

URBAN LANDUSE EXTENSION ON AGRICULTURAL LAND USE IN TUNFURE, GOMBE STATE OF NIGERIA

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ABSTRACT

Land use has been defined as the total of arrangements, activities, and inputs that people undertake in a certain land cover type, with changes overtime by the complex interaction of structural and behavioral factors associated with technological capacity, demand, and social relations that affect both environmental capacity and the demand, along with the nature of the environment of interest. This paper term to address how agricultural land use has been reduced due to increase or extension of urban land use, by looking at; the different land use and pattern in Tunfure within a period of 20 years, evaluate the trend of land use and to examine the impact of the urbanization process on agricultural activities in the study area. In order to maintain consistent data for the study period, all image data used in this study were Landsat TM data of 30M resolution for a period of 20years(1996-2016). In this study five main methods of data analysis were adopted which are: calculation of the area in square kilometer of the resulting land use types for each study year and subsequently comparing the results, overlay operations, maximum likelihood classification and land consumption rate and absorption coefficient. The result shows a noticeable change in land use in the study area, which has resulted to the town having a growth pattern of concentric zone model with link to multiple nuclei model. Based on the findings, recommendations were.

Key words: Agricultural Land use, Changes, Land use, Urban Land use.

INTRODUCTION

Changes in land use can be categorized by the complex interaction of structural and behavioral factors associated with technological capacity, demand, and social relations that affect both environmental capacity and the demand, along with the nature of the environment of interest (Verburg et al., 2004). Different scholars across the globe at one time or the other have carried out research on land use and land cover to address the land use issues using different methodology. Van (2008) carried a research in Vietnam, on how land use and land cover patterns have undergone a fundamental change due to rapid economic development under its reformative economic policies. Urban growth has been speeding up; as a result, an extreme stress to the environment has occurred. This is particularly true in Ho Chi Minh City where agricultural land has been gradually disappearing each year, converted into urban or related uses. Furthermore, because of the lack of appropriate land use planning and the measures for sustainable development, rampant urban growth is creating severe environmental consequences.

Jianga, Xiangzheng et al (2013) carryout a research on the impact of urban expansion on agricultural land use intensity in China and their findings illustrate the linkages between urban expansion, agricultural land, and agricultural production. They identified a negative relationship between urban expansion and agricultural land use intensity. A declining level of agricultural land use due to urban labor absorption suggests that other factors of production have to compensate for the decrease in agricultural production capacity in order to meet the country's increasing demand for food. Where they come up with several possible outcomes: improvement of agricultural productivity, agricultural imports, and agricultural land expansion. Land consolidation and extended mechanization might lead to further improvement in the efficiency of production. Agnes (2013) worked on Urbanization and Changes in Farm Size in Sub-Saharan that in Africa and Asia from a Geographical Perspective, the past century have entailed a relatively speaking rapid redistribution as well as growth of urban populations, with the urban population surpassing the rural one for the first time in 2008. Processes of urban growth and their implications for farming and changes in farm sizes especially are likely to be shaped both by global influences as well as more localized aspects. Africa and Asia are the only continents where average farm size has declined over the past four decades. In sub-Saharan Africa the average farm size was 2.4 hectares in the 1990s. Using remote sensing data and GIS analysis shows that more recent changes in farm size, covering twenty one regions in eight African countries for the period between 2002 and 2008 confirm the declining trend in farm size that has been reported on by others.

Kharel (2010) carryout a research on impacts of urbanization on environmental resources: a land use planning perspective in the United States, he asserted that the underlying causes of land use change are the fundamental forces that alter one or more proximate causes and operate at regional or even global level. Some of the identified most commonly used fundamental forces are technological, economic, political, institutional, demographic and cultural. In the context of the United States, these underlying causes/fundamental forces are also the causes of urbanization which in turn is the driver of land use change. In Nigeria just as in other part of the world man has been altering the natural environment either for settlement, agricultural activities, fuel wood etc. Similar studies were carried out on Spatio temporal Analyses of Land Use and Land Cover Changes in Suleja Local Government Area, Niger State, Nigeria. The result shows that 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, commercial activities and urban expansion (Sunday and Abdullahi 2013).

Onoja S., Omomoh E., et al (2012) impact of urbanization on agriculture and wetland management in Makurdi town, Benue state of Nigeria. Their study observed that urbanization has really impacted on the wetland in the study area, as the size of wetland kept on reducing year after years and with it attendant consequences on the farmer's livelihood and the country's food security. A research by Opeyemi (2006) on change detection in land use and land cover using remote sensing data and GIS in Ilorin and its environs in Kwara State Ilorin of Nigeria, he stated that Kwara State capital has witnessed remarkable expansion, growth and developmental activities such as building, road construction, deforestation and many other anthropogenic activities since its inception in 1967 just like many other state capitals in Nigeria. This has therefore resulted in increased land consumption and a modification and alterations in the status of her land use land cover over time however his result shows a rapid growth in built-up land between 1972 and 1986 while the periods between 1986 and 2001 witnessed a reduction in this class. It was also observed that change by 2015 may likely follow the trend in 1986/2001 all things being equal.

Uchua (2011) mapping and analysis of agricultural systems in a part of the lower River Benue Basin, Nigeria From his study he concluded that the need for optimal use of land has never been greater than at present, when rapid population growth and urban expansion are turning land into a relatively scarce commodity for agriculture. On this basis, the use of remote sensing technology has been rapidly expanded for the development of key sectors including agriculture. This study concluded that the agricultural land use has reduce due to urban expansion as result of population growth and satellite remote sensing technique will continue to be a very important factor in the improvement of present system of generating agricultural information. Satellite remote sensing provides various platforms for agricultural surveys especially as it relates to agricultural land use systems.

In Gombe State urban expansion is as a result of population growth another research carried out on land use land cover change detection in Dadin Kowa Dam yamaltu Deba LGA Gombe State. (Ibe 2015). Owing to the recent rapid development in Tunfure, due to it closeness to Gombe city, this has therefore resulted to increase in land use rate, which has automatically changed the land use and land cover pattern of the town. A modification and alteration of the land use and land cover over time without any detail and comprehensive attempt to evaluate this changes overtime with a view to detect the land consumption rate has been a problem. Now the main problem of the area is the shortage of land for expanding agricultural activities and settlements, and how to protect biodiversity. There is no known research to the researcher that was carried out on the rate of urban land use extension in the area and it effect on

agricultural land. Therefore, this research work is to cogent urban land use extension on agricultural land use in Tunfure, Gombe state of Nigeria.

