Trend, Pattern and Extent of Changes in The Vegetation Cover of Guga Forest Reserve, Giwa - Kaduna (1986-2019)

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Abstract- Nigeria was identified as one of the countries with the highest rate of forest loss (3.3 percent) in the world. Since 1990, the country has lost 6.1 million hectares or 35.7 percent of its forest covers. It also recorded that Nigerian most biodiversity ecosystem is fast depleting at an unbelievable rate. The aim of this research was to determine the trend, pattern and extent of landuse/landcover change of Guga Forest Reserve in, Shika, Giwa Local Government Area of Kaduna State, Nigeria. The methodology adopted for this research includes using Remote Sensing and Geographic Information (GIS) techniques, Landsat MSS imagery of 1986, Landsat TM imagery of 1990, Landsat ETM+ data of 1999 and Landsat 8 OLI image 2019. The datasets were processed and classified into land use/land cover classes using the supervised classification technique in Erdas imagine 9.2 environment and ArGIS 10.1. The result revealed that between 1986-1990, built-up, agricultural land and water body increased at the rate of 1.7%, 0.6% and 3.8% per annum while forest, and bare land declined at the rate of -0.3%, - 1.2% annually. Between 1990 and 1999, built-up, and agricultural land increased at the rate of 0.9%, 2.3% annually while forest, bare land and water body declined at the rate of -0.2%, -4.1% and -10.4% annually within these same periods. More so, in 1999 to 2019, built-up, agricultural land and water body increased at the rate of 0.9%, 1.2% and 0.2% annually while forest and bare land decreased at the rate of -1.8% and -2.2% per annum. The study concludes that there is high rate of urban encroachment in the Guga forest reserve area. There is serious encroachment of physical development and cultivation on the forest cover. These could be attributed to inadequate monitoring of the forest reserve. If this situation continues at this rate, the vegetation cover in the area would soon be lost to the detriment of the environment. The built-up area and agricultural land have shown a continuous increased within the period of study while forest/vegetation and bare land declined. The research recommends that the management of Guga forest reserve should adopt Remote Sensing and Geographic Information System (GIS) techniques which have proved to be efficient in the monitoring of vegetation cover. This would help to control encroachment and illegal logging in the area and the people should be sensitized through enlightenment campaigns on the consequences of indiscriminate tree felling. Alternative sources of cooking energy should also be emphasized.

Index Terms- Land Use; Land Cover; Change; Rate; Pattern; Environment

I. INTRODUCTION

Otu, Joseph and Eja, (2011) reported that FAO"s Global Forest Resource Assessment (Tanko, 2011) cited in FAO, (2010a; 2010b), estimated that the global forest area currently covers about 4.033 billion hectares and it also report that between 2000 and 2010, the world has lost about 130 million hectares of its forest. Tanko, 2011 cited in FAO, (2011c) report that global forests area will continue to decline. However about one half of the forest that covers the earth is gone. A positive sign is that, the estimated loss of forests area at global level decline from 16 million hectares per year between 2000 and 2010 that is each year 16 million hectares disappear. The World Resource Institute estimates that only about 22 percent of the world original forest cover remain intact-most of this, is in three large areas: the Canadian and Alaska boreal forest, the boreal forest of Russia, and the tropical forest of the Northwestern Amazon Basin and the Guyana shield.

Forests in Africa are extremely diverse. Deforestation and urban population growth have gradually increased together, with heaviest forest losses coming in the area where wood is needed for fuel, construction purposes or where forest land is needed for growing crops (Mortimore, 1970). The forest in Africa currently covers about 23 percent of the land; it was reported that 75 million hectares of forest land (10 percent of the total forest area) was converted into other land uses between 1990 and 2010 (Aroins, 1998; FAO, 2011c; Danburi, 2014; Zubair, 2016; Turner, *et. al.*, 2017).

According to Cunningham and Cunningham (2004), an estimated 12.5 million km^2 of tropical land were covered with closed canopy forest a century ago and 9.2 million hectares or about 0.6 percent of the remaining tropical forest is cleared each year. This situation occurs as a result of over exploitation due to high demand for food, energy and fodder and through illegal logging and non-replacement of the natural vegetation; people have decided to use firewood as an alternative means of energy for domestic purpose. Another dimension is added by felling and burning of wood to produce charcoal and this is causing serious depletion of the forest resources (Okonkwo, Umar, and Nwafor; 2002; Tanko, 2011; Danburi, 2014).

