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DIVERSITY AND DISTRIBUTION OF MACROPHYTES IN MADHYA KACHNAR BEEL AND POKTAR BEEL OF NORTH DINAJPUR DISTRICT, WEST BENGAL: A STUDY ON QUANTITATIVE ANALYSIS OF BIOINDICATOR

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Abstract: Wetlands are distinct ecosystem that is saturated with water either seasonally or permanently. Aquatic macrophytes are the indispensable component of this wetland ecosystem which constitute the taxonomically most diverse macroscopic assemblage and perform many significant roles for nurturing the aquatic ecosystem.They have several intrinsic properties that allow them to reciprocate with environmental heterogeneity. Macrophytes are mainly characterized by life form, growth form, diversity, plasticity of different physiological as well as environmental condition. The present research devoted to study of the quantitative analysis of some ecological parameters of macrophytes of Madhya Kachnar Beel and Poktar Beel of North Dinajpur District. Macrophytes species were collected and identified for documentation during extensive wetland survey, which was conducted from November 2021- Deceember 2023. Current analysis reporting the presence of 30 species belonging to 20 families. Among these Cyperaceae is the most dominant family followed by Poaceae and Pontederiaceae. Besides that life form, growth form of macrophytes were also analysed. Different quantitative parameters such as diversity index, species richness, similarity index along with RA, RD, RF and IVI were also evaluated, where *Aeschynomene aspera* showed the highest IVI value (14.69) and *Cyperus eragrostis* showed the lowest IVI value (4.79).

Keywords- Indispensable component, Plasticity, Diversity, Species richness.

I. INTRODUCTION

Wetlands are the most distinct and diverse ecosystem, which is inundated with water either seasonally or permanently. Wetlands are the most productive ecosystems that sustain and nurture human life as well as other aquatic organisms (Tiwari and Sandya,2022; Tasker et al., 2022). The wetland ecosystem plays a critical role by providing shelter, replenishing and purifying water, maintaining natural cycles, and supporting a wide range of biodiversity. The purpose of investigation of wetland ecosystem is to enlist the floral diversity, details study of diversity with some of their ecological parameters, management, conservation in their native places, and restoration(Shelekar et al., 2022; Mukherjee and Mandal, 2023a). Macrophytes are the key component of any wetland ecosystem as they are not only the bioindicator of water body health but also have a significant role, in producing oxygen, wastewater treatment, improving water and sediment quality as well as an important source of livelihood for local people (Jogdand, 2022; Mukherjee and Mandal, 2023b; Vukov et al., 2023). As no specific study on wetlands and macrophytes has been done previously present research was conducted in two wetlands of North Dinajpur district, for a details analysis of the current status, distribution, and diversity of macrophytes as this knowledge accelerates the conservation of biodiversity, as well as sustainable development of wetland ecosystem.

II. MATERIALS AND METHODS

2.1 Study site

The selected study area is North Dinajpur district which lies between 25.11◦ N to 26.49◦ N latitude and between 87.49◦ E to 90.00◦ E longitude. The total area of the district is about 3142 sq. km. Kulik, Mahananda, Nagar etc are the main rivers of this district. The

district is rich in alluvial soil and mostly sandy to sandy-loam in texture and porous along with thick forest. The district is divided into two subdivision i.e. Raiganj and Islampur.

2.2 Maddhya Kachnar Beel

The wetland is situated at 87.53° E longitude and 25.16° N latitude at Gaisal -1 mouza in Islampur block. It is a manmade and perennial wetland. The wetland is under public ownership.The total area covered by the wetland is about 5 acres.

2.3 Poktar Beel

It is located at 88.11° E longitude and 26.18° N latitude. It is a large, manmade, perennial wetland which is situated at Ruiwa mouza of Islampur block. The wetland is under public ownership and jointly owned. The total area covered by the wetland is about 9 acres.

