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MONITORING OF SPATIO-TEMPORAL CHANGES IN HOJAI DISTRICT, ASSAM USING GEOSPATIAL TOOL

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Abstract: Drastic transformation in land use and land cover has become the prime factor for changing environmental nature for the last several decades. Nowadays, land pattern analysis is a leading topic for analyzing, managing, and predicting land dynamics. It helps to sustainable development, planning, and management to achieve its utmost potentiality. In the era of the increasing environmental problems, population explosion, and unregulated natural resource extraction hike the significance of geospatial technologies to analyze the land use and land cover dynamics. In this paper, multi-temporal Landsat data have been used for analyzing land use and land cover changes in the Hojai district of last 20 years. ISO cluster unsupervised classification method has applied using Arc GIS and ERDAS imagine software. The classified images on land use and land cover change have clarified the untenable use of land cover in the study area. It has shown the drastic degradation of dense forest, sparse vegetation, and open space areas, which may cause an immense environmental degradation and impede sustainable augmentation of the development. Therefore, a comprehensive analysis of the prevailing land resource management is immensely required to restrain future impairment of ecological atrophy.

Keywords: Land Use, Land Cover, Multi-Temporal Landsat Data, Iso Cluster Unsupervised Classification Method, Arc GIS Software, ERDAS Imagine Software.

Article History
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Introduction:

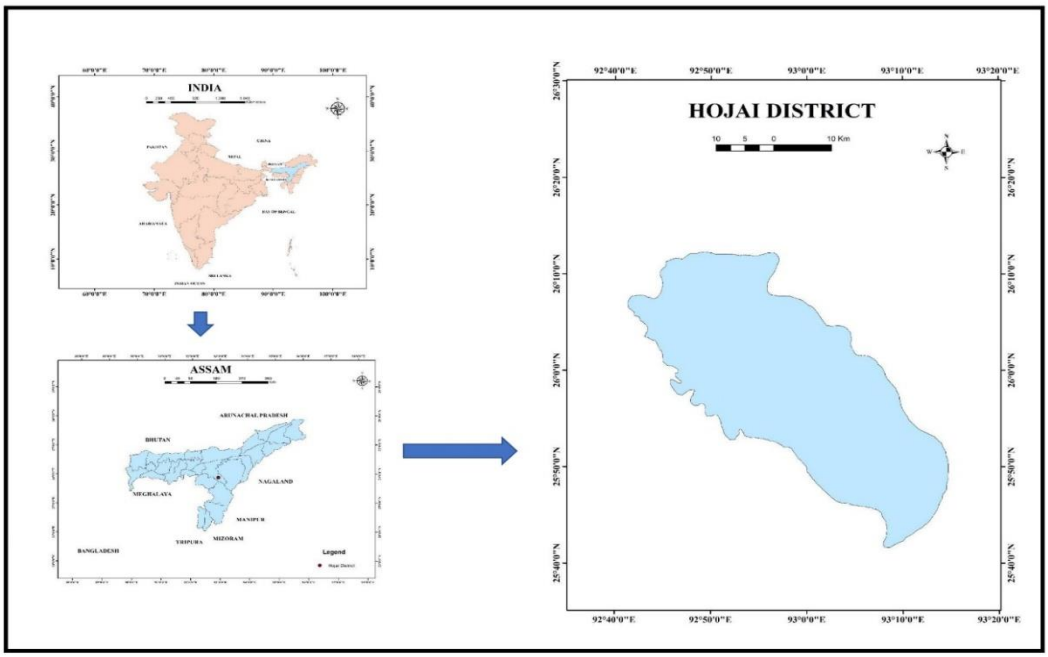
As like natural force the human civilization also brings drastic modification in land use and land cover dynamics. Land use pattern reveals the relationship between man and natural environment (Gngaraju et al., 2017) and increasing population pressure on the earth surface has lead to various changes on environment. Human have been modifying land to obtain their food and other essentials since time immemorial which leads to unprecedented changes in the environment (Parsa, 2016). These rates of changes have significant impact on anthropoids along with other species living in this planet. Increase in human population, rapid rate of urbanization, accelerated socio-economic activities have intensified the environmental changes over the decades (Mahmood et al., 2010). Among the changes created by human one of the major form are land use and land cover changes. The changes in the land use and land cover results into depletion of forest cover, loss of wetlands which creates threats to wild life and biodiversity loss(Jibril& Liman, 2014).According to FAO, the primary forest area has decreased by over 80 million hectares since 1990 across the world. Agricultural proliferation is also one of the major drivers for deforestation and allied loss of biological diversity. Between 2000 and 2010, large scale commercial agriculture accounted for 40% of tropical deforestation and local subsistence agriculture for another 33%. There are total 20,334 tree species had been included in the IUCN Red List of threatened species (IUCN, 2019), of which 8056 were estimated as globally threatened. Arisdason. W. &Lakshminarasimhan, (2020) stated, India supports a diverse range of ecological setups such as grassland, wetlands, coastal area, marine and desert. All these possess high biological diversity. These diverse ecological setups proliferating due to geographic location situated at the conjunction of three major global biogeographic realms, i.e. Indomalesian, Eurasian, and Afro-tropical. Hence, World Conservation Monitoring (2000) recognized India as one of the 17 mega-diversity countries in the world. There are four major biodiversity hotspots situated in India, namely Northeast India and Andaman Islands (Indo-Burma), Nicobar Island

