AN EXAMINATION OF LONG TERM VARIATION IN LANDUSE/LANDCOVER TYPES IN JALINGO METROPOLIS, NIGERIA

[1] Danjuma, Andembutop Kwesaba, [2]Ali, Andesikuteb Yakubu,[3] Karma, I Magaji, [4]Jeb, David Nyomo and[2] Binbol, N. L

1. Department of Geography, Benue state University, Makurdi, Nigeria
2. Department of Geography University of Jos, jos Nigeria
3. Department of general studies, College of Agriculture, Jalingo, Nigeria
4. National centre For Remote sensing Jos, Nigeria

ABSTRACT

The study examined the changes in land use/land cover (LULC) in Jalingo between 1988 and 2006. Six LULC types were classified in the study area from Landsat TM image of 1988, and Landsat ETM image of 1999.The six LULC types were bareland, built-up, cultivation, shrubland, water body and wetland. The data were analyzed using thinning, overlay operations, ground truthing, calculation of the area in km^2 of the resulting LULC type.The software used in the analysis are ERDAS and ILWIS 3.2.The areas of bareland, cultivation, water body, shrubland and wetland have decreased by 1.53km^2 (1.6%), 19.22km^2 (71%),0.15km^2 (0.6%) 0.22km^2 (0.81%) and1.64km^2 (6.0%) from 1988 to 2006. Conversely, the area of built-up land has increased by 15.62km^2 (40.2%) during the same period. Built-up land lost 11.64 km^2 and gain 27.26km^2 from 1988 to 2006 with the highest contribution of 19.22km^2 (71%) from cultivated land. The study recommended among others, the need for appropriate legislations to be put in place to check indiscriminate sprawling. The study concludes that increase in the proportion of urban population is the principal driver of land use/land cover change in Jalingo town.

INTRODUCTION

According to the United Nations Development Programme (UNDP) (2007), 3 billion people about (50%) of the world's population live in urban areas. Current estimate show that by 2030, about 61 percent of the total population in the world will be living in cities and that all the world's increase in population in the next three decades will occur in low and middle-income countries (Peter 2000). In view of the implications of the increasing urban population in low and middle – income countries, the 2002 Johannesburg's World summit on Sustainable development (WSSD) called on all government to address the overwhelming challenge of provision of urban basic services especially decent houses, water and sanitation for the teaming people in slums where quality of life is appalling.

Africa, in the global context, is generally assessed as a rural and least urbanizing continent with the attendant high rate of slums development, crime, underdevelopment as well as overpopulation (Peters, 2000). However, in most recent time, current trends suggested that Africa's rate of urbanization is two times faster than Latin America and Asia (Tannerfeldt, 1995). Globally, rapid urban growth appears not to have translated to proportionate economic growth and better welfare for the citizens (Kjellstrom and Mercedo, 2008). For instance, out of the twenty countries identified by the United Nations as possessing the lowest Human Development Index (HDI) in 2005, about 19, representing 95%, are in Africa. Within the sub-Saharan Africa for example, there are well over 166 million urban slum dwellers, which also represent about 71.9% of its total population, and thus there is increasing urban poverty and low life expectancy in the region (United Nations Habitat, 2005).

Conservative estimate by Peters (2000) indicated that within the next two decades, 87% of the population growth in Africa will take place in urban area out of which about 55 percent would be living in urban area in view of the increasing environmental deterioration.

In china for instance, where the rate of urbanization is high, alot of impacts had been recorded on the landuse/ land cover pattern.

According to Wolf, Van Wijik, Cheng, Hu, Van Diepen Jongbloed, Van Kenlen, LU, and Roetter (2003), China's urban population during the 1990s, grew by about 16million per year to a total of 459 million in the year 2000. This urbanization process and rising incomes have been the driving forces behind changes in the agricultural sector, with a consequent impact on the landuse/land cover. Around the many very large and fast-growing cities in China, and in particular mega-cities such as Beijing, intensification of agricultural production is taking place at an accelerated pace. For instance, demand is rapidly increasing for high quality food products (e.g. vegetables and dairy products). This has created incentives for farmers to abandon traditional farming systems. The associated increase in animal can cause pollution of the environment and, furthermore, the increasing production of horticultural crops around urban areas, which generally require large fertilizer and biocide applications and large amounts of irrigation water can have negative effects on the landuse/land cover.

According to Susan, (2002) in Lawanson, (2006), roads and sprawling neighborhoods are replacing pristine wildlife habitats at an alarming pace, putting the survival and reproduction of plants and animals at risk. Suzan further stressed that in the last few decades, rapidly growing human settlements have consumed large amount of land in Nigeria, while wildlife habitat have shrunk, fragmented, or disappeared altogether..

Rees and Weakernagel (1994) pointed out that various activities of the urban dwellers have exposed the agricultural lands to the various agents of erosion which eventually leads to the losing of the soil nutrients thereby resulting to poor yields.

