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Analysis of Land Use/ Land Cover Changes in Gusau, Zamfara State, Nigeria

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This study analysed the land use/land cover change in Gusau Zamfara State, Nigeria. The objectives were to examine change in sizes of land use/cover in Gusau Zamfara State; compare the growth of the various land uses and determine which land use is advancing most. To achieve the objectives, satellite imageries of Gusau covering 2000 – 2018 were required from Global Land Cover Facility (GLCF) using the composite band and clip tool in ArcGIS 10.5 Thereafter, satellite imageries for 2000, 2005, 2010 and 2018 were extracted. Then supervised image classification with a Maximum Likelihood Algorithm was carried out using ENVI 4.2 to classify all the images into unique spectral land use/cover classes to generate the land use/land cover change of Gusau,. The images were appropriately classified and sizes of each land use/cover were presented in table. Result showed consistent increases and decreases of built-up and forest land respectively between 2000 and 2018. As built-up land increases from 6.48764km^2 in 2000 to 16.1586km^2, 22.3749km^2 and 28.2411km^2 by 2005, 2010 and 2018 respectively; forest land decreases from 17.6731km^2 in 2000 to 12.9348km^2, 11.4741km^2 and 6.93km^2 by 2005, 2010 and 2018 respectively. Between 2000 and 2005, agricultural land increases from 30.4119km^2 to 47.2815km^2; but decreases from 47.2815km^{2}to 45.3393km^{2}between 2005 and 2010, and from 45.3393km^{2}to 39.3219km^{2}between 2010 and 2018. Water body and barren land also recorded overall decreases with variability through the periods. Built-up land showed continues growth with 316.69 percentage increases in eighteen (18) years (2000-2018.Built-up land is the most advancing land use in Gusau Zamfara State, Nigeria. It was concluded that urbanization is reducing land availability for other uses and needs to be properly planned for environmental sustainability.

Keywords: Land, Land use, Land cover, Urbanization, Satellite imageries, Gusau, Zamfara State.

Introduction

Land is the most important natural resources on which all human activities take place. Land use/ land cover regularly undergo changes as a result of increase in population and human activities which increases the demand on static land. Man uses land for farming, forest, pasture, transportation, education, commercial and other uses. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management. Trend of change is essential for various reasons. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current level. Changes in land cover can be due to urban expansion of agricultural land, changes in river regimes, shifting cultivation, the spread of erosion and desertification and so on. This, therefore, requires not only the identification of features but also the comparison of subsequent data in order to recognize when valid change has taken place. Land use change is a fundamental course of resource conflicts currently happening in Gusau and entire Zamfara State, It is major issue of concern with regards to change in the global environment and insurgency. The role of land and natural resources in conflict is attracting increased international attention due to the changing nature of armed conflict and as a result of a variety of longer-term, global trends. Competition for land resources is a major cause of conflict between and within nations and there can be

significant impacts on land from violent conflicts. Violent activities such as bombing and forest burning can be a direct force of land degradation and land use change (Witmer, 2015), but usually occur across small spatial and temporal scales. United Nations (UN, 2010) reported that "*disputes over land and resources are an important source of deadly conflict. They may stem from land grabs, boundary disputes and displacement as a result of man-made or natural disasters, government resettlement policies, climate change or other factors. They are often made more complex by the multiplicity of actors and economic interests involved, and both the drivers and actors involved may change over time*".

Ironbar and Anam (2018) noted that **"**land and its resources are very important to mankind as they provide a wide range of man's needs. The needs, therefore, impinge on man to utilize land and its resources to satisfy his insatiable needs. Decisions concerning land utilization involve a complex mix of economic, political and cultural purposes. Land utilization, however, depends on who owns/controls a given plot of land, and also, on the incentives and pressures which sharpen the land owner's behavior. In recent times, due to increasing pressures on land as a result of migratory nomads and decreasing access to land, there has been an increase in land use disputes and such has led to an increase in communal conflicts that have arisen from such disputes.

