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Urban Growth Assessment and Its Impact on Deforestation in Kwali Area Council, Abuja Nigeria Using Geospatial Technology

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Abstract

The level of Urbanization in Kwali Area Council in last thirty (31) years has resulted to the degradation of vegetal cover. This study assessed the impact of urban growth on vegetation cover between 1987 and 2018 using geospatial technology. The images of different epochs (1987, 2001 and 2018) were classified into built-up area, farmland, grassland, forestland and bare land. This was carried out using ARC GIS 10.1 and Idrisi Selva software's. The result indicates that built-up area and bare land increased between 1987 and 2018 while vegetation cover decreased. This shows a rapid increase in built-up area (urban growth) and rapid decrease in forest (deforestation), which may be attributed to lack of improper environmental protection strategy . The study demonstrates the potentialities of remote sensing and GIS in assessing urban growth and its impacts on deforestation. The outcome of the study can serve as input into a relationship model for predicting the impact of urban growth on deforestation. The study further recommend the urgent need to carry out the Master Plan Review to secure the vegetative land cover, particularly the forest lands which have been greatly encroached by urbanization. The government should encourage environmental sustainable programmes that will foster forest development, urban agriculture and other urban expansion processes in Kwali Area Council

I INTRODUCTION

The increase in population in an area either through birth or migration has many consequences on the environment. The rapid population growth leads to demand for resources such as food, water, timber, energy increases posing a high pressure on the landscape (UNEP, 2011). Rapid urbanization has raised several challenges for land cover changes in FCT (Ejaro, 2009). Globally vegetation influences climate and its removal degrade the ecosystem. According to Valerie et al., (2008), there are limits to the number of people that can be adequately housed and catered for in urban areas by the available physical infrastructures. Recently, viewing the earth from space has become necessary to the influence on vegetation resources base over time (Ujoh et al., 2010). Nowadays half of the world's population lives in urban areas (Bokaie et al, 2016), leading to new Challenges, namely the impact of urbanization on the environment (Winarso and Firman, 2015; Buchori and Sugiri, 2016) .urbanization and economic growth on transportation routes are characteristic in which investment and industrialization can make rural areas into urban area (McGee, 2010; Setyono et al., 2016; Sugiri et al., 2011; Handayani, 2013). Improper control policy can lead to new problems, especially environmental sustainability in the metropolitan area (Surya, 2016; Pribadi, 2015; Wu et.al.2009). One of the environmental impacts of urbanization is the conversion of land especially on forest land.

Increased population, massive fuelwood harvesting, urban expansion, devegetation for agricultural and construction purposes among other activities degrade vegetation in Kwali Area Council. There is need to monitor the process of urbanization and to understand the dynamics of vegetation in the area for sustainability of the environment. The study of land conversion by various methods has been widely conducted (Phuc et al., 2014; Miettinen et al., 2012; Zhang et al., 2015; Wijaya, 2015) but a study of the relationship between urbanization and forest land loss is lacking. In FCT, Ejaro (2008) assessed land use/cover

changes using multi-temporal satellite data. Fanan, et al.(2011 also studied agricultural land loss due to urbanization in FCT.these studies however involves the whole of Abuja. But to be specific, none of these studies have observed the impact of urbanization on the vegetation of Kwali, it is in view of this the study was carried out to observe the impact of urbanization on vegetation change between 1987 and 2018. The purpose of this study is to see the extent of forest conversion as a result of urbanization.

Aim and Objectives

The aim of this study is to assess the effect of urban expansion on vegetation degradation in Kwali Area Council using geo-spatial technology.

The objectives are to:

I. Analyse the land use/ cover in the study area.

II. Assess the spatio-temporal changes of vegetation cover

III. Assess the impact of urbanization on vegetation cover.

Study Area

The area of this study is Kwali Area Council. It lies between latitude 8^0 30'N and 9 ^{0}00 'N and longitude 6^0 30'E and $7^0$40'E. Kwali area council is bordered by the Abuja Gwagwalada Area council to the north, Kuje Area Council to the west and Abaji Area Council to the south (Fig.1). The area council occupies a land mass of about 1206 Km^2square kilometres. Gwagwalada experiences extreme seasonal variation in monthly rainfall. The rainy period of the year lasts for 8.2 months.It falls within the Guinea savannah vegetation. The vegetation combines the best features of the southern tropical rain forest and guinea savanna of the North.The soil is reddish with isolated hills filled by plains and well drained sandy clay loams which supports farming of the major crops such as sorghum, millet, melon, yam, soybean,

benniseed, cassava and rice cultivation (Abuja ADP, 2004). There is an increase in human activities over the years due to population growth. The original settlers are Gwari, Koro, Bassa, Gade and the Hausa Fulani as well as immigrant's population of other Nigerians.

