

Urban Growth and Land Use/Land Cover Transformation in Jere LGA, Borno State, Nigeria: A Decadal Spatiotemporal Analysis Using Remote Sensing and GIS

**Ali Mai Boyoma, Moh'd Kashif Khan, Swati Mauryan, Saalah Yakubu Saalah, Mustapha Shettima,
Abba Jato Ibrahim, Aliyu Hassan Muhammad, Umar Jiddum Jidda, Mustapha Umar Badiya,
Isa Ali Kaka, and Habib Umar Badiya**

Department of Environmental Science, Integral University Lucknow, India

ABSTRACT: The rapid urbanization has emerged as one of the key contributors of land use and land cover (LULC) in most developing areas especially Sub-Saharan Africa. This study evaluates land use/land cover (LULC) of Jere Local Government Area (LGA), Borno State, northeastern Nigeria, in the years 2015 to 2025 using analytical methods of multispectral Landsat satellites and Geographic Information System (GIS). Maximum Likelihood Classification Supervised To allow the generation of quantitative decadal LULC maps, Landsat 8 OLI (2015) and Landsat 9 OLI -2 (2025) scenes were run with a supervised Maximum Likelihood Classification to obtain the results in six of the identified land cover categories, namely built -up areas, bare land, farmland, mosaic cropland, vegetation, and water bodies. The results point to the fact that the landscape is changing radically. The extent of bare land increased significantly, 9.6 34.0% (81.3 to 286.5 km²), with a net growth of around 205 km², a factor that was due to wars that led to desertion of land, unproductive land use methods and increased aridification of the Lake Chad Basin due to climatic changes. There was a drastic reduction in the area of farmlands by more than 61.9 to 39.0 percent of the total area under study; hence, endangering the productivity of agriculture and the local food security. The urbanisation and pressures in the resettlement following the conflict, increased built-up areas more than two folds as they went up to 9.9 compared to 4.2. Water bodies (2.3 per cent to 1.4 per cent) and mosaic cropland (16.5 per cent to 9.8 per cent) showed very small changes and vegetation cover showed a marginal growth (5.5 per cent to 5.9 per cent). These results highlight the compounding effects of insecurity, climate change, and unregulated urban development on the topography of the northeastern area of Nigeria and reflect the invaluable characteristics of satellite-based LULC in supporting the predicate knowledge-based land use planning, environment care, and sustainable development policy.

KEYWORDS: Urban Growth, Land Use/Land Cover Change (LULC), Remote Sensing, Geographic Information System,

I. INTRODUCTION

The urbanization is one of the most far-reaching demographic and spatial changes of the twenty-first century. The booming development of city and urban centres have radically reorganized human settlements, redirected ecological systems, and redefined the pattern of land use on a scale and rapidly never before seen (Eigenbrod et al., 2011; Shaw and Das, 2018; Zhou et al., 2019). Now, urbanization as suggested by UN-Habitat (2006) does not necessarily mean the actual geographical spread of towns and cities; but also the process of increasing the population density in specific geographic areas (towns and cities) which is accompanied by immense ramifications concerning land resources and infrastructural development as well as environmental sustainability.

The largest population in the world today lives in cities, and this figure is expected to grow to 68 percent by 2050, though in Africa and Asia, the population growth is projected to rise to the greatest extent (United Nations Department of Economic and Social Affairs, 2018). Urban dynamism is taking place at a very rapid rate in Sub-Saharan Africa especially as it is the place where natural population growth is high, rural-urban migration is high, and secondary cities and peri-urban settlements are expanding (UN-Habitat, 2014). The case of Nigeria is an example of this trend since it is

the most populous state in Africa. The urban population grew by 29.7 percent in 1990 to 51.2 percent in 2019 (World Bank, 2020) in massively and steadily transforming into urban residency and exposing the natural environment to significant pressure in terms of land resources and infrastructure.

One of the most severe outcomes of this urban growth is the change in land use and land cover (LULC), a process that triggers the worsening of the environment, the destruction of agricultural activity, the decline of bio-diversity, and the alteration of hydrology (Mosammam et al., 2017). The identification and measurement of LULC alterations have thus gained precedence in urban geography, environmental science as well as land use planning. Remote sensing and Geographic Information System (GIS) technologies have become tools that cannot be ignored in quantifying these changes, which is able to provide timely, spatially explicit, and economical information over large areas and through time (Keshtkar et al., 2017). Access to free satellite imagery, especially Landsat programme has further democratized the ability of researchers and planners in developing countries to be able to observe and react to changes in land cover. The high-rate urbanization in the country has created a set of interrelated issues such as environmental degradation, overextension of city infrastructure, loss of fertile arable land, and informal settlements (Oyinloye and Adesina, 2011; UN-Habitat, 2010). In northeastern Nigeria, these difficulties are acute, as since 2009 the insurgency of Boko Haram has worsened the humanitarian crisis to the point where the traditional mechanisms of land use control are collapsing amid the pressure of conventional urbanization, population displacement is driven by armed conflict, and land is being abandoned (Fashae et al., 2022). The epicentre of this crisis is the Borno State where the millions of internally displaced persons (IDPs) have fled to the urban and peri-urban areas, especially around the Maiduguri Metropolitan Council and the neighboring local government areas.

The local government area (LGA) of Jere, which is the next-door area to Maiduguri, is a critical case study in this scenario. Having been a historically agrarian LGA that has taken in a number of displaced population and urban overspill over the last ten years, Jere LGA provides a good opportunity to study the dynamic of LULC in semi-arid northeastern Nigeria. Although being strategically important, the published literature on systematic and spatially rigorous investigations of the LULC change in the Jere LGA has limited literature thus, it is a major gap in knowledge that has direct implications on land use governance and post-conflict reconstruction planning.

This paper finds solutions to this gap by utilizing the multi-temporal Landsat satellite imagery and GIS based supervised classification to examine LULC changes in Jere LGA in 2015 and 2025. To be specific, the objectives of the study are to: (i) map and estimate the spatial structure of LULC, 2015 and 2025; (ii) determine the magnitude, direction, and rate of change of each land cover type at a period of ten years; (iii) determine the key contributors of the observed LULC changes; and (iv) report on the implications of changes to sustainable land management, food security, as well as urban planning in the post-conflict environment in northeastern Nigeria. The results will help in the current research literature of remote sensing and LULC in Nigeria, and also present evidence-based action measures to informed planning and policy actions in one of the most environmentally and socially susceptible regions in the country.

