

SUSTAINABLE URBANIZATION AND LAND USE/LAND COVER CHANGE DYNAMICS IN EPE, BADAGRY, AND IKORODU, LAGOS STATE, NIGERIA (2010–2025): A GIS AND REMOTE SENSING APPROACH

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Abstract

This study examines sustainable urbanization and land use/land cover (LULC) change dynamics in Epe, Badagry, and Ikorodu areas of Lagos State, Nigeria, from 2010 to 2025 using GIS and remote sensing techniques. Multi-temporal Landsat imagery for 2010 and 2025 was obtained from United States Geological Survey (USGS), processed, classified, and analysed to quantify LULC transitions and spatial patterns of urban growth. Supervised classification and post-classification change detection were employed, while spatial metrics were used to evaluate the intensity and direction of urban expansion. The results reveal rapid growth of built-up areas across the three urban fronts, largely at the expense of vegetation, soil, and drainage. Ikorodu experienced the most intense and compact urban expansion driven by industrial development and improved transport connectivity, while Epe and Badagry exhibited more dispersed, peri-urban growth patterns associated with residential expansion, tourism-related activities, and land speculation. These changes have generated significant sustainability concerns, including ecosystem degradation, loss of productive land, and increased pressure on infrastructure and public services. The study highlights strong links between population growth, policy-driven infrastructure investments, and spatial land transformation processes. By integrating geospatial analysis with sustainability perspectives, the findings provide empirical evidence to support proactive urban planning, environmentally sensitive land management, and balanced regional development in Lagos State. The results are particularly relevant for achieving resilient urban futures aligned with sustainable development goals and climate adaptation strategies nationally.

Keywords: *Sustainable urbanization, Land use change, Land cover dynamics, GIS, Remote sensing, Urban expansion, Lagos State, Nigeria*

Introduction

Urbanization remains one of the most significant drivers of land transformation globally, particularly in Sub-Saharan Africa, where cities are expanding rapidly due to population growth, rural–urban migration, economic concentration, and

infrastructure development (UN-Habitat, 2022). Nigeria reflects this broader trend, with Lagos State emerging as one of Africa’s fastest-growing megacities. The continuous growth of Lagos has intensified pressure on land resources, resulting in substantial land use/land cover

(LULC) changes characterized by the expansion of built-up areas and the progressive conversion of agricultural land, wetlands, vegetation, and other ecological landscapes into residential, commercial, and transportation infrastructure (Aniramu *et al.*, 2026; Awoniran *et al.*, 2025). As land availability declines within the metropolitan core, urban expansion increasingly extends into peri-urban districts such as Epe, Badagry, and Ikorodu. These areas, historically dominated by farming systems, wetlands, mangrove ecosystems, and natural vegetation, are experiencing accelerated spatial transformation driven by housing demand, industrial growth, improved road accessibility, and speculative land development. Similar urbanization patterns across developing regions often occur faster than institutional planning and environmental regulation can respond, contributing to urban sprawl, fragmented landscapes, and inefficient land utilization (Seto *et al.*, 2012; Güneralp *et al.*, 2020). The environmental implications of these changes are increasingly concerning. The conversion of permeable natural surfaces into impervious built environments alters hydrological processes, increases surface runoff, reduces infiltration capacity, and intensifies urban flood risk. In Lagos, the decline of wetlands, vegetation cover, and other ecological buffers has been linked to increased flood vulnerability, ecosystem degradation, urban heat island effects, and reduced ecological resilience (Akiyode, 2024; Aniramu *et al.*, 2026). These transformations also threaten food security, biodiversity conservation, and the long-term sustainability of peri-urban ecosystems. Geospatial technologies, particularly Geographic Information

Systems (GIS) and remote sensing, have become indispensable for monitoring and analysing urban landscape transformations. Multi-temporal satellite imagery from platforms such as Landsat provides reliable datasets for classifying land cover types, detecting change trajectories, and quantifying urban expansion over time (Weng, 2012; Zhu *et al.*, 2019). GIS further supports spatial analysis, mapping, and change detection, enabling the measurement of built-up growth, vegetation loss, land fragmentation, and spatial development patterns. The integration of GIS and remote sensing therefore provides a robust framework for evaluating urban growth dynamics and their sustainability implications. Despite increasing scholarly attention on Lagos megacity, most existing studies focus on central metropolitan districts or short-term analyses, with limited long-term comparative assessments of peri-urban districts. Comparative studies examining urban growth and LULC dynamics across Epe, Badagry, and Ikorodu over extended periods remain scarce, despite their growing strategic importance in Lagos' outward expansion. Addressing this gap is essential for understanding spatial variations in peri-urban transformation and informing sustainable land-use planning.

Therefore, this study aims to assess the dynamics of land use/land cover change and sustainable urbanization in Epe, Badagry, and Ikorodu, Lagos State, Nigeria, between 2010 and 2025 using GIS and remote sensing techniques. Specifically, the study seeks to: (i) map and classify major land use/land cover categories across the study areas; (ii) analyse the spatio-temporal patterns and magnitude of LULC changes between

2010 and 2025; and (iii) evaluate the sustainability implications of observed land transformations for urban planning, environmental management, and resilient development in peri-urban Lagos.

