Land Use/Land Cover and Urbanization Trends in Mandi Adampur: A GIS and Remote Sensing Analysis

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Abstract: *This study presents a comprehensive analysis of the Land Use/Land Cover (LULC) changes and urbanization trend in Mandi Adampur over three decades (2001, 2011, and 2021) using GIS and remote sensing techniques. The analysis reveals significant transformations in the town's land use patterns, primarily driven by urbanization and commercialization. In 2001, agricultural land was the dominant land use, covering 46.4% of the area, but this decreased to 41.1% by 2021, as urban and commercial area expanded. The unplanned urban residential areas and adjacent rural village settlements saw notable growth, while industrial areas increased by 1.0% over the three decades. The study also highlights the decline in green areas, emphasizing the growing pressure of urban sprawl on natural resources. The findings suggest that Mandi Adampur is experiencing a shift from an agrarian-based economy to an urban- commercialization landscape, raising concerns about the sustainability of agricultural land and ecological balance. This analysis underscores the need for strategic urban planning and sustainable urban land management practices to balance development with the conservation of agricultural and environmental resources.*
Keywords: *Land Use, Land Cover, Remote Sensing, GIS, Decadal.*

I.   Introcution:

Land Use/Land Cover (LULC) mapping and analysis is a crucial tool for understanding the spatial dynamics of urbanization, agricultural practices, and environmental changes over time. It helps to monitor the conversion of land from one use type to another, providing valuable insights into the effects of urban expansion, industrialization, and agriculture on natural resources. The use of Geographic Information Systems (GIS) and remote sensing technologies has significantly advanced the ability to analyze these changes at both local and regional scales (Jensen, 2005). These technologies allow for accurate, large-scale mapping and temporal analysis, which are essential for urban planning, environmental management, and policy-making.

Mandi Adampur, located 16 KM from Agroha in the Hisar district of Haryana, India, has witnessed significant changes in land use over the past few decades, driven by recent trend of urbanization and commercial and industrial growth. The town, traditionally an agricultural hub and a grain market for surrounding prosperous agricultural area and has experienced increasing pressures from unplanned urban sprawl as population growth accelerates. These shifts have led to a transformation of the landscape, with implications for both the environment and local socio-economic activities (Roy et al., 2018).

In India, rapid urbanization has been a key driver of land use changes, particularly in regions with growing populations and industrialization. Several studies have documented similar patterns in other Indian cities, where agricultural lands have been converted into urban areas, leading to the reduction of green areas, agricultural productivity, and biodiversity (Nayak et al., 2020; Kumar et al., 2021). In this context, understanding the LULC dynamics of Mandi Adampur is critical for developing strategies that ensure sustainable urban and rural development while protecting natural resources.

This study aims to analyze the LULC changes in Mandi Adampur from 2001 to 2021 using GIS and remote sensing, with the objective of identifying trends in urban expansion, agricultural land reduction, and the impacts on green spaces. The results of this analysis will provide important insights into the changing land use patterns of the area and help inform future urban planning and land management strategies.

Study area:

Mandi Adampur is a town located in the Hisar district of Haryana, a state in northern India. Situated approximately 35 kilometers from Hisar city, Mandi Adampur serves as an important agricultural and Tehsil Headquarter hub in the region. The town (Municipal Committee Boundary) is geographically positioned at a latitude of 29.18° N and a longitude of 75.30° E. It is part of the southwestern Haryana region, which has a semi-arid climate and is characterized by hot summers, moderate winters, and an annual rainfall that is relatively low compared to other parts of India.
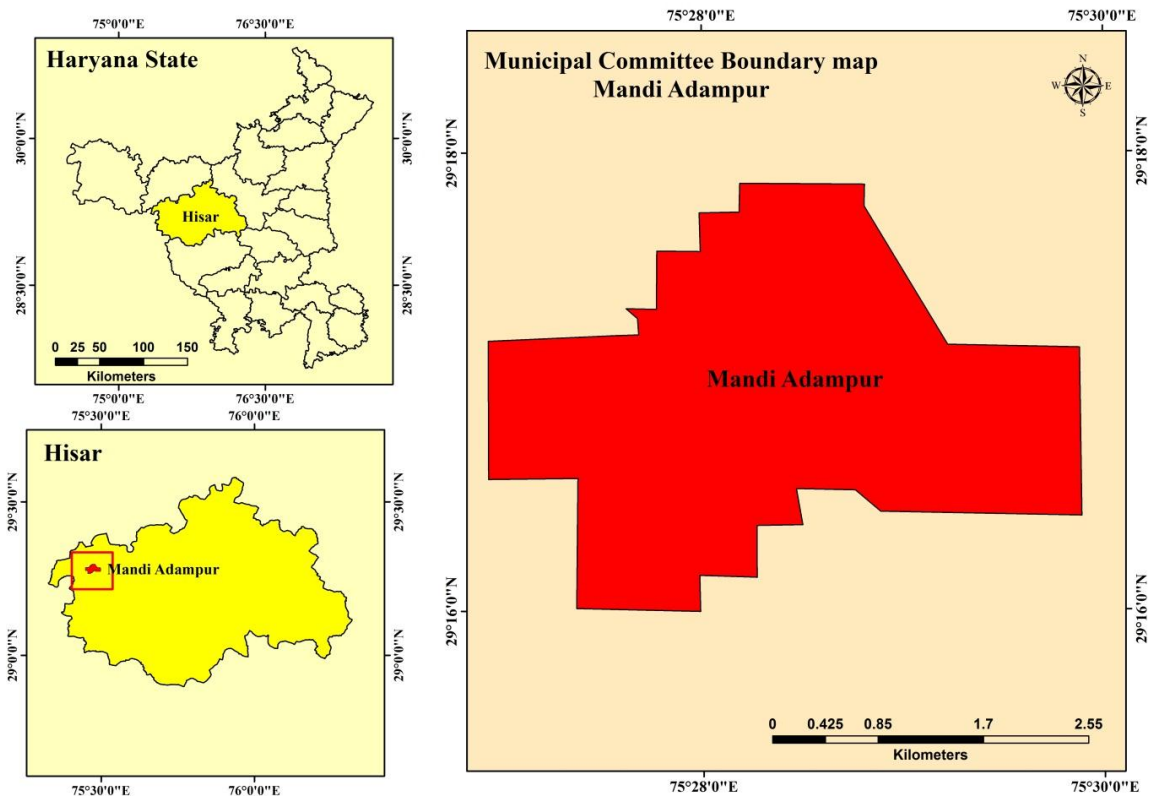
Location Map of Study Area

Figure-1: Locational map of study area (Mandi Adampur, District Hisar, Haryana)

The town of Mandi Adampur covers an area of about 14.4 square kilometers and has a population of approximately [insert population] as per the most recent census. Historically, the economy of Mandi Adampur has been agrarian, with wheat, rice, and cotton being the primary crops grown in the surrounding canal irrigated agricultural lands. The town and its surrounding areas have a mixed landscape, combining agricultural fields, residential areas, and some commercial areas.

The region falls under the arid to semi-arid zone, with primary source of canal irrigation and groundwater. Over the past few decades, however, rapid urbanization has begun to influence the land use patterns, reducing the amount of agricultural land and increasing built-up areas. The introduction of new small scale industrial units and commercial centers in the area has gradually shifted the economic focus, making Mandi Adampur a developing urban center of Hisar district but the town is facing the rising sub-surface water table and poor urban infrastructure development problems. In absence of urban local bodies governance system this town has faced the severe constraints of finances and urban administrative infrastructure. Before June 2021 this township was administratively governed by two Panchayat's and a Panchayati Raj administrative system is well equipped to run the township administration effectively.

Mandi Adampur also has a rich cultural heritage, with local grain market and small-scale industries contributing to its economic activities. Despite the growing urbanization, the area still maintains a strong connection to its rural roots, with a significant portion of its land devoted to farming.

Geographically, Mandi Adampur lies close to other important towns in the Hisar district, such as Hisar city and Barwala, which influences the town's connectivity and potential for regional growth. The town is well connected by road, with access to the major highways that link it to other parts of Haryana and northern India. The local transportation network includes roads, and rail connectivity is available through nearby Hisar city, which provides access to broader regional and national markets.

In recent years, the town has experienced increasing pressure from unplanned urbanization and industrial expansion, which has led to a transformation in land use. The area's land cover has changed significantly, with more land being converted from agriculture to urban, commercial and industrial uses, making it an important case study for examining the impact of urban sprawl on agricultural land and environmental sustainability.