2.4 Macrophytes collection and identification

Extensive field survey was conducted from November 2021 to December 2023, for the collection of macrophytes specimen and to make the detail database of floristic composition, vegetation richness and diversity. Macrophytes specimen were dried properly by changing the paper at regular interval and worked out have been done in the laboratory for the identification. Authentic identification have been done with the help of some standard taxonomic literatures (Cook, 1996; Mandal and Mukherjee, 2014, 2016a, 2016b, 2017; Mandal and Mondal, 2020; Mandak et al., 2022a, 2022b;Verma, 2022; Ashrafuzzaman et al, 2023; . Bamania and Sharma, 2023; Basar and Rahman, 2023; Bhanja et al., 2023; Maitry et al., 2023; Mjelde et al., 2023; Paradiya et al., 2023; Patel and Patel, 2023; Pathak, 2023; Radhanpuri, 2023; Ramalakshmana et al.,2023a, 2023b; Sharma, 2023; Singh et al.,2023; Syed and Sonule,2023;Tamang et al.,2023;Thrupthi and Deviprasad, 2023;Tian et al., 2023; Troia, 2023; Maitry et al., 2023; Mandal and Mukherjee, 2023a, 2023b, 2023c;2023d, 2023e; Mukherjee and Mandal, 2023c, 2023d, 2023e). For comparing morphological characteristics and checking the valid scientific name **POWO** (Plants of the World Online, 2023) ,**WFO** (World Flora Online, 2023) and **GBIF** (Global Biodiversity Information Facility) were used. Herbarium sheets of the identified specimen were kept at Taxonomy of Angiosperms and Biosystematics laboratory of SKBU, Purulia. Macrophytes were classified after Raunkiaer's life forms (1934) growth forms also classified according to Cook (1996).

The depth, density, diversity and different types of macrophytes present in a system are indicators of waterbody health. The absence of macrophytes may indicate water quality problems such as excessive turbidity, herbicides, or salinization which interfere with plant growth and development. A large number of macrophytes are the good indicators for heavy metals and excessive nutrients in any aquatic ecosystems such as *Hydrilla verticillata, Ipomoea aquatica, Pontederia crassipes, Pistia stratiotes* etc (Ali et al., 2022; Lazim et al., 2022; Zhou et al., 2023).

2.5 Quantitative analysis of macrophytes specimens

Random quadrarts were laid for specimen sampling which consist of four different sites in each of the wetland. Quantitative or statistical analysis is the most important and helpful method to prepare diversity index comparing the two different wetland ecosystems. Ecological importance as well as relative importance of the species was analysed by calculating IVI (importance Value Index).

2.6 Measurement of diversity indices

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

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

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

H'= Index of species diversity

ni= Density of one species

N= Density of all species

e= Base of natural logarithm (ni/N)=2.303log10(ni/N)

Σ(ni/N)= Addition of the expression for the values of i=1 to i=s

b. 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).

2.7 Box-plot Analysis

Descriptive statistics and box-plots have been used to compare different sets of data by using PAST (Paleontological Statis tics) 4.14 software. Species were compared habitat-wise and seasonal species richness of plants, by using box-plot to display the set of data distribution in terms of quartiles.

2.8 Principal Component Analysis (PCA)

It is one of the most frequently used multivariate data analysis tool that investigates multidimentional datasets with quantitative variables. Here it is used to find out the underlying correlations between the plant species and different ecological parameters.

III. RESULTS AND DISCUSSION

Table 1. Documentation of macrophytes inhabiting Madhya Kachnar beel and Poktar beel in North Dinajpur District.