In the loss of biodiversity according to World Fact Book (2012), Nigeria was identified as one of the countries with the highest rate of forest loss (3.3 percent) in the world. Since 1990, the country has lost 6.1 million hectares or 35.7 percent of its forest covers. It also recorded that Nigerian most biodiversity ecosystem is fast depleting at an unbelievable rate. For example, between 1990 and 2005, Nigeria lost an average of 409,700 hectares of forest every year equal to an average deforestation rate of 2.38 percent. As of 2005, Nigeria has the highest rate of deforestation in the world according to Food Agriculture Organization of the United Nations (FAO, 2010b). The significant effect of loss of forest/vegetation is the exposure of bare surfaces to disaster such as erosion, pollution and consequently climatic change with an adverse effect on both physical and human environment (Sheyi, 2004; Zubair, 2016; Turner, *et. al.*, 2017).

Forest Reserves

Forest Reserves are areas designated by the government for the protection of timber and other forest resources. Harvesting of timber may be allowed under permit and under special concession to people in the surrounding community. Harvested timbers are mostly replaced with exotic trees species. Most of these Forest Reserves are also poorly managed by the various state ministries of Agriculture and natural resources (Usman and Adefalu, 2010; Danburi, 2014; Zubair, 2016).

The first Forest Reserve in Nigeria is the Olokemeji reserve established near Ibadan around 1900 (Onokerhoraye, 1985; Tanko, 2011). This was followed by the establishments of other Forest Reserve in various parts of what forms the present-day Nigeria. In these reserve, lumbering activities where made illegal. By 1908, a Forest Ordinance promulgated by the colonial government gave protection to all commercial timber outside the reserves.

In 1917, the first definitive government policy on forestry came into existence. In that year, the then governor, Lord Lugard, stated that each province of the country must reserve a minimum of 25% of its forests. This policy statement later faced lots of opposition in the eastern part of the country. This was because of the high population density and the resultant higher pressure on land (Egboh, 1979).

At the time of independence in 1960, many Forest Reserves were already in place in the country. Many of these Forest Reserves were to later become Game Reserves. For instance, the Yankari Game Reserve which was opened in 1962 was a forest reserve for some time (Onokerhoraye, 1985). From about 800 Forest Reserves and about 30 Game Reserves in the 1980s, the number of the forest reserves in the country has now increased to 966. There are also eight National Parks, twelve strict Nature Reserves and 28 Game Reserves in the country today (Areola, 1982; Federal Government of Nigeria, 2001).

The indiscriminate felling of trees has continued in virtually every part of the country. For instance, the Federal Department of Forestry (2001) estimated that Nigerian forests are being depleted at an annual rate of 3.5%. Nigeria used to have about 20% of its area covered by natural forests but these have been reduced to about 10%. It lost about 60% of its natural forests to agricultural encroachments, excessive logging and urbanization between the 1960s and the year 2000 (FAO, 2001). In some areas natural forest has been totally replaced with monocultures of exotic trees. Indiscriminate felling of trees has continued in both the high forest and savannah areas which have resulted to serious reduction in timber resources.

There is the fear that what is left of the forests and the wildlife may be completely lost within the next few years if care is not taken. The rate of afforestation continues to be far slower than the rate of exploitation (Tanko, 2011; Danburi, 2014; Turner, *et. al.*, 2017).

II. METHODOLOGY

Reconnaissance Survey

A reconnaissance survey was carried out in the area to enable the researcher to get familiar with the state and nature of the forest/vegetation cover in the study area.

Types of Data

In order to achieve the aim and objectives of this study, the types of data used for the study were satellite imageries, Administrative map, and topographic map of the study area at a scale of 1:40,000.

