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Impact of Developmental Activities on Urban Wetlands in Guwahati City, Assam

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ABSTRACT

Being a transitional zone between terrestrial and aquatic ecosystem, wetlands are by far the most productive ecosystem, scattered all over the globe. Assam being gifted with abundant rain and rivers too facilitates numerous wetlands, locally known as *Beels*. One among them is the Deepor Beel,, situated in Guwahati city. It is the only Ramsar site in Assam. Deepor Beel plays a very vital role by supporting a rich biodiversity and also plays an important role in maintaining the ecological balance of the entire area on the south west of the Guwahati city. It is also the major storm water retention basin of the city. However, unchecked urbanization leading to increased water pollution, encroachment, reclamation and fragmentation has been gradually pushing this very wetland into extinction. This study has tried to look into this very aspect of wetland loss due to dynamics of urban Land Use Land Cover in the wetland area by using satellite imageries of the area from 1977 till 2006. Use of geospatial technology has helped in quantifying the wetland loss very effectively. The study shows that there has been loss of wetland areas and fragmentation which in turn plays a negative role in maintaining sustainability of the environment in that area.

Key Words: Wetlands, Land Use Land Cover Change, Remote Sensing, GIS, Urbanization

INTRODUCTION

Wetlands have been defined in a variety of ways. Several factors such as personal perspective, position in the landscape, wetland diversity and function

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contribute to the traceable nature of the definition. In its simplest form, wetlands may be defined as the interface or transitional zone between land and water. Two of the most commonly used definitions are as under:

i) **US Fish and Wildlife Service (Cowardin *et al*., 1979)**

"Wetlands are lands transitional between terrestrial and an aquatic system where the water table is usually at or near the surface or the land is covered by shallow water level. For purposes of this classification, wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is nonsoil and is saturated with water or covered by shallow water level at some time during the growing season of each year".

ii) **Ramsar Convention (1971)**

"Submerged or water saturated lands, both natural and manmade, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 meters".

Article 2.1 further provides that wetlands 'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands'.

Wetlands cover approximately 5% - 8% of the world's land surface (7-10 million km2), and contain 10%-20% of the global terrestrial carbon (Mitsch and Gosselink, 2007). Wetlands play an important role in the global carbon cycle (Sahagian and Melack, 1998; IPCC, 2007; Prigent *et al*., 2001), thus, they must be conserved for carbon cycling as well as for their importance as natural habitats (IPCC, 2007; Rebelo *et al*., 2009). Wetland ecosystems are associated with a diverse and complex array of direct and indirect uses. Direct uses include water supply source and harvesting of wetland products such as fish and plant resources. Indirect benefits are derived from environmental functions such as floodwater retention, groundwater recharge/discharge, climate mitigation, and nutrient abatement (IPCC, 2007). They have been described as the "kidneys" of the landscape as they filter sediments and nutrients from surface water. Wetlands are also often referred to as "biological supermarkets" because they support all life forms through extensive food webs and biodiversity (Mitsch and Gosselink, 2007).

However, Wetlands are one of the most threatened habitats of the world. They are often termed as waste lands, transformation of which through draining, dredging and infilling seemed a fitting fate for them. Studies have shown that human activities in wetlands may cause alterations of wetlands (Song *et al*., 2012). Changes in wetland areas may significantly affect ecosystem processes (Barducci *et al*., 2009). Changes in Land Use Land Cover have important consequences on natural resources (Houghton, 1994; Houghton *et al*., 1999; Liu *et al*., 2005; USDA, 2009; Garg el al.,2013), and are regarded as a primary source of land degradation (Tolba and El-Kholy, 1992; Wang *et al*., 2009). The loss of inland wetlands mainly results from drainage for agriculture, forestry, and mosquito control; and filling for residential, commercial, and industrial development (Ralph *et al*., 1998). The transformation from wetlands to croplands is a result of the pressure to supply more food and provide more economic income for the rapidly increasing population and to meet economic demands (Mitsch and Gosselink,2007; Rebelo *et al*., 2009; Wang *et al*., 2011). Hence, identifying, delineating, and mapping of wetlands on a temporal scale provide an opportunity to monitor the changes, which is important for natural resource management and planning activities (Prasad *et al*., 2002). Remote sensing is a very cost efficient means for delineating wetlands over time and space and can provide useful information on wetland characteristics (Ozesmi and Bauer 2002; Wulder *et al*., 2004).

