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RESEARCH ARTICLE

AQUATIC PLANT COMMUNITY CHARACTERISTICS OF SOME MAJOR WETLANDS OF NALBARI DISTRICT OF ASSAM AND RESOURCE COLLECTION FROM IT BY THE PEOPLE OF ITS VICINITIES

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ABSTRACT

The present study deals with the investigation of the macrophytic diversity of some major wetlands of Nalbari district of Assam, India and their economic prospects. The study was carried out for a period of two years i.e. from January, 2011 to December, 2012. Four wetlands namely Batua kamakhya beel, Borbilla beel, Borali beel and Ghoga beel were selected for the present investigation. While Borali beel and Ghoga beel are regularly affected by river flood water, the other two wetlands i.e. Batua kamakhya beel, Borbilla beel face no such disturbances and are very rich in resources which are utilized by the people living in its vicinities. Various diversity indices of the wetland plant communities were calculated to show the species richness (Margalef, 1964), Shannon – Weiver Diversity Index (Shannon and Weiver, 1963), Simpson's Dominance Index (Simpson, 1949), Evenness Index (Pielou, 1966) and Similarity index (Sorensen, 1948). During the study period significant values of species richness, diversity and dominance index, evenness and similarity index of the aquatic macrophytes were recorded during the summer season of the study periods. The study shows that the wetlands although situated away from one another yet so far as species contents are concerned, the wetlands have similarities in their plant species composition. These wetlands also act as sources of livelihood and source of bioresources for the people living around its vicinities. During the present study, 141 aquatic macrophytic species belonging to 116 genera and 53 families have been collected and identified from the wetlands of the study sites. Of these 141 species, 55 numbers of aquatic macrophytes which have found to be utilized by the local villagers for different purposes like food (7 sp.), fodder (11 sp.), vegetables (15 sp.), medicine (12 sp.), biofertilizers (9 sp.) and religious functions (8 sp.) for their day to day uses. But unfortunately the population of some economically important macrophytes of the wetlands i.e. *Nelumbo nucifera, Trapa natans, T. bispinosa* and *Euryale ferox* are decreasing alarmingly due to excessive anthropogenic pressure as well as natural disturbances in the wetlands occurring over the last few decades. Therefore, proper conservation measure should be taken to conserve these wetlands of the district which are sheltering many important plant species along with other vital resources.

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INTRODUCTION

Wetlands are characterized by the heterogeneous assemblage of species attributed with significantly large number of gene pools belonging to both the wetland and ecotone species (Tinner, 1993). It can be defined as lands transitional between terrestrial and aquatic ecosystem where water table is usually at or near the surface or the land is covered by shallow water (Mitsch and Gosselink, 1986) and it occupies 4-6% of earth's land area (Matthews and Fung, 1987). They act as bio-filter, as they intake large amount of organic as well as inorganic nutrients from the eutrophic water bodies nutrient enriched pollutant through various dynamic processes, e.g. water cycle, nutrient cycle and food chain. Therefore the wetlands are known as 'Kidney of the Landscape' or 'Biological Super Market'. Aquatic macrophytes and its role have tremendous significance in wetland ecosystems. Two factors i.e. number of species and importance values (number, biomass, productivity and so on) of individuals, determine the species diversity of a community (Odum, 1996). Importance Value Index (IVI) is a useful quantative parameter to evaluate the community structure, as it provides an overall picture of the density, frequency and cover of a species in relation to community (Curtis and McIntosh, 1951).

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Assam is gifted with many extensive water bodies commonly known as "beels" which contain vitally important bioresources like food, fodders, vegetables, medicines and biofertilizers which are regularly collected by the people living in its vicinities. In Assam two major rivers namely the Brahmaputra and the Barak are there and the "beels" are situated along the tributaries of these two river systems. Wetlands are potentially rich in aquatic resources, which play a significant role in maintaining biodiversity. They offer habitats suitable for support of growth of a variety of aquatic life forms. Besides, macrophytes are also an important component of an aquatic ecosystem and play a major role in productivity of aquatic ecosystem. Wetlands are not only important life-support system for the flora and fauna alone but also act as sources of livelihood and supply bioresources to supplement the day-to-day life of human populations surrounding them. Several works relating to aquatic and wetland flora have been carried out by many workers throughout the world including various parts of India (Mirashi, 1954; Subramanyam, 1961; Unni, 1971; Srivastava, 1987). Biswas & Calder (1936) first gave a detailed account of aquatic plants of the Indian subcontinent. Later, series of records have been published on aquatic plant resources of the country. Subramanyam (1962) described morphology and distribution of 117 taxa of aquatic angiosperms in India. Later on Deb (1975) reported the distribution and status of 144 aquatic and wetland taxa in different states of India. Several workers have done significant works on the phytosociology of different macrophytes in different freshwater bodies of India (Billore and Vyas, 1981; Cottam and Curtis, 1956; Cowder *et al.,* 1977; Dey and Kar, 1989; Kar and Barbhuiya, 2000; Misra, 1974).

