Geotemporal Dynamics of Landuse and Landcover Change Analysis for Greater Kohima Town, Nagaland, India

Avinuo Khoubve[1], Thsope Medo[2], Nesatalu Hiese[2], C. Lakshumanan[1]

[1]Department of Remote Sensing, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India
[2]Nagaland Science & Technology Council (NASTEC), Department of Science & Technology, Kohima, Nagaland, India
Email: khoubveavinuo@gmail.com

Abstract: Landuse Landcover mapping is a vital tool for investigating the landuse patterns and understanding the surface changes that has taken place over time. The increase of urbanization has initiated a major change in Kohima Town in the recent years. Hence, it was important to detect the changes caused by different activities. The present study is an attempt to assess the Landuse Landcover change in Kohima Town, Nagaland, India. Satellite Imageries of 2014 and 2022 of the study area was used where major classes were categorized. As a result, major change was observed in built up area by an increase of 14.65 km^2 (17.50%) from 2014-2022, while there was a decline in the scrub land area by 13.65 km^2 (16.30%), followed by forest, cropland and other classes. This study employs the use of Geospatial technique in detecting the landuse patterns of the greater Kohima town, Nagaland. Therefore, it emphasizes the importance of precise land management and can present as an essential source of information whereby planners and policy makers can use to sustainably plan the environment.

Keywords: Landuse Landcover, built up, change analysis, NRSC level-III classification

1.INTRODUCTION

Urbanization is rapidly sweeping the state of Nagaland, be it the commercial hub of Nagaland Dimapur; or the Capital of Nagaland-Kohima. Urbanization causes expansion both vertically as well as horizontally (Yhoshü and Chase, 2019). The term landuse landcover means the utilization of land for purposes such as agriculture, development, conservation, recreation etc., is the resultant of man-environment relation influenced by nature and socioeconomic dynamics of man (Seyam *et al*., 2023). Over a period of time, these changes if not monitored and managed can led to loss of the environmental quality. Various method of observation regarding Earth surface change are used. Landuse landcover (LULC) observation is a powerful technique which helps in change detection measure (Seldou *et al*., 2023).

The usage of continuous satellite-based multi temporal data have helped in monitoring estimate earth resources for understanding their periodical land changing trend, LULC mapping has opened doors to new insights selection of areas designed to agricultural, urban and/or industrial areas (Roy and Inamdar, 2019). Information regarding LULC possibilities for their optimal use is essential for proper selection, planning and implementation of land use so as to meet the requirement of growing population and its increasing socioeconomic necessities. Proper implementation programs therefore, become paramount to a sustainable environment to avoid environmental problems like landslide, flood etc. (Reis, 2008).

LULC means the use of land via agriculture, conservation, development, recreational places, wildlife habitats, and urban regions or any other activity and the outcome of human-environment interaction in a particular location, as influenced by climate change processes and socioeconomic dynamics (Rawat and Kumar, 2015; Prakasam, 2010; Reis, 2008). The demand in LULC mapping using remote sensing data has been growing due to the impact of LULC changes in the ecosystem (Macarringue *et al*., 2022). The basic premise in using remote sensing data for LULC is that changes in land cover result in changes in radiance values which can be remotely sensed. Changes in land cover by land use do not necessarily imply degradation of the land. However, due to shift in land use patterns, land cover changes that affects biodiversity, water and other processes that come together to affect climate and biosphere (Riebsame *et al*., 1994). Information on land use/cover and their potentials through best use becomes essential for the selection, planning, sustainable land resource management and understanding the surface changes (Tewabe and Fentahun, 2020).

2.STUDY AREA

The study area is the capital of the Indian State of Nagaland. Kohima constitutes both a district and a municipality. The present study area is located at 25.697651o to 23.842730o North latitudes and 92.973602o to 94.751007o East Longitudes. The study area is located in high hills with rugged terrain conditions. It has an average elevation of 1261 metres (4137 feet) and covers an area of 1,463 sq.km, with a density of 213 per sq.km. Kohima Town is located on the top of a high ridge and the town serpentines all along the top of the surrounding mountain ranges. It covers an area of 22308.2 km2. It is bounded by Wokha in the North, Phek in the east, Manipur State in the South and Dimapur in the West. As per 2011 census, Kohima District is most populated district of Nagaland state in India.

