# Investigating Wetland Changes in Ilaje Local Government Area, Ondo State, Nigeria 1991-2024: A GIS Approach

Ikezam Innocent Weje; Fyneface Chijioke Wachukwu; & Great Oluwatobi Akinduro

*Department of Urban and Regional Planning*
*Rivers State University Nkpolu- Oroworukwo Port Harcourt*

***Abstract***
*Ecological restoration and sustainable management of wetland is becoming an increasingly sought-after natural climate solution. As the world journey through sustainability, wetland shall continue to play essential role in the socio-economic and political live of any place. The study explored wetland dynamics in Ilaje Local Government Area of Ondo state with a view to ascertain their status and disposition over time. The study leaned on positivist research paradigm utilising the quantitative research approach. The research design was the longitudinal survey since the study sought to examine wetland status and changes in Ilaje over time. Both primary and secondary data sources were utilised. Primary data were mainly through personal observation and the use of hand held Global Positioning System (GPS) to collect geospatial coordinates and conduct ground-truthing. Secondary data were obtained from published official statistics and desk top review of literature. More so, satellite imagery of the area for 1991, 2001, 2011, 2021 and 2024 were sourced from the repository of the should be "United States Geological Survey (USGS) at 30 metres resolution while results are presented in tables, graphs to enhance comprehension. Study revealed a spatial-temporal variation in the wetland resources of the area for the period under investigation. For example, in 1991, wetland occupied an area of 14,960ha representing (11%) of the total landmass. Vegetation (Forests and Agriculture) occupied 84.5%, waterbody, 3.2%, while built-up occupied an area of 1.3%. The land use budget of Ilaje LGA for 2001 indicates an increase of wetland area and built-up area, but a decline in vegetal area. The 2011 land-use budget of the area also revealed an interesting scenario as there was further increase in wetland area and built-up area. The 2021 figures showed further increase for wetland. The increase recorded in water body and wetland areas may be attributed to the consequences of sea level rise and/or climate change that has made areas which hitherto were dry land turning them into wetland areas. Addressing this complexity and the challenges of increased wetland area occasioned by climate change and variability as the case of Ilaje LGA requires a holistic approach that integrates environmental conservation with sustainable development strategies.*

**Keywords:** wetland conservation; built-up; sustainable management; climate change, ecosystem

## 1.0 Introduction

According to the Ramsar Convention Secretariat (Ramsar, 1971), wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed 6 meters. Wetlands are one of the world's most important resources because of the many environmental and socio-economic benefits they provide. Although wetlands cover only an estimated area of 6% of the earth surface (Turner, 1991), Mitsch and Gosselink (2007), opined that wetland play essential role in the maintaining the ecological system. Directly or indirectly, wetlands

provide almost all of the world's consumption of freshwater. More than one billion people depend on them for a living and 40 per cent of the world's species live and breed in wetlands (OECD 1996). They are essential for performing many ecosystem services, such as food control, maintenance of biodiversity, fish production, carbon storage, aquifer discharge and flood control as well as providing habitat for many endangered species (Barbier, Acreman, & Knowler, 1997). For Turner (1991), in spite of the role wetland play in the sustenance of the ecosystem, they are among the most threatened of all environmental resources.

Nigeria is blessed with an estimated 28,000 km2 (3%) wetlands area (Uluocha & Okeke, 2004), majority of the wetland resources are under threat occasioned by oil and industrial waste pollution, population pressure, rapid urbanisation, mining, dam construction and transportation routes among others. It is for the enormous role wetland play in the stabilisation of ecosystem that the Goal 15 of the Sustainable Development Goals (SDGs) focuses specifically on managing forests sustainably, restoring degraded lands and successfully combating desertification, reducing degraded natural habitats and ending biodiversity loss by 2030 (UN 2015). llaje Local Government Area (LGA) is richly endeared with wetland resources all of which play an essential role in the development of the area. To ascertain the status of wetland resources in Ilaje LGA needs curious investigation. The present study therefore examined the changes in the wetland of the area from 1991-2024 with a view to ascertain their status and changes there from.

