

Land Use/ Land Cover Change Detection using Geoinformatics in Mahendragarh city, Haryana

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Abstract

The city Mahendragarh is the district Mahendragarh has seen significant extension & development during the last few years. In this paper, the change in land-use/cover has been estimated with time range of 1991 - 2025 and the change detection was quantified. The land-use/cover data generated through satellite imagery has been classified into four major classes i.e., (i) Built-up land (ii) Water Bodies (iii) open area (iv) Vegetation. The investigation is helped out through Geoinformatics approach by using, LANDSAT 5TM, LANDSAT 7 ETM, LANDSAT 8-9 OLI /TIRS, LANDSAT 8-9 OLI /TIRS. Observing of land-use/spread mirrored that changes were more noteworthy in degree over the time range of 35 years in the land under various classes. The most sensational changes are the increase in built-up land. Apart from this decrease in vegetation cover area and open area also. Results demonstrates an expansive change in the territory of various land use classifications amid the period from 1991 to 2025. The open land covering an area of about 43 percent in 1991 reduced to 17 percent in 2025. The built-up area increased from 18 percent in 1991 to 65 percent in 2025. The barren land area increased from 6.45 % in 2007 to 16.97 in 2017 The Water bodies increased 3 percent from 1991 to 4 percent in 2025. The vegetation area has also decreased from 36 percent in 1991 to 14 percent in 2025. Urban extension and various anthropogenic exercises have brought genuine misfortunes of agricultural land, vegetation and water bodies.

Keywords: Development, Geoinformatics, Anthropogenic, genuine, vegetation.

Introduction

The whole world is facing a growing wave of urbanization. With more than 50% of the worldwide population living in urban regions, the urban population will grow by 2.5 billion from 2018 to 2050, with most of the increase concentrated in Africa and Asia. This process of urban expansion has become more prominent in developing countries such as India where medium and small towns are experiencing rapid urbanization during recent decades. A better understanding of land use and land cover (LULC) change may pave the way to unravel urban growth dynamics (Sultana and Karnimi, 2023). Land Use/Land Cover (LULC) transformation is one of the most important indicators of urban growth and spatial development. The rapid expansion of urban areas due to population growth, industrialization, infrastructure

development, and socio-economic transformation has significantly altered the natural landscape in many parts of the world. Urban centers are continuously expanding beyond their traditional boundaries, leading to conversion of agricultural land, vegetation, and open spaces into built-up areas.

Land use refers to the manner in which land is utilized by human beings for various activities such as residential, commercial, industrial, transportation, and agricultural purposes, whereas land cover represents the physical features present on the earth's surface including vegetation, water bodies, barren land, and built-up surfaces. The analysis of land use and land cover transformation helps in understanding the changing spatial structure of urban areas and provides valuable information for urban planning and environmental management (Lillesand, Kiefer and Chipman, 2015).

Urbanization has emerged as one of the dominant processes affecting land transformation in India. Rapid demographic growth and increasing economic activities have accelerated the conversion of natural and rural landscapes into urban land uses. The process of urban sprawl, characterized by uncontrolled outward expansion of urban areas, has significantly influenced the environmental quality and sustainability of cities. Such transformations often lead to loss of vegetation cover, reduction in open spaces, pressure on water resources, increase in land surface temperature, and ecological imbalance (Jensen, 2005).

The state of Haryana has witnessed substantial urban growth during the past three decades due to economic development, improved transportation facilities, and regional connectivity. Cities and towns of southern Haryana, including Mahendragarh, have experienced noticeable spatial expansion and changes in land utilization patterns. Mahendragarh city, being an important administrative and educational centre of the region, has undergone rapid urban transformation during the study period. The expansion of residential colonies, institutional infrastructure, transportation networks, and commercial activities has considerably modified the land use/land cover structure of the city.

