Change Detection Study Using Remote Sensing Technique, Pune District, Maharashtra, India.

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***Abstract*—The environment and resources are greatly impacted by rapid urbanization and changes in land use land cover. Multi-spatial and multi-temporal remote sensing data are now more readily available and of higher quality, making it feasible to quickly and economically identify changes in LULC. This study aims to quantify changes in LULC area of Pune District of Maharashtra state located in India, using Resourcesat-2, LISS-III and Sentinel 2A Images. Using ERDAS 2014 software, LULC changes were identified in sentinel 2A satellite images from December 2024 and Resourcesat-2 satellite images from December 2010.The built-up area has grown 10.8 times during the past 14 years as a result of industrial development, population growth and permanent migration was the main driving forces for built up area expansion. In the same way, the percentage of barren land decreases from 34.95% in 2010 to 20.57% in 2024.**

***Index Terms*—Built up, Change detection, ERDAS, Pune district, Remote sensing.**

I. INTRODUCTION

Timely and accurate change detection of Earth's surface features is extremely important for understanding relationships and interactions between human and natural phenomena in order to promote better decision-making Lu et al. (2004). Economic, cultural, political, historical, and land-tenure considerations all have an impact on land use at different scales Tamilenthi and Baskaran (2013). Land use referred to as man's activities and the various uses which are carried on land. When there is a lot of land pressure, low agricultural incomes, and unsustainable population growth as is the case in the majority of the world's developing nations urbanization is unavoidable. Urbanization is, in a sense, beneficial to human progress Chakor et al. (2024). However, a lot of the issues that our cities face today are caused by unchecked urbanization, which has led to poor living conditions, serious issues with drinking water, noise and air pollution, garbage disposal, traffic congestion, etc. To improve these environmental degradations in and around the cities, the technological development in relevant fields have to solved these problems caused by rapid urbanization, only then the fruits of development will reach most of the deprived ones Mishra et al. (2017).

Planning efforts are significantly impacted by recent technical advancements in the field of spatial technology. For a nation like India, which has diverse geographic patterns, cultural activities, etc., this area of planning is crucial. The goal of GIS is to visually represent the intricate patterns and linkages that define actual planning and policy issues by adding a new dimension to data analysis through maps Afaq and Manocha (2021). Monitoring social indicators requires the use of change analysis, which is supported by the visualization of spatial patterns. As a result, need assessment ought to Improve.

Change detection is the measure of the distinct data framework and thematic change information that can guide to more tangible insights into underlying process involving land cover and land use changes than the information obtained from continuous change Ramchandra and Kumar (2004). The four components of change detection that remote sensing generally takes into account are (a) detecting changes, (b) determining their type, (c) measuring the aerial extent of changes, and (d) evaluating the spatial pattern of changes, according to Macleod and Congalton (1998).

The objectives of this paper are to explain remote sensing applications in various stages of planning, implementation and monitoring of the urban area.

Overview of change detection studies

The most important activity used in surveying and change detection is remote sensing Saber et al. (2021). To track changes in land use and land cover, a range of change detection methods are available. According to Nelson (1998), these methods can be divided into two primary groups: enhancement change detection methods and post classification comparison methods.

Post classification techniques

In the post classification technique, spectral classifications for the same area at two different times are independently produced and then compared (Mas, 1999). The benefit of post-classification techniques is that they offer direct insight into the types of changes in land cover. The classification process used with these techniques can be either supervised or unsupervised. Using a post classification technique in a semi-arid setting, Sohl (1999) demonstrated 96 percent accuracy for identifying new forest land and 62 percent accuracy for identifying new agricultural land. Additionally, Sohl (1999) emphasized the method's ability to give consumers a thorough descriptive comparison of images. Pilon et al. (1988) employed post classification in combination with a simple enhancement technique to differentiate areas of human induced change from areas of natural change. Mas (1999) also obtained the highest accuracy with this technique in a study comparing six different techniques.

Enhancement changes detection techniques

In enhancement approaches, photos from several dates are mathematically combined to create a composite image that exhibits changes in distinguishable hues (Pilon et al. 1988). One benefit of using enhanced change detection approaches is that they are typically more accurate at detecting regions of spectral change (Singh, 1989). However, these techniques often require additional analysis to characterize the nature of the spectral change, and also require more accurate image normalization and co-registration.