MATERIALS AND METHODS

Study Area:

Tunfure in Akko local government area of Gombe state is located at latitude $10^{\circ}12'0''N$ to $10^{\circ}21'00''N$ and longitude $10^{\circ}54'00''E$ to $11^{\circ}9'0''E$ and it is bounded by Billiri LGA to the south, Gombe LGA to the East, Dukku/Kwami LGA to the north and Lafiyaw to the west. The area has a total land mass of 8.212 km^2 . It a cosmopolitan community of different tribes ranging from renown Fulani and Hausa, Tula, Tangale, Waja, Tera, Igbo, Yoruba to remote Jukun and Tula etc.

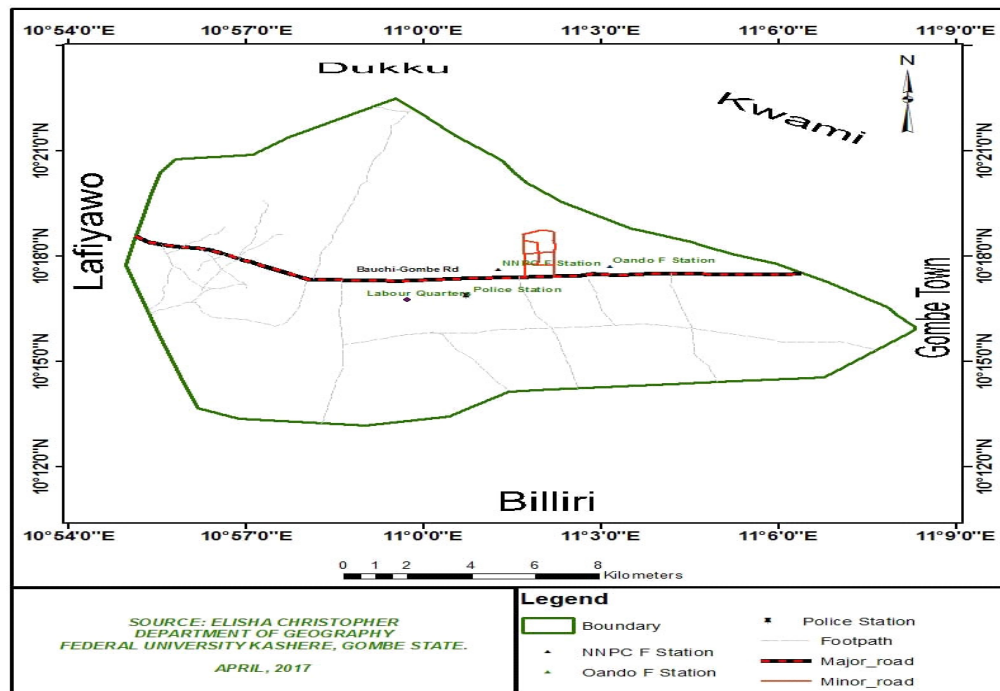


Figure 3.1: Map of the Study Area

MATERIAL

Source of Data

The data were sourced from two main sources:

Primary source: This includes the use of Handheld GPS to collect data(x and y) coordinate of the area for ground trothing or as reconnaissance data.

Secondary source: This includes the use of relevant textbooks, articles, journals, published/ unpublished material and satellite imageries of Tunfure for a period of 20 years (from 1996-2016) was sourced from National centre for remote sensing (NCRS) Jos.

Nature of Data

Data on land use, land cover (satellite imageries), and rate of changing of the pattern for six periods from 1996, 2000, 2004, 2008, 2012 and 2016 were employed.

METHODS

Method of data collection

Satellite imagery of the study area was acquired from National Centre for Remote Sensing Jos from 1996, 2000, 2004, 2008, 2012 and 2016 (span of 20 years) and Ground Truth or Reconnaissance data was acquired with a Handheld Global Positioning System, using the absolute positioning method to obtain the geographic coordinates (points) within the study area.

Method of data analysis

Using the ArcGIS 10.3 software tool for layer combination, Colour Composites of the Landsat imageries were produced by stacking bands 4, 3, and 2 of the 1996, 2000, 2004, 2008, 2012 and 2016 Landsat Imageries, The Landcover features were made visually differentiable by the result of the combination and the following feature classes were identified; Woodland, shrub land, farmland and built up areas. And a training sample were created using the polygon feature in selecting the area, and for accuracy, a minimum of 5 samples per classes were created. The supervised Maximum Likelihood classification using ArcGIS 10.3 software was employed in analyzing the land use of the study area. Statistical diagram/maps such as maps, tables, figures and charts were used for results presentation. Descriptive statistics and simple percentages were also employed. Geographic Information System (GIS) analysis that is ArcGIS 10.3 was used in classification to analyze the land use and land cover changes in the study area. In achieving this, the first task was to develop a table showing the area in square kilometer and the percentage change for each year (1996, 2000, 2004, 2008, 2012 and 2016) measured against each land use land cover type. Overlaying was also carried out to determine the extent of agricultural land use base on the impact of urban expansion.

RESULTS

Land Use and Land Cover Change Pattern in Tunfure from 1996 – 2016

Generally the land use land cover pattern in Tunfure has been subject to change due to human activities in the area. In 1996 shrub land occupies the highest class with 46%, followed by farmland with 35%, wood land occupying 18% while built up areas occupies only 1% of the total land use classes as shown in Table 1 and Fig 3 below. But in 2016 the land use/land cover has changed because of human intensification, farmland occupies the highest percentage in the study area with 38%, followed by shrub land with 30%, built up area has increase

and this may be due to population growth and migration which increased to 25% while wood land reduced to 3% (see table 6).

The table 1 below shows that built-up in 1996 occupies the least class with just 1% of the total classes this may be due to the fact that Gombe was made the state capital in 1996 which is the date of creation. Also, farming seems to be practiced moderately, occupying 35% of the total land use. This may be due to the fact that the city is just moving away from the rather traditional setting where farming seems to form the basis for living.

