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MONITORING URBAN EXPANSION AND AGRICULTURAL LAND TRANSFORMATION IN KAMRUP METROPOLITAN, ASSAM: A GEOSPATIAL ANALYSIS

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ABSTRACT

Rapid urban expansion in and around Guwahati has reshaped the physical and socio- economic landscape of Kamrup Metropolitan district over the past two decades. This study evaluates the extent and pattern of agricultural land transformation in three sub- urban centres, Azara, Chandrapur, and Sonapur, between 1999 and 2024. Using multi- temporal satellite imagery sourced from USGS and Bhuvan, Land Use/Land Cover (LULC) maps were generated through supervised classification, supported by field verification. NDVI analysis was carried out to assess vegetation health and identify shifts in agricultural intensity. The spatial datasets were complemented by primary household surveys to understand local perceptions and the socio-economic drivers of land conversion. The results reveal a steady decline in agricultural land, accompanied by a marked increase in built-up areas that expanded outward from Guwahati's urban core. Agricultural land losses were most pronounced in Azara, where residential growth and institutional development have accelerated land conversion. Chandrapur and Sonapur, though still semi-rural, show emerging transition zones where agricultural plots are giving way to real estate, commercial activities, and transport infrastructure. NDVI values indicate a gradual reduction in vegetation density, reflecting both land conversion and increasing pressure on remaining agricultural fields. Survey responses highlight rising land prices, improved connectivity, livelihood shifts, and changing aspirations as major drivers behind the transformation. Overall, the study demonstrates how urban expansion has reshaped peri-urban agriculture, with implications for food security, ecological stability, and regional planning. The findings reinforce the need for spatially informed land governance and sustainable development measures to balance urban growth with the preservation of critical agricultural land.

KEYWORDS: Urban expansion, Agricultural land transformation, LULC change detection, NDVI analysis, Peri-urban dynamics.

1. INTRODUCTION

Agriculture continues to play a central role in sustaining rural economies across India, supporting nearly half of the country's population and shaping patterns of land use in both rural and peri-urban regions (Patel et al., 2019). Rapid urban expansion and peri- urban land transformation have been widely documented across developing regions, particularly in Asia and Africa, where urban growth increasingly encroaches upon agricultural and natural landscapes (Seto et al., 2011; Cohen, 2006; Lambin et al., 2003; Foley et al., 2005; Weng, 2001). Though, over the past few decades, rapid urban expansion, infrastructure growth, and demographic pressures have intensified competition for land, especially in areas situated along the rural-urban transition belt (Ma ey al., 2018). These interactions have accelerated the conversion of agricultural landscapes into built-up zones, frequently altering local livelihoods, ecological processes, and regional planning priorities (Asabere et al., 2020). Within this broader national context, Assam presents a distinctive case, where environmental vulnerability, a predominantly agrarian economy, and expanding urban centres intersect to produce complex land-use dynamics. The Kamrup Metropolitan district, anchored by Guwahati, the largest city in Northeast India, exemplifies these processes with particular clarity.

In India, several studies have highlighted the rapid transformation of peri-urban landscapes under population pressure, infrastructure expansion, and economic transition (Joshi and Bharti, 2015; Patil and Shinde, 2018; Sharma and Kumar, 2020), with similar patterns reported from Assam and the Brahmaputra Valley region (Ahmed and Gogoi, 2015; Das and Deka, 2019; Dutta and Sarma, 2020).Although Guwahati's urban footprint has expanded steadily since the 1990s, its adjoining sub-urban regions have experienced even more rapid and spatially uneven transformations. Locations such as Azara, Chandrapur, and Sonapur, once dominated by paddy fields, wetlands, and low-density settlements, are now undergoing structural shifts driven by rising land values, transportation linkages, developmental institutions, and changing aspirations of rural households. As agricultural land parcels shrink or fragment, the consequences extend beyond land availability; they influence vegetation health, water resources, and socio- economic stability. The decline in agricultural space also raises concerns about long-term sustainability, particularly in a state where rural communities remain highly dependent on cultivation and allied activities Advances in Remote Sensing and Geographic Information Systems (GIS) now offer powerful tools to map and evaluate such transformations with greater precision. Multi-temporal satellite imagery enables continuous monitoring of Land Use/Land Cover (LULC) transitions, while Normalized Difference Vegetation Index (NDVI) assessments help quantify changes in vegetation vigour and agricultural intensity over time (Bojago, et al., 2025). Together, these methods provide a spatial and temporal understanding of how urban pressures reconfigure agricultural landscapes, allowing researchers to link environmental shifts with socio-economic drivers on the ground. Applying these tools to Kamrup Metropolitan is particularly significant, given the absence of micro-level, long- term datasets for Assam's peri-urban regions and the pressing need for empirically grounded land-management strategies.

In this context, the present study undertakes a 25-year assessment (1999–2024) of urban expansion and agricultural land transformation in the sub-urban areas of Kamrup Metropolitan district. Using a combination of LULC classification, NDVI analysis, and primary household surveys, the research traces patterns of agricultural decline, identifies spatial hotspots of change, and examines the local drivers shaping land conversion. By integrating geospatial evidence with socio-economic insights, the study provides a comprehensive understanding of how peri-urban spaces evolve under the influence of an expanding metropolitan core. The findings aim to contribute to policy debates on sustainable land governance, food-system resilience, and balanced regional development in Assam.

