

ASSESSMENT OF IMPACT OF URBANISATION ON DEEPOPOR BEEL WETLAND

**(Report submitted to the fulfillment of internship programme with the ENVIS
Centre-Assam of Assam Science Technology and Environment Council,
Guwahati, Assam)**



SUBMITTED TO

**Assam Science Technology
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Again, I want to thank my Guide, H.O.D of department of “Architecture Town and Regional Planning” of IEST, Shibpur professor Swati Saha for allowing me the leave to carry out the internship programme under ASTEC.

Place: Guwahati

Date: 11.01.2016

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CERTIFICATE

This is to certify that the project report entitled “**Assessment of Impact Of Urbanization on Deepor Beel Wetland**” has been carried out by Parangam Sarman Basistha, a student of 4th semester of Master of Urban and regional Planning (M.U.R.P) of Indian Institute of Engineering Science and Technology Shibpur (IEST, Shibpur), as an intern in “Assam Science technology and Environment Council” under my supervision.

During the internship programme he has studied available books and reports, done rapid visual assessment in Deepor Beel and its adjacent village areas, and has undergone basic training on use of remote sensing images and GIS in collaboration with the “**Assam Remote Sensing Centre**” of ASTEC.

We hope this project will help him in his future practical field.

Place: ASTEC, Guwahati

Date: 11.01.2016

Jaideep Baruah

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Chapter 1: Introduction

Population of world is growing rapidly and urban population in the urban centres has been a presser for the existing infrastructure like water supply, drainage, sanitation facilities. Rural push and urban pull is the result of migration towards the cities. Huge migration in search of job, education and better lifestyle is the cause of conversion of peri urban area into urban sub centers. Urbanization is the root cause of environmental degradation and natural resources depletion

Guwahati being the gateway to the North Eastern India and an important centre for economic, social, educational, commercial and transportation activities. The city has experienced urban growth and urbanization which results into various environmental problems.

Deepor Beel is a permanent fresh water lake and the only Ramsar site in Assam is Experiencing adverse human activities; filling of wetlands for habitation purpose, cutting the sides of wetlands, pollution, fishing, killing of migratory birds, excessive fodder practices etc. Degradation of water quality, sedimentation in the lake surface, deforestation activities in and around the Beel area has increased the importance of conservation and restoration of the Beel.

The study initiated by the understanding the importance of ecosystem and effect of urbanization over environment. The internship programme under ASTEC is intended to develop understanding of the cause of environmental degradation and to know the proposals and policies developed by the GMDA authority for the conservation and management of the Deepor Beel.

The study is based on various secondary sources from books, internet, ENVIS booklets and discussion with different officials of ASTEC. Discussions and interviewing with the officials is beneficial for the development issue based solutions. Different wetland related article, excess of the departmental library become helpful to develop understanding in the field of conservation and restoration measures.

1.1: Aim of the Internship

“To have knowledge about conservation and management procedures of water bodies with re arrangement of the land uses with the help of GIS interface and with the discussion of officials and executives”

1.2: Objective of internship

- To have understanding about conservation and management procedures and techniques.
- To find out the present and future Government activities to restore the Beel ecosystem
- To learn basics of GIS software like Arch GIS and Bhuvan.

Chapter 2: About Deepor Beel Wetland



Figure 2.1: Deepor Beel in evening time (Photo source: Gautam Deka)

Deepor Beel (Assamese: দীপৰ বিল) is a permanent fresh water lake and largest Beel in the Brahmaputra valley of Lower Assam. Deepor Beel is the only Ramsar site in Assam and among the third Ramsar site of the north eastern region of India “*Deepor Beel is representative of the wetlands found within the Burma Monsoon Forest biogeographic region*” (Saikia, Kumar Saikia and Bhatta, 2014). Deepor Beel is designed as “Wetlands of International Importance” under the *Ramsar Convention on wetlands, 1971* and was declared as Ramsar site in 2002. It located between latitude 26°03'26"–26°09'26"N and longitude 90°36'39"–90°41'25"E and situated 10 km southwest of Guwahati city, surrounded by residential, commercial, institutional & industrial areas. It is situated at an altitude of 53 meters above MSL, maximum depth is 4m and average depth is 1 m. Deepor Beel covers an area of 41 sq km and categorized as large oxbow lake (Deka, Tripathi & Mohammad 2011).

Deepor Beel provides direct or indirect benefits to fourteen villages (1200 families) around the wetland. Almost 500 families of scheduled cast people are directly dependent on fishing and collection of herbaceous plant (Saikia, Kumar Saikia and Bhatta, 2014). Fresh water fish is the vital source of protein for those families which depends on the wetland. Deepor Beel was

included in the Directory of Asian Wetlands. Ramsar Convention in 2002 declared 40.14 sq km as Deepor Beel wetland and 4.14 sq km area was proposed as a wildlife sanctuary under the Wildlife Protection Act of India, 1972 (Government of Assam, 1989).

2.1: LOCATION OF DEEPOR BEEL

Deepor Beel wetland is located between 90°36'39" E and 91°04'25" E and 26°05'25" N and 26°09'26" N at the south bank of river Brahmaputra. The Beel is located about 10 km south west of the Guwahati city in the Kamrup Metro district of Assam. The Beel and its adjacent village's falls under Azara revenue circle of Kamrup-metro district. The national highway 37 (NH-37) is located in the northern side of the Beel and touches its periphery at different places like Dharapur, Azara etc. Different institutions such as Gauhati University, Assam Engineering College, Assam Ayurvedic College, and Forest School located in the Northern side of the wetland.



