International Journal of History and Scientific Studies Research (IJHSSR)
||Volume|| 1 ||Issue|| 7 ||Pages|| 16-24
ISSN: 2581-8767 || December || 2019

Urban Growth Pattern and Agricultural Land Use Dynamics in Gombe City, Nigeria.

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ABSTRACT: *Urban growth, particularly in developing countries of the world continues to draw attention as one the crucial issues of global change in the 21st century affecting the physical dimension of cities. The study examines the impact of urban growth on agricultural land use in Gombe city. To achieve the objectives of the research, Geographic Information System (GIS) technique was adopted to determine the pattern of urban growth. Inferential statistical technique "Paired T-test" was equally employed to test the research hypothesis and analyse the impacts of urban expansion on agricultural land use in the study area. Results obtained from the analysis of urban growth pattern showed that the total built up area has grown from 1,234.28 hectares (12.34km^2) in 1998 to 2,565.15 hectares (25.65km^2) in 2008 and then to 5,889.11hectares (58.89km^2) in 2018. Paired T-test computation (P-value=0.022) further revealed that urban growth in most cases has affected the agricultural land use in the study area. In this study, it has been possible to effectively capture the changing pattern of urban landscape. The study revealed that Gombe city has been experiencing fragmented urban growth process, particularly at the fringe areas with substantial increase in built-up area, while the city centre underwent relatively compact growth by infilling open spaces and edge expansion over time. It is concluded therefore, that urban growth in the study area has been affecting agricultural land use at the urban fringes by replacing the viable agricultural lands for mostly residential land use development. It is therefore, recommended that proper measures should be put in place to checkmate the incessant growth of the study area into various directions thereby reducing effects on the agricultural land use that can augment the shortage of the urban food requirement.*

KEYWORDS*: Agricultural, City, Growth, Land use, Urban.*

I. INTRODUCTION

Urban growth patterns are characteristics of spatial changes that take place in metropolitan areas of the world (Aguilera et al., 2011). The spatial configurations and the dynamics of urban growth are important topics of analysis in the contemporary urban studies (Bhatta, 2011). Wilson et al (2003) identified three major types of urban growth patterns as: infill, expansion, and outlying. Infill development is a new development within remaining open spaces in already existing built up areas, where as expansion or sometimes called urban extension or edge expansion is a non-infill development extending the urban foot print in an outward direction and sometimes called urban fringe development. Outlying or leap frog development is a change from non-developed to developed land cover occurring beyond existing developed areas. Leap frog development is also referred as urban sprawl. That is the expansion of urban area in a way that demands the extension of public facilities. Tian et al (2011), compared the spatial and temporal dynamic pattern of the urban growth for the five urban areas of Shanghai, Nanjing, Suzhou, Wuxi and Changzhou in the Yangtze River Delta region, china. The results of their research revealed that during the fifteen years, urban growth patterns were dramatically uneven over three periods.

Urban growth is usually accompanied by human transformation of the landscape at the point of concentration. In the initial stages of urbanization of an area the transformation starts with gradual but profound changes in land use. The advanced stages of transformation may be so profound that the landscape is almost completely covered by cultural features. In the early stages in the urbanization of an area, the land is cleared of vegetation to make room for human occupancy. This leads to reduced infiltration capacity of the urban land (Sagua, 1998: 269). The unprecedented rate of urbanization and urban growth pattern have resulted in continues reduction of fertile agricultural lands in the fringes of urban areas, especially in the developing countries of the world. It was estimated that about 14 million hectares of land (approx. 475,000 ha/yr.) in the developing countries would be converted into various land uses for development between 1990 and 2020 (Naab *et al.* 2013).
It was suggested that about four hundred thousand (400,000) hectares of vegetative land cover has been lost (Adesina, 2005), with more expected to be lost as a result of various physical developmental projects in most urban settlements (Appiah, 2014; Dekolo and Olayinka, 2014; Mugish and Nyandwi, 2015). Such loss could be

due to increase in residential areas and new patches of settlements (Zasada, 2011) which result in the outward expansion of built-up areas beyond visible and invisible city borders into green areas mainly used for farming (Brennan, 1999; Kwasi, 2004; Oyesiku, 2010). In the advanced stage of urban growth, much of the land is covered by man-made structures such as commercial, industrial, houses, pavement of street network, and building of gutters and water channels. Urbanization in sub-Saharan Africa is altering traditional livelihood strategies and displacing agricultural land uses in many areas (Angel *et al.*, 2005; Adeboyejo and Abolade, 2007). Olima (2003) opined that population growth rate in both urban and rural areas is not commensurate with the quantity of land supply. Land is fixed in nature and so does not increase with increasing population growth. Expansion of cities affects the areas surrounding them (the greenbelts) by altering the natural resource base and converting vegetal land cover to new uses, thus challenging the environment and dwellers' livelihoods **(**Gündel, 2006).When most of the available land in an urban area is built up, increased pressure on land might lead to extension of urban land use to the stream channels, flood plains and restriction of streams to artificial channels. Most urban centres in Nigeria witness high density of buildings in the residential areas. It was observed that in the early 1950s, rapid urbanization has been a feature of Nigeria. The Human Development Report (2004), Oyesiku and Alade (2010) observed that almost half of the Nigeria population (45.9% of 120.9 million) reside in urban areas. Mabogunje (2002); Gbadegesin *et al.* (2010); and UNDP (2011) observed that urban population growth between 1953 and 2007 rose from 10.6% to about 50% of the total population. This exponential population growth caused overcrowding and a distortion in cityscape (Ogu, 1999). Besides rapid urban population increase in existing cities, more urban centres emerge with the creation of new states (Osuocha, 2006).

