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Physico-chemical Properties of Water and Its Impacts on the Species Diversity of Aquatic Plants at Disangmukh Wetland of Assam, India

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ABSTRACT

Disangmukh wetlands are an agglomeration of few wetlands beside the levee region of River Brahmaputra where the tributary Disang meets the Mighty Brahmaputra. The present study examines the physic-chemical properties of water and sees the relationship between water quality and the aquatic macrophytes in the Disangmukh wetland of Assam. The samples of plants and water were collected from four sites of Disangmukh wetland namely Ronga Garh, Rongmon, Kaziranga and Longsai beel. The plant's samples were collected using the quadrat sampling method with 1 square meter and the diversity has been calculated using the Shannon Diversity Index (SDI) ($H = -\Sigma^s [(Pi) \times \ln (Pi)]$). The results show the highest SDI at Longsai beel (2.58) and it was followed by Rongmon beel (2.2), Ronga Garh beel (2.13) and Kaziranga beel (2.11). DO, ORP and TDS shows a positive correlation with plant diversity.

Key words: *Aquatic macrophytes, Shannon diversity, Water quality, Wetlands, Brahmaputra*

Introduction

Macrophytes or aquatic plant is an integral part of wetlands that play a crucial role in determining the structure and function of the ecosystems. It defined as aquatic photosynthetic organisms, large enough to see with the naked eye, which grows annually or seasonally submerged below, floating on or up through the surface of the water (Thomaz, 2008; Murphy, *et al.*, 2019). It provides a wide range of ecological services and makes a substantial contribution to the structure, function and service provision of aquatic ecosystems (Hare *et al.*, 2018). The most remarkable function provided by aquatic plants is primary production (Cronin *et al.*, 2006.) and is also associated with the ecosystem processes such as biomineralization, sedimentation, transpiration, elemental cycling, materials transformations, and release of biogenic trace gases into the atmosphere (Carpenter and Lodge, 1986). The presence or absence of certain macrophytes species in an ecosystem can represent the status of water quality (Sugier and Lorens, 2010) and thus it can be considered as measurable indicators of the ecological health of freshwaters ecosystem (Rameshkumar *et al.,* 2019).

Diversity is defined as one of the most significant community attributes which can determine stability, productivity and migration (Stirling and Wilsey, 2001; Zhang *et al.*, 2019). It mainly comprises two different aspects that are species richness and evenness. The diversity of aquatic plants is not identical during all seasons rather it changes seasonally with the changes in rainfall, water level, and other environmental conditions. This changing nature of mac-

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rophytes diversity is directly or indirectly impact the ecological health of the ecosystem. Numbers of physicochemical properties of water like temperature, pH value, turbidity, and conductivity, Dissolve oxygen, Oxidation Reduction Potential (ORP), etc. are the major factors that are highly influencing the freshwater ecosystems and finally influence the distribution as well as diversity aquatic macrophytes communities (Rameshkumar, *et al.,* 2019). Increases of temperature directly or indirectly affect growth, productivity, and distribution of terrestrial and aquatic vegetation (Kankaala *et al.,* 2002). High temperature increases the amount of dissolved organic carbon concentrations that resulting in browner water in aquatic ecosystems which affect the growth and productivity of native and non-native aquatic plant species (Netten *et al*., 2010). The pH, which plays a key role to regulate the acidic or basic characteristics, is a major property of any aquatic ecosystem because it greatly influences all the biochemical functions and retention of physicochemical attributes of the water (January *et al.,* 2013). The higher amount of pH is not suitable for aquatic life at a certain level, however, an optimum level of pH was recommended by BIS (2003) which ranged from 7 to 8.5. The amount of Dissolved oxygen is dependent on the physical, chemical and biological activities of the water bodies, which is one of the major parameters of water quality to measure the trophic status and the magnitude of eutrophication in aquatic systems (Hosetti and Patil, 1987). The phytosociological character of macrophytes is highly influencing by Dissolved oxygen. Oxidation-Reduction Potential does not affect the growth of macrophytes directly but does influence on controlling environmental conditions such as biological activity and nutrient flow. The ORP level of 250-400 mV to be considered as good to optimal water quality. ORP level below 200 mV can indicate low Dissolved Oxygen, high nitrites or Dissolved Organic Carbon (DOC). On the other hand, the ORP level of more than 550 mV also harmful to plant communities. Total dissolved solids represent the total concentration of the dissolved substance in water such as inorganic and organic matter and other dissolved matter. The optimal level of TDS in lake and wetlands are 50-250 mg/l (Enviro Science Enquiry).

