# ASSESSING THE IMPACT OF URBANIZATION ON NATURAL VEGETATION IN IKPOBA-OKHA USING LANDSAT IMAGERY

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**BENIN CITY**

**FEBRUARY, 2025**

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**A PROJECT SUBMITTED TO THE DEPARTMENT OFGEOMATICS, FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCES (BSCGEM-B.SC. GEOMATICS) DEGREE**

**SUPERVISOR:**

**SURV. DR. GEOFFREY NWODO**

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## CERTIFICATION

This is to certify that this project was carried out by **OKONKWO BARNABAS UZOCHUKWU** with the matriculation number **ENV1906064** of the department of Geomatics, Faculty of Environmental Sciences, University of Benin, Edo State, Nigeria.

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# DEDICATION

I dedicate this work to almighty God for providing me the strength and wisdom needed to accomplish this research.

## ACKNOWLEDGEMENT

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I want to specially appreciate with a deep sense of gratitude my project supervisor, Surv. (Dr) Geoffrey Ogbonna Nwaodo for his inevitable guidance,constructive criticism and mentorship, not only in carrying out this work, but throughout my journey as a student, I am sincerely grateful.

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I extend my profound thanks to my parents, Mr. and Mrs. Jonathan Okonkwo for their unwavering support throughout my journey in the university of Benin, My elder brother, Mr. John Somtochukwu Okonkwo, sisters: Mrs. Chioma Umenyora, Mrs. Precious Nkemdilim and Mrs. Favor Ezinwanne Emezi. I thank you all.

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# ABSTRACT

Urbanization significantly alters natural landscapes, often leading to vegetation loss and environmental degradation. This study assesses the impact of urban expansion on natural vegetation in Ikpoba-Okha using Landsat satellite imagery. By analyzing multi-temporal remote sensing data, the research examines land cover changes, vegetation decline, and urban growth patterns over time. Image classification techniques, such as Normalized Difference Vegetation Index (NDVI) analysis, are employed to quantify vegetation loss. The findings provide valuable insights into the ecological consequences of urbanization, aiding in sustainable land-use planning and environmental conservation efforts in the region.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Urbanization, the process of population-shift from rural to urban areas, is a global phenomenon that has accelerated dramatically in recent decades (Thanh 2021). The urban growth rate in Nigeria has been reported to be approximately 5.5% per annum, which is notably higher than the overall national population growth rate of about 2.8% (Zadawa 2015; Akindele, 2019).

This rapid urban expansion has profound implications for land use patterns, environmental quality and quality of life. Ikpoba-Okha, a Local Government Area in Edo State, Nigeria, exemplifies this urban transformation. Located in the outskirts of Benin City, Ikpoba-Okha has experienced substantial growth and development in recent years, driven by factors such as improved transportation links, and population migration from surrounding rural areas.

As cities expand, they often do so at the expense of natural ecosystems and green spaces. Green infrastructure, which encompasses all natural, semi-natural, and artificial networks of multifunctional ecological systems within, around, and between urban areas, plays a crucial role in maintaining environmental quality and supporting urban sustainability (Климанова et al., 2018). These green spaces provide numerous ecosystem services, including air purification, temperature regulation, flood mitigation, and biodiversity conservation (Grabowski et al., 2022).

The loss of green infrastructure due to urbanization has significant environmental consequences, one of the most notable being the Urban Heat Island (UHI) effect. (Kleerekoper et al., 2012). UHI refers to the phenomenon where urban areas experience higher temperatures compared to their rural surroundings. This temperature difference is primarily attributed to the replacement of natural surfaces with impervious materials like concrete and asphalt, which absorb and retain heat more effectively. (Peng et al., 2011; Lee et al., 2019; Venter et al., 2021).

Satellite imagery has emerged as a key indicator for studying the changes, effect and, by extension, the impacts of urbanization on local climate and natural vegetation, which can be derived from remote sensing data, provides valuable insights into the characteristics of different land cover types and their changes over time. (Venter et al., 2021). Remote sensing and Geographic Information System (GIS) technologies offer powerful tools for monitoring and analyzing land use changes, green cover loss, and temperature variations across large spatial and temporal scales. Landsat satellite imagery, with its long-term data record and moderate spatial resolution, is particularly well-suited for studying urban growth and its environmental impacts over extended periods (Dou et al., 2014).

In the context of Ikpoba-Okha, understanding the relationship between urbanization, natural vegetation loss, and land surface temperature is important for the following reasons:

**Urban Planning:** Insights from this study can inform sustainable urban development strategies that balance growth with environmental conservation.

**Climate Change Adaptation:** As global temperatures rise, maintaining urban green spaces becomes increasingly important for climate resilience.

**Public Health**: Urban heat islands can have significant health impacts, particularly on vulnerable populations. Understanding these effects can help in developing targeted interventions.

**Ecosystem Conservation:** Quantifying the loss of green infrastructure can highlight the urgency of conservation efforts and guide restoration initiatives.

**Policy Development:** Evidence-based research can support the formulation of policies promoting natural vegetation in urban areas.

This study aims to bridge the gap in understanding the specific impacts of urbanization on natural vegetation in Ikpoba-Okha, using satellite imagery. By analyzing satellite imagery over a 20-year period (2003-2023), the research will provide a comprehensive assessment of land use changes, green cover loss, and temperature variations in the area. The findings will contribute to the growing body of knowledge on urban ecology in rapidly developing regions and offer valuable insights for sustainable urban management in Ikpoba-Okha and similar urban areas in Nigeria.

## 1.2 Statement of the Problem

The rapid urbanization of Ikpoba-Okha Local Government Area in Edo State, Nigeria, presents a critical environmental challenge that demands urgent attention. As the area experiences unprecedented growth, driven by population influx, the consequent transformation of natural landscapes into built-up areas is occurring at a rapid rate. This urban expansion is primarily taking place at the expense of natural vegetation, including forests, wetlands, and other natural ecosystems that play vital roles in maintaining environmental balance. (Aweh, 2023).

The core problem this study addresses is the lack of comprehensive understanding and quantification of the impact of this urban growth on natural vegetation in Ikpoba-Okha, particularly using satellite imagery. This makes it challenging to assess the full extent of environmental degradation and to develop targeted conservation strategies. Furthermore, the relationship between urbanization, green infrastructure loss, and changes in land surface temperature in Ikpoba-Okha has not been thoroughly investigated thereby creating a gap in knowledge which hampers our understanding of the urban heat island effect in the area and its potential consequences for local climate and public health.

The loss of natural vegetation poses several risks to the environment and climate as has been demonstrated in many literatures. However, the potential impacts of green infrastructure loss in Ikpoba-Okha, such as air purification, water regulation, and biodiversity support, have not been adequately assessed. This knowledge gap hinders the development of comprehensive environmental management plans.

The findings in this research will provide a scientific basis for informed decision-making in urban planning and environmental management in Ikpoba-Okha, contributing to more sustainable and resilient urban development in the face of ongoing growth pressures.

## 1.3 Aim and Objectives

The primary aim of this study is to assess the impact of urbanization on green infrastructure in Ikpoba-Okha Local Government Area, Edo State, Nigeria, from 2003to 2023, using satellite imagery.

The specific objectives of the study include the following.

1. To analyze the spatial variation in coordinates/locations variation in land surface using different LULC in Ikpoba-Okha.

II. To map the changes in land use/land cover (LULC) patterns and natural vegetation in Ikpoba-Okha between 2003 and 2023.

III. To examine natural vegetation loss, and their implication.

## 1.4 Scope and Limitations

This study focuses on assessing the impact of urbanization on natural vegetation in Ikpoba-Okha Local Government Area, Edo State, Nigeria, using satellite imagery.

The scope of the research is defined as follows:

The study area is limited to the administrative boundaries of Ikpoba-Okha Local Government Area. While adjacent areas may be considered for context, detailed analysis will be confined to Ikpoba-Okha. The study period spans 20 years, from 20023 to 2023.Analysis will be conducted at 10year intervals: 2003, 2013 and 2023.

Data Sources: Primary data will be derived from Landsat satellite imagery (Landsat 5, 7, and 8). Supplementary data may include local climate records, population statistics, and urban development plans, if available.

Land Use/Land Cover Classes: The study will focus on major LULC classes relevant to urbanization and green infrastructure, including but not limited to: built-up areas, forests, water bodies, agricultural land, and bare soil.

Green Infrastructure: For this study, green infrastructure will encompass natural and semi-natural areas such as forests, parks, wetlands, and urban vegetation.

The Limitations of the research are defined as follows:

Data Resolution: The spatial resolution of Landsat imagery (30m for multispectral bands, 100m for thermal bands) may limit the detection of fine-scale urban features and temperature variations.

Cloud Cover:

The presence of cloud cover in satellite imagery may affect data availability and quality for certain dates, potentially leading to data gaps or the need for image compositing.

Temporal Frequency: The analysis at 5-year intervals may not capture short-term or seasonal variations in land use or temperature patterns.

Ground Truth Data: Limited availability of historical ground truth data may affect the accuracy assessment of LULC classifications, especially for earlier years in the study period.

Socio-economic Factors:

The study primarily focuses on physical changes and does not deeply explore socio-economic drivers of urbanization, which may be crucial for comprehensive urban planning.

Climate Variability:

Natural climate variability and broader climate change trends may influence LST patterns, these limitations should be considered when interpreting the results and applying the findings of this study. Future research could address these limitations to further enhance our understanding of urbanization impacts on green infrastructure in Ikpoba-Okha and similar rapidly developing urban areas.

## 1.5 Justification of study.

This research on the impact of urbanization on natural vegetation re in Ikpoba-Okha, using satellite imagery is justified by a confluence of critical factors that underscore its importance and timelines.

Ikpoba-Okha, like many areas in Nigeria, is experiencing rapid urbanization. Understanding the environmental consequences of this growth is crucial for sustainable development. This study will provide valuable insights into the pace and pattern of urban expansion in the area, shedding light on the loss of natural vegetation due to urbanization. Such losses can have severe environmental consequences, including increased flooding, reduced air quality, and loss of biodiversity.

Quantifying these changes is essential for developing effective environmental management strategies.

In the context of global climate change, urban areas are particularly vulnerable to heat stress, the findings of this study will provide evidence-based insights for urban planners and policymakers in Ikpoba-Okha which is crucial for maintaining the balance between urban development and environmental conservation.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Urbanization

Urbanization is a complex phenomenon characterized by the increasing movement of populations from rural to urban areas, driven by various socio-economic factors. This process has profound implications for both the migrants and the urban environments they enter.

The motivations for rural-to-urban migration often include the pursuit of better employment opportunities, improved living standards, and access to services that are typically more abundant in urban settings. For instance, studies have shown that individuals migrate to urban areas to escape economic hardships prevalent in rural regions, seeking jobs in non-agricultural sectors that promise higher wages and
better living conditions (Afzal et al., 2018; Ray & Dutta, 2019; Biswas et al., 2019).

The relationship between urbanization and economic growth is well-documented. Urban areas tend to offer more diverse job opportunities, which attract individuals from rural backgrounds. This migration is not merely a demographic shift; it also contributes significantly to the economic dynamism of cities. As urban populations grow, cities become centers of economic activity, innovation, and cultural exchange, which can further stimulate migration. For example, urbanization in Bangladesh has been linked to rapid industrialization and economic development,
with migration being a primary driver of urban population growth (Biswas et al., 2019; Shams et al., 2014).

However, urbanization also presents challenges, particularly in developing countries where infrastructure and services may not keep pace with rapid population growth. The influx of migrants can lead to overcrowding, increased demand for housing, and strain on public services such as healthcare and education. In many cases, this results in the emergence of informal

settlements or slums, where living conditions are often substandard (Shams et al., 2014; Yasin et al., 2012). The urbanization process can exacerbate social inequalities, as migrants may find themselves in precarious employment situations and lacking access to essential services (Yasin et al., 2012;
Moses et al., 2017; Nasreen & Manzoor, 2017).