Several methods and techniques have been developed and applied to quantify and characterize the urban growth process and patterns. Traditionally, visual interpretations of high resolution aerial photographs were used to acquire comprehensive information for mapping of urban areas. This mapping technique is expensive and time consuming for the estimation of urban growth. However, with the gradual advancement and availability of high temporal and spatial resolution remote sensing imageries, the possibilities of monitoring urban problems with a better accuracy have become more promising. Hence accurate mapping of urban environments and monitoring urban growth is becoming increasingly important at the global level (Guindon and Zhang, 2009).Nowadays, there are several remote sensing satellite systems such as Land sat (TM and ETM+), ASTER IKONOS, GeoEye, Quick bird, Rapid Eye, world view providing from medium to high and very high resolution imagery. It is also believed that remote sensing imagery is a powerful tool for acquiring data to analyse and map spatio-temporal land use change and urban growth process at different spatial scale (Huang et al., 2007; Yang and Lo, 2002; Yu et al., 2011). Particularly in developing countries, remote sensing may provide fundamental observations of urban growth pattern and environmental conditions that have not been available from other sources (Miller and Small, 2003). Yet, it lacks the ability to fully describe the underlying urban processes (Herold et al., 2005).

Gombe is one of the rapidly growing urban centres in the country. It has been growing very fast since it became the capital city of the state in 1996. The issue of insecurity in the north east Nigeria is another reason why the city is experiencing serious physical expansion due to influx of people from the neighbouring states especially Borno and Yobe states where the crises of Boko Haram Terrorists continue to claim more lives and hinder socio-economic growth in the affected areas. It was observed that from increase in people mostly in the state capital added pressure to the existing built up areas and that has resulted into purchase of agricultural fertile lands around the urban centre for residential development (Bala, 2015). So, the question that always arises is: what is what is the extent of urban growth in Gombe city? It is against this background that the study attempts to examine the urban growth pattern and its effects on agricultural land use in Gombe city.

II. STUDY AREA

Gombe State is located between Latitude 10° 15′ 02"N to 10º20′00"N and between longitude 11°05′00"E to11º15′05"E. It shares common boundary with Akko Local Government Area in south and west, Yamaltu-Deba L.G.A. to the east and Kwami L.G.A. to the north (fig. 1). It also occupies a total land area of 52Km^2. It is the capital of Gombe state with a population of 266,844 (NPC, 2009). Today, the population is projected to be 399,531 persons using 3.2% growth rate Gombe State Office (NPC, 2009). Gombe State is well linked to other regional centres by trunk "A" roads. A single gauge railway line on the Bauchi to Maiduguri route also links the town, in addition to an international airport.