## 2.0 Study Area.

Ilaje is one of the LGAs of Ondo state in the South-West of Nigeria. Its headquarters is Igbokoda. It situates within Latitude: 6°00 - 6°30N and Longitude: 4°30 - 5°00E of UTM Zone 31N (Figure 1). Ilaje occupies a Land area of 1,318km2 (509 sq. miles). It is bounded on the North, by Okitipupa Local Government, to the south, by Atlantic Ocean, to the West, by Ogun State and in the East, by Delta State. In 2006 it had a population of 290,615 persons. The climate of Ilaje is tropical influenced by its coastal location. The region experiences warm to hot temperatures throughout the year. The average annual temperature hovers around 27°C (81°F). Ilaje is rich in natural resources including oil and gas and contributes significantly to the progress of Nigeria's oil industry.

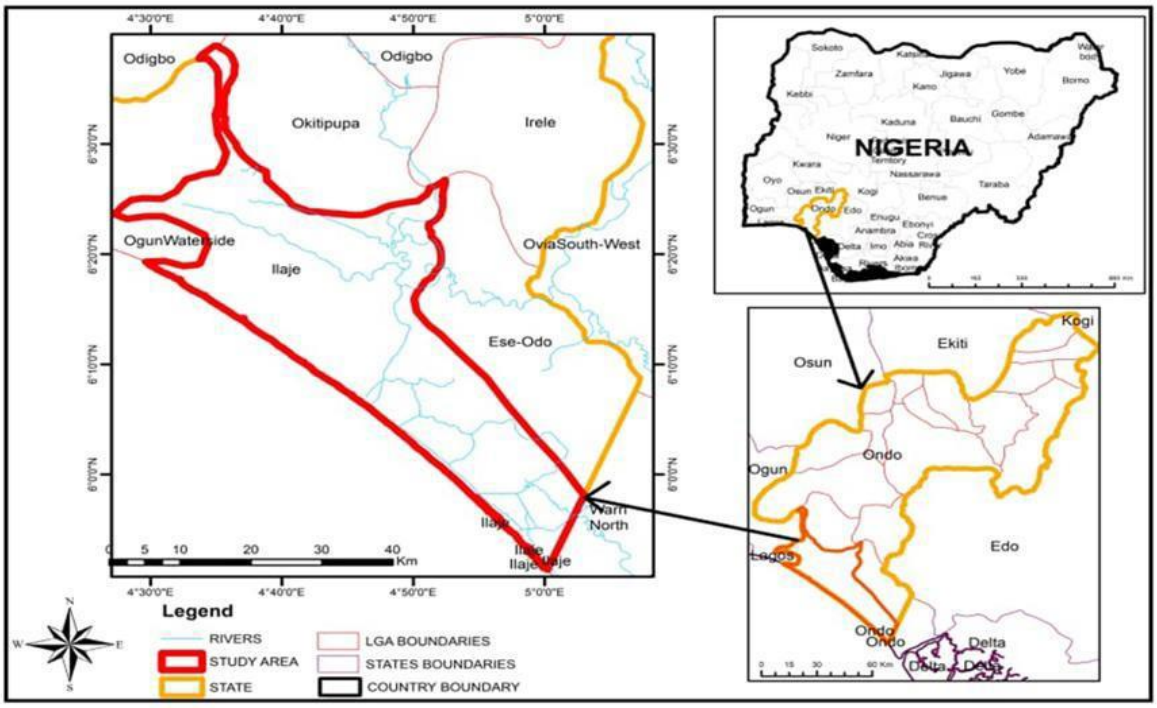



**Figure 1: Study Area**
**Source: URP Department, Rivers State University, Port Harcourt (2023)**

## 3.0 Review of Related Literature

### 3.1 Succession Theory

Succession theory in wetlands, as proposed by Odum in 1987, suggests that wetland ecosystems undergo series of predictable changes in plant and animal community over

time. This theory posits that wetlands undergo transition through various stages of development, ultimately leading to the establishment of mature and stable ecosystems. According to Odum (Op cit), wetland succession typically begins with the colonization of pioneer species adapted to the harsh and dynamic environmental conditions of newly formed wetlands. These pioneers' species, such as certain grasses, sedges, and herbaceous plants, are often capable of rapid growth and reproduction, facilitating the initial establishment of vegetation in the wetland. As the wetland continues to develop, these pioneer species gradually give way to more competitive and shade-tolerant species, leading to changes in the composition and structure of the plant community. Over time, a diverse array of vegetation, including shrubs and trees, becomes established, further shaping the wetland landscape.

