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Original Research Paper

Geography

LAND USE/LAND COVER MAPPING AND CHANGE DETECTION USING SATELLITE DATA – A CASE STUDY OF GUWAHATI CITY, ASSAM

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ABSTRACT

Changes in land use Land cover is a dynamic process, which vary with space and time and it become a central component in current strategies in managing natural resources and monitoring environmental changes. Digital change detection is the process that helps in determining the changes associated with land use and land cover properties with reference to geo registered multi temporal remote sensing data. The objective of this paper is to analyse the land use land cover changes in Guwahati city of Assam Using multi temporal remote sensing data LANDSAT TM 1991, and LANDSAT ETM 2009. The city has witnessed a very high rate of growth of population during this period, which leads to various problems like growth of slums, urban sprawls, deforestation, environmental degradation etc. The detection of Land use change of Guwahati city for the last two decades was analysed by supervised classification, where 8 land-use classes have been selected and analysed using Eradas Imagine software. The result show changes in the agricultural land and forested area in fringe areas of the city and open land within the city and a great expansion of settlement.

KEYWORDS :

INTRODUCTION:

The study of Land Use and Land Cover Change in Geography is very important to understand the human-environment interaction. While on the one hand, Land Cover is the depiction of the physical surface of earth, Land Use on the other hand is a strictly anthropogenic phenomenon, which, most simply means the human use of land. A change in the Land Use/Land Cover is an indicator of human induced landscape change and thus, a measure of the scope and intensity of human influence on environment.

The rapid growth of population and urbanization are transforming an increasingly large part of the inhabited world. The uneven nature of growth population has altering the nature and pattern of land use practices as villages have been converted into cities and cities into metropolitan regions. Land use concerns the products and/or benefits obtained from use of the land as well as the land management actions (activities) carried out by humans to produce those products and benefits (FAO 2010).

Remote sensing is an imperative tool to measure the temporal change of land use practices both in local and regional level. Change Detection involves the application of multi-temporal data to analyse it quantitatively to visualize the temporal variations. In general, it can be defined as the process of identifying differences of various physical features over the earth surface at different times. It is a very important tool to demonstrate the land use change, deforestation, disaster mapping, change of ecosystem, urban sprawl etc.

Study Area:

The present study is confined to the city of Guwahati, the largest city of Assam and the Northeast India, which is often referred as the gateway to the North Eastern region. Guwahati is a part of Kamrup Metropolitan district and is situated between 26°11 N and 26°18 N latitude and between 91°44 E and 91°73 E longitude. The city lies between the banks of the Brahmaputra river and the foothills of the Shillong plateau, which covers an area of 328 sq. KM.

In Guwahati, Land Use/Land Cover change has happened at an unprecedented rate in the past four decades. Till 1971, Guwahati was a relatively medium sized city with a population of 200,377. However, in 1972, the city was catapulted to political importance by being made the capital of Assam. This has caused an exponential rise in population which increased to 584,342 in 1991 and 963,429 in 2011 (provisional). This rapid population growth is mirrored in the scale of change of Land Use and Land Cover in and around the city. Some of the most evident impacts of this change have been loss of forest and wildlife, loss of fertile agricultural land, fall in quality of drinking water, increase in traffic bottlenecks, growth of slums and peri-urban settlements, and an overall degradation of city landscape.

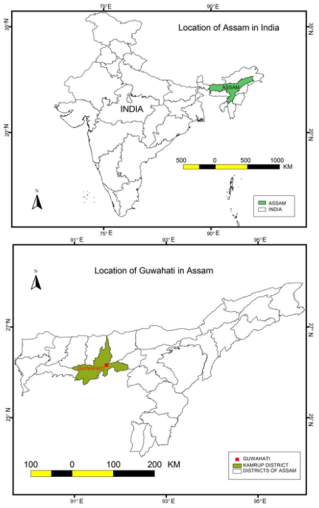

Fig 1-Location map of the study area

DATABASE AND METHODOLOGY:

The Landsat images of 1991 (TM) and 2009 (ETM+) were collected from the website of Global Land Cover Facilities (GLCF). ArcGis 10 was used to create and delineate the shapefile of Guwahati city on the basis of Bing map and converted it into WGS 1984 coordinated system. Thereafter, the shapefile was loaded into Erdas Imagine 9.2 and used the vector layer as AOI to extract the boundaries from the Landsat images for both the years. Supervised classifications were performed by using maximum likelihood classifier algorithm after selecting 8 land use classes, viz. Agriculture, Settlement, Dense forest, Open forest, Open land, Wasteland, Water body

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and Sands. After classifying both the images, Change detection technique was used to measure how the attributes of a particular area have changed between the two decades.