Despite the reported impacts posed by urbanization on land use/land cover worldwide, no research has been carried out particularly on Jalingo town, Taraba state, Nigeria to ascertain the extent of damages urbanization has caused on the landuse/ land cover pattern in the town. This study will therefore document the impact of urbanization on landuse/land cover in Jalingo town.

Study area

Jalingo is located in north-eastern Nigeria. It became the capital city of Taraba State in 1991 following the creation of Taraba State from the defunct Gongola State. The city is bordered on the east by Yoro Local Government Area, on the north-west is Lau Local Government Area, and on the south is the Ardo-Kola Local Government Area. It is located at Latitude 8^{o}54"N and Longitude 11^{o}22"E (Figure 1.6.1.1 and 1.6.1.2). According to the 2006 population census, Jalingo has estimated population of 118,000 people. Jalingo occupies a total land area of 219.18km^2

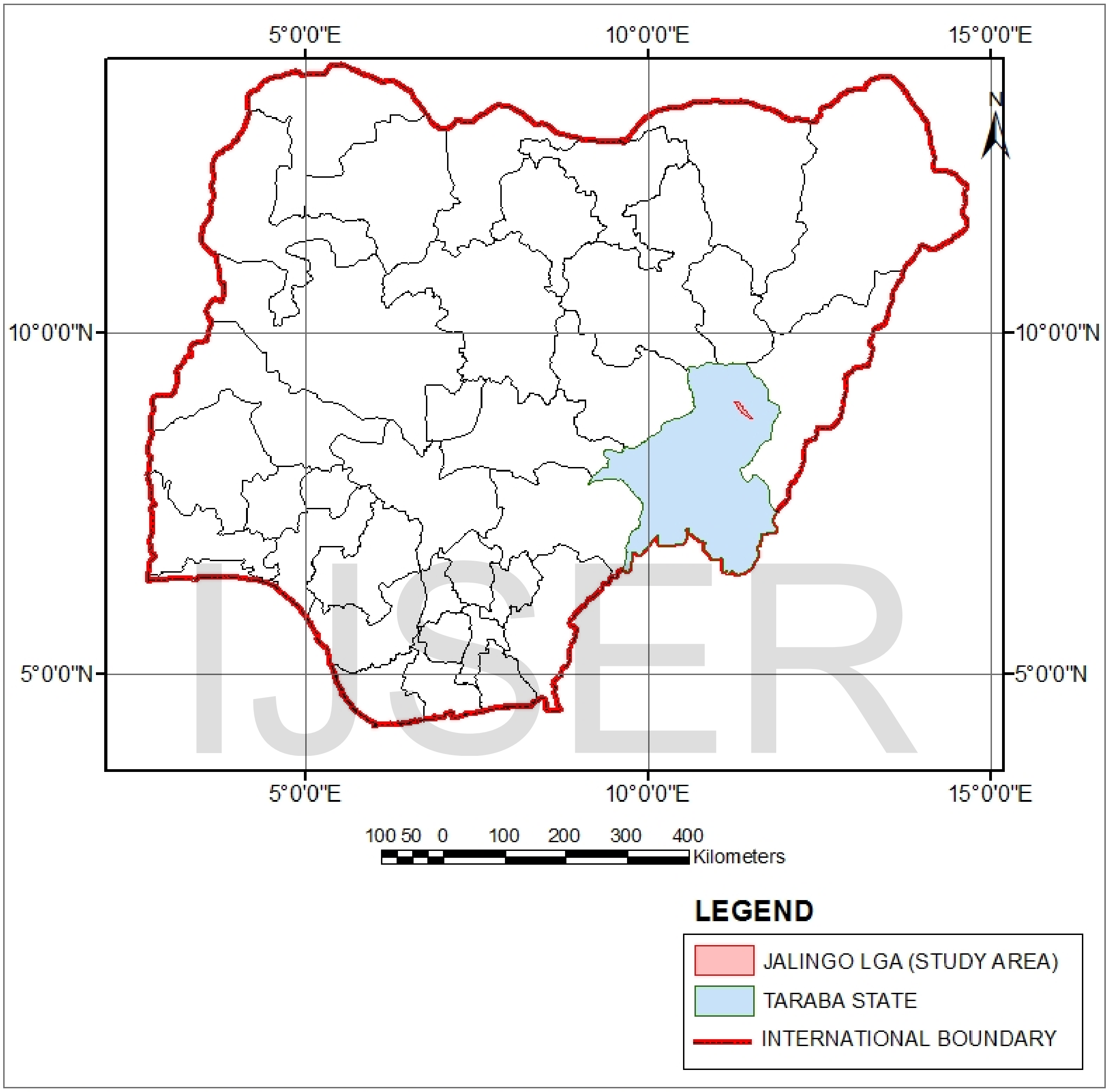

Fig: 1 Map of Nigeria showing Taraba State

Source: Taraba State Ministry of Land and Survey, (2013).