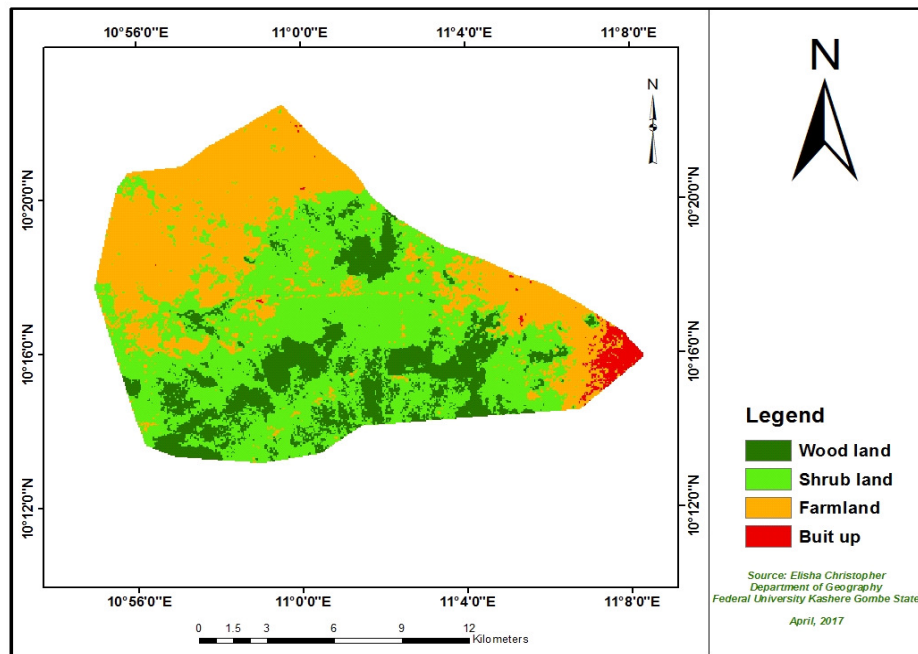


Figure 2: Land use/ land cover of 1996

Table 1: Land use/land for 1996

S/N	Land use	Land use/land for 1996	
		Area (KM ²)	PERCENTAGE (%)
1	Wood land	1.48	18
2	Shrub land	3.78	46
3	Farmland	2.87	35
4	Built up	0.08	1
Total		8.212	100

Source: Fieldwork 2017

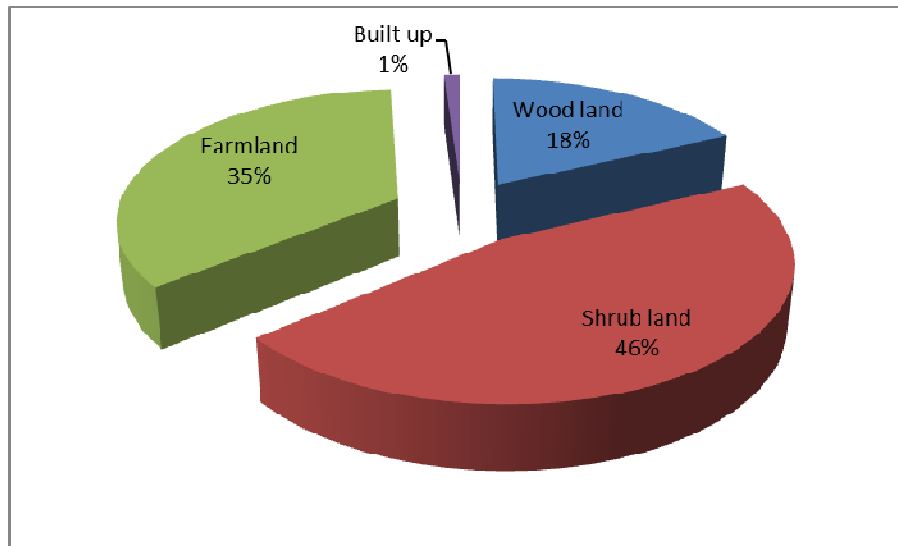


Fig 3: Pie chart showing percentage distribution of Land use for 1996

The pattern of land use land cover distribution in 2000 also follows the pattern in 1996. Shrub land still occupies the major part of the total land with about 46% and farm land also remains static but there is a little reduction in wood land 17% and built-up areas increased to 2% of the total classes as shown in table 2 below.

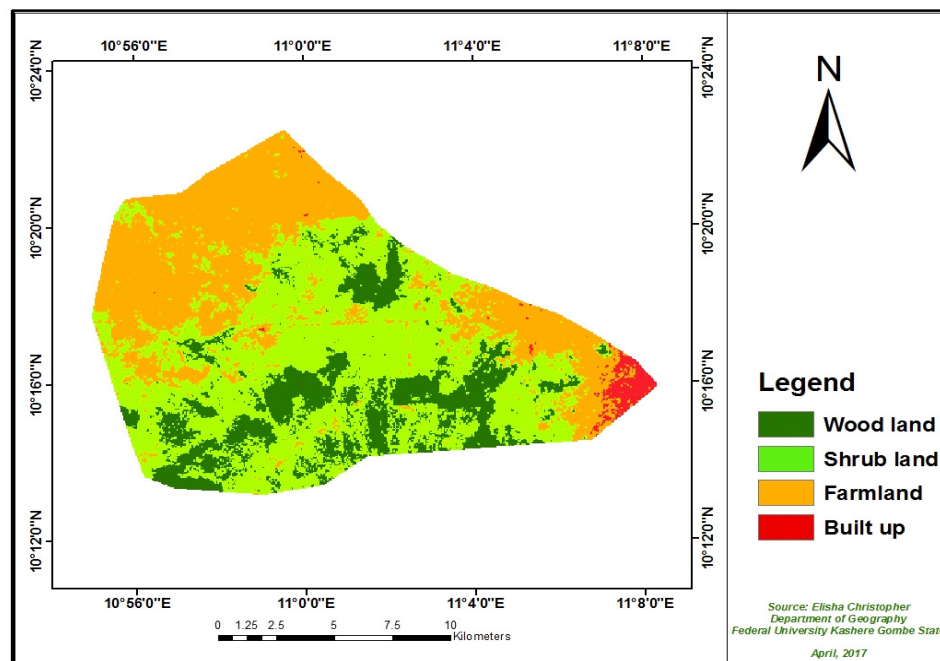


Figure 4: Land use/land for 2000

Table 2: Land use/land for 2000

Urban Landuse Extension on Agricultural Land Use in Tunfure, Gombe State of Nigeria

S/N	Land use	Land use/land cover for 2000	
		Area (KM ²)	(%)
1	Wood land	1.39	17
2	Shrub land	3.78	46
3	Farmland	2.87	35
4	Built up	0.16	2
Total		8.212	100

