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Research Paper

Assessment of Land Use and Land Cover Changesin Wukari, Taraba State

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Abstract
A lot of changes has occurred overtime, urban development and the likes have taken place, a lot of agricultural lands are lost which might lead to food scarcity, flooding and deforestation are gradually becoming the order of the day, rivers and ponds are being lost, the ecosystem is imbalanced. As a result, there was a need to examine the land use and land cover changes in Wukari from 2004 to 2024 at 5 years' interval, the study made use of series of Landsat satellite imagery, at a resolution of 30m. This study assessed land use/land cover (LULC) changes in Wukari LGA from 2004 to 2024 using change detection analysis and community surveys.
The data was processed using ArcGIS 10.8 software to establish the land use-land cover situations for 20 years, the changes that occurred was noted
The classified maps were exported from GEE and further processed in ArcMap 10.8 for cartographic visualization. ArcMap was used to create detailed LULC maps for each year and transition period, producing a clear representation of spatial patterns. Microsoft Excel was used to produce tables and statistical summaries. Excel was used in the computation of area statistics, transition matrices, and trend analysis.
The result shows that Wukari LGA's landscape has undergone major transformation over the past two decades, with urban growth as the primary driver of change.
It is strongly recommended that strong government policies should be made to regulate unplanned urban expansion and safeguard agricultural lands.
Keywords: *land use - land, changes, geospatial technique*

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I. Introduction

Wukari, isa major town in SouthernTaraba, Nigeria, it has experienced noticeable changes in land use and land cover because of increase in population, agricultural growth,improved infrastructuraldevelopment, and other human activities. These changes that have occurred for years basically has environmental and socio-economic implications, which includes but not limited to deforestation, loss of biodiversity, soil degradation, and unplanned urban sprawl. Despite the importance of understanding these land changes, there is limited up-to-date, spatially accurate information on the extent and nature of LULC transformation in Wukari. This data which is turned into information will assist the government, planners, and environmental managers to improve land management strategies.

The inadequate comprehensive assessment tools and geospatial analysis in the study area leaves a critical gap in sustainable land use planning. Therefore, it is essential to assess and monitor the spatio-temporal changes in land use and land cover using geospatialtechnologies to provide a betterunderstanding of how Wukari's landscape has changed over time.

This study seeks to bridge this gap by analyzing satellite imagery across selected years to detect patterns, trends, and drivers of LULC changes in Wukari, thereby supporting informed decision-making and environmental sustainability,

II. Aim And Objectives Of The Study

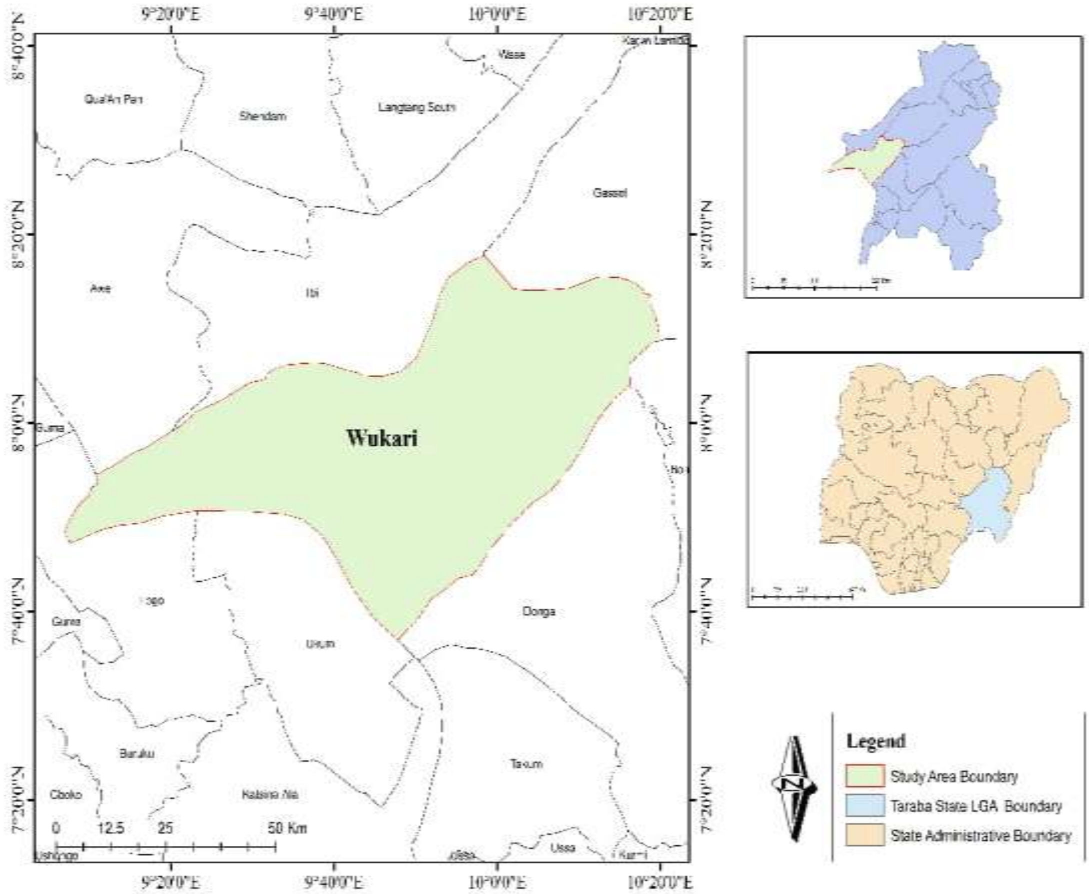
The aim of this research is to examine the temporal changes in land use and land covers in Wukari, specific objective are:

1) Classification of Land Use and Land Cover Changes over time
2) Determine the factors driving Land Use and Land Cover Changes in Wukari town

3) Investigate the current Land Use and Land Cover types in Wukari
4) Examine the socio-economic impacts of Land Use and Land Cover changes in Wukari town

Study Area

Wukari is located in the southern part of Taraba State, Nigeria, situated in the northeastern region of the country. It lies between latitude 7º.87'N and longitude 9º78'E.The town serves as the administrative headquarters of the LGA.Covering an area of about 4,308square kilometers, Wukari shares boundaries with several LGAs: Donga to the north, Ibi to the west, and Takum to the south. It also borders parts of Benue State to the southwest. The area is accessible via major roads connecting it to Jalingo (the state capital), Makurdi, and other neighboring towns. Ifatimehin et al., 2009.



Source: Authors analysis

III. Materials And Methods

The method provides a detailed explanation of how the research was carried out.

