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Assessment of Landuse and Landcover of Keffi Local Government Area, Nasarawa State, Nigeria

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Abstract
This study was carried out to analyze the Landuse and Landcover of Keffi Local Government Area of Nasarawa State. The methodology used to achieve the objectives in this research were Remote Sensing and Geographic Information Systems. Various methods of data analysis were used during data analysis – Earth Resources Data Analysis System (ERDAS) Imagine, Leica Geo Office, Environment for Visualizing Images (ENVI), ESRI Aeronautical Reconnaissance Coverage Geographic Information Systems (ArcGIS) 10.4 and Microsoft Excel 2013 software packages. Findings from the study revealed that, there is a considerable increase of population in the study area, leading to increase in Built-up areas and its effects on other LULC categories. Agricultural land witnessed a decrease from 91.21 kilometre square (62.79%) to 86.91 kilometre square (59.84%) between 1995 and 2005, with magnitude changes of 28.42 kilometre square and annual change rate of 2.842 kilometre square. Thereafter, it decreased from 86.91 kilometre square (59.84%) to 57.09 kilometre square (39.31%) between 2005 and 2015 with magnitude changes of 29.82 kilometre square and annual change rate of 2.981 kilometre square respectively. With decreased Agricultural Lands and increased population, food scarcity is bound to happen. Built-Up areas increased from 13.53 kilometre square (9.32%) to 25.08 kilometre square (17.27%) between 1995 and 2005, with magnitude changes of 11.55 kilometre square and annual change rate of 1.155 kilometre square. Further increase from 25.08 kilometre square (17.27%) to 64.21 kilometre square (44.21%) was witnessed between 2005 and 2015, with magnitude change of 39.23 kilometre square and annual change rate of 3.923 7.29. Other LULC Categories of Vegetation, Rock Outcrops and Wetlands experienced significant decreases between 1995 and 2015. The use of geospatial techniques and technologies in the study of LULC change in Keffi revealed an increase in Built-up areas due to continuous expansion, massive construction work, wide spread commercialization of local economy and rapid urbanization of the area as a result of the establishment of Nasarawa State University. Based on the research findings, there is therefore the need for Nasarawa State Government to equip the planning authorities and other Ministries involved in decision making with adequate spatial data to ensure broad based decisions.

Keywords: Landuse, Landcover, Built-up Area, Planning, Urbanization

Introduction
The increasing demand for land, coupled with other anthropogenic activities threatening the existence of vegetal cover, demands effective measurement, understanding and monitoring of the dynamics of Landuse/Landcover (LULC) information which is essential for the selection, planning and implementation of management strategies to meet the increasing demands for basic human needs and welfare of the ever growing population. (Arveti et al. 2016).
Since humans began controlling fire and domesticating plants and animals, they have cleared more forest land to wring more value from the land. Thus, about half of the ice-free land surface have been converted or substantially modified by human activities over the last

ten thousand years. (Population Reference Bureau, 2001; Mittermeier, 2003.)

The impact of human activities on LULC has hitherto become tremendous. Global consumption of natural resources of fuel and hydrocarbons has greatly increased on one hand, while more forest lands have been cleared for agricultural purposes on the other hand. All these have resulted in some environmental problems such as oil spillage, soil erosion, flooding and loss of prime agricultural and forest lands. (Laka 1994).

Land is increasingly becoming a scarce resource due to immense pressure on it as a result of increased population and increasing socio-economic activities. This pressure has resulted in the unplanned and uncontrolled nature of growth of urban centers as well as changes on the LULC of the earth surface.

Rapid urban expansion, especially from unplanned urbanization process followed by industrialization process has contributed to most environmental issues of flooding, soil erosion as well as loss of forest lands and prime agricultural land. These consequent environmental problems have led environmentalists to seek to monitor the rate of disappearance of natural ve etal cover as well as changes in LULC worldwide.

LULC change has become a central component in the current strategies for managing natural resources and monitoring environmental changes. Since the late 1960s, the rapid development of the concept of vegetation mapping has led to the increased studies of LULC change worldwide (Yang, 2001). Providing an accurate assessment of the extent of the health of the world's forests, grasslands and agricultural resources has become an important priority (Yang, 2001).

LULC changes are products or outcomes of prevailing interacting natural and anthropogenic (socio-economic) factors (Fagbeja,2000; Fashona and Omojona, 2005) and their utilization by man in time and space (Clevers et al., 2004). Historical LULC and its changes that are being altered by human activities have a significant impact on the Earth's landscape, perturbing energy, moisture, and chemical fluxes which impact the Earth's climate.

Statement of the Research problem.