(Sundaland), Western Ghats (and Sri Lanka), Eastern Himalayas. These highly significant species occupied areas evince peculiar cluster of endemic species and also experiencing habitat loss. In the regional level, according to a report of Government of India, 2003, Assam has 26.50% of forest area in 1969-70 whereas it reduces to 24.58% in 2003 (Tamuli & Choudhury, 2009). Similarly, Hojai district has been facing drastic deterioration in forest area. Due to increasing population growth, the demand for limited resources are gradually increasing since last few decades and it triggers the immense pressure on limited natural resources. Therefore, there is an urgent need to analyse the changing pattern of land use and land cover to figure out the probable reasons for these biodiversity deteriorations in the study area. Hence, this land use and land cover analysis using unsupervised algorithms become most essential for land use planning and frame an efficient strategy for the conservation of biodiversity as soon as possible.

Study Area

Hojai is a newly formed district in Assam. It is situated in the southernmost part of the Nagaon district covering an area of about 1685 square kilometre and bordered by Karbi Anglong district in it's East, West, South and North-East part. It has included three Legislative Assembly Constituencies namely Jamunamukh, Hojai and Lumding and three revenue circles namely Hojai, Daboka and Lanka. According to 2011 census, it has 9,31,218 persons, of which 4,76,480 are males and 4,54,738 are females.

Fig.1 Location of Study Area



Objective

The major objective of the present paper is to analyse the spatio- temporal changes in the Hojai district in the last 20 years from 1999 to 2019.

Database and Methodology

The study is based on primary and secondary data. For the accomplishment of an accurate analysis of LULC changes tend, we have taken three cloud-free Landsat images from the United States Geological Survey website. To avoid any prejudice in the analysis, we have taken the satellite images from the same season. To assess the changing pattern of land use and land cover pattern, three land use maps have prepared with the help of ERDAS IMAGIN and Arc GIS software.