II. STUDY AREA

Pune is important district of Maharashtra state in India with an area of 15643 Km2 (Fig.1). It is surrounded by Thane district on the northwest, Raigad district on the west, Satara district on the south, Solapur district on the southeast, and Ahilyanagar district on the north and northeast. Pune is 559 meters (1,863 ft) above sea level. The district lies between latitudes 17.5° and 19.2° north and longitudes 73.2° and 75.1° east. The majority of the 600–700 millimeters of rainfall that occurs on average occurs during the monsoon season, which runs from July to October. The area adjacent to the Western Ghats gets more rain than areas further east. The district experiences hot, tropical temperatures between 20°C and 38.9°C. Clayey loams make up the majority of the soils in the Pune district. It also includes clayey, shallow, well-drained soils and calcareous, deep, and moderately well-drained soils. Fig. 1 displays the research area's index map.

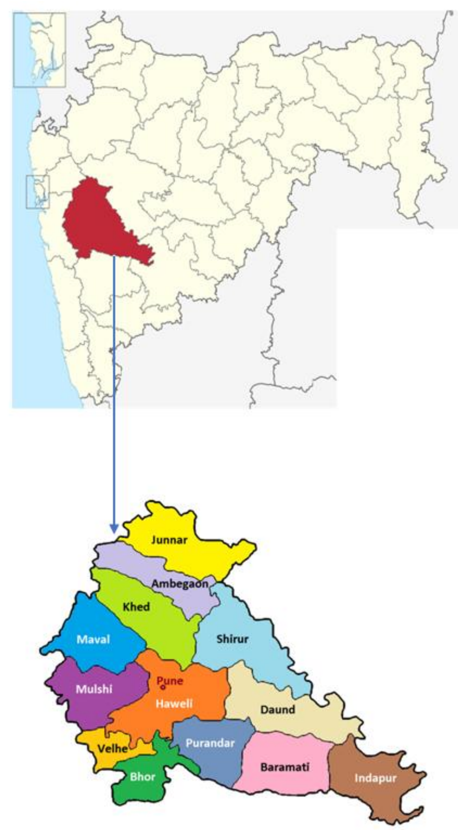

Fig1. Index map of study area.

III. MATERIALS AND METHODS

Survey of India Toposheet of scale 1:50,000 has been used to demarcate the district boundary. The flow chart of methodology adopted for this study is highlighted below in Fig. 2. For the purpose of evaluating the temporal changes in the Land Use Land Cover Resource sat-II, LISS-III images of resolution 23.5m x 23.5m from NRSC were used for December 2010; similarly, Sentinel 2A satellite images of resolution 10m x 10m from European were used for December 2024.

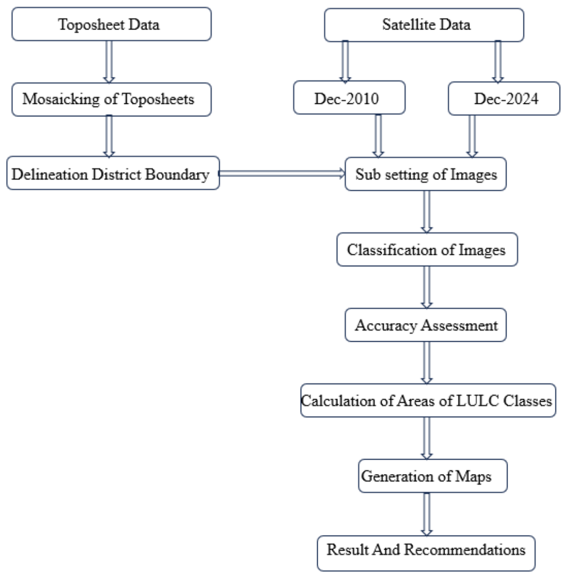

Fig 2. Methodological flow chart

The Land Use Land Cover in the study area, during 2010 and 2024 were derived from the Satellite images were compared with one another. This information was used for carrying out change detection studies for the period 2010 and 2024.

The ERDAS IMAGINE SOFTWAR 2014 was used to prepare the LULC changes during 2010-2024. The necessary accuracy assessment was carried out and correction were made at required places.

