International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 13, Issue 11 [November. 2024] PP: 89-96

Land Use and Land Cover Mapping of Siwani Region Using Remote Sensing and ARCGIS 10 Software

Dr. Priyanka Redhu
(pursuing Ph.D in Environment science and Engineering)

Abstract
Land use and land cover (LULC) mapping is an essential process in managing natural resources effectively. This research focuses on the use of Remote Sensing and Geographic Information System (GIS) techniques to analyse land use and land cover patterns in the Siwani region of Haryana, India. The study aims to develop LULC maps, geomorphological features, and assess their applications in resource management. Data from Indian Remote Sensing (IRS) satellites, particularly IRS-1D LISS-III imagery, were used in conjunction with GIS to provide detailed spatial analysis. This paper outlines the methodology, software tools, and results that demonstrate the significant contribution of remote sensing and GIS to sustainable land use planning.
Keywords*: Land use, Land cover, Remote Sensing, Geographic Information System (GIS), Siwani region, Resource management.*

Date of Submission: 04-11-2024 Date of acceptance: 16-11-2024

I. Introduction

Land use and land cover (LULC) are two interconnected yet distinct concepts essential for understanding the impact of human activities on terrestrial ecosystems. Land use refers to the various ways in which human activities utilize the land surface, such as agriculture, residential areas, and industrial sites **(Chaudhary et al., 2020).** Conversely, land cover pertains to the physical features present on the surface, such as vegetation, water bodies, and urban structures, regardless of human involvement **(Giri et al., 2018)**. Together, these concepts provide a foundational understanding of how natural landscapes are altered by human intervention and environmental factors.

This research paper delves into the LULC patterns in the Siwani region, utilizing RS and GIS to examine the spatial distribution and temporal changes of land use and land cover. By mapping and analyzing these patterns, this study aims to contribute to effective resource management strategies for the region, addressing challenges posed by land use changes and supporting sustainable environmental practices **(Alonso et al., 2024).** The findings from this study will provide a valuable reference for policymakers and stakeholders involved in regional planning and resource management.

II. Objectives

The primary objectives of this study are:

1. To prepare a detailed land use/land cover and geomorphological map of the study area.
2. To utilise GIS techniques in the mapping process.
3. To understand the applications of the Global Positioning System (GPS) for spatial data collection.

III. Review of Literature

Land use and land cover (LULC) analysis provides vital insights into environmental change and urban development patterns. According to Clawson and Stewart (1965), land use comprises activities and modifications undertaken by humans that are directly associated with the land surface (**Clawson and Stewart.,1965)** . Conversely, Burley (1961) described land cover as the vegetation, water bodies, bare soil, and artificial structures present on the earth's surface, which can be either naturally occurring or man-made. Differentiating between land use and land cover is critical for analyzing human impacts on natural landscapes and understanding the influence of urbanization on ecological systems **(Turner et al., 1993).**

Technological advancements in Geographic Information Systems (GIS) and Remote Sensing (RS) have significantly enhanced the ability to monitor, map, and analyze LULC changes **(Jensen, 2007)**. GIS enables the efficient organization, analysis, and visualization of spatial data, providing a comprehensive understanding of land use patterns over time **(Longley et al., 2015)**. As these tools continue to evolve, they become even more critical in addressing the challenges posed by rapid urbanization and environmental change. This paper employs GIS and

Remote Sensing to analyze LULC in the Siwani region, offering valuable insights that support sustainable land management and urban planning strategies **(Singh et al., 2024).**

IV. Study Area

The study area covers the Hisar block in Hisar district and the Siwani block in Bhiwani district of Haryana, India, extending over 505 square kilometres. The geographical location of the region is between 28°55' N to 29°10' N latitudes and 75°30' E to 75°45' E longitudes. The northern part of the area is relatively flat, while the southern section is characterised by sand dunes and interdunal areas. One of the most widely used data formats for information extraction about the land-use and land-cover is the infrared False Colour Composite (FCC) image. The extraction of information from such images about ground reality is done by image interpretation for which generally three methods namely photo interpretation, spectral analysis and data integration are used.

REMOTE SENSING & GIS.TOPOGRAPHY

In general the topography of the study area is uneven. However, a close examination of the relief reveals that the north part of the study area is almost flat with occasional variations but southern half comprises sand dunes and interdunal sandy area.The nearest meteorological observatory is situated at Hisar. The temperature ranges from 5° C to 45°C. Maximum temperature often touches 45°C by the end of June.