Change Detection operation allows for two continuous raster images as input. The user can define a threshold value for the change of a single pixel must have from one year to the next to be marked as change. After that a highlight file was created, marking pixels that have increased or decreased more than the threshold value. We have classified the highlight changes in percentage as increased more than 15 percent and decreased more than 15 percent. Those highlighted pixels could represent areas where a new building has been constructed or a forested area clear cut. It gives a quick look at the amount of change between the two time periods. It gives the high-level view of change for an area so that the amount of effort to capture the change can be more reasonably estimated.

The Matrix operation from the GIS Analysis allows two thematic images or vector file of different years to be compared. We have entered our both supervised classification images as input and by comparing two classified sets of data; we have eliminated false positives due to radiometric differences. For example, two simple classified images were fed into the process and had three classes in each file of water, open land and forest, the resulting file from the Matrix operation is a thematic image where classes such as 'was water is now water' shows no change from previous year to present year. It gives an easy understanding of change of different land use classes.

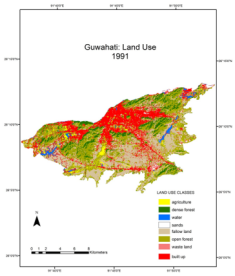

Fig 2- Land use of Guwahati by Supervised Classification: 1991

Table-1: Land Cover Flow Matrix

YEAR	2009								
	CLASS	wasteland	dense forest	sands	open forest	water body	agriculture	open land	settlement
	wasteland	29.25	0	0.54	0	4.2	9.48	0	0
	dense forest	104.04	560.61	0	804.96	7.83	9.54	215.1	370.17
	sands	10.98	2.16	42.57	12.96	1.89	0.45	107.73	111.33
1991	open forest	32.31	383.13	1.8	2131.56	48.96	30.6	1894.59	1730.7
	water body	1.35	12.69	4.41	10.53	54.72	77.76	178.92	82.17
	agriculture	0	39.06	0	118.17	30.02	13.74	399.33	264.15
	open land	17.19	60.93	1.98	631.35	33.03	6.66	2543.85	2183.67
	settlement	27.18	67.14	24.21	120.42	40.59	19.8	682.47	3348

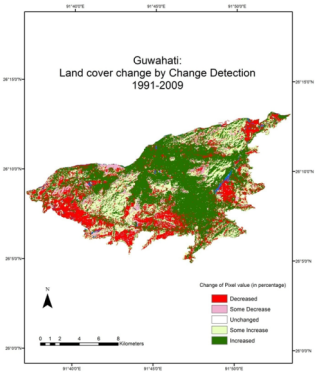

Fig 4. Change detection of Guwahati, 1991-2009

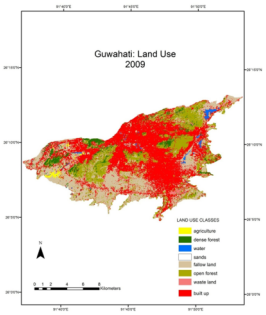

Fig 3- Land use of Guwahati by Supervised Classification: 2009

Results and Analysis:

Land use pattern of a city represents the interaction among the physical factors, historical factors and social and economic factors, with the character of the city dependent on the present land use. This is how the shopping areas, industrial areas, offices and other areas fit in with the land use for residential, public, semi-public, etc. (Rahman 1981).

In Guwahati, the land use pattern shows a common trend for the last few decades. The forest cover is declining at a very rapid scale as in 1991, 10.49 percent and 31.66 percent of the total geographic area was covered by dense forest and open forest respectively, which is declined to 5.7 percent for dense forest and 19.39 percent for open forest in 2009. It is observed that most of dense forests are found in the Nilachal hills, Jalukbari hills, Japorigog hills, Sila Pahar and Narengi hills, while the major decline of dense forest covers are mostly occurred in the Narakasur hills, Kharghuli hills and Sonaighuli hills. The agricultural land use also shows a declining trend. In 1991, 864.54 hectare area was covered by agriculture, which declined to 168 hectare in 2009, which means 80.57 percent of agricultural land was lost between 1991 and 2009. At present, agricultural activities are mostly found in the fringe areas of the city, mainly along the bank of Brahmaputra river and Deepor beel (ramsar site).

