IMPACT OF URBANIZATION ON AGRICULTURAL LANDS IN LAFIA LOCAL GOVERNMENT AREA, NASARAWA STATE

Dantijani, N[1], Hassan, A.B[1], Muhammed, M[1], Emigilati, M.A[1] and Kuta, G.I[1]

[1]Department of Geography Federal University of Technology, Minna, Niger State, Nigeria

e-mail :aisha.hassan@futminna.edu.ng

ABSTRACT

Lafia is one of the fastest growing city in Nigeria, yet it lacks reliable, modern, scientific monitoring techniques to effectively monitor and manage land use/cover changes brought about by urbanization. This research looks at the impact of urbanization on agricultural lands in Lafia local government area, Nasarawa state. The capabilities of satellite remote sensing in terms of large spatial coverage, spatial and temporal resolutions adequate for these types of studies, as well as the ability of GIS to handle spatial and non-spatial data, make it the optimal approach for this research. To achieve this, Landsat Thematic Mapper (1986), Landsat ETM+ (1999) and Landsat 8(2016) were used to provide maps for land use/cover change and analysis. A post classification approach was adopted with a maximum likelihood classifier algorithm. The analysis revealed that, Agricultural land has decreased by 8.5% while Built-up has increased by 39%, population increase and executive lowliness are the driving factors of land use change and farmland has 0.6% of converting to built-up in the next 10 years. Agricultural lands and vegetal cover are most threatened, and most land allocated for these uses has been legally or illegally converted to other land uses. The continual increase of the aerial coverage of built up area needs to be checked by promulgating a law of unlawful expansion to achieve sustainable urban and environmental development and planning in the study area.

Keywords: Urbanisation, GIS, Remote sensing

1. Introduction:

Agriculture is the main source of livelihood for many developing countries. In Nigeria, the sector contribute about 55% of gainful employment and almost 40% of the share of GDP. Before the discovery of oil, this figure is as high as 75 – 80% of GDP (Yusuf, 2014). The modernization of Agriculture in any economy is dependent on the amount of fertile land allocated to it. Urbanization in recent times tends to deprive agriculture of its needed land.

World population is currently growing at a rate of 1.2% annually, which is a net addition of 77 million people every year, six countries accounts for half of the increase: India 21%, china 12%, Pakistan 5%, Bangladesh, Nigeria and the united states of America 4% each (UN, 2011). Global proportion of urban population has been rising rapidly over the last decade. The average increase in global urban population between 1950 and 2005 was 2.6%, while Africa's average increase urban growth was 3.6% for the same period. At the regional level,

West African average growth was 4.3% and Nigeria 4.4% (Adepoju, 2007) . World population projected to reach 9.7 billion by 2050 with most growth on developing regions especially Africa (UN, 2015).

Africa is urbanizing fast. Its rate of urbanization soared from 15% in 1960 to 40% in 2010, and is projected to reach 60% in 2050 (UN habitat, 2010). Urban population in Africa are expected to triple in the next 50 years, changing the profile of the region and challenging policy makers to harness urbanization for sustainable and inclusive growth. According to UN (2004), Africa is the least urbanized but most rapidly urbanizing and it is expected to experience rapid rate of urbanization during 2000 – 2030. By 2030, 53% of its inhabitants will live in urban areas, Africa and Asia will each have higher numbers of urban dwellers than any other major area of the world (UN, 2004).

Since the end of World War II, West Africa has been distinguished by extremely high urban growth due to a high population growth rate (Africapolis, 2000). Spurred by the oil boom prosperity of the 1970s and the massive improvements in roads and the availability of vehicles, Nigeria since independence has become an increasingly urbanized and urban oriented society (Olorunfemi, 2014). Nigeria is a vast agricultural country "endowed with substantial natural resources" which include: 68 million hectares of arable land; fresh water resources covering about 12 million hectares, 960 kilometers of coastline and an ecological diversity which enables the country to produce a wide variety of crops and livestock, forestry and fisheries products (Arokoyo, 2012). Agriculture is the dominant occupation of the inhabitants of Nasarawa state. Some of the major agricultural products in the state include maize, sorghum, millet, rice, groundnut cowpea, soya beans, melon, yam, cassava, sweet potatoes, Mango, cashew, oil palm, cattle, sheep, goats, poultry, and fisheries. Nasarawa state (the home of solid minerals) is blessed with numerous solid minerals such as Beryl, tourmaline, quartz, columbite, granite, limestone, Barytes, glass sand, marble and salt (Salau, and Attah, 2012) . Lafia being a state capital has experienced rapid expansion since 1996 when it was designated state capital owing to the influx of formal and service workers as well as business entrepreneurs. Growth and developmental activities such as buildings, road construction, deforestation, and many other anthropogenic activities. For the reasons of its size and status as state capital as well as the location near the federal capital territory (FCT), Lafia is now the first order town in the state.