STUDY AREA

The Deepor Beel has been considered as the target wetland of study in this paper. It is worth mentioning that the Deepor is not an isolated wetland but a network of various small adjoining wetlands and swampy areas, drained by two most important streams i.e.Basistha and Kalmoni. Hence, to make the study more effective in terms of impact on the wetland ecosystem, the whole water shed of Deepor Beel has been delineated and considered as

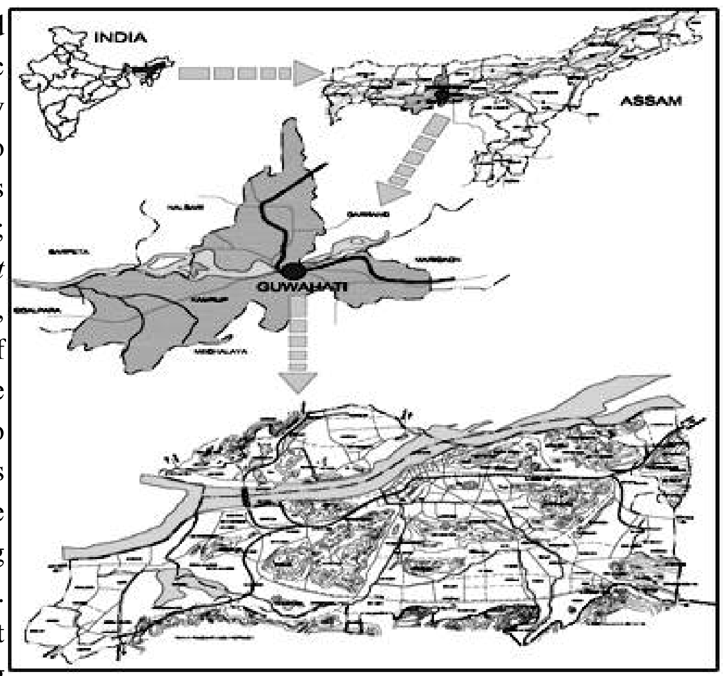

Figure 1. Location of Deepor Beel (Map not to Scale)

the study area (Figure 1 and Figure 2). The Deepor Beel catchment covers approximately 211 sq. km area with Basistha and Kalmoni as two major streams and Khanajan through which Deepor drains its water into Brahmaputra river. Deepor Beel is located between, 91° 37' 6.46" E to 91° 40' 48.82" E and 26° 5' 40.02" N to 26° 9' 5.18" N, south of Brahmaputra River in Kamrup District, 18 km south west of Guwahati city in Assam .It lies at an altitude of 53 meter above MSL and covers an area of about 4,000 ha. The wetland is surrounded by the Bharalu basin on the east, Basistha basin in the south East, Kalmani River on the west, Jhalukbari Beel on the north and Rani and Garbhanga Reserve forests on the south. The national Highway (NH-37) passes a little distance away from the eastern boundary of the lake. The main wetland is subdivided into three major parts, the Barbeel, Kharbari and the Chanabeel. Moreover there are certain dendretic extension at the northern part of the Beel (Bhuyan, 2008).