2. STUDY AREA

Kamrup Metropolitan District in the Brahmaputra Valley has undergone rapid peri-urban expansion due to Guwahati's growth, resulting in substantial conversion of agricultural land and natural vegetation (Ahmed and Gogoi, 2015; Das and Deka, 2019). Previous studies identify the district's peri-urban fringe as highly vulnerable to unplanned land-use change and ecological stress, making it suitable for long-term LULC and NDVI analysis (Borah and Goswami, 2018; Dutta and Sarma, 2020). The study focuses on three peri-urban localities, Azara, Chandrapur, and Sonapur, situated within the Kamrup Metropolitan district of Assam, in Northeast India. The district represents one of the most rapidly transforming urban regions in the Brahmaputra Valley, shaped by Guwahati's expanding metropolitan influence. Geographically positioned between 26°05′ to 26°12′ N and 91°35′ to 91°55′ E, Kamrup Metropolitan encompasses a transition zone where fertile agricultural plains meet undulating hill tracts, producing a heterogeneous ecological and socio-economic landscape (Fig. 1). Assam's physiography is broadly divided into major landform units, including the alluvial Brahmaputra Valley and the Barak Valley, separated by the hill ranges such as the Karbi Anglong and North Cachar (Barail) Hills, which mark the intervening highlands between these basins (Assam State Disaster Management Plan (ASDMP), 2022). Kamrup Metropolitan district lies within the Brahmaputra Valley on the southern bank of the Brahmaputra River, occupying predominantly fertile alluvial plains with scattered low hills and wetland features characteristic of the region (ASDMP, 2022). The district includes the state capital region of Dispur and the metropolitan core of Guwahati, where rapid urban expansion and developmental pressures are leading to notable peri- urban land-use changes in adjoining rural settlements.

Azara: Located on the western fringe of Guwahati, Azara lies within a gently undulating terrain shaped by alluvial deposits of the Brahmaputra. The locality is characterized by fertile plains, scattered low hills, and small drainage channels flowing northwards. Its proximity to major institutions, most notably the Indian Institute of Technology (IIT) Guwahati, has accelerated residential growth and commercial development. Agricultural land, historically used for paddy cultivation, is increasingly being converted to built-up spaces as road networks and land markets expand.

Chandrapur: Situated to the east of the metropolitan core, Chandrapur occupies a mixed landscape of floodplain agriculture and adjoining hill systems. It lies near the confluence of the Digaru and Kalang rivers with the Brahmaputra, making the region ecologically sensitive and hydrologically dynamic. The southern and southeastern tracts of Chandrapur merge with the forested slopes of the Amchang Wildlife Sanctuary, creating a transitional environment where agricultural fields, forest patches, and rural settlements coexist. Seasonal flooding, land availability, and increasing urban spillover from Guwahati collectively influence land-use decisions in this locality.

