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Polymer Composite Mapping: Analyzing Land Use/Land Cover Changes in Mathura District, Uttar Pradesh, India

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Abstract

Polymer-based mapping approaches are utilized in this study to improve the accuracy and consistency of LULC classification. Utilizing the special qualities of polymers like their elasticity, robustness, and adaptability, we create a strong framework for mapping LULC dynamics. Over the past few years, the district of Mathura in the state of Uttar Pradesh has experienced substantial expansion and development. This study assessed the change detection and estimated the shift in land-use/cover for the duration of 2013–2023. Five main classifications have been identified from the land-use/land cover data obtained from satellite image: (i) Built-up; (ii) Fallow; (iii) Agriculture; (iv) Water Bodies; and (v) Forest. The use of the Landsat sensors from 2013 and 2023 with a Geoinformatics methodology aided the investigation. Observations of land-use and spread revealed that changes in the land under different classes over a ten-year period were more notable in degree. The rise of built-up and barren land is the most striking change. Along with this decrease in the amount of land used for agriculture, water bodies, and forests. The findings show a significant shift in the areas covered by different land use classifications between 2013 and 2023. From 14.86 percent in 2013 to 23.04 percent in 2023, the built-up area grew. Between 2013 and 2023, the extent of fallow land rose from 296.96% to 42.96%. From roughly 50.09% of the total area in 2013 to 31.66% in 2023, there was less agricultural land. Between 2013 and 2023, the percentage of water bodies fell from 2.53% to 0.56%. Additionally, the forest area shrank from 2.84 percent in 2013 to 1.77 percent in 2023. The anthropogenic activities of urban expansion have resulted in significant problems for water bodies, forests, and agricultural land.

Keywords: Polymer coating, environmental monitoring, remote sensing, change detection, landsat sensor, land use/cover and GIS

INTRODUCTION

The development of materials utilized in remote sensing devices is greatly aided by polymer chemistry work (1). For example, polymer-based components are frequently used in sensors and imaging systems installed on satellites or drones due to their optical qualities, endurance, and light weight (2). These materials help capture data related to land cover changes over time. In Geoinformatics, sensors are employed for various purposes such as monitoring vegetation, urban sprawl, or deforestation. Polymer coatings can be applied to these sensors to enhance their performance and longevity, allowing for more accurate and sustained data collection in diverse environmental conditions. Large volumes of data are produced by Geoinformatics, including GIS data, satellite photography, and different spatial datasets (3). Polymer chemistry plays a role in the creation of robust and high-capacity storage materials that are utilized to preserve this data (4). Polymers are also necessary for the production of microchips and other hardware that is needed for data processing and analysis. The creation of materials for environmental monitoring and assessment involves polymer chemistry. Polymers are utilized, for example, in the production of instruments for soil analysis, air pollution monitoring systems, and water quality sensors.

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These technologies aid in evaluating the environmental effects of changes in land use. Through the integration of principles from Geoinformatics and polymer chemistry, scientists can create novel approaches for tracking changes in land use, evaluating the effects these changes have on the environment, and putting sustainable land management methods into action. This multidisciplinary strategy is essential for tackling the intricate problems related to land use dynamics in a society that is becoming more urbanized and ecologically conscious.

These days, the territory's shifting patterns of land usage, land dispersion, and development of settlement call for a more sophisticated framework(5). Examples of such frameworks include remote sensing and GIS, which provide a more comprehensive and condensed inclusion of large areas than aerial photography(6). In order to anticipate potential changes in this status in the upcoming years, an attempt will be made throughout this assessment to lay out the current state of land use in the Mathura district, taking into account the rate of land use and any changes that have occurred in this status, especially in the urbanized land. For the planning, selection, and execution of land usage, knowledge about land use and land distribution, as well as potential outcomes for their optimal use, is crucial(7).The new instruments for monitoring changes in land use include remote sensing and GIS approaches(8). Due to the rapidly growing administrative segment, the Mathura district in Uttar Pradesh, which is also a part of the National Capital Region, has expanded national attestation throughout the last several years. This is one of the main reasons that Mathura was selected for this contextual study. The goal of this research is to create a spatial data of land usage and distribution for the years 2013 through 2023.

STUDY AREA

The study's primary focal area is the Uttar Pradesh state's Mathura district. Delhi is around 162 miles away, and it is located at 27.28°N 77.41°E. It is 174 meters above sea level on average (see figure 1). The district's 3376 sq. km. total size makes up 4% of the state's overall area. The Yamuna River runs along the shores of the Mathura District.

