

Urban Expansion and Loss of Agricultural Land: A Spatial Analysis of Jaipur Peri-Urban Areas

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Abstract: The process of urbanization in Indian towns continues to develop which creates major effects on the nearby areas. People have converted agricultural fields into new residential areas which now include multiple shopping centers and restaurants. The research uses GIS and remote sensing methods to study land use changes which occurred in the urbanizing areas of Jaipur. Between 1997 and 2020 agricultural land lost most of its value while residential and industrial development experienced fast growth according to the study findings. The establishment of corridors which follow main transportation routes has accelerated land development activities. The research identifies three primary elements that drive urban expansion and infrastructure development and determine governmental policy decisions. The activities that people perform create environmental destruction which results in decreased groundwater supply and prevents farming communities from conducting their daily activities. The study shows that cities need environmentally friendly building methods, strict land-use management systems, and safety steps for the farmlands nearby.

Keywords: Urbanization, GIS and Remote Sensing Methods, Industrial Development, Environmental Destruction, Strict Land-Use Management Systems, Groundwater Supply etc.

I. Introduction

1.1 Background

Urbanization has become the primary factor influencing land utilization in developing countries, particularly in India. Urban areas have expanded rapidly due to population growth and economic development and infrastructure development, which has led to the loss of nearby farmland. The city of Jaipur in Rajasthan has experienced significant growth during the past three decades as a major urban center [1]. Peri-urban areas in the past functioned as vital agricultural regions which supplied food to cities and helped sustain the economic activities of nearby rural areas. The increasing need for residential and commercial and industrial facilities has led to the widespread transformation of farmland into urbanized spaces. The process of urban expansion into rural areas creates complex social and environmental challenges, which cities face when they expand their boundaries into surrounding rural lands.

1.2 Problem Statement

The fast development of Jaipur's urban area has led to complete destruction of farms located in the regions that surround the city. The process of transformation leads to three results which include diminished agricultural output and destruction of ecological systems and disturbance of rural populations. The urban sprawl that developed without restrictions created development patterns which spread across land and resulted in greater environmental destruction and depletion of vital natural resources including groundwater. Cities can expand whenever they want because there are no effective land-use regulations which creates major issues for urban development. The solution to this problem requires development of urban areas which will protect both agricultural fields and environmental resources in peri-urban zones.

1.3 Objectives of the Study

1. The research project utilizes spatial analysis techniques to investigate the temporal variations in land use and land cover patterns in the peri-urban regions of Jaipur. Its objective is to quantify the magnitude of agricultural land loss resulting from urban development and to pinpoint the precise locations of this loss within the study area.
2. The study will identify which factors most significantly drive the transformation of farmland into developed urban space.
3. The study will evaluate how urban development affects both environmental systems and social-economic conditions in the communities that border cities.
4. The research will develop policy recommendations to achieve sustainable urban development while protecting agricultural land from urban development pressures.

II. Study Area Profile

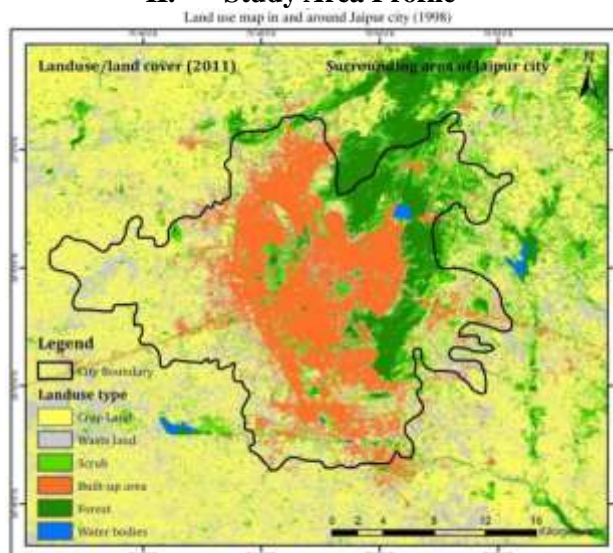


Figure 1: Assessment of Urban Sprawl and its Impact on Natural Environment in and around Jaipur city, Rajasthan, India, Source: Rajpoot, P. S. Assessment of Urban Sprawl and its Impact on Natural Environment in and around Jaipur city, Rajasthan, India.

