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Analysis of Land Use and Land Cover Dynamics Using Geospatial Techniques: A Case Study of Pasighat Circle, East Siang District, Arunachal Pradesh

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Abstract: ***The global landscape has been changing over the years with the changes in land use and land cover (LULC). LULC change analysis enables us to understand which LULC class is changing to the other over time. Such information is necessary for effective utilization of land resources. The paper aims at analysing the changes in land use and land cover classes of Pasighat circle of East Siang district, Arunachal Pradesh from 2001 to 2021. The study has been done using remote sensing and GIS (Geographic Information System) techniques as these are the most efficient and effective ways of analysing LULC changes within a short temporal period. Landsat images of 2001 and 2021 were used to prepare the LULC maps of the respective years. Data processing and analysis have been done in Arc GIS 10.8 software. Onscreen visual image interpretation method has been used* to classify the study area into six LULC classes namely Agriculture Land, Built - up Land, Vegetation, Sand, Open Land and Water bodies. The change analysis shows that there is a significant increase in built - up land (205.33 %), and agriculture land (22.46 %) while a negative change in area can be seen in vegetation (16.38 %). Negligible change is observed among the LULC classes of sand, open land and water bodies during the period of study.***

Keywords: LULC, remote sensing, Landsat, Arc GIS, change analysis.

1. Introduction

Land is one of the most important natural resources. Land resources are considered as a base for various developmental activities on the earth (Vyas et al., 2017). Currently, land is becoming scarcer as a resource and land resources are clearly under stress as a result of the demands of increasing population and urbanization. Continuous human interactions keep on modifying the land use land cover to fulfil the enhanced demand especially due to significant increase in population and development towards better facilities (Garg et al., 2019). Today, with the growing population pressure, low man - land ratio and increasing land degradation, the need for optimum utilization of land assumes much greater relevance (Manonmani & Suganya, 2010). In order to use land optimally, it is necessary to have information on existing land cover/land use, and the capability to monitor the dynamics of land use resulting out of newer demands of increasing population and changed lifestyles. Some of the areas in which land cover/land use maps are important include preparation of developmental plans both in rural and urban sectors, environmental impact assessment, environmental hazard zonation, utility and infrastructure planning, etc. (Joseph, 2013). The term land cover relates to the type of feature present on the surface of the earth while the term land use relates to the human activity or economic function associated with a specific piece of land (Lillesand et al., 2011).

Land use and land cover change analysis is very essential for better understanding of landscape dynamic. Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement (Rjasekhar et al., 2017). Change detection analyses describes and quantify differences between images of the same scene at different times (Sundarakumar et al., 2012). Remote sensing and GIS technologies help to study and monitor the land use and land cover dynamics. It is a cost - effective approach towards identifying changes in land use and land cover occurring over a given period (Acheampong et al., 2018). In order to detect the LULC change, remotely sensed images are classified through two different approaches of digital classification and visual interpretation. Visual interpretation is the best approach which helps us to avoid generating lots of incorrect classifications (Dadras et al., 2014). Visual Image Interpretation method of classification of remotely sensed data is an effective method of classifying land use and land cover especially when the analyst is familiar with the area being classified (Singh, 2015). Therefore, Onscreen Visual Image Interpretation technique is applied for LULC mapping as the study area is acquainted to the researcher.

2. Materials and Methods

2.1 Study area

The present work is a case study on Pasighat circle of East Siang district of Arunachal Pradesh, India. The geographical extent of the study area is 27°56’ to 28°10’ N latitudes and 95°13’ to 95°26’12” E longitudes covering an area of 316.21 sq. km. Physiographically, Pasighat circle is mostly a plain area while the northernmost part is hilly and mountainous. The study area has a humid subtropical climate with an

average annual temperature of 26.4°C. July and August are the hottest months and December and January are the coldest months. Rainfall occurs mostly throughout the year. However, heavy rainfall occurs during the South - west monsoon season i. e. June to September. The annual rainfall of Pasighat is 2686 mm. An important climatic feature of the study area is heavy wind circulation during winter. The major river of the study area is the Siang, which originates from Chemayungdung glacier in southwestern Tibet, where it is popularly known as the Tsangpo. River Siang merges with Dibang and Lohit rivers in Assam to form Brahmaputra. The mighty Siang also forms the natural boundary of the study area in the northern and western sides.