Data Acquisition

The study utilized Landsat imagery to capture the land use/land cover (LULC) changes in Wukari LGA over the period from 2004 to 2024. The satellite images used are detailed in Table 1. For the years 2004 to 2014, Landsat 7 images were used. These images were acquired using the Enhanced Thematic Mapper Plus (ETM+) sensor, which provided a spatial resolution of 30 meters. Specifically, images from paths 189 and rows 54/55 were used for this period. For the years 2019 to 2024, a combination of Landsat 8 and Landsat 9 images were employed. Landsat 8's Operational Land Imager (OLI) and Landsat 9's OLI-2 sensors were used, which also provided a spatial resolution of 30 meters. The images were selected based on minimal cloud cover (less than 10%) and were acquired during the dry season (January–March) to avoid phenological variations that could affect classification accuracy. The acquisition details, including dates and WRS paths/rows, are provided in Table 1

Table 1: Details of Landsat Imagery Used for LULC Analysis in Wukari LGA

Year		Sensor	Cloud Cover (%)	Acquisition Date	WRS Path/Row
2004		Landsat 7 ETM+		2004-02-15	
2009		Landsat 7 ETM+		2009-03-20	
2014		Landsat 7 ETM+	10	2014-02-10	189/54, 189/55
2019		Landsat 8 OLI		2019-01-25	
2024		Landsat 9 OLI-2		2024-02-28	

Source: Researcher’s Result (2025)

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Image Preprocessing

All images were preprocessed to ensure good quality data. Radiometric correction was applied to minimize the effects sensor degradation and atmospheric conditions. For Landsat 8 and 9 images, the Reflectance LaSRC (Landsat Surface Code) algorithm was used, while for Landsat 7 images, the LEDAPS algorithm was applied. This step ensured accurate surface reflectance values. Geometric correction was performed to align images, achieving a root mean square error (RMSE) of less than 0.5 pixels. Atmospheric correction utilized the Dark Object Subtraction (DOS) method to minimize haze and aerosol effects, ensuring consistent reflectance values across all time points

The study employed the Support Vector Machine (SVM) algorithm within the Google Earth Engine (GEE) platform for LULC classification. Training samples were collected using a stratified random sampling approach, making sure all LULC classes are represented very well. These samples was gotten from high-resolution imagery (e.g., Google Earth Pro) and field surveys conducted in 2024.

The accuracy of each classified map was effectively examined making use of the confusion matrix. Validation samples were independently collected using a systematic sampling approach, with 300 points per class (total 1500 points per year).

Change detection was performed using post-classification comparison within GEE. This involved comparing LULC maps from consecutive time periods to identify transitions between classes. The change detection matrices, as detailed in Table 2

The maps thatwere classified was then exported to GEE and further processed in ArcMap 10.8 for cartographic visualization. ArcMap software was used to create detailed LULC maps for each year and transition period, giving a legible representationof every spatial patterns. Tables and statistical summaries was created making useof Microsoft Excel

Objective-Specific Analysis Methods

Objective 1: classification of Land Use and Land Cover Changes over time

Method Used:

i Remote sensing and GIS analysis were used to classify satellite images of Wukari town for different years.

ii Image classification (such supervised classification) was applied to identify various land use/land cover types.

iii Changes between years were examined and analyzed making us of using**change detection techniques**, and results were displayed in the form of maps and tables.

Objective 2: Determine the factors driving Land Use and Land Cover Changes in Wukari town

Method Used:

Data from awell-**structuredquestionnaire**was used in the form of descriptive **statistics** (frequencies and percentages) to identify major driving forces.

Factors that includes but not limited to population growth, urban expansion, economic activities, and government policies were assessed based on respondents' answers.

Objective 3: Investigate the current Land Use and Land Cover types in Wukari

Method Used:

i . current satellite imagery was processed using an appropriate GISsoftware for classification and mapping of existing land use types for example as built-up areas, farmland, forest, and water bodies.

ii. ground trothing was done to validate the classification.

- Results was discussed inconnection to local livelihoods and community well-being.

Objective 4: examine the socio-economic impacts of Land Use and Land Cover changes in Wukari town

Method Used:

- Questionnaire data related to socio-economic impacts (e.g., on agriculture, income, housing, and employment) were analyzed using **frequencies, percentages, and charts**.
- The degree of impact on households was also measured and categorized (e.g., significant, moderate, slight)

IV. Result And Discussion

This chapter presents the results of the Land Use and Land Cover (LULC) analysis for Wukari LGA, showing spatial and temporal changes from 2004 to 2024.

The following sections present the LULC maps, accuracy metrics, and change patterns for each study year, offering a comprehensive view of the area's landscape transformation.

Table 3: Land Use/Land Cover (LULC) Distribution from 2004 to 2024

Land Cover Type	2004 (ha)	2009 (ha)	2014 (ha)	2019(ha)	2024 (ha)
Agricultural Land	382,430.788	330,038.582	353,206.495	322,792.148	366,623.869
Bare Surface	1,489.262	1,077.462	1,419.616	963.042	1,158.401
Built-up Area	2,460.587	3,031.493	3,939.130	4,693.095	6,528.533
Vegetation	36,988.289	89,812.962	64,821.541	93,541.142	47,960.465
Waterbody	3,205.475	2,613.901	3,187.618	4,584.974	4,303.115
Total	**426,574.4**	**426,574.4**	**426,574.4**	**426,574.4**	**426,574.384**

Source: Researcher's Result (2025)

LULC classification of Wukari LGA in 2004 shows a root l baseline for more analysis of land use evolution

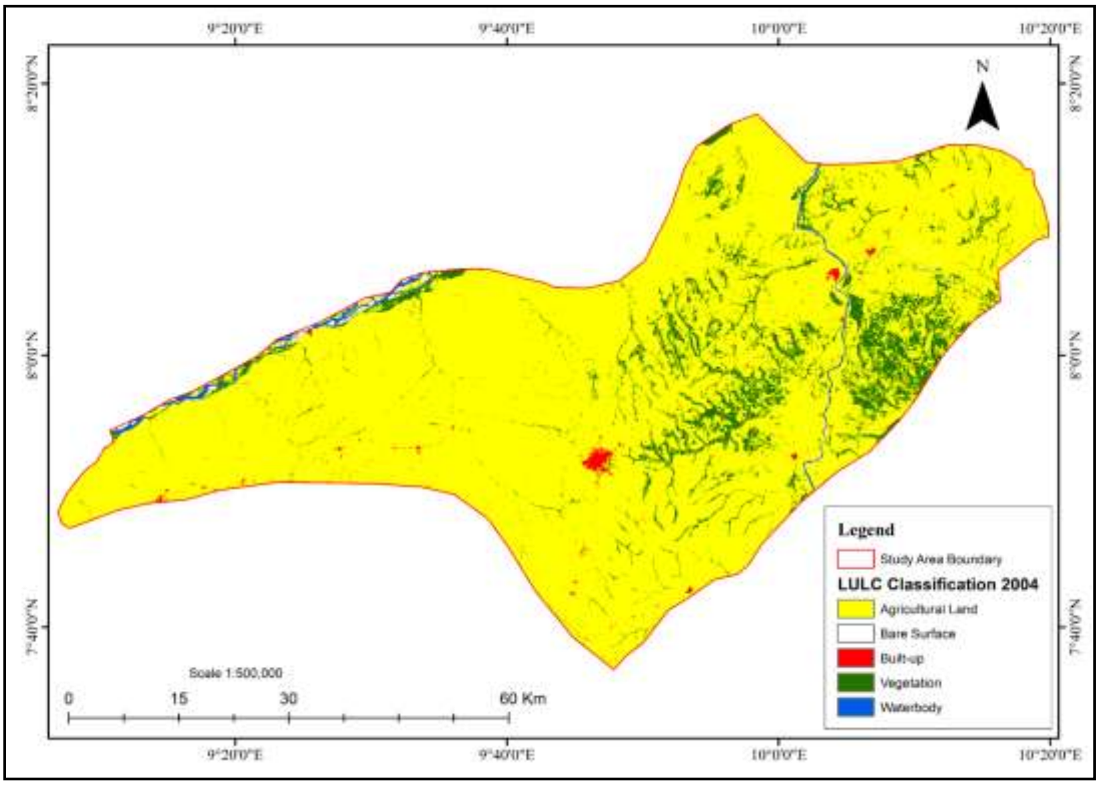

Figure 1. 1: LULC Classification 2004

The 2009 LULC dataset shows a tangible transformation in Wukari's land use configuration

