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LANDUSE AND LANDCOVER CHANGE OF DHUBRI DISTRICT, ASSAM, USING GEOSPATIAL TECHNIQUES

Hasne Toufiki[1], Sourabh Dutta[2] and B.S. Mipun[3]
[1]Research Scholar, Department of Geography, The Assam Royal Global University, Betkuchi, Guwahati
[2]Assistant Professor, Department of Geography, Pub-Dikrong College, Laholial.
[3]Professor and Dean, Department of Geography, The Assam Royal Global University, Betkuchi, Guwahati.

Abstract

The landuse and landcover in Dhubri District have significantly changed over the past 40 years, as observed during the 1990-2020 study period. A major shift has been seen in the LULC category. A specific attempt has been made in these studies to map out the landuse/landcover status of Dhubri district in order to identify any changes that may have occurred. Based on the variance seen in the area, the area's lulc has been divided into six major classes. The result showed the overall amount of agricultural land decrease significantly between 1990 and 2020, from 606.05 sq km to 556.69 sq km whereas the amount of built up increased positively from 161.52 sq km to 426.03 sq km during the same period. Geospatial technique coupled with field survey has been used for the study. The kappa coefficient of the lulc categories for the year 1990 is 87.88% and 2020 is 80.04%. The study gives a summary of the district current lulc trends and will help to contribute and provide to sustainable landuse management and protection.

Key words: Built-up area, Dhubri District, LULC, RS and GIS

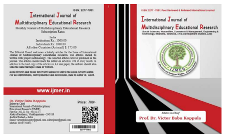
Introduction

Human activities have significantly altered, earth's landuse and landcover over the past three centuries altering the face of the earth for the last few centuries (Roy & Roy, 2010) leading to conflicts with biodiversity, food security, sustainability and ecosystem vulnerability. Landuse also impacts socio-economic and environmental systems, highlighting the need for sustainable solutions. (Lambin et al., 2001; Roy & Roy, 2010). The growth of urban development, technological advancement, and population increase have drastically altered the LULC (Voogt & oke, 2003). Due to their interchangeable usage, landuse and landcover are the two broad categories into which LULC changes on Earth's surface can be separated. (Barnsley et al., 2001; Dimyati et al., 1996; Roy & Roy, 2010) Scientists worldwide are interested to study landuse/landcover pattern and changes because they understand how important land resources are in achieving environmental security, sustainable development (Xiubin,1996) assessing current state and predicting future changes (Ojima et al., 1994). The most relied-on data source for LULC generation and mapping is imagery obtained from satellites. (El-Kawy et al., 2011) Thematic Mapper (TM) imagery is utilized to map landcover (Aplin et al.,1999) enabling tracking and evaluation of natural and anthropogenic changes. (Yang & Lo, 2002). In this study the researcher mainly used satellite imagery to examine lulc changes focusing on Landsat images from 1990, 2000, 2010 and 2020. The LULC maps are developed using supervised, accuracy measurement is also done to validate and the result is within the acceptable limit.

Literature Review

Many studies have been done on landuse and landcover changes all over the world. (Kotoky et al., 2012) used RS and GIS to evaluate landuse and landcover changes along the Dhansiri River channel from 1975 and 2008, reveling significant decrease in cropland area. (Roy & Roy, 2010) the study utilized RS and GIS to analyze the current trends in landuse and landcover through to case studies. (Sharma et al., 2005) The study utilized satellite-based remote sensing technology to analyze the LISS 3 image in East Sikkim, achieving an overall accuracy of 83.72%. (Shalaby & Tateishi ,2007; Kumar, 2007) studied the LULC in their study by using RS and GIS.

