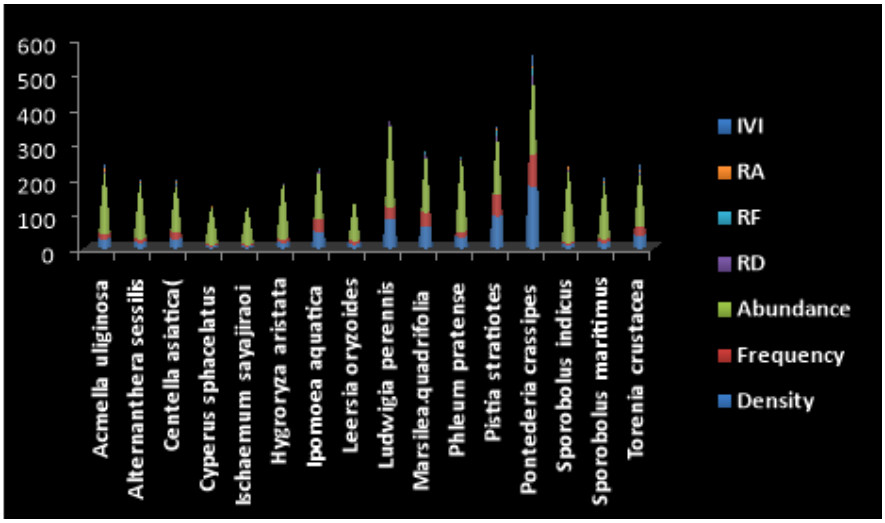


Figure 4: Density, Frequency, Abundance, and IVI of the macrophytes inhabiting Mahanadi and Harapukhur Beel,Bihar

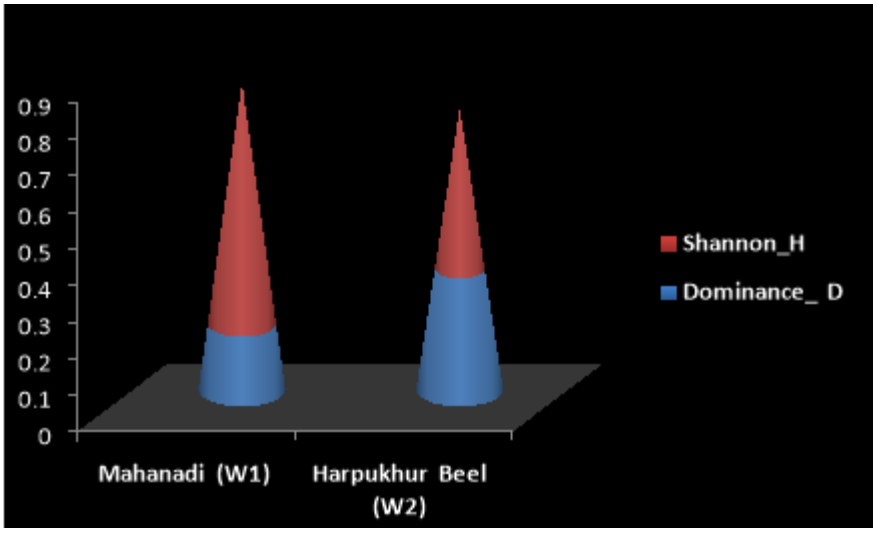


Figure 5: Showing variations in diversity indices of macrophytes in two wetlands.

Conclusion

Aquatic macrophytes are no doubtly the most important and remarkable key component for any of the wetland ecosystem.The aforesaid study also concluded that huge expansion of macrophytes in each of the beel is directly showing the richness of nutrients which promote the vegetation growth of macrophytes. Several anthropogenic activities including human disturbances directly or indirectly reinforce the wetlands to become nutrient rich. Besides that the dominance nature of *Pontederia crassipes* in terms of density, abundance, frequency and highest IVI also showing its invasive tendency and high affinity for eutrophic waterbody. Lastly the study emphasize on the immediate necessary action for the conservation and restoration of the wetlands which will also be very effective for growing macrophytes vegetation. Regular observation and application of appropriate management strategies are also required for the sustainable development.

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