# Land Use Land Cover Change Analysis in Fagge Local Government, Kano State from 1991-2019

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# Abstract

Land Use and Land Cover (LULC) are important components of the environmental system and changes in it mirror the impacts of human activities on the environment. These impacts needed to be determined in order to get a clear picture of the extent at which different land use practices change over time. This study focused on the Land use and land cover changes of Fagge local government Kano state between 1991 and 2019 and also identify the driving forces of such changes. The data for the study two 30m x 30m Landsat images (Landsat 4&8) of the two years i.e. 2019 and 1991. The two images undergo series of image analysis and classification using ArcGIS 10.7 and ENVI 5.1 and the result where presented in form of maps, charts and tables. The result also shows that the changes that occurred from 1991 to 2019 in Fagge local government to be positive and negative changes. There happen to be a positive in the size of built-up areas in Fagge from 1991 − 2019 with a change of +4.678km$^2$. The vegetation cover experienced a negative change of -8.87km$^2$ while the barren land also had an increase in size with a positive change of +4.199. The data collected from previous studies indicated that the main driving behind the various changes may include; urban expansion, population growth, commercial and economic activities, security, and Government law and policies. It was recommended that Sufficient land use/land cover information should be acquired, Sensitization programs on land use / land cover, Geospatial techniques should be adopted by Government and NGO's and lastly Government policies should geared to ensuring that there is balance in the utilization of the available land in the country

# 1.0. Introduction

At the early stages since settlement, humanity has relied on land to sustain its food production and economic development, which has been changing the global landscape. The relentless pressure to meet the needs and demand-driven development activities of a growing population is adding to the pressure on the planet [1, 2]. In this context, man-made activities and their accompanying land use and land cover (LULC) changes have become an unavoidable problem and increase the risk of global environmental degradation [3]. Since the early years, more than half of the world's landscapes have been affected by human activity or some kind of man-made development, and in the worst case, many natural resources have been heavily used or depleted [4].

Land use and land cover (LULC) changes are local lying and location-specific and are now one of the most important aspects of environmental change worldwide. The impact of extensive changes in LULC to the natural environment is multifaceted, including climate change, changes in the hydrological cycle, increased water extraction, impaired water quality, degradation of soil nutrients, increased surface erosion and loss of biodiversity [5]. As a result, information on land use and land cover, trends of change and optimal use of land resources has become predetermined criteria for regional land use planning and effective natural resource management [6].

Land is one of the most important natural resources, as life and various developmental activities are based on it. Land-cover change has been identified as one of the most important drivers of changes in

ecosystems and their services. These changes result from population growth and migration of poor rural people to urban areas for economic opportunities. Urban sprawl in Nigeria has put profound pressure on housing, infrastructure, and the environment [7]. It is therefore necessary to investigate the dynamics of city growth in Nigeria. Currently, there is little or no up-to-date comprehensive documentation on trend and magnitude of land use/land cover pattern dynamics in Nigeria. Natural land cover in the area has changed over time and is still changing. Natural and man-made factors have affected the environment. The social and environmental impacts of loosely planned urban cities can be disastrous, especially in cities that are experiencing dramatic urban expansion in a short period of time [8]. Predicting and understanding urban growth and change is critical for urban planners and resource managers, especially in rapidly changing environments. The application of remote sensing data makes it possible to study changes in land cover with less time, lower cost and higher precision. Remote sensing and geographic information systems (GIS) provide effective methods for analyzing land-use issues and tools for land-use planning and modeling. Therefore, we can identify the definition pattern of land change over time in a particular region, and we can define the rate of change, the direction and growth rate of the change, and more.

Oyinloye [9] studied the spatial growth of Akure Ondo State using satellite imagery from 1972, 1986 and 2002. Results in both cities indicate that the agricultural sector has rapidly been converted to urban (non-agricultural) land use. Another study by Cheruto et al. [10] and Jiya et al. [11] used the monitoring classification maximum liker algorithm to detect land use/land cover changes in observed multispectral satellite data. The results show that different LULC categories have increased and decreased over the years. A Canadian study showed that in detecting LULC changes, it is worth noting the dynamic nature of different forest types, the increase in building area and the significant depletion of wetlands [6].

