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URBAN GROWTH AND BIODIVERSITY IN IBESIKPO ASUTAN LOCAL GOVERNMENT AREA, AKWA IBOM STATE, NIGERIA

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ABSTRACT

Purpose: This study investigated the impact of urban growth on biodiversity in the Ibesikpo Asutan Local Government Area, Akwa Ibom State, from 1986 to 2024. This is in a view to providing sustainable policy recommendations for environmental management.

Design/methodology/approach: The study utilizes an approach involving primary data acquisition. However, spatial data derived from GIS and field surveys were employed. For the assessment of urbanization, purposive sampling guided the selection of satellite imagery, to ensure the research findings were statistically representative of the urban-rural gradient and geographically, a multi-stage stratified random sampling process was executed, and ecological field surveys with socio-economic data from household heads.

Findings: Land Use/Land Cover (LULC) analysis revealed expansion of built-up areas from 2,132.81 ha to 4,953.36 ha, resulting in the loss of over 4,200 ha of forest land, between 1986 and 2024. This was achieved at the expense of over 4,200 ha of forest land. Results of Analysis of Variance and the Post-hoc Tukey HSD tests, with p-values of 0.014 and 0.011 respectively, confirmed that there was a statistically significant difference in biodiversity between the three urban gradients and that high urbanisation significantly reduces biodiversity density within Ibesikpo Asutan LGA.

Research limitations/Implications: this study was defined to provide a focused and achievable analysis of the complex relationship between urban growth and biodiversity, which consisted of lumber trees. Within Ibesikpo Asutan Local Government Area. The study successfully bridges the gap between macro-level drivers (demographic/economic) and micro-level ecological consequences (species compositional change) in a single, quantitative framework, advancing urban ecology literature.

Practical implications: the study proposes evidence-based policy recommendations, including legally binding urban growth boundaries, mandatory Environmental Impact Assessments (EIAs), and community-based restoration programmes utilizing local ecological knowledge **Originality:** This study showed that spatial features exert a mappable, structured and quantifiable spatial influence on the viability of commercial real estate investment in the study area.

Originality/value: The study showed that urban expansion between 1986 and 2024 led to a substantial (4,200 ha) loss of forest land in Ibesikpo Asutan Local Government Area. Highlighting the impact of such expansion on ecological environment.

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Keywords: Urban Growth, Biodiversity Loss, Land-Use and Land-Cover Change (LULC), Habitat Fragmentation, built-up areas.

1. INTRODUCTION

The dynamic relationship between human development and the natural world is one of the most pressing issues of our time, with urbanization standing out as a primary driver of environmental change. Urban growth, defined by Chowdhury and Bhadra (2020) and Liu, Wang, and Li, (2025) as the physical expansion of cities and towns, is an irreversible process that profoundly alters landscapes, fundamentally changing how ecosystems function. As human populations increasingly concentrate in urban centres, natural habitats are converted into residential, commercial and industrial zones, leading to a cascade of ecological consequences. This transformation poses a direct threat to biodiversity, which encompasses the variety of life on earth at all levels from genes to ecosystems. The study of this interlinkage, therefore, is crucial for understanding the environmental costs of human progress and developing strategies for sustainable development that do not come at the irreversible expense of the planet's ecological health. This research seeks to contribute to this discourse by examining the specific impacts within a rapidly developing local context.

Historically, human settlements have always impacted their surrounding environments, but the scale and speed of this impact have accelerated since the Industrial Revolution of the 1800s. The shift from agrarian societies to industrial and urban economies has fuelled an unprecedented rate of urban expansion, a phenomenon referred to as "unplanned urbanization" in some academic circles (Akpan and Eze, 2023). Early urban centres were often limited in their footprint, but with advancements in transportation, technology and population growth, cities have expanded outwards in a process known as urban sprawl. This historical trend has systematically encroached upon natural habitats, leading to their degradation and conversion. This perspective highlights that the challenge is not new, but its contemporary scale demands more rigorous scientific investigation and proactive policy responses to mitigate the long-term ecological damage that has accumulated over centuries of human expansion.

At a global level, the effects of urbanization on biodiversity are documented and far-reaching (McDonald, *et al.,* 2020). The most immediate and severe impact is habitat loss, where natural ecosystems are completely replaced by built infrastructure (Simkin, *et al.,* 2022). This is often followed by habitat fragmentation, where remaining natural patches are isolated from one another by urban land cover, leading to significant ecological degradation (Wang, Zhou, Pickett, Yu, and Han, 2025). These fragmented habitats are too small to support viable populations of many species, leaving them vulnerable to local extinction. Furthermore, urbanization introduces a host of environmental stressors, including pollution from industrial activities and vehicles, altered hydrological cycles due to impermeable surfaces, and the known urban heat island effect, all of which put immense pressure on native species (Pimm, Raven and O'Hara, 2022; Dobson, Olatunji and Adedoyin, 2023). These stressors collectively lead to a decline in specialist species while favouring a few generalist species that adapt to urban environments, resulting in a global homogenization of urban wildlife.

The scale of the global urbanization challenge has been formally recognized by major international bodies. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), in its 2021 assessment report (Pörtner, *et al.,* 2021) underscored the profound interlinkages between urbanization and biodiversity loss, highlighting it as one of the primary threats to ecological integrity. Similarly, the United Nations Human Settlements Programme has consistently emphasized the need for sustainable urban planning in its reports (UN-Habitat, 2022). These international reviews and assessments provide a stark global context, demonstrating that the issues being investigated in this study are not isolated but are part of a broader, interconnected global crisis. They call for localized studies to better understand the specific mechanisms and

impacts of urban growth in diverse geographical and socio-ecological settings, thereby providing the empirical data needed for effective global policy.

