

Spatiotemporal Analyses of Land Use and Land Cover Changes in Suleja Local Government Area, Niger State, Nigeria.

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Abstract

This study examines the spatial and temporal changes in land use and land cover in Suleja Local Government Area (LGA) of Niger State between 1987 and 2012, as well as, the rate of change, factors responsible and suggests measures on how to check the trend in order to maintain sustainable development. The study utilised ILWIS 3.3 software for the processing and classification of the tri-date (1987, 2001, and 2012) satellite images. The method for the analyses of the land use and land cover change is the Post-classification Comparison Method (PCM). Land use and land cover change data obtained from each period is presented in colour composite maps and tables. The results obtained show that the proportion of area covered by built up land, farm land and bare soil is on the increase, whilst there is decline in vegetation. Built up land increased from 7.0 km² (or 5.2%) in 1987 to 17.9 km² (or 12.5%) in 2012, farmland from 50.1 km² (or 36.7%) to 63.0 km² (or 46.2%) and a decline in vegetation from 68.7 km² (or 50.4%) in 1987 to 43.1 km² (or 31.6%) in 2012. The study reveals that urbanization is largely responsible for the significant change and modifications in land use and land cover in Suleja LGA. These land use and land cover changes lead to environmental degradation, biodiversity loss, infrastructure overload, etc. To mitigate these impacts there should be constant monitoring of urban growth and changes in land use/land cover and put in place appropriate response mechanism in line with the towns and regional master plan to maintain sustainable development of Suleja LGA.

Keywords: Land use, Land cover changes, Spatiotemporal, Sustainable Development, Satellite Images, Time lapse analyses, Urbanization,

Introduction

Humans have been altering land cover since time immemorial through the use of fire to flush out game and, since the advent of plant and animal domestication, through the clearance of patches of land for agriculture and livestock. In the past two centuries the impact of human activities on the land has grown enormously, altering entire landscapes, and ultimately impacting the earth's nutrient and hydrological cycles as well as climate (De Sherbin, 2002).

Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of land use and land cover change (LULCC) are far greater than ever in history, driving unprecedented changes in ecosystems and environmental processes at local, regional and global scales. These land uses exert pressure on the seemingly finite land resources in urban centres, thus land is fast becoming a critical resources, its demand remain a fundamental issue of both academic and policy discourse (Ujoh, 2008).

In recent times, significant population increase, migration, accelerated socio-economic activities and increased demands on the landscapes for food and shelter and an increased number of products of man's living environment have led to unparallel changes in land use and modification of rural and urban environments. Ifatimehin and Ufuah (2006) and Rimal (2001) asserts that, the change in land cover occurs even in the absence of human activities through natural processes whereas land use change is the manipulation of land cover by humans for multiple purposes; food, shelter, fuel wood, timber, fodder, medicine, raw materials and recreation. So many socio-economic and environmental factors inter play in land use and land cover dynamics

Major consequences of the globally recognized rapid land use and land cover changes are; land degradation, agricultural yield depletion, loss of biodiversity and ecosystem functioning. Due to poorly planned human interference, many Africa countries have experience untold environmental degradation and ecological deterioration in the past century, with little or no real solution to alleviate many of these concerns. Adequate information and appropriate technology are limited factors for effective environmental management (Eedy, 1999). The understanding of land use and cover dynamics and interactions with socioeconomic and biophysical factors is a necessary tool that will aid the analysis of land-use and land-cover change across scales.

Land use and land cover change is the quantitative changes in the areal extent (increases or decreases) of a given type of land use or cover type. It also includes alteration or modification and conversion from one type of use or cover to another (Briassoulis, 2000). Garba (2008) observed that land cover change provides a means of understanding and managing the problems of degradation and shortage of land and water resources. Land cover change has been described as the most significant regional anthropogenic disturbance to the environment

(Roberts, et al, 1998). In additions, land cover change occur when one land cover type is converted to another, or is modified, such as a change in agricultural land to residential, or an intensification of existing use, such as from light to heavy industry. Land cover is continually influenced by land use due to human cultural, social, and economic activities (Lambin et al, 2003; Erle and Roberts, 2010).

Land use change over time is an inevitable phenomenon occurring globally due to both temporary and or permanent interest of the inhabitants in a particular area. The phenomenon could be revealed either in a small or large scale but the most interesting and fundamental observation is that change occurs over time in a particular place. It has also been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" (FAO, 1999).