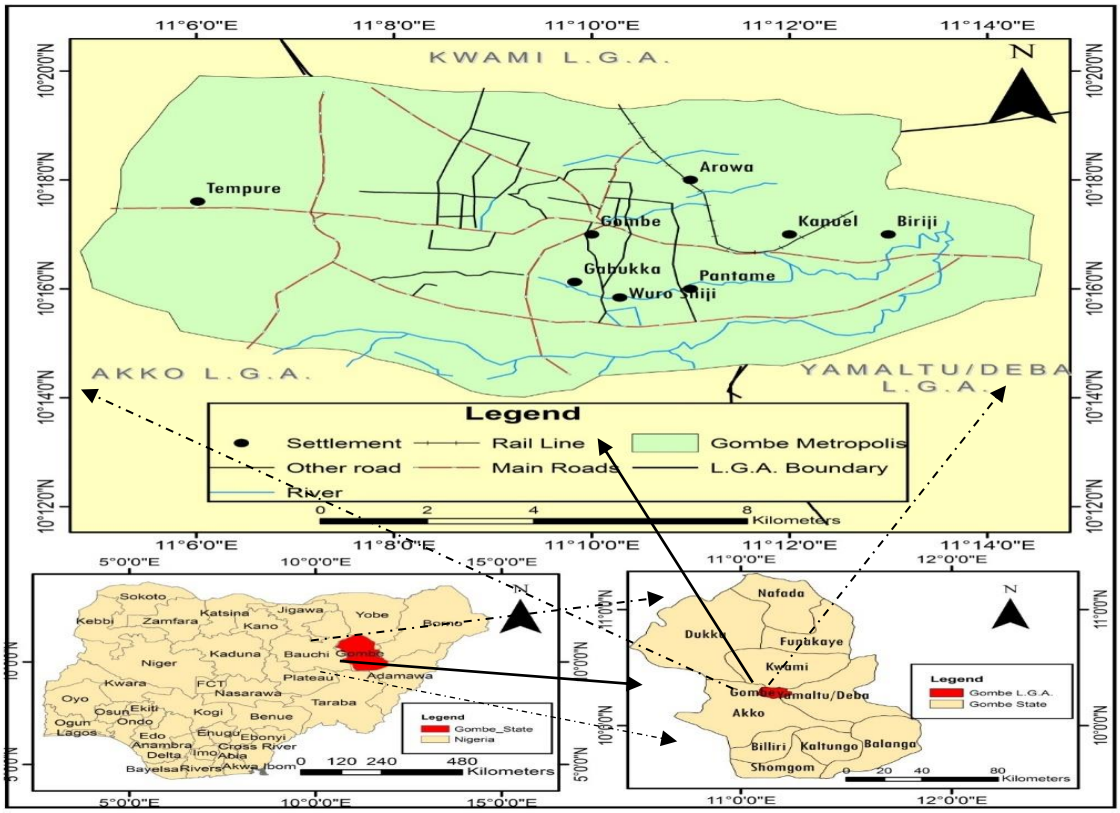

Figure 1: Gombe City.
Source: Author's Work, 2019.

III. MATERIALS AND METHODS

Two sources of data were used in the course of carrying out this research work. These include: Primary sources; information acquired through questionnaire survey and personal interviews, and the researcher's observations. Secondary sources; information acquired through the use of textbooks, theses, dissertations, research projects, journals publications, monographs and Google earth. A total of two hundred fifty (250) respondents were statistically drawn from the sampling frame that covers the area under study (see table 1). Simple random sampling technique was employed to select the areas and also to administer the copies of the questionnaire designed in the outskirts areas of the city, mostly the small villages around the city that their farmlands have already been taken by urban expansion for various developmental purposes.

Table 1: Sample Size of the Respondents

Sample Points	Sample Size	Percentage
Arawa	25	10.0
Liji	18	7.2
Kundulum	20	8.0
Bogo	32	12.8
Wuro Juli	27	10.8
Sarankiyo	25	10.0
Wuro Kesa	28	11.2
Tumfure	30	12.0
Lafiyawo	25	10.0
Shongo Sarkin Yaki	20	8.0
Total	**250**	**100**

Source: Author's Work, 2019.

Geographic Information System (GIS) and remote sensing techniques were used to determine the pattern of urban growth in the study area. In this respect, satellite imageries were sourced and analysed to reveal the pattern of urban growth and also to determine whether urban growth has linkage to agricultural land use depletion. Supervised Classification technique was adopted using Erdas Imagine software and ArcGIS software.

Different Remote Sensing and Geographic Information System (GIS) data from reliable sources have been used in this research. Three medium resolutions Landsat ETM, Landsat ETM+ images of 1998, 2008 and Landsat-8 of 2018 were used to detect urban land cover change patterns of the study area. These images were obtained from United States Geological Survey (USGS) website as standard products, i.e. geometrically and radio-metrically corrected. In order to avoid the impact of seasonal variation, all images are selected from the same season in such a way that the cloud cover will not exceed 10%. The images are also of the same level of spatial resolution of 30m which makes it easier for comparison of changes and patterns that occurred in the time under consideration (see table 2 below).

Table 2: Characteristics of Satellite Images Used in the Study

S/No.	Satellite platform	Sensor Type	Imagery Date	Image Resolution	Source
1	Landsat 5	TM	December, 1998	30 Meters	USGS
2	Landsat 7	ETM+	December, 2008	30 Meters	USGS
3	Landsat 8	TIRS	January, 2018	30 Meters	USGS

TM: Thematic Mapper (and Multi Spectral Scanner)
ETM: Enhanced Thematic Mapper
TIRS: Thermal InfraRed Sensor (and operational land imager)
USGS: United State Geological Survey
Source: Author's Work, 2019.

IV. RESULTS AND DISCUSSION

Results of Image Classifications: The classifications of multi-temporal satellite images in to built-up and farmland for the three different time periods of 1998, 2008 and 2018 has resulted in a highly simplified and abstracted representation of the study area (Figure 2a, b and c). Figure 2d further shows the three different periods of urban landscape dynamics Gombe resulting from increased built up expansion. The classified images show a clear pattern of increased urban expansion prolonging both from urban centre to adjoining non-built up areas. Post classification comparison of the classified images revealed the growth pattern of the city in different directions, notably toward the southern and western parts of the city where new patches of settlements already sprang up, the infilling of the open spaces between already built up areas and the dynamics of urban expansion in the study area. The results of the classified images also suggested that the Gombe city has been undergoing a change that continue to take over the arable lands at the urban fringes especially to the west, north and south, but in the east, the rock formation of Liji Hill appeared to have hindered the development toward that direction.