Man has altered so much of the natural vegetation, that is, the primeval plant-cover, that over most, if not all, of the earth's surface, the term can hardly be used in its strictest correct sense. Probably, the most remote parts of the Amazon-basin and of the coniferous forests of Asia and America are primeval. Elsewhere, the nature of the natural vegetation can only be deducted, often very speculatively (Monkhouse, 1954).

Lack of affordable accommodation for low and middle income workers of Abuja, the proximity of these settlements to Abuja and the low land prices have attracted many workers from Abuja and other migrants to settle there. As a result, the area has experienced rapid population growth and continuous expansion after the relocation of the Federal Capital Territory (FCT) from Lagos to Abuja in 1991. The upsurge in population of such towns was further encouraged by the desire of the FCT administration to restore Abuja to its master plan by the demolition of all forms of illegal structures within its territory. The work, wide spread commercialization of local economy and rapid urbanization, this has imposed significant pressure on the environment and natural resources with serious implications on socio-economic development and spatial organization within the territory and beyond its boundaries. In addition, the spatial expansion of the settlements in the area has been going on without significant control. Thus urban sprawling is on the increase.

Rapid urbanization, ever increasing population and socio-economic activities in Keffi LGA has informed the ever increasing haphazard way in which forest lands are being converted to other uses. Attempts at monitoring and controlling of urban sprawl in the study area failed due, likely, to inadequate data on the importance of LULC change monitoring in the global functioning of the earth's natural systems.

Research Questions

This study attempt to seek answers to the following questions.

i. What are the various LULC types in Keffi LGA, Nasarawa State, Nigeria?
ii. What percentage of Keffi LGA is covered by vegetation (green area) and what percent is covered by other landuses (brown area) ?
iii. What is the rate and trend of change in the LULC of Keffi LGA?
iv. What are the factors responsible for this change in LULC over Keffi LGA?

Objectives of the Study

The objectives of this study are to:

i. Characterize the types of LULC in Keffi LGA Nasarawa State Nigeria.
ii. Determine the extent of change in LULC in the study area.
iii. Determine the rate and trend of change in LULC in the study area, and
iv. Estimate the proportion of the green areas that has been converted to other LULC over time.

Significance of the Study

This study has produced critical knowledge and a forecasting capability that will continuously improve decision of Urban Planners in Keffi LGA to effectively plan and manage the land resources within Keffi LGA. The study has identified and mapped the past and present patterns of LULC change in the study area and examined the extent and rate of change in LULC patterns in the study area, thereby, serve as a reference to Nasarawa State urban planners on how to plan well in order to curtail some of the effects of urban growth particularly Keffi LGA Nasarawa Sate for sustainable development of the area.

The study provides information about enhancement methods that should be used to evaluate the future scenario of the LULC change in Keffi LGA over time.

The findings of this research serve as veritable information that will enlighten the people living within the study area against the danger and implications of the LULC changes in the greater Keffi LGA Nasarawa State, in other for the populace to stop or reduce deforestation.

Conceptual Framework

Concept of Land Management

Land comprises the physical environment, including climate, relief, soils, hydrology and vegetation, to the extent that these influence potential for land use. It includes the results of past and present human activities, e.g. reclamation from the sea, vegetation clearance, and adverse results, e.g. soil salinization. A land-mapping unit is a mapped area of land with specified characteristics. Land-mapping units are defined and mapped by natural resource surveys, e.g. soil survey, forest inventory. Their degree of homogeneity or of internal variation varies with the scale and intensity of the study. In some cases, a single land-mapping unit may include two or more distinct types of land, for example, a river flood plain, mapped as a single unit but known to contain both well-drained alluvial areas and swampy depressions. Land is thus a wider concept than soil or terrain. Variation in soils, or soils and landforms, is often the main cause of differences between land-mapping units within a local area: it is for this reason that soil surveys are sometimes the main basis for definition of land-mapping units. However, the fitness of soils for land use cannot be assessed in isolation from other aspects of the environment, and hence it is land, which is employed as the basis for suitability evaluation. Land use refers to the manner in which human beings employ the land and its resources. Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi natural Habitats such as arable fields, pastures, and managed woods. It also has been defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" (FAO, 2013; FAO/UNEP, 2017).

Factors Influencing Land Use Management.

In this section, factors influencing the effectiveness of land use management are presented. These include availability of information, land use management framework, appropriateness of policy measures, coordination of policy measures and allocation of adequate resources and administrative system.

(a). Availability of Information

The availability of adequate information on land is a necessary prerequisite for the effective implementation of land use management system and land policy measures. As Adeniyi (1999) points out, even the most unsophisticated and rudimentary effort to establish positive control requires information. At the very minimum, it is necessary to have records of existing land use, development density, and ownership, along with accurate information on soil characteristics, the location and capacity of existing utilities and services. For planning purposes, information on economic and social characteristics of the population and its activities are essential.