Olujide et al. [12]concluded in their study that, there had been significant changes in land use/land cover (LULC) and that built-up land and agricultural land had continued to expand; Forest bare rocks and bodies of water on the other hand, have regressed. It was noted that, in various studies, the development of urban built-up areas had led to a reduction in land under agriculture and other natural vegetation [12, 13, 14]. There have been a lot of studies on land use/land cover change detection in Nigeria [15, 12, 9, 11] but few have done in Kano State [8, 7, 16]. Therefore this study will use GIS techniques for land use land cover change analysis in Fagge local government, Kano State from 1991–2019 and the factors responsible for the change in the study area. To achieve this aim the following specific objectives are to be employed:

1. To identify land use/cover of the study area as at 1991 and 2019
2. To determine changes that occur from 1991–2019 within the study area
3. To assess the factors responsible for the change

# 2.0. Research Methodology

# 2.1. The Study Area

### 2.1.1. Location and Extent

Fagge Local Government Area is located in the central part of Kano State Metropolis in Nigeria. Geographically, it is bordered to the North by Ungogo local government, to the East by Nassarawa local government, to the West by Dala local government and Kano-municipal by the South [7]. It is positioned between latitude 11° 59' 28" to latitude 12° 4' 18" North of equator and longitude 8° 28' 17" to longitude 8° 32' 59"East of Greenwich Meridian. It has an estimated land mass of 48.184712 km$^2$ (18.604221 sq. ml.), Time Zone WAT (UTC+1), 3-digit postal code prefix 700, ISO 3166 and code NG.KN.FA [7].

### 2.1.2. Administration and Population

Fagge local government area was created in 1996 during General Sani Abacha's regime; it has ten (10) wards with Waje District as it's headquarter, its official language is English. The wards are; Fagge 'A', Fagge 'B', Fagge 'C', Fagge 'D', Fagge 'E', Kwachiri, Rijiyar Lemo, 'Yammata Gabas, Sabon Gari West and Sabon Gari East [7]. The local government is headed by chairman, care taker, sole administrator or interim management officer and supported by vice, while the wards are represented by councilors that serve as local legislatures [7]. Fagge local government secretariat has principal officers as follows; the Director Personnel Management (D.P.M), Internal Auditor, Chief Personnel Officer (C.P.O), Treasurer, Head of Social and Community Development Department, Head of Works and Housing, Head of Health and Medical, Head of Agriculture and Natural Resources, Head of Planning Research and Statistics and Staff Officer [7].

Fagge local government is experiencing a lot of immigrants from the neighboring countries, Middle East and eastern Asia, such as Niger, Chad, Cameroon, China, Benin, India, Lebanon, and Saudi Arabia. Though census figures did not portrays the actual number of the people in the area, but it gives an estimation of the population [7]. The population of Fagge local government area, according to the last census of 21-03-2006 it was recorded to about 200,095 people and the population distribution by sex shows that male ware 111,859 while female figured at 88,236. The Population Projection Density was 11,237.6 in ha/km$^2$ for the year 2011 and Change rate was +3.36% / year for the period of 2006 – 2011 [7]

### 2.1.3. Socio-Economy

Fagge local government area is dominated by Islam as major religion with Christianity in Sabon Gari district. Hausa is the predominant local language in Fagge local government area, but few Fulani and Kanuri can be found in Waje and Kwachiri Districts particularly. While Yoruba people dominate Sabon Gari West and Igbo people dominate Sabon Gari East. Also Edoma and Igala tribes sparsely distributed in Sabon Gari district [7].

Businesses, Farming, Art and Craft are common economic activities in Fagge local government area. Kwachiri district and kwakwachi area of Sabon Gari district are farming zone producing garden produce and cereals such as millet, guinea corn, maize, wheat, mango, and guava. Sabon Gari is known as business zone with activities like; paper printing, spare parts, clubs, hotels, bars, transports, restaurants,

communication and building materials [7]. The Waje district which is surrounded by eight major markets and serves as Central Business District (CBD) of Kano state is a zone of business, art and crafts, such as mechanics, metal work, tailoring, dyeing, carpentry, banking, transports, repairing, garments and restaurants [7].

The major markets are; Kwari market is for garments and textiles. Kofar Mata market is for plastics, audio-video cassettes, baby care, shoes and bags, vegetables, boutiques, and cosmetics. Abattoir market is for meat and live stocks. Triumph market for electronics. Wapa market is for bureau de change. Hajj camp market is for jewelries, traveling boxes and garments. Ikeja market is for motors and spare parts. France road market is for building materials. Sabon Gari market is for general goods. Singer market is for food stocks. Beirut market is for computers, cell phones, accessories, and cafe. Galadima market is for vegetable and red oil, gari, yam, newspapers, fish and bush meats [7].

## 2.1.4. Climate and Landform

Generally, the climate of the study area is that of tropical continental type. This type of climate has clear wet and dry seasons with more dry than wet months [17], which is categorized under Aw in Koppen's climatic classification. Consequently allow mean annual rainfall of 880mm is a typically occurrence. The area is characterized by four months of wet season and eight months of dry season.

