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Effects of anthropogenic and natural environmental changes on riverine wetlands of Nalbari district of Assam, North East India: a framework for ecological assessment

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Abstract

The present study has been carried out to study the ecological degradation of two important wetlands of Nalbari dstrict of Assam i.e. Ghoga beel and Borali beel using satellite imagery of LANDSAT TM data in three different years viz. 1987, 1999 and 2013. Land use and land cover change is a useful parameter for determining the degradation which is facing the pressure of several natural as well as anthropogenic activities. Five land use and land cover classes viz. Water body, Cropland (Kharif), Agri-plantation (Human settlement), Cropland (Rabi), Aquatic vegetation were derived from the interpretation of satellite data for both the wetlands. The present investigation shows that the percent of area lost of both the wetlands was found to be 43.63% and 64.24% respectively during the year 1987 to 2013. Therefore proper conservation and restoration measures should be taken to prevent for triggering the further degradation of the wetlands.

Key Words: Conservation and restoration measures, Degradation, Land use and land cover, Wetlands.

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Introduction:

Wetlands are the most fragile ecosystem in the world. Wetland plays a significant role in regional ecosystem, such as the regulation of climate, cleansing of environment and balancing of regional water and provides suitable habitat for aquatic flora and fauna. Based on several estimates, the extent of the world's wetlands is generally thought to be from 7 to 9 million km^2, or about 4 to 6 percent of the land surface of the earth (Mitsch and Gosselink 2000). They keep changing their structure and functions with time and support a wide range of flora and fauna. Any change in their hydrologic conditions affects the biodiversity of the ecosystem, which has also been regarded as their degradation. Both natural and anthropogenic activities around the wetlands such as siltation, weed infestation, encroachment, overfishing, grazing by domestic livestock, development of fisheries, disturbance from recreational activity and tourism are also responsible for degradation of the wetlands. The wetlands of the worlds are now facing serious threats due to various natural as well as anthropogenic disturbances. Besides, due to changing environmental characteristics as well as increased anthropogenic pressures on them, both urban and rural wetlands are in a process of degradation.

In Assam 5097 wetlands have been mapped at 1: 50,000 scale by using Geographic Information System. In addition 6081 small wetlands having area less than 2.25 ha have also been identified, both by Space Application Centre of ISRO, Ahmedabad jointly with Assam Remote Sensing Application Centre Guwahati in 2006-07. The wetlands of North East India, particularly in Assam, are facing serious threats due to increasing anthropogenic pressure. Though considerable works have been carried out on the land use and land cover changes of different wetlands of India and rest of the countries (Ellis et al., 2010; Bradley & Mustard, 2005; Turner, 2001; Hunsaker et al., 1994), no detail studies of LU/LC changes of Borali beel and Ghoga beel of Assam, India have been carried out yet. Therefore the present study has been carried out to investigate and evaluate the present status of these two wetlands and also to assess the morphological changes of the wetland ecosystem as well.

Study Area:

Borali beel is situated in the Eastern part of Nalbari district in the global position at latitude N26^{0} 42$^{/}$ 40.8$^{//}$ and E91^{0} 05$^{/}$ 00.2$^{//}$ longitude. It is also a perennial wetland of the district and covers an effective area of about 40 hectare. Borali beel is connected with an inlet Satha channel on the north side of the beel which is flowing throughout the centre of the beel and came out as an inlet in the south western side and ultimately merge with the river Pagladia a tributary of the river Brahmaputra. Ghoga beel is situated in northern side of Nalbari district at the global position N26^{0} 28$^{/}$ 16.7$^{//}$ latitude and E91^{0} 29$^{/}$ 02.2$^{//}$ longitude. It covers an effective area of 46 hectare. It has an inlet in northern side i.e. Ghoga jan which is flowing throughout the centre of the beel and its outlet meet with Bholakuchi

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switch gate in south eastern side of the beel which ultimately merge with the river Pagladia a tributary of the river Brahmaputra.