The city has shown major decline in water bodies. In 1991, an area of 422.5 hectare was covered by water bodies, which was declined to 221 hectare in 2009. Most of the water bodies are now converted into agricultural land uses and wastelands. Similar trend also appeared for sands. Though this land use class was very minimal but a change of -74 percent appeared for sands during these two decades and this class is only found along the bank of Brahmaputra.

In Guwahati, Wasteland showed the highest growth among all land use classes with a growth rate of 411 percent between 1991 and 2009. Open land class also showed a positive growth between 1991 and 2009. In 1991, 27.73 percent of the total area was covered by open land while in 2009, it was 30.48 percent. It is evident from the matrix table that 1894.59 hectare of open forest in 1991 was converted into open land in 2009. (Table. 1)

Table 2- Land cover changes of 8 classes in Guwahati between 1991 and 2009

YEAR	1991	2009			
LAND USE CLASS	AREA IN HECTARE	AREA IN %	AREA IN HECTARE	AREA IN %	CHANGE BETWEEN 1991-2009
AGRICULTURE	864.54	4.38	168	0.85	-80.57
DENSE FOREST	2072.25	10.49	1125.72	5.70	-45.68
OPEN FOREST	6253.65	31.66	3829.95	19.39	-38.76
WATER	422.55	2.14	221.31	1.12	-47.63
OPEN LAND	5478.66	27.73	6021.99	30.48	9.92
BUILT UP	4329.81	21.92	8090.19	40.95	86.85
WASTELAND	43.47	0.22	222.3	1.13	411.39
SANDS	290.07	1.47	75.51	0.38	-73.97
TOTAL	19755	100	19755	100	

The city has been sprawling in a curvilinear fashion and has developed a rough crescent shape with a core in the central areas. The city has tentacles extending in the form of growth corridors towards south, east and west. It can be easily understandable from the fact that, in 1991, 4330 hectare (29 %) of the total area of the city was covered by built-up land uses, which increased to 8090 hectare (41 %) in 2009. Guwahati city has experienced considerable population growth during these two decades, although the decadal growth rate seems to have a declining trend over the years. The population of Guwahati city including the urban agglomeration has registered a growth from 584,342 in 1991 to 9, 68,549 in 2011. Since the scope of lateral expansion of the city is restricted by its unique geographical situation, hence, the urban growth of the city has been highly unplanned. Rapid population growth, high migration rates and change in land use patterns have adversely affected the environment and ecology of the city.

Impact of Land use change:

Land use change is by and large a human induced phenomena. The impact of land use can be broadly classified into 2 categories: Environmental impacts and Socio-Economic impacts.

Environmental impacts:

- Land use changes have a major impact on natural resources including water, soil, air, nutrients, plants, and animals
- Intensive farming and deforestation may cause soil erosion, salinization, desertification, and other soil degradations
- Urban expansion causes air pollution, water pollution and urban flooding.
- Habitat destruction, fragmentation, and alteration associated with urban development are a leading cause of biodiversity decline and species extinctions
- Construction and mining activities in the highlands lead to high risk of landslides.

Socio-Economic impacts:

- Conversion of agriculture and Forest cover to built-up land uses reduces the amount of land available for food and timber production.
- Rapid growth of urban population in most of the developing countries leads to growth of slums.
- Urban expansion to the rural areas leads to the rise of land/house prices which poor people can't afford.
- Robust growth of built-up areas or peri-urbanization causes urban chaos like traffic-bottleneck, traffic-accidents, social insecurities etc.

CONCLUSION:

The present study assesses the changing pattern of land use practices in Guwahati between 1991 and 2009. It is observed from the flow matrix table that there is a continuous decrease in the forest area, wetlands and cultivable land, while there has been tremendous increase in built-up area and wastelands that has degraded the city's life and environment. The unplanned growth and development of the city has led to an increase of various geo-environmental issues. The illegal constructions in the hills have increased the risks of landslides in the city. In 2013, the State Disaster Response Force (SDRF) has conducted a survey and identified 366 landslide prone areas perched on 18 small to large hills in city where more than 20,000 live. So, it is important for the urban and environmental planners to work with mutual collaborations for a better urban life in Guwahati. New afforestation programs should implement in the already deforested areas and social forestry programs should be promoted. Government should also endorse satellite towns or alternative development centers for overpopulated city of Guwahati for a sustainable development of the city.

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