### 3.2 Ecological Theory

Ecological systems theory was developed by Bronfenbrenner in 1979 to explain the in connectedness of systems and their possible impact on human development. The ecological theory refers to a diverse sets of models used in ecology to examine the

patterns in nature, and balance of ecosystems. When applied to wetland, the theory explains the interconnectedness of nature and human activities. This theory has been used in the analysis of and understanding of the intricate relationship between human activities, environmental factors and ecosystem responses. the theory identified four subsystems that singularly or jointly influences wetland changes to include: microsystem referring to the direct interactions between humans and the wetland in the form of fishing, recreation etc. The mesosystem describes the interaction between different microsystems like agriculture and urban development. The exosystem on the other hand speaks of the external factors influencing wetlands such as climate change or policy decision while the macro system concentrates on the broader societal and cultural contexts shaping human-wetland interactions. For ecological theory, although wetlands are crucial and provides huge benefits, the intricate relationship between human activities in the form of agriculture, urbanisation has significantly altered wetland ecosystem. For example, the expansion of urban areas can have cascading effects on the natural environment, including the degradation or loss of wetlands.

For the proponents of the ecological theory, deeper understanding of the interconnectedness of these systems is key for sustainable management of wetland resources

### 3.3 Empirical Review

There exist lots of studies from different authors in this area of inquiry. Increased interests by scholars in this field may be due to the vital role wetlands play in the socio-economic and general well-being of any society. For example, Ojekunle (2011) reviewed the ecology of Nigerian wetlands in order to determine the factors influencing their utilization in sustainable food production and likewise presented a design alternative for food and water re-use production. The study recommended for the use of water-recycling systems, such as waste water treatment plant and reclaimed water reservoirs; to ensure sustainable use of water.

In another study, Dauda (2014) while examining the ways the Nigerian communities can salvage wetland ecosystem to ensure sustainable fish production, identified wetlands as one of the high valued resources which has been exposed to indiscriminate use. In a study conducted on the geospatial mapping of wetland potential in Ilesa, Osun State, Nigeria, Orimoogunje, Oyinloye and Soumah (2009) identified urbanisation and agricultural activities as constituting major threats to wetlands in

study area. According to them, urbanisation and agro-economic activities put pressure on wetland resources in the area of study. Urbanisation, over-cultivation and encroachment of wetland resources due to increased population pressure and the suitability of the areas for the production of arable crops increased the stress on wetland resources in area.

In a related study, Tijani, Olaleye and Olubanjo (2011) examined the impact of urbanisation on wetland degradation in Eleyele, Ibadan, and South West Nigeria. Findings identified environmental impacts of urbanisation and land-use as key factors in the degradation of Eleyele wetland in Ibadan.

Similarly, Ajibola, Adewale and Ijasan (2012) examined the effects of urbanisation on Lagos wetlands and were able to establish that the primary causes of wetland loss in Lagos metropolis are majorly human motivated. Such human activities listed by the researchers include incessant sand-filling and conversion of wetlands environment for economic uses, high rural-urban migration and increased dredging of wetland sites within Lagos State

Akue, Weje and Brown (2022) conducted a study to explore the nexus between urban growth trend and wetland loss in port Harcourt municipality. Results of analysis revealed that there exists spatial-temporal variation in wetland loss in the study area between the years under review with wetland decreasing form 34633511.38m2 in 1990 to 30945235.9m2 in 2000, and to 23297313.11m2 in 2010 to 18688909.45m2 in year 2020. A very high positive correlation coefficient (Rs) of 0.99 obtained expresses the strong relationship between urban growth and wetland loss in the study area. The study recommends that government and its relevant Ministries, Departments and Agencies (MDAs) should embark on wetland creation, development, and conservation to ensure the continuity in the services, functions, and value of wetland ecosystems in the study area.