The district of Jaipur experiences rapid urban development within its eastern Rajasthan territory. The district experiences a shift from agricultural activities toward urban development [2]. The 11000 square kilometer semi-arid area depends on groundwater resources because it receives minimal rainfall and experiences extreme temperature variations. The residents of Jagatpura, Sanganer, Bagru, and Ajmer Road and Tonk Road areas cultivated wheat, mustard, bajra, and lentils when they still lived in rural areas. The population growth and economic expansion and infrastructure development of the last three decades have caused significant changes to these urban boundaries that extend from the city [3]. The construction of residential buildings has increased because of the Jaipur International Airport and industrial development and the new highway connections that include NH-48.

Jagatpura has developed into an industrial and textile hub while Sanganer serves as a primary residential area that contains educational institutions. The Jaipur Development Authority (JDA) controls city development through its master planning and land pooling programs. The programs simplify the process of acquiring agricultural land and transforming it into urban development space [4]. The urban development projects of Jaipur now create a dynamic metropolitan space which combines different types of land use. The real estate market is growing rapidly while agricultural land is becoming smaller and traditional social systems and economic systems are experiencing changes. The upcoming changes will create effects that will transform the economy and food security situation and environmental conditions of the area.

III. Methodology

3.1 Research Design and Approach

The research utilized a quantitative spatial-analytical framework to examine urban expansion and the reduction of agricultural land in the peri-urban regions of Jaipur. The methodologies utilized encompass remote sensing data, Geographic Information System (GIS) tools, and statistical analysis to evaluate the temporal and spatial variations in land use patterns. The research methodology here utilizes data from different diverse temporal intervals to assess the magnitude nature of land transformation-based structure.

3.2 Data Sources

The study here relies on both primary spatial datasets and as well as secondary statistical sources, as summarized below:

| Data Type | Source | Purpose |
|---------------------|-------------------------------|---|
| Satellite Imagery | Landsat (USGS), Sentinel | Land Use/Land Cover (LULC) classification |
| Administrative Data | Rajasthan Government Reports | Agricultural statistics and land records |
| Census Data | Census of India | Population growth and urbanization trends |
| GIS Layers | Open-source spatial databases | Mapping and spatial analysis |
| Literature | Peer-reviewed studies | Comparative validation |

Table 1: Spatial Datasets and Secondary Statistical Source, Source: Authror Generated

3.3 Spatial Analysis Techniques

The research classified land into four primary categories which correspond to the Land Use/Land Cover (LULC) classification system. The GIS software enables researchers to achieve accurate results through supervised classification of satellite images. The research study employs change detection analysis to monitor land category transformations which occurred during two different time periods from 1997 to 2010 and from 2020 to 2021 [5]. The researchers conduct regional overlay analysis to study urban expansion patterns and the resulting farmland loss which occurred because of urban development. Buffer analysis enables users to identify growth corridors and peri-urban hotspots which extend between major roads and urban centers.

3.4 Data-Centric Spatial Workflow Diagram

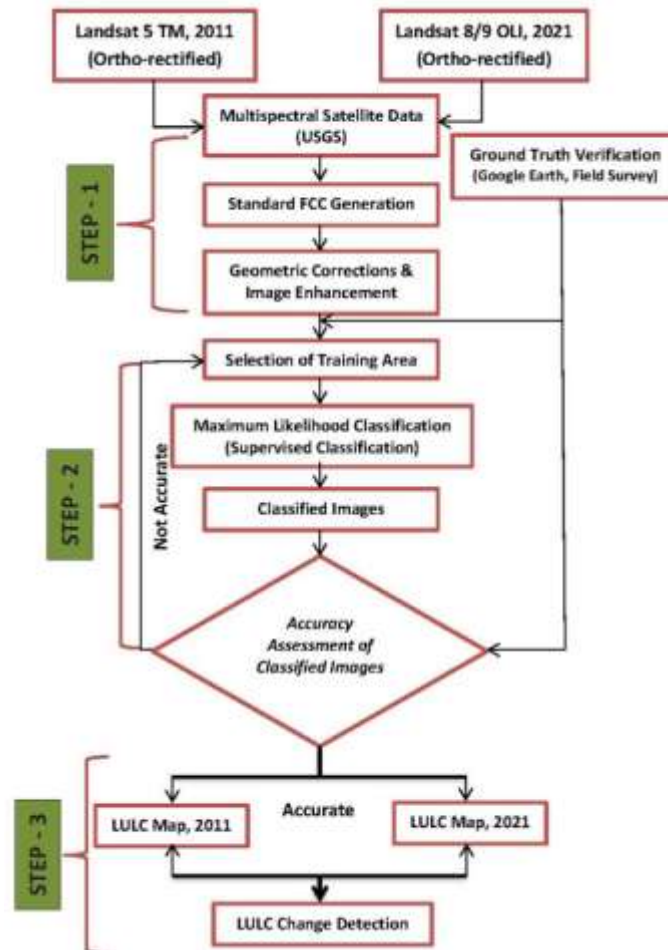


Figure 2: Monitoring ecosystem transitions and land use dynamics in the Indian Sundarbans for example using remote sensing and GIS techniques, Source: <https://doi.org/10.1007/s44288-025-00275-7>