The temperature is characterized by warm to hot throughout the year, although cool periods occur around October to February. Olofin [17] observed the mean annual temperature of about 26$^o$C, but the monthly values of coldest months range between 21$^o$C and that of hottest months have the mean value of 31$^o$C. Evapo-transpiration (ET) is generally higher than the precipitation with estimate of 2,538mm. Per annum

The climate is very much influenced by two air masses namely; tropical maritime and tropical continental air masses. The study area is normally divided into four climatic periods annually; the warm raining season (June -September), the cool dry season (November- February), the hot dry season (march-may) and warm dry season (October- November) [17].

The study area form part of the plains of the Hausa land. And it is generally plain with elevation not higher than 600 meters above mean sea level. The general relief of the study area is between 485 meters and 570 meters. The area is characterized by basement complex rocks and granitic materials. The materials consist of metamorphic and igneous rock types of Precambrian origin [17].

## 2.1.5. Soil and Vegetation

The soil are matured on the plain, but seriously altered due to human settlements. The influence of topography, wind drift materials, and climate are what shaped the aggregate of the soil. The matured soil are said to be latosols of ferruginous type. The soil is however well drained, brown to reddish in color [17].

Fagge Local Government area is located in the Sudan savannah zone, typically characterized by trees scattered all over, which are mostly having broad canopy and not exceeding 20 meters in height. In

addition, trees species are mostly adapted to drought conditions through long taproots and leathery leaves. Grasses are abundant with their height hardly reaching 1.5 meters at maturity level, and tend to dry up in the dry season. But today the vegetation are form part of human settlements in which it is seriously depleted though the construction process, as a result cultural vegetation has replaced the natural one in the area where exotic species are predominant [17]

## 2.2. Source of Data

The type of data used for this study secondary data type which Include:

1. 30 x 30 Landsat 8 image (April, 2019) acquired from USGS earth explorer
2. 30 x 30 Landsat 4 image (April, 1991) acquired from USGS earth explorer
3. Kano State, local governments and ward Administrative boundary shapefiles acquired from GRID3 Nigeria (including, Healthcare facilities, Market, Schools, Settlements, Build up areas) etc.
4. Reports and journals from previous studies related to the study

## 2.3. Instruments

1. ArcGIS 10.7 software
2. Google Earth Pro
3. ENVI 5.1. software
4. Microsoft Excel

## 2.4. Method of Data Analysis

### 2.4.1. 1991 and 2019 Land use/land cover of Fagge local government

To obtain the LULC of the study area for two years (1991 and 2019) the two Landsat images of the two years were import into the ENVI 5.1. Software to be analyzed using the ENVI tools. The Landsat image of each year undergo the following analysis:

1. **Layer Stacking:** The images obtained for this study were of .TIFF format, even though these files are readable by ENVI, but they are of individual bands that have to be stacked together in order to obtain one image file with all the bands for ENVI software to be able to read the image and use it for analysis and interpretation
2. **Image sub setting:** Landsat images contain different layers and cover a very large area this includes areas that are not of interest Therefore, there is a need to process the images to cover only the specified area of interest in order to enhance productivity and better handling of the image. The preparation and cropping of the images to cover the specified area required were achieved using

subset tool in ENVI. The Region of interest tool was first to demarcate the area of interest using polygon and then it was subset using the subset tool

3. **Image Classification:** One of the main purposes of satellite remote sensing is to interpret empirical data and classify features. Image classification involves classifying image pixels into a specified number of categories or categories based on the strength value of a data file. Images can be classified in two ways, including unsupervised classification and supervised classification [18]. The supervised classification through maximum likelihood algorithm was applied to perform image classification. This classification has been found to be the most commonly and widely used classifier[19]. Based on prior knowledge of the study area and use of Google earth as reference three land use land cover classes are to be classified in the study area: Built-up areas, bare surface and vegetation cover. The supervised classification requires region of interest for each category and the region of interest were used to define spectral reflectance pattern or signature of each LULC category, following by the signatures would then be used in classifying the pixels into a certain category which has the same spectral patterns using the classifier algorithm. The region interest of each category were created with the assistance of visual analysis on the images via the color composite (Band 2-3-4 and 3-4-5) [20] and also using the ancillary information from the digital land use map and Google Earth.

Having undertaken the above stated steps and assigned commensurate number of pixels to various land use/land cover classes, each image was separately classified using the supervised classification maximum likelihood algorithm in ENVI 5.1 edition  the images where saved as .TIF files and imported into ArcGIS 10.5

4. **Extraction by Mask:** The two images fit into the boundary of the study area using the extraction by mask tool to ease analysis based on  the study area

5. **Land use/land cover Map:** The maps were then classified into 4 (Built-up areas, Bare Lands, Vegetation cover and water bodies) using the reclassify tool of ArcGIS to produces LULC map. Another field was create in the attribute table and the land area of each will be calculated using the Field Calculator.

