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Minna, Niger State, Nigeria.

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Federal University of Technology, Minna, Niger State, Nigeria

EDITORS IN CHIEF

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PREFACE

The School of Environmental Technology International Conference (SETIC 2024), organized by the School of Environmental Technology, Federal University of Technology Minna, Nigeria, is a prestigious platform that brings together experts from diverse fields to exchange knowledge and drive innovation. This year, the conference is held in collaboration with notable institutions, including the School of Architecture and Design, Lovely Professional University, New Delhi, India; Abubakar Tafawa Balewa University (ATBU), Bauchi State, Nigeria; the Architectural Engineering Department, Najran University, Najran, Saudi Arabia; Perch Inc Development Consultancy Services, Zimbabwe; Faculty of Health Sciences, Graduate Education Institute, Istanbul Gelişim University, Istanbul, Turkey; Robotics & Additive Technologies Innovation Research Cluster, Transport & Communication Institute, Riga, Latvia; Architectural Engineering Department, College of Engineering, University of Hail, Hail, Saudi Arabia; New Gate University, Minna, Nigeria; and the University of Law Business School, Birmingham, United Kingdom, to mention a few.

This year's theme, "Global Economic Revolution and the Resilience of the Built Environment in an Emerging World," seeks to explore the dynamic relationship between global economic shifts and the adaptability of the built environment. The theme emphasizes the necessity for resilience, sustainability, and innovation in the face of unprecedented challenges and evolving economic landscapes. The sub-themes of the conference delve into crucial aspects such as sustainable design, technological integration, disaster management, and the role of policy in shaping future infrastructures.

The response to this year's conference has been both enthusiastic and far-reaching, with participants from a wide range of countries, including Latvia, India, Turkey, United Kingdom, Malaysia, Saudi Arabia, Zimbabwe, South Africa, and beyond. The hybrid nature of the event offering both virtual and physical participation has enabled an even broader exchange of ideas and perspectives. The conference serves as a vibrant platform for professionals, academics, and researchers to engage with cutting-edge developments in the built environment and related fields, fostering collaborations that will shape the future of global practice.

A wide range of papers, spanning science, engineering, and the social sciences, have been presented at this year's event, highlighting the interdisciplinary nature of challenges we face and the solutions to these challenges.

We would like to express our deep gratitude to the SETIC 2024 Conference Organizing Committee (COC) for their unwavering dedication and hard work in making this conference a resounding success. We are confident that this event will inspire all participants and leave a lasting impact on the field

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Impact of Urban Expansion on Agricultural Land in Minna, Niger State, Nigeria

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Abstract

Arable agricultural land has been threatened by many factors among which is rapid rate of urbanization. The study assessed the impact of urban expansion on agricultural land towards sustainable land use policy in Minna, Niger State, Nigeria. Remote sensing data provided useful estimations of agricultural land loss on a regional scale. Satellite data of period from 2000-2020 were collected to analyze the extent of land change dynamics in Minna and to determine the impact of changing pattern of urban expansion on agricultural land in Minna. Remote sensing image processing, supervised classification technique using a Support Vector Machine (SVM) classification algorithm was employed based on five land use (Agricultural land, built-up area, bare surface, Natural vegetation, water bodies) classes. The analysis results reveal a decline in agricultural land and increase in the built-up area indicating an encroachment on agricultural land. The result shows a significant modification in land use landcover observed as agricultural lands underwent noticeable decline by 20.816km2 whereas built up area increased substantially by a value of 37.23km2. The land use landcover projection result revealed that 76% of urban expansion will result in 24% of agricultural land loss by year 2030 in Minna. In conclusion, the urban expansion has significant impact on agricultural land loss in the study area. Overcoming urban encroachment into agricultural lands requires adequate policy formulations amenable to sustainable urban planning and development. The results highlight the need for policy makers and synergies between urban and land management authorities, as well as the Ministry of Agriculture to implement policies to protect agricultural land.

