SPATIAL DYNAMICS OF LAND USE LAND COVER OF MINNA CITY AND ENVIRONS, NIGER STATE, NIGERIA

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ABSTRACT

Aims: Spatial dynamics of land use land cover of Minna city and environs, Niger State, Nigeria.
Study design: Survey and longitudinal research were carried out. .
Place and Duration of Study: Minna town, Niger State, Nigeria between 1990 and 2022.
Methodology: This study investigated the dynamics of land use land cover of Minna city and environs, Niger State, Nigeria using satellite remote sensing and Geographic Information System (GIS) technique.
Results: Findings of the study showed that in 1990, land use type was dominated by agricultural land (50%), followed by vegetation land (30%). However, built-up area was less than 10% indicating that urban heat stress was limited. It was observed that the built-up area concentrated on the center and north-western segments of the city. In 2010, bare ground dominated the land use type of Minna city and environs at the rate of 45%. This was followed by agricultural land at the rate of 35%. The built-up area occupied 15% of the entire land surface area of the city, indicating a tremendous rise from the previous decades. In 2022, the land use type showed a tremendous rise in agricultural land at the rate of 37%. This was followed by bare ground at an alarming increase of 36%. The built-up area ranked third at the rate of 20%, showing that the city had a severe urban heat effect due to heat generated by urban pavement materials.
Conclusion: Thus, the practice of sustainable land use, good implementation of forest practice, appropriate water resources conservation and the promotion of alternative livelihood to agriculture should be implemented for the Minna inhabitants to reverse the situation of LULC changes without further delay.

Keywords: Spatial, Dynamics, Land Use, Land Cover, Environs

1. INTRODUCTION

Land Use occurs as a result of human activities taking place in a particular geographical area. These land use types are affected by biophysical modification due to urbanization, industrialization and population distribution. Land use is the general classification of the earth's landscape according to the particular dominant use in which the land is subjected to at a particular time. Land use changes at the local, regional and global scales due to its effects on the ecosystems and the general environment. Thus, land use change plays a significant role in managing the ecological and environmental planning processes (Zhao et al. 2004)

The study of LULC changes has emerged due to the motive to examine changes that have occurred on the surface of the earth. Therefore, change detection has become a process of managing and monitoring urbanization, environmental resources and population dynamics of a given geographical space (Hassan, Shabbir and Ahmad, 2016). Though, there are a lot of techniques for studying LULC as part of using a change detection approach. The change detection process investigates the changes that have taken place in an urban area within a given period. It has become imperative to have accurate and reliable information on the changes that have taken place in the human environment for a good management framework to be developed for an urban center (Giri et al. 2005).

Thus, LULC has been studied using Satellite Remote Sensing (SRS) and Geographic Information System (GIS) techniques to understand changes that have taken place over time in an environment. This is because they have accurate geo-referencing procedures and reliable digital format (Lu et al. 2004; Chen et al. 2005). The application of multi-temporal remotely sensed data has made it possible to address the issues of LULC using SRS and GIS techniques. The main purpose of using these data for change detection is that it has the capacity to identify surface characteristics in two or epochs (Chan et al. 2001). For example, Rembold et al. (2000) has applied Landsat TM to understand changes in LULC between 1972 to 1994 in central and southern Ethiopia. Shalaby and Tateishi (2007) have applied Satellite Remote Sensing (SRS) and Geographic Information System (GIS) techniques to detect changes in LULC of Egypt by applying Landsat retrieved data. Also, Gao and Liu (2010) studied land degradation trends and waterlogs in north-eastern China using Landsat imageries in an interval of ten years (1990 to 2010). In this vein, this study is carried out to understand the dynamics of land use land cover of Minna city and environs, Niger State, Nigeria to provide information that can be used to develop a good urban land surface management framework.

