

## Geospatial Assessment of Land Use–Land Cover Dynamics and Their Impacts on Local Climate in

Ijebu-Ode, Nigeria

**BY**

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### **ABSTRACT**

This study examines the relationship between land use–land cover (LULC) changes and local climate variation in Ijebu-Ode, Nigeria, using geospatial techniques and climate data from 1984 to 2020. Landsat satellite imagery and ERA5/NIMET datasets were utilized to analyze spatial and temporal changes in vegetation and surface temperature. The Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) were derived from multi-date Landsat imageries. Results reveal a significant increase in built-up areas (+22.46%) and a reduction in dense vegetation (–52.8%) over the study period, corresponding with a notable rise in mean LST from 26.9°C to 35.2°C. The findings demonstrate a strong linkage between urban expansion, vegetation degradation, and localized warming, highlighting the need for sustainable land management and urban planning policies that integrate climate adaptation measures.

**Keywords:** Land use - land cover, climate change, land surface temperature, NDVI, geospatial analysis, Ijebu-Ode

### **1. INTRODUCTION**

Climate change remains one of the most pressing global challenges, with local manifestations strongly influenced by land use and land cover dynamics. In rapidly urbanizing regions such as Ijebu-Ode, Nigeria, the transformation of

vegetated surfaces into impervious built-up areas has significant implications for local climate regulation. These transformations disrupt natural energy and water fluxes, contribute to increased surface temperature, and alter local microclimates.

The global concern for anthropogenic climate modification stems from the replacement of

natural landscapes with built-up surfaces. These changes increase surface albedo, reduce evapotranspiration, and modify the hydrological and energy balance, thereby influencing local and regional climates. In tropical environments, where rainfall and temperature are key determinants of agricultural productivity and ecosystem balance, these shifts can have far-reaching environmental and socioeconomic consequences.

The use of geospatial tools such as Remote Sensing and Geographic Information Systems (GIS) provides an effective framework for monitoring land transformations and analyzing their climatic implications. This study therefore aims to assess the relationship between LULC changes and local climate variability in Ijebu-Ode, Nigeria, using satellite-based data for the period 1984–2020.

## 2. Study Area

Ijebu-Ode lies between latitudes  $6^{\circ}47'N$  and  $6^{\circ}52'N$  and longitudes  $3^{\circ}53'E$  and  $3^{\circ}59'E$  within Ogun State, Southwest Nigeria. The area falls under the humid tropical climatic zone characterized by two distinct seasons: the wet season (April–October) and the dry season (November–March). Mean annual rainfall ranges between 1523 mm and 2340 mm, while the average annual temperature hovers around  $27^{\circ}C$ .

The town has experienced rapid population growth and expansion due to its position as a commercial hub. Natural vegetation, originally

dense forest and riparian vegetation, has been progressively converted into built-up and agricultural lands. These transitions make the city a suitable case study for examining how land-use dynamics influence local climate conditions.

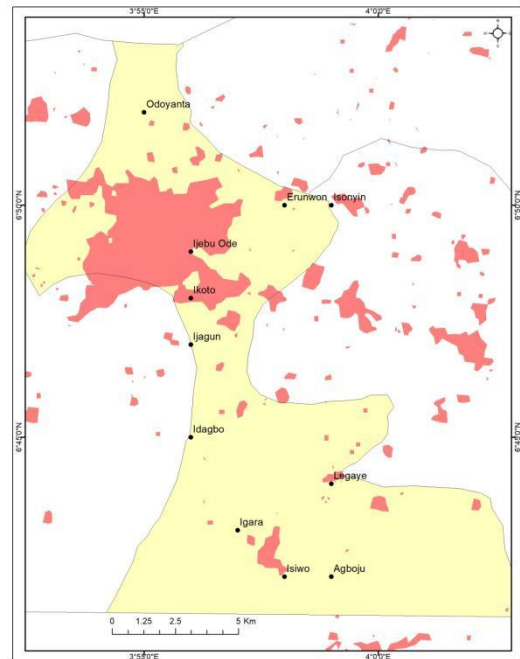


Fig.1 Map of the study area

## 3. Data and Methods

### 3.1 Data Sources

- Landsat Data: Landsat TM (1984), ETM+ (2000), and OLI (2020) were used for land cover analysis.
- Climate Data: ERA5 Copernicus reanalysis data and NIMET (Ijebu-Ode station) rainfall and temperature records (1984–2020).
- Software: ERDAS Imagine 2015 and ArcGIS 10.7 for image processing and spatial analysis.