II. STUDY AREA AND METHODOLOGY

2.1 Study Area

Jere Local Government Area (LGA) is in the Northern region of Borno State in Nigeria and has a longitude of 13°09E and 14°04E and a latitude of 11°57N and 13°04N (Isah et al., 2010). It occupies the area of approximately 868 km² with its administrative headquarters situated in Khaddamari (Wikipedia, 2012). It borders Maiduguri Metropolitan Council (MMC), Magumeri LGA and Mafa LGA to the south east, the west and east respectively (Samuel, 2008). The 2006 National Population Census (NPC, 2006) shown that the population of the area was estimated to be 1,119,381, having a clear dry season season between October and May and a rainy season between June and September. Rainfall is largely seasonal, having one maximum in the months of August, which is caused by the south-westerley monsoon winds and other dry season is caused by north-easterly Sahara Desert harmattan winds. The annual rainfall is 500-750 mm, although some reports show that the rainfall exceeds 600 mm (Goni, 2006; University of Maiduguri Meteorological Centre, 2002). Jere is situated in the Chad Basin, which is a structural depression, and is plainly covered with flats with 320 m above sea level elevations and having a low topography leading down to Lake Chad (Nyanganji, 1996). River Ngadda is the major drain in the area. The soils are also sandy-loam or heavy clay and are usually fertile and are used in irrigated agriculture like wheat, rice and vegetables. The Sahel savanna is characteristic of vegetation which is made of shrubs and sparsely located trees (Waziri, 2009).

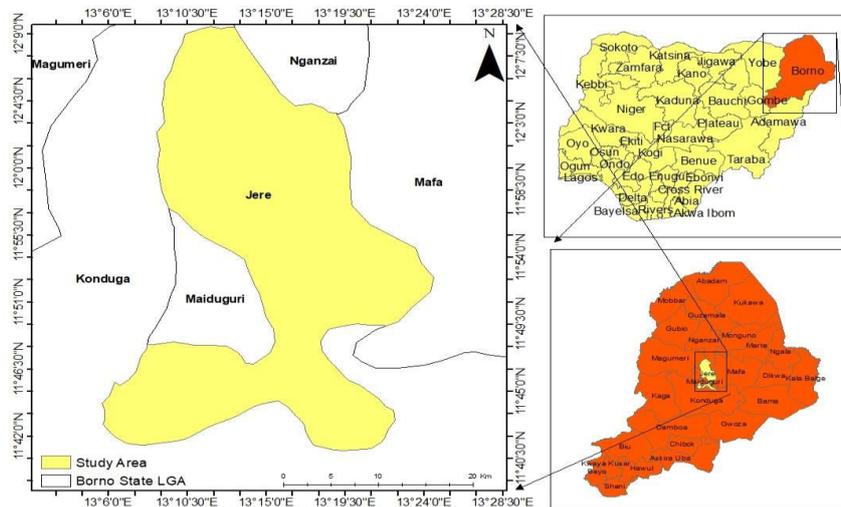


Figure 3.1: Map Showing the Study area

2.2 Methodology

2.2.1 Data Sources

The information used in this research was collected both through primary and secondary sources. The main source of data is the multi-date satellite data which has been obtained in the portal of the United States Geological Survey (USGS) Earth Explorer (<https://earthexplorer.usgs.gov/>). The main foundation of LULC classification and analysis of change detection lies in these images. The sources of secondary data will consist of published textbooks, peer-reviewed articles in the journals, academic theses, governmental reports, and other relevant online sources. They were used to give the theoretical background and help in the interpretation of the results of the classification and prove the results on the background of existing literature on the dynamics of urban land use in semi-arid conditions.

2.2.2 Satellite Datasets

The research involved two Landsat satellite images taken in November 2015 and November 2025 respectively, with the assumption of temporal stability being to consider images of the same season in order to reduce the possibility of phenological changes. Both pictures are located at path 185, row 52 of the Landsat Worldwide Reference System (WRS-2) and they were collected under minimal cloud cover to achieve the quality and reliability of the classification products. The datasets used are summed up in Table 2.1.

Table 2.1: Satellite Datasets Used in the Study

Satellite	Bands Used	Resolution	Date Range	Source URL
Landsat-8 OLI	B2–B5	30 m	Nov. 2015	https://earthexplorer.usgs.gov/
Landsat-9 OLI-2	B2–B5	30 m	Nov. 2025	https://earthexplorer.usgs.gov/

Source: USGS Earth Explorer (<https://earthexplorer.usgs.gov/>)

2.3 Data Processing

2.3.1 Pre-processing

The satellite images were all downloaded on the USGS Earth Explorer portal as Level-2, Collection-2 (L2C2) products, which are radiometrically and atmospherically refined surface reflectance data. The images that were selected to be acquired were based mainly on the quality of the image but mainly the image with a cloud content of less than 10 percent was selected.

All Landsat images were georeferenced to the datum of geography known as the World Geodetic System 1984 (WGS_1984) and projected to the Universal Transverse Mercator (UTM) Zone 33N coordinate system so that there was a spatial consistency between the two eras. The ArcGIS 10.8.2 software was used to process and analyze the images.

Single spectral bands were stacked to form multi-band stacked composite images. The Clip tool of ArcGIS 10.8.2 was then employed to clip the stacked images with the study area boundary hence limiting the analysis to the boundaries of the Maiduguri Urban. Between different colour composites (True Colour / False Colour Infrared) were created to allow visual interpretation and training sample collection to apply supervised classification.