In recent years, the ecologist, researchers as well as academicians have given more interest to study the aquatic macrophytes and its diversity due to its growing importance. The major aim of the present study was to examine the impacts of some selected physicochemical parameters of water on the diversity of aquatic macrophytes in the Disangmukh wetland of Assam, India.

Materials and Methods

Study Site

Situated at the junction of the mighty Brahmaputra River and its major tributary Disang, the study site of Disangmukh is located in the north of Sivasagar district in Assam, lies between 27º02 N to 27º42303 N latitude and 94º302 E to 94º362E longitude. It is a famous tourist place of the state, dominated by Mising people, one of the colourful communities of Assam. The river Disang, a south bank tributary of the Brahmaputra that originated from the Indo-Burma border region and flowing through the western part of Arunachal Pradesh, Dibrugarh, Charaideo and Sivasagar district of Assam and finally joints with the river Brahmaputra at Disangmukh. According to an estimation made by Panchayat & Rural Development (P & RD, 2017), Assam the total population of the area is about 10,197. This area is mainly a wetland area and is severely affected by floods each year. There are almost 13 major beels of varied sizes namely Nagaghuli, Rongmon, Naa Ali, Digholi beel, Sola beel, Okhoi Bill, Kaziranga beel, Ronga Garh, Podum, Pani Kati, Borun Dubi, Borsola and Langsai beel.

This wetland is very significant for the rural people of Disangmukh because it provides fishing ground, drinking water, edible plants and flowers, facilities for washing and bathing, irrigation facilities for agricultural fields and grazing lands for cattle. Ecologically this area is also very significant. All types of aquatic plants or macrophytes species viz. emergent, floating-leaved, submerged and free-floating are observed here and it played a key role for better health of the ecosystem.

Data Collection

The macrophytes data have been collected from four wetlands viz. Ronga Garh, Rongmon, Kaziranga, and Longsai during both the summer and winter seasons. Four quadrants with 1 m^2 were selected from each and then collect and count the individuals of each plant's species using the floristic habitat sampling method.The summer data were collected from June to July 2019 and winter data were col-