Objective of the study

The present study aims at the following objectives:

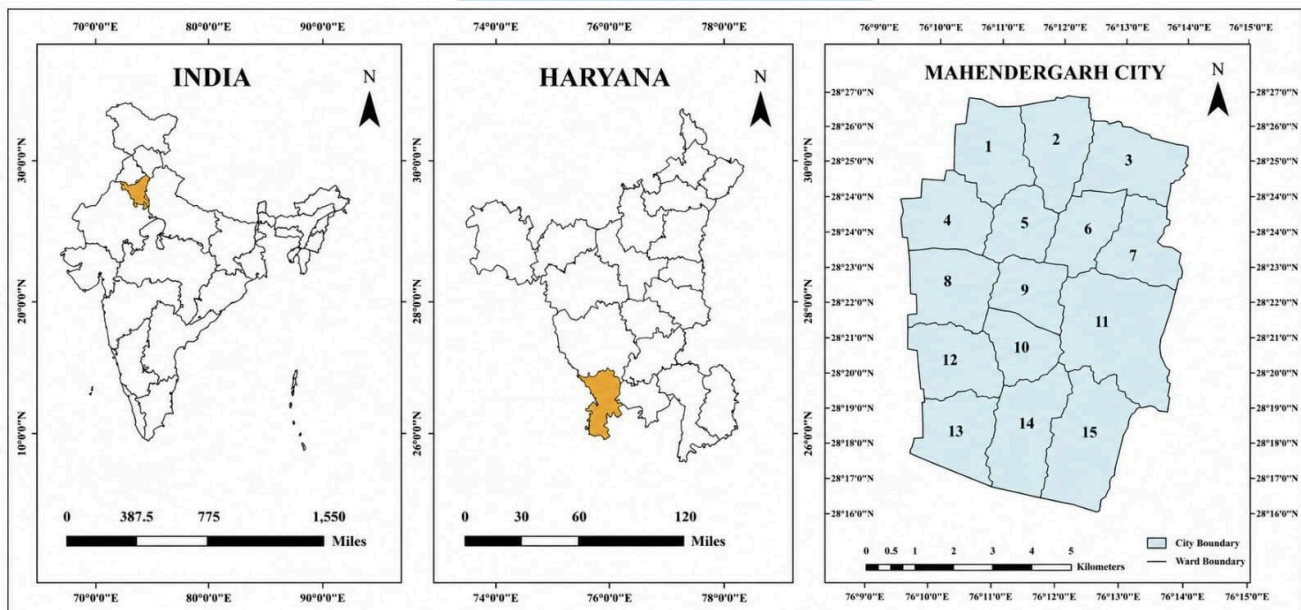
- (i) To analysis the Land Use/Land Cover transformation in Mahendragarh city over a period extending from 1991 to 2025.
- (ii) To examines the temporal and spatial changes in major land use categories such as built-up area, vegetation, open land, and water bodies.

Study Area

The Mahendragarh city is located in the semiarid region of the state. The city has about 20 sq.km of geographical area. It lies in the south Haryana between 27° 47' North to 28° 26' North Latitude and 75° 56' East to 76°51' East Longitude. Landscape of the district comprises of undulating plains, sand dunes and baring rocky surface. Topography of the district is peculiar. The residuals of the Aravali are spreading in the district giving the rocky outlook. Climate of the district is hot and semiarid in nature. The region lies in the rainfall regime of below 400 mm average annual rainfall which denotes the condition of water

scarcity in the region. The higher variation between amount of received rainfall and amount of evapo-transpiration causes the decline in soil moisture and more extensive and intensive exploitation of ground water resources. Due to scarcity of monsoon rainfall and continuously declining water resources the region has faced several times the drought conditions.

Map 1: Study Area



Source: Prepared by research scholar using Arc GIS

Database and Methodology

The analysis of Land Use/Land Cover (LULC) transformation requires reliable spatial and non-spatial data along with appropriate analytical techniques. The study is based on multiple sources of spatial and statistical data collected from different government departments, satellite platforms, and official records. The collected data has been processed and analysed to prepare the Land Use/Land Cover maps of Mahendragarh city for the years 1991, 2001, 2011, and 2025. In the present study, Remote Sensing and Geographic Information System (GIS) techniques have been used to analyse the spatial and temporal changes in Mahendragarh city from 1991 to 2025.

The methodology adopted for the study includes collection of satellite imagery, preparation of municipal boundary, georeferencing, image interpretation, digitization, land use classification, and comparative analysis of temporal changes. The study utilizes both primary and secondary data sources for preparation and analysis of LULC maps. Spatial data processing and mapping were carried out using GIS software and remotely sensed imagery.