Briassoulis (2001) argued that land is used to meet a multiplicity and variety of human needs and to serve numerous, diverse purposes. When the users of land decide to employ its resources towards different purposes, land use change occurs producing both desirable and undesirable impacts. The analysis of land use change is essentially the analysis of the relationship between people and land. Why, when, how, and where does land use change happen? Human activities are the key factor of the changing environment which also has direct and indirect consequence on human life and livelihoods. The dynamics in land use alter the availability of different important resources including vegetation, soil, water, and others (Chomitz & Kamari, 1998; Bruijnzeel, 2004). According to Cheruto *et al.* (2016), the surface of the earth is undergoing rapid land-use/land-cover (LULC) changes due to various socioeconomic activities and natural phenomena.

Land use change is the rapid growth and expansion of urban centres, rapid population growth, scarcity of land, the need for more production, changing technologies are among the many drivers of LULCC in the world today (Barros, 2004). According to (Masek *et al.*, 2000) LULCCs respond to socioeconomic, political, cultural, demographic and environmental conditions and forces which are largely characterized by high human populations. LULCC has become one of the major concerns of researchers and decision makers around the world today.

"Land use" refers to what man do on the land surface, that is, the manner in which human beings employ the land and its resources (e.g., agriculture, settlement, industrial, educational). "Land cover" defines the ecological state and physical appearance of the land surface (e.g., water, crops, forest, human structures, shrubs) (Turner *et al.*, 2007; Brandon, 2001; Geist *et al*., 2001). Worldwide, land cover change is caused by changes in the way people use and manage land (Millennium Ecosystem Assessment (MEA), 2005a).

According to Abiodun (2011), countries across West Africa have recorded many resource-centred conflicts that have affected inter-group relations and, quite expectedly, the resource that has been in contention here is land. Broadly, the root causes of this category of conflict can be brought under six headings: disagreements over historical claims, changes in climatic conditions, consequences of changes in the nature of power balance; elite manipulation, youth reactions to vulnerability and exclusion and alterations in boundary structures. While in some cases each one of the listed items has

been sole causes of conflicts, in most cases, many of these have come together to explain the causes of acrimonious intergroup relations.

The recent classification of some Fulani herdsmen as Boko Haram collaborators by the Nigerian military and politicians (McGregor, 2014) reveals the complexities of violent clashes between cattle breeders and sedentary agriculturalists across different parts of the country. The alleged involvement of camel pastoralists from the Republic of Niger in some conflicts in the north-western and central regions of Nigeria also highlights the need to analyse land use change and occurrence of conflicts (Blench, 2010; Krause, 2011; Abass, 2012; Audu, 2013; McGregor, 2014).

Major conflicts in Northern Nigeria has been attributed to land resource use and climate change which the latter is also a consequence of land use. Nigeria Watch (2018) stated that Zamfara remains the second most dangerous state in Nigeria after Borno. Though, Zamfara killing has been linked to the conflict between herdsmen and farmers which resulted from population growth, land use change, climate change and others. There is poor documentation on land use change in Gusau, Zamfara State, Nigeria. Thus, this necessitates this study.

Methodology

The study area Gusau is the capital of Zamfara state Nigeria. Gusau is located in the North West region of Nigeria between latitudes 12^0 16' 28'' N and 6^0 67' 45'' E. The climate of Gusau metropolis is hot and humid (A W climate) according to Kop pen's climate classification. The town has the hottest spot in the state with maximum temperatures of 29.7^0c- 33.6^0c and the minimum of 21.7^0c to 24.2^0c.

Gusau is populated mostly by Hausa and Fulani people, other tribes include Igbo, Yoruba Igala and Nupe. Gusau has a population of 226,857 making it the biggest city in Zamfara State. Though, Gusau was predominantly rural economy majorly farmers and pastoralists, the creation of Zamfara State in 1996 had transformed the economic activities and land use of Gusau into urban area. Gusau being the Zamfara State capital is currently dominated by urban land use such as administrative, commercial, educational, recreational, transportation and residential land use especially within the centre. While the outskirt is still dominantly rural for land use such as farming and animal rearing. The expansion of unban land use such as administrative land coupled with increasing barren land due to desert encroachment has being reducing land availability for rural economic activities which is suspected to have led to armed banditry in Gusau.