Dhubri a densely populated district in Assam is experiencing lulc changes due to rapid urban growth and development, increasing it more prone to geomorphic hazards. For appropriate land utilization, planning, management and sustainable development, it is imperative that current LULC status to be updated. Therefore, the study aims to analyze landuse and landcover over the past 40 years integrate visual interpretation with supervised classification using GIS and Remote sensing.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Study Area:

Dhubri District is a flood plain occupying an area of 1553 sq km located in the western most corner of Assam near the Indo-Bangladesh border. It is one of the most populus district having 896 persons per sq km (Census, 2011). It is surrounded by Kokrajhar in the North, South Salmara and the state of Meghalaya in the south, W.B and Bangladesh in the west and Goalpara and Bongaigaon in the east. The geology of the district mainly consists of Inselberg, older alluvium and younger alluvium. The district is characterized by very damp and humid due to high temperature and heavy rainfall. The district was drained by the River Brahmaputra and its tributaries like Gangadhar, Sankosh, Tipkai and Champamati.Fig.1shows study are map.

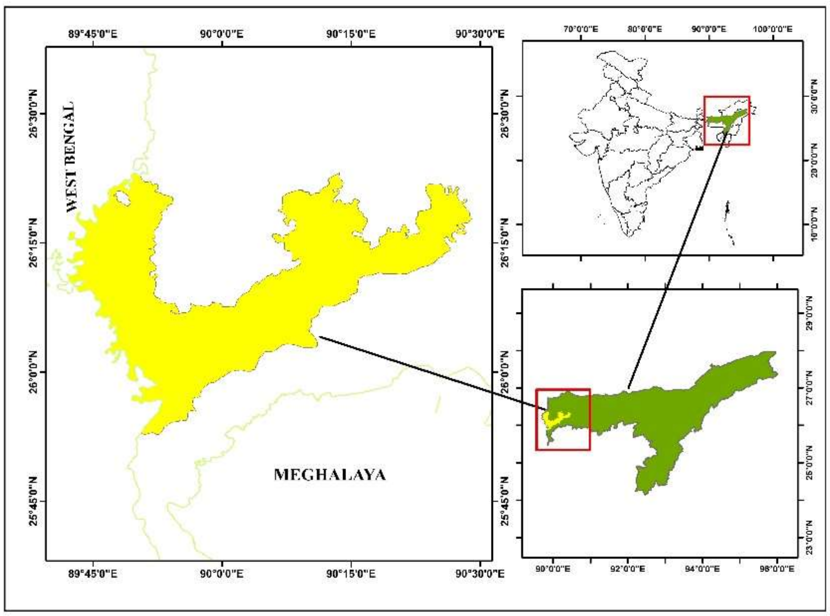

Fig:1 Study area map

Datasets

The dataset included in the study consist of Landsat Thematic Mapper (TM) 3-4-5 C1 level-1 satellite images were used for the lulc classification (Tucker et al.,1985) of 1990, 2000,2010 and Landsat 7(ETM+) C1 LEVEL1 images for 2020.The satellite images were acquired for free from the Landsat archive of the United States Geological Survey extracted from the website (https://earthexplorer.usgs.gov/). The Database and their source of extraction was given in the following table: -

Table:1 Source type and scale/resolution of data used

Year	Data type, Source	Wavelength in micrometre	Date of capture	Date of data collection
2020	Satellite image of Band 3-Red, Band 4 (NIR) Band 5 shortwave inerrant (SWIR)	0.77-0.90 0.77-0.90 1.55-1.75 Resolution in meter 30	6 April 2020	18 Aug 2023
2010			5 June 2010	23 Sep 2023
2000			19 April 2000	18 Aug 2023
1990			5 August 1990	22 Aug 2023

Source: - USGS- Earth Explorer (2023)