Keywords: Agricultural land loss, Land use landcover, Urban expansion, Urbanization, Spatio-Temporal analysis.

1. Introduction

The consequence of urban expansion on agricultural land is that it brings about loss of agricultural land. The expansion of cities has resulted in the loss of agricultural land, reduction in agricultural land size (Maxwell, 2021). Urbanization leads to the extension of urban socio-spatial morphologies and infrastructure, which encroach on agricultural activities. This has impacted the size and quality of farm lands available in the agricultural sector. Rapid expansion of urban settlements driven by an increase in human population, socioeconomic activities and economic prosperity turns pressure on the surrounding environment (Al-Kofahi *et al*., 2018). The rate of land loss to urbanization in recent times has been a source of concern globally, thus the need for effective monitoring and regulation (Al-Kofahi *et al.*, 2022).

Sequel to the creation of Niger state in 1976 and the increase in its administrative functions, the state has experienced population rise from approximately 3 million in 2006 to a projected 12 million by the end of year 2023 (NBS, 2019). The rapid increase in the population of Niger State is attributed to the inflow of people in search of Job in the state due to the establishment of Gidan Kwano Campus and NECO headquarter office and other institutions. Rapid urbanization and socioeconomic transformation triggers change in land use in the short run, and in the long term it results in the degradation of landscape ecology and the human environment (Brinkhoff, 2021). The consequences of expansion of built-up land in both urban and rural regions is loss of agricultural land (Zhou *et al.*, 2022). The alteration of built-up land in urban and rural areas is a significant determinant of the extent of loss of agricultural land (Zhou *et al.*, 2023).

Given the aforementioned considerations, it is evident that there exists a necessity for obtaining more precise and dependable data pertaining to the preservation of cultivated land and urbanization, particularly within the Minna metropolis. The study assessed the impact of urban expansion on agricultural land towards sustainable land use policy in Minna. This study provides inform data that will assist decision making in agricultural land preservation in the state and Nigeria as whole.

2. Literature Review

2.1 Effect of Urbanization on Agriculture

Agriculture is the backbone of the economy, which provides livelihood to 65 to 70 percent of the total population and employ about 52 percent population of the country (Pramanik and Sarkar, 2021. The urban population of the world will grow by more than billion between 2010 and 2025, whereas the rural population will hardly grow at all (Satterthwaite *et al.,* 2019). Rapid urban population growth because of continue migration results in increase in the demand of land, particularly for housing, water and energy (Pramanik and Sarkar, 2021; Iheke and Ihuoma, 2018). Iheke and Nto (2015) reported that urbanization is an important driving force in migration and community. Urbanization has led to conversion of agriculture land into non-agriculture purposes such as factories, buildings, residential or other commercial use (Liu and Liu, 2021). Ho and Lin (2021) found that the urban population growth was the cause of farmland conversion into coastal cities in Vietnam**.** Han and He (2021) found a significant positive relationship between urban population growth and farmland conversion in to cities. They also found that real estate speculation also results in agriculture land conversion. Land conversion has negative impact on the agriculture land. Assessing the impact of urban expansion on agricultural land in Minna will assist in the dearth data of extent of encroachment on agricultural land and its potential future impacts on agricultural land loss in Niger State. Furthermore, the findings will serve as valuable resources for informing urban-rural development planning, rural revival efforts, and the effective implementation of arable land protection measures.

3. Methodology

3.1 The Study Area

Minna, Niger State administrative capita is located in North Central Nigeria. Minna is located on longitude 9°22'31" to longitude 9°47'59"N and Latitude 6°10'06" to 6°39'15"E (See Figure 1) with a total land area of 6,789 square kilometres (Daniyan & Mohammed, 2018). The land cover of Minna is predominantly built-up area, vegetation, agriculture, outcrops barren land and water body. Minna enjoys a climate typical of the middle belt zone, Guinea savannah with distinct wet and dry seasons. The rainy season starts around April and last till October; it has a mean annual rainfall of about 1334mm (52inches) with September recording the highest rains of about 300mm. The mean monthly temperature is highest in March at 35°C and lowest in August at 22.3°C. The mean monthly relative humidity is highest in August at 60% and lowest in January at 19% respectively (Ojeh *et al*., 2021). This shows that Minna has prefect weather or climate that favours the growth and development of agricultural crops.

