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Patternand Intensity of Urban Expansion in Moradabad District: A Spatio-Temporal Tehsil-Level Analysis

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Abstract: ***Urbanization is one of the major land transformation processes taking place worldwide, particularly in developing countries such as India. In recent decades, secondary cities have expanded rapidly across the globe. In this context, a comprehensive understanding of Land Use Land Cover and Urban Expansion Intensity dynamics is crucial for rational urban planning and policy formulation. This study examined the spatiotemporal pattern of urban expansion using Remote Sensing and GIS techniques. Maximum Likelihood Supervised classification and Urban Expansion Intensity Index have been utilised through satellite imagery of Moradabad district for 2004 and 2024. LULC categories help quantify the growth of various land use classes, whereas Urban Expansion Intensity measures the rate and magnitude of urban growth in Moradabad District. The results reveal a significant increase in built-up area. Particularly in Moradabad tehsil, with a 176% growth over 20 year period, contrasted by decline in agricultural land, water bodies and vegetation cover. The Tehsil-level analysis exposes the uneven growth of built-up area within the district, with very high growth in Moradabad tehsil compared to Bilari, Kanth and Thakurdwara. The findings underscore the need for urban planning, afforestation, river buffer protection and sustainable development and the integration of geospatial monitoring in developmental policies.***
Keywords: Urban Expansion Intensity, Land Use land Cover Analysis, Remote sensing and GIS

I. INTRODUCTION

Urbanization is amajor land transformation process taking place worldwide. In both developing and developed countries, the spread of urban areas into hinterlands has become a primary challenge in terms of unplanned exponential growth. This will avoid the negative effects such as loss of fertile agricultural land and deterioration of natural ecosystems. farming (Johnson, 1974). According to the World Urbanization Prospects(2025) revision report of the UN Department of Economics and Social Affairs(UNDESA), 45per cent of the world's 8.2 billion population live in cities, an increase from just 20 per cent in 1950. Projections made in the report indicate that two-thirds of the world's population growth between 2024 and 2050 will occur in urban areas. Rapid urbanization is a twentieth-century phenomenon, which began due to industrialization, economic development and population growth especially in the West. In the present century, this has shifted towards the developing countries like India. The speed and scale of urbanization have transformed the villages into towns, towns into cities and cities to mega cities like Delhi and Mumbai. Urbanisation is essentially characterised by the transformation of land use and land cover where humans are primary drivers of alterations and results in climate and ecosystem changes. (Terzi et al. 2020). Mapping and monitoring of urban growth dynamics can be performed using satellite images and spatial data. (Hai & Yamaguchi, 2007). In the past two decades, several studies have been conducted to stud urban expansion, spatial and temporal patterns of urban expansion Rubio et al. (2012), intensity and magnitude of expansion (Salem, et al.2021),monitoring land use transformations(Tiwari, Atul K. et. el. 2024), flood risk management (Zhang, Hao, et. al., 2008), future simulations (Roy B., 2021) using remote sensing and GIS. With the advancements in availability and resolution of remote sensing images, it has become possible to effectively monitor and analyse urban expansion and land use change in a timely and cost-effective manner (Yang et. al., 2002). This study deals with the patterns and trends of urban expansion and urban expansion intensity using Remote Sensing and GIS techniques. Maximum Likelihood Supervised classification and Urban Expansion Intensity Index have been utilised through satellite imagery of Moradabad district(Figure 1) for 2004 and 2024. LULC categories help quantify the growth of various land use classes whereas, Urban Expansion Intensity measures the rate and magnitude of urban growth in Moradabad District. The objectives are: (i) to map and classify the LULC of the Moradabad district for 2004 and 2024. (ii) quantify and compare the built-up area and its intensity of increase using Urban Expansion Intensity

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The Moradabad District is one of the north-western districts of Uttar Pradesh, bounded by the parallels 28.30 to 29.15 N and meridians of 78.32 to 78.9E.For better administration the district has been divided into four tehsils-from north to south: Thakurdwara, Kanth, Moradabad, Bilari(Fig1). The district forms part of the Ramganga and Ganga Plain, with a monotonous plain region with no distinct physiographic features except for river valleys and shallow depressions. The area is drained by Ramganga River, River Gangan and other smaller tributaries like Karula, Sot, Dehla.With a total population of about 8.87Lakh (Census, 2011) Moradabad has experienced high population growth: 49.4% in 2001 and 38.3% in 2011. Consequently, it has experienced urban expansion and land use changes with a growing population and infrastructural development.