Methodology and Data Collection:

The methodology for this study involves the use of Geographic Information System (GIS) and Remote Sensing techniques to map and analyze land use changes over time. The following steps outline the methodology and data collection process used in this study:

1. Data Collection:

To conduct a robust analysis of LULC changes, various data sources were utilized:

- **Satellite Imagery**: Satellite images from Landsat series (Landsat 5, Landsat 7, and Landsat 8) and Google Earth High Resolution data were used for the years 2001, 2011, and 2021. Landsat imagery is preferred for such studies due to its historical availability and resolution, providing a good balance between spatial and temporal detail. The images were obtained from the United States Geological Survey (USGS) Earth Explorer portal. The images were selected based on cloud-free conditions and similar seasonal periods (typically post-monsoon) to ensure comparability.

Topographic Maps: Historical topographic maps (if available) and land use maps from local authorities or government sources were used to further corroborate the LULC classifications and Town and Country Planning maps for the MC boundary and LULC references.

2. Manual Classification of Land Use/Land Cover (LULC)

Manual classification of LULC is a traditional, but reliable method for mapping land use types when using high-resolution satellite imagery. In this study, manual classification was employed as a complement to supervised classification to improve the accuracy of LULC identification and mapping.

Steps in Manual Classification:

- **Image Interpretation**: Initially, the satellite images of 2001, 2011, and 2021 were visually interpreted. Features such as urban settlements, agricultural fields, industrial areas, roads and water bodies etc. were identified by analyzing the spectral patterns in the images.
- **Manual Delineation**: The interpretation of LULC classes was done manually by delineating polygons around the identified land use categories. This was done with the help of GIS software (e.g., ArcGIS or QGIS), where polygons were drawn directly on the satellite images based on visual cues.
- **Obtaining TCP Maps**: Town and Country Planning maps were sourced from local planning authorities, such as the Municipal Corporation of Hisar or the Haryana Urban Development Authority (HUDA). These maps often show land use zoning, transportation networks, residential areas, industrial zones, and public facilities.
- **Refinement**: After the initial manual classification, the results were compared with secondary data sources such as historical maps, land use records, and field data to correct any misclassifications. This process ensured that the land use categories were accurately represented in the final map.
- **Final Classification Map**: The manual classification yielded LULC maps for each year (2001, 2011, and 2021), highlighting the shifts in land use over time.

II. Result and Discussion:

The Land Use/Land Cover (LULC) analysis of Mandi Adampur for 2001, 2011, and 2021 reveals significant changes over three decades. Agricultural land, the predominant category in 2001, has gradually declined due to urban expansion, with built-up areas increasing in 2011 and 2021. Described in maps and tables given below:

Land Use/Land Cover (LULC) 2001:

The Land Use/Land Cover (LULC) table for Mandi Adampur in 2001 provides a detailed breakdown of land use categories, their respective areas in hectares, and their percentage share of the total land. Agricultural land dominates, covering 446 hectares (46.4%), reflecting the town's agrarian focus.
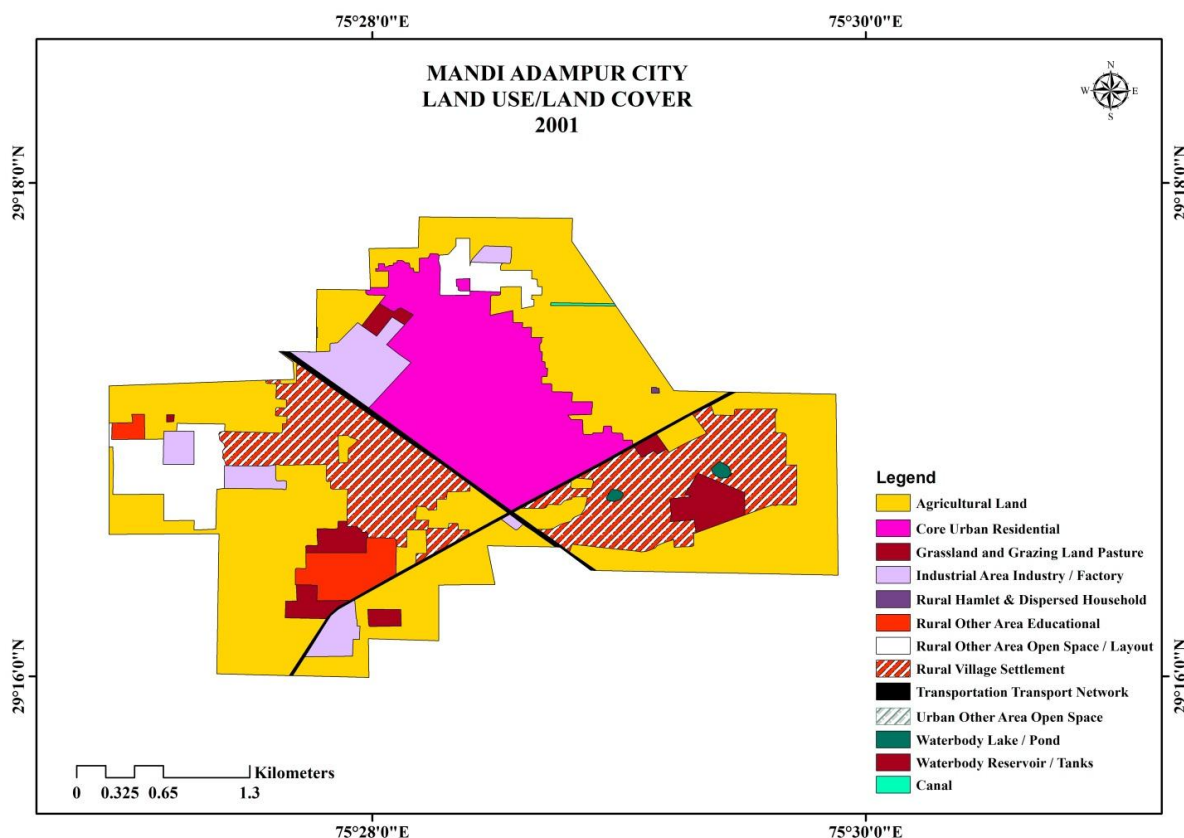
Figure-2: Land Use/ Land Cover Map of Mandi Adampur City (2001)

Rural village settlements and core urban residential areas follow, occupying 179.6 hectares (18.7%) and 161.2 hectares (16.8%), respectively, highlighting a mix of rural and urban habitation. Other notable uses include open spaces (52.0 ha, 5.4%), industrial areas (47.7 ha, 5.0%), and grasslands (25.9 ha, 2.7%), which support grazing and ecological balance. Water resources, such as reservoirs (8.5 ha, 0.9%), ponds (1.8 ha, 0.2%), and canals (0.8 ha, 0.1%), form a small fraction of the area, emphasizing limited surface water availability. Transportation networks occupy 13.9 hectares (1.4%), while rural hamlets and dispersed households cover a negligible 0.2 hectares (0.0%). This distribution highlights the town's predominantly agricultural character, with urbanization gradually influencing the land use pattern.

Table-1: Area of Urban Land Use (2001) of Mandi Adampur City.

Sr. No.	Urban Landuse (2001)	Area (in Hectare)	Area in %
1	Agricultural Land	446.0	46.4
2	Rural Village Settlement	179.6	18.7
3	Core Urban Residential	161.2	16.8
4	Rural Other Area Open Space / Layout	52.0	5.4
5	Industrial Area Industry / Factory	47.7	5.0
6	Grassland and Grazing Land Pasture	25.9	2.7
7	Rural Other Area Educational	23.6	2.5
8	Transportation Transport Network	13.9	1.4
9	Waterbody Reservoir / Tanks	8.5	0.9
10	Waterbody Lake / Pond	1.8	0.2
11	Canal	0.8	0.1
12	Rural Hamlet & Dispersed Household	0.2	0.0
Total		**961.2**	**100**

The 2001 LULC analysis of Mandi Adampur shows a predominantly agrarian landscape with agricultural land comprising nearly half of the area. Urbanization is evident with significant portions allocated to residential, industrial, and transportation uses, while water bodies and green spaces are minimal. The findings underscore the need for balanced planning to support urban growth while conserving agricultural and ecological resources.