FIGURE-1

V. DATABASE AND METHODOLOGY

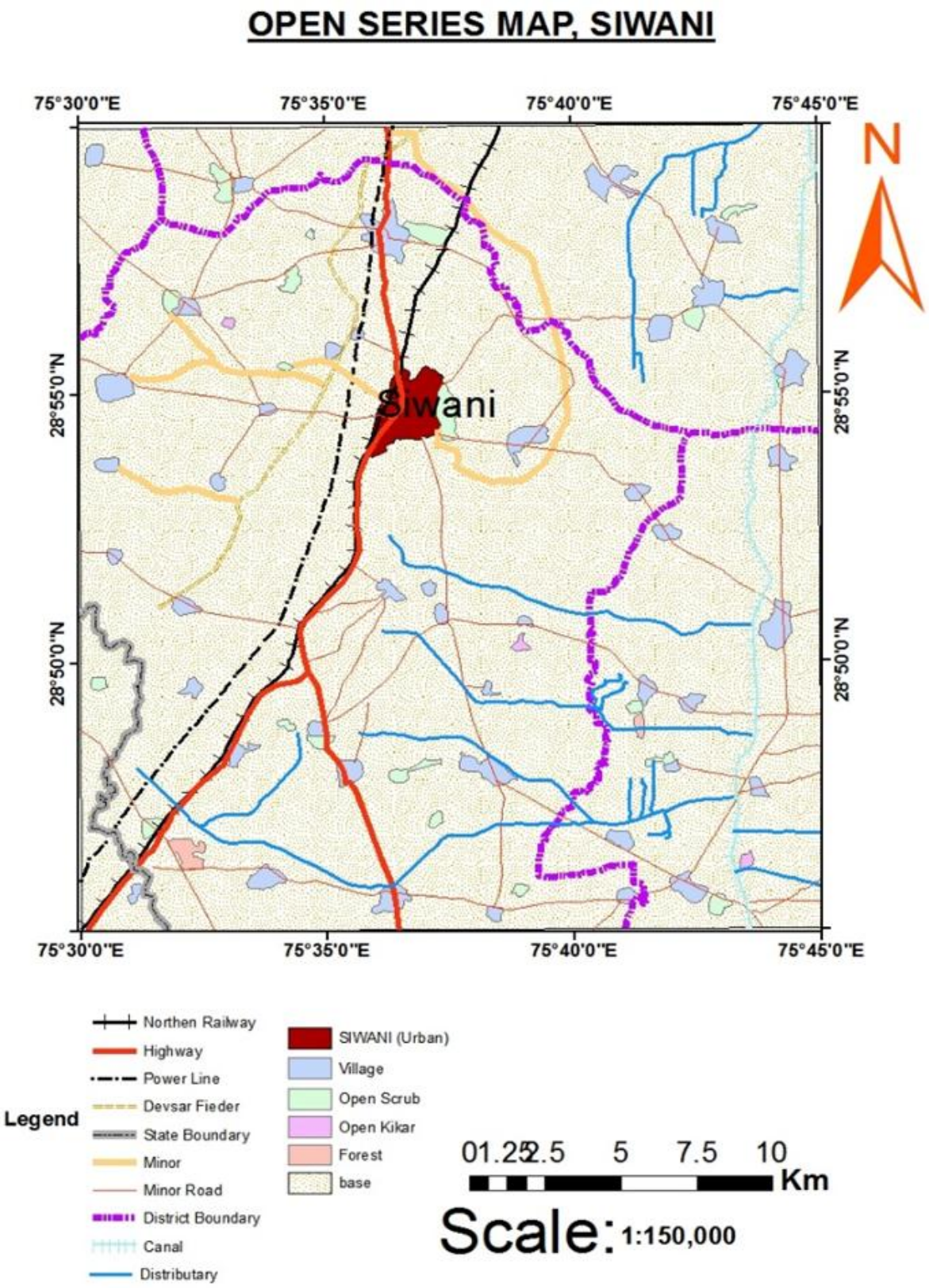
The process of land use/land cover mapping involves the integration of remote sensing data and GIS tools to visually interpret satellite imagery and digitally analyse geographical patterns in the Siwani area. By employing the False Colour Composite (FCC) method and advanced GIS software, the study focuses on land classification and feature delineation.