There is an increasing need to be able to precisely describe and classify land cover and land uses in order to define sustainable land use systems that are best suited for each place. The driving force for most land use and cover changes is population growth, although there are several other interacting factors involved (Ramankutty, et al, 2002).

Competing land uses (agriculture and human settlements mainly) are contributing to the decline of forest and woodland areas and the rising demand for fuel wood and charcoal is also a major cause of deforestation. Settlements represent the most profound human alteration of the natural environment through a spectrum of urban landuse activities (Ifatimehin and Ufuah, 2006). Which include, but are not restricted to transportation, commercial, industrial, residential, institutional and recreational landuses. Over harvesting, agricultural encroachment and unregulated burning are believed to be contributing to the decline of many species in the wild. There are also incidental impacts on land cover from other activities such as forest and lakes damaged by acid rain from fossil fuel combustion, and crops near cities damaged by tropospheric ozone as a result of emissions from automobiles (Meyer, 1995). One of the greatest challenges facing mankind today is land degradation although, the problem is as old as settled agriculture, its extent and impact on human welfare and global environment are now more than before (Lai and Stewart, 1990).

In addition, changes in land use and land cover, especially when coupled with climate variability and change, are likely to affect ecosystems and the many important goods and services that they provide to society (Loveland, et al, 2003). Land conversion is the greatest cause of extinction of terrestrial species, of particular concern is deforestation, where logging or burning is followed by the conversion of the land to agriculture or other land uses. Even if forest is left standing, the resulting fragmented landscape typically fails to support many species that previously existed there (Bierregaard, et al, 2000). Land use could be rural or urban, although sometimes, rural land use is commonly equated to agricultural land use, the non-agricultural land use is also important because it represents the focal areas of activities which directly or indirectly relate to, and whose socio-economic significance depends on the success of agriculture (Ebong, et al, 2002).

Land use change may involve either a shift to a different use, such as agricultural land changing to residential, or an intensification of the existing use, such as from light to heavy industry. The dual role of human activity in contributing to the causes and experiencing the effects of global change processes brought about by land use changes emphasizes the need for better understanding of the interaction between humans and the environment. This need becomes more imperative as changes in land use become more rapid. (IWR, 1999) For example, areas covered by woody vegetation may represent an undisturbed natural shrubland, a forest preserve recovering from a fire, regrowth following tree harvest (forestry), a plantation of immature rubber trees (plantation agriculture), widen agriculture plots that are in between periods of clearing for annual crop production, or an irrigated tea plantation. (Turner, 2002) observed that, changes in land cover and in the way people use the land have become recognized over the last 15 years as important global environmental changes in their own right.

From the foregoing it is imperative to say that, scientific investigation of the causes and consequences of land use and land cover change requires an interdisciplinary approach integrating both natural and social scientific methods, which have emerged as the new discipline of land-change science. In order to use land optimally, it is not only necessary to have the information on existing land use/ land cover, but also the capability to monitor the dynamics of land use resulting from both changing demands of increasing population and natural forces that act to alter and shape the landscape (Lambin et al, 2003). An improved understanding of historical land-use and land-cover patterns provides a means to evaluate complex causes and responses in order to better project future trends of human activities on land. Thus, the need to study land use and land cover change has become a central component in current strategies in managing natural resources and monitoring environmental changes.

The causes of land use change can be divided into two categories:

Proximate (Direct or Local) causes and Underlying (Indirect or Root) causes. Direct or Local causes of land use change explain how land cover and ecosystem are modified by humans' e.g. farms, household, communities etc. Indirect or root causes originate from regional (Districts, Provinces, or country) and they tend to be complex as a

result of the interactions both Social, Political, Economic, Demographic, Technological, Cultural and Biophysical variables. In addition, according to Eric et al. (2007) major causes of land use change include: Natural variability, Economic and Technological Factors, Demographic factors, Institutional factors, Cultural factors and Globalization.

Urbanization and Land use and Land Cover Change

It is generally believed that urbanization has both direct and indirect impacts on land use transformation. Urban sprawl is one of the most noticeable effects of urbanization on land use. Though, sprawl can alter a region's unique rural character by creating miles of undifferentiated new developments that bring habitat loss along with traffic congestion. (Rimal, 2001) opined that urbanization is an inevitable process due to economic development and rapid population growth. Urbanization is a process of increase of modernization system which modifies the socioeconomic activities and revolutionizes the land use practice according to time frame.