2.3.2 Image Classification

Both the satellite images were classified supervised with the Maximum Likelihood Classification (MLC) algorithm in ArcGIS 10.8.2. One of the most popular parametric classifiers in the remote sensing is the MLC algorithm because of its statistical strength; each pixel is allocated to a specific class in which it is more likely to belong than any other specific class as it depends on the statistical properties (mean and covariance) of the training samples, and thus it is especially applicable to multi-spectral Landsat images. Each LULC class was represented by training samples (regions of interest) that were collected with great care by synthesising field knowledge of the study area with reference imagery of high resolution provided by Google Earth and the expert interpretation of colour composites. Each class was digitised at least with 20 training polygons so as to guarantee the statistical reliability of the classification model. The recorded classified images were further provided with accuracy testing with the help of stratified randomized sampling strategy and confusion table, after which the Overall Accuracy (OA) and Coefficient of Kappa were obtained. This study has been classified using six LULC classes, as shown in Table 2.2 below.

Table 3.2: LULC Classification Scheme

No.	LULC Class	Description
1	Built-up Area	Residential, commercial, industrial structures and impervious surfaces
2	Water Body	Rivers, streams, ponds, lakes and other permanent or seasonal water features
3	Vegetation	Dense and sparse natural vegetation, shrubs and grasslands
4	Bare Land	Exposed soil, degraded land and surfaces without vegetation cover
5	Farmland	Cultivated agricultural land, smallholder farms and crop fields
6	Mosaic Cropland	Mixed cropland and natural vegetation with no dominant class exceeding 50%

Source: Author's Compilation, 2025

2.4 Method of Data Analysis

After using the image classification, the LULC 2015 and 2025 maps were analysed to determine the degree and rate of change of each land cover type in the ten-year period. The analysis of change detection was done by calculating the areal extent (in hectares and percentage of total area) of each LULC class of both time periods and subsequent cross-tabulation (change matrix) to establish gains, losses, and net of changes of each class.

The change in terms of rate per LULC class was obtained as shown below:

$$\text{Rate of Change (\%)} = [(A_2 - A_1) / A_1] \times 100$$

Where A_1 represents the area of a selected LULC class in 2015, and A_2 is the area of the same in 2025.

The presentation of results is conducted in terms of thematic LULC maps that are displayed in ArcGIS 10.8.2 using a standardised colour scheme to differentiate each class. The supporting data are presented in tables (frequency distribution tables) and graphs (bar charts and pie charts) to help to compare the data and be used to ensure the interpretation of spatial and temporal trends in the change of land use/land cover on the territory of the area under study.

III. RESULTS AND DISCUSSION

3.1 Land Use/Cover Distribution of Jere Local Government Area

The dynamics of land use and land cover (LULC) is essential to the determination of environmental change, sustainable land management, and urban and regional planning decision making. Recently, the importance of LULC changes detection is growing because it has both direct and indirect effects on the functioning of ecosystems and human health especially in the rapidly developing urbanized countries (Koko et al., 2022; Akaolisa et al., 2023). Rapid population growth and socioeconomic development have been cited as the key factors that have contributed to increasing transformations of LULC in Nigeria, which is one of the most populous nations in the world with an estimated population of 227 million people (Adeyemi et al., 2022; Fashae et al., 2022). Jere Local Government Area (LGA) located in Borno State, northeastern Nigeria is not an exception of these national patterns. In this section, the findings of supervised image classification of the remotely sensed data obtained in years 2015 and 2025 are provided, which is the opportunity to systematically and decadal evaluate the LULC change in six established categories of land cover: bare land, built-up areas, farmland, mosaic cropland, vegetation, and water bodies.

The LULC analysis used in the year 2015 on the baseline year indicates that agricultural land uses dominated Jere LGA. The largest land cover class, as outlined in Table 3.1, and as shown in Figures 3.1 and 3.2, is farmland, which covered about 522.1 km² (61.9%) of the total study area of 843.4 km². Mosaic cropland, which constitutes heterogeneous agricultural parcels containing mixed types of crops, added another 139.0 km² (16.5%), and all these facts reflect the disproportionately agrarian nature of the landscape in 2015. The collective area of agricultural land uses (farmland and mosaic cropland) amounted to about 78.4% of Jere LGA in 2015, which can be explained by the traditional reliance of the local community on the rain-fed and small-scale irrigation agriculture as the main livelihood strategy. This is in line with previous research in northeastern Nigeria which has long been characterized by the dominance of agricultural activities as the primary land use patterns before the increase in pressure of conflict and displacement in the Lake Chad Basin area (Olajuyigbe, 2018).

The largest proportion was that of bare land, 81.3 km² (9.6%), then vegetation cover with 46.3 km² (5.5%), water bodies with 19.3 km² (2.3%), and finally built-up areas with 35.5 km² (4.2%). The comparatively small size of built-up areas in 2015 is a manifestation of the rural nature of the local government area in 2015. Similar results were reported in research conducted on other areas of the local government in Nigeria, where built-up areas had held small shares of the total land area at the base years, then expanded with population influx and urban periphery development (Koko et al., 2022; Fashae et al., 2022). The fact that there were large areas of vegetated surfaces and water bodies in 2015 means that the landscape retained useful ecological processes that sustained biodiversity, and played a role in hydrological control at that time.

Table 3.1. Land Use/Cover Distribution of Jere Local Government Area: 2015 and 2025

Land Use Class	Area (km ²) 2015	% 2015	Area (km ²) 2025	% 2025
Bare land	81.3	9.6	286.5	34.0
Built-up areas	35.5	4.2	83.2	9.9
Farmland	522.1	61.9	329.1	39.0
Mosaic cropland	139.0	16.5	82.9	9.8
Vegetation	46.3	5.5	49.8	5.9
Water bodies	19.3	2.3	11.8	1.4
Total	843.4	100.0	843.3	100.0