Figure 2.2: Deepor Beel location and accessibility

2.2: PHYSIOGRAPHY OF DEEPOR BEEL:

The Deepor Beel is located in a U shaped valley bounded by steep highlands in the North and south side of the Beel. Geologic and tectonic history of the region, hydrology and channel dynamics of rivers and pattern of land use in the area can be linked to the origin and development of the wetland. Basistha and Kalmani rivers and monsoon run off is the major source of water for the wetland (envfor.nic.in/divisions/csurv/WetlandInventory.pdf). The Deepor Beel and its fringe areas are made up of recent alluvium consisting of clay, silt, sand and pebbles whereas the hills in the north and south side of the Beel's are of Archaean (4000–2500 million years ago) age (envfor.nic.in/divisions/csurv/WetlandInventory.pdf). The wetland receives surface runoff from the nearby hills which is one of the reasons of sedimentation of the wetland. Deposited soil in the bed of the wetland is the cause of lowering the depth of the Beel. In the rainy season the depth of the Beel increases up to four meter while in the dry season the depth drops to one meter. The spatial extent of Deeper Beel area has registered decrease from 1990 to 2002 (Sharma, Bakimchandra, Parida).

2.3: DEEPOR BEEL RESOURCES

Deepor Beel is contiguous with Rani and Garbhanga reserved forests (> 100 km²) (Mitra, Bezbaruah 2014). Endangered Asiatic elephants (*Elephas maximus*) is found in the Rani and Garbhanga reserved forests are dependent on Deepor Beel for their water and food. The existence of the two forests has increased socio economic importance of the Deepor Beel wetland as well as serves as means of livelihood from Non-timber forest products (NTFPs). Deepor Beel is the rest house for migratory birds proves to be one of the largest aquatic bird's habitats in Assam. In winter season for a single day 19,000 water birds are counted (Mitra, Bezbaruah 2014). Deepor Beel is listed in Birdlife International's list of Important Bird Areas (IBA) for its diversity of bird's habitat. Deepor Beel serves as major fish breeding ground which supplies fish to all nearby water bodies (Mitra, Bezbaruah 2014).



Fig 2.3 Common floating leaved anchored hydrophytes: *Euryale ferax* *Salibs*

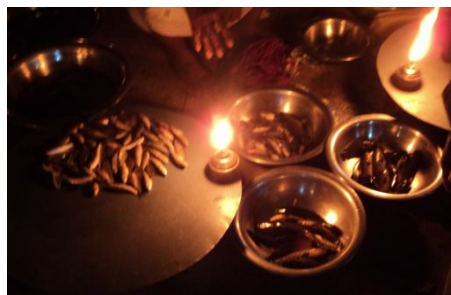


Fig 2.4 Different types of Fishes found in Deepor Beel

(Photo from Godhuli Bazar, Azara)

Source: *RIS_Deepor Beel*

List of List of Red-listed species by International Union for the Conservation of Nature (IUCN) found in Deepor Beel wetland

Common Name	Scientific Name
<i>Mammals</i>	
Asiatic elephant	<i>Elephas maximus</i>
Irriwaddy squirrel	<i>Callosciurus pygerythrus</i>
Hoolock gibbon	<i>Hylobates hoolock</i>
<i>Birds</i>	
Spot-billed pelican	<i>Pelecanus philippensis</i>
Baers Pochard	<i>Aythya baeri</i>
Lesser Adjutant stork	<i>Javanicus</i>
Pallas's Sea Eagle	<i>Haliaeetus leucogaster</i>
Slender-billed vulture	<i>Gyps tenuirostris</i>
Ferruginous Duck	<i>Aythya nyroca</i>
Greater Adjutant stork	<i>Leptoptilos dubius</i>

(Source: Mitra, Bezbaruah 2014)

Deepor Beel is home for almost 232 bird species belonging to 42 family's majority of which migratory birds. There are 15 endangered species of avian fauna found in the Deepor Beel .Deepor wetland is home for almost 50 fauna species belonging to 19 families, 20 Amphibians species, 12 Lizards species, and 18 Snakes species.

Dry weight Fish biomass of the Beel is about 1.5 to 3.8 gm/m² which is very rich in quantity and signifies the resource value of the wetland. Fish yield in the Beel at the rate of 245 kg per hectare (Govt. of Assam, 1990).The primary productivity of Deepor Beel biomass is estimated at 30.69-50.40 gm/cm². The adjacent areas of the Beel is productive as the area is fed by the run off of the

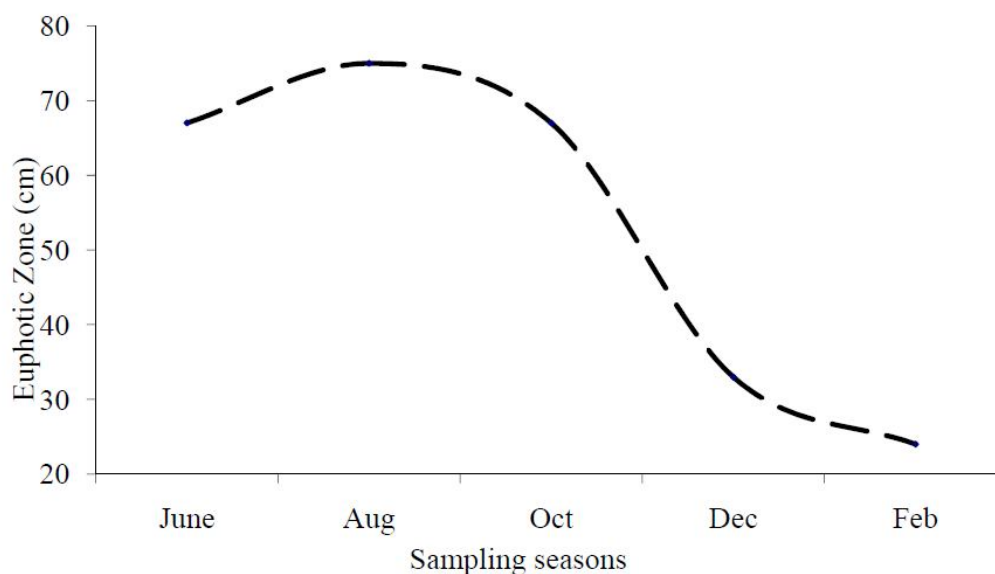
hills.600 hectares of agricultural land more than 2500 tons of rice are produced/Ha around the Deepor Beel wetland (Saikia, Saikia, Bhatta)