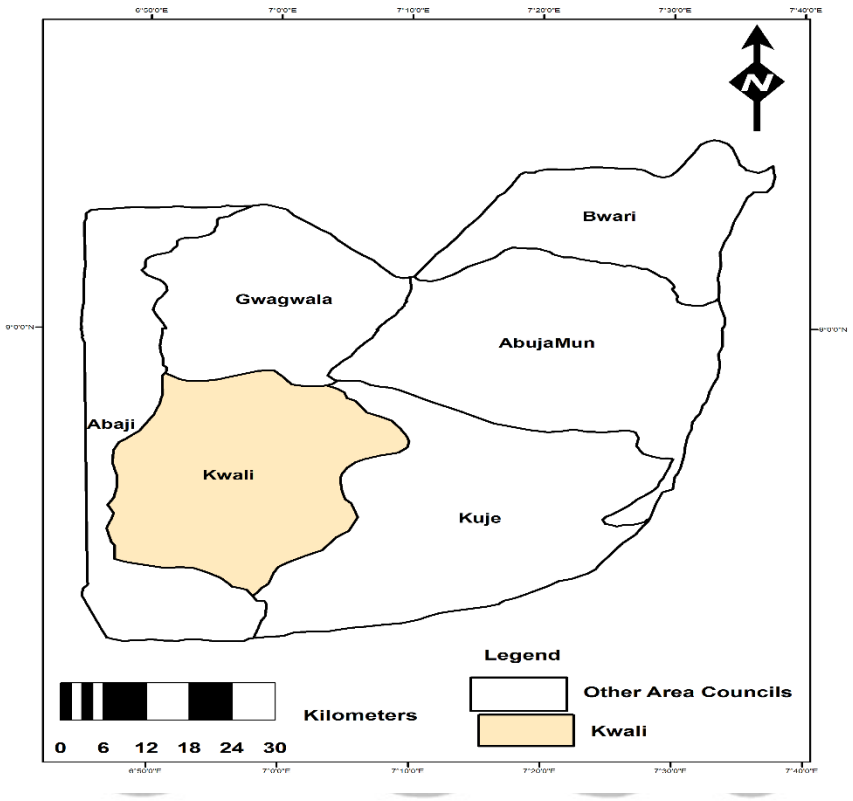

Fig 1: Study Area Map

II METHODOLOGY

a. **Reconnaissance Survey: A**n exploratory survey was carried out in the study area to get the researcher familiar with the study area and pick coordinates used for training sites and land use/ cover accuracy assessment.

b. Sources of Data

The data consist of satellite imagery, Administrative map covering Kwali Area Council:

I. Administration map of Kwali Area Council obtained from the Council Secretariat

II. Land sat-5 TM 1987 obtained from the official website of Global Land Cover Facility (30m resolution).

III. Land sat-7 ETM 2001 obtained from the official website of Global Land Cover Facility (30m resolution).

IV. Landsat 8 2018 obtained from the official website of Earth explorer (30m resolution).

Software's used

I. **ArcGIS 10.1:** for extraction of the study area using clipping algorithm and also for land use/cover maps composition.

II. **Idrisi Selva:** for land cover classification, areal statistics extraction and accuracy assessment

c. Processing of Satellite Images

The satellite image was imported into the GIS software and the study area was clipped out.

I. **Development of Classification Scheme**: Five land use/land cover categories were used. These are built-up area, Forest land, Grassland, Farm land and bare land. It's based on prior knowledge, reconnaissance survey and knowledge from other research works.

II. **Satellite band combination**: The bands 3, 4, 5 were combined using the composite band algorithm in idrisi software. The result is a coloured image depicting the various land use/ cover.

III. **Digitizing of Satellite Image**: The digitize tool in Idrisi Selva software was used in digitizing the training sites for the various land use /cover categorise in layers of Built – up areas, Forest land, Grassland, Farm land and Bare Land.

IV. **Change detection Analysis:** After the classification for each of the study epochs, a change detection analysis was conducted to see the to and fro changes in land cover

under study. The classified image were rectified to the same resolution to enable overlaying analysis.. The land change modeller in idrisi selva software was used.

V. Groundtruthing was conducted to establish relationship between the classified land use/cover maps and the reality on ground in some sampled locations. A hand held GPS receiver was used to facilitate navigation and identification of the sampled locations (i.e. longitude and latitude).