### 3.2 Image Processing and Classification

Landsat images were geometrically corrected and subset to the study area boundary. A supervised maximum likelihood classification approach was used to identify five land cover classes: built-up area, dense vegetation, sparse vegetation, bare surface, and water body.

### 3.3 NDVI Derivation

NDVI was computed using the equation:

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

where NIR is near-infrared reflectance and RED is red band reflectance. NDVI values close to +1 indicate dense vegetation, while values near 0 represent non-vegetated surfaces.

### 3.4 Land Surface Temperature (LST)

Thermal infrared bands (10.4–12.5  $\mu\text{m}$ ) from Landsat images were used to calculate LST using the following steps:

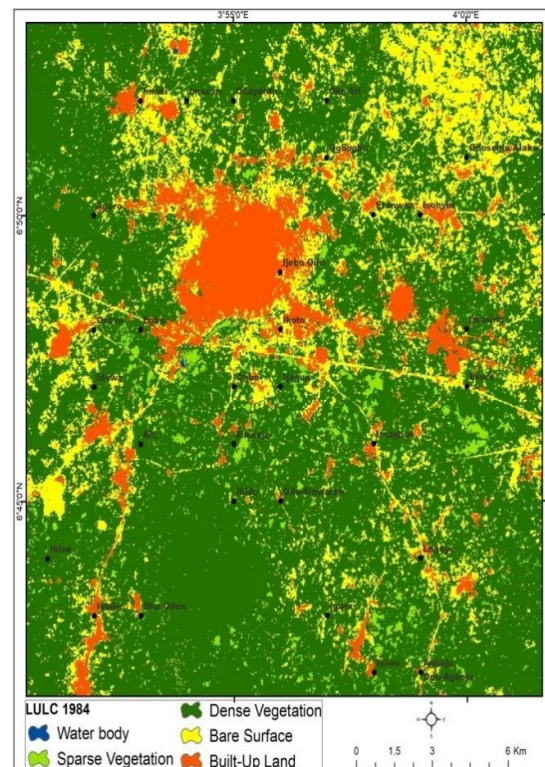
1. Conversion of digital numbers (DN) to spectral radiance.
2. Conversion to brightness temperature (Kelvin).
3. Adjustment for surface emissivity.

The resulting temperature maps were used to analyze spatial temperature variations across different land cover types.