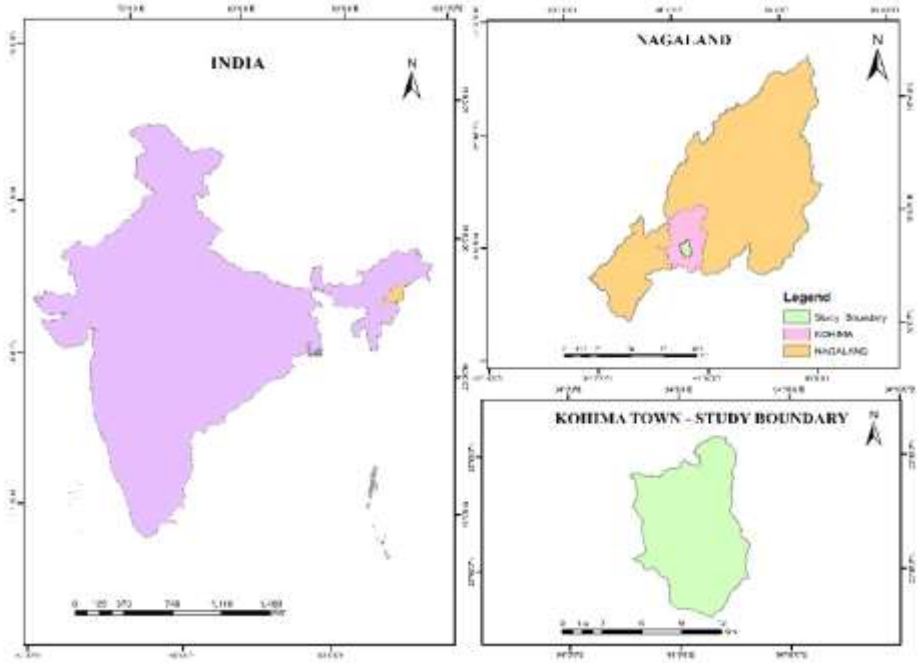

Figure 1. Location of Study Area

3. METHODOLOGY

3.1 Datasets

Sl. No	Type	Data Source
1	LISS IV	NRSC
2	Study Boundary	NASTEC

3.2 Processing

Change analysis of Landuse Landcover is the key aspect of this study by using satellite images. The Supervised classification (Maximum likelihood classification) method has been used in this study, which is well established. This classification method helps in grouping the different classes of LULC sensed from satellite imageries. This method contains the supervision of pixels by an image; a numerical explanation of different land cover types exists in the scene.

Different Training sites are taken as the representative sample of identified Land cover type. Then, the training sites are used for compilation to form a key that can explain a numerical value of different land cover expressed by spectral attributes for a particular type of interest (Ramachandran and Reddy, 2017). Maximum Likelihood (ML) is one of the widely used algorithms in supervised classification to classify images (Jensen, 2005). The principle is the probability function that assumes the training data for each class in each band, which is normally distributed (Basukala, A.K. *et al*, 2017).

The Supervised classification of the year 2014 was used as the base layer for change analysis. On screen and digital interpretation was employed for the year 2022 to detect the changes. Technical Manual of Land Use / Land Cover Classification- NRC LULC mapping by National Remote Sensing Centre (NRSC, 2012), Level III classification was followed. Table 1 describes the details of land use and land cover of each type used.

Table 1. Details of land use and land cover of each type used.

S. No	Class	Description
1	Built up	This class includes concrete buildings; Buildings for residential, industrial, and commercial use; educational institutions; transportation; open-roof concrete structures and other man-made structures.
2	Cropland	This class includes high-density cropland, paddy field, Terrace cultivation and other agricultural land.
3	Fallow Land	These are the lands, which are taken up for cultivation but are temporarily allowed to rest, un-cropped for one or more season, but not less than one year and for not more than five years.
4	Forest	Open and dense forest, woodland etc.