### 2.4.2. Factors responsible for Land use/Land cover change

The factors were derived from previous literature related to the study area to ascertain desired result.

# 3.0. Result And Discussion

# 3.1. Land Use/Land Cover of Fagge as at 1991

From the Landsat 4 image which was classified using GIS software to produce land use land cover map to show various land marks (vegetation, built-up areas, barren land and water bodies) of the local government (see Fig. 2). The built-up areas in the local government as at 1991 covers a total land area of

about 9.038 km$^2$ while vegetation cover with the highest coverage has a total area of 18.475 km$^2$. The barren lands cover 7.732 km$^2$ of the total area with bodies being the least with 0.0153 km$^2$ (see Table 1).

Table 1
Area covered by each land use/land cover in 1991

| SN | Land use/Land cover | Area (Km$^2$) | Percentage (%) |
|---|---|---|---|
| 1 | Built-up Areas | 9.038 | 25.65 |
| 2 | Vegetation | 18.457 | 52.37 |
| 3 | Barren Lands | 7.732 | 21.94 |
| 4 | Water Bodies | 0.0153 | 0.04 |
| | Total | 35.2423 | 100 |
| Source: Data Analysis 2019 | | | |

## 3.2. Fagge Land use/Land cover in 2019

As seen from the result of the image analysis (Fig. 3), the built-up areas in Fagge local government in 2019 is about 13.716 km$^2$ covering 38.92% of the total land area and 27.20% of the total area is covered by vegetation. The barren lands covers about 11.931 km$^2$ which is the second largest LULC whereas water bodies cover 0.0081 km$^2$ (see Table 2)

Table 2
Area covered by each land use/land cover in 2019

| SN | Land use/Land cover | Area (Km$^2$) | Percentage (%) |
|---|---|---|---|
| 1 | Built-up Areas | 13.716 | 38.92 |
| 2 | Vegetation | 9.587 | 27.20 |
| 3 | Barren Lands | 11.931 | 33.85 |
| 4 | Water Bodies | 0.0081 | 0.02 |
| | Total | 35.2421 | 100 |
| Source: Data Analysis 2019 | | | |

## 3.3. Occurred Changes in Fagge Local Government from 1991–2019

Result from data analysis showed there is a vast change among the land use/land cover in the local government. Some show positive change (Increase) while some show a negative change (Decrease). The built-up area showed a change from 1991 to 2019 of + 4.678 km$^2$ which means there is an increase in the

coverage of build-up areas. This might be as a result of increase in population (NBS 2018) and urban growth in local government. There is also a change of -8.87 km$^2$ as shown in Table 3 for the vegetation cover from 1991 to 2019. This means that the amount of vegetation cover in the area has decrease in size (see Fig. 4). While the barren land experience a positive change with a change of + 4.199 meaning an increase in total size covered (see Table 3).

Table 3
Changes between 1991 and 2019

| SN | Land use/Land cover | 1991 | | 2019 | | Change | |
|----|---------------------|------|---|------|---|--------|---|
| | | Area (Km$^2$) | Percentage (%) | Area (Km$^2$) | Percentage (%) | Area (Km$^2$) | Nature of Change |
| 1 | Built-up Areas | 9.038 | 25.65 | 13.716 | 38.92 | 4.678 | Progression |
| 2 | Vegetation | 18.457 | 52.37 | 9.587 | 27.20 | -8.87 | Regression |
| 3 | Barren Lands | 7.732 | 21.94 | 11.931 | 33.85 | 4.199 | Progression |
| 4 | Water Bodies | 0.0153 | 0.04 | 0.0081 | 0.02 | -0.0072 | Regression |
| | Total | 35.2423 | 100 | 35.2421 | 100 | | |
| Source Data analysis 2019 | | | | | | | |

# 3.4. Factors Influencing the Changes

Previous studies have indicated the various factors that have led to the land use/land cover changes in Kano and Nigeria as a whole. As stated by a report by UN [21], Nigeria cities notably Lagos, Ibadan and Kano are listed among the first one hundred cities in the world [21], which shows there will be pressures on land and thus high urban dynamics. These pressures on land are caused by increased rate of urbanization carried with it obstinate urban problems, for example pollution, poor environmental sanitation, crime, unemployment and overcrowding among others [22]. Many writers confirmed that Nigerian urban centers are faced with rapid growth and development, which contribute to land use change. Fagge local government is among the urban centers in Kano state this factors might also be one of the reasons why the changes have occurred from 1991–2019. Bala [7] in his study state that the main driving forces of the changes in Fagge local government where urbanization rate and population growth. While Ayila et al. [16] stated that the commercial nature of the state with most of the Markets located at Fagge local government where the main reason behind this changes. Some of the key factors may include.