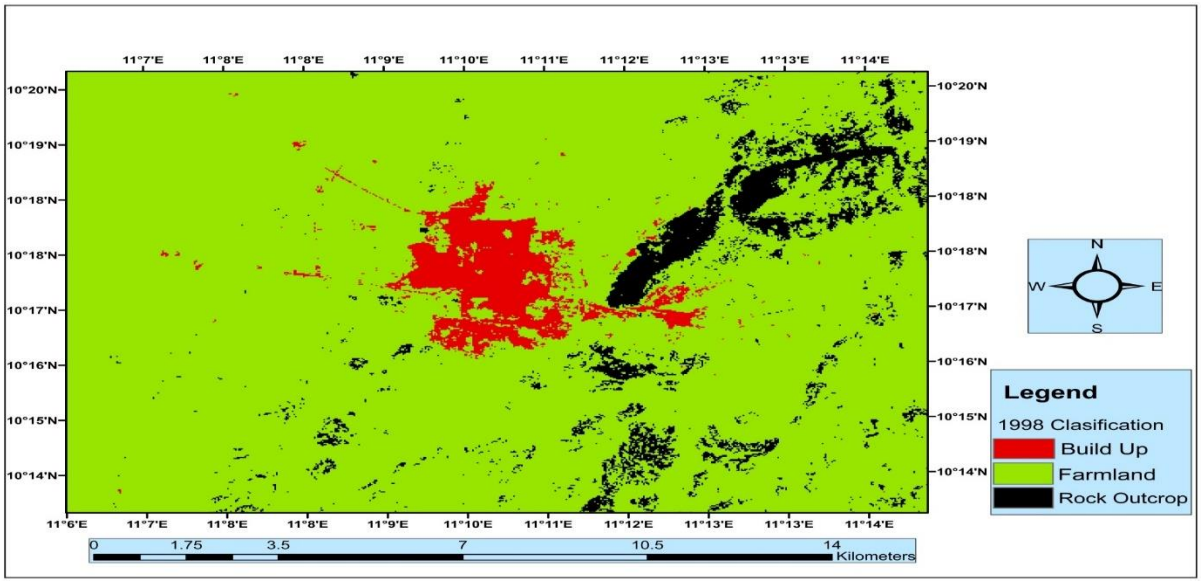

Figure 2a: Classified Image of Gombe City (1998)
Source: Author's Analysis, 2019.

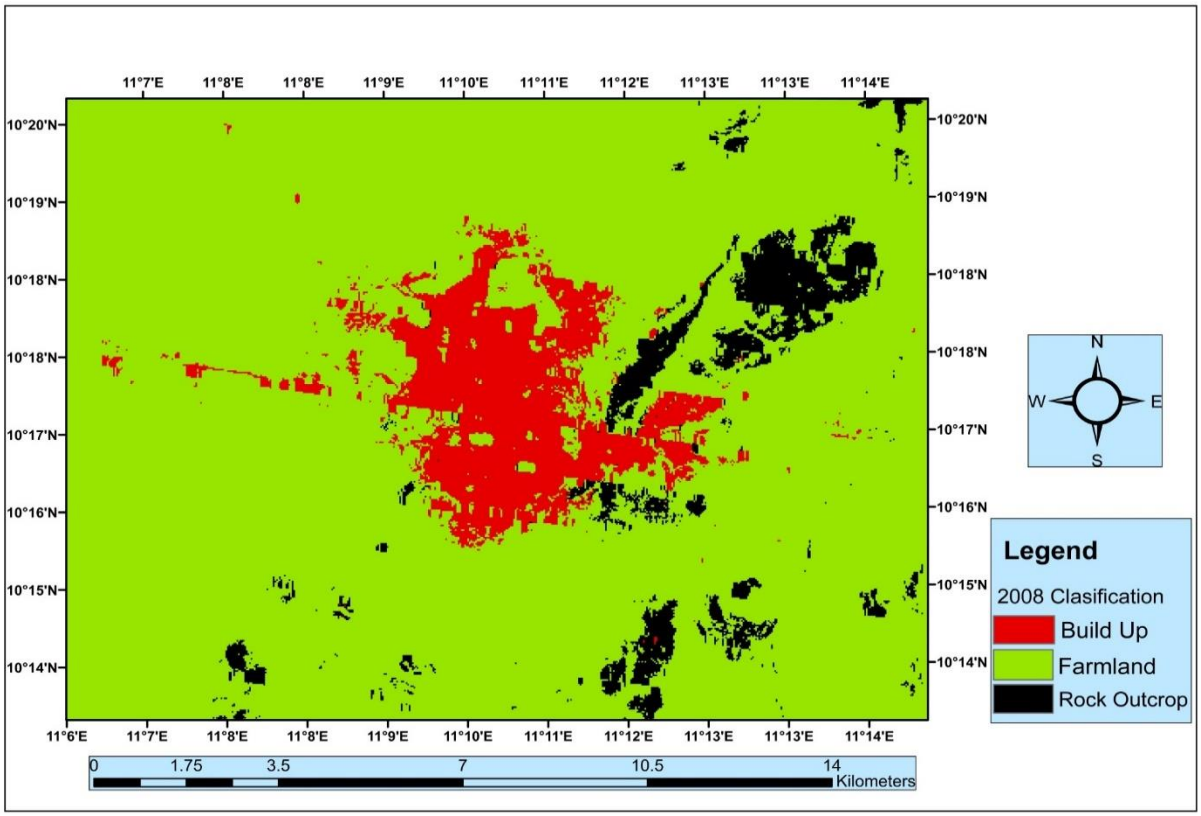

Figure 2b: Classified Image of Gombe City (2008)
Source: Author's Analysis, 2019.

