Morphological aspects of Floodplain Wetlands with Reference to the upper Brahmaputra River Valley

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Abstract- The floodplains of Brahmaputra river valley and its tributaries in Assam are full of wetlands with different types and sizes. The state has only the inland wetlands of both natural and man-made types. The people of Assam have a long history of eco-friendly utilization and management of wetland resources. Over the years the surrounding people of wetlands have been exerting pressure on wetland resources and as a result of it wetlands have undergone degradation at an alarming rate. The present study focuses on two major issues; firstly, to study of the morphological characteristics of flood plain wetlands in the upper Brahmaputra river valley through combination of remote sensing, GIS analysis and field observation. Secondly, to map the wetland ecosystem and degradation of structural habitat caused by streams and riparian alteration.

The study highlights an imperative need for restoration of wetlands and need for satellite remote sensing for monitoring and dynamic assessment of fluvial ecosystem changes which facilitates planning for ecosystem conservation, management and restoration.

Index Terms- Morphology, Floodplain, wetland, riparian alteration.

I. INTRODUCTION

The river Brahmaputra is one of the world's largest rivers with a drainage area of 580,000 sq. km. (50.5% in China, 33.6% in India, 8.1% in Bangladesh and 7.8% in Bhutan). In India, its basin is shared by Arunachal Pradesh (41.9%), Assam (36.3%), Meghalaya (6.1%), Nagaland (5.6%), Sikkim (3.8%) and West Bengal (6.3%). In the plains of Assam the Brahmaputra flows in a highly braided channel marked by the presence of numerous mid-channel and lateral bars and islands. An extremely dominant monsoon interacting with a unique physiographic setting, fragile geological base and active seismo-tectonic instability together with anthropogenic factors have molded the Brahmaputra into one of the world's most intriguing gigantic fluvial system (Goswami, 1985; Ives and Messerli,1889).

The valley of the river Brahmaputra with its innumerable fresh water lakes (locally called beel), or ox-bow lakes (era suti), marshy tracts and seasonally flooded plains and hundreds of riverine sandbars and islands was, till recently, an ideal wetland eco-system which contained specialised wetland animals like the fresh water dolphin, dugong and the great Indian one-horned rhino and reptiles like the crocodile, the winter monitor lizard and few species of turtles (ENVIS,2004). All these creatures are either extinct or highly endangered at present. The destruction of the Brahmaputra valley wetland system started with the arrival of the water hyacinth from Central America more than a century ago. Extensive growth of this fast growing weed can cut out sun light from the micro flora and also produces faster eutrophication by slowing down water current and depositing debris at the bottom. The second phase of enhanced eutrophication took place with the raising of earthen bunds along the banks of almost the entire length of the river and many of its tributaries after the 1950 earthquake. These artificial levees cut off, to a great extent, the periodic flushing out of the wetlands by the monsoon flood. The third and the final onslaught on the wetlands have taken place with the arrival of the human settlers in the sand bars and the minor riverine islands, mostly in the lower Assam. This has turned the wetlands into agricultural zones rich in rice and vegetables but totally denuded of wildlife. It is therefore felt to be an imperative need to conserve these wetlands and protect their unique biodiversity. If properly managed, the wetlands are going to be a source of immense wealth for this state leading also to enrichment of the quality of its environment (ENVIS,2004). Hence, a preliminary attempt has been made to study the morphological aspects of Floodplain Wetland of the river Brahmaputra particularly of the Panidihing wetland in this paper.

II. OBJECTIVE

To study of the morphological characteristics of flood plain wetlands in the study area through combination of remote sensing data and field observation and to map the wetland degradation.

III. STUDY AREA

The study area, Panidihing- a natural wetland ($27^0 10^/$N-$27^0 45^/$N & $94^0 25^/$E-$94^0 40^/$E) located in the Sivasagar district ($26^0 43^/$N-$27^0 18^/$N & $94^0 26^/$E-$95^0 23^/$E).The total geographical area of the district and the present study area are 2668 sq. k.m. and 33.93 sq.k.m., respectively. The altitude of the area varies from 86 meters to 150 meters. The study area is bounded from north by Sapekhati Bam, Kokilamari village and Milankur Village; south by Disang river; west by river Brahmaputra and bounded from east by the Dimou river. The area lies between the Brahmaputra, Disang and the Dimou river. The natural boundary is demarcated by Dimou River (6.5 k.m. in length).