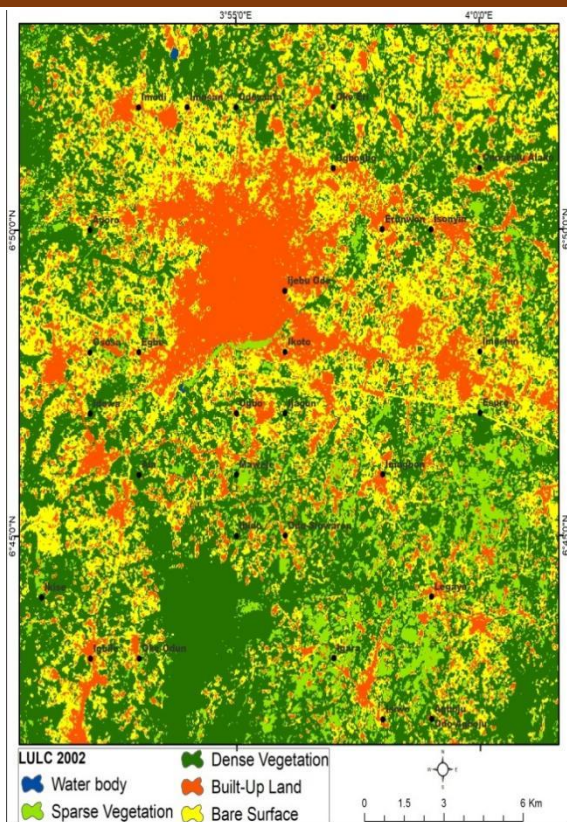
## 4. Results and Discussion

### 4.1 Land Use–Land Cover Changes (1984–2020)

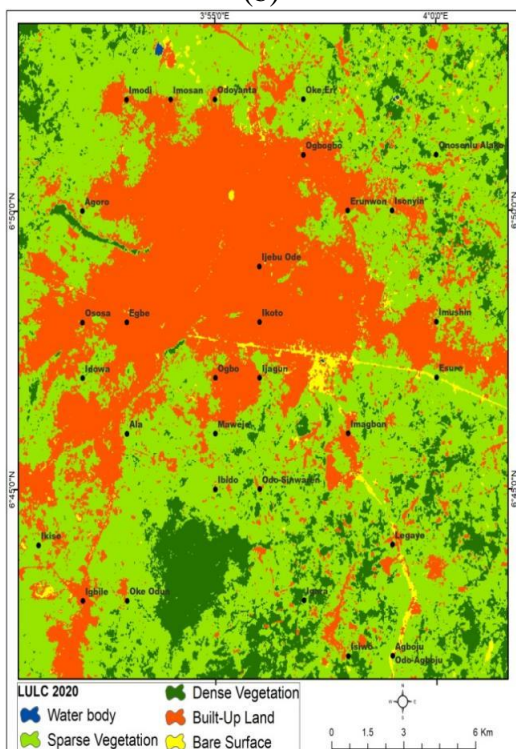
Between 1984 and 2020, dense vegetation decreased from 309.89 km<sup>2</sup> (68.85%) to 54.24 km<sup>2</sup> (12.05%), while built-up areas increased from 41.53 km<sup>2</sup> (9.23%) to 142.66 km<sup>2</sup> (31.69%). Sparse vegetation also expanded, largely reflecting agricultural and secondary regrowth areas. These findings confirm intense land conversion driven by population growth, industrialization, and infrastructure expansion.



(a)



(b)



(c)

Fig.2 (a), (b) & (c) Land and Land Cover analyses for Ijebu-Ode (1984-2020)

S/N	LULC CLASSES	DESCRIPTION OF THE LULC
1.	Built-Up Land	Roads, Buildings, Open spaces
2.	Dense Vegetation	Shrubs, Fallows, Riparian forests.
3.	Sparse Vegetation	Crop lands, Farmlands, Grazing lands
4.	Water Body	Rivers, Streams, Wet Lands,

Table 1(b) Area covered by Land use/Land

Classes/ Area (Sq.Km)	1984	2002	2020
Water body	0.12	0.13	0.15
Sparse Vegetation	12.21	35.74	246.48
Dense Vegetation	309.89	198.17	54.24
Bare Surface	86.36	132.22	6.57
Built-Up Land	41.53	83.84	142.66
<b>Total Area (Sq.Km)</b>	<b>450.10</b>	<b>450.10</b>	<b>450.10</b>

Cover classification features

Classes/ Percentage (%)	1984	2002	2020
Water body	0.026	0.03	0.034
Sparse Vegetation	2.71	7.94	54.76
Dense Vegetation	68.85	44.03	12.05
Bare Surface	19.19	29.37	1.46
Built-Up Land	9.23	18.63	31.69
<b>Total Percentage (%)</b>	<b>100 (%)</b>	<b>100 (%)</b>	<b>100 (%)</b>

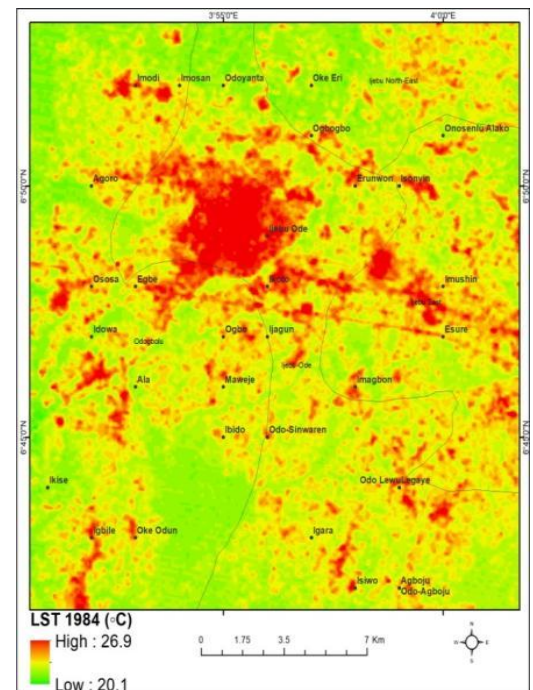
Table 1(c) Percentage covered by Land use/Land Cover classification features