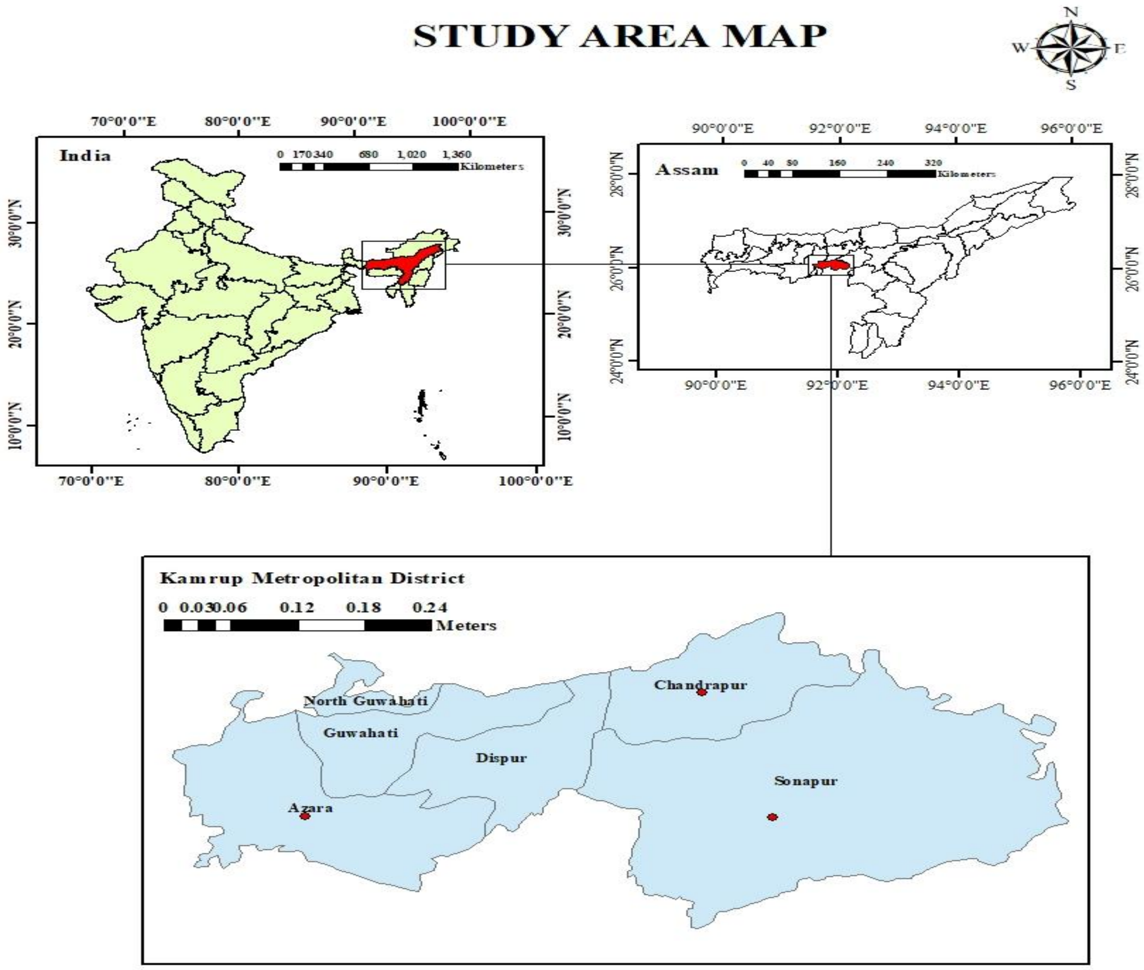

Fig. 1: Study Area.

Sonapur: Sonapur, located approximately 20 km east of Guwahati along National Highway 27, marks a distinct hill-plain interface between the Brahmaputra lowlands and the rising spurs of the Meghalaya Plateau. Its topography is characterised by undulating uplands, low-lying agricultural plains, and networked water bodies fed by the Digaru and Kalang rivers. Historically agrarian, Sonapur is now undergoing rapid transformation driven by improved connectivity and emerging commercial activities. The presence of wetlands, forest margins, and expanding built-up clusters make it a critical site for examining land- use transitions under urban influence.

2.1. Climate and Ecological Characteristics

The region experiences a humid subtropical monsoon climate, with heavy rainfall between June and September and mild winters from November to February. Annual rainfall ranges between 1,700-2,500 mm, supporting rich vegetation in both the lowlands and adjoining hill tracts. Kamrup Metropolitan falls within the broader Indo-Burma Biodiversity Hotspot, hosting diverse flora and fauna, especially in areas adjoining Amchang Wildlife Sanctuary and other reserved forests. The ecological sensitivity of this transitional landscape heightens the implications of land conversion and declining vegetation cover.

3. DATABASE AND METHODOLOGY

The present study adopts an integrated methodological approach combining spatial datasets, multi-temporal satellite imagery, household-level primary data, and secondary literature to develop a comprehensive analytical framework for examining land-use transformation in the peri-urban areas of Kamrup Metropolitan district. The core spatial datasets comprise multi-temporal satellite images acquired from the USGS Earth Explorer, Bhuvan Geoportal, and Google Earth Pro. Imagery corresponding to selected benchmark years between 1999 and 2024 was used to capture long-term landscape dynamics and urban expansion processes. These datasets were employed to generate Land Use/Land Cover (LULC) maps and to assess vegetation dynamics through the Normalized Difference Vegetation Index (NDVI).

The LULC classification scheme adopted in this study follows established remote sensing classification frameworks as proposed by Anderson et al. (1976). Vegetation condition and temporal variability were evaluated using NDVI, a widely recognized indicator of vegetation vigour and biomass productivity (Tucker, 1979; Carlson & Ripley, 1997; Xian & Crane, 2005). Together, LULC and NDVI analyses provide complementary insights into spatial patterns of land transformation and ecological change associated with suburban expansion.

In addition to remote sensing data, the study incorporates primary information collected from 30 households each across the peri-urban localities of Azara, Chandrapur, and Sonapur. A stratified random sampling technique was employed to ensure representation across different settlement types. The household survey captured information on occupational structure, land ownership patterns, livelihood transitions, and local perceptions of urban expansion and land-use change. Furthermore, secondary sources—including government reports, village directories, census publications, and peer-reviewed research—were systematically reviewed to contextualize observed spatial trends and to support interpretation of agricultural and socio-economic transformations in the region.

Following data compilation, a structured methodological framework was implemented to quantify and interpret land-use change over the 25-year study period. Pre-processed satellite images were classified using a supervised classification approach based on the Maximum Likelihood algorithm, enabling the categorization of land into agricultural land, built-up areas, vegetation, water bodies, fallow land, and other relevant classes. Training samples for classification were identified through field familiarity, visual interpretation of high-resolution imagery, and reference to historical satellite data. Classification accuracy was evaluated using confusion matrices and Kappa statistics to ensure the reliability of LULC outputs prior to temporal comparison. Comparable RS– GIS-based approaches have been widely applied in both Indian and international studies to assess land-use dynamics (Reddy & Areendran, 2012; Kumar & Pandey, 2013).

Subsequently, LULC maps generated for each benchmark year were compared to determine the magnitude and direction of land-use transitions, with particular emphasis on the conversion of agricultural land and the spatial expansion of built-up areas in the suburban fringe of Kamrup Metropolitan district (Fig. 2).

To understand vegetation health and agricultural intensity, NDVI values were computed for three time points, 2001, 2013, and 2024, using the red and near-infrared bands of satellite images. The NDVI outputs were categorized into low, medium, and high vegetation density zones, enabling the identification of declining vegetation cover, shifts in agricultural activity, and areas experiencing increasing anthropogenic pressure.

The socio-economic component of the methodology involved organising household survey responses into structured tables and analysing them through descriptive statistics. Parameters such as land-use decisions, livelihood diversification, perceived drivers of agricultural decline, and impacts on income and productivity were examined. Graphs and charts were used to support interpretation and highlight differences across the three study localities.