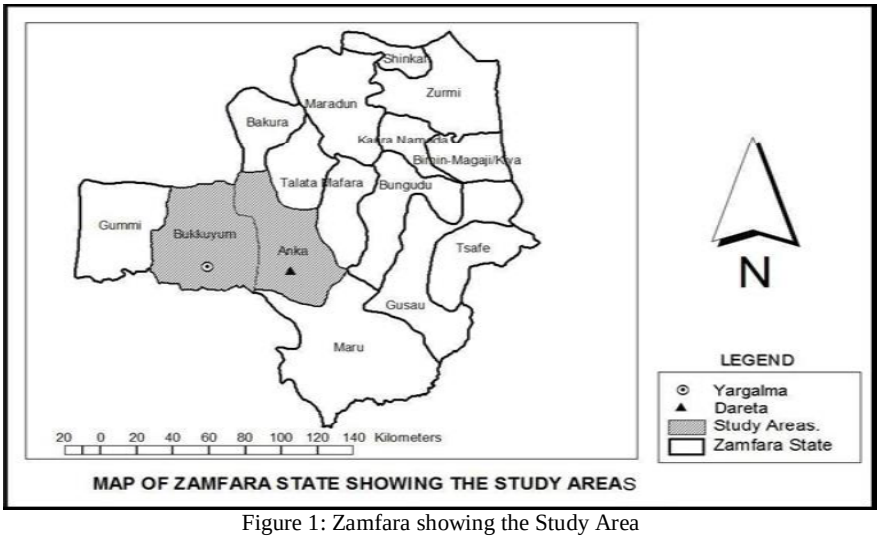

Figure 1: Zamfara showing the Study Area
Source: Zamfara State Ministry of Land and Survey (2016)

Satellite imageries of Gusau for the year 2000, 2005, 2010 and 2018 were required from Global Land Cover Facility (GLCF) using *the composite band and clip tool in ArcGIS 10.5*. After which subsets of Gusau were extracted using the composite band and clip tool in ArcGIS 10.5. To generate the land use/land cover change of Gusau, supervised image classification with a Maximum Likelihood Algorithm was carried out using ENVI 4.2 to classify all the images into unique spectral land cover classes. The classification used bands 4 and 5, to generate a false colour image of Gusau. With the aid of extensive ground truthing, the images were appropriately classified and sizes of each land use/cover were presented in table. Thereafter, statistical techniques (mean, percentage increase and moving average) were used to compare the growth of various land uses/covers and determine the most advancing land use/ cover.

Result and Discussion

Land use/land cover maps of Guasau in the 2000, 2005, 2010 and 2018 were produce to show the pattern of use/land cover change in Guasau (Figures 1-4)