Pasighat circle consists of 26 villages and a district headquarter, Pasighat which is situated at 155 mtrs above sea level. Pasighat town was established in the year 1911 by the Britishers and thus is the oldest town in the state. It is growing as an important urban centre of Arunachal Pradesh after its twin capital, Itanagar and Naharlagun. The total population of Pasighat circle is 36, 354 with an urban and rural population of 24656 and 11698 respectively (Census of India, 2011). The population density of the study area is 114 which is higher than the population density of its mother district, East Siang i. e.28 persons per sq. km. Pasighat is mostly inhabited by the Adi tribe who belongs to the Sino - Tibetan family of Mongoloid race.

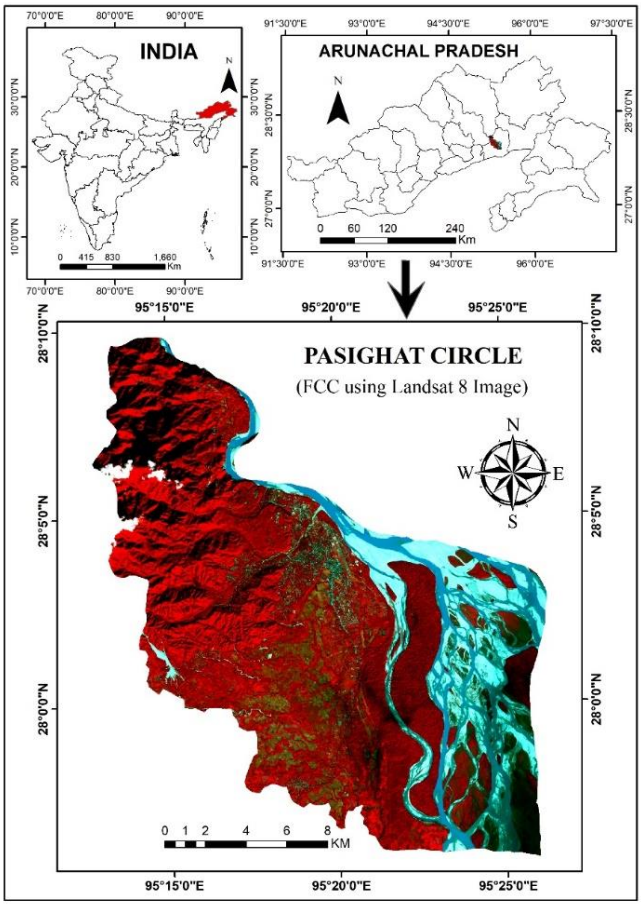

Figure 1: Location Map

2.2 Methodology

The analysis of LULC dynamics of Pasighat circle is done in four main stages, namely, data collection, data pre - processing, image classification and change detection. The flowchart of methodology used for the study is given in Figure 2. Arc GIS 10.8 software is used for data analysis, image classification, thematic maps preparation and area calculations. Graphs and tables are prepared using MS Office 2021 Excel which is also used for LULC change calculations.

2.2.1 Data Collection

The satellite data used in the study consists of the Landsat images of 2001 and 2021 (Table 1). The selection of the satellite data is based on the image quality with cloud cover range of 0 to 10 %. To avoid the effect of seasonal variations, the images of the same month for the years 2001 and 2021 are used. The demographic data is derived from the census of India (2001 and 2011). The climate data has been collected from Water Resource Department, Pasighat and Rural Works Department, Itanagar, Arunachal Pradesh.

Table 1: Details of Satellite data used in the study

Sl. No.	Data Type	Path / Row	Date of acquisition	Spatial resolution	Source
1	Landsat 7 ETM+	135 / 041	1 Dec 2001	30m	USGS Earth Explorer
2	Landsat 8 OLI/TIRS	135 / 041	16 Dec 2021	30m	USGS Earth Explorer

2.2.2 Data Pre - Processing

The different bands of the downloaded satellite data are stacked to get the composite images of 2001 and 2021. Each of the composite images are pan - sharpened by using the panchromatic band to improve the image quality. The map published by the Census of India (2011) is used to delineate

the study area. This base layer is used to extract the study area from the satellite images.

2.2.3 Image Classification

Onscreen Visual Image Interpretation method is used to classify the Landsat images of the study area into different LULC categories. This method of image classification makes use of elements like tone, shape, size, texture, pattern, shadow, site and association to interpret the image. Thus, the LULC maps of 2001 and 2021 is prepared using the image interpretation elements. To maintain accuracy in delineating different classes in the Landsat images, field verification has been carried out using GPS. The main purpose of field survey was to identify sites which were difficult to classify in the images. The identified LULC classes in the study area are agriculture land, built - up land, vegetation, sand, open land and water bodies.