Urbanization is a universal concept, signifying changes in man's interests, activities and values, and appearing to have been related to increasing functional specialization in human societies. It is characteristics and processes of manifestations which differs from place to place given environmental, socio-cultural and political conditions peculiar to the a particular geographical location. Thus, urban growth is a quantitative measure frequently associated with progress. The extent to which urbanization affects land use change and the ways in which they interact to yield has both direct and indirect impacts on land use transformation Yichun, et al (2007).

A fact widely acknowledged is, unplanned growth of urban areas throughout the nations especially in the developing countries of Africa has been responsible for the fragmentation of landscapes and disruption of hydrologic and other cycles of nature. Keating, et al (2003) asserts that the rapid unplanned urbanization observed in many parts of Africa is changing the context for human population and natural systems interaction. Land cover and land use changes associated with urbanization are important drivers of local geological, hydrological, ecological, and climatic change. The resources and environment of urban centres all over the world are increasingly being depleted partly due to the pressure from the concentration of people, human population is growing fast especially in developing countries and the desire for land increase daily (World Bank, 1992).

Application of Geo-spatial technology in Land Use Land Cover Change Studies

Remote sensing helps in acquiring multi spatial and temporal data through space borne remote sensors (Ramachandra and Kumar, 2004). Remote sensing tends to orient towards any applications that are of direct and immediate benefit to people and society. Dutta (2006) highlighted the advantages of remote sensing. To understand how land use and land cover change affects and interacts with global earth systems, information is needed on what changes occur, where and when they occur, the rates at which they occur, and the social and physical forces that drive those changes (Lambin, 1997).

There has been a worldwide increasing awareness and studies on land use and land cover change analysis in the last four to five decades. The importance of such studies to sustainable development plan of nations has been universally recognized. Mapping land use land cover change using remote sensing and GIS techniques is an area of interest that has been attracting increasing attention globally. Understanding the significance and potential consequences of land cover changes for climate, biogeochemistry, or ecological complexity is difficult without land use information. Information about change is necessary for updating land cover maps and the management of natural resources (Rajeshwari, 2006).

Remote sensing and Geographical Information system provide fundamental tools which can be useful in the investigation at the village district as well as the city levels (Rimal, 2005). Their analysis includes statistical analysis, trend analysis, overlays buffering, distance analysis, cost analysis and many more (Arimoro et al, 2002).

Several studies and literature abound on the application of remote sensing and GIS in LULCC studies. A few of such studies in Nigeria include (Abubakar, 1998; Adeniyi, and Omojola, 1999; Franke-Scharf, 2000; Mashi and Alhassan, 2004; Akinyemi, 2005; Adepoju, et al, 2006; (Mengistu and salami, 2007; Ademiluyi, et al, 2008; Garba, 2008; Ujoh, 2008; Ejaro, 2009a; Ejaro, 2009b; Abbas, et al, 2010; Eludoyin, et al, 2011).

Suleja and Madalla towns (in suleja LGA) as urban settlements are regarded as some of the fastest growing heterogeneous and cosmopolitan communities in the country, due to their close proximity to the Federal Capital City of Abuja, Nigeria. As a result of the accelerated growth of the towns due to the continuous influx of migrant traders, resident civil servants and other people from different walks of life, many parts of their natural land cover over the years has given way to different forms of anthropogenic land use or activities.

Today, more and more of the land cover in Suleja Local Government Area is giving way to the rapid infrastructural development at an alarming rate, this trend if not checked it could have negative consequences in the future especially on both the inhabitants, environment and the climatic condition of the town altogether. And consequent upon this, it will certainly be a draw back in the area of conservation and sustainable development of vegetation/ land cover and other resources in the local area, State and the Country as a whole.

Conceptual framework

The conceptual framework of this study is based on population, urbanization and landscape change processes. This is founded on Coccossis (1991) notion of concept of ecological equilibrium cited by Briassolis (2000). According to this concept, a region has four sets of factors, population, resources, technology and institutions that are constantly in a state of dynamic equilibrium. Changes in the spatial structure of an area are the result of changes in the equilibrium between these factors. Extending the argument to the land use theme, Coccossis (19191) cited by Briassoulis (200) suggests that “in this conceptual framework, changes in land use are the result of changes in the size and distribution of population, technological innovation and economic restructuring, social organization and policy”. It is pertinent to observe that population, urbanization and environment relationship is complex and multidisciplinary. The theoretical approach taken to study this relationship depends on the researchers’ disciplinary background and objective of study. This study dwells on population, urbanization and land use/cover change linkage. Rogers (1982) points out that natural increase explains most urban population growth and high levels of rural- to- urban migration tend to accelerate urbanization. The consequence of urbanization on the environment are well documented (Peng, Chen and Cheng, 2000; Lambin, Geist and Lepers, 2003; Hongming, Zie and Xiuping, 2004; Oswaldo and Fath, 2011)