### 4.2 NDVI Trends

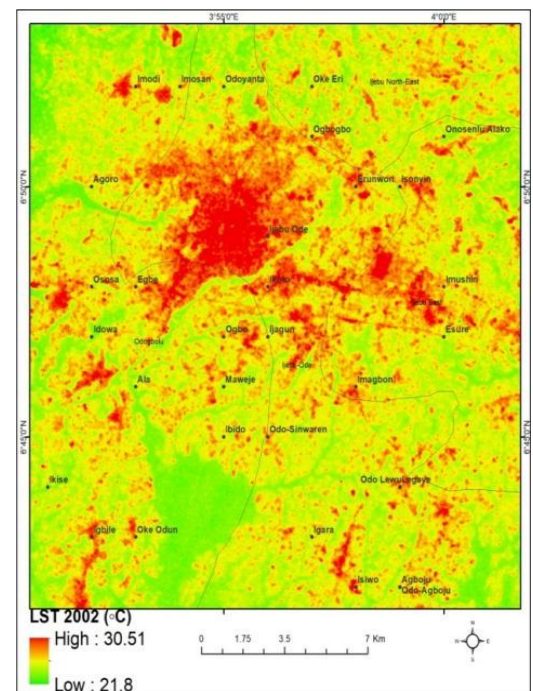
The NDVI analysis indicated declining vegetation vigor over time, with mean NDVI dropping from **0.65** in 1984 to **0.31** in 2020. Areas with high NDVI values corresponded with forested regions, while low NDVI values indicated bare or built-up surfaces. This pattern shows a transition from dense forest to degraded vegetation due to human activities such as farming, logging, and sand mining.

### 4.3 Land Surface Temperature Variability

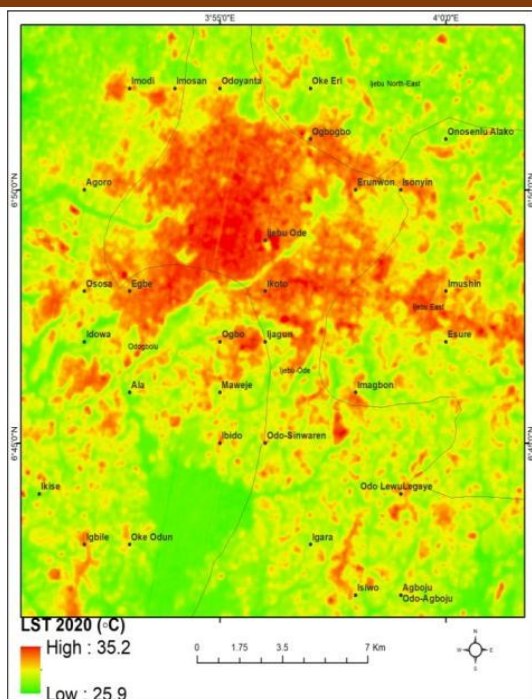
LST maps revealed a progressive rise in temperature over the years. In 1984, LST ranged from **20.1°C–26.9°C**; in 2000, it rose to **21.8°C–30.5°C**, and by 2020, temperatures peaked at **35.2°C**. High LST zones were concentrated around urban centers and newly developed areas, whereas low LST values were observed in vegetated regions. This inverse relationship between vegetation cover and temperature supports the findings of Pielke et al. (2002) that urbanization modifies local microclimates through energy balance alterations.



(a)



(b)



(c)

Fig. 3 (a), (b) & (c) Land Surface Temperature of Ijebu-Ode (1984-2020)

#### 4.4 Correlation Between LULC and LST

Correlation analysis between NDVI and LST values showed a strong negative correlation ( $r = -0.81$ ), indicating that vegetation loss directly contributes to surface warming. The pattern aligns with global studies demonstrating that vegetation plays a critical role in moderating surface temperatures through shading and evapotranspiration.

#### 5. Conclusion

This study demonstrates that land use–land cover changes have significantly influenced the local climate of Ijebu-Ode. The steady increase in built-up areas and the corresponding decline in vegetation cover have led to a noticeable rise in surface temperatures, a clear indication of urban heat island formation.

Integrating climate-sensitive strategies into urban development is therefore essential to mitigate adverse thermal effects and sustain environmental quality.

#### 6. Recommendations

1. Integrate climate considerations into land use and urban planning processes.
2. Promote urban greening—including tree planting, green roofs, and buffer zones.
3. Monitor land and climate changes through routine satellite-based assessments.
4. Encourage public awareness on sustainable land management practices.
5. Adopt policies that reduce deforestation and support reforestation in urban fringes.

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