Software Used

1. **ARC/MAP 10**: This GIS tool allows precise mapping and visual representation of land use patterns. With its versatile functionalities, you can overlay different layers of geographical information and interpret spatial data effectively.
2. **MS Office Suite**: Tools like Word, Excel, and Access play a crucial role in data organisation, statistical computations, report writing, and managing GPS data for accurate fields.

Preparation of Base Map

To transfer the land use details, a base map was prepared on a 1:50,000 scale using survey of India topographic sheets of study area. Information including roads, canals and location of villages were traced on the base map so that alignment problems of tracing with satellite data could not take place. Base map of present study shown in Fig. 4.



Visual Interpretation of Data

Satellite imagery from IRS-1D LISS-III, captured on October 5, 2006, serves as the primary data source. The visual interpretation technique is based on identifying various land features using shape, size, texture, tone, and location characteristics. The interpretation combines both qualitative observations and ground-truth validation to ensure the accuracy of the land use map.

Table-2 Image Interpretation Key for Land Use/Land Cover (LU/LC)

Land use/ Land cover	Tone	Size	Shape	Texture	Association
Settlement					
Build Up land	Bluish Grey	Varying	Definite	Coarse	Streets
Agricultural Land					
Cropland	Red/Greenish	Varying	Rectangular	Fine to Medium Coarse	Outskirts of Settlement
Fallow Land	Yellowish White to Reddish White	Varying	Rectangular	Medium to Fine Coarse	Outskirts of Settlement
Plantations	Dark Red	Varying	Irregular	Coarse with Mottling	Agricultural Land
Wastelands					
Scrubland	Dull Red / Brown / Greenish	Varying	Irregular	Coarse	Foothills, Rocky Slopes
Brick Kilns	Light Green	Varying	Regular	Coarse	Wasteland
Degraded Grazing Land	Dull Red / Brown	Varying	Irregular	Coarse to Mottled	Village Peripheries
Waterlogged	Black	Varying	Irregular	Coarse	Agricultural Land

Digital Data Analysis

Using ERDAS and ArcMap, the digital image analysis processes individual pixels (or DN values) to classify land features. These pixels correspond to the level of electromagnetic energy reflected from the earth's surface, which helps in delineating distinct land cover types.

Geo-referencing and Mosaicing

The geo-referencing process ensures that satellite imagery aligns with the standard geographical coordinates, while mosaicing helps combine overlapping satellite images to create a complete map of the study area. Geo-referencing includes two types: image-to-image registration and image-to-map rectification, both involving careful adjustments based on Ground Control Points (GCPs).

Ground Truthing and Data Collection

Field verification of the interpreted data was conducted using GPS technology, validating uncertain areas. Ground-truthing ensures that the land cover classification aligns with real-world observations, especially in complex or ambiguous regions.

Map Composition

Once the data was verified, the maps were created in ArcMap and then exported into a more accessible format (JPEG) for final reporting.

Table 3. Details of Ground control points

Sr No.	**Name**	**Location in degree**	**Ellipsoidal elevation**
1	**Canal crossing on NH 65 Chaudharywas**	28˚59’293’’N 75˚36’142’’E	242 Metres
2	**Barwa Village**	28˚57’900’’N 75˚35’981’’E	243 Metres
3	**Railway Road Crossing near Siwani**	28˚55’033’’N 75˚36’295’’E	244 Metres
4	**Sand Dunes Rupana Village**	28˚55’799’’N 75˚37’817’’E	245 Metres
5	**Railway Road Crossing on NH 65 to Lilas Village**	28˚50’358’’N 75˚34’267’’E	246 Metres
6	**Water Works Isharwal**	28˚45’634’’N 75˚41’919’’E	248 Metres

VI. Results and Discussion

6.1 Land Use/Land Cover Map

The LULC map revealed the major categories of land use in the study area, including built-up land, agricultural land, and wastelands. Hisar was identified as the primary urban centre, while the rural areas were mainly associated with agricultural activities. Major crops cultivated in the area include bajra, jowar, millets, and cotton.Built-up areas are divided into urban and rural regions. In your study, Hisar is identified as the main urban centre. This information is vital in understanding the agricultural productivity and crop diversity of the Siwani region.