Africa, as a continent, is at the epicentre of the global urbanization trend, experiencing the world's highest rates of urban growth. Unlike the more gradual historical urbanization of developed nations, African cities are expanding at an unprecedented speed, often in an unplanned and haphazard manner (Akpan and Eze, 2023). This rapid and often chaotic expansion puts immense pressure on natural resources and ecosystems. The conversion of land for residential and commercial purposes frequently occurs without adequate environmental impact assessments, leading to widespread habitat destruction and degradation. Furthermore, this urbanization is closely linked to shifts in livelihoods, as people migrate from rural areas to cities, abandoning traditional agricultural and resource-based activities. The unique and highly biodiverse ecosystems of Africa, ranging from tropical rainforests to savannahs, are therefore disproportionately at risk from this rapid land-use change, making the continent a crucial area for ecological research.

The African perspective on urbanization reveals unique challenges and outcomes. One of such is that the rapid pace of urban expansion often outstrips the capacity of governance and urban planning, leading to a proliferation of informal settlements and a lack of green infrastructure. This form of development directly encroaches upon ecosystems, including forestlands, wetlands and agricultural areas, with consequences for species dependent on these habitats (Ibe and Nwosu, 2020; Ukpong, *et al.*, 2025). The fragmentation of habitats is a particularly severe issue, as it creates isolated pockets of nature that are unable to support healthy, genetically diverse populations. The introduction of non-native species, often hitchhiking along with urban development, further disrupts fragile local ecosystems, outcompeting native lumber trees and large mammals. These patterns underscore the need for targeted research that informs more resilient and sustainable urban models for African cities.

Within this continental context, Nigeria stands out due to its immense population and high rate of urbanization. As the most populous nation in Africa, it is home to some of the continent’s fastest-growing cities. The relentless rural-to-urban migration has placed immense pressure on urban and peri-urban environments, leading to significant land-use changes (Obi *et al.*, 2024; Anifowose and Olorunfemi, 2023). This demographic shift drives the conversion of vast tracts of land from natural and agricultural uses to built-up areas, often resulting in environmental degradation. The challenges of urban growth in Nigeria are multifaceted, involving issues of infrastructure deficit, waste management and environmental pollution. These factors combine to create a complex and often hostile environment for biodiversity, making the Nigerian context a case study for understanding the broader urban-ecological dynamic in a developing country.

Research in Nigeria has consistently highlighted the severe environmental impacts of urban land-use changes. In the Niger Delta, urban expansion has led to considerable biodiversity loss (McMahon, Okafor, and Egbuna, 2024), while studies in southwestern Nigeria demonstrate that these changes directly affect local biological variety (Olorunfemi and Alabi, 2022). Furthermore, Odu and Ekwere (2021) confirmed that urbanization significantly reduces plant species diversity across the country. While these studies provide valuable insights, they emphasize a critical need for granular, site-specific research to inform localized conservation strategies that account for regional ecological nuances.

Akwa Ibom State serves as a prime example of rapid urban and economic development. Research on its capital, Uyo, has documented a clear trend of habitat loss and fragmentation (Udo, Essien, and Akpan, 2023; Akpan and Onogwu, 2025, Ulaeto, Uyanga and Bassey, 2013). Despite these findings in neighbouring areas, there remains a significant research gap regarding the specific effects of urban growth within the Ibesikpo Asutan Local Government Area. There is a distinct lack of empirical data on how local urbanization influences the composition and health of the area’s native lumber trees. This study aims to fill this gap by providing a foundational dataset to inform local governance and sustainable planning.

Ideally, urban planning should be guided by sustainable development principles, ensuring that infrastructure expansion does not lead to the irreversible loss of natural habitats. This promotes a symbiotic relationship between urban centres and the environment, preserving vital ecological corridors. However, in many developing regions like Sub-Saharan Africa, over 80% of urban growth is unplanned and driven by rural-urban migration. The absence of effective land-use policies results in a chaotic pattern of urbanization that directly conflicts with biodiversity conservation. In Nigeria, where more than two-thirds of cities are expanding at an alarming rate, this poses a direct threat to the nation's ecological heritage.

Ibesikpo Asutan is experiencing a similar trajectory of unchecked growth. Studies on neighbouring centres like Uyo reveal that forest cover declined significantly while built-up areas expanded by approximately 7,192.74 hectares between 1986 and 2024 (Akpan and Onogwu, 2025). Similarly, Ibe and Nwosu (2020) documented the negative implications of urban expansion on forest cover in Owerri. Given its proximity to Uyo and Ibesikpo Asutan, this likely mirrors these patterns, facing increasing pressure on its forests, wetlands, and farmlands. This reality represents a measurable threat to native lumber trees, necessitating this research to quantify the direct relationship between land-use changes and species decline to ensure long-term environmental sustainability.

This study seeks to investigate the impact of urban growth on biodiversity in the Ibesikpo Asutan Local Government Area of Akwa Ibom State, with a view to providing sustainable policy recommendations for environmental management. The specific objectives are;

i. To analyse the pattern and rate of urban growth in the Ibesikpo Asutan Local Government Area, from 1986 to 2024.
ii. To examine the pattern and rate of land-use change in the Ibesikpo Asutan Local Government Area, from 1986 to 2024.
iii. To evaluate the key drivers of urban growth and their correlation with biodiversity loss in the study area.

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2. LITERATURE REVIEW

The scholarly discourse on urban growth and land-use change, particularly in developing nations, has evolved significantly with the advent of remote sensing and Geographic Information System (GIS) technologies. Literature broadly establishes that rapid and often unplanned urbanization is a dominant driver of landscape transformation, leading to profound environmental consequences. Studies such as those by Anifowose and Olorunfemi (2023) and Akpan and Eze (2023) provide a macro-level perspective, examining the challenges of urban growth and its impact on environmental sustainability and ecosystem services across Nigeria and West Africa, respectively. These works highlight a recurring theme: the accelerated rate of population growth in urban centres consistently outpace the capacity for planned infrastructural development, resulting in phenomena like urban sprawl, habitat fragmentation, and the depletion of natural resources. There is a clear consensus that this uncontrolled expansion is a significant threat to long-term ecological and socio-economic wellbeing.

