Geospatial Analysis of Landuse/Landcover Change in Wudil Town of Kano State, Nigeria

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Abstract. Wudil is an ancient town in the savannah of northwestern Nigeria that is now growing. The growth of the town has set in landuse/landcover change in the area. In order to understand the pattern of the change, Remote Sensing and Geographic Information System techniques were used to examine the current trend in the landuse/landcover change in the area, while questionnaire survey was used to investigate the factors responsible for the change. Landsat images of the town for 2000 and 2014 were processed and classified using maximum likelihood classifier. Results showed that the built-up area expanded from 15% in 2000 to about 21% in 2014, while open fields increased tremendously from 0.2% in 2000 to 14% in 2014. Conversely, cultivated lands decreased by over 20% and vegetation decreased by just 2% over the period of study. But the water body increased by 1.3% resulting from the expansion of the shoreline due to erosion induced by seasonal flooding in the area. Other factors of landuse/landcover changes in the area are deforestation and housing construction. Although, it is generally believed by the residents of Wudil that the town is growing, there is no consensus among the residents on the factors responsible for the growth of the town. About 75% of the people attributed the growth of the town to the location of Kano University of Science and Technology in the town, while about 25% of them linked the growth of Wudil to the nodal characteristics of the town. In a growing town like Wudil, an integrated masterplan is required to guide future development in the town.

Keywords: Determinants of Change, GIS, Landuse/landcover change, Remote Sensing.

1. INTRODUCTION

Landcover comprises of the physical and human landscapes such as vegetation, rocks, roads and farmlands that cover the land. Landuse refers to human activities such as farming, quarrying, and transportation on the land. Landuse change is one of the most significant factors responsible for global environmental change (Rimal, 2006) such as climate change. Although Rimal (2006) observed that landuse/landcover change can take place even exclusively through natural processes, human activities are currently highly influential in global and local landuse/landcover change. Ejaro and Abdullahi (2013) discovered that population growth, increased demand for food and shelter, as well as increased socio-economic activities have led to unprecedented landuse/landcover dynamics and transformation of rural and urban environments.

Understanding landuse/landcover change is very necessary for proper landuse planning, development, and management. But the problem of understanding the pattern and modeling of urban landuse change has been inadequacy of georeferenced data and lack of analytical tools (Rimal, 2006) especially in Nigeria. But, the availability of free geographical data and open source GIS that can be accessed freely on the internet can be used to address part of this problem.

In order to detect landuse change of Devak catchment, Screenivasulu and Pinnamaneni (2010) produced a landuse/landcover map of the catchment by classifying a false color composite (FCC) image of the study area. This was implemented using Remote Sensing and Geographic Information System (GIS) techniques. They discovered changes from one landuse to another. For example, results of their study showed that 76% of erstwhile open scrub land has been replaced with forest and agriculture over the period of study.

The application of Remote Sensing and GIS techniques has been demonstrated by Balogun et al. (2011) in analyzing urban growth and landuse change in Akure town of southwestern Nigeria between 1986 and 2007. They found rapid increase in built-up and resultant decrease of the dense forest of Akure area.

Likewise, Ejaro and Abdullahi (2013) used the post classification comparison method to analyze the spatiotemporal dynamics of landuse and landcover in...
Suleja area of Niger State in north central Nigeria. Results of their study showed continuous expansion of built-up area and declining of vegetation cover in the area. Urban growth and landuse change are ongoing processes in many towns and cities in Nigeria. But the trend, the pattern and the determinants of landuse change vary spatially and temporally. Wudil is an ancient town in the savannah of north-western Nigeria that is presently growing. The growth of the town has set in landuse/landcover change in the area. The aim of this study is to analyze the changes in landuse/landcover types of Wudil town from 2000 to 2014, with a view to understand the pattern of change and investigate the geographical determinants of the change in the area.

1.1. Area of Study

Wudil town is located on latitude 11.570317N, 11.869425N and longitude 8.779696E, 8.936728E of the Greenwich meridian as shown in figures 1 and 2. The 2006 population census put the population of the area at 185,189 with an estimated landmass of 458 km². The general method for this study is presented in the flow chart below (Figure 3).

2. MATERIALS AND METHODS

2.1. Types and Sources of Data

The study used both spatial and non-spatial data. The spatial data is the Landsat images of Kano State which were acquired for two periods: 2000 and 2014. Both 2000 and 2014 Landsat images were downloaded from the United State Geological Survey (USGS).

