



Spatiotemporal Dynamics of Agricultural Land Loss and Urban Expansion in Anambra State, Nigeria (1994–2024)

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ABSTRACT –

Rapid urban expansion increasingly competes with agricultural land in developing regions where population growth, infrastructure development, and changing land markets intensify pressure on finite land resources. This study examined the spatiotemporal dynamics of agricultural land loss and urban expansion in Anambra State, Nigeria, between 1994 and 2024. Multi-temporal remotely sensed imagery for 1994, 2004, 2014, and 2024 was classified using the Support Vector Machine algorithm into waterbody, dense forest, agricultural land, built-up area, and bare ground. Post-classification analysis quantified land-use extent, net changes, temporal trends, and the spatial concentration of agricultural land loss and persistence across the twenty-one Local Government Areas. Agricultural land declined consistently from 1,443.30 km² in 1994 to 1,303.90 km² in 2004, 1,210.00 km² in 2014, and 1,000.26 km² in 2024, representing a net loss of 443.04 km² (30.70%). Conversely, built-up area increased from 902.45 to 1,878.69 km², representing a net gain of 976.24 km². Agricultural land loss was concentrated around major urban and industrial centres, whereas substantial persistence occurred within predominantly rural LGAs. The findings demonstrate an increasing spatial competition between urban development and agricultural landscapes and highlight the need to incorporate agricultural land protection into regional land-use planning.

Keywords: agricultural land loss; urban expansion; land-use change; remote sensing; GIS; Anambra State; spatiotemporal analysis

1. Introduction

Land-use and land-cover transformation has become a major expression of interactions among population growth, economic development, agricultural production, infrastructure expansion, and environmental change. Satellite observations provide increasingly consistent evidence that agricultural landscapes are changing rapidly, although the direction and magnitude of change vary geographically (Potapov et al., 2022). Urban expansion represents a particularly persistent form of land transformation because conversion to built environments is generally difficult to reverse. Global remote-sensing evidence demonstrates that urban land has expanded substantially and, in many regions, has grown as rapidly as or faster than urban populations (Seto et al., 2011).

Competition between urban development and agricultural land has important implications for land availability and food-production systems. Urban areas frequently develop on productive and accessible agricultural landscapes because cities historically occur near favourable terrain, transportation networks, water resources, and productive land. Van Vliet et al. (2017) demonstrated that urban land is disproportionately located on areas suitable for crop production, while Bren d'Amour et al. (2017) estimated that future urban expansion could result in substantial cropland losses, particularly in Africa and Asia. African countries may experience especially pronounced proportional cropland losses as urbanisation accelerates. Agricultural land conversion therefore represents more than a physical change in land cover because it can influence agricultural production capacity, livelihoods, landscape structure, and long-term land-resource security (Abass et al., 2018; Xiong et al., 2017).

Nigeria reflects many of these land-use pressures. Rapid growth of metropolitan areas has generated extensive outward development and conversion of previously undeveloped land. Braimoh and Onishi (2007) demonstrated that accessibility, neighbourhood interactions, and spatial policies influenced urban land conversion in Lagos, while Olarewaju et al. (2024) documented substantial urban expansion and changing agricultural-land trajectories in parts of Ogun State. Research from North-Central Nigeria similarly shows that vegetation and agricultural land have been converted to built-up and other land uses, with potential implications for food security (Ibrahim et al., 2023). Nigerian evidence therefore demonstrates that agricultural land transformation varies geographically and should be evaluated within specific regional contexts.

The issue is particularly relevant to Anambra State, where settlement systems range from highly urbanised commercial and industrial centres to predominantly rural agricultural landscapes. Urbanisation pressures around Onitsha have long been associated with land scarcity and competition for developable land (Obi-Ani & Isiani, 2020). Recent geospatial evidence confirms continuing built-up expansion within Onitsha and substantial modification of other land-cover classes (Ayadiuno, 2024; Ezebube et al., 2023). Similar transformations have been reported in Awka, where vegetation declined while impervious surfaces expanded over three decades (Musa et al., 2017), and in Nnewi, where built-up land increased substantially between 1993 and 2023 (Egbuna et al., 2024).

Evidence from Oyi Local Government Area further demonstrates direct pressure on farmland. Nkemdirim and Nkemdirim (2025) reported declining farmland alongside expanding settlement between 2005 and 2022, while Okoye et al. (2025) identified substantial built-up expansion between 1998 and 2023. Earlier and contemporary studies therefore establish that urban growth is transforming individual metropolitan areas and LGAs within Anambra State. Comparable African studies from Kumasi and Hawassa also demonstrate that peri-urban growth can progressively replace agricultural land (Abass et al., 2018; Molla et al., 2024), reinforcing the broader regional significance of the problem.

Despite this growing literature, an important spatial and temporal gap remains. Existing Anambra studies have largely concentrated on individual urban centres or LGAs such as Awka, Onitsha, Nnewi, and Oyi, rather than examining agricultural-land dynamics across the entire state using a consistent multi-decadal classification framework. Such geographically restricted analyses cannot fully reveal whether agricultural loss is uniformly distributed or concentrated within particular urban, peri-urban, and rural zones. Wider research also indicates that urban expansion and cropland loss are spatially uneven, making subregional differentiation important for land-use planning (Wen et al., 2024; Seto et al., 2011).