5	Jhum Cultivation	Shifting cultivation, slash and burn cultivation.
6	Plantation	Plantation, vegetable crops etc.
7	Quarry	Surface rocks and stone quarries, sand and gravel pits, brick kilns, etc.
8	River	Streams, rivers and watersheds.
9	Scrub Land	Vegetation, scrubby vegetation mixed with grasses, pastureland, herbs and other small plants.
10	Waste Land	Solid waste dumps
11	Waterbody	This class describes those areas covered by water for example: reservoirs, ponds, lakes, and streams.

For this study, the workflow is shown on the flow diagram to understand the process (Figure 2).

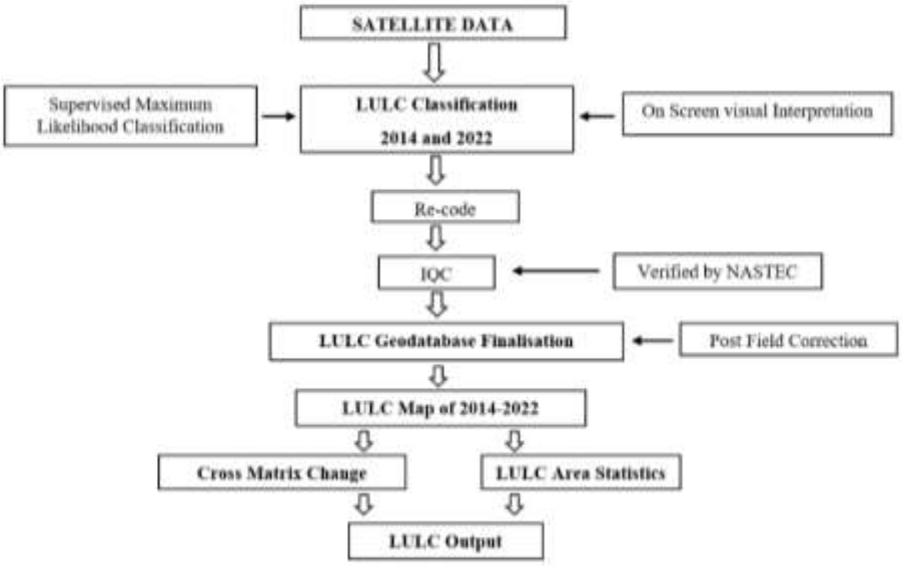

Figure 2. Flowchart of the methodology

4.RESULT

4.1. LAND USE LAND COVER STATUS

The study area of Kohima town which covered an area of 83.74 km^2 of Kohima District showed a major change in built up, forest, scrubland and cropland among all the other classes of LULC used in the study. The built up area in 2014 covered 4.10% with an area of 3.43 km^2, forest area covered 45.80% with an area of 38.36 km^2, scrubland area covered 45.86% with an area of 38.40 km^2 and cropland area covered 3.16% with an area coverage of 2.65 km^2 of the total geographical area. In 2022, the built up area covered 21.60% with an area of 18.09 km^2, forest area covered 44.87% with an area coverage of 37.58 km^2, scrubland area covered 29.56% with an area of 24.75 km^2 and cropland area covered 2.99% with an area of 2.50 km^2 of the total geographical area. The statistics of different classes along with other minor changes are given in table 2.