Finally, spatial and socio-economic findings were integrated to develop a holistic understanding of land-use dynamics in Kamrup Metropolitan. This combined approach enabled the study to link observable geospatial trends with ground-level livelihood realities, highlighting the interplay between urban expansions, agricultural land shrinkage, and changing socio-economic conditions in peri-urban Assam.

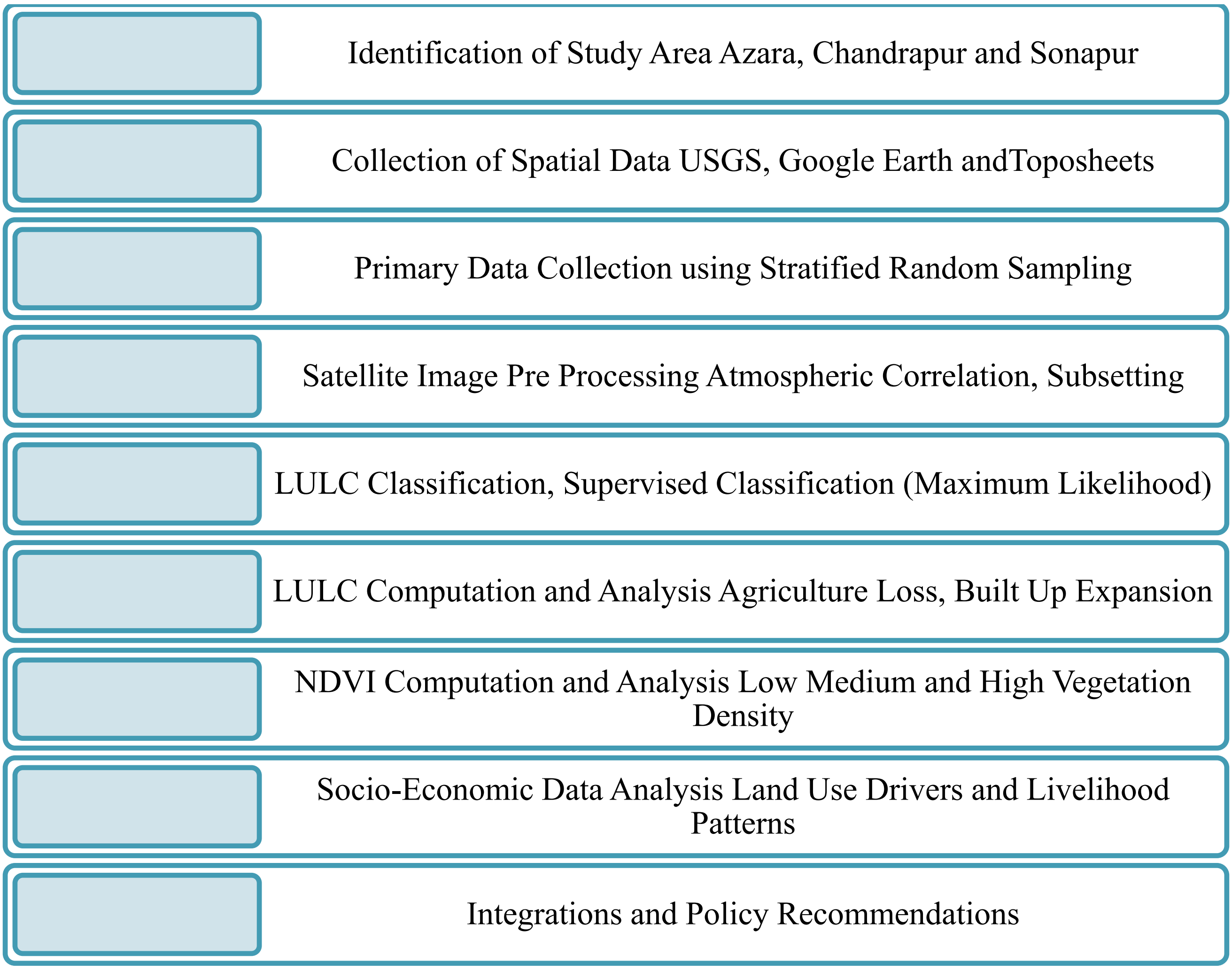

Fig. 2: Database and Methodology

4 RESULT AND DISCUSSION

4.1. Land Use/Land Cover Change (1999-2024)

Remote sensing and GIS-based approaches have proven effective for monitoring long- term land use/land cover (LULC) dynamics and urban sprawl at multiple spatial scales (Anderson et al., 1976; Bhatta, 2010; Jat et al., 2008; Dewan and Yamaguchi, 2009; Roy et al., 2015; Chandrasekar et al., 2010). The LULC analysis shows a clear shift from natural and agricultural land toward built-up surfaces across Kamrup Metropolitan District. In 1999, agricultural land accounted for 11% of the district's area, distributed in scattered patches between natural vegetation and settlement zones. Natural vegetation dominated the southern, south-western, and eastern regions at that time, forming large contiguous green belts (Fig. 3).