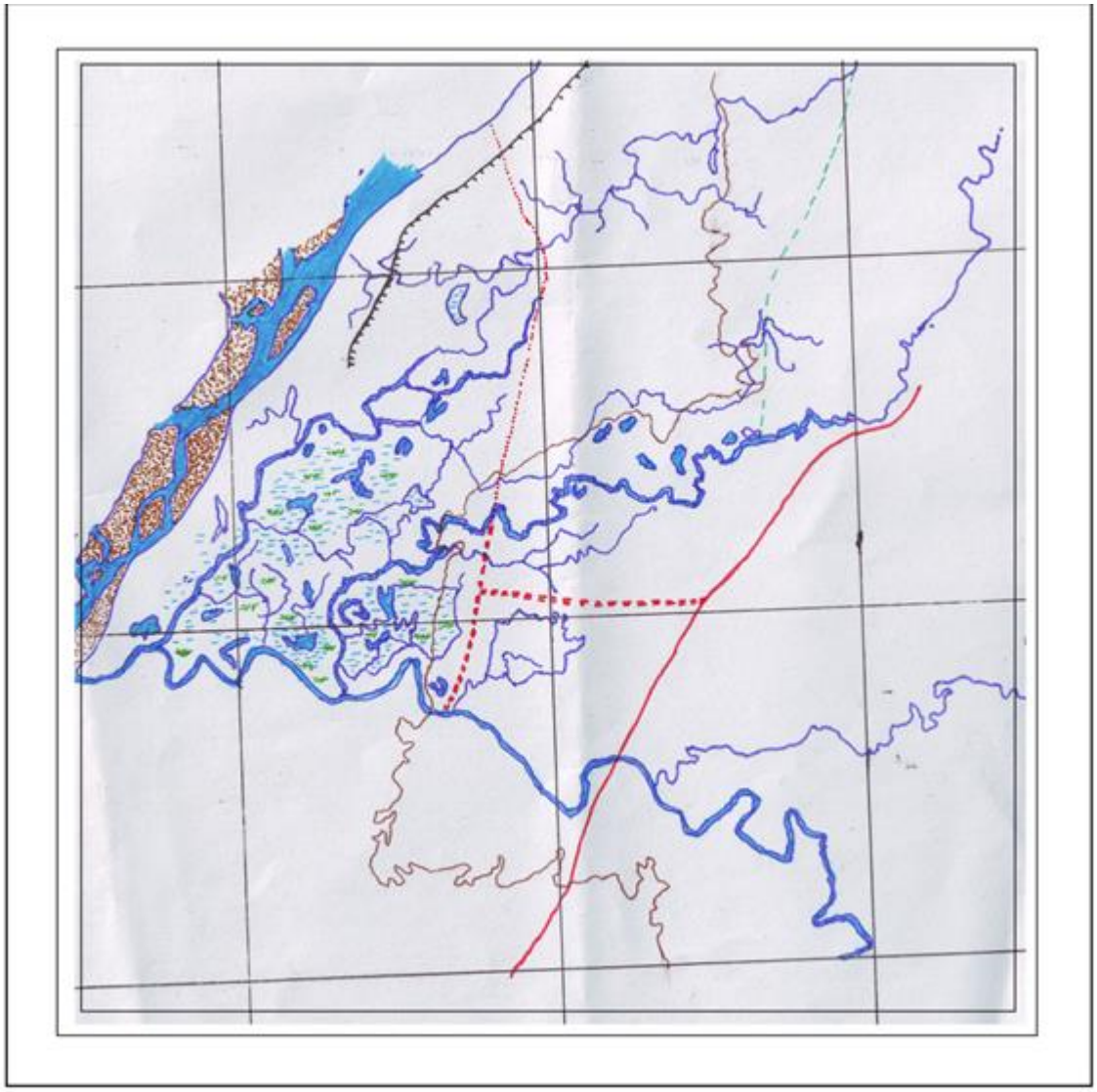
The area comprises of alluvial flood plain of the Brahmaputra River and is predominated by grassland and wetlands. The terrain is gently slopped from east to west. The area falls under temperate climate zone and the climate can be divided into four

seasons- viz. winter season, pre-monsoon season, monsoon, post monsoon season. The rain fall occurs during the monsoon season. The average annual rainfall is recorded during the last 20 years is 2370mm. The mean annual temperature during winter 9^0c to 23^0c and during summer 21^0c to 33^0c. The relative humidity varies from 60% to 90%.