Land Use/Land Cover (LULC) 2011:

The Land Use/Land Cover (LULC) table for Mandi Adampur in 2011 illustrates notable changes in land use compared to 2001. Agricultural land remains the dominant category, covering 415.3 hectares (43.2%), though it has slightly decreased from 46.4% in 2001, reflecting urban expansion. Rural village settlements have grown to 194.8 hectares (20.3%), indicating increased rural habitation. Core urban residential areas show a marginal increase to 164.7 hectares (17.1%), while industrial areas expand slightly to 50.8 hectares (5.3%), signaling moderate industrial growth.
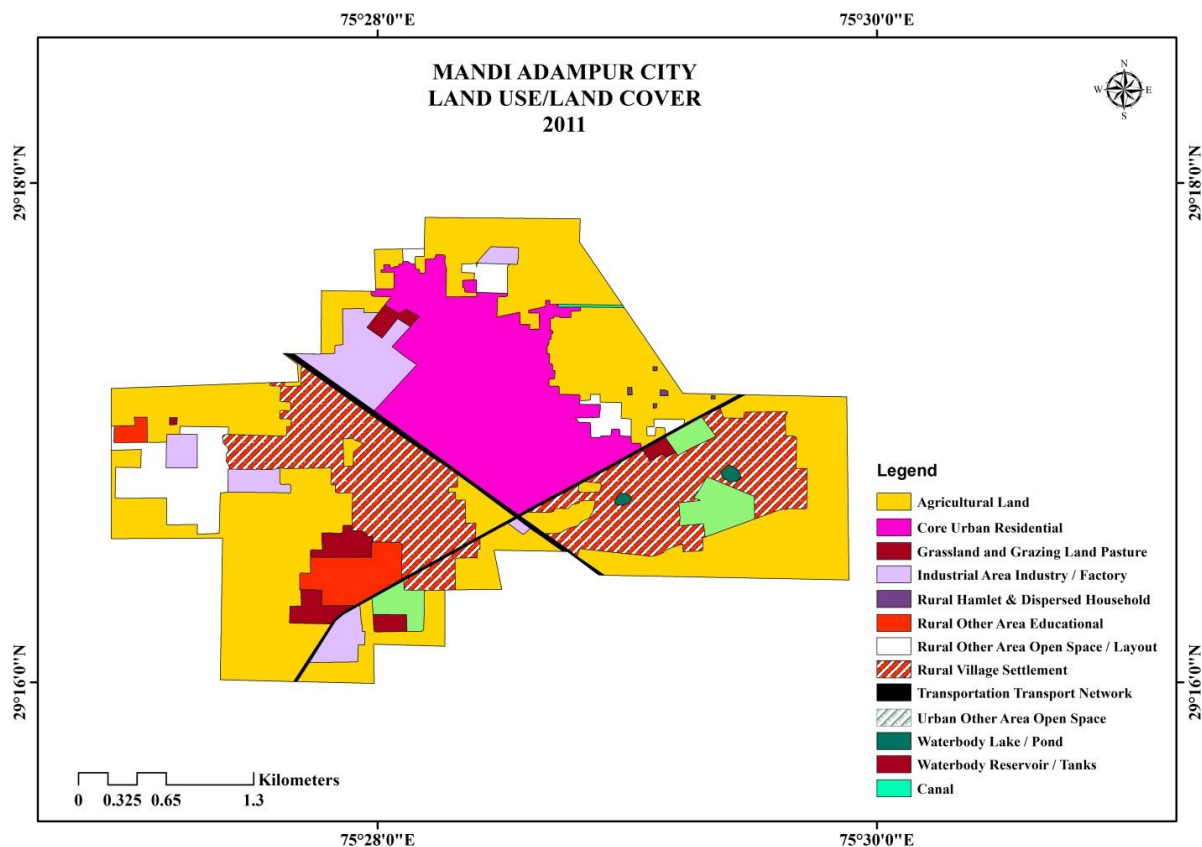

Figure-3: Land Use/ Land Cover Map of MandiAdampur City (2011).

Rural open spaces have reduced to 48.5 hectares (5.0%), and rural mixed settlements emerge as a distinct category, occupying 25.5 hectares (2.7%). Grassland and grazing lands decline to 12.5 hectares (1.3%), while educational spaces, transport networks, and water bodies remain unchanged in area and percentage. The data highlights ongoing urbanization and industrialization, contributing to a gradual reduction in agricultural and green spaces, emphasizing the need for sustainable land management to balance urban growth with ecological conservation.