6.2 Geomorphological Features

The geomorphological analysis highlighted the contrasting topography of the study area, with the northern section being almost flat, while the southern region consisted of sand dunes. This variation in landforms plays a crucial role in determining land use patterns, particularly in terms of agricultural productivity and water resource management.

6.3 Applications of GIS in Resource Management

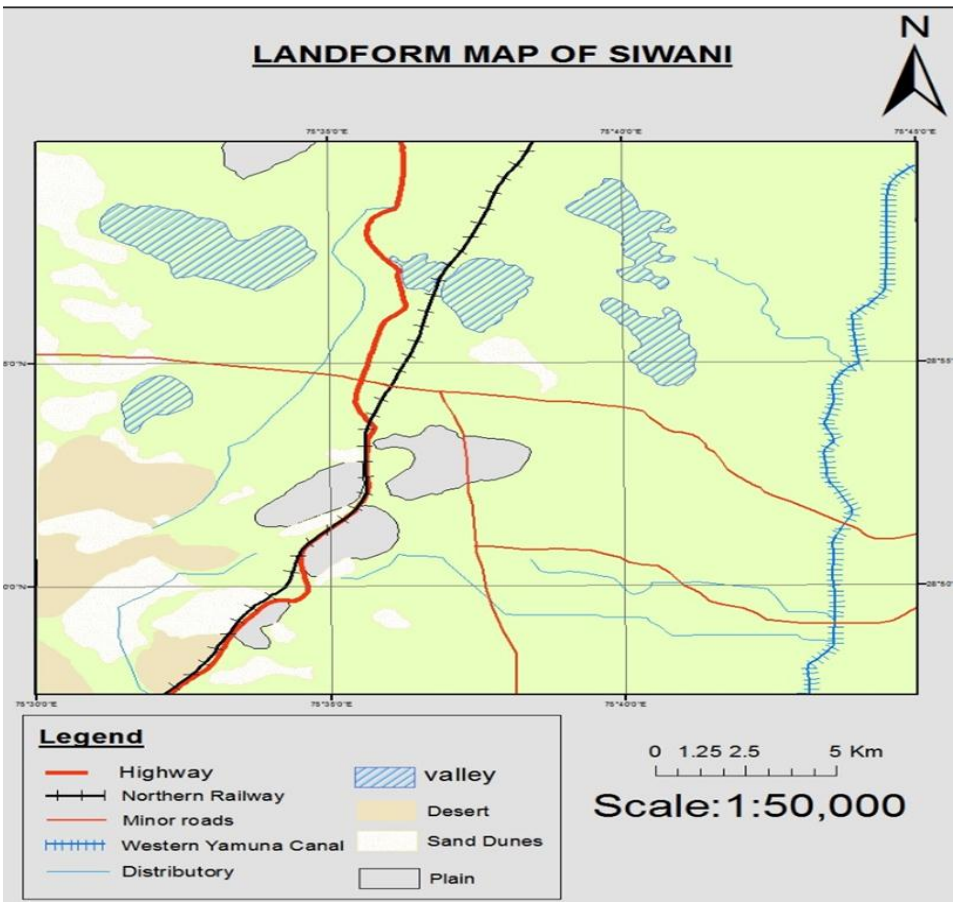
GIS played a crucial role in integrating multiple data sets, including satellite imagery, topographic data, and field observations. This integration facilitated a comprehensive understanding of land use patterns and helped identify areas at risk of land degradation, such as regions prone to soil erosion and water scarcity.For instance, by combining Indian Remote Sensing (IRS) imagery with topographic data, GIS can map areas that are more suitable for agriculture versus those that require conservation efforts due to slope or erosion risks.