Sources of Data

The primary data used for the research are mainly satellite images acquired from National Centre for Remote Sensing in Jos and these include the following:

i. Landsat Multispectral Scanner (MSS) of 7th December, 1986 with a spatial resolution of 79meters.

ii. Landsat Thematic Mapper (TM) of 27th November, 1990 with a spatial resolution of 30meters.

iii. Landsat Enhanced Thematic Mapper Plus (ETM+) of 19th October, 1999 with a spatial resolution of 30meters.

iv. Landsat 8 (OLI) of 20th October, 2019 with a spatial resolution of 30meters.

The extent of the change of the forest covers within the study periods:

To determine the extent of forest change in the study area, the forest cover layer for the periods of study were extracted from the land use/land cover classified images and the statistics were generated, showing the extent of the changes that have occurred over time.

The trend and pattern of the forest change in the study area over these periods

To achieve this objective, the percentage and rate of forest change in the area in kilometers as derived from the classified image statistics were used. The area change of forest was ascertained by subtracting the former area coverage of the forest from the latter. The change in square kilometers (observed change) = the area coverage of forest of the recent image minus the area coverage of forest of the previous image.

Percentage change was however determined by dividing the observed change by the changes in latter years (base year) multiplied by 100.

$$\text{Percentage change (rate)} = \frac{\textit{Observed change} \times 100}{\textit{Base year}}$$

To obtain the annual rate of change in the forest, the percentage of the change of the forest was divided by the study period.

$$\text{Annual Rate of change} = \frac{\%\ \textit{Change}}{\textit{No. of Study year}}$$

III. RESULT AND DISCUSSIONS

Rate and Pattern of Land Use/Land-Cover Change

The rate and pattern to which each land use/ land cover class is changing per year however is tabulated in hectares and percentage as shown in the Table 1:

Table 1: Annual Rate of Land use/Land cover Change

	1986 - 1990		1990 -1999		1999 -2019		1986 - 2019	
Land use	Ha	%	Ha	%	Ha	%	Ha	%
Bare land	-17.3	-1.2	-54.3	-4.1	-18.7	-2.2	-30.0	-2.1
Built up	3.9	1.7	2.2	0.9	1.3	0.5	2.0	0.9
Agric/land	13.8	0.6	58.3	2.3	29.0	0.9	36.3	1.5
Forest	-2.0	-0.3	-1.3	-0.2	-11.6	-1.8	- 6.9	-1.0
Water	1.6	3.8	-4.8	-10.4	0.0	0.2	-1.3	-3.3

Source: Field Survey, 2020

The analysis as shown in Table 1 revealed that, between 1986-1990, built-up, agricultural land and water body increased at the rate of 1.7%, 0.6% and 3.8% per annum while forest, and bare land declined at the rate of -0.3%, - 1.2% annually. Between 1990 and 1999, built-up, and agricultural land increased at the rate of 0.9%, 2.3% annually while forest, bare land and water body declined at the rate of -0.2%, -4.1% and -10.4% annually within these same periods. More so, in 1999 to 2019, built-up, agricultural land and water body increased at the rate of 0.9%, 1.2% and 0.2% annually while forest and bare land decreased at the rate of -1.8% and -2.2% per annum.

In general, between 1986-2019, the built-up and agricultural land increased at the rate of 0.9%, 1.5% per annum within the period of study. On the contrary, forest, bare land and water body were declining at the rate of -1.0%, -2.1 and -3.3% per year. Going by this rate, if no adequate measure is put in place to monitor and protect the forest reserve, it may be lost completely.

The Extent of Built-up Land

The extent of built-up land within these study periods is shown in Fig. 1 and Fig. 2. Table 1 shows the extent of the urban expansion between the various time periods.