2. material and methods

Minna, the study area is located approximately within longitude $6^0$30'50"E and $6^0$35'10"E and latitude $9^0$35'40"N and $9^0$40'0"N of the GMT (Figure 1.1). The town is the capital city of Niger State having boundaries with Federal Capital Territory (FCT), Kaduna, Kwara, Kebbi and Zamfara respectively. The city has built-up quarters such as Bosso, Maitumbi, Shango, Barikiri Sale, Fadikpe, Dutsen Kura etc. Due to urban growth, Minna city is clustered together as one metropolis. It is a northern city crisscrossed by the River Niger, which contributes to the general atmospheric weather pattern. The study area has the wet season that is windy and the dry season is partly cloudy. The city is hot all year round. The temperature varies from (60°F to 94°F) and is rarely below 54°F or above 101°F (Happiness et al., 2007). The city is known for its wet season from April to October and dry season from November to March. The rainfall is below 2000mm per annum. Its relative humidity is high in the months of July to September and gradually reduces its intensity to March (Odu and Imaku, 2013).

For satellite data retrieval and analysis, the algorithm for extracting Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI) from Landsat 5, 7 and 8 thermal infrared sensors was used. The different surface emissivity sources from the Google Earth Engine (GEE), which is an advanced earth science data and analysis platform allow the estimation of LST products from any part of the globe, covering 1990, 2010 and 2022. Landsat 5, 7 and 8 thermal infrared sensors, using different surface emissivity sources from the GEE and Landsat ETM+ were engaged to achieve the changes in land surface area. The NDVI and NDBI were used to understand changes in vegetal cover and built-up areas. NDVI was to create differences in land greenness while NDBI separates built-up parcels by grouping infrastructure and pavement materials.

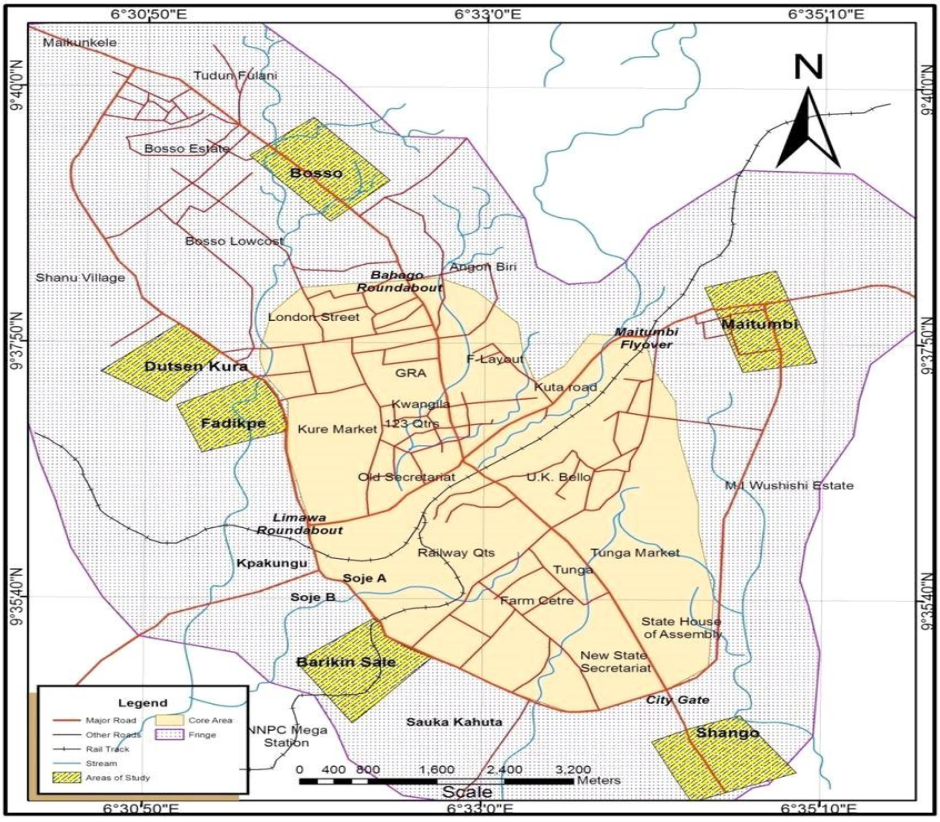

Figure 1: Study Area of Minna Town and Environs

3. results and discussion

Land Use Land Cover (LULC) is the physical appearance of the land being occupied by vegetation, built-up, forest, bare land and water bodies, etc. In 1990, land was dominated by agricultural land (50%), followed by vegetation land (30%). The built-up area was less than 10% indicating that urban heat stress was limited. It was observed that the built-up area concentrated at the center and north-western segments of the city (Figure 2).