2.2.4 Change Analysis

Post - Classification Comparison is one of the most popular methods in change detection analysis. It provides "from - to" change analysis using classified images of different times. Post - Classification change detection provides thorough and in - depth information on the changes of one land cover type with other land cover types in terms of the location of the change, the extend of the change and the amount of the change (Stemn & Agyapong, 2014). The two classified images of 2001 and 2021 are overlaid to generate the LULC change map.

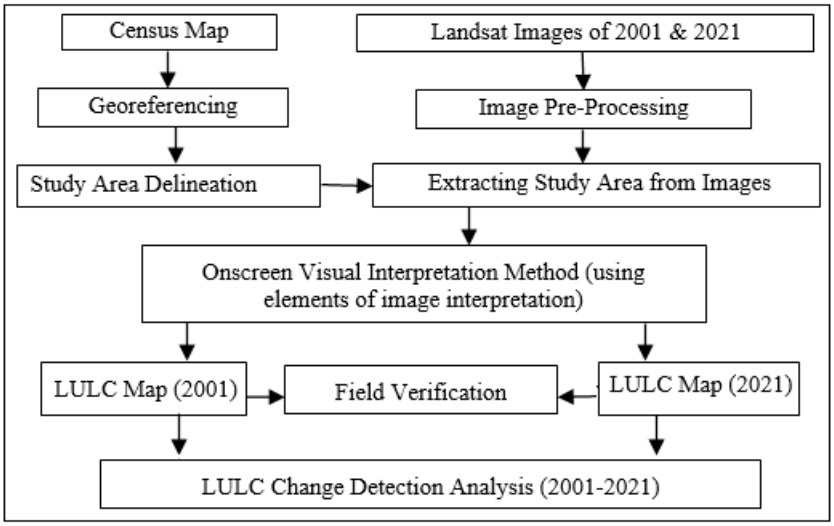

Figure 2: Methodology Flowchart

3. Results and Discussion

The study area has been classified into six land use land cover categories, i. e. agriculture land, built - up land vegetation, sand, open land and water bodies. The LULC maps and the changes from 2001 to 2021 has been diagrammetrically illustrated in figures 3, 4 and 6.

The statistical results of change detection is given in table 2. The results show that the areal coverage of vegetation has drastically change from 55.31% to 46.25% of the total area. It represents a decrease of 28.65 sq km from 2001 to 2021. This decrease in vegetation cover is mainly because of population growth resulting into increase in built - up and agricultural activities. The decadal population growth of the study area from 2001 to 2011 is 15 percent (Census of India, 2011). Consequently, agricultural land increases from 56.81 sq km in 2001 to 69.57 sq km in 2021. Thus, it has a net increase of 12.76 sq km. Similarly, built - up land ocupied 6.19 sq km in 2001 and 18.9 sq km in 2021 representing an increase of 205.33% during the study period. Thus, the built - up class exhibits the most rapid positive change among all the LULC categories. Table 2 also reveals that Open land accounts for 7.88 sq km in 2001 and 11.47 sq km in 2021. Least transformation is of sand and water bodies which accounts for only 0.29 sq km and 0.12 sq km decrease in area from 2001 to 2021 respectively.