Study Area

The study area comprises Epe, Badagry, and Ikorodu (Figures 1, 2 and 3), three peri-urban districts of Lagos State, Nigeria, forming part of the rapidly expanding Lagos metropolitan region. These districts are experiencing significant urbanization due to population growth, infrastructural development, and economic activities spilling over from the Lagos central business district. Lagos is among the fastest-growing megacities in Africa, with a population exceeding 17 million in 2025, of which substantial portions reside in peripheral districts such as Epe, Badagry, and Ikorodu (United Nations, 2019; World Bank, 2023).

Epe is situated in the eastern corridor (6.6°N, 3.9°E) (Figure 1), has emerged as a strategic growth zone due to its proximity to the Lekki Peninsula and the Lekki Free Trade Zone. The Lekki–Epe corridor has seen significant infrastructural investments, including road networks, housing schemes, and commercial developments, which have accelerated the conversion of agricultural land and natural landscapes into urban land uses (World Bank, 2023). Epe’s peri-urban settlements are increasingly accommodating populations displaced by housing shortages and high living costs in the Lagos mainland.

Badagry is located along the western coastal corridor near the Nigeria - Benin border (6.4°N, 2.9°E) (Figure 2), is experiencing renewed urbanization driven

by cross-border trade, infrastructure development, and population spillover from Lagos. Historically a major trade and cultural center, Badagry has witnessed growth along the Lagos - Badagry corridor, including the Badagry - Lagos Expressway, which enhances connectivity and facilitates new residential and commercial developments (UN-Habitat, 2022). The climate across these districts is tropical wet and dry characterized by a mean annual temperature of 27 - 29°C and total annual rainfall between 1,500 - 2,000 mm (Oni *et al.*, 2022). The vegetation is primarily derived savanna and mangrove forest along coastal and lagoon areas, with natural vegetation rapidly declining due to urban expansion. These ecological characteristics, combined with the districts’ topography, relatively flat terrain with occasional low-lying wetlands make them susceptible to flooding and other urban environmental hazards.

Ikorodu is located in the northeastern corridor of Lagos State, approximately 6.6°N, 3.5°E, along the Lagos Lagoon (Figure 3). It lies about 36 km from Lagos Island and is a key peri-urban growth node due to improved transportation networks, industrial estates, and residential developments. Over the past three decades, Ikorodu has undergone significant population increase and spatial expansion, with urban growth concentrated along the Ikorodu–Lagos main road and adjoining suburban settlements (Seto *et al.*, 2012). The district’s expansion has also been influenced by government infrastructure projects, including road upgrades, housing initiatives, and commercial developments.