Weje and Dapa (2015) worried by the rapid disappearance of wetland resources in Port Harcourt carried out a study and found that the increasing population of Port Harcourt precipitates a situation where wetlands are reclaimed for residential use. The study revealed that uncoordinated nature of land reclamation (usually done with local materials) leads to the formation of slums in the area.

Weje and Nwabueze, (2018) also looked land use and land-cover dynamics in Ukwuani Local Government Area, Delta State, Nigeria**.** The findings indicated that the areas covered by forest which was

77,948 $m^2$ in year 2000, reduced to 25,226 $m^2$in 2018 and the areas covered by other land uses increased from 389,449 $m^2$. in 2000 to 442,234 $m^2$ in 2018. The total forest land lost to other land uses amount to approximately 52,785 $m^2$ while the total land area gained by other land uses amount to approximately 52,785 $m^2$.

In view of the importance of wetland in achieving a sustainable development in the area, there is need to examine wetland resources in Ilaje and the likely changes they may have undergone over time. This was considered a gap in knowledge which the present study seeks to fill.

## 4.0 Method and Materials

The study leaned on the positivist research paradigm utilising the quantitative research approach. The research design was the longitudinal survey since the study sought to examine the changes in land use land cover of Ilaje over time (1991 -2024). Both primary and secondary data sources were used. The primary data were mainly through personal observation and the use of hand held Global Positioning System (GPS) to collect study area coordinates of features and ground truthing. Secondary data were obtained from review of past data, official information and desktop review of literature. More so, satellite Imagery- of the area for 1991, 2001, 2011, 2021 and 2024 were sourced from repository of the United Geological Survey at 30 metres resolution.

The images were clipped in the ArcGIS Pro environment using the clipping tool under the Data management tools in ArcGIS Pro toolbox. The images were then stacked together to create a False composite of the study area using the Band combination button under the Image Analysis tools, Band 4, Band 3, and Band 2 were stacked into one image.

The false colour Image was there after classified by picking respective training polygon as training samples for different classes of the analysis (wetland, Built-up, Vegetation and Waterbody). The Training sites were identified as clusters of land-cover classes in the study area through ground trothing of various sites in the city.

A signature file was created to assign signature for each class and a classifier algorithm (maximum likelihood) was chosen to classify the image. The result of this classification was that each pixel belonging to different classes were properly indicated and detected. To enhance understanding, results were presented in forms of graphs, tables, charts and maps.

## 5.0 Results and Discussion

Table 1 shows the spatial distribution of wetland and other land-uses in Ilaje LGA for the period 1991, 2001, 2011, 2021 and 2024. Findings reveal a spatial-temporal

variation in the wetland of the area for the periods under investigation. For example, in 1991, wetland occupied an area of 14,960ha representing (11%) of the total landmass of the study area. Vegetation (Forests and Agriculture) occupied 114,462ha (84.5%), waterbody covered 4,315ha (3.2%), while built-up occupied an area of 1,737ha (1.3%) of the total land area (see figure 2).

However, the land use budget of Ilaje LGA for 2001 indicates an increase in wetland area from 14,960ha (11%) in 1991, to 20,497ha (15.1%) representing a 4.1% increase. There was however a decline in Vegetal area from 114,462ha in 1991 (84.5%) to an area of 106,740ha (78.8%), in 2001. Waterbody covered an area of 4,837ha (3.6%), while built-up also witnessed an increase covering an area of 3,400ha (2.5%), a 1.2% increase from the 1991 figure.

The spatial distribution of wetland and other land-uses in 2011 also revealed an interesting scenario as there was further increase in wetland area to 21,983Ha (16.2%). Vegetation covered an area of 104,396ha (77.1%), Waterbody 4,974ha (3.7%) while built-up also increased to an area of 4,121ha (3.0%) (Figure 4). In 2021, there was further increase in wetland occupying 17% of the land area (23,001ha), vegetation covered 100,018ha (73.8%), Waterbody 7,700 ha (5.7%) and built-up occupying 4,755ha (3.5%). The land use budget of the study area for 2024 did not differ significantly from those of 2021 as wetland area maintained land area of 23,053ha (17%). Vegetation covered an area of 99,430ha (73.4%), Waterbody 7,300ha (5.4%) while built-up covered an area of 5,691ha (4.2%) (Figure 6).