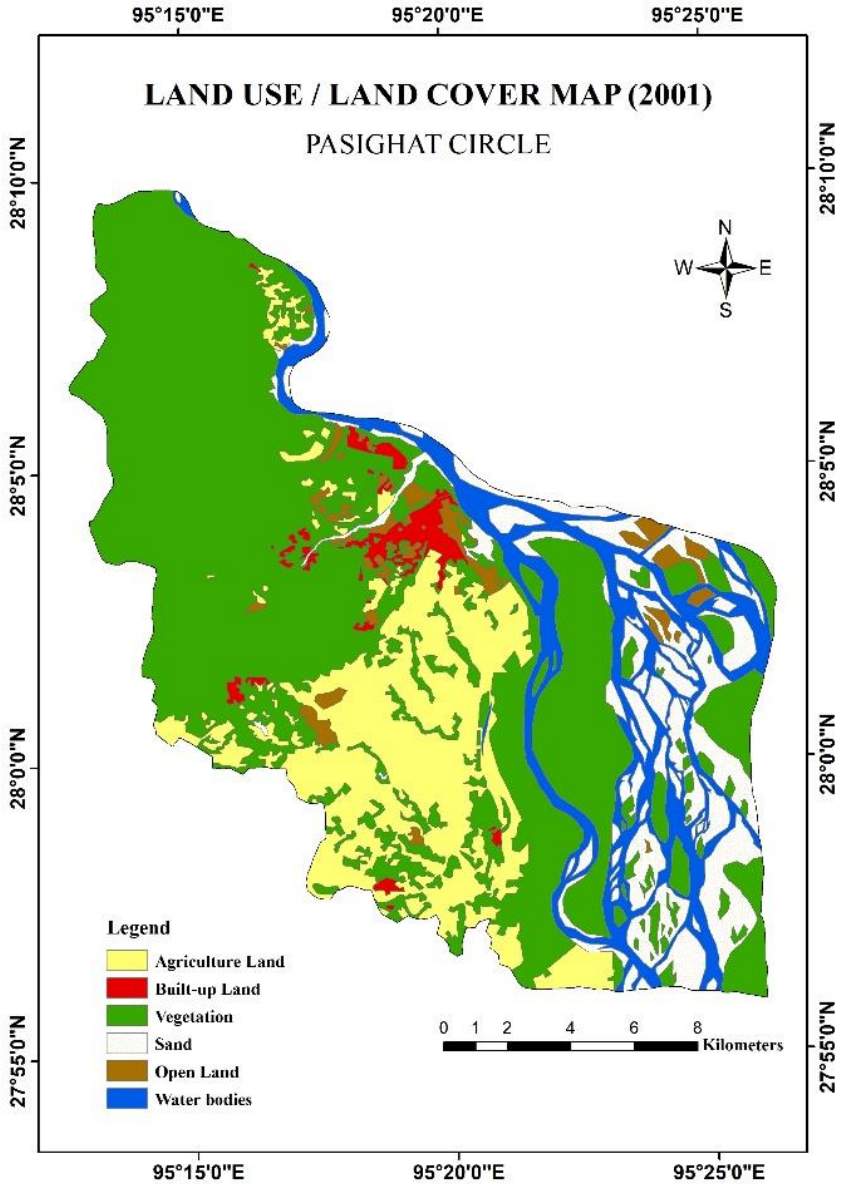

Figure 3: LULC map of 2001

Table 2: Area coverage for various LULC classes and LULC change statistics

Sl No.	LULC Class	2001		2021		Area change (2001 - 2021)	
		Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area change (Km^2)	Area change (%)
1	Agriculture Land	56.81	17.97	69.57	22.00	12.76	22.46
2	Built - up Land	6.19	1.96	18.90	5.98	12.71	205.33
3	Vegetation	174.89	55.31	146.24	46.25	- 28.65	- 16.38
4	Sand	35.81	11.32	35.52	11.23	- 0.29	- 0.81
5	Open Land	7.88	2.49	11.47	3.63	3.59	0.46
6	Water bodies	34.63	10.95	34.51	10.91	- 0.12	- 0.35
Total		**316.21**	**100.00**	**316.21**	**100.00**		