(b). Land Use Management Framework

According to Baba (1994) land use management framework is the most important factor in the successful formulation and implementation of land policies. Land is usually administered by a group of government departments, ministries, autonomous or semi-autonomous government agencies, with each overseeing a specific aspect of land management. Some common aspects overseen by the agencies include the distribution of land rights,

the regulation and monitoring of market processes, public lands, development planning and control, technical standards, and fiscal matters. The adequacy and effectiveness of a land use management system affects the ability to implement all aspects of an urban land policy, and the achievement of the desired policy objectives. It affects the ability to plan and regulate the use of land, the ability to enforce regulations, and the ability of the public sector to successfully participate directly in the land management system.

Instruments for Efficient Land Use Management Systems.

The wide variety of factors influencing the formulation of land policies and the establishment of a land use management system makes it impossible to develop a prescription or have a perfect recipe for an effective land use management system. There appears, however, to be a consensus in the literature on land on the instruments and requirements for an effective and efficient system. These instruments and requirements are generally used to achieve broad objectives of land policies. Mabogunje (1992) and Kombe *et al.* (2000) have however, identified some of the objectives generally put forward for the creation of an effective system. The objectives include: the provision of an adequate supply of land for urban productive activities, including the provision of basic services; the facilitation of good planning that minimizes the use of resources relative to social and economic benefit; the achievement of greater equity in wealth and income, including access by low income families to land and shelter; and a spatial distribution of population and activities at regional and national levels consistent with general national priorities.

Methodology

The Study Area

Location

Keffi is one of the Local Government Areas (LGAs) in Nasarawa State. Keffi LGA has fifteen (15) districts namely; Angwan Salamu, AngwanJ abal, Angwan Maiganga, Angwan Lambu, Dan Dabi, Fagidi, Ganta, Angwan Kare, Jigwada, Kaibo Mada, Sabon Gida Saura, Tila, Tunayi and Yar-kadde. The LGA lies between latitudes 8^0 51^0 and 8^0 53^0 North of the equator and longitudes 7^0 50^0 and 7^0 510 East of the Greenwich meridian. The Local Government is an historic town in the state with a total land area of approximately 140km^2. Keffi LGA share common boundary with Kaduna State to the North, Federal Capital Territory to the West, Kogi and Benue States to the South and Taraba and Plateau States to the East respectively (figure 3.1).

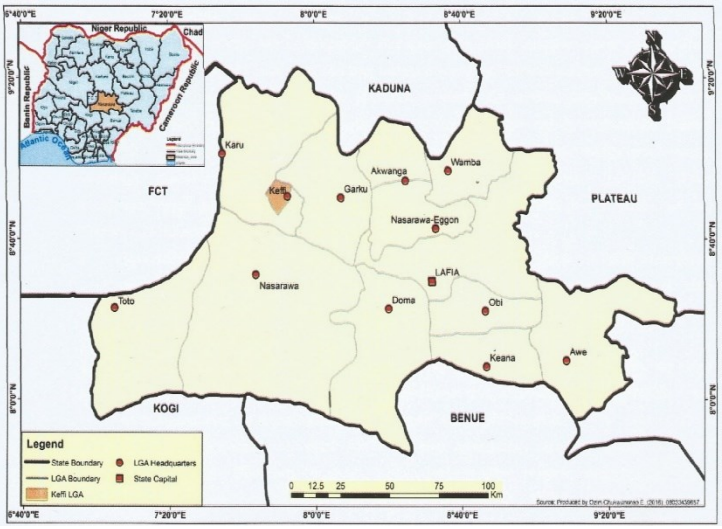


Figure 1: Nasarawa State showing Keffi Local Government Area.
Source: Department of Geography, Nasarawa State University (2018).

Reconnaissance Survey

This is usually the first survey conducted by a researcher in other to familiarize himself with the study area. It involves a visit to the study area, where the researcher moves round making observations, recording and drawing sketches on a sheet of paper and taking note of all the prominent features on the ground.

Data Sources

The study will make use of primary and secondary datasets.

Primary Data

Field survey guided by Global Positioning System (GPS) device will be used to collect existing control points for Land use analysis and other ground controls to geo-reference the land use and soil maps that will be acquired. Also, Global Positioning System (GPS) device will be used to collect coordinates of Schools, Markets, Health Centres, Public water utilities (Bore holes).