In Assam the works regarding the ecological studies of aquatic macrophytes were done by the few workers (Saikia, 2005; Kalita, 2007; Nath, 2012; Borah, 2014). Baruah *et al.* (2011) studied a simple diagnostic tool for measuring Subansiri river health. Dutta *et al.* (2011) also studied the Influence of riparian flora on the river bank health of Subansiri river. Borah and Sarma (2012) studied the phytosociological investigation visa vis human impact on two wetlands of Sonitpur district of Assam. Deka and Sarma (2014) studied Ecological studies of macrophytes of two major wetlands of Nalbari district of Assam , India. Again, Deka and Sarma (2014) reported the present status of aquatic macrophytes of the wetlands of Nalbari district of Assam, India. Sarma and Deka (2014) also studied the Quantative analysis of macrophytes and physico-chemical properties of water of two wetlands of Nalbari district of Assam, India. Wetlands in India are facing tremendous anthropogenic pressures such as rapidly expanding human population, large scale changes in land use and cover and improper use of watersheds, which in turn greatly influence the aquatic biodiversity (Prasad *et al*., 2002; Singh *et al*., 2006; Kumar and Gupta, 2009; Ramachandra, 2010; John and Francis, 2010). Anthropogenic activities, urbanization, accelerated industrialization, extensive growth of exotic aquatic weeds, encroachments, frequent and excessive collection of aquatic resources are the major causes of degradation of majority of the wetlands of Assam. So far no detail ecological investigation of the wetlands of Nalbari district of Assam has been reported by any worker. Therefore, the present investigation carries significance so far as the importance, conservation and management of the wetlands and its resources of the present investigation is concerned.