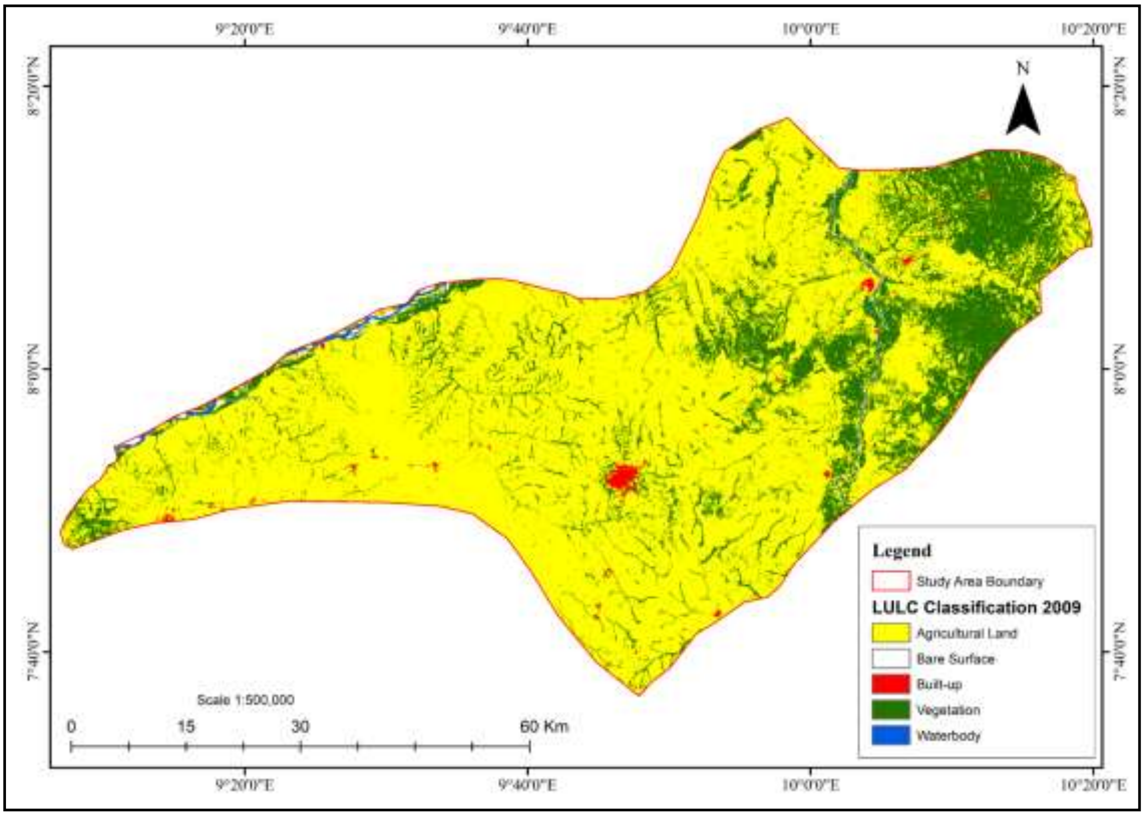

Figure 1. 2: LULC Classification 2009

The 2014 LULC analysis of Wukari LGA continues to show land use evolution with significant characteristics

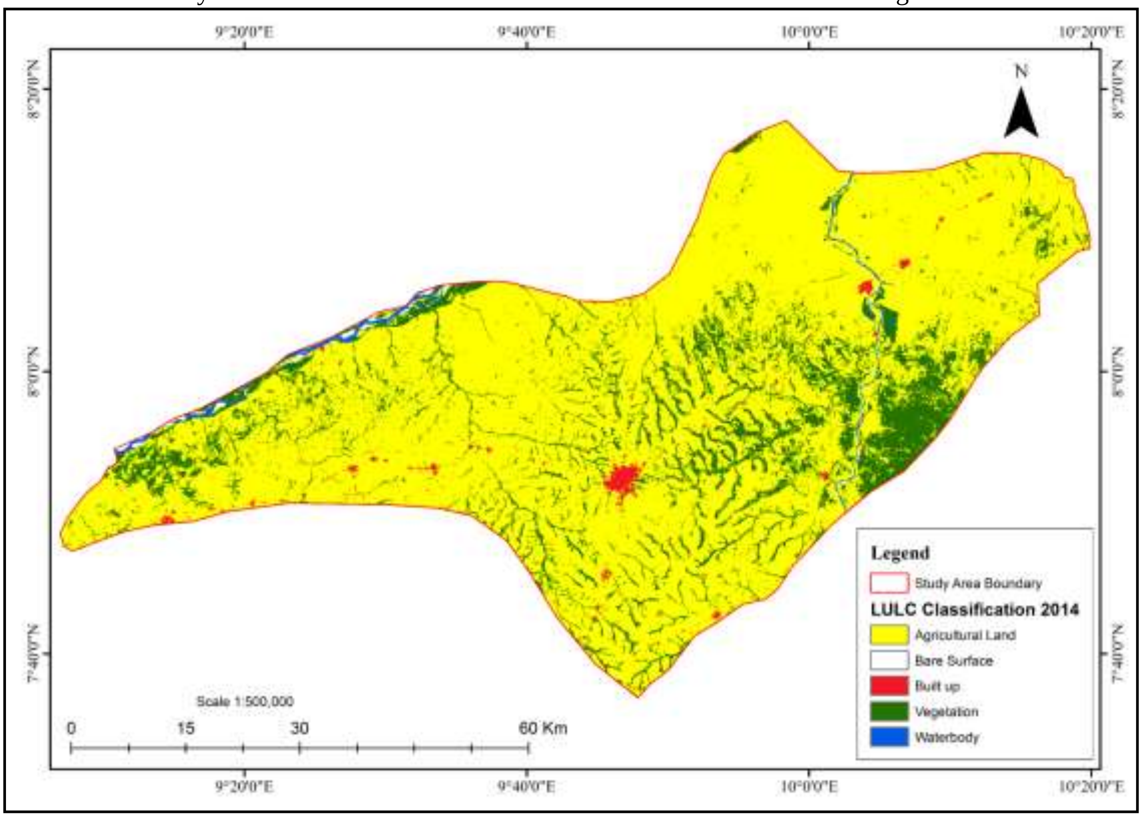

Figure 1. 3: LULC Classification 2014

The 2019 LULC dataset for Wukari LGA reveals further complexities in land use transformation.