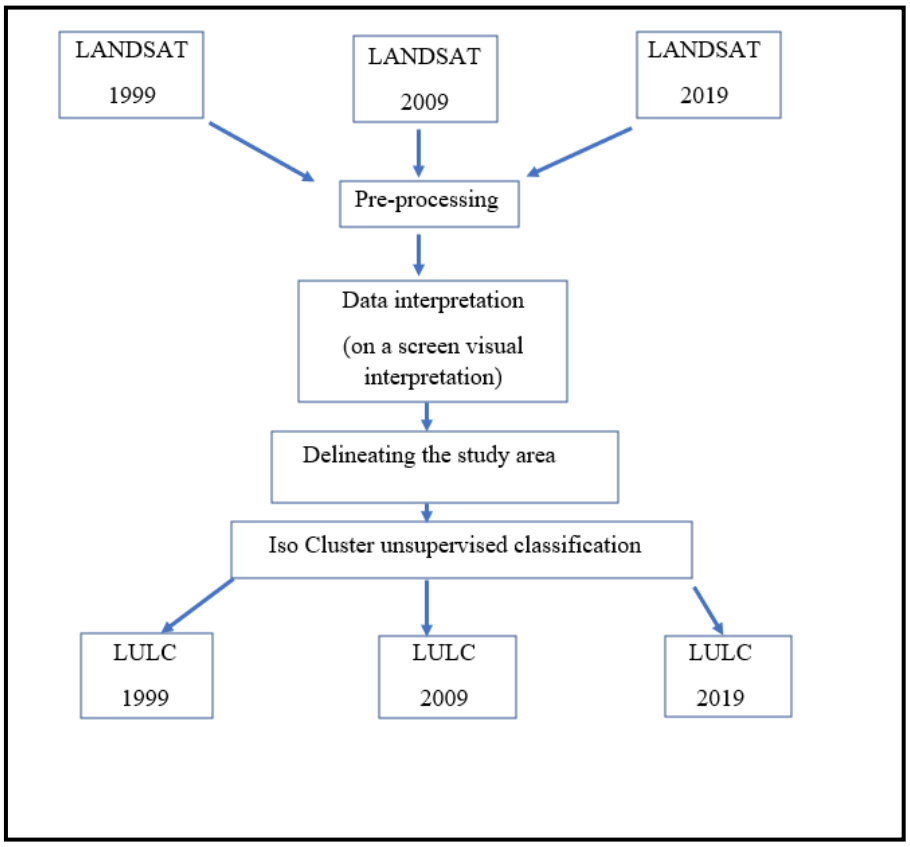


Fig.2 Cartographic model of the study

Table 1: Types of Satellite Data Used in the Study Area

Satellite	Sensor	Acquisition date	Resolution	Path/Row
LANDSAT 5	TM	1999-02-26	30m	136/42
LANDSAT 5	TM	2009-02-21	30m	136/42
LANDSAT 8	OLI-TIRS	2019-01-16	30m	136/42

Satellite images have classified with the help of the unsupervised classification method. Moreover, ground verification has also taken into consideration through the ground control point of Google Earth Pro software, and to some extent, field survey has also conducted to get more accuracy. Likewise, we have fathomed the changes of LULC visual elucidation facets and figure out six land use and land cover classes, they are dense forest, built up area, water body, sparse vegetation, agricultural land, open field.

Table 2: Description of A Land Use and Land Cover Classification

LULC classes	**Description**
Water Body	Water body accumulation of water on the surface of

	the earth such as ponds, lakes, streams, etc.
Settlement	Area concentrated with settlement which constitute or is a part of urban area.
Sparse Vegetation	Area covered with scattered greenery.
Forest Land	Area with tree canopy of more than 60%.
Agricultural Land	Irrigated and fellow agriculture land.

Results and discussion

Land uses mainly refer to the human activity on the earth's surface. Land use and land cover changes have great impact on human and environment. Analysis of land use/land cover changes has great significance to manage resources and (Ram & Kalarkar, 1993) for sustainable development (Zhang and Hao, 2020). When land use and land cover changes exerts adverse impact on environment and not follow the rules of sustainable development, then it creates several environmental problem such as soil erosion, artificial flood, landslide, global warming and so on (Rawat et al., 2013). Therefore, it has urgent need to assess the pattern of land use land cover changes to maintain ecological set up of environment as well as to achieve sustainable development. Hence, on the basis of the interpretation of satellite imagery and existing study area condition, we have classified the study area into six categories. These are dense forest, built up area, water body, sparse vegetation, agricultural land, open field (table 1). We have used multiple datasets including 1999, 2009 and 2019 to enumerate the spatio-temporal changes in land use land cover over the period in the study area.

Forest land

Being one of the important natural resource forest have fulfilled human needs in a various way but due to increasing human action forest land has also been facing severe declension. Increasing built up area as a result of high population growth leads to decreasing trend of dense forest. It has been seen that in 1999, forest land has covered by 385.64 square kilometre (26.48%) and in 2009, 243.1 square kilometre (16.68%). This data shows a drastic change in area under forest land between 1999 to 2009. It has shown a considerable decrease of 142.54 Km2 (9.8%) from 1999 to 2009. The probable reason for the declining area under forest may be attributed to urbanization where people migrated to nearby hilly area which triggered deforestation and other disaster like landslide. Though area under forest decline during 1999 to 2009 in the study it has been seen that in 2019 area under forest has been increased by 33.9 square kilometre. This may be due to increasing awareness created by government and other NGO's among people regarding the consequences of deforestation on environment and human life because of which people replenish forest land to save the planet earth from increasing global warming and other consequences.