Table-2: Area of Urban Land Use (2011) of MandiAdampur City.

Sr. No.	Urban Landuse (2011)	Area (in Hectare)	Area in %
1	Agricultural Land	415.3	43.2
2	Rural Village Settlement	194.8	20.3
3	Core Urban Residential	164.7	17.1
4	Industrial Area Industry / Factory	50.8	5.3

5	Rural Other Area Open Space / Layout	48.5	5.0
6	Rural Mixed Settlement	25.5	2.7
7	Rural Other Area Educational	23.6	2.5
8	Transportation Transport Network	13.9	1.4
9	Grassland and Grazing Land Pasture	12.5	1.3
10	Waterbodies Reservoir / Tanks	8.5	0.9
11	Waterbodies Lake / Pond	1.8	0.2
12	Canal	0.8	0.1
13	Rural Hamlet & Dispersed Household	0.6	0.1
Total		**961.2**	**100**

The 2011 LULC analysis of Mandi Adampur shows a slight decline in agricultural land due to urban and industrial expansion, with increases in rural settlements and core urban residential areas. The emergence of rural mixed settlements and a reduction in green spaces highlight ongoing urbanization. The findings stress the need for sustainable planning to balance development with the preservation of agricultural and ecological resources.

Land Use/Land Cover (LULC) 2021:
The Land Use/Land Cover (LULC) table for MandiAdampur in 2021 reveals continued urbanization and land use changes over the past two decades. Agricultural land, though still dominant at 395 hectares (41.1%), has decreased significantly from 43.2% in 2011, reflecting ongoing urban and industrial development. Rural village settlements expanded slightly to 198 hectares (20.6%), and core urban residential areas grew marginally to 166.2 hectares (17.3%).
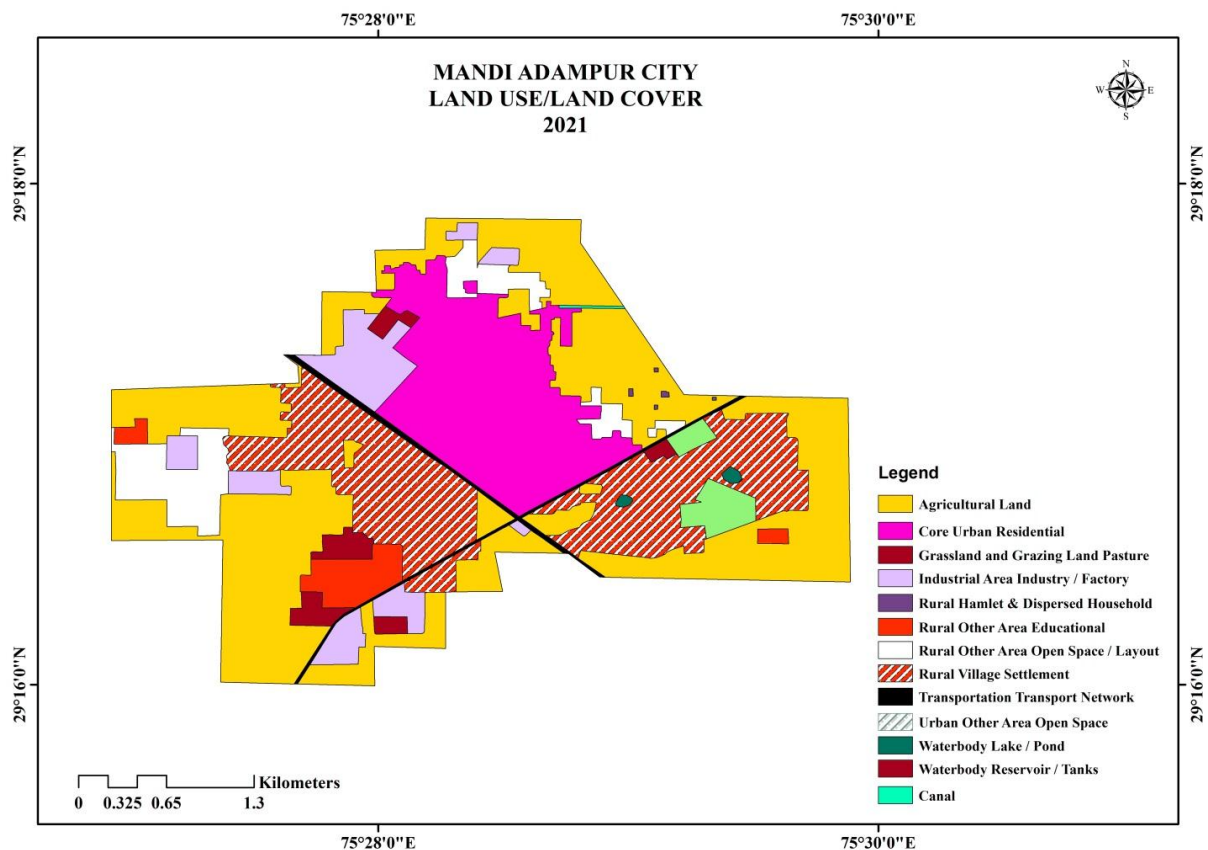