2.4: ENVIRONMENTAL QUALITY OF DEEPOR BEEL

Point source pollution can be successfully managed by proper watershed management cases whereas water pollution from non point sources has remained a major problem as non point sources are harder to identify, isolate, and control. Water quality deterioration is mainly due to pollutants such as fertilizer, pesticides, suspended solids, biomedical wastes, industry waste etc which impacts on the overall health of aquatic communities in wetland systems. Presents of trace metals such as arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu); lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn) etc in water are cause of various diseases. Nibedita Kapil & Krishna G. Bhattacharya, from Gauhati University has conducted a study to determine the transparency of Deepor Beel and to determine the Variation of the depth of the Euphotic Zone. For the study Water samples were collected at three different depths, Euphotic zone was found with the help of Secchi disk. From the study the transparency of Deepor Beel can be estimated which shows the increased value of euphotic zone. The variation of transparency may be the results of increased water volume in wet months of June and August or might be the growth of aquatic vegetation.

Excessive growth of algae, presence of suspended soil Particles creates turbidity of water which reduces transparency and photosynthesis in the deeper layers of water column and results into low productivity of algae and water hyacinths contributing to the high growth of fish productivity (Nibedita Kapil & Krishna G. Bhattacharyya, 2012)

Figure: Variation of the depth of the Euphotic Zone with sampling months



Source: Nibedita Kapil & Krishna G. Bhattacharya, research paper 2012, (Downloaded from www.ccsenet.org/ep)

Table: Transparency data for Deepor Beel wetland (TD total depth in cm, EZ Euphotic zone depth in cm, T fully transparent, ND not determined)

Batch	June		August		October		December		February		April	
	TD	EZ	TD	EZ	TD	EZ	TD	EZ	TD	EZ	TD	EZ
1	230.0	68.5	475.0	77.0	232.0	49.0	82.0	43.5	65.0	31.2	100.0	T
2	210.0	160.0	183.0	73.0	181.0	54.5	51.0	32.5	27.0	15.0	71.0	T
3	137.0	95.0	390.0	51.0	195.0	58.5	52.0	19.5	16.0	8.0	32.0	T
4	90.0	T	240.0	84.0	41.0	NA	30.0	ND	24.0	ND	25.0	ND
5	207.0	T	170.0	77.5	165.0	59.0	67.0	50.1	18.0	T	41.0	T
6	210.0	66.0	475.0	67.0	240.0	58.0	96.0	40.5	66.5	T	96.0	T
7	50.0	21.5	478.0	65.5	137.0	49.0	36.0	19.0	52.0	33.2	32.0	T
8	102.0	52.5	415.0	89.0	239.0	73.5	72.0	45.0	30.0	T	55.0	T
9	205.0	124.0	280.0	90.0	120.0	T	48.0	T	21.0	T	30.0	T
10	130.0	49.0	460.0	72.0	100.0	80.0	42.0	20.0	35.0	T	25.0	T
11	110.0	29.5	500.0	79.0	205.0	97.0	55.0	ND	43.0	T	91.0	48.0
12	95.0	7.0	120.0	109.0	150.0	95.5	49.0	29.5	25.0	T	21.0	T
13	90.0	ND	315.0	41.5	120.0	ND	99.0	ND	91.0	34.0	ND	ND
Mean	143.5	67.3	346.2	75.0	163.5	67.4	59.9	33.3	39.5	24.3	51.6	--
Min	50.0	7.0	120.0	41.5	41.0	49.0	30.0	19.0	16.0	8.0	21.0	--
Max	230.0	160.0	500.0	109.0	240.0	97.0	99.0	50.1	91.0	34.0	100.0	--

Source: Nibedita Kapil & Krishna G. Bhattacharya, research paper 2012, (Downloaded from www.ccsenet.org/ep)

2.5: ENVIRONMENTAL ISSUES ON DEEPOR BEEL

The Northeast Frontier Railway (NFR) Constructed A Railroad Along The Southern Boundary Of The Deepor Beel In 2001. The Wetland Ecosystem Has Disturbed By The Railroad As It Has Fragmented The Wetland Into Two Parts. Embankment for the Rail Road has resulted in the Water Flow Blockage of the Beel which disturbs the Entire Eco System of the Beel. Deepor Beel segment of rail road falls in between Azara and Kamakhya station administrated by Rangiya division of NFR. *“An average of 20 passenger trains and 14 freight trains use this track every day. “One train takes 42 minutes to pass through the Deepor Beel area “(Mitra, Bezbaruah 2014, page 3). The rail traffic will definitely increase in future for the growth achieved by Guwahati city and for the large quantity of resources availability in the region such as, mineral resources (coal, oil, and uranium), agricultural products (rice, tea, fruits, and spices) and forest products (timber and plywood) etc.*

