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Spatiotemporal Analysis of Vegetation in Ideato North, Imo State (2005-2025) Using Remote Sensing Techniques

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Abstract

Vegetation degradation remains one of the most pressing environmental challenges in tropical rural-peri-urban landscapes, where rapid land transformation often occurs without systematic monitoring. This study investigates the spatiotemporal dynamics of vegetation change in Ideato North Local Government Area, Imo State, Nigeria, between 2005 and 2025 using multi-temporal Landsat imagery and the Normalized Difference Vegetation Index (NDVI). Satellite data for 2005 and 2025 were preprocessed through radiometric, atmospheric, and geometric corrections before NDVI computation. The resulting NDVI maps were reclassified into vegetation health categories and subjected to change detection analysis to quantify spatial transitions over the 20-year period. Findings reveal a substantial 29% decline in dense and healthy vegetation, accompanied by a 15% increase in sparse or stressed vegetation and a 14% expansion of open/bare land. Urban land increased modestly by 1%, reflecting gradual peri-urban growth. Spatial analysis further indicates pronounced fragmentation of previously contiguous vegetation blocks, suggesting declining ecological integrity and increased landscape vulnerability. These changes are strongly associated with anthropogenic pressures, particularly agricultural expansion, settlement growth, and land clearing practices. The results underscore a significant shift in ecosystem structure and productivity within Ideato North, with implications for soil stability, biodiversity conservation, carbon sequestration, and local climate regulation. By integrating remote sensing and GIS techniques, this study provides an evidence-based framework for long-term vegetation monitoring and sustainable land-use planning. The findings highlight the urgent need for targeted conservation policies, afforestation initiatives, and community-driven land management strategies to mitigate further environmental degradation and enhance ecological resilience in southeastern Nigeria.

Keywords

Spatiotemporal, Vegetation, Remote Sensing, Land Use, Ideato North

1. Introduction

1.1. Background of Study

Vegetation is one of the most critical natural resources sustaining the Earth's life-supporting system. It helps regulate the climate and atmospheric balance by sequestering carbon, maintaining biodiversity, controlling erosion, sustaining the water cycle, and providing food, shelter, fuel, and medicine to people [1]. From a global perspective, vegetation serves as a stabilizing force countering climate oscillation, while its decline indicates loss of ecosystem functioning and sustainability.

Over the past few decades, vegetation across different biomes is under increasing pressure from both natural and anthropogenic activities such as climate change, wildfire outbreaks, pest and disease infestation, urban expansion, industrial growth, agricultural sprawl, logging, and infrastructural development. The Food and Agriculture Organization [2] states that the world lost more than 100 million hectares of forests from 2000 to 2020, underlining the need for conservation and restoration initiatives. Sub-Saharan Africa, including Nigeria, displays notable trends of vegetation decline, predominantly caused by the rise in socio-economic and demographic factors. Population increase, widespread poverty, lax environmental policies, and unsustainable reliance on natural resources are some of the drivers of land cover change [3].

The need to fulfill the peoples' requirements for food, fuelwood and even space for housing has contributed towards the destruction of large areas of plant life which affects the local population and the climate as well. In Nigeria, which is Africa's most populated country, there have been marked changes concerning land use and land cover over the past few decades [4]. Imo State, which is situated at the southeastern region of the country, was previously covered with extravagant tropical rain forests. At present, the region is dominated secondary successional vegetation, derived savannah, farmland, as well as urban sprawl. The uncontrolled growth of population, immigration, urbanization, and policy neglect have all contributed towards the severe fragmentation and destruction of forest ecosystems [5]. Overall human activity in Ideato North Local Government Area (LGA) has increased due to the strategic transport routes, fertile agricultural soils, and growing urban centers.

Ideato North location is the southern part of Imo State. It is predominantly rural with peri-urban centers which makes it a town with villages [6]. The locals practicing farming make use of the available land whether for subsistence or commercial purposes. Farming in commercial scale, and deforestation are surpassing the ability for land to sustain agricultural activities. Areas with new farmland are replacing those which had degenerated step by step but if it goes on like this, the world is facing severe changes that are irreversible, which would be catastrophic. Impacting the environment will put the region's existing capacity to support set off new threshold.

Monitoring vegetation using the Normalized Difference Vegetation Index (NDVI) method is common. NDVI methodology estimates quantity and health of vegetation based on reflectance measurement in red and near-infrared light. Mapping vegetation, as well as detecting seasonal and long-term changes across various landscapes, can be advanced with NDVI utilization. It functions as a substitute for biomass production, the condition of plants, and land productivity, making it essential for ecological and agricultural research.

In this study, we aim to explore how vegetation in Ideato North Local Government Area has changed over the last two decades by using satellite images from the Landsat missions. By focusing on two key years, 2005 and 2025, we will track the rate and pattern of vegetation decline across the area. This timeline allows us to examine how land use has shifted over time, where the most significant changes have occurred, and what may be driving those changes, whether it's expanding settlements, farming activities, or the construction of new roads and infrastructure [7].

The goal is not just to map what has been lost, but to help communities and decision-makers see where we can still act. By identifying areas that are most affected, as well as those with potential for restoration, the findings will be valuable to local authorities, urban planners, environmental advocates, and residents alike. Ultimately, this research supports broader global efforts to promote sustainability and climate resilience. It aligns with the Sustainable Development Goals, specifically those focused on climate action (Goal 13), protecting life on land (Goal 15), and building sustainable cities and communities (Goal 11). In doing so, the study hopes to offer not just data, but a tool for informed action and positive environmental change in Ideato North.