IV. RESULT AND DISCUSSION

The LULC classes of the research region are prepared using a subset of the obtained images from 2010 and 2024. Fig. 3 displays the 2010 and 2024 subset images.

Both the 2010 and 2024 images underwent supervised categorization for the classification-based method. The ability to generate an equal number of classes for every collection of image is the primary benefit of employing supervised categorization.

After that, a map of all class transitions was created by combining the classifications using ERDAS Imagine 2014 software. The final output image was then created by assigning colors to the transitions according to the kind of change that was taking place.

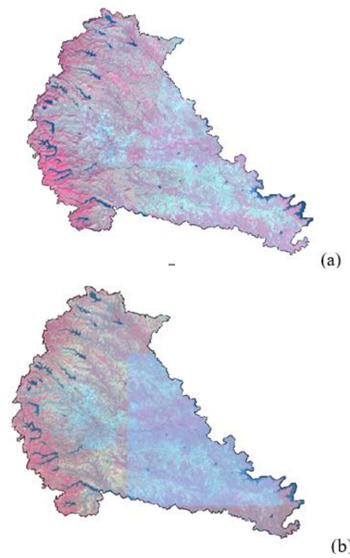

Fig 3. Subset Image of Study Area a) Dec-2010, b) Dec-2024

The spatial changes in land use and cover between 2010 and 2024 are depicted in the maps with clarity (Fig. 4).

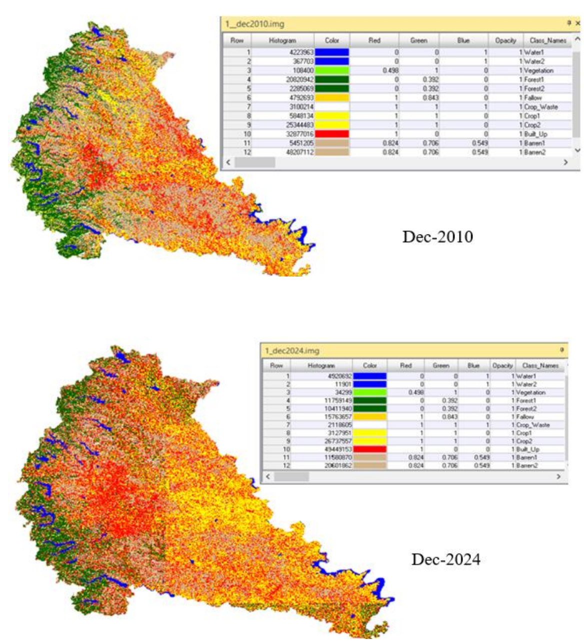

Fig. 4. LULC analysis for 2010 and 2024 data.

Table1.Showing spatial changes.

Sr. No	LULC Classes	Area (2010) Sq.km	Area (2024) Sq.km	Changes in area (Sq.km) *	Changes in %
1	Water	467.8496	493.2591	+25.4095	+0.16
2	Vegetation	11.0450	3.4299	-7.6151	-0.05
3	Forest	2354.2980	2217.1000	-137.1980	-0.88
4	Fallow	488.3320	1576.3700	+1088.0380	+6.96
5	Crop Waste	315.8840	211.8600	-104.0240	-0.67
6	Crop	3178.2420	2986.5550	-191.6870	-1,23
7	Built Up	3359.0504	4935.1460	+1576.0956	+10.08
8	Barren	5467.2990	3218.2800	-2249.0190	-14.38

(*+ is Increase of area, - is Degrease of area)

V. CONCLUSION

1. Urbanization is increasing rapidly (built-up land +10.08%) at the cost of barren land (-14.38%) and agricultural land (-1.23%).
2. Deforestation is occurring (forest -0.88%), although at a relatively lower rate.
3. More agricultural land is left fallow (fallow land +6.96%), which could be due to land degradation or changing farming patterns.
4. Water bodies have slightly increased (+0.16%), which could be due to better water management practices.
5. Reduction in crop waste (-0.67%) suggests improved agricultural efficiency.
6. The major transformation over the 14-year period is the expansion of urban areas and a decline in barren land and agricultural land. While some positive trends exist, such as better water management and reduced crop waste, deforestation and declining vegetation remain concerns.
7. These insights are useful for urban planners, environmentalists, and policymakers to ensure sustainable land use planning and conservation efforts.

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