The environmental implications of urbanization are also very significant. As cities expand, they often face increased pollution and resource depletion especially of green infrastructure and natural vegetation. The concentration of populations in urban areas leads to higher emissions of pollutants, which can adversely affect air quality and public health. For instance, research has indicated that urbanization in China has been associated with increased CO2 emissions, driven by the higher consumption patterns of urban populations compared to their rural counterparts (Zhang et al.,
2021; Qin & Liao, 2015). Additionally, the environmental degradation resulting from urbanization can have long-term consequences for both urban and rural areas, as ecosystems are disrupted and natural resources are overexploited (Zhang et al., 2021).

**Natural Vegetation: Concept and Importance**

Natural vegetation refers to plant life that grows and thrives in an area without human intervention. It plays a crucial role in maintaining ecological balance, supporting biodiversity, and providing essential ecosystem services. Defined by environmental scholars as "a naturally occurring network of plant species that sustain local ecosystems and contribute to environmental stability," natural vegetation is vital for enhancing climate resilience, preserving wildlife habitats, and mitigating the impacts of urbanization (Климанова 2018). As urban areas expand, maintaining natural vegetation becomes increasingly important to combat challenges such as climate change, habitat loss, and environmental degradation.

The role of natural vegetation in urban areas extends beyond aesthetics; it is fundamental in addressing key environmental issues such as air purification, stormwater management, and temperature regulation. For example, trees and green spaces can significantly reduce urban heat island effects by providing shade and cooling, thus improving overall urban livability (Vargas-Hernández & Zdunek-Wielgołaska, 2020). Additionally, preserving natural vegetation enhances biodiversity by supporting various plant and animal species, which is crucial for maintaining ecological equilibrium in densely populated areas (Grabowski et al., 2022).

Studies have demonstrated that effective conservation and integration of natural vegetation into urban planning can yield substantial economic, social, and environmental benefits. Economically, preserving vegetation can lower infrastructure costs by reducing the need for extensive stormwater drainage systems and increasing property values through enhanced aesthetics and recreational opportunities (Li et al., 2015). Socially, green spaces promote community cohesion and provide areas for recreation, contributing to improved mental and physical well-being (Li et al., 2015). Environmentally, natural vegetation plays a vital role in carbon sequestration and air quality improvement, helping to mitigate climate change impacts (Sun & Cui, 2018).

## 2.2 Impact of Urbanization on Natural Vegetation

Urbanization has a profound impact on natural vegetation, affecting its availability, quality, and ecological functions. As cities expand and populations grow, natural landscapes are often cleared for infrastructure development, leading to vegetation loss and a decline in ecosystem services. This shift poses significant challenges for biodiversity conservation, climate regulation, and urban sustainability.

One of the primary consequences of urbanization on natural vegetation is habitat fragmentation. As urban areas grow, continuous green spaces become divided into smaller, isolated patches, reducing their effectiveness in supporting wildlife and ecological functions (Li et al., 2015). This fragmentation diminishes key services such as air and water purification, carbon sequestration, and temperature regulation (Vargas-Hernández & Zdunek-Wielgołaska, 2020). In rapidly urbanizing regions, the loss of extensive natural vegetation can intensify the urban heat island effect, leading to higher temperatures and increased energy demands for cooling (Dou et al., 2014).

Furthermore, urbanization places immense pressure on existing vegetation due to rising population densities and increased demands for land, recreation, and climate mitigation (Sun & Cui, 2018). For instance, cities like Dhaka have experienced significant vegetation loss due to rapid urban expansion, disrupting local ecosystems and reducing resilience against climate-related challenges (Biswas et al., 2019). Additionally, the uneven distribution of natural vegetation in urban settings can lead to social inequalities, where marginalized communities may have limited access to green spaces, negatively impacting their quality of life (Климанова et al., 2018).

The relationship between urbanization and natural vegetation is also shaped by socio-economic factors. In many rapidly growing cities, the need for housing and infrastructure often takes precedence over environmental conservation, leading to the widespread destruction of vegetation (Shams et al., 2014). This trend is especially evident in developing countries, where urban migration driven by poverty and economic opportunities often results in unregulated development with little consideration for preserving natural vegetation (Shams et al., 2014). To address these challenges, urban planners and policymakers must prioritize sustainable urban development strategies that integrate natural vegetation conservation to enhance environmental resilience and sustainability (Vargas-Hernández & Zdunek-Wielgołaska, 2020).

## 2.3 Satellite Imagery as a Tool for Assessing Urbanization Impacts

Satellite imagery serves as a powerful tool for assessing the effects of urbanization on natural vegetation, particularly through its ability to monitor land cover changes over time. The expansion of urban areas often results in the loss of vegetation, increased impervious surfaces, and environmental degradation. Remote sensing technologies, such as Landsat and MODIS satellite imagery, allow for the analysis of these changes at various spatial and temporal scales, providing valuable insights into the relationship between urban growth and ecosystem health (Dou et al., 2014).

As urbanization progresses, the transformation of natural landscapes into built environments leads to a decline in vegetation cover. This shift can be effectively analyzed using satellite-derived indices such as the Normalized Difference Vegetation Index (NDVI), which measures vegetation health and density. Research in cities like Qingdao has demonstrated that areas experiencing rapid urbanization show declining NDVI values, correlating with increased built-up surfaces and reduced vegetation (Dou et al., 2014). The loss of natural vegetation not only contributes to environmental challenges such as rising temperatures but also diminishes essential ecosystem services, including air purification, carbon sequestration, and water regulation (Vargas-Hernández & Zdunek-Wielgołaska, 2020).

## 2.4 Urban Heat Island (Uhi) Effect

The Urban Heat Island (UHI) effect is a significant environmental phenomenon in which urban areas experience higher temperatures than their rural surroundings. This temperature disparity is primarily driven by urbanization, which replaces natural vegetation with impervious materials such as concrete and asphalt, altering land surface characteristics and local climate patterns (Dou et al., 2014). The UHI effect has profound implications for urban sustainability, public health, and the preservation of natural vegetation.

As cities expand, the reduction of green spaces intensifies the UHI effect, resulting in warmer urban environments. Satellite imagery provides a crucial means of detecting and analyzing these changes by capturing variations in land cover and surface reflectance. Studies indicate that urbanization and industrialization contribute to temperature increases, with satellite data revealing higher temperatures in densely built-up areas compared to surrounding vegetated regions (Dou et al., 2014). In rapidly developing cities such as Qingdao, satellite-derived analyses have shown strong correlations between declining vegetation cover and rising urban temperatures. This warming effect increases energy demand for cooling, exacerbates heat stress, and places additional strain on urban infrastructure.

The UHI effect also influences the health and sustainability of natural vegetation. Elevated temperatures can hinder plant growth and reduce vegetation resilience, limiting the ability of urban green spaces to provide key ecosystem services such as cooling through evapotranspiration, air purification, and stormwater management (Vargas-Hernández & Zdunek-Wielgołaska, 2020). While vegetation plays a crucial role in mitigating urban heat through shading and moisture release, urban expansion often leads to the loss of these benefits, reinforcing the cycle of warming and environmental degradation.

Additionally, the UHI effect can exacerbate social inequities, as lower-income communities often have less access to green spaces and are disproportionately affected by heat-related health risks (Grabowski et al., 2022). Satellite imagery has been instrumental in mapping these disparities, highlighting areas with insufficient vegetation and guiding urban planners toward more equitable distribution of green spaces (Qin & Liao, 2015).

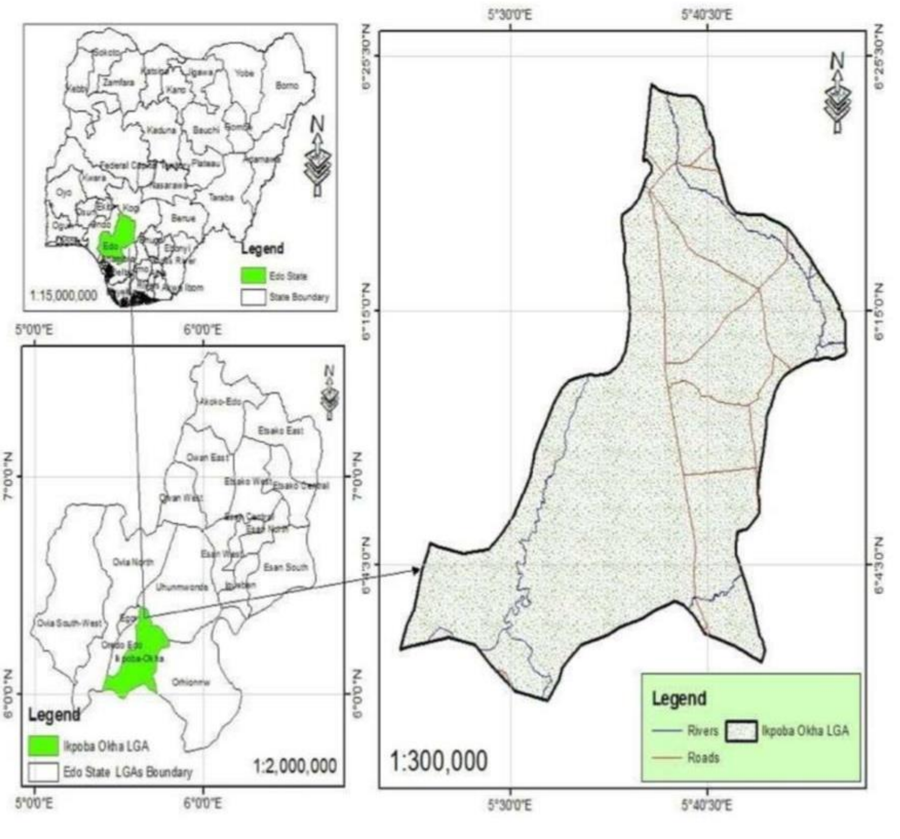
To combat the UHI effect and promote urban sustainability, cities must integrate natural vegetation into their development strategies. Remote sensing technologies enable the identification of critical areas for intervention, supporting the creation of urban forests, green roofs, and parks that enhance climate resilience (Климанова et al., 2018). By leveraging satellite imagery to monitor and manage vegetation changes, urban planners can develop strategies to mitigate the environmental impacts of urbanization, ultimately leading to healthier and more sustainable cities.

## CHAPTER THREE

## METHODOLOGY

### 3.1 Description of the Study Area

Ikpoba-Okha Local Government Area (LGA) is one of the 18 LGAs in Edo State, situated in the southern part of Nigeria. The LGA has its administrative headquarters in Idogbo and is geographically positioned approximately between latitudes 6° 0' N to 6° 25' N of the Equator and longitudes 5° 25' E to 5° 45' E of Greenwich Meridian. Ikpoba-Okha LGA shares boundaries with Oredo LGA to the west, Egor LGA to the northwest, Uhunmwonde LGA to the north, and Orhionmwon LGA to the east and southeast.




The land area of Ikpoba-Okha LGA spans 862 square kilometers and it is considered one of the larger LGAs in Edo State. As of the 2006 census, its population was reported to be 371,106, though current figures would likely be higher due to population growth since then. The climate in this region is classified as tropical savanna (Aw in the Köppen climate classification), characterized by a distinct wet season and dry season. Based on available climate data, temperatures in Ikpoba-Okha typically range from lows of about 23°C to highs of about 32°C throughout the year. The rainfall pattern is bi-modal, with peaks typically occurring in June and September. Annual rainfall is estimated to be around 2000-2500 mm. Geologically, Ikpoba-Okha LGA is situated within the sedimentary basin of southern Nigeria, primarily underlain by the Benin Formation, which consists of continental sands and sandstones with minor clay intercalations. This geological setting influences the area's geomorphology and hydrological characteristics.