1.2. Study Area

Ideato North Local Government Area (LGA) is one of the 27 LGAs in Imo State, southeastern Nigeria, as shown in **Figure 1** below. It lies between latitude 5˚51'59.48"N, Longitude 7˚1'15.44"E and Latitude 5˚45'42.53"N, and Longitude 7˚13'8.99"E of the equator and Greenwich meridian respectively. The area shares borders with Ideato South to the south, Njaba and Orlu LGAs to the east and northeast, and Isu LGA to the northwest. The administrative center is in Urualla, a central town within the LGA as presented in **Figure 2** below. Predominantly rural, Ideato North has seen growing peri-urban development in recent years [8]. It is made up of several autonomous communities and towns such as Osina, Akokwa, Obodoukwu, and Uzii. The population is mainly from the Igbo ethnic group, and the local economy revolves around agriculture, small-scale trading, and traditional crafts. According to the 2006 census, about 183,260 people lived here, but this number has likely increased with natural population growth and migration.

The climate is typical of the tropical rainforest zone, with two distinct seasons: a rainy season from March to October and a dry season from November to February. Annual rainfall averages around 2000 mm, though climate change and local weather patterns can cause fluctuations [9]. Temperatures stay fairly warm throughout the year, averaging between 25˚C and 30˚C, and humidity is usually high, especially during the rainy months [10].

Originally, Ideato North was covered in dense tropical rainforest, but years of deforestation, shifting cultivation, and development have transformed the landscape [11]. Today, you'll find a patchwork of secondary forests, fallow lands, croplands, and scattered shrubs [12]. Some remnants of the original forest remain in less accessible or protected spots. The soils are mostly sandy loam, supporting crops like cassava, yam, maize, and vegetables. However, soil erosion, especially where the land is bare, has become a growing problem.

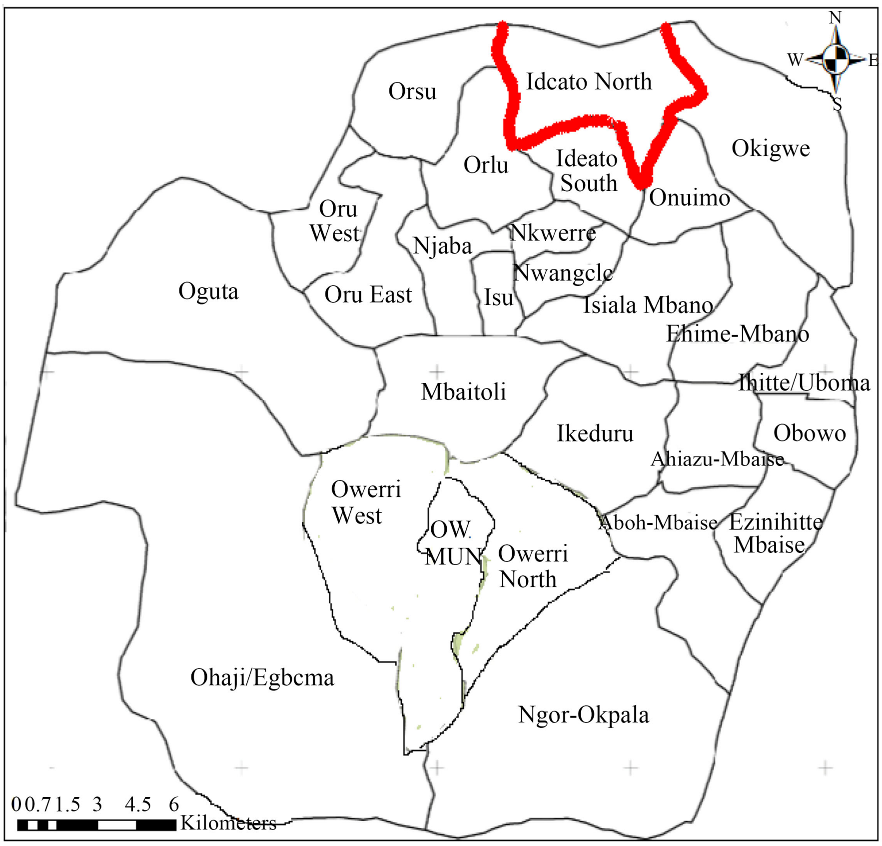

Figure 1. Map of imo state showing the study area (Ideato north) (Iro, 2026).