Sl. No.	Scientific Names	Family	Life form (LF)	Growth form (GF)	W_1	W_2
1	*Aeschynomene aspera* L.	Fabaceae	TH	Hel		+
2	*Albidella oligococca* (F.Muell.) Lehtonen	Alismataceae	TH	Hyp	+	+
3	*Alternanthera philoxeroides*(Mart.) Griseb.	Amaranthaceae	TH	Hel	+	
4	*Centella asiatica* (L.) Urb.	Apiaceae	TH	Hel		+
5	*Cyanotis axillaris* (L.)D. Don ex Sweet	Commelinaceae	HCP	Vit	+	
6	*Cyperus difformis* L.	Cyperaceae	TH	Hel	+	+
7	*Cyperus eragrostis* Lam.	Cyperaceae	TH	Hel		+
8	*Cyperus iria* L.	Cyperaceae	TH	Hel	+	
9	*Eclipta prostrata* (L.) L.	Asteraceae	CH	Hel	+	
10	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	TH	Vit	+	+
11	*Ipomoea aquatica* Forssk.	Convolvulaceae	HCP	Hyp	+	+
12	*Ipomoea quamoclit* L.	Convolvulaceae	HCP	Hyp	+	+
13	*Limnophila heterophylla* (Roxb.) Benth.	Plantaginaceae	TH	Hyp	+	
14	*Ludwigia adscendens* L.) H.Hara	Onagraceae	TH	Hyp		+
15	*Ludwigia perennis* L.	Onagraceae	TH	Hel	+	
16	*Marsilea quadrifolia* L.	Marsileaceae	TH	Ple	+	+
17	*Nymphoides hydrophylla* (Lour.) Kuntze	Menyanthaceae	HY	Eph		+
18	*Paspalum dilatatum* Poir.	Poaceae	TH	Ple	+	+
19	*Phleum pratense* L.	Poaceae	TH	Ple		+
20	*Pistia stratiotes* L.	Araceae	TH	Ple	+	+
21	*Pogostemon stellatus* (Lour.) Kuntze	Lamiaceae	HCP	Hyp	+	+
22	*Pontederia crassipes* Mart.	Pontederiaceae	HY	Ple	+	+
23	*Pontederia hastata* L.	Pontederiaceae	HY	Hyp		+
24	*Pontederia vaginalis* Burm.f.	Pontederiaceae	HY	Vit	+	
25	*Potamogeton crispus* L.	Potamogetonaceae	CP	Vit		+

26	*Schoenoplectiella lateriflora* (J.F.Gmel.) Lye	Cyperaceae	TH	Hel		+
27	*Scirpus sylvaticus* L.	Cyperaceae	TH	Hel		+
28	*Sporobolus indicus* (L.) R.Br.	Poaceae	TH	Ple		+
29	*Torenia crustacea* (L.)Cham. & Schltdl.	Linderniaceae	TH	Hel		+
30	*Utricularia aurea* Lour.	Lentibulariaceae	CP	Ple	+	+

W1 : Madhya Kachnar beel**; W2:** Poktar beel**; LF: CH** = Chamaephytes, **CP** = Cryptophytes, **HCP** = Hemicryptophytes, **HY=** Hydrophytes, **TH** = Therophytes. **GF: Eph=**Ephydate**, Hel** = Helophyte, **Hyp** = Hyperhydrate, **Ple** = Pleustophyte, **Vit** = Vittate.

Table 2. Wetlandwise Diversity-index analysis of the aquatic macrophytes.

Name of the wetlands	Macrophytes species richness reported in wetlands	No. of sites	Dominance_ D	Shannon_H
Madhya Kachnar beel (W1)	18	4	0.18	1.19
Poktar beel (W2)	23	4	0.13	0.9

A total of 30 different macrophytes belonging to 21 families have been documented from these two studied wetlands. Among these, Cyperaceae showed the highest dominance (17 %) followed by Poaceae and Pontederiaceae (each contain 10 %) [Fig.1].

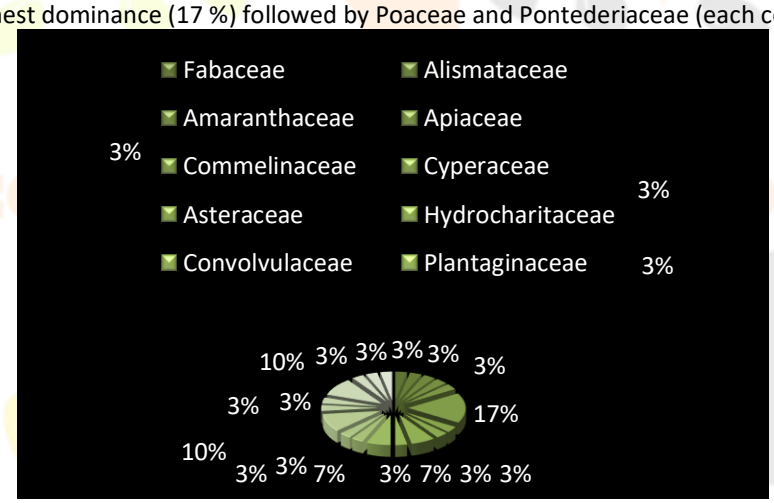
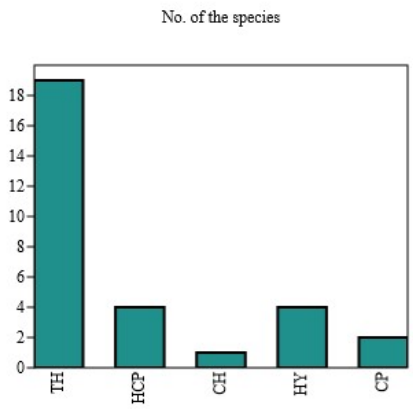


Fig. 1. Familywise distribution of macrophytes.