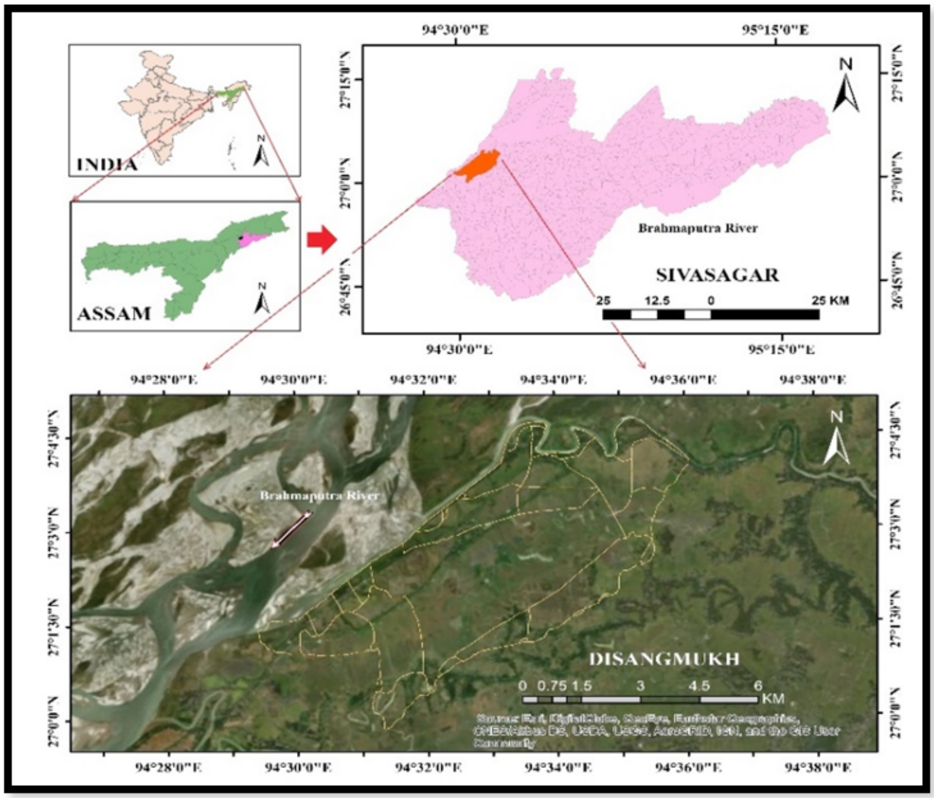

Fig. 1. Location of Disangmukh wetland

lected during January and February 2020. Water samples also collected in both seasons regarding the analysis of the Physico-chemical properties of water such as pH, temperature, Dissolved Oxygen, TDS, turbidity, etc. Samples were collected in plastic bottles of 0.5 L and measured using the Hydrolab DS5X multi-parameter water quality instrumentand the Turbidity meter was used to measure the turbidity.

Plants Diversity Analysis

Two factors need to measures diversity index, one is species richness that is the number of species, and evenness or equitability, that is how equally abundant the species are. In the present study, the species diversity index is calculated with the help of the most widely used indices that is the Shannon Diversity Index (H). It is calculated the following formula

$H = -\Sigma^{s} [(Pi) \times \ln (Pi)]$

(Shannon and Wiener, 1949)

Pi = Proportion of total samples represented by species (n/N)

S= Number of species or species richness

The Shannon diversity index ranges typically from 1.5 to 3.5 and rarely reaches 4.5, the larger values reflect the higher species richness and evenness in a community, while lower value indicates the communities with lower species richness and evenness (Mendes *et al*., 2008).

To estimating the evenness of the species, the formula is given by Buzas and Gibson, (1969) has been used where it is expressed as:

E = eH/S

Where E is the Evenness, eH is the Shannon Index and S is the total number of Taxa.

Results and Discussion

Temperature is a major physical parameter that significantly influences the growth of plants (Zhang, *et al.*, 2019). The optimum temperature for photosynthesis of aquatic plants usually ranged from 25 to 32 °C (Barko *et al*., 1982) . The maximum water temperature during the observation period ranged from 29.7° to 32.1 °C. The highest temperature was recorded at the Longsai beel that is 32.1 °C out of the four study sites. It was followed by Ronga Garh beel (31.5 ºC), Kaziranga beel (30.5 ºC) and Rongmon beel (29.7 ºC). The water pH was recorded highest at Ronga Garh beel (7.51) and it was followed by Longsai beel (7.48), Kaziranga beel (7.47) and Rongmon beel (7.46). Among these four beels, the water pH was slightly high at Ronga Garh and Longsai beel due to its closest human settlement. The turbidity was recorded to be highest at Kaziranga beel which was 28.56 NTU. It was followed by Ronga Garh beel (25.40 NTU), Rongmon beel (17.50 NTU) and Longsai beel (16.29 NTU). The macrophytes diversity also highly influencing by Dissolved oxygen. The most common sources of Dissolved Oxygen (DO) in freshwater bodies are from the diffusion of air, photosynthetic oxygen produces by aquatic plants, wind action and addition of cold water (Ellis *et al.,* 1946). Dissolved Oxygen affects the growth, distribution, survival, behaviours and physiology of aquatic plant communities and thus it is considered as one of the best indicators to assess the health of an aquatic ecosystem. The amount of DO was recorded to be 7.84 mg/l at Ronga Garh beel which may be considered as highest among the four sites. On the other hand, it was recorded to be 7.59 mg/l at Rongmon beel which may be considered as lowest among four sites. The amount of Dissolved Oxygen was recorded as 8.83mg/l and 7.64 mg/l at Rongmon and Kaziranga beel respectively.