Focusing on micro-level dynamics, several studies employ GIS and satellite imagery to quantify land-use changes within specific urban environments. The work of Udo *et al.* (2023) on the Uyo metropolis serves as a direct point of comparison for the present research in Ibesikpo Asutan. Their findings revealed a significant decline in forest cover from 31.05% to 16.43% and an expansion of built-up areas from 23.44% to 44.80% between 1986 and 2024. This quantitative data provides an empirically grounded finding that mirrors the work of Ibe and Nwosu (2020) in Owerri, which detailed similar urban

expansion encroaching upon forest cover. These studies collectively establish a data-driven pattern of land conversion from natural landscapes to built-up environments.

A key conceptual variable is the pattern of growth. Akpan and Onogwu (2025) and Udo *et al*. (2023) found that urban growth in Uyo exhibited a "concentric pattern" outward from the urban core, influenced largely by road infrastructure. While this strengthens the theory of a radial, infrastructure-driven growth model, it juxtaposes against other cities that exhibit "leapfrog" or fragmented growth patterns, highlighting the context-specific nature of urbanization.

This reviewed literature demonstrated a strong preference for multi-temporal Land-Use and Land-Cover (LULC) change detection. Umoren and Essien (2020) and Olorunfemi and Alabi (2022) utilized this approach, relying on supervised or unsupervised image classification to quantify changes. Beyond mere quantification, Akinyemi and Akangbe (2024) shifted focus toward the drivers of peri-urbanization. They identified population pressure, economic growth, and inadequate policy as primary drivers echoed in peri-urbanization.

Temporal analysis consistently identifies a significant acceleration in Nigerian urban growth post-1986. Udo *et al*. (2023) demonstrated that while built-up areas expanded by only 3.58% between 1986 and 2005, the expansion from 2005 to 2024 was a staggering 17.78%. This exponential trend is corroborated nationwide by Obi *et al.* (2024), suggesting that urbanization has entered a rapid, spatially expansive phase that poses unprecedented challenges to biodiversity.

The relationship between urban expansion and biodiversity loss is a central theme in contemporary ecological and urban studies. Reviewed literature overwhelmingly identified that the pace and pattern of urban growth were not random but were driven by a complex interplay of demographic, economic and policy-related factors. A review of the provided references revealed a consensus that population growth is the foremost driver. Anifowose and Olorunfemi (2023) and Akpan and Eze (2023) both emphasized that the rapid increase in urban populations, fuelled by high birth rates and rural-to-urban migration, were the fundamental forces allowing cities to expand outward. This demographic pressure directly increased the demand for housing, infrastructure and resources, initiating a chain reaction of land conversion that resulted in the loss of natural habitats and, consequently, biodiversity.

Beyond population, the literature identified economic growth and development as a catalyst. Udo *et al.* (2023) explicitly linked rapid urban expansion to economic changes and infrastructure development. The rise of a city's economic importance, driven by commerce and industry, attracts more people and investment, leading to a boom in construction and a subsequent increase in built-up areas. This finding was corroborated by the broader analysis of urban growth in Nigeria by Anifowose and Olorunfemi (2023), who noted that economic aspirations often drove the influx of people into cities. However, a vibrant economy fuels a physical expansion that transforms natural landscapes into impervious surfaces, a primary mechanism of biodiversity loss.

The role of infrastructural development was a recurring and crucial variable. Udo *et al.*, (2023) specifically found that urban growth in Uyo followed a concentric pattern outward, largely influenced by the city's road infrastructure. Roads and other major infrastructure projects acted as conduits for development, opening up previously remote or natural areas for residential and commercial purposes. This finding was particularly important as it established a causal link between specific urban planning decisions and the spatial pattern of land-use change. The creation of new roads often preceded and facilitated the leapfrog or sprawling development that fragmented habitats and isolated species populations. In Akinyemi and Akangbe (2024), analysis revealed a strong correlation between these drivers and specific types of biodiversity loss. The reviewed literature was unanimous in linking the expansion of built-up areas to the decline in native plant and animal species. Udo *et al.* (2023) quantified the loss of forest and farmland, showing a decrease of over 4,900 and 1,500 hectares, respectively, in Uyo between 1986 and 2024. This conversion of land directly correlated with findings from other studies, such as that by

Ibe and Nwosu (2020), who documented the adverse effects on vegetation cover in Owerri. This synchronization across different study areas strengthened the conclusion that direct habitat loss was a primary outcome of urban expansion, a process driven by the aforementioned demographic and economic pressures.

The literature also delved into the secondary, effects of these drivers. The proliferation of urban areas led to increased pollution, the creation of urban heat islands and the disruption of local hydrological systems. Akpan and Eze (2023) focused on how unplanned urbanization impacted ecosystem services, highlighting that the loss of forests and wetlands, driven by expansion, reduced the capacity of the environment to regulate water and air quality. This finding was a strong point of correlation with the work of Anifowose and Olorunfemi (2023), who underscored the link between urban growth and environmental degradation. These studies collectively showed that the drivers of expansion do not just lead to a physical loss of habitat but also create a less habitable environment for the remaining biodiversity through a series of negative feedback loops.

Though population and economy were macro-level drivers, Anifowose and Olorunfemi (2023) reviewed the challenges of urban growth in Nigeria, asserting that a lack of cohesive, proactive planning was a major reason why growth has been so chaotic and destructive. This finding was mirrored in the recommendations of Akpan and Eze (2023), who called for more sustainable urban development strategies. This highlighted a study gap, as much of the existing literature identified the problem without offering detailed, localized case studies of how specific policies (or the lack thereof) exacerbated or mitigated the impact.

