ANALYSIS OF URBAN SPRAWL AND ITS EFFECT IN MARARABA, KARU LOCAL GOVERNMENT AREA OF NASARAWA STATE, NIGERIA

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Abstract

Cities and towns in developing countries all over the world are experiencing an unplanned and uncontrolled development known as Urban sprawl. Sprawl is often uncoordinated and extends along the fringes of metropolitan areas with incredible speed. This research is aimed at examining urban sprawl in Mararaba between 1998 and 2018.The data used for the study were Landsat 5 Thematic Mapper (TM) of 1998, Landsat Enhanced Thematic Mapper plus (ETM+) data of 2008 and operational land imager of 2018.The extent of urban land use was determined by using the attribute and statistics data generated from the classification result and used for post-classification comparison among the years. Result showed that Mararaba witnessed a remarkable growth between 1998 and 2018 from mere 1.1178 Km2 in 1998 to about 5.8716 Km2 in 2018. This growth contributed to the sharp decline in farmland from 4.0545 km2 (48.27%) in 1998 to decline to 1.0512 km2 (12.51%) in 2018. Bare surfaces witnessed an increase over the years of this study. This increase is as a result of clearing of natural vegetation for urban development, thereby exposing the land to direct contact with rainfall, leading to gully erosion in the area. Light vegetation also witnessed a sharp decreased from (6.23%) in 1998 to (13.99%) in 2018. Therefore, increase in population led to the increase in urban sprawl in the study area. The study recommends that there is a need for a regular monitoring of urban sprawl and development in the study area by the state government especially with the aid of geospatial techniques for better decision making

Keywords: Cities, Urbanization, Urban Sprawl, Land-use/Cover, Population, Change, GIS

1. Introduction

Cities and towns in developing countries are experiencing rapid population growth and uncontrolled development known as urban sprawl. For the first time in history the urban population of the world has outnumbered the rural population (Chunwate *et al.,* 2019). This epochal transition occurred mostly in Africa and other developing countries of Latin America and Asia. In fact, the world has urbanized faster than originally predicted by Malthus (1978). Urbanization is the increasing number of people in urban areas resulting to the development of towns and cities. This is usually as a result of the movement of people from rural to urban areas leading to population growth in towns and cities (Isma'il *et al.,* 2015). Urbanization is not only characterized by

demographic change but involves social change, technological advancement and economic transformation. These changes are influenced by social, political and geographical factors and therefore vary from one geographical location to another.

Sprawl takes place either in radial direction around a well-established city or linearly along highways (Torrens, 2006). Patterns of sprawl and analyses of spatial and temporal changes could be done through various methods. The Mapping process provides a "picture" of where this type of growth is occurring, which helps to identify the environmental and natural resources threatened by such sprawls, and to suggest the likely future directions and patterns of sprawling growth. The effects of sprawl on agricultural land use and other land uses such as residential, commercial, industrial and institutional are other concerns that are dependent on the mapping and study of the sprawl process. Ultimately, the power to manage sprawl resides with local government authorities that are saddled with the responsibility of urban developmental control (Chunwate *et al.*, 2019).

Urban sprawl is often uncoordinated and extends along the fringes of metropolitan areas with incredible speed. Commonly, this uncoordinated development encroaches agricultural and resource land uses in the process. Land is often developed in a fragmented and piecemeal fashion, with much of the intervening space left vacant or in uses with little functionality (Torrens and Alberti, 2002).

Sprawl in Nigeria consists of informal housing developments on the urban periphery, on land that is mostly privately owned, sold in single small plots. These newly developed areas have been called peri-urban areas and the inter-metropolitan periphery, The ex-urban areas beyond the suburbs are sometimes called fringe developments and extended places (Rikko, 2013)

The study on urban environmental issues using remote sensing and GIS techniques in India, indicated major urban environmental problems that occur due to high population growth (the 46.31% increase during 1991-2001). Also, the uncontrolled and mismanaged urban expansion has led to the doubling of the densely built-up area during the last decade in Delhi (Atiqur, Maik, Alka, and Javed, 2009)

All cities in Nigeria are experiencing sprawl; Awka metropolis is not an exception because of the scale and type of development on some of the city's most agriculturally productive land. In the past decade, the city's built up area burst outward in an explosion of sprawl that consumed former agricultural land at a break-neck pace (Lazarus, 2012) .