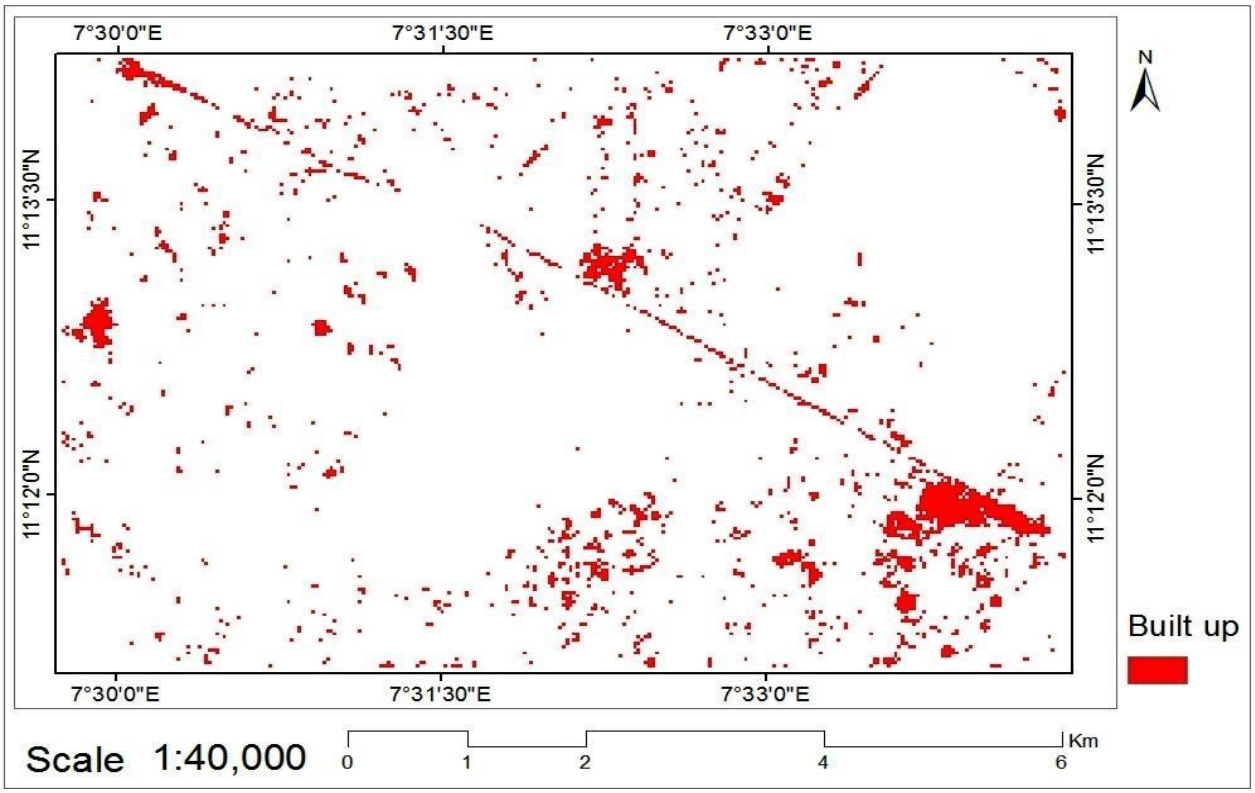

Fig 1: 1986 Built-up Map of the Study Area
Source: Field Survey, 2020

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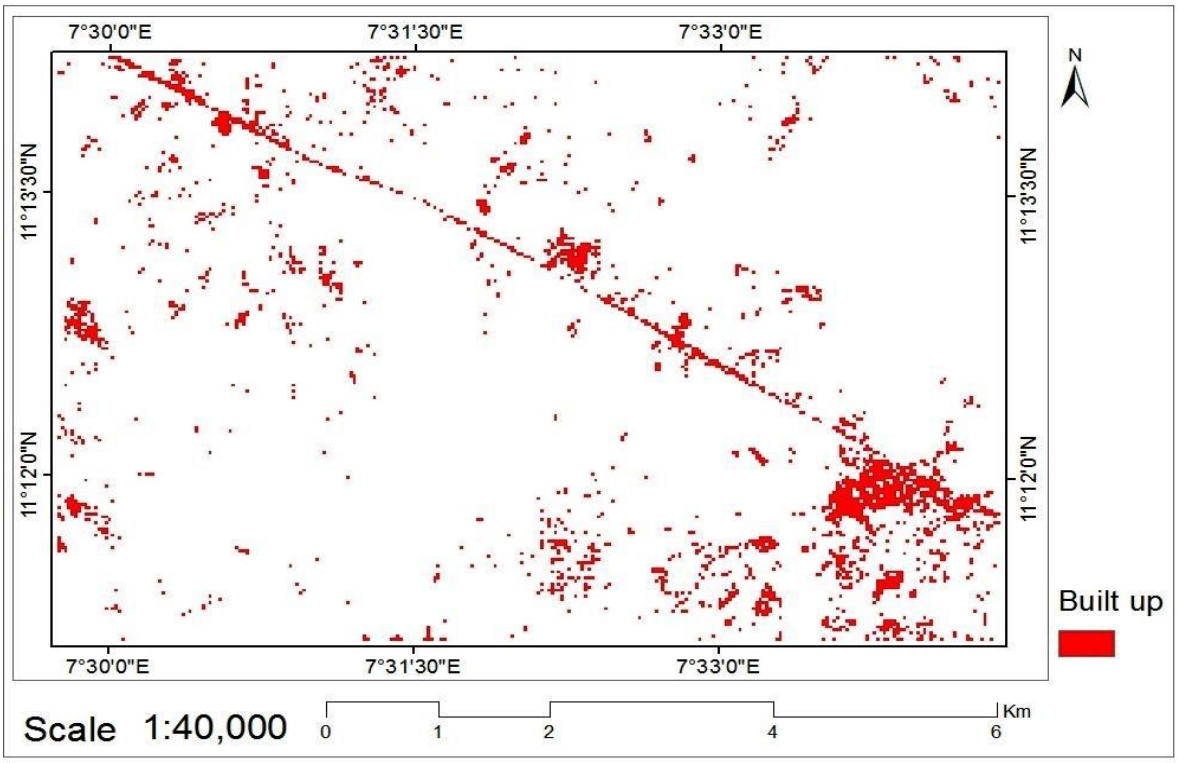