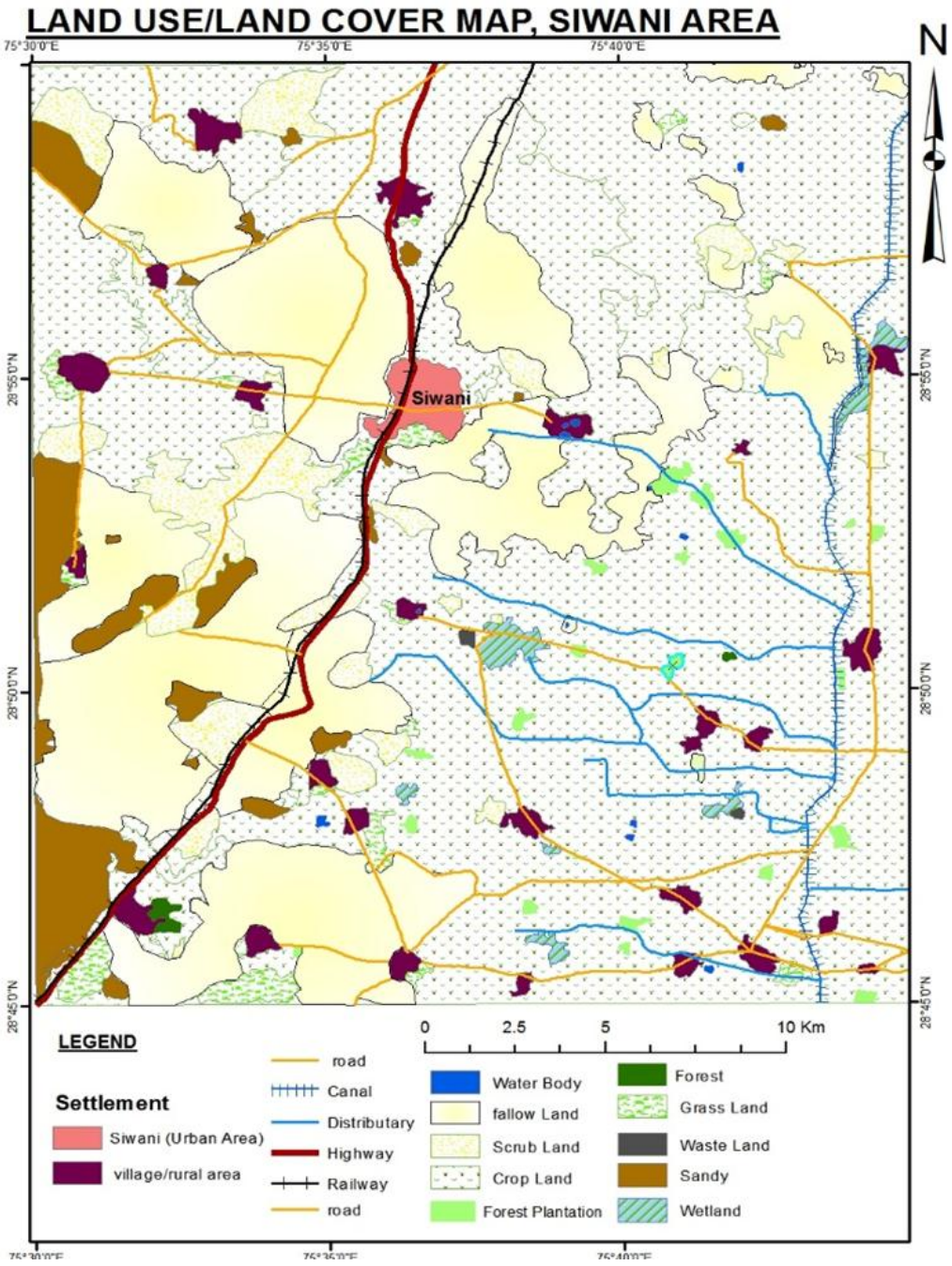
Monitoring Land Use Efficiency:

In resource management, GIS can be used to monitor how efficiently land is being utilised. In the Siwani region, this could involve analysing the relationship between land use patterns and crop yields. GIS helps map productivity zones and guides resource allocation, ensuring that areas with the highest potential are maximised while degraded lands are rehabilitated.

Table-4 Land use/ Land cover classification and area

S. No.	LEVEL-1	LEVEL-II	Area in sq. Km.
1.	**Build up land**	1.1 Urban	0.69
		1.2 Rural	5.40
2.	**Agricultural land**	Crop land	233.30
3.	**Sandy Plain**	3.1 Sandy Area	397832.35
		3.2 Waterlogged area	1998.45





VII. Conclusion

This study demonstrates the effectiveness of Remote Sensing and GIS in mapping land use and land cover, particularly in regions with diverse topographical features. The LULC map generated provides valuable insights for resource management, urban planning, and environmental impact assessments. Future research should focus on temporal analysis to monitor land use changes over time and assess the sustainability of current practices.