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Methodology

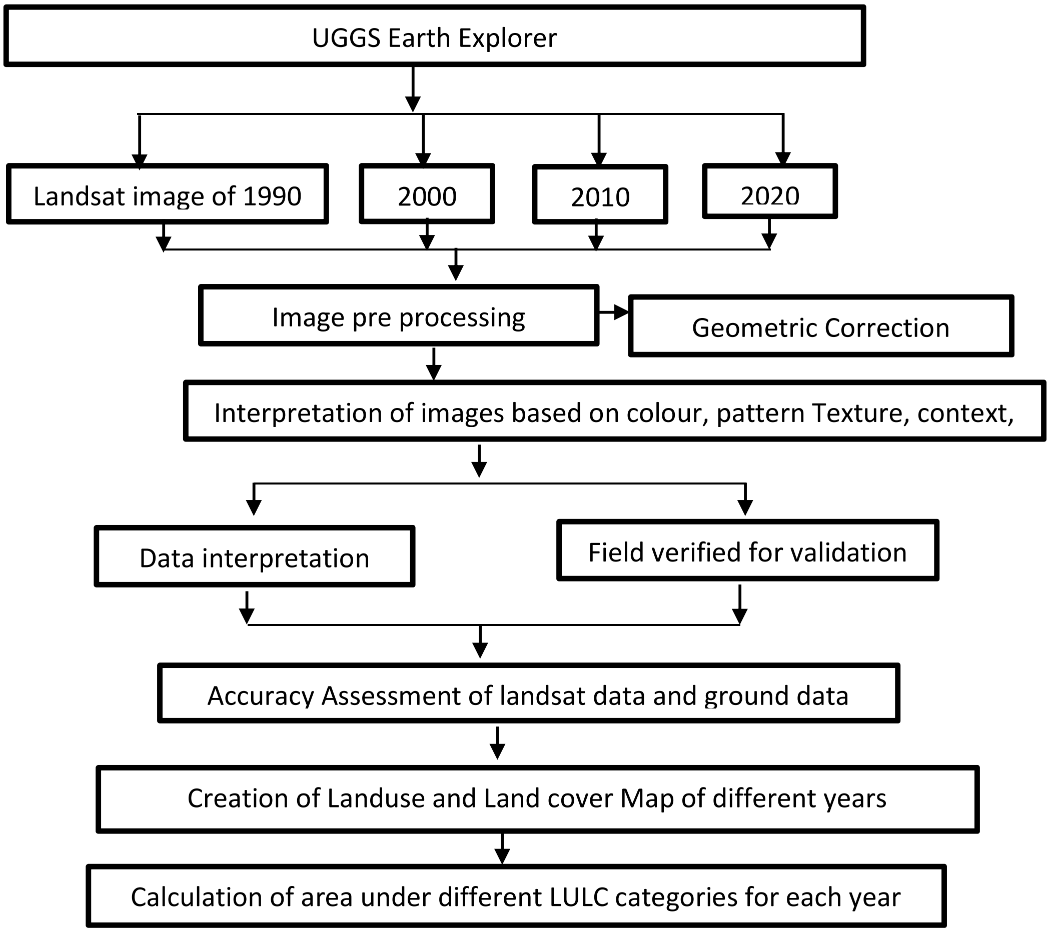

Fig :2 Methodology

The 1990, 2000, 2010 and 2020 LULC image were extracted from the satellite imagery of various Landsat 4 and 5 (TM) and 7 (ETM+) of bands 3 -Red, Band 4 (INR), and Band 5 short wave infrared (SWIR) at a resolution of 30 m wavelength in 0.45 – 0.52, 0.77 -0.90 and 1.55-1.75. Erda's Imagine 9.2 software is taken into consideration for the year 2010 Landsat 7 image in order to rectify the line striping error the output was exceptionally clear, including the research area. The images are supervised to identify distinct types of surface cover based on color, texture and shape. 350 training points are taken for each category, and the computer is trained to identify spectrally comparable areas using numerical data. The computer than compares each pixel to the signature and determines the most closely matched class. The data is then transformed into polygons and computed over a 10 years interval from 1990-2020. To find out the LULC change, the data of all the years were compared in excel that clearly shows changes over the years.

Result and Discussion

River, sandbar, wetlands, vegetation, agricultural land and built-up area were the six LULC class categorized for the study area. Satellite image files were classified under different LULC categories based on various elements such as shape, tone, texture, association, shadow, site pattern etc. (Sarma et al., 2015). The study area's LULC was evaluated using the variations in satellite images status from 1990, 2000, 2010 and 2020.

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The various types of landuse and landcover (LULC) up to 1990, arranged by availability, can be delineated as Agricultural Land (39.02%) >Vegetation (25.51%)> River (12.86%) > Built up area (10.40%) > Sandbar (9.20%) > wetlands (3.01%).