Fig 2: 1990 Built-up Map of the Study Area
Source: Field Survey, 2020

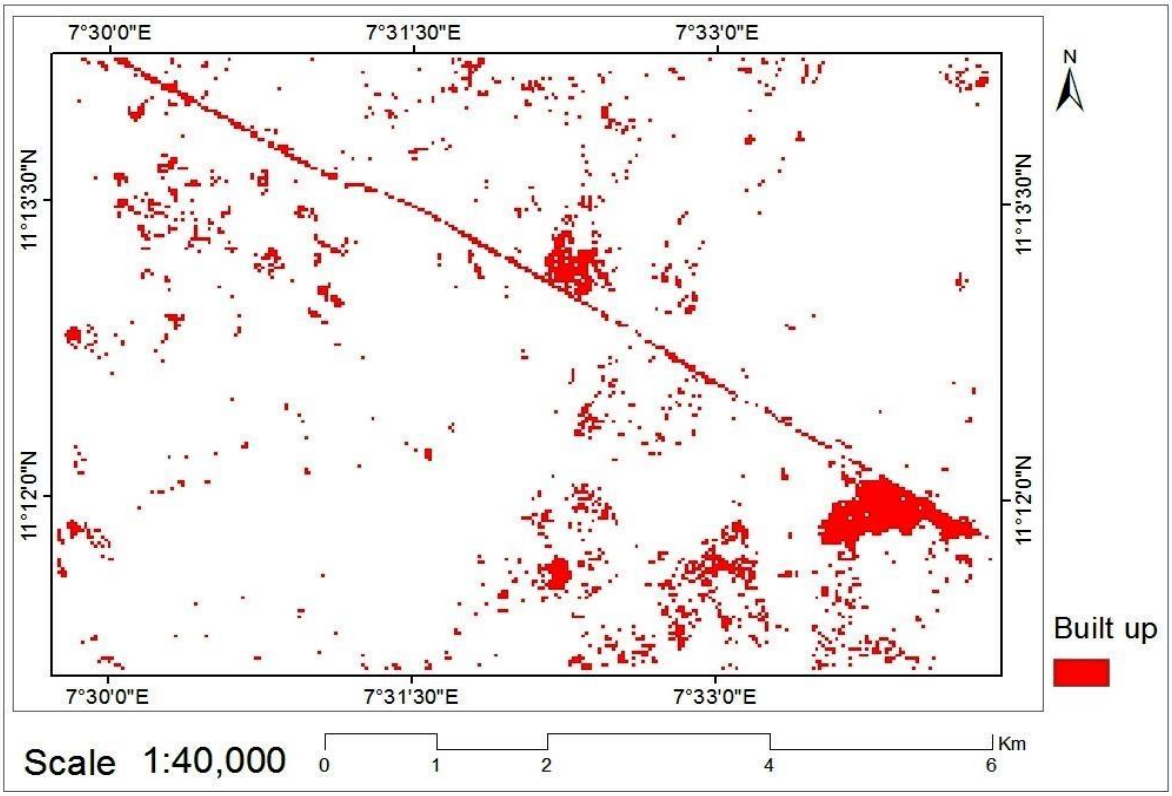

Fig 3: 1999 Built-up Map of the Study Area
Source: Field Survey, 2020

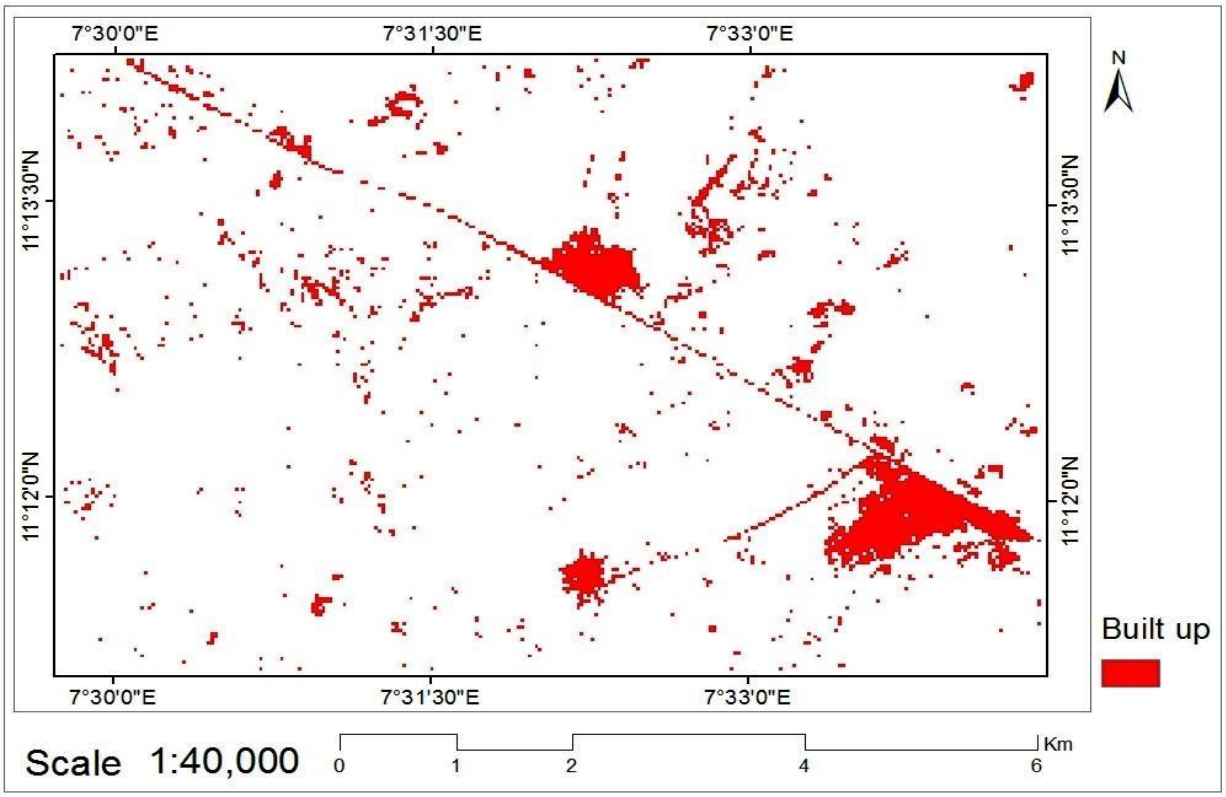

Fig 4: 2019 Built-up Map of the Study Area
Source: Field Survey, 2020

Table 2: Extent of Urban Expansion in the Area

Period	Year	Built Up (Ha)	Change		Growth Rate	
			Ha	%	Ha/Year	%/Year
1986-1990 (4years)	1986	224.8	15.9	7.0	3.9	1.7
		240.5				
1990-1999 (9years)	1990	240.5	19.6	8.2	2.2	0.9
1999-2019 (20years)	1999	260.1	19.4	7.5	1.3	0.5
1986-2019 (33years)	1999	260.1	54.7	24.3	2.0	0.9
	2019	279.5	2019	279.5		
	1986	224.8				

