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Research Article

A Geospatial Assessment of Campus Growth on the Urbanization of Ado Ekiti, Ekiti State Nigeria

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Abstract

This study examines the influence of campus growth on the urbanization of Ado Ekiti, Ekiti State, Nigeria, focusing on metropolitan urban sprawl. Utilizing both primary and secondary data, the research sources original data from the Ekiti State Office of the Surveyor General, which includes boundary point coordinates for three major institutions: Federal Polytechnic Ado Ekiti, Afe Babalola University Ado Ekiti (ABUAD), and Ekiti State University (EKSU). Complementary satellite imagery data were obtained from Landsat 7 ETM (2004), Landsat 8 OLI-TIRS (2014), and Landsat 9 OLI-TRIS (2024), with a resolution of 30 meters. A fundamental aspect is the identification of changes in Land Use and Land Cover (LULC) over time, analyzed through remote sensing and GIS methods using Landsat imagery from the founding years of the campuses. The methodology involved preprocessing steps such as mosaicking and photo editing, followed by image enhancement techniques like histogram equalization. Supervised classification, particularly Maximum Likelihood Classification, was employed to categorize land cover into built-up areas, vegetation, and water bodies across the years 1998, 2004, 2014, and 2024. Buffer zones of one, two, and three kilometers were created around each campus using ArcMap's "Buffer" feature. The findings reveal that all three campuses significantly influence the local urban landscape, with ABUAD showing the most rapid expansion since its establishment. This study underscores the relationship between campus growth and urbanization dynamics in Ado Ekiti, emphasizing the need for ongoing monitoring and strategies to mitigate the effects of urban expansion in metropolitan areas.

Keywords

Assessment, Campus, Growth, Urbanization, Metropolitan, Urban Sprawl

1. Introduction

Higher institution campuses have shown to have a notable influence on the productivity of cities by serving as hubs for knowledge, innovation, and the construction of residential buildings. The connection between higher institution campuses and their host cities is influenced by various factors, including academic structures, research initiatives, social programs, and educational offerings provided by the institution. Institutions contribute innovative solutions to address societal and economic challenges, directly and indirectly benefiting the city. In return, cities cater to the needs of students and faculty by offering services, transportation, accommodation, and amenities. This reciprocal relationship is vital for building the competitive profile of both institution and cities [7]. While institutions often have close physical ties to cities for convenience, rising land prices and globalization have led to the development of

campuses on the city outskirts, impacting urban transformation. Consequently, higher institution campuses maintain both physical and functional relationships with cities, with proximity to the city core providing access to services, while campuses on the outskirts drive urban development, prompting the creation of new infrastructure to meet evolving needs [4].

The physical relationship between higher institution campuses and cities encompasses their topological positioning relative to each other, varying from being gated within, integrated with, or located outside the city. The spatial configuration further defines this relationship, influenced by the urban network connecting those [6]. As higher institution expand, their physical ties with cities evolve, with newly built campuses shaping new city centers due to increased student and staff populations, effectively making higher institution significant landholders in the city's morphological structure [2]. While some higher institution aim for self-sufficiency, providing necessary facilities and services, high levels of independence may lead to resource competition between educational objectives and service provision, highlighting the importance of a balanced relationship with the city [6]. However, proximity to higher institution campuses may increase vulnerability to crime, particularly in areas with high resident throughput like student neighborhoods [3].

Moreover, the physical connection between higher institution campuses and cities significantly influences the openness of the higher institution and students' social lives. Campuses located on the outskirts must cultivate their social environments to meet student needs, while greater openness to the city amplifies the campus's impact on its surroundings [5]. Residents' perception of campus publicness is closely tied to its physical relationship with the city center, shaping the emotional and social ecology of both the campus and surrounding urban areas [1]. Additionally, the campus-city physical relationship affects students' spatial requirements and academic performance, with integrated campuses facilitating group activities and potentially enhancing academic outcomes [7].

This paper underscores the evaluation of the Impact of Campus Expansion on Urbanization in Ado Ekiti, Ekiti State, Nigeria: A Study of Metropolitan Urban Sprawl Monitoring.

The Study Area

Ado-Ekiti, an ancient city in Nigeria, lies between latitudes 7° 34' and 7° 41' north of the equator and longitudes 5° 11' and 5° 16' east of the Greenwich meridian. Its history predates the establishment of the Ewi dynasty in 1310 AD. Approximately 700 years ago, during the princely endeavor initiated by descendants of Oduduwa from Ile-Ife, Ado-Ekiti gained prominence under the leadership of 'Oba Ado,' also known as the 'Elewi' [8]. Designated as the headquarters of the Ekiti Divisional Council in 1916, it attained the status of a state capital on October 1, 1996. With a recorded population of 257,519 individuals in the 2006

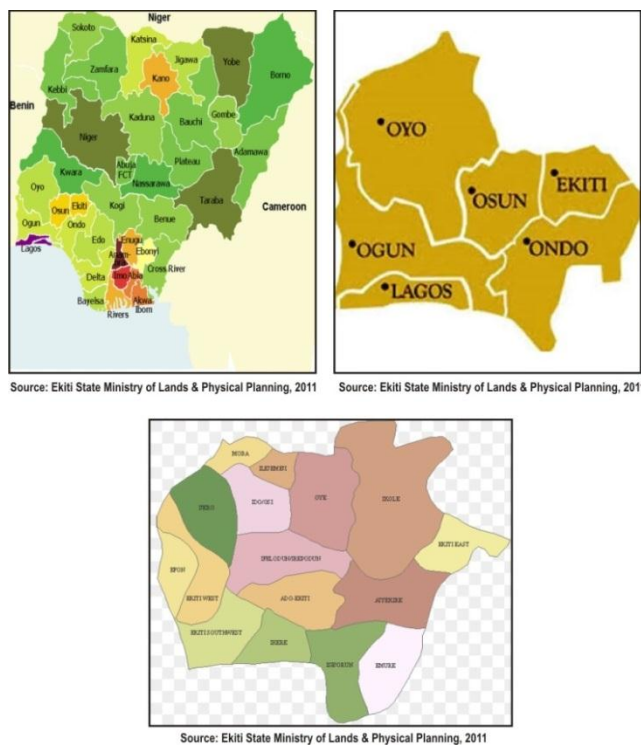census, Ado-Ekiti's urbanization trend suggests an estimated population of around 300,000 [9].

Source: Ekiti State Ministry of Lands & Physical Planning, 2011   Source: Ekiti State Ministry of Lands & Physical Planning, 2011

Source: Ekiti State Ministry of Lands & Physical Planning, 2011

Figure 1. Map of the study area.