The topography of Ikpoba-Okha is generally characterized by a gently undulating lowland terrain. The Digital Elevation Model (DEM) would likely reveal that most of the area lies between 20 to 120 meters above mean sea level (AMSL). The landscape is influenced by the Ikpoba River and its tributaries, which have created alluvial plains and contribute to the area's drainage pattern. The natural vegetation of Ikpoba-Okha falls within the tropical rainforest belt. However, much of the original vegetation has been altered due to urbanization, agricultural activities, and human settlement. The current vegetation is a mix of secondary forest, derived savanna, and urban green spaces.

The soil in Ikpoba-Okha is predominantly sandy to sandy-loam. These soils support various agricultural activities.

### 3.2 Data Collection

The Data collected for analysis would be of two types. Remote Sensing Data and Supplementary Data.

## 3.3 Remote Sensing Data

This study will primarily utilize Landsat satellite imagery for the analysis of land use/land cover changes and land surface temperature variations. Specifically, we will use data from Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS).

The rationale for choosing Landsat imagery includes:

1. Long-term data record: Landsat provides a consistent record of Earth observation data spanning over four decades, allowing for long-term change analysis.
2. Suitable spatial resolution: The 30m resolution for multispectral bands and 100m (resampled to 30m) for thermal bands is appropriate for urban-scale studies.
3. Spectral characteristics: Landsat sensors provide spectral bands suitable for both land use/land cover classification and land surface temperature derivation.
4. Free availability: Landsat data is freely available, making it cost-effective for research purposes. The temporal coverage of the study will span from 2003to 2023, with data collected at 5-year intervals: 2003, 2013 and 2023. This timeframe allows for a comprehensive analysis of urban growth and environmental changes over two decades.

Data acquisition will involve downloading pre-processed Landsat images from the United States Geological Survey (USGS) Earth Explorer platform. We will prioritize scenes with minimal cloud cover (<10%) and those captured during the dry season to ensure consistency in vegetation phenology and reduce atmospheric interference.

## 3.4 Supplementary Data

To complement the remote sensing analysis, we will collect the following supplementary data:

Local climate records: Temperature and precipitation data from nearby weather stations will be obtained from the Nigerian Meteorological Agency (NiMet) to validate and contextualize the land surface temperature trends derived from satellite data. This supplementary data will aid in interpreting the remote sensing results within the broader context of urban development and environmental change in Ikpoba-Okha.

## 3.5 Data Processing and Analysis

### 3.5.1 Pre-Processing of Satellite Imagery

To ensure the accuracy and reliability of our analysis, the following pre-processing steps will be applied to the Landsat imagery:

1. Geometric Correction: Although Landsat data is typically provided with good geometric accuracy, we will verify and, if necessary, refine the geometric correction using ground control points derived from high-resolution imagery or topographic maps of the study area.
2. Atmospheric Correction: The Dark Object Subtraction (DOS) method will be applied to remove atmospheric effects and convert top-of-atmosphere reflectance to surface reflectance. This step is crucial for accurate land use/land cover classification and multi-temporal analysis.
3. Radiometric Calibration: Digital numbers (DN) will be converted to top-of-atmosphere radiance and then to surface reflectance using the calibration coefficients provided in the Landsat metadata.

## 3.6 Land Use/Land Cover (Lulc) Classification

For LULC classification, we will employ a supervised classification approach using the Random Forest algorithm. This choice is based on its robustness, ability to handle high-dimensional data, and effectiveness in land cover classification tasks.

The major LULC classes to be considered are:

1. Built-up areas
2. Forests
3. Water bodies
4. Agricultural land

5. Bare soil

The classification process will involve:

1. Training Data Collection: Representative training samples for each LULC class will be collected using high-resolution imagery (e.g., Google Earth) and existing land use maps as reference.

2. Feature Selection: In addition to spectral bands, we will calculate vegetation indices (e.g., NDVI, EVI) and textural features to improve classification accuracy.

3. Classification: The Random Forest classifier will be trained using the collected samples and applied to the entire image.

4. Accuracy Assessment: A confusion matrix will be generated using an independent set of validation points. Overall accuracy, user's and producer's accuracies, and the Kappa coefficient will be calculated to assess classification performance.

### 3.7 Land Surface Temperature (LST) Retrieval

LST will be derived from the thermal bands of Landsat imagery using the following steps:

1. Conversion of DN to at-sensor radiance

2. Conversion of at-sensor radiance to at-sensor brightness temperature

3. Estimation of land surface emissivity using the NDVI Thresholds Method

4. Calculation of LST using the mono-window algorithm

The specific equations and parameters for these steps will be adapted based on the Landsat sensor (TM, ETM+, or TIRS) used for each time period.

### 3.8 Green Infrastructure (Gi) Mapping

For this study, green infrastructure will be defined as natural and semi-natural areas including forests, parks, wetlands, and urban vegetation. GI will be extracted from the LULC classification by combining the relevant classes (primarily forests and vegetated areas within the urban matrix).

Additionally, the Normalized Difference Vegetation Index (NDVI) will be used to identify and map urban vegetation that may not be captured in the broader LULC classification.

**Spatial Analysis**

Spatial analysis will be conducted using a combination of ArcGIS and QGIS software. The following analyses will be performed:

1. Change Detection: Post-classification comparison will be used to quantify and map changes in LULC and GI between 2002 and 2022. This will involve overlaying the classified maps from different years and computing the area of change for each LULC transition.
2. Correlation Analysis: Pearson's correlation coefficient will be calculated to investigate the relationship between urbanization (increase in built-up area), GI loss, and LST changes. This analysis will be performed at both the pixel and zonal (e.g., ward or district) levels.
3. Urban Heat Island (UHI) Analysis: UHI intensity will be calculated as the difference between LST in urban areas and surrounding rural areas. Hot spots and cool spots will be identified using spatial statistics tools (e.g., Getis-Ord Gi*).
4. Spatial Metrics: Landscape metrics such as patch density, edge density, and Shannon's diversity index will be calculated to quantify the spatial patterns of urbanization and GI fragmentation.

## CHAPTER FOUR

## RESULTS AND DISCUSSION

### 4.1 Land Use Land Cover Analysis of study area for 2003.

Figure 4.1a: Shows LULC for 2003 with color code **Purple** for settlement or built up areas, **Yellow** for bare land or developing areas, **Light Blue** for stream, river or other water bodies, **Light Green** for Vegetation, **Dark Green** for Crop land or Cultivated land, **Blue** for Swampy area or wetted vegetation.

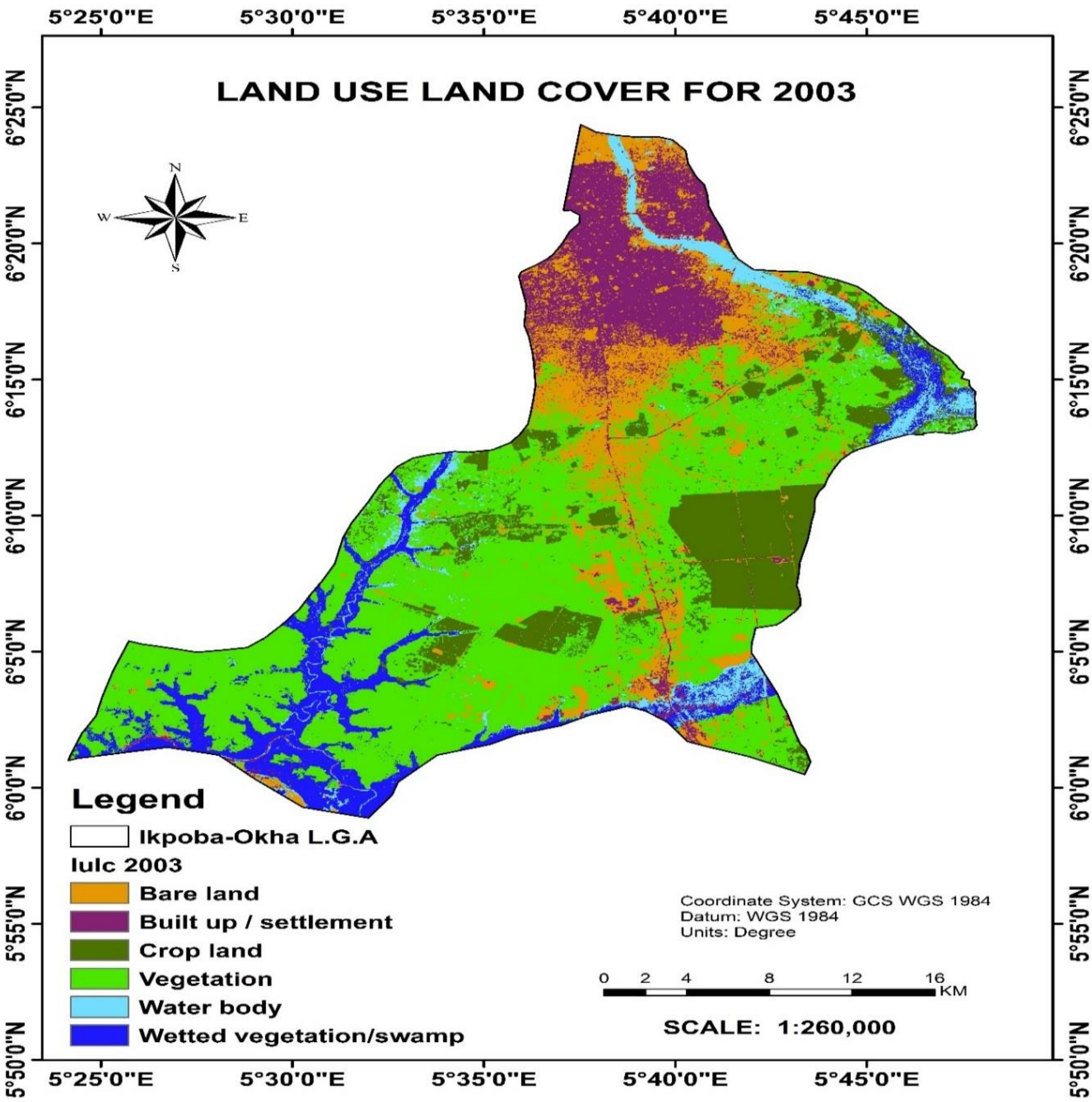



**Figure 4.1a: LULC Map of Study Area for Year 2003.**

**Figure 4.1b**: Shows LULC calculated Area for 2003 with settlement or built up areas having an estimated area of **98.416** (Sq.Km), Bare land or developing areas with an Area of **123.297** (Sq.Km), Stream, river or other water bodies with an area of **41.738** (Sq.Km), Vegetation with an area of **390.378** (Sq.Km), Crop land or Cultivated land with an area of **108.075** (Sq.Km), Swampy area or wetted vegetation with an area of **77.439** (Sq.Km).