The aim of this study is to examine the spatial and temporal changes in land use land cover in Suleja Local Government Area of Niger State between 1987 and 2012. The specific study objectives are; to examine the spatial and temporal changes that have taken place, examine the rate of change, highlight the factors of population and urbanization largely responsible for the changes and suggest measures on how to check the trend in order to maintain sustainable development.

The Study Area

Suleja Local Government Area lies between latitude 9°6’13.8’’ and 9°17’49.35’’ north of the equator and longitude 7°6’58.6’ and 7°12’18.41’ east of Greenwich Meridians. It has an area of 136.33 sq km. The LGA is only 110km south-east of the State Capital Minna and bounded by the Federal Capital City of Abuja at the west in just about 65km away. Suleja lies on the physiographic unit known as central highland and is located on relatively high grounds of over 1200 feet or 366m above sea level. The topography is fairly rugged, with common occurrences of inselbergs over the urban landscape. Suleja town lies on a steep sloping valley of folded mountains and huge out-cropping granite rocks. Similarly the town lies on the valley of river, gorges and many small streams running across it. Figure 1, show the study area, Suleja LGA, of Niger State.

Suleja enjoys sub-humid climatic condition with mean annual rainfall of 1640mm and a raining season of over 7 months in the year. There is a single maxima in the rainfall regime usually in the month of august. Temperature is generally high in the summer months, but cools during the hamattan months which last from November to March (Aminu, et. al. 2013).

The rapid growth and expansion of the population of Suleja Local Government Area (LGA) can be explained by the large influx of people into the LGA its location near the Federal Capital City of Abuja has had the most profound effect on its population expansion. The increase in population over the years has brought about rapid development in physical structures and its micro economy at large. The official population figure for Suleja LGA in the last census 2006 is estimated at 216, 578 people (NPC, 2006).