Hashidu and Muhammed, 2018) Analysis of urban sprawl using geospatial techniques in Gombe metropolis, Gombe State, Nigeria. Result reveals that the spatial extent of urban sprawl occupied about 12.78% between 1991 and 2014 and high annual rate of 12.78% were also witnessed in 2014. It was also found that there was a progressive increase of urban sprawl both in terms of extent and annual rate throughout the study period, especially between the period of 2005 and 2014. It is recommended that there is a need for a regular monitoring of urban sprawl and development in the study area by the state government especially with the aid of geospatial techniques for better decision making.

Similarly, (Kanayochukwu and Dogo, 2019) examined urban growth and housing problems in Karu Local Government Area of Nasarawa State in Nigeria. Questionnaire survey was used to acquire primary data which was complemented with secondary data. Findings revealed a strong correlation between urban growth and housing problems in the area. The study also identified housing problems such as overcrowding and congestion, poor accessibility, substandard and inadequate housing, as well as insufficient basic amenities and infrastructural facilities in the area as a result of its close proximity to FCT. Hence there is a need to examine the effect, nature and the pattern of sprawl in the area, for proper decision making and thereby, to enhance sustainable development.

2. Materials and Methods

Karu Local Government Area of Nasarawa State is located between latitudes 8° 5’ N and 10° 42’ N and longitudes9° 25’E and 7° 54’E of the Greenwich Meridian while Mararaba is located between latitudes 7° 34’ 40’’ N and 7° 37’ 00’’N and longitudes 9° 0’ 30’’ E and 9° 2’ 00’’E of the Greenwich Meridian as shown in Figure 1. Mararaba is an unplanned area covering a spatial extent of about 800sqkm (KAPDA, 2001). It extends from the eastern boundary of the Federal Capital Territory Abuja (Old Nyanya) to Gora about 15 kilometers to Kefi as shown in Figure 1.