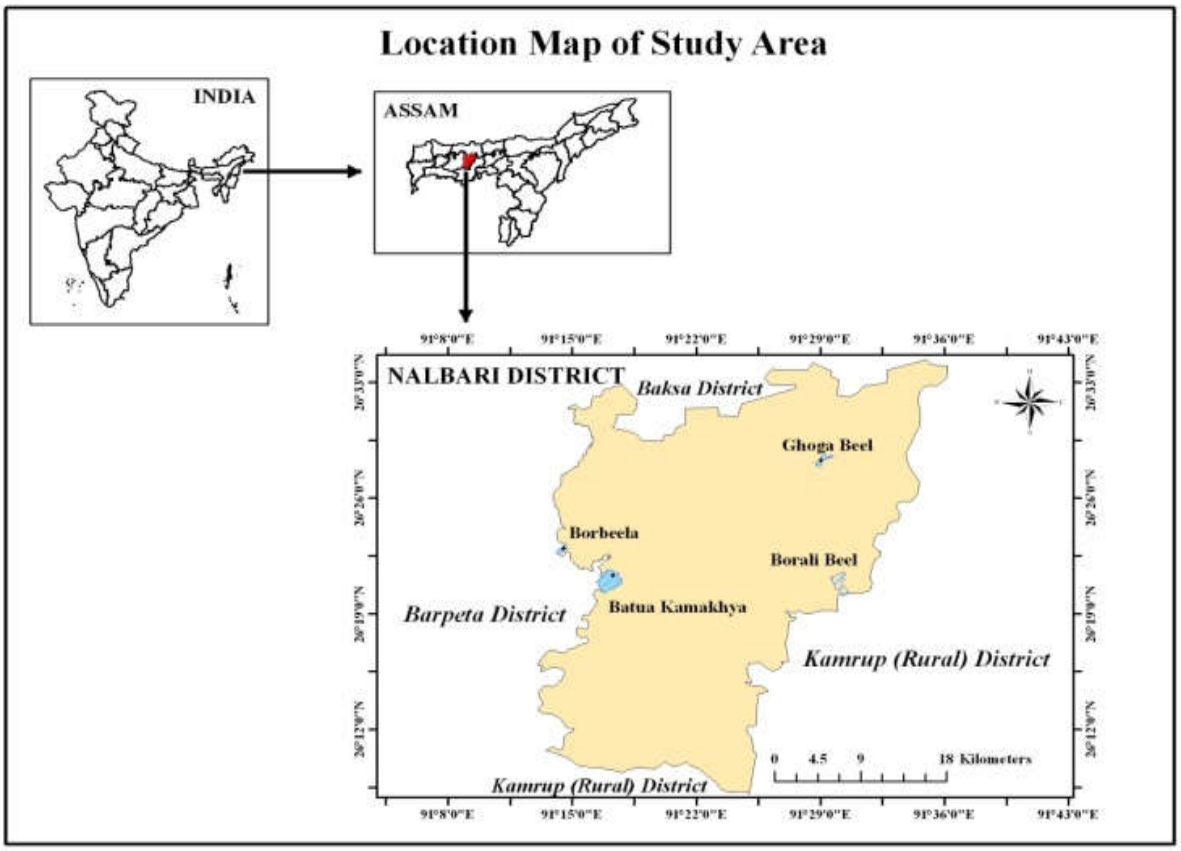

Fig. 1. Location map of the study sites

Study site

Nalbari district of Assam extends from 26^0 $10^/$ N to 26^0 $47^/$ N latitude and 90^0 $15^/$ E to 91^0 $10^/$ E longitude. The district is bounded in the north by the Indo-Bhutan International boundary, in east and south by Kamrup district and the west is bounded by Barpeta district. The maximum and minimum temperatures of the district are 35^oC and 6^oC respectively. The normal annual rainfall in the district is 2685.5 mm. The total geographical area of the district is 1009.57 sq km, which is 1.28 % of the total area of the state. The district falls within the lower Brahmaputra valley zone of Assam. The four wetlands covered during the present investigation are the most significant ones of the district. The two largest wetlands of the district i.e. Batua kamakhya beel and Borbilla beel are situated in south-western and western side of the district covering an area of 65 hectares and 55 hectares respectively. Other two wetlands Borali beel and Ghoga beel are situated in east and northeast side of the district covering a total area of more than 100 hectares. Batua kamakhya beel and Borbilla beel are facing disturbances of both natural as well as man induced. The other two wetlands Borali beel and Ghoga beel confronts mainly natural disturbances of very high intensity in the form of flood during the summer of every year, caused by the river Pagladia which is a tributary of the river Brahmaputra.

MATERIALS AND METHODS

For the study of aquatic macrophytes of the study area, the wetlands were visited twice in a month during January, 2011 to December, 2012. The whole year is arbitrarily divided into two seasons i.e. summer (April to September) and winter (October to March). Macrophytes were collected and preserved according to the conventional herbarium techniques (Jain and Rao, 1976). Collected materials were identified with the help of standard literatures and also at the herbarium of Department of Botany, Gauhati University. People from different communities living in the villages adjacent to the wetlands of the study site were interviewed to collect data about various uses of plants and other resources. To study the phytosociological characters of the wetlands, quadrats of 1m x 1m size were used within the communities. Every month 50 quadrats each were randomly placed in the respective wetlands during the summer as well as in winter season to find out the Importance Value Index (IVI) of species, by following the methods as described by Misra (1969). Different diversity indices like Species richness (Margalef, 1964), Shannon-Weaver Diversity Index (Shannon and Weaver, 1963), Simpson Dominance Index (Simpson, 1949), and Species evenness index (Pielou, 1966) and Similarity index (Sorensen, 1948) of the wetland plant communities were used to obtain various analytical data of the communities by using the following formulas:

1. Species richness (d):

$d = S/\sqrt{N}$

Where, S=Total number of species, and N =Total number of individuals of all the species.

2. Shannon–Weaver index of diversity ($\bar{H}$):

$$\bar{H} = -\sum pi \ln pi$$

Where, pi = the proportion of Importance Value of the ith species (pi = ni / N, ni is the Importance Value of ith species and N is the Importance Value of all the species).

3. Simpson's index of Dominance (D):

$$D = \sum (pi)^2$$

Where, pi = the proportion of Important Value of the ith species (pi =ni / N, ni is the Importance Value of ith species and N is the Importance Value of all the species).

4. Evenness index (E):

$$E = \bar{H}/\log S$$

$\bar{H}$ = Shannon–Weaver diversity
log S= Natural log of the total number of species recorded.

5. Similarity Index (SI):

$SI = 2C/ A+ B$

Where, A = Number of species present in community A
B = Number of species present in community B
C = Number of species common in both the communities

RESULTS

During the present study, 141 macrophytic species belonging to 116 genera and 53 families have been collected and identified from the wetlands of the study sites. Margalef Diversity Index has no limit value and it shows a variation depending upon the number of species. The present study indicates that species richness was highest in Borbilla beel (24.02) during the summer season. This is followed by Batua kamakhya beel (21.44), Borali beel (19.98) and Ghoga beel (17.74) respectively. Whereas during the winter season species richness was found to be maximum (12.31) in Batua kamakhya beel. This is followed by Borbilla beel (11.52), Borali beel (11.15) and Ghoga beel (10.44) respectively (Table 1). Shannon-Weaver Diversity Index is an index applied to biological systems derived from a mathematical formula used in communication area. It is the most preferred index among the other diversity indices. The index values are between 0.0 – 5.0. Results are generally found between 1.5 –3.5 and it exceeds 4.5 very rarely. The values above 3.0 indicate that the structure of habitat is stable and balanced; the values under 1.0 indicate that there are pollution and degradation of habitat structure. The study also shows that Shannon-Weaver diversity index was highest in Batua kamakhya beel (3.45) which is relatively less disturbed wetland during the summer season of the study periods. In Borbilla beel Shannon-Weaver diversity index was found to be 3.31 in the same season. This is followed by Borali beel (3.01) and Ghoga beel (2.032), a highly naturally disturbed wetland, respectively.