Result and Discussion

There are some observations below:

Land Use/Land Cover Analysis of Mahendragarh City

Land Use/Land Cover (LULC) analysis provides a clear understanding of the spatial structure, urban growth pattern, and environmental transformation of a city over time. Temporal analysis of land use

categories helps in identifying the magnitude and direction of urban expansion as well as changes in natural and semi-natural land cover. In the present study, LULC analysis of Mahendragarh city has been carried out for the years 1991, 2001, 2011, and 2025 using GIS and Remote Sensing techniques.

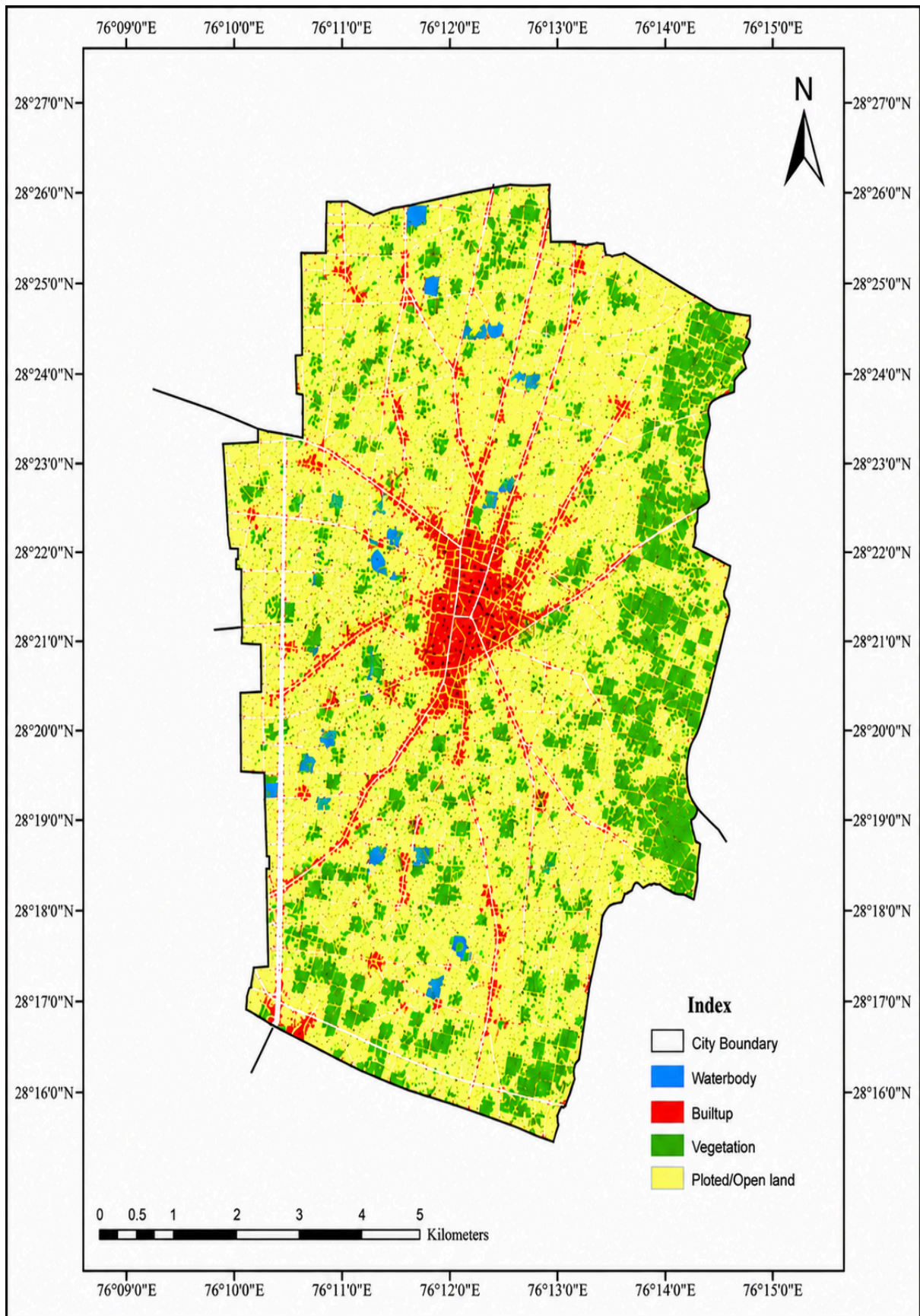
Land Use/Land Cover Pattern in 1991

Table 1: Land Use and Land Cover Area Distribution in 1991

Land Use Category	Area (sq. km.)	Percentage
Built-up Area	4.20	18%
Vegetation	8.50	36%
Open Land	10.10	43%
Water Bodies	0.70	3%

Source: Prepared by Research scholar from primary data.