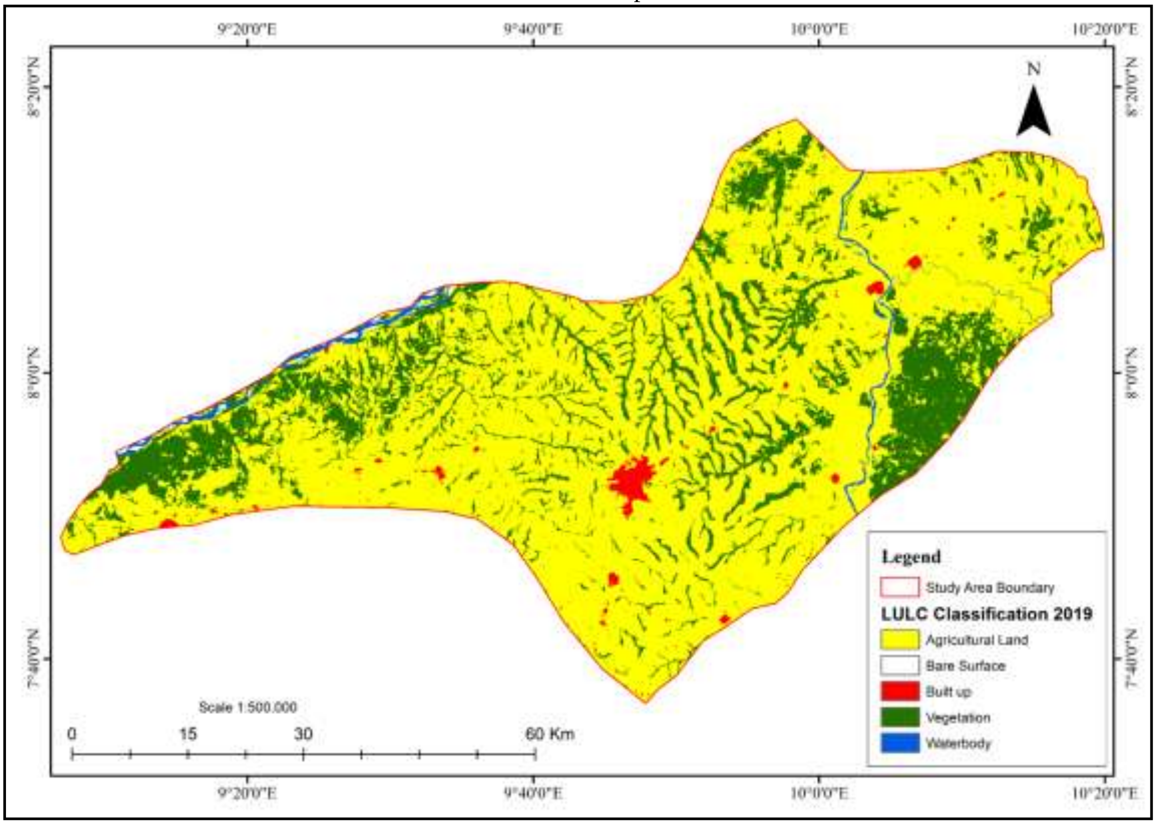

Figure 1. 4: LULC Classification 2019

The 2024 LULC analysis of Wukari LGA presents a NUANced landscape of land use evolution. Agricultural land rebounded to 366,623.87 hectares, suggesting renewed agricultural investment or conversion of non-agricultural lands to cultivation town throughout the two-decade study period.

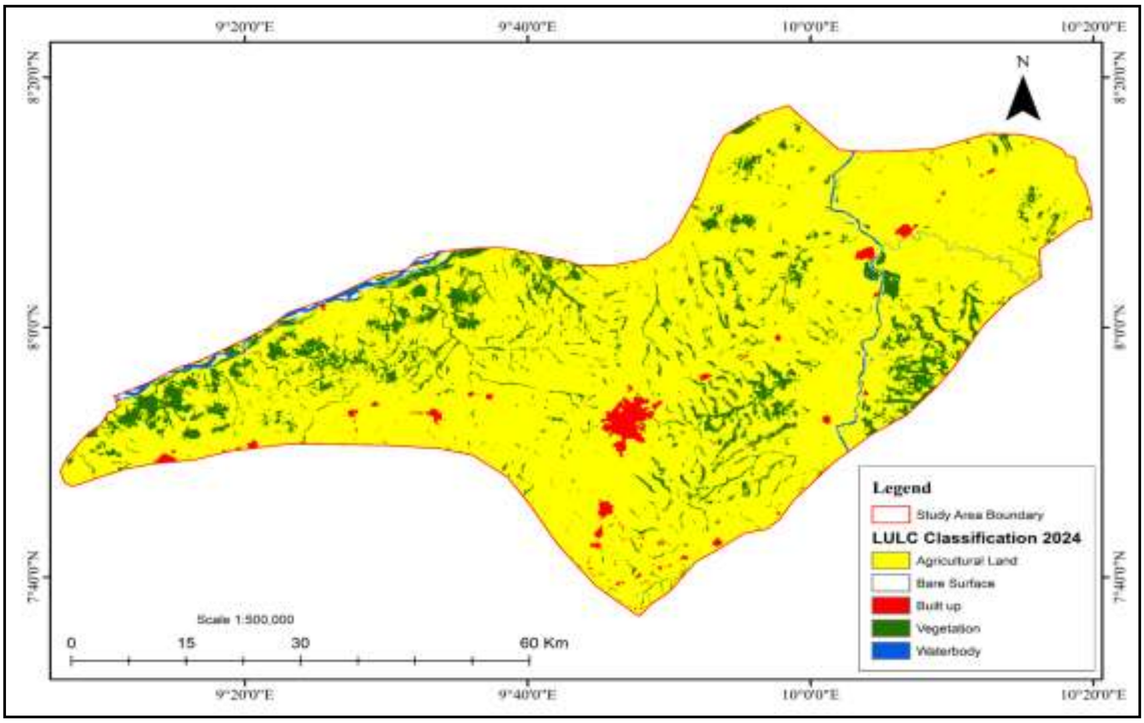

Figure 1. 5: LULC Classification 2024

Table 4.: Classification Accuracy Assessment (2004–2024)

Year	Overall Accuracy	Kappa Coefficient
2004	0.9762	0.9664
2009	0.8947	0.8615
2014	0.9610	0.9426
2019	0.9444	0.9237
2024	0.9240	0.9085

Source: Researcher's Result (2025)

The questionnaire data supports this observation, with 47.6% of respondents identifying population growth and urbanization as the primary driver of land changes in Wukari LGA, and 36.5% of respondents observing the expansion of built-up areasMeanwhile, Agricultural Land experienced a net decrease, shrinking from 382,430.79 hectares in 2004 to 366,623.87 hectares in 2024, despite some periods of resurgence. This fluctuation highlights a dynamic relationship between agriculture, urbanization, and vegetation