Table 1. Diversity indices of aquatic macrophytes in the wetlands of the study sites

Diversity indices	Batua kamakhya beel		Borbilla beel		Borali beel		Ghoga beel	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Species richness	21.44	12.31	24.025	11.52	19.988	11.15	17.74	10.44
Shannon- Weaver diversity index	3.451	2.709	3.316	2.802	3.01	2.379	2.032	1.779
Simpson index of dominance	0.052	0.117	0.015	0.064	0.042	0.169	0.088	0.022
Evenness index	0.927	0.813	0.995	0.872	0.896	0.737	0.611	0.580

Table 2. Similarity Index among the wetlands during the summer season

	Batua kamakhya beel	Borbilla beel	Borali beel	Ghoga beel
Batua kamakhya beel	0	0.701	0.567	0.631
Borbilla beel		0	0.686	0.676
Borali beel			0	0.586
Ghoga beel				0

Table 3. Similarity Index among the wetlands during the winter season

	Batua kamakhya beel	Borbilla beel	Borali beel	Ghoga beel
Batua kamakhya beel	0	0.695	0.531	0.315
Borbilla beel		0	0.586	0.675
Borali beel			0	0.563
Ghoga beel				0

Table 4. Utilization of aquatic plant species by the people living in the vicinities of the wetlands of the study sites: [H= Herb, Us= Undershrub, Sh= Shrub, Cl= Climber, NA=not available]

Scientific name of the species	Vernacular name	Family	Parts used	Use (s)
Acorus calamus L.	Boch	Araceae	Rhizome	Rhizome is chewed with honey and ghee to increase memory. Rhizome extract is used in cough, stomach ulcer and fever. Dried rhizome piece are worn along with neck chain to cure whooping cough of children.
Aeschynomene aspera L.	Shola	Papilionaceae	Soft pith	Soft pith is used in making cork, toys and fishing apparatus.
A. indica L.	Kuhila	Papilionaceae	Soft pith	It is used to make bottle corks, fish net floats and fish baskets.
Alocasia indica (Lour) Koch	Mankochu	Araceae	Stem, leaf	Stem, leaf and rhizome are used as vegetable.
Alpinia allughas (Retz.) Rosc.	Tora	Zingiberaceae	Rhizome	Rhizome is used as condiments and seeds as spice.
Alternanthera philoxeroides (Mar) Grisep	Panikhutura	Amaranthaceae	Twig	Tender twigs are utilized as supplementary vegetable.
A. sessilis (L.) R.Br. ex. DC.	Matikanduri	Amaranthaceae	Twig	Used in reducing fever and also
Aponogeton appendiculatus	NA	Aponogetonaceae	Tuber	Tuber is used as supplementary vegetable.
Azolla pinnata R.Br.	Puni	Azollaceae	Plant body	Used as manure in cultivated field.
Carex baceans Linn.	Biyani bon	Cyperaceae	Rhizome	Rhizome is used in marriage ceremony.
Centella asiatica (L.) Urban	Bormanimuni	Apiaceeae	Stem, leaf	Stem and leaves are used consumed as tonic for improving memory and also used in skin disease.
Ceratophyllum demarsum Linn.	Siyal bhobora	Cerratophyllaceae	Leaf, shoot	Leaf paste is used as cooling agent. It is a good oxygenator and can be used as decorative aquarium plant.
Commelina benghalensis Linn	Kona simolu	Commelinaceae	Young leaf, shoot	Roots are used to cure skin diseases and snake bite and also used as fodder.
C. diffusa Burm.	Kona simolu	Commelinaceae	Stem	Stem juice is applied to stop bleeding of wounds, cuts and also good fodder for cattle.
Cynodon dactylon (L.) Pers.	Dubari bon	Poaceae	Whole plant	Used in religious purposes.
Cyperus corymbosus Rottb.	Uria bon	Cyperaceae	Stem	Stem is used for making mats and rope.
Eclipta prostrata L.	Kehraj	Asteraceae	Leaf, flower	Used as hair oil and in jaundice and ulcer. It is also applied on wounds and skin diseases of cattle.
Eichhornia crassipes (Mart.) Solm.	Panimeteka	Pontedariaceae	Plant body	It is used for the preparation of paper making bags and biogas. Used in potato cultivation. Some people also prepare "Khar" (alkali) locally from *E. crassipes*.
Enydra fluctuans Lour.	Helonchi saak	Asteraceae	Leaf, shoot	Tender shoot is used as vegetable. It is also for the treatment of liver and in neuralgia and nervous diseases.
Euryale ferox Salisb.	Nikori	Nymphaeaceae	Seed	Fruits are eaten as raw. Powdered seeds are used in preparation of "dal Makhana".
Hydrilla verticillata (L.f.) Royle	Pani birina	Hydrocharitaceae	Whole plant	Good fodder for herbivorous fishes.
Hydrocotyle sibthorpioides Lmmk.	Sarumanimuni	Apiaceae	Leaf, stem	Leaf and stem juice is consumed for curing liver problem and skin diseases.
Hygroryza aristata (Retz.) Nees	Petuli dol	Poaceae	Whole plant	Good fodder for cattle and buffalo.
Hymenachne acutigluma (Steud) Gill.	Dol ghah	Poceae	Whole plant	Good fodder for cattle and buffalo.
H. assamica (Steud) Gill	Dol ghah	Poceae	Whole plant	Good fodder for cattle and buffalo.
Ipomoea aquatica Forssk.	Kolmou	Convolvulaceae	Young leaf and stem	Used as vegetable. Leaf juice is used for purification of blood.
I. carnea var. *fistulosa* (Mart. ex Choisy) Austin	Bor Kolmou	Convolvulaceae	Stem	Dried stems are used as firewood and also used for making fences of houses.