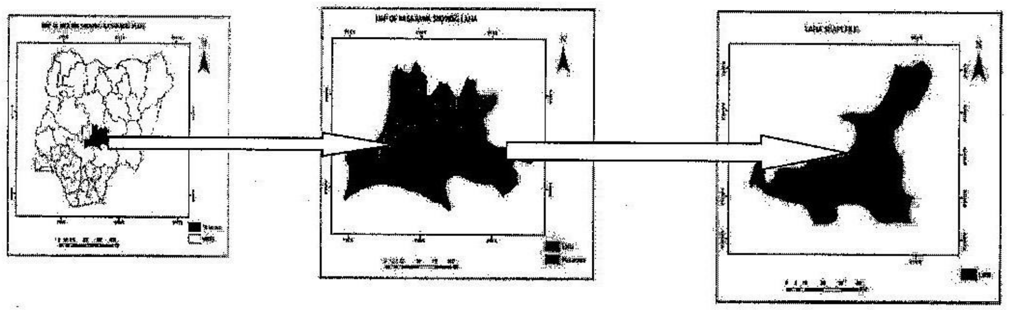


Figure 1, Map of the Study Area

2. **Literature Review:**

Adepoju, 2007 integrated Landsat imageries, Maps and Census data to analyze Land use Land cover change detection in Metropolitan Lagos, Nigeria. The study revealed that rapid population growth in the study area has been, and continues to be, the main driving force for the rapid land cover change. He also used Landsat TM, Landsat ETM and SPOT HRV2 for the study. Ejaro and Abdullahi, (2013) worked on the spatiotemporal analysis of Land use Land cover changes in Suleja Local government area, Niger state, Nigeria. They utilized ILWIS 3.3 Software and Satellite imageries such as NigSat-1, Landsat-TM and Landsat ETM+ to analyze the rate of change and Factors responsible for this changes. Anthropogenic activities have been identified to cause the changes in land use/land cover and these are driven by synergetic factors of rapid growth of population and urbanization.

Nuhu and Ahmed, (2013), merged information obtained from field work and Google earth images digitized with ArcGIS 9.3 version which was used as the base map for the study. The land use types and their characteristics were identified based on their physiographic characteristics which satisfied the research; Agricultural land use in sub-Saharan Lafia of Nassarawa State, Nigeria. The methodology developed by Adepoju, (2007) was adopted for this research.

3. **Methodology**

3.1 *Data and Data Source*

S/N	DATA	YEAR	PATH/ROW	SCALE	SOURCE
1	Landsat 5 (TM)	1986	188/54	30m™	USGS
2	Landsat 7 (ETM+)	1999	188/54	30m™	USGS
3	Landsat 8 (OLIS)	2016	188/54	30m™	USGS
4	Administrative and Local govt. Map of Nigeria	2016		1:500000	NASRDA

Landsat images of Nasarawa state for the years 1986, 1999 and 2016 were imported and pre-processed in ERDAS imagine 2014 for sub-setting of the image on the basis of Area of Interest (AOI) using Lafia shape file.

The data was unzipped and imported into ERDAS Imagine software 2014, which converted the data to imagine (.img) image format. The importation was on band by band basis. Bands 1 - 5 and 7 were then layer stacked for both Landsat TM 1986, ETM+ and OLIS. Bands 6 (TM), band 6 (ETM+) and 8 (ETM) were excluded in both images because in Thermal Infrared (TIR) and 15 meters spatial resolution this was considered not as useful for this research as band 8 (ETM). The resolution merge spatial enhancement technique was used for the improvement of Landsat ETM (28.5 meter) image. The main importance of this technique is that it retains the thematic information of the multiband raster image. Using Erdas imagine 2014 software, spatial enhancement from the image interpreter menu was used, where convolution (filtering on images) and kernel selection was carried out.