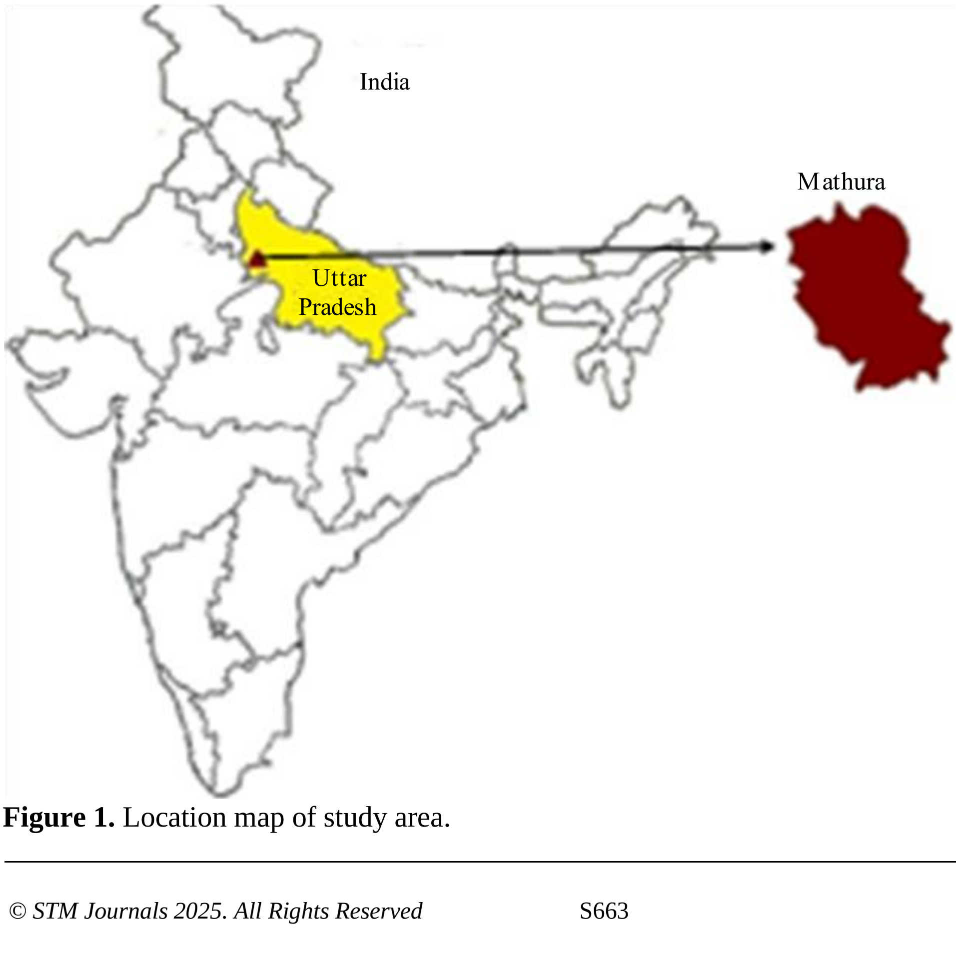

Figure 1. Location map of study area.

MATERIALS AND METHODOLOGY

Landsat sensors were used to map the examination territory and determine land use/spread order for the years 2013 and 2023.The USGS Earth Explorer provided the satellite data that covered the study area. The Supervised Image Classification technique was used to create the land usage/land cover classifications from the various satellite pictures(9). A field tour was conducted in order to verify GPS ground truth data, update the land usage/land cover status that was seen on the field visit, and carefully check the interpretation of a chosen group of images. Land use change statistics were created in order to determine how the study area's land cover and land use changed between 2013 & 2023. For the specified period, the percentage change was also ascertained.

RESULTS AND DISCUSSION

The classification of land use and land cover (LULC) was performed using satellite imagery data. The study area was analyzed using supervised image classification. An area's general land use gives insight into how its natural or cultural resources are used overall(10). This research evaluates the variations in the land cover/land use of the Mathura region by comparing the discrepancies between Figures 2 and 3 during a ten-year period (2013–2023). Table 1 shows the findings of the current investigation. From 14.86 percent in 2013 to 23.04 percent in 2023, the built-up area grew. Between 2013 and 2023, the extent of fallow land rose from 296.96% to 42.96%. From roughly 50.09% of the total area in 2013 to 31.66% in 2023, there was less agricultural land. Between 2013 and 2023, the percentage of water bodies fell from 2.53% to 0.56%. Additionally, the forest area has shrunk from 2.84 percent in 2013 to 0.56% in 2023. The class of built-up and fallow land is growing, and this leads to the conclusion that the population's weight is doing a very active job of decreasing the spread of agriculture. Therefore, it is essential to carefully review any variations in land use/land cover to maintain a practical area for real progress.