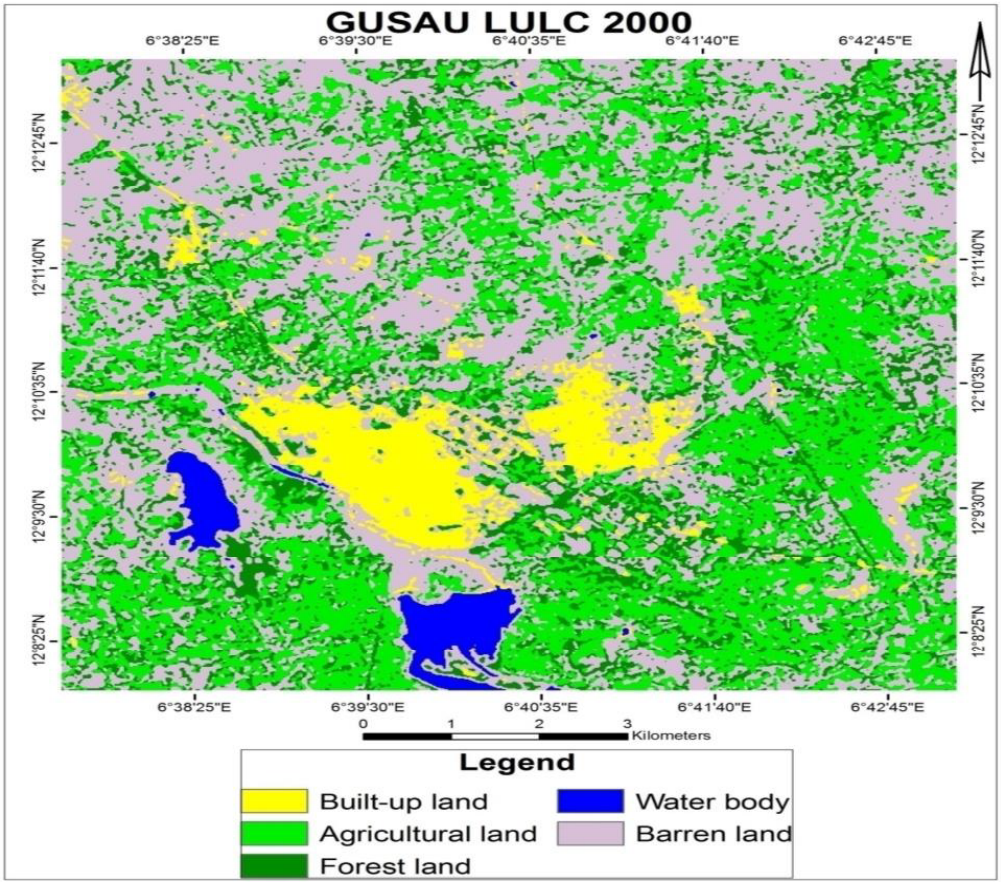

Figure 1: Year 2000 Landsat Image of Guasau Metropolis
Source: Derived from classification (supervised) of Landsat 2000

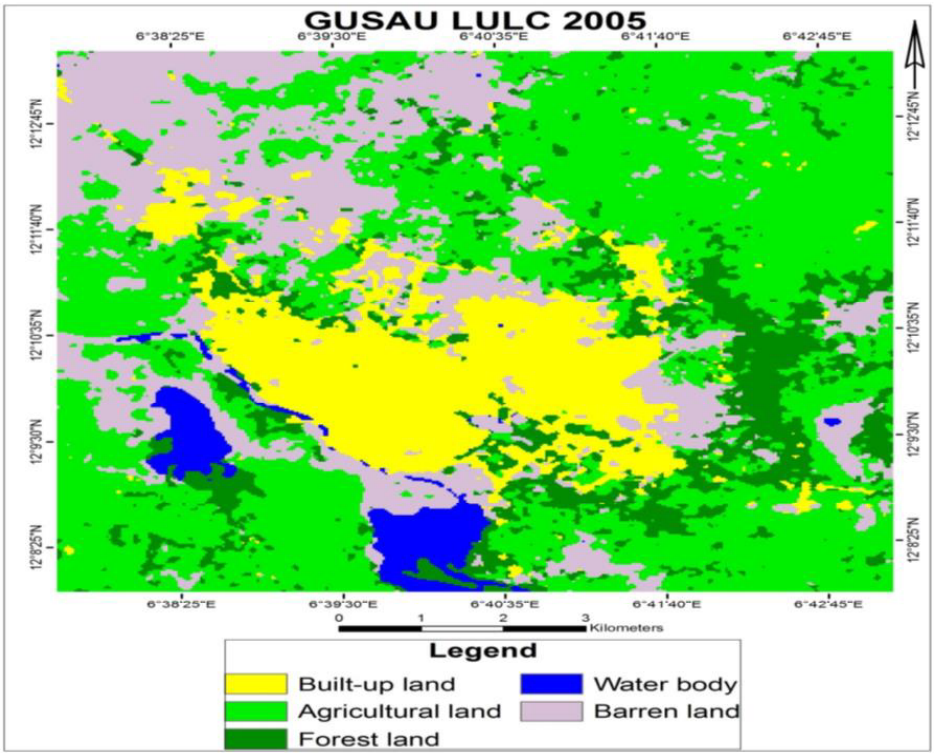

Figure 2: Year 2005 Landsat Image of Guasau Metropolis
Source: Derived from classification (supervised) of Landsat 2005