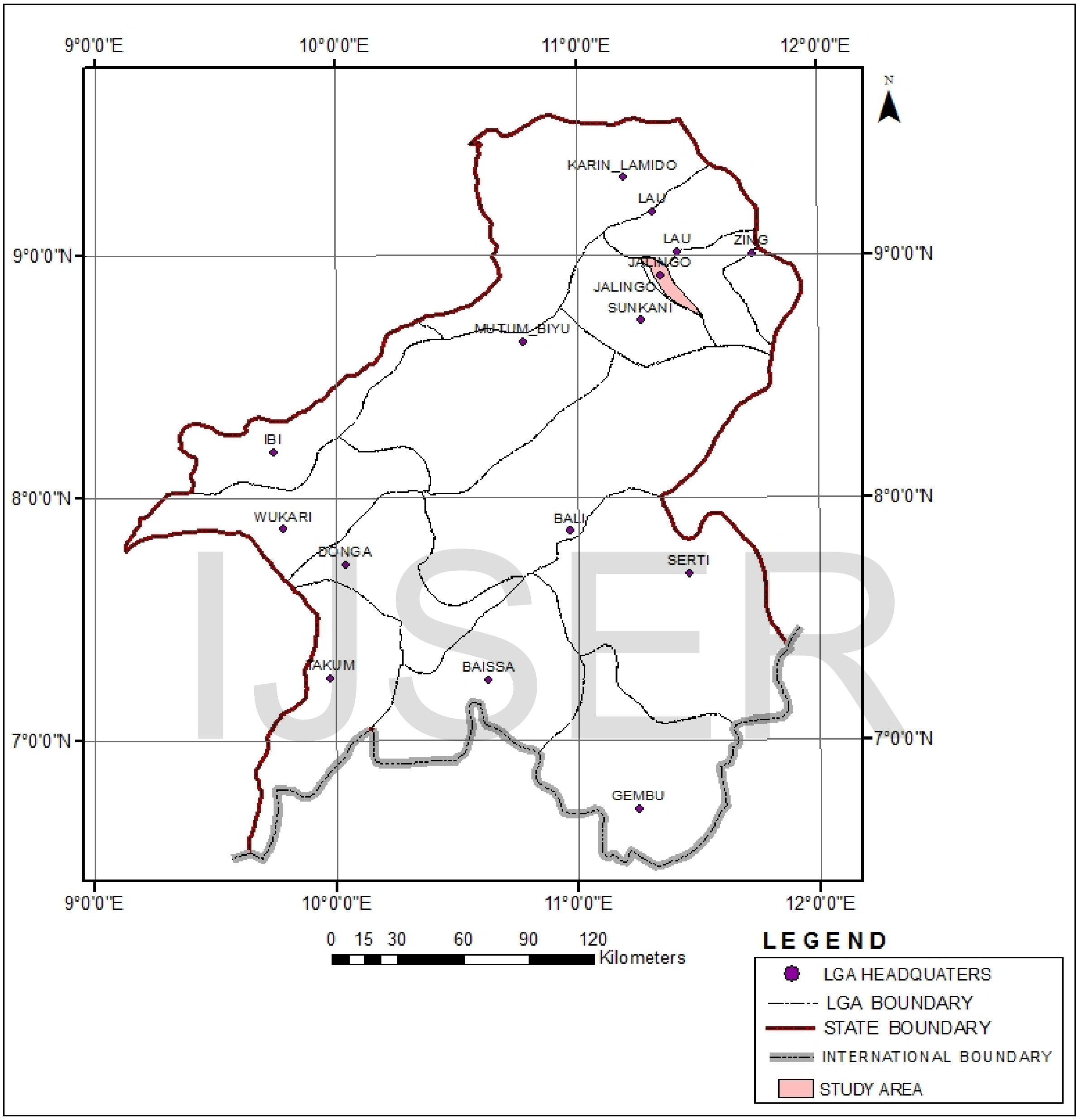

Fig: 2 Map of Taraba State showing study area (Jalingo)

Source: Taraba State Ministry of Land and Survey, (2013).

Data needs/source

The data needed for this research work are the different land use/land cover types (in area square km) in Jalingo. Landsat TM of 1988 and landsat ETM images of 1999 were acquired from the National Center for Remote Sensing (NCRS) Jos. The satellite images were used for land use/land cover change detection and monitoring in the study area.

Processing of satellite images

The raw satellite images of Landsat TM and ETM were first processed before usage. The images were rectified to a common Universal Transverse Mercator (UTM) coordinate system based on the topographical map of Jalingo. This converted the imagery format of North-East to South-West orientation to a topographical map format with North-South orientation.

Method of classification of land use/land cover types.

Supervised classification method was used in this research work for the interpretation of satellite images. Supervised classification using maximum likelihood classifiers is a well established technique for the interpretation of satellite and airborne remotely-sensed images (Weng, 1999). Supervised classification has been developed for satellite image-processing where it has been applied to the classification of spectral layers. However, it can also be applied to other forms of remote sensing and has been used for the classification of interpolated acoustic reflectance data (Zhang et.al, 2004). It can also be used to convert different forms of data, not just 'spectral' values. For example classification can combine reflectance, depth (height), variability e.t.c. Although many of the variables may be correlated, supervised classification is a very versatile and statistically robust tool. However, to work well, the images should be distortion-free. This is often difficult to achieve with different degrees of distortion across an image. Distortion away from the nadir (the point on the sea floor directly under the remote sensing instrument) is a particular problem for many acoustic swath systems and is particularly noticeable where image strips have been mosaic together.