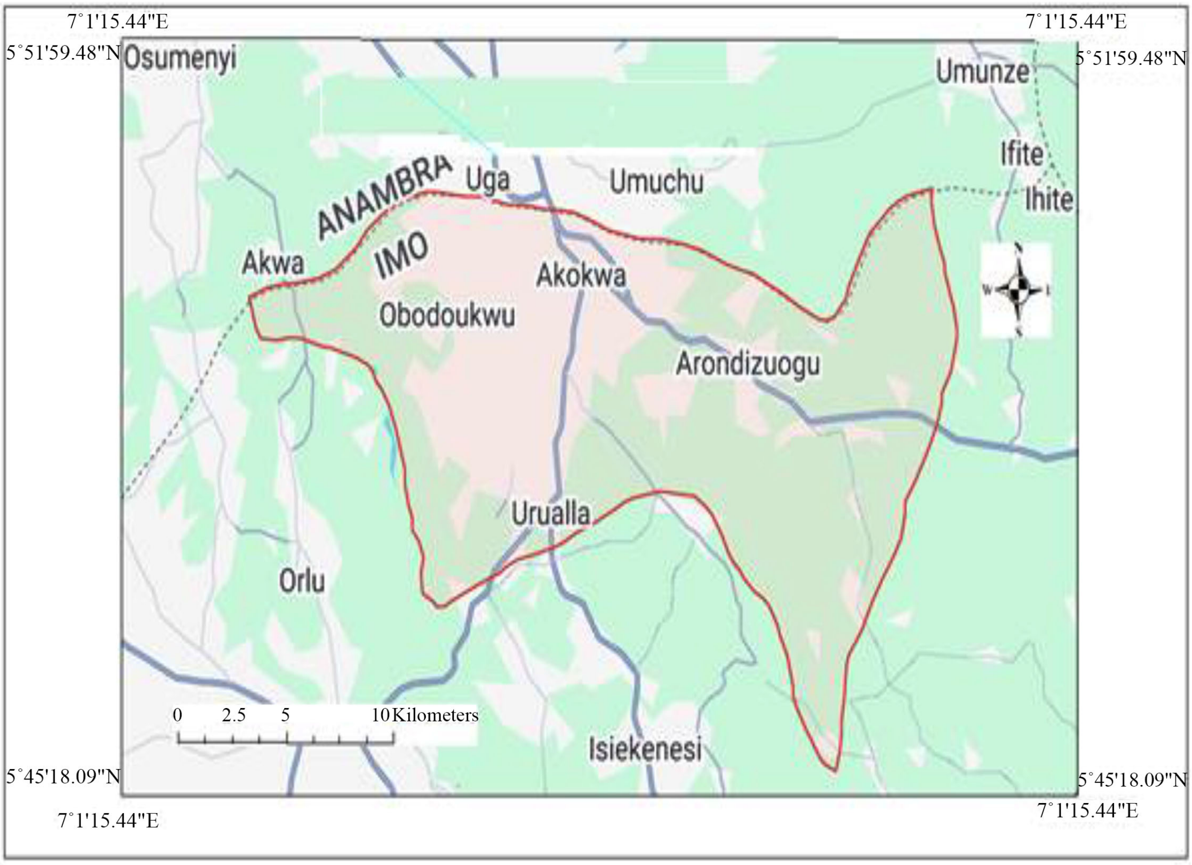

Figure 2. Study area Ideato north L.G.A (Iro, 2026).

The terrain is gently rolling, with elevations ranging from about 100 to 250 meters above sea level. This combination of undulating land, heavy rainfall, and poor land management has led to erosion and land degradation in parts of the area. Gullies and degraded farmland highlight the need for sustainable land use and better vegetation management [13].

Overall, Ideato North offers a valuable case study for understanding vegetation changes over time. Its varied land uses, environmental challenges, and ongoing development pressures make it a good example of the broader trends shaping southeastern Nigeria's landscape.

2. Research Methodology

2.1. Research Design

This study uses a quantitative and analytical approach, combining remote sensing with GIS mapping to explore how vegetation has changed in Ideato North LGA over the past 20 years. By blending these geospatial techniques, the research captures both where and how vegetation has shifted across time.

2.2. Data Sources

- Landsat (2005 and 2025) datasets.

- Field Observation and Ground Truthing: GPS-based field validation.

The use of NDVI thresholds across Landsat 7 and Landsat 9

The use of a common NDVI classification threshold across **Landsat 7** and **Landsat 9** is justified because NDVI is a normalized, ratio-based index that minimizes sensor-specific differences. Since NDVI is computed from the relative contrast between red and near-infrared reflectance (NIR − RED)/(NIR + RED) (NIR − RED)/(NIR + RED) (NIR − RED)/(NIR + RED), it reduces the influence of absolute radiometric variations between sensors, making outputs from different Landsat missions directly comparable. Both sensors also have comparable spectral band configurations for red and near-infrared wavelengths, meaning they capture vegetation reflectance characteristics in a consistent manner. After applying standard preprocessing steps, such as radiometric calibration, atmospheric correction, and geometric alignment, the resulting NDVI values fall within the same theoretical range (−1 to +1) and retain similar ecological meaning. Therefore, applying uniform NDVI thresholds across both datasets ensures methodological consistency and allows for reliable temporal comparison, particularly in change detection studies where differences in classification should reflect real environmental change rather than sensor-related inconsistencies.

Image Preprocessing

Image preprocessing involved radiometric and geometric correction, atmospheric correction using software ENVI and ArcGIS. The images were subset to the boundary of Ideato North LGA (Figure 3 and Figure 4).