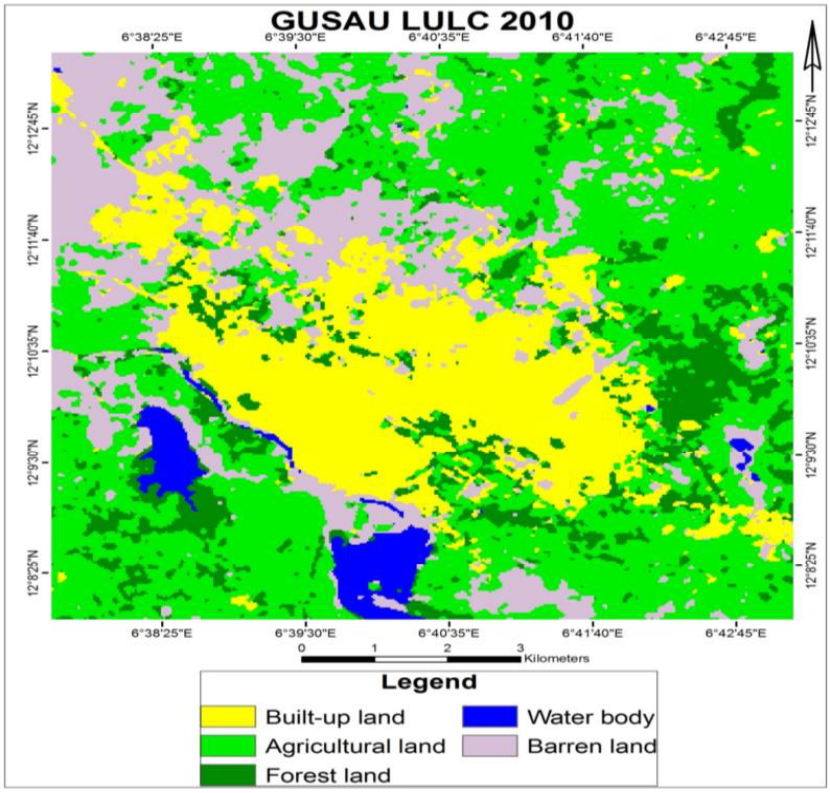

Figure 3: Year 2010 Landsat Image of Guasau Metropolis
Source: Derived from classification (supervised) of Landsat 2010

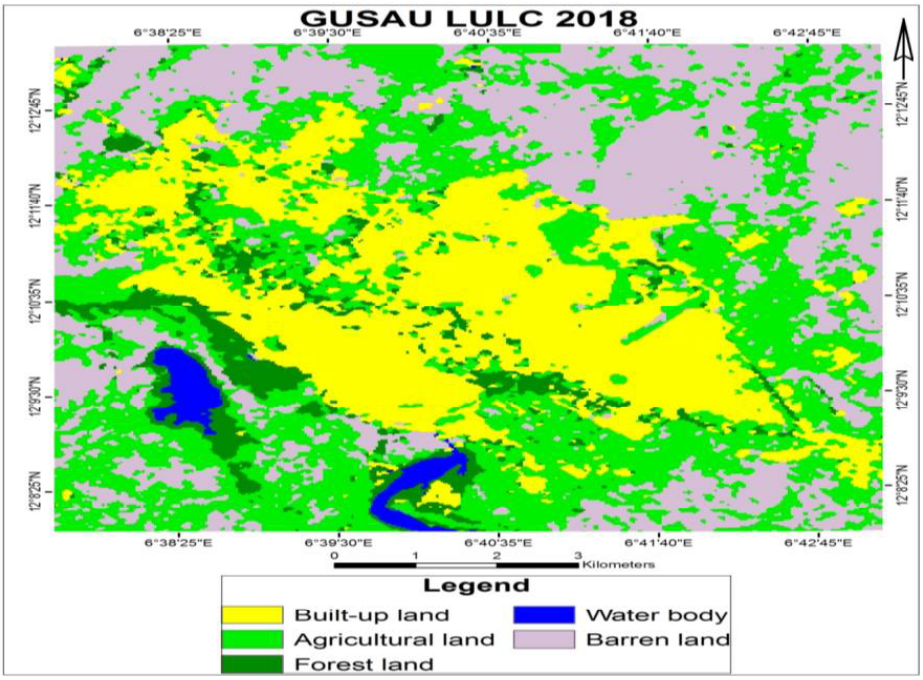

Figure 4: Year 2018 Landsat Image of Guasau Metropolis
Source: Derived from classification (supervised) of Landsat 2018