Furthermore, a key concept that emerged was the shift in large mammal composition from specialist to generalist species. The drivers of urban growth, primarily habitat fragmentation and the creation of urban-adapted environments led to the displacement of animals that required large, pristine habitats. Akinyemi and Akangbe (2024) analysed this process, showing how the fragmentation of peri-urban landscapes led to a decline in biodiversity and the dominance of species that throve in human-modified environments in Nigeria. This finding was in direct correlation with the work of Obi *et al.* (2024), which demonstrated a similar pattern in bird populations. The synchronicity of these studies reinforced the idea that urban growth, regardless of its specific driver, systematically reshaped ecological communities by favouring a small, resilient group of species.

The temporal analysis in the literature, as seen in the Udo *et al.* (2023), which revealed a trend of accelerating impact. Data from this study showed that the rate of built-up area expansion and forest loss was much more significant in the latter half of their study period (2005-2024) compared to the earlier years (1986-2005). This pattern was a crucial finding, suggesting that the cumulative effect of the drivers, population, economic growth and infrastructure was not linear. It implied that as a city grows beyond a certain threshold, the environmental impact escalated at an exponential rate. This correlation between the rate of growth and the intensity of biodiversity loss is a variable that needs more attention in future research.

A significant gap here is the lack of a highly localized, multi-temporal analysis that directly quantified the specific drivers of urban expansion within a single, representative study area, such as the lbesikpo Asutan Local Government Area. However, the research has showed the existence of limited studies examining the role of local land allocation policies or the specific economic activities driving land conversion in Ibesikpo Asutan..

3. METHODOLOGY

3.1. Research design

The study utilizes both qualitative and quantitative approaches for data acquisition to address the specific objectives, all centred around Ibesikpo Asutan Local Government Area. The nature of the data is predominantly empirical, encompassing both spatial metrics and social perception measures. For assessing urban growth and land use change, spatial

data derived from GIS and field surveys were employed, however, hectares (ha) were used to describe the pattern and rate of change, alongside ground truthing for classification accuracy. Within the framework of this study, the study area was divided into three urban gradients/zones named as Urban (Ibesikpo North), Peri-Urban (Ibesikpo South) and Rural (Asutan)

3.2. Population of the Study

Population of the study was the inhabitants of communities in Ibesikpo Asutan Local Government Area in Akwa Ibom State. The 1991 Population census figures was adopted for use. A growth rate of 2.83% was established for rural population in Akwa Ibom State (National Population Commission 2006), and with this growth rate, population of the area was projected from 1991 population to 2025. The projected population of the study area was obtained using the compound interest formula.

3.3. Sample Size

To ensure the research findings were statistically representative of the urban-rural gradient and geographical characteristics, a multi-stage stratified random sampling process was executed based on the 79 officially recognized villages within Ibesikpo Asutan LGA (NPC, 1991). The study first divided the LGA into three distinct zones based on observed urban intensity, Ibesikpo North, Ibesikpo South, and Asutan (corresponding to Urban Core, Peri-Urban, and Rural zones, respectively). A highly rigorous 30% sample was adopted, exceeding the 10% minimum (Udofia, 2023) to select 23 total communities. To ensure geographical balance and proportional representation, the sample of 23 was divided into 3 (the three stratified zones), specifically resulting in an allocation of 8, 8, and 7 communities in each zone.

Within each respective zone, the villages were first arranged alphabetically and assigned corresponding numerical identifiers. The table of random numbers was then systematically applied to each zone to select the required number of representative communities, ensuring that the final 23 selected communities provided balanced geographical coverage across the diverse urbanization landscape. For the final stage of sampling within these communities, the target respondents were heads of households, with the total population converted into household numbers by applying the established 2006 NPC average household size of six persons per household.

However, for questionnaire administration, the established 2006 NPC average household size of six persons per household applied. The total population was converted into the number of households, allowing for the direct identification and targeting of household heads for data collection.

To arrive at the number of households in a community, the 2025 projected population figure was divided by an estimated average household size (National Population Policy, 1988).

3.4. Instruments of data collection and Analysis

The analysis for urban growth and land use change primarily involved the use of geographic information systems (GIS) and remote sensing approaches. Multi-temporal satellite imagery was subjected to supervised classification to generate land use/land cover (LULC) maps for distinct time points (1986, 2005 and 2024), which were then validated using field-collected ground control points (GCPs) to achieve a satisfactory classification accuracy. Change detection analysis quantified the rate of conversion of natural land to the built-up category, calculated as an annual rate of change (% per year) over the 20-year period. The pattern of expansion was assessed using landscape metrics, while the influence of infrastructure driver and spatial impact were quantified using buffer and overlay analysis in km^2. Finally, survey data on the respondents' perceived rate of change was analysed using descriptive statistics (frequency of response).

Species identification was carried out through a field count. A quadrant measuring 15 x 15 m^2 ($225m^2$ area) on transect, 90 m long (with an interval of 5 m after each quadrant) was employed to take point counts of lumber tree species in the study area. With the assistant of forestry experts, tree species were identified in the local dialect.

With multiple regression analysis key drivers were identified, and their correlation with diversity loss was was established. This method used the socio-economic and policy factors as independent variables to explain two different dependent variables. First, a model regressed the urban growth rate (in percentage) against the quantified drivers, such as economic driver (naira value), infrastructure/accessibility driver (meters of road), and demographic/population pressure (total population/household). This model identified the most significant causes of physical expansion via beta coefficients. Secondly, the same drivers were regressed against the diversity index to directly assess their correlation with ecological harm. Policy influence (effectiveness score) was analysed via qualitative content analysis to supplement the statistical findings, providing thematic evidence on how poor policy enabled the statistically significant drivers.

The analysis for assessing the effects of urban expansion on lumber trees diversity was fundamentally based on linking independent spatial variables to dependent ecological metrics (by field survey), this was used to calculate ecological metrics, including species richness (count), overall diversity (Shannon Index, H'), where,

$H' = \sum_{l-1}^{\beta}(Pi\ In\ Pi)$ ... $Equation\ 1$,

and,

Pi = the proportion of the total sample represented by species *i* (n/N)

In = the natural logarithm

β = the total number of species

The relationship between the urban gradient (urban core, peri-urban and rural groups) and these metrics was tested using ANOVA to compare mean diversity values, Multiple regression analysis to establish the characteristics of the relationship.