Collected macrophytes were classified and categorized on the basis of life form (Raunkiaer, 1934) and growth forms (Cook, 1996). Bar graph of life form (Fig. 2) showed the highest distribution of Therophytes (19), followed by HCP and HY (4 each). Graphical representation of growth form (Fig. 3) showed there is the highest distribution of helophytes (11) followed by hydrophytes and Pleustophyte (7 each).



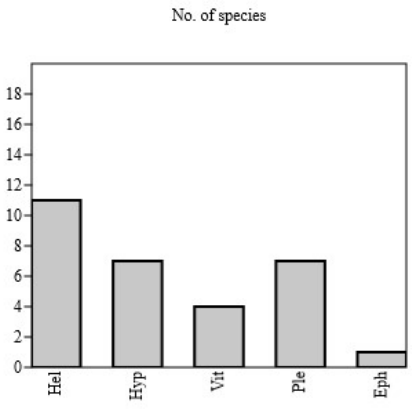


Fig. 2. Distribution of life forms (Raunkiaer, 1934) Fig 3: Distribution of growth forms (Cook, 1996)

Diversity index analysis (Fig:4) showing the highest dominance(1.19) in case of Poktar beel (W2). Shannon-Weiner index(H) is also high(0.9) for Poktar beel (W2).

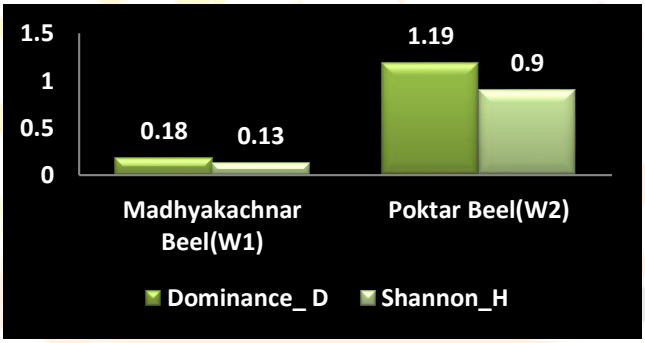


Fig. 4. Wetland wise diversity indices of documented macrophytes.

Box plot analysis have been done on the basis of abundance, frequency, density and IVI of both the wetlands to compare the dataset found at different time intervals during extensive field survey. Minimum, maximum and mean values of the frequency, density, abundance and IVI of each species within the wetland are shown through the box-plot.

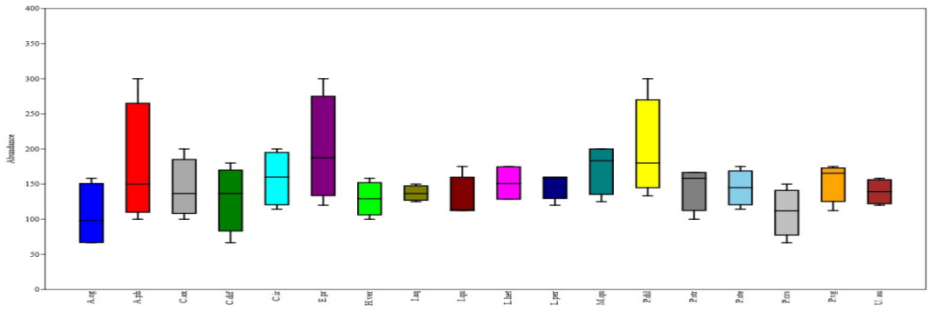


Fig. 5. Box Plot for abundance of macrophytes of W1.