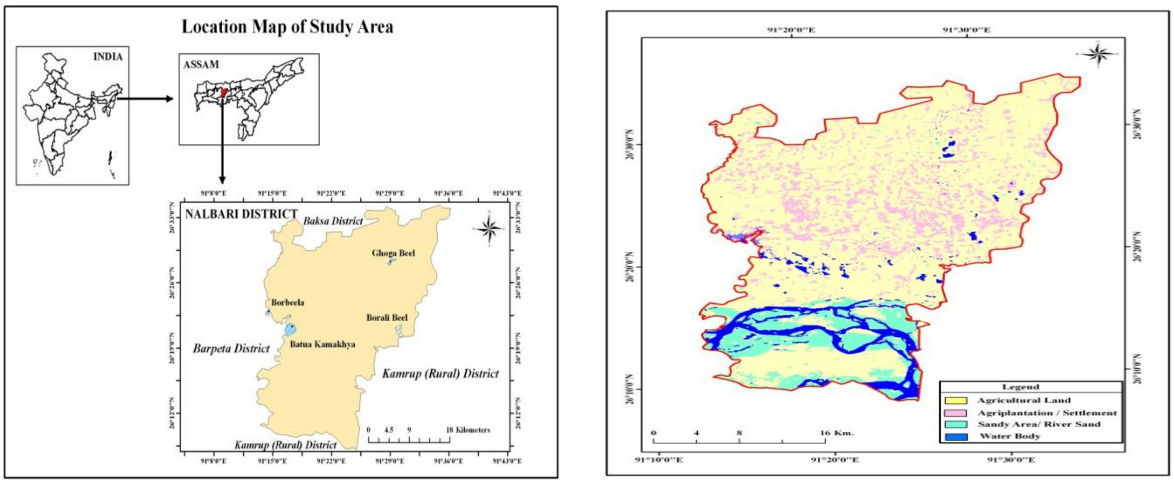

Fig 1: Map showing the location of the study sites as well as LU/LC.

Material and Methods:

Data Source & Methodology for Land Cover Change Analysis:

Data Source:

To analyze the land use change dynamics of the wetlands of the study sites multi dated, multi seasons satellite imageries were used. Besides this, the Survey of India topographical sheet at 1:50,000 scales were used for delineation the wetland boundary and to generate baseline information for the study area. The details of the datasets used in this study are shown in Table-1

Table 1: Datasets used for monitoring the LU/LC change:

Data Type	Path/ Row	Date of acquisition	
		Pre-Monsoon	Post-Monsoon
Landsat TM	136/42, 135/42	1987 (February& March)	1987 (September& October)
Landsat TM	136/42, 135/42	1999 (February& March)	1999 (September& October)
IRS LISS III	109/52, 111/52	2013 (February& March)	2013 (September& October)

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Methodology:

Satellite imagery of Landsat TM of 1987 and 1999 and IRS P6 LISS III of 2013 were used to analyze the land cover change dynamics of the wetlands. The Landsat TM of 1987, 1999 and IRS P6 LISS Satellite image 2013 including the pre-monsoon and post-monsoon seasons were procured from National Remote Sensing Centre (NRSC), Hyderabad. The imageries were projected to UTM – WGS 84 projection system using Landsat ETM image as reference. Sub-pixel image to image registration accuracy was achieved through repeated attempt. Radiometric correction of all the images was done using dark pixel subtraction technique (Lillesand, et. al. 2004). Buffer operation of the wetlands was done for two kilometer to assess the land use change in and around the wetlands. Re-sampling of IRS P6 LISS III imagery was carried out at 30 m. pixel size as the other imageries (Landsat TM 1987 and 1999) were of 30 m. resolution. Subset operation of satellite imageries of 1987, 1999 and 2013 was carried out by creating an area of interest (AOI) layer of the vector layers.

After sub setting, the images of the study area were processed through spectral enhancement technique using ERDAS imagine 9.2 software. Principal component analysis (PCA) was carried out to all the images. All the images were converted into three principal components. The bands of PCA data are non-correlated and independent, and are often more interpretable than the source data (Jensen, 1996). After generating the hybrid PCA images for all the years a supervised classification, technique was used using maximum likelihood algorithm to assess the land cover change dynamics in fringe areas of wetlands from 1987 to 2013. Five land use types were identified from the field observation and training sets of the land cover classes were gathered using handheld GPS receiver. After classifying all the images of 1987, 1999 and 2013 the post classification comparison method was used to detect the changes in land cover types of the wetlands. The method consist in overlaying, using a cross operation, the comparison of two images and classification. The cross operation allows the analyst to know the extent and nature of the changes observed, in other words, the transition between different land cover classes and the corresponding areas of change. Applying this method finally, land cover change analysis of of the wetlands of the study areas has been done. All these image-processing operations were carried out in ERDAS Imagine 9.2 software.

Diversity indices like Shannon-Weaver Diversity Index (Shannon and Weaver, 1963), Simpson Dominance Index (Simpson, 1949), and Species evenness index (Pielou, 1966) and Species richness (Margalef, 1964), of the wetland plant communities were used to obtain various analytical data of the communities by using the following formulas:

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1. Shannon–Weaver index of diversity (H'): $H' = -\sum pi \ln pi$ 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).