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Derivation of land use/land cover types

Six land use/land cover types namely Bareland, Built-up lands, Cultivation, Shrubland, Water body, Wetland, were derived from the landsat TM and ETM satellite images in conjunction with ground truthing using supervised classification method.

Data Analysis

To detect and analyze the changes in land use/land cover due to urbanization in the study area, satellite images of 1988 and 1999 was used to investigate the temporal and spatial changes in land use/land cover due to urbanization in Jalingo city.

Six main methods of data analysis were adopted in this study as follow:

i. Image thinning

The first process in the analysis of satellite images is thinning. This is a process where the researcher carefully studies the images and removes the possible noise from them in order to get theh correct picture of the area under study.

ii. Overlay operations

Overlay operations is concerned with the identification of the actual location and magnitude of change in a particular land use or land cover type. In this research, overlay operations was however limited to build-up since the major concern in the research is the impact of urbanization on other land use and land cover.

iii. Ground-truthing

Ground-truthing is a term used in remote sensing; it refers to information collected on location. Ground truth allows image data to be related to the real features and materials on the ground. The collection of ground truth data enables calibration of remote sensing data, and aids in the interpretation and analysis of what is being sensed. Examples include cartography, meteorology, analysis of aerial photographs satellite imagery and other techniques in which data are gathered at a distance.

In this study, ground-truth was carefully done to ascertain the various land use/land cover types physically found in the study area so as to insure that the information reflected on the satellite images are true reflections of what is obtained on the ground.

iv. Calculation of area in square of the resulting land use/land cover types

To calculate the area in km2 of the resulting land use/land cover types for each study year, a table was developed showing the area in km^2 and the percentage for each year (1988, 1999 and 2006) measured against each land use/land cover type. The percentage change was calculated by dividing observed change by the sum of changes multiply by 100.

$$\text{Percentage change} = \frac{\text{observed change}}{\text{Sum of change}} \times 100 \quad \ldots\ldots\ldots\ldots(1)$$

(Opeyemi 2006)

v. Long term changes in land use/land cover types

To determine the long-term changes in LULC types, a table was generated showing the areas in Km^2 of the various LULC types for each study year. The long term changes, that is, loss/gain of each LULC type is derived by subtracting the amount of land area in km^2 for each LULC type in 1988 from those of 2006.

Table1: Classification of land use/ land cover in Jlingo 1988,1999 and 2006

LULC Types	1988 Area(km^2)	%	1999 Area (km^2)	%	2006 Area(km^2)	%
Bareland	7.38	3.40	0.97	0.4	6.3	2.9
Built-up	8.95	3.7	16.77	7.9	27.11	12.7
Cultivation	171.35	80.8	134.13	63.2	132.33	62.7
Shrubland	18.47	8.7	22.03	10.3	40.18	18.9
Water body	3.72	1.7	5.44	2.5	5.72	2.6
Wetland	9.31	4.3	40.24	18.9	7.54	3.5
TOTAL	219.18	100	219.18	100	219.18	100