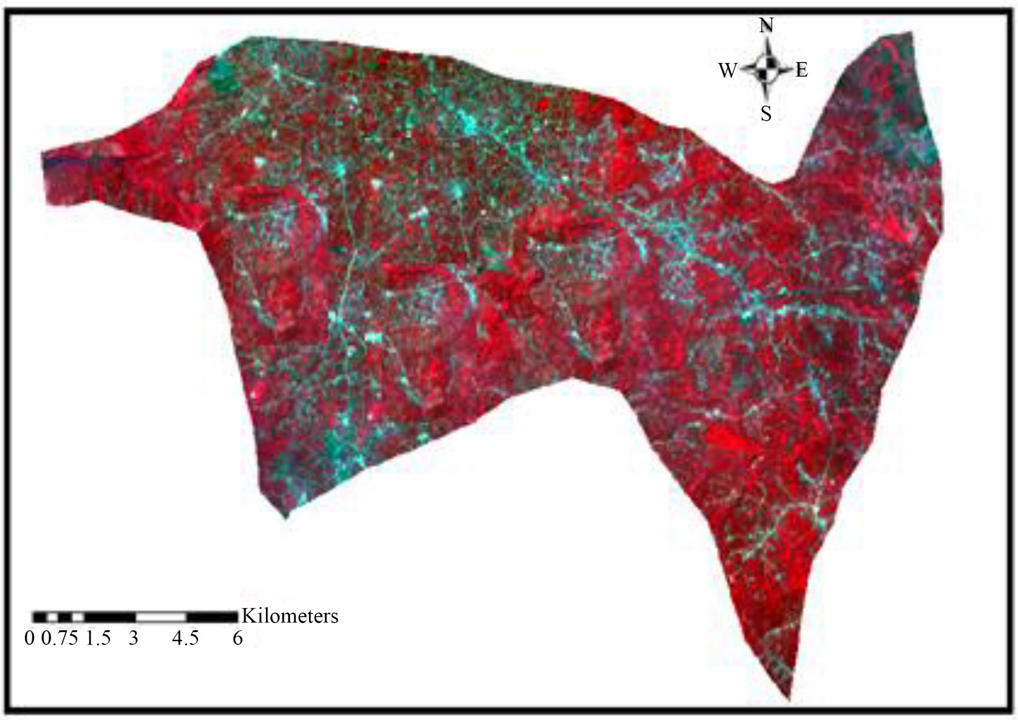

Figure 3. A subset Landsat 7 imagery of Ideato North, year 2005 (path 188 and row 056) Landsat collection 2 level 2, date acquired: 2005/12/27.

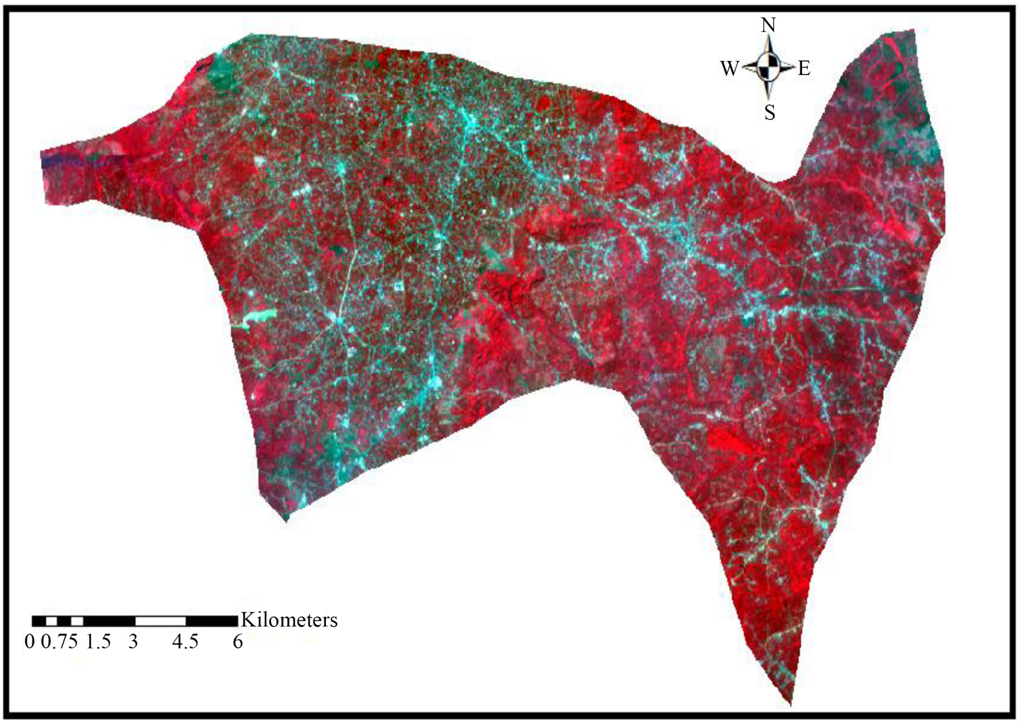

Figure 4. A subset Landsat 9 imagery of Ideato North, year 2025 (path 188 and row 056) Landsat collection 2 level 2, date acquired: 2025/12/27.

2.3. Vegetation Index Calculation

NDVI and Its Interpretation Using Landsat Bands

The **Normalized Difference Vegetation Index (NDVI)** is a widely used vegetation index that helps measure the presence and condition of vegetation on the Earth's surface. It is derived from the reflectance of red and near-infrared (NIR) light captured by satellite sensors. NDVI is calculated using the formula:

$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}} \quad (1)$$

This formula works by comparing the difference and the sum of near-infrared and red-light reflectance values. Vegetation reflects and absorbs light in different ways. Healthy green plants absorb most of the red light for photosynthesis and reflect a high amount of near-infrared light. In contrast, unhealthy or sparse vegetation reflects more red light and less near-infrared light. Non-vegetated surfaces such as bare soil, roads, or water reflect both wavelengths more evenly.

In practical terms, NDVI values range from −1 to +1. Values closer to +1 (for example, 0.6 to 0.9) indicate dense, healthy vegetation, while values near zero suggest bare ground or sparse vegetation. Negative values usually represent non-vegetated areas, such as water bodies or built-up surfaces. NDVI Classification: To translate the continuous NDVI values into interpretable land cover categories relevant to vegetation health and human impact, the NDVI rasters were reclassified into distinct thematic classes:

Dense/Healthy Vegetation: High NDVI values (e.g., >0.5). Signifies areas of robust photosynthetic activity, typically forests, dense woodlands, or thriving agricultural crops. Sparse/Unhealthy Vegetation: Moderate NDVI values (e.g., 0.2 - 0.5). Indicates areas with vegetation under stress, such as degraded forests, savannas in dry season, or poorly performing crops, often linked to water scarcity, disease, or anthropogenic pressure.

Open/Bare Land: Low positive NDVI values (e.g., 0.0 - 0.2). Represents exposed soil, rocks, dry grasslands, fallow fields, or recently cleared areas. Urban Land: Very low or sometimes negative NDVI values. Characterizes built-up areas, roads, and impervious surfaces.