Both inverse and reverse options of the image inversion function to enhance images was used. Inverse emphasizes details in the dark portions of an image, while reverse simply reverses the DN vales. All satellite data were studied by assigning per-pixel signatures and differentiating the land use/land cover into six classes on the bases of the specific Digital Number (DN) value of different landscape elements. The objective of image classification in this research is to create cluster classes from multispectral images to make sense of spectral information contained in the images. The area coverage of different classes of multitemporal images was compared for changes that have taken place between dates of the images.

Supervised classification with maximum likelihood classifier was used because it gives a better result than any other algorithms such as neural network, contextual, minimum distance etc.

Supervised image classification was carried out. The delineated classes are built-up, bare-ground, rock, farmland, vegetation and water body. For each of the predetermined land cover landuse type, training samples were selected by delimiting polygons around representative sites. Spectral signatures for the respective land cover types derived from the satellite imagery were recorded by using the pixels enclosed by these polygons.

The digital format of the imagery was imported into the GIS environment which serves as a valuable platform for data capturing, storage, manipulation, analysis and display of partially referenced data.

Change detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Lu et al., 2003). This research is focused on the changes between class (conversion between land cover types) and within-class (changes within a land cover type). Post classification change detection approach was employed due to its ability to bypass the problems and difficulties associated with analysis of images acquired at different times of the year and sensors. In this research, land cover change is detected as a change in land cover label between two image dates. It is based on two independent true land cover class classifications, and was achieved by supervised classification. Erdas imagine software 2014 and Idrisi software were used for this analysis.

The survey, part of the qualitative research, served as broad and quantifiable background data in which the case studies were conceptualized. Interviews and questionnaires were considered the best means of unraveling the silent issues behind the factors of land cover land use change in the study area. The reconnaissance survey conducted in August 2016 revealed that there were several other factors that are responsible and encouraging land cover/use change besides population growth.

A number of 130 questionnaires were administered, 3 was missing and 17 returned, giving a total of 150 questionnaires for this research. The data and information gotten was collated and analyzed using SPSS analysis.

The visual analysis of the satellite images used in this research provided insight into the landscape structure of the study area. This helped with understanding the spatial distribution and arrangement of different land use/ landcover types as shown by textural difference throughout the study area. Though visual analysis does not reveal quantitative or statistical data facts, it provided a good knowledge of the general pattern of land use and land cover distribution in Lafia. This played a crucial role in understanding the direction of growth and salient issues that have led to land use/cover conversion and differential rates.

Markovian chain analysis was used to describe land use change from one period to another and this was used as the basis for projecting future changes. This was achieved by developing a transition probability matrix of land use change from time one to time two, which showed the nature of change while still serving as the basis for projecting to a later time period using Idrisi software .The transition probability may be accurate on a per category basis, but there is no knowledge of the spatial distribution of occurrences within each land use category. Hence, Cellular Automata (CA) was used to add spatial character to the model. CA Markov used the output from the Markov Chain Analysis particularly Transition Area file to apply a contiguity filter to "grow out" land use from time two to a later time period. In essence, the CA develop a spatially explicit weighting more heavily areas that proximate to existing land uses. This ensured that land use change occurs proximate to existing like land use classes, and not wholly random.

4. Results and Analysis

- ✓ **Production of Landuse/Landcover maps of the study area**

  The land use land cover maps of Lafia town, Nasarawa state is generated after running a maximum likelihood supervised classification as well as a post classification algorithm for the period of 30 years [1986, 1999 and 2016].