III RESULTS PRESENTATIONS

Table 1: land use/land cover distribution from 1987-2018

S/N	*Classes*	*1987(Area) Km^2*	*%*	*2001(Area) Km^2*	*%*	*2018(Area) Km^2*	*%*
1	Forest Land	238.18	19.75	213.462	17.7	153.75	12.74
2	Grassland	379.64	31.48	331.65	27.5	264	21.85
3	Farmland	356.61	29.57	329.1	27.29	343	28.42
4	Built Up	114.8	9.517	218.99	18.15	293.23	24.31
5	Bare land	116.6	9.67	112.3	9.31	153	12.64
Total		1206	100	1206	100	1206	100

Table-1, revealed a remarkable increase in built-up area in the study area during the last thirty one years. The built up areas increased consecutively across the study epochs; 9.5% in 1987, 18.7% in 2001 and 24.7% in 2018. Built up area gained 104.19sqkm equivalent to 8.6% of the area under study from 1987 to 2001 and further gained 74.24sqkm equivalent to 6.15% of the total area under study from 2001 to 2018. The increment in built-up area may be attributed to rapid population growth due to rural-urban drift which in turn leads to housing and infrastructural development in the area. Thus, it can be asserted that the built-up area's increment is a sign of urban growth, with negative impact on vegetation and other resources.

The forest area decreased from 238.18sqkm in 1987 to 213.4sqkm in 2001 resulting in a decrease of 25sqkm equivalent to 2.07% of the total area of the land under study. Furthermore, the forest cover decreased to 153.75 (2001 to 2018) resulting in loss of 59.71sqkm, equivalent to 4.9% of the total area under study. Expressed in percent change, the forest cover in 1987 was 19.75% of the total study area (Table 1); decreased 17.7% in 2001 and decreased to 12.74% in 2018. Grassland covers 379.64sqkm in 1987 decreased to 331.65 in 2001 and 264sqkm in 2018. The grassland land loss 49.99sqkm between 1987 to 2001 equivalent to 3.97% of the total land area under study and 67.65sqkm loss occurred between 2001 to 2018 equivalent to 5.60% of the area under study. Farmland, on the other hand, decreased in area from 29.57% to 27.29% from 1987 to 2001 and increased to 28.49% in 2018.there was 27.51sqkm loss in farmland equivalent to 2.28% of the area under study between 1987 and 2001.Furthermore Farmland gained 13.9sqkm equivalent to 1.15% of the total area under study. Bare land areas decreased from 116.6sqkm in 1987 (9.67% of total study area) to 112.3sqkm in 2001 (9.31% of total land of study area) resulting in a decrease of 4.3sqkm equivalent to 0.35% of the total land of the study area. Bare land increased to 153sqkm (12.64% of total land of the study area) in 2018 resulting in an increase of 40.7sqkm equivalent to 3.37% of the total land of the study during the period 2001 - 2018.

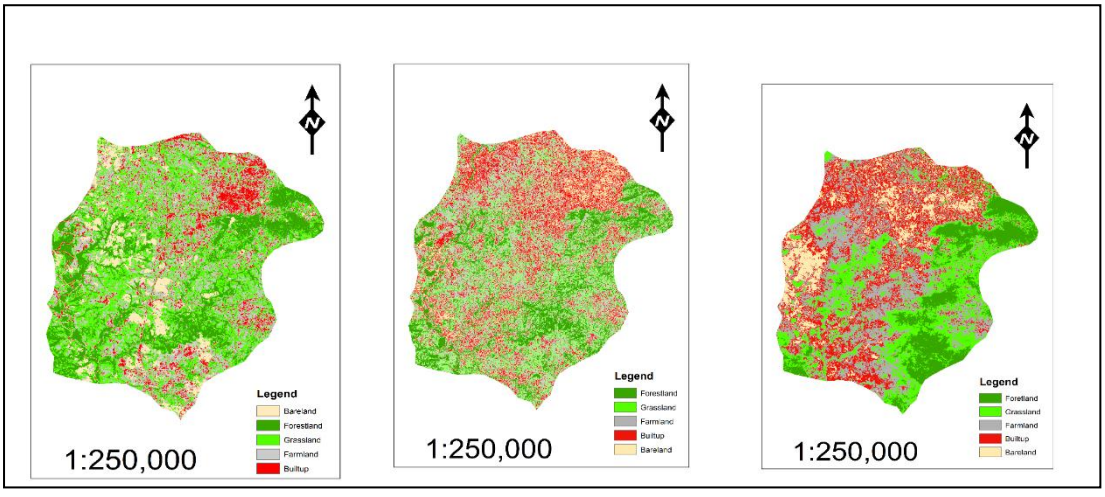

Fig.2: classified land use/cover maps of 1987, 2001 and 2018

Source: Authors Laboratory/ field analysis (2019)