2. 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).

3. Evenness index (E): E= H'/logs, Where H' = Shannon–Weaver diversity, and log S= Natural log of the total number of species recorded.

4. Species richness (d): $d = S/\sqrt{N}$ where, S=Total number of species, and N =Total number of individuals of all the species.

Results and discussion:

Five land use and land cover classes were derived from the interpretation of satellite data for the study area. These are- Water Body, Cropland (Kharif), Agri-plantation (Human settlement), Cropland (Rabi), Aquatic vegetation.

Table 2: Land use and land cover changes of the wetlands during 1987-2013 (Area in hectare)

Land use Classes	Borali beel			Ghoga beel		
	1987	1999	2013	1987	1999	2013
Water spread area	369	266	208	179	106	64
Kharif cultivation	585.27	700.51	765.82	1017.72	1130.09	1064.97
Agriplantation(Settlement)	1158.48	1256.66	1285.89	643.86	835.13	855.04
Rabi cultivation	853.92	828.83	866.47	983.34	757.37	855.49
Aquatic vegetation	370.53	285.18	211.01	99.81	95.12	84.22

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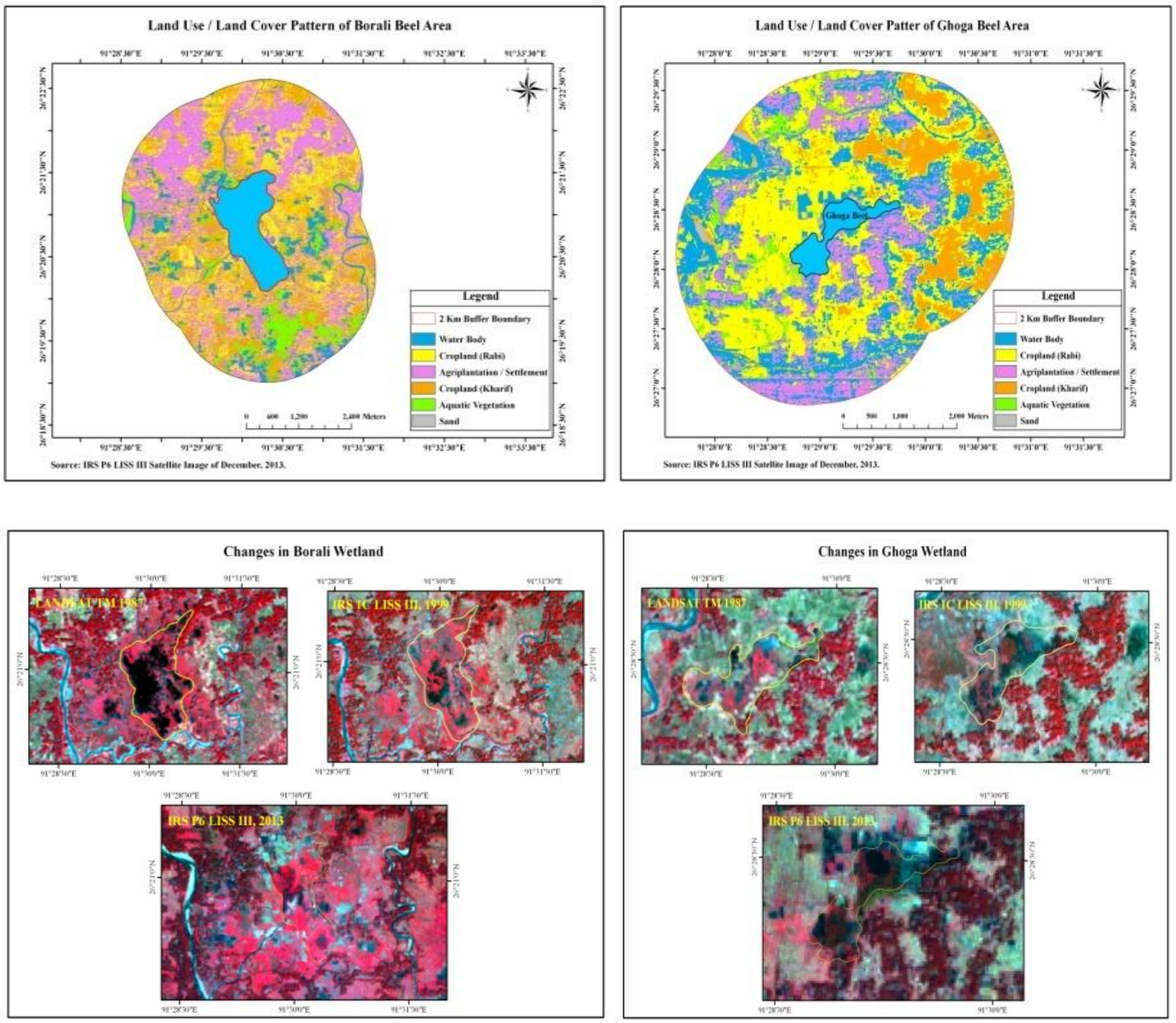
Figure 2: Changes of Land Use and Land Cover pattern of Borali beel and Ghoga beel from 1987 to 2013.)