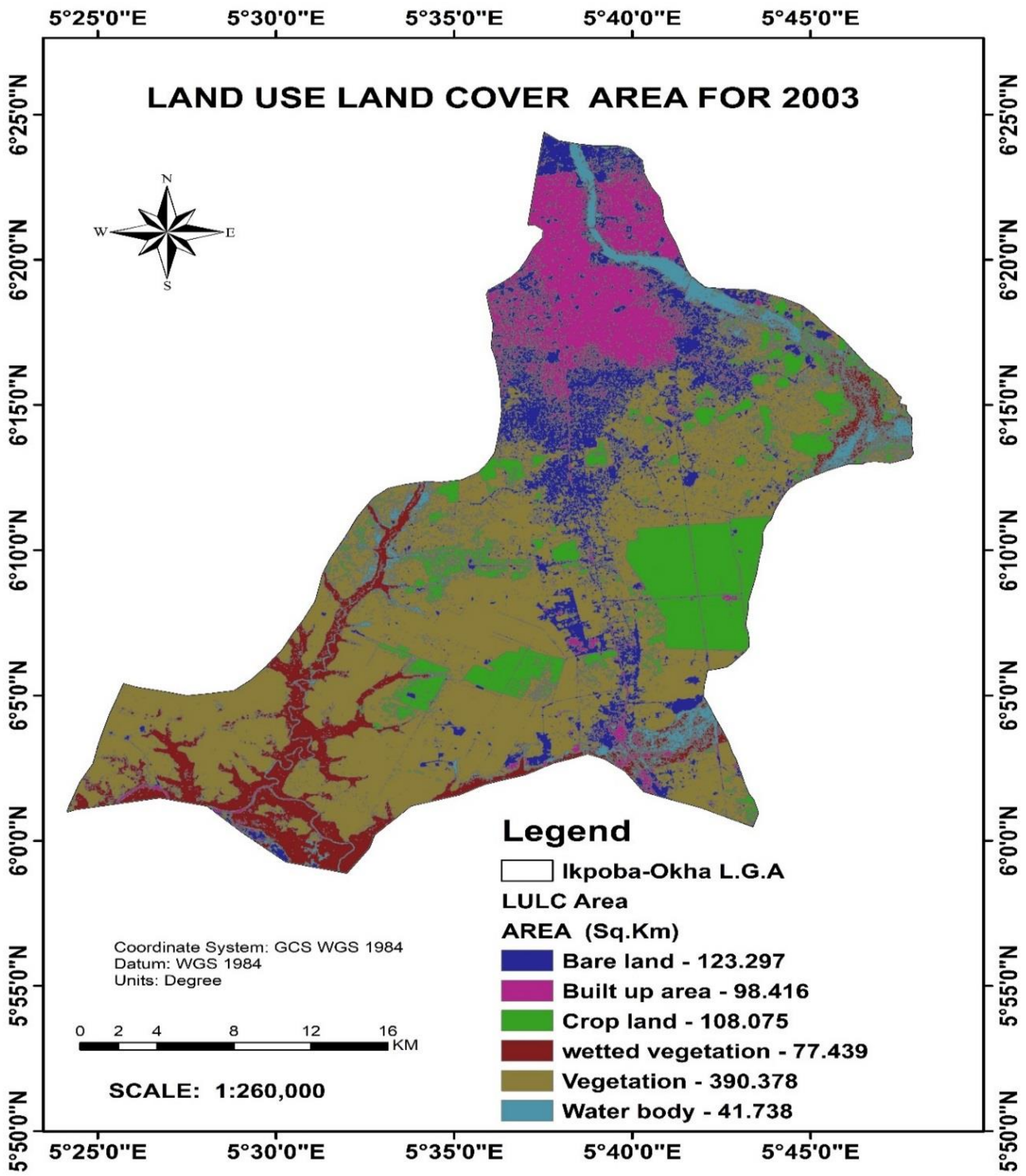



**Figure 4.1b: LULC Estimated Area Map of Study Area for Year 2003.**

## 4.2 Land Use Land Cover Analysis of study area for 2013.

Figure 4.2a: Shows LULC for 2013 with color code **Red** for settlement or built up areas, **Yellow** for bare land or developing areas, **Light Blue** for stream, river or other water bodies, **Light Green** for Vegetation, **Purple** for Crop land or Cultivated land, **Green** for Swampy area or wetted vegetation.

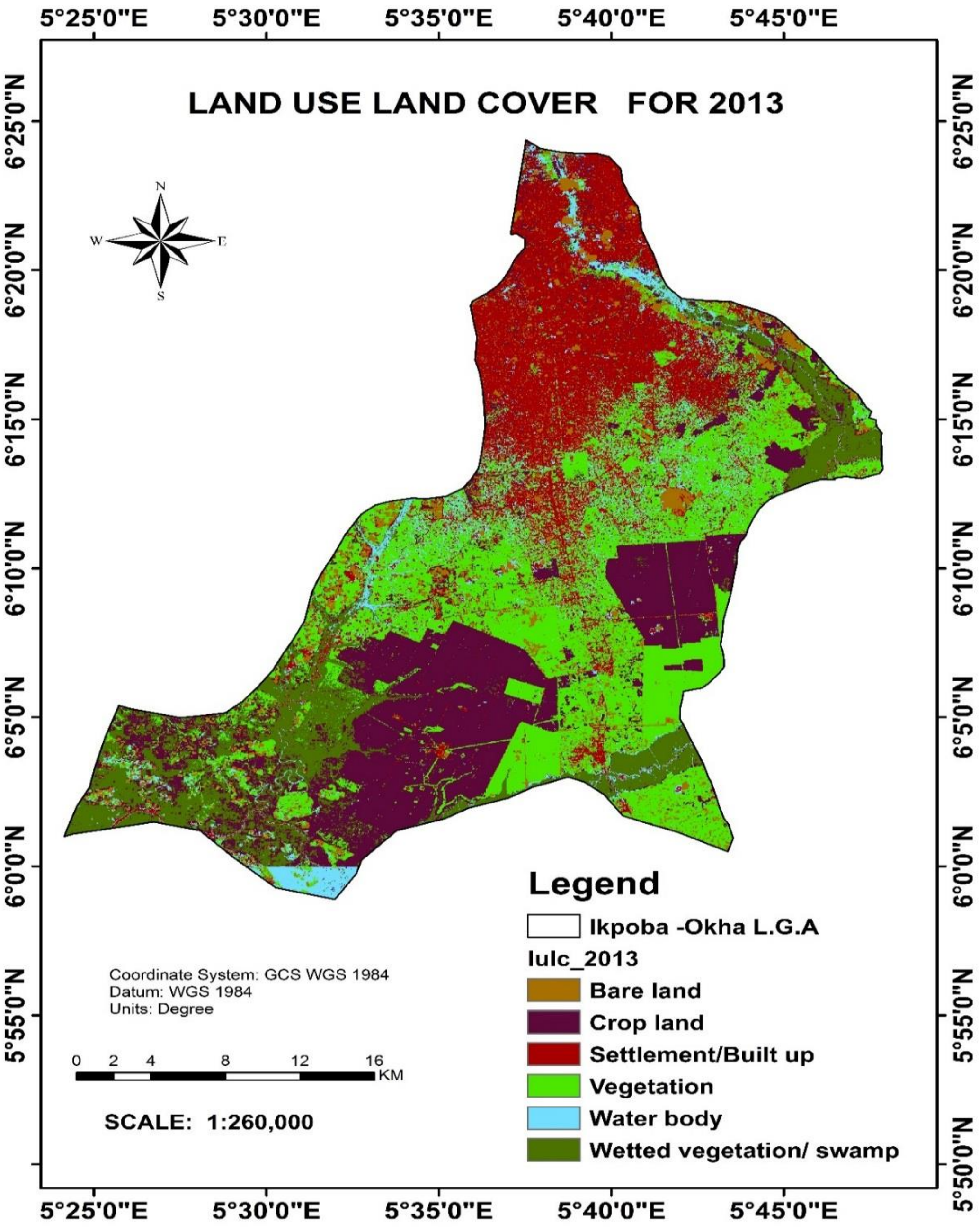



**Figure 4.2a: LULC Map of Study Area for Year 2013.**

**Figure 4.2b**: Shows LULC calculated Area for 2013 with Settlement or built up areas having an estimated area of **168.577** (Sq.Km), Bare land or developing areas with an Area of **59.981** (Sq.Km), Stream, river or other water bodies with an area of **52.758** (Sq.Km), Vegetation with an area of **241.943** (Sq.Km), Crop land or Cultivated land with an area of **211.202** (Sq.Km), Swampy area or wetted vegetation with an area of **104.878** (Sq.Km).

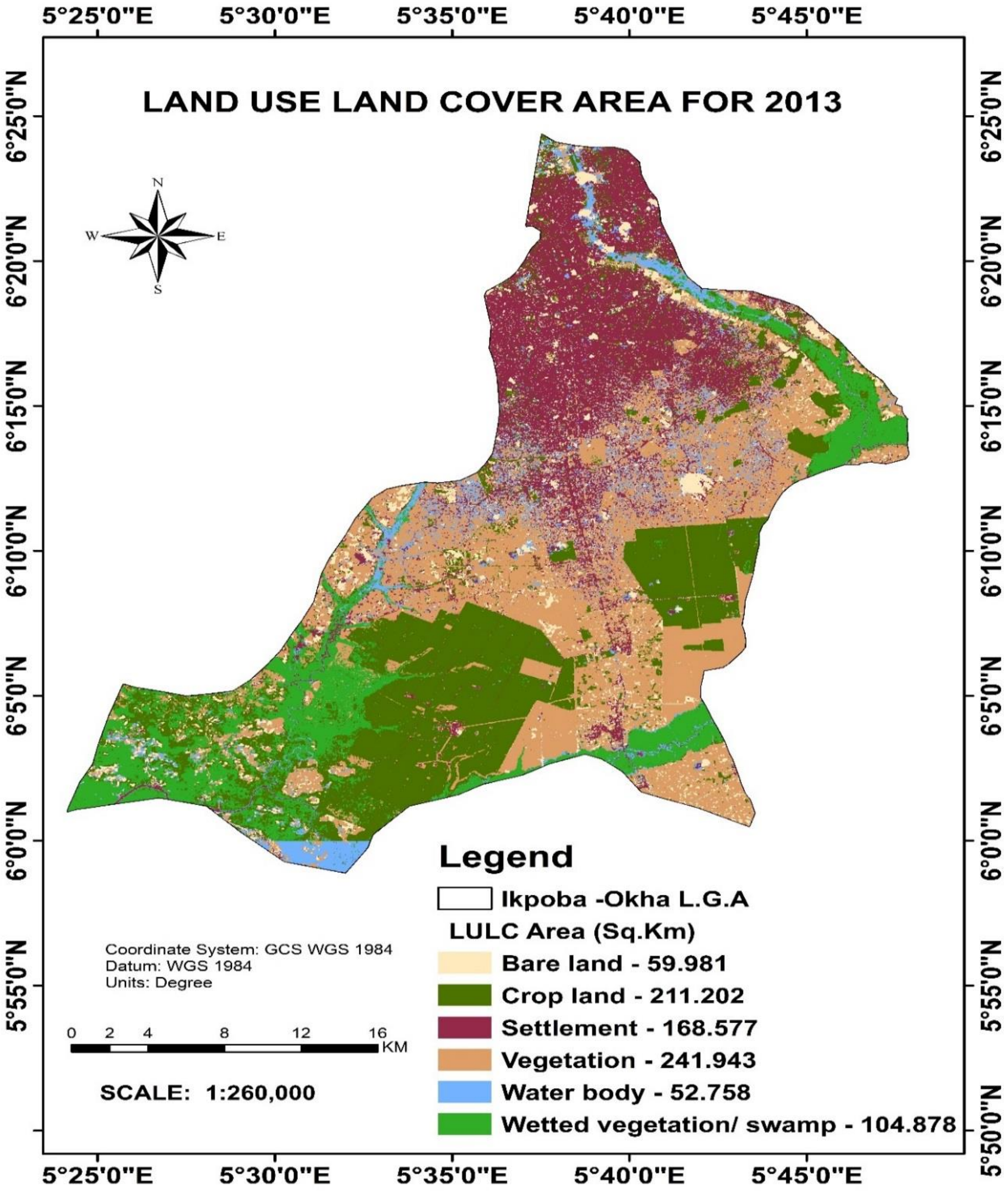



**Figure 4.2b: LULC Estimated Area Map of Study Area for Year 2013.**

### 4.3 Land Use Land Cover Analysis of study area for 2023.

Figure 4.3a: Shows LULC for 2023 with color code **Red** for settlement or built up areas, **Yellow** for bare land or developing areas, **Light Blue** for stream, river or other water bodies, **Light Green** for Vegetation, **Purple** for Crop land or Cultivated land, **Deep Green** for Swampy area or wetted vegetation.