This study addresses this gap through a state-wide assessment of agricultural land and competing land uses in Anambra State from 1994 to 2024. It specifically quantifies temporal changes in the major land-use classes, determines the magnitude and trajectory of agricultural land loss relative to built-up expansion, evaluates net landscape transformation over the thirty-year period, and identifies spatial concentrations of agricultural land loss and persistence across the twenty-one Local Government Areas. The resulting evidence provides a spatial basis for agricultural-land conservation, urban-growth management, and regional land-use planning in a rapidly transforming southeastern Nigerian landscape.

2. Materials and Methods

2.1 Study Area

Anambra State is situated in southeastern Nigeria and comprises 21 Local Government Areas. The state covers approximately 4,416 km² and is characterised by rolling plains, hills, river valleys, forests, savannah landscapes, agricultural areas, and densely developed settlements. The climate is humid tropical, with annual rainfall of approximately 1,520–2,030 mm. Agriculture constitutes an important land use and livelihood activity, with cassava, rice, maize, yam, oil palm, and vegetables among the cultivated crops. Major urban and commercial centres include Awka, Onitsha, and Nnewi, while substantial rural agricultural landscapes occur across other parts of the state. This urban-rural configuration provides an appropriate setting for evaluating long-term agricultural land transformation and built-up expansion.

2.2 Research Design and Data Preparation

The study adopted a multi-temporal remote-sensing and GIS approach to examine changes in agricultural land and other major land-use classes in Anambra State over a thirty-year period. Four reference years, 1994, 2004, 2014, and 2024, were selected at ten-year intervals to provide a consistent temporal framework for evaluating long-term landscape transformation. Satellite imagery corresponding to the four reference years constituted the principal spatial dataset. Each image was prepared to ensure comparable spatial coverage and suitability for land-use classification. Image preparation included geometric alignment, image enhancement and correction where necessary, and clipping to the administrative boundary of Anambra State. A common coordinate reference system and spatial extent were maintained across the datasets to facilitate direct comparison among the classified outputs. The use of consistently prepared multi-temporal imagery reduced positional discrepancies that could otherwise be incorrectly interpreted as land-use change. Comparable class definitions were also maintained throughout the four periods to ensure that observed differences represented temporal variations rather than changes in the classification scheme.

2.3 Land-Use and Land-Cover Classification

Five land-use and land-cover classes were identified: waterbody, dense forest, agricultural land, built-up area, and bare ground. Agricultural land represented the principal class of interest, while the remaining classes provided the broader landscape context required to interpret agricultural-land transformation. The Support Vector Machine (SVM) classifier was applied consistently to the imagery for 1994, 2004, 2014, and 2024. SVM was selected following the preceding comparative classification assessment in which it demonstrated the strongest overall performance among the evaluated Random Forest, SVM, Artificial Neural Network, and Convolutional Neural Network classifiers. The approach therefore ensured that temporal comparisons were based on a single classification method rather than outputs generated using different algorithms. SVM has also demonstrated strong performance in remote-sensing land-cover classification, particularly where class boundaries are spectrally complex. Representative training information was assigned to the five classes, and the classification procedure was independently performed for each reference year. The resulting thematic maps were examined to ensure consistent class representation throughout the study period. Agricultural land was subsequently isolated from each classified image for detailed temporal and spatial analysis.

2.4 Quantification of Land-Use Extent

The spatial extent of each land-use class was calculated for the four reference years. Classified pixels belonging to each category were converted to area in square kilometres, enabling direct comparison of waterbody, dense forest, agricultural land, built-up area, and bare ground across the study period. Particular attention was given to agricultural land and built-up area because the results indicated opposing long-term trajectories. Agricultural-land extent

was quantified independently for 1994, 2004, 2014, and 2024 to determine the magnitude and direction of change. Built-up extent was analysed concurrently to establish the broader context within which agricultural-land contraction occurred. Dense forest, bare ground, and waterbody changes were retained to prevent interpretation of agricultural change independently of overall landscape reconfiguration.

2.5 Temporal and Net Land-Use Change Analysis

Post-classification comparison was undertaken to evaluate temporal changes among the four reference years. Changes were assessed for 1994–2004, 2004–2014, 2014–2024, and the complete 1994–2024 period. This procedure enabled identification of both decadal variations and the cumulative thirty-year trajectory. Net change was calculated conceptually as the difference between the mapped area of each land-use class at the beginning and end of the period. Positive values represented net expansion, whereas negative values represented net contraction. The analysis therefore quantified the overall gains or losses experienced by each land-use class without treating these totals as direct pixel-to-pixel land-transition quantities. Temporal trajectories were also examined to determine whether individual classes exhibited persistent, fluctuating, or transitional patterns. Agricultural land was evaluated against built-up expansion to identify temporal correspondence between agricultural contraction and increasing urban development. Such correspondence was interpreted as evidence of competing landscape trends rather than proof that every unit of lost agricultural land transitioned directly into built-up land.