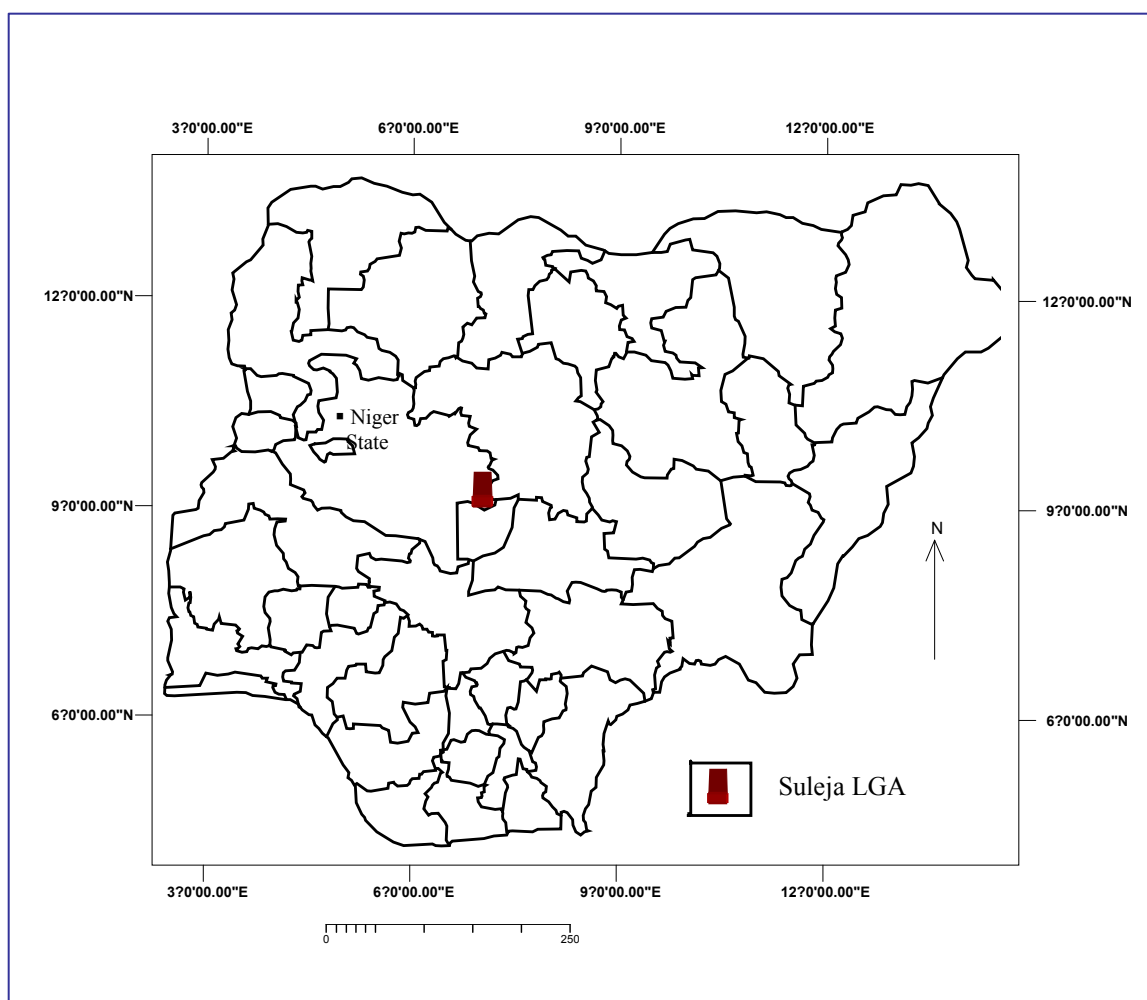


Fig. 1 Map of Nigeria showing Suleja LGA (the study area)

The materials used in this study are satellite images of three different epochs (Table 1), sourced from the National Space Research and Development Agency (NASRDA) and Global Land Cover Facility (GLCF) website. The administrative map of Suleja Local Government Area was a valuable material.

Table 1 Satellite images used

S/No	Satellite Type	Resolution	Path/Row	Date of Observation	Source
1.	Nigeria Sat-1	32M	Zone/Scene 7	14/2/2012	NASRDA
2.	Land Sat TM	30M	189/54	27/12/2001	GLCF
3.	Land Sat ETM+	30M	189/54	21/12/1987	GLCF

The study utilised ILWIS 3.3 software for the processing and classification of the satellite images. The method involved scanning and digitization of map of Suleja LGA, Georeferencing, sub setting the map boundary on satellite images, application of supervised maximum likelihood classification logic (Maximum Likelihood Classifier) for the classification of the images and conduct post classification comparison technique for change detection. The outputs were; generation of change map products and LULC change statistics used for analyses.

The following land use/land categories were used in this study: Bare surface, Built-up land, Farm land, vegetation.

Land use land cover change data obtained from each epoch is presented in colour composite maps and tables. The method for the analyses of the LULC Change is the Post-classification Comparison Method (PCM). Post-classification comparison analyses reveal the change between two epochs. Change data is generated and from the change statistics the rate of change is derived. The spatial and temporal changes are examined.

Classification Accuracy Assessment average score of 96% was achieved using the error matrices method. Field verification was carried out in order to generate additional data to test the quality or accuracy of the classification. It is done by creating a confusion matrix, in which classification results are compared to the

additional ground verification information in order to test the quality or accuracy of the satellite images classification.

Results and discussion

Land use and land cover change distribution and time lapse analyses

The static land use and land cover distributions for each study year is presented in table 2 and figures 2, 3, and 4.

Table 2 Land Use /Cover Distributions in Suleja LGA in (1987-2012)

S/N	Land use/ cover classes	1987		2001		2012	
		Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)
1.	Bare surface	10.528	7.7	11.129	8.2	13.183	9.7
2.	Built up	7.041	5.2	12.110	8.9	17.090	12.5
3.	Farm land	50.101	36.7	55.508	40.7	62.952	46.2
4.	Vegetation	68.665	50.4	57.588	42.2	43.110	31.6
	Total	136.335	100	136.335	100	136.335	100

Land use and land cover distribution in 1987

Table 2 and figure 2 reveal that in 1987 the predominant category is vegetation 68.665km² (representing 50.4%) of the study area. Suleja LGA shares boundary with the FCT, Abuja and its major towns Madalla and Suleja are satellite towns to the Federal Capital City, Abuja. As at 1987 the seat of the federal capital had not been relocated to Abuja. The inhabitants were very small in number and their occupation then was farming and hunting and other primary activities. There was no effect of FCT, Abuja on Suleja LGA and built up land occupied only 7.041 (5.2%). Farm land occupied 50.101km² or (36.7%). Settlements like Fadaman-abuchi, Bamburu, Kuchiko, Zariyawa, Tungan-shanu, Gajiri, Numba, Chaza, parts of Rafin-chinnaka and Gwazunu were heavily engaged in farming.