The data as observed from the 2020 LULC map is however different and can be represented as Agriculture land (35.85%) > built up area (27.43%) > Vegetation (15.51%) > Sandbar (11.95%) >River (7.56%) > Wetlands (1.70%). In contrast to the vegetation area in 1990 (25.51%), a decrease of 10% in the vegetation are was registered in 2020 (15.51%). When the River area of 1990 (199.72 sq km) was compared to that of 2020 (117.46sq km), a decrease of 5.29 % was recorded. There is a favorable correlation between the increase in built-up area and the decline in Agricultural land and Vegetation. It is quite visible since the buildup increased by 17.03% from 10.40% in 1990 to 27.43% in 2020. Expect the Built-up area (17.03%) and Sandbars (2.75%) all the other categories of LULC classes of Dhubri district shows on decreasing trend from the year 1990 -2020.The following are the changes that has been noted in the research areas LULC for the six main LULC categories between 1990 – 2020.Table:2 shows the lulc changes from 1990-2020.

Table:2 shows the area and percentage of change of different lulc classes. (1990-2020)

LULC Class	1990		2000		2010		2020	
	Area in km²	Area in%	Area in km²	Area in %	Area in km²	Area in %	Area in km²	Area in %
River	199.72	12.86	115.47	7.45	114.87	7.40	117.46	7.56
Sandbar	142.86	9.19	162.42	10.48	150.66	9.71	185.6	11.95
Wetlands	46.74	3.00	40.52	2.61	35.96	2.32	26.38	1.70
Vegetation	396.11	25.50	294.88	19.02	261.76	16.86	240.84	15.51
Agricultural land	606.05	39.02	666.97	43.03	612.38	39.45	556.69	35.84
Built-up area	161.52	10.40	272.74	17.40	377.37	24.27	426.03	27.44
Total =	1553	100.00	1553	100	1553	100	1553	100

River and Sandbars: - The area covered by rivers in the study region was 199.72 sq km in 1990; this decreased to 115.47 and 114.87 sq km in 2000 and 2010 and just 117.46 sq km in 2020. Between 1990 and 2020, over 5.3 % of the region was lost due to riverbanks conversion to croplands and sandbars as a result of the overabundance of the sediment that the river transports and the uses of riverbanks for human habitation. From 1990 to 2020 nearly 76.13sq km of the river area transformed to sandbars, 36.04 sq km transformed to vegetation, 21.00 sq km into built up areas and 21.69 sq km transformed into barren land which is now used for Agriculture purpose.

Between 1990 and 2020, the study area experienced a 2.75% increase in sandbars, from 142.86 sq km to 185.6 sq km. The study region, a floodplain, experiences reduced river flow, resulting in the formation of both temporary and permanent sandbars, also called char lands. The study area has been seen a positive increase of sandbars, as 76.13 sq km river, 43.84 sq km of barren land, 3.81 sq km vegetation area and 9.62 built up sq km area has transformed into sandbars since 1990 to 2020. They are mostly used as permanent settlement are inundated during the rainy season, also utilized for agricultural purpose.

Wetlands: - These bodies of water are conspicuous elements of the Brahmaputra River's floodplain. Wetlands are vital for their residents because of their biological interactions between soil, water, vegetation and animals that enable them to carry out certain task and produce healthy wildlife, agriculture, and forest assets (kotoky et al. 2012). In 1990 wetlands were 46.74 sq km which further decreased to 26.38 sq km in 2020. Nearly 1.13 % decrease have been noticed from the year 1990 – 2020. Out of the total area which was under waterbodies in 1990, 17.31 sq km transformed into agricultural land, 8.86 sq km of area has been transformed into built up area, 3.59 sq km into vegetation area in the year 2020.