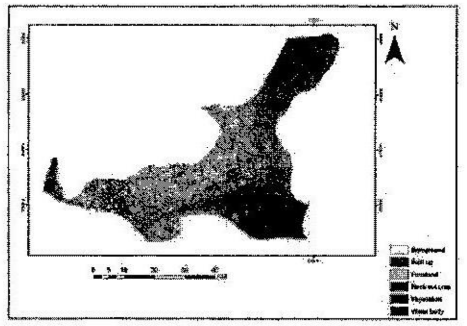


Figure 4.1: 1986 Land Use Land Cover Map of Lafia town

Source: Author's GIS Analysis 2016

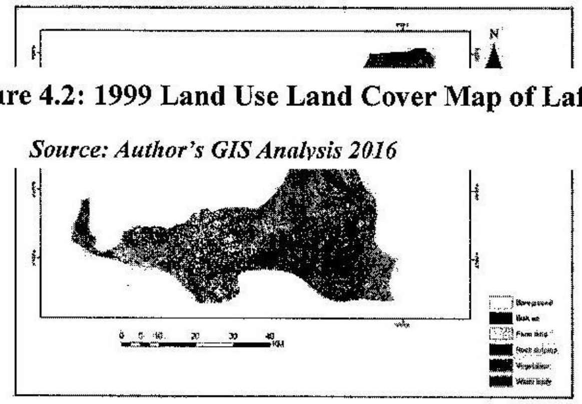


Figure 4.2: 1999 Land Use Land Cover Map of Lafia town

Source: Author's GIS Analysis 2016

From the 1999 land use map, there is a significant increase on the Farmland and Built-up areas, this is due to migration of people from nearby areas to Lafia as a result of favorable weather condition and available land for Agriculture.

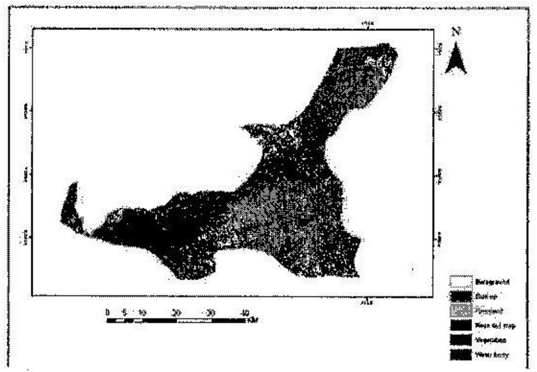


Figure 4.3: 2016 Land Use Land Cover Map of Lafia town

Source: Author's GIS Analysis 2016

Figure 4.3 above shows the landuse map of Lafia in 2016, most of the other land use type are being converted to Built-up, especially Vegetation and Farmlands. As the population of the area increase, urbanization is set to occur in such areas, and this leads to the erection of buildings. The three Landuse/Land cover maps shows distinct differences in the classes classified. The Table below gives the analysis of the above images.

Land cover Type	1986 Area [Ha]	1986 %	1999 Area [Ha]	1999 %	2016 Area [Ha]	2016 %
Bare-ground	31332.06	13.71303	8807.22	3.854635	26994.69	11.8147
Built-up	1295.82	0.567138	7590.78	3.322238	89864.1	39.3306
Farmland	30382.38	13.29738	58163.58	25.45631	38607.03	16.89705
Rock out-crop	876.78	0.383738	2634.39	1.152987	25529.13	11.17327
Vegetation	163577.3	71.5925	150836	66.01601	46861.02	20.50955
Water body	1019.52	0.446211	451.98	0.197817	627.93	0.274825
Total	228483.9	100	228483.9	100	228483.9	100

✓ **Rate of change of Landuse from Agriculture to Urbanization**

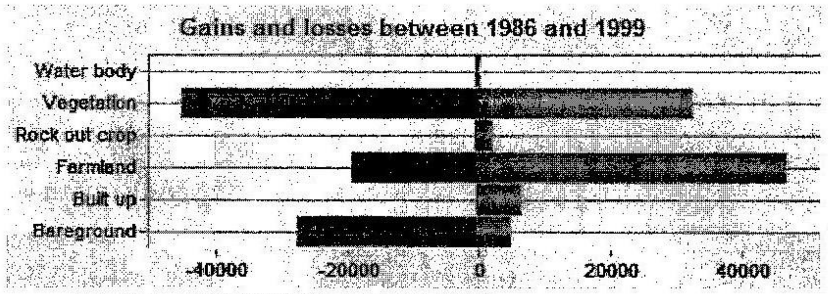
The post classification comparison of land use/landcover classes gives the change that took place between 1986 and 1999; 1999 and 2016; and 1986 to 2016 in hectares (Table 4.2). The land cover classes show detail of spatio-temporal changes between different land cover types.