For satellite imagery, different Landsat missions use specific bands for the red and near-infrared wavelengths: Landsat 5 and 7: Red band: Band 3, Near-Infrared (NIR) band: Band 4, Landsat 8 and 9: Red band: Band 4, Near-Infrared (NIR) band: Band 5.

This index will be computed for each study year and classified into vegetation density categories (dense, moderate, sparse, and non-vegetated). By applying the NDVI formula to these bands, this research will evaluate vegetation distribution, density, and changes over time. This technique is essential for monitoring deforestation, afforestation, and ecological restoration projects in Ideato North.

2.4. Image Acquisition and Preprocessing for NDVI Analysis

Satellite imagery from Landsat 7 (for 2005) and Landsat 9 (for 2025) was obtained from the USGS Earth Explorer platform. Key preprocessing steps included:

- Radiometric correction to eliminate noise and sensor errors.
- Cloud masking to reduce cloud interference.
- Geometric correction to ensure spatial accuracy.
- Clipping of imagery to Ideato North boundary to focus analysis on the study area.

NDVI Calculation

NDVI was computed for both years using the formula:

$$NDVI = (NIR - RED)/(NIR + RED)$$

where: NIR = Near-Infrared band; RED = Red band.

- For Landsat 7 (2005):
  - NIR = Band 4
  - RED = Band 3
- For Landsat 9 (2025):
  - NIR = Band 5
  - RED = Band 4

The raster calculator was used in ArcGIS to apply the NDVI formula pixel-wise, producing NDVI rasters for both years.

NDVI Reclassification

To distinguish healthy vegetation from other land cover types, the NDVI rasters were reclassified into binary form using the following thresholds as shown in Table 1:

Table 1. NDVI classification.

NDVI Range	Class Name	Description
−1.0 to 0.0	Urban/Built-up & Water	Represents non-vegetated surfaces such as buildings, roads, and water bodies with negligible or negative vegetation reflectance.
0.0 to 0.2	Open/Bare Land	Indicates exposed soil, sand, degraded land, and recently cleared surfaces with minimal vegetation presence.
0.2 to 0.5	Sparse/Unhealthy Vegetation	Represents areas with low vegetation density or stressed vegetation, including fallow land and degraded farmland.
0.5 to 1.0	Dense/Healthy Vegetation	Corresponds to areas with high vegetation vigor such as forests, dense shrubs, and well-developed crops.

All NDVI maps were reclassified using this four-class scheme for both 2005 and 2025 to ensure consistency in change detection analysis.

Raster to Polygon Conversion and Area Calculation

The classes NDVI raster were converted into a polygon layer to allow for spatial quantification:

- Conversion: Raster to Polygon (Conversion Tools → From Raster → Raster to Polygon).
- Simplify Polygons: Unchecked to retain spatial precision.
- The result: vector layer with attributes 0 = non-vegetated, 1 = healthy vegetation.

Area Measurement:

- A new field (Area_ha) was created in the polygon attribute table.
- Area was computed in hectares using the “Calculate Geometry” function.

NDVI Calculation and Vegetation Change Analysis

Normalized Difference Vegetation Index (NDVI) is a key remote sensing metric used to assess and monitor vegetation health across landscapes. In this chapter, NDVI was calculated and analyzed for the years 2005 and 2025 in Ideato North LGA using Landsat satellite imagery. The methodology involved image preprocessing, NDVI computation, classification, and spatial quantification to detect changes in vegetation cover over the 20-year period.

Ground-truthing Description of the work

The ground-truthing in this study was conducted in a general and exploratory manner, involving GPS-based field observations of major land cover types. These observations informed visual interpretation and supported the classification process, but were not used in a rigorous validation framework.

2.5. Spatial and Temporal NDVI Change Analysis

By comparing the classified NDVI maps of 2005 and 2025, significant trends in vegetation dynamics were identified: Figure 5: Landsat 9 (2025) Clipped Bands 5 and 4, Displays the raw NIR and RED bands used for NDVI generation. Highlights land features and spectral differences prior to NDVI computation.

Figure 6: 2025 Reclassified NDVI Map Shows the spatial distribution of healthy

vegetation (in green) and non-vegetated areas (in gray). Dense clusters of vegetation appear reduced compared to 2005. The classification thresholds were carefully selected based on the spectral characteristics of Ideato North LGA, verified through visual interpretation of the imagery and ancillary knowledge. **Figure 5** (2025 Reclassified NDVI Map) and 7 (2005 Reclassified NDVI Map) present the final, interpretable maps showing the spatial distribution of these classes, using green for healthy vegetation, yellow for sparse/healthy vegetation, brown for Urban land, white for bare/open land and gray for non-vegetated/urban areas.

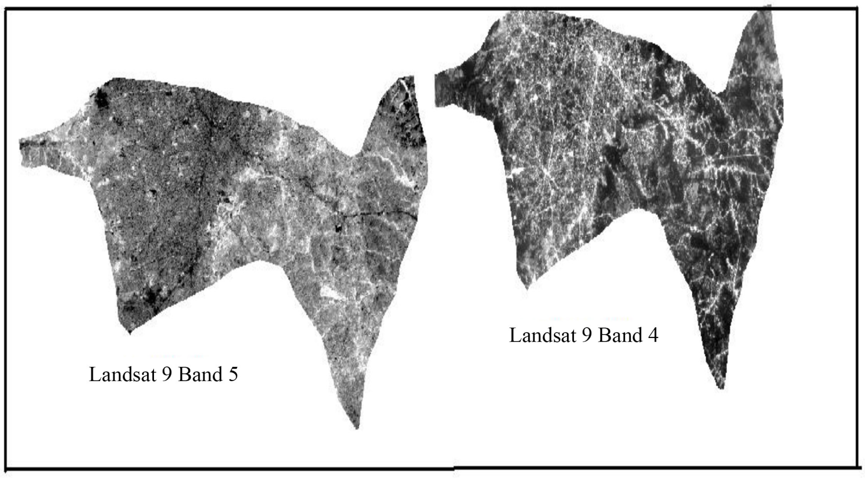

Figure 5. 2025 clipped band 5 and 4 landsat 9 of Ideato North.