Total wetland area in the district is 12582 ha that includes 530 small wetlands (<2.25 ha). River/stream occupies 69.13% of wetlands. The other major wetland types are Waterlogged-natural (10.57%), Lake/pond (8.28%), Ox-bow lakes (4.2%). There are 25 Tank/pond with 310ha area (2.46%) . Details of wetland statistics is given in Table.21. Aquatic vegetation is mainly observed in Lake/pond, waterlogged wetland types. The area under aquatic vegetation is more or less same in both the seasons. Seasonal fluctuation of open water spread of wetlands does not vary during both the seasons. The turbidity of water is moderate in both the seasons. The following table shows the area estimates of wetlands in Sivasagar Area in hectare:-

Sr. No.	Wetcode	Wetland Category	Number of Wetlands	Total Wetland Area	% of wetland area		Open Water
Post-monsoon Area				**Pre-monsoon Area**			
1100				**Inland Wetlands - Natural**			
1	1101	Lakes/Ponds	30	1042	8.28	220	262
2	1102	Ox-bow lakes/ Cut-off meanders	75	529	4.20	317	333
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	16	113	0.90	40	36
5	1105	Waterlogged	34	1330	10.57	145	89
6	1106	River/Stream	74	8698	69.13	6045	5773
1200				**Inland Wetlands -Man-made**			
7	1201	Reservoirs/Barrages	-	-	-	-	-
8	1202	Tanks/Ponds	25	310	2.46	304	266
9	1203	Waterlogged	5	30	0.24	30	14
Sub-Total			**259**	**12052**	**95.79**	**7101**	**6773**
Wetlands (<2.25 ha), mainly Tanks		530	530	4.21	-		-

Source; ENVIS, Assam (2004).



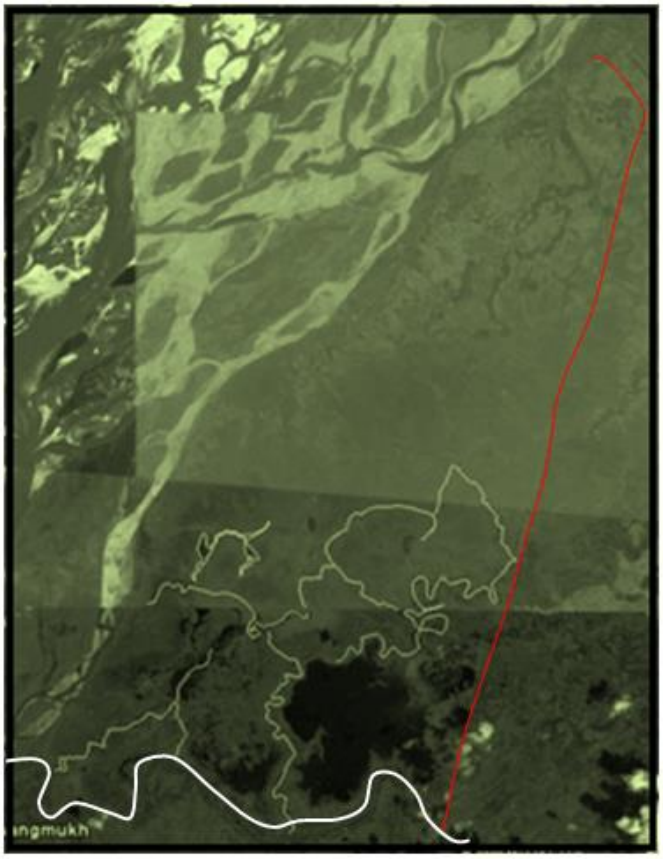
IV. METHODOLOGY

Drainage, swamps, *Beels* , *(Dehadrai, 2006)*, abandoned channels, aquatic vegetation, ox-bow lakes, etc. from Panidihing Wetland are identified and mapped form Topographical sheets of 1:50,000 scale. Their present size, shape and areas have been measured from satellite Imagery and maps collected from Divisional Forest Office, Sivasagar district. Reports from various departments, viz. the Assam Remote Sensing Application Center, Fishery, Agriculture, Forestry and Governments publication are used for the study. Besides, in order to study the present conditions of the Panidihing wetlands several field visits have been carried out in the study area for necessary observation and information.