Vegetation and Agricultural Lands: - In the study region, "Vegetation" mostly refers to the natural vegetation and "Agricultural land" refers to the land that local population uses for farming. In the year 1990, 25.51% of the total area falls under vegetation and 39.02% falls under agricultural land. In the year 2020 a decreasing trend has been observed. Vegetation decreases from 396.11 sq km to 240.84 sq km and Agricultural land from 606.05 sq km to 556.69 sq km during the period

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1990 – 2020. In the study area, a rising tendency of vegetation and farmland area being converted to development area was noted. 165.55 sq km of cropland and 143.47 sq km of Vegetation area have been converted to build up area. Beside this 43.84 sq km, 6.94 sq km, 72.70 sq km of the agricultural land has been transformed into Sandbar, Waterbodies and Vegetation from 1990 -2020. For the agricultural land 4.14 sq km, 161.16 sq km and 3.81 sq km has been transformed to waterbodies, barren land and sandbars.

Built-up area: In the study area settlement was seen in an increasing trend from the year 1990 to 2020. In 1990 built up area of the study area was 10.40% which shows a drastic change of 27.43% in the year 2020. There is a drastic increase of 17.03 % from 1990 to 2020. More and more lands were being converted from other landuse categories to the buildup category, which led to this increasing tendency of this area. It was observed as the first most landuse category in 2020 from the land use category i.e. 4th in 1990.

The study reveals a significant negative shift in agricultural landuse and wetlands from 1990-2020, impacting ecological and hydrological health in the area. Majority of the area under wetlands are mainly converted into agricultural land and built-up area. Most of the area that was once covered by rivers, sandbars, agricultural land and waterbodies has been converted into buildup areas, that shows the study region's buildup area a positive change from 1990 – 2020. Similarly maximum area under river were transformed to built-up areas, agricultural areas and sandbars.

According to the LULC of the study region under observation, 550.63 sq km out of the 1553 sq km of the total land area remained unaltered during the period (1990- 2020) making out about 35.45 %, However, 341.60 sq km of the region were turned into built up area which was regarded as one of the major shifts in landuse practices. The transformation of land area into unplanned settlement will substantially affect the current biodiversity of the district. The current trend of deforestation and anthropogenic activity has reached an alarming state, resulting in improper landuse and landcover alteration in the study area. Proximate concerns indicate an urgent necessity to oversee alteration in vegetation, landuse and the present condition of all landcover and landuse regions of within the district to address challenges for efficient management. Figure: 3a and 3b shows the lulc map of Dhubri district.

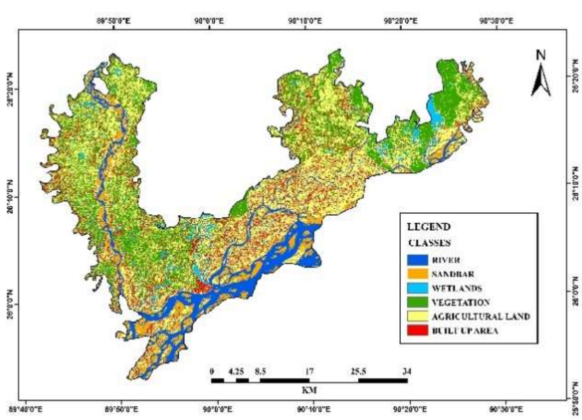

Fig:3a lulc map1990

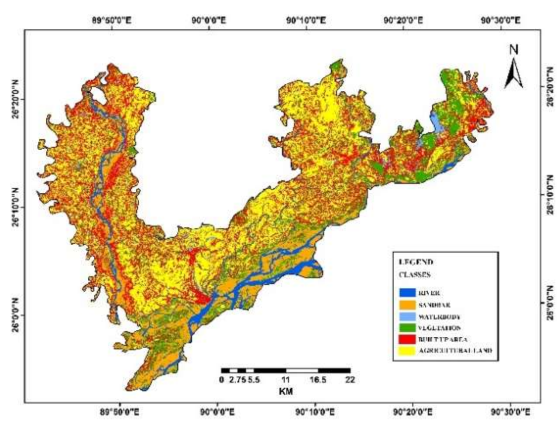

Fig:3b lulc map 2020

Accuracy Assessment: The Dhubri district LULC map's accuracy evaluation was based on the ground truth points noted during the field survey. A GPS device was used to randomly gather these points. For the various LULC class, the user's accuracy and produces accuracy was calculated using error matrices. Both the individual and combined Kappa coefficients and overall accuracies for every image were determined (Kumar, 2017). The overall accuracy and the Kappa Coefficient of the LULC of the different year from 1990 to 2020 is shown with the help of the following table. Table:3 shows the Accuracy measurement of the study period of 1990 to 2020