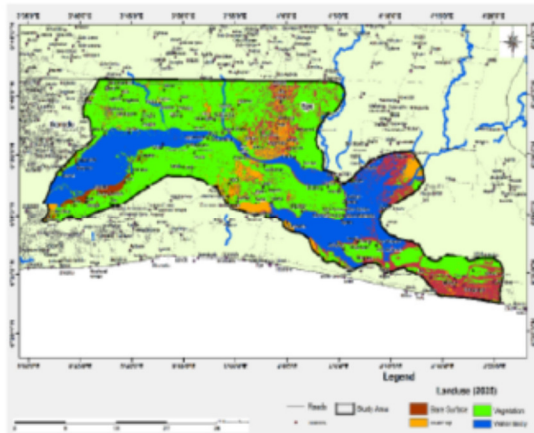


Fig. 1: Map of Epe

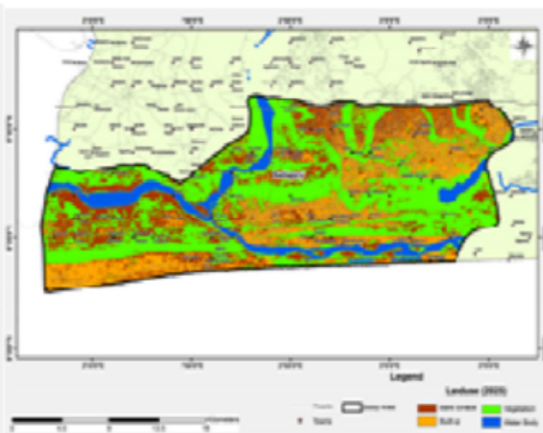


Fig. 2: Map of Badagry

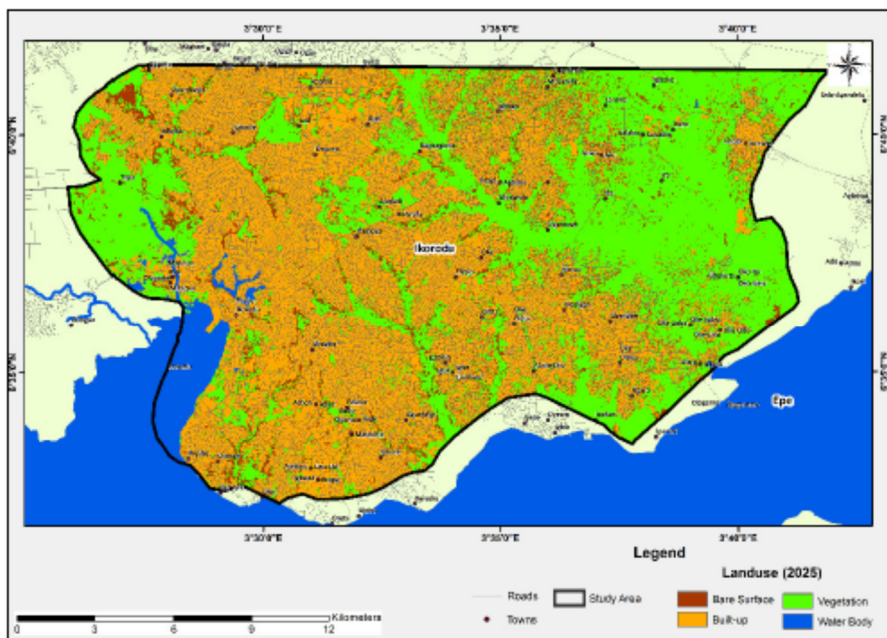


Fig. 3: Map of Ikorodu

Methodology

Multi-temporal Landsat images of Badagry, Ikorodu, and Epe for 2010 and 2025 were obtained from the United States Geological Survey (USGS), alongside ancillary datasets including administrative boundaries and demographic statistics. All satellite images underwent standard pre-processing procedures, including radiometric calibration, atmospheric correction, and geometric rectification to

improve image quality and ensure spatial consistency. Similar preprocessing protocols have been widely adopted in recent urban land change studies across rapidly urbanizing African cities to reduce spectral distortion and improve classification reliability (Awoniran *et al.*, 2025; Aniramu *et al.*, 2026). Supervised image classification using the Maximum Likelihood Algorithm (MLA) was employed to classify land cover into built-

up areas, vegetation, water bodies, and bare surfaces. The choice of MLA is supported by recent studies which report its strong performance in medium-resolution Landsat-based urban classification due to its statistical robustness and suitability for heterogeneous urban landscapes (Akiyode, 2024; Gilbert and Shi, 2024). Comparable studies on peri-urban Lagos and other Nigerian cities similarly utilized supervised Maximum Likelihood classification for mapping urban expansion and vegetation loss, reporting reliable classification outputs for long-term LULC monitoring (Oyeleye *et al.*, 2023; Adewumi and Olusola, 2024).

Post-classification comparison was applied to detect land use/land cover transitions between 2010 and 2025, enabling the quantification of change magnitude, direction, and spatial distribution. This method remains one of the most widely used approaches for multi-temporal change detection because of its effectiveness in identifying class-to-class transitions and minimizing interpretative ambiguity (Congalton and Green, 2019). Recent studies examining urban growth dynamics in coastal and peri-urban environments across West Africa have similarly adopted post-classification comparison to analyse built-up expansion and wetland decline (Mensah *et al.*, 2023; Zhou *et al.*, 2021). Classification accuracy was assessed using confusion matrices, overall accuracy, producer's and user's accuracy, and Kappa statistics, in line with established remote sensing standards. Recent LULC studies recommend overall accuracy thresholds above 85% and Kappa coefficients greater than 0.80 as indicators of strong classification performance for urban land cover studies

(Congalton and Green, 2019; Zhu *et al.*, 2019). The adoption of these methods ensures methodological consistency with contemporary geospatial research and enhances the reliability of findings for sustainable urbanization assessment in Lagos peri-urban districts.

Results and Discussion

Land Use/Land Cover Analysis of Badagry between Year 2010 and 2025

Table 1 and figures 4 and 5 presents the distribution of land use/land cover (LULC) classes in Badagry for the years 2010 and 2025. The total mapped area remained relatively constant at approximately 49,231 ha, indicating that the changes observed represent internal land-use transformations rather than an expansion of the study boundary. Such assessments are commonly conducted using Geographic Information Systems (GIS) and remote sensing techniques, which enable researchers to detect spatial and temporal landscape changes and understand patterns of environmental transformation over time (Idowu *et al.*, 2020). An examination of the built-up category shows that the built-up area slightly decreased from 12,340.35 ha (25%) in 2010 to 12,104.82 ha (25%) in 2025. Although the percentage share remained unchanged, the marginal reduction in area suggests relative stability in the spatial extent of urban development within the study area. This pattern may reflect urban consolidation or redevelopment within already developed spaces rather than extensive outward expansion, a phenomenon sometimes observed in peri-urban coastal settlements where environmental or spatial constraints limit urban sprawl. However, previous studies on land use dynamics in Lagos generally report a consistent expansion of

built-up areas due to rapid population growth, infrastructural development, and increasing economic activities (Akinyemi *et al.*, 2022; Idowu *et al.*, 2020). Urban growth in Lagos has historically resulted in the conversion of vegetation, wetlands, and bare surfaces into built-up land, reflecting growing demands for housing, transportation infrastructure, and commercial development (Akinyemi *et al.*, 2022). The bare surface category experienced a substantial decline, decreasing from 16,461.36 ha (33%) in 2010 to 12,071.61 ha (25%) in 2025, representing the largest reduction among all land-use classes (Table 1). This decline suggests that areas previously characterized by exposed or unused land have undergone significant transformation into other land-cover types, particularly vegetation or built-up areas. In rapidly changing urban and peri-urban environments, bare surfaces often represent transitional landscapes that are eventually converted into agricultural land, vegetated areas, or urban developments. Similar trends have been reported in LULC studies across Lagos State, where bare land is gradually replaced through human activities, ecological regeneration, and land management interventions. Vegetation recorded the most significant increase during the study period, rising from 16,526.43 ha (34%) in 2010 to 20,718.54 ha (42%) in 2025, representing an expansion of more than 4,000 ha (Table 1). This substantial increase indicates a positive shift toward vegetation growth within the landscape. The expansion may be attributed to natural vegetation regeneration, agricultural activities, or environmental conservation initiatives. In some cases, areas previously classified as bare land gradually transition into