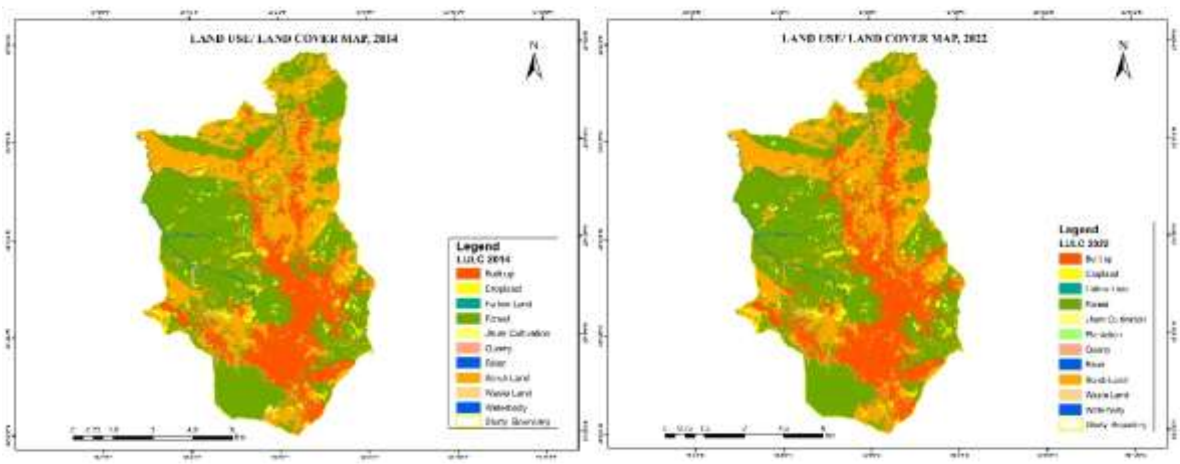

Figure 3. Landuse/ Landcover Map 2014-2022

Table 2. LULC geographical distribution in 2014 and 2022

S. No	Class	2014		2022	
		Area (km^2)	Percentage (%)	Area (km^2)	Percentage (%)
1	Built up	3.43	4.10	18.09	21.60
2	Cropland	2.65	3.16	2.50	2.99
3	Fallow Land	0.05	0.06	0.07	0.09
4	Forest	38.36	45.80	37.58	44.87
5	Jhum Cultivation	0.12	0.14	0.07	0.08
6	Plantation	0.00	0.00	0.02	0.03
7	Quarry	0.11	0.13	0.13	0.15
8	River	0.49	0.59	0.49	0.59
9	Scrub Land	38.40	45.86	24.75	29.56
10	Waste Land	0.12	0.14	0.02	0.02
11	Waterbody	0.01	0.02	0.01	0.02
	Grand Total	83.74	100.00%	83.74	100.00%

4.2. LAND USE LAND COVER CHANGE ANALYSIS

The result of the study showed significant change detection (Table 3) which has been observed during the study period, the main changes observed for the time period of 2014-2022 was that of built up, forest, scrubland and cropland. The study indicates that there is an increase in the built up areas by 17.50% covering an area of 14.65 km^2 of the total geographical area respectively. While, there was a decline in the scrubland area by 16.30% with a negative value of 13.65 km^2. Forest area has also declined by 0.93% with a negative value of 0.78 km^2, followed by cropland, wasteland and other classes respectively (Table 3). Comparatively, river and water body showed no change in the increase or decrease during the span of 8 years. The increase in built up area is a result of increase in population, improved transportation, accessibility and improved health care services and more infrastructural development in Kohima town. Clearing up of forest for Commercial and settlement purpose due to increase in population is one of the main causes for decline in the scrubland and Forest area.