References

[1]. Ahmed, A. A., & Hassan, Z. (2023). Application of remote sensing and GIS for land use/land cover change analysis in Sudan. Remote Sensing Applications: Society and Environment, 29, 100774.

[2]. Alia, N., & Salem, A. (2022). Land cover classification using Sentinel-2 images and machine learning techniques. ISPRS International Journal of Geo-Information, 11(5), 290.

[3]. Alonso, R., Garrido, F., & Mateu, J. (2024). A spatial-temporal analysis of land use dynamics in Mediterranean ecosystems. Land, 13(3), 412.

[4]. Anderson, A., & Li, J. (2022). Assessing land use changes with GIS and remote sensing: A case study in Southeast Asia. Geocarto International, 37(10), 1082-1096.

[5]. Baig, M. H. A., & Khalid, S. (2023). Urban expansion detection using remote sensing and geospatial technologies in Lahore, Pakistan. Sustainability, 15(7), 3421.
[6]. Brown, D. G., & Stewart, K. (2022). Land use and land cover transitions: Methods, models, and applications. Global Environmental Change, 73, 102474.
[7]. Burley, T. M. (1961). Land Cover and Land Use in Geographical Research. Annals of the Association of American Geographers, 51(2), 127-130.
[8]. Chaudhary, R., Verma, V., & Singh, S. (2020). Human impacts on land use and land cover: A global perspective. Environmental Research Journal, 14(3), 201-219.
[9]. Chen, H., Zhang, Y., & Wang, X. (2023). A review of land use and land cover change models: Methodologies, challenges, and opportunities. Earth Science Reviews, 234, 104192.
[10]. Clawson, M., & Stewart, C. L. (1965). Land use and land cover: An introductory review. Geographical Review.
[11]. Clawson, M., & Stewart, C. L. (1965). Land Use Information: A Critical Survey of U.S. Statistics Including Possibilities for Greater Uniformity. Resources for the Future.
[12]. Das, B., & Singh, S. (2023). Remote sensing-based assessment of land degradation in the Indo-Gangetic plain. Environmental Monitoring and Assessment, 195, 1047.
[13]. Devi, G., & Reddy, B. (2024). Impact of land cover change on hydrological processes using GIS techniques. Hydrology Research, 56(1), 85-99.
[14]. Dong, Y., & Li, X. (2023). Remote sensing data fusion for monitoring land use changes. Remote Sensing of Environment, 293, 113520.
[15]. Elia, G., & Francini, F. (2023). Monitoring forest land cover changes using satellite data. Land, 13(2), 243.
[16]. Fernández, J., & Navarro, R. (2024). Assessing land cover changes using UAV imagery. Journal of Applied Remote Sensing, 18(1), 016002.
[17]. Gao, L., & Wang, H. (2023). Application of big data in land use and land cover monitoring. International Journal of Digital Earth, 16(2), 347-368.
[18]. Giri, C., Zhu, Z., & Reed, B. (2018). A comparative analysis of the accuracy of global land cover data sets. Remote Sensing of Environment, 79(4), 95-104.
[19]. Guo, X., & Wu, Y. (2022). GIS-based land cover analysis of forested regions in China. Remote Sensing, 14(9), 2045.
[20]. Kim, Y., & Lee, D. (2023). Remote sensing for urban land use dynamics: Case study of Seoul. Sustainability, 15(6), 2483.
[21]. Kumar, S., & Jain, P. (2022). Land degradation assessment using Sentinel data and GIS tools. Journal of Environmental Management, 305, 113072.
[22]. Li, X., & Wang, P. (2023). Spatiotemporal trends in land cover change in eastern China using remote sensing. Geosciences, 13(4), 125.
[23]. Liu, B., & Chen, L. (2024). Evaluating urban sprawl with GIS and remote sensing techniques: A multi-temporal analysis. International Journal of Urban Planning, 48(2), 69-83.
[24]. Ma, R., & Zhou, F. (2023). GIS-based land suitability analysis for sustainable agriculture. Environmental Modelling & Software, 154, 105462.
[25]. Singh, S., & Mishra, A. (2024). A GIS-based model for predicting urban land use change. International Journal of Urban Planning, 52(3), 165-181.
[26]. Sokhi, B. S., & Rashid, S. M. (1999). GIS-based urban planning. International Journal of Remote Sensing.