In 2010, bare ground dominated the land use type of Minna city and environs at 45% (Figures 4 and 5). This was followed by agricultural land at the rate of 35%. The built-up area occupied 15% of the entire land surface area of the city, indicating a moderate rise from the previous decades. In this year, built-up area was found to concentrate in the centre and around all segments of the city. This implies that urban heat must have increased, making the city more uncomfortable for the inhabitants.

In 2022, the land use type showed a rise in agricultural land at the rate of 37% (Figures 6 and 7). This was followed by bare ground at an alarming increase of 36%. Built-up area ranked third at the rate of 20%, showing that the city had a severe urban heat effect due to heat generated by urban pavement materials. The development pattern showed that built-up area concentrated on the city center and the northern segment of the city.

Land Use Land Cover (LULC) of this study is the same with the findings of Gebeyehu et al. (2021) who used GIS application to analyze the land use types of Gubalafto district, Northeastern Ethiopia in 1986, 2000, and 2016. The study unveiled that cultivated and settlement land cover occupied 75% of the entire land use type. It was also found that within 30 years, grazing land occupied 11.1% in 1986 and had decreased to 5.7% in 2016. On the other hand, cultivated and settlement land rose from 45.6% in 1986 to 49.5% in 2016, while forest

cover declined from 8.9 to 2% in the same period. This study showed that human activities can modify the surface features of a city and raise the urban heat phenomenon, thereby causing heat stress and discomfort to city dwellers.