2.2. Methods of Data Analysis.

Different methods were adopted to analyze both the spatial and the non-spatial data. These include:

1) Maximum Likelihood Classification of the images.
2) Calculation of the Area in hectares of the resulting land use/land cover types for each study year and subsequently comparing the results.
3) Descriptive statistics for analyzing the questionnaire.

2.3. Review of the Methods of Data Analysis

Landsat images for the years 2000 and 2014 covering path 188 and row 52 were used for the research. The images were initially cropped to the particular region of interest using the subset tool. Image processing techniques such as radiometric corrections were used. Training sites were developed based on the reference data from Google Earth, and signature files were created from the make signature (MAKSIG) module of Idrisi selva 17 software. Then, a hard classifier known as maximum likelihood was used in classifying the Landsat images into five landuse categories namely: built-up areas, cultivated lands, open field, vegetation, and water body. The maximum likelihood classification uses probability density function associated with a particular training site signature; pixels are assigned to the most likely class based on comparison of the posterior probability that it belongs to each of the signature being considered (Eastman, 2012). The same methods have been adopted by Carmelo et al. (2011) in land cover classification and change detection analysis using multi-temporal remote sensed imagery and landscape matrix in Avellino (southern Italy). It was also used by Screenivasulu and Pinnamaneni (2010) and Ejaro and Abdullahi (2013) in their studies on the analysis of landuse/landcover change.

In addition, the maximum likelihood classifier was preferred because Thakur et al. (2012) compared the three methods of supervised classification namely: Mahalanobis, Maximum likelihood and the Minimum
distance to mean classification to analyze landuse/landcover change in Jabalpur district of central India. They found that out of the three classification methods, Maximum likelihood has the highest overall accuracy.

Fig. 1: Map of Kano State in Nigeria showing Wudil Town

Fig. 2: Map of the Study Area (Wudil Town)
2.4. Sampling Techniques for the Questionnaire Survey

In order to acquire information about the geographical determinants of landuse/landcover dynamics in Wudil, questionnaire survey was carried out. Like many other northern Nigerian cities, Wudil is dichotomous in nature, comprising of a new town (Sabon gari) and an old town (Tsohon gari).

However, the sample size is calculated using Slovin’s formula: $n = \frac{N}{1+Ne^2}$

where $n =$ sample size; $N =$ population size; $e =$ margin of error

Hence, 120 questionnaires were used. In this case, 100 questionnaires were administered to the residents.
in the area, and 20 questionnaires were administered to stakeholders which included government officials and traditional rulers in the area. In this case, systematic random sampling method was used.

3. RESULTS AND DISCUSSIONS

3.1. GIS Analysis


This section presented the changes that have taken place in the landuse/landcover classes of Wudil town from 2000 – 2014.

Findings revealed that the built-up area increased from 15% in 2000 to about 21% in 2014 as shown in Table 1 and visualized in Figures 4 and 5. This is due to the increasing number of people and migrants which has resulted into increasing number of houses in the area. However, this growth rate of Wudil significantly contrasts with that of Kazaure, another ancient town in northwestern Nigeria, where the built-up area expanded rapidly from 13.5% in 1999 to 29.7% in 2007 (Isma’il et al., 2013).

Moreover, results showed that the cultivated lands in Wudil have decreased enormously from 68.6% in 2000 to 48% in 2014. This is in view of the fact that agriculture is the major occupation of the inhabitants of the area, but a number of the inhabitants of Wudil are now engaged in other economic activities such as civil service and trading. Besides, the built-up area has expanded into the cultivated lands. However open fields have abruptly increased from 0.2% in 2000 to 14.4% in 2014. This could be attributed to bush clearing and deforestation for agriculture, housing and energy use.

Furthermore, vegetation has slightly decreased from close to 14% in 2000 to about 12% in 2014 as shown in Figure 6. This is attributed to deforestation resulting from increased demand for housing and energy services in the area. Also, water body has increased from 2.3% in 2000 to 3.6% in 2014. This is as a result of the increase in the shoreline due to erosion induced by seasonal flooding in the area.
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Fig. 5: Landuse/landcover map of Wudil town in 2014