Source: Author's research work

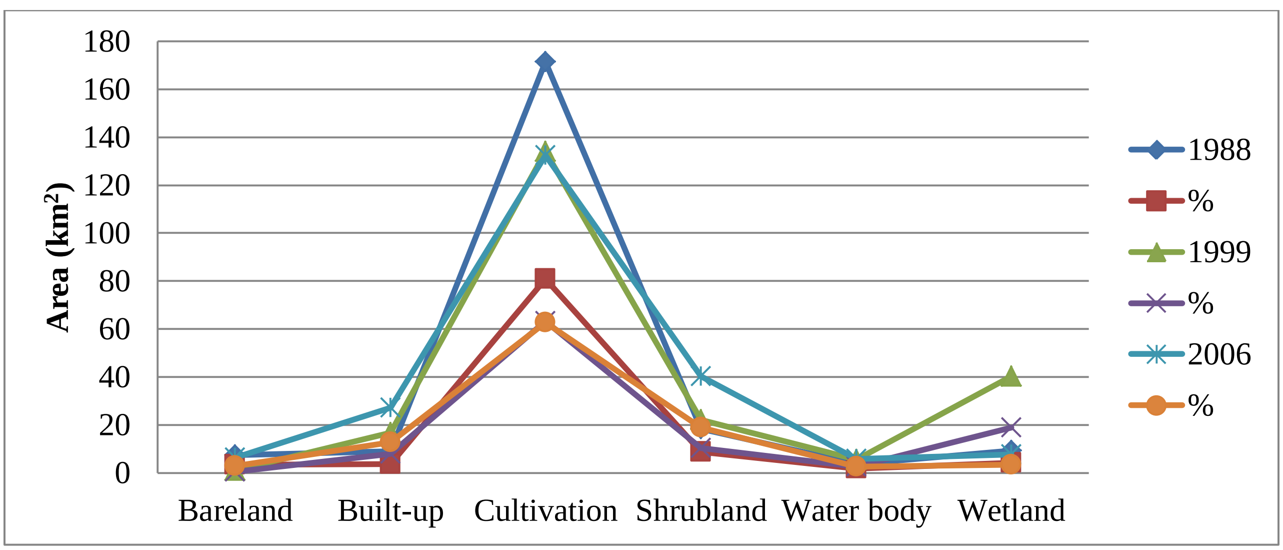

Figure1: Graphical representation of table 4.2.1 above

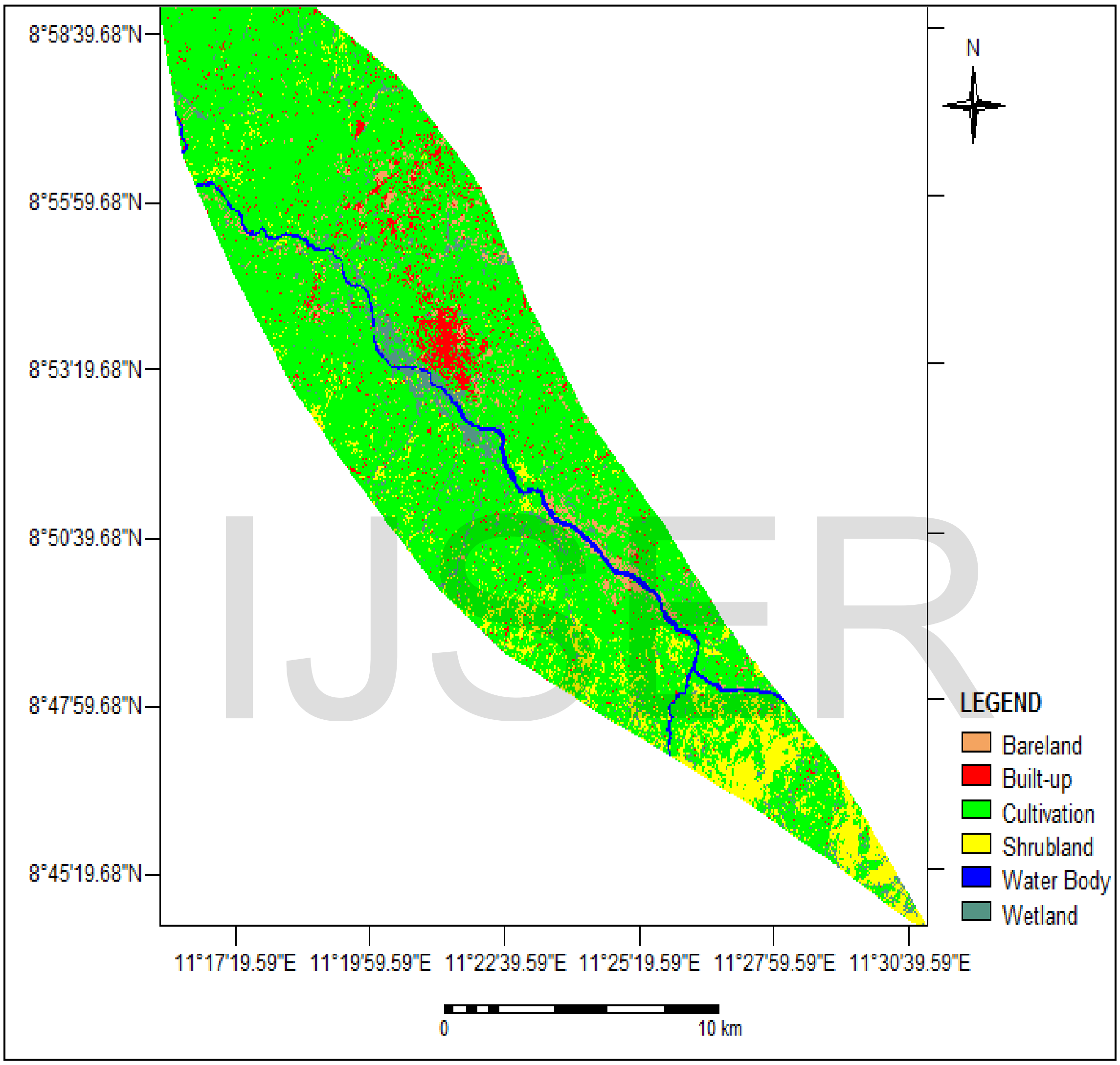

Figure 2: Land use/land cover in Jalingo, 1988.

Classification of land use/ land cover types in Jalingo, 1988-2006.