Table 4.2: 1986 and 1999 Land Cover Change derived from Post-Classification Comparison.

Land cover Type	1986 Area [Ha]	1986 %	1999 Area [Ha]	1999 %	Change Area	% Change
Bare-ground	31332.06	13.71303	8807.22	3.854635	-22524.8	-9.85839
Built-up	1295.82	0.567138	7590.78	3.322238	+6294.96	2.7551
Farmland	30382.38	13.29738	58163.58	25.45631	+27781.2	12.15893
Rock out-crop	876.78	0.383738	2634.39	1.152987	+1757.61	0.769249
Vegetation	163577.3	71.5925	150836	66.01601	-12741.4	-5.57649
Water body	1019.52	0.446211	451.98	0.197817	-567.54	-0.24839
Total	228483.9	100	228483.9	100		

Table 4.2 above shows detail of temporal change between land cover types. The urban/built-up area has increased by 2.6%, and farmland has increased by 12.16%. Increase in Farmland is due to prevalent Agricultural activities within 1986 and 1999 which caused drastic reduction of Bare-ground. Water body reduced by 0.25%. There is an increase of 0.77% in Rock out-crop which is due to the decrease in Vegetation, as vegetation decrease, Rocks which are covered by vegetation is exposed. Below is the graphical representation of this analysis

Figure 4.4a, chart showing Land cover change between 1986 and 1999



Source: Author's GIS Analysis 2016

Table 4.3: 1999 and 2016 Land Cover Change derived from Post-Classification Comparison.

Land cover Type	1999 Area [Ha]	1999 %	2016 Area [Ha]	2016 %	Change Area	% Change
Bare-ground	8807.22	3.854635	26994.69	11.8147	+18187.47	7.96 60066
Built-up	7590.78	3.322238	89864.1	39.3306	+82273.32	36.0 0837
Farmland	58163.58	25.45631	38607.03	16.89705	-19556.6	-8.5 5927
Rock out-crop	2634.39	1.152987	25529.13	11.17327	+22894.74	10.0 2029
Vegetation	150836	66.01601	46861.02	20.50955	-103975	-45. 5065
Water body	451.98	0.197817	627.93	0.274825	+175.95	0.07 7008
Total	228483.9	100	228483.9	100		

From table 4.3 above, the urban/built-up area has drastically increased by 36%, and farmland has decreased by 8.56%. As Lafia town becomes urbanized which means increased in Built-up areas, Rock out-crop 10.02% and Bare-ground 7.96%; Farming activities is reduced, Vegetation is also reduced by 45% as it is cleared to make room for space. Water body increased by 0.1% due to sensor difference or canalization projects in the study area. Below is the graphical representation of this analysis.

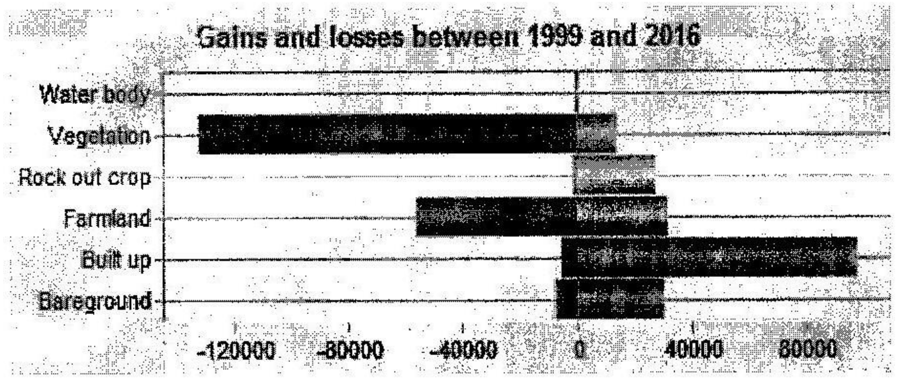


Figure 4.4b, chart showing Land cover change between 1999 and 2016

Source: Author's GIS Analysis 2016

The spatial growth or expansion in other land cover types especially built-up has directly taken place on the agricultural land and vegetation as this is the only land cover type with a decrease in area coverage for the period under study.