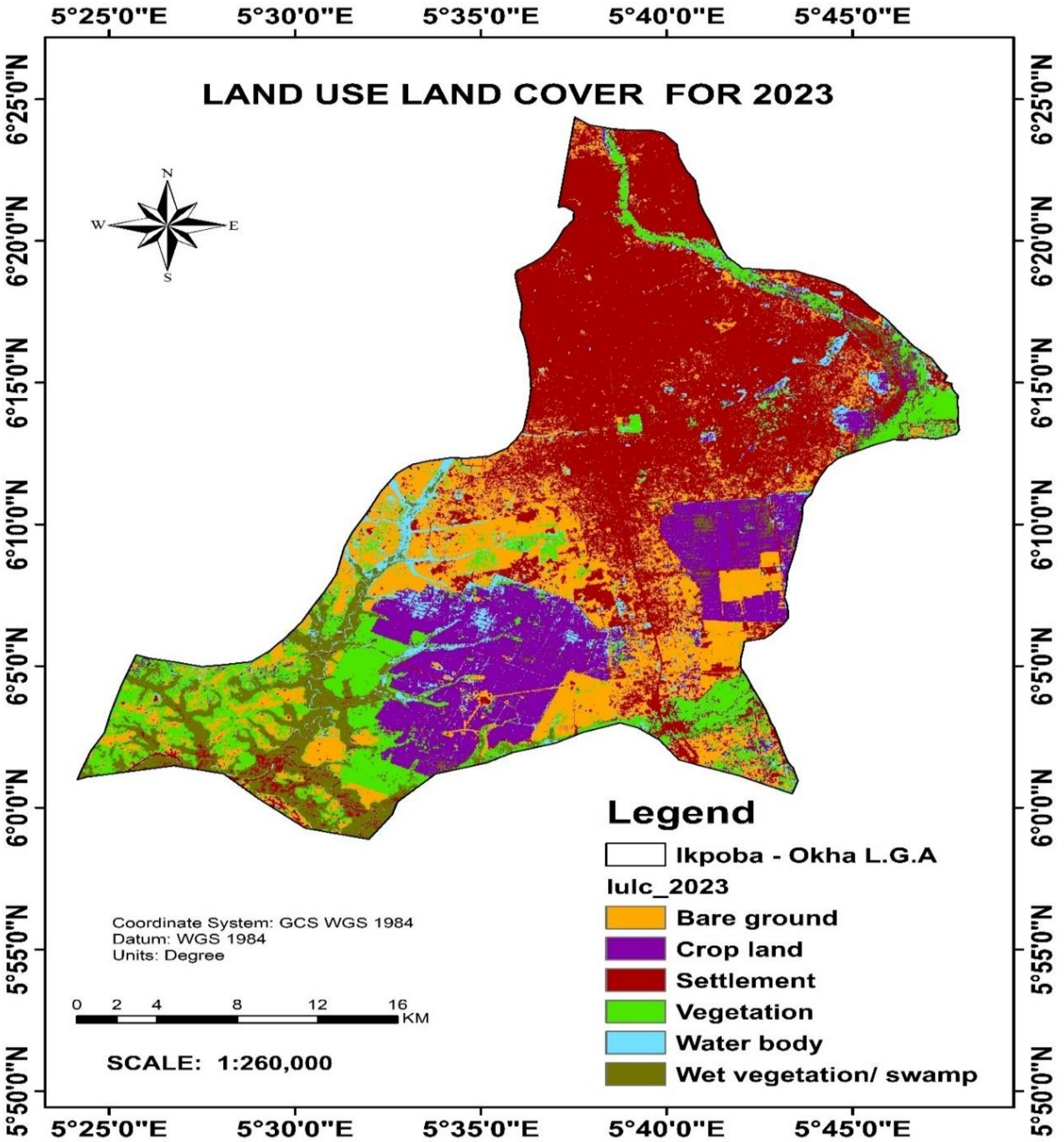



**Figure 4.2a: LULC Map of Study Area for Year 2023.**

**Figure 4.3b**: Shows LULC calculated Area for 2023 with Settlement or built up areas having an estimated area of **334.919** (Sq.Km), Bare land or developing areas with an Area of **164.723** (Sq.Km), Stream, river or other water bodies with an area of **39.758** (Sq.Km), Vegetation with an area of **109.404** (Sq.Km), Crop land or Cultivated land with an area of **126.916** (Sq.Km), Swampy area or wetted vegetation with an area of **63.610** (Sq.Km).

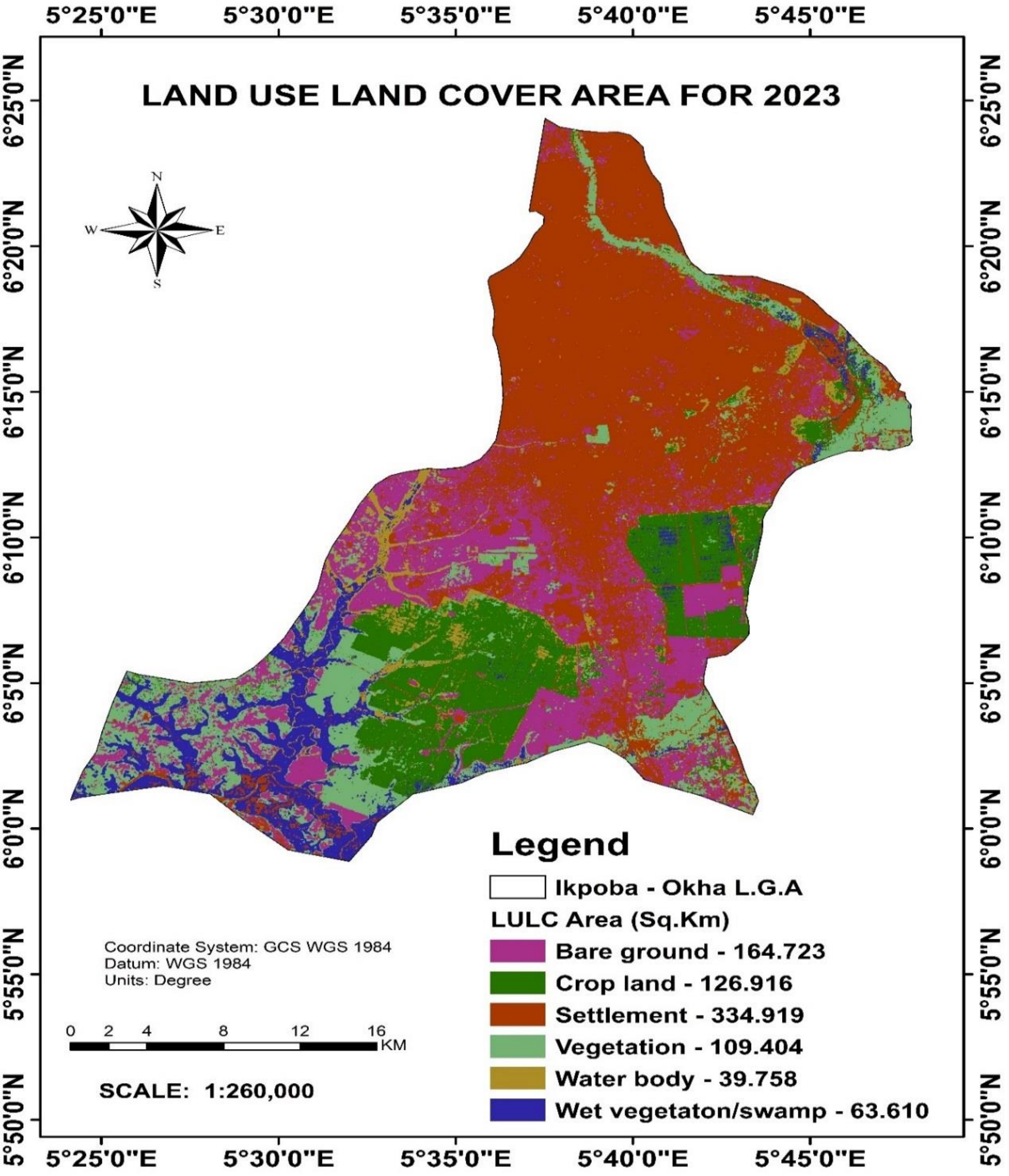



**Figure 4.3b: LULC Estimated Area Map of Study Area for Year 2023.**

**Table 4.1:** Shows the percentage of calculated area of Land Use Land Cover for year 2003, With Bare land covering 15%, Built up area covering 12%, Crop land covering 13%, Swampy area or wetted Vegetation Covering 9%, Vegetation Covering 47%, water body 5%.

TABLE SHOWING TOTAL PERCENTAGE OF LAND USE LAND COVER FOR 2003

| Row Labels | Sum of area | Row Labels | Sum of area | % |
|---|---|---|---|---|
| bare land | 123.2973468 | bare land | 123.2973468 | 15% |
| built up area | 98.41643758 | built up area | 98.41643758 | 12% |
| crop land | 108.0752098 | crop land | 108.0752098 | 13% |
| swampy area/ wetted vegetation | 77.43884813 | swampy area/ wetted vegetation | 77.43884813 | 9% |
| vegetation | 390.3775509 | vegetation | 390.3775509 | 47% |
| water body | 41.73758103 | water body | 41.73758103 | 5% |
| **Grand Total** | **839.3429743** | **Grand Total** | **839.3429743** | 100% |

**Table 4.1: Percentage Area of LULC for 2003.**

**Table 4.2:** Shows the percentage of calculated area of Land Use Land Cover for year 2013, With Bare land covering 7%, Built up area covering 20%, Crop land covering 25%, Swampy area or wetted Vegetation Covering 12%, Vegetation Covering 29%, water body 6%.

TABLE SHOWING TOTAL PERCENTAGE OF LAND USE LAND COVER FOR 2013

| Row Labels | Sum of erea | Row Labels | Sum of erea | % |
|---|---|---|---|---|
| bare land | 59.98110736 | bare land | 59.98110736 | 7% |
| crop land | 211.2017579 | crop land | 211.2017579 | 25% |
| settlement | 168.5774031 | settlement | 168.5774031 | 20% |
| vegetation | 241.942677 | vegetation | 241.942677 | 29% |
| water body | 52.75839261 | water body | 52.75839261 | 6% |
| wetted vegetation/ swamp | 104.8779165 | wetted vegetation/ swamp | 104.8779165 | 12% |
| **Grand Total** | **839.3392544** | **Grand Total** | **839.3392544** | 100% |

**Table 4.2: Percentage Area of LULC for 2013.**

**Table 4.3:** Shows the percentage of calculated area of Land Use Land Cover for year 2023, With Bare land covering 20%, Built up area covering 40%, Crop land covering 15%, Swampy area or wetted Vegetation Covering 8%, Vegetation Covering 13%, water body 5%.

TABLE SHOWING TOTAL PERCENTAGE OF LAND USE LAND COVER FOR 2023

| Row Labels | Sum of area |
|---|---|
| bare ground | 164.723112 |
| crop land | 126.9161031 |
| settlement | 334.919009 |
| vegetation | 109.4045052 |
| water body | 39.75800047 |
| wet vegetaton/swamp | 63.60966235 |
| **Grand Total** | **839.330392** |

| Row Labels | Sum of area | % |
|---|---|---|
| bare ground | 164.723112 | 20% |
| crop land | 126.9161031 | 15% |
| settlement | 334.919009 | 40% |
| vegetation | 109.4045052 | 13% |
| water body | 39.75800047 | 5% |
| wet vegetaton/swamp | 63.60966235 | 8% |
| **Grand Total** | **839.330392** | 100% |

**Table 4.3: Percentage Area of LULC for 2023.**

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION.