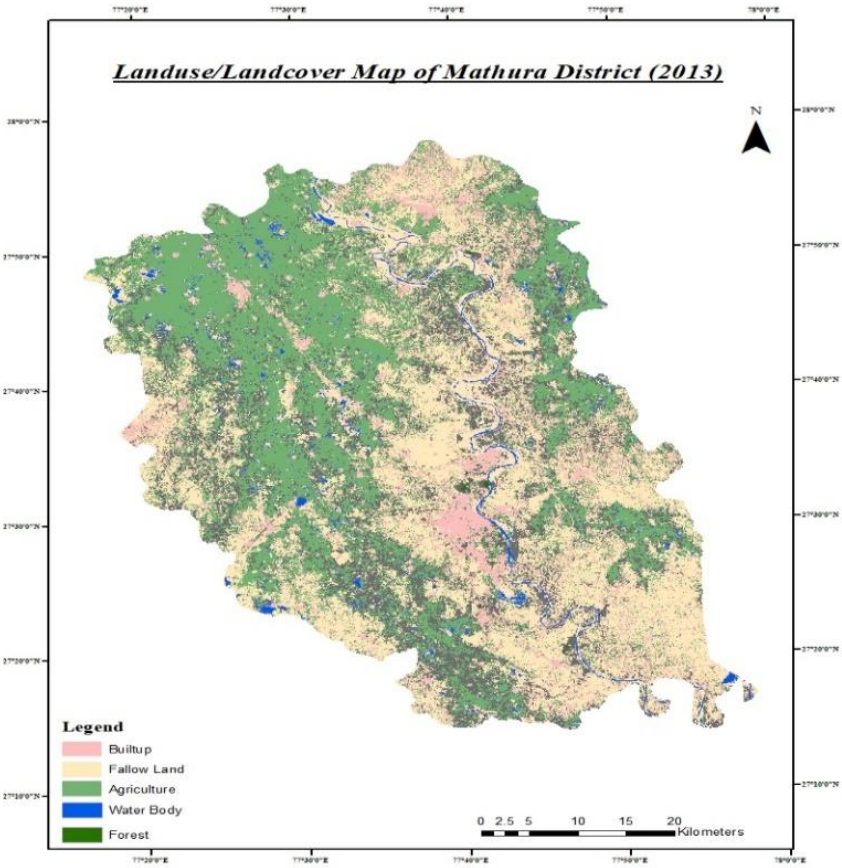

Figure 2. Map of land use / land cover (2013).