Source: Fieldwork 2017

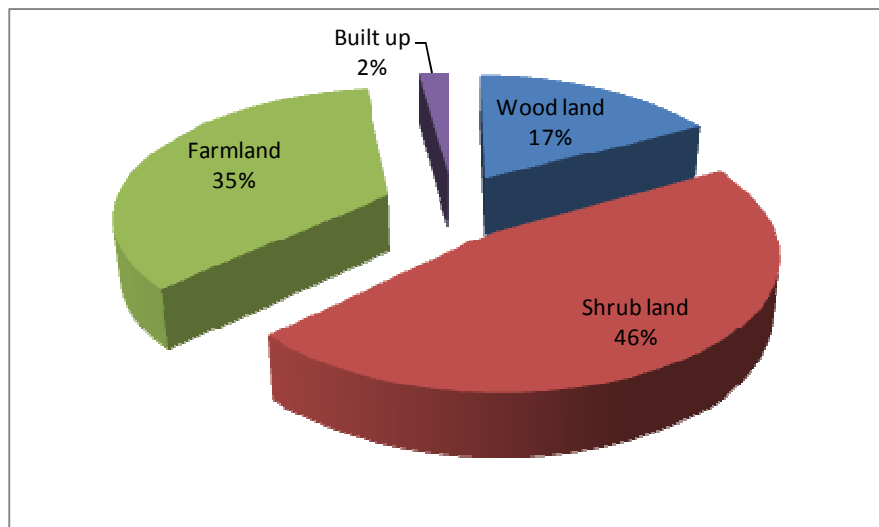


Fig 5: Pie chart showing percentage distribution of Land use for 2000

In 2004, shrub land also has the highest percentage occupying 46% of land use in the study year and this can be due to the increase in deforestation where people cut down trees for bio-fuel which lead to the reduction in wood land to 10%, farm land has 42% then finally built up areas occupies the least percentage with only 2% which is shown in table 3 below.

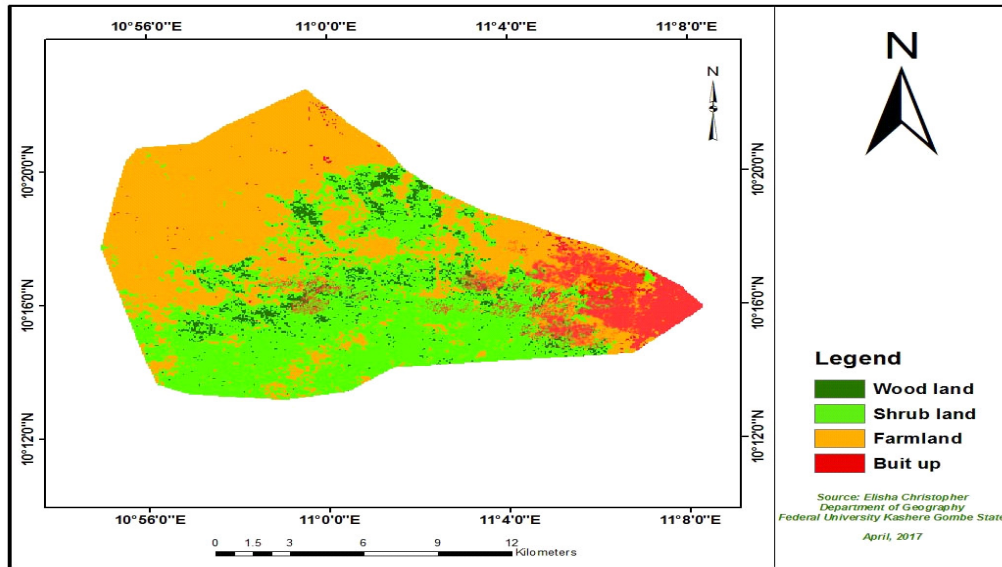


Fig 6: Land use/land cover in 2004

Table 3: Land use/land for 2004

S/N	Land use	Land use /land cover for 2004	
		Area KM ²	%
1	Wood land	0.82	10
2	Shrub land	3.78	46
3	Farmland	3.45	42
4	Built up	0.16	2
Total		8.212	100

Source: Fieldwork 2017

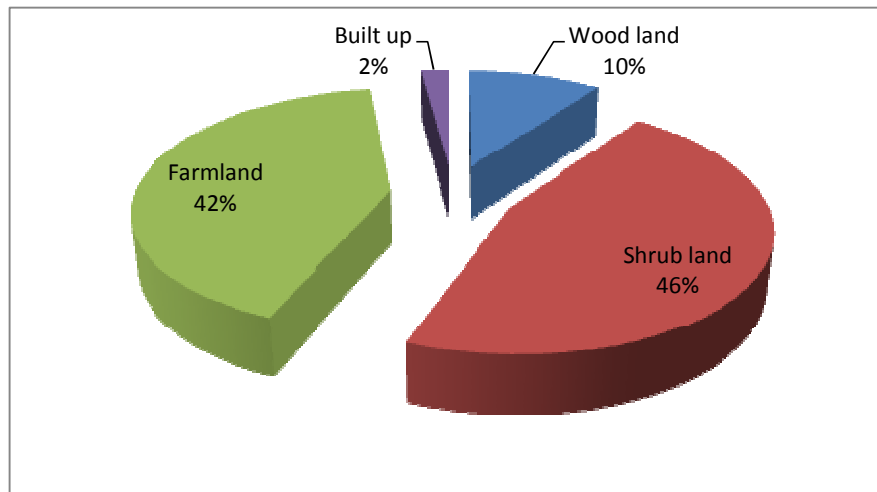


Fig 7: Pie chart showing percentage distribution of Land use for 2004

In the table 4 below, the land use/land cover pattern of 2008 farm land occupies the highest percentage with 48% in the total classes and this is because

more farm land are needed for cultivation where shrub land tends to reduce to 40% because more shrub land are converted to farm land, then wood land also reduce to 5% but built up areas increased to 7%.

Table 4: Land use/land for 2008

S/N	Land use	Land use/land cover 2008	
		Area KM ²	%
1	Wood land	0.41	5
2	Shrub land	3.28	40
3	Farmland	3.94	48
4	Built up	0.57	7
Total		8.212	100