## 5.1 Summary

The study aimed to investigate the impact of natural vegetation on urbanization in Ikpoba-Okha L.G.A Using Satelite Imagery between 2003 and 2023. The objectives were to analyse the spatial variation in land surface using different LULC spatial coordinate in IKpoba-Okha, map the changes in land use land cover (LULC) patterns and natural vegetation in Ikpoba-Okha between 2003 and 2023, examine natural vegetation loss and their implication.

To achieve these objectives, Landsat imagery was downloaded from USGS (United State Geological Survey), Imported into ArcGIS, the imageries were analysed and LULC for 2003, 2013 and 2023 was produced. Supervised Classification was carried out on the extracted study area shape file for Landsat imagery and the accurate results were produced. The result produced which is a raster was then converted to polygon for the area to be calculated.

From the supervised classification for 2003, we have Bare land covering 15%, Built up area covering 12%, Crop land covering 13%, Swampy area or wetted Vegetation Covering 9%, Vegetation Covering 47%, water body 5%.

From the supervised classification for 2003, we have Bare land covering 7%, Built up area covering 20%, Crop land covering 25%, Swampy area or wetted Vegetation Covering 12%, Vegetation Covering 29%, water body 6%.

From the supervised classification for 2003, we have Bare land covering 20%, Built up area covering 40%, Crop land covering 15%, Swampy area or wetted Vegetation Covering 8%, Vegetation Covering 13%, water body 5%.

Therefore, Urbanization in Ikpoba-Okha has significantly impacted vegetation cover, as revealed by Land Use and Land Cover (LULC) imagery analysis. Over the years, increasing built-up areas have led to the depletion of green spaces, reducing forested and agricultural lands. The conversion of vegetation into residential, commercial, and industrial zones has altered the natural landscape, contributing to biodiversity loss and environmental degradation as seen from the maps Vegetation reduced from the maps above, **Vegetation reduced from 390 Sq.Km from 2003 to 109 Sq.km in 2023.**

LULC imagery highlights a steady decline in vegetation as urban sprawl expands. The encroachment of settlements and infrastructure development has fragmented ecosystems, affecting soil quality, local climate, and water resources. This rapid land transformation underscores the need for sustainable urban planning strategies to balance development with ecological conservation.

The LULC imagery analysis further reveals that areas previously covered by dense vegetation have been progressively replaced by bare land and built-up settlements. This shift not only reduces carbon sequestration capacity but also contributes to rising temperatures due to the urban heat island effect. The loss of green cover impacts air quality and increases surface runoff, leading to a higher risk of flooding, particularly during heavy rainfall.

Additionally, the expansion of roads, industries, and residential areas has led to habitat fragmentation, threatening local flora and fauna. The reduction in tree cover affects agricultural productivity, as soil erosion and nutrient depletion become more pronounced. Water bodies, which play a crucial role in maintaining ecological balance, also face degradation due to increased sedimentation and pollution from urban activities.

## 5.2 Conclusion

The analysis of Land Use and Land Cover (LULC) imagery in Ikpoba-Okha reveals a significant decline in vegetation cover due to rapid urbanization. The continuous expansion of built-up areas has led to the loss of natural green spaces, negatively impacting biodiversity, air quality, and local climate conditions. Increased land conversion has also contributed to soil erosion, flooding, and habitat destruction. If this trend continues unchecked, the long-term environmental consequences could be severe, affecting both ecological sustainability and the well-being of the local population.

Urbanization is inevitable, but its negative impact on vegetation in Ikpoba-Okha can be mitigated through proactive planning and environmental stewardship. By integrating green infrastructure, enforcing land-use policies, and leveraging modern technology for environmental monitoring, the region can achieve balanced urban growth while preserving its natural ecosystem. A collective effort from stakeholders—including the government, private sector, and local communities—is essential to ensuring a sustainable and resilient future for Ikpoba-Okha.

Protecting vegetation today is an investment in a healthier and more sustainable tomorrow.

## 5.3 Recommendation

To mitigate the negative impact of urbanization on vegetation in Ikpoba-Okha, the following measures are recommended:

1. **Implementation of Green Infrastructure:** Incorporating urban parks, tree-planting initiatives, and green belts into city planning can help restore lost vegetation and improve environmental conditions.

2. **Sustainable Land-Use Planning:** Authorities should enforce zoning regulations that balance development with conservation, preventing uncontrolled land conversion.
3. **Afforestation and Reforestation Programs:** Large-scale tree-planting efforts should be encouraged to replace lost vegetation and enhance carbon sequestration.
4. **Environmental Impact Assessments (EIA):** Prior to any development project, comprehensive environmental assessments should be conducted to ensure that urban expansion does not lead to further ecological degradation.
5. **Community Awareness and Participation:** Educating residents about the importance of vegetation and involving them in conservation activities can foster a culture of environmental responsibility.
6. **Use of Remote Sensing for Monitoring:** Continuous monitoring of land cover changes using LULC imagery and GIS technology will help policymakers track urban expansion and implement timely interventions.
7. **Flood Control Measures:** Since vegetation loss contributes to increased surface runoff and flooding, strategies such as wetland conservation and improved drainage systems should be adopted.
8. Furthermore, leveraging modern technology such as Geographic Information Systems (GIS) and Artificial Intelligence (AI) for land-use monitoring can enhance decision-making. Regular assessments using remote sensing can help detect early signs of environmental degradation, allowing timely interventions.
9. **Economic incentives** such as tax benefits for property owners who maintain green spaces or adopt eco-friendly building designs can encourage sustainable urban development. In addition, investment in renewable energy and waste management programs can reduce environmental pollution, which often accompanies rapid urban expansion.

## Long-Term Benefits of Sustainable Urban Planning

By adopting and enforcing sustainable urban planning strategies, Ikpoba-Okha can experience several long-term benefits, including:

1. **Improved Air and Water Quality:** Increased vegetation helps filter air pollutants and protect water bodies from contamination.
2. **Reduced Urban Heat Island Effect:** More green spaces will help regulate temperature extremes, creating a healthier urban environment.
3. **Enhanced Biodiversity:** Protecting and restoring vegetation will support local wildlife and preserve natural habitats.
4. **Lower Risk of Flooding and Soil Erosion:** Trees and vegetation stabilize the soil, reducing surface runoff and mitigating flood risks.
5. **Better Livelihoods and Economic Growth:** Sustainable urban development attracts investment, improves tourism, and enhances the overall quality of life for residents.

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# APPENDIXES\


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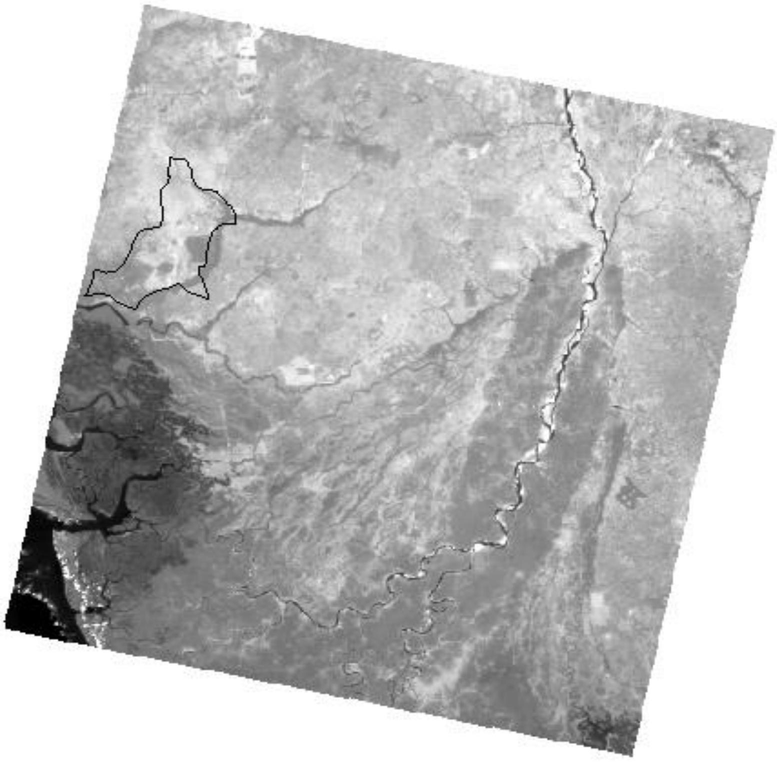

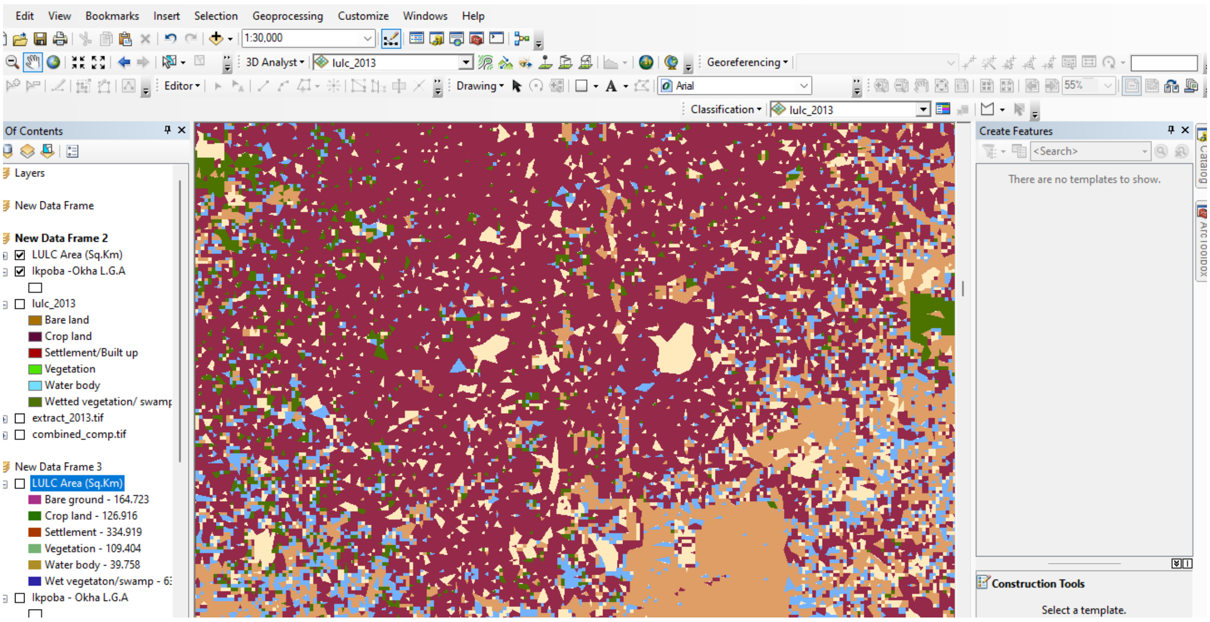
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Editor
Drawing
Arial
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Layers
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New Data Frame 2
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Ikpoba -Okha L.G.A
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Bare land
Crop land
Settlement/Built up
Vegetation
Water body
Wetted vegetation/ swamp
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New Data Frame 3
LULC Area (Sq.Km)
Bare ground - 164.723
Crop land - 126.916
Settlement - 334.919
Vegetation - 109.404
Water body - 39.758
Wet vegetaton/swamp
Ikpoba - Okha L.G.A
Create Features
<Search>
There are no templates to show.
Construction Tools
Select a template.