Fig. 6: Landuse/landcover changes in Wudil from 2000 – 2014

Table 1: Showing landuse/landcover changes in Wudil from 2000 – 2014

<table>
<thead>
<tr>
<th>Landuse Type</th>
<th>2000 Area in hectares</th>
<th>2000 Percentage</th>
<th>2014 Area in hectares</th>
<th>2014 Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 built-up areas</td>
<td>528.84</td>
<td>15.00%</td>
<td>755.37</td>
<td>21.41%</td>
</tr>
<tr>
<td>2 cultivated lands</td>
<td>2421.00</td>
<td>68.60%</td>
<td>1705.68</td>
<td>48.35%</td>
</tr>
<tr>
<td>3 open field</td>
<td>5.94</td>
<td>0.20%</td>
<td>508.59</td>
<td>14.41%</td>
</tr>
<tr>
<td>4 Vegetation</td>
<td>489.78</td>
<td>13.90%</td>
<td>429.84</td>
<td>12.19%</td>
</tr>
<tr>
<td>5 water body</td>
<td>82.44</td>
<td>2.30%</td>
<td>128.52</td>
<td>3.64%</td>
</tr>
<tr>
<td>6 Total</td>
<td>3528</td>
<td>100.00%</td>
<td>3528</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
3.2. Field Survey Results

This section highlights the determinants of landuse/landcover change, based on the information acquired from field survey in the area.

3.2.1. Socio-economic Characteristics of Respondents

Findings from the questionnaire survey showed that 81% of the respondents are males while 19.0% are females. Also, majority of the respondents comprising of 44% fall within the productive age of 21-30 years, followed by the age groups 31-40 years, 41-50 years, and 51-60 years which make up 19%, 17%, and 16% of the respondents respectively as shown in Figure 7. However, the level of income of the respondents showed that majority of them constituting about 23% fall within the medium income earners of NGN 11000-20000 monthly, while 22% of them earn NGN 21000-30000 monthly; and 36% of the respondents earn <5000-10000. This is an indication of better socioeconomic status of the people in the town.

![Fig. 7: Age of Respondents](image)

Findings further revealed the educational qualifications of the respondents as illustrated in Figure 8 below; it was found that 90% of the respondents have undergone formal education which include primary, secondary and tertiary education, while 9% of them have Quranic education and 1.0% are illiterates. This suggests that Wudil is a literate society.

The employment profile of the respondents as shown in Figure 9 indicates that previously 34% of the respondents were students, 23% were farmers, 21% were traders, and 17% were civil servants. But presently, 32% of the respondents are students, 25% are civil servants, 22% are traders, and 18 are farmers, while about 2% of them are fishermen and only 1% of the sampled population is unemployed. The reduction in the number of farmers and large increase in the number of civil servants in Wudil is an evidence of urbanization manifesting in transition from primary to secondary and tertiary activities in the area.

Although 66% of the sampled people are indigenes of Wudil, about 40% are non-indigenes from different parts of the country, comprising of traders and a large number of students that moved to Wudil for academic purposes due to the location of Kano University of Science and Technology in the town. Others moved to Wudil to settle with their families, and a significant number of them moved to seek for jobs or for civil service as shown in Figure 10. This is another evidence of urban growth in the area.

3.2.2. Determinants of Landuse/landcover Change in Wudil Town from 2000 – 2014

It is generally believed by the residents and stakeholders of Wudil that the town is growing, but 75% of them attributed the growth of the town to the location of the university resulting into rapid increase in economic activities and residential expansion in the area. However, about 25% of the respondents linked the growth of Wudil to the nodal characteristics of the town. This is because the town is a gateway to other states in the region and has served as a rest station for a long time. The major problems of the growth of the town are congestion, inadequate housing, increasing pressure on the available resources, indiscriminate
dumping of refuse, and increase in crime and social vices in the area.

4. CONCLUSIONS

This study analyzed the landuse/landcover dynamics in Wudil town of Kano state, Nigeria. The expansion of the built-up area by about 6% over a period of 14 years suggests that the growth of the town is presently slow. The decrease in vegetation by just 2% is unexpected as the rate of deforestation is very high in many towns of the savannah. But the massive increase in open fields and decrease in cultivated lands are evidences of urbanization in the area. However, future urban growth of the town may not likely follow the same trend.

![Educational Qualifications of Respondents](image)

**Fig. 8: Educational Qualifications of Respondents**

![Employment Profile of Respondents](image)

**Fig. 9: Employment Profile of Respondents**
4.1. Recommendations

(1) Therefore, a study on the future urban growth scenario of Wudil town is required.

(2) In a growing town like Wudil, an integrated masterplan is required to guide future development in the town.

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