The study's spatial process is made up of the following:

1. Getting satellite images from different time periods
2. Pre-processing georeferencing and fixing the atmosphere
3. Using trained methods to classify LULC
4. Checking for accuracy with real-world data
5. Change detection and study of spatial overlays
6. Interpretation and proof from statistics.

The research study's land change patterns can be understood through two frameworks which include Bid-Rent Theory and spatial workflow. The theory explains why land that is closer to cities and important transportation routes is worth more money which leads to more residential and commercial development. Land at the edges of Jaipur which farmers use for agricultural purposes is now being developed into built-up areas because land buyers show increased interest in purchasing the property. Theoretically, researchers can understand spatial outcomes by linking land use changes to the economic drivers that produce those changes. The research demonstrates that urban growth patterns discovered through GIS analysis of corridor areas depend

on existing infrastructure and accessibility which determine land development patterns. The combination of spatial methods with economic theory enables researchers to study urban sprawl while assessing its impact on agricultural land conversion within the research area.



Figure 3: Bid-Rent Theory and spatial workflow, Source: Author Generated

3.5 Limitations of the Study

The research study employs effective analysis techniques but it still contains multiple weaknesses [6]. The study uses medium-resolution satellite images which decrease its ability to make precise fine-scale classifications and it depends on secondary data sources to interpret the societal and economic implications of its data. The research study faces challenges in studying long-term trends because of missing periods when data becomes accessible. The combination of GIS with remote sensing technology enables researchers to achieve highly precise results when studying urban expansion and agricultural land development.

IV. Results & Spatial Analysis

4.1 Land Use Change Dynamics

The land use patterns in surrounding areas of Jaipur which extend to nearby urban centers have experienced major transformations during the past two decades. The most noticeable trend is the quick turning of farmland into built-up places, which is caused by cities growing [7]. The satellite image study from 1997 to 2010 and the research conducted in 2020 show decreasing agricultural land area and increasing residential business and industrial land use. The table clearly shows that the amount of land used for farming has decreased by about 27%, while the amount of land used for living has grown by the same amount [8]. The agricultural landscapes face direct impact from urban growth according to the evidence shown by this inverse relationship.

| Land Use Category | 1997 | 2010 | 2020 | Net Change (1997–2020) |
|-------------------|------|------|------|------------------------|
| Agricultural Land | 62% | 48% | 35% | -27% |
| Built-up Area | 18% | 30% | 45% | +27% |
| Vegetation Cover | 12% | 10% | 9% | -3% |
| Barren Land | 8% | 12% | 11% | +3% |

Table 2: Land Use/Land Cover Change in Jaipur Peri-Urban Areas (%), Source: Author Generated

4.2 Spatial Distribution of Urban Expansion

Jaipur city develops through corridor-based expansion instead of instant citywide growth. The land experiences its greatest transformation along major transport lines which include Ajmer Road extending west Tonk Road extending southeast and Delhi Road extending northeast. The routes develop both real estate and industrial sectors through their expansion. The most residential development occurs in Jagatpura and Sanganer because these areas connect to vital facilities which include airports and industrial estates. The urban development pattern shows edge expansion because built-up areas develop from the city center towards surrounding rural regions.