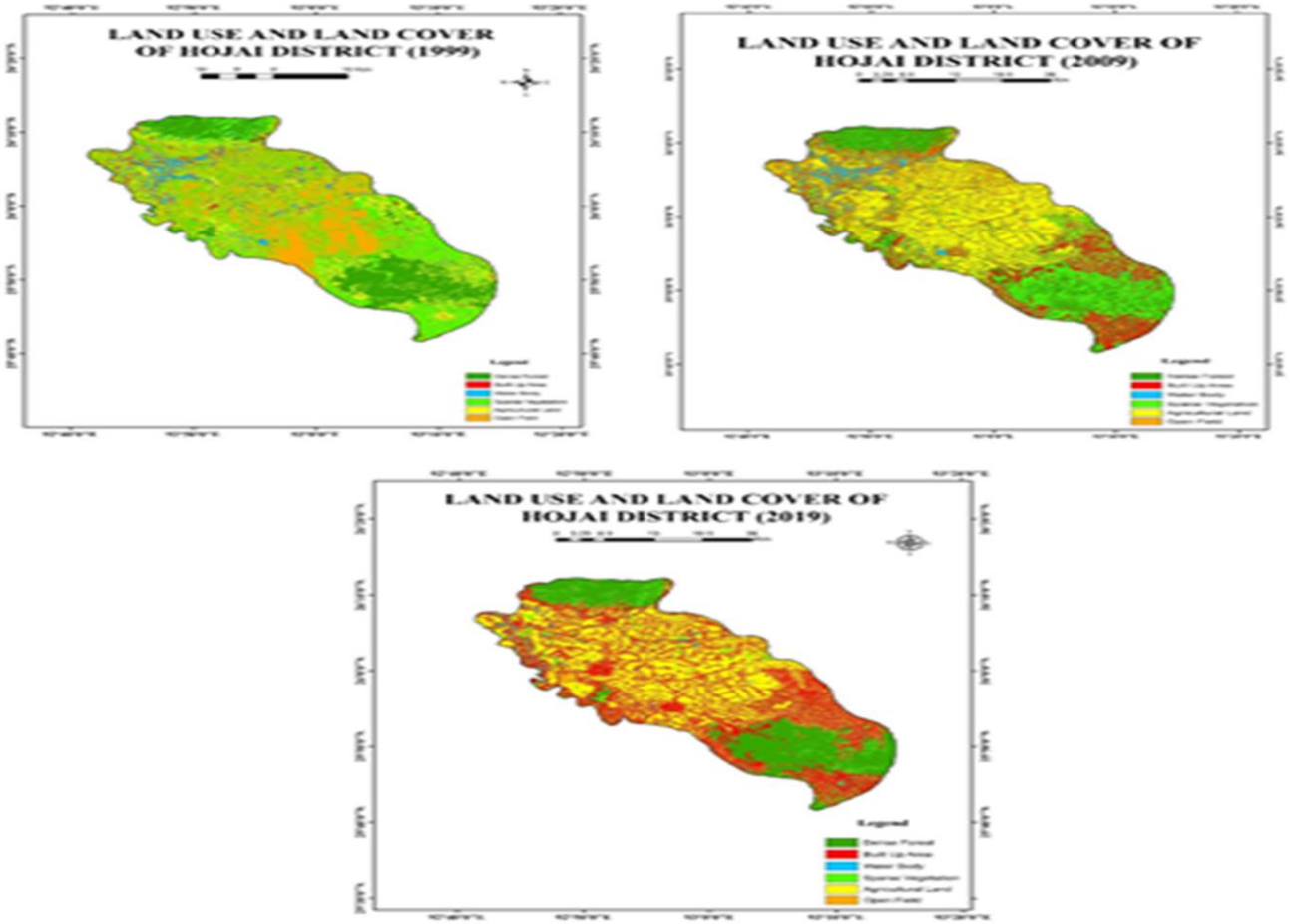


Fig.3 Land Use and Land Cover pattern of Different Years

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Built up area

The change detection map (fig. 3) depicted that built up areas is increasing gradually. Built up areas are those where people resided which ranges from a small array of dwellers to a megacity. Increasing built area shares a close relationship with population growth and urbanization. In the study area also increasing population leads to increasing area of built up area which results into decreasing area under forest, wetlands etc. As depicted by the images built up area in the study area increased by 205.76 sq kilometre (14.12%) from 1999 to 2009. In 2019 there is an tremendous hike in built area which occupy 470.49 square kilometre (32.29%). Which depict an overall increase of 369.98 square kilometre (25.39%) from 1999 to 2019 area under built up area. Such an increasing trend of area under built up area indicates the loss dense forest, vegetation, water bodies including wetland area which also leads to biodiversity loss.