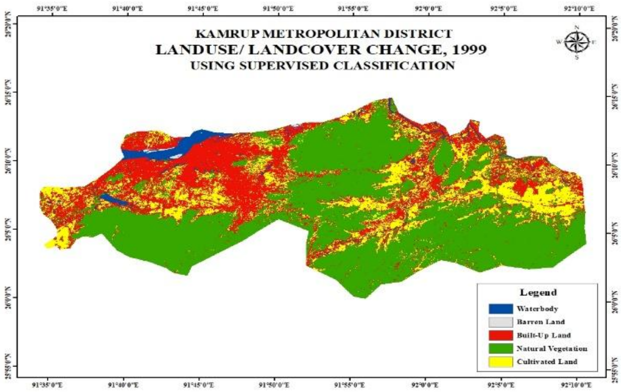

Figure 3: Landuse/Landcover map of Kamrup Metropolitan District, 1999.

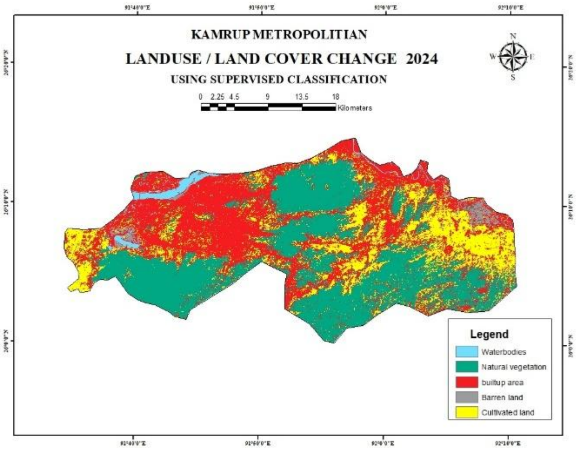

Fig. 4: Landuse/Landcover map of Kamrup Metropolitan District, 2024.

By 2024, the district experienced substantial land conversion driven by rapid urban expansion. Built-up areas became the most dominant feature, spreading extensively across central and western zones and expanding outward into peri-urban localities such as Azara, Chandrapur, and Sonapur (Fig. 4). The observed increase in built-up area and decline in agricultural land in Kamrup Metropolitan is consistent with findings reported from other Indian and Asian peri-urban regions (Mukherjee & Singh, 2021; Seto et al., 2011; Zhang & Seto, 2011). Some of the major transformations include are:

Azara shows a sharp and continuous rise in built-up area, increasing from 400 ha in 1999 to 1,800 ha in 2024, making it the fastest-urbanizing zone among the three areas. Agriculture declines from 2,200 ha to 1,000 ha, reflecting a 55% loss as farmland is rapidly converted to residential and institutional uses. Natural vegetation decreases even more sharply, falling from 1,800 ha in 1999 to 900 ha in 2024, representing a 50% reduction due to clearing, construction, and land fragmentation. Water bodies shrink steadily from 1,750 ha to 900 ha, indicating a 48% decrease and suggesting the loss or modification of wetlands during urban expansion. Barren land gradually increases from 250 ha to about 360 ha, indicating ongoing land clearing and surface exposure linked to continuous development (Fig. 5).

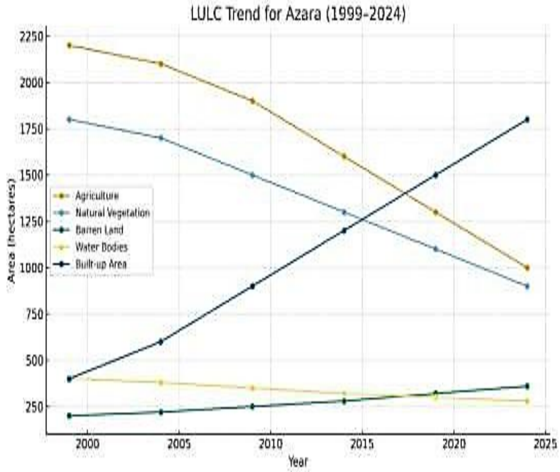

Fig. 5: Land Use/ Land Cover Trend of Azara from 1999 to 2024.
Source: Prepared by Researcher, 2025.

Chandrapur shows a steady rise in built-up area, increasing from 350 ha in 1999 to 1,500 ha in 2024, reflecting gradual but persistent urban influence. Agricultural land decreases from 2,600 ha to 1,800 ha, indicating a 31% reduction over the 25-year period. Natural vegetation also declines from 3,000 ha in 1999 to 2,100 ha in 2024, marking a 30% loss as semi-rural landscapes become fragmented. Barren land increases from 150 ha to 280 ha, showing nearly a doubling, which suggests ongoing clearing and construction activities. Water bodies show a minor decline from 500 ha to 450 ha, indicating relatively stable hydrological conditions compared to the other land-cover classes (Fig. 6).

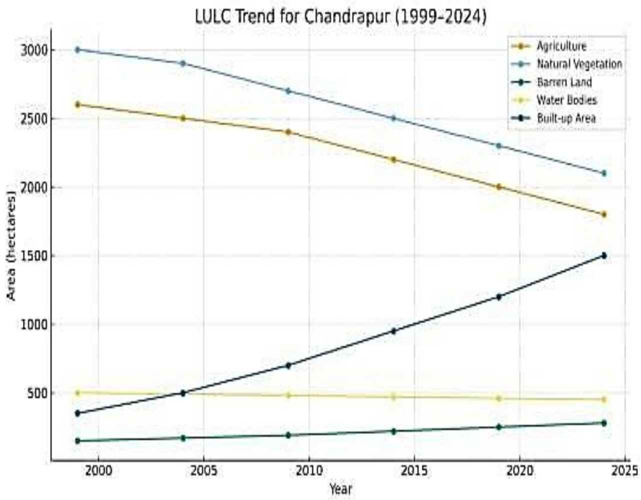

Fig. 6: Land Use/ Land Cover Trend of Chandrapur from 1999 to 2024.
Source: Prepared by Researcher, 2025.