Map 2: Land Use and Land Cover Area of Mahendragarh City, 1991



Source: Prepared by research scholar using Arc GIS

Table 1 and map 2 shows the land use and land cover area of Mahendragarh city in 1991. The table indicate that open land found is highest proportion that is 43 percent followed by 36 percent area is vegetation cover and 18 percent constructed by build-up area and only 3 percent land under water body in 1991. The land use and land cover pattern of Mahendragarh city in 1991 reflects the characteristics of a relatively small and compact urban settlement. During this period, urban development was concentrated mainly around the historical core of the city, while large portions of the municipal area remained covered by open land and vegetation. The built-up area was limited in extent and mostly confined to the central part of the city. Residential settlements, local markets, institutional structures, and transportation facilities formed the major components of the built-up landscape. The city exhibited a compact urban morphology with limited outward expansion.

Vegetation cover occupied a considerable portion of the municipal area. Agricultural land and scattered green patches were dominant in peripheral regions. Open land constituted the largest land use category during this period, indicating low intensity of urbanization and availability of undeveloped land within the municipal boundary. Water bodies are limited in extent and mainly consisted of small ponds and seasonal water accumulation areas.

Land Use/Land Cover Pattern in 2001

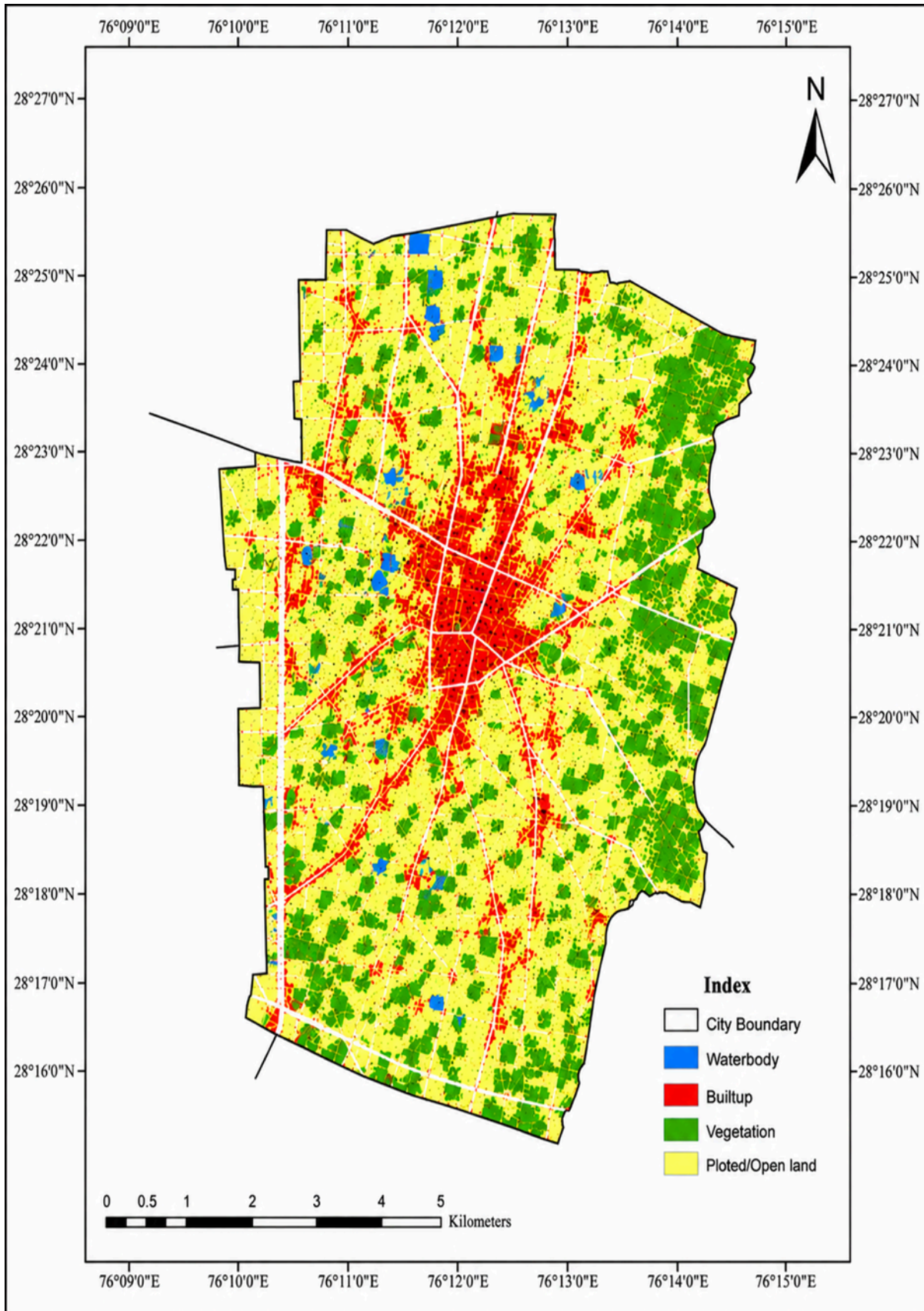
Table 2 and map 3 shows the distribution of land use and land cover area of Mahendragarh city in 2001. The LULC pattern of 2001 indicates noticeable urban growth and spatial transformation compared to 1991. The table designates that the build-up area has been increased over the period of time from 1991 to 2001, as Mahendragarh city experienced increasing population pressure, infrastructural development, and expansion of residential areas. The built-up area expanded considerably beyond the traditional urban core. Urban growth occurred mainly along major roads and transportation corridors. Over the period of time the ratio of open area and vegetation area has been decreased, for the reason is that agricultural land and open spaces began to transform into residential colonies and mixed land use zones. Vegetation cover started declining due to increasing urban encroachment, while open land continued to reduce gradually. But in the case of water bodies the ratio is contained from 1991 to 2001.