Source: Fieldwork 2017

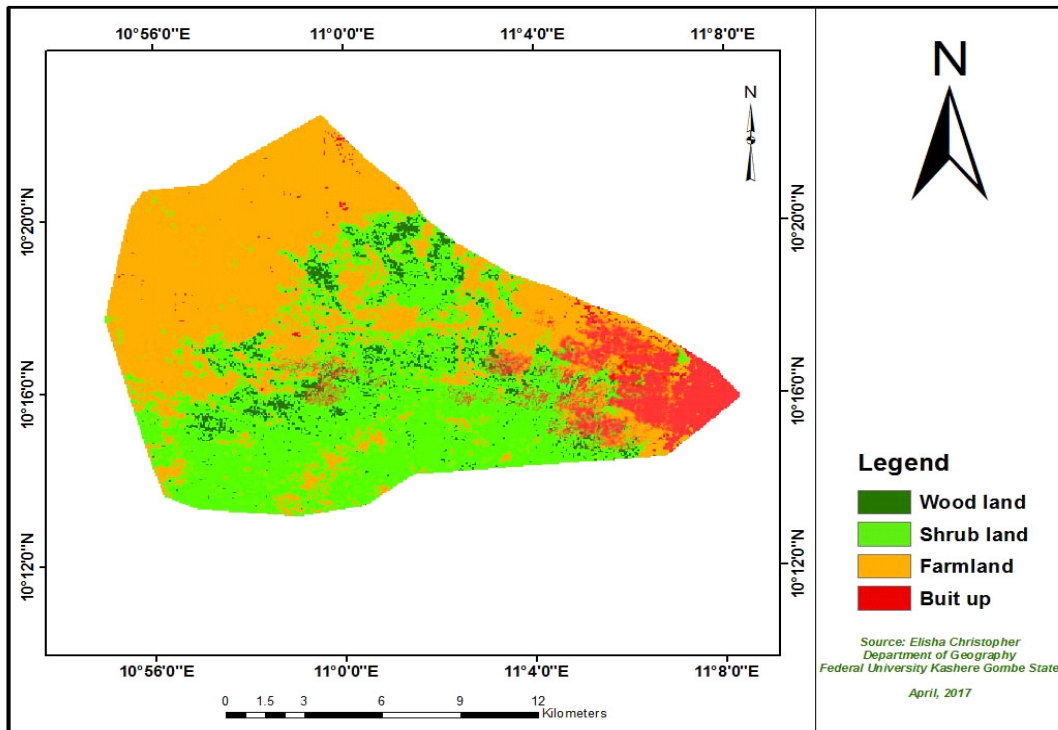


Fig 8: Land use/land cover in 2008

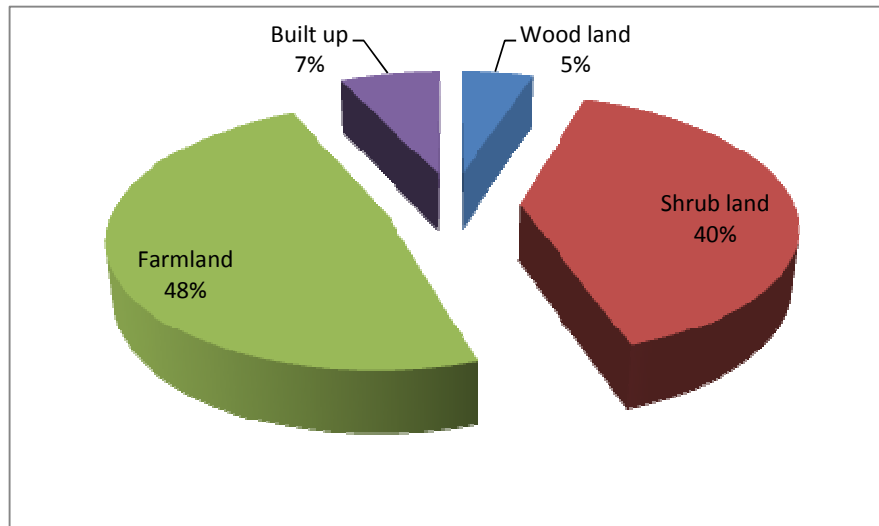


Fig 9: Pie chart showing percentage distribution of Land use for 2008

In the below table (table 5) indicate that, in 2012 farm land occupies the highest percentage with 43% followed by shrub land with 34% and wood land reduced to 4% while built up increase to 17%, this can be due to population growth.

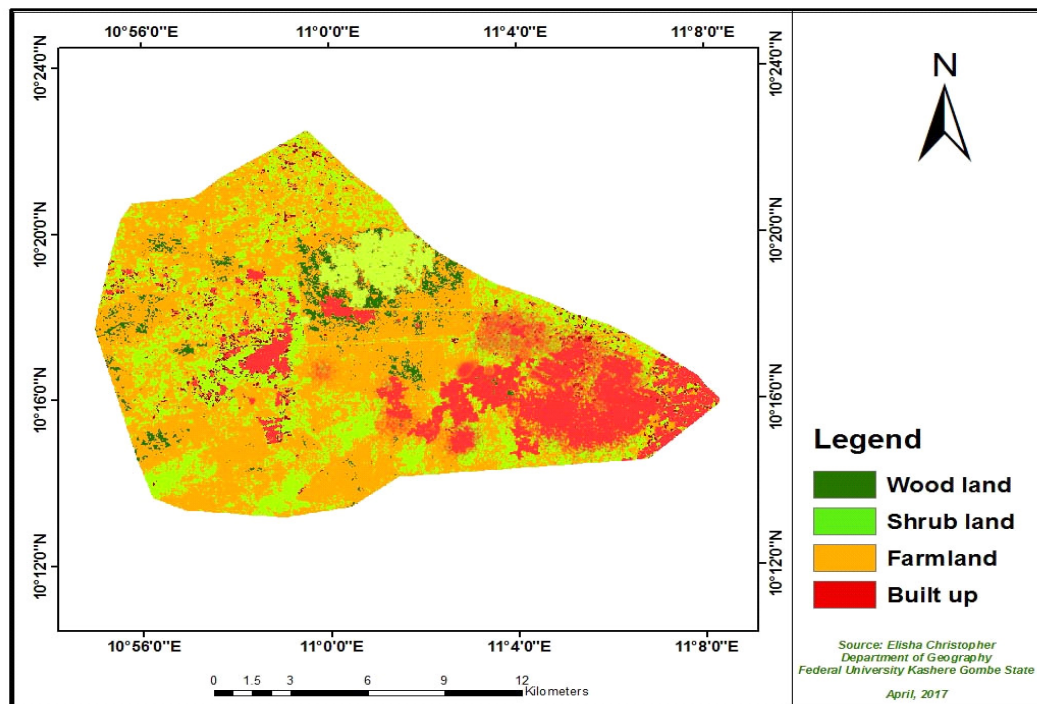


Fig 10: Land use/land cover in 2012

Table 5: Land use/land for 2012

S/N	Land use	Land use/land cover for 2012	
		Area (KM ²)	%
1	Wood land	0.33	4
2	Shrub land	2.79	34
3	Farmland	3.53	43
4	Built up	1.40	17
Total		8.212	100