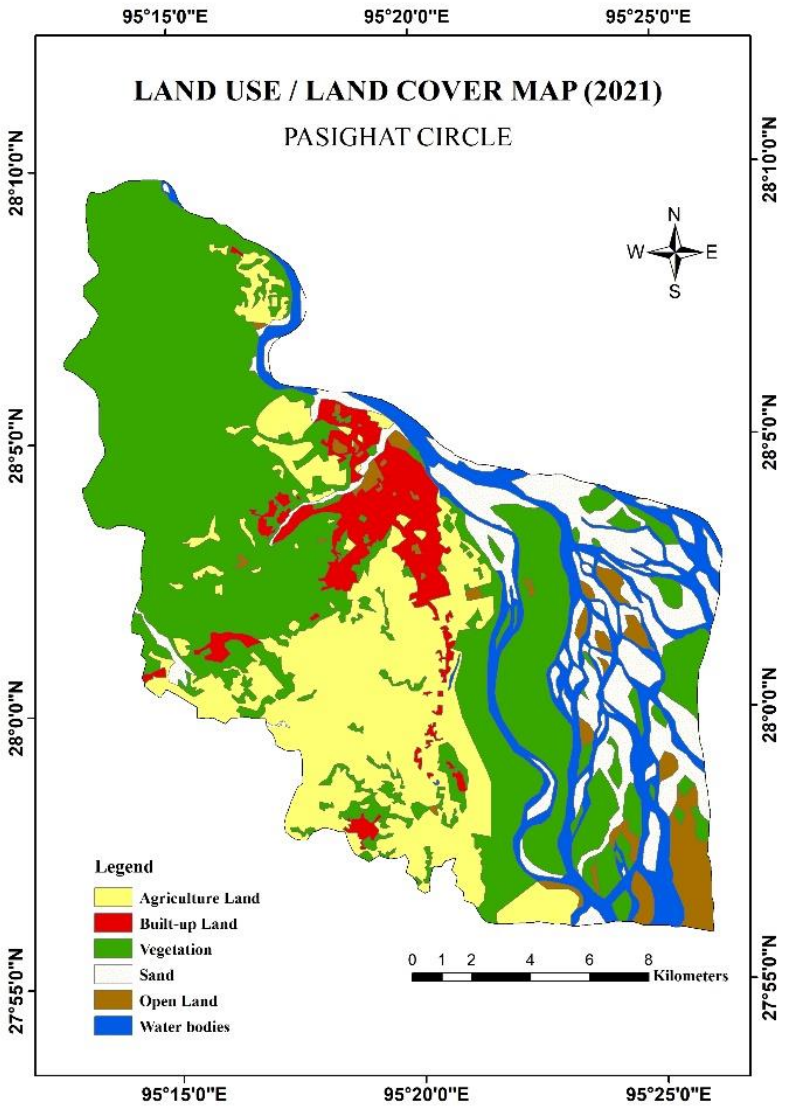

Figure 4: LULC map of 2021

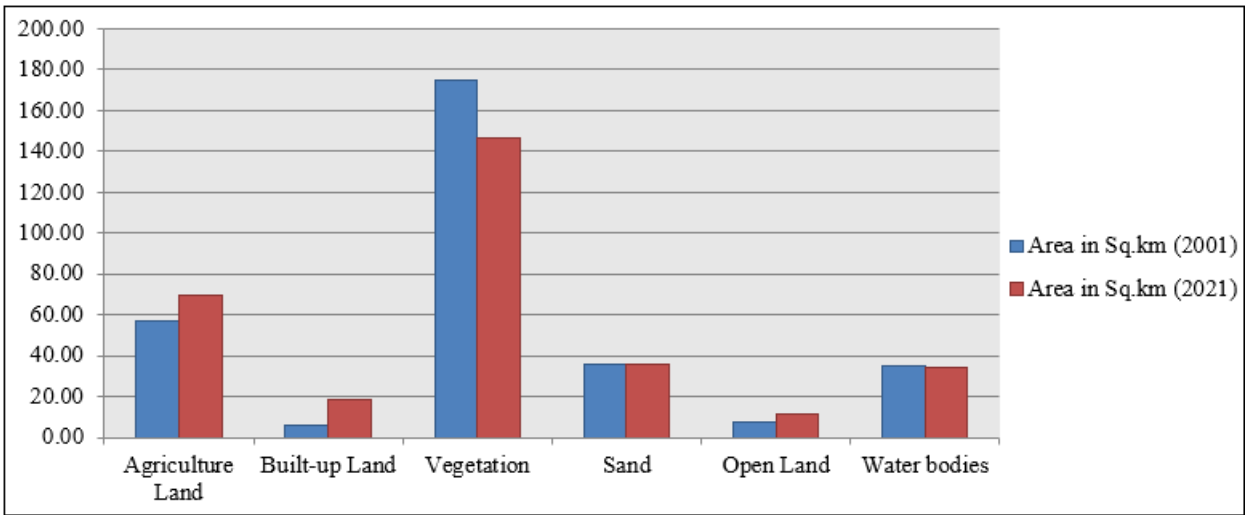

Figure 5: Graphical representation of LULC classes

The most important aspect of change detection analysis is to identify which class has been transformed to the other. Table 3 reveals the LULC change matrix from 2001 to 2021. As expected, the areal coverage of vegetation changed to agriculture land is quite apparent i. e., 17.23 sq. km. This is attributed to increasing population of Pasighat circle wherein agriculture is still one of the most important economic activities. Water bodies changed to sand and vice - versa during the study period accounts for 14.15 sq. km. and 10.03 sq. km. respectively. The factors responsible for these

changes are the braiding nature and constantly shifting course of river Siang resulting into large number of sand bars and water channels. The study shows that among all the LULC classes, most of the changes in terms of transformation of one class to another occurred in vegetation while built - up class exhibits the least transformation to any other LULC class.