vegetated landscapes through afforestation, ecological recovery, or improved land management practices. This increase in vegetation is particularly important for environmental sustainability, as vegetation plays a crucial role in carbon sequestration, climate regulation, soil protection, and biodiversity conservation, especially within coastal ecosystems such as Badagry. Water bodies also recorded a slight increase from 3,903.21 ha (8%) in 2010 to 4,336.38 ha (9%) in 2025 (Table 1). The modest growth in water coverage may be linked to coastal and hydrological processes such as tidal influences, wetland expansion, sedimentation patterns, or improved classification accuracy in satellite imagery. In coastal environments like Badagry, fluctuations in water bodies are common due to lagoon dynamics, coastal erosion, flooding events, and human activities such as dredging and land reclamation. Previous studies on Lagos coastal ecosystems indicate that wetlands and water bodies often experience spatial variability as a result of both natural environmental processes and anthropogenic interventions.

Overall, the land use/land cover dynamics observed in Badagry between 2010 and 2025 reveal a notable landscape transformation characterized by a significant decline in bare surfaces, considerable expansion of vegetation cover, relatively stable built-up areas, and a slight increase in water bodies. These trends suggest a gradual transition from exposed or undeveloped land toward more vegetated landscapes, which may enhance ecological stability, environmental resilience, and climate regulation within the region. Nevertheless, continuous monitoring is essential because the rapid urbanization occurring across Lagos State

has the potential to convert natural landscapes into built-up areas over time (Akinyemi *et al.*, 2022; Idowu *et al.*, 2020). Therefore, the integration of remote sensing and GIS technologies remains crucial for tracking land-use

dynamics and supporting sustainable land-use planning, environmental management, and policy decision-making in rapidly growing coastal cities such as Badagry.

Table 1: Land Use/Land Cover Distribution/Change of Badagry between Year 2010 and 2025

Land use	Year 2010		Year 2025	
	Area(ha)	Percent	Area(ha)	Percent
Built-up	12340.35	25%	12104.82	25%
Bare Surface	16461.36	33%	12071.61	25%
Vegetation	16526.43	34%	20718.54	42%
Water Body	3903.21	8%	4336.38	9%
Total	49231.4	100%	49231.35	100%

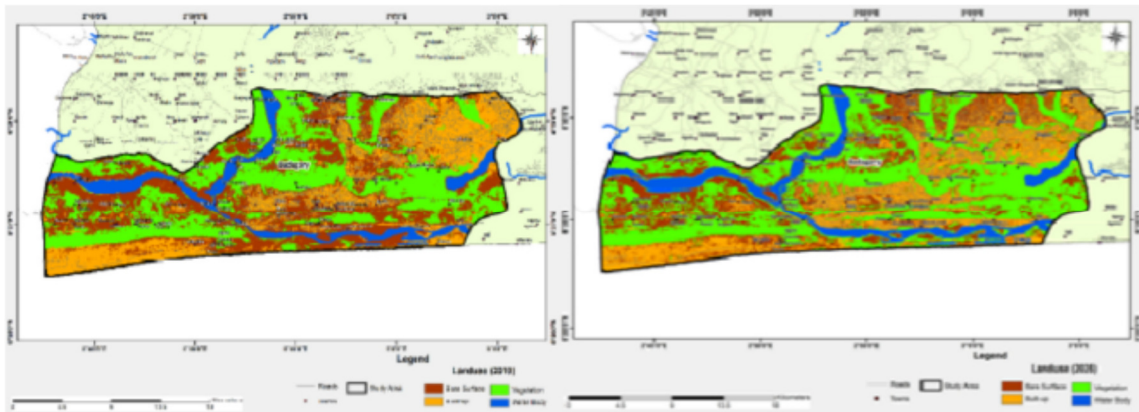


Fig. 4: Land use/ Land cover of Badagry (2010) Fig. 5: Land use/ Land cover of Badagry (2025)

Land Use/ Land Cover Analysis of Ikorodu between Year 2010 and 2025

Table 2 and figures 6 and 7 presents the distribution of land use/land cover (LULC) classes in Ikorodu, Lagos State, for the years 2010 and 2025. The total mapped area remained relatively constant at about 36,767 ha, indicating that the observed changes represent internal landscape transformations rather than changes in the study boundary. Such analyses are typically conducted using Geographic Information Systems (GIS) and remote sensing techniques, which enable researchers to detect spatial and temporal land-cover dynamics and

evaluate the environmental implications of urban expansion (Idowu *et al.*, 2020; Oladokun *et al.*, 2021). Overall, the results show significant urban growth accompanied by a reduction in vegetation cover, a pattern widely reported in rapidly urbanizing regions of Lagos State and other developing cities (Seto *et al.*, 2012; Akinyemi *et al.*, 2022).