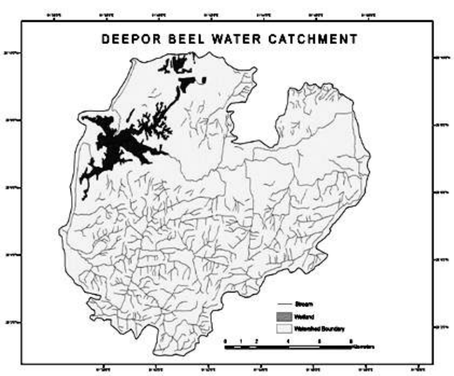

Figure 2. Deepor Beel watershed

Data:

To carry out the impact of urbanization on wetlands, Land Use Land Cover maps of the study area have been prepared for different time periods using the Survey of India Topographical sheets (No. 78 N/12 and 78 N/16) and satellite imageries with the following description:

Sl No.	Sensor	Resolution (m)	Date of Acquisition
1	MSS	70	28-02-1977
2	LandSat TM	30	26-11-1991
3	LandSat ETM+	30	17-02-2002
4	LandSat ETM+	30	26-10-2006

METHODOLOGY

Geospatial technology has been found to be of immense useful in analysis of LULC over time. This study involves analysis of satellite imageries over different time periods since 1977 till 2006 for cloud free seasons of the study area. For this purpose, first of all the topographical sheets have been geocoded using ArcGIS 9.2 software. Then from the geo-rectified toposheets, the Deepor Beel water shed has been delineated. After that the satellite imageries of different time periods have been geo-referred using the watershed map of the study area. Then from the images, the study area has been sub sated out. They are then subjected to supervised classification to arrive at the detailed LULC maps of the study area. Supervised or unsupervised classification methodologies were widely accepted for LULC dataset development (Jensen *et al*., 1995; Niu *et al*., 2009;

Klemas, 2011). Various statistical techniques have been utilized to arrive at the various LULC statistics for the studied period. The data thus derived are then compared to access the impact of urbanization and consequent land use dynamics and its impact on the wetland ecosystem.

RESULTS AND DISCUSSION

Wetlands, particularly in the rapidly expanding urban areas, faces tremendous pressure in terms of pollution, encroachment etc. The City of Guwahati is one of the rapidly expanding city in entire Ne India. Various studies have shown that the city has expanded at the cost of once extensive network of wetlands and swamps, locally called Beels.. During the last two decades, the Deepor Beel and its adjoining area has undergone considerable transformation in terms of ecological and social character . It has been observed that natural and anthropogenic problems i.e., (i) disturbance from transport artery i.e. construction of railway line along the southern boundary; (ii) industrial development within the periphery; (iii) large scale encroachment within the wetland; (iv) allotting government vacant land to private party; (v) brick making factory and soil cutting and erosion; (vi) hunting, trapping and killing of wild birds and mammals; (vii) commercial scale forest exploitation (viii) unplanned fishing practice without controlling mesh size and using water pump, etc. are dominant in Deepor Beel area

Thus to quantify this changes, a detailed LULC maps for the Deepor Beel catchment has been attempted. Here to be noted is that this study is limited only to the change in LULC only. The LULC of the Deepor Beel watershed has been categorized into 6 major LULC types (Table1).

Table 1. Land Use Land Cover of Deepor Beel Catchment

Land Cover Category/Area (ha)	1977	1991	2002	2006
Dense Forest	10209	10241	10711	11176
Open Forest	4549.6	4039.7	4173.3	3926
Agriculture Land	835.32	491.33	1468.4	332.82
Fallow Land	2456.9	1981.2	1297.6	2240.4
Water Spread Area	475.98	687.05	485.73	450.54
Swampy Land	1849.3	2528.4	1418.9	1045.6
Built Up Land	866.87	1273.8	1688.5	2071.2
total	21243	21243	21243	21243