2. Materials and Methods

This study assesses the impact of campus growth on the urbanization of Ado Ekiti in Ekiti State, Nigeria. The research primarily employed geographic coordinates and shapefiles for three educational institutions: Afe Babalola University (ABUAD), Ekiti State University (EKSU), and the Federal Polytechnic Ado-Ekiti. Additionally, satellite images from 1998, 2004, 2014, and 2024 were utilized, which were sourced from the official website of the United States Geological Survey (USGS).

The satellite data was acquired from Landsat satellites, specifically:

1) The 1998 images were obtained from Landsat 7 ETM, captured on October 16th.
2) The 2004 images were sourced from Landsat 8 OLI-TIRS, taken on March 23rd.
3) The 2014 images were from Landsat 8 OLI-TIRS, captured on December 14th.
4) The 2024 images were obtained from Landsat 9 OLI-TIRS, collected on January 16th.

The selection of the image dates was based on the quality of images available for each respective year, with preference given to those that exhibited minimal interference. All satellite images were projected to the WGS_1984_UTM_Zone_31N coordinate system, and the

geographic coordinates and shapefiles for the three campuses were georeferenced accordingly.

To analyze the surrounding land cover, buffer zones of 1 km, 2 km, and 3 km were created around each campus using the 'Buffer' tool in ArcMap. The 'Clip' tool was then used to extract land cover data within these buffer zones for each year. The Tabulate Area tool facilitated the calculation of built-up areas within each buffer zone, yielding quantitative data on the extent of urbanization around each campus. This methodology enabled a comprehensive analysis of the spatial extent and growth of built-up areas influenced by the campuses over the study period.

Data Processing

The satellite images underwent several preprocessing steps, including mosaicking and clipping to the study area,

followed by image enhancement techniques such as histogram equalization to improve feature visibility. To classify the images into different land cover classes—namely built-up areas, vegetation, and water bodies—supervised classification methods were employed, specifically the Maximum Likelihood Classification technique. Training data for each land cover class were collected, and classification accuracy was subsequently assessed. This classification process was carried out separately for each year: 1998, 2004, 2014, and 2024.

Additionally, buffer zones of 1 km, 2 km, and 3 km were created around each campus using the 'Buffer' tool in ArcMap. The summary results and analyses are presented in Figures 2 to 15 and Tables 1 to 7.