The change detection analysis reveals that increasing population of Pasighat has resulted into expansion of built - up areas. Vegetation, agricultural land and open land are mostly converted into built - up areas. The LULC change matrix (table 3) shows that 6.76 sq. km of vegetation, 3.88 sq. km of agricultural land, and 2.12 sq. km of open land have been transformed into built - up areas during the last 20 years. Pasighat, being an important urban centre of the state has good transportation and communication system, better facilities of health and education, employment opportunities, recreational activities, etc. These factors along with natural increase, push from subsistence agriculture and pull of relative higher urban wages, attracts people from nearby rural areas towards the study area.

Table 3: LULC Change Matrix (2001 - 2021)

LULC Categories		Land use / Land cover 2021 (sq km)						Row Total (2001)
		Agriculture Land	Built - up Land	Vegetation	Sand	Open Land	Water bodies	
Land use / Land cover 2001 (sq km)	Agriculture Land	49.83	3.88	2.4	0.23	0.44	0.03	**56.81**
	Built - up Land	0.03	5.98	0.13	0.01	0.04	0	**6.19**
	Vegetation	17.23	6.76	136.52	5.13	4.21	5.04	**174.89**
	Sand	0.43	0.14	4.36	15.32	5.53	10.03	**35.81**
	Open Land	1.97	2.12	1.84	0.68	0.76	0.51	**7.88**
	Water bodies	0.08	0.02	0.99	14.15	0.49	18.9	**34.63**
Column Total (2021)		**69.57**	**18.9**	**146.24**	**35.52**	**11.47**	**34.51**	**316.21**

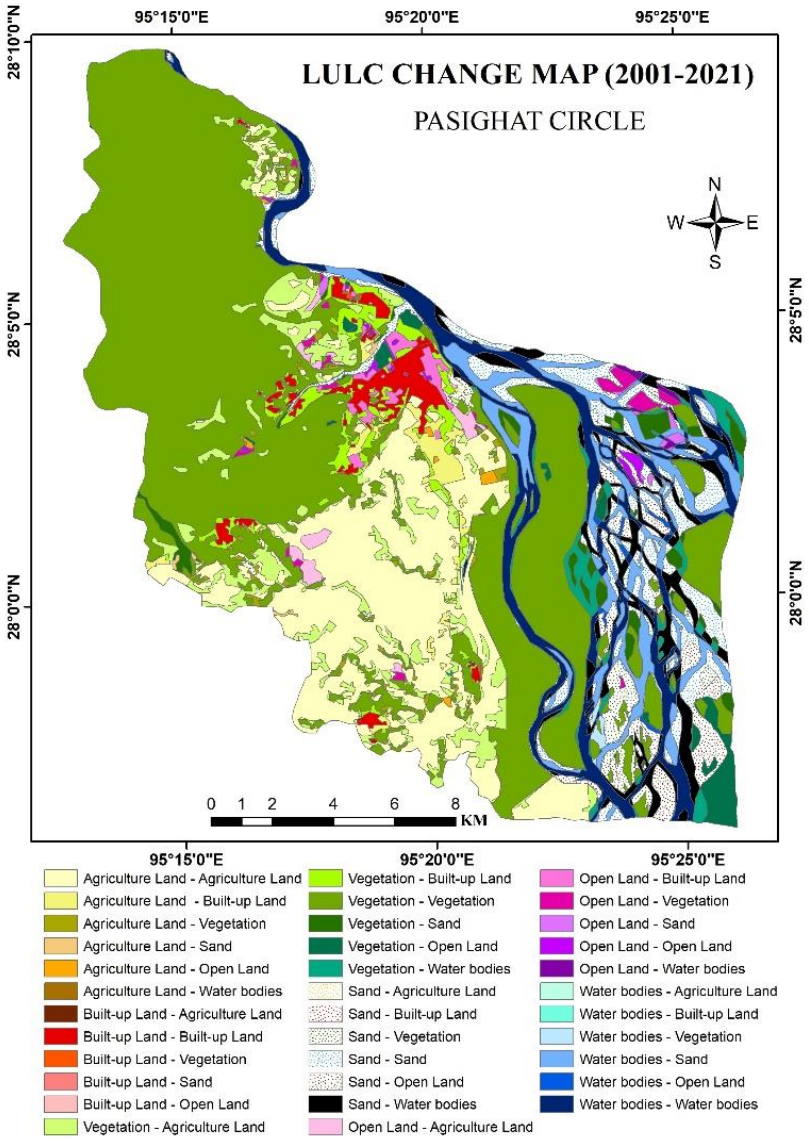

Figure 6: LULC change map (2001 - 2021)