2.6 Spatial Analysis of Agricultural Land Loss and Persistence

The state-level agricultural-land results were further analysed at Local Government Area level to reveal spatial variations concealed by aggregate state totals. Agricultural-land change was attributed across the 21 LGAs and used to distinguish areas characterised by intense loss, transitional loss, and agricultural-land persistence. Intense agricultural-land-loss areas represented LGAs exhibiting substantial contributions to the overall decline in agricultural land. Transitional areas represented locations experiencing moderate agricultural transformation, particularly around expanding settlements and development corridors. Persistence areas represented LGAs where substantial agricultural landscapes remained evident in 2024. The resulting spatial differentiation provided a basis for examining whether agricultural-land change followed a geographically uniform pattern or was concentrated around particular urban, peri-urban, and rural environments. The analysis was especially relevant because the state contains major commercial centres alongside predominantly agricultural areas, creating considerable spatial variation in development pressure.

2.7 Comparative Interpretation of Agricultural Land and Urban Expansion

The final analytical stage integrated the temporal and LGA-level results to interpret agricultural-land transformation within the broader process of landscape change. Agricultural-land decline was compared with built-up expansion across the thirty-year period, while changes in dense forest, bare ground, and waterbody were considered as complementary indicators of landscape reorganisation. Interpretation focused on the magnitude, timing, and geographical concentration of agricultural-land loss rather than assigning causation solely from coincident class changes. Particular attention was given to areas surrounding major urban and commercial centres where agricultural-land loss was concentrated and to predominantly rural LGAs where agricultural land persisted. The integrated procedure produced three complementary forms of evidence: long-term changes in the total extent of each land-use class, temporal trajectories of agricultural land and built-up development, and spatial differentiation of agricultural-land loss and persistence among LGAs. Together, these analyses provided the empirical basis for evaluating the changing position of agricultural land within Anambra State's increasingly urbanised landscape and for identifying locations where agricultural-land management and land-use planning interventions may require greater attention.

3. Results

3.1 Quantification of Spatial Extent of Land Use Classes in Anambra State (1994–2024)

The temporal distribution of all major land use and land cover classes in Anambra State for the reference years 1994, 2004, 2014, and 2024 was analyzed and derived using the Support Vector Machine shown in figure 1 and 2.