1. **Population Growth**: the population changes in Fagge local government is moving in a vast rate with an estimated Change of + 3.35%/year (2006–2016) [23]. This increase in population will lead to increase housing demand hence enticing change to one or more land uses or land cover.

2. **Government Law and Policy**: The land use Act of 1978, which vested all land into the hand of state Governors has also contributed to land use change [22]. The empowered the Governor to declare any land urban area and also has the power of allocation as well as acquisition. This power has given the loyalists of the governors to request for any land at any location irrespective of what the land is being used for before [22]. This has also enabled the government officials to manipulate the allocations of land within the state. This indicate how incorrect policies of government and weakness of agricultural sector in the country have resulted in farmland use change. The farmlands are not working in full capacity so the government allocate the lands to people who used it for varying activities hence changes in land use/ land cover

3. **Economic and Commercial Activities**: It is also worthy to note that, the driving forces behind the rapid change is the huge commercial activity in the study area [16]. The area provides a stable and continued market for both manufactured and semi-processed goods. The volume of trading activities conducted on daily basis in the markets, notably Muhammadu Abubakar Rimi (Sabon – Gari), Kwanar Singer and Kantin Kwari which will lead to various changes like increased infrastructure and population hence land use/land cover changes [16].

4. **Security**: The closeness of Army Barracks (Bukavu Barraks) and (Air force Base) to the study area is one of the reasons there is increase in Built-up areas. Because people (especially the non-locals) feel more save settling as they feel more secured in case of any insurgency.

# 4. Conclusion

Mapping and monitoring of land use/land cover is significant for many management and planning activities as it is considered as a key element for better understanding of the earth and its system. The present study shows how well LU/LC classification and its change analysis of the year 1991 and 2019 of the study area can be easily carried out using Remote Sensing and GIS technology. Population, Urban Expansion and Government Law have been discovered to be the major driving forces to the ever growing land use changes in Nigeria. And lastly the study indicates a significant expansion of built-up area. On the other hand there is decrease in agricultural area and water spread area. Based on the findings of this study, the following recommendations are made to effectively utilize and plan for land use/land cover changes

1. **Acquiring Sufficient land use/land cover information**: Information on land use/land cover and its best use possibilities is significant to the selection, planning and implementation of land-use plans to meet the growing demand for basic human needs and benefits.

2. Sensitization programs land use / land cover should be flogged up and promoted by governmental and non-governmental organization (NGOs) people and the society at large on the impact of their activities on the changes

3. Generation of a comprehensive data and periodical reviews of all areas for effective land use planning

4. Geospatial techniques should be adopted by Government and NGO's to help in understanding of land use planning

5. Government policies should geared to ensuring that there is balance in the utilization of the available land in the country in such a way that there will sustainable development in the land management in the country.

## Declarations

## Availability of Data and Material:

All data used for this study are acquired from open sources. Whereas for all software used (ArcGIS 10.7, ENVI 5.1.) the author has license to use

## Conflict of Interest/Competing Interest:

There is no conflict of interest.

## Funding:

This research was fully funded by the Author. The study does not require much expenses so no outside funding was need

## Authors Contributions:

The study conception and design were all done by the author. All things regarding this paper such as Material preparation, data collection and analysis were performed by the author in the person of Al-amin Ahmad Abbas. The manuscript was written and complied by the author.

## Acknowledgement:

I wish to use this opportunity to thank USGS earth explorer for providing us with open access data to be used for this kind of research