Figures 1-4 illustrate the patterns of land use/land cover at four different intervals. The figures showed changes in the pattern and sizes of different land use/land cover among the years(2000, 2005, 2010 and 2018). Though built -up is found mostly at the centre in the four maps, the sizes varies and showed continues increase in size. In the year 2000 built-up land was almost exclusively found at centre but subsequent years shows expansions. The expansion of built-up area have reduce other land use and land cover. However in other to understand the pattern of land use /land cover change over the period of study, the sizes of varous land use /land cover at different interval were measured.

The Sizes of Different Land Uses/Land Cover in Guasau, Zamfara State

Using extensive ground truthing, the images were appropriately classified and sizes of each land use/land cover were presented in table 1.

Table1: The Sizes of Land Use/Land Cover Distribution in Gusau (2000 −2018)

Year	2000		2005		2010		2018	
Class	Area (Km²)	Area (%)	Area (Km²)	Area (%)	Area (Km²)	Area (%)	Area (Km²)	Area (%)
Built-up land	6.4876	6.29	16.1586	15.58	22.3749	21.58	28.2411	26.21
Agricultural land	30.4119	29.46	47.2815	45.58	45.3393	43.71	39.3219	36.5
Forest land	17.6731	17.12	12.9348	12.47	11.4741	11.06	6.93	6.43
Water body	2.1131	2.05	3.0924	2.98	2.7918	2.69	1.6038	1.49
Barren land	46.5450	45.09	24.2667	23.39	21.7539	20.97	31.6476	29.37
Total	103.2307	100.01	103.734	100	103.734	100.01	107.7444	100

The sizes of different land use/land cover in Guasau, Zamfara State as shown in Table 1 are discussed as follows:

A. The Sizes of built –up land in Guasau Zamfara State from 2000-2018

Table1 showed that the size of built –up land in Gusau Zamfara state are 6.4876 Km², 6.29 Km², 16.1586 Km², 15.58 Km², 22.3749 Km², 21.58 Km², 28.2411 Km²and 26.21 Km² in 2000, 2005, 2010,2015 and 2018 respectively. Built-up land has grown from 6.4876Km^2 in year 2000 to 28.2411Km^2 in 2018. This means that built-up land in 2018 is 4.4 times its size in 2000 given 316.69 % percentage increase within period of study (2000-2018 eighteen years).

B. The Sizes of Agricultural land in Guasau Zamfara State from 2000-2018

As shown in table 1, Agricultural land are reducing as the sizes of Agricultural land are fluctuating, it increased from 30.4119Km^2 to 47.2815Km^2 between 2000 and 2005 and started reducing to 45.33931Km^2 and 39.3219Km^2 in 2010 and 2018 respectively Agricultural land increases from 30.4119km^2 in 2000 to 47.2815km^2 in 2005; but started decreasing from 47.2815km^{2}to 45.3393km^2 between 2005 and 2010, and from 45.3393km^{2}to 39.3219km^{2}between 2010 and 2018. The decreasing size of agricultural land may be attributed to increasing built-up land (urbanization).