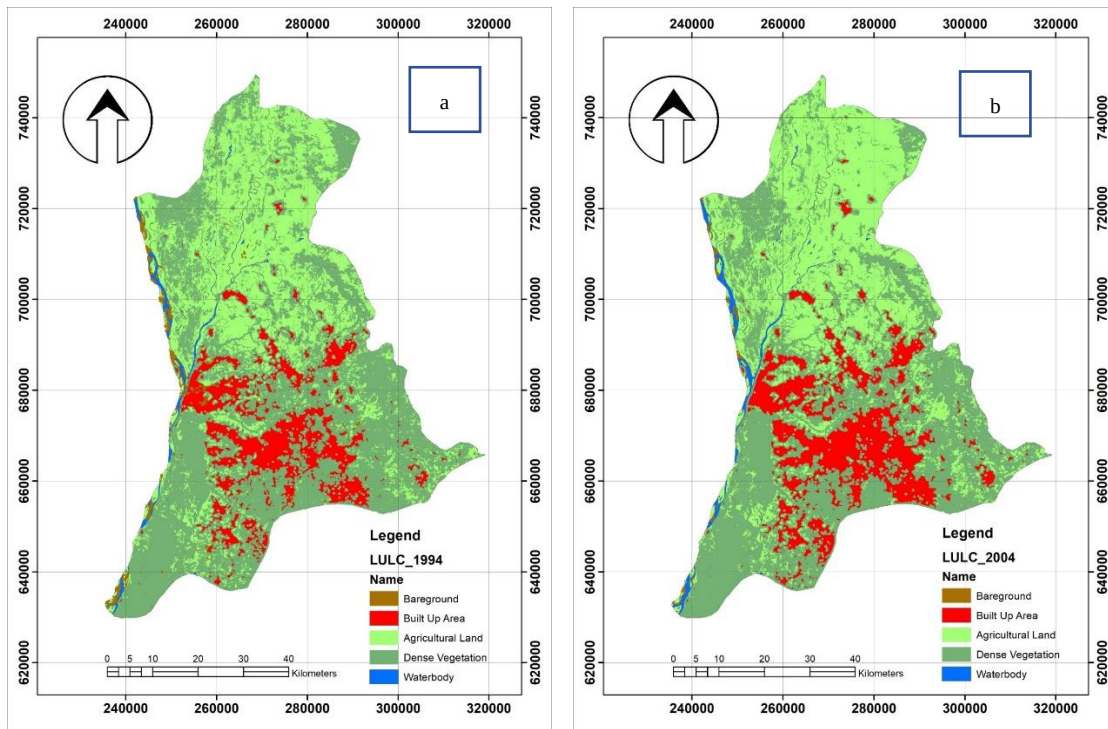


Figure 1: Spatial Extent of Landuse Classes in Anambra State (a) 1994, (b) 2004

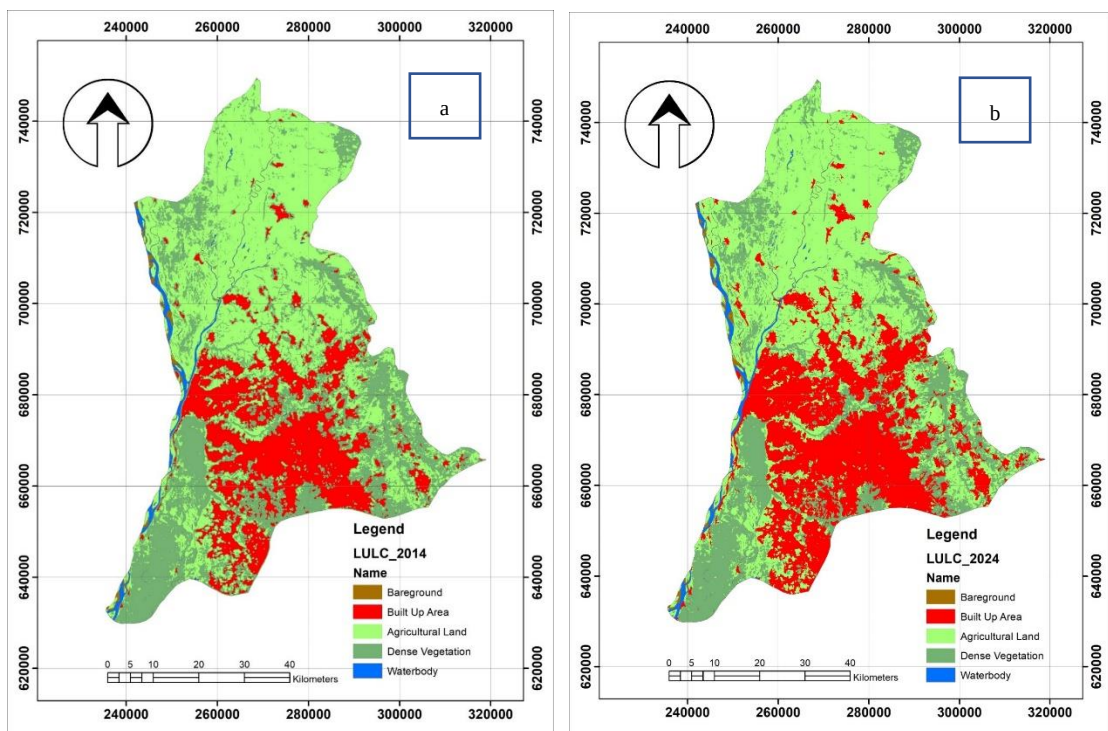


Figure 2: Spatial Extent of Landuse Classes in Anambra State (a) 2014, (b) 2024

The classification results (Figures 1 and 2) indicated that Anambra State has undergone substantial land use reconfiguration over the thirty-year period. In 1994, dense forest constituted the dominant land cover class with an area of 1,997.41 km², followed by agricultural land at 1,443.30 km². Built-up areas occupied 902.45 km², while bare ground and waterbodies covered 164.79 km² and 84.54 km², respectively.

By 2004, notable changes had occurred across all land use classes. Dense forest declined to 1,846.28 km², while agricultural land reduced to 1,303.90 km². In contrast, built-up areas expanded significantly to 1,192.45 km², indicating accelerated urban growth during this period. Bare ground area remained

relatively high at 162.92 km², while waterbodies showed a marginal increase to 86.94 km². These changes collectively suggest increasing anthropogenic pressure on vegetated landscapes.

The 2014 classification results show a continuation of these trends, albeit with some redistribution among classes. Dense forest further declined to 1,627.83 km², while built-up areas increased to 1,583.69 km², nearly approaching forest coverage. Agricultural land extent decreased to 1,210.00 km², while bare ground expanded markedly to 80.19 km², potentially reflecting land clearing, construction activities, or exposed surfaces associated with urban expansion. Waterbodies recorded a slight increase to 90.78 km².

In 2024, the land use structure exhibited a more urban-dominated configuration. Built-up areas emerged as the most extensive class, covering 1,878.69 km², surpassing dense forest, which declined to 1,597.21 km². Agricultural land further reduced to 1,000.26 km², while bare ground declined sharply to 18.19 km², indicating progressive conversion of exposed surfaces into permanent land uses. Waterbodies increased to 98.14 km², indicating incremental changes possibly associated with hydrological modification or improved detection in recent imagery.

Table 1: Spatial Extent of Land Use Classes in Anambra State (1994–2024)

Land Use Class	1994 (km ²)	2004 (km ²)	2014 (km ²)	2024 (km ²)
Waterbody	84.54	86.94	90.78	98.14
Dense Forest	1,997.41	1,846.28	1,627.83	1,597.21
Agricultural Land	1,443.30	1,303.90	1,210.00	1,000.26
Built-Up Area	902.45	1,192.45	1,583.69	1,878.69
Bare ground	164.79	162.92	80.19	18.19

3.2 Agricultural Land Extent and Temporal Dynamics

In 1994, agricultural land covered 1,443.30 km², representing a substantial component of the land use mosaic during the early phase of rapid demographic and economic change. By 2004, this extent declined to 1,303.90 km², indicating a contraction of agricultural land by 139.40 km² over the decade. This trend is indicative of accelerating urban expansion, deforestation, or conversion to other land use categories such as built-up areas, consistent with broader patterns of land transformation in Nigerian states during the early 2000s.