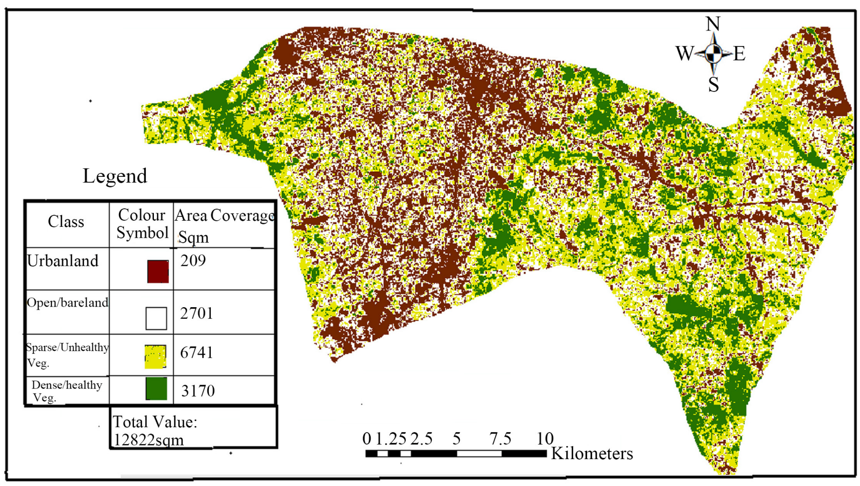

Figure 6. 2025 clipped NDVI reclassified image of Ideato North.

Figure 7: Landsat 7 (2005) Clipped Bands 4 and 3. The original NIR and RED bands used for the 2005 NDVI analysis, present a higher reflectance of healthy vegetation, typical of less disturbed landscapes.

Figure 8: 2005 Reclassified NDVI Map reveals substantial areas under healthy vegetation (bright green tones). Indicates the pre-development state of the landscape.

Visual Narrative (Figures 6-8): The 2005 map (Figure 8) is dominated by swathes of bright green, indicating extensive tracts of Dense/Healthy Vegetation. Large, contiguous blocks are clearly visible, suggesting a landscape with substantial natural or well-managed vegetative cover.

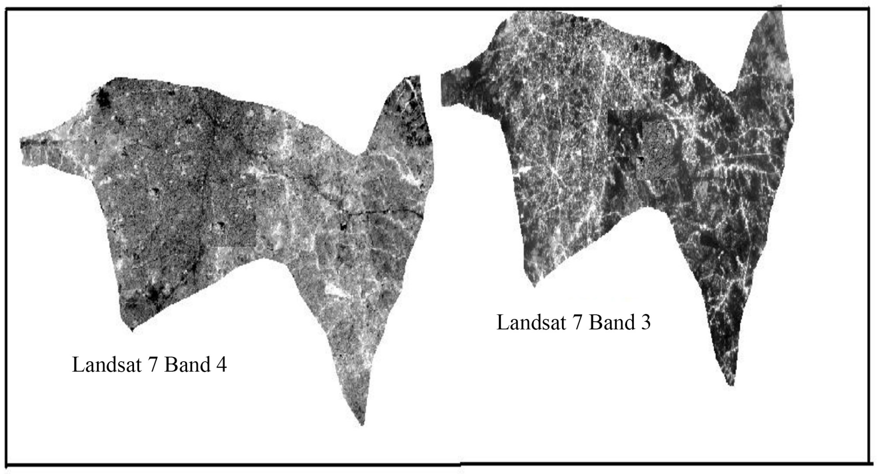

Figure 7. 2005 clipped band 4 and 3 of landsat 7 of Ideato North.

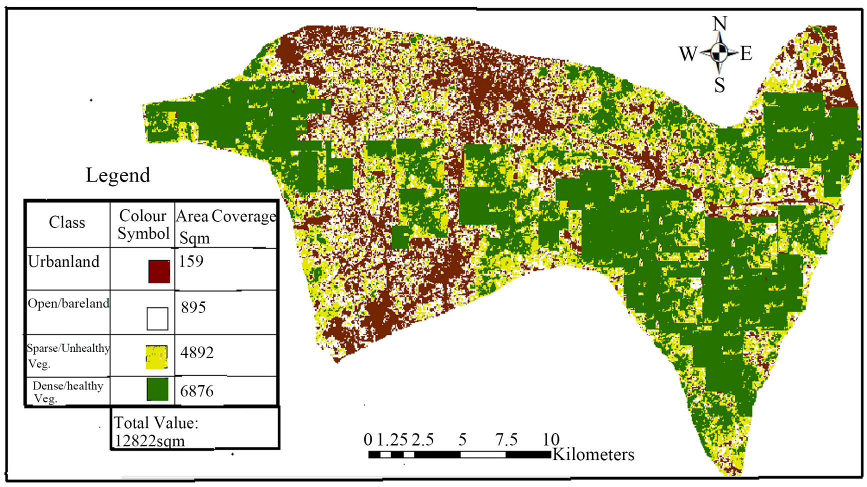

Figure 8. 2005 clipped NDVI reclassified image of Ideato North.