C. The Sizes of Forest land in Guasau Zamfara State from 2000-2018

The sizes of forest land as shown in table 1 are 17.6731 km^2, 12.9348 km^2, 11.4741 km^{2}and 6.93 km^2 in 2000, 2005, 2010, 2015 and 2018respively. This indicates that forest land decreases from 17.6731km^2 in 2000 to 12.9348km^2 in 2005 and from 11.4741km 2 in 2010 to 6.93km 2 in 2018. Forest land drease from 17.6731Km^2 to 6.93Km^2 2018

D. The Sizes of Water body in Guasau Zamfara State from 2000-2018

Water body records overall decreases with variability through the periods. Between 2000 and 2005 water body increased from 2.1131km^2 to 3.0924km^2 and Between 2005 and 2010, water body slightly decrease from 3.0924km^{2}to 2.7918^{2}km, and finally between 2010 and 2018, as water body decrease from 2.7918km^{2}to 1.6038km^2. Water body increased drastically from 2000 to 2005 after it started reducing with sharp decrease from 2010 to 2018.

E. The Sizes of Barren Land in Guasau Zamfara State from 2000-2018

Barren land decreased largely from46.5450km^2 to 24.2667km^2 between 2000 and 2005, and slightly decreases from 24.2667km^2 to 21.7539km^2. And finally between 2010 and 2018, barren land increased drastically from 21.7539km^2 to 31.6476km^2. Barren land was highest in 2000 but decrease sharply in 2005 and from 2005 to 2010 there was slight decrease after which it increased much between 2010 and 2018.

Comparison of the Growth Trend of the Various Land Uses/Covers

The sizes of land uses/covers were not uniform among the various maps (200-2018) and changes that occurred also differ among the land uses/covers (Table 2).

The land use/land cover distribution of Gusau shown in table 4.2 revealed consistent increases and decreases of built-up and forest land respectively between 2000 and 2018. As built-up land increases from 6.48764km^2 in 2000 to 16.1586km^2, 22.3749km^2 and 28.2411km^2 by 2005, 2010 and 2018 respectively; forest land decreases from 17.6731km^2 in 2000 to 12.9348km^2, 11.4741km^2 and 6.93km^2 by 2005, 2010 and 2018 respectively. Between 2000 and 2005, agricultural land increases from 30.4119km^2 to 47.2815km^2; but decreases from 47.2815km^{2}to 45.3393km^2 between 2005 and 2010, and from 45.3393km^{2}to 39.3219km^{2}between 2010 and 2018. Water body and barren land also records overall decreases with variability through the periods. Interestingly, whereas between 2000 and 2005 water body increased from 2.1131km^2 to 3.0924km^2, barren land decreased considerably from46.5450km^2 to 24.2667km^2. Between 2005 and 2010, when water body slightly decrease from 3.0924km^{2}to 2.7918^{2}km, barren land also slightly decrease from 24.2667km^2 to 21.7539km^2. And finally between 2010 and 2018, as water body considerably decrease from 2.7918km^{2}to 1.6038km^2, barren land

increased from 21.7539km^2 to 31.6476km^2(Figure 5) .

Table 2: The Land Use/Land Cover Distribution of Gusau

Year	Built -up land (Km^2)	Agricultural land (Km^2)	Forest Land(Km^2)	Barren Land(Km^2)	water Body(Km^2)
2000	6.4876	30.4119	17.6731	46.545	2.1131
2005	16.1586	47.2815	12.9348	24.2667	3.0924
2010	22.3749	45.3393	11.4741	21.7539	2.7918
2018	28.2411	39.3219	6.93	31.6476	1.6038