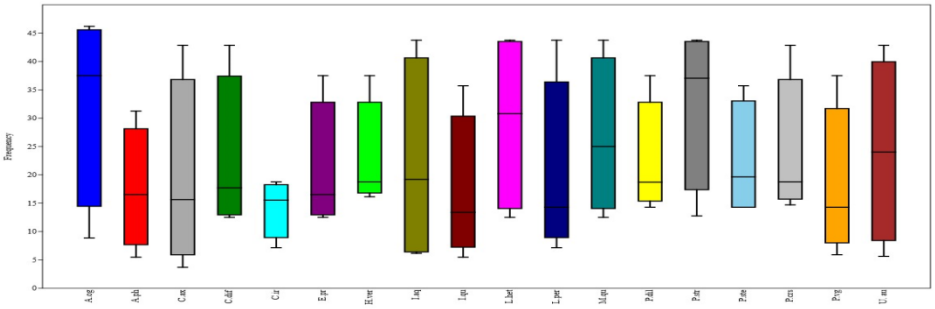


Fig. 6. Box Plot for frequency of macrophytes of W1.

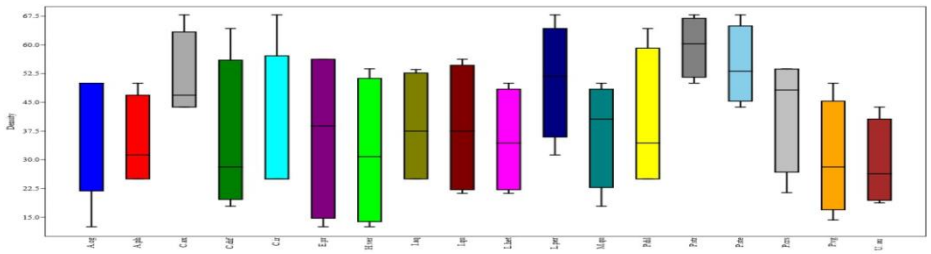


Fig. 7. Box Plot for density of the macrophytes of W1.

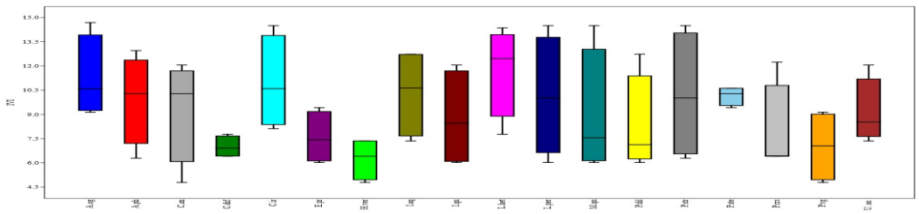


Fig. 8. Box Plot for IVI of the macrophytes of W1.

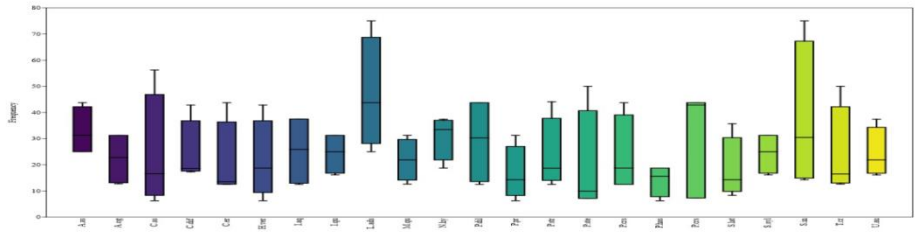


Fig.9. Box Plot for frequency of macrophytes of W2.

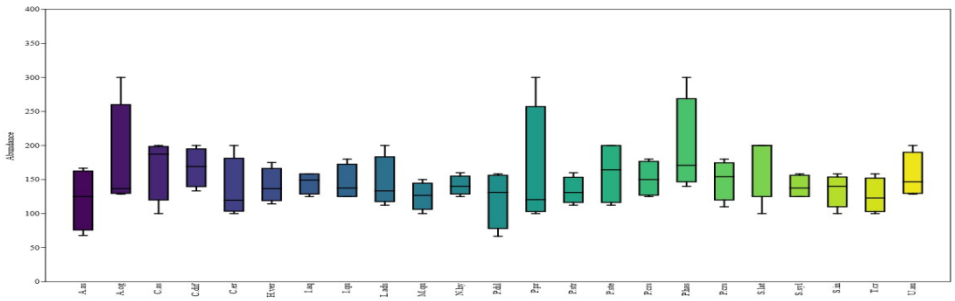


Fig.10. Box Plot for abundance of macrophytes of W2.