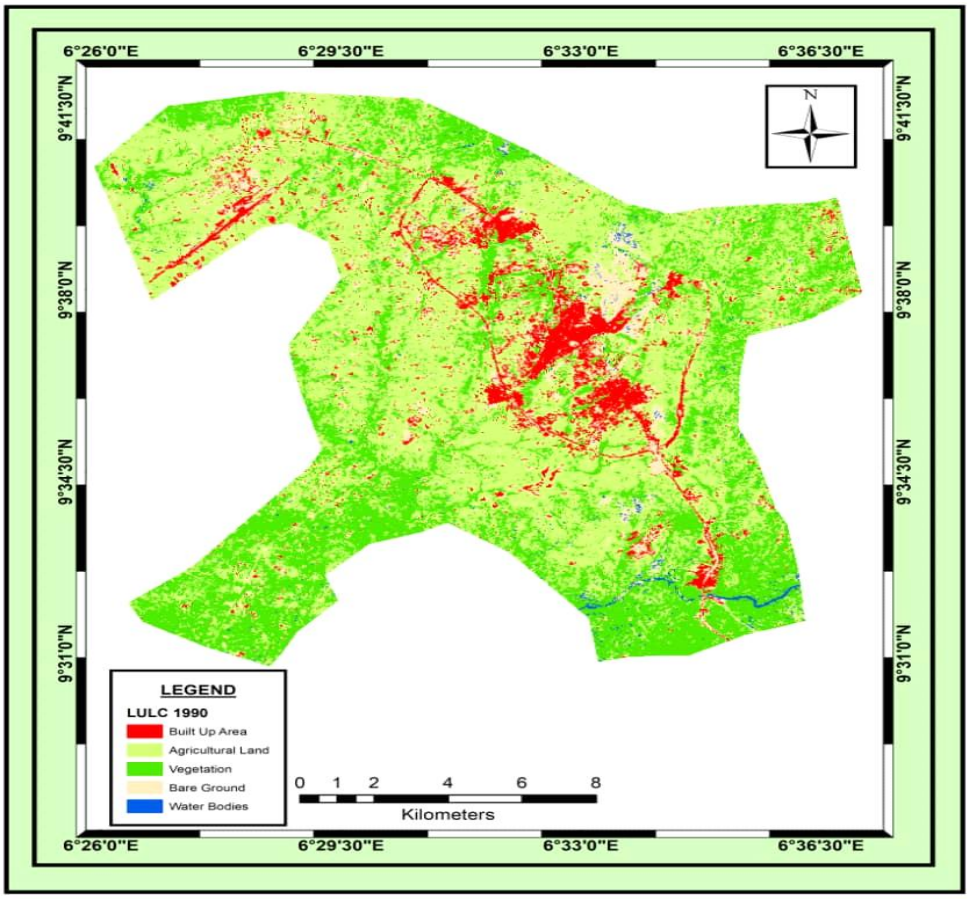

Figure 2: Land Use Land Cover of Minna City and Environs (1990)

Figure 3: Distribution of LULC of Minna City and Environs (1990)

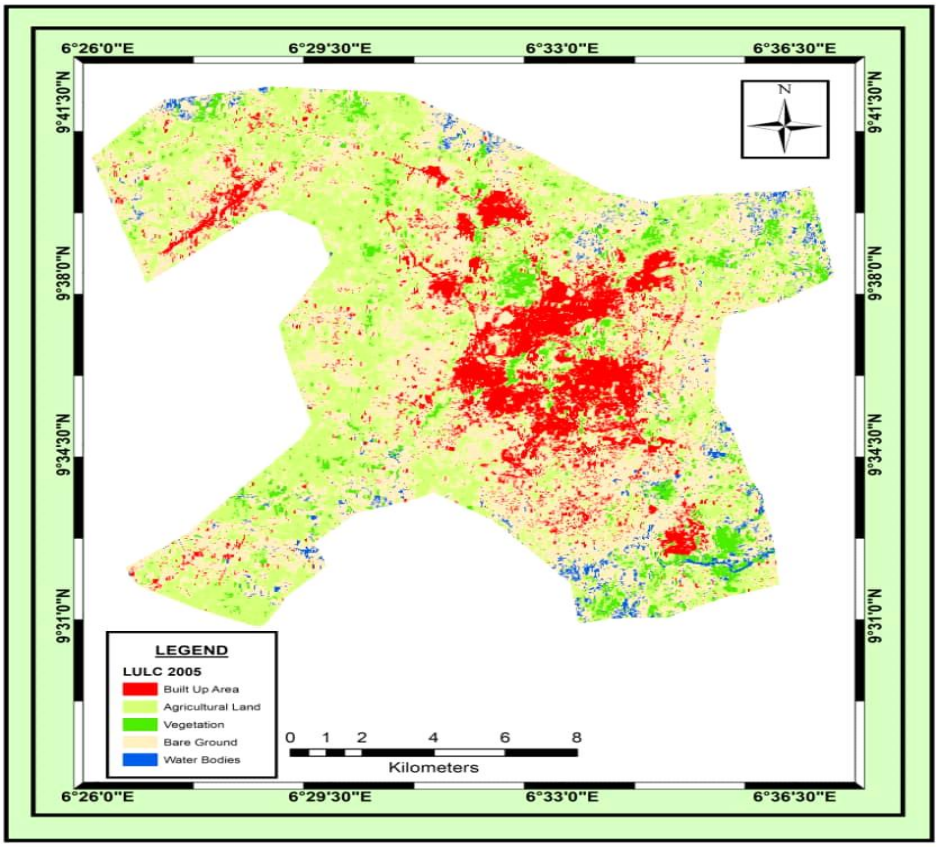

Figure 4: Land Use Land Cover of Minna City and Environs (2010)

Figure 5: Distribution of LULC of Minna City and Environs (2010)