The Guwahati Municipality dump yard (24 Ha) located in Boragaon, lies in the eastern corner of Deepor Beel. The dump yard becomes functional in 2005, three years after Deepor Beel’s status as Ramsar Site. Women and children from the adjacent slum areas of Boragaon, are seen in the dump yard for collection of plastics and other products (Bara Sayantan, 2011)

Figure: the Municipal dump yard near Deepor Beel



Source: Down to Earth, August 2011 by Sayantan Bara



(Source: Down to Earth, September 2011 by Sayantan Bara)

Chapter 3: Impact of Urbanization on the wetland environment

3.1 Growth of the city

Biotic diversity change and climate change is the major problem caused by rapid and unplanned development of urbanization. High population growth and more demand for land have been changing the urban landscape of Guwahati city. Urbanization in Guwahati is complex, diverse and fragmented which results in the modification of the natural land cover of the city (Borthakur Monjit, Nath Bhrigu Kr.).

Guwahati the capital city and the gate way of north east India are also not exceptional on it. Guwahati is the capital city of Assam, which is among the states with low level of urbanization. 14.1 per cent of the state's population was living in urban areas in 2011, which is an increase from 12.9 per cent in 2001 and 11.1 per cent in 1991 (Gogoi Lakhimi). After the shifting of the state capital from Shillong to Dispur, the city has been faced lots of problems which impact on the degradation of environment and poses as a threat to the biodiversity.

To regulate the development, land use zoning has assigned the proposed Master Plan for Guwahati 2025. Urban landscape change has clearly seen over the eco-sensitive and Green belt areas, especially towards the periphery of the city (Borthakur Monjit, Nath Bhrigu Kr.).

Transfer of capital from shilling to Guwahati and establishment of new industry and rampant growth of commercial activities has attracted large no of migrants from different parts of Assam and from the other parts of India. Migrants demanded for land and demand of land has increased in Guwahati rapidly. Encroachment over vulnerable lands, growth of several new colonies, filling up of low lying areas for residential establishments has expanded the city horizontally. The core areas of the city due to lack of land availability has expanded vertically causing dense urban structure (Gogoi Lakhimi). The city is growing rapidly in last few decades with growth rates of 131.60 in 1971-1991 and 38.59 in 1991-2001. The total area of the city was only 43.82 square kilometer in 1971. In 1974 it came under the administration of Municipal Corporation with 34 wards and the area increased to 216.79 square kilometers (Govt of Assam as mentioned by (Gogoi Lakhimi). Sectoral form of development can be seen in Guwahati incorporating new village areas day by day.

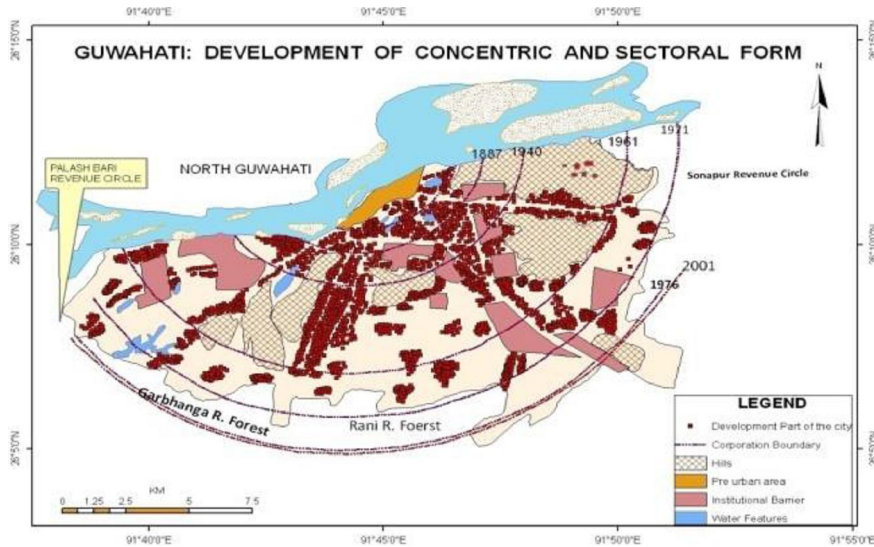


Figure 3.1: Growth pattern of Guwahati (Gogoi Lakhimi).

3.2: land use change and natural resources depletion in Guwahati

With the expansion of the city, the land use pattern has been changing resulting decrease of the natural resources. Due to the human anthropogenic activities land use pattern of the city has changed which can be seen from the following table:

Table 1: Areas under Different Land Use Categories in Guwahati, in Km2 (%), 1977-2007.

Land Use Category / Year	1977	1999	2007
Agricultural Land	15.79 (7.00)	12.46 (6.00)	9.85 (5.00)
Barren Land	30.68 (14.00)	17.5 (8.00)	0.36 (5.00)
Dense Forest	40.76 (19.00)	35.9 (17.00)	23.0 (11.00)
Swamp	24.07 (11.00)	21.1 (10.00)	94.5 (44.00)
Built up Land	49.02 (23.00)	70.3 (32.00)	94.5 (44.00)
Open Forest	7.96 (4.00)	11.9 (5.00)	15.8 (7.00)
River	21.56 (10.00)	25 (12.00)	22 (10.00)
Sand Bar	15.9 (7.00)	12.1 (6.00)	1.14 (6.00)
Scrub Land	10.45 (5.00)	9.7 (4.00)	9 (4.00)
Wetland	0.6 (.003)	0.6 (.003)	0.58 (.003)
Total Area	216.79 (100)	216.79 (100)	216.9 (100)

Source: Borah .J, and Gogoi B, 2012 as mentioned by (Gogoi Lakhimi).