Source: Authors' Analysis of Satellite Imagery, 2025

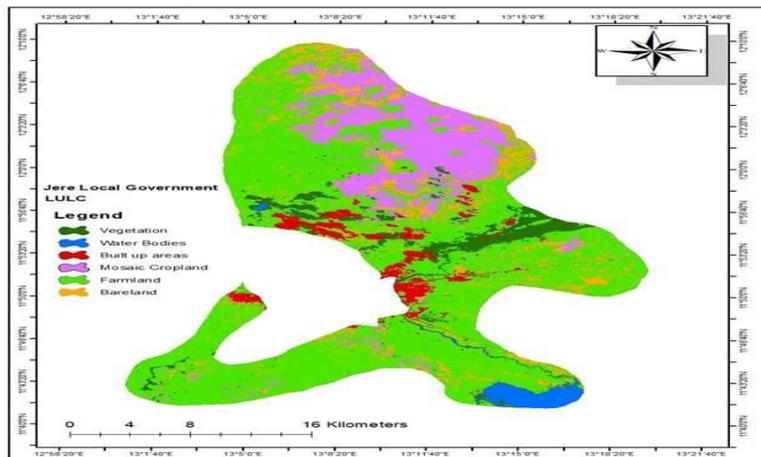


Figure 3.1. Land Use/Cover of Jere Local Government Area for the year 2015

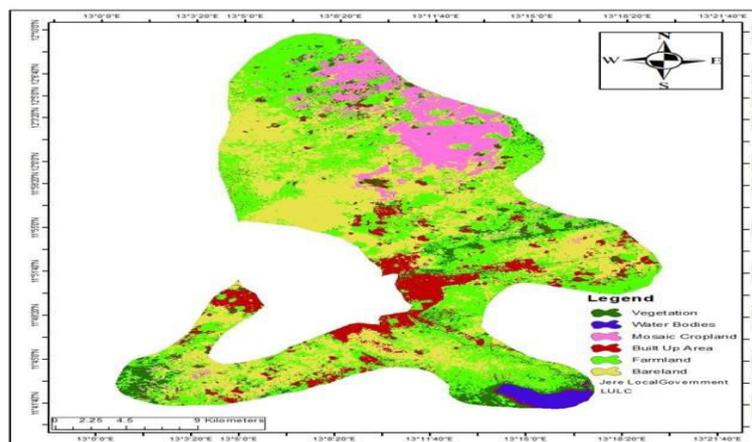


Figure 3.2. Land Use/Cover of Jere Local Government Area for the year 2025

In 2025, the scenario of the Jere LGA had changed significantly in a profound manner. The hegemony of bare land as the dominant land cover type was 286.5 km^2 (34.0%) of the total study area, which is more than 205 km^2 or about 252% compared to 2015. This dramatic increase in bareland is an important discovery that would be under close scrutiny in the light of current degradation of land, displacement due to conflicts and climatic activities which are common in northeastern Nigeria. According to the UNCCD (2023), the global land degradation in 2015-2019 had consumed at least 100 million hectares of productive land per year, with sub-Saharan Africa being victims of the process with rates significantly higher than the global average. The scale of the increase in the area of barelands in Jere LGA is in line with this larger regional trend and could indicate a mix of land abandonment due to the conflict-related displacement of the population, unsustainable land management systems, and the growing aridification of the climate change in the Lake Chad Basin.

The LULC analysis of 2025 indicates a significantly different area to the 2015 baseline and it is possible to conclude that there are extensive structural changes in the land use patterns during the ten years period. According to Table 3.1 and Figure 3.2, the predominant land cover by 2025 was bare land with the total area of the study area being about 286.5 km^2 (34.0) covering the majority of the study area totaling over 205 km^2 or 252 percent of the original 2015 area. This massive growth of bare land is an important discovery and this need to be analyzed keenly amidst current land degradation, displacement due to conflict and pressures of climatic conditions that are typical to the northeastern region of Nigeria. According to the UNCCD (2023), the global land degradation in 2015-2019 had consumed at least 100 million hectares of productive land per year, with sub-Saharan Africa being victims of the process with rates significantly higher than the global average. The scale of the increase in the area of barelands in Jere LGA is in line with this larger regional trend and could indicate a mix of land abandonment due to the conflict-related displacement of the population, unsustainable land management systems, and the growing aridification of the climate change in the Lake Chad Basin.

The area of farm land shrank significantly in 2015 to 329.1 km^2 (39.0%) in 2025, a net decline of about 193 km^2 of the cultivated territory. Such reduction in agricultural land within one decade is disastrous in terms of food security. The fact that the rural communities in Jere LGA of the sub-Saharan area depend heavily on agricultural work, while the fertile farmlands are transformed into bare lands, exerts acute stress on the available food supply and livelihood in the area (Bjornlund et al., 2022). With urbanization, similar tendencies of contracting farmlands and land degradation have been observed in researches conducted in Nigeria. As an example, the analysis of Ota LGA in Ogun State revealed that the agricultural fields were becoming more and more covered by industrial zones and urban sprawl in 2015-2023 (MDPI, 2025), and the research in Ekiti State showed that the territory of agricultural lands was gradually replaced by built space when the agricultural population in the urban areas grew (Olorunfemi et al., 2018). The reduction in the mosaic cropland (139.0 km^2 to 82.9 km^2 , 16.5 to 9.8) is another report supporting the general fall in the agricultural productivity in the landscape.

Developed areas had a significant growth and increased to 35.5 km^2 (4.2) in 2015 to 83.2 km^2 (9.9) in 2025 (growth of 134.4). This trend of accumulated urban expansion is in line with the reported trends of accelerated urbanization in the Nigerian secondary cities and local government regions. Koko et al. (2022) established that residential and commercial spaces in Kano metropolis expanded between 1991 and 2020 with a total area of 66.16 km^2 and 218.72 km^2 with an anticipated increase anticipated in the next several decades. On the same note, the case studies of Lagos and Abuja have once again corroborated the view that developed expansion comes at the cost of vegetated land resources, as well as, productive farmlands (Babalola & Akinsanola, 2016; MDPI, 2019). The city development witnessed in the Jere LGA though not as clear as the big cities especially in the metropolitan regions, represents the gradual process of expanding the region into the larger urbanization process due to people movement, rural urban migration, economic activities and post conflict reconstruction program.

There was a marginal rise of vegetation cover of 46.3 km^2 (5.5) in 2015 to 49.8 km^2 (5.9) in 2025. This small increase is positive, but the size of the vegetated area is still small and does not have enough to offset massive losses of agricultural lands and the catastrophic increase of bare areas in bad conditions. Studies have continuously shown that a right coverage of vegetation is a prerequisite of ecological stability, the preservation of biodiversity, and the regulation of the surface temperature and water cycle in semi-arid areas like those located in northeastern Nigeria (Olorunfemi et al., 2018; Kuma et al., 2022). The water bodies were slightly reduced by 19.3 km^2 (2.3) to 11.8 km^2 (1.4), a decline that

is credited to a series of factors such as seasonal variation, higher water extraction in domestic and agricultural activities, and the recorded reduction in water bodies in the wider Lake Chad Basin due to the effects of climate change.