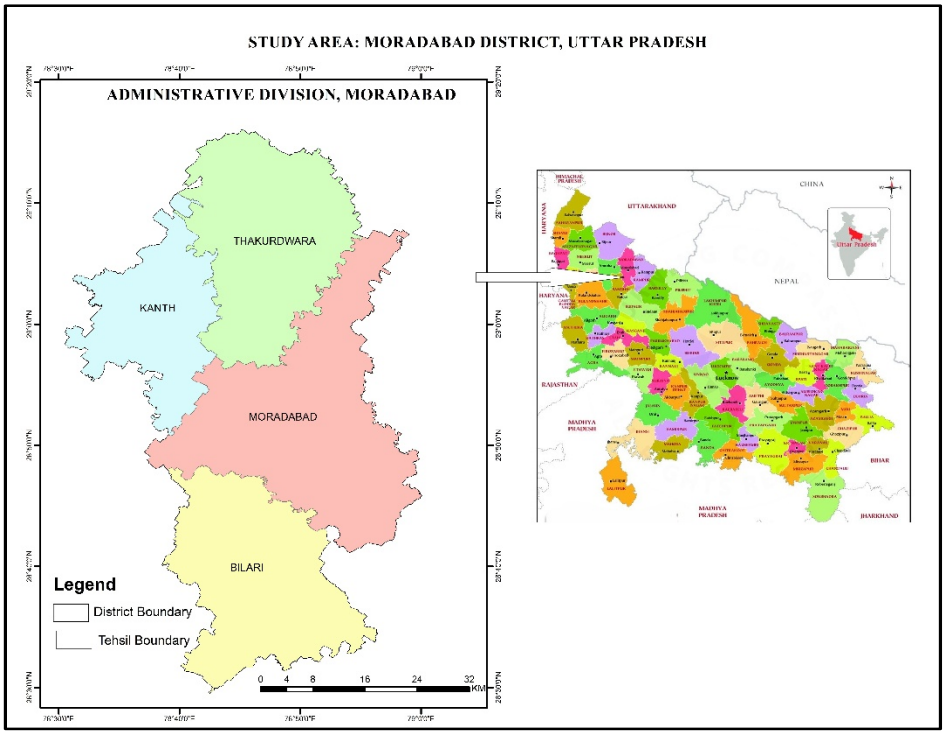


Figure 1 Study Area

II. SUMMARY OF LITERATURE

Author	Region	Main Driving Factor
Piotr Litynski et. al.	Multiple urban areas (Cracow, Warsaw etc. Poland	Economic factors, planning tradition, population changes, and availability of land for development; differences in socio-economic and territorial conditions; post-socialist suburbanization due to transition from centrally controlled to free market economy
Al-Husban, Yusra	Al-Balqa, Jordan	Rapid urbanization and environmental changes; decline in vegetation coverage; rising demands for residential land use; urban sprawl leading to reduction in agricultural and green vegetated areas
Iswari Nur Hidayati et. al.	Yogyakarta, Indonesia	Population growth, economic growth, and environmental development; uncontrolled urban growth forcing urban structure change; conversion of agricultural land and urban green space into constructed land
Hao Zhang et. al.	Foshan, China	Rapid urbanization driven by prosperous labor-intensive industries; socio-economic development and economic factors; expansion of human settlements and economic growth leading to flood risk in hinterland

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Junmei Tang and Liping Di	Delhi, India	Temporal assessment of farmland loss due to rapid urbanization due to economic development and population growth using Markov-Cellular Automation model
Mahesh Kumar Jat, Mahender Choudhary, and Ankita Saxena	Ajmer, Rajasthan	Economic development, population growth, and unplanned urbanization using satellite image land use classification and urba growth assessment
Praveen Kumar et. al.	Tirupati, India	Effects of rapid urbanization andclimate variability on vegetation(NDVI), Land Surface Temperature(LST) and Urban heat islands.