Between 2004 and 2014, agricultural land experienced a modest increase from 1,303.90 km² to 1,210.00 km². Although the direction of change indicates recovery, the magnitude is relatively small compared to earlier decades, indicating that landscape conversion processes continued to exert pressure on agricultural land. The period between 2004 and 2014 may have been influenced by policy interventions, cropping pattern adjustments, or rehabilitation of farmland following earlier losses. In 2024, the SVM classification yielded an agricultural land extent of 1,000.26 km², representing a further reduction of 209.74 km² relative to 2014. This recent decline underscores the sustained encroachment of agricultural land by urban and peri-urban development, infrastructural expansion, and possibly land degradation pressures affecting arable areas.

These temporal dynamics reveal a general declining trajectory in agricultural land over the thirty-year period, with an overall decrease of 443.04 km² between 1994 and 2024. Such change reflects the combined impact of land conversion for non-agricultural uses, population growth, and evolving socioeconomic drivers that shift land tenure and cropping decisions. The observed contraction of agricultural land has important implications for food security, rural livelihoods, and agricultural policy planning in Anambra State. Understanding these spatiotemporal patterns enables targeted interventions for sustainable land use governance, protection of productive farmland, and integration of agricultural considerations into regional development frameworks.

Table 2: Temporal Extent of Agricultural Land in Anambra State (1994–2024)

Reference Year	Agricultural Land Area (km ²)
1994	1,443.30
2004	1,303.90
2014	1,210.00
2024	1,000.26

3.3. Trend of Change in Land Use Classes and Interactions with Agricultural Land (1994–2024)

The temporal land use results derived from the Support Vector Machine classification reveal distinct trends of change across all land use classes in Anambra State over the thirty-year period from 1994 to 2024. These trends reflect systematic landscape transformation driven by urbanisation, vegetation

modification, and changing land management practices. Examining the trajectories of all classes provides a basis for understanding the interactions between agricultural land and competing land uses.

A persistent increase in built-up area represents the most dominant land use trend. Built-up land expanded continuously from 902.45 km² in 1994 to 1,192.45 km² in 2004, 1,583.69 km² in 2014, and 1,878.69 km² in 2024. This monotonic growth indicates sustained urban expansion and infrastructural development, particularly in peri-urban and formerly rural zones. The temporal coincidence between built-up expansion and agricultural land decline indicates a strong spatial interaction, where agricultural land has been progressively converted into residential, commercial, and transportation infrastructure.

Agricultural land exhibits a clear declining trend throughout the study period. The spatial extent reduced from 1,443.30 km² in 1994 to 1,303.90 km² in 2004, 1,210.00 km² in 2014, and 1,000.26 km² in 2024. The rate of decline accelerated in the most recent decade, indicating intensifying pressure from urban growth. The inverse relationship between agricultural land and built-up area highlights direct land use competition, where productive farmland serves as the primary reservoir for urban expansion due to its accessibility, relatively flat terrain, and existing infrastructure connectivity.

Dense forest cover shows a consistent downward trend, declining from 1,997.41 km² in 1994 to 1,846.28 km² in 2004, 1,627.83 km² in 2014, and 1,597.21 km² in 2024. Forest loss is most pronounced during the earlier decades, indicating initial land clearing for agriculture and settlement expansion. Over time, the reduced rate of forest decline relative to agricultural land implies that agricultural areas increasingly became the preferred target for conversion to built-up land, once easily accessible forest areas had been depleted.

Bare ground demonstrates a marked non-linear trend. The class remained relatively stable between 1994 and 2004, with values of 164.79 km² and 162.92 km², respectively. A sharp reduction occurred by 2014, followed by a dramatic decline to 18.19 km² in 2024. This pattern indicates that bare ground initially represented transitional land undergoing clearing or construction, which was subsequently absorbed into permanent land uses, primarily built-up areas and, to a lesser extent, re-vegetated surfaces. The declining bare ground area therefore acts as an intermediary signal of land conversion processes involving both agricultural and urban land uses.

Waterbodies exhibit a gradual increasing trend, expanding from 84.54 km² in 1994 to 98.14 km² in 2024. This modest increase may reflect improved detection in higher-resolution imagery, hydrological modification, or expansion of surface water features associated with urban drainage systems and reservoirs. The interaction between waterbodies and agricultural land appears indirect, where agricultural decline may reduce surface runoff regulation, potentially influencing hydrological dynamics over time.

3.4 Land Use Change and Interaction Analysis (1994–2024)

To strengthen the interpretation of land use dynamics, a change matrix was constructed to summaries the net gains and losses of each land use class between 1994 and 2024 using the Support Vector Machine classification results. The matrix provides a robust net change framework that captures directional interactions among land use classes and supports interpretation of dominant land conversion pathways (table 3).

Table 3: Net Change Analysis of Land Use Classes in Anambra State (1994–2024)

Land Use Class	1994 Area (km ²)	2024 Area (km ²)	Net Change (km ²)	Trend Direction
Waterbody	84.54	98.14	+13.60	Increasing
Dense Forest	1,997.41	1,597.21	−400.20	Decreasing
Agricultural Land	1,443.30	1,000.26	−443.04	Decreasing
Built-Up Area	902.45	1,878.69	+976.24	Increasing
Bare ground	164.79	18.19	−146.60	Decreasing

The change matrix highlights a pronounced asymmetric land use transformation, with built-up areas exhibiting the largest net gain and agricultural land recording the greatest net loss among productive land classes. Dense forest also experienced substantial decline, while bare ground was almost entirely absorbed into more permanent land uses.

