POLICY RECOMMENDATION

To foster landscape resilience and ensure the sustainability of ecosystem services amid rapid urbanisation and climate change, an integrated, regionally adaptive urban sustainability framework should be established. This framework should incorporate city-specific ecological management, community-driven environmental education, enhanced carbon sequestration efforts, and robust policy implementation to strengthen ecosystem services. By aligning urban planning with ecological principles, promoting afforestation and agroforestry, and engaging local communities in sustainable land use practices, policymakers can create resilient urban landscapes that balance development with long-term environmental sustainability.

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For further information, please contact: Director of porgamme, WASCAL DRP CCHH, Federal University of Technology, PMB 65, Minna Niger Nigeria | +2348136448836 | wascal_cchh@futminna.edu.ng | wascal.futminna.edu.ng/

Designed & Prinited by: DVC Global Links® @ +2347036553040 | bolupeter@gmail.com

INTEGRATING ECOLOGICAL SUSTAINABILITY INTO URBAN POLICY

TO PROMOTE RESILIENT CITY GROWTH, COMMUNITY-LED CONSERVATION, AND CLIMATE ADAPTATION IN NIGERIA

Rotimi Oluseyi OBATERU*, Appollonia Aimiosino OKHIMAMHE, Olutoyin Adeola FASHAE, Christopher CONRAD
***Correspondence: obateru.rotimi@st.futminna.edu.ng; Tel.: +2348169720255.**

EXECUTIVE SUMMARY

This study investigates the impact of landscape dynamics on ecosystem services in Nigerian cities within the Rainforest and Guinea savanna ecological regions, identifying the critical need for city-specific, sustainable urban management. Using geospatial, biophysical, and socioeconomic techniques, the research highlights rapid urban expansion, agricultural activities, and climate variability as primary drivers of landscape change, significantly impacting ecosystem health. Findings inform four policy areas for improved ecosystem resilience: tailored urban planning, stakeholder engagement, sustainable land use, community education, carbon sequestration initiatives, and policy-backed ecosystem services. These recommendations aim to balance urban growth with ecological health amidst climate challenges.

INTRODUCTION

Rapid urbanisation, expected to increase Nigeria's urban population to 67% by 2050 (Ma et al., 2021), poses serious threats to ecological health and climate resilience (Obateru et al., 2025) (Figure 1). This study investigates how landscape dynamics affect carbon storage, sequestration, and heat mitigation in Nigerian cities within the Rainforest and Guinea savanna regions. To ensure sustainable urban growth, integrating scientific assessments into planning processes is crucial. Findings provide actionable insights for policymakers to develop community-driven strategies that enhance landscape resilience, sustain ecosystem services, and mitigate climate vulnerabilities.

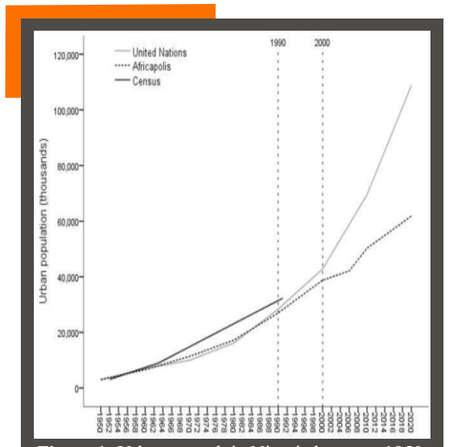

Figure 1: Urban growth in Nigeria between 1950 and 2020 (Bloch et al., 2015)

RESEARCH APPROACH

Employing geospatial, biophysical, and socioeconomic approaches, this study assesses urban landscape transformations in Nigeria's Rainforest (Akure and Owerri) and Guinea savanna (Makurdi and Minna regions (1986-2022). It applies machine learning for land-use analysis, models ecosystem services via Integrated Valuation of Ecosystems Services and Tradeoffs (InVEST) platforms, and gathers household survey insights from 1552 participants. Land Use Change Evaluation (MOLUSCE) modules simulate future trends, with validation showing over 70% accuracy.

KEY RESEARCH FINDINGS

1. Landscape transformation and fragmentation

Over 36 years, Makurdi experienced the highest urban expansion rate (0.74% year^{-1}), with Akure, Owerri, and Minna following. Akure and Makurdi saw extensive vegetation loss to agriculture, while rainforest cities had the most agricultural land converted to built-up areas (Figure 2). Landscape fragmentation increased in all cities, but agricultural practices like rotational bush fallowing helped restore landscapes in Akure and Makurdi.