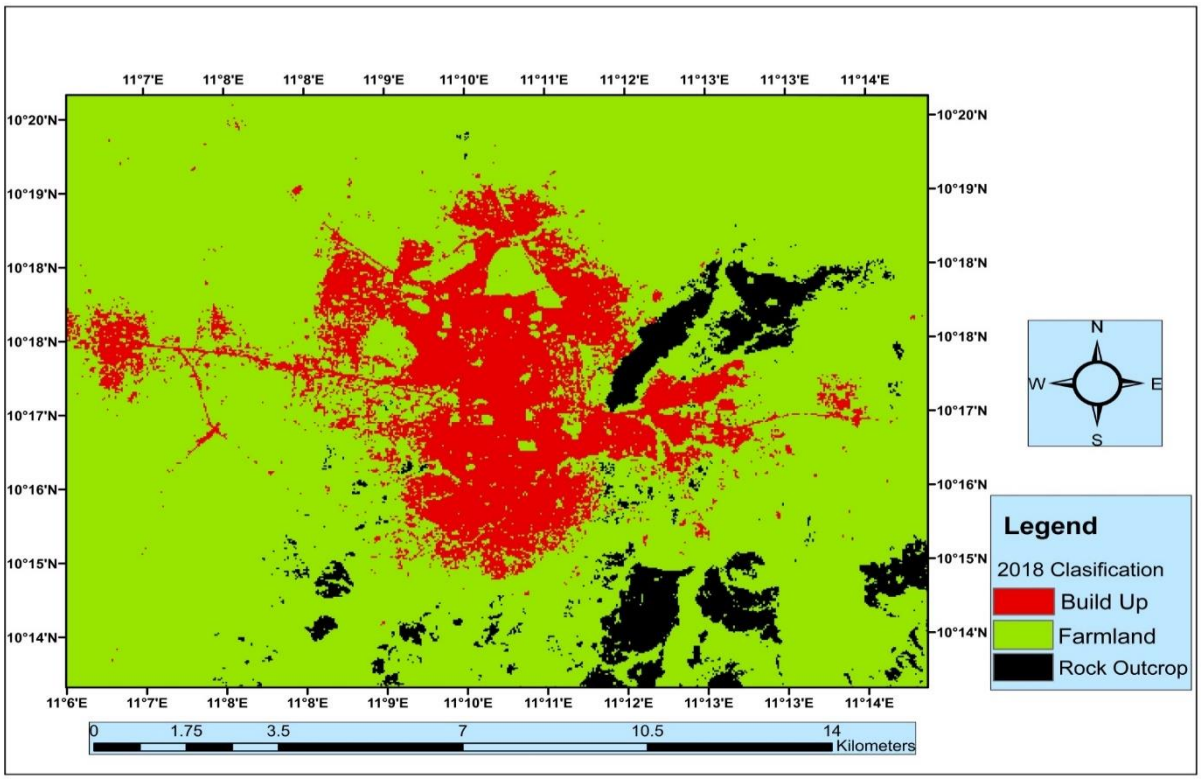

Figure2c: Classified Image of Gombe City (2018)
Source: Author's Analysis, 2019.