Table 5: Land Use/Land Cover Transition Matrix (Area in Hectares) – 2004 to 2024

Status	Change (2004–2009)	Change (2009–2014)	Change (2014–2019)	Change (2019–2024)	Change (2004–2024)
Agricultural Land (No Change)	292,116.47	313,208.73	301,807.10	309,589.09	342,915.68
Bare Surface → Agricultural Land	176.07	538.03	108.99	58.03	492.32
Built-up → Agricultural Land	136.34	137.86	1,094.64	245.91	391.93
Vegetation → Agricultural Land	60,649.25	15,629.20	19,744.77	56,478.85	22,608.10
Waterbody → Agricultural Land	107.42	527.51	11.72	263.51	201.61
Agricultural Land → Bare Surface	276.90	49.16	34.18	41.10	88.71
Bare Surface (No Change)	569.85	518.15	775.55	530.72	456.93
Built-up → Bare Surface	87.78	71.21	0.06	0	77.92
Vegetation → Bare Surface	38.51	0.16	5.32	1.41	6.15
Waterbody → Bare Surface	446.14	437.67	146.04	583.85	527.26
Agricultural Land → Built-up	1,070.05	690.92	1,795.38	2,075.78	4,635.60
Bare Surface → Built-up	4.19	74.51	3.41	0	10.97
Built-up (No Change)	2,693.37	2,129.66	2,764.17	4,444.45	1,814.31
Vegetation → Built-up	153.90	6.93	127.53	5.58	64.60
Waterbody → Built-up	3.28	131.38	0	0.25	0
Agricultural Land → Vegetation	35,969.48	68,337.75	48,750.26	10,869.09	33,778.54
Bare Surface → Vegetation	12.16	56.98	0.09	0.63	11.12
Built-up → Vegetation	2.05	20.60	55.61	0.30	13.22
Vegetation (No Change)	28,867.0841	21,362.4841	44,727.5541	37,011.8541	14,170.7141
Waterbody → Vegetation	8.40	33.22	39.18	72.55	7.44
Agricultural Land → Waterbody	606.08	105.43	790.40	216.24	961.58
Bare Surface → Waterbody	313.85	301.50	530.33	372.22	517.16
Built-up → Waterbody	113.97	98.52	9.24	0	159.62
Vegetation → Waterbody	106.53	34.00	265.48	48.55	198.55
Waterbody (No Change)	2,045.26	2,072.82	2,987.38	3,664.42	2,464.35
Total	**426,574.3841**	**426,574.3841**	**426,574.3841**	**426,574.3841**	**426,574.3841**

Source: Researcher's Result (2025)

LULC Changes from 2004 to 2009

The period from 2004 to 2009 marked the initiation of significant LULC transformations in Wukari LGA. During this interval, agricultural land experienced notable changes, with 35,969.48 hectares transitioning to vegetation, likely reflecting fallow practices, agricultural land abandonment, or reforestation initiatives. This shift is evident in Table 5, which quantifies the extent of land transitioning from agricultural land to vegetation. Additionally, 1,070.05 hectares of agricultural land were converted to built-up areas, signaling the initial phases of urban encroachment into agricultural zones. Table 5 highlights the area of agricultural land that transitioned to built-up areas. Conversely, 60,649.25 hectares of vegetation were converted back to agricultural use, possibly driven by expanding agricultural activities or changes in land use policies. This reverse transition is also detailed in Table 5. Built-up areas expanded into bare surfaces, with 4.19 hectares undergoing this change, as indicated in the table. Waterbodies showed a net gain during this period, expanding by 606.08 hectares from agricultural land and 313.85 hectares from bare surfaces. However, waterbodies also lost area to agricultural land (107.42 hectares), vegetation (8.40 hectares), and built-up expansion (3.28 hectares). these changes are comprehensively documented in TABLE 5. FIGURE 4.6 provides a cartographic visualization of these changes, highlighting the spatial distribution of LULC transitions during this interval.