3.2 Spatiotemporal Analysis of LULC Change: 2015–2025

Figure 3.3 gives the comparative visualization of the LULC dynamics that will be realized in the Jere LGA in the year 2015-2025. It can be seen, based on the analysis, that there are four main trends, namely, dramatic growth of bare land, a dramatic shrinkage of agricultural land, gradual increase in built-up areas, and a moderate decrease in the extent of surface water. All of these trends when taken together are indicative of the intertwining of urbanization, climate change, land degradation, and socioeconomic disruption that are active in northeastern Nigeria.

The most noticeable modification is the almost threefold increment in the bareland cover 9.6 percentage of the entire study area to 34.0 percentage. This dramatic change in just ten years can hardly be found in the published literature on LULC change in the Nigerian local government areas and should be taken seriously by the policy makers and land managers. In the Agricultural sector, studies in sub-Saharan Africa have proved that the combination of unsustainable farming methods, deforestation, over grazing and more unpredictable rain distribution has led to land degradation and conversion of the vegetated and productive farm lands to bare and non-productive surfaces (Nkonya et al., 2008; Tefera et al., 2024). The long-term humanitarian crisis due to insurgency in the particular case of the State of Borno State has resulted in the high rate of population displacement, land desertion, and the breakdown of traditional land management systems, which are likely to have increased the rate of land degradation in Jere LGA during the study period.

The joint decrease in farmlands (22.9 percentage points) and mosaic croplands (6.7 percentage points) and in parallel with the increase in barelands indicates that agricultural desertification and soil erosion and not urban conversion singly may be the most significant source of landscape alteration. Such interpretation is consistent with the results of the wider northeastern Nigerian environment, in which displacement due to conflict has been observed to be a major factor affecting the agricultural land abandonment and the resultant soil cover erosion (Fashae et al., 2022). It is also similar to the Ethiopian evidence, the agricultural expansion and land abandonment due to conflict and displacement are found as the determinants of LULC change in the watershed level (Kuma et al., 2022).

The growth of built-up areas -4.2 to 9.9 per cent- is also in line with the overall urban development in the Nigerian LGAs and the continuing processes of densification and infrastructural development as well as the absorption of the displaced people in peri-urban settlement. The patterns of urban growth in Kano (Koko et al., 2022), Abuja (MDPI, 2019), as well as Suleja (Garba, 2016) have recorded that over the similar time-frames the proportional increases in built-up extents exist, usually accompanying rural-to-urban migration, post-conflict reconstruction and governmental investment in infrastructure. Coupled with results of Jere LGA, the argument that urbanization in Nigeria is advancing faster than formal land use planning can keep up with it reinforces research findings by other researchers on urbanization in sub-Saharan African cities generally (UN-Habitat, 2014).

This slight decrease in the water masses by 2.3% to 1.4% is in line with the satellite-related evidence of hydrological changes in the Lake Chad Basin, where the areas of water bodies have significantly decreased over the last decades in response to decreased rainfalls, escalated evapotranspiration, and increased water abstraction (Policelli et al., 2019). The decrease recorded in Jere LGA is not substantial in its own right, but it has great consequences on the livelihoods of the local people, farming water supply, and health of the aquatic organisms. The regular observation with multi-temporal satellite data will be useful to identify the trends in future in order to initiate policy responses in time.

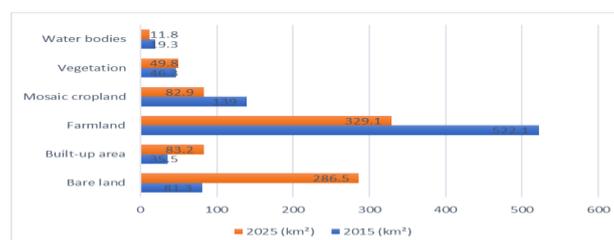


Figure 3.3. Comparative Land Use/Land Cover Change in Jere Local Government Area: 2015 vs. 2025

IV. IMPLICATIONS FOR SUSTAINABLE LAND MANAGEMENT AND URBAN PLANNING

The reported LULC variations in Jere LGA between 2015 and 2025 have significant consequences on sustainable development, environmental and land use planning in northeast Nigeria. The uncontrolled growth of bare land and the massive shrinkage of the farmland also brings immediate alarm regarding the food security systems, soil health, and the productive potential of the local landscape in the long run. In sub-Saharan Africa, many rural communities rely on the land and, as a result, the degradation of productive farmlands is directly correlated with poverty and food insecurity (Barbier and Hochard, 2018; FAO, 2023). In the case of Jere LGA, which has a long history of agricultural activities being the main contributor to the local economy, the reversal of this situation should be prioritized.

The phenomenal urbanization of the Jere LGA has led to the need to come up with and adopt elaborate land use plans that consider both the environmental sustainability goal and the socioeconomic development goal. The study on the land cover change in the Abuja city-region has established that uncontrolled urban growth often creates discrepancies between formal land use plans and the actual land cover affecting the efficiency of planning tools and leading to ineffective provision of infrastructure (MDPI, 2019). To prevent such a situation in Jere LGA, the local government officials must invest in regular LULC surveillance through the benefits of freely available satellite data platforms, set up effective boundaries that delimit urban sprawl, and create policy that rewards sustainable agricultural intensification on the current farmlands to alleviate the pressure on the natural landscape.

Combating land degradation should be adjusted to the efforts of the United Nations Convention to combat desertification (UNCCD) and Sustainable Development Goals (SDG 15: Life on Land). Afforestation and reforestation, community-based rehabilitation of degraded lands, and adoption of sustainable agricultural practices such as integrated soil fertility management, contour farming and agro-forestry systems have been proven to restore degraded lands and increase the provision of ecosystem services in similar semi-arid areas in sub-Saharan Africa (Tefera et al., 2024; UNCCD, 2023). Local communities would have significant roles to play in the implementation of such interventions in Jere LGA since they would have indigenous knowledge of local land management systems and technical assistance of government bodies and international development partners.