There has been considerable decrease in agricultural land (from 7% to 5%), barren land (from 14% to 5%), and dense forest (from 19% to 11%). and swamps (11% to 8%) during the period 1977 – 2007. As expected, from 22.61 per cent of the total built up land area has increased to 43.59 per cent with a rate of increase of 3.09 per cent per year. (Gogoi Lakhimi).

In a research paper Monjit Borthakur, Bhriku Kr. Nath has calculated the Major Land Use and Land Cover Change in the Guwahati Metropolitan Area (1991 to 2009). The study has revealed that low dense Settlement area decreased by 5.83 percent in 2000, as most of the low density areas were converted to high dense Settlement areas. National highway 37 from Jalukbari to Khanapara in 2000 and LGBN International Airport at Borjhar has also caused major change to land cover.

	2000	2009
	p.c. of change over '91	p.c. of change over '00
Trees & shrubs	-22.53	-1.72
Dense Vegetation	-4.88	-26.23
High dense Settlement	56.15	23.85
Low dense Settlement	-5.83	2.65
Open Space	-0.70	-16.71
Water	-9.44	-4.97

Source: Monjit Borthakur, Bhriku Kr. Nath

3.3: Impact on Deepor Beel Environment

Rapid growth of city population and land cost increase has resulted in the encroachment of the Deepor Beel. Northern and eastern parts of the Beel have been occupied by the private as well as the government organizations. Encroachment has blocked the natural drainage pattern of the Deepor Beel causing the water level imbalance in the Beel. Soil erosion and improper catchment treatment and agricultural practices have led to sedimentation in the Beel.

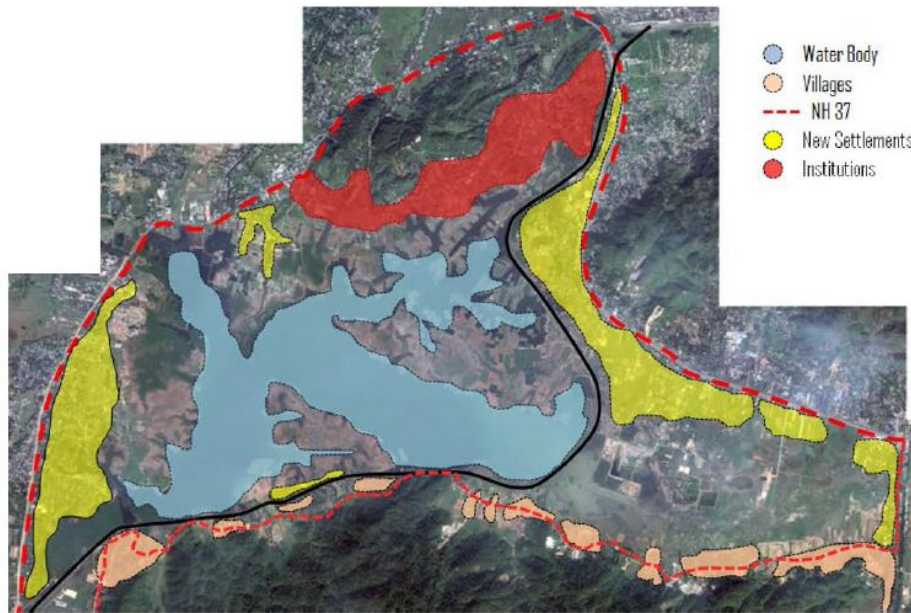
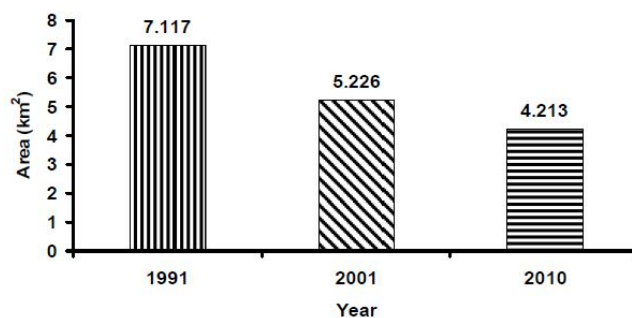


Image 3.2 : Map showing Settlement areas near Deepor Beel

Source: Koushik Praschaya, 2012, Need for eco sensitive planning_a case of Guwahati, CEPT University library

Encroachment problem and land use change has changed the special pattern of Deepor Beel water area. In a study by shows that the change in permanent water land has decreased by day by day.



Source: A multi-temporal remote sensing approach for monitoring changes in spatial extent of freshwater Lake of Deepor Beel Ramsar Site, a major wetland of Assam, Jyotishman Deka, Om Prakash Tripathi & Mohammad Latif Khan

The permanent lake water area has decrease from 7.1 sq km in 1991 to 5.2 sq km in 2001 and to 4.2 sq km in 2010. Decrease in water body spatial extent of Deepor Beel Ramsar site is indication of adverse impact of urbanization. Growth of aquatic weeds has seen in the Deepor Beel area.

Major cause of weeds growth is mainly because of the nutrients and sewage flow to the Beel. Chemical manure in the agricultural land in the nearby areas of the Beel increases the nutrient supply to the Beel.