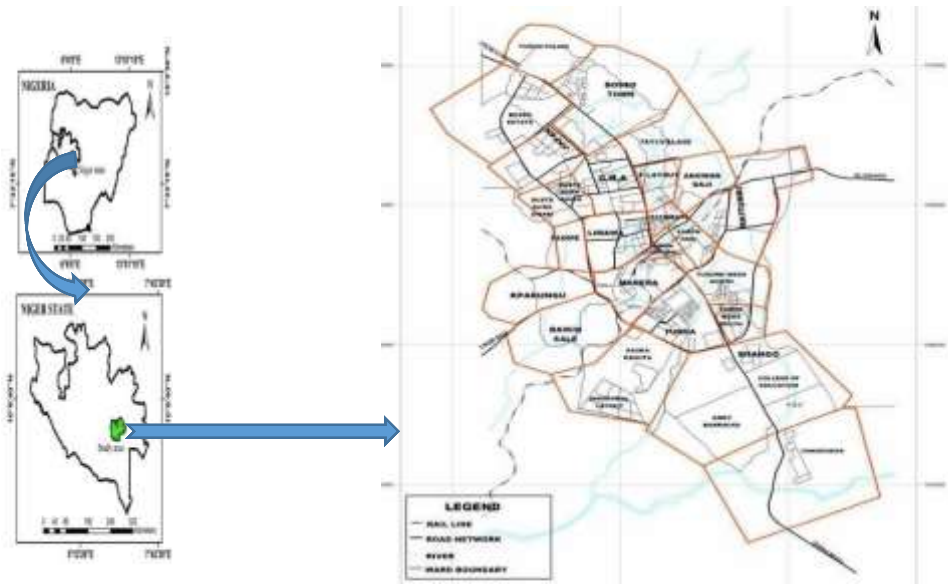

Figure 1. Minna: the study area.

3.2 Methods

Landsat images data with spatial resolution of 30m covering the study area were obtained and downloaded from the Landsat archive of the United State Geological Survey (USGS) earth explorer portal (http://earthexplorer.usgs.gov/) for period of 2000 and 2010 for 2 spatio-temporal periods(200-2010 and 20102020) of 20years(See Table 1).

Table 3.1: Data type specification.

Data	Dates of acquisition	Resolutions	Azimuth
Landsat TM data	2000-01- 29T16:24:59Z	30m	135.92
Landsat-7 ETM+ data 2000	2010-01-04T14:34:24Z	30m	143.34
Landsat8 OLI/TIRS	2020-03-25T14:39:34Z	30m	115.25

3.3 Image processing and Analysis

3.3.1 Image classification

The georeferenced image data obtained were processed first by extracting study area using extract by mask tool in the ArcGIS software mask tool in spatial analyst. Training sampling of the cover features based on the spectral reflectance were digitized and signature file created to enable image classification. This is the process of grouping into segments adjacent pixels that have similar spectral characteristics. Based on the training set of pixels supervised classification using a Support Vector Machine (SVM) classification algorithm on land use classes (Agricultural land, built-up area, bare surface, Natural vegetation, water bodies) derive LULC map.