Secondary Data

The type and sources of secondary data for this study are:

i. Landsat Thematic Mapper (TM) satellite image of 1995 with spatial resolution of 30m was acquired from the National Centre for Remote Sensing, Jos-Nigeria.
ii. Landsat Enhance Thematic Mapper (ETM+) satellite image of 2005 with spatial resolution of 30m was acquired from the National Centre for Remote Sensing, Jos-Nigeria.
iii. Landsat Enhance Thematic Mapper (ETM+) of 2015 with spatial resolution of 5m was acquired from the Nasarawa Geographic Information System (NAGIS), Karu LGA.
iv. Soil map of Nasarawa State at a scale of 1:50,000 were acquired from the Geologic Survey Office, Abuja.
v. Geological map of Nasarawa State at a scale of 1:500,000 were acquired from the Geologic Survey of Nigerian Agency, Abuja.
vi. Existing literature from journal articles, conferences proceedings, past theses and reports, books and web references.

Techniques and Procedures of Data Collection

(a). Scanning: A scanner is a device that converts hardcopy analogue media into digital images by scanning successive lines across a map or document and recording the amount of light reflected from a local data source (Longley *et al.*, 1999). Large-format feed scanner will be used to transform the analogue topographic, geological and soil maps of the study area into digital format and import them into the GIS software for extraction and analysis.

(b). Digitization: The vectors data for the study will be obtained from scanned maps through heads-up digitization using ESRI ArcGIS 10.4 software package and a computer screen using a mouse or digitizing cursor to digitize roads and drainage networks, contour, soils and geological maps of the study area.

Data Processing

In order to achieve the set of objectives of this research, various methods of data analysis will be used utilizing ERDAS Imagine, Leica Geo Office, ENVI, ESRI ArcGIS 10.4 and Microsoft Excel 2013 software packages.

(a). Sub-set: Satellite image covering Keffi will be extracted from full scene Thematic Mapper (TM) of 1995, Enhanced Thematic Mapper (ETM+) of 2005 and 2015.

(b). Image restoration: The satellite data will be subjected to image correction, calibration and restoration process in order to remove flaws and deficiencies from the raw satellite data and achieve as faithful a representation of the earth surface and the originality of the data.

(c). Image enhancement: The satellite image will be modified to optimize their appearance to the visual system. Visual analysis is key element as they alternate the appearance of the image in such a way that the information contained in the image is more readily interpreted visually in terms of a particular need.

(d). Geometric rectification: The satellite data will be rectified and geo-referenced to the UTM map projection (zone 32), Minna, Nigeria, horizontal datum.

(e). Data Extraction: The land use data for change analysis will be generated from digital image processing of Landsat TM, ETM+, and will be used to extract Road intersections, roads and drainage network. Topographic Map will be used to generate contour for the creation of digital elevation model. Soil and Geological maps will be used to generate data for land suitability analysis. The extraction of the datasets will be by digital image processing and heads-up digitization using the combination of the software packages listed above.

(f). Ground truthing: Ground truthing will be carried out with GPS to check, verify areas of doubt features on the maps.

(g). Buffering: Buffering is a process of processing a zone of interest usually of specified width around a map element such as roads, rivers, marshy areas, etc. In this study, a buffer zone will be created using ArcGIS around water bodies (rivers and marshy area), and road networks to satisfy the set criteria of distance. The guidelines in line with Land Use Act Cap 202 of 1990 and the Nigeria Urban and Regional planning Act of 1990 to monitor and control all developments approved setbacks were adopted, which include;

i. Highway "A": Buildings must observe 45m to the Centre line of the road.
ii. Local Distributors: Buildings must observe 30m to the Centre of the road.
iii. Access Roads within Neighbourhood: Buildings must observe 5m to the Centre of the road.
iv. Rivers: Buildings must observe 30m and 15m to the edge of the rivers, streams etc.

Satellite Image Classification

A supervised classification approach will be adopted using maximum likelihood with a threshold of 50. Sample set of the classified satellite images will be created which contains the domain of all the land use classes selected. The classification scheme that is adopted for this research is the United State Geological Survey classification scheme level one (1), which provides a basis for land use assessment. The classification obtained in this research are;

i. Built up areas
ii. Water bodies
iii. Agricultural land
iv. Vegetation
v. Rock out crops and
vi. Bare surfaces.

The aerial extent of each land use types will be automatically calculated by the computer. To compare these sets of data, the resulting values were converted to percentage and used as absolute data for the presentation of the rate and magnitude of the changes using statistical analysis.

Creation of Land-Use Suitability Maps

The Model Builder in ESRI's ArcGIS 10.4 will be used to create the models for all individual goals and objectives. The Model Builder can be seen as a graphic programming environment within ArcGIS. All tools from the toolbox, which is a large set of geo-processing tools, can be used to create complex geographical analysis. The tools that will be used to create the suitability maps depends on the aim of the concerning goal, objective and sub-objective. However, the outcome is always a map with suitability values between 1 and 10.

Result and Discussion

Introduction

This chapter discussed the results of the research as well as the outcomes. It presented the results in tables and figures showing trends of change and variations between the years analyzed (1995, 2005 and 2015).