Continue…….

Kyllinga monocephella Roxb.	Murphulla	Poaceae	Whole plant	Fodder for cattle and buffalo.
Leersia hexandra Swartz	Erali bon	Poaceae	Whole plant	Fodder for cattle and buffalo. Flowering inflorescence is used in religious purposes.
Lemna minor Torrey	Soru puni	Lemnaceae	Whole plant	Good fodder for fishes and duck, used as manure in paddy fields
Ludwigia adscandans (L.) Hara	Pani khutura	Onagraceae	Leaf	Leaf juice is used in jaundice and skin disease.
L. perrenis Linn	Pani long	Onagraceae	Whole plant	Plant boiled with coconut oil is applied externally for reducing fever.
Marsilea quadrifolia Linn	Pani tengesi	Marsileaceae	Tender shoot	Tender shoots are used as vegetable.
Monochoria hastata Presl	Kar meteka	Pontederiaceae	Tender leaf, flower	Tender leaves and flowers are used as vegetable.
M. vaginalis (Rurm.f) Presl	Bhat meteka	Pontederiaceae	Tender leaf	Tender leaves are used as vegetable.
Najas indica (Willd) Chem	Pani likosi	Najadaceae	Whole plant	Good fodder for herbivorous fishes.
Nelumbo nucifera (Gaertn)	Podum	Nymphaeaceae	Rhizome, leaf petiole, fruiting torus	Rhizome, leaf petioles and fruiting torus is sold as vegetables and the flowers are used for sacred offering in Hindu rituals. Roots are used in small pox and dysentery.
Nymphaea alba Linn	Boga vet	Nymphaeaceae	Flower, stem	Stem is used as vegetable and flowers are used in religious purposes.
N. nouchali Burm.f	Bhet	Nymphaeaceae	Petiole and rhizome	Petioles and rhizomes are used as supplementary vegetable. It is also used to to cure disease related to urinary tract.
N. rubra Roxb. Ex Salibs	Ronga bhet	Nymphaeaceae	Fruit, flower	Fruits are consumed as raw and flowers are used for sacred offering in Hindu rituals
Nymphoides indica (L.) O. Kuntze	Buta bhet	Nymphaeaceae	Petiole, rhizome	Petioles and rhizomes are eaten as vegetable. It is also used for reducing fever.
N. hydrophylla (Roxb) O. Kuntze	Pan chuli	Nymphaeaceae	Leaf	Leaf juice is used in jaundice and skin infection.
Ottelia alismoides (L.) Pers	Panikola	Hydrocharitaceae	Leaf	Leaves are used as poultices on arms and legs to control fever.
Pistia stratioites L.	Borpuni	Araceae	Whole plant	Used as fish fodder. It is also used in skin disease, ulcer and piles.
Polygonum hydropiper Linn	Bihlongoni	Polygonaceae	Leaf	Leaf juice is used in skin disease and uterine disorder.
Rumex nepalensis Spreng	Bon paleng	Polygonaceae	Leaf	Leaf juice is applied in burning.
Sagittaria sagittifolia L.	Pani kochu	Alismaceae	Leaf	Leaf is antiseptic and is known to be used in snake and insect bite.
Salvinia molesta Mitchell	Puni	Salviniaceae	Whole plant	Good fodder for some herbivorous fishes.
Schoenoplectus articulates (L.)	Ghogal	Cyperaceae	Stem	Dried stem is used for making inferior quality of mattress.
S. grossus (L.fil)	Ghogal	Cyperaceae	Stem	Dried stem is used for making very inferior quality of mattress.
Spilanthus paniculata DC.	Mahabhringaraj	Asteraceae	Flower	Flowers are chewed to get relief from tonsillitis and toothache.
Spirodela polyrhiza (L.) Schl.	Soru puni	Lemnaceae	Whole plant	Good fodder for duck and also for grass carp.
Trapa natans(L.) var. *bispinosa* Roxb	Singori	Trapaceae	Fruit	Fruits are eaten raw as they are rich in starch.
Vallisneria spiralis Linn	Fita ghah	Hydrocharitaceae	Whole plant	Fodder for fishes and also a good aquarium plant.
Xanthium strumarium L.	Agora	Asteraceae	Seeds, fruits	Used in chronic malaria and urinary troubles. Fruits are also used to cure small pox.