Table 4.4: 1986 - 2016 Land Cover Change derived from Post-Classification Comparison.

Land cover Type	[Ha]	1986 %	2016 Area [Ha]	2016 %	Change Area	% Change
Bare-ground	31332.06	13.71303	26994.69	11.8147	-4337.37	-1.89833
Built-up	1295.82	0.567138	89864.1	39.3306	+88568.28	38.76347
Farmland	30382.38	13.29738	38607.03	16.89705	+8224.65	3.599663
Rock out-crop	876.78	0.383738	25529.13	11.17327	+24652.35	10.78953
Vegetation	163577.3	71.5925	46861.02	20.50955	-116716	-51.083
Water body	1019.52	0.446211	627.93	0.274825	-391.59	-0.17139
Total	228483.9	100	228483.9	100		

Through the period of 30years in Lafia town, Nasarawa state, Landuse undergone a severe change where a land cover is either reduced or increased. This change is calculated in percentage and area (hectares) within each land use class as represented in the Table above.

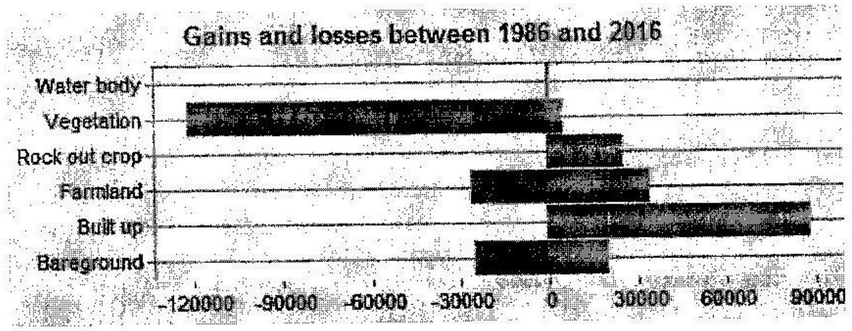


Figure 4.4c, chart showing Land cover change within 1986 - 2016

Source: Author's GIS Analysis 2016

Below are figures showing changes specifically on Built-up and Farmland areas.