Table 2: Land Use and Land Lover Distribution in 2001

Land Use Category	Area (sq. km.)	Percentage
Built-up Area	7.10	30%
Vegetation	6.50	28%
Open Land	9.20	39%
Water Bodies	0.80	3%

Source: Prepared by research scholar from primary data

Map 3: Land Use and Land Cover Area of Mahendragarh city, 2001



Source: Prepared by research scholar using Arc GIS

Land Use/Land Cover Pattern in 2011

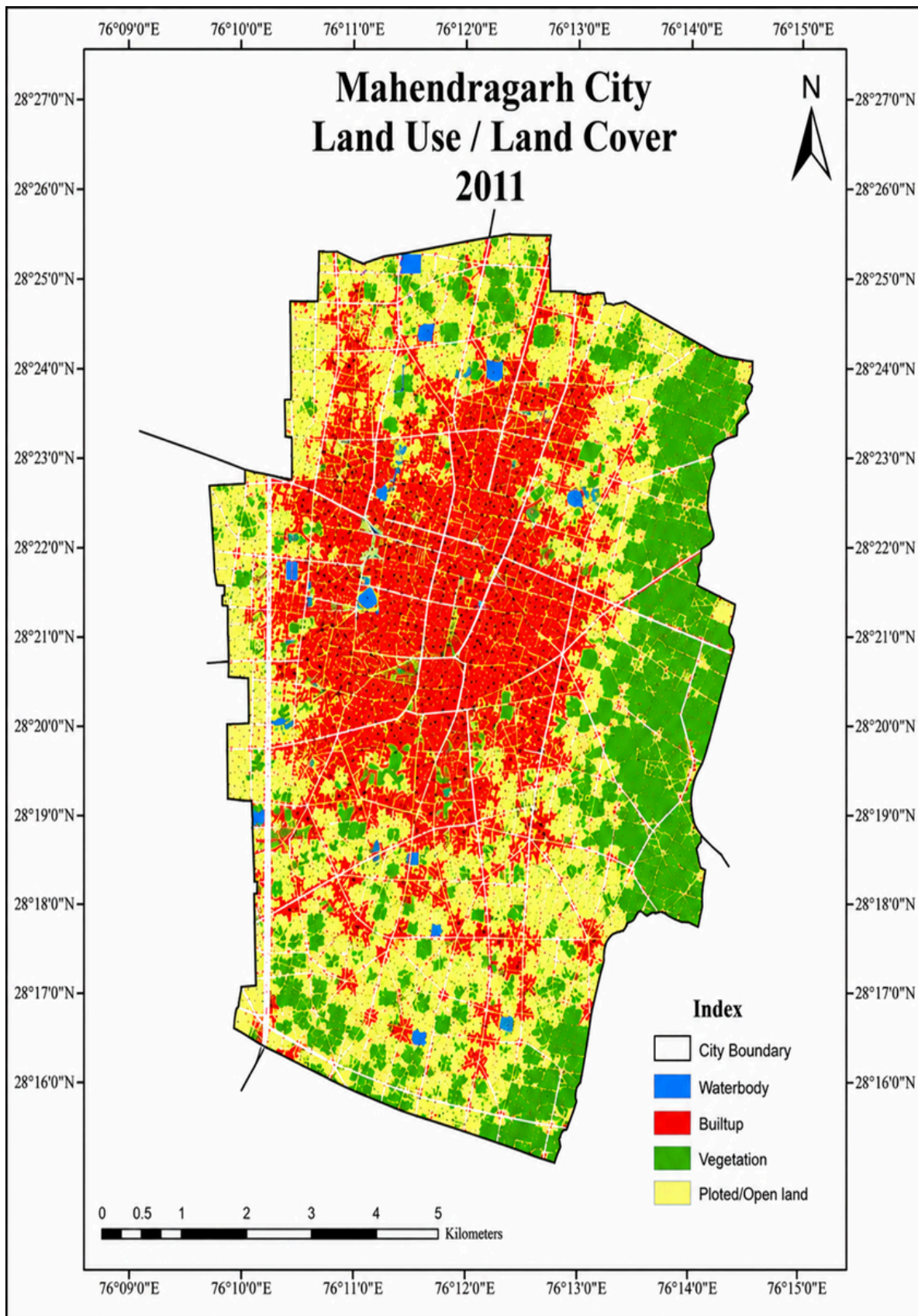
The table 3 and map 4 shows that the year 2011 marks a significant phase in the urban transformation of Mahendragarh city. The LULC pattern indicates rapid expansion of built-up area and substantial modification of the urban landscape. Urban growth became more dispersed and widespread during this period. Residential colonies, institutional complexes, transportation infrastructure, and commercial development expanded considerably across peripheral areas. Vegetation and open land experienced further decline due to accelerated urbanization.

Table 3: Land Use and Land Cover Area of Mahendragarh City in 2011

Land Use Category	Area (sq. km.)	Percentage
Built-up Area	11.20	48%
Vegetation	5.20	22%
Open Land	6.10	26%
Water Bodies	0.90	4%