From the exposition made above, there appears to be constant increase in both built-up and wetland areas in Ilaje LGA for the period of studies. The steady rise in both built-up and wetland resources of Ilaje LGA is not only surprising but a contradiction of similar studies such those of Akue, Weje and Brown, (2022); Weje and Dapa (2015); and Odubo and Weje, (2022) that had established an inverse relationship between urban built-up and wetland decline. The core of these studies is that as urban built-up increase, there is usually an accompanying decline in wetland through the processes of land reclamation

As should be expected, the steady increase in wetland area of Ilaje LGA may be attributed to the impact of climate change that has exacerbated flooding incidences in some coastal communities. Climate variability has brought lots of changes in the weather pattern between and among points in space. In the case of Ilaje, changes in flow pattern of natural drains occasioned by climate impact precipitates situation in

which rivers and natural drains overflow their banks extending to areas that where hitherto dry, converting them to wetland areas.

Secondly, the very slow pace of change observed in the built-up land use indicates a very low urbanisation rate in the area. Ilaje being a rural coastal region is still immured from the very intense demand for land space experienced in urban areas. This low competition among land uses accounts for the relative stable status of land use distribution in the area.

**Table 1 Land Use Distribution of 1991-2024**

| Variable | 1991 | | 2001 | | 2011 | | 2021 | | 2024 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % | Area (ha) | % | Area (ha) | % | Area (ha) | % | Area (ha) | % |
| Water Body | 4,315 | 3.2 | 4,837 | 3.6 | 4,974 | 3.7 | 7,700 | 5.7 | 7,300 | 5.4 |
| Built-Up | 1,737 | 1.3 | 3 ,400 | 2.5 | 4,121 | 3.0 | 4,755 | 3.5 | 5,691 | 4.2 |
| Vegetation | 114,462 | 84.5 | 106,740 | 78.8 | 104,396 | 77.1 | 100,018 | 73.8 | 99,430 | 73.4 |
| Wetlands | 14,960 | 11.0 | 20,497 | 15.1 | 21,983 | 16.2 | 23,001 | 17.0 | 23,053 | 17.0 |
| Total | 135,474 | 100 | 135,474 | 100 | 135,474 | 100 | 135,474 | 100 | 135,474 | 100 |