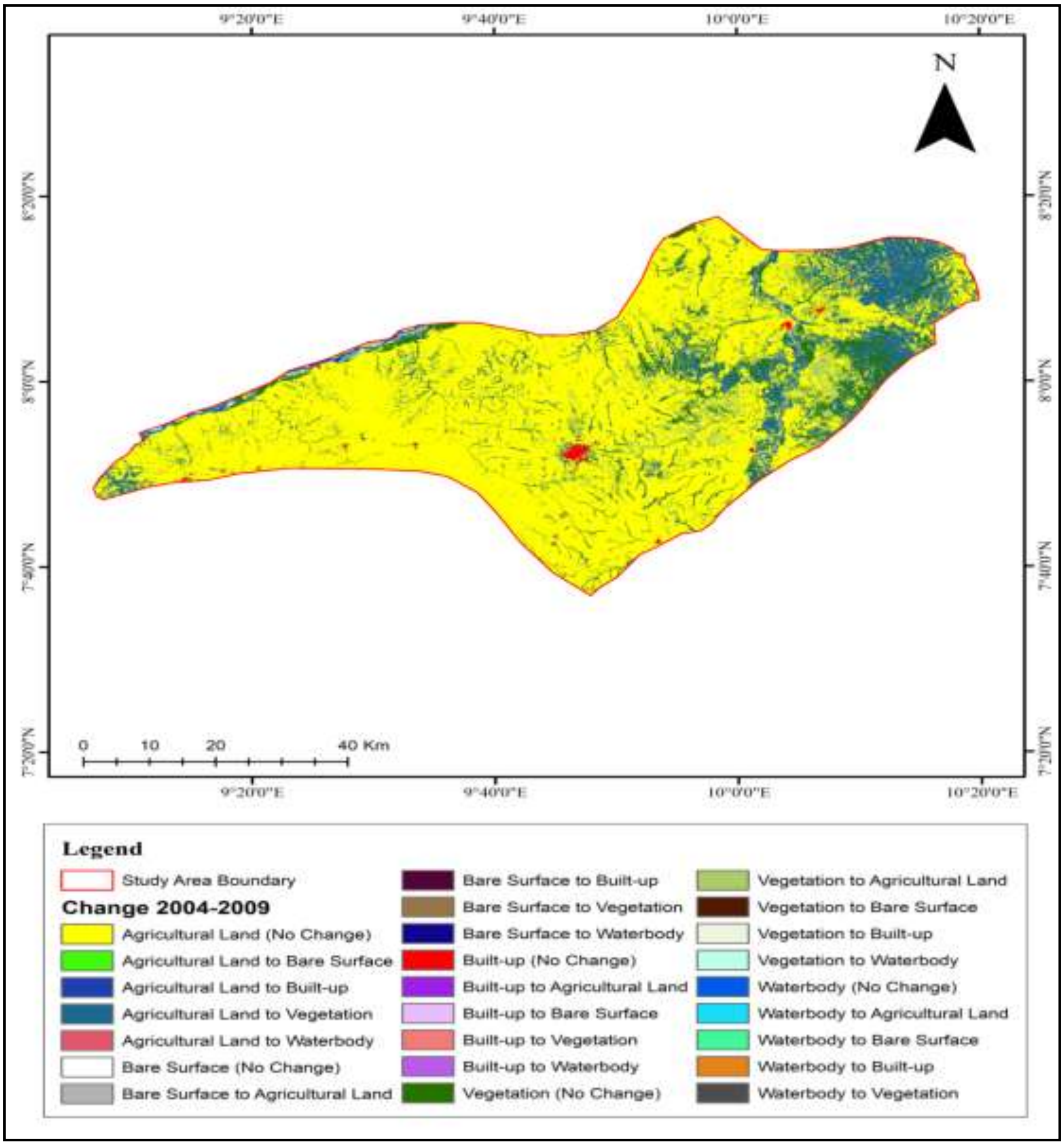

Figure 1. 6: LULC Changes in Wukari Town from 2004 to 2009

LULC Changes from 2009 to 2014

From 2009 to 2014, the LULC dynamics in Wukari LGA continued to evolve with distinct patterns. Agricultural land saw a substantial shift of 68,337.75 hectares to vegetation, indicating large-scale land use changes possibly linked to agricultural restructuring or environmental conservation efforts. This significant transition is quantified in Table 4.3. Conversely, 15,629.20 hectares of vegetation were converted back to agricultural use, as detailed in the table. Built-up areas further expanded, claiming 690.92 hectares from agricultural land and 74.51 hectares from bare surfaces. Table 4.3 highlights these expansions. Notably, 20.60 hectares of built-up areas were reclaimed for vegetation during this period, a reversal also captured in the table. Waterbodies continued to expand, converting 11.72 hectares of agricultural land and 530.33 hectares of bare surfaces. However, they also lost smaller areas to agricultural land (11.72 hectares) and vegetation (39.18 hectares). These dynamics are comprehensively documented in TABLE 4.3. FIGURE 4.7 offers a visual depiction of these changes, illustrating the spatial dynamics of LULC transitions during this interval.

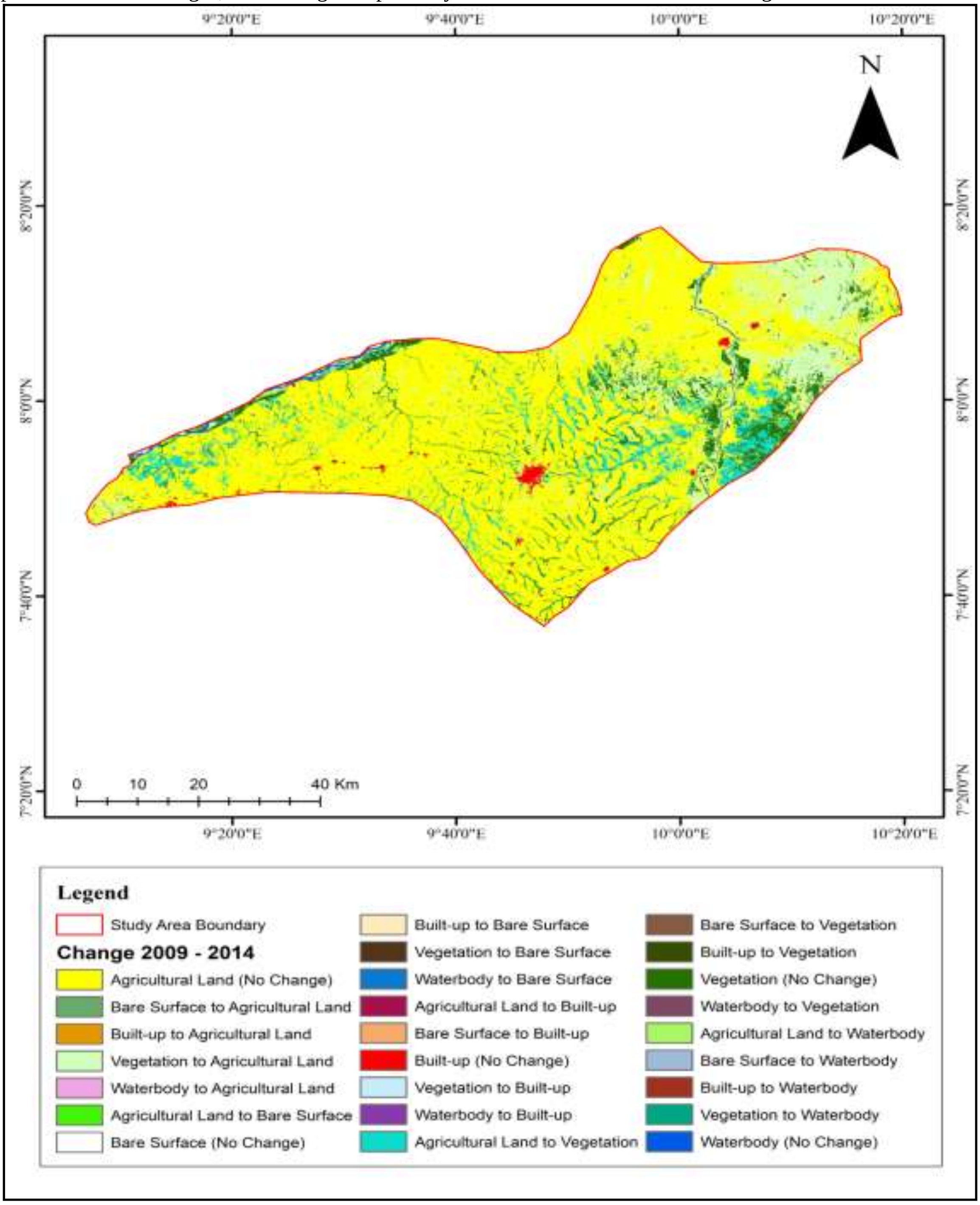

Figure 1. 7: LULC Changes in Wukari Town from 2009 to 2014

3 LULC Changes from 2014 to 2019

The period from 2014 to 2019 revealed a nuanced pattern of LULC changes in Wukari LGA. Agricultural land continued to undergo significant transformations, with 48,750.26 hectares transitioning to vegetation. This substantial shift is quantified in Table 4.3. However, there was a notable increase in agricultural land gained from vegetation, amounting to 19,744.77 hectares, as detailed in the table. Built-up areas expanded further into agricultural lands by 1,795.38 hectares and into vegetation by 127.53 hectares. These expansions are highlighted in Table 4.3. Waterbodies demonstrated continued expansion, converting 790.40 hectares of agricultural land and 146.04 hectares of bare surfaces. Conversely, they lost area to vegetation (265.48 hectares) and built-up expansion (9.24 hectares). These changes are comprehensively documented in Table 4.3. Figure 4.8 provides a cartographic representation of these changes, highlighting the spatial distribution of LULC