Sonapur shows a steady increase in built-up area, rising from 250 ha in 1999 to 1,400 ha in 2024, reflecting gradual peri-urban expansion. Agricultural land declines from 3,000 ha to 2,300 ha, indicating a 23% reduction over 25 years. Natural vegetation decreases from 4,200 ha to 3,400 ha, marking a 19% loss as rural landscapes slowly fragment. Barren land increases from 120 ha to 250 ha, more than doubling, due to clearing and ongoing development activities. Water bodies reduce slightly from 600 ha to 520 ha, showing a 13% shrinkage, likely linked to wetland modification and land conversion (Fig. 7).

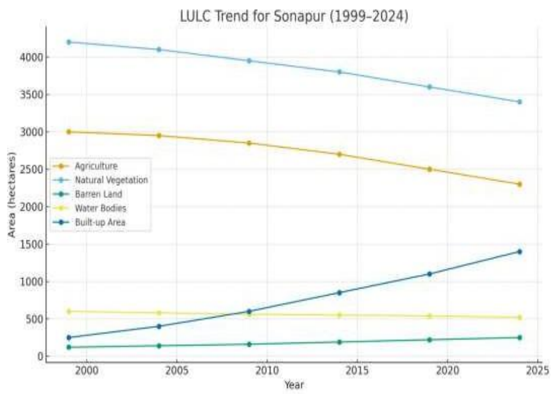

Fig. 7: Land Use/ Land Cover Trend of Sonapur from 1999 to 2024.
Source: Prepared by Researcher, 2025.

These patterns reflect the transition of the district from a mixed rural–urban system to a predominantly urbanizing landscape.

1. Built-up Expansion Patterns

Built-up expansion is concentrated in three peripheral growth hubs: Azara shows the most aggressive expansion, where settlements, institutions, and commercial establishments have encroached into cultivated land and natural vegetation zones.

Chandrapur built-up increase is moderate but expanding along major transportation corridors and near waterbodies, reflecting typical peri-urban transition patterns.

Sonapur development remains comparatively dispersed, yet steady transformation is observed toward residential and service-related land uses, particularly near the NH-27 corridor.

Overall, urban growth radiates outward from Guwahati, forming a continuous zone of expansion toward western and eastern suburban clusters.

1. Agricultural Land Transformation

Agricultural land in Azara, Chandrapur, and Sonapur shows a steady decline between 2001 and 2013 as rural spaces transitioned toward urban and peri-urban functions. Household data confirm that urban expansion is the primary driver of this shift, reported by 7 respondents in Azara, 4 in Chandrapur, and 8 in Sonapur. Industrialization and infrastructure developments, though less frequent, also contributed, particularly in the rapidly transforming belts around Azara and Sonapur.

The consequences of this decline are evident in farmers' experiences. Reduced cultivable land was reported by 3 households in Azara, 1 in Chandrapur, and 4 in Sonapur, alongside concerns over soil degradation, water scarcity, and rising production costs. These pressures have collectively weakened the viability of traditional cultivation. As a result, cropping patterns have begun to change. Soil degradation, climate variability, and the conversion of farmland for non-agricultural uses have pushed farmers to adjust or reduce cropping intensity, reflecting the broader trend of fragmented and increasingly marginal agriculture in Kamrup Metropolitan's peri-urban landscape.

NDVI Change Analysis

NDVI analysis across the study period indicates a clear decline in vegetation health as urbanization intensified. In 2001, very low NDVI values ranging from –0.13 to 0.018 were concentrated in the district's urban core and in emerging peri-urban pockets around Azara and Chandrapur, reflecting limited vegetation cover in these zones. By 2013, moderate vegetation persisted in semi-rural areas, though increasing fragmentation signalled growing development pressures. Declining NDVI trends in peri-urban areas have also been reported in earlier studies, linking vegetation loss with urban expansion and land conversion pressures (Herold et al., 2003; Mundia & Aniya, 2006; Ouedraogo et al., 2010).

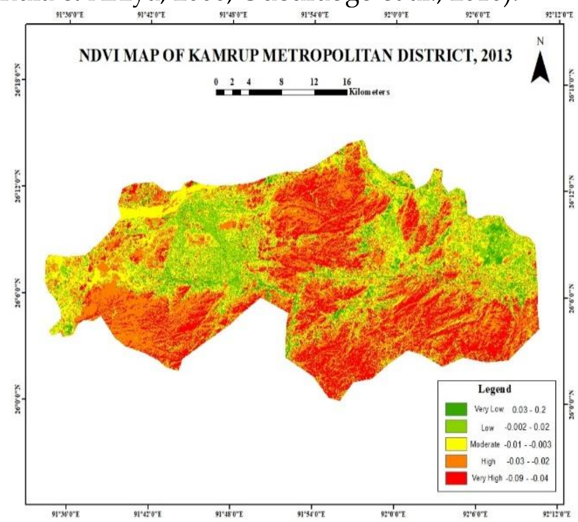

Fig. 8: NDVI Map of Kamrup Metropolitan District, 2013.