III. MATERIAL AND METHODS

Data Type	Source	Year(s)	Spatial Resolution
Satellite Imagery	Landsat 5 TM	1994	30 m
Satellite Imagery	Landsat-8 OLI	2024	30 m
Administrative Boundaries	Survey of India / Bhuvan	Latest	Vector
Population Data	Census of India	1991–2021	Statistical

Table 1: Satellite Source

IV. SOFTWARE AND TOOLS USED

- QGIS 3.28 and ArcGIS 10.8 for spatial analysis and map generation.
- ERDAS Imagine for image preprocessing and classification.
- Google Earth Engine for temporal comparisons.
- MS Excel for statistical analysis

A. Image Preprocessing

To ensure data quality and consistency for Land Use/Land Cover (LULC) mapping and built-up analysis, the satellite images Landsat 7, and Landsat 8 used in this study were preprocessed. In order to minimize atmospheric and sensor-related variations, preprocessing involved radiometric correction. Multi-temporal analysis was made possible by the spatial alignment of the images to geographic coordinates through geometric corrections and image registrations. The images were cropped to the edge of the study area and cloud and shadow masking were used to remove unnecessary pixels. Spectral band selection in spectral resolution and band designations to combine data from several sensors.

1) Land Use and land Cover classification: Supervised Classification Technique was used to categorize district into different classes: agricultural land, water body, built-up area, vegetation and other. It involves training a classification algorithm with the help of training samples and apply the trained classifier to the entire remote sensing image to assign each pixel or segment to a specific land cover class.

2) Classification Accuracy: Kappa coefficient: In remote sensing, kappa is frequently used to evaluate the precision of land cover classifications, which assign various classes to individual pixels or areas within an image. It offers a more complex assessment of classification performance rather than just accuracy, especially when there is an imbalance in the classes or when chance agreement plays a big role. The range of the kappa coefficient is 0-1.

3) Urban Expansion Intensity: Urban expansion intensity quantifies the rate and magnitude of conversion of non-urban land into built-up structures and developed areas. It measures how rapidly urbanization occurs within a metropolitan region over a specified timeframe.

Urban expansion intensity is calculated using:

$$Iue = (\Delta Ui \times 100)/ (TLA \times \Delta t)$$

where Iue is urban expansion intensity, ΔUi is urban expansion during 2004-2024, TLA is the total area of the district. The index value ranges from 0-1, where values near 0 indicate low level of urban growth and the values near one experience high level of urban growth.

This metric normalizes urban growth relative to the total available land and time duration, enabling comparative analysis of urbanization rates across different regions and time periods. Higher intensity values indicate more rapid land conversion to urban uses, reflecting stronger urban development pressure and potential environmental impacts.