In stark contrast, the 2025 map (Figure 6) shows a pronounced fragmentation and reduction of these healthy green zones. They appear more scattered and isolated. The dominant visual impression shifts towards the yellows/browns (representing Sparse/Unhealthy Veg) and the grays (Open/Bare Land and Urban), indicating a landscape where vegetation health and coverage have significantly diminished.

Change Detection and Spatial Quantification:

The classified NDVI maps for 2005 and 2025 were directly compared pixel-by-pixel. The total area (in hectares or square kilometers) covered by each land cover class in each year was calculated. The difference in the percentage coverage of each class between the two years was computed, revealing the magnitude and direction of change over the 20-year period. These quantitative results are synthesized in **Table 1**. The visual comparison of the classified NDVI maps (**Figures 6-8**) and the quantitative analysis (**Table 2**) reveal a landscape undergoing significant and concerning transformation.

Table 2. NDVI percentage difference (2025 and 2005).

Class	2025%	2005%	Difference in %	Description of Change
Urban land	2	1	+1	Slight urban expansion over vegetated areas
Open/bareland	21	7	+14	Land degradation or clearance for development
Sparse/unhealthy Veg	53	38	+15	Vegetation stress due to anthropogenic pressure
Dense/healthy Veg	25	54	−29	Significant decline in vegetation health

3. Discussion, Summary of Findings and Conclusion

3.1. Discussion

The spatiotemporal analysis of vegetation dynamics in Ideato North LGA between 2005 and 2025 reveals a marked and statistically meaningful transformation of the landscape. Using NDVI derived from Landsat imagery, the study demonstrates a clear downward trajectory in dense and healthy vegetation, accompanied by a substantial rise in sparse vegetation, bare land, and urban surfaces. These findings are consistent with global and regional observations that link vegetation decline to anthropogenic land-use pressure [1] [2].

The 29% reduction in dense and healthy vegetation over the 20-year period is particularly alarming. In ecological terms, such a decline indicates reduced photosynthetic activity, diminished biomass accumulation, and weakening ecosystem resilience. NDVI has long been validated as a reliable proxy for vegetation vigor and productivity [14], and therefore the observed reduction strongly suggests ecosystem stress rather than mere seasonal variability. The fragmentation patterns visible in the 2025 map further imply habitat disruption, which often leads to biodiversity loss and reduced ecological connectivity.

The 14% increase in open/bare land reflects expanding land clearance, likely driven by agricultural intensification, sand mining, road construction, and settlement growth. In rural-peri-urban systems such as Ideato North, agricultural expansion remains a dominant driver of deforestation and vegetation degradation [3]. The shift from dense vegetation (54% in 2005) to sparse/unhealthy vegetation (53% in 2025) suggests that even areas that retain vegetative cover are under stress, possibly due to soil nutrient depletion, shortened fallow cycles, and continuous cropping. This aligns with earlier findings that tropical rural landscapes under demographic pressure experience gradual ecological exhaustion rather than abrupt total clearance [4]. Urban land increased modestly by 1%, but this figure should not be underestimated. Urban growth often triggers secondary effects beyond its spatial footprint, including road networks, land speculation, and peri-urban agricultural intensification. The pattern observed suggests incremental but steady urban encroachment, consistent with peri-urban development trends documented in southeastern Nigeria [5]. Even small increases in built-up surfaces contribute to altered hydrological regimes, increased runoff, and local heat island effects.

The spatial comparison between 2005 and 2025 maps illustrates a transition from contiguous forest blocks to fragmented vegetative patches. Fragmentation reduces ecosystem services such as carbon sequestration, microclimate regulation, and erosion control [1]. Given Ideato North's rolling topography and high rainfall, reduced vegetation cover increases susceptibility to soil erosion and gully formation, an environmental challenge already documented in parts of Imo State [13]. The results also align with [2] reports highlighting Sub-Saharan Africa as a hotspot of forest loss driven by subsistence agriculture and weak land governance. While global forest loss figures often focus on large-scale industrial deforestation, this study underscores the cumulative effect of smallholder-driven land transformation at the local scale. Such localized degradation, when aggregated, contributes significantly to regional ecological instability.

Importantly, the shift from dense vegetation to sparse vegetation does not represent a neutral transition. Sparse or stressed vegetation reflects declining ecosystem productivity and may indicate reduced resilience to climate variability. In tropical systems, vegetation stress can amplify vulnerability to drought and extreme rainfall events [7]. Therefore, the decline documented in this study has implications not only for biodiversity but also for climate adaptation and food security.

3.2. Summary of Findings

The major findings of the study are summarized as follows:

1) Significant Decline in Dense Vegetation:

Dense and healthy vegetation decreased from 54% in 2005 to 25% in 2025, representing a 29% loss over two decades.

2) Increase in Sparse/Unhealthy Vegetation:

Sparse vegetation increased by 15%, indicating growing environmental stress and degradation rather than total deforestation alone.

3) Expansion of Open/Bare Land:

Open and bare land increased from 7% to 21%, a 14% rise, suggesting intensified land clearing and degradation.

4) Gradual Urban Expansion:

Urban land increased by 1%, reflecting ongoing peri-urban development.

5) Landscape Fragmentation:

Vegetation patches have become more fragmented and isolated, reducing ecological connectivity and ecosystem stability.

6) Evidence of Anthropogenic Pressure:

The spatial and quantitative patterns strongly indicate that human activities, particularly agriculture, settlement expansion, and land clearance, are primary drivers of vegetation change.