3. Results and Analysis
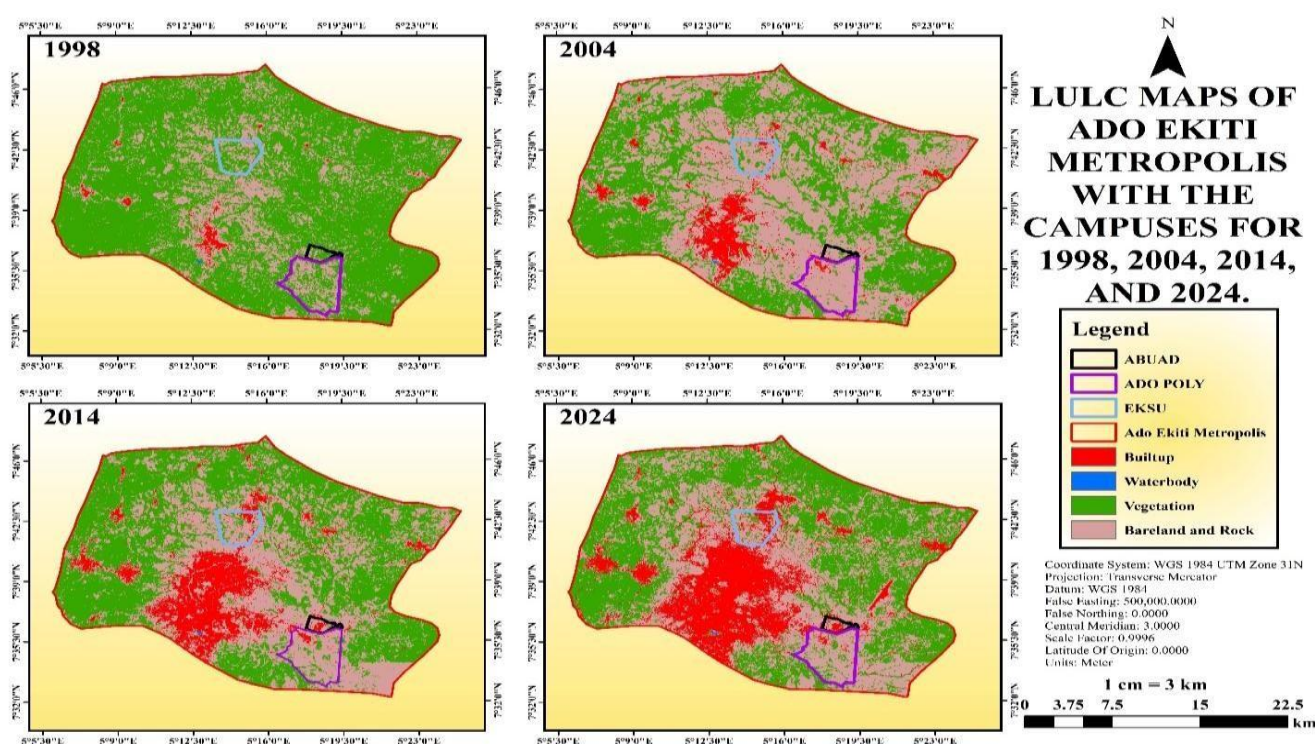
3.1. Maps of Lulc for the Study Area

Figure 2. *Maps of LULC of the Study area for the years considered.*

Table 1. *Table of Ado Ekiti Metropolis LULC data.*

ADO EKITI METROPOLIS LULC DATA				
LULC/YEAR	1998	2004	2014	2024
Builtup	6490	37942	83615	135097

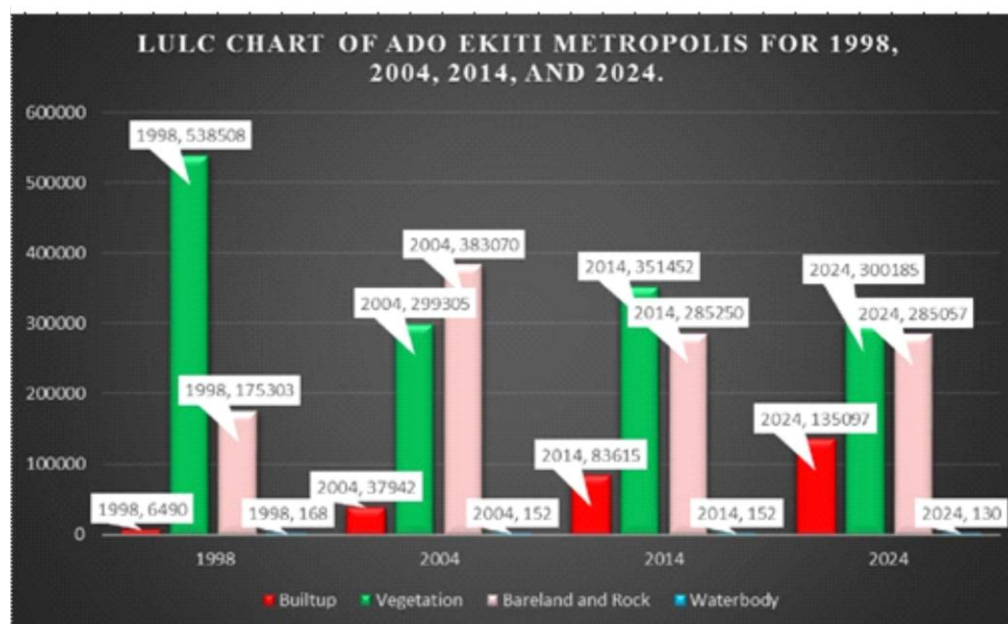| ADO EKITI METROPOLIS LULC DATA				
LULC/YEAR	**1998**	**2004**	**2014**	**2024**
Vegetation	538508	299305	351452	300185
Bareland and Rock	175303	383070	285250	285057
Waterbody	168	152	152	130
TOTAL	720469	720469	720469	720469

Figure 3. LULC charts of Ado Ekiti metropolis for the considered years.

Over the past 26 years, Ado Ekiti Metropolis has seen significant development. The built-up area increased dramatically from 6,490 hectares in 1998 to 135,097 hectares in 2024. Vegetation cover declined from 538,508 hectares to 300,185 hectares, reflecting urban expansion's impact on natural landscapes. Bareland and rock areas fluctuated, peaking in 2004, and waterbody areas slightly decreased from 168 to 130 hectares, showing minimal changes in water features.

The shift from predominantly rural land use to urbanized areas suggests a significant increase in housing, commercial buildings, roads, and other infrastructure. This urban sprawl has likely had profound impacts on the socio-economic landscape of Ado Ekiti, providing new opportunities for business and employment but also presenting challenges such as increased demand for services, infrastructure, and environmental management.

3.2. Maps of Lulc of Abuad with the Surrounding Area

The LULC data for Afe Babalola University, Ado Ekiti (ABUAD), established in 2009, highlights substantial campus development over the years. The built-up area surged from 13 hectares in 2009 to a projected 1303 hectares in 2024, reflecting the university's rapid expansion and the development of facilities, student housing, and infrastructure. Vegetation cover declined significantly from 2371 hectares to 215 hectares, illustrating the impact of urbanization on the natural environment. Bareland and rock areas fluctuated, peaking at 2643 hectares in 2004 before decreasing to 1830 hectares by 2024. No water bodies were recorded. This data underscores the significant transformation around ABUAD, stressing the importance of sustainable urban planning and environmental management to balance growth with ecological preservation.
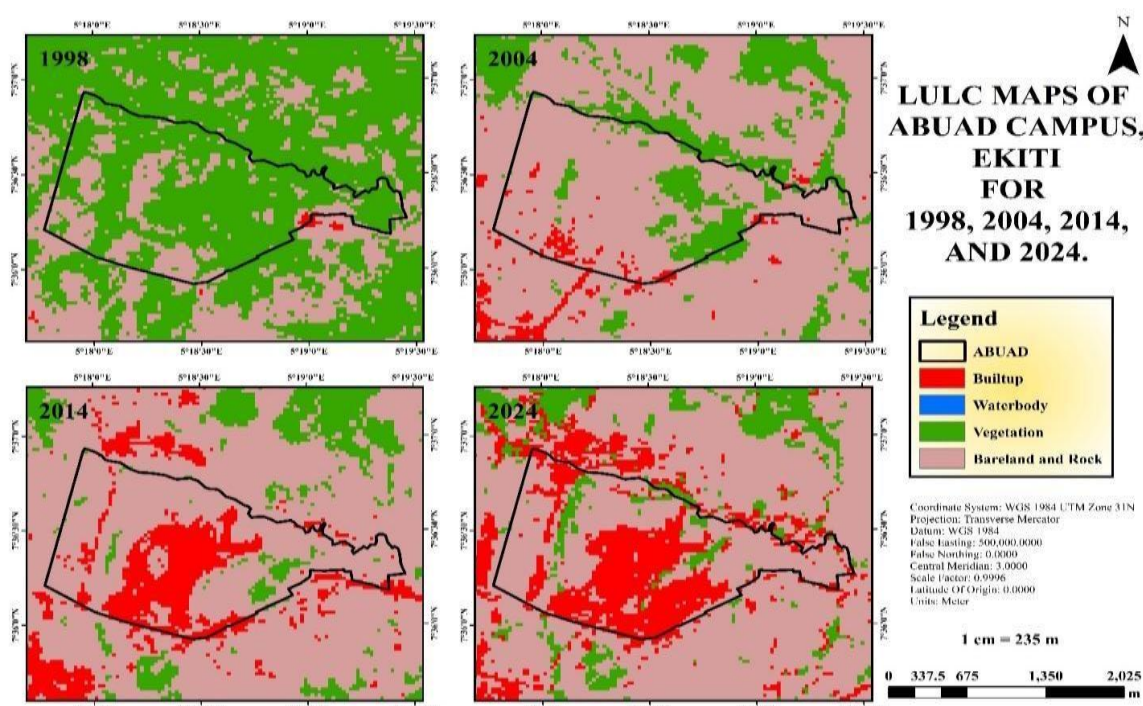
Figure 4. Maps of LULC of ABUAD with the surrounding area.

Table 2. Table of ABUAD LULC data.