V. RESULTS AND DISCUSSION

Genesis of the Panidihing Wetland:

The wetland lying in between the three river system, south by Disang , east by Demou and west by Brahmaputra is of fluvial origin . The toposheet (No 83 I/12) shows that the Panidihing Wetland lies within the contour height of 300 meter. Hence, surface slope doesn't have greater effect in the origin of the wetland. The *Doab* like location of the Panidihing , natural levee formation , embankment of the above rivers and the bordering historical *Dhai Ali* has made the area water logged and moist. The main *beels* of the wetland are Gorimari, Segunpara, Takai, Goboka, Singorijan, Gela Dimou Beel, Mora Disang, Balijan Beel, Kekrakhati Beel, Ketari Beel, Dighali and Phulai.



Fluvial regime of the wetland:

The wetland is fed by river water, particularly the Demou, the Disang and the Brahmaputra. All these three are perennial rivers and are being nourished by the seasonal rainfall and the surface run-off. The maximum and minimum water discharge of Dimou river is 16 and 2 cubic meter per second respectively. While the river Disang shows the maximum and minimum discharge of 1078 and 915 cubic meter per second respectively. The river Disang is highly sinuous. In this course the width of the river is 100 meter and depth is 12 meter. The average sediment load carried by river Disang is 219 ha/m (*Sharma,2008)*. The abundant streams of Disang River form a good number of *beels* in the plain course. Such *beels* that falls within the study area are Dighali and Phulai *beel*. Besides these rivers and beels, there are a few seasonal streams that feed the fluvial regime of the wetland during summer season, viz. Boloma, Singorajan, Samarajan, Garmuriajan, Morisuti, Dipling, Champai, Balikur, Naharanijan, Jamugurijan, Najan and Atilajan. The flow pattern seems to be fluctuating. The flow increases considerably during monsoon rains. The rivers have its minimum flow during January and to May period. The maximum flow is attained from the month of July, August, September, and October. After the month of October there is a steady fall in flow.

Apart from the hydrology of the above three main drainage of the wetland, the seasonal rainfall also feeds the fluvial regime of the wetland. Table 1 shows the rainfall f the Sivasagar district for last decade (2001-2009):

Years	Monsoon Season (Rainfall in M.M.)				Annual rainfall (Rainfall in M.M.)
	June	July	August	September	
2000	290.1	172.0	285.4	151.3	1247.3
2001	211.2	174.9	146.5	201.4	1084.4
2002	201.9	378.4	342.7	257.8	1432.7
2003	303.5	481.6	325.6	296.7	2314.3
2004	390.8	363.5	285.4	323.5	2178.3
2005	100.7	431.2	391.8	73.0	1900.8
2006	229.6	367.6	219.6	171.2	1478.1
2007	282.1	403.4	293.9	359.1	1840.5
2008	358.7	356.5	293.9	190.6	1523.4

Source, Statistical Handbook, Assam

Bio-diversity of the Wetland:

Floral Diversity

The Panidihing wetland is predominantly covered by grasslands and *Beels. It represents five biomes*- Assam alluvial Plains Semi Evergreen Forest, Eastern Seasonal Swamp Forest, Eastern Wet Alluvial Grasslands and Wetlands. In these biomes the most representative plant species found are *Dillenia indica, Ficus glomerata, Albizzia lucida, Anthcephalus cadamba, Eugenia jamblana, Duabanga snneratioides, Bombax ceiba, Bischofia javanica, Alstonia scholaris, Macaranga denticulate, Zizyphus jujube, Erythrina variegate, Saccharum species, Impereta cylindrical, Arundo donax, phragmites kerka, Typha elephantine , Ipomea reptans, Ipomea aquatica, Enhydra fluctuans, Pistia stratites, Lema paneicstata ,Neyraudia reynaudiana, Nymphia spp, Eichhornia spp etc.*

Faunal Diversity

Except seasonal visit of a herd of elephants comprising of about 50 individuals migrating from Arunachal Pradesh through Dhemaji district the wetland doesn't harbor any important mammalian species. Foxes and lesser cats take shelter in the wetland. Besides this, 160 species of birds identified so far in the wetland (Borooah 1990,1994). It is the breeding ground local waterfowls. As the wetland is on the banks f Brahmaputra and Desang, it acts as a breeding ground of variety of fishes and replenishes the fish production in the nearby wetlands and in the rivers.