V. CONCLUSION

In this work, the use of supervised image classification of multitemporal satellite image was used to evaluate the changes of LULC in Jere Local Government Area, Borno State, Nigeria, during the years 2015-2025. The findings indicate a landscape that is changing very fast and in most cases in an undesirable manner. The bare land that covered 9.6 percent of the study area in the years 2015 increased by a staggering percentage of 34.0 in 2025 with a net area of about 205km² per decade. Such a disastrous cause of land degradation can be explained with the complex interrelationship of land abandons in response to conflict, unsustainability in land management, and environmental stress associated with climatic changes in the northeastern part of the Nigerian territory. At the same time, agricultural lands were shrinking by 61.9-39.0% of the total land, which indicated the substantial loss of agricultural productivity that had direct effects on food security and the rural population. The relative change in built-up areas increased more than two times - 4.2 to 9.9 percent - due to advancing urbanization and expansion of infrastructure, and water bodies and mosaic cropland recorded slighter yet exponential decreases. Such results are widely consistent with reported patterns of LULC change in similar local government units in Niger, and in line with observed patterns of increasing rates of land degradation across the sub-Saharan region. The research highlights the urgent necessity of having systematic and satellite-based LULC monitoring as a fundamental instrument of evidence-based land use planning and environmental governance. Future studies that implement a more sophisticated category technique, socioeconomic driver analysis and predictive modelling should be used so as to better clarify the trends and contributing factors of LULC alteration in Jere LGA and as such provide a sound scientific foundation of intervention policy to reverse land degradation, sustainable management of urban growth as well as insurance of the natural resource foundation on which local livelihoods rest.

REFERENCES

1. Adebayejo, A. T., & Abolade, O. (2006). Analysis of Spatial Changes in Ogbomoso City. *Journal of the NITP*, XIX, 35-47
2. Adediji, A. and Ajibade, L.T. (2008) The Change Detection of Major Reservoirs in Osun State, Nigeria Using Remote Sensing (RS) and GIS Techniques. *Journal of Geography and Regional Planning*, 1, 110-115.
3. Adeyemi, A. A., Fashae, O. A., & Oyediji, O. (2022). Land use and land cover analysis in Nigeria: a systematic review. *Bulletin of the National Research Centre*, 46(1), 1–18. <https://doi.org/10.1186/s42269-024-01286-z>
4. Akaolisa, C. C. Z., et al. (2023). Monitoring LULC change dynamics for sustainable landscape management in Nigeria. *Land Use Policy*, 128, 106609.
5. Albert, O, Merem, E. C., & Twumasi, Y. A. (2006). Use of GIS and Remote Sensing Technology as a Decision Support Tool in Land Administration - The Case of Lagos, Nigeria. *Promoting Land Administration and Good Governance 5th FIG Regional Conference*. Retrieved from <https://www.researchgate.net>
6. Anderson JR, (1976) A Land use and Land covers Classification System for use with Remotely Sensed Data. *Geological Survey Professional Paper 964*, Washington.D.C
7. Babagana, M. (2019). Land use Land Cover Change Detection: A Case Study: Maiduguri Capital City, Borno State, Nigeria, 1984 -2018. *International Journal for Research in Applied Science and Engineering Technology*, 7(3), 747–755. <https://doi.org/10.22214/ijraset.2019.3132>
8. Babalola, O. S., & Akinsanola, A. A. (2016). Change detection in land surface temperature and land use land cover over Lagos Metropolis, Nigeria. *Journal of Remote Sensing and GIS*, 5, 171. <https://doi.org/10.4172/2469-4134.1000171>
9. Barbier, E. B., & Hochard, J. P. (2018). Land degradation and poverty. *Nature Sustainability*, 1(11), 623–631. <https://doi.org/10.1038/s41893-018-0155-4>
10. Barros, J. X. (2014). Urban growth in Latin American cities: exploring urban dynamics through agent-based simulation (Doctoral), University of London.[2] GEONETCAST Spatial Database, CAZs UNIMAID, 2016 [3] Goetz, S.J., Smith, A. J., Jantz C., Wright, R. K., Prince, S.
11. Bello, S. A. (2019). Changes in land use /Land cover of Maiduguri Urban, Borno State Nigeria. *International Journal of Scientific and Research Publications*. <https://doi.org/10.29322/ijrsrp.9.03.2019.p87103>
12. Bjornlund, H., van Rooyen, A., & Stirzaker, R. (2022). Ensuring food security in sub-Saharan Africa. *International Journal of Water Resources Development*, 36(S1), S1–S26.
13. Bukar, M. G., Oyebamiji, N. A. and Adeogun, P. F.(2020).diversity and composition of tree species in the university of maiduguri, campus.*journal of research in forestry, wildlife & environment* 13(3).
14. Bukar, S. & Adams, F & Joseph, M. (2017). Mineralogy and Geochemistry of Mudstones of the Bama Ridge (Upper Chad Formation) Bornu Basin, North-Eastern Nigeria. 2. 153-159
15. Etim N.E. and Dukiya J.J. (2013) GIS Analysis of Peri-Urban Agricultural Land Encroachment in (FCT), Nigeria. *International Journal of Advanced Remote Sensing and GIS*, Vol. 2, issue 1, pp. 303-315
16. Fashae, O. A., Olusola, A. O., Ndubuisi, A. N., & Uluwadare, A. J. (2022). GIS and remote sensing mapping of land use land cover dynamics in Nigeria. *GeoJournal*, 87, 1067–1082. <https://doi.org/10.1007/s10708-020-10289-2>
17. Food and Agriculture Organization of the United Nations (FAO). (2023). *State of Food and Agriculture 2023*. FAO, Rome.
18. Koko, A. F., Yue, W., Abubakar, G. A., Hamed, R., & Alabsi, A. A. N. (2022). Spatiotemporal land use/land cover mapping and prediction based on hybrid modelling approach: A case study of Kano metropolis, Nigeria (2020–2050). *Remote Sensing*, 14(23), 6083. <https://doi.org/10.3390/rs14236083>
19. Kuma, H. G., Feyessa, F. F., & Demissie, T. A. (2022). Land-use/land-cover changes and implications in Southern Ethiopia: evidence from remote sensing and informants. *Heliyon*, 8(3), e09071. <https://doi.org/10.1016/j.heliyon.2022.e09071>
20. MDPI (2019). Land cover change in the Abuja city-region, Nigeria: integrating GIS and remotely sensed data to support land use planning. *Sustainability*, 11(5), 1313. <https://doi.org/10.3390/su11051313>
21. MDPI (2025). Land use and land cover changes: a case study of Ota LGA, Nigeria. *Land*, 14(2), 389. <https://doi.org/10.3390/land14020389>
22. Nkonya, E., Pender, J., Kaizzi, K., Kato, E., Mugarura, S., Ssali, H., & Muwonge, J. (2008). Linkages between land management, land degradation, and poverty in Sub-Saharan Africa. *IFPRI Discussion Paper 00159*.
23. Olajuyigbe, A. E. (2018). Urban land use planning and environmental sustainability in Nigeria. *Land Use Policy*, 79, 103–118.