Source: Fieldwork 2017

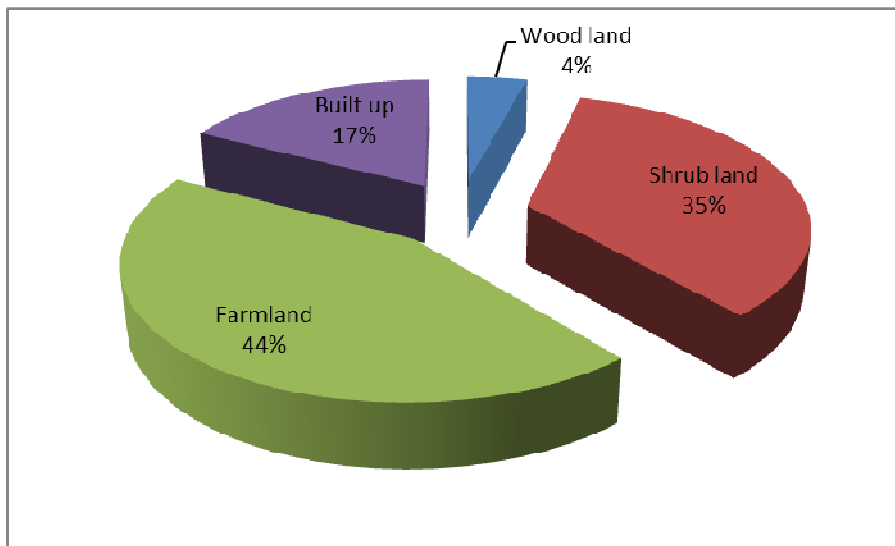


Fig 11: Pie chart showing percentage distribution of Land use for 2012

However in 2016 farm land also occupies the highest percentage in the total classes which is occupying 40%(but has reduced compared to previous years), shrub land occupies 31% of the total area but there is rapid growth in built up areas with 26% while wood land reduced to 3% which can also be seen table 6 below.

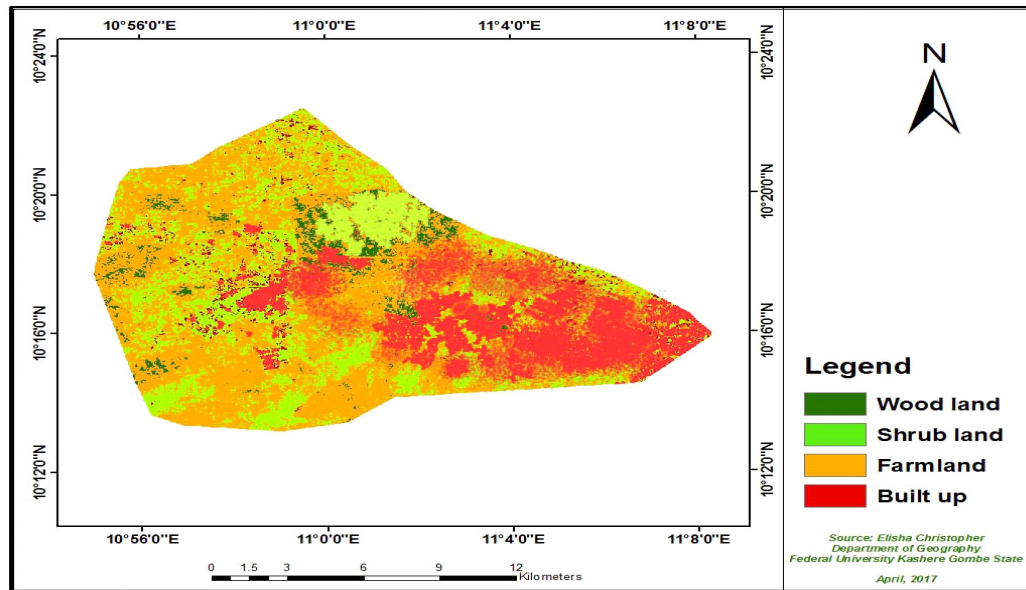


Fig 12: Land use/land cover in 2016

Table 6: Land use/land for 2016

S/N	Land use land	Land use/land cover for 2016	
		Area KM ²	%
1	Wood land	0.25	3
2	Shrub land	2.55	31
3	Farmland	3.28	40
4	Built up	2.14	26
	Total	8.22	100

Source: Fieldwork 2017

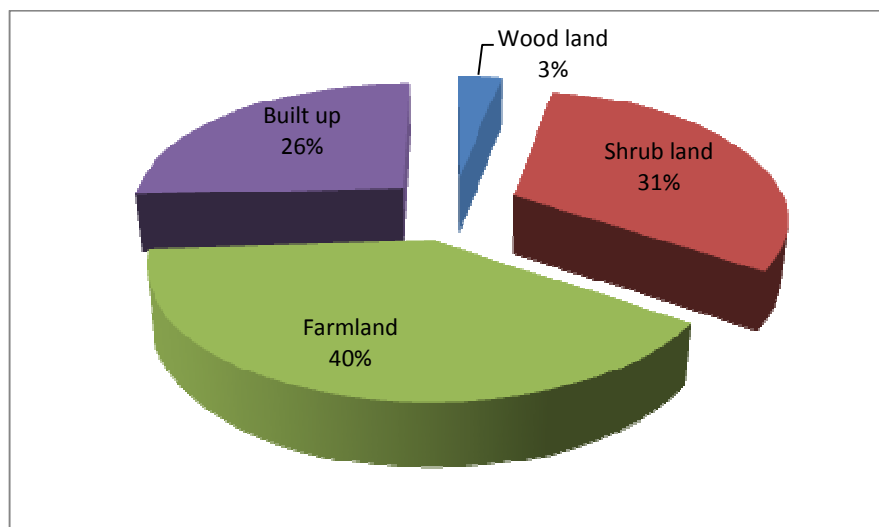


Fig 13: Pie chart showing percentage distribution of Land use for 2016

Trend of land use and land cover of Tunfure

The trend(changes in land use) at which the land use and land cover of Tunfure for a period of 20 years (1996-2016) differs among the classes, where others increased significantly other declined drastically with the passage of time. Built-up area has increased from 1% in 1996 to 26% in 2016 which signifies the rapid growth of the area (Urban expansion). Woodland has decreased over the years from 18% in 1996 to 3% in 2016 as seen in table 9 below, which can be due to fuel wood exploration and clearing of land for cultivation. Shrub land has been static between 1996 and 2004 with about 46% but subsequently declined to 31% in 2016 as seen in table 9 below. This decline is as a result of urban expansion where shrub lands were cleared for other land uses. Based on the overlay map of 1996-2000 the result shows a total change that occur between which indicate that wood land had reduced by 1%, shrub land and farmland has remain constant while built up areas has increased with 1% as shown in table 7 below.

Table 7: Trend (changes) in the land use from 1996-2000.