Collectively, these findings confirm that Ideato North LGA is undergoing sustained environmental transformation characterized by declining vegetation health and increasing land degradation.

3.3. Conclusions

This study provides clear empirical evidence that vegetation cover in Ideato North LGA has significantly deteriorated between 2005 and 2025. The 29% reduction in dense vegetation represents not just a statistical decline but a fundamental shift in ecosystem structure and function. The concurrent rise in sparse vegetation and bare land underscores progressive land degradation rather than isolated disturbance events. The use of NDVI derived from Landsat imagery proved effective in quantifying vegetation dynamics and detecting spatial patterns of environmental change. The methodology offers a replicable and cost-efficient monitoring framework for local governments and environmental planners. If current trends continue unchecked, Ideato North risks accelerated soil erosion, reduced agricultural productivity, biodiversity loss, and increased climate vulnerability.

The findings call for immediate policy interventions, including:

- Community-based afforestation and reforestation programs.
- Strengthened land-use regulation and enforcement.
- Promotion of sustainable agricultural practices.
- Establishment of continuous vegetation monitoring systems using remote sensing.

Ultimately, sustainable land management must become a priority in Ideato North. Environmental recovery remains possible, but it requires coordinated action grounded in scientific evidence. This study provides that evidence and establishes a baseline for future monitoring and policy development.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Lambin, E.F., Geist, H.J. and Lepers, E. (2003) Dynamics of Land-Use and Land-Cover Change in Tropical Regions. *Annual Review of Environment and Resources*, **28**, 205-241. https://doi.org/10.1146/annurev.energy.28.050302.105459

[2] Food and Agriculture Organization (FAO) (2020) Global Forest Resources Assessment 2020: Main Report. FAO.

[3] Adefisan, E.A., Abatan, A.A. and Ogundele, F.O. (2019) Assessment of Land Use and Land Cover Changes in Nigeria Using Geospatial Techniques. *Environmental Monitoring and Assessment*, **191**, 1-15.

[4] Eni, D.D., Obiefuna, J.N. and Oko, C.E. (2008) Land Use and Land Cover Dynamics in Southeastern Nigeria. *Nigerian Journal of Environmental Sciences*, **6**, 23-34.

[5] Alegbeleye, O.O., Iro, S.I. and Okeke, C. (2024) Urban Expansion and Forest Ecosys-

tem Fragmentation in Southeastern Nigeria. *Journal of Environmental Geography*, **17**, 45-60.

[6] Iro, S.I. (2025) Assessment of Impact of Land-Use Activities at the Watershed of Njaba River Imo State Using GIS and Remote Sensing Technology. *Trends in Environmental Sciences*, **1**, 16-22. https://doi.org/10.21124/tes.2025.16.22

[7] Idowu, T.E., Olawuni, P.O. and Adewumi, J.R. (2020) Vegetation Dynamics and Climate Variability in Tropical West Africa Using NDVI. *Remote Sensing Applications: Society and Environment*, **18**, 100-115.

[8] Iro, S.I. (2020) Determining Causes of Gully Erosion and Associated Rates of Change in South-East Nigeria, Using a Remote Sensing and GIS Methodology. *American Journal of Environmental Sciences*, **16**, 96-111. https://doi.org/10.3844/ajessp.2020.96.111

[9] Obiahu, O.H. and Elias, E. (2020) Effect of Land Use Land Cover Changes on the Rate of Soil Erosion in the Upper Eyiohia River Catchment of Afikpo North Area, Nigeria. *Environmental Challenges*, **1**, Article 100002. https://doi.org/10.1016/j.envc.2020.100002

[10] Iro, S.I., Ezedike, C.E. and Pat-Mbano, E.C. (2021) The Application of Kernel Density tool in Determining Health Effects Associated with Areas Inundated with Flood in Owerri Urban Nigeria. *IASR Journal of Agriculture and Life Sciences*, **1**, 7-14. https://www.google.com/url?sa=i&source=web&rct=j&url=https://www.researchgate.net/publication/357805690_The_Application_of_Karnel_Density_tool_in_Determining_Health_effects_Associated_with_Areas_Inundated_with_Flood_in_Owerri_Urban_Nigeria&ved=2ahUKEwiI1uyUy_eUAxUZ0EAHX_kEA4Qy_kOegoIAggACAAIEBAC&opi=89978449&cd&psig=AOvVaw29Kbi7X3Q8qEZv9wkPHXrT&ust=1781006175734000

[11] Iro, S.I. and Achalonu, C.A (2020) The Vectorisation and Quantification of Some Gully Sites in Southeast Nigeria to Determine Their Extent and Rates of Gully Change. *Global Scientific Journals in Environmental Science*, **8**, 2601-2628. https://www.researchgate.net/publication/344069798_The_Vectorisation_and_quantification_of_some_gully_sites_in_Southeast_Nigeria_to_determine_their_extent_and_Rates_of_Gully_change

[12] Okeke, C.A., Nwosu, P.C. and Ubah, I.C. (2022) Vegetation Cover Change Detection in Southeastern Nigeria Using Satellite Imagery. *African Journal of Environmental Science and Technology*, **16**, 243-255.

[13] Iro, S.I., Duru, P.N. and Achalonu, C.A. (2022) The Use of Remote Sensing and GIS Methodology in the Analysis of Urualla Gully Erosion Site Imo State Nigeria. *Environmental Science: Current Research*, **5**, Article 030. https://doi.org/10.24966/escr-5020/100030

[14] Tucker, C.J. (1979) Red and Photographic Infrared Linear Combinations for Monitoring Vegetation. *Remote Sensing of Environment*, **8**, 127-150. https://doi.org/10.1016/0034-4257(79)90013-0