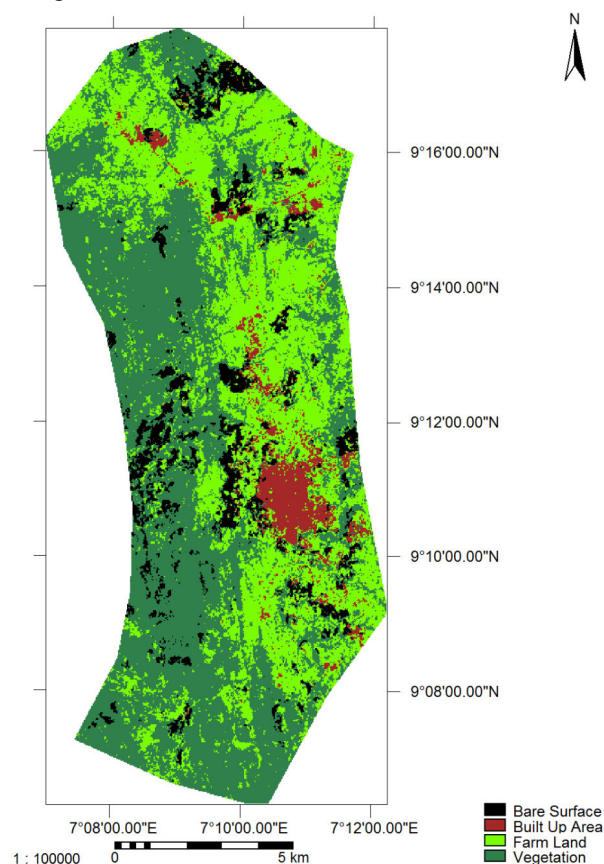


Fig.2 Land use Land cover map of Suleja in 1987

Land use and land cover distribution in 2001

Figure 3 and table 2 reveals that in fourteen years from 1987-2001, though vegetation still constituted the largest

land use category there was a decline as it occupied 57.558km² (42.2%) of the total land cover of the study area. Built up land increased to 12.110km² (8.9%). There was settlement expansion around Madalla, and Suleja, Bagama and Kurmin-sarki. It is pertinent to note that in 1991, the seat of Nigeria federal government was relocated to the Federal Capital Territory, Abuja. This has had huge influence on the rapid population growth and urbanization of the towns in Suleja LGA especially the major towns of Suleja and Madalla which lie adjacent to Abuja and serve as satellite towns to Abuja. The sudden change in demography and other physical modifications was as a result of the continued influx of people due largely to urbanization. Bare soil increased to 11.129km² (8.2%) due to the opening up of new areas for construction of houses and transport routes.