Land use Years	Woodland %	Shrub land %	Farmland %	Built up %
1996	18	46	35	1
2000	17	46	35	2
Difference in %	-(1)	0	0	1

Source: Fieldwork 2017

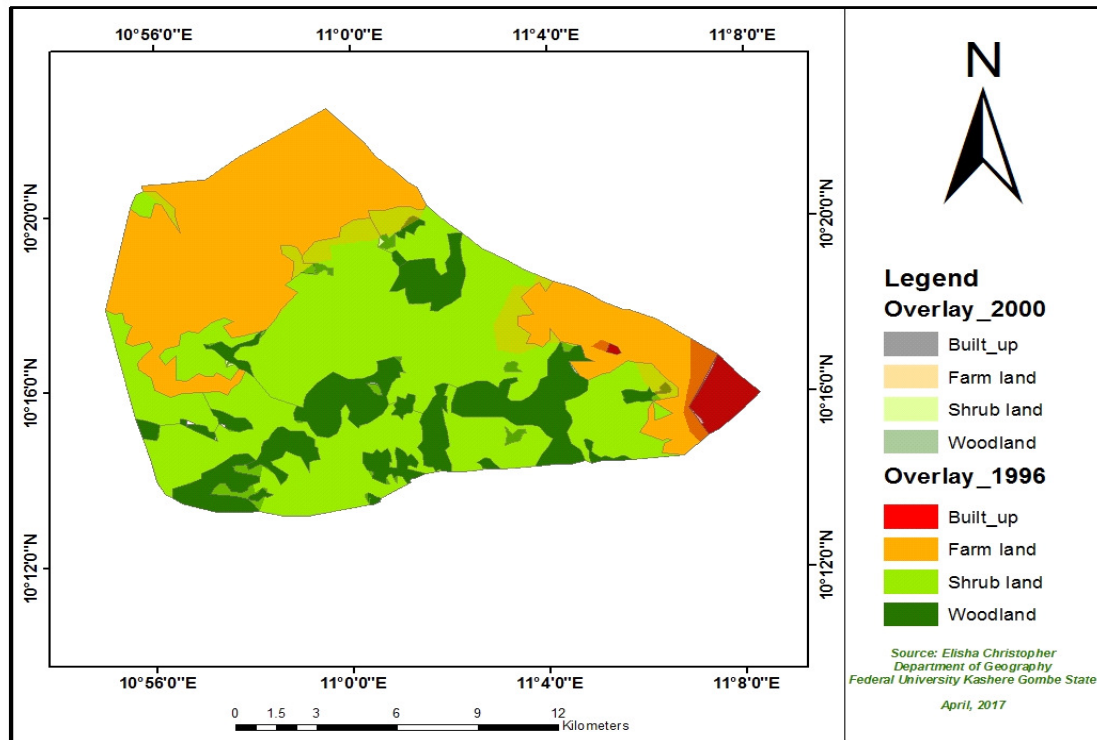


Fig 14: Land use/land cover overlay for 1996 -2000

In 2004 to 2008 the result of the overlay shows that woodland has reduced by 5%, shrub land has by 6%, farmland has increase with 6% and built up areas has also increase with 5% as seen in the table 8 below:

Table 8: Trend (changes) in the land use from 2004-2008.

Land use Years	Woodland %	Shrub land %	Farmland %	Built up %
2004	10	46	42	2
2008	5	40	48	7
Difference in %	-(5)	-(6)	6	5

Source: Fieldwork 2017

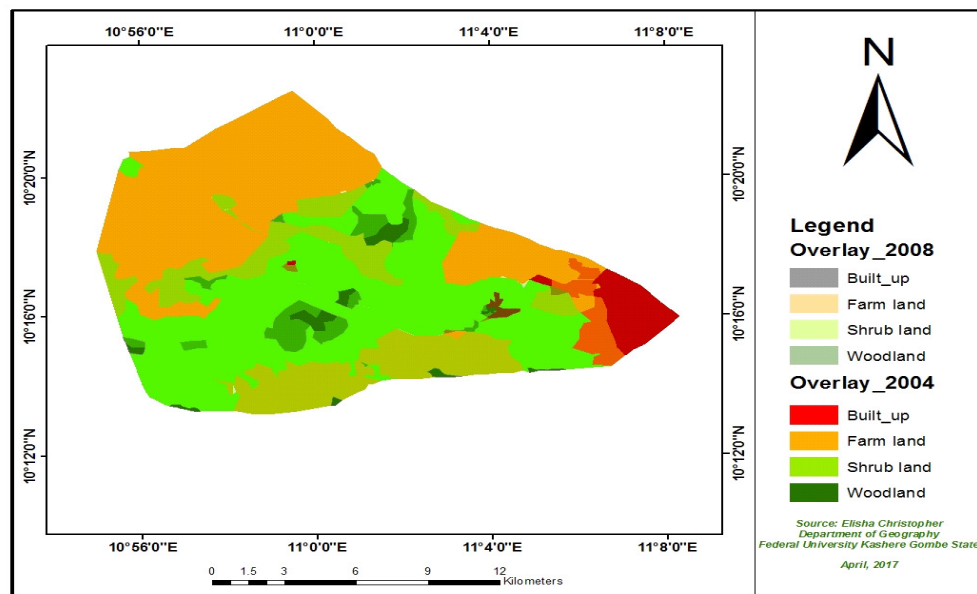


Figure 15: Land use/land cover overlay for 2004-2008

Between 2012 and 2016 woodland has a noticeable decreases of 1%, shrub land with a total decrease of 3%, followed by farm land which reduced by 3% and lastly built up areas has a noticeable increase of 9% which is shown in table 9 below:

Table 9: Trend (changes) in the land use from 2012-2016.

Land use Years	Woodland %	Shrub land %	Farmland %	Built up %
2012	4	34	43	17
2016	3	31	40	26
Difference in %	-(1)	-(3)	-(3)	9