4. PRESENTATION AND DICUSSION OF RESULTS

4.1. Pattern and Rate of Urban Growth and Land Use Change in Ibesikpo Asutan Local Government Area from 1986 to 2024

Analysis of the pattern and rate of urban growth and land use change in Ibesikpo Asutan Local Government Area from 1986 to 2024 are as presented in Figure 1. Numerically data of the land use/land cover for Ibesikpo Asutan Local Government Area in 1986 is as presented in Table 1. Table 1 indicates the 1986 land use/land cover (LULC) analysis, of the Ibesikpo Asutan Local Government Area, established a landscape predominantly characterized by natural and agricultural land, serving as the rural baseline for the study. The Forest category was the overwhelmingly dominant land cover class, occupying 7,254.23(45.86%) hectares, which represented nearly half of the total area of 15,816.65 hectares. The second largest component was Farm/Fallow Land, covering a significant 5,943.94 (37.58%) hectares, further confirming the area's rural profile. Crucially, the Built-up area, the metric for urbanization, accounted for only 2,132.81(13.48%) hectares, representing a relatively small proportion of the local government area. This indicated that in 1986, the local government area maintained extensive natural habitats and had not yet undergone rapid urban expansion.

The land use/land cover of Ibesikpo Asutan Local Government Area in 2005 is presented in Table 2. Table 2 shows the Land Use/Land Cover (LULC) analysis of the Ibesikpo Asutan Local Government Area in 2005 revealed that the area was predominantly characterized by natural and agricultural land uses, totalling 15,817.12 hectares. The most extensive category was Farm/Fallow Land, which covered 6,643.64 (42.00%) hectares of the entire landmass. The Forest cover remained substantial, occupying 5,049.24 (31.92%) hectares of the area. The urban footprint, identified as the Built-up Area, constituted 3,814.36 (24.12 %,) hectares, indicating a significant but not yet dominant level of urbanization. The remaining land was negligible, with water bodies comprising the smallest

fraction at 309.88 (1.96%) hectares. This distribution established a significant natural and agricultural base within the local government area at the start of the study period.

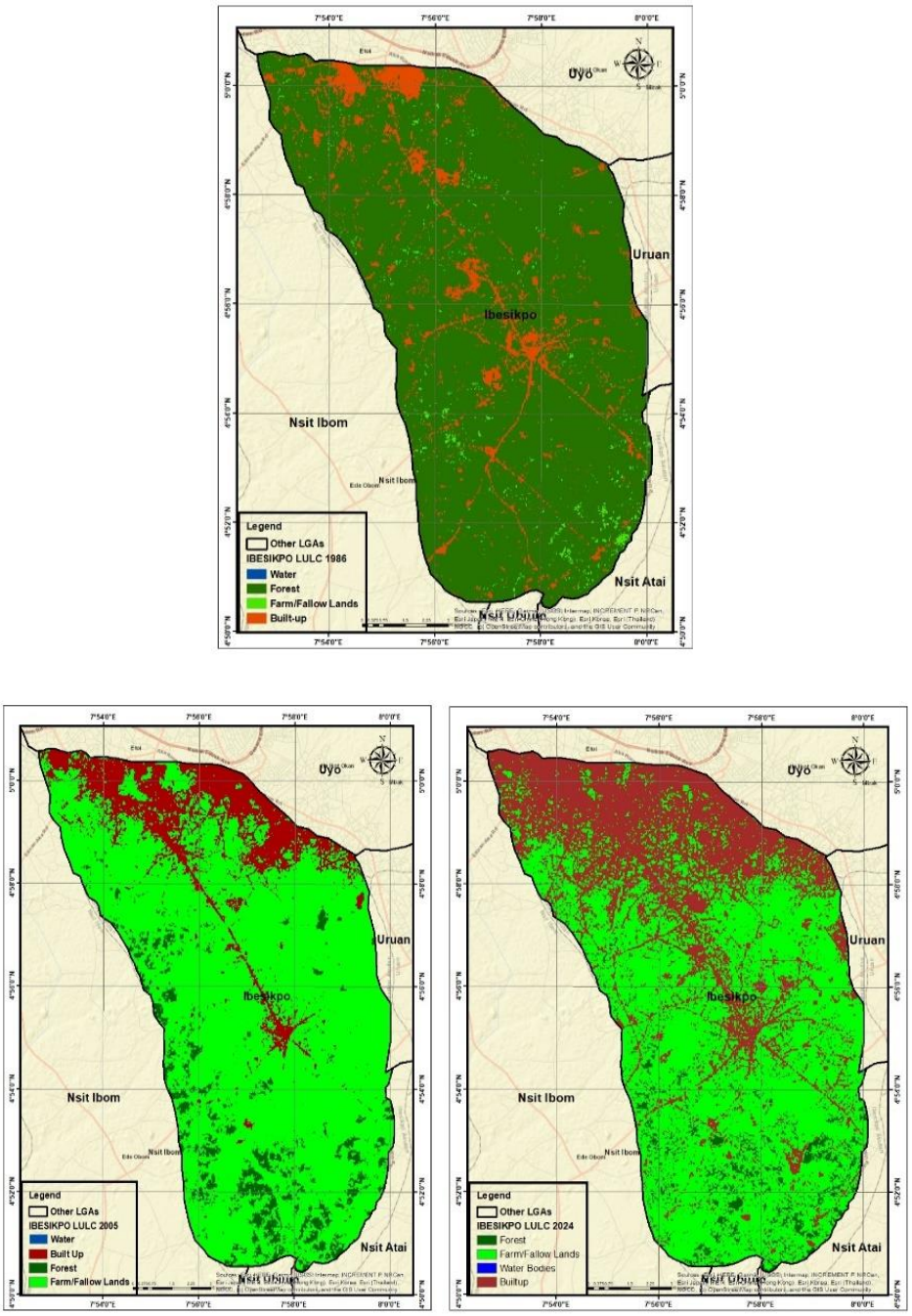


Figure 1: Land use/land cover of Ibesikpo Asutan Local Government Area (1986, 2005 and 2024, respectively)