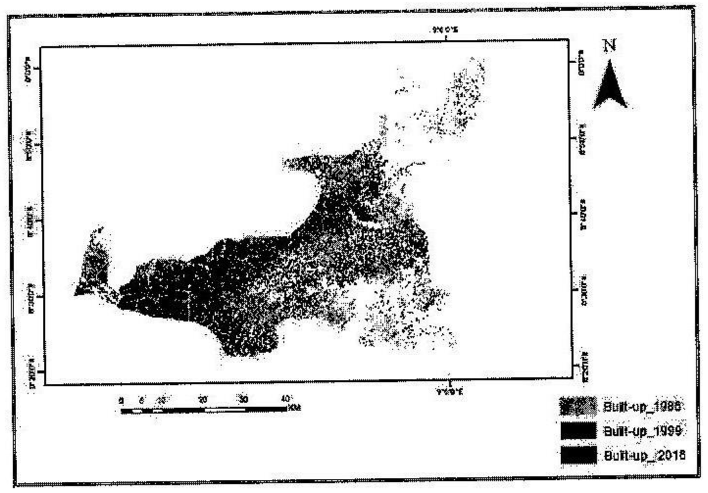


Figure 4.5, changes in Built-up from 1986 - 2016

Source: Author's GIS Analysis 2016

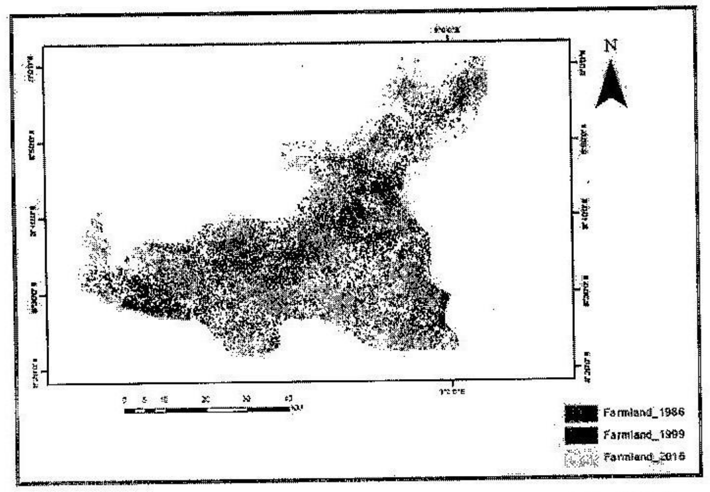


Figure 4.6, changes in Farmland from 1986 - 2016

Source: Author's GIS Analysis 2016

In 1968 Built-up accounted for 1% of the study area, 3% in 1999, while in 2016 Built-up areas accounted for 39%. The rate of Built-up growth, which is faster than any other land use/cover types, does not do justice to the Farmland land use conversion in the study area as this is primarily a result of the dominant growth in Built-up at the outskirts of the Town. The change in Agricultural land use area is clearly visibly from Figures 4.6. Most of the growth associated with Agricultural land use is due to transformation between land use classes.

✓ Future pattern of land use land cover in 10years (2026).

The transition probability matrix is used to record the probability that each land cover category will change to other category. This matrix is produced by the multiplication of each column in the transition probability matrix by the number of cells of corresponding land use in the later image.

For the 6 by 6 matrix table presented below, the rows represent the older land cover categories and the column represents the newer categories. Although this matrix can be used as a direct input for specification of the prior probabilities in maximum likelihood classification of the remotely sensed imagery, it was however used in predicting land use land cover of 2026.

Table 4.5: Transitional Probability table derived from the land use land cover map of 1986 to 2016

Landuse classes	2026					
	Bare ground	Built up	Farm land	Rock out crop	Vegetation	Water body
Bare ground	0.283	0.5256	0.1287	0	0.0628	0
Built up	0.0506	0.7261	0.1607	0.0039	0.0293	0.0295
Farm land	0.1412	0.5547	0.1386	0.0285	0.137	0
Rock out crop	0	0	0.2217	0.5289	0.2462	0.0031
Vegetation	0.1344	0.1066	0.2505	0.1828	0.3258	0
Water body	0.0286	0	0.1574	0	0.2632	0.5509

Source: Author's GIS Analysis 2016

From table 4.5 above, Row categories represent land use land cover classes in 2016 whilst column categories represent 2026 classes. Bare ground has a 0.5256 probability of becoming Built-up and a 0.283 of remaining Bare-ground in 2026. This therefore shows an undesirable change (reduction), with

a probability of change which is much higher than stability. Built up during this period will likely be class with a 0.7261 probability of increasing built up in 2026; Farmland also has a 0.5547 probability of becoming Built-up; Rock out crop has a 0.5289 probability of remaining Rock out crop, this signifies stability so as Vegetation and Water body with a probability of 0.3258 and 0.5509 respectively. From the transitional probability matrix, the Landuse classes for 2026 can be deduced.

Table 4.6: Projected Land use land cover for 2026

Land use classes	2026	
	Area(Ha)	Area (%)
Bare ground	23950.89	10.48227
Built up	105846.3	46.32436
Farmland	40757.13	17.83764
Rock out crop	23525.91	10.29628
Vegetation	31335.12	13.71403
Water body	3074.13	1.345414
Total	228489.5	99.99999