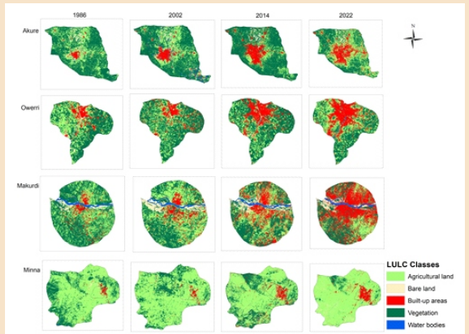

Figure 2: LULC change in Akure, Owerri, Makurdi and Minna between 1986 and 2022

2. The nature of ecological services changes

Ecosystem service capacity declined across all ecoregions from 2002-2022, particularly within 510 km of urban centers. Carbon storage losses were highest in Minna (33.83%) and Owerri (21.95%) (Figure 3). Urban heat mitigation also weakened, with Akure and Makurdi seeing the largest declines (13%). The urban heat island effect expanded significantly, increasing environmental stress and highlighting the urgent need for sustainable urban planning strategies.

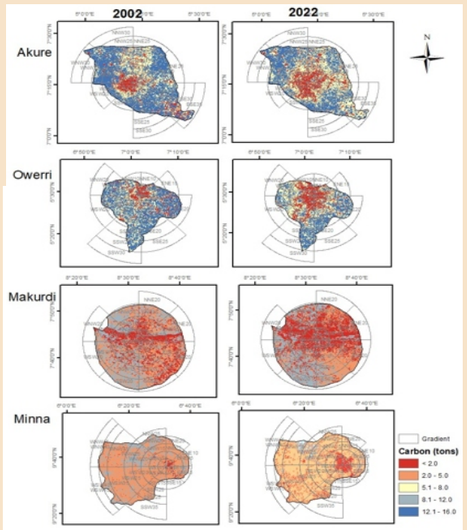

Figure 3: Spatial Distribution of Carbon Storage in 2002 and 2022

3. Drivers of landscape and ecological changes

Key drivers of landscape change include urban expansion, agricultural practices, infrastructure development, and fuelwood production (Figures 4 and 5). Climate variability played a significant role in Akure and Makurdi (28.5%-34.4%), while population growth and economic activities were major factors in Owerri and Minna (19.9%-36.3%). These findings emphasize the need for targeted policies to address the impact of urbanisation on ecological impact.

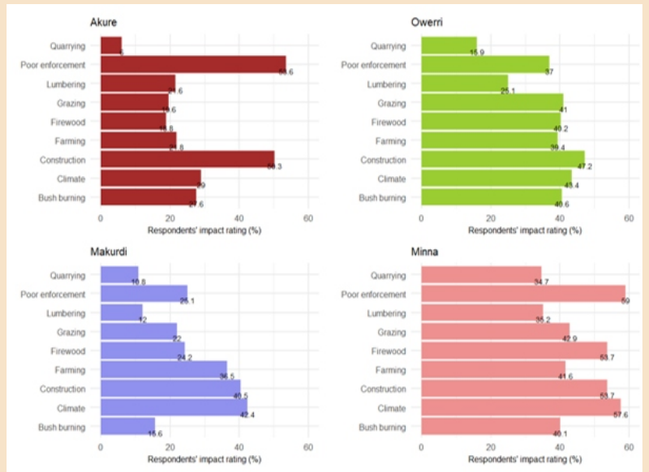

Figure 4: Contribution of anthropogenic activities to landscape changes across cities

Figure 5. Expansion of built-up areas into green spaces in Umualum Uratta, Owerri (Source: Google Earth, 2023).

4. Future pattern of landscape and ecosystem conditions

Future projections indicate significant urban expansion, particularly in Akure and Owerri. This growth is linked to ecosystem degradation, with carbon storage declining most in Owerri (20.02%) and Akure (3.32%). However, Minna may see a 3.47% increase. These trends highlight the urgent need for sustainable land-use planning to mitigate environmental impacts.

IMPLICATION OF FINDINGS

The findings of this study revealed that developmental activities shape landscape characteristics and ecosystem services more than ecological differences, highlighting the complex factors driving landscape change in Nigeria. City-specific sustainable urban management is essential to mitigate environmental challenges, including air and water pollution, flooding, erosion, deforestation, and poor waste management, ensuring resilient and ecologically balanced urban growth.