4. Conclusion

The study proves that remote sensing and GIS technology is the most efficient and effective method of analysing land use/land cover changes within a short temporal period. The present work on change analysis shows how the landscape of Pasighat circle is changing. The study reveals that there is an increase in the areal coverage of built - up and agriculture land from 2001 to 2021. A significant negative change in areal coverage can be seen among LULC class of vegetation. The vegetation has been converted into built - up and agricultural lands by the increasing population of the study area. The braiding nature of river Siang also plays an important role in the transformation of one class to another, particularly of water bodies to sand and vice - versa. The paper also hints at anthropogenic activities leading to the change in land use and land cover. Thus, the study is helpful in analyzing the changes in LULC categories of Pasighat Circle from 2001 to 2021. Furthermore, this work will help the town authorities and planners to develop proper plans for effective utilization of land while maintaining environmental sustainability.

References

[1] Acheampong, M., Yu, Q., Enomah, L. D., Anchang, J. & Eduful, M. (2018). Land use/cover change in Ghana's oil city: Assessing the impact of neoliberal economic policies and implications for sustainable development goal number one – A remote sensing and GIS approach. *Land Use Policy*, *73*, 373 - 384. https: //doi. org/10.1016/j. landusepol.2018.02.019

[2] Dadras, M., Shafri, H. Z. M., Ahmad, N., Pradhan, B., & Safarpour, S. (2014). Land use/cover change detection and urban sprawl analysis in Bandar Abbas city, Iran. The Scientific World Journal. https: //doi. org/10.1155/2014/690872

[3] Garg, V., Nikam, B. R., Thakur, P. K., Aggarwal, S. P., Gupta, P. K. & Srivastav, S. K. (2019). Human - induced land use land cover change and its impact on hydrology. *HydroResearch*, *1*, 48 - 56. https: //doi. org/10.1016/j. hydres.2019.06.001

[4] Joseph, G. (2013). *Fundamentals of Remote Sensing*. Universities Press (India) Private Limited.

[5] Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. (2011). *Remote sensing and image interpretation* (5th ed.). Wiley India Pvt. Ltd.

[6] Manonmani, R., & Suganya, M. D. (2010). Remote sensing and GIS application in change detection study in urban zone using multi temporal satellite. *International Journal of Geomatics and Geosciences*, *1* (1), 60 - 65.

[7] Rjasekhar, M., Raju, G. S., Raju, R. S., & Basha, U. I. (2017). Landuse and landcover analysis using remote sensing and GIS: A case study in Uravakonda, Anantapur district, Andhra Pradesh, India. *International Research Journal of Engineering and Technology*, *4* (9), 780 - 784.

[8] Singh, K. R. (2015). *Mapping and Quantitative Assessment of Vegetation of Jiribam Sub - Division, Imphal East District, Manipur, India using Remote Sensing and GIS (*Unpublished doctoral dissertation). Assam University, Silchar, Assam.

[9] Stemn, E. & Agyapong, E. (2014). Assessment of urban expansion in the Sekondi - Takoradi metropolis of Ghana using remote - sensing and GIS approach. *International Journal of Science and Technology*, *3* (8), 452 - 460.

[10] Sundarakumar, K., Harika, M., Begum, S. K. A., Yamini, S., & Balakrishna, K. (2012). Land use and land cover change detection and urban sprawl analysis of Vijayawada city using multitemporal Landsat data. *International Journal of Engineering Science and Technology*, *4* (1), 170 - 178.

[11] Vyas, P. R., Vaishnav, A. K., & Sharma, J. P. (2017). Land use/Land cover analysis of Teetriya gram panchayat using GIS and remote sensing techniques. In P. R, Vyas (Ed.). *Remote sensing and geographical information systems: Basics and applications (*pp.214 - 225). Rawat Publications.