Source: Prepared by research scholar from primary data

Map 4: Land Use and Land Cover Area of Mahendragarh City, 2011



Source: Prepared by research scholar using Arc GIS

Land Use/Land Cover Pattern of Mahendragarh City in 2025

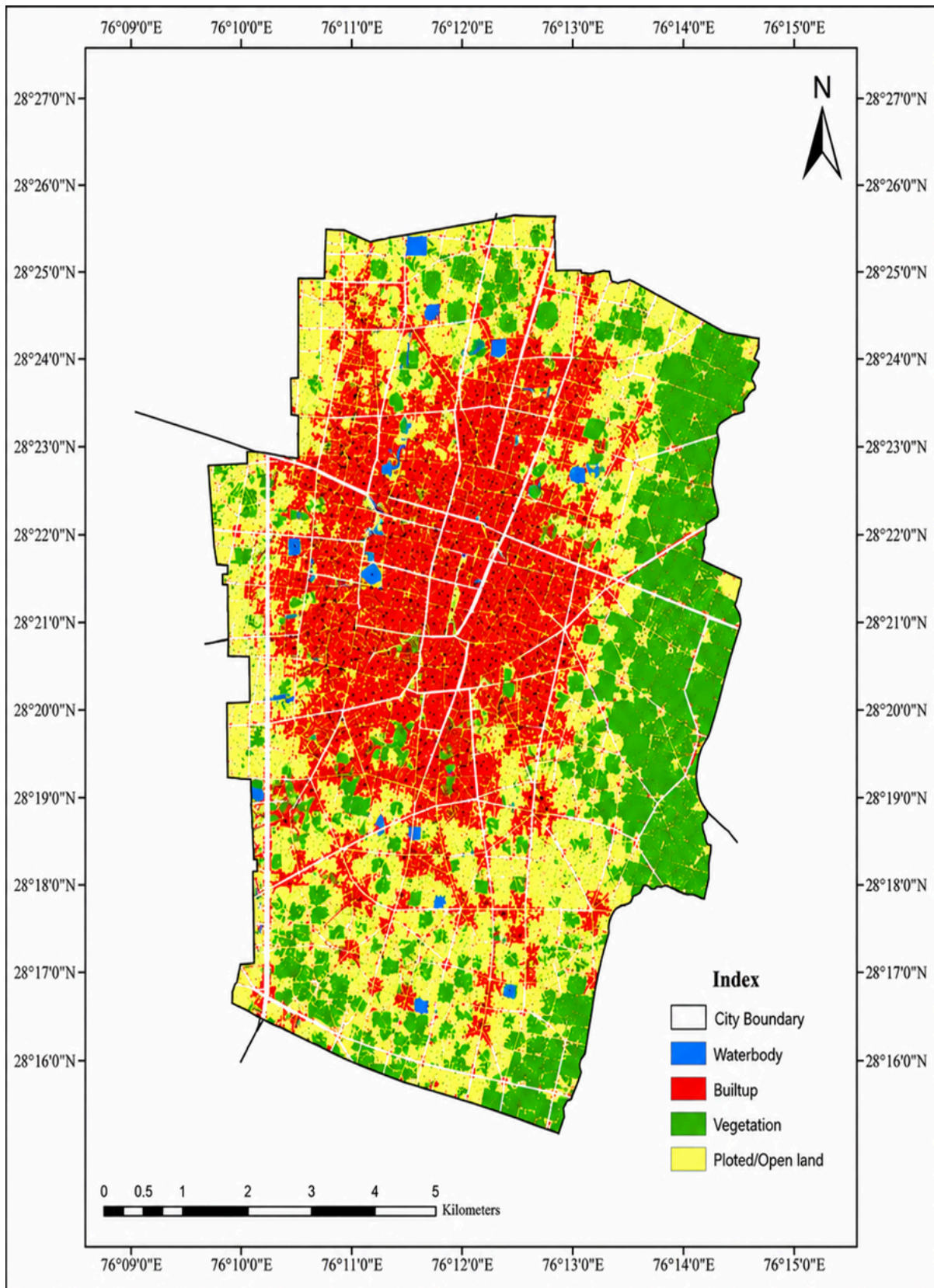
The table 4 and map 5 shows the LULC pattern of 2025 represents the most urbanized stage in the transformation of Mahendragarh city. Built-up land dominates the municipal area and reflects accelerated urban expansion over the last three decades. The city exhibits a sprawling urban landscape characterized by extensive residential colonies, institutional development, transportation infrastructure, and commercial growth. Vegetation and open land survive mainly in fragmented peripheral patches. If we concluded this table that the water bodies has been increased of the period of time that is 1991 to 2025.

Table 4: Land Use and Land Cover Area of Mahendragarh City in 2025

Land Use Category	Area (sq. km.)	Percentage
Built-up Area	15.30	65%
Vegetation	3.20	14%
Open Land	4.00	17%
Water Bodies	1.00	4%

Source: Prepared by Research Scholar from primary data.

Map 5: Distribution of Land Use and Land Cover Area of Mahendragarh City in 2025



Source: Prepared by Research Scholar using Arc GIS.

Conclusion

The study establishes that Land Use/Land Cover (LULC) transformation in Mahendragarh city is a continuous and dynamic process influenced by urbanization, population growth, infrastructural development, and increasing human activities over the period 1991–2025.

The analysis reveals a substantial increase in built-up area from 4.20 sq. km. in 1991 to 15.30 sq. km. in 2025, indicating rapid urban expansion and spatial growth of the city. The study demonstrates that vegetation cover and open land have continuously declined due to increasing urban encroachment, residential development, and conversion of agricultural land into built-up surfaces.