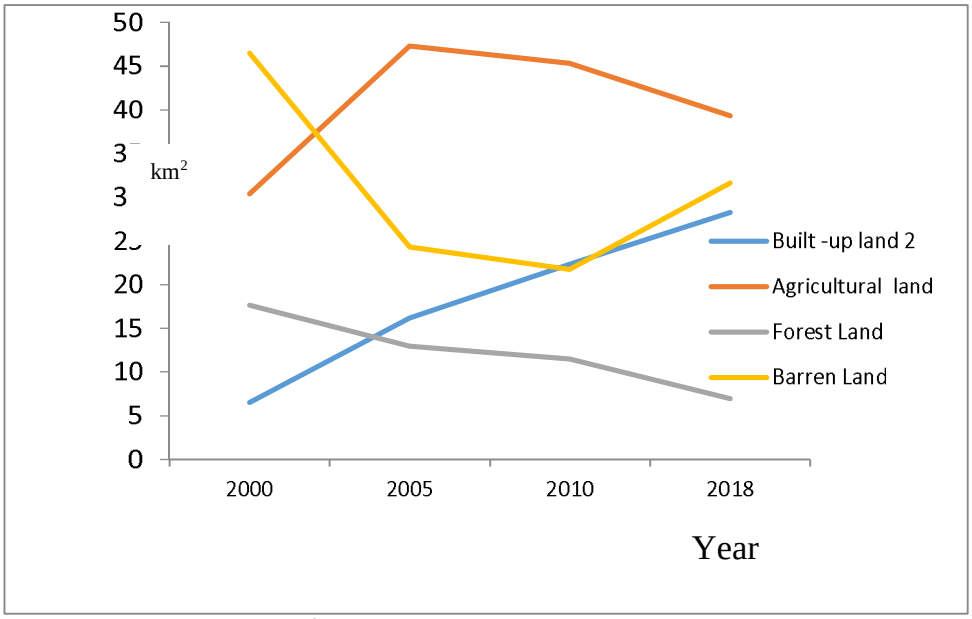

Figure 5: Trend of the Various Land Uses/Covers
Source: Field Survey, 2018

Figure 5 shows how each land use/cover increased or decreased from year 2000-2018.Since land is static, change in a Land use/cover class neither add nor reduce the size of land but can lead to reduction or expansion in the size of other land use/ land cover class. Each land use/land cover class was correlated with others to find the relationship (Table 3).

Table 3 presents the correlation matrix of land use/land cover class as follows: The correlation coefficient (r) for built –up land and agricultural land is 0.48 which means that there is a slight positive correlation between built-up land and agricultural land. This is against the common belief that urbanization has taken up land meant for farming. The correlation coefficient (r) for built –up and forest land is -0.98 which means that there is a strong negative correlation between built-up and forest land, so an increase in built-up land leads decease in forest land. The correlation coefficient (r) for built–up and water body is -0.23 which means that there is a slight negative correlation between built-up and water body. Then an increase in built –up land leads to slight decrease in water body. The correlation between built-up land and barren land is -0.71 so there is strong negative correlation between built-up land and barren. Therefore, increase in built-up land leads decrease in barren land.

While agricultural land showed a slight negative correlation (-3.7) with forest land, it showed a strong positive correlation (0.73) with water body. Thus, increase in agricultural land leads to slight decrease in forest land while an increase in agricultural will cause increase in water body or vice

visas. There is also strong negative relationship between Agricultural land and barren land as the correlation coefficient was -0.95. Forest land had slight (0.36) and weak (0.6) positive correlation with water body and barren land respectively. Water body and barren land had (0.52) positive correlation.

Table 3: Correlation Matrix of Land use/land Cover Classes

	Built - Upland	Agricultural land	Forest land	Water body	Barren land
Built -Upland	1				
Agricultural land	0.48	**1**			
Forest land	-0.98	-0.37	1		
Water body	-0.23	0.73	0.36	1	
Barren land	-0.71	-0.95	0.6	-0.52	1

Conclusion/Recommendations

Data from the survey showed that there are changes in the pattern and sizes of different land use/land cover among the years (2000, 2005, 2010 and 2018). Built –up land is rapidly increasing while land use for agriculture, forest and water body are decreasing. Land use/ land cover showed changes in percentage coverage from 2000-2018. Base on the research Findings the following recommendations were made:

i. The agency responsible for urban land use planning should be integrative in approach. Urban planning should integrate measures that will mitigate urbanization problems by introducing initiatives aimed at addressing poverty, improving water supply, and tackling pollution and climate change that will result from deforestation and urban land use.
ii. Gusau Local Government Council should strive for sustainable development which relates to positive socio-economic change that does not undermine the ecological and social systems on which a society is dependent.
iii. Establishment of traditional laws by the local administration to ensure the proper management and use of land and natural resources.
iv. Afforestation should be practice by community members to prevent climatic anomalies that will result from reduction in forest land.
v. Green infrastructure should made compulsory in the local government to reduce effects urbanization.

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