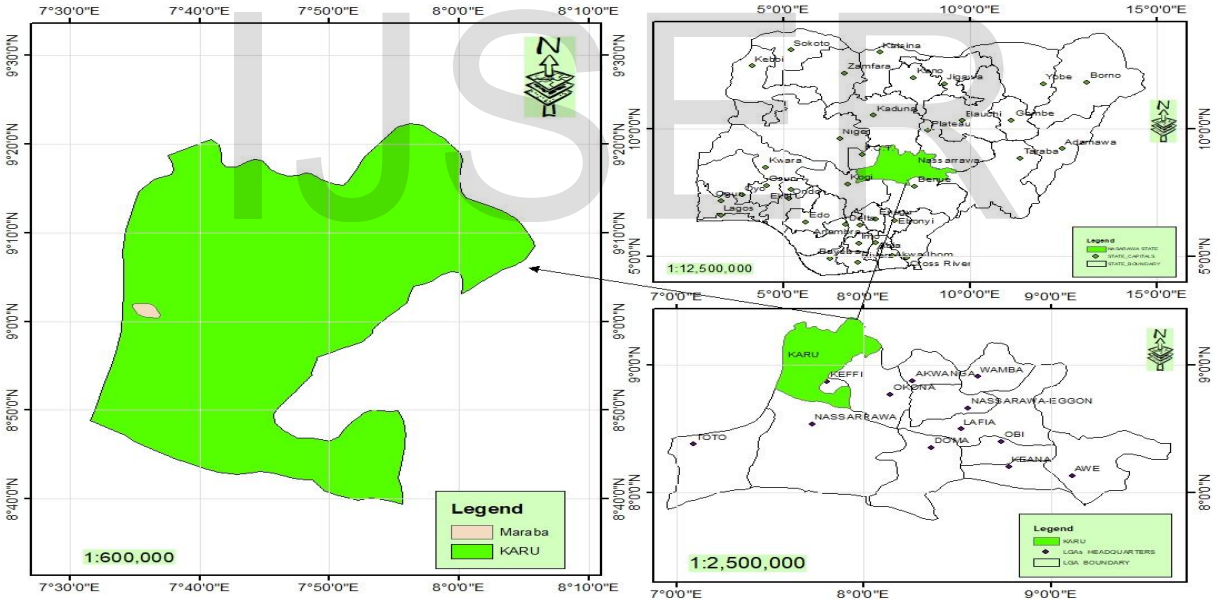

Figure 4.1: Map of the Study Area

The area has an estimated population of 10,000 in 1991, and is believed to have grown rapidly to an estimated population of 50,000 and 130,000 by 2001 and 2010 respectively; due to continuous migration of people from other parts of the country to this area (Yari *et al.*, 2002; Isma’il *et al.*, 2015)

Mararaba is located within a broad gentle rolling undulating plain with elevation ranging from 300 to 500 meters above sea.

The soils derived from this bedrock structure are generally deep and well drained with high fertility rating and variable run-off potential, with variations mainly along the stream-beds where the soils are higher in clay content (Yari *et al.*, 2002). The natural vegetation in the area is of the park savannah type, featuring dense tropical woodland with shrubs and grasses; with variations reflecting the influence of local conditions such as relief, soil, and recently the effect of human activities. The area has two distinct seasons (wet and dry), typical of north-central Nigeria. The spatial pattern of rainfall in the study area is slightly influenced by the north central highlands with a mean annual rainfall between 1100mm to about 2000mm. Mararaba is cosmopolitan in nature with various ethnic groups living together in harmony. The major indigenous ethnic groups in the area are Gbagyi, Koro, Yeskwa, Gwandara and Gade. There are many settlers comprising of Mada, Eggon, Hausa-Fulani, Igbo, Tiv, Yoruba who migrated to take advantage of the economic potentials in the area (Nasarawa State, 2010). The Landsat imageries of 1998, 2008 &2018 serves as the primary data used in generating LULC distribution of the study area. (Fig.1.4). Based on prior knowledge of the area and field survey, a classification scheme on Anderson et al, (1976) level 1 classification was adopted and modified into four classes representing built up, vegetation, farmland and bare surface. The maximum Likelihood Method was used. achieved through field survey and administering of structured questionnaire to the resident of the study area. Idrisi Terrset, ArcGIS 10.3, MS Excel, Microsoft Office were used to extract and classify the land use and land cover of the study area. Results were summarized in tables, figures and were discussed using descriptive statistics.

After the images were geo-referenced and geometrically rectified, Image clipping was performed using spatial analyst tool on a sub-scene from the full image on the basis of a frame covering the area of the study. These preprocessing tasks allowed the export of the satellite images to the ArcGIS and ERDAS for classification and extraction of land use and land cover information. Supervised classification was performed on the same images, with random training samples using on-screen digitizing from on the standard menu of the software; Land cover types classification and identification were performed. The 1998, 2008 and 2018 images provided a means to determine LULC in the categories; built-up, bare surface, vegetation (light and dense), and farmland. The area coverage for each land use/land cover types was calculated for the years covered by this study. This was done to generate a table showing the area in square kilometers and the percentage change for years 1998, 2008 and 2018

To determine the extent of urban land use between 1998 and 2018, the attribute and statistics from the classification result was generated and used for post-classification comparison among the years. The built-up was also extracted for each of the periods and the extent of the built up area was calculated in km^2. The extent of urban sprawl between 1998 and 2018 was analyzed by subtracting the reference year of land cover of 2018 from the base year 1998. To determine the rate and

pattern of urban sprawl in the study area, tables were used to show the rate of urban sprawl using the resulting value generated to compare the set data for 1998 and 2018, the total extent of the sprawl in km^2 was divided by the number of years within the period that is; 1998-2018. To assess the environmental impacts of urban sprawl in the study area, 5 points likert scale of measurement was used to elicit the respondents' opinion on the perceived impacts of the unprecedented growth of Mararaba town

3. Results and Discussion

This section presents the results of analysis on the classes, extent of the urban sprawl, rate and magnitude of urban growth as well as perception on the environmental impact of urban sprawl in the study area. Table 1 shows the spatial extent of land use/land cover classes in the study area.