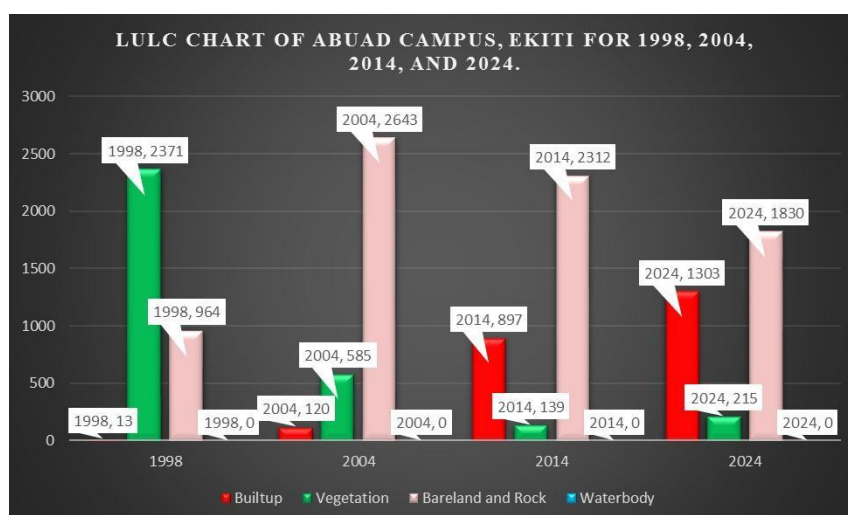| ABUAD LULC DATA				
LULC/YEAR	**1998**	**2004**	**2014**	**2024**
Builtup	13	120	897	1303
Vegetation	2371	585	139	215
Bareland and Rock	964	2643	2312	1830
Waterbody	0	0	0	0
TOTAL	3348	3348	3348	3348

Figure 5. LULC charts of ABUAD Campus, Ekiti for the considered years.

3.3. Maps of Lulc of Ado Poly with the Surrounding Area

The Land Use and Land Cover (LULC) data for The Federal Polytechnic, Ado-Ekiti, reveals significant changes from 1998 to 2024. The built-up area has expanded from 16 hectares in 1998 to 1677 hectares by 2024, indicating substantial campus development driven by the growth of academic buildings, facilities, and student accommodation. A comparison with ABUAD shows that the built-up area at this institution increased more rapidly over a shorter period (15 years) compared to Ado Poly (26 years).

The vegetation cover at Ado Poly decreased from 11,985 hectares in 1998 to 1441 hectares in 2004, and then slightly increased to 4201 hectares by 2024. This could be attributed to green initiatives aimed at mitigating the impact of urbanization on natural landscapes. Additionally, the bare land and rock areas at Ado Poly grew from 13,077 hectares in 1998 to 22,646 hectares in 2004 and then stabilized at approximately 19,200 hectares.
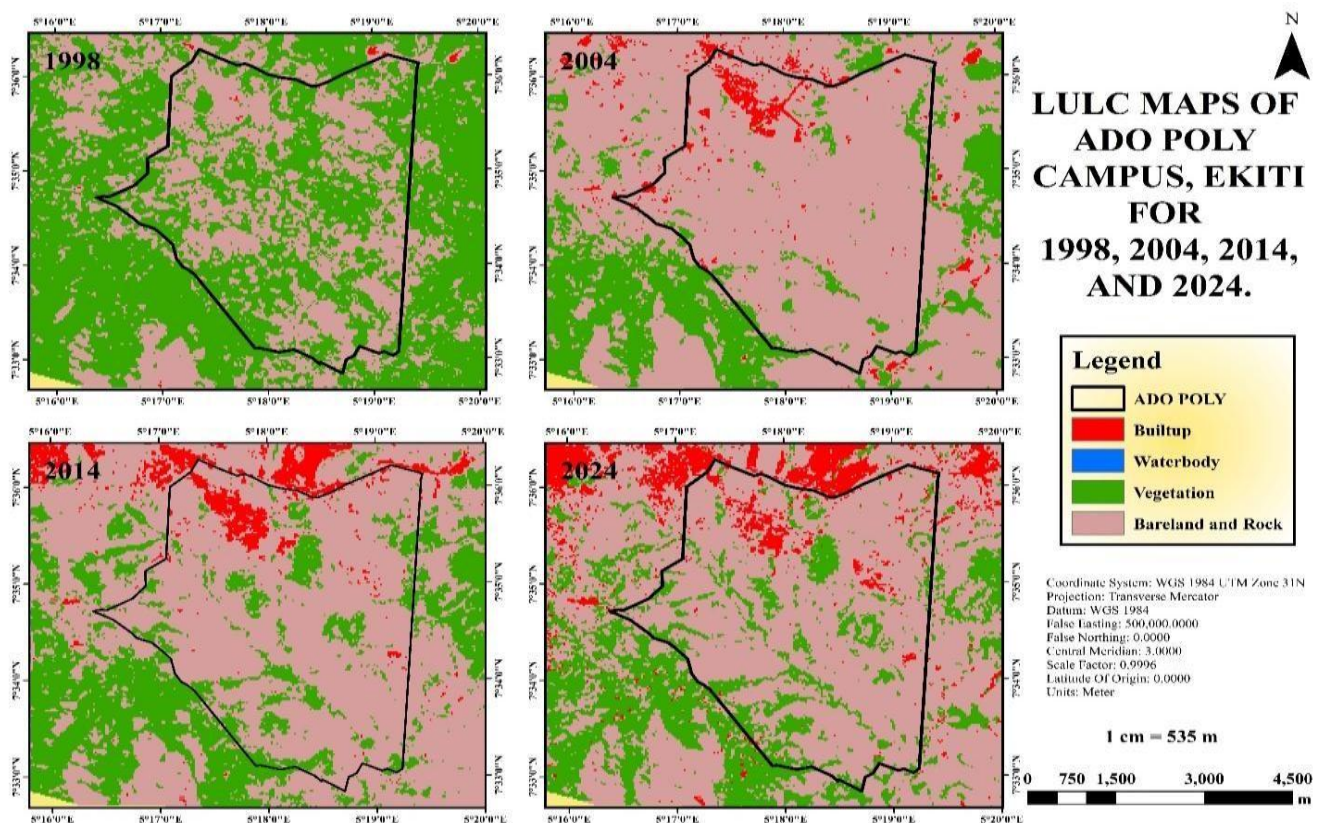

Figure 6. Maps of LULC of Ado poly with the surrounding area.

Table 3. Table of Ado Poly LULC data.

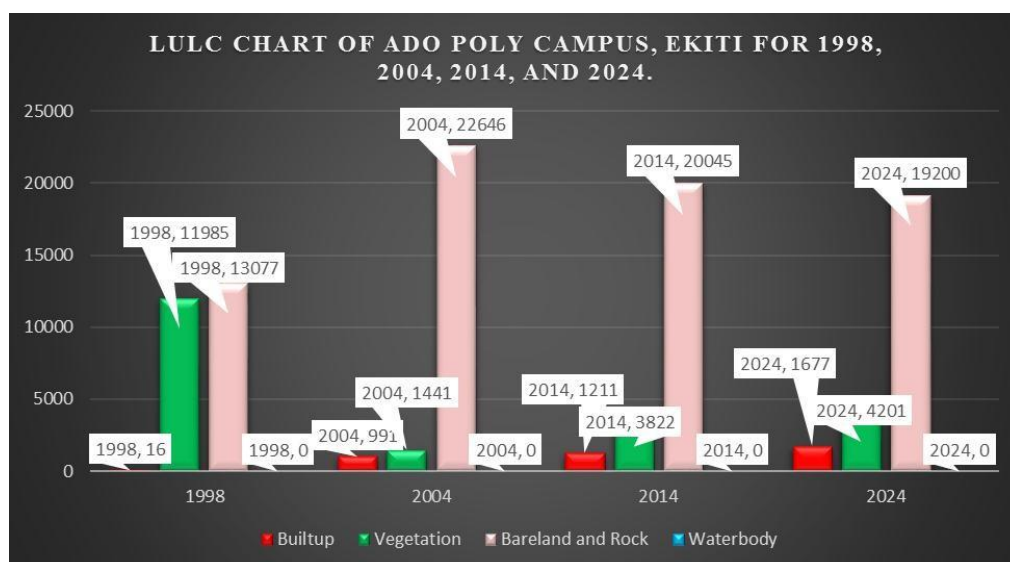| ADO POLY LULC DATA				
LULC/YEAR	1998	2004	2014	2024
Builtup	16	991	1211	1677
Vegetation	11985	1441	3822	4201
Bareland and Rock	13077	22646	20045	19200
Waterbody	0	0	0	0
TOTAL	25078	25078	25078	25078

Figure 7. LULC charts of Ado Poly Campus, Ekiti for the considered years.
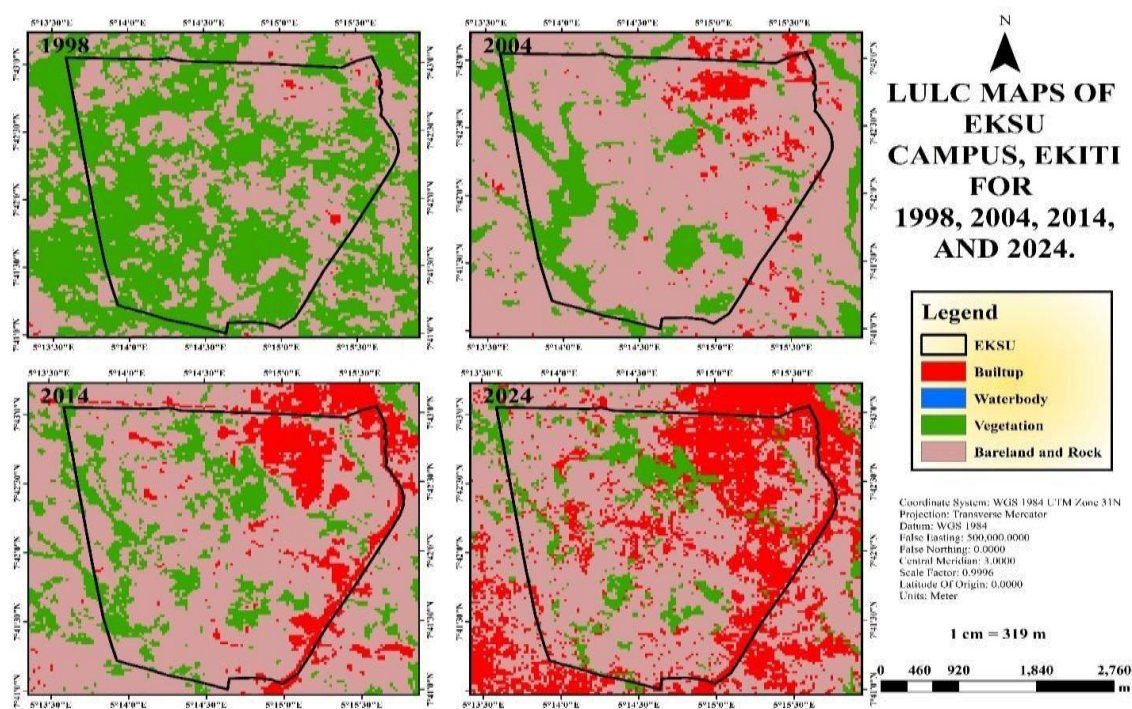
3.4. Maps of LULC of EKSU with the Surrounding Area

Figure 8. Maps of LULC of EKSU with the surrounding area.

Table 4. Table of EKSU LULC data.

EKSU LULC DATA				
LULC/YEAR	1998	2004	2014	2024
Builtup	49	683	1672	3385
Vegetation	7053	2411	2377	1600

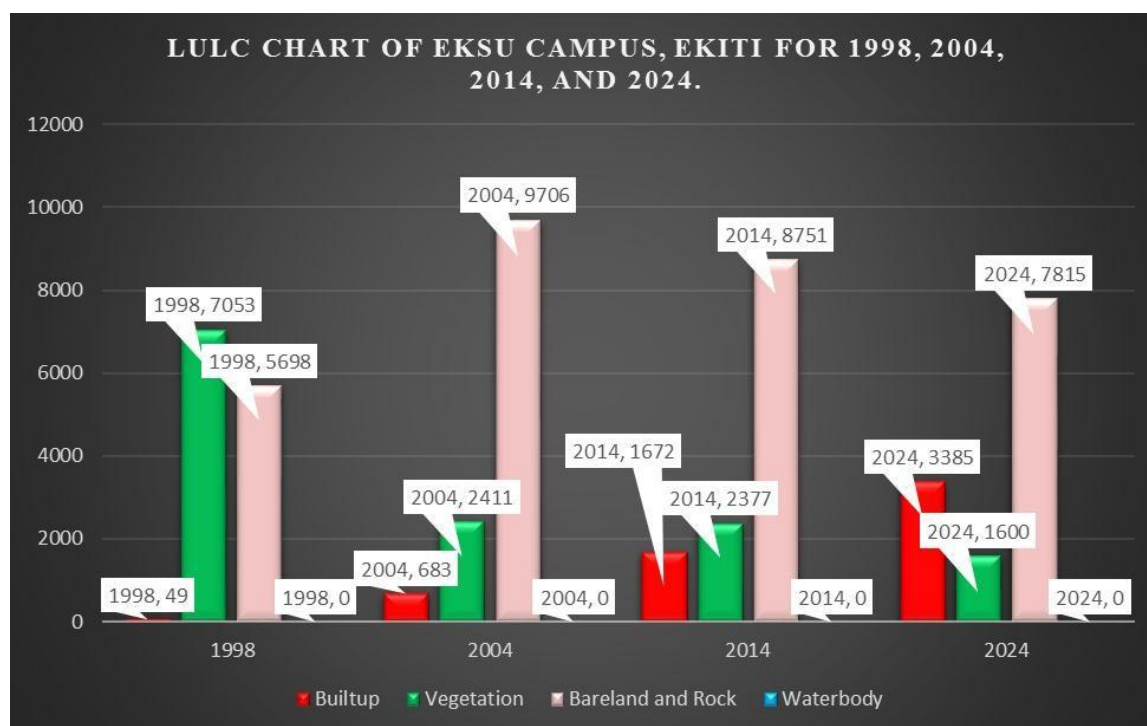|	EKSU LULC DATA			
LULC/YEAR	1998	2004	2014	2024
Bareland and Rock	5698	9706	8751	7815
Waterbody	0	0	0	0
TOTAL	12800	12800	12800	12800

Figure 9. LULC charts of EKSU Campus, Ekiti for the considered years.

Ekiti State University (EKSU), established as Obafemi Awolowo University, Ado-Ekiti on 30 March 1982 by the administration of Chief Michael Adekunle Ajasin, has witnessed substantial changes from 1998 to 2024. The LULC data reveals significant expansion, with the built-up area growing from 49 hectares in 1998 to a projected 3385 hectares in 2024. This growth reflects extensive campus development due to increasing facilities, infrastructure, and student population.

Vegetation cover decreased sharply from 7053 hectares in 1998 to 1600 hectares by 2024, indicating significant deforestation and land clearing for development purposes. The area of bare land and rock fluctuated, growing from 5698 hectares in 1998 to 9706 hectares in 2004, then decreasing to 7815 hectares by 2024. No water bodies were recorded throughout this period.

While all three campuses have seen significant growth, ABUAD experienced the most rapid expansion in terms of built-up area percentage increase, followed by Ado Poly, and then EKSU.

ABUAD's growth is particularly noteworthy given its shorter timeframe.

3.5. Maps of the Campuses with 1km, 2km and 3km Buffer Abuad

The Land Use and Land Cover (LULC) data for the area surrounding Afe Babalola University, Ado Ekiti (ABUAD) reveals significant urban development within 1km, 2km, and 3km buffers from 1998 to 2024.

In the 1km buffer zone, the built-up area increased from 69 hectares in 1998 to 1891 hectares in 2024. This dramatic growth reflects extensive campus expansion and associated infrastructure development.

Within the 2km buffer, the built-up area surged from 70 hectares in 1998 to 3547 hectares in 2024, indicating substantial urban sprawl as the university and surrounding community expanded.

The 3km buffer saw an increase from 72 hectares in 1998 to 5547 hectares in 2024, highlighting widespread

development and the transformative impact of ABUAD on the region's landscape.

Overall, the data illustrates the rapid and extensive urbanization around ABUAD, underscoring the university's significant influence on regional development over the past 26 years.
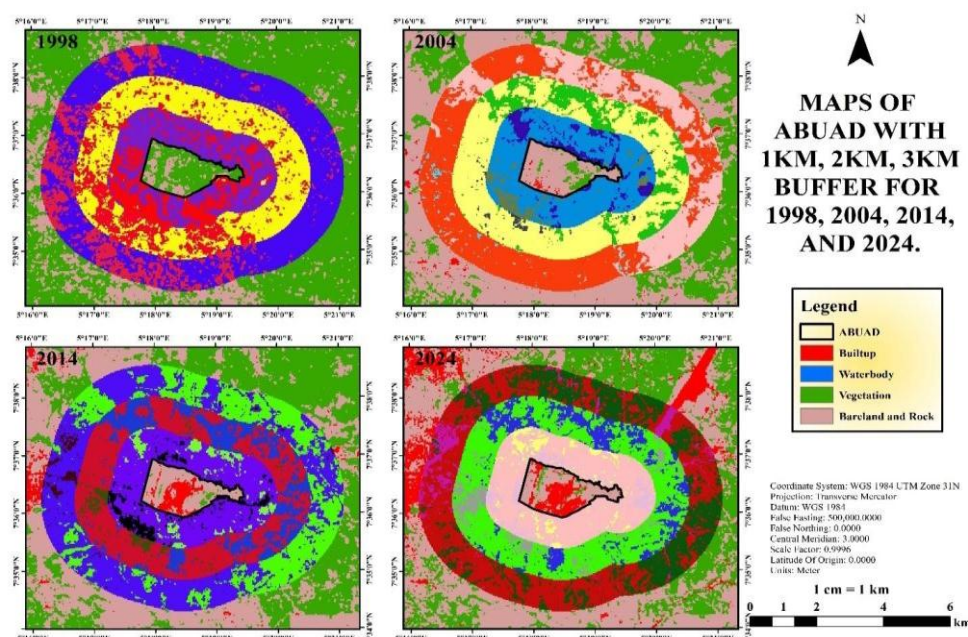

Figure 10. Maps of LULC of 1km, 2km and 3km buffer around ABUAD.

Table 5. Table of ABUAD Buffer built up data.

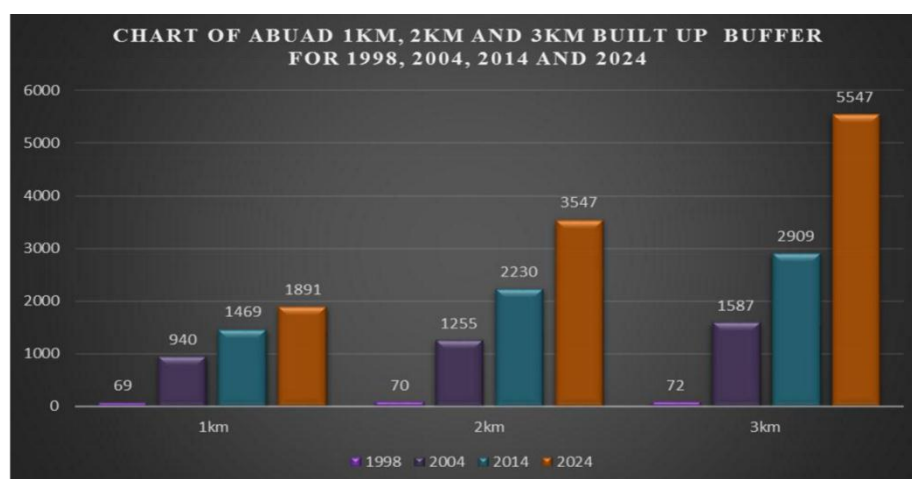| ABUAD BUFFER BUILD UP AREA			
YEAR/BUFFER	1km	2km	3km
1998	69	70	72
2004	940	1255	1587
2014	1469	2230	2909
2024	1891	3547	5547

Figure 11. LULC charts of 1km, 2km and 3km buffer around ABUAD.
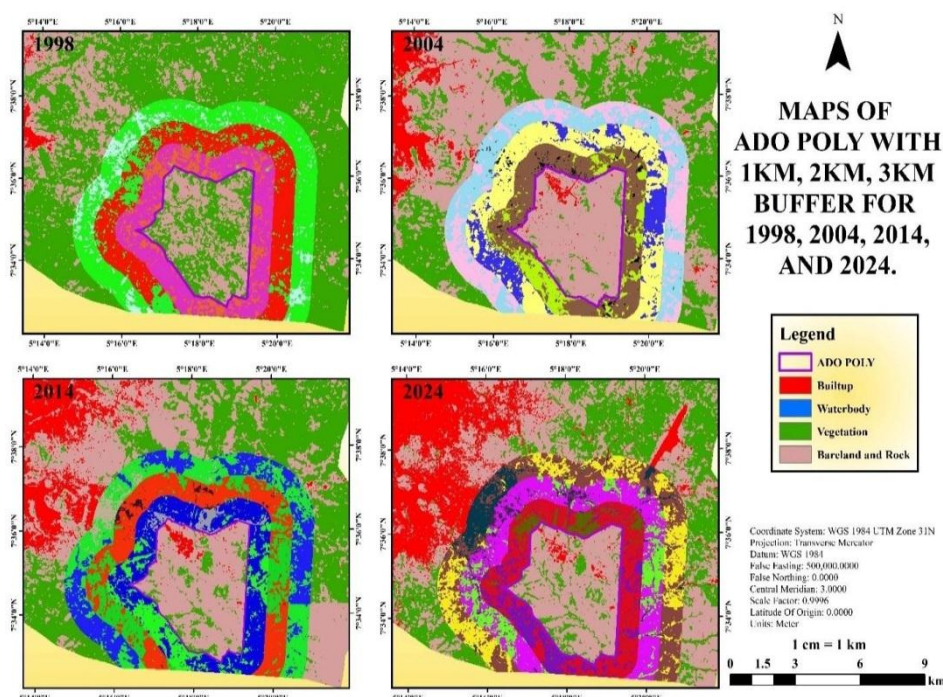
3.6. Ado Poly

Figure 12. Maps of LULC of 1km, 2km and 3km buffer around Ado Poly.

Table 6. Table of Ado Poly Buffer built up data.

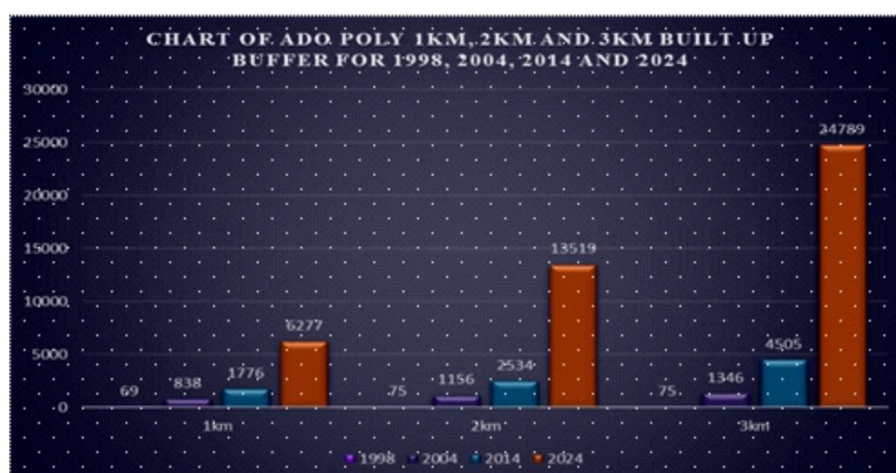| ADO POLY BUFFER BUILD UP AREA			
YEAR/BUFFER	1km	2km	3km
1998	69	75	75
2004	838	1156	1346
2014	1776	2534	4505
2024	6277	13519	24789

Figure 13. LULC charts of 1km, 2km and 3km buffer around ABUAD.

The Land Use and Land Cover (LULC) data for the area surrounding The Federal Polytechnic,

Ado-Ekiti (Ado Poly) shows significant urban development within 1km, 2km, and 3km buffers from 1998 to 2024. Within the 1km buffer zone, the built-up area increased from 69 hectares in 1998 to 6277 hectares in 2024. This substantial growth reflects extensive campus expansion and infrastructure development, transforming the immediate vicinity.

In the 2km buffer, the built-up area surged from 75 hectares in 1998 to 13,519 hectares in 2024, indicating significant urban sprawl as the institution and its surrounding community grew. The 3km buffer saw an increase from 75 hectares in 1998 to 24,789 hectares in 2024, highlighting widespread development and the transformative impact of Ado Poly on the region's landscape.

Overall, the data illustrates the rapid and extensive urbanization around Ado Poly, underscoring the institution's significant influence on regional development over the past 26 years.
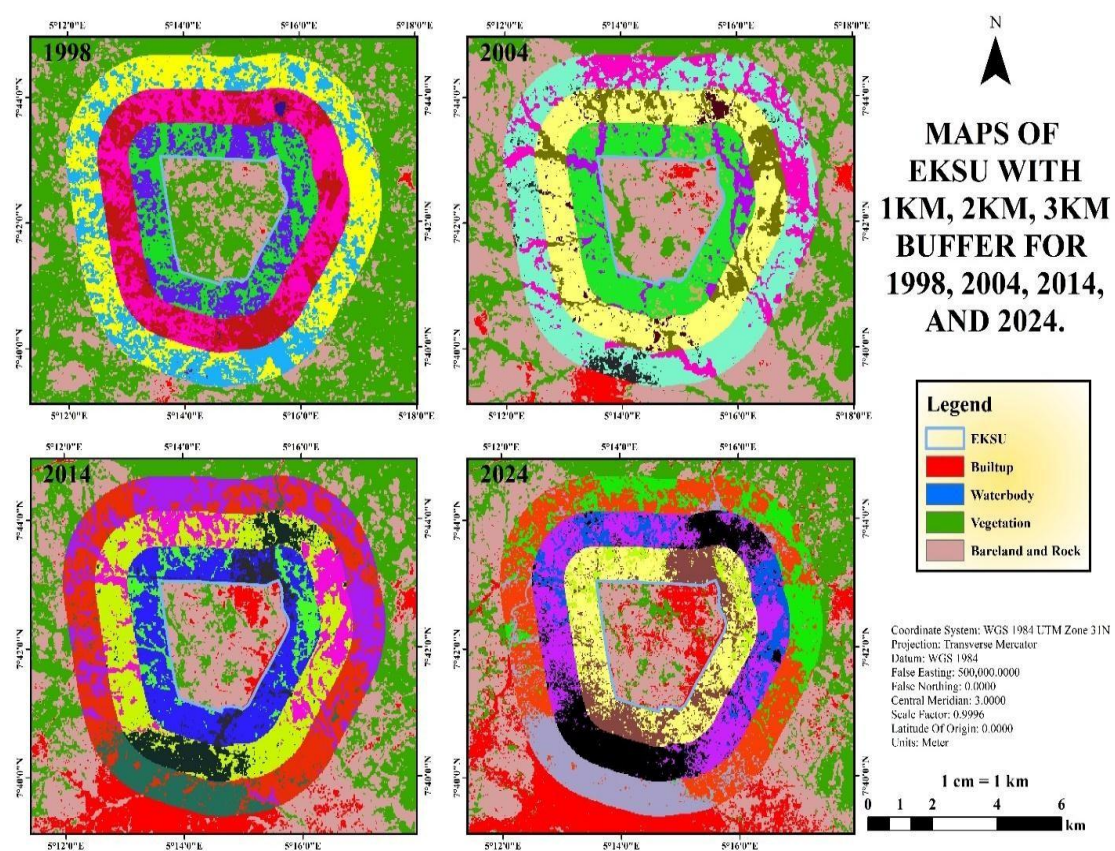
3.7. EKSU

Figure 14. Maps of LULC of 1km, 2km and 3km buffer around EKSU.

Table 7. Table of EKSU Buffer built up data.

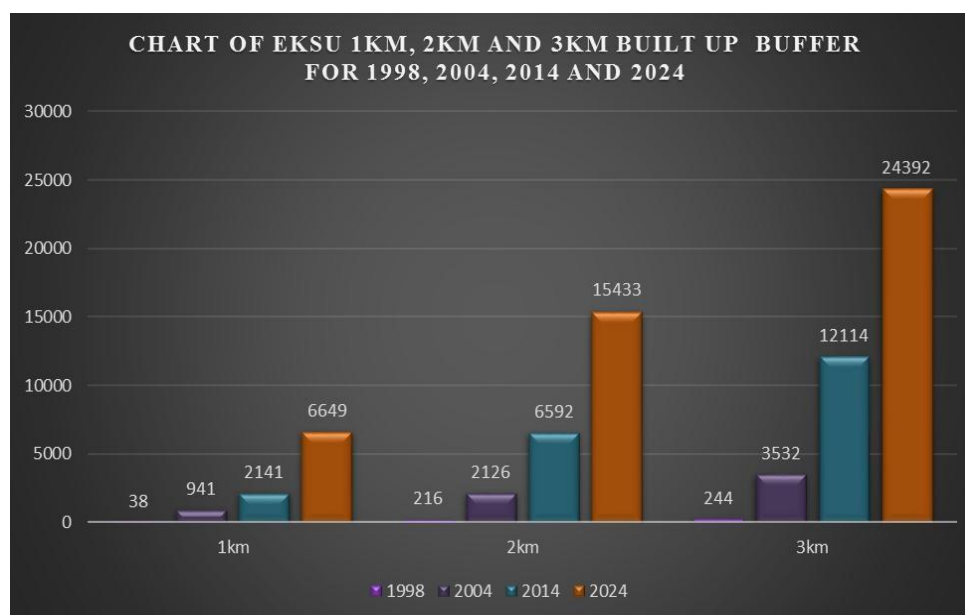| EKSU BUFFER BUILD UP AREA			
YEAR/BUFFER	1km	2km	3km
1998	38	216	244
2004	941	2126	3532
2014	2141	6592	12114
2024	6649	15433	24392

Figure 15. LULC charts of 1km, 2km and 3km buffer around EKSU.

The Land Use and Land Cover (LULC) data for the area surrounding Ekiti State University (EKSU) reveals significant urban development within 1km, 2km, and 3km buffers from 1998 to 2024.

The built-up area in the 1km buffer zone expanded from 38 hectares in 1998 to 6649 hectares in 2024. This substantial growth reflects extensive campus expansion and infrastructure development, transforming the immediate vicinity of the university.

Within the 2km buffer, the built-up area increased from 216 hectares in 1998 to 15,433 hectares in 2024, signifying significant urban sprawl as the institution and its surrounding community expanded.

The 3km buffer grew from 244 hectares in 1998 to 24,392 hectares in 2024, highlighting widespread development and the transformative impact of EKSU on the region's landscape.

Overall, the data illustrates the rapid and extensive urbanization around EKSU, emphasizing the university's significant influence on regional development and land use transformation over the past 26 years.

4. Discussions/Findings

The purpose of this research was to assess the impact of campus growth on the urbanization of Ado Ekiti in Ekiti State, Nigeria. The findings indicate that campus growth has played a significant role in shaping the urban landscape of Ado Ekiti.

The expansion of campus areas has contributed to economic growth by increasing commercial activity; numerous new businesses and restaurants have opened near university campuses, creating new job opportunities and stimulating local economic development. Additionally, the growth of these campus areas has necessitated investments in infrastructure, including the construction of new roads, enhancements to public transportation systems, and the development of amenities such as parks and recreational facilities.

Furthermore, campus growth has enhanced social diversity in the city, as it attracts students and faculty from various backgrounds, thereby enriching the community.

However, the study also highlights some challenges associated with campus growth, including traffic congestion, rising crime rates, and issues related to housing affordability.

Overall, this analysis has provided valuable insights into the spatial patterns of campus growth and its implications for urban development in Ado Ekiti.

5. Conclusions

This research paper evaluates the impact of campus expansion on urbanization in Ado Ekiti, Ekiti State, Nigeria, ultimately leading to metropolitan urban sprawl. The study highlights the level of development and growth observed in the three campuses since their establishment, along with their influence on urbanization in Ado Ekiti and the surrounding metropolitan area.

The findings indicate that campus growth has significantly impacted the urbanization of Ado Ekiti, providing insights into innovative planning strategies, policy measures, and land management practices aimed at monitoring metropolitan urban sprawl.

In conclusion, the study's findings have important implications for urban planning and development in Ado Ekiti. To effectively address the challenges associated with campus growth, it is recommended that policymakers and planners incorporate campus growth considerations into their urban planning decisions.

Abbreviations

ABUAD   Afebabalola University, Ado Ekiti
EKSU   Ekiti State University, Ado Ekit
LULC   Land Use Land Cover
USGS   United States Gemological Survey

Author Contributions

Ogunlade Simeon Oluwole: Formal Analysis, Funding acquisition, Project administration, Resources, Writing – original draft

Oyewunmi Emmanuel Gbenga: Conceptualization, Supervision, Validation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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