The temporal comparison of LULC maps confirms that Mahendragarh city has transformed from a compact urban settlement into a more dispersed and sprawling urban landscape over nearly three decades. The analysis indicates that the most rapid urban expansion occurred after 2001, when residential colonies, commercial activities, and institutional infrastructure expanded significantly toward peripheral regions.

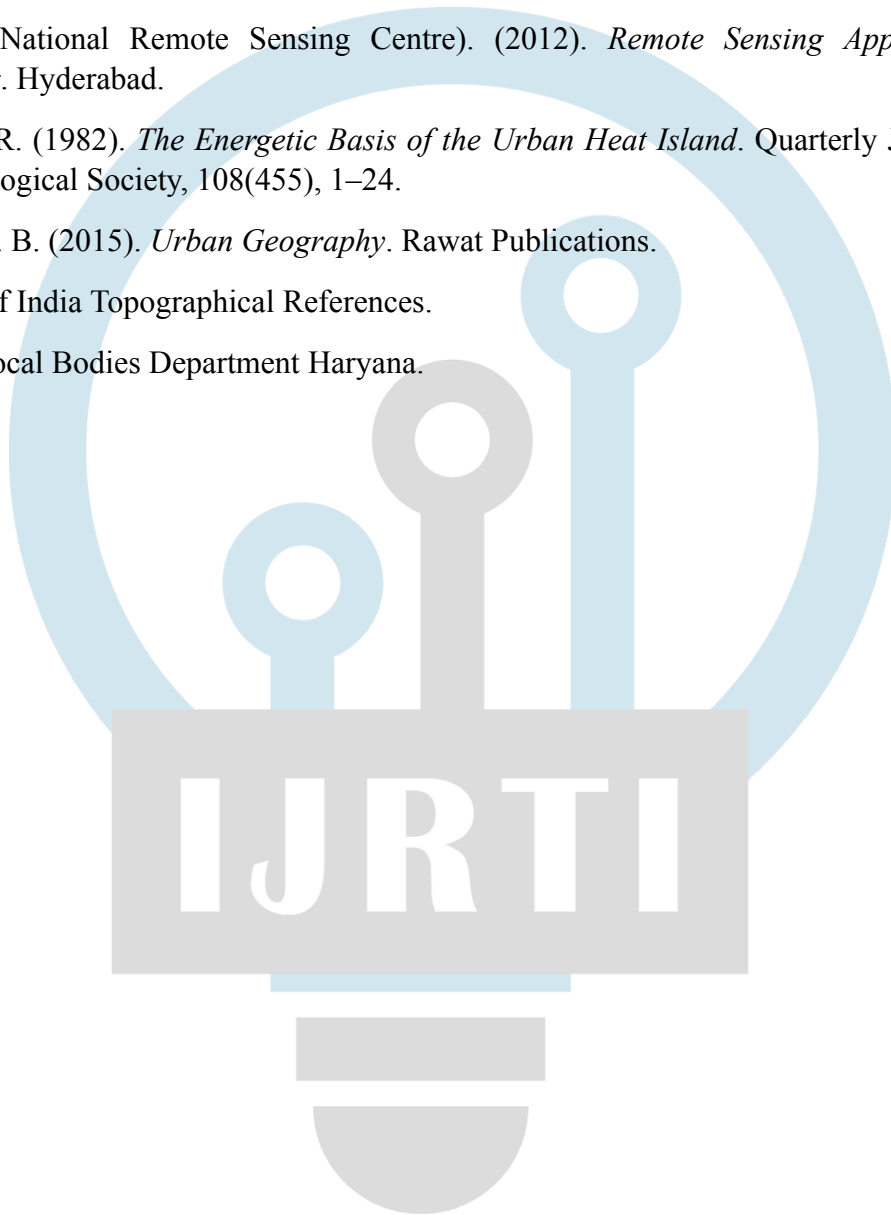
The study establishes a strong relationship between population growth and land transformation, where increasing population created greater demand for housing, infrastructure, transportation facilities, and urban services. The environmental analysis confirms that LULC transformation has resulted in ecological imbalance, reduction in green spaces, increase in impervious surfaces, and rising urban heat conditions within Mahendragarh city.

The study demonstrates the effectiveness of Remote Sensing and GIS techniques in mapping, monitoring, and analysing urban growth and Land Use/Land Cover transformation over time.

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