In winter season, Shannon-Weaver diversity index was found to be highest in Borbilla beel (2.80) which is followed by Batua kamakhya beel (2.70), Borali beel (2.37) and Ghoga beel (1.77) respectively (Table 1). Less diversity indices was observed in Ghoga beel due to more anthropogenic pressure in this wetland. Besides as this wetland is linked to the river Pagladia, during the devastating flood of 1984, 2000, 2004 and 2012 due to the overflowing of the river Pagladia, the floodwater carried heavy silt load and get deposited in the wetland areas of the Ghoga beel, as a result of which many of the areas of the wetland with its macrophytes along their propagules were submerged by this heavy silt load. Simpson index values remains between 0 – 1. Simpson index of dominance was highest in Ghoga beel (0.088) as it contains the lowest species diversity during the summer season of the study periods. This is followed by Batua kamakhya beel (0.052), Borali beel (0.042) and Borbilla beel (0.015) respectively. On the other hand it shows highest values in Borali beel (0.169) during the winter season of the study period which is followed by Batua kamakhya beel (0.117), Borbilla beel (0.064) and Ghoga beel (0.022) respectively (Table 1).

The ratio of the observed value of Shannon-Weaver diversity index to the maximum value gives the Pielou Evenness Index result. The values are between 0 – 1. When the value is getting closer to 1, it means that the individuals are distributed equally (Pielou 1966). Evenness index was found to be highest in Borbilla beel (0.995) during the summer season of the study periods. This is followed by Batua kamakhya beel (0.927), Borali beel (0.896) and Ghoga beel (0.611) respectively. During the winter season also Borbilla beel shows the highest evenness index (0.872) which is followed by Batua kamakhya beel (0.813), Borali beel (0.737) and Ghoga beel (0.580) respectively (Table 1). During the summer season of the study periods Batua kamakhya beel and Borbilla beel showed the maximum similarity index (0.701) among the plant communities and the lowest similarity index value was observed between Batua kamakhya beel and Borali beel (0.567) in the same season (Table 2). During the winter season also, maximum similarity index was found between Batua kamakhya beel and Borbilla beel (0.695) (Table 3). On the other hand in the same season Batua kamakhya beel and Ghoga beel showed the lowest similarity index (0.315) i.e. maximum dissimilarity among the plant communities of the wetlands of the study sites (Table 3). The cause behind this dissimilarity is the maximum anthropogenic and natural disturbances like construction of fisheries inside the wetlands and devastating flood caused by river Pagladia respectively. Similarity index among the wetlands shows higher values during the summer season. It is due to availability of water in each wetland of the study sites during the summer season for the growth of macrophytes. The high organic contents leached

from the surrounding areas of human habitations and agricultural fields in the form of remains of detritus and cow and buffalo dung by rain water during the summer season enhanced the nutrient contents of the habitat for the growth of macrophytes. On the other hand the reduced water levels and the corresponding change of morphology of the wetlands obviously supported a specific wetland plant species to adapt in the wetlands during the winter season.

The common habitats of hydrophytes and marshy vegetation of the district are in the ponds, tanks, river, ditches, low-lying water logged areas, rice fields and comparatively larger water bodies locally known as "beels" which are ideal habitats for many aquatic, semi aquatic wetland and marshy plants. Seasonal puddles and ditches are scattered throughout the district, more commonly along the interior of the villages. Except the "beels", other wetlands filled remain up with water during the monsoon season and remain dry during the winter. In the "beels" water may persist throughout the year. In Nalbari district, all the wetlands are occupied by various types of macrophytes viz. free floating, submerged, rooted with floating leaves, emergents, and marshy which are an integral part of the ecosystems and many of them acts as bio-filters. The study reveals that majority of the poor people living in the vicinity of the wetlands of the study sites depend on the wetland's resources for their livelihood. They collect resources from the wetlands for different purposes such as food, fodder, vegetables, medicinal plants, biofertilizers or small scale industries and religious and cultural activities. During the study period 55 numbers of aquatic macrophytes were recorded from the wetlands of the study sites which have found to be utilized by the local villagers for different purposes like food (7 sp.), fodder (11 sp.), vegetables (15 sp.), medicine (12 sp.), biofertilizers (9 sp.) and religious functions (8 sp.) for their day to day uses.