V. RESULTS AND DISCUSSION

LULC Classification

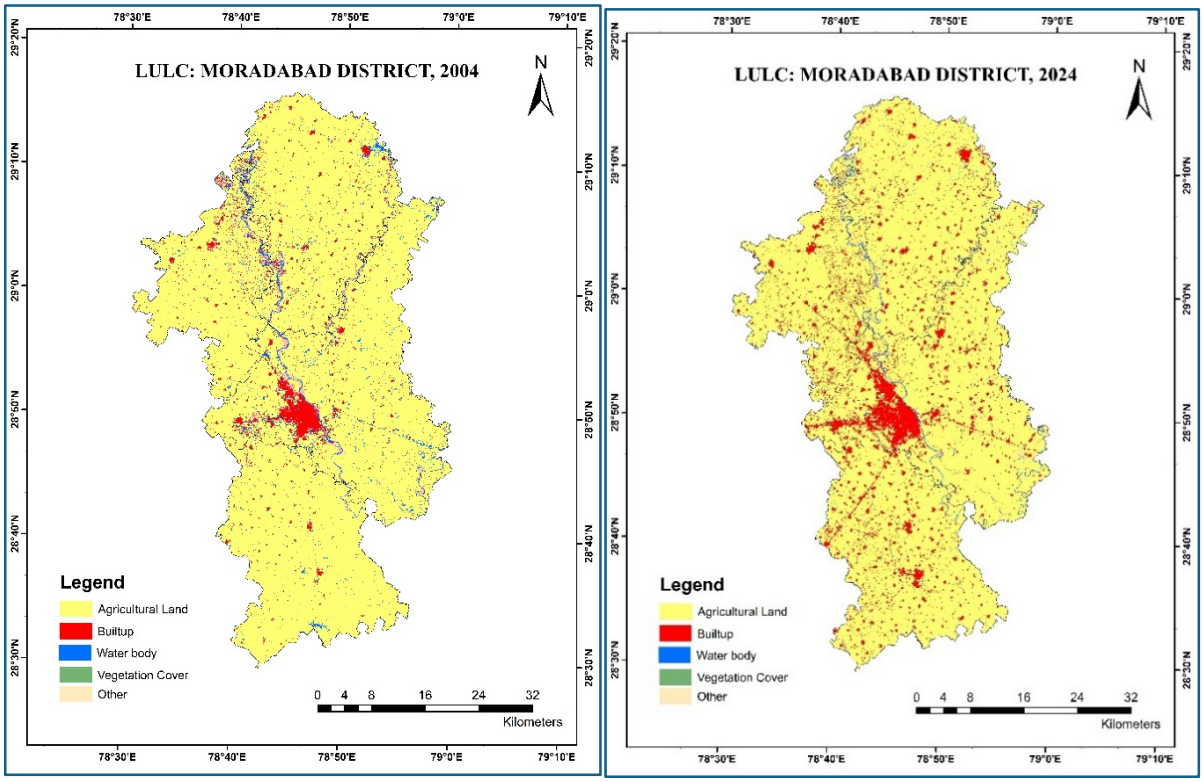


Figure: 2 LULC Moradabad District(2004-2024)

Categories	2004(Sq. Km)	2024(Sq. Km)	Change Percent
Agricultural Land	1960.2	1937.8	-1.14%
Built-Up Area	78.34	216.3	+176.2%
Water Body	57.6	28.6	-50%
Vegetation	1.3	0.56	-56%
Other	38.2	13	-65%
Total	2195	2195	

Table 2: LULC Classification Comparison (2004-2024)

Table2 presents a thorough summary of the area of land use classes in the study area and the change it experienced over a period of 20 years, i.e. from 2004-2024. Agricultural land has traditionally dominated the economic activity in the district with about 89.3% of the total area in 2004 with a slight decrease to about 88% in 2024. This indicates slight contraction in the net sown area. In contrast, the built-up area showed exponential growth of 176% increase in area. This increased the share of built-up area from merely 3.5% in 2004 to about 9.8% in the total area of the district highlighting rapid urban expansion driven by population growth, economic development and infrastructural development. Water bodies declined sharply by 50% indicating water resource depletion and encroachment of water bodies. The vegetation cover in the district is concerningly a very minor component with about 0.56sq. km reduced more than half in past two decades from 1.3 sq. km.

Overall, the table illustrates the dynamic spatial transformations in Moradabad District, with a clear trend of urban growth at the expense of agricultural land, water bodies, vegetation, and other land use

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A. Urban Expansion Intensity