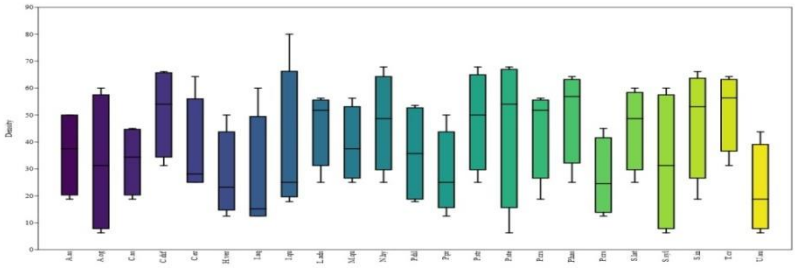


Fig.11.Box Plot for density of macrophytes of W2.

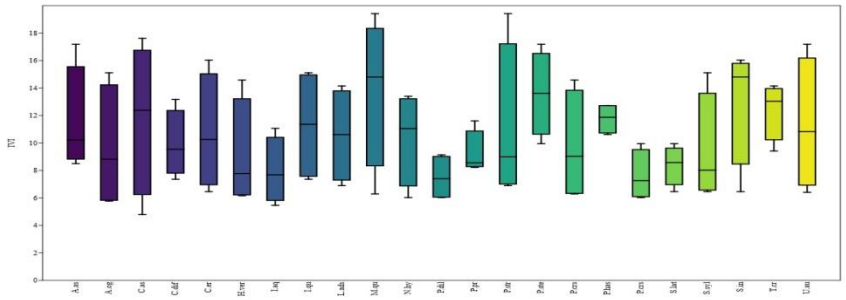


Fig.12. Box Plot for IVI of macrophytes of W2.

PCA biplot multivariate analysis has also been implemented to explore the multivariate relationship among the plant species composition. Different ecological parameters such as frequency, density, abundance, and IVI related to macrophytes of both W1 and W2 were taken to study the correlation among them. PCA illustration showed that some of the species negatively correlated due to their dissimilar distribution in the W1 and W2.

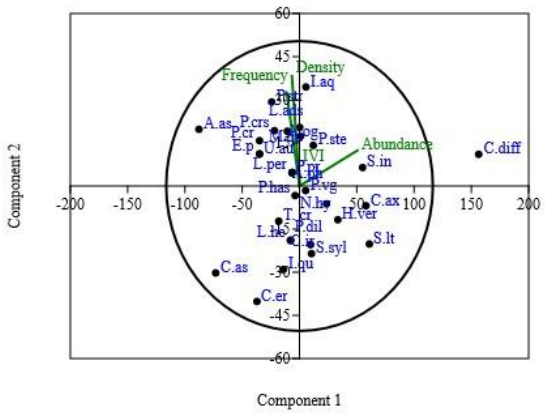


Fig. 13. PCA biplot of the different ecological parameters of the studied plant specimens.

IV. CONCLUSION

Present research clearly indicate that macrophytes proliferation is increasing in both the wetlands, as both of the wetlands show rich macrophytes growth. Analysing of Shannon-Weiner and Simpson diversity index in case of two different wetlands give the conclusion that Poktar beel (W2) contain high species richness as well as some rare species. Besides that Simpson dominance index is also high for Poktar beel (W2). In comparison between the two wetlands, the result depicts that Madhya Kachnar beel (W1) is facing challenging environment due to some anthropogenic pressure, habit and habitat loss of native flora, and species fragmentation which is real threat to the beel. As a result the forgoing study aims to conduct every immediate and necessary actions for the conservation and sustainable development of the wetland. Continuous observations at regular interval and proper oversight strategies are required for maintaining the sound health of the wetland. Besides that, need effective tie-ups of trained academicians and proffesionals, including government as well as non government organization, watershed management specialist planners and decision makers to be linked with local expertise for overall management of wetlands.

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Conflict of Interest: There is no conflict of interest.

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