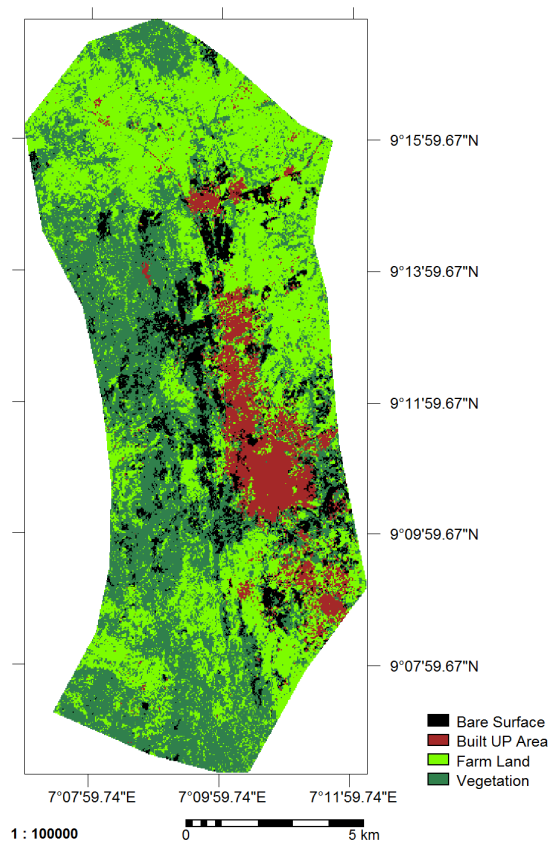


Fig. 3 Land Use/Land Cover map of Suleja in 2001

Land use and land cover distribution in 2012

The LULC distribution trend differed slightly from 2001 to 2012 as seen in figure 4 and table 2. Despite its continuous decline over the years due largely to human activities in the study area, vegetation still maintained its lead with areal coverage of 43.110km² (31.6%). More land is converted to farmlands because there is an increase in farm land category to 69.952km² (46.2%). Built up land category increased by 3.6% occupying 17.090km² (12.5%) of the land use. Bare soil category continued to increase with increase in physical development in terms of provision of infrastructures and other construction works which is gradually subjecting the land to the vagaries of land degradation.

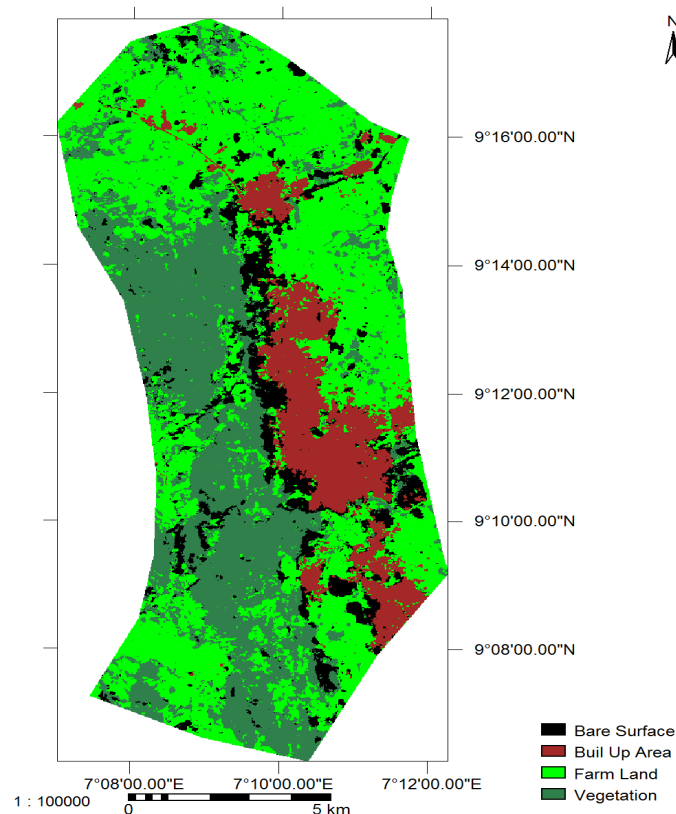


Fig 4 Land Use/Land Cover map of Suleja in 2012

Time lapse analysis and Rate of change in land use land cover

The rate of change of the LULC between 1987 and 2001, and between 2001 and 2012 is not uniform (table 3).

Table 3. Time lapse change and rate of change in land use and land cover

S/No	Land use/land cover classes	Area change (km ²) between 1987-2001	% Rate of Change between 1987-2001	Area change (km ²) between 2001-2011	% Rate of Change between 1987-2001
1	Bare surface	0.601	5.7	2.054	18.5
2	Built up land	5.069	72.0	4.980	41.1
3	Farm land	5.407	10.8	7.444	13.4
4	Vegetation	-11.077	-16.1	-14.478	-25.1

In the fourteen years interval between 1987 and 2001, both positive and negative change in land use and land cover categories were experienced. Table 3 reveals that bare surface, built up land and farmland increased at the rates indicated therein. Whereas vegetation declined at the rate of -16.1%. The significant rate of change is in built up land which increased at the rate of 72%. This increase is due to the rapid urbanization witnessed especially from 1991 when the seat of the federal government moved to Abuja. The satellite towns of Suleja and Madalla serve most lower/middle income civil servants, assistants to politicians, commercial traders and artisans that came to explore the opportunities in the federal capital, Abuja. The cost of living in Abuja city especially accommodation is too high for these category of people hence their influx to Suleja and Madalla. This has stimulated rapid urbanization and the consequent land use and land cover changes in table 3.

In the period between 2001 and 2012 the trend continued. The significant changes are in the increase in built up land and decline in vegetation which increased and decreased at the rates of 41.1% and -25% respectively. The reasons for the increase in built up land are population growth and rapid urbanization. The decrease in vegetation is because it is cleared to pave way for housing and other infrastructure needed to cater for the rapid urbanization.