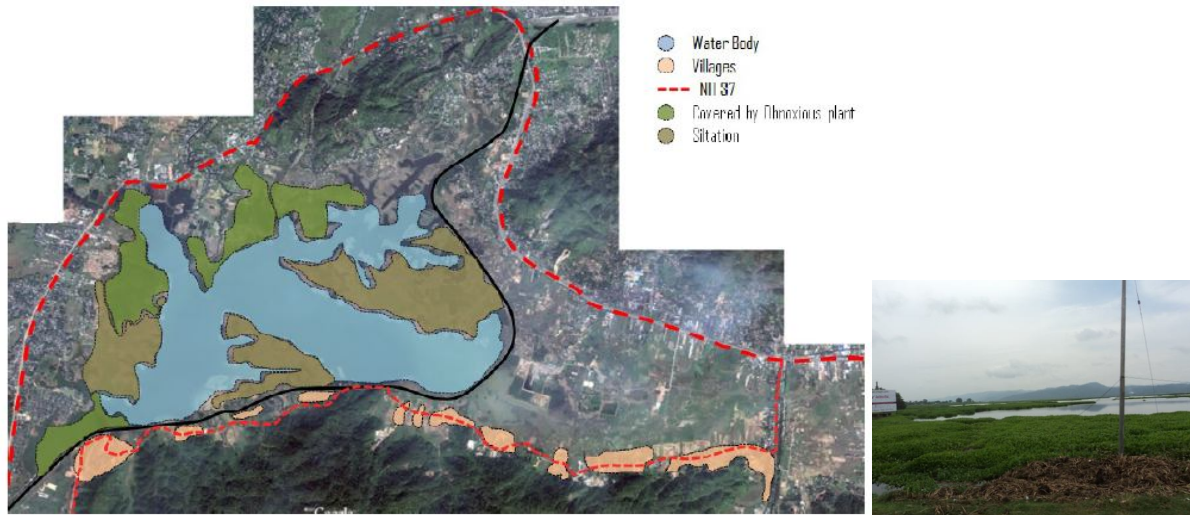


Image 3.3: Showing areas of siltation and weeds

Source: Koushik Praschaya, 2012, Need for eco sensitive planning_a case of Guwahati, CEPT University library

Guwahati oil refinery waste is directed through the Bharalu and Kalmoni rivers to the Beel. The channels also carry other industrial and hospital waste to the Beel. The water has turned black and smelly. Sewage discharge into the water might have caused the fall in oxygen levels resulting in the death of fishes.

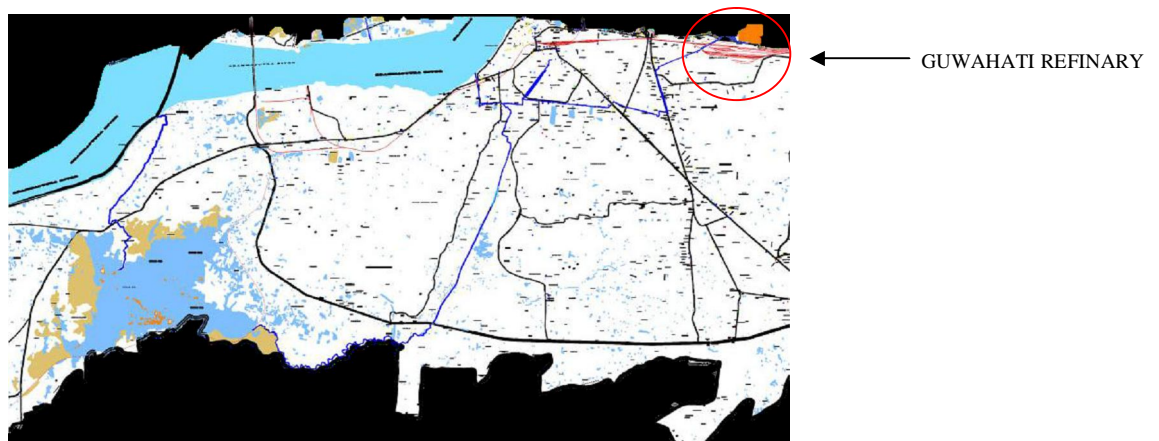


Figure 3.4: Map showing Guwahati refinery

Source: Master plan 2025, GMDA

Dumping of municipal solid wastes in its close proximity at Boragaon by the Guwahati Municipal Corporation (GMC) has pushed the wetland's pollution to alarming levels. The problem has got aggravated during the monsoons, with rainwater sweeping large amounts of garbage from the dumping site to the Beel. Which now results the death of carp fishes – Rohu, Mrigal, Catla, etc, at the Deepor Beel was the maximum as compared to other species.



Figure 3.5: Map showing garbage disposal ground near Deepor Beel
Source: Master plan 2025, GMDA

There are lots of stone quarries existed in the Rani hill. During rainy season the mud water coming from the hills and settled under the bill which causes siltation and results in the decreasing the depth of the Beel.



Image 3.6: Stone quarries near Deepor Beel
Source: Sristi Gogoi, 2015, GCA work, unpublished

Establishment of industries within periphery of the wetland system is leading to water quality deterioration and soil pollution. Permitting temporary brick kilns and associated soil quarrying from within the wetland have led to massive destruction of top soil and other ecosystem components. There are long term negative environmental impacts of establishment of brick kilns on soil productivity and soil micro-flora and fauna.