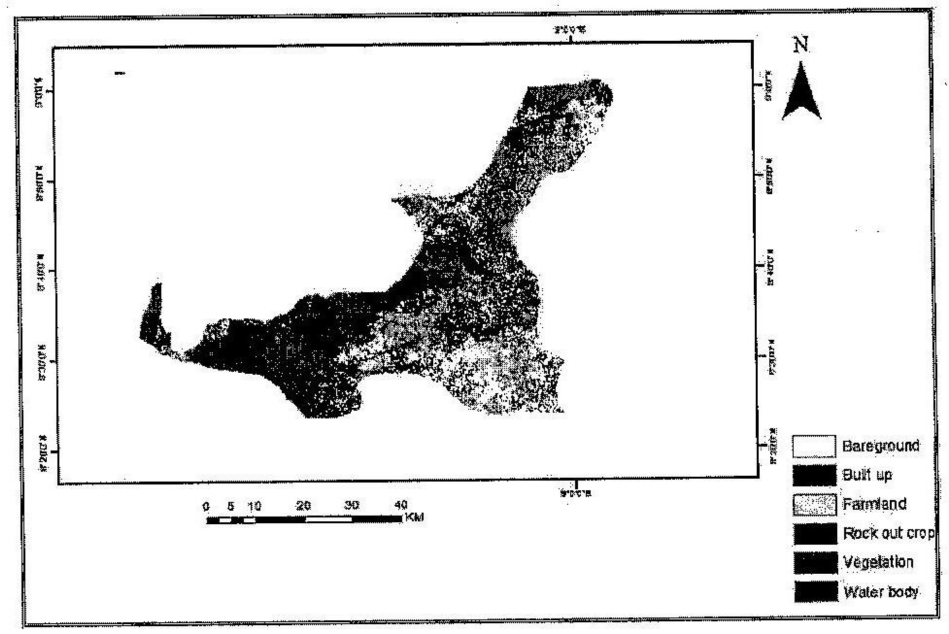


Figure 4.8; Projected Land Use Land Cover Map of Lafia for 2026, Map Derived From the 1986, 1999 And 2016 Use Land Cover Map

Source: Author's GIS Analysis 2016

✓ **Factors responsible for change in Landuse**

Several factors are responsible for the fast growth of Lafia town which are summarized in this section as represented in the chart below.

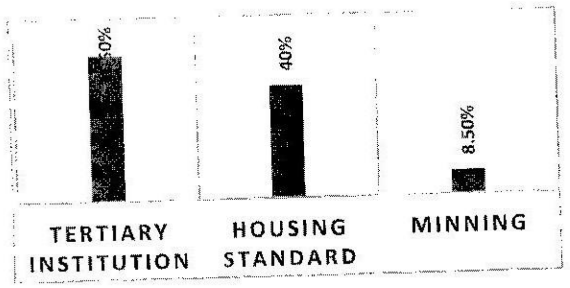


Figure 4.7 Drivers of urbanization in Lafia

In the first instance population dynamics manifested in urban population growth and rural to urban migration are by far the most significant driving forces of urban expansion of Lafia, Nasarawa state, through natural increase due to high fertility rate and decline in mortality.

The state has a federal polytechnic in Nasarawa local government area of the state, college of education in Akwanga, college of Agriculture in Lafia, Nasarawa state polytechnic in Lafia, Nasarawa state university in Keffi, a newly established federal university of Lafia in Lafia town,

and other vocational training schools. This account for high population in the area thereby driving urbanization at a high rate.

since the establishment of the FCT, Abuja in 1976 and the movement of the federal government offices and parastatals in 1991 as well as the demolition of informal settlements in 2006, mass movements of people into the suburbs has been unparalleled. As a result, settlements in Nasarawa have experienced unprecedented urbanization, increase in demand for land and rapid development of infrastructural facilities, social services and housing, changes in land tenure, increase in real property development and value, economic, social and political activities which are each contributing significantly to rapid urbanization of the area.

Additionally, there is demand for larger suburban lands and the desire of individuals for more living space. This explains why developers have preferred Nasarawa where large parcels of land is available at relatively cheaper rates than the Federal Capital city where land acquisition is restricted, costly and development control is more stringent. It also further explains why majority of the low and medium income groups whose houses were demolished from the FCT Abuja relocated to Nasarawa where about 40% of both the federal government and private sector workers reside and only transit to the capital city to work.

Nasarawa state is home to the Farin Ruwa falls in Wamba local government area of the state. Farin Ruwa falls is reputed to be one of the highest falls in Africa. This influence Tourism in the state. There is also the salt village in Keana local government area of the state. It produces naturally iodized salt from the lake located near it. The town is also the cradle of Alago civilization.

5. Conclusion

This study has shown clearly the extent to which the use of Remote Sensing technique can be helpful in providing bio- physical information necessary for assessing and monitoring the environmental impact of development projects. Urban growth analysis of Lafia town, Nasarawa state has been mapped out in this research and it has shown a rapid growth and decrease in the classes that was developed, Since the results obtained showed a rapid growth of built- up area this can cause shortage in food production, pollution, congestion, traffic, urbanization, and high rate of crime in the study area.

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