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Accuracy assessment of the study period of 1990 to 2020, using user accuracy, producer accuracy, overall accuracy and kappa co-efficient methods														
	User accuracy (%)						Producer accuracy (%)							
Year	River	Sandbar	wetland	Vegetation	Agricultural land	Build up area	River	Sandbar	wetland	Vegetation	Agricultural land	Build up area	Over all accuracy (%)	Kappa Coefficient (%)
1990	99	98.03	99	79.83	84.4	96.87	100	100	99	99	92	62	92	87.88
2000	85.29	96.03	98.43	86.18	80.34	88.28	87	97	63	93	98	94	88.66	85
2010	89.69	93.93	97.64	85.41	87.25	86.48	87	93	83	86	96	89	89	97.92
2020	85.29	96.03	98.43	82.6	72.05	69.52	87	97	63	76	98	73	82	80.04

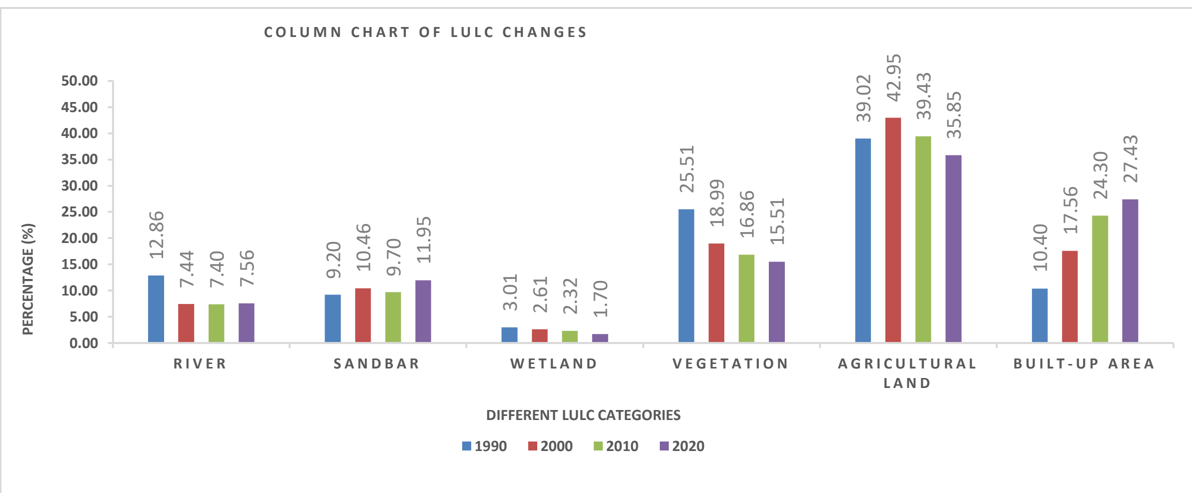

Fig:4 Lulc change status over ten years' intervals in Dhubri District.

Conclusion:

Using Remote Sensing, GIS methodologies and techniques the current study illustrates and highlights the changes in LULC based on Landsat temporal remotely sensed pictures of the year 1990, 2020, 2010 and 2020.The research found that changes happened in river, built up area and vegetation cover and the percentage is shown in fig:4 and table:3 respectively. The local environment in Dhubri district of Assam has deteriorated over the 40 years due to a variety of anthropogenic activities that include excess forest and vegetation destruction, buildup area for human settlement, grazing, sand mining and general resource exploitation, as well as poor landuse and landcover management. Thus, it is necessary to adopt a perspective measure in this regard. So, the current generated data set will facilitate forecasting of landuse and landcover changes across time in the study area. This will also address the direct and indirect environmental issues anticipated as a result of the drastic change in land use pattern.

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