Land use/ cover Change from 1987 to 2018

Figure 3 revealed that the grassland and Forest land declined. The rate of change was greater from 2001 to 2018. Forest land and Grassland showed a general decline throughout the periods (1987-2018) whereas farmland, bare land and built-up area in contrast showed general trend of increase in these periods. The removal of forest land to expand cultivation and cutting of trees is the dominant human activities in the study area. The expansion of farmlands and intense deforestation were directly linked to population growth. The major changes observed were decrease in the overall area of forest land and an increment of agricultural area, bare land and built up area. There have been significant conversion between forest land to farmland, grassland, and built up to other land classes. Based on the change detection, parts of the forest lands were continuously cleared to expand farmlands and built areas.

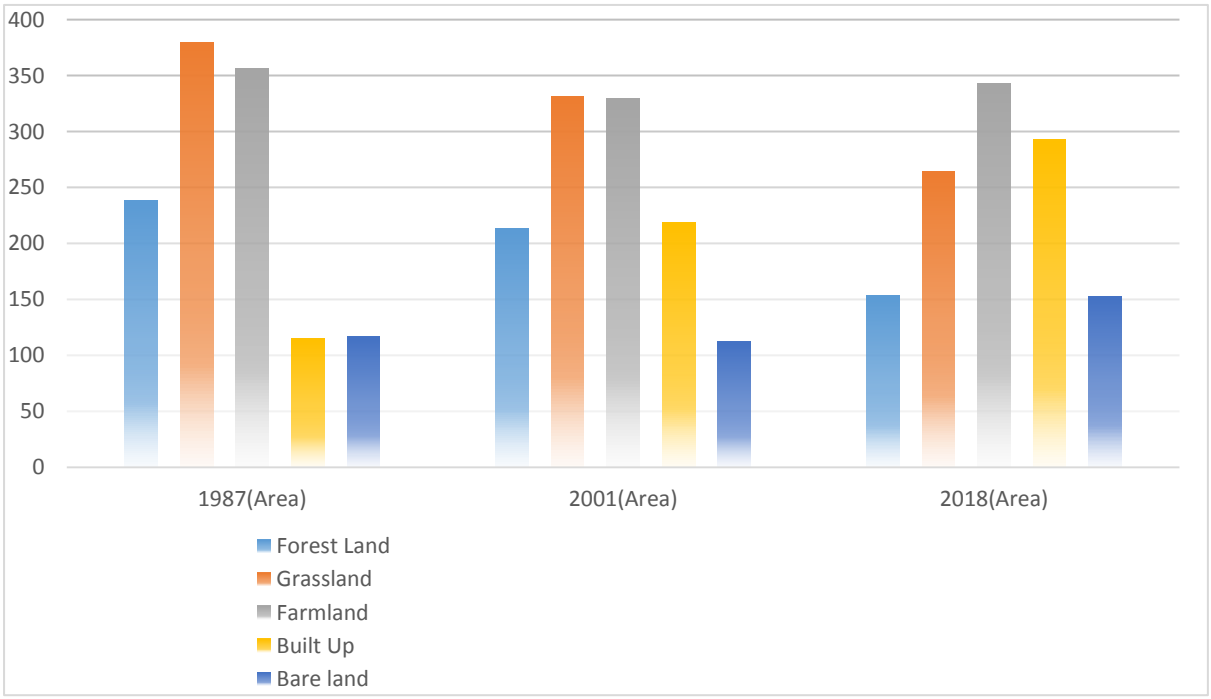

Fig.3: Spatial temporal changes in Land use/cover from 1987 to 2018

CONCLUSIONS

The study revealed variation in trends and extent of change in land use and land cover types during the two study periods: 1987 to 2018. During the study period, forestland and grassland decreased consecutively while Farmland, bare land and Built-up area increased. The rapid increase in built-up area indicates urban growth while the decrease in forest indicates deforestation. The deforestation may be attributed to lack of proper environmental protection strategy. The study demonstrates the potentialities of remote sensing and GIS in assessing urban growth and its impacts on deforestation, and the outcome of the study can serve as an input into a relationship model for predicting the impact of urban growth on deforestation. To minimize deforestation in the area, all forest frontier should be communally involved in planning, management and profit sharing. Community participation in forest ownership and management needs to be encouraged with restrictions on extraction and conversion. Moreover, effective implementation, mitigation strategies should involve active stakeholder participation, development of management plans, monitoring and enforcement. The master plan should be strictly implemented to avoid encroachment on vegetal cover.

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