The built-up area increased from 16,129.8 ha (44%) in 2010 to 17,903.07 ha (49%) in 2025, representing the most prominent positive change among the land-cover classes. This increase reflects the rapid urbanization of Ikorodu, which has gradually evolved from a peri-urban

settlement into a major residential and commercial hub within the Lagos metropolitan region. Urban expansion is commonly associated with increasing demand for housing, transportation infrastructure, and economic activities, which drives the conversion of natural land covers into developed land (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Previous studies have similarly reported significant expansion of built-up areas in Lagos, where urban land has grown substantially over the past few decades as the city continues to attract migrants, investments, and infrastructural development (Oladokun *et al.*, 2021). The bare surface category also recorded a considerable increase, rising from 1,104.21 ha (3%) in 2010 to 3,312.45 ha (9%) in 2025. This growth may reflect ongoing construction activities, land clearing for development, or exposed soils associated with urban expansion. In many rapidly developing urban environments, bare surfaces often represent transitional landscapes that precede infrastructural development or urban construction. The increase in bare surfaces may also contribute to environmental challenges such as higher land surface temperatures and intensified urban heat island effects, which are commonly associated with rapid urban growth and land-cover transformation (Oladokun *et al.*, 2021; Amaechi *et al.*, 2024).

In contrast, vegetation cover declined significantly from 18,724.95 ha (51%) in 2010 to 14,669.1 ha (40%) in 2025, representing a loss of more than 4,000 ha. This decrease indicates that a substantial portion of previously vegetated land has been converted into built-up areas and bare surfaces. The reduction in vegetation is consistent with trends observed in many rapidly urbanizing regions where natural

landscapes are gradually replaced by residential, commercial, and infrastructural developments (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Studies on urban growth in Lagos have similarly shown that vegetation and agricultural lands often decline as urban areas expand, leading to increased environmental pressures such as flooding, habitat loss, and rising urban temperatures (Idowu *et al.*, 2020). The water body category showed only a slight increase, rising from 808.11 ha (2%) in 2010 to 882.45 ha (2%) in 2025, with the percentage share remaining unchanged. The relatively stable extent of water bodies suggests that major hydrological features such as rivers, lagoons, and wetlands have remained largely unchanged within the study period. However, slight variations may result from seasonal hydrological fluctuations, tidal influences, improved satellite classification accuracy, or minor wetland expansion. In coastal and lagoon environments such as those surrounding Ikorodu, water bodies can fluctuate due to natural hydrological processes and human activities such as dredging, reclamation, and urban development (Oladokun *et al.*, 2021).

Overall, the LULC dynamics in Ikorodu between 2010 and 2025 reveal a clear pattern of rapid urban expansion, characterized by increasing built-up areas and bare surfaces accompanied by a significant decline in vegetation cover. These trends highlight the intensifying urbanization of Ikorodu as part of the broader Lagos metropolitan growth corridor. While urban expansion supports economic development, housing provision, and infrastructural growth, it also raises environmental concerns, including loss of green spaces, increased flood risk, and urban heat island effects

(Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Consequently, continuous monitoring using GIS and remote sensing techniques is essential for guiding sustainable urban

planning, environmental management, and policy interventions in rapidly growing urban centers such as Ikorodu (Idowu *et al.*, 2020).

Table 2: Land Use/Land Cover Distribution/Change of Ikorodu between Year 2010 and 2025

Land use	Year 2010		Year 2025	
	Area(ha)	Percent	Area(ha)	Percent
Built-up	16129.8	44%	17903.07	49%
Bare Surface	1104.21	3%	3312.45	9%
Vegetation	18724.95	51%	14669.1	40%
Water Body	808.11	2%	882.45	2%
Total	36767.1	100%	36767.07	100%

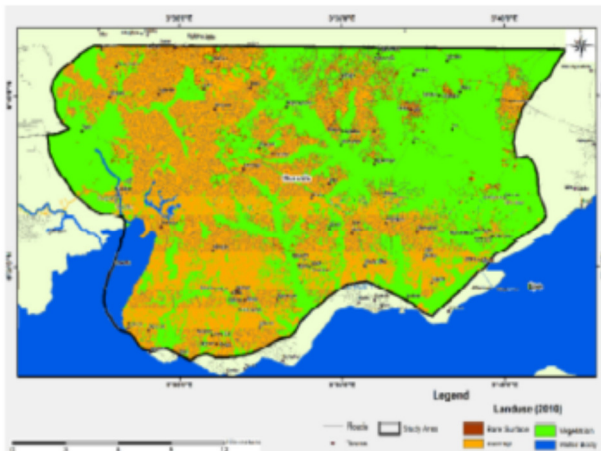


Fig. 6: Land use/ Land cover of Ikorodu (2010)

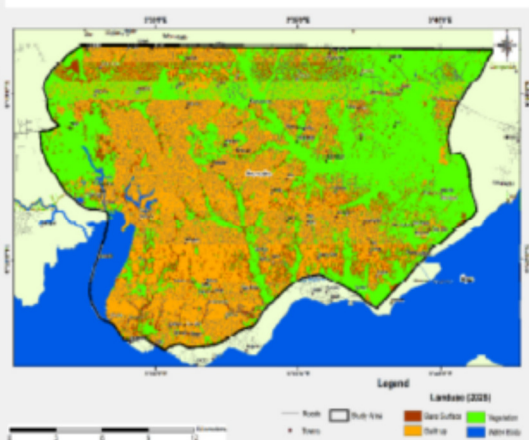


Fig. 7: Land use/ Land cover of Ikorodu (2025)