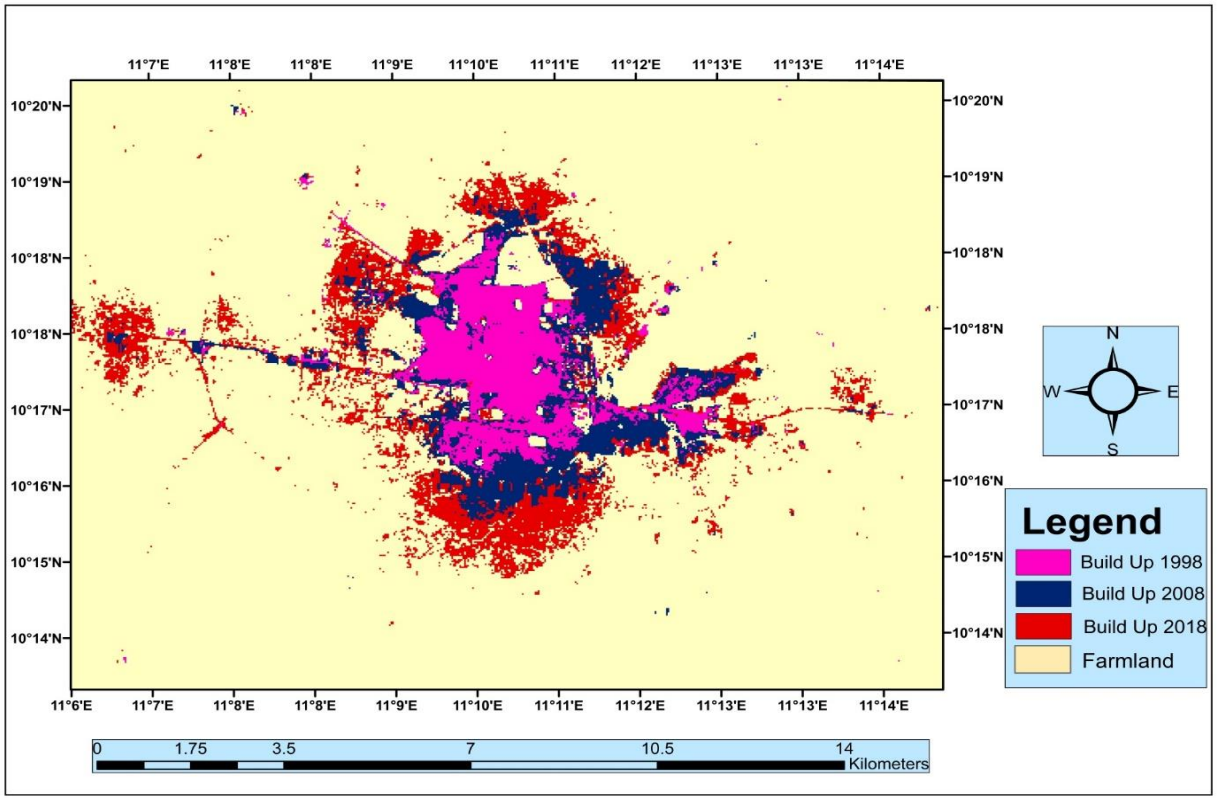

Figure2d: Overlaid Classified Image of Gombe City (1998-2018)
Source: Author's Analysis, 2019.

Analysis of the Pattern of Urban Growth: Table 3 presents the information on the analysis of the extent of urban growth in Gombe city. The results shows that the Total Built-up Area (TBA) has grown from 1, 234.28 hectares (12.34km^2) in 1998 to 2,565.15 hectares (25.65km^2) in 2008 and to 5,889.11 hectares (58.89km^2) in 2018. The highest rate of urban growth is observed during the third period of urbanization (2018) in which the built up area increased almost twice (60.8%) within 10 years interval. This is followed by 12.7% and 26.5% during the first (1998) and the second (2008) periods of urbanization respectively. However, the results revealed that more rapid urbanization occurred in the study area during the period of 2008 where the process show an increase of more than doubled from 12.7% to 26.5% compared to the two other period (1998 and 2018). Thus, this cannot be unconnected with the influx of people from neighbouring states due to Boko Haram crises where a lot of people moved to Gombe since it was considered to be relatively peaceful. It should be noted that the period of urbanization (2008 to 2018) in terms of absolute land cover change remains the fastest witnessing the conversion of 5,889h of non-built up land to urban area to the detriment of agricultural land use.

Table 3: Built up Area Analysis Based on Total Area Expansion

Study Period	Area Hectare/Km^2	Area (%)
1998	1,234.28h/12.34 Km^2	12.7%
2008	2,565.15h/25.65Km^2	26.5%
2018	5,889.11h /58.89Km^2	60.8%
Total	**10,688.54h/96.88Km^2**	**100%**

Source: Author's Work, 2019.

Furthermore, rapid urban growth process in the study area has been revealed by the continuous rise of the number of patches (NP) in the landscape throughout the study periods. This could be an indication of the heterogeneous and fragmented urban growth process taking place over time. Significant change is observed during 1998 to 2008. However, the pick occurred in 2008 to 2018, indicating the continuing development of scattered and fragmented

urban patches in the area under study. Consequently, the situation can be attributed to the emergence of small and patchy built up areas in and around the periphery of the city. However, the analysis of urban growth pattern in Gombe city over time as described above show that urbanization process has substantially changed the land cover with a significant land conversion. Built up area has been undergoing fragmented development process in all the study periods, with a substantial increase in built up area during the second and the third periods (2008 and 2018). In addition, the analysis also revealed that the city is experiencing infill and edge expansion around the urban core, mainly during second period (2008). It also unveiled the increasing patch shape complexity of the study area which could be as a result of infill development or the merger of new patches with the existing patches.

Relationship between Urban Growth and Agricultural Land Use in Gombe City: The hypothesis earlier formulated as**:** there is no significant relationship between agricultural land use change and urban growth process in Gombe city was tested. Paired T-test was used in testing the hypothesis. The result shows that the significant 2-tailed or P-value result is 0.022. Note that, it is considered to be significant if the P-Value is less than 0.05. The P-value is 0.022. Since the P-value is less than 0.05, the $H_0$is hereby rejected and therefore, conclude that there is a significant relationship between urban growth and agricultural land use change in the study area. Though, urban growth has significant relationship with agricultural land use in Gombe, it may not be the sole determinant because other factors like: migration, personal increase in income, the desire to own personal home and loan scheme from banks are also among the major contributors of urban landscape expansion in the area thereby reducing the arable land for farming along the urban foot prints. This is supported by the questionnaire survey where majority of the respondents revealed that continues urban expansion is gradually taking over the agricultural lands around the urban centre (see figure 3 below).