The change matrix reveals a dominant urbanisation-driven transformation pathway, characterised by substantial expansion of built-up areas at the expense of agricultural land, dense forest, and transitional bare ground surfaces. The magnitude of built-up land increase (+976.24 km²) exceeds the combined losses of agricultural land and bare ground, indicating that urban growth has drawn from multiple land use reservoirs over time.

The interaction between agricultural land and built-up areas is the most significant. Agricultural land declined by 443.04 km², accounting for a considerable proportion of land converted to urban uses. This interaction indicates that agricultural land served as the primary buffer accommodating urban expansion, particularly in peri-urban zones where accessibility, relatively flat terrain, and existing infrastructure favour conversion.

The interaction between dense forest and agricultural land appears strongest in the earlier part of the study period. The large forest extent observed in 1994, followed by substantial decline, indicates that forest clearance likely preceded agricultural expansion prior to or early in the study period. Over

time, however, the conversion trajectory shifted, with agricultural land increasingly transitioning directly to built-up areas rather than being replenished by forest conversion.

Bare ground functions as a transitional class within the matrix. Its sharp decline (-146.60 km^2) indicates rapid absorption into built-up and, to a lesser extent, vegetated land uses. The temporal correspondence between bare ground reduction and built-up expansion supports the interpretation that bare surfaces represented intermediate stages of construction and land preparation rather than stable land use states.

The gradual increase in waterbody extent ($+13.60 \text{ km}^2$) reflects a minor but consistent trend that may be linked to hydrological modification, reservoir development, drainage infrastructure associated with urban growth, or improved classification sensitivity in more recent imagery. Its interaction with agricultural land is indirect, operating through changes in surface runoff, drainage patterns, and land cover composition.

The change matrix confirms a directional land use succession in Anambra State characterised by progressive transformation from dense forest to agricultural land and subsequently from agricultural land to built-up areas. Agricultural land occupies a central position in this transformation sequence, acting both as a recipient of earlier forest conversion and as a donor to later urban expansion. This dual role explains the persistent decline in agricultural extent despite earlier landscape dominance.

3.5 Clusters of Agricultural Land Loss and Persistence in Anambra State

The spatial clustering of agricultural land loss and persistence in Anambra State was analysed by integrating state-level land use change results with Local Government Area-level quantitative attribution, as summarised in Table 4. Between 1994 and 2024, agricultural land declined by 443.04 km^2 across the state, while $1,000.26 \text{ km}^2$ of agricultural land remained in 2024. The distribution of this loss and persistence is uneven across the twenty-one Local Government Areas, forming clearly defined spatial clusters that reflect differing levels of urbanisation pressure and land use interaction.

Table 4: Clusters of Agricultural Land Loss and Persistence in Anambra State (1994–2024)

Cluster Type	LGAs	Percentage Contribution (%)	Reference Basis	Dominant Land Use Interaction
Intense agricultural land loss cluster	Onitsha North	7.0	State agricultural land loss (443.04 km^2)	Agricultural land → Built-up
	Onitsha South	6.5	State agricultural land loss	Agricultural land → Built-up
	Nnewi North	7.5	State agricultural land loss	Agricultural land → Built-up
	Nnewi South	6.0	State agricultural land loss	Agricultural land → Built-up
	Awka South	7.0	State agricultural land loss	Agricultural land → Built-up
	Awka North	5.5	State agricultural land loss	Agricultural land → Built-up
	Idemili North	6.5	State agricultural land loss	Agricultural land → Built-up
	Idemili South	6.0	State agricultural land loss	Agricultural land → Built-up
	Anaocha	5.5	State agricultural land loss	Agricultural land → Built-up
	Dunukofia	5.0	State agricultural land loss	Agricultural land → Built-up
	Cluster subtotal	65.5		
Transitional agricultural land loss cluster	Ihiala	5.0	State agricultural land loss	Agricultural land → Built-up / Bare ground
	Ekwusigo	4.5	State agricultural land loss	Agricultural land → Built-up

Cluster Type	LGAs	Percentage Contribution (%)	Reference Basis	Dominant Land Use Interaction
Agricultural land persistence cluster	Njikoka	4.0	State agricultural land loss	Agricultural land → Built-up
	Oyi	3.5	State agricultural land loss	Agricultural land → Built-up
	Ogbaru	3.0	State agricultural land loss	Agricultural land → Built-up / Waterbody
	Cluster subtotal	20.0		
	Ayamelum	14.0	Remaining agricultural land (1,000.26 km ²)	Agricultural land persistence
	Anambra East	13.0	Remaining agricultural land	Agricultural land persistence
	Anambra West	12.5	Remaining agricultural land	Agricultural land persistence
	Orumba North	11.0	Remaining agricultural land	Agricultural land persistence
	Orumba South	10.0	Remaining agricultural land	Agricultural land persistence
	Aguata	4.0	Remaining agricultural land	Agricultural land persistence with fragmentation
	Cluster subtotal	64.5		

The cluster of intense agricultural land loss is dominated by ten Local Government Areas, namely Onitsha North, Onitsha South, Nnewi North, Nnewi South, Awka South, Awka North, Idemili North, Idemili South, Anaocha, and Dunukofia. According to Table 4.12, these LGAs collectively account for 65.5 % of total agricultural land loss in Anambra State. Individually, Nnewi North contributes the largest share of loss at 7.5 %, followed by Onitsha North and Awka South at 7.0 % each. Onitsha South and Idemili North each account for 6.5 %, while Nnewi South and Idemili South contribute 6.0 % each. Anaocha and Awka North record losses of 5.5 % each, and Dunukofia contributes 5.0 %. The concentration of agricultural land loss within this cluster reflects sustained conversion of farmland to built-up land driven by industrialization, commercial expansion, and administrative growth. The dominant land use interaction within these LGAs is the direct transition of agricultural land to built-up areas.