Source: Author's Analysis, 2020

The results shown in Table 2 revealed that, between1986-1990 the built-up area increased to about 7.0%, while in 1990-1999, it increased to about 8.2%. By 1999-2019, there was an increased in built-up area of about 7.5% while 1986-2014, there was a dramatic increase in built-up to about 24.3%. The Shika area was growing at the rate of 0.9% within the period (1986-2019) studied. Between 1999-2012, about 19.4 hectares of land which amounted to about 7.5% was added to built-up land use and within these same periods it recorded an annual growth rate of about 0.5%. In other word about 1.2 hectares of land was built-up yearly at that period.

More so, the evidence of this urban expansion could be seen in built-up map of the study area in Fig.1, 2, 3 and 4 above. The improvement or rather increase in the built-up area could be attributed to the relocation of the teaching hospital to its permanent site which triggered the need for people to acquired land to built on, this also attracted lot of commercial activities in this area. A lot of people could afford to build their own houses. This mounted pressure on the land and consequently, built-up land use increased at the detriment of other land cover types in the area as seen in the figures. This means that the rate at which the land-use was increasing is attributed to increase in human population over time.

Vegetation Change

The extent of forest change from 1986 to 2019 is shown in Figs. 4. Table 3 shows the extent to which forest has been loss between the various time periods.

Table 3: Extent of Forest Loss

Period	Year	Forest (Ha)	Change		Growth Rate	
			Ha	%	Ha/Year	%/Year
1986-1990	1986	673.1	-7.8	-1.2	-2.0	-0.3
	1990	665.3	(4years)			
1990-1999	-		12.0	-1.8	-1.3	-0.2
	1990	665.3	(9years)			
	1999	653.3				
1999-2019 (20years)	-		174.2	-26.7	-11.6	-1.8
	1999	653.3				
1986-2019 (33years)	- 2019	479.1	194.0	-28.8	-6.9	-1.1
	2019		479.1			
	1986	673.1				

Source: Field Survey, 2020

The results as shown in Table 2 reveal that the forest land decreased from -7.8 hectares in 1986 to 1990. The forest land was declining at the rate of - 0.3% within the period (1986-1990) studied. The period between 1990 and1999 recorded a loss in forest land of about -12.0 hectares and was decreasing at the rate of -0.2% per annum. More so, from 1999 to 2019, about -174.2

hectares of forest land which amounted to about -26.7% was loss annually, the period recorded an annual growth rate of about -1.8%. In other word about -11.6% hectares of forest land were loss to built-up yearly at that period.

Generally, the period between 1986 to 2019, about -1.1% of the forest was loss to other land use type. The result indicates that each year the forest land is been loss giving room to urban expansion as shown in Table 3 above. The period 1990-1999 recorded the highest decreased in forest land with an annual growth rate of - 0.2%.

IV. CONCLUSION AND RECOMMENDATIONS

Conclusion

This study reveals high rate of urban encroachment in the Guga forest reserve area. There is serious encroachment of physical development and cultivation on the forest cover. These could be attributed to inadequate monitoring of the forest reserve. If this situation continues at this rate, the vegetation cover in the area would soon be lost to the detriment of the environment. The built-up area and agricultural land have shown a continuous increased within the period of study while forest/vegetation and bare land declined.

Recommendations

Based on the identified changing nature and rate of various land-use/land-cover types identified in the study area especially from 1986 to 2019, the following are recommended:

- The management of Guga forest reserve should adopt Remote Sensing and Geographic Information System (GIS) techniques which have proved to be efficient in the monitoring of vegetation cover. This would help to control encroachment and illegal logging in the area.
- The people should be sensitized through enlightenment campaigns on the consequences of indiscriminate tree felling. Alternative sources of cooking energy should also be emphasized.

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