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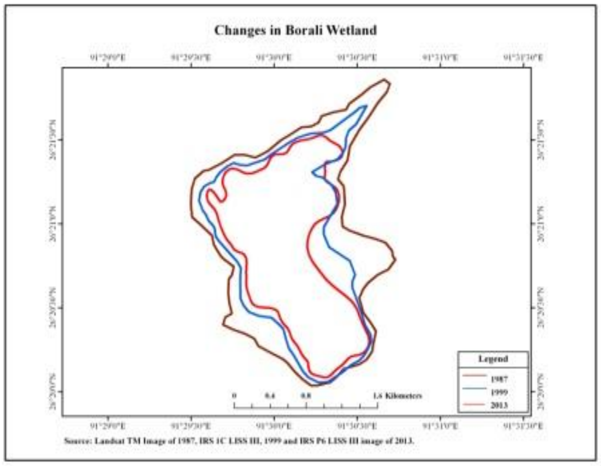

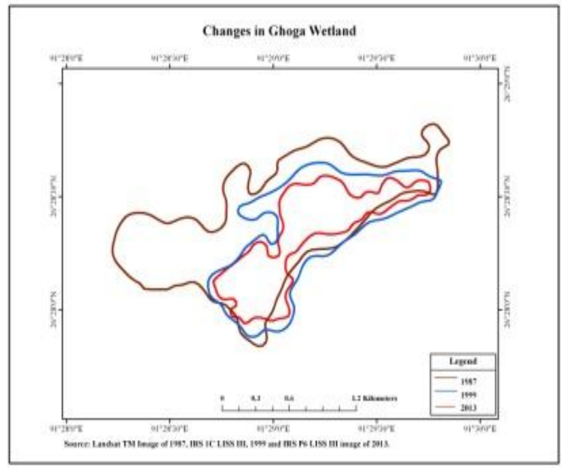

Source: Satellite imagery of Landsat TM of 1987 and IIRS P6 III of 1999 and 2013, NASA's Global Land Cover Facilittator & National Remote Sensing Centre, Hyderabad

In Borali beel water spread area of the beel was found to be 369 hectare in 1987, which was reduced to 266 hectare in 1999 and in the year 2013 its water spread area has declined to 208 hectares. The percent of area lost of Boralia beel during the year 1987 to 2013 was found to be 43.63% which is due to siltation caused by the overflowing of the river Pagladia leading to agricultural practices in those shallow or raised bed of the wetland. Kharif cropland has been increased by 180.55 hectares (30.84%) from 1987 to 2013. Rabi Cropland has been slightly increased by 12.55 hectares representing (1.4%) in the wetland areas. Agriplantation has been increased by 127.41 hectares having (10.99%). Similarly aquatic vegetation of the wetland areas has significantly reduced by 159.52 hectares representing 43.05% during 1987 to 2013 (Table 2).

In Ghoga beel water spread area of the wetland was found to be 179 hectare in 1987, which was reduced to 106 hectare in 1999 and in the year 2013 its water spread area has declined to 64 hectare. The percent of area lost of Ghoga beel during the year 1987 to 2013 was found to be 64.24% which is due to siltation caused by the overflowing of the river Pagladia and subsequently development of commercial fisheries in that shallow and raised bed of the wetland and agricultural practices respectively. Kharif cropland has been increased by 47.25 hectares (46%) inside the wetland areas from 1987 to 2013. Agriplantation has been increased by 211.18 hectares having 32.79%. Rabi Cropland has been increased by 127.85 hectares from 1987 to 2013 representing 31%. On the otherhand aquatic vegetation of the wetland areas has been reduced by 15.59 hectares representing 15.6% during 1987 to 2013 (Table 2).