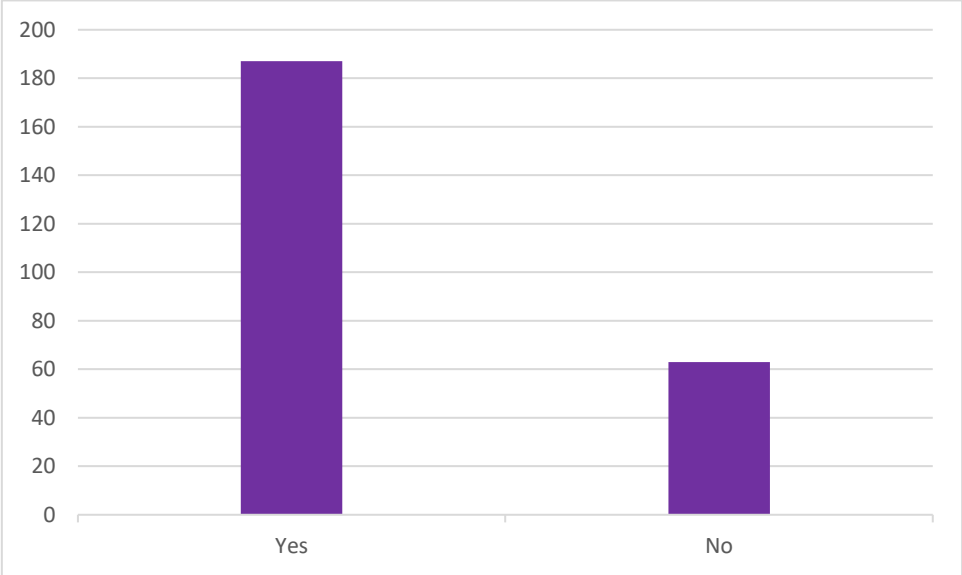

Figure 3: Relationship between Urban Growth and Agricultural Land Use Change.
Source: Author's Work, 2019.

Figure 3 above present the information on the relationship between urban growth and agricultural land use change in Gombe city. The results shows that about 74.8% (187) of the respondents believed that the loss of agricultural farmlands have direct link with the increase in size of the urban area. Only 25.2% (63) shows that urban expansion has no or less effects on the agricultural land uses in the study area. The survey further revealed some of the effects identified to include: loss of arable agricultural land for farming, increase in poverty and crimes among urban dwellers due to loss of employment from farms, increase surface run off due to vegetation cover removal, incessant flooding in the study area resulting from construction of houses on or blockage of the water ways, increase in surface temperature etc.

IV. CONCLUSION

The analysis of urban growth pattern in Gombe city over time as described above shows that urbanization process has substantially changed the land cover with a significant land conversion. Built-up area has been undergoing fragmented development process in all the study periods, with a substantial increase in built-up area during the second and the third periods (2008 and 2018). In addition, the analysis also revealed that the city is experiencing

infill and edge expansion around the urban core, mainly during second period (2008). It has also unveiled the increasing patch shape complexity of the study area which could be as a result of infill development or the merger of new patches with the existing patches. It was further believed that the loss of agricultural farmlands have direct link with the increase in size of the urban area with substantial increase in the built up and reduction in farm lands for agricultural purposes. The study therefore, recommends that:

1. Policies should be put in place to control the unwanted sprawling of the urban area in to agricultural lands.
2. It is also important to look at the driving forces of urban growth at disaggregate spatial scale including more variables such as socio-economic, demographic variables and political forces. This could be helpful in revealing the detail causal factors of urban expansion at local scale in the study area.
3. Relevant employment should be provided for the people who lost their jobs from the agricultural sector to reduce hardship of poverty and urban crimes among youths.

REFERENCES

1. Adesina F.A, (2005). Geo-information and Natural Resources Exploitation in Africa; United Nations Economic and Social Council. Paper Delivered in Fourth Meeting of the Committee on Development Information, Addis Ababa on 23-28 April.
2. Adeboyejo, T. and Abolade, O. (2007), Household Responses to Urban Encroachment on the Rural Hinterland in the Ogbomoso Urban Fringe, Nigeria. http://www.populationenvironmentresearch.org/workshops.jsp#w2007.
3. Aguilera, F., Valenzuela, L. M., and Botequilha-leitao, A. (2011). Landscape metrics in the analysis of urban landuse patterns: A case study in a Spanish metropolitan area. Journalof Landscape and urban Planning. 99(3-4), 226-238.
4. Angel, S., Sheppard, S., and Civco, D. (2005). The Dynamics of Global Urban Expansion. Washington, DC: World Bank.
5. Appiah, D. O. Bugri, J. T. Forkuo, E. K. and Boateng, P. K. (2014). Determinants of Peri-Urbanization and Land Use Change Patterns in Peri-Urban Ghana. Journal of Sustainable Development; Vol. 7, No. 6; 2014 ISSN 1913-9063 E-ISSN 1913-9071 Published by Canadian Center of Scienceand Education.
6. Bala, R.H. (2015) Effects of Road Transport Development on Urban Growth and Commercial Activities in Gombe Metropolis, Gombe State Nigeria. An Unpublished M.Sc. Thesis. Ahmadu Bello University, Zaria, Kaduna State Nigeria.
7. Bhatta, B. (2009). Analysis of Urban Growth Pattern Using Remote Sensing and GIS: A casestudy of Kolkata, India. International Journal of Remote Sensing. 30 (18), 4733-4746.
8. Bhatta, B. (2011). Urban Growth Analysis and Remote Sensing. Springer Briefs in Geography.
9. Brennan, E M (1999) Population, Urbanization, Environment and Security: A Summary of the Issues, Washington DC, Woodrow Wilson International Center for Scholars Comparative Urban Studies Occasional Papers Series, 22.
10. Dekolo, S. O and Olayinka, D. N. (2014). Monitoring peri-urban land use change with multi temporal Landsat imagery. Retrieved from https://www.researchgate.net/publication/265476498 accessed on 13 August, 2017.
11. Gbadegesin, J. T., Oladokun, T. T. and Ayorinde, O. I. (2010). Urban Renewal as a tool for Sustainable Urban Development in Nigeria: Issues and Challenges. Journal of Sustainable Developmentand Environmental Protection, 1 (1), 57–68.
12. Gezaheng, A. A. (2013). Quantifying Urban Growth Pattern in Developing Countries Using Remote Sensing and Spatial Metrics: A Case Study in Kampala, Uganda. Unpublished M.sc. Thesis, Department of Geo-information Science and Earth Observation, University of Twente Netherland.
13. Guindon, B., and Zhang, Y. (2009). Automated Urban Delineation from Landsat Imagery based on Spatial Information Processing. Journal of Photogrammetric Engineering Remote Sensing. 75(7), 845-858.
14. Gündel, S. (2006). A Report on Synthesis of Urban and Peri-Urban Agricultural Research. Commissioned by the Renewable Natural Resources Research Strategy (RNRRS) Programme.
15. Herold, M., Couclelis, H., and Clarke, K. (2005). The Role of Spatial Metrics in the Analysis and Modeling of Urban Landuse Change. Journal of Computers, Environment and Urban Systems. 29(4) 369-399.
16. Huang, J., Lu, X. X., and Sellers, J. M. (2007). A Global Comparative Analysis of Urban Form. Applying Spatial Metrics and Remote Sensing. Journal of Landscape and Urban Planning. 82(4) 184-197.