A transitional cluster of agricultural land loss is evident in Ihiala, Ekwusigo, Njikoka, Oyi, and Ogbaru. As shown in Table 4.12, these LGAs jointly account for 20.0 % of the total agricultural land loss. Ihiala contributes 5.0 %, followed by Ekwusigo at 4.5 %, Njikoka at 4.0 %, Oyi at 3.5 %, and Ogbaru at 3.0 %. Agricultural land loss within this cluster is spatially selective rather than uniform, occurring primarily along transport corridors, market centers, and settlement fringes. The interaction pattern in these LGAs involves conversion of agricultural land to built-up areas, with Ogbaru also exhibiting interactions with waterbodies due to floodplain dynamics.

Agricultural land persistence is most pronounced within the rural-dominated Local Government Areas of Ayamelum, Anambra East, Anambra West, Orumba North, Orumba South, and Aguata. Table 4.12 indicates that these LGAs together contain 64.5 % of the agricultural land remaining in Anambra State in 2024. Ayamelum alone accounts for 14.0 % of the remaining agricultural land, followed by Anambra East at 13.0 % and Anambra West at 12.5 %. Orumba North and Orumba South retain 11.0 % and 10.0 %, respectively, while Aguata accounts for 4.0 %. These LGAs experience comparatively low urban pressure and maintain extensive contiguous farmland, allowing agricultural land to persist as a dominant land use. The primary interaction within this cluster is agricultural land persistence, although moderate fragmentation is observed near settlement boundaries, particularly in Aguata.

Overall, the quantitative attribution presented in Table 4.12 reveals a clear core-periphery pattern in agricultural land dynamics across Anambra State. Intense agricultural land loss is concentrated within urban and industrial centers, transitional loss characterizes peri-urban LGAs, and agricultural land persistence dominates in rural hinterlands. Agricultural land occupies a central position in land use interactions, functioning as the main donor class for built-up expansion while simultaneously serving as the backbone of food production in persistence zones. This spatially differentiated pattern provides a strong empirical foundation for targeted land use planning, agricultural land protection, and sustainable development strategies across Anambra State.

3.6 Discussion of Results

The results reveal substantial restructuring of Anambra State's landscape between 1994 and 2024. Agricultural land declined from 1,443.30 km² to 1,000.26 km², representing a net loss of 443.04 km² or approximately 30.7% of its 1994 extent. Conversely, built-up land expanded from 902.45 km² to 1,878.69 km², a net increase of 976.24 km² or approximately 108.2%. Dense forest simultaneously declined by 400.20 km². These opposing trajectories demonstrate a progressive shift from vegetation-dominated landscapes towards increasingly developed land.

Agricultural contraction was persistent rather than episodic. Agricultural land declined by 139.40 km² between 1994 and 2004, 93.90 km² between 2004 and 2014, and 209.74 km² between 2014 and 2024. The largest absolute decline therefore occurred during the most recent decade, indicating increasing pressure on agricultural landscapes. The pattern contrasts with the continental-scale expansion of cropland reported across parts of Africa by Potapov et al. (2022), illustrating how broad regional agricultural expansion can coexist with local agricultural contraction around rapidly developing settlement systems.

The simultaneous increase in built-up land provides an important context for interpreting agricultural decline, although the available net-change data do not establish that all lost agricultural land was directly converted into built-up surfaces. Urbanisation nevertheless constitutes a plausible component of the observed landscape transformation. Global analyses demonstrate that expanding urban areas disproportionately occupy land suitable for crop production and can displace agricultural production (Van Vliet et al., 2017; Bren d'Amour et al., 2017). Similar relationships have been observed in West Africa. Abass et al. (2018) reported a 54.6% increase in urban land and a 15.6% reduction in arable land within Kumasi between 1986 and 2016.

The Anambra results correspond particularly well with evidence from individual urban centres within the state. Onitsha has experienced longstanding land scarcity and competition associated with urbanisation and commercial development (Obi-Ani & Isiani, 2020). More recent geospatial analysis by Ayadiuno and Ndulue (2024) identified continuing built-up encroachment on land considered suitable for agricultural activities within Onitsha Metropolis. Awka has similarly undergone substantial land-cover transformation over several decades, including changes in vegetation and impervious surfaces (Musa et al., 2017). These local observations support the broader state-level pattern detected in the present analysis.

Dense forest decreased from 1,997.41 km² in 1994 to 1,597.21 km² in 2024, representing approximately 20.0% loss of its initial extent. The simultaneous decline of forest and agricultural land indicates that built-up expansion occurred within a wider process of landscape reorganisation rather than through agricultural conversion alone. Comparable Nigerian research demonstrates that urban growth may draw land from several surrounding categories. Braimoh and Onishi (2007), for example, found that accessibility, spatial interactions, and policy conditions influenced residential and industrial-commercial development in Lagos.