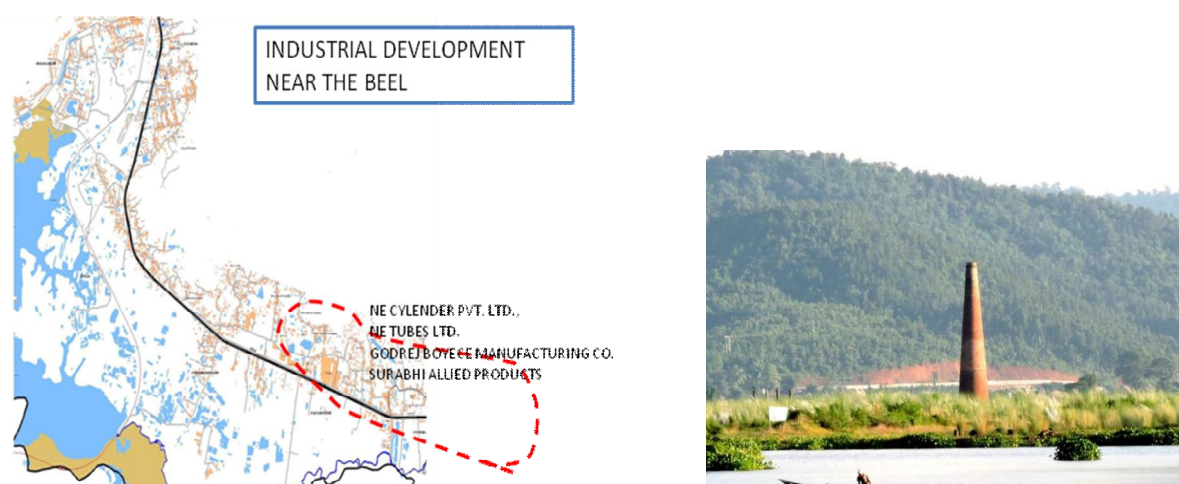


Figure 3.7: Map showing industry areas near Deepor Beel

Hunting, trapping and killing of wild birds and mammals and community fishing activities has adversely affected the Beel ecosystem. Community fishing and catching of gravid and brood fishes are causing sharp decline of fish productivity of the wetland. Species diversity and species habitat has been changed due to the unplanned fishing practice performed by the village people near the fringe areas of the Deepor Beel.



Source: Sristi Gogoi, 2015, GCA work, unpublished

Chapter 4: Future proposals to conserve the urbanization led environmental problems

The conservation of the Deepor Lake is with the vision intended to bring people close to nature and to manage the climatic change that has been increasing and with the increase of population of the city. Preservation of the diverse habitat of birds, aquatic and terrestrial animals with the strategy to preserve the livelihood of the dependent community is the vision towards conservation proposals for Deepor Beel (DPR for Project Management Consultancy Services for Restoration and Development of Water Bodies, 2012).

The zoning of Deepor Beel has been done ensuring the conservation and preservation of the natural habitat and divided into 3 parts, the core area as ecologically protected water conservation zone. Two water retention zones have been proposed on either side of the conservation zone. A riparian corridor has been introduced along the water body on the north eastern side as a protective buffer to arrest any further encroachment inside the water boundary.

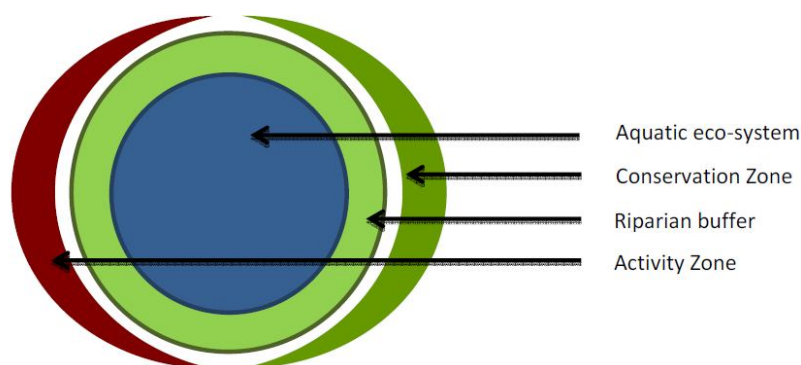


Figure 4.1: Zoning of Deepor Beel

(Source: DPR for Project Management Consultancy Services for Restoration and Development of Water Bodies, 2012)

Northern and western sides of the lake are with low density with low rise settlements. Nature reserves are maintained on north, east, south and western sides of the lake. Activities like eco parks, bird watching, forest camps, board walks along the forest wilderness and nature watches are conceived in these nature reserve areas.

In the southern side, between the road and the railway line, botanical garden is proposed which will enhance the greenery of the shoreline of the lake and generate economy as well as employ some of the locals. Active recreation areas such as picnic spots and parks are proposed on the

southern side of the lake. Handicrafts and fishermen's village is proposed near the Beel area specially the Keotpara village.

Convention Centre is proposed on the opposite side of that road. Node I have the most commercial activities happening around it. Eco Resorts are clustered near Node III, forming the second commercial activity zone. Institutional area consisting of nature interpretive Centre is anticipated near the nature reserve in the eastern side. A cycle track starts from the eco resort area and ends at the institutional area.