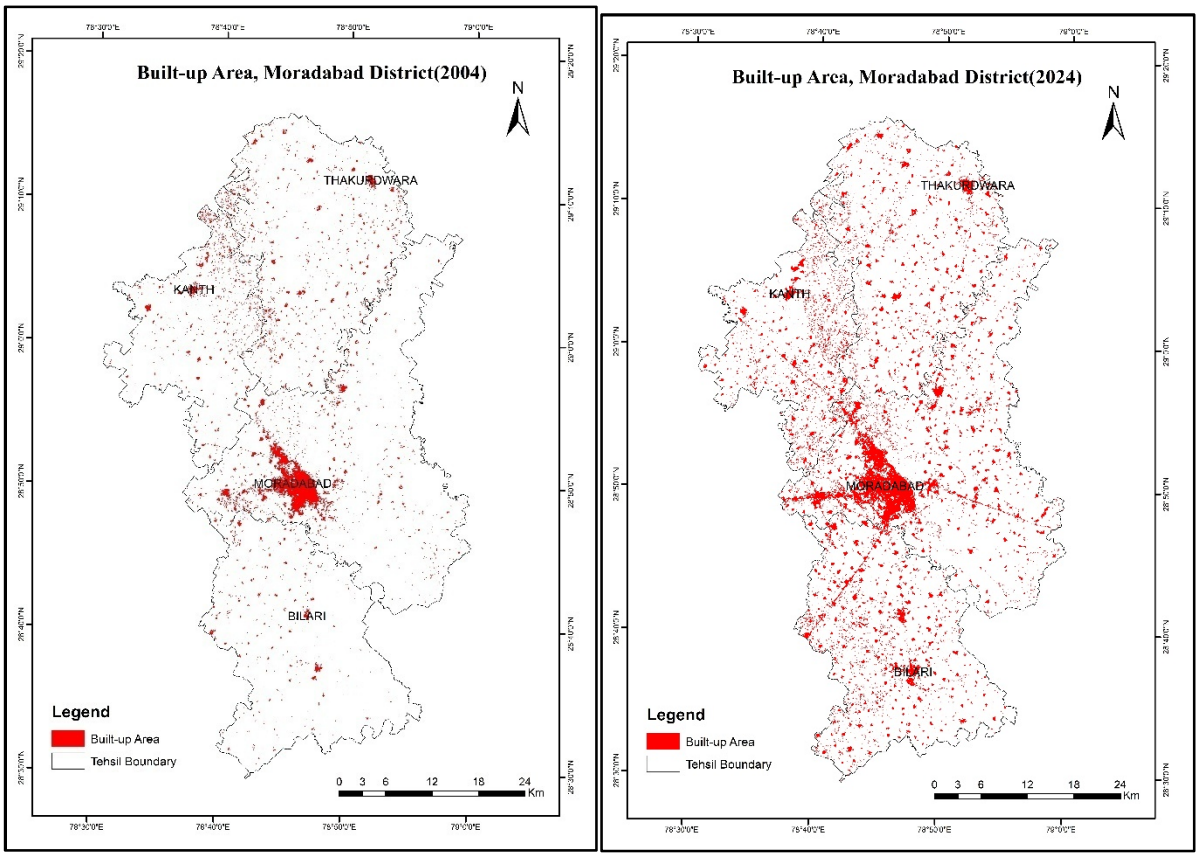


Figure: 3 Built-up Area, Moradabad District(2004-2024)

Tehsil	2004	2024	Total Area	UEI
Bilari	7.4	40.1	555.8	0.29
Kanth	14.0	33.1	366.4	0.26
Moradabad	45.2	107.1	771	0.40
Thakurdwara	18.0	35.7	547.4	0.16

Table 3: Tehsil-level Built-up Area

The table-3 presents the urban expansion intensity(UEI) across four tehsils in Moradabad District over the period of 20 years i.e., 2004-2024, highlighting spatial growth patterns. Moradabad tehsil demonstrates the highest UEI of 0.49 with its built-up area expanding from 45.2sq km to 107.1 sq. km indicating rapid urbanization. Following Moradabad Tehsil is Bilari, with 0.29 UEI where built-up land increased from 7.4 sq. km to 40.1 sq. km. Kanth has 0.26 and the least UEI is seen in Thakurdwara shows the lowest UEI at 0.16.

The variation in the UEI reveals the differing intensity of development and spatial heterogeneity at intra-district level. Such urban growth dynamics are crucial for targeted urban planning and balanced resource management.

B. Visual Representation through GIS Maps

- Temporal Change(2004-2014): Progressive urban sprawl in all districts and the enlarged urban center at Moradabad Tehsil
- Hotspots: All four Tehsils have hotspots of built-up areas along roads, river and industrial centres(Figure-3)
- Built-up Density map: High density zone occurs primarily in Moradabad tehsil (Figure 3)

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C. Accuracy Assessment

Accuracy assessment of each class of Land Use Land Cover was carried out using 200 random stratified points and cross verified using Google Earth and Google Maps.

Year	Overall Accuracy	Kappa Coefficient
2004	82.3	0.78
2024	90.5	0.88

Lower accuracy of 2004 satellite imagery is due to scan-line error in Landsat-7 image and lower resolution.