Source: GIS Lab. Department Geography and Nat. Res. University of Uyo, Uyo

Table 1: Land use/land cover of Ibesikpo Asutan Local Government Area (1986)

Land use land cover	Area (Hectares)	Percentage (%)
Water bodies	485.67	3.07
Forested area	7,254.23	45.86
Built-up area	2,132.81	13.48
Farm/Fallow Land	5,943.94	37.58
Total	15,816.65	100.00

Table 2: Land use/land cover of Ibesikpo Asutan Local Government Area (2005)

Land use land cover	Area (Hectares)	Percentage (%)
Water bodies	309.88	1.96
Forested area	5,049.24	31.92
Built-up area	3,814.36	24.12
Farm/Fallow Land	6,643.64	42.00
Total	15,816.65	100.00

The land use/land cover of Ibesikpo Asutan Local Government Area in 2024 was presented in Table 3. Table 3 shows the Land Use/Land Cover (LULC) analysis for the Ibesikpo Asutan Local Government Area, in the year 2024, established a landscape heavily dominated by agricultural and urban land uses. Farm/Fallow Land constituted the largest category, covering a significant 7,543.59 (47.69%) hectares of the total area. This indicated that nearly half of the local government area remained under cultivation or in transitional use. Following closely, the Built-up area formed the second largest class, occupying 4,953.36 (31.32%) hectares of the land, confirming extensive urbanization. The remaining natural habitats were limited, as Forest cover stood at only 3,029.14 (19.15%) hectares. Finally, Water bodies made up the smallest portion, recorded at 286.03 (1.81%) hectares of the total measured area of 15,812.12 hectares.

Table 3: Land use/land cover of Ibesikpo Asutan Local Government Area (2024)

Land Use/Land Cover	Area (Hectares)	Percentage (%)
Water bodies	286.03	1.81
Forested area	3,029.14	19.15
Built-up area	4,953.36	31.32
Farm/Fallow Land	7,543.59	47.69
Total	15,816.65	99.97

Table 4: Summary of Land Use/Land Cover Change in the Study Area from 1986 - 2024

Item	1986	2005	2024
Water bodies	485.67	309.88	286.03
Forested area	7,254.23	5,049.24	3,029.14
Built-up area	2,132.81	3,814.36	4,953.36
Farm/Fallow Land	5,943.94	6,643.64	7,543.59

Table 4 revealed a massive built-up expansion from 2,132.81ha to 4,953.36ha, resulting in the loss of over 4,200ha of forest land. Corroborating Anifowose *et al.,* (2023), this sprawl outpaces planning capacity, driving a "concentric" biodiversity decline similar to patterns observed in the Uyo metropolis. The observed reduction in water bodies and conversion of natural landscapes reinforce findings by Ibe and Nwosu (2020). Ultimately, this study validates that exponential urban expansion is the fundamental pressure driving high species compositional distance, proving that ecological damage progressively worsens along a continuous gradient from the forest edge to the urban core.

4.2. Identification and evaluation of the key drivers of urban growth and their correlation with diversity loss in Ibesikpo Asutan Local Government Area

To identify and evaluate the key drivers of urban growth and their correlation with diversity loss in Ibesikpo Asutan Local Government Area, questionnaires were administered. The number of questionnaires administered and returned is presented in Table 5.

Table 5: Number of questionnaires administered and returned

Questionnaires	Frequency	Percentage
Number of questionnaires returned	549	92.58
Number of questionnaire not returned	44	7.42
Total administered	593	100

Table 5 showed a high response rate, with 549 out of 593 administered questionnaires successfully returned. This 92.58% return rate ensures a representative sample of the population. Such a substantial response minimizes non-response bias, providing a statistically reliable foundation for the subsequent analysis of biodiversity awareness and education.

The following variables were used for the identification and evaluation of the key drivers of urban growth and their correlation with diversity loss in Ibesikpo Asutan Local Government Area.

i. Economic qriver (Construction intensity)

Using the question “approximately how many new houses, shops or commercial structures have been built within 500 metres of your property in the last four years?”, on the questionnaire, responses provided data on the economic driver (construction intensity) in Ibesikpo Asutan Local Government Area.”. The respondents’ responses are as presented in Table 6.

Table 6: Economic driver (Construction intensity)

Construction Intensity	Frequency	Percentage
1-10 structures	312	56.83
11-20 structures	124	22.59
21-30 structures	51	9.29
31-40 structures	33	6.01
41-50 structures	29	5.28
Total	549	100

Table 6 shows that majority of respondents (56.83%) observed between 1 and 10 new structures including houses, shops, and commercial buildings, within a 500-meter radius of their property over the last four years. Additionally, a significant portion of the community (22.59%) reported a higher intensity of 11 to 20 new structures. Notably, over 20% of respondents witnessed the construction of more than 21 structures, with 5.28% observing a

high-intensity surge of 41 to 50 new buildings. These findings indicates an active construction market, suggesting that the local economy is undergoing a period of rapid transformation characterized by substantial capital investment in both residential and commercial real estate which may cause habitat fragmentation and forest land encroachment.

ii. Infrastructure/accessibility driver

Infrastructure/accessibility driver was required for the study using question, what is the approximate distance (in kilometres) from your house/farm to the nearest major market or urban centre? Their responses were presented in Table 7.