Water Bodies

Water bodies which includes both natural and manmade water features including ponds, lakes, water reservoir, wetlands, canals etc. and the study reveals that, the areas under water body decreased over the years. In 1999 water body covered by 46.89 Km2 (3.22%) and in the year 2009, it has decreased to 40.689 Km2 (2.79%). There is a decrease of 6.201 Km2 from 1999 to 2009. The decreasing trend of area under water body has also been seen in 2019 which witnessed 14.23 square kilometre (0.98%) decreased from 2009 to 2019.

Sparse Vegetation

Sparse vegetation can describes as forest and scrubs scattered in a large array of a landmass. In the study area due to increasing built up areas, the areas under sparse vegetation have been facing severe deterioration. In 1999, sparse vegetation has covered by 486.19 Km2 (33.39%) and in 2009, 447.33 Km2 (30.70%). There is a remarkable drop in the area under sparse vegetation during 1999 to 2009. It has shown a significant decrease of 38.86 Km2 (2.69%) from 1999 to 2009. Increasing population growth and their demand for land for settlement is the major reason for its drastic drop in the area under sparse vegetation. The increasing built up area has lead to decreasing area under sparse vegetation by 326.72 square kilometres (22.43%) from 2009 to 2019. The deterioration of vegetation cover has negative impact on the ecological set up of the environment in the study area.

Table 3: Land Use and Land Cover Statistics of the Study Area in Sq. Km. (1999-2019)

Categories	1999	2009	2019
Water body	46.8918	40.689	26.45
Dense forest	385.64	243.1	277.05
Settlement	100.51	306.27	470.49
Agricultural land	184.8	294.59	471.08
Sparse vegetation	486.19	447.33	120.61
Openfield	251.97	124.84	91.14
Total	1456.00	1456.824	1456.82

Source: Calculated Based on Data from Landsat imagery

Agricultural land

Agriculture is one of major source of sustenance and livelihood in the study area. Sustainable agricultural augmentation is most essential for human well-being, economic prosperity, escalation of ecological setup (Popkin, D'Anci, & Rosenberg, 2010). In the satellite image, the land area appeared as a reddish tone with various shapes and sizes in a contiguous/dispersed pattern. In the study area, it incorporates croplands, agricultural plantations, fallow land, peddy fields etc. As depicted in the images the area under agricultural land increasing over the period. As in 1999 the area cover under agricultural land has covered 184.8 square kilometres (12.69) which increased to 294.59 square kilometres (20.22%) and 471.08 square kilometres (32.33%) in 2009 and 2019 respectively. Which indicate an increase of 286.28 square kilometers during the period from1999 to 2019.

Table 4: Land Use and Land Cover Statistics of the Study Area in Percentage (1999-2020)

Categories	1999	2009	2019
Water body	3.22	2.79	1.81
Dense forest	26.48	16.68	19.01
Settlement	6.90	21.02	32.29
Agricultural land	12.69	20.22	32.33
Sparse vegetation	33.39	30.70	8.27
Open field	17.30	8.56	6.25
Total	100	100	100

Source: Calculated Based on Data from Landsat imagery

Open field

In the study area, there has been seen decreasing area under open field due to increasing built up area. Increasing population in the district converted the open field to settlement areas. As in 1999 open field covered 251.97 square kilometres (17.30%) which decreased by 8.74% in 2009. Further in 2019 the area under open field decreased to 91.14 square kilometres which witnessed an overall decrease of 160.83 square kilometres.

Conclusion

The present study has undertaken for the detection and monitoring of possible changes that has been taken place in terms of land use and land cover changes in the district through high resolution images for the year 1999, 2009 and 2019. The analysis of the present work indicates that there have been drastic changes in land use and land cover during the selected periods in the study area. The major changes have been seen in terms of dense forest, sparse vegetation and water bodies where these areas show negative changes by deteriorating its area. The positive changes have been found in terms of agricultural field which remarkably increases over the years. In the study area increasing population leads to increasing built up areas which results into deterioration of vegetation cover in the district. Therefore in the spatio-temporal analysis of the study we have found both positive and negative changes over the selected periods.

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