A total of six land use / land cover (LULC) types were classified in the study area namely bareland (comprising of bare surfaces), built- up (comprising of roads, highways, buildings, and other paved surfaces), cultivation, (Comprising of cultivated farmlands), shrubland (comprising of grass and shrubs), water body (comprising of rivers, streams, open reservoir), and wetland (comprising of marshes). The LULC types in Jalingo are presented in table1 and figures 2 and 4.

In 1988, cultivation has the largest area of 171.35 km^2, representing 80.8%of the study area. Bareland occupied 7.38 km^2 representing 3.40%, while built-up has 8.95km^2, shrubland has 18.47km^2 representing 3.7%. Water body occupied 3.72km^2 representing 1.7%. Wetlands, on the other hand occupy 9.31km^2 representing 4.3% of the study area

Cultivation and bareland have the largest and least areas of 134.13km^2 and 0.97km^2 in 1999, representing 63.2% and 0.4% of the study area respectively. Built-up has 16.77 representing 7.9, while shrubland and water body have 22.03km^2 and 5.44km representing 10.3% and 2.5% of the study area respectively. Last but not the least, wetland occupy 40.24km^2, representing 18.9% (table 1 and figure 2).

In 2006, cultivation and water body still have the largest and least areas of 132.33km^2 and 5.72km^2, representing 62.3% and 2.6% of the study area respectively. Bareland and built-up occupy 6.3km^2 and 27.11km^2, representing 2.9% and 12.7% respectively. Shrubland and wetland on the other hand, have 40.18km^2 and 7.5km^2, representing 18.8% and 3.5% respectively (table 1 and figure 2).

The high percentage of bareland area in 1988 may be unconnected to the fact that then Jalingo was just a local government headquarter and hence less economic activities. Built- up was less in 1988 with only 3.7% of the study area. This may also be attributed to the same reason stated above. Cultivation in 1988 recorded the highest percentage of land area in Jalingo with 80.8%. This was because at that time Jalingo was more of a rural setting where farming is the main occupation of the populates. The low percentage of shrubland in Jalingo in 1988 could be attributed to the long period of drought witnessed that year. The drought affected the growth of grasses and shrubs in the area. Water body recorded the lowest percentage of land area in 1988 compared to other study years. It could be remembered that 1988 was a drought year in that part of the country. This could be responsible for the low percentage of water body observed that year. Wetland also has the lowest percentage of land area in 1988 compared to other study years. This may still be due to the long period of drought experienced that year.

In 1999, bareland reduced to 0.4% of the total land area in the study area. This was due to the expansion in size of the town. Jalingo was made state capital in 1991 and this of course, has influenced the growth of the town both in terms of population and city size. More bare lands were taken over by buildings and other economic activities as a result of the population growth. The percentage of built-up area in the study area increased to 7.9% in 1999 after the town had been made state capital in 1991. This was due to the boom in population of the town and the increase in economic and industrial activities. The percentage of cultivated land on the other hand decreased to 63.2% in 1999. This may be due to the fact that most of theagricultural land were bought over and converted to other economic uses to accommodate the increasing population. Apart from this, most of the people who got jobs with the state government then abandoned their farming occupation for civil service. Shrubland, in 1999 increased to 10.3%. This may be as a result of disengagement of many people from agriculture to other sector of the economy and the abandoned farmlands gradually turned to shrubland as time went on. In 1999, water body also increased to 2.5% as against 1.7% in 1988. This was due to the restoration of the rainfall being experienced in the area.

Wetland also witnessed an increased in percentage of land area compared to 1988. This, the researcher believes was due to the restoration of the usual amount of rainfall of 1,500mm annually.

In 2006, however, bareland increased to 2.9% compared to 0.4% recorded in 1999. This may be as a result of bush burning and cutting down of shrubs for fuel. There was a dramatic increase in percentage of built-up area from 7.9% in 1999 to 12.7% in 2006. This attests to the fact that the government of Reverend Joly Nyame at that time embarked on city decongestion campaign in order to decongest the city centre. This, he did by building several housing estates in the outskirt of the town, relocation of giant projects such as the games village, specialist hospital and the air port to the outskirt of the town. Apart from all these, there was also increase in economic activities by private and corporate bodies in Jalingo town which resulted in the increase in built-up area. Cultivation in 2006 further decreased to 62.3% which shows more and more agricultural lands had been converted to built- up and other purposes. Also at this time, the city had started moving away from the traditional setting where farming seems to form the basis for living. The improvement in the welfare of workers could also attest to this as people are now engaging in other sectors of the economy which are more benefiting than farming. Another increase in shrubland was witnessed in 2006 with 18.9%. The same reason as in year 1999 above could be responsible for this. Water body, in 2006 witnessed an insignificant increase in the percentage of land area covered. The area had 2.6% of water body as against 2.5% obtained in 1999. This shows the annual rainfall of about 1,500mm usually witnessed in the area was maintained within the periods of 1999 and 2006. In 2006 however, the percentage of wetland in Jalingo reduced to 3.5%. This may be due to encroachment into the wetland areas as a result of population growth. Most of the wetlands, especially the ones around Mayo-Goi have been taken over by buildings while some parts of it have been converted to farmland for cultivation of crops such as rice and sugarcane. This may be the root cause of the serious floods that occurred in the area in the recent years.