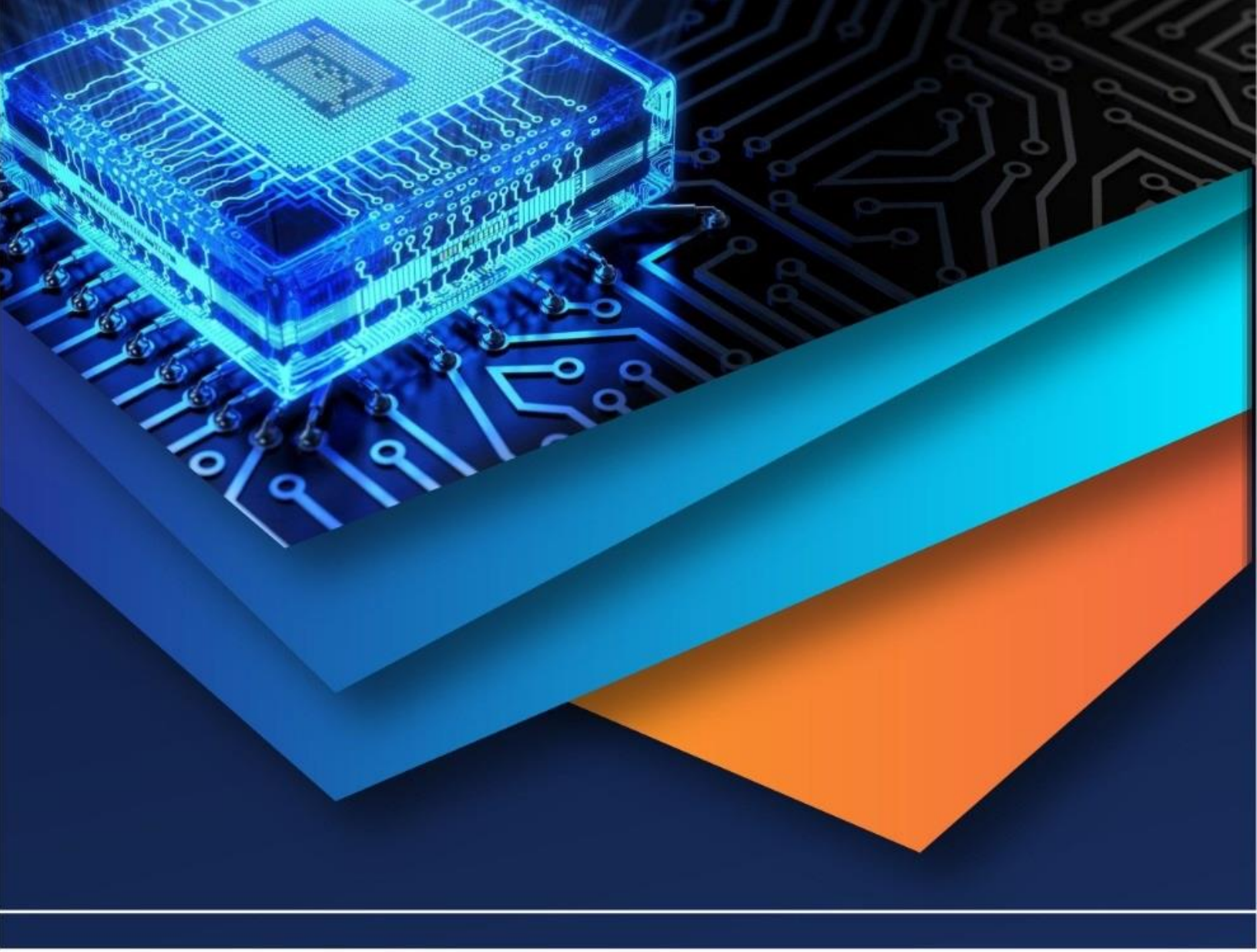
VI. CONCLUSION

The present study highlights the dynamics of urban expansion in Moradabad District over a period of two decades. The spatiotemporal transformations have been studies with the help of Remote Sensing and GIS to obtain time-efficient and accurate results. The results of Land Use/Land Cover using supervised classification highlights the prominence of agricultural land in the district with increasing built-up area at the expense of waterbody, agricultural land and vegetation cover. It also highlights the grave situation of ecology in the district with less than 1 per cent area under vegetation cover. The Tehsil-level Urban Expansion Intensity (UEI) analysis shows a considerable heterogeneity within the district, with Moradabad Tehsil experiencing significant increase in built-up area (176.2%), followed by Bilari and Kanth, while Thakurdwara shows relatively lower growth. This shows unbalanced urban development within the district and skewed urban sprawl around the administrative, industrial and transport corridor. Such growth patterns, if not checked will eventually lead to environmental degradation, depletion of water resources and reduced agricultural productivity and ultimately increased vulnerability to climate-related risks.