**Source: Researcher's Fieldwork (2024)**

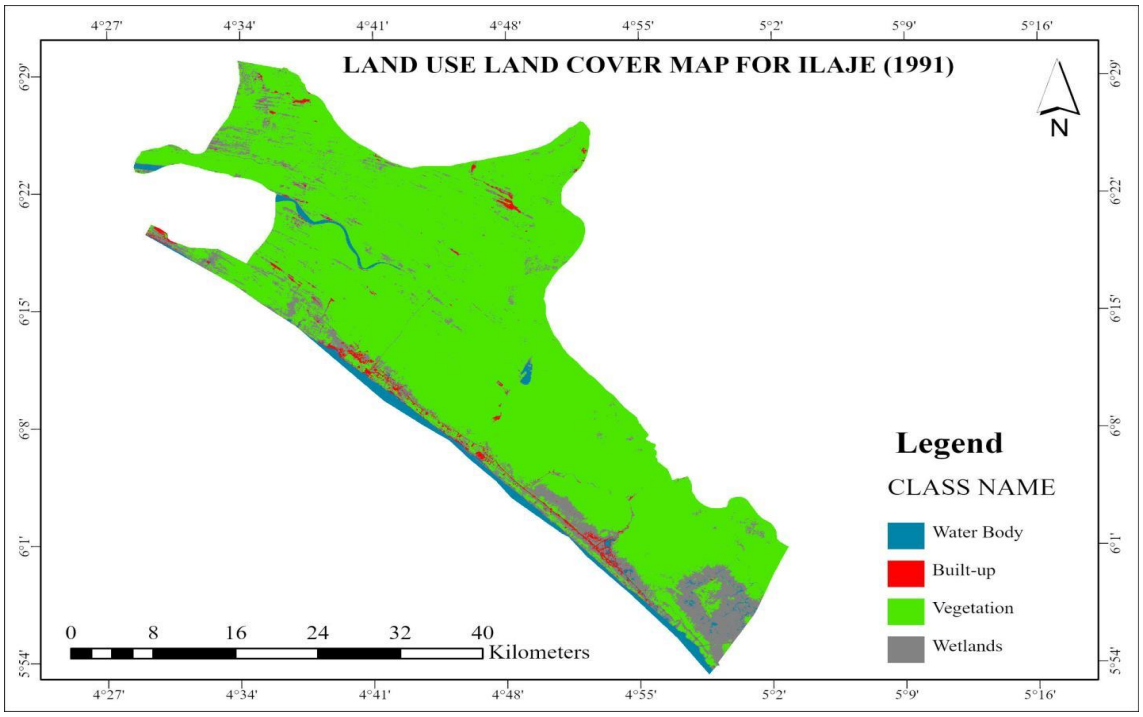



*Figure 2: Land Cover of Ilaje ,1991*
*Source: Field work, 2024*

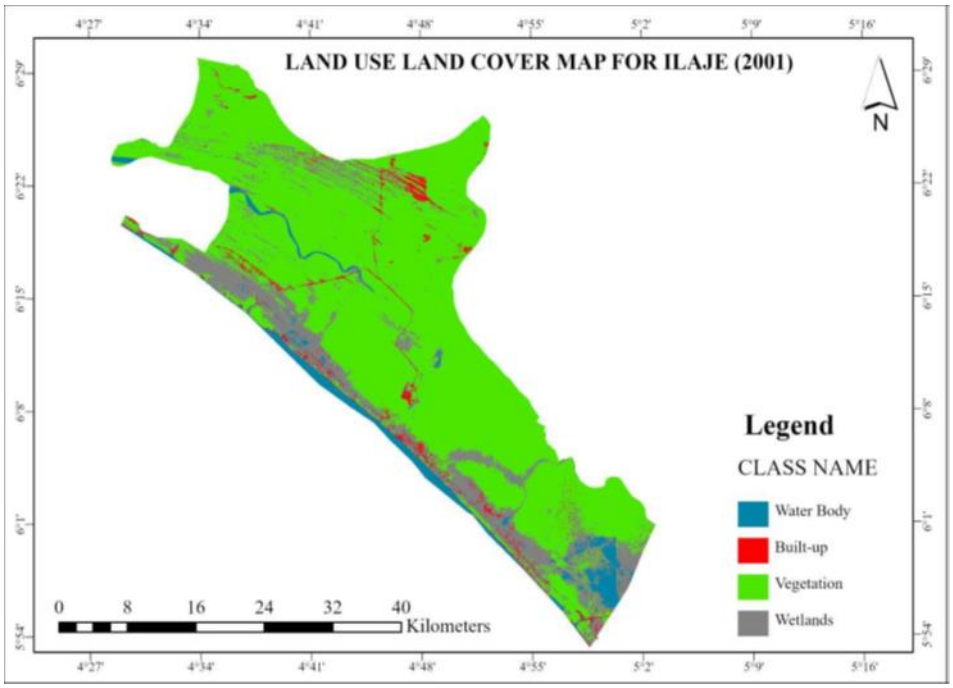



*Figure 3: Ilaje land cover in 2001*
*Source: field work, 2024*

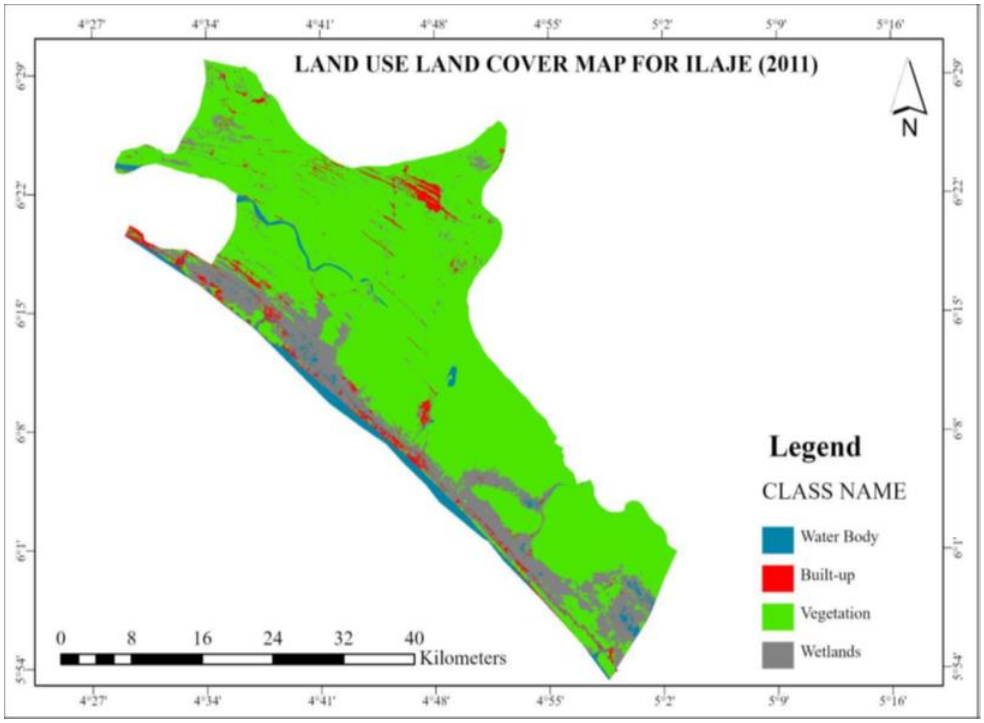



*Figure 4: Ilaje land cover, 2011*
*Source: Field work, 2024*

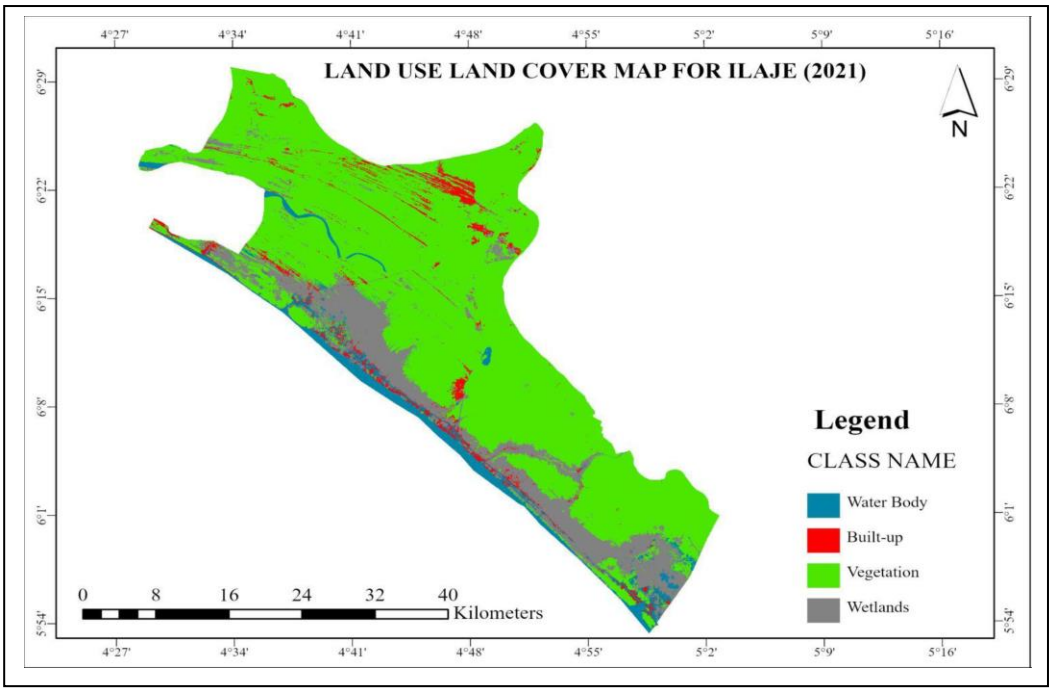



*Figure 5: Ilaje land cover, 2021*
*Source: Fieldwork, 2024*

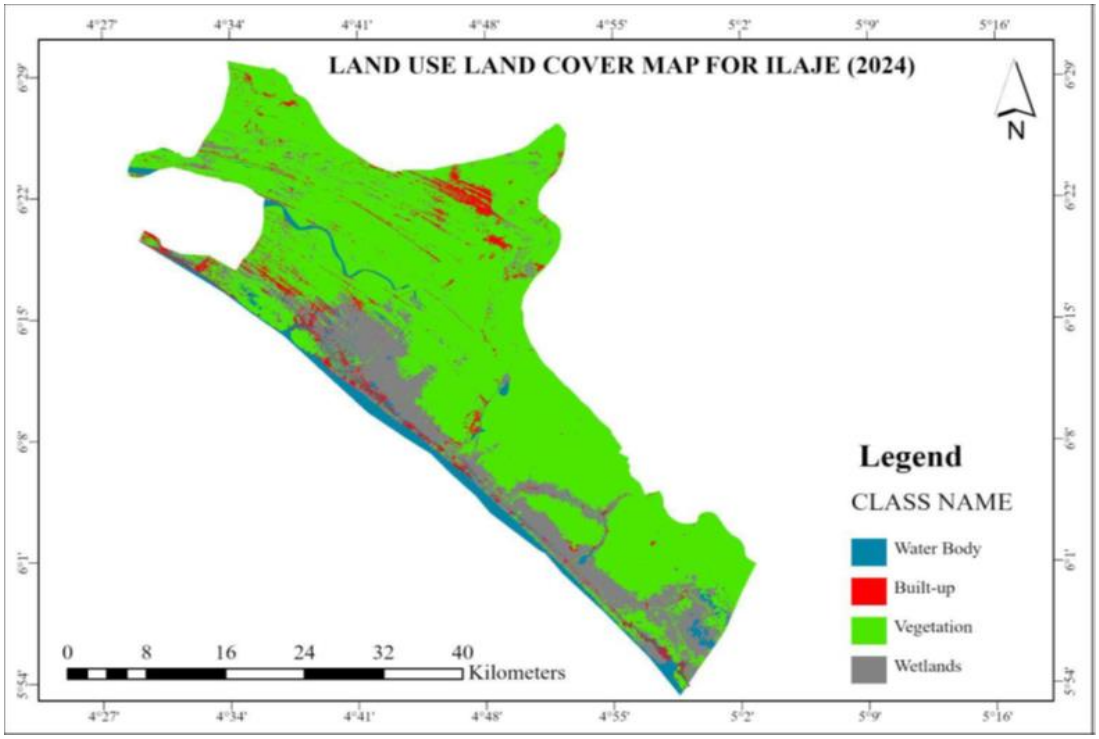



*Figure 6: Ilaje land cover, 2024*
*Source: Fieldwork, 2024*

## 6.0 Conclusion and Recommendation

Infrastructural development and other forms of built-up expansion often times results in the loss of crucial habitat of various plant and animal species, thereby disrupting the delicate balance of the ecosystem. Urban expansion poses significant challenges to the preservation and sustainability of natural environment. The finding of this study indicates that there is a progressive increase in both built-up areas, water bodies and wetland within the period under investigation (1991-2024). This implies that communities in Ilaje LGA experienced rapid increase in built-up areas, this increase did not have any appreciable negative impact on the water bodies and wetland areas. Thus as built-up area increase, so did wetland and areas occupied by water bodies. Increase in both water body and wetland areas within the period under review may be attributed to the consequences of sea level rise and/or climate change that has brought areas that hitherto were dry-land, turning them into wetland conditions. Addressing this complexity and the challenges of increased wetland area occasioned by climate change and variability as is the case of Ilaje. This calls for a holistic approach and integration of climate considerations is valid but vague. It lacks specific, actionable strategies for planners and policymakers.in Ilaje must integrate climate change considerations into long-term planning frameworks for a sustainable development of the area.

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