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The increasing population of the surrounding villages of the wetlands of the study sites is a major cause of degradation of the wetlands. These threats have resulted not only in shrinking of the wetland area but also deteriorated the natural environment for the survival of different flora and fauna within the wetland ecosystem as well. Significantly, due to the increase literacy rate among the inhabitants and also for improvement of socioeconomic condition of the fringe villages of the wetlands of the study sites, the dependency of the people on the wetlands have been found to be decreased over the last few years.

Table: 3 Diversity indices of aquatic macrophytes of the wetlands

Sl. No.	**Diversity indices**	**Borali beel**		**Ghoga beel**	
		Summer	Winter	Summer	Winter
1	Shannon- Weiver diversity index	3.01	2.379	2.032	1.779
2	Simpson index of dominance	0.042	0.169	0.088	0.022
3	Evenness index	0.896	0.737	0.611	0.580
4	Species richness	19.988	11.15	17.74	10.44

The present study shows that during the summer season, Shannon-Weaver diversity index was highest in Borali beel (3.01) and Ghoga beel it was found to be (2.032). In winter season, Shannon-Weaver diversity index was found to be highest in Borali beel (2.379) and in Ghoga beel it represents (1.779) (Table 3). 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, many of the areas of the wetland with its macrophytes along with its propagules were submerged by this heavy silt load. 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. On the other hand it shows highest values in Borali beel (0.169) during the winter season of the study period. Evenness index was found to be highest in Borali beel (0.896, 0.611) respectively both in summer and winter season. The study also indicates that species richness was found to be highest in Borali beel (19.98, 11.15) both in summer and winter season of the study period (Table 3).

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Siltation

Alluvial grassland patches after flood

Encroachment

Agricultural practices inside wetland areas

Fig 3: Causes of degradation of the wetlands

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Conclusion:

Landsat TM images from 1987-2013 shows considerable spatio-temporal changes of the wetlands of the study sites. The analysis of satellite data from 1987-2013 shows that wetland of the present study sites are shrinking from year to year. 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 both the wetlands, the devastating flood of 2004 and 2012, caused by the overflowing river Pagladia which carried heavy silt load and get deposited into the wetland areas of the Borali beel and Ghoga beel wetland, which is one of the major causes of decreasing the population of economically important species like *Nelumbo nucifera* and *Trapa natans* and *Euryale ferox* in both the wetlands. This natural disturbance in the form of flood by the river Pagladia badly affects the macrophytic community structure of the Borali beel where the purely aquatic plant communities are replaced by some patches, supporting alluvial grassland as pockets in the midst of the wetland where they were completely absent earlier. Besides the construction of dykes near the wetlands, development of commercial fisheries, construction of roads and luxuriant growth of *Eicchornia crassipes* etc are also other causes of degradation of the wetlands recorded during the present investigation. So measures for conservation and sustainable development of these important wetlands with the community participation should be taken at the earliest

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References:

1. Mitsch, W.J. and Gosselink, J.G. (1986). *Wetlands*. Van Nostrand Reinhold, New York.
2. Jensen, J. R. (1996). Introductory digital image processing. Prentice hall press, New Jersey, USA. p. 318.
3. Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2004). Remote sensing and image interpretation. Fifth Edition, John Wiley, New York.
4. Simpson, E.H. (1949). Measurement of diversity, Nature, 163-188.
5. Shannon, C.E. & Weaver, W. (1963). The Mathematical Theory of of Communication-University of Illinois, Urbane, IL, 125.
6. Pielou, E.C. (1966). An introduction to Mathematical Ecology, John Wiley and Sons, New York.
7. Margalef, R. (1964). Perspective in Ecological Theory, University of Chicago Press, Chicago, 112.
8. Ellis, E. C., Goldewijk, K.K., Siebert, S., Lightman, D., & Ramankutty, N. (2010). Global Ecology and Biogeography. Anthropogenic transformation of the biomes 1700–2000. 19: 589–606.
9. Bradley, B. A., & Mustard, J. F. (2005). Remote Sensing of Environment. Identifying land cover variability distinct from land cover change, cheatgrass in the Great Basin. 94: 204–213.
10. Turner, B. L. (2001). Ecological Perspectives in Science, Humanities, and Economics. Land-Use and Land-Cover Change: Advances in 1.5 Decades of Sustained International Research. 10: 269–272.
11. Hunsaker, C. T., O'Neill, R.V., Jackson, B.L., Timmins, S.P., Levine, D.A., & Norton, D.J. (1994). Landscape Ecology, Sampling to characterize landscape pattern. 9: 207–226.

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