Although fishing is the primary livelihood of the people living in the fringe areas of these wetlands, many aquatic plant species are collected regularly by the people for their day to day use and also as a source of income. Batua kamakhya *beel* is the only source of livelihood for the people living around its vicinities. Collection of fodder *(Hygroryza aristata, Leersia hexandra, Hymenachne assamica, Hymenachne acutigluma* etc.) is a major activity of the people living in the vicinities of this wetland. During monsoon and post monsoon seasons around 250-300 people from the area collect fodder from Batua kamakhya *bee*l wetland daily and sell it in the nearby markets and earn rupees three hundred to three hundred fifty per person per day. Besides collecting fodder, people of the neighbouring areas of the wetlands also collect other resources from the wetlands for different purposes like food, vegetables, medicines, biofertilizers and also for religious functions. A number of plant species that are found in the wetlands are source of important economic resources for the people living in the vicinities of the wetlands. Various plants found in the wetlands are also a source of edible fruits, such as *Nelumbo nucifera, Nymphaea alba, Nymphaea rubra,* and *Trapa natans* etc. Some medicinal plants found in these wetlands are used to cure various human diseases. Besides, some plant species like *Schoenoplectus grossus* and *Schoenoplectus articulatus* are also used for making inferior quality of mattress, that provide economic livelihood to the communities living in the adjacent areas of the wetlands. During investigation, it has been observed that a single plant can be used for more than two different purposes. For example, *Ipomoea aquatica* can be used as vegetable as well as for medicinal purposes. Similarly *Nelumbo nucifera* and *Nymphaea* spp. are used as vegetable and also in religious functions (Table 4). Several ritual and cultural activities are also associated with these wetlands. During the *Bohag bihu,* a spring festival, observed throughout Assam in the first month of Assames new year "Bohag" (April), people of the adjacent areas of the wetlands bring their cattle for bathing there. Again in the same month, people of the Borbilla village near Borbilla beel offer puja to the goddess Manasa on the bank of the Borbilla beel wetland. During this puja festival, people of the Borbilla village collect plant species like*, Nymphaea alba, Nymphaea rubra, Nelumbo nucifera* which grows in the wetland for offering to the goddess.

DISCUSSION

The study indicates that although normal human interference in the form of use of wetland water for day to day necessities, collection of fish and fodders by the people of its surrounding areas exist in the wetlands of the study sites, the natural disturbances in the form of annual flood by the river Pagladia badly affects the macrophytic community structure of the Ghoga beel and Borali beel where the purely aquatic plant communities are replaced by some patches of alluvial grassland. On the other hand heavy grazing by domestic buffalos during certain periods of the year also seasonally affects the aquatic plant community structure of Borali beel. But gradually, such valuable wetlands of the district are degrading due to several natural as well as anthropogenic activities like the devastating flood of 1984, 2000, 2004 and 2012 caused by the overflowing of river Pagladia which carried heavy silt load and get deposited into the wetland areas of the Borbilla beel and Ghoga beel wetland, which is one of the major causes of decreasing the population of economically important species like *Nelumbo nucifera, Trapa natans* and *Euryale ferox* in these two wetlands. Besides the construction of boundary surrounding the wetlands, development of commercial fisheries inside the wetland areas, construction of roads through the centre of the wetlands and luxuriant growth of *Eichhornia crassipes* have caused not only the degradation of the wetlands of the study sites but also badly affected the whole wetland ecosystems as well. Therefore proper conservation measures of these wetlands are the need of the hour to protect these important wetlands from degradation and for its sustainable exploitation.

REFERENCES

Baruah, D., Borah, S., Hazarika, L.P., Dutta, R., Bakalial, B., Biswas, S.P. and Sarma, S.K. 2011. A simple diagnostic tool for measuring river health – example from a tropical snow fed river. *Annal of Biological Research*, 2 (5): 432-443.

Billore, D.K. and Vyas, I.N. 1981. Distribution and production of macrophytes in Pichhola Lake, Udaipur. *International Journal of Ecological Science*, 7: 45-54.

Biswas, K.P. and Calder, C.C. 1936. Handbook of common water and marsh plants of India and Burma, New Delhi.

Borah, B. 2014. Ecological assessment of wetlands of sonitpur district of Assam with reference to conservation strategies. Unpublished Ph.D. Thesis, Gauhati University, Guwahati, Assam.

Borah, B. and Sarma, S.K. 2012. Phytosociological investigation visa vis human impact on two wetlands of Sonitpur district of Assam, India. *Journal of Advance plant Sciences,* 6 (5 & 6): 91-101.

Cottom, G. and Curtis, J.T. 1956. The use of distance measures in phytosociological sampling. *Ecology*, 37 : 151-160

Cowder, A.A., Bristow, J.M., King, M.R. and Vander, K.S. 1977. Distribution, seasonality and biomass of aquatic macrophytes in Lake Opinicon. *Naturaliste Can*., 104: 441-456.

Curtis, J.T. and McIntosh, R.P. 1951. An upland forest continum in the prairie forest border region of Wisconsin Ecology, 32 : 476-98.

Deb, D.B. 1975. A study on the aquatic vascular plants of India. *Bulletin of Botanical Society of Bengal*, 29 (2): 155-170.

Deka, U. and Sarma, S.K. 2014. Ecological studies of macrophytes of two major wetlands of Nalbari district of Assam, India. *New York Science Journal*, 7 (6): 1-8.