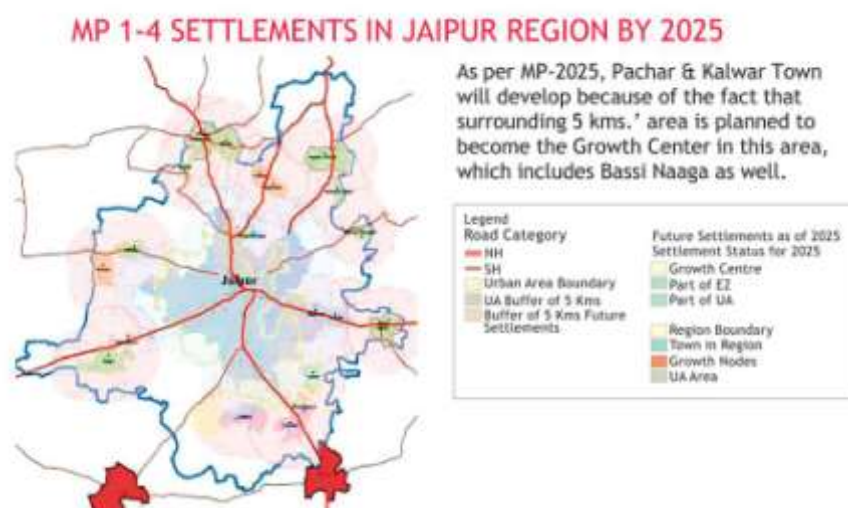


Figure 4: Jaipur Region Settlements 2025, Source: <https://www.shreeramgroup.com/projects-shubh-angan.php?>

4.3 Agricultural Land Loss Patterns

The research demonstrates that cities first convert their most productive agricultural land into urban development. The conversion process especially impacts agricultural land which lies near water sources and transportation links [9]. The chosen conversion method results in greater negative impacts on agricultural production. The period between 1997 and 2010 experienced annual farming land loss which reached between 1.5% and 2%. The following decade showed an even faster increase in the existing pace of development. The conversion matrix from the research period indicates that approximately 33% of farmland has been changed into developed spaces.

| Time Period | Agricultural to Built-up Conversion (%) |
|------------------|---|
| 1997–2010 | 18% |
| 2010–2020 | 13% |
| Total Conversion | 31% |

Table 3; Conversion Matrix (Agricultural Land to Built-up Area), Source: Author Generated

4.4 Environmental Implications (Spatial Perspective)

The areas around Jaipur which experience urban expansion face environmental decline because their natural spaces and agricultural fields have been destroyed. Urban areas that undergo increasing development show urban heat island effects through satellite measurements which document rising surface temperatures [10]. The current situation is worse because cities lost their natural land areas which stopped groundwater recharge making deep aquifers now essential for water supply. The division of farmland into smaller sections has created two negative effects which include the destruction of wildlife habitats and the degradation of soil health. The existing green buffers in the area have been replaced by impermeable surfaces which now create new patterns of water movement in the local environment.

4.5 Key Spatial Insights

1. Urban expansion mainly occurs through the development of major transportation routes.
2. The most agricultural land losses occur in locations which provide easy access and contain extensive infrastructure.
3. Urban development proceeds through circular and corridor-based patterns instead of following direct pathways.
4. Environmental degradation through urban high-density development occurs in areas which require space for its progression.

The spatial analysis demonstrates that Jaipur's peri-urban development proceeds with rapid movement and irregular distribution while economic conditions and infrastructure development decide its progression. The process results in a precise and substantial reduction of agricultural territory.

V. Discussion

The urbanization patterns around Jaipur demonstrate that city expansion results in agricultural land loss. The population growth creates two major needs for housing and city infrastructure development [11]. The economic power of Jaipur as a regional center has increased because more people from rural areas and small towns have moved to the city [12, 13]. The development of infrastructure particularly on Ajmer Road and Tonk Road has created new patterns of land use. The increased land accessibility has resulted in higher land prices which led some landowners to transform their agricultural properties into residential and commercial developments. The existing system which includes land pooling and development authority expansion plans enables developers to create extensive land changes [14].

The majority of changes generate multiple effects on different sectors. The economic benefits create better opportunities for cities to expand and create additional employment opportunities. The two factors simultaneously create negative impacts on food security and the sustainability of agricultural production. The urban heat islands develop more severe conditions because people remove vegetation and open spaces from the environment. Rural communities have adopted new work methods which have led to changes in their employment patterns [15]. The peri-urban area of Jaipur continues to grapple with its two major challenges which are growth and sustainability.

VI. Problems

Urban development which proceeds without restrictions results in chaotic land usage patterns and ineffective construction of public facilities. Continuous loss of agricultural territory produces negative effects on local food production systems while reducing environmental stability. Urban population growth combined with decreasing number of groundwater recharge areas has intensified the problem of groundwater depletion. The situation becomes more complex because land-use regulations experience insufficient implementation while integrated planning systems remain inadequate. The urgent requirement for sustainable urban management in peri-urban regions becomes more apparent through environmental damage which results in biodiversity loss and rising temperatures.