Source: Fieldwork 2017

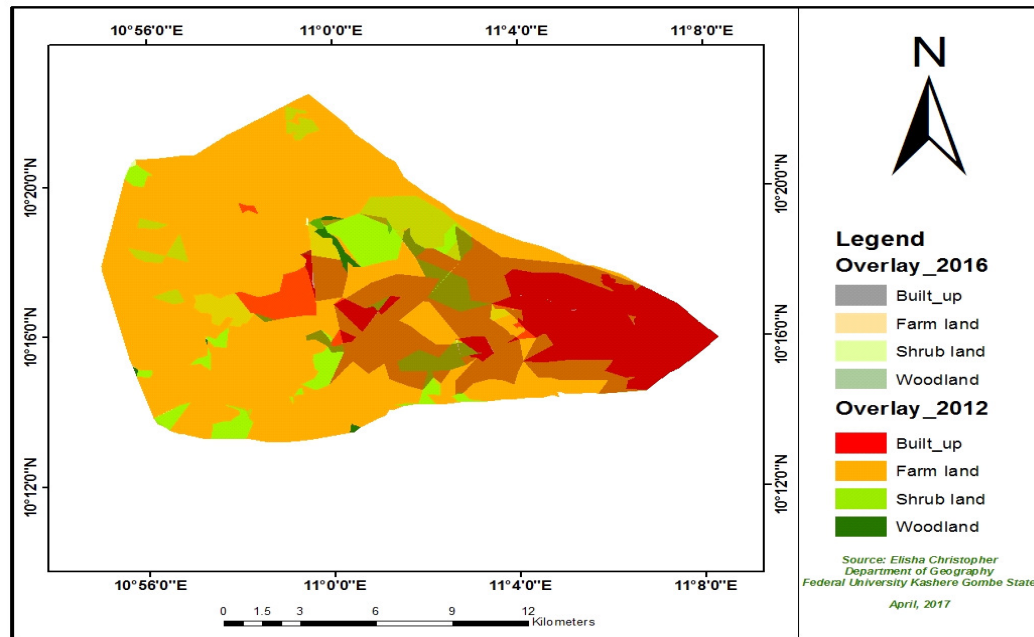


Figure 16: Land use/land cover overlay for 2012-2016

However, Burgess (1925) in his work “Urban Land Use Model” presented a descriptive urban land use model, which divided cities in a set of concentric circles expanding from the downtown to the suburbs. This is in conformity with the land use analysis of 1996 (figure 2) where built up areas are found close to the CBD (Gombe main town) but as the population increase the bourgeois push away poor people to the outskirts of the city centre. The model also assumes a relationship between the socio-economic status (mainly income) of households and the distance from the Central Business District (CBD) that other smaller CBDs develop on the outskirts of the city near the more valuable housing areas to allow shorter commutes from the outskirts of the city which can also be seen in this study where Tunfure market serve as the CBD to the residents for the transaction of goods and services.

Impact of Urbanization on Agricultural Activities

Urbanization has an impact on agricultural activities in the study area. Many of the residents have engaged themselves in other activities other than farming but those that are still practicing farming activities have intensified their cultivation to meet the demand of the increasing population. Even though some farmlands were lost it has brought about expansion and intensification of farming activities away from the built-up area. The can be seen from the analysis from presented table see (table 4) shrub land has the highest percentage which occupied 46% of the total classes, followed by farmland with 35%, woodland occupied 18% and settlement occupied only 1% of the total classes but in 2016 it

can be seen from the land use land cover analysis of 2016 see (table 9) farmland occupied highest percentage with 38% in the total classes followed by shrub land which has reduced to 30%, wood land also has reduced to 3% but built up areas has drastically increase. From the above result we can see that built up areas has been expanding due to population growth while farmland keep on decreasing which may lead to less productivity in the study area.

DISCUSSION SUMMARY

This study focuses on land use urban expansion on agricultural land use as contained as farmland, woodland; with the use of geospatial techniques to provide information on the Land use/Land cover changes in Tunfure, Gombe State of Nigeria. Based on the provided statistics, it can be seen that Land use changes have occurred in the study area since 1996 to 2016. It can be said that the built-up land of the study area within the study period has increased mainly at the expense of woodland and shrub land. Agricultural land has increase from 1996 to 2008 as it has been stated in this research to be a result of high demand on farm for cultivation. The Land use change on Built-up area is justified by the increase in population of the study area. The highest increase in the built-up was noticed between 2008 and 2016; from 7% to 26%, and it has been shown by the study that urban expansion has taken place in the study area, of which Linear and Clustered patterns are the major patterns.

Although the built-up area has increased greater portion of the study area has remained undeveloped. This calls for a proper planning for the control of the urban expansion in Tunfure.

MAJOR FINDINGS

- ❖ The study reveals that the land use changes in Tunfure over the study period have seen expansion of the built-up area from 1996 to 2016 (from 1% to 26%) and farmland (from 35% to 40%). This shown that there is an urban expansion which has also increase agricultural land use (based on the fact most of the people are into primary activities), while the land cover kept on shrinking with shrub land reducing from 46% to 31% and wood land declining from 18% to 3%.
- ❖ Similarly, the trend at which the land uses are changing have maintained a certain pattern where the built-up areas has been increasing (from 1% to 26%) while the woodland has been decreasing throughout the years (from 18% to 3%). This shows that the land uses are increasing while the land cover are decreasing.
- ❖ The study shows that urbanization has an impact on agricultural activities in the study because many of the residents have engaged themselves in other activities other than farming but those that are still

practicing farming activities have intensified their cultivation to meet the demand of the increasing population.

- ❖ Based on the findings it is also in conformity with the land use land cover analysis of 1996 where built up areas are found close to the CBD (Gombe main town) but as the population increase the bourgeois push away poor people to the outskirt of the city centre. The model also assumes a relationship between the socio-economic status (mainly income) of households and the distance from the Central Business District (CBD) that other smaller CBDs develop on the outskirts can also be seen in this study area where Tunfure market serve as the CBD to the residents for the transaction of goods and services.
- ❖ Finally the result from overlay show a noticeable change in the study area where woodland that occupied 18% from the total classes in 1996 has now reduced to 3% in 2016 which means 15% of the woodland has disappeared and converted to other land uses, shrub land with 46% in 1996 and 31% in 2016 account for a total change of 16%, then farm land with 35% in 1996 has a noticeable increase of 3% as it was 40% in 2016 and lastly built up areas in 1996 with 1% has drastically increased to 26% in 2016 amounting to 25% increase.

CONCLUSION

This study offers an avenue to observe as well as to study the changes that took place in Tunfure. The findings of this work show that human activities have increased which in turn lead to the decline of the vegetation of the area. The classification achieved in this study produces an overall accuracy that fulfills the minimum accuracy threshold. Accurate and updated land cover change information is necessary for understanding main factors causes and environmental consequences of such changes. While remote sensing has the capability of monitoring such changes, extracting the change information from satellite data relies on effective and accurate change detection techniques.

RECOMMENDATION

In agreement with the findings of the study the following recommendations were made:

- ❖ Considering the rate at which the land cover is declining government should designate some areas as forest reserve.
- ❖ Looking at the rapid expansion of the built up area, government should provide layout plan for proper planning due urban expansion in the area. social amenities should be provided, and evenly distributed within the study area to control urban expansion.
- ❖ Agricultural incentives should be given to farmers to maximize their production on the available land so as to meet the food demand of the increasing population and agricultural land should be properly managed.

- ❖ Although, medium spatial resolution (30m) images have been appreciated for reliable results in Land use land cover analyses, it is recommended that higher resolution 5m satellite images should preferably be used. This is owing to the fact that image pixels of 5m² define features on the landscape more clearly than those of 30m² pixels, and it will tend to provide a more reliable and accurate model of the landscape features.
- ❖ Land use land cover should be used by the state government for community mapping, stakeholder's involvement in land management and town planning. The researcher therefore recommended that further studies on this topic or similar should be carried out in other department, University, Organizations, and Countries as this will help in making empirical comparisons of result between departments, university, and country with regards to their constraints with emphasis on geospatial technologies techniques. Because geospatial techniques properly used will help in land use studies, urban development, natural resource management, flood control, biodiversity conservation, risk management etc.

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