Land Use/ Land Cover Analysis of Epe between Year 2010 and 2025

Table 3 and Figures 8 & 9 presents the distribution of land use/land cover (LULC) classes in Epe, Lagos State, for the years 2010 and 2025. The total mapped area remained constant at approximately 160,561.9 ha, indicating that the observed variations represent internal land-use transformations rather than an expansion of the study boundary. Such assessments are typically conducted using remote sensing and Geographic Information Systems (GIS) to monitor spatial and temporal land-cover changes and evaluate the environmental implications of urban expansion and

landscape transformation (Oladokun *et al.*, 2021; Akinyemi *et al.*, 2022). These geospatial techniques have been widely applied in Lagos State to understand patterns of urban growth, environmental change, and land transformation in rapidly developing coastal regions (Idowu *et al.*, 2020). Overall, the results indicate increasing urban development and land surface exposure accompanied by reductions in vegetation and water bodies, reflecting the broader pattern of land-cover transformation occurring in Lagos as population growth, migration, and economic activities intensify (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). The built-up area increased significantly from 6,281.1

ha (4%) in 2010 to 12,972.0 ha (8%) in 2025, representing more than a twofold increase. This growth reflects the expanding urbanization of Epe, which has increasingly attracted residential developments, transportation infrastructure, and economic activities due to its strategic location within the Lagos metropolitan expansion corridor. Urban growth in Lagos has been characterized by the progressive expansion of built-up areas into previously undeveloped land, largely driven by population increase, migration, and economic opportunities (Akinyemi *et al.*, 2022; Seto *et al.*, 2012). Previous studies have shown that built-up land in Lagos has expanded substantially over the past decades, often at the expense of vegetation and other natural land-cover types (Oladokun *et al.*, 2021). The bare surface category also recorded a considerable increase, rising from 14,999.76 ha (9%) in 2010 to 22,154.67 ha (14%) in 2025. This increase may be attributed to land clearing, construction activities, sand filling, and other preparatory processes associated with urban development. In rapidly urbanizing regions, bare surfaces often represent transitional landscapes that precede infrastructural development and settlement expansion. The increase in exposed surfaces can also contribute to environmental challenges such as higher land surface temperatures and intensified urban heat island effects, which have been linked to urban growth and vegetation loss in Lagos (Idowu and Olalekan, 2025; Amaechi *et al.*, 2024). In contrast, vegetation cover declined from 96,178.68 ha (60%) in 2010 to 86,316.66 ha (54%) in 2025, representing a loss of nearly 10,000 ha. This reduction indicates that large portions of previously vegetated land have been converted into built-up

areas and exposed surfaces. Such vegetation loss is consistent with trends observed in many rapidly growing urban regions where urban expansion leads to the fragmentation and decline of natural ecosystems (Seto *et al.*, 2012). Studies on land-cover change in Lagos have similarly reported that increasing built-up development is strongly associated with reductions in vegetation cover and agricultural land, which may contribute to environmental challenges such as flooding, biodiversity loss, and microclimatic changes (Akinyemi *et al.*, 2022; Idowu *et al.*, 2020). The water body category also experienced a slight decline, decreasing from 43,102.35 ha (27%) in 2010 to 39,118.59 ha (24%) in 2025. This reduction may be linked to land reclamation, sedimentation, or conversion of wetlands for urban and infrastructural development. In Lagos coastal environments, water bodies and wetlands often experience spatial fluctuations due to both natural hydrological processes and anthropogenic activities such as dredging, sand filling, and land reclamation (Oladokun *et al.*, 2021; Amaechi *et al.*, 2024). Previous studies have reported that the expansion of urban land in Lagos has contributed to reductions in wetlands and water bodies, which may increase flood vulnerability and environmental degradation (Akinyemi *et al.*, 2022). Overall, the LULC dynamics in Epe between 2010 and 2025 reveal a clear pattern of landscape transformation characterized by increasing built-up areas and bare surfaces, accompanied by declining vegetation and water bodies. These trends highlight the growing urban influence in Epe as part of the expanding Lagos metropolitan region. While such development can support economic growth, infrastructure expansion, and

improved accessibility, it may also intensify environmental challenges, including loss of green spaces, increased flood risk, and climate-related impacts (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Therefore, continuous monitoring using

GIS and remote sensing technologies remains essential for supporting sustainable land-use planning, environmental management, and policy formulation in rapidly developing coastal areas such as Epe (Idowu *et al.*, 2020).