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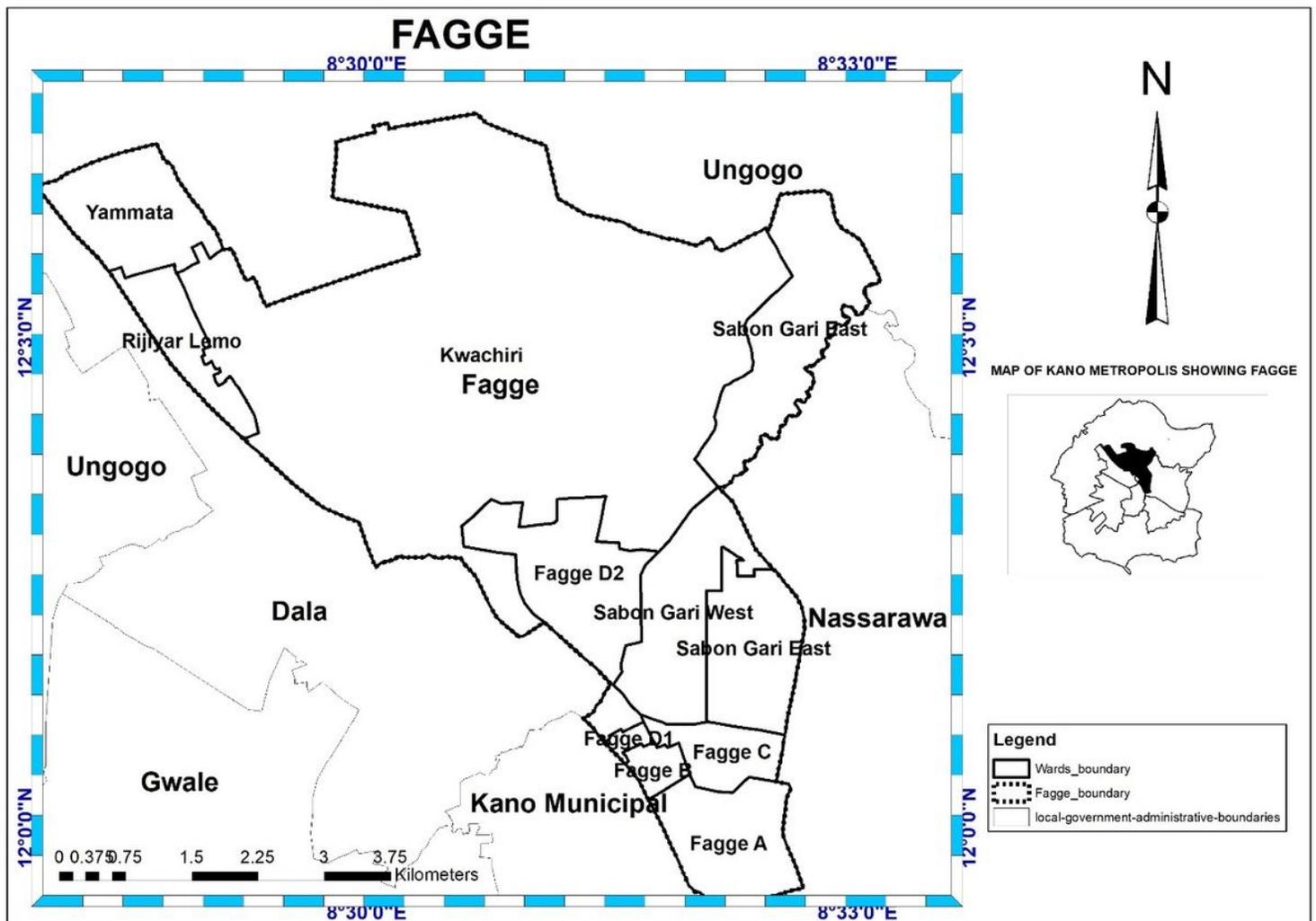
# Figures