Deka, U. and Sarma, S.K. 2014. Present status of aquatic macrophytes of the wetlands of Nalbari district of Assam, India. *Asian Journal of Plant Science and Research*, 4 (3): 67-75.

Dey, S.C. and Kar, D. 1989. Aquatic macrophytes of Lake Sone in Assam. *Enviromental Ecology,* 7(1): 253-254.

Dutta, R., Baruah, B. and Sarma, S.K. 2011. Influence of riparian flora on the river bank health of a Himalayan River before being regulated by a large dam in North East India. *Annal of Biological Research,* 2(4): 268-280.

Jain, S.K. and Rao, R.R. 1976. A Hand Book of Field and Herbarium Methods, Today and Tomorrow Printers and Publishers, New Delhi.

John, J. and Francis, M.S. 2010. Wetland algal resources of western Ghats (Idukki district region), Kerala, India. *Journal of Basic and Applied Biology*, 4(3): 34-41.

Kalita, G. 2008. "*Ecological study of wetlands of Kamrup district of Assam, India*". Unpublished Ph.D Thesis, Gauhati University, Guwahati, Assam.

Kar, D. and Barbhuiya, M.H. 2000. Studies on the aquatic macrophytes of Chatla Haor floodplain wetland in Cachar district in Assam, Indian Science Congress, New Delhi.

Kumar, P. and Gupta, S.K. 2009. Diversity and Abundance of Wetland Birds around Kurukshetra, India. *Our Nature,* 7: 212-217.

Margalef, R. 1964. *Perspective in Ecological Theory*. University of Chicago Press, Chicago, p. 112.

Matthews, E. and Fung, I.. 1987. Methane emission from natural wetlands, Global Distribution area, and Enviromental Characteristics of Sources. *Global Biogeochemical Cycles,* 1: 61-36.

Mirashi, M.V. 1954. Studies the hydrophytes of Nagpur. *Journal of Indian Botanical Society*, (33): 299-308

Misra, K.C. 1974. *Manual of Plant Ecology*, Oxford and IBH Publishing, New Delhi, p. 491.

Misra, R. 1969. *Ecology Workbook*. Oxford and IBH, Calcutta.

Mitsch, W. I. and Gosselink, I.G. 1986. *Wetlands*. Van Nostard Reinhold, New York,.

Nath, S.K. 2012. Aquatic Macrophytes of Laokhowa Wildlife Sanctuary, Assam, India, *International Journal of Engineering Research and Applications*, 2 (5): 1911-1913.

Odum,E. P. 1996. *Fundamentals of ecology*, 3rd editio, Natraj publishers, Dehradun, India, p. 574.

Pielou, E.C.1966. *An introduction to Mathematical Ecology*, John Wiley and Sons, NY.

Prasad, S.N., Ramachandra, T.V., Ahalya, N., Sengupta, T., Kumar, A., Tiwari, A.K. and Vijayan, V.S. 2002. Conservation of wetlands of India- A review. *Tropical Ecology,* 43 (1) : 173-186.

Ramachandra, T.V. 2010. Wetlands: need for appropriate strategies for conservation and sustainable management, *Journal of Basic and Applied Biology,* 4 (3): 1-17.

Saikia, M. 2005. "*Ecological study of wetlands of Nagaon district of Assam, India*", Unpublished Ph.D Thesis, Gauhati University, Guwahati, Assam.

Sarma, S.K. and Deka, U. 2014. Quantative analysis of macrophytes and physic-chemical properties of water of two wetlands of Nalbari district of Assam, India, *Annals of Biological Research*, 5 (5):77-84.

Shannon, C.E. and Weaver, W. 1963. *The Mathematical Theory of Communication*, University of Illinois, Urbane, IL, p. 125.

Simpson, E.H. 1949. Measurement of diversity. *Nature*, 163-188.

Singh, A.K., Panday, R.K. and Singh, S. 2006. *Understanding wetlands*. Everyman's science Xii (2): 116-119.

Sorensen, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. Det. Kong. Danske Vidensk. Selsk Biology SKr (Copenhagen), 5: 1-34.

Srivastava, R.C. and Kumar, A. 1987. Aquatic and Marshy Angiosperms of Madhya Pradesh. *Journal of Ecology Tau. Bor*, 9: 433-458.

Subramaniam, K. 1961. *Aquatic angiosperms*. Botanical Monograph 3, Council of Scientific and Industrial Research, New Delhi, p. 190.

Subramanyam, K. 1962. *Aquatic Angiosperms*, New Delhi.

Tinner, R.W. 1993. Wetlands are Ecotones: Reality or Myth. In: Gopal, B. A Hillbricht- Iikowska, Wetze, R.G. (eds.), *Wetlands and Ecotones. Studies on Land-Water Interactions*, pp. 1-15.

Unni, K.S. 1971. Studies on the vegetation of ponds, swamps and river banks in Raipur, Madhya Pradesh. *Journal of Bombay Natural History Society*, 64(1), 95-102.

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