3.3.2 Spatiotemporal changing pattern of urban expansion in relation to agricultural land use.

The change detection method used in this study is the 'Area Analysis method'. This involves the analysis which highlights the trend of the urban development on agricultural land over the period under assessment. The processes involved are as follows; the geoprocessing was selected and the earlier periods of the year and the observed change of each period of the year i.e. 2000 and 2010, and 2010 and 2020 geometry were calculated and intersected so as to estimate the change. Furthermore, the change detection was done on the attribute by adding new field and renamed change and the type is "Text" and ok was clicked, however the field calculator was activated and a visual basic expression ("Class_2000" & "to "& "Class_2010") was inputted and ok was clicked. After the process was done the output was inferred according to the change that occurred. After the processes, the agricultural land and built-up area from the change detection was executed in the overlay method.

3.3.3 Projection of the land use land cover in 2030 to predict the percentage of Agricultural land loss

The integrated Cellular Automata - Markov Chain (CA-Markov) model was employed to simulate future urbanization by 2030 to predict the percentage of agricultural land loss. CA-Markov allows us to make predictions about the long-term behaviour of the scenario of land use landcover change, and to identify patterns and trends in its behaviour (Tariq *et al*., 2020). The model relies on the interaction between the grid size, cellular space, cell neighbourhood, and transition rules. The equation of a CA-Markov model can be written as:

$$P(t + 1) = T^{*} P(t) \quad (1)$$

where

P(t) and P(t + 1) represent the state vectors at time t and t + 1, respectively

T = the transition matrix. The transition matrix T specifies the probability of transitioning from each current state to each possible future state.

4. Results and Discussion

4.1 Spatio-temporal Magnitude of Land use landcover Dynamics in Minna (2000 – 2020)

The magnitude of land use landcover lost or gain and the rate of change per decade was examined to determine the extent of agricultural land loss in Minna within the spatio-temporal period studied (2000-2010 and 2010-2020) in the last 20years across the four categories of the land use land cover classes(Built-up area, bare surface, agricultural land and natural vegetation). Figure 2 present the distribution of landuse landcover in the year 2000, 2010, and 2020. The result shows that in year 2000, the agricultural land constitute significant portion of the area with spatial extent of 69.75km^2 (51%), followed by Bare surface which is next covered 30.68km^2 (23%), built-up area occupied 22.01km^2 (16%) and natural vegetation accounted for 13.06 km^2 (10%) of the total area. By the year 2010, The result confirms changes in the landuse landcover including agricultural land which constitute 36%(48.59Km^2) of the total cover, followed by built-up area 33% (44.22Km^2), bare surface 16% (22.19Km^2) and natural vegetation 15% (20.17Km^2). Findings as observed a declined in agricultural land whereas built-up area experienced gain with spatial extent. Furthermore, Land use land cover dynamic in the year 2020 revealed significant increase in the builtup area covering 59.24km^2 (44%), followed by agricultural land 46.03km^2 (34%), and bare surface 23.20km^2 (38.41%) which respectively experienced a decline. Natural vegetation expressed an exponential decrease to 12.384km2 (9%) due to rapid urbanization and human anthropogenic activities. Water bodies also represented slight decrease in surface area with 0.242km2; this could be as a result of change in climate pattern.