Characterization of Land use type in the Study Area

The LULC change analysis is based on the satellite imageries of Landsat Thematic Mapper (TM) Satellite Image of 1995, Landsat Enhance Thematic Mapper (ETM+) of 2005 and 2015. The results of the analysis are presented in the form of maps, tables and bar graphs which formed the basis of discussion. The categories of LULC identified in the study area are; Agriculture, Bare Surfaces, Built-Up areas, Vegetations, Rock Outcrops and Water bodies. LULC in the area was observed to vary among classes and decades. Table 4.1 shows the tabulated LULC coverage of the various years (1995, 2005, and 2015).

Table 1: Characteristics of Land use/cover of Keffi for 1995, 2005, and 2015

LULC Categories	1995	2005	2015	
	Hectares	**Hectares**	**Hectares**	**Remarks**
Agriculture	9121	8691	5709	Decreased
Bare Surfaces	810	576	228	Decreased
Built-up Areas	1353	2508	6421	Increased
Vegetation	1764	1162	729	Decreased
Rock Outcrops	314	331	305	Decreased
Wetlands	1161	1255	1131	Decreased
TOTAL	**14523**	**145.23**	**145.23**	

Source: Author's GIS Analysis, (2019).

Keffi LULC Dynamics (1995-2015).

Table 2: Percentage of LULC for Keffi - 1995, 2005, and 2015

Land Use/Cover Categories	1995		2005		2015	
	Area (Km2)	**Percentage (%)**	**Area (Km2)**	**Percentage (%)**	**Area (Km2)**	**Percentage (%)**
Agriculture	91.21	62.79	86.91	59.84	57.09	39.31
Bare Surfaces	8.1	5.58	5.76	3.97	2.28	1.57

Built-up Areas	13.53	9.32	25.08	17.27	64.21	44.21
Vegetation	17.64	12.15	11.62	8	7.29	5.02
Rock Outcrops	3.14	2.16	3.31	2.28	3.05	2.1
Wetlands	11.61	8	12.55	8.64	11.31	7.79
TOTAL	**145.23**	**100**	**145.23**	**100**	**145.23**	**100**

Source: Author's GIS Analysis (2019).

As can be seen in Table 1, Agricultural land witnessed decrease from 91.21 kilometre square (62.79%) to 86.91 kilometre square (59.84%) between 1995 and 2005, with magnitude change of 28.42 kilometre square and annual change rate of 2.842 kilometre square. Thereafter, it decreased from 86.91 kilometre square (59.84%) to 57.09 kilometre square (39.31%) between 2005 and 2015 with magnitude changes of 29.82 kilometre square and annual change rate of 2.981 kilometre square respectively as shown in figures 4.1, 4.2, 4.3 and 4.4.

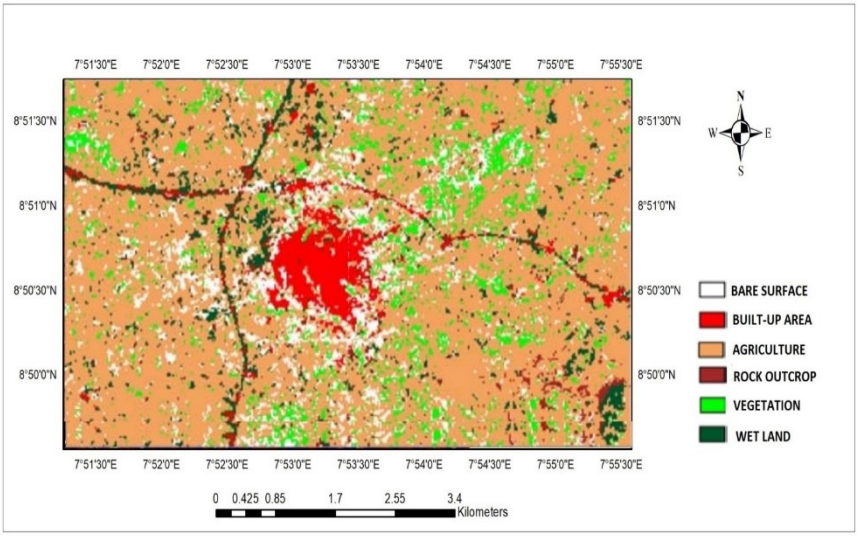


Figure 2: Classified LULC Map of Keffi 1995
Source: Author's GIS Analysis (2019).

Built-Up areas increased from 13.53 kilometre square (9.32%) to 25.08 kilometre square (17.27%) between 1995 and 2005, with magnitude changes of 11.55 kilometre square and annual change rate of 1.155 kilometre square. Further increase from 25.08 kilometre square (17.27%) to 64.21 kilometre square (44.21%) were witnessed between 2005 and 2015, with magnitudes changes of 39.23 kilometre square and annual change rate of 3.923 7.29 as shown in tables 4.1, 4.2, and 4.3, and figures 1, 2, 3 and 4.