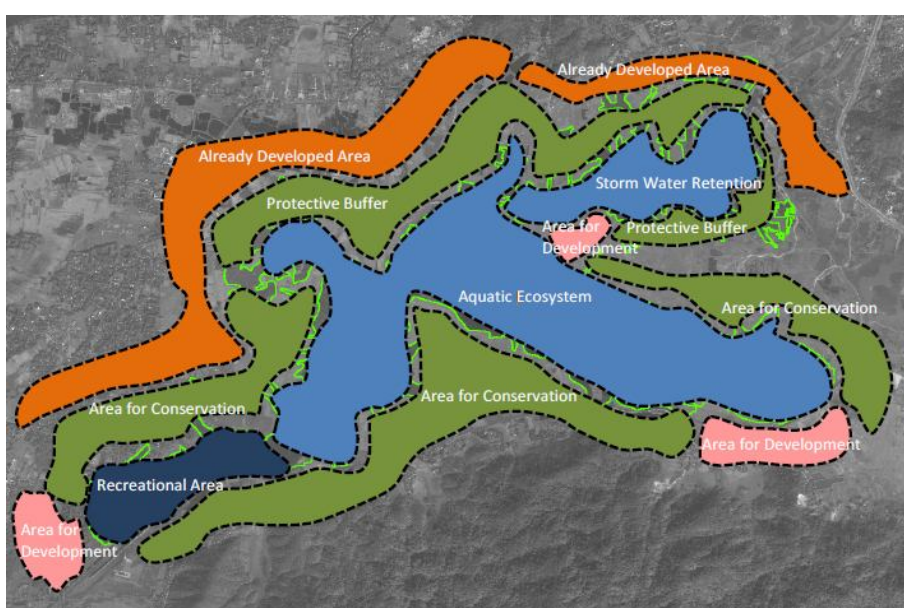
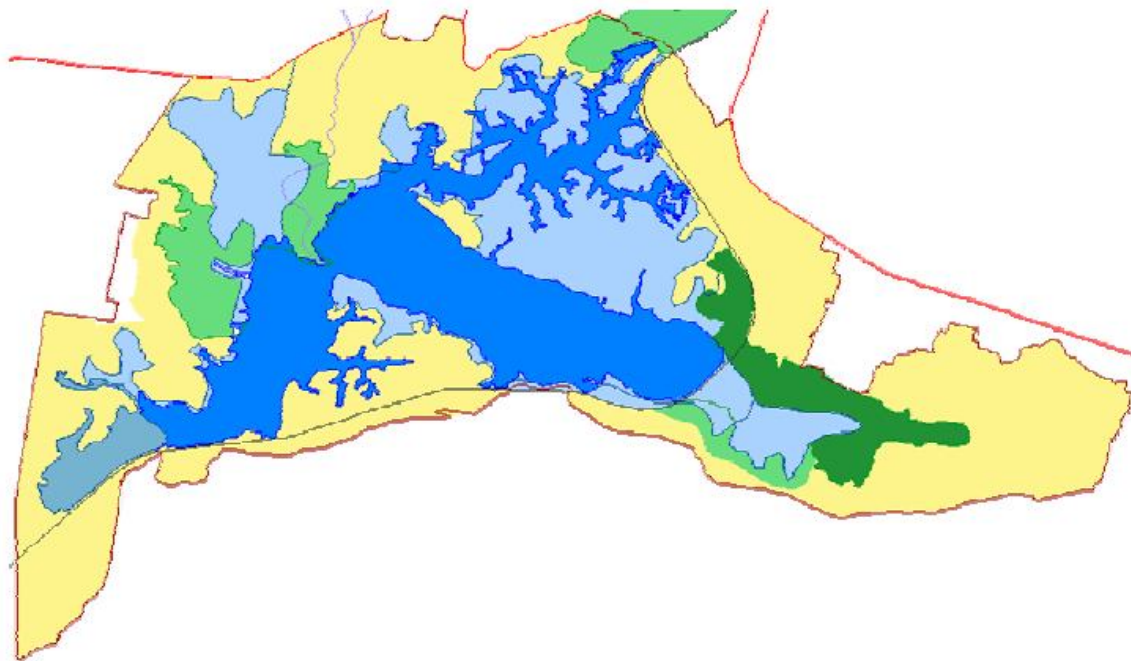


Figure 4.2: Proposed zoning of the Deepor Beel as per the DPR made by GMDA (Source: DPR for Project Management Consultancy Services for Restoration and Development of Water Bodies, 2012)

Protect, restore and manage is the basics of ecological management. No developmental activity is anticipated in this zone. In the case of Deepor Beel, it encompasses the core area in the Ramsar site, as well as the areas surrounding it which complement the ecological integrity of the protected area. The ecological management zone near Deepor Beel has been divided into two parts viz: Core/ Protected Area and Water Zone

The following Map shows the proposed management zoning for the Deepor Beel area. Proper implementation of the proposed policies and zoning proposals can be effective in conservation and restoration of the Beel.



Explaining Ecological Management Zones in Context of Deepor Beel:

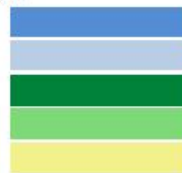
Core Area: Protected Area

Water Zone

Wetland Zone (Ecological Restoration Zone1)

Wetland Footprint (Ecological Restoration Zone2)

Project Management Zone



(Source: DPR for Project Management Consultancy Services for Restoration and Development of Water Bodies, 2012)

Chapter 5: Conclusion

Urbanization is an inevitable process. As need increases more and more village areas get included into urban periphery. Ecological and environmental degradation is outcome of urbanization. Stress on ecology, food, environment even shear on the fresh available air is getting low day by day. Ecological conservation is must to protect the human culture-to preserve the proud modernization.

Proper conservation measures as well as awareness generation among the citizen to reduce environmental degradation reuse of resources, sustainable and wise use of nature resources can lead to a healthy and sustainable human society.

The zoning and proposals designed by the GMDA must be implemented and constant feed backing and monitoring must be done. During the internship I have assess the recent human induced ecological problems and studied some proposals from GMDA to minimize it. GIS and remote sensing techniques I have learned from the internship. I will be happy enough to carry out these learning's for my future research work.

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