REFERENCES

[1] Al-Husban, Yusra. "Urban expansion and shrinkage of vegetation cover in Al-Balqa Governorate, the Hashemite Kingdom of Jordan." *Environmental Earth Sciences* 78, no. 21 (2019): 620.
[2] Bedada, B. A. (2024). *Urban Land Use Land Cover Dynamics and Urban Expansion Intensity Assessment Using Multi-Temporal Landsat Imageries and Google Earth Engine over Adama City, Ethiopia*. https://doi.org/10.20944/preprints202412.2631.v1
[3] Hai, P. M., & Yamaguchi, Y. (2007). Characterizing the Urban Growth From 1975 To 2003 of Hanoi City Using Remote Sensing and a Spatial Metric., 21(2), 104–110
[4] Indrawati, L., Sigit Heru Murti, B. S., Rachmawati, R., & Aji, D. S. (2020). Effect of Urban Expansion Intensity on Urban Ecological Status Utilizing Remote Sensing and GIS: A Study of Semarang-Indonesia. *IOP Conference Series: Earth and Environmental Science*, *451*(1). https://doi.org/10.1088/1755-1315/451/1/012018
[5] Jain, M., Dawa, D., Mehta, R., Dimri, A. P., & Pandit, M. K. (2016). Monitoring land use change and its drivers in Delhi, India using multi-temporal satellite data. *Modeling Earth Systems and Environment*, *2*(1). https://doi.org/10.1007/s40808-016-0075-0
[6] Johnson, J. H. (Eds.). (1974) Suburban growth, geographical processes at the edge of the Western city, John Wiley & Sons: London
[7] Lity´nski, P. The Intensity of Urban Sprawl in Poland. ISPRS Int. J. Geo-Inf. 2021, 10, 95. https:// doi.org/10.3390/ijgi10020095
[8] Praveen Kumar, Roshini, and J. Brema. "Integrated Assessment of Rainfall Trends and the Effects of Urbanization in the Amaravati River Basin." In *International Conference on Advances in Materials, Modeling, and Analysis for Sustainable and Resilient Infrastructure*, pp. 115-132. Singapore: Springer Nature Singapore, 2025.
[9] Roy, B., & Kasemi, N. (2021). Monitoring urban growth dynamics using remote sensing and GIS techniques of Raiganj Urban Agglomeration, India. *Egyptian Journal of Remote Sensing and Space Science*, *24*(2), 221–230. https://doi.org/10.1016/j.ejrs.2021.02.001
[10] Salem, M., Bose, A., Bashir, B., Basak, D., Roy, S., Chowdhury, I. R., Alsalman, A., &Tsurusaki, N. (2021). Urban expansion simulation based on various driving factors using a logistic regression model: Delhi as a case study. *Sustainability (Switzerland)*, *13*(19). https://doi.org/10.3390/su131910805
[11] Saxena, Ankita, Mahesh Kumar Jat, and Mahender Choudhary. "Analysis of urban growth using geospatial techniques." *image* 1000, no. 4 (1997): 28-50.
[12] Tang, Junmei, and Liping Di. "Past and future trajectories of farmland loss due to rapid urbanization using Landsat imagery and the Markov-CA model: a case study of Delhi, India." *Remote Sensing* 11, no. 2 (2019): 180.
[13] Terzi F, Tezer A, Turkay Z, Uzun O, Köylü P, Karacor E, Okay N, Kaya M (2020) An ecosystem services-based approach for decision making in urban planning. Journal of Environmental Planning and Management, 63(3):433-452
[14] Tiwari, A. K., Pal, A., & Kanchan, R. (2024). Mapping and Monitoring of Land Use/Land Cover Transformation Using Geospatial Techniques in Varanasi City Development Region, India. *Nature Environment and Pollution Technology*, *23*(1), 365–379. https://doi.org/10.46488/NEPT.2024.v23i01.031
[15] UN DESA (2025) United Nations Department of Economic and Social Affairs Population Dynamics. World Urbanization Prospects: The 2018 Revision https://population.un.org/wup/assets/Publications/undesa_pd_2024_key_messages_wup_2025.pdf
[16] Yang X, Lo CP (2002) Using a time series of satellite imagery to detect land use and land cover changes in the Atlanta, Georgia metropolitan area. Int J Remote Sens 23(9):1775–1798
[17] Zhang, Hao, Wei-chun Ma, and Xiang-rong Wang. "Rapid urbanization and implications for flood risk management in hinterland of the Pearl River Delta, China: The Foshan study." *Sensors* 8, no. 4 (2008): 2223-2239..www.mdpi.org/sensors

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