Table 1 shows land use/cover analysis in Mararaba for the period of 1998-2018. Result in Table 1 shows that vegetation witnessed a sharp decrease from 2.7036 km2 (32.19%) in 1998 to 1.008 km2 (12.01%) in year 2008. It further decreased from 1.008 km2 (12.01%) to 0.3042 km2 (3.62%) in 2018. This decrease is as a result of clearing of natural vegetation for urban development, thereby exposing the land to direct contact with rainfall, leading to gully erosion

Table 4.1 land use and land cover Distribution in Mararaba (1998, 2008 and 2018)

Classification Category	1998		**2008**		**2018**	
	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)	Area (Sqkm)	Area covered (%)
Built up	1.1178	13.31	4.1355	49.26	5.8716	69.88
Agric Land	4.0545	48.27	2.7297	32.51	1.0512	12.51
Vegetation	2.7036	32.19	1.008	12.01	0.3042	3.62
Bare surface	0.5229	6.23	0.5229	6.20	1.1754	13.99
Total	**8.3988**	**100**	**8.3988**	**100**	**8.3988**	**100**

Source: Analyzed from image, 2018

in the area. The built-up area witnessed considerable increase throughout the study period occupying 1.1178 km2 (13.31%) in 1998, 4.1355 km2 (49.26%) in 2008 and

5.8716 km2 (69.88%) in 2018. The results show that the urban growth of Maraba varied with time and class of land use, while in 1998 and 2008 the growth rate is little, it became higher between 2008 and 2018 due to the population increase and development brought about creation of the new state capital. This progressive increase in built-up area is in agreement with the work of Ade and Afolabi (2013). on

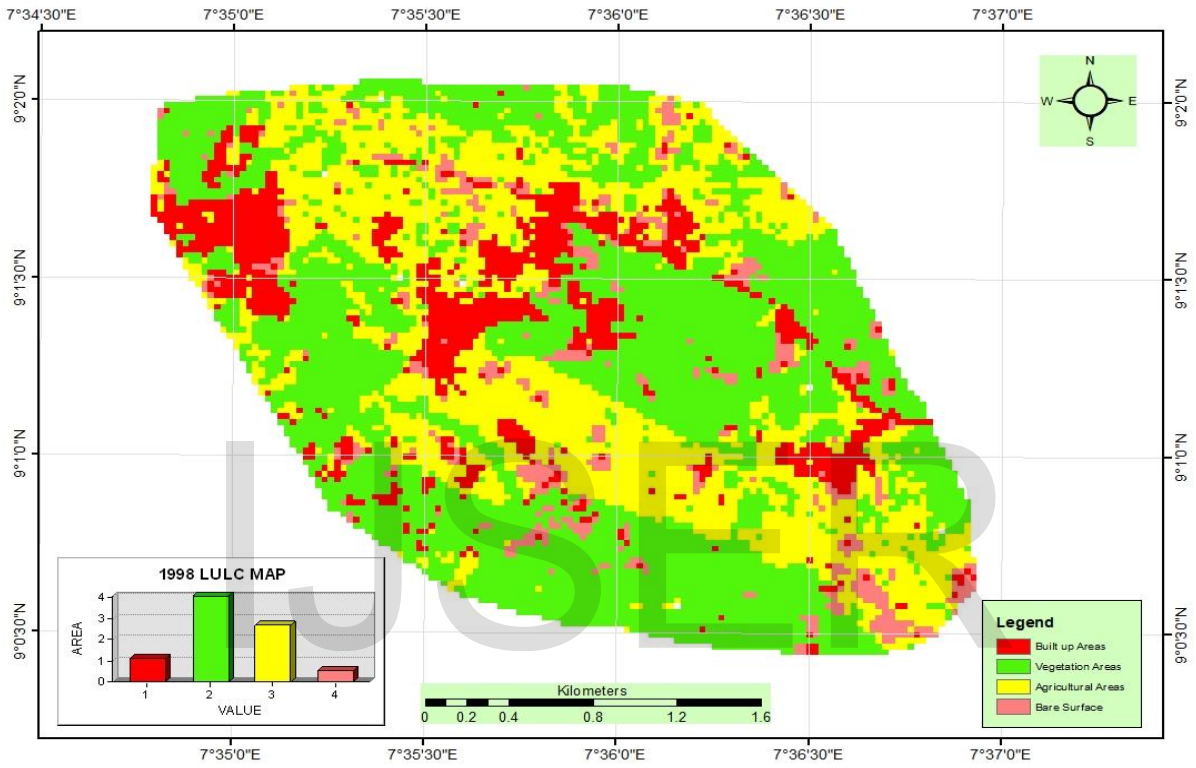

Figure 2. Classified land use/cover map of study area in 1998. Source: Authors Analysis