Table 3: Land Use/Land Cover Distribution/Change of Epe between Year 2010 and 2025

	Year 2010		Year 2025	
	Area(ha)	Percent	Area(ha)	Percent
Land use				
Built-up	6281.1	4%	12972.0	8%
Bare Surface	14999.76	9%	22154.67	14%
Vegetation	96178.68	60%	86316.66	54%
Water Body	43102.35	27%	39118.59	24%
Total	160561.9	100%	160561.9	100%

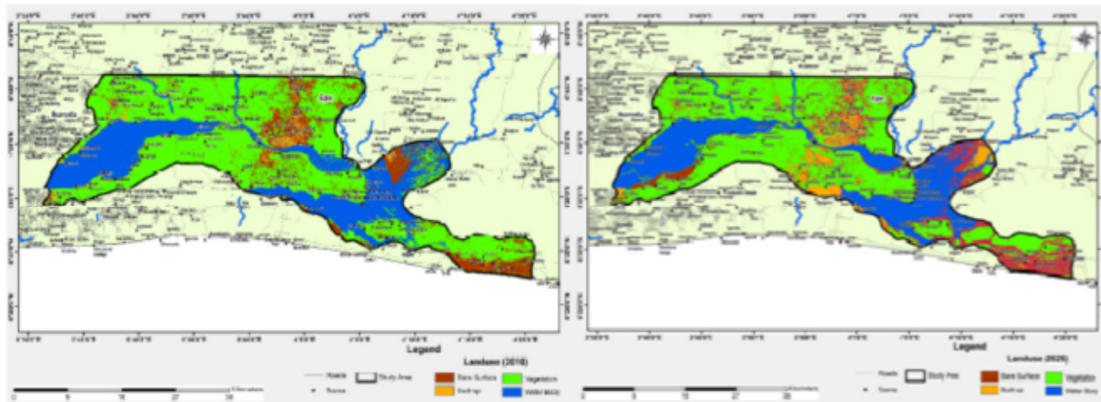


Fig. 8: Land use/ Land cover of Ikorodu (2010) Fig. 9: Land use/ Land cover of Ikorodu (2025)

Comparative Analysis of Land Use/ Land Cover of Badagry, Ikorodu, and Epe between Year 2010 and 2025

The comparative analysis of land use/land cover (LULC) dynamics in Badagry, Ikorodu, and Epe between 2010 and 2025 reveals significant spatial transformations associated with rapid urbanization within the Lagos metropolitan region. The study identifies notable changes in the distribution of built-up areas, vegetation, bare surfaces, and water bodies across the three coastal and peri-urban districts. The total mapped areas for each study location remained constant over the study period, indicating

that the observed variations represent internal land-cover transformations rather than changes in the spatial boundary of the study areas. Remote sensing and GIS have become indispensable tools for monitoring such spatio-temporal landscape changes and evaluating the environmental implications of urban expansion in rapidly growing cities (Idowu *et al.*, 2020; Oladokun *et al.*, 2021). A comparative assessment of the three districts shows that urban expansion is most pronounced in Ikorodu, followed by Epe, while Badagry exhibits relatively stable built-up patterns during the study period. In Ikorodu, the built-up area

increased from 16,129.8 ha (44%) in 2010 to 17,903.07 ha (49%) in 2025, indicating strong urban growth. This increase reflects Ikorodu's transformation from a peripheral settlement into a major residential and commercial hub within Lagos metropolis. The district has experienced rapid population growth, improved transportation connectivity, and increasing economic activities, all of which have stimulated the expansion of urban infrastructure and residential development. Similar trends have been reported in studies of urban growth in Lagos, where built-up land continues to expand as the city attracts migrants and economic investments (Akinyemi *et al.*, 2022; Oladokun *et al.*, 2021).

In contrast, Epe recorded a moderate but significant increase in built-up land, rising from 6,281.1 ha (4%) in 2010 to 12,972.0 ha (8%) in 2025, representing more than a twofold increase. This pattern suggests that Epe is increasingly becoming an urban growth corridor within the Lagos metropolitan region, partly due to infrastructure expansion and the strategic development initiatives in the Lekki–Epe axis. The growth of residential estates, road infrastructure, and economic activities in this corridor has contributed to the gradual conversion of natural land covers into urban land uses. Such patterns align with global observations that urban expansion in developing countries is largely driven by population increase, economic opportunities, and infrastructural development (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Badagry, however, presents a slightly different pattern. Although the built-up area remained relatively stable at about 25% of the total land area between 2010 and 2025, the district experienced notable internal land-cover adjustments. The relatively

stable built-up proportion may be attributed to the dominance of coastal wetlands and environmental constraints that limit extensive urban expansion in the area. However, the stability of built-up land does not necessarily imply the absence of urban pressures, as internal restructuring and redevelopment may still occur within already developed spaces. Another important pattern observed across the three districts is the increase in bare surfaces, particularly in Ikorodu and Epe. In Ikorodu, bare surfaces expanded from 3% to 9%, while in Epe they increased from 9% to 14% between 2010 and 2025. This expansion is likely associated with land clearing, construction activities, sand filling, and other preparatory processes linked to urban development. In rapidly urbanizing regions, bare surfaces often represent transitional landscapes preceding infrastructural development or settlement expansion. Increased exposure of land surfaces has also been linked to environmental challenges such as urban heat island effects and increased land surface temperature, particularly in densely developing urban areas (Amaechi *et al.*, 2024; Idowu and Olalekan, 2025). Vegetation dynamics across the three districts reveal contrasting patterns. In Ikorodu and Epe, vegetation cover declined significantly, indicating substantial conversion of natural landscapes into built-up areas and exposed surfaces. In Ikorodu, vegetation decreased from 51% in 2010 to 40% in 2025, representing a loss of more than 4,000 ha, while in Epe vegetation declined from 60% to 54%, corresponding to a loss of nearly 10,000 ha. This trend is consistent with findings from other studies in Lagos and other rapidly urbanizing cities, where vegetation and agricultural lands are often