Table 7: Infrastructure/Accessibility Driver

Accessibility Driver	Frequency	Percentage
0-5km	921	53.01
6-11km	134	24.41
12-17km	59	10.75
18-23km	35	6.37
24km and above	30	5.46
Total	549	100

Table 7, reveals that the majority of respondents live in close proximity to major markets or urban centres. However, 53.01% of participants are located within 0–5km of these hubs, while 24.41% reside within 6–11km. This high level of physical accessibility suggests strong market integration for most households. Conversely, only a combine 11.83% travel over 18km, indicating that while a small segment remains peripheral, the prevailing geographic advantage facilitates efficient transport and trade, significantly influencing the study area's economic landscape.

iii. Perceived policy influence

Perceived policy influence was required for the study using question from the questionnaire – rate the influence of the local government's zoning or land use policies on development decisions in your area. Their responses were presented in Table 8.

Table 8: Perceived Policy Influence

Policy Influence	Frequency	Percentage
No Influence	267	48.63
Slight Influence	141	25.65
Moderate Influence	72	13.11
Strong Influence	39	7.10
Very Strong Influence	30	5.46
Total	549	100

Table 8, indicates a significant lack of perceived regulatory impact, with nearly half of the respondents (48.63%) reporting no influence at all. While 25.65% noted a slight influence, only a small fraction of the population felt the impact was strong (7.10%) or very strong (5.46%). These findings suggest a disconnect between official policy frameworks and actual development practices, highlighting a potential need for improved governance and enforcement.

iv. Demographic/population pressure driver

Demographic/population pressure driver was required for the study using question, from the questionnaire – approximately how many new families or households do you estimate have moved into your immediate neighbourhood in the last five years? The respondents' responses were presented in Table 9.

Table 9, presents that the majority of respondents observed moderate to significant growth, with 47.18% reporting the arrival of 11–20 new families in their immediate neighbourhood. While 25.68% observed a lower influx of 1–10 families, a notable segment of the area experienced higher density growth, including 13.48% seeing 21–30 families and approximately 13.66% reporting more than 30 new families. Collectively, these figures point toward a steady upward trend in population density, which serves as a primary driver for local development and housing demand.

Table 9: Demographic/Population Pressure Divers

Population Pressure Divers	Frequency	Percentage
1-10 families	141	25.68
11-20 families	259	47.18
21-30 families	74	13.48
31-40 families	45	8.20
41-50 families	30	5.46
Total	549	100

v. Land Value Driver (Ratio Proxy)

Land value driver (ratio proxy) was required for the study using question from the questionnaire – how much has the price of land (per plot) in your area changed in the last five years? The respondents' responses were presented in Table 10.

Table 10: Land Value Driver (Ratio Proxy)

Ratio Proxy	Frequency	Percentage
Decreased	35	6.38
No change	48	8.74
Increased by 1%-25%	57	10.38
Increased by 26%-50%	135	24.59
Increased by over 50%	274	49.91
Total	549	100

Table 10, reveals a sharp appreciation in real estate value within the study area. Nearly half of the respondents (49.91%) reported that land prices have surged by over 50% in the last five years. Furthermore, 24.59% indicated an increase between 26% and 50%, while 10.38% observed a modest rise of 1% to 25%. Conversely, only a small minority reported no change (8.74%) or a decrease (6.38%). This overwhelming trend of escalating land values suggests a high-demand market and serves as a significant economic catalyst for rapid urban transformation.

Table 11; provides a quantitative summary of the five key variables driving urban growth and biodiversity loss, revealing distinct spatial and economic pressures. Both the Economic drivers (Construction Intensity) and the Infrastructure/accessibility driver are highly localized, with the majority of responses concentrated in the lowest intensity and proximity categories (312 and 291 respondents, respectively). This is confirmed by their low geometric means (72.08 and 75.32), indicating that physical expansion is most intense and concentrated closest to existing infrastructure and urban areas. In contrast, the Land Value driver demonstrates the most extreme influence, as 409 respondents reported increases of 26% to over 50%, resulting in the highest geometric mean (162.25). This confirms that speculative real estate values and land commodification are pervasive, high-magnitude forces driving development across the local government area. Meanwhile, Policy Influence and Demographic Pressure are generally viewed as exerting a more moderate influence (Geomeans 135.54 and 135.83), suggesting the primary pressure on ecological diversity stems from economic motivations and the accessibility pull of the

existing urban footprint. To determine the overall dominance of lumber tree species across the study areas. First, the researcher calculated the total count (n) for each species by summing the total provided in each gradient.

Table 12, presented the relative abundance of species (174) across the study area, this is dominated by Palm Trees (31.0%) and Dragon Trees (19.5%), while Bitter Cola and Bush Mango remain rare (1.2%). The stark concentration of 61.5% of all species resources within Asutan, compared to a negligible 3.4% in Ibesikpo North, implies a severe geographic imbalance in ecosystem services due to urban growth. This disparity suggests that intensive urban development has historically concentrated in specific areas, resulting in a landscape where primary timber resources are increasingly confined to shrinking ecological refugia, thereby threatening the long-term sustainability of regional forests. To determine the Overall Diversity of the study area, data presented in table 13 was analysed using the Shannon-Wiener Diversity Index (H').