Factors Responsible for Land use and Land Cover Change

The major factors responsible for the land use and land cover changes in the study area are urbanization and population dynamics. As stated earlier Suleja LGA is adjacent to the FCT, Abuja. Suleja town is a satellite town to the nation's capital city about 65km away. Madalla, town in Suleja LGA even shares border with

Zuba town in the FCT and is about 45km from Abuja. This proximity to the nation's capital together with the impetus of return to democracy since 1999, has led to influx of people to Suleja LGA with concomitant effect of urbanization on land use and land cover changes.

The population of Suleja has experienced a phenomenal growth due to immigration and natural increases (from 108,561 in 1991 to 216,578 in 2006; NPC, 2006). This has opened up varied human activities associated with land use such as constructions and engineering works, socio economic and other commercial activities and urban expansion. This can be seen from the increases witnessed in the steady rise in built up land.

Naturally, increase in population usually corresponds to increase in or demand for more food. Therefore, the need for more land to farm becomes very imperative and this of course implies that more vegetation would have to be depleted. This can be observed in table 2, with significant increase in farm land from 50.101 km² in 1987 to 62.952 km² in 2012, and a decline of vegetation from 68.665 km² to 43.110 km² over the same period.

Though land can be altered by natural forces other than man, such natural events as climate variability, denudation, flooding and other ecosystem dynamics, all these are likely threats that can alter or initiates modifications upon land cover. How these natural factors may have contributed to the observed changes in the study area and is a subject of further studies. This study largely corroborates other similar studies on the impact of urbanization on land use and land cover changes in Nigeria and other parts of the world (Mashi and Alhassan, 2004; Akinyemi, 2005; Abdullah, 2006; Mohammed, 2007; Ojile, 2007; Ujoh, 2008; Ejaro, 2009a and b; Eludoyin, Wokocha and Ayolagbo, 2011; Arome and Ejaro, 2012; Peng, Chen and Cheng, 2000; Rimal, 2001; Lambin, Geist and Lepers, 2003; Hongming, Zie and Xiuping, 2004; Yichun, et. al.,2007).

Conclusion and recommendations

This study has provided data on the type, pattern and rate of land use and land cover change in Suleja LGA. The study reveals that urbanization is largely responsible for the significant change and modifications in land use and land cover in Suleja LGA. The results obtained show that the proportion of area covered by built up land, farm land and bare soil is on the increase, whilst there is decline in vegetation. Since 1991 when the seat of Nigeria federal government was officially relocated to Abuja, the neighbouring towns in Suleja LGA witnessed a large influx or immigration of people into them because of proximity to the federal capital city and low cost of living.

In general, 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. These factors give rise to the expansions that have greatly influenced the changes leading to an increase in the pressure on land, loss of adaptive capacity, and means of production which will ultimately lead to changes in social organization and attitudes. Thus, the effects of changes brought about in land use/land cover on physical environment calls for concern by speeding up measures for sustainable development to preserve the natural environment because, if mitigating measures are not put in place now or those put in place are not seriously implemented, the trend could lead to serious environmental degradation.

Arising from the need for sustainable development of Suleja LGA the following recommendations are proffered:

- i. All towns in Suleja LGA as well as others adjacent to the federal capital city, Abuja, should have the town's master plans as well as a regional master plan to integrate a coordinated sustainable development plan. The existing Suleja town master plan should be revised in the light of new realities.
- ii. Suleja LGA administration should move to ensure that important locations are adequately protected from damage, especially the existing vegetation and conserve its biological diversity for sustainable use in the future.
- iii. There should be a constant monitoring of urban growth and changes in land use/land cover consequent on urbanization and put in place appropriate response mechanism in line with the towns and regional master plan. As urbanization throws up many challenges such as environmental degradation, crime, slums, traffic congestion, unemployment, over stretch of existing infrastructures and many more.
- iv. Illegal conversion of land to other uses other than what it is meant for should be stopped and where feasible such infringements should be reversed to the original plan.
- v. There is a strong need to further strengthen the Suleja-Abuja Joint Commission which is headed by the FCT Minister. This commission evolves strategies towards optimizing the proximity of the contiguous states of Nasarawa and Niger and providing succour in form of intervention and provision of essential infrastructures to the host neighbouring states that accommodate most of the low and middle income workers. This commission can handle the towns

and regional master plan advocated.

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