the other hand, farmland which occupied 4.0545km2 (48.27%) of land in 1998 decreased to 2.7297 km2 (32.51%) and 1.0512 km2 (12.51%) in 2008 and 2018 respectively. The decrease in farmland throughout the study period must have been caused by the increase in built-up area which led to the conversion of farmlands to built-up lands. This is in line with the work of Nwafor (2006) who also found that farmlands decreased as built-up area increased. Bare surface occupied 0.5229 km2 (6.23%) in 1998 and decreased slightly to 0.5229 km2 (6.23%) in 2008 and increased progressively to 1.1754 km2 (13.99). Figures 2-4 shows the land use/ land cover classification of the study area for the years 1998, 2008 and 2018.

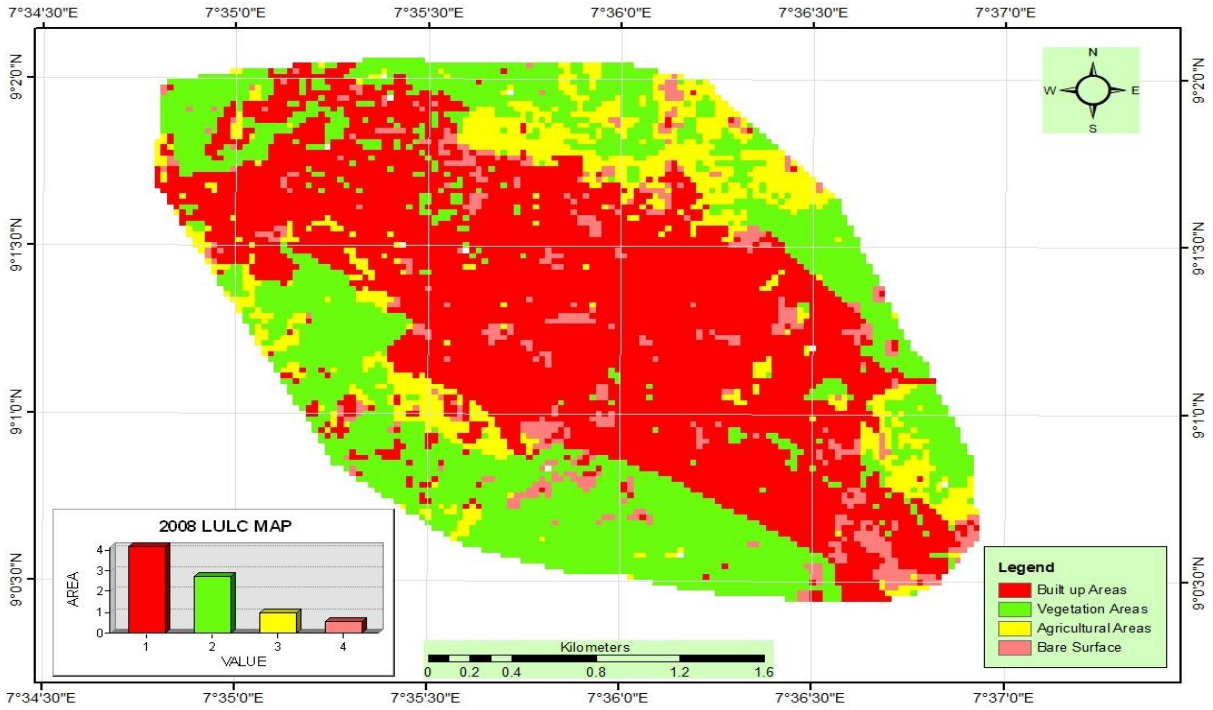

Figure 3. Classified land use/cover map of study area in 2008. Source: Authors Analysis, 2019