## TABLE SHOWING TOTAL PERCENTAGE OF LAND USE LAND COVER FOR 2023

| Row Labels | Sum of area |
|---|---|
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| settlement | 334.919009 |
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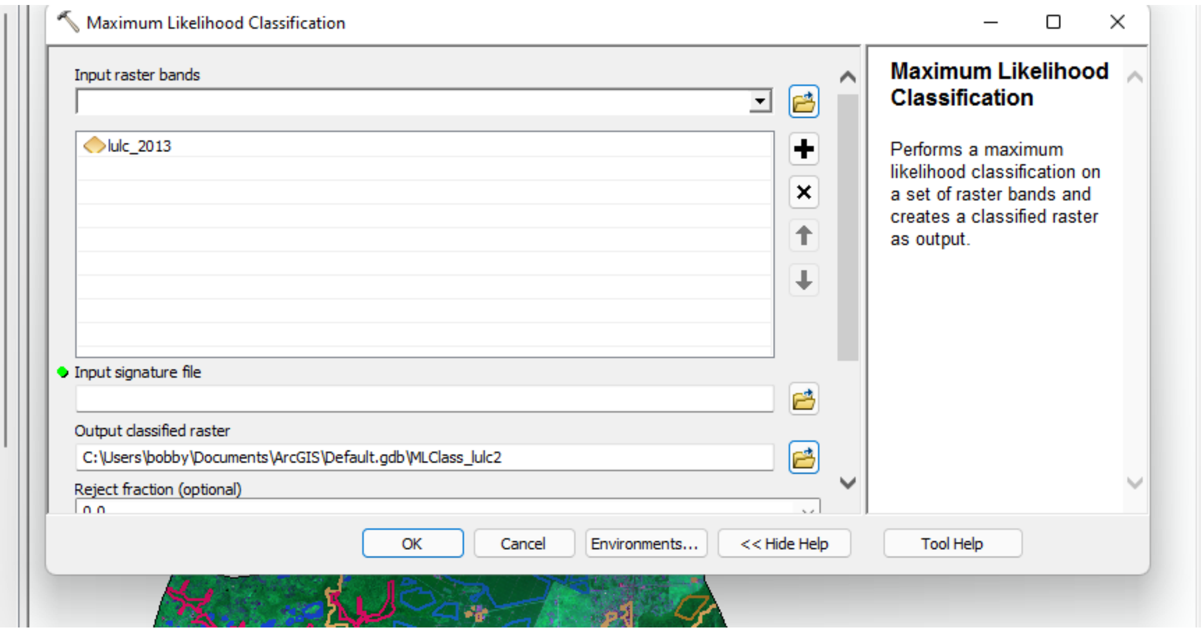

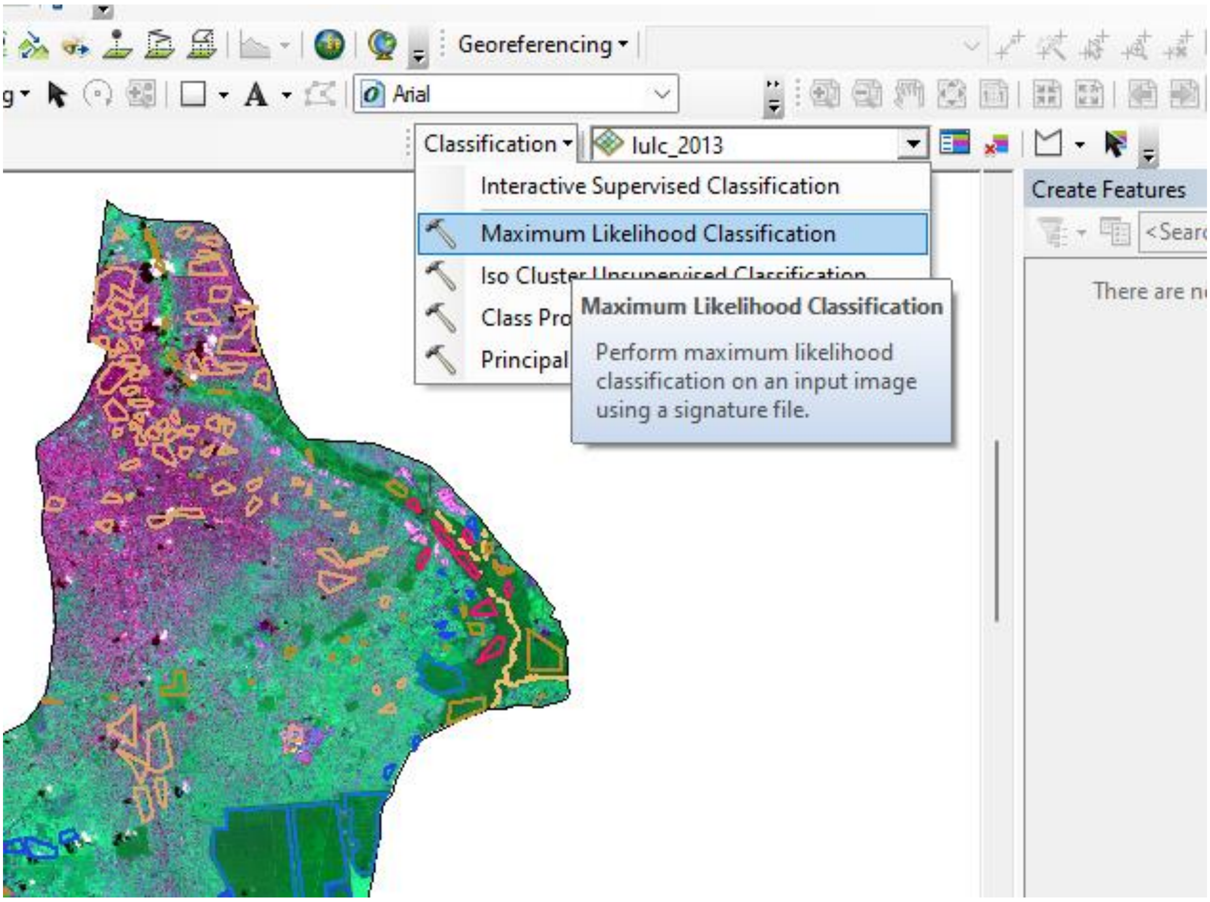
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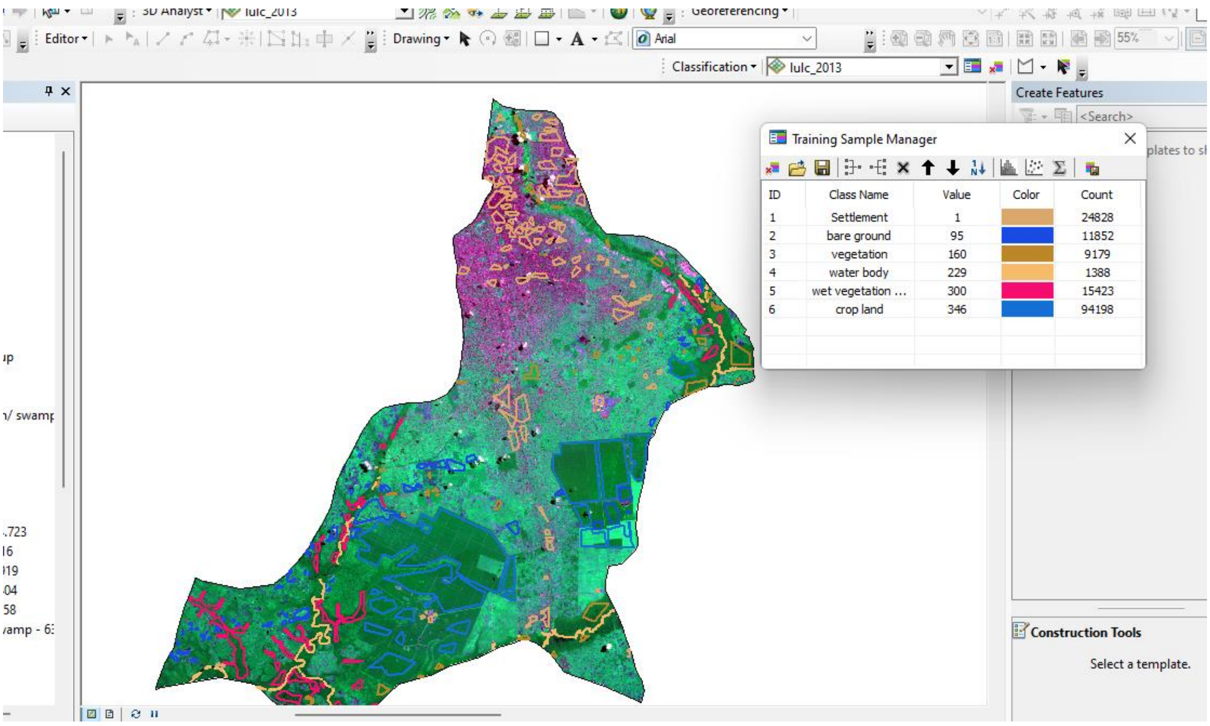
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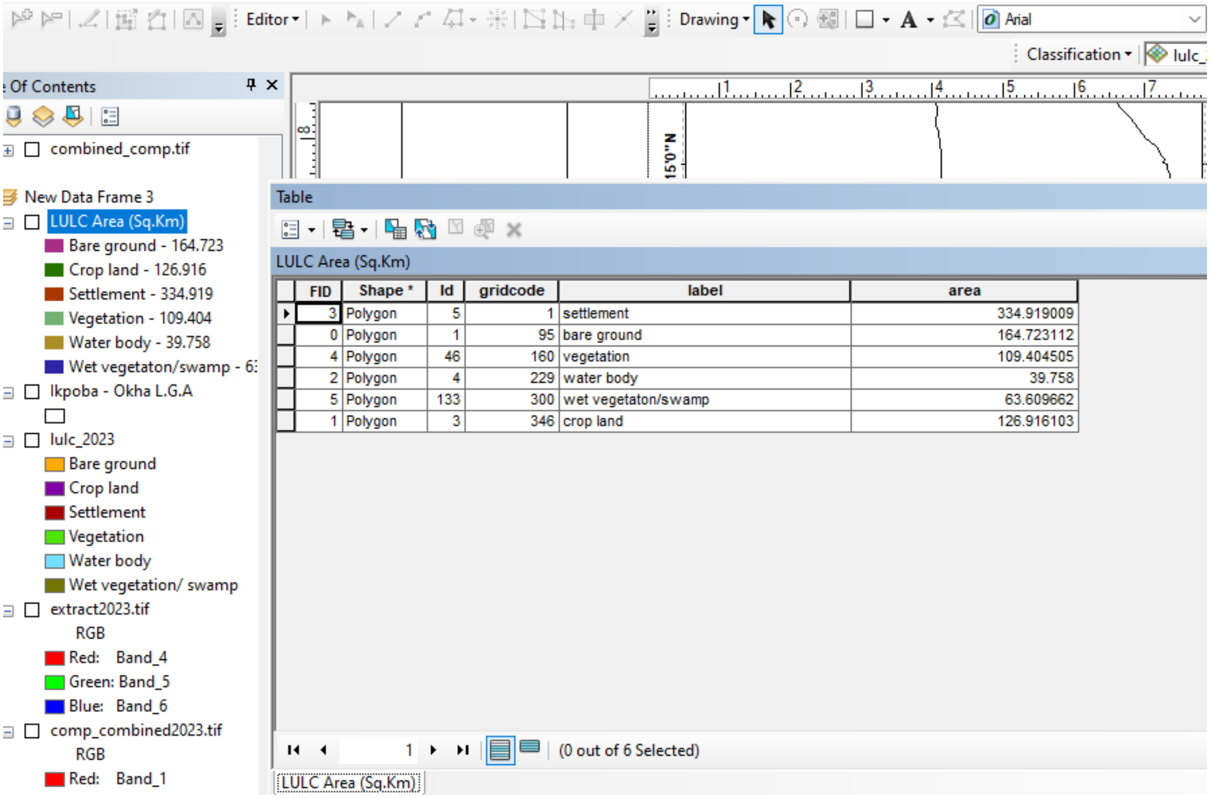
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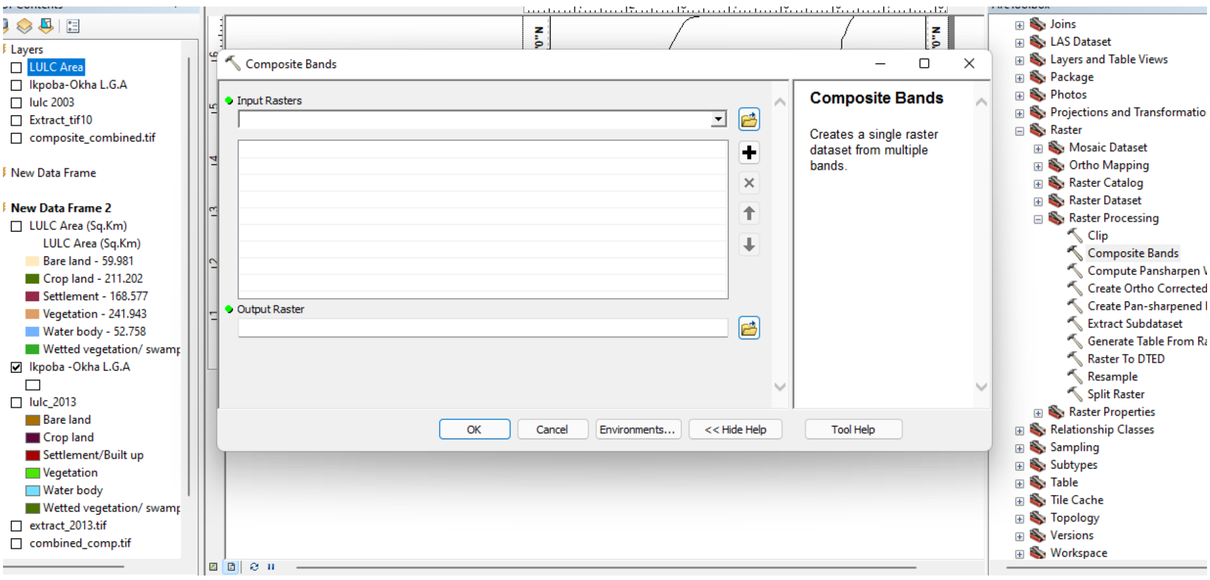
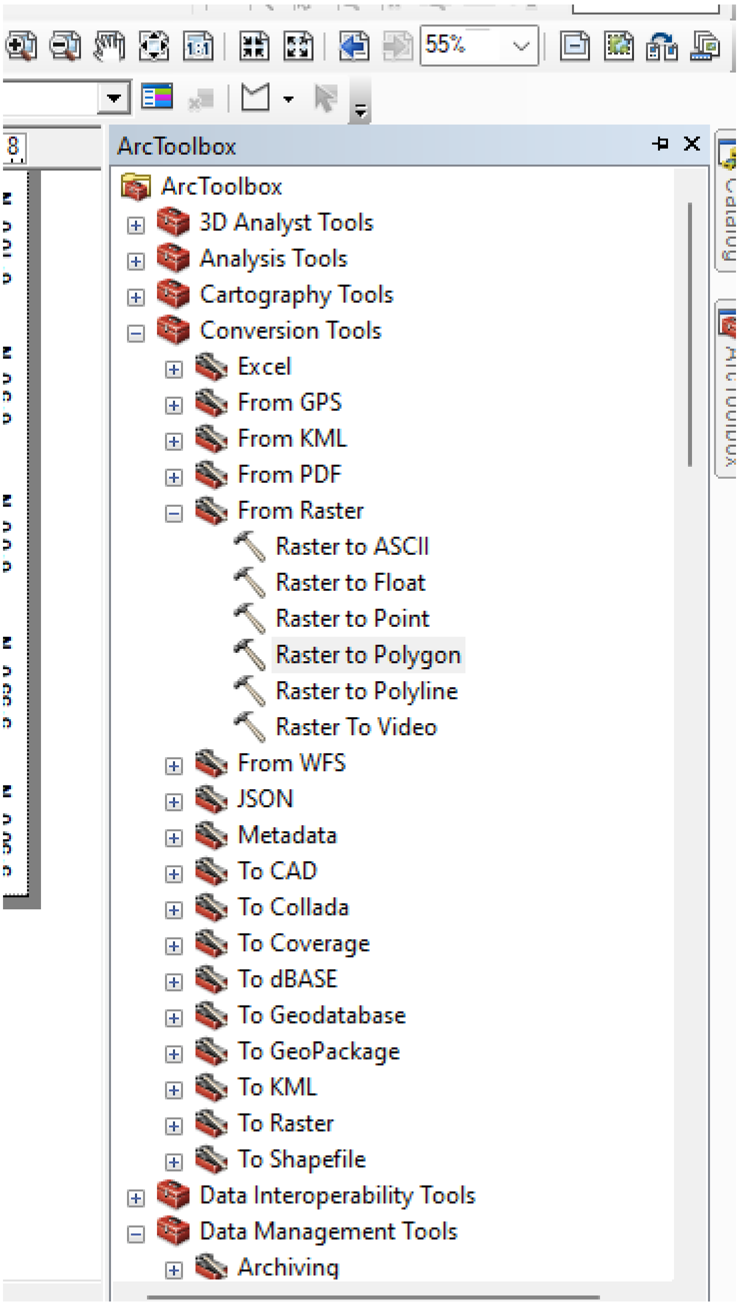
combined_comp.tif
New Data Frame 3
LULC Area (Sq.Km)
Bare ground - 164.723
Crop land - 126.916
Settlement - 334.919
Vegetation - 109.404
Water body - 39.758
Wet vegetaton/swamp - 63
Ikpoba - Okha L.G.A
lulc_2023
Bare ground
Crop land
Settlement
Vegetation
Water body
Wet vegetation/ swamp
extract2023.tif
RGB
Red: Band_4
Green: Band_5
Blue: Band_6
comp_combined2023.tif
RGB
Red: Band_1
Table
LULC Area (Sq.Km)
FID | Shape * | Id | gridcode | label | area
3 | Polygon | 5 | 1 | settlement | 334.919009
0 | Polygon | 1 | 95 | bare ground | 164.723112
4 | Polygon | 46 | 160 | vegetation | 109.404505
2 | Polygon | 4 | 229 | water body | 39.758
5 | Polygon | 133 | 300 | wet vegetaton/swamp | 63.609662
1 | Polygon | 3 | 346 | crop land | 126.916103
(0 out of 6 Selected)
LULC Area (Sq.Km)