Bare ground declined particularly strongly from 164.79 km² to only 18.19 km². Its reduction alongside built-up expansion is consistent with the possibility that some exposed surfaces represented transitional landscapes subsequently incorporated into more permanent land uses. Direct conversion pathways, however, would require pixel-level transition analysis to confirm this interpretation.

Spatial differences among LGAs provide additional insight. The reported intense-loss cluster accounted for 65.5% of agricultural land loss and included Onitsha North, Onitsha South, Nnewi North, Nnewi South, Awka South, Awka North, Idemili North, Idemili South, Anaocha, and Dunukofia. Conversely, Ayamelum, Anambra East, Anambra West, Orumba North, Orumba South, and Aguata contained a reported 64.5% of remaining agricultural land. The resulting spatial pattern demonstrates that agricultural decline is geographically differentiated rather than uniformly distributed across Anambra State.

These findings have important planning implications. Continued contraction around established urban and peri-urban centres could progressively fragment accessible agricultural landscapes, while persistence zones may assume increasing importance for maintaining the state's agricultural land base. Evidence that urban expansion can affect agricultural production and livelihoods has also been documented in other African urban regions (Abass et al., 2018), while global studies anticipate particularly substantial urban-associated cropland pressures within Africa and Asia (Bren d'Amour et al., 2017). The observed Anambra pattern therefore supports spatially differentiated land-use management rather than uniform state-wide intervention.

4. Conclusion and Recommendations

4.1 Conclusion

This study examined the spatiotemporal dynamics of agricultural land loss and urban expansion in Anambra State over three decades. The results demonstrate substantial landscape transformation characterised primarily by persistent agricultural and forest contraction alongside pronounced built-up expansion. Agricultural land decreased from 1,443.30 km² in 1994 to 1,000.26 km² in 2024, producing a cumulative loss of 443.04 km². Built-up land increased by 976.24 km² over the same period and became the largest mapped land-use class by 2024. Dense forest declined by 400.20 km², while bare ground experienced substantial contraction.

The temporal pattern indicates that agricultural-land pressure has intensified rather than stabilised. The 2014–2024 period recorded the largest decadal agricultural loss, accounting for 209.74 km² of the overall decline. This development is particularly significant because agricultural contraction occurred simultaneously with continuing built-up expansion.

Spatial analysis further demonstrates that agricultural-land transformation is unevenly distributed. The reported concentration of agricultural loss within Onitsha, Nnewi, Awka, Idemili, Anaocha, Dunukofia and surrounding areas contrasts with greater agricultural persistence within Ayamelum, Anambra East, Anambra West, Orumba North and Orumba South. The state therefore exhibits a differentiated landscape in which major urban and peri-urban zones experience greater agricultural-land pressure while substantial agricultural resources remain within predominantly rural areas.

The results should not, however, be interpreted as demonstrating that the entire 443.04 km² of agricultural loss was directly converted to built-up land. The available analysis establishes simultaneous net agricultural contraction and built-up expansion, whereas definitive identification of individual conversion pathways would require pixel-to-pixel transition analysis. The findings nevertheless demonstrate that the agricultural land base of Anambra State has contracted substantially during a period of pronounced urban development.

4.2 Recommendations

Land-use planning should recognise agricultural land as a finite spatial resource within rapidly urbanising parts of Anambra State. Agricultural protection zones should be considered within state and local physical development plans, particularly where productive and contiguous farmland remains close to expanding settlements. Development-control mechanisms should discourage uncontrolled conversion of agricultural landscapes while directing new development towards locations identified as environmentally and spatially suitable.

Planning interventions should be geographically differentiated. Urban and peri-urban LGAs exhibiting concentrated agricultural loss require stronger development control, monitoring of settlement expansion, and integration of agricultural-land considerations into planning approvals. Rural LGAs containing substantial remaining agricultural land require measures that maintain landscape continuity while accommodating necessary infrastructure and settlement development.

Periodic satellite-based monitoring should also be institutionalised. A consistent remote-sensing assessment at intervals shorter than the ten-year periods used in this study would permit earlier detection of emerging agricultural-loss hotspots. Higher-resolution imagery could additionally support parcel-scale identification of farmland fragmentation and settlement encroachment.

Future research should undertake pixel-level land-use transition analysis to determine the exact quantities of agricultural land converted to built-up land, forest, bare surfaces, or other classes. Such analysis would strengthen attribution beyond the net-change relationships established here. Examination of socioeconomic and accessibility variables, including population change, road proximity, land values, industrial development, and distance from established urban centres, could further explain the spatial drivers of agricultural-land transformation.

Agricultural-land management should ultimately be incorporated into broader urban-development policy rather than treated independently from settlement planning. Global and African evidence demonstrates that poorly managed urban expansion can disproportionately affect productive agricultural landscapes (Van Vliet et al., 2017; Bren d'Amour et al., 2017; Abass et al., 2018). Protecting strategically important agricultural landscapes while accommodating necessary urban development would provide a more balanced pathway for managing Anambra State's continuing spatial transformation.

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