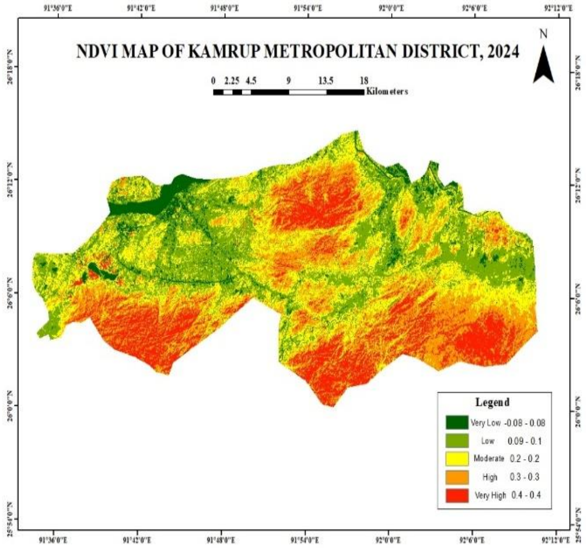

Fig. 9: NDVI Map of Kamrup Metropolitan District, 2024.

By 2024, high NDVI values (0.29 to 0.45) were largely restricted to the southern and southeastern regions particularly around Jorabat, Sonapur, and Basishtha, where dense vegetation and agroforestry systems continue to exist. In contrast, low NDVI values dominated the northern and central parts of the district, aligning with expanding settlement areas.

Overall, the spread of low NDVI zones reflects the conversion of cropland and natural vegetation into built-up land, while moderate NDVI pockets in Chandrapur and Sonapur suggest ongoing agricultural activity, though increasingly constrained by urban expansion (Fig. 8 and Fig. 9). Azara shows the strongest vegetation decline, with Very Low NDVI rising sharply from 300 ha (2001) to 890 ha (2024) due to intense built-up growth. Low NDVI also increases from 900 ha to 1,480 ha, reflecting expanding settlements and reduced agricultural cover. Moderate NDVI decreases from 1,400 ha to 900 ha, indicating substantial loss of mixed vegetation and cropland. High NDVI falls by more than half, from 700 ha to 330 ha, showing fragmentation of healthy vegetation. Very High NDVI almost disappears (from 100 ha to 20 ha), proving Azara has undergone the deepest ecological degradation among the three areas (Table 1).

Table 1: NDVI Classification for Azara (2001–2024).

NDVI Class	2001	2013	2024	Interpretation
Very Low	300	520	890	Buit-up expansion causing major vege
Low	900	1200	1480	Urban expansion and reduced agriculture
Moderate	1400	1120	900	Decline in cultivated land and scrub vegetation
High	700	520	330	Rapid reduction in dense vegetation
Very High	100	60	20	Only small forest remnants survive

Source: Calculated and computed in GIS software by Researcher, 2025.

Chandrapur shows a moderate increase in low-value NDVI, with Very Low NDVI rising from 250 ha (2001) to 600 ha (2024), reflecting gradual peri-urban influence. Low NDVI increases from 1,100 ha to 1,540 ha, suggesting thinning vegetation and expanding built-up pockets. Moderate NDVI declines from 2,100 ha to 1,720 ha, marking steady loss of agricultural and mixed vegetation areas. High NDVI decreases from 1,350 ha to 1,020 ha, indicating controlled but continuous vegetation reduction. Very High NDVI shrinks slightly from 200 ha to 130 ha, confirming Chandrapur is experiencing measured ecological change, slower than Azara but still significant (Table 2).

Table 2: NDVI Classification for Chandrapur (2001–2024).

NDVI Class	2001	2013	2024	Interpretation
Very Low	250	390	600	Patchy urban influence around corridors
Low	1,100	1,350	1540	Gradual vegetation thinning
Moderate	2,100	1,950	1720	Moderate loss of mixed vegetation and farmlands
High	1,350	1,180	1020	Slow but steady decline
Very High	200	170	130	Forest patches slightly shrinking

Source: Calculated and computed in GIS software by Researcher, 2025.

Sonapur maintains the healthiest vegetation cover, with Very Low NDVI increasing mildly from 150 ha (2001) to 350 ha (2024), showing limited soil exposure. Low NDVI rises from 900 ha to 1,200 ha, reflecting gradual peri-urban expansion but less intense than Azara or Chandrapur. Moderate NDVI remains relatively stable, decreasing only from 2,400 ha to 2,050 ha, indicating strong retention of mixed vegetation and cropland. High NDVI declines from 2,000 ha to 1,720 ha, but still remains the highest among the three regions. Very High NDVI remains comparatively strong, reducing only from 500 ha to 420 ha, showing Sonapur retains the most robust natural vegetation (Table 3).

Table 3: NDVI Classification for Sonapur (2001–2024).

NDVI Class	2001	2013	2024	Interpretation
Very Low	150	220	350	Limited soil exposure due to rural character
Low	900	1,050	1,200	Peri-urban expansion increasing but controlled
Moderate	2,400	2,260	2,050	Agriculture and mixed vegetation still controlled
High	2,000	1,880	1,720	Strong natural cover retained
Very High	500	460	420	Sonapur retains the highest dense vegetation zone

Calculated and computed in GIS software by Researcher, 2025.

Socio-Economic Insights from Household Surveys

Household survey findings highlight strong socio-economic pressures accompanying land-use change. Population growth and housing expansion were identified as the primary drivers of agricultural land conversion, reported by 30% respondents in Azara, 26.6% in Chandrapur, and 23.3% in Sonapur. These trends align with the district's rapid peri-urban growth and rising land demand.