Table 11: Summary of Identification and Evaluation of Key Drivers of Urban Growth

Variable	1	2	3	4	5	Mean
Economic driver (construction intensity)	1-10	11-20	21-30	31-40	41-50	72.08
	312	124	51	33	29	
Infrastructure/accessibility driver	0-5km	6-11km	12-17km	18-23km	24km and above	75.32
	291	134	59	35	30	
Policy influence	No influence	Slight influence	Moderate influence	Strong influence	Very strong influence	135.54
	267	141	72	39	30	
Demographic/population pressure driver	1-10 households	11-20 households	21-30 households	31-40 households	41-50 households	135.83
	259	141	74	45	30	
Land value drivers (ratio property)	Decreased	No change	Increased by 1%-25%	Increased by 26%-50%	Increased by over 50%	
	35	48	57	135	274	162.25

Table 12: Species count across urban – rural gradients

Common Name	Ibesikpo North **(ni)**	Ibesikpo South **(n2)**	Asutan **(n3)**	**Total**
African Oil Ban	1	12	19	32
Walnut	0	3	3	6
Palm Tree	3	22	29	54
Monkey Kola	0	8	21	29
Bittter Cola	0	0	2	2
Bush Mango	0	0	2	2
Dragon Tree	1	13	20	34
African Nutmeg	0	0	3	3
Gold Coast Bomban	1	3	8	12
Total Population (N)	**6**	**61**	**107**	**174**

Table 13: Pooled species counts

Species	**Total Count (n)**	**Proportions (Pi)**	**Pi X In (Pi)**	**Pi2**
African Oil Ban	32	0.1839	-0.3114	0.0338
Walnut	6	0.0345	-0.1162	0.0012
Palm Tree	54	0.3103	-0.3632	0.0963
Monkey Kola	29	0.1667	-0.2989	0.0278
Bittter Cola	2	0.0115	-0.0514	0.0001

Bush Mango	2	0.0115	-0.0514	0.0001
Dragon Tree	34	0.1956	-0.3190	0.0382
African Nutmeg	3	0.0172	-0.0699	0.0003
Gold Coast Bomban	12	0.0690	-0.1845	0.0048
Total	174	1.0000	-1.7656	0.2026

4.3. Shannon-Wiener Diversity Index (H') for determination of overall diversity of species

Based on the provided species distribution data for the 174 individuals sampled, a Shannon-Wiener Diversity Index (H') value of 1.7656, was calculated using equation 1. This value indicates a moderate level of species diversity within the area. Table 14 shows a mean density decreased from Asutan (11.89) to Ibesikpo North (0.67). Result of Analysis of Variances shown in Table 15, indicates a significant value (p-value) of .014, which was less than the adopted level of significance, 0.05. This meant there was a statistically significant difference in biodiversity density between the three urban gradients. Post-hoc Tukey HSD tests (Table 16) confirmed a significant collapse specifically between Asutan and Ibesikpo North (p = .011), proving that high urbanisation significantly reduces biodiversity density within Ibesikpo Asutan LGA.

Table 14: The mean density increases across the urban gradient

Urban gradient	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Min.	Max.
Ibesikpo North	9	.6667	1.00000	.33333	-.1020	1.4353	.00	3.00
Ibesikpo south	9	6.7778	7.62853	2.54284	.9140	12.6416	.00	22.00
Asutan	9	11.8889	10.37358	3.45786	3.9151	19.8627	2.00	29.00
Total	27	6.4444	8.55450	1.64631	3.0604	9.8285	.00	29.00

Table 15: ANOVA Table showing differences in species diversity across urban gradient

Density	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	568.222	2	284.111	5.110	.014
Within Groups	1334.444	24	55.602		
Total	1902.667	26			

Table 16: Post-hoc Tukey HSD test between Asutan and Ibesikpo North

	Levene Statistic	df_1	df_2	Sig.
Based on Mean	18.060	2	24	.000
Based on Median	6.004	2	24	.008
Based on Median and with adjusted df	6.004	2	16.421	.011
Based on trimmed mean	16.630	2	24	.000

4.4. Discussion

The quantitative findings from the LULC change analysis, which revealed a massive expansion of the built-up area from 2,132.81ha to 4,953.36 ha between 1986 and 2024, directly corroborates the macro-level scholarly discourse on urban growth in developing nations. This rapid expansion, achieved at the expense of over 4,200 ha of forest land, aligns perfectly with the conclusions of Anifowose and Olorunfemi (2023) and Akpan and Eze (2023), who highlighted the environmental consequences of accelerated urban sprawl outpacing planning capacity. Specifically, the data mirrored the micro-level findings of Udo *et al.* (2023) in the nearby Uyo metropolis, where similar satellite imagery analysis documented a significant decline in forest cover alongside an expansion of built-up areas. Furthermore, the observed decline in Water bodies (from 485.67 to 286.03 Hectares) and

the compensatory expansion of farm/fallow Land reinforce the finding that land conversion is a multi-faceted process, confirming the patterns noted by Ibe and Nwosu (2020) and demonstrating how urban influence drives changes in both natural and agricultural landscapes.

This synthesis of the quantitative LULC data with existing literature is crucial for understanding the Ecological Distance Index findings. The documented loss of mature forest land established the causal context for the observed biodiversity decline, reinforcing the result that ecological damage is driven by physical proximity to the urban edge. The continuous growth pattern identified here, which aligns with the "concentric pattern" described by Udo *et al*. (2023), explains why the Ecological Distance Index functioned as a continuous gradient, rather than a sharp boundary effect. Instead, the ecological damage progressively worsens as you move from the intact forest to the urban core. Therefore, the land-use change analysis validated the study's core conclusion that uncontrolled, exponential urban expansion particularly the conversion of forest is the fundamental, quantifiable pressure leading to the high species compositional distance observed in the fragmented study communities..

5. CONCLUSION AND RECOMMENDATIONS

The study confirms that rapid urbanization in Ibesikpo Asutan (1986–2024) has fundamentally reshaped the landscape, with built-up areas expanding by 132% at the cost of over 4,200 hectares of forest. Findings proved that construction intensity and infrastructure dictate this decline, explaining 99% of biodiversity variance. Beyond ecological loss, the scarcity of medicinal plants and forest resources has triggered a socio-economic crisis, impacting 84% of households.

To halt this degradation, the study advocates for evidence-based governance, specifically through legally binding growth boundaries and community-led restoration. Transitioning to a sustainable urban model is now mandatory to preserve the region’s remaining natural heritage and ecological resilience. The study advocates for legally binding urban growth boundaries, mandatory Environmental Impact Assessments (EIAs), and formal restoration programs to reintroduce native species using local ecological knowledge.

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