17. Kwasi N. G. (2004). Urbanization Process –Environmental and Health Effects in Africa. Population Environment Research Network (PERN) Cyber seminar, Urban Expansion: The Environmental and Health Dimension.
18. Mabogunje, A. L. (2002) Reconstructing the Nigeria City: The New Policy on Urban Development and Housing, Amole, D. et al (eds), The City In Nigeria, (2002), Proceedings of a National Conference. Obafemi Awolowo University Ile –Ife, Nigeria, pp 1 –9.
19. Mugish, J. and Nyandwi, E. (2015). Kigali City Peri-Urbanization and its Implications on Peri-Urban Land Use Dynamics: Cases of Muyumbu and Nyakaliro. GeoTechRwanda 2015 –Kigali, 18- 20 November 2015.
20. Miller, R. B., and Small, C. (2003). Cities from Space: Potential Applications of Remote Sensing in Urban Environmental Research and Policy. Journal of Environmental Science Policy. 6 (2) 129-137.
21. Naab, F. Z., Dinye, R. D. and Kasanga, R. K. (2013). Urbanisation and its Impact on Agricultural Lands in Growing Cities in Developing Countries: A Case Study of Tamale in Ghana. ModernSocial Science Journal, 2, No. 2, 256-287.
22. National Population Commission (NPC), (2009)Census Results, NPC Gombe Office. http//june12post.com/ national-population-commissions-housing-census.
23. Ogu, V. I. (1999). Evolutionary Dynamics of Urban Land Use Planning and Environmental Sustainability in Nigeria, Planning Perspectives, 14(4), 347-368, Routledge, London.
24. Olima, W. H. A., (2003). Urbanisation and Housing Challenges. Cities in Africa Conference.
25. Rapporteur's report.
26. Osuocha, I. L. (2006). Towards sustainable Urban Growth: A critical Review of City Development Strategies (1986-2006). (Unpublished thesis) Department of Architecture, Imo State University, Owerri.
27. Oyesiku, K and Alade, W. (2010). Historical Development of Urban and Regional Planning in Nigeria State of Planning Report, Nigerian Institute of Town Planners.
28. Sagua, L. (1998). Impact of Urban Growth on Runoff in Auchi. Federal Ministry of WaterResources, Lagos Nigeria.
29. Tian, G., Jiang, J., Yang, Z., and Zhang, Y. (2011). The Urban Growth, Size Distribution andSpatio-Temporal Dynamic Pattern of the Yangtze River Delta Megapolitan Region, China. Journal of Ecological Modeling. 222(3), 865-878.
30. Wilson, E. H., James, D. H., Daniel, L. C., Michael, P. P., and Chester, A. (2003). Development of Geospatial Model to Quantify, Describe and Map Urban Growth. Journal of Remote Sensing of Environment. 86(3), 275-285.
31. Yang, X., and Lo, C. P. (2002). Using a Time Series of Satellite Imagery to Detect Landuse Land Cover Changes in the Atlanta, Georgia Metropolitan Area. International Journal of Remote Sensing 23(9), 1775-1798.
32. Yu, W., Zang, S., Wu, C., Liu, W., and Na, X. (2011). Analyzing and Modeling Landuse LandCover Change (LUCC) in the Daqing City, China. Journal of AppliedGeography. 31(2), 600-608.
33. Zasada, I. (2011). Multifunctional Peri-Urban Agriculture-A Review of Societal Demands and the Provision of Goods and Services by Farming. Land Use Policy 28 (2011) 639–648.
34. The study identified the negative relationship between agricultural land use and urban growth pattern in the study area. It is therefore, recommended that