## Figure 1

showing map of study area Source: GRID3 2019



FAGGE LOCAL GOVERNMENT 1991 LAND USE/LAND COVER MAP

MAP OF KANO METROPOLIS
SHOWING FAGGE LOCAL GOVERNMENT

Legend
- LGA_Boundary
- Wards_Boundary

Fagge_1991
Land use/Land Cover
- Barren Land
- Built-up Areas
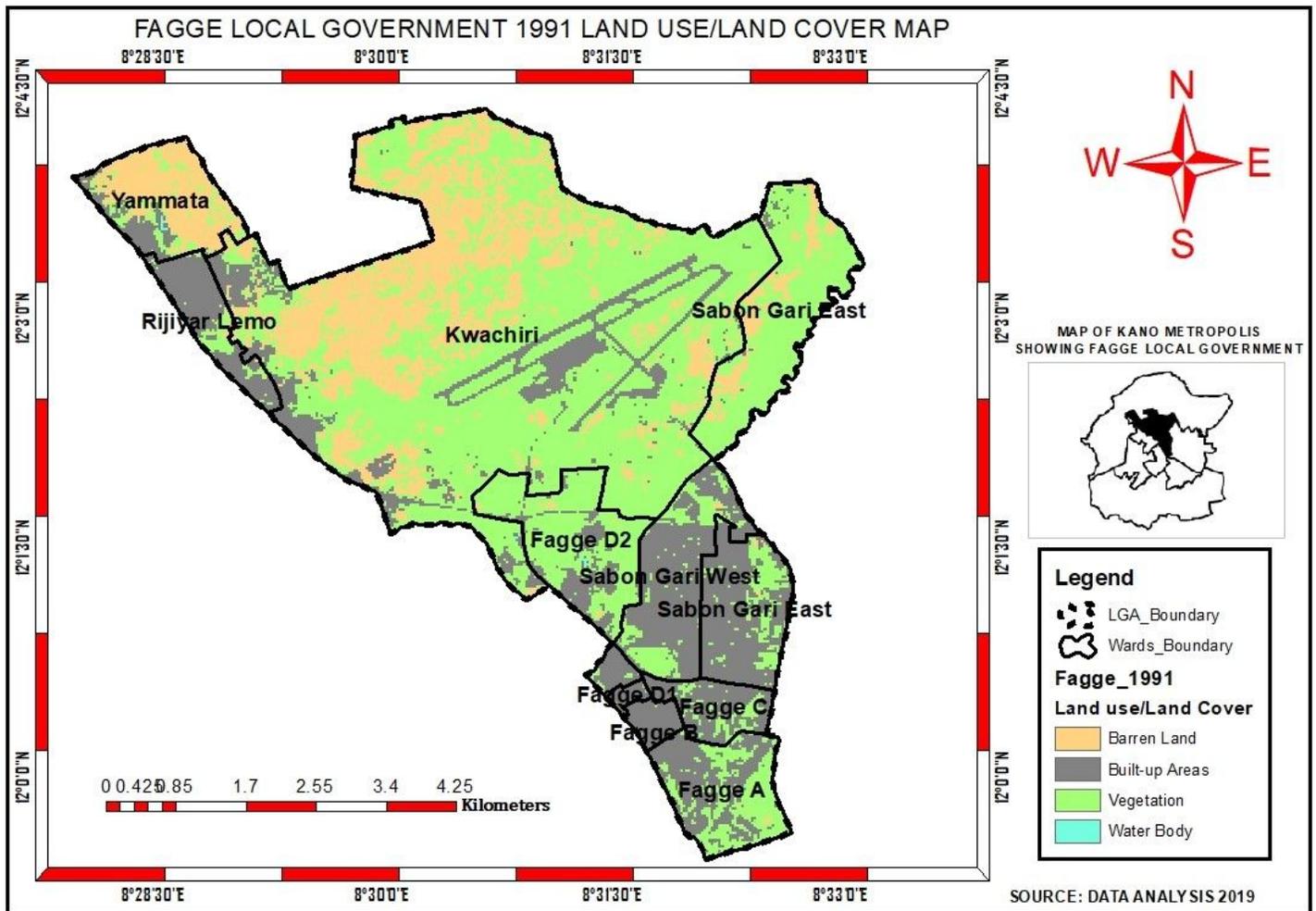- Vegetation
- Water Body