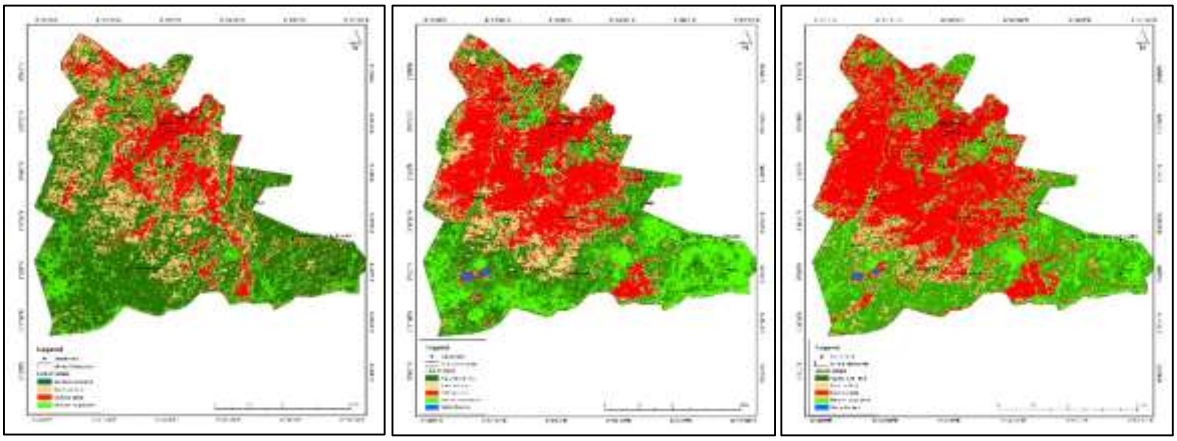

Figure 2: Land use land cover distribution in Minna metropolis in 2000, 2010 and 2020

Table 2 present the spatio-temporal magnitude of change in land use landcover in Minna. Result reveals that within the first decade (2000 – 2010), agricultural land lost 21.16km^2 and bare surface lost 8.496 km^2 at the rate of 1.5 and 0.7 respectively. Meanwhile, built-up area gained an extent of 22.213 km^2 and natural vegetation gained 7.11 km^2 at the rate of 1.7and 0.5 growth respectively. In the following decade (2010 – 2020) however, all other land use lost their coverages with only built-up area gaining an extent of about 15.02 km^2 at the growth rate of 1.1 which is about the total area lost by the other land use types. This suggests that the other land use types all transited to built-up area which is an indication of rapid urbanization.

Table 2: Transition probability matrix of the land use land cover (2000 – 2020)

Land use Class	**Spatio-Temporal Landuse/Landcover Change Dynamic**							
	2000 – 2010				**2010 – 2020**			
	Area (km2)	**%**	**Annual rate**	**Inference**	**Area (km^2)**	**%**	**Annual rate**	**Inference**
Agricultural land	-21.16	-15	-1.5	Decrease	-2.5	-2	-0.2	Decrease
Bare surface	-8.496	-7	0.7	Decrease	-4.58	-3	-0.3	Decrease
Built-up area	22.213	+17	1.7	Increase	15.02	11	1.1	Increase
Natural vegetation	7.11	+5	0.5	Increase	-7.79	-6	-0.6	Decrease
Water Bodies	Null	Null	Null	Null	-0.081	0	0	Decrease

4.2 Spatio-temporal Changing Pattern of Urban Expansion in relation to Agricultural Land Use

The agricultural land use conversion to built-up area in 2000 – 2010, 2010 – 2020 and overall 2000 – 2020 was mapped and the spatial change analysed as presented in Figure 3. The analysis result has shown substantial agricultural land covering 12.972km^2 equivalent to 10% were converted to built-up from 2000 to 2010. This agricultural land loss is as a result of 1.7% annual growth rate of urbanization between 2000 and 2010 resulting in 22.313sq km built-up increase (See Table 3). This trend suggests that bulk of cultivatable land in Minna metropolis was consumed by physical development from 2000 to 2010.