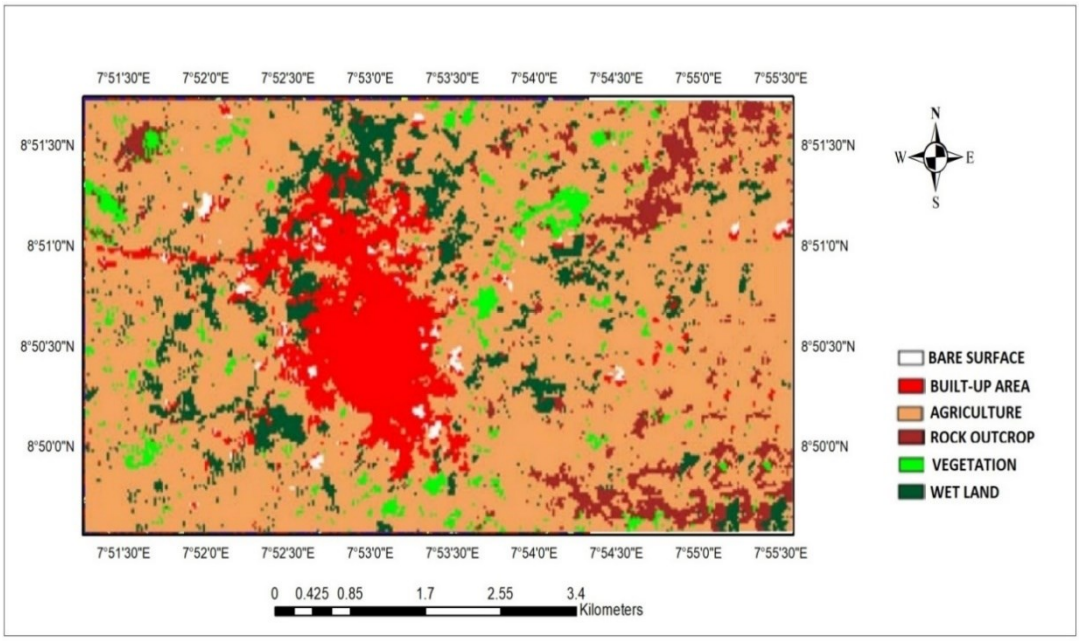


Figure 3: Classified Land Use Land Cover Map of Keffi 2005 Source: Author's GIS Analysis (2019). 2019

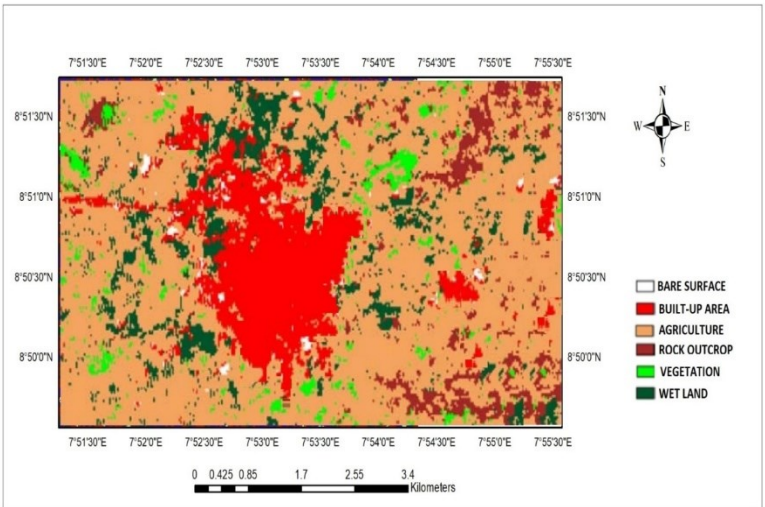


Figure 4: Classified Land Use Land Cover Map of Keffi2015
Source: Author's GIS Analysis (2019).

Bare surface refers to areas that are exposed and vacant land. They include the playing ground at the Nasarawa State University which is used by the students for sporting activities, matriculation and convocation, and other open spaces between buildings. Bare surfaces witness a decrease from 8.1 kilometre square (5.58%) to 5.76 kilometre square (3.97%) between 1995 and 2005. Further decrease from 5.76 kilometre square (3.97%) to 2.28 kilometre square (1.57%) was observed between 2005 and 2015, with magnitude change of 3.48 kilometre square and annual change rate of 0.344 kilometre square, as shown in tables 1, 2, and 3, and figures 1, 2, 3 and 4.