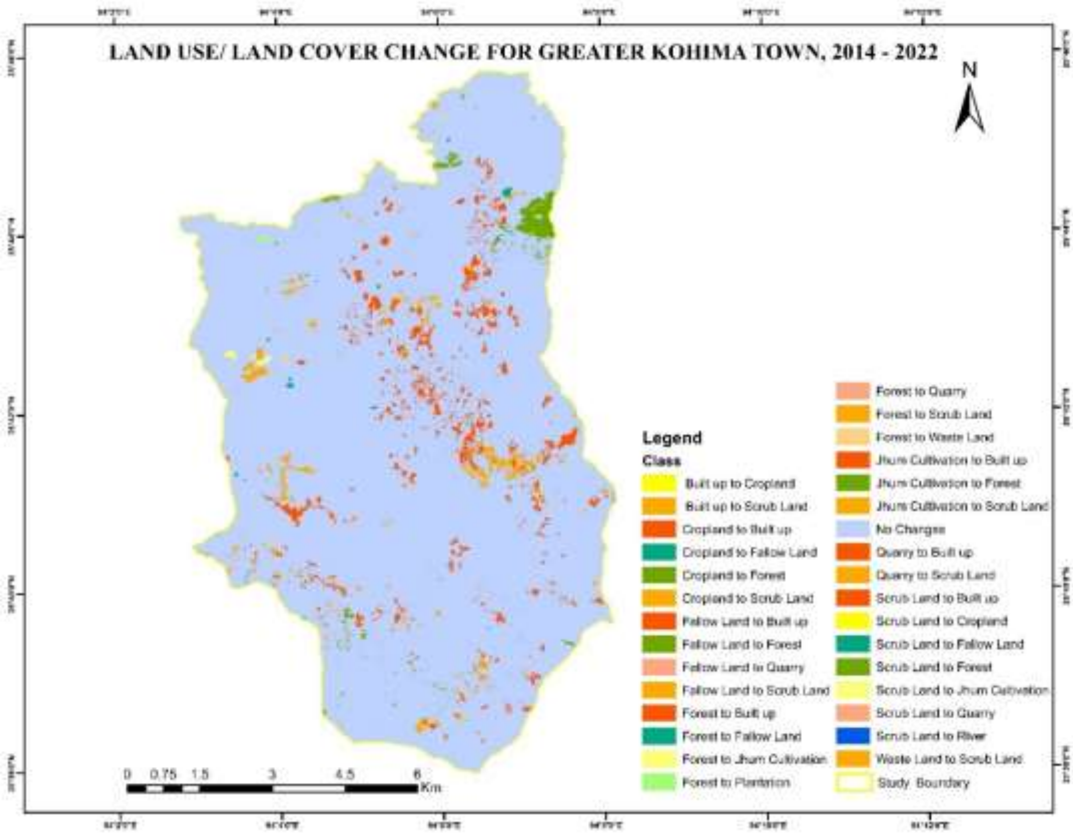

Figure 4. Landuse/Landcover change detection from 2014-2022

Table 3. LULC change analysis 2014-2022

Sl. No	Level III	2014	2022	Change in Km^2	Change in %
1	Built up	3.43	18.09	14.65	17.50
2	Cropland	2.65	2.50	-0.14	-0.17
3	Fallow Land	0.05	0.07	0.02	0.02
4	Forest	38.36	37.58	-0.78	-0.93
5	Jhum Cultivation	0.12	0.07	-0.05	-0.06
6	Plantation	0.00	0.02	0.02	0.03
7	Quarry	0.11	0.13	0.02	0.02
8	River	0.49	0.49	0.00	0.00
9	Scrub Land	38.40	24.75	-13.65	-16.30
10	Waste Land	0.12	0.02	-0.10	-0.12
11	Waterbody	0.01	0.01	0.00	0.00
	Grand Total	83.74	83.74		