24. Olorunfemi, I. E., Fasinmirin, J. T., & Akinola, F. F. (2018). Soil physico-chemical properties and fertility status of long-term land use/land cover changes: A case study in forest vegetative zone of Nigeria. *Eurasian Journal of Soil Science*, 7(2), 133–150.
25. Oyediji, O. T., & Adenika, C. U. (2022). Deforestation, land degradation and livelihood implications in southwestern Nigeria. *Environmental Challenges*, 8, 100551.
26. Policelli, F., Hubbard, A., Jung, H., Zaitchik, B., & Ichoku, C. (2019). Lake Chad total surface water area as derived from land surface temperature and radar remote sensing data. *Remote Sensing*, 10(2), 252.
27. Tefera, M. L., Mulatu, D. W., & Yimer, F. (2024). Land degradation and the upper hand of sustainable agricultural intensification in sub-Saharan Africa: a systematic review. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, 125(1), 63–83.
28. UN-Habitat. (2014). The state of African cities: re-imagining sustainable urban transitions. UN-Habitat, Nairobi.
29. Abbas, I. I. (2013). An assessment of Land Use/Land Cover changes in a section of Niger Delta, Nigeria. *Frontiers in Science*, 2(6), 137–143. <https://doi.org/10.5923/j.fs.20120206.02>
30. United Nations Convention to Combat Desertification (UNCCD). (2023). UNCCD Data Dashboard: Global land degradation trends 2015–2019. UNCCD, Bonn.
31. Ezeomodo, Innocent & I., Igbokwe. (2013). Mapping and Analysis of Land Use and Land Cover for a Sustainable Development Using Low Resolution Satellite Images and GIS. *International Journal of Engineering and Management Sciences, Science and Nature India*. Vol.3. Pg.513-519.
32. Glaeser, E. L. & Kahn, M. E., (2004) "Sprawl and urban growth," *Handbook of Regional and Urban Economics*, in: J. V. Henderson & J. F. Thisse (ed.), *Handbook of Regional and Urban Economics*, edition 1, volume 4, chapter 56, pages 2481-2527 Elsevier.
33. Hadi S. J., S. Z. M. Helmi and D. M. Mustafa (2014). Modelling LULC for the period 2010-2030 using GIS and Remote sensing: a case study of Tikrit, Iraq, 7th IGRSM International Remote Sensing & GIS Conference and Exhibition, IOP Publishing, Earth and Environmental Science 20 (2014) 012053 doi:10.1088/1755-1315/20/1/012053.
34. Houghton, R. A. (1994). The worldwide extent of Land-Use change. *BioScience*, 44(5), 305–313. <https://doi.org/10.2307/1312380>
35. Ifeoluwa A.B., Debo. Z.A., Ahmed, B. and Tobi, E.M. (2011). "Analysis of urban expansion and land use changes in Akure, Nigeria, using Remote Sensing and Geographic Information System (GIS) techniques". *Journal of Geography and Regional Planning*, 4(9): 533-541.
36. Jimme, M.A., Bashir, A. and Adebayo, A.A. (2016) spatial distribution pattern and terrain analysis of urban flash floods and inundated areas in maiduguri metropolis, borno state, northeast, nigeria. *Journal of geographic information system*, 8, 108-120.
37. Joseph, G & Jeganathan, C (2018): *Fundamentals of Remote Sensing*, Universities Press Private Limited, Hyderabad, pp456-469.
38. Koko, A. F., Wu, Y., Abubakar, G. A., Hamed, R., & Alabsi, A. a. N. (2020). Monitoring and Predicting Spatio-Temporal Land Use/Land Cover Changes in Zaria City, Nigeria, through an Integrated Cellular Automata and Markov Chain Model (CA-Markov). *Sustainability*, 12(24), 10452. <https://doi.org/10.3390/su122410452>
39. Lambin, E.F., (2001) *The Causes of Land-Use and Land-Cover Change: Moving beyond the Myths*. *Global Environmental Change*, 11, 261-269.
40. Lamine, C., Garçon, L., Brunori, G., (2018). Territorial agrifood systems: A Franco-Italian contribution to the debates over alternative food networks in rural areas. *Journal of Rural Studies*. <https://doi.org/10.1016/j.jrurstud.2018.11.007>
41. Leary, M. R., Tate, E. B., Adams, C. E., Allen, A. B., & Hancock, J. (2007). Self-Compassion and Reactions to Unpleasant Self-Relevant Events: The Implications of Treating Oneself Kindly. *Journal of Personality and Social Psychology*, 92, 887-904. <https://doi.org/10.1037/0022-3514.92.5.887>
42. Lin, Li., (2003) Simulating Spatial Urban Expansion based on a Physical Process. *Landscape and Urban Planning*, Vol. 64, issues 1-2, 2003, pg. 67-76
43. Madulu, N. (2004). Assessment of linkages between population dynamics and environmental change in Tanzania. 9.
44. Mandelas A. E, Hatzichristos T. and Prastacos P.(2007) A fuzzy cellular automata based shell For modeling urban growth- a pilot application in Mesogia area, 10th AGILE