Physico-Chemical Characteristics:

The physicochemical parameter of water samples were collected from three sampling stations(SS1, SS2 & SS3) from April 2010 to march 2011 is presented in the tables. It is found that the pH of the water was very alkaline during the pre monsoon, when compare to the monsoon and post monsoon seasons. It also recorded lowest pH values during post-monsoon and maximum during pre-monsoon season (Jadhav and Deshmukh,2006 ; Jindal and Gusain,2007). It also stated that intense photosynthetic activities of phytoplankton will reduce the free carbon dioxide content resulting in increased pH values (Gupta ; Gupta ,2006).

Sampling Stations	Ph			DO			WT			BOD			ALK			AT		
	Monsoon	Post Mon	Pre Mon	Monsoon	Post Mon	Pre Mon	Monsoon	Post Mon	Pre Mon	Monsoon	Post Mon	Pre Mon	Monsoon	Post Mon	Pre Mon	Monsoon	Post Mon	Pre Mon
SS1	7.13	7.73	7.80	7.30	7.38	6.33	18.43	25.3	25.8	1.8	1.5	2.2	58.2	63.2	66.9	25.1	28.5	32.6
SS2	7.05	7.85	7.88	7.73	7.10	6.15	21.1	23.7	25.3	1.6	1.7	2.4	56.4	64.4	64.7	27.4	26.3	32.5
SS3	7.33	6.09	7.85	7.25	7.5	6.29	22.5	24.3	24.7	1.4	2.6	2.5	60.3	62.3	52.9	27.0	27.1	30.2

**Tests done by NEIST, Jorhat*

Change Detection:

The toposheet of SOI (No: 83 I/12) and the two Satellite Imageries (GeoEye/SPOT) of 1972, 2000 and 2010 respectively shows the changes in the wetland area in terms of its geographical area, conversion of wetland into agricultural land and encroachment of human habitat in the wetland. The rate of change of total area from 1972 to 2000 is 17% (41 sq.K.M in 1972 and 33.93 K.M. in 2000-as per DFO, Sivasagar), but from 2000 to 2010 is 21% (33.93 sq. K.M. in 2000 and 26.57 sq.K.M.). The field observation reveals the fact that human encroachment has become prominent as they have expanded their economic activities in the form of Paddy cultivation, Dairy farming, Daily fishing, mustard seed cultivation, removal of top soil layers by the contractors for construction and illegal felling down of the trees having high economic value. Use of modern method of agriculture, such as, inorganic fertilizer, mechanization in ploughing, sowing and harvesting has been adversely affecting both the faunal and floral realm of the Panidihing wetland. Another fatal threat to the wetland is the rich growth of *Ipomoea aquatica over* the extensive area. This has been restricting the growth of diverse plant species. The preliminary field visits also bring about a salient feature of the wetland to the effect that gradual siltation in the wetland has been going on in each and every over flooding. Upland of the wetland has been overgrazed by the increasing number of livestock which are coming not only from the neighboring areas but also from the distant places of the district.

Change Detection by GeoEye, SPOT Image (2000 & 2010 superimposed)

VI. CONCLUSION AND PERSPECTIVE

The paper is a segment of ongoing Ph.D work. Raw data so far collected and observations made till the writing of this paper are the main data base . This study reports preliminary investigative information on the morphological aspects of the Panidihing wetland as well as the changes it has been receiving from man induced environmental impact. It needs mention here that no other voluntary or the governmental agencies have been monitoring the spatio-temporal nature and extent of the Panidihing wetland. The records available with the forest department are quite obsolete as of now and the true demarcation of Panidihing Bird Sanctuary and the Panidihing Reserved Forest is also erroneous. Thus, the entire investigation on this issue will involve primary data collection with sophisticated modern tools

and techniques, viz. high resolution satellite imagery (LISS-III/IV), DGPS, most representative sample collection (species, soil, water and population), total weather station for local climatological data, bio and geo-statistical tools, etc.

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