Long-term changes in LULC in Jalingo, 1988-2006.

The result of long term change in LULC in Jalingo is presented in table 2: below. Bareland has lost 1.098km^2 representing 14.6% from 1988 to 2006.

Table 4.3.1: Long –term changes in land use/land cover

Landuse/ land cover types	1988 (km^2)	1999 (km^2)	2006 (km^2)	LOSS/GAIN (km^2)	% Change	Annual Rate Of Change (%)
Bareland	7.38	0.97	6.3	-1.08	-14.6	-8.1
Built-up	8.95	16.77	27.11	18.16	202.9	11.3
Cultivation	171.35	134.13	132.33	-39.02	-22.8	-1.7
Shrubland	18.47	22.03	40.18	21.71	117.5	6.5
Water Body	3.72	5.44	5.72	2.0	53.8	2.9
Wetland	9.31	40.24	7.54	-1.77	-19.0	-1.1

Source: Author’s research work

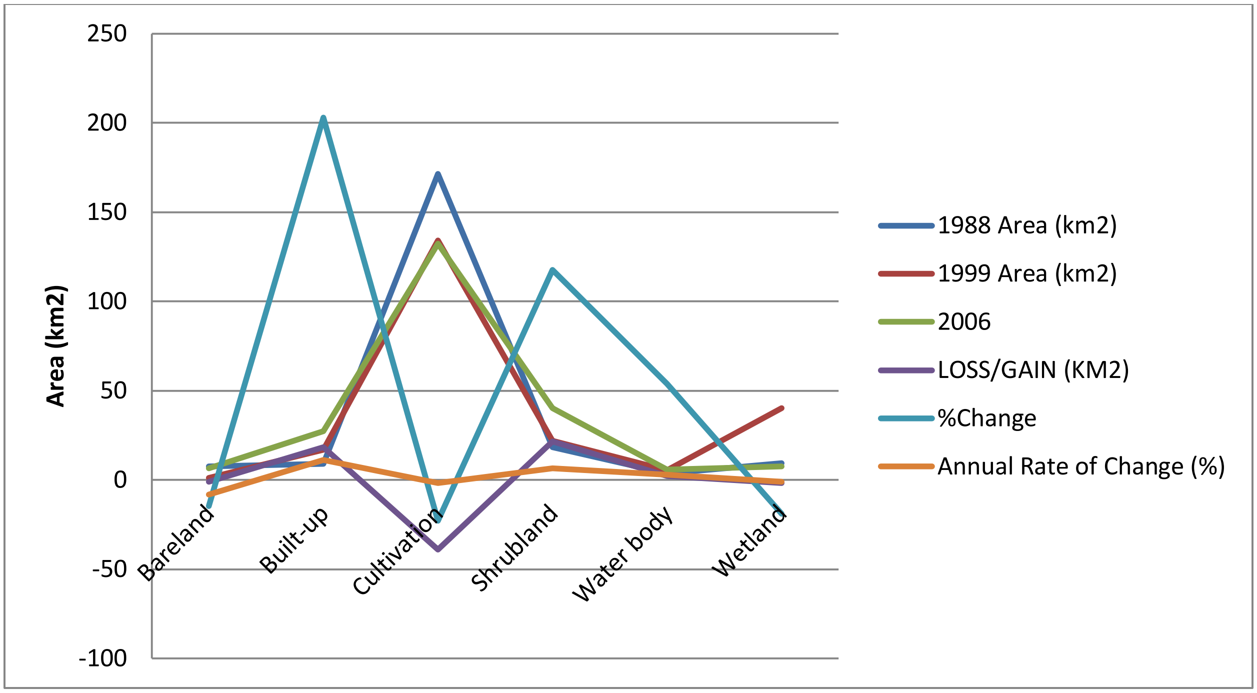

Figure 4.3.1: Graphical representation of the table 4.3.1 above.