SOURCE: DATA ANALYSIS 2019

## Figure 2

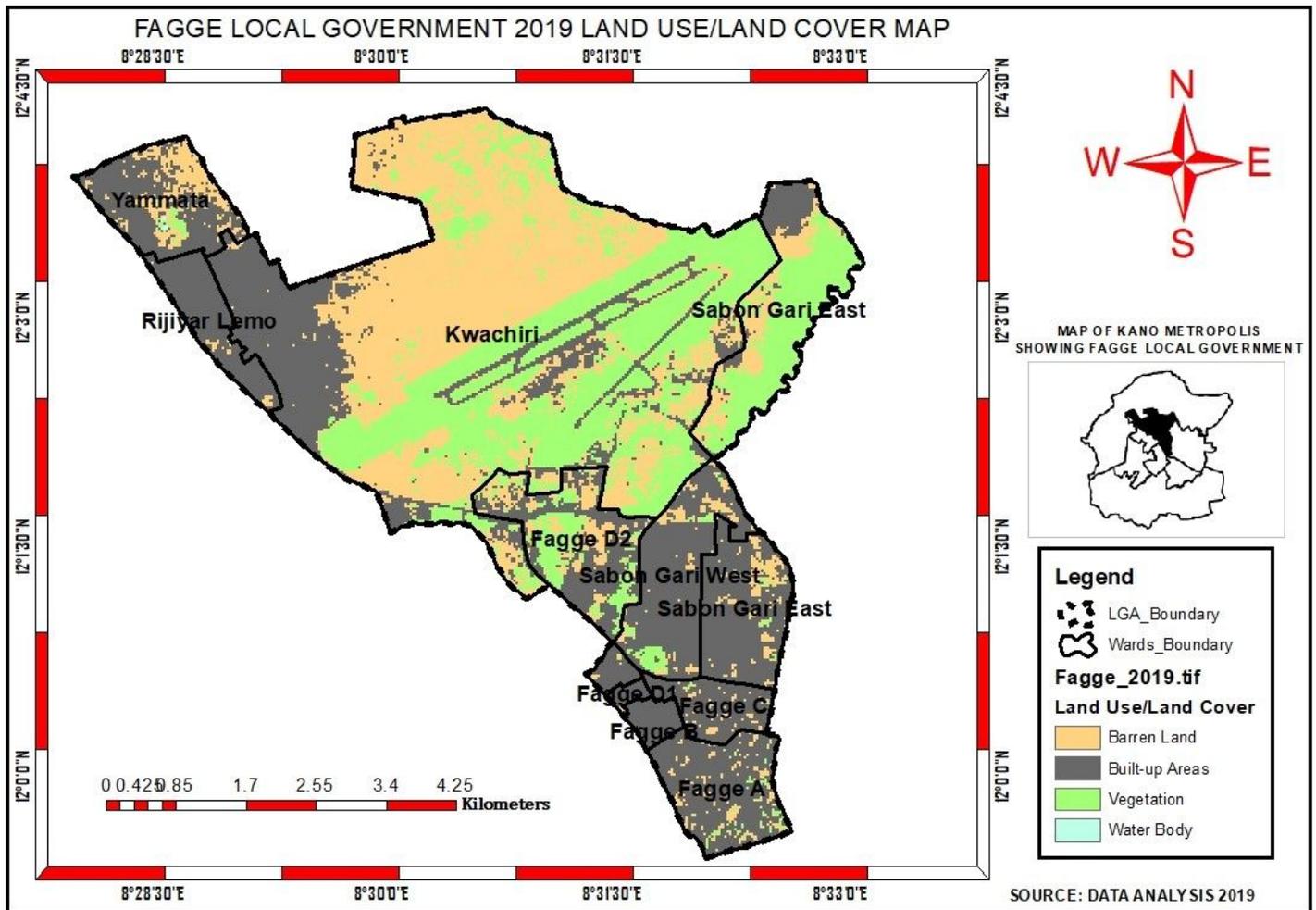Showing 1991 land use/land cover. Source: Data Analysis 2019

**Figure 3**

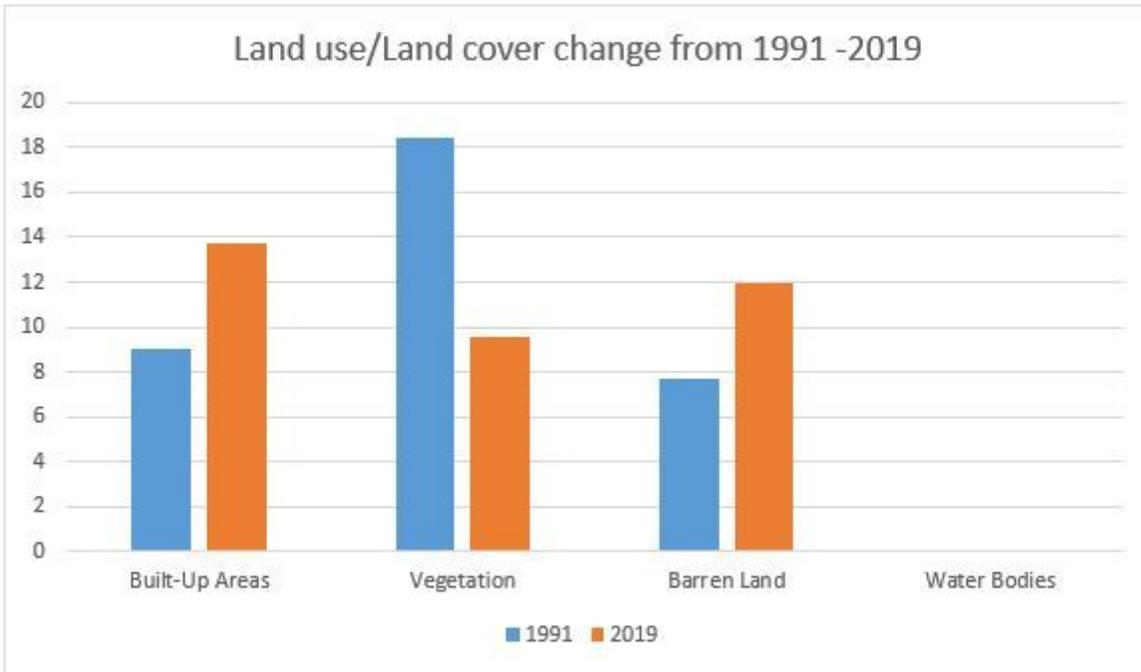Showing Fagge 2019 Land use Land Cover Image Source: Data Analysis 2019

**Figure 4**

showing Changes through the years. . Source: Data Analysis 2019