44. Manish K.T., Aruna S., and Vivek K. (2012) Mapping and evaluation of urban sprawl using an integrated approach of Remote Sensing and GIS Technique (Review). *International Journal of Advanced Technology & Engineering Research*, 2 (1)
45. Masek, J. G., Vermote, É., Saleous, N., Wolfe, R. E., Hall, F. G., Huemmrich, K. F., . . . Lim, T. (2006). A Landsat Surface Reflectance Dataset for North America, 1990–2000. *IEEE Geoscience and Remote Sensing Letters*, 3(1), 68–72. <https://doi.org/10.1109/lgrs.2005.857030>
46. Mayomi I. & Jimme A. M.(2014),a decade assessments of maiduguri urban expansion (2002 geospatial approach. *Global journal of human-social sciences*, 14(2).
47. Milesi, C., (2003). Assessing the impact of urban land development on net primary productivity in the southeastern United States. *Remote Sensing of Environment*, 86(3), 401–410. [https://doi.org/10.1016/s0034-4257\(03\)00081-6](https://doi.org/10.1016/s0034-4257(03)00081-6)
48. Mohammed, H., Dayyabu, H.A. and Muhammed, U. (2018) assessment of consumption rate of solid biomass fuels and the consequent environmental impact in maiduguri metropolis. *Open journal of air pollution*, 7, 34-47.
49. Nyanganji, J.K. (1996): towards sustainable management of the ngadda catchments, maiduguri. Letter day pub. Nga maiduguri.
50. Obiefuna J. N., P. C. Nwilo, A. O. Atagbaza and C.J. Okolie (2013). Spatial Changes in the wetlands of Lagos/Lekki Lagoons of Lagos, Nigeria. 6(7).
51. Omogunloye O. G. and O. O. Ayeni (2012) “ Geospatial Analysis of Hotels in Lagos State with Respect to Other Spatial Features” CiteSeerx – Developed and hosted by The College of Information Science and Technology, The Pennsylvania State University. ”*Research Journal in Engineering and Applied Sciences*” (2012), (ISSN-2276-8467), RJE, Vol 1, No(6), Pp-393 – 403
52. Oyinloye, M. A. (2010). Spatial Analysis of Urban Growth in Akure, Nigeria; Unpublished PhD Thesis, Federal University of Technology, Akure, Nigeria.
53. Oyinloye, M.A. (2010) Spatial Analysis of Urban Growth in Akure, Nigeria. Unpublished PhD Thesis, Department of Urban and Regional Planning, Federal University of Technology, Akure.
54. Oyinloye, M.A. (2013). Geospatial Analysis of Urban Growth- The Case of Akure, Nigeria *American Journal of Social Issues and Humanities*, 3(4): 200 – 212.
55. Pontius R. G. and H. Chen (2006). Land-Use and Cover Change Modeling, Clark University, www.econgeography.org/~rpontius/pontius_chen_2006_idrisi.pdf · PDF file
56. Sarkar, A (2019): *Practical Geography- A systematic Approach*, Orient Blackswan Private Limited, Hyderabad, pp 395-415.
57. Schowengerdt, R.A. (2007) *Remote Sensing, Third Edition: Models and Methods for Image Processing*. Elsevier, Arizona.
58. Shettima M.K, Mayomi I and Daura, M.M.(2019),geospatial assessment of the impact of topography on flood vulnerability in maiduguri, nigeria. *Jalingo journal of social and management sciences*, 1(4).
59. Singh, S. K., Srivastava, P. K., Pandey, A. C., & Gautam, S. K. (2013). Integrated Assessment of Groundwater Influenced by a Confluence River System: Concurrence with Remote Sensing and Geochemical Modelling. *Water Resources Management*, 27(12), 4291–4313. <https://doi.org/10.1007/s11269-013-0408->
60. Smith, A. J. (2006) Monitoring and predicting urban land use change: Application of multi-resolution multi-temporal satellite data. *IGRASS’03 proceedings.2003 IEEE International*.Vol.3pp.1567-1569
61. Thaddaeus, J.(2015),the potentials of plastic wastes recycling in maiduguri metropolis. *International journal of advanced research*, 3, (8), 624-634.
62. Turner, L.A. (2003) Data Collection Strategies in Mixed Methods Research. In: Tashakkori, A.M. and Teddlie, C.B., Eds., *Handbook of Mixed Methods in Social and Behavioral Research*, SAGE Publications, Thousand Oaks, 297-319.
63. Verburb P.H., K. Kok, R.G. Pontius and A. Veldkamp (2006) Modeling land-use and land-cover change. In: *Land-use and land-cover change*. Springer, Berlin, pp 117–135.
64. Waziri M (2012). Spatial pattern of maiduguri city. *Researchers' guide*. First published 2009 by adamu joji publishers no. 123 mangwarori street, kano state, nigeria.
65. Waziri, M. (2009) spatial pattern of maiduguri city: researchers’ guide. Adamu joji publishers, kano city.
66. Weng Q., (2003). Land use change analysis in the Zhujiang Delta of China using satellite remote sensing, GIS and stochastic modelling, *Journal of Environmental Management*, Volume 64, p. 273–284.
67. Weng, Q, Qiao, L., Yang, S, and Guo, H.(2003). Guangzhou’s growth and urban planning, 1960-1997 an analysis through remote sensing. *Asian Geographer*, Vol.22(1-2), pp.77-92.

68. Wilkie, D.S., and Finn, J.T. (2009) Remote Sensing Imagery for Natural Resources Monitoring. Columbia University Press, New York. p. 295.
69. Wing, M.G (2008): Geographic Information Systems- Application in Natural Resource Management, Oxford University Press, New York, pp 2-24.
70. Yakubu M., Odihi J.O., Lawan Z.A. and Hassan.(2018), impact of anthropogenic activities on the quality of shallow groundwater of the chad basin in maiduguri, nigeria. International journal of physical and human geography, 4(2).
71. Zhang, H., Li, T., & Han, J. (2020). Quantifying the relationship between land use features and intra-surface urban heat island effect: Study on downtown Shanghai. Applied Geography, 125, 102305. <https://doi.org/10.1016/j.apgeog.2020.102305>
72. Zubair, A.O. (2008). Monitoring the Growth of Settlement in Ilorin, Nigeria (A GIS and Remote Sensing Approach). The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science, 3(7): 225-232.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details