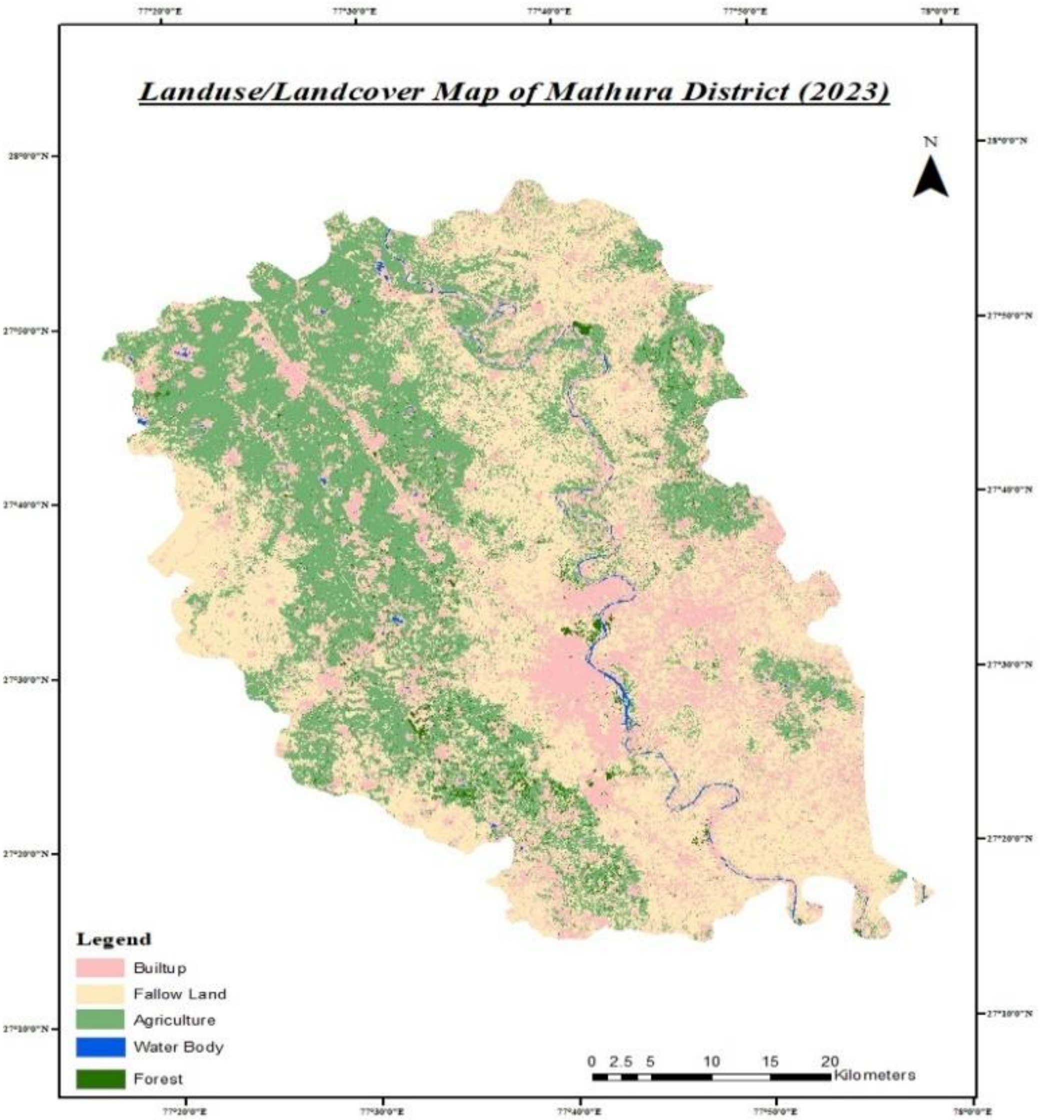

Figure 3. Map of land use / land cover (2023).

Table 1. Analysis of changes in Land use / Land cover, 2013- 2023.

Land use/Land cover Class	Area (sq.km) 2013	% Area (sq.km) 2013	Area (sq.km) 2023	% Area (sq.km) 2023	Change Rate (2013-2023) in Sq.km
Built-up	501.7	14.86	778.07	23.04	276.37
Fallow	1002.62	29.69	1450.7	42.96	448.08
Agriculture	1691.22	50.09	1069.16	31.66	-622.06
Water Bodies	85.34	2.53	18.92	0.56	-66.42
Forest	95.76	2.84	59.79	1.77	-35.97
Total	3376.64	100	3376.64	100	

CONCLUSION

Using Geoinformatics to detect changes in land use and cover (LULC) has shown to be a very useful tool for resource management, urban planning, and environmental monitoring(11). GIS technology and remote sensing data integration make it possible to efficiently gather, analyze, and visualize spatial data over wide geographic areas and long time periods(12). This makes it easier to spot trends, patterns, and abnormalities in land cover and use information that is essential for making well-informed decisions. The evaluation concluded in the Mathura region. Research on altering land usage and land cover patterns has shown that the Mathura district has seen notable changes during the ten-year period from 2013 to 2023. From 501.7 km^2 in 2013 to 778.07 km^2 in 2023, the area of built-up grew. From 1002.62 km^2 in 2013 to 1450.7 km^2 in 2023, the area of fallow land grew. In 2013, the area under cultivation was approximately 1691.22 km^2; by 2023, that number had dropped to 1069.16. From 85.34 km^2 in 2013 to 18.92 km^2 in 2023, the water bodies shrank. Additionally, from 95.76 km^2 in 2013 to 59.79 km^2 in 2023, the forest area shrank. The results of this study demonstrate that the impact of human activity on the region's natural resources has resulted in a notable increase in the area's built-up and fallow land. The increase of neglected land over that time period is the cause of the decline in agricultural land between 2013 and 2023. Additionally, the water bodies have been depleting more quickly, which is extremely concerning. In any event, these patterns need to be carefully examined to see if the condition is manageable going forward. The use of GIS in LULC change detection has several advantages, but there are drawbacks as well. These include the need for accurate and current data, the intricacy of data processing, and the requirement for specific technical knowledge. The usefulness of Geoinformatics in monitoring changes in land use will be further enhanced by addressing these issues through improvements in data sharing frameworks, capacity-building efforts, and remote sensing technological breakthroughs. All things considered, the application of GIS to identify LULC changes is a potent strategy that offers vital information for environmentally friendly development and preservation(13). The possibilities of GIS will grow as technology develops further, providing even more opportunity to comprehend and control the dynamic interaction between human activity and the environment.

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