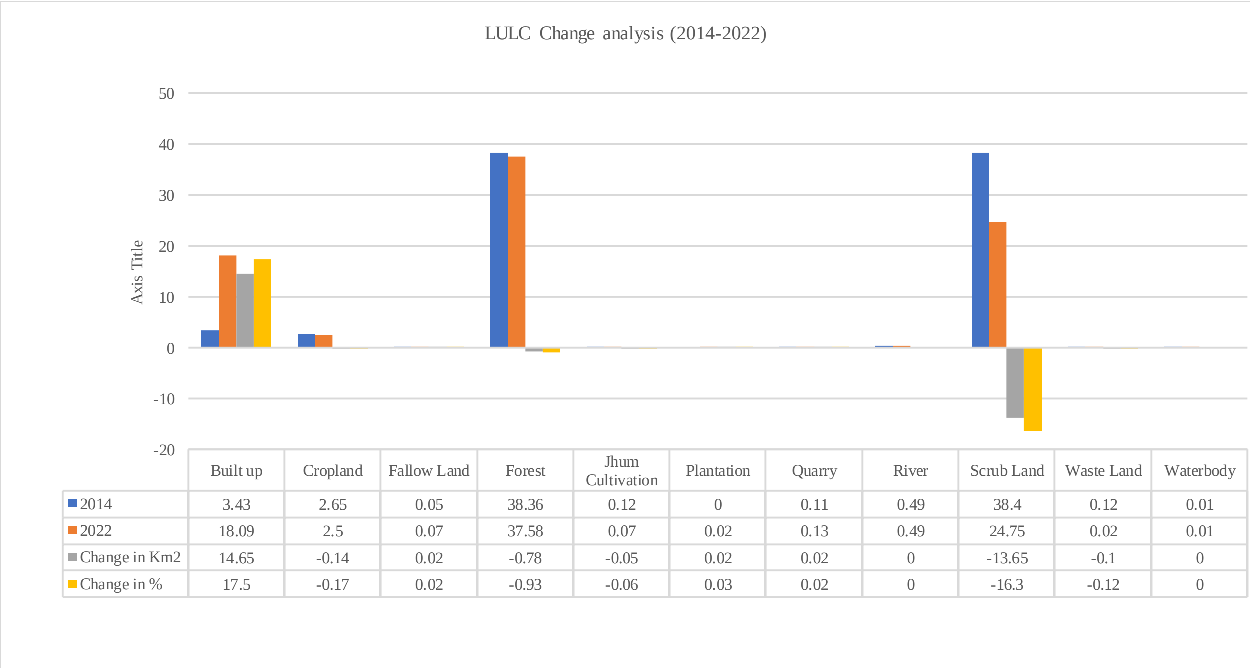

Figure 5. Graphical representation of LULC change analysis (2014-2022)

Table 4. Cross matrix change analysis of landuse landcover between 2014-2022 in sq.km

		2022											
	Class	**Built up**	**Cropland**	**Fallow Land**	**Forest**	**Jhum Cultivation**	**Plantation**	**Quarry**	**River**	**Scrub Land**	**Waste Land**	**Waterbody**	**Grand Total**
2014	**Built up**	3.431	0.003							0.000			**3.434**
	Cropland	0.011	2.491	0.011	0.002					0.133			**2.647**
	Fallow Land	0.002		0.004	0.000			0.005		0.042			**0.054**
	Forest	0.539		0.026	36.698	0.029	0.024	0.021		1.002	0.017		**38.358**
	Jhum Cultivation	0.017			0.002					0.099			**0.118**
	Quarry	0.024						0.077		0.007			**0.108**
	River								0.490				**0.490**
	Scrub Land	14.064	0.010	0.034	0.876	0.040		0.023	0.000	23.356	0.000		**38.403**
	Waste Land									0.115			**0.115**
	Waterbody											0.015	**0.015**
	Grand Total	**18.088**	**2.504**	**0.075**	**37.578**	**0.069**	**0.024**	**0.126**	**0.491**	**24.755**	**0.018**	**0.015**	**83.743**

5.CONCLUSION

The present study shows that the landuse/landcover change analysis study can be successfully applied to identify landuse pattern using geospatial technique. On the basis of classified image, forest is found as a dominant category in the study region, though when compared with both the study year i.e., 2014 and 2022, the Forest area showed a negative change with 0.93% in the year 2022. Further, built up area has been increasing significantly throughout the period showing a positive change of 17.50% in 2022. The increase in built up area is also a result of the decrease in the scrubland area, where 14.064 km^2 (table 4) of the area has been utilized for built up activities. The detection in the land use pattern is an important activity for managing our natural resources for judicious use. The span of 8 years has led to a growth in the urban settlement. As a result, this study indicates that there has been a significant increase in the built up area due to increase in population, improved transportation, accessibility and more infrastructural development in the town. Thus, it concludes that a major LULC change is identified, and the rapid urbanization and commercial activities are the driving factors to trigger the transformation in the study area during the recent years.

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