Layers
LULC Area
Ikpoba-Okha L.G.A
lulc 2003
Extract_tif10
composite_combined.tif
New Data Frame
New Data Frame 2
LULC Area (Sq.Km)
LULC Area (Sq.Km)
Bare land - 59.981
Crop land - 211.202
Settlement - 168.577
Vegetation - 241.943
Water body - 52.758
Wetted vegetation/ swamp
Ikpoba -Okha L.G.A
lulc_2013
Bare land
Crop land
Settlement/Built up
Vegetation
Water body
Wetted vegetation/ swamp
extract_2013.tif
combined_comp.tif
Composite Bands
Input Rasters
Output Raster
OK
Cancel
Environments...
<< Hide Help
Tool Help
Composite Bands
Creates a single raster dataset from multiple bands.
Joins
LAS Dataset
Layers and Table Views
Package
Photos
Projections and Transformatio
Raster
Mosaic Dataset
Ortho Mapping
Raster Catalog
Raster Dataset
Raster Processing
Clip
Composite Bands
Compute Pansharpen
Create Ortho Corrected
Create Pan-sharpened
Extract Subdataset
Generate Table From R
Raster To DTED
Resample
Split Raster
Raster Properties
Relationship Classes
Sampling
Subtypes
Table
Tile Cache
Topology
Versions
Workspace


55%
ArcToolbox
ArcToolbox
3D Analyst Tools
Analysis Tools
Cartography Tools
Conversion Tools
Excel
From GPS
From KML
From PDF
From Raster
Raster to ASCII
Raster to Float
Raster to Point
Raster to Polygon
Raster to Polyline
Raster To Video
From WFS
JSON
Metadata
To CAD
To Collada
To Coverage
To dBASE
To Geodatabase
To GeoPackage
To KML
To Raster
To Shapefile
Data Interoperability Tools
Data Management Tools
Archiving

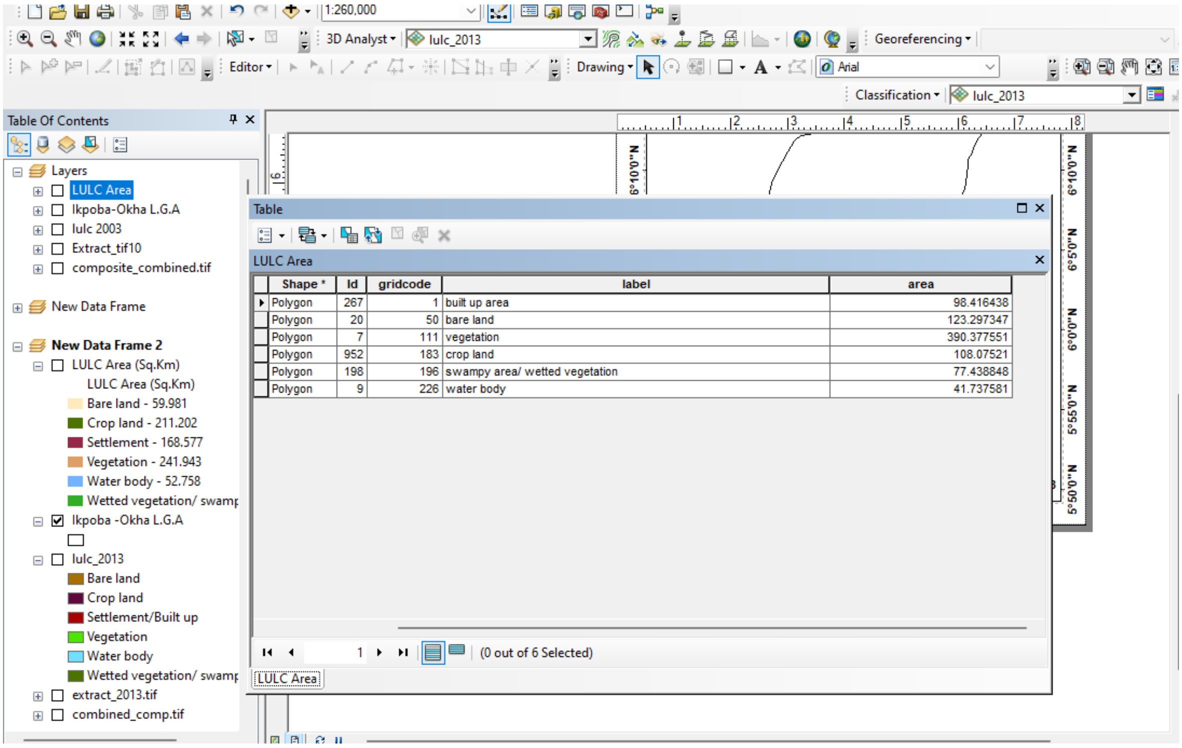



**TABLE SHOWING TOTAL PERCENTAGE OF LAND USE LAND COVER FOR 2003**

| Row Labels | Sum of area |
|---|---|
| bare land | 123.2973468 |
| built up area | 98.41643758 |
| crop land | 108.0752098 |
| swampy area/ wetted vegetation | 77.43884813 |
| vegetation | 390.3775509 |
| water body | 41.73758103 |
| **Grand Total** | **839.3429743** |

| Row Labels | Sum of area | % |
|---|---|---|
| bare land | 123.2973468 | 15% |
| built up area | 98.41643758 | 12% |
| crop land | 108.0752098 | 13% |
| swampy area/ wetted vegetation | 77.43884813 | 9% |
| vegetation | 390.3775509 | 47% |
| water body | 41.73758103 | 5% |
| **Grand Total** | **839.3429743** | 100% |