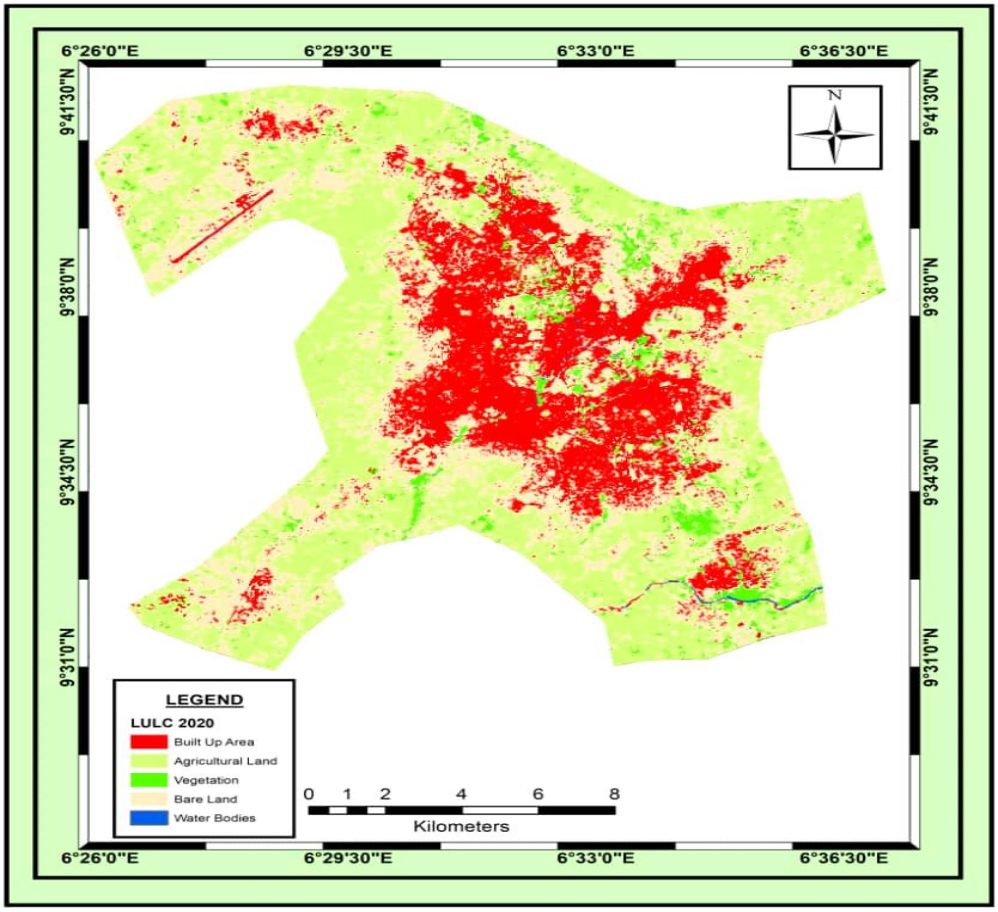

Figure 6: Land Use Land Cover of Minna City and Environs (2022)

Figure 7: Distribution of LULC of Minna City and Environs (2022)

4. Conclusion

This study investigated the dynamics of land use land cover of Minna city and environs, Niger State, Nigeria from 1990 to 2022 using satellite remote sensing and Geographic Information System (GIS) technique. Results from the satellite imageries showed that Minna city and environs had undergone intense land use land cover changes over the past 32 years. The LULC trend indicated that agricultural and built-up lands were on the increase; while vegetation cover and water bodies were significantly declining. These changes were connected to the rising population of people which has expanded the settlement area, thereby altering the biophysical component. The study showed that intense and over-use of agricultural land had turned a greater part of the land cover to bare land leading to severe land degradation in Minna city and environs. This study therefore highlighted the need to conduct a comprehensive examination of LULC practices carried out by humans so as to develop a good management framework that would promote sustainable LULC in the study area. Thus, the practice of

sustainable land use, good implementation of forest practice, appropriate water resources conservation and the promotion of alternative livelihood to agriculture should be implemented for the Minna inhabitants to reverse the situation of LULC changes without further delay.

Competing interests

We declare that this study does not have any competing interest.

Authors' Contributions

"Nwaerema P. designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Jiya S. N. and Oye I. managed the analyses of the study. 'Adama, C. K, Jibrin, A. M. and Muhammad, M. I managed the literature searches. All authors read and approved the final manuscript."

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