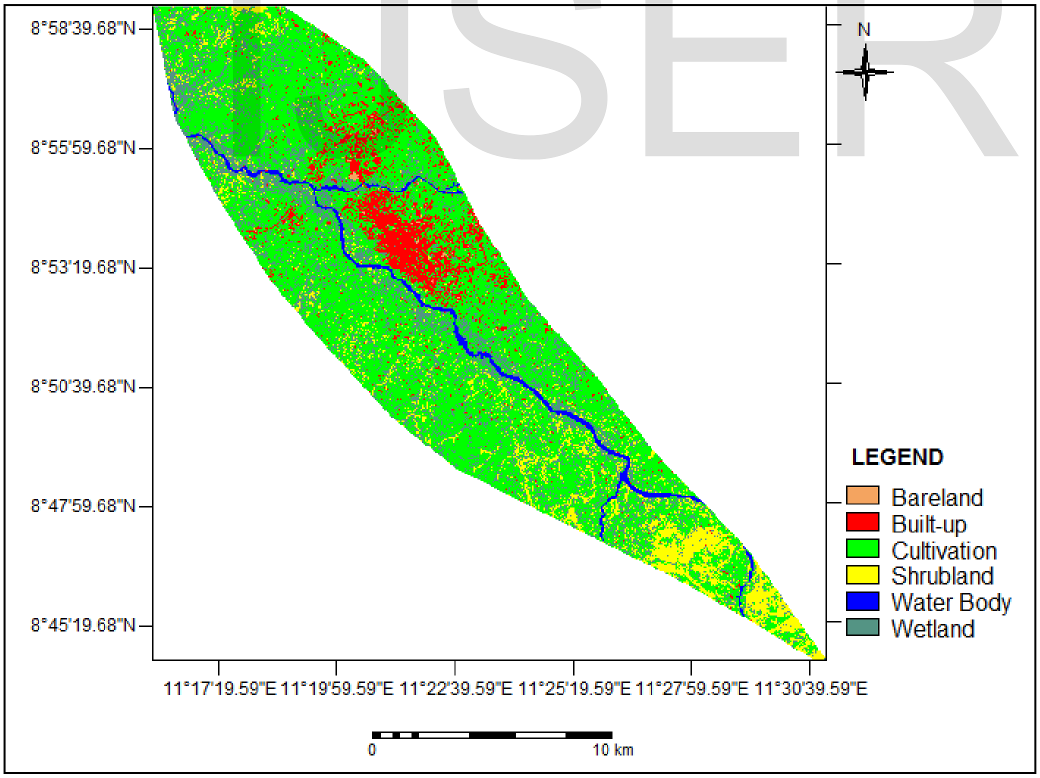

Figure 3: Land use/land cover in Jalingo, 1999.

This may be as a result of increase in population after Jalingo was made state capital in 1991. Large percentage of bareland was converted to other uses to accommodate the teaming population. Built-up on the other hand, witnessed a positive change of 18.16km^2, representing 202.9% within the same period in question. This is still unconnected to the population boom that took place within the said period. A part from the private or individual construction, the government also embarked on several infrastructural developments to transform the town to a status of a state capital. All these developmental projects resulted to the conversion of other land uses to built-up.

Cultivation had a negative change of – 39.02km^2, representing -22.8% within the period of 1988 and 2006. This may be due to the fact that many people abandoned farming for white collar jobs after the town was made state capital in 1991. Moreover, a lot of agricultural lands were converted to settlements to accommodate the influx of people into the town. Shrubland had a positive change of 21.7km^2, representing 117.5% within the period under study. This resulted from the abandoned farmlands which after a long period of time turned to shrubland. Also some crops such as maize, guinea-corn and cassava in their matured stages may be captured as shrubland if not carefully observed. All these may be responsible for the high percentage rate of shrubland within the period under study.

Water body also witnessed a positive percentage change of 2km^2, representing 53.8% within the period under study. It could be remembered that the study area witnessed a long period of drought in 1988, followed by periods of increased rainfall. This could be responsible for the increase in percentage change of water body within the period under study. The wetland on the other hand, had a negative percentage change of -1.77km^2, representing -19% within the period under study. This as earlier stated, may be due to encroachment into the wetland areas as a result of population increase. Most of the wetlands have been drained and converted to settlement and farmland.

Conclusion

This research work was carried out to ascertain the changes in land use/land cover (LULC) types in Jalingo metropolis. The research was objectively done and the results proved that expansion in size of the town is the main cause of LULC change in Jalingo city, within the period of 1988 and 2006.

The researchers therefore, call for more studies to be carried out in this area so as to come out with more recommendations to proffer better solutions to the problems of urbanization on LULC types in Jalingo city and Nigeria in general.

Recommendations.

Having analyzed the changes in LULC types due to urbanization in Jalingo, the researchers hereby recommend the following measures to mitigate the impacts.

Development along flood plain, drainage channels, infrastructure easements and flood prone areas should be avoided. Development Control Authorities (e.g Town Planning and Capital Cities Development Authorities) should enter into partnership with private sectors to ensure that physical development legislations are strictly adhered to by developers.

There is need for appropriate legislations to be put in place to check indiscriminate sprawling. The relevant regulatory institutions and agencies should be empowered to monitor the level of compliance and met out appropriate sanctions.

Researches have shown that the best general way to protect areas of high diversity threatened by urbanization is to purchase those areas specifically for the purpose of conservation (Luck et al, 2004). Combating the threat of urbanization on surrounding land use/land cover is one of the greatest challenges facing conservationists and ecologists. It demands a thorough and often complicated process in which areas of high priority are identified, assessed, and either conserved or restored. These are the first steps in limiting the many ecological disturbances already caused by growing urbanization. Taking a more proactive stance towards conservation right now and in the near future, however, is the only way to assure those future generations in the services of nature we often take for granted.

With the above given recommendations, the researcher believes the impacts of urbanization on LULC will be mitigated if strictly adhered to.

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