Oxidation-Reduction Potential (ORP) also known as Redox Potential is the best way to measures the water potential ability to oxidize organic contaminants. In other words, ORP measures the ability of a lake or river to cleanse itself or break down waste products such as contaminants and dead plants and animals. Higher ORP value indicates the lots of oxygen present in water bodies. Oxidation-Reduction Potential does not affect the growth of macrophytes directly but does influence on controlling environmental condition such as biological activity and nutrient flow. The ORP level of 250-400 mV to be considered as good to optimal water quality. ORP level below 200 mV can indicate low Dissolved Oxygen, high nitrites, or Dissolved Organic Carbon (DOC). On the other hand, the ORP level of more than 550 mV also harmful to plant communities. In the present study, the ORP was recorded highest at Longsai beel (317 mV) and was followed by Rongmon beel (314 mV), Kaziranga beel (311 mV), and Ronga Garh beel (298 mV). The Concentration of too high and too low Total Dissolved Solid (TDS) affect the growth of aquatic life. In Disangmukh TDS ranged between 117 mg/l to 181mg/l. It was recorded high at Longsai beel (181 mg/l) and was followed by Ronga Garh beel (169 mg/l), Rongmon beel (121 mg/l) and Kaziranga beel (117 mg/l).

During the observation period, the Shannon Index was recorded to be highest at Longsai beel (2.58) and it was followed by Rongmon beel (2.2), Ronga Garh beel (2.13) and Kaziranga beel (2.11). Although the species richness of Ronga Garh beel was more than the Rongmon and Kaziranga beel, it's Shannon index is lower than that of both beels, because its species abundance was highly dominated by only three species namely *Pistia, Salvinia Natans* and *Scirpus*. But both species richness and evenness were

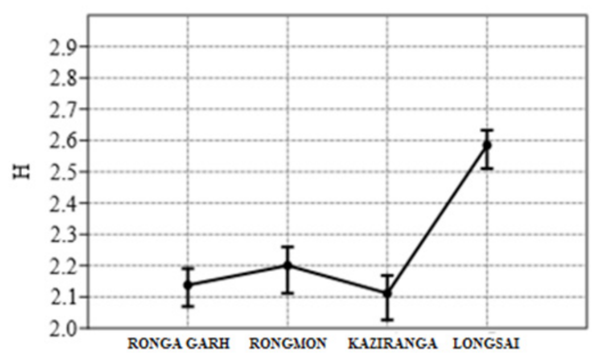

Fig 2. Shannon Diversity Index of macrophytes

Table 1. Pearson Correlation coefficient between the Shannon Index (H) and Water Quality Parameters

Parameters	Mean	Standard Deviation (ó)	Correlation (r)
Temperature (ºC)	30.95	±0.92	0.62
pH	7.48	±0.02	-0.14
Turbidity (NTU)	21.94	±5.18	-0.75
Dissolved Oxygen (mg/l)	7.72	±0.11	0.51
ORP (mV)	310	±7.24	0.61
TDS (mg/l)	147	±28.35	0.65

high at Longsai beel and that why its Shannon index was also recorded high as compare to the other three beels.

The growth of aquatic macrophytes in an aquatic ecosystem depends upon a combination of factors including sediment characteristics, nutrient quality of water and soil and other physicochemical parameters of the environment (Sandaruwani, *et al.*, 2018). After calculating the correlation coefficient between water quality and species diversity, a positive correlation is found between species diversity and temperature, DO, ORP and TDS. Temperature is positively correlated because it significantly increased the growth of plants. The optimum temperature for photosynthesis of aquatic plants is usually ranged from 25º to 32 ºC (Barko, *et al.*,1982; Pedersen *et al.*, 2013). The water pH is negatively correlated with diversity because excessive pH value protects the growth of aquatic plants. Shannon diversity is negatively correlated with water turbidity because high water turbidity limits the growth of aquatic vegetation.

Conclusion

The study of aquatic plants has considerably increased over the last century, because of its increasing importance in an aquatic ecosystem. It plays an important role in the structure and function of the aquatic ecosystem. It influences the geomorphological, hydrological as well as physicochemical environment, and interact with a range of organism by providing food and habitat. Simultaneously, aquatic plants are primarily influenced by various factors such as physicochemical properties of water and soil, climate and anthropogenic activities. Thus the present study examined the physico chemical characteristics of water in the study site and find out the correlation between species diversity and water quality.

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