Vegetation includes forest, shrubs and tall grasses found in most part of the study area, especially at the fringes of the urban area where cultivation and settlements have not occurred. Result from the analysis shows that natural vegetation has drastically declined from 17.64 kilometre sq (12.15%) in 1995 to 7.29 kilometre sq (5.02%) in 2015. Rock out crops showed a relative increase in mass from 3.14 kilometre sq (2.16%) to 3.31 kilometre sq (2.28%) between 1995 and 2005. A notable decrease was experienced from 3.31 kilometre sq (2.28%) to 3.05 kilometre sq (2.1%) between 2005 and 2015.

Wetland comprises rivers, ponds, lakes and marshy areas. Processed data from Satellite imageries confirmed that Wetlands covers11.61kilometre square(8%) in 1995. Wetlands then increased by 2005, it covered 12.55 kilometre square (8.68%) indicating a magnitude increase of 0.94 kilometre square. Wetlands then decreased to 11.31 kilometre square (7.79%) in 2015 with magnitude change of 1.24 kilometre square, as shown in tables 1, 2, and 3, and figures 1, 2, 3 and 4.

Rate and Trend of LULC Change in Keffi.

It can be observed from the figure 4.4 and tables 3 and 4 shows that the growth rate of Keffi varied with time and class of Landuse, while in1995 and 2005 the growth rate is relatively little, it became higher between 2005 and 2015 due to the population increase and development brought about by the opening of Nasarawa State University. The maps revealed that most of the areas covered by Natural Vegetation have been converted to Built-up and Agricultural use within these periods. Result from the analysis shows that Natural Vegetation has drastically reduced inthe study area in2015 compared to what was obtainable in 1995.

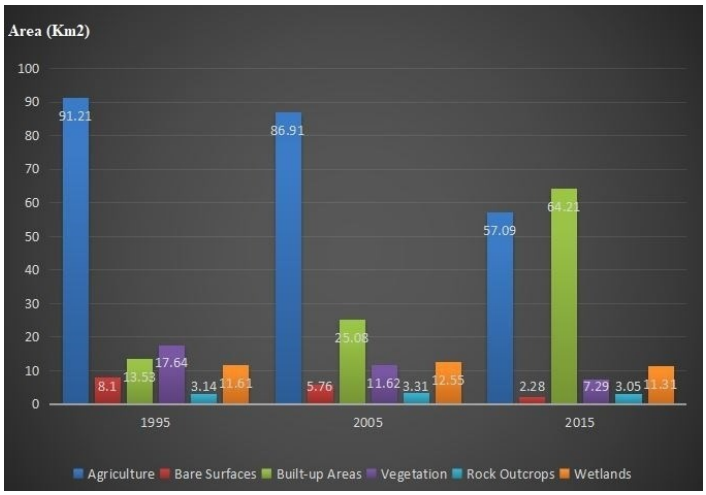


Figure 5: Bar chart showing LULC Change from 1995 to 2015
Source: Author's GIS Analysis (2019).

Natural vegetation is fast disappearing due to the effect of human activities and urban expansion. This result is inferred on the fact that increased population due to the influx movement of people to Keffi from the Federal Capital Territory, Abuja and neighbouring states result to increase in demand for shelter as such Natural Vegetation is been cleared for Built-up area. Also, fuel wood represents the

traditional energy source in use especially by the indigenous people and the low income in general. It is used as the main source for cooking at homes and in the catering industry, bakeries and restaurant. Access to fuel wood is either by cutting trees directly from the nearby vegetations or from the cleared vegetations for construction sites and agricultural development. This further enhanced to the decrease in Natural Vegetation in the area.

Table 3: Magnitude and Annual Change Rate of LULC - 1995 to 2005.

LULC Categories	1995 Area (Km2)	2005 Area (Km2)	Magnitude of Change (Km2)	Annual Rate of Change (Km2)
Agriculture	91.21	86.91	4.3	0.43
Bare Surfaces	8.1	5.76	2.34	0.234
Built-up Areas	13.53	25.08	11.55	1.155
Vegetation	17.64	11.62	6.02	0.602
Rock Outcrops	3.14	3.31	0.17	0.017
Wetlands	11.61	12.55	0.94	0.094
TOTAL	**145.23**	**145.23**	**25.32**	**2.532**

Source: Author's GIS Analysis (2019).

The conversion of Agricultural land to Build-up area is rapid. Agricultural land witnessed a rapid decrease between 1995 and 2015. This result implies that between the period of 1995 and 2015, there is a decrease in agricultural activities likely due to the changes in the occupation of the work force of the area. The people are taking advantage of the Nasarawa State University and relocation of FCT to Abuja for employment opportunity. The relocation of the Federal Capital Territory from Lagos to Abuja creates employment opportunities due to the massive construction work, wide spread commercialization of local economy and rapid urbanization, as such the youths of this area and other migrants move to the city in search for a greener pasture, thereby abandoning agricultural activities for women and old people. Most other studies such as Mundia and Aniya (2005) who studied LULC changes and urban expansion of Nairobi City using Remote Sensing and GIS showed that the urban expansion has been accompanied by loss of natural vegetation and urban sprawl. Agricultural land is on the increase in all of these studies because of the need for increase food production to feed the fast growing population. In contrast, this study revealed a decrease in agricultural production.