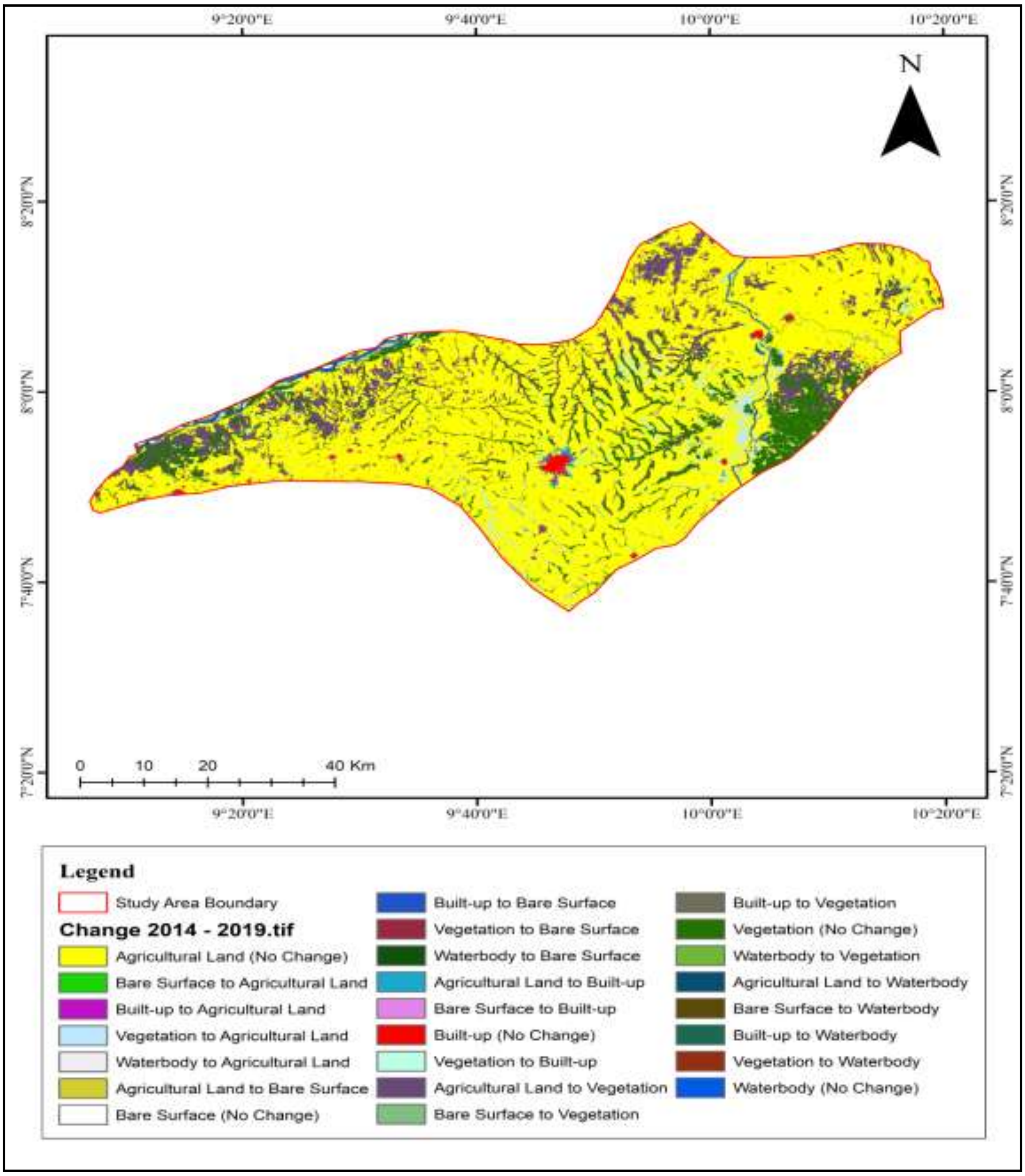

Figure 1.8: LULC Changes in Wukari Town from 2014 to 2019

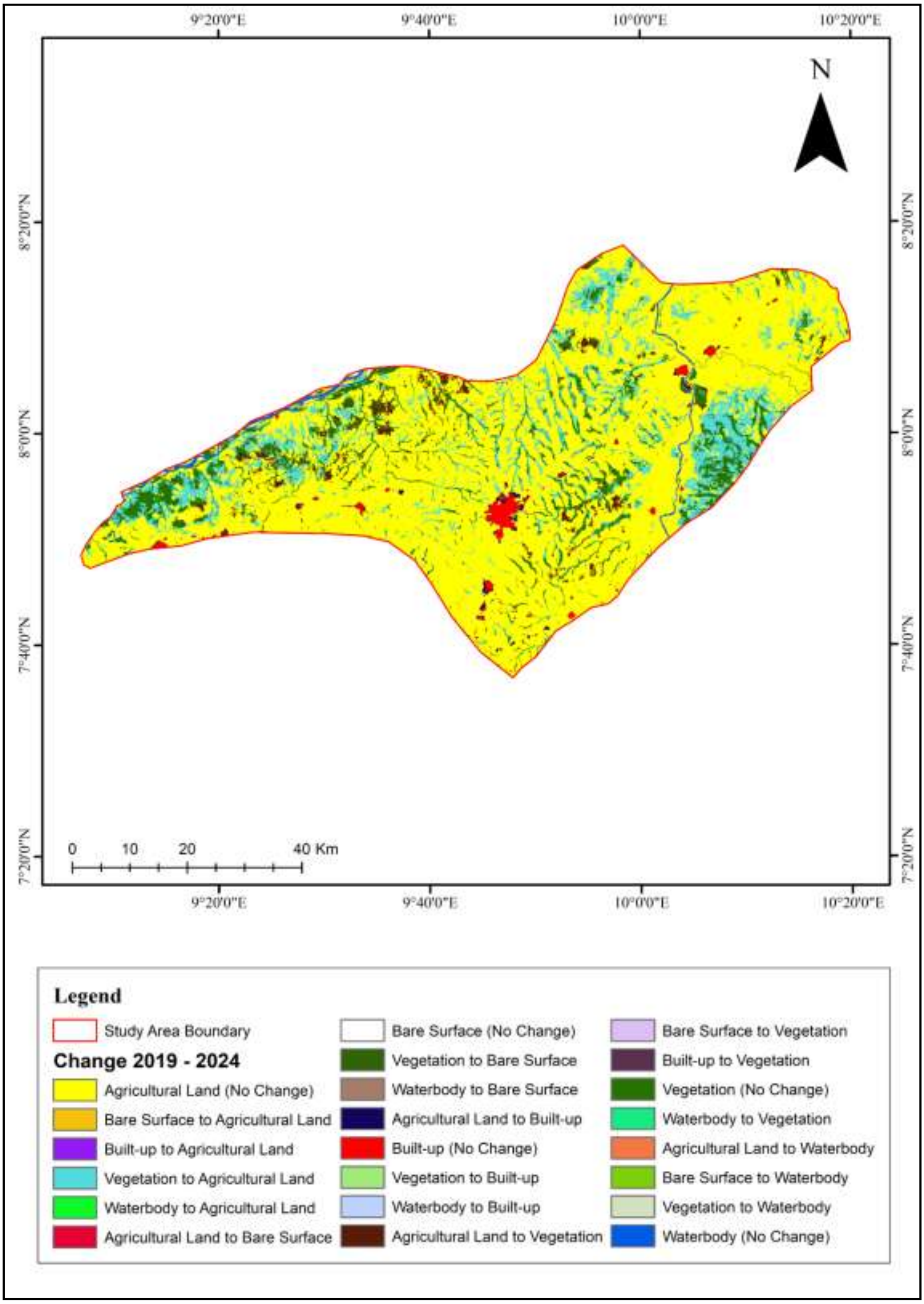

Figure 1. 9: LULC Changes in Wukari Town from 2019 to 2024

LULC Changes from 2019 to 2024

The most recent interval, from 2019 to 2024, showed a contraction in agricultural land transitions to vegetation, with 10,869.09 hectares converting. This change is quantified in Table 4.3. Meanwhile, agricultural land derived from vegetation reached 56,478.85 hectares, as detailed in the table. Built-up areas underwent significant expansion, claiming 2,075.78 hectares from agricultural land and 5.58 hectares from vegetation. These expansions are highlighted in Table 4.3. Waterbodies exhibited a contraction trend, losing 216.24 hectares to agricultural land, 372.22 hectares to bare surfaces, and 48.55 hectares to vegetation. These changes are comprehensively documented in Table 4.3. Figure 4.9 offers a visual representation of these changes, illustrating the spatial dynamics of LULC transitions during this interval.