Water resources show clear signs of stress. Groundwater reduction was noted by 20% households in Azara, 40% in Chandrapur, and 45% Sonapur, while pollution of waterbodies was reported by 25%, 20% and 20% households respectively. Such impacts reflect increasing pressure on local hydrology due to settlement expansion and land conversion. Livelihood patterns have also shifted as farming becomes less viable.

In Azara, 25% respondents moved into service-sector employment, while 35% respondents in Chandrapur turned to wage labour. Sonapur households displayed a more diversified response, engaging in business, wage work, and service-sector roles. These transitions illustrate how urbanisation is reshaping economic opportunities, often moving households away from agriculture toward less stable non-farm livelihoods.

4.2. Integrated Interpretation

The integrated analysis of LULC patterns, NDVI trends, and household-level responses shows that urban expansion is the primary force driving land transformation in Kamrup Metropolitan's peri-urban regions. Agricultural decline is unevenly distributed, with Azara experiencing the most rapid loss of cultivable land, Chandrapur showing slower but consistent change, and Sonapur still retaining significant agricultural pockets despite emerging development pressures.

Declining NDVI values across the northern and central parts of the district indicate reduced vegetation density, particularly in areas undergoing accelerated urbanization. Household survey data reinforce this pattern by highlighting widespread livelihood transitions toward wage labour, service-sector employment, and small-scale business activities as farming becomes less viable.

Environmental stresses, such as groundwater depletion, soil degradation, and pollution of waterbodies, further demonstrate the ecological costs of unchecked land conversion. Taken together, these insights underscore the need for integrated land-use planning, conservation of remaining agricultural spaces, and livelihood-support strategies that help communities adapt to the rapidly evolving peri-urban landscape of Kamrup Metropolitan.

4.3. Policy Recommendations

Integrated land-use planning and sustainable urban growth strategies have been emphasized globally to address the ecological consequences of rapid urbanization (Turner et al., 2007; United Nations, 2018). The observed patterns of agricultural decline, vegetation loss, water stress, and livelihood transitions highlight the need for coordinated interventions to manage peri-urban growth in Kamrup Metropolitan. Based on the LULC, NDVI, and household survey insights, the following policy recommendations are proposed:

4.4. Promotion of Integrated Land-Use Planning

A district-level land-use framework is essential to regulate unplanned expansion in peri- urban areas like Azara, Chandrapur, and Sonapur. Clear zoning guidelines should safeguard remaining agricultural land and environmentally sensitive areas while directing growth toward designated urban corridors. Also, protection and of Agricultural Land is also important.

Given the uneven but significant loss of farmland, policies should support:

- Protect and Restore Agricultural Land: The sustainable farming can be helpful in reviving the degraded soil, while incentives may be given to locals for retaining agricultural land, mainly in Chandrapur and Sonapur. Also, promoting peri-urban agriculture along with agroforestry may be helpful in safeguarding local food security in the face of rapid urban expansion.
- Improve Management of Water Resource: It was found that the local water body getting more polluted and the ground water level are

also falling. This can be checked by monitoring groundwater extraction, conserving and desilting existing waterbodies, improving wastewater management and pollution control.

- Support Livelihood Diversification: The changing land use dynamics will mean more households will move away from farming; hence a structured livelihood support is essential. It may be done through skill development for off farming activity, for service, promotion of local enterprises and entrepreneurships in semi-urban areas. Initiatives to promote access to credit and training facilities for transitioning farmers should be in place for livelihood security.
- Improved Infrastructural Planning: The infrastructural growth seeks to balance between development and ecology. New developmental projects like roads, housing or any industrial projects should integrate green buffers, effective drainage, and environmental safeguards to reduce any environmental challenges.
- Promote community participation and strengthen Local Governance: Sustainable planning depends on active collaboration with village committees, urban local bodies, and community groups. Involving residents in monitoring land-use change and environmental impacts can improve transparency and ensure that development reflects local priorities.
- Promote Monitoring through Geospatial Tools and techniques Regular use of satellite-based LULC, NDBI and NDVI analysis can be helpful in identifying early signs of land conversion and vegetation loss, supporting timely, evidence-based planning decisions.

5. CONCLUSION

This study illustrates the profound ways in which rapid urban expansion has reconfigured the peri-urban landscapes of Kamrup Metropolitan over the last 25 years. The Land Use/Land Cover (LULC) analysis reveals a persistent decline in agricultural land, most pronounced in Azara, while Chandrapur and Sonapur exhibit more gradual yet consistent patterns of land transformation. Complementary NDVI analysis indicates a noticeable reduction in vegetation density, particularly across the northern and central parts of the district, underscoring the combined effects of land conversion and increasing ecological stress.

Insights from household surveys further demonstrate that these spatial transformations have had direct socio-economic consequences, accelerating shifts away from agriculture toward wage labour, service-sector employment, and diversified non- farm livelihoods. Together, the spatial and socio-economic findings highlight the interlinked nature of urban growth, environmental change, and livelihood transitions in peri-urban settings.

Overall, the results underscore the urgency of adopting integrated land-use planning frameworks, strengthening environmental management strategies, and implementing targeted livelihood support measures to ensure that urban development in Kamrup Metropolitan proceeds in a sustainable and socially inclusive manner. In the absence of timely and coordinated interventions, continued land conversion is likely to exacerbate ecological degradation and further weaken the agricultural foundation that has traditionally supported peri-urban communities in the district.

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