Bare surfaces witness a steady decrease from 1995 to2015. This decrease is as a result of human need for more space for shelter. The rocky outcrops form part of the numerous hills and young granite that slope into the rivers and provide water shed. There was increase in this land cover from1995 to 2005. This change could be attributed to the fact that the processes of erosion and denudation erode the soils around the rock outcrops and exposing them the most, thereby increasing their aerial coverage.

Table 4: Magnitude and Annual Change Rate of LULC - 2005 to 2015

LULC Categories	2005 Area (Km2)	2015 Area (Km2)	Magnitude of Change (Km2)	Annual Rate of Change (Km2)
Agriculture	86.91	57.09	29.82	2.982
Bare Surfaces	5.76	2.28	3.48	0.348
Built-up Areas	25.08	64.21	39.13	3.913
Vegetation	11.62	7.29	4.33	0.433
Rock Outcrops	3.31	3.05	0.26	0.026
Wetlands	12.55	11.31	1.24	0.124
TOTAL	**145.23**	**145.23**	**78.26**	**7.826**

Source: Author's GIS Analysis (2019).

Wetlands increased between 1995 and 2005 and decreased between 2005 and 2015. This could be attributed to climate fluctuation and the increase demand of water by the fast growing population of the area for irrigation and other uses. Most of the streams has dried up or are seasonal while the size of the rivers and other water bodies are changing. However, the exposed river beds provide a good source of sand and gravel for the construction industry. The construction companies excavate these materials. In the process, large open shallow pits are left behind that are sometimes converted into refuse disposal site or get filled with water during the rainy season.

Factors Responsible for LULC in Keffi

The period of thirty (30) years - 1995 to 2015 witnessed considerable increase in population in the study area, this can be inferred from the fact that the land area covered by built-up area, comprising of residential, commercial, industrial and institutional land uses are on the increase, there by affecting other land use/cover categories. For instance, the maps confirmed that built up areas increases from 1995 and 2015.

The most dramatic increase and the continuous expansion experienced in built-up area are shown between 2005 and 2015 which coincides with the period when the Nasarawa State University was founded. The upsurge in population of the area was further enhanced in recent time by the desire of the FCT administration to restore Abuja to its master plan by the demolition of all forms of illegal structures within its territory.

This rapidly growing population area with a mixture of low and high density developments is characterized by mixed land use. In this case, the frontage of the houses are used as shops, workshops and other small scale economic activities while the inner rooms are used for residences. Mixed used is more common near the University, Keffi Park, and CBD. However, other specific land uses are also identified such as commercial land use comprising of banks, markets and shopping complexes, serviced oriented activities such as retailing finished products and petrol filling stations. Industrial land uses include privately owned informal businesses like welding, furniture making, and general electrical and engineering works. It is difficult to determine the spread of these informal industries.

Analysis and field work revealed that most of the areas with mixed land uses are unplanned, with high density developments within the right of way of the Abuja-Keffi highway, local distributors, streets and water bodies.

Conclusion

The use of geospatial techniques and technologies in the study of LULC change in Keffi revealed an increase in built-up areas due to continuous expansion, massive construction work, wide spread commercialization of local economy and rapid urbanization of the area as a result of the founding of the Nasarawa State University. This has imposed significant pressure on the environment and natural resources with serious implications on socio-economic development and spatial organization within the area and beyond its boundaries. Lack of land use planning and zoning regulation results to haphazard land use pattern and unplanned, uncontrolled and informal growth process of settlements in the area. This reduces the quality of life and economic attraction.

Recommendations

i. Based on the research findings, there is need for Continuous mapping of these resources at a minimum of 4 to 5 years interval is imperative in other to keep abreast of our environmental resources and the environmental problems.

ii. The present study did not assess the environmental impacts of developments. No doubt, this study have both negative and positive impacts on the environment for which information about these will be of great use in planning and management for sustainable developments. Many more studies on these impacts are needed as a matter of urgency.

iii. The rate at which population is increasing, the places where people are and where they are moving to need to be properly understood. This will enable better population management and the rate and needs to create or expands settlements. The environmental impacts on this farmland, water and other resources need also to be understood.

iv. The Government needs to have a better and master plan for Keffi Local Government in under to have a conducive environment for its citizens. This can be achieved by investing in the acquisition and management of remotely sensed data and Geo-Information Technology in order to develop a database, which will enhance the management of land use in the area.

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