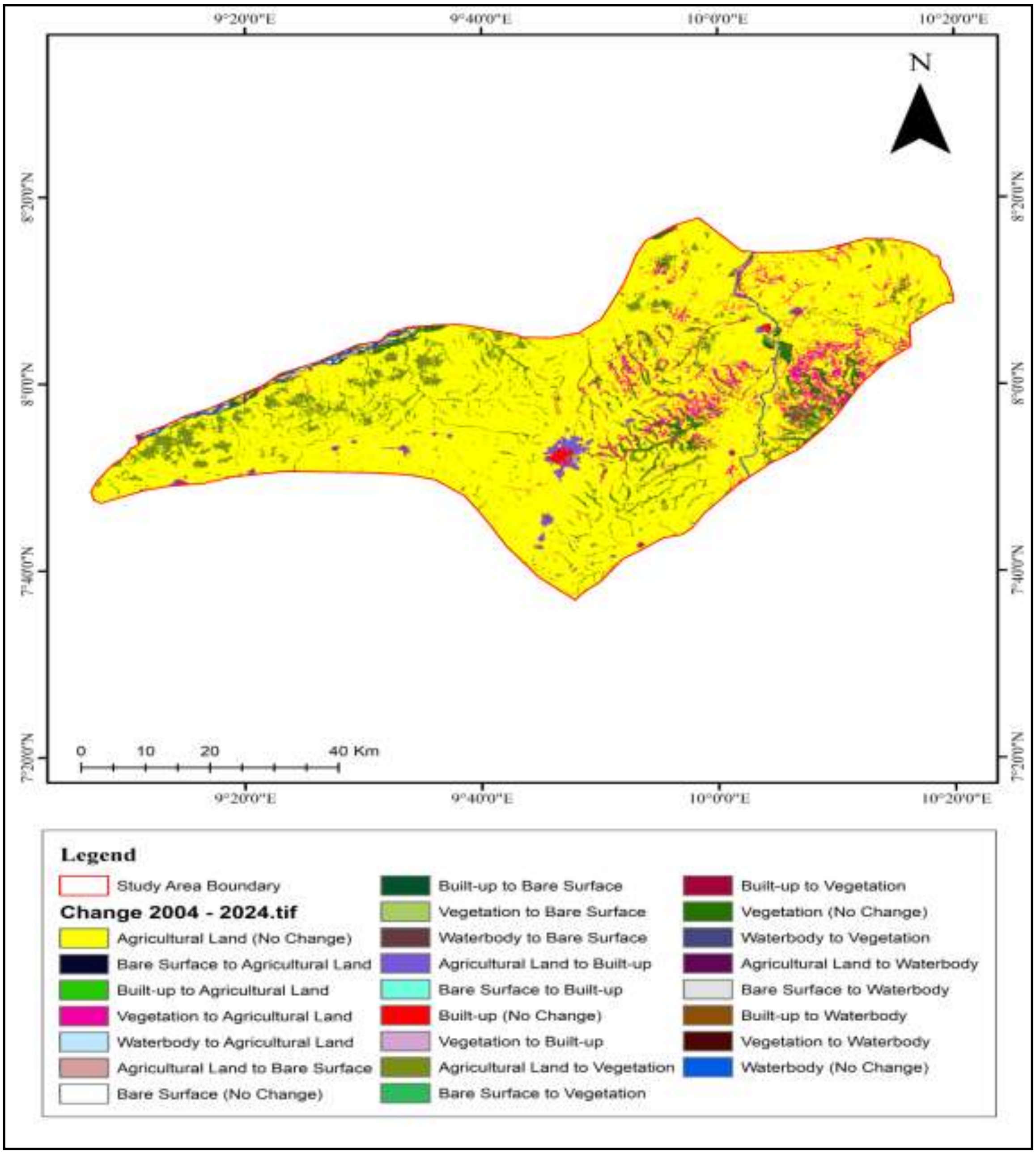

Figure 2: LULC Changes in Wukari Town from 2004 to 2024

SUMMARY OF LULC CHANGES FROM 2004 TO 2024

The comprehensive change detection analysis reveals a complex tapestry of LULC transformations in Wukari LGA from 2004 to 2024

V. Discussion

The analysis of LULC changes in Wukari LGA from 2004 to 2024 at 5 years' interval shows series of changes into the development of the local government area developmental and environmental transitions. The results clearly showthat that urbanization has been a very strong force, with built-up areas regularly expanding and other land use categories paying the price especially agriculture.

VI. Summary, Conclusion And Recommendations

Summary of Findings

This study assessed land use/land cover (LULC) changes in Wukari LGA from 2004 to 2024 using change detection analysis and community surveys. The results revealed complex and dynamic transformations driven largely by socio-economic pressures, environmental management practices, and natural processes.

The findings indicate that Wukari LGA's landscape has undergone significant transformation over the past two decades, with urban growth as the primary driver of change.

It is strongly recommended that strong government policies should be made to regulate unplanned urban expansion and safeguard agricultural lands.

The most significant component taken into account in studies of global change

Is land use change (Loveland et al., 2000; Tsarouchi & Buytaert, 2018; Rolando etal, 2017). According to jatua (1993) variations in climatic elements plays a great role in influencing agricultural practices and the general lives of the inhabitants of an area. Overall assessments have indicated that climate change is largely induced by human factors especially clearance of vegetation cove

The conversion of forests and other natural habitats into agricultural land can have long-lasting impacts on ecosystems and biodiversity (Awotwi et al., 2018). However, man continues to harm forests through a range of anthropogenic activities, despite how essential they are to both human existence and the ecosystem Abdullahi et al 2017, Wajim 2020

Deforestation is defined as the clearing and removal of forest trees when the land is used for non-forest purposes (FAO 2022). Adetoye et al 2017, (Ibrahim, 2023).

The impacts of LULC change are profound, affecting environmental quality, biodiversity, and human livelihoods Furthermore, recent literature analysis of other urban areas of Nigeria and other sub-Saharan African cities revealed an inconsistent association between the impacts of land use changes on agricultural lands. Statuto ,2016 and Zemba 2012

Remote sensing is widely used for monitoring LULC changes because it provides consistent, large-scale coverage over time. Satellite data, such as from Landsat, MODIS, and Sentinel, can detect changes in vegetation cover, urban expansion, and deforestation. Landsat's long-term data availability makes it particularly valuable for historical analysis of LULC trends (Wulder et al., 2012

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