VII. Policy Suggestions

The sustainable land-use planning methods need to be implemented for solving the problems that arise from urban development in cities. The establishment of strict zoning regulations should prevent any conversion of agricultural land into different uses without proper authorization. Cities should develop upward built environments which will prevent horizontal sprawl development. The establishment of green belts and farming zones around urban areas will assist in maintaining ecological balance through environmental preservation. The integration of GIS-based monitoring tools into planning processes will enable better decision-making for professionals. The implementation of policy changes which support sustainable farming practices will provide farmers with incentives while reducing land conversion pressures. Regional growth requires a balance between urban development and environmental conservation to achieve sustainable progress.

VIII. Conclusion

The study map shows that built-up areas are growing while green spaces and farmland are getting smaller. Urban areas provide better environmental protection together with sustainable food production for growing populations. The study results demonstrate that effective regulations and planning systems together with strategic approaches are essential for achieving sustainable development goals. The implementation of sustainable development requires creating an equilibrium between urban development and agricultural conservation which will protect environmental stability while supporting Jaipur's expanding urban areas.

Reference

- [1]. Kafy, A. A., Naim, N. H., Khan, M. H. H., Islam, M. A., Al Rakib, A., Al-Faisal, A., & Sarker, M. H. S. (2021). Prediction of urban expansion and identifying its impacts on the degradation of agricultural land: A machine learning-based remote-sensing approach in Rajshahi, Bangladesh. In *Re-envisioning remote sensing applications* (pp. 85-106). CRC Press.
- [2]. Shaw, R., & Das, A. (2018). Identifying peri-urban growth in small and medium towns using GIS and remote sensing technique: A case study of English Bazar Urban Agglomeration, West Bengal, India. *The Egyptian Journal of Remote Sensing and Space Science*, 21(2), 159-172.
- [3]. Zhao, C., Jensen, J., Weng, Q., & Weaver, R. (2018). A geographically weighted regression analysis of the underlying factors related to the surface urban heat island phenomenon. *Remote Sensing*, 10(9), 1428.
- [4]. AITHAL, B. H. (2019). TV RAMACHANDRA.
- [5]. Al Kafy, A., Al Rakib, A., Akter, K. S., Rahaman, Z. A., Jahir, D. M. A., Subramanyam, G., ... & Bhatt, A. (2021). The operational role of remote sensing in assessing and predicting land use/land cover and seasonal land surface temperature using machine learning algorithms in Rajshahi, Bangladesh. *Applied Geomatics*, 13(4), 793-816.

- [6]. Udas-Mankikar, S., & Driver, B. (2021). Blue-green infrastructure: An opportunity for Indian cities. ORF occasional paper, 317.
- [7]. Qiao, Z., & Yuan, X. (2021). Urban land-use analysis using proximate sensing imagery: a survey. *International Journal of Geographical Information Science*, 35(11), 2129-2148.
- [8]. Alkhelaiwi, M., Boulila, W., Ahmad, J., Koubaa, A., & Driss, M. (2021). An Efficient Approach Based on Privacy-Preserving Deep Learning for Satellite Image Classification. *Remote Sens.* 2021, 13, 2221.
- [9]. Chatterjee, S., & Roy, S. (2021). Land use land cover dynamics with the outgrowth of Burdwan town (India): problems with sustainable solutions. In *Modern Cartography Series* (Vol. 10, pp. 603-626). Academic Press.
- [10]. Ellis, E. C., Beusen, A. H., & Klein Goldewijk, K. (2020). Anthropogenic biomes: 10,000 BCE to 2015 CE. *Land*, 9(5), 129.
- [11]. Seto, K. C., Güneralp, B., & Hutyrá, L. R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, 109(40), 16083-16088.
- [12]. Blei, A. M., Angel, S., Civco, D. L., Liu, Y., & Zhang, X. (2018). Accuracy assessment and map comparisons for monitoring urban expansion: the Atlas of urban expansion and the global human settlement layer. Lincoln Institute of Land Policy: Cambridge, MA, USA.
- [13]. Gong, P., Li, X., & Zhang, W. (2019). 40-Year (1978–2017) human settlement changes in China reflected by impervious surfaces from satellite remote sensing. *Science Bulletin*, 64(11), 756-763.
- [14]. Dadashpoor, H., & Ahani, S. (2019). Land tenure-related conflicts in peri-urban areas: A review. *Land use policy*, 85, 218-229.
- [15]. Liu, F., Zhang, Z., Zhao, X., Wang, X., Zuo, L., Wen, Q., ... & Liu, B. (2019). Chinese cropland losses due to urban expansion in the past four decades. *Science of the Total Environment*, 650, 847-857.