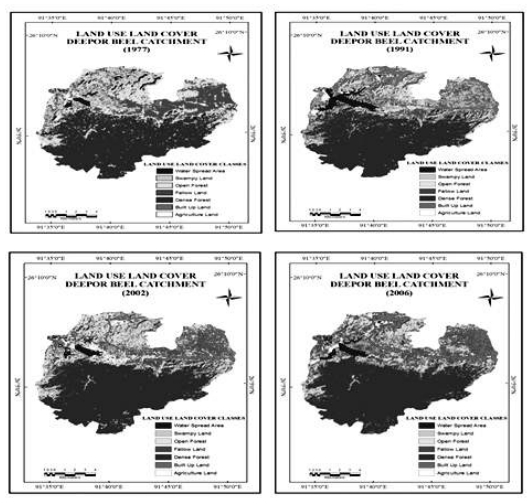

Figure 3. Land Use Land Cover Maps of Deepor Beel Catchment

The analysis of the LULC of the area shows that there has been noticeable change across all the categories. The data shows there is shrinkage of wetland area (basically the water spread area) over the studied period. It has reduced by 5.34 % from 1977 to 2006 (Figure 3). At the same time, there has been fragmentation of the water body. On the other hand, the city area i.e., the built-up land or the impervious layer of the city has registered a whopping 138.93% increase over the studied time period (Figure 4). This surge in built up area can easily be interpreted from the fact that all other categories of LULC except Dense forest registered negative growth over the studied time period (Table 2).

Table 2. Percentage Area Change

Land Cover Category/pc change in area	(1977-1991)	(1991-2002)	(2002-2006)	(1977-2006)
Dense Forest	0.32	4.58	4.35	9.48
Open Forest	-11.21	3.31	-5.93	-13.71
Agriculture Land	-41.18	198.85	-77.33	-60.16
Fallow Land	-19.36	-34.50	72.65	-8.81
Water Spread Area	44.34	-29.30	-7.24	-5.34
Swampy Land	36.72	-43.88	-26.31	-43.46
Built Up Land	46.94	32.56	22.66	138.93

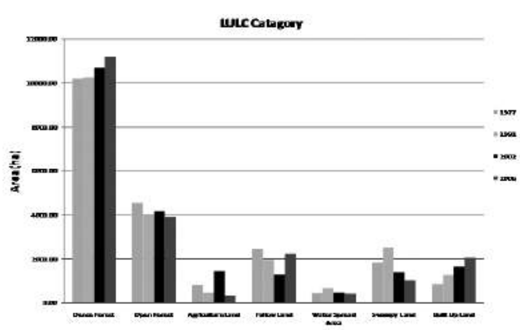

Figure 4. LULC Categories

Thus, it has been observed that Deepor Beel has been shrinking and got fragmented over the studied period. Emergences of various aquatic weeds such as water hyacinth etc are also observed in subsequent years. Rapid urbanization, Illegal settlements and industries establishment around the wetland are found to be accelerating the waste and pollution problems of the ecosystem. Construction of railway line in the eastern part of this wetland is yet another major reason for fragmentation. Altogether these threats have resulted not only in shrinking of the lake area but also deteriorated the natural environment for the survival of different flora and fauna within the wetland. Thus, decrease in beel area due to encroachment, heavy deposits results in reduction of water retention capacity and creation of dry surface areas.

CONCLUSION

India has a long history and tradition of conservation of natural resources. As part of religious ritual, people revere and worship many rivers and wetlands throughout the country. Similar kind of practices also prevails in Assam and its adjoining areas. It has been reported that the fisherman living and practicing fishing activities in and around Deepor Beel also performs many rituals and pujas namely Ganga Puja etc. However, Deepor Beel has been bearing the brunt of the city's unplanned development. Perhaps foremost among the problems is the dumping of municipal solid wastes, including toxic disposals, which are increasingly finding their way into the very core of the wetland. Continued discharge of the city's untreated sewerage through the Bahini and Bharalu Rivers virtually turned Deepor Beel into a stinking tank. The problem has got aggravated during the monsoons, with rainwater sweeping large amounts of garbage from the dumping site into the beel. It has thus been observed that encroachment, pollution, sedimentation etc has caused a great injury to the ecosystem health. Thus the above study highlights the urgent need to formulate sustainable conservation and management plan for the Deepor Beel catchment as a whole. Use of remote sensing and GIS technology is found to be very useful in this regard.

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