converted into residential and commercial developments (Akinyemi *et al.*, 2022; Seto *et al.*, 2012). Vegetation loss may have significant environmental consequences, including reduced carbon sequestration capacity, habitat fragmentation, and increased vulnerability to flooding and climate variability. Interestingly, Badagry shows an opposite trend, where vegetation increased from 34% in 2010 to 42% in 2025. This increase may be attributed to natural vegetation regeneration, improved land management practices, or reclassification of previously bare or degraded land into vegetated landscapes. The growth of vegetation in Badagry may contribute positively to ecological sustainability by enhancing biodiversity conservation, improving carbon storage, and stabilizing coastal ecosystems. Water body dynamics also varied across the three districts. In Ikorodu, the proportion of water bodies remained relatively stable at about 2%, suggesting minimal hydrological changes within the study period. In contrast, Epe experienced a slight decline in water bodies from 27% to 24%, possibly due to land reclamation, sedimentation, or conversion of wetlands for urban development. Coastal environments within Lagos frequently experience fluctuations in water bodies as a result of both natural hydrological processes and anthropogenic activities such as dredging and sand filling (Oladokun *et al.*, 2021). Meanwhile, Badagry recorded a slight increase in water bodies, which may be associated with tidal influences, wetland expansion, or seasonal hydrological variations in the coastal lagoon system.

Overall, the comparative analysis of Badagry, Ikorodu, and Epe demonstrates that urban expansion within the Lagos metropolitan region is occurring at

varying intensities across different districts. Ikorodu shows the most intense urban transformation, characterized by significant increases in built-up land and bare surfaces alongside declining vegetation cover. Epe exhibits emerging urbanization, reflecting its growing importance as a development corridor in the Lekki–Epe axis. Badagry, on the other hand, shows relatively stable built-up patterns with increasing vegetation, indicating a somewhat different trajectory influenced by environmental constraints and coastal ecosystem dynamics.

These findings highlight the complex relationship between urban growth and environmental change in rapidly developing metropolitan regions. While urban expansion supports economic development, housing provision, and infrastructure growth, it can also intensify environmental challenges such as loss of vegetation, increased flood risk, urban heat island effects, and ecosystem degradation (Seto *et al.*, 2012; Akinyemi *et al.*, 2022). Therefore, continuous monitoring using remote sensing and GIS technologies is essential for understanding land-cover dynamics and guiding sustainable land-use planning, environmental management, and policy formulation in Lagos and other rapidly urbanizing coastal cities (Idowu *et al.*, 2020).

Implications of Findings of the Study

The comparative analysis of land use/land cover (LULC) dynamics in Badagry, Ikorodu, and Epe between 2010 and 2025 demonstrates significant urban expansion and internal landscape transformations within Lagos State. Rapid increases in built-up areas and bare surfaces, coupled with reductions in vegetation and water bodies, have several critical implications for environmental

management, urban planning, and policy formulation. Environmentally, the loss of vegetation and wetlands increases vulnerability to flooding, urban heat island effects, and biodiversity decline, particularly in rapidly urbanizing districts such as Ikorodu and Epe. Conversely, Badagry's increase in vegetation suggests potential ecological resilience and the positive impact of natural regeneration or land management initiatives.

From a planning perspective, the findings highlight the urgent need for strategic urban development and infrastructure management to accommodate population growth while maintaining ecological sustainability. The observed spatial variations in LULC changes underscore the importance of district-specific planning interventions, as uniform policies may not adequately address the localized drivers of urban growth and environmental degradation.

Conclusion

Recommendations

The study recommended the following;

1. Sustainable Urban Planning: Implement land-use zoning and building regulations to prevent uncontrolled urban sprawl, particularly in rapidly developing districts like Ikorodu and Epe.
2. Vegetation and Wetland Conservation: Prioritize protection and restoration of green spaces and wetlands to enhance ecological stability, reduce flood risks, and maintain biodiversity.
3. Targeted Land Management: Develop district-specific interventions; for instance, promote ecological enhancement in Badagry while managing vegetation loss and bare surface expansion in Ikorodu and Epe.

The comprehensive analysis of land cover and land use changes of Badagry, Ikorodu, and Epe spanning one and half decades, which is between 2010 and 2025, reveals several significant trends. Ikorodu experienced the most pronounced urban transformation, with substantial expansion of built-up areas and bare surfaces at the expense of vegetation. Epe displayed moderate urban growth, reflecting its emergence as a strategic development corridor, while Badagry showed relatively stable built-up areas accompanied by an increase in vegetation, indicative of partial ecological recovery. Overall, these patterns reveal the complex interplay between urbanization, land-cover change, and environmental sustainability in Lagos State's peri-urban and coastal districts. The study underscores the necessity of continuous monitoring using GIS and remote sensing to inform sustainable land-use planning and mitigate environmental risks associated with urban expansion.

4. Geospatial Monitoring: Institutionalize routine GIS and remote sensing surveillance to track LULC dynamics, guide policy decisions, and support sustainable urban growth.
5. Community Engagement and Awareness: Educate residents and stakeholders on sustainable land-use practices and climate adaptation strategies to foster community-driven environmental stewardship.

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