Figure-4: Land Use/ Land Cover Map of MandiAdampur City (2021)

Industrial areas witnessed a notable increase to 60.5 hectares (6.3%), and rural open spaces also grew to 60 hectares (6.2%), indicating diversified land usage. Educational spaces increased modestly to 25.7 hectares (2.7%), while rural mixed settlements declined to 17.9 hectares (1.9%). Grasslands, transportation networks, and water bodies remain largely unchanged in area, with reservoirs/tanks and lakes/ponds still minimal. This data underscores the steady shift from agriculture to urban and industrial land use, emphasizing the importance of sustainable urban planning to protect agricultural land and manage ecological resources effectively.

Table-3: Area of Urban Land Use (2021) of MandiAdampur City.

Sr. No.	Urban Landuse (2021)	Area (in Hectare)	Area in %
1	Agricultural Land	395.0	41.1
2	Rural Village Settlement	198.0	20.6
3	Core Urban Residential	166.2	17.3
4	Industrial Area Industry / Factory	60.5	6.3
5	Rural Other Area Open Space / Layout	60.0	6.2
6	Rural Other Area Educational	25.7	2.7
7	Rural Mixed Settlement	17.9	1.9
8	Transportation Transport Network	13.9	1.4
9	Grassland and Grazing Land Pasture	12.5	1.3
10	Waterbody Reservoir / Tanks	8.2	0.9
11	Waterbody Lake / Pond	1.8	0.2
12	Canal	0.8	0.1
13	Rural Hamlet & Dispersed Household	0.6	0.1
Total		**961.2**	**100**

The 2021 LULC analysis of MandiAdampur highlights continued urban and industrial expansion, leading to a decline in agricultural land. Increases in rural settlements, industrial areas, and open spaces reflect intensified development activities. The findings stress the need for sustainable land management to balance urban growth with the conservation of agricultural and ecological resources.

III.   Conclusion:

This study provides a comprehensive analysis of Land Use/Land Cover (LULC) changes in Mandi Adampur, District Hisar, from 2001 to 2021 using GIS and remote sensing technologies. The results highlight significant shifts in land use, particularly with the expansion of urban areas and the corresponding decline in agricultural land. Over the two-decade period, the agricultural land decreased substantially, while urban residential, industrial, and transportation areas grew, reflecting the region's urbanization trends.

Manual classification of satellite imagery combined with georeferencing of Town and Country Planning (TCP) maps enabled a detailed understanding of land use patterns and their transformation. The study revealed that urban sprawl in Mandi Adampur has gradually encroached upon agricultural zones, which is a common trend in rapidly urbanizing regions. The industrial sector also expanded, although at a slower rate compared to residential development.

These findings underline the importance of integrating remote sensing data with town planning documents to assess the impact of urban growth on land use. The study also emphasizes the need for sustainable urban planning strategies to manage the loss of agricultural land and mitigate the adverse effects of unplanned urbanization. The insights from this research will help in future land use policies and planning that aimed at balancing urban development with the preservation of agricultural lands and natural resources in Mandi Adampur. Recent years due to constraint of rising ground water level with poor infrastructure development and lack of drainage alongwith traffic congestion is hindering the urban development of the town. This town needs sustainable urban planning and land management to stop haphazard unplanned residential and commercial development of the town.

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