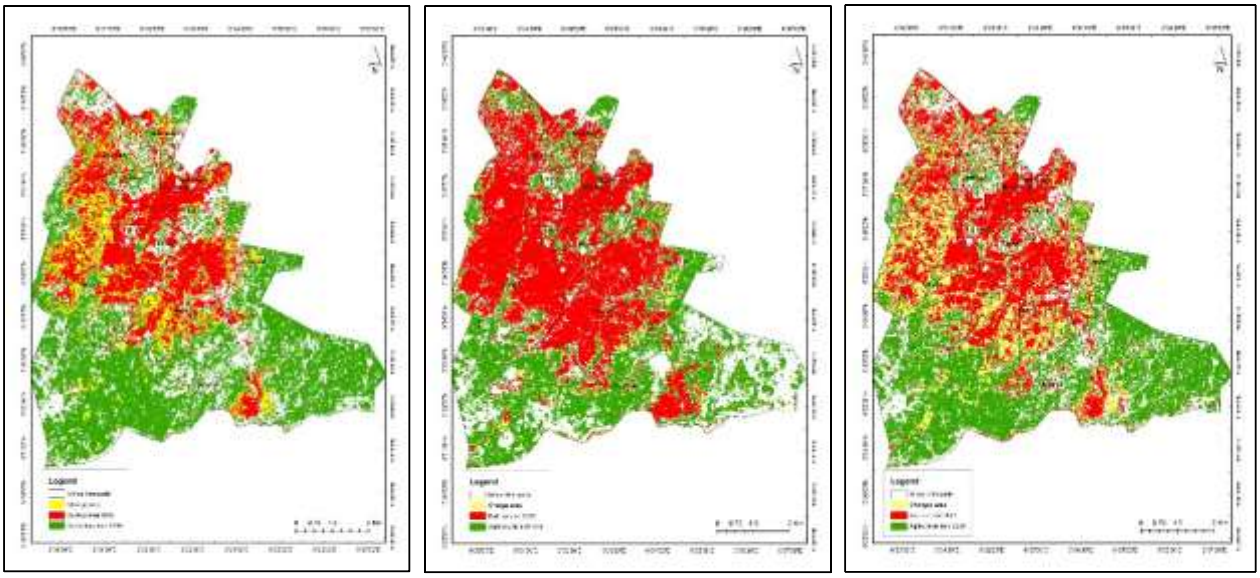

Figure 3: Change Transition in agricultural land loss to built-up area (2000 – 2010 and 2010-2020)

Table 3: Overall Transition of agricultural land to built-up area (2000 – 2020).

Period (Years)	No. Years	Agricultural land – Built-up area		Annual Rate	Built-up
		Area (km^2)	%	%	Area km^2
2000 – 2010	10	12.972	10	1.7	22.213
2010 – 2020	10	7.844	6	1.1	15.020
2000 - 2020	20	20.816	16	2.8	37.233

4.3 Projection of the land use land cover to predict Impact of Urbanization on Agricultural Land Loss

Table 4 present the result of the analysis of the projected impact of urbanization on agricultural land loss. The result of the projection of landuse landcover from 2020 to 2030 revealed that in the next 10 years, 76% increase in the built-up area will result to 24% of agricultural land loss in Minna (Figure 4). However, this finding provide future insights on urban development expansion pattern and agricultural land loss.

Table 4: Statistic analysis of the projected agricultural land and built-up area in 2030.

S/N	Class in 2030	Area (Km^2)	%	Inference
1	Agricultural land	33.124	24	Loss
2	Built-up area	102.368	76	Increase
	Total	135.531	100	

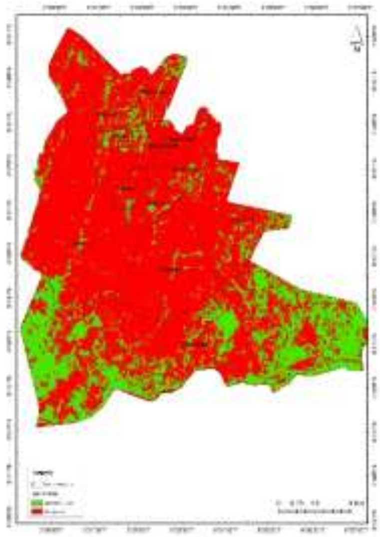

Figure 4: Projected agricultural land and built-up area in 2030

5. Conclusion

Minna is one of the emerging and rapid growing cities. Geospatial satellite imagery provided the essential measuring of spatial and temporal phenomena that are otherwise impossible to try using traditional mapping for the study. The change detected provides the bases for understanding patterns of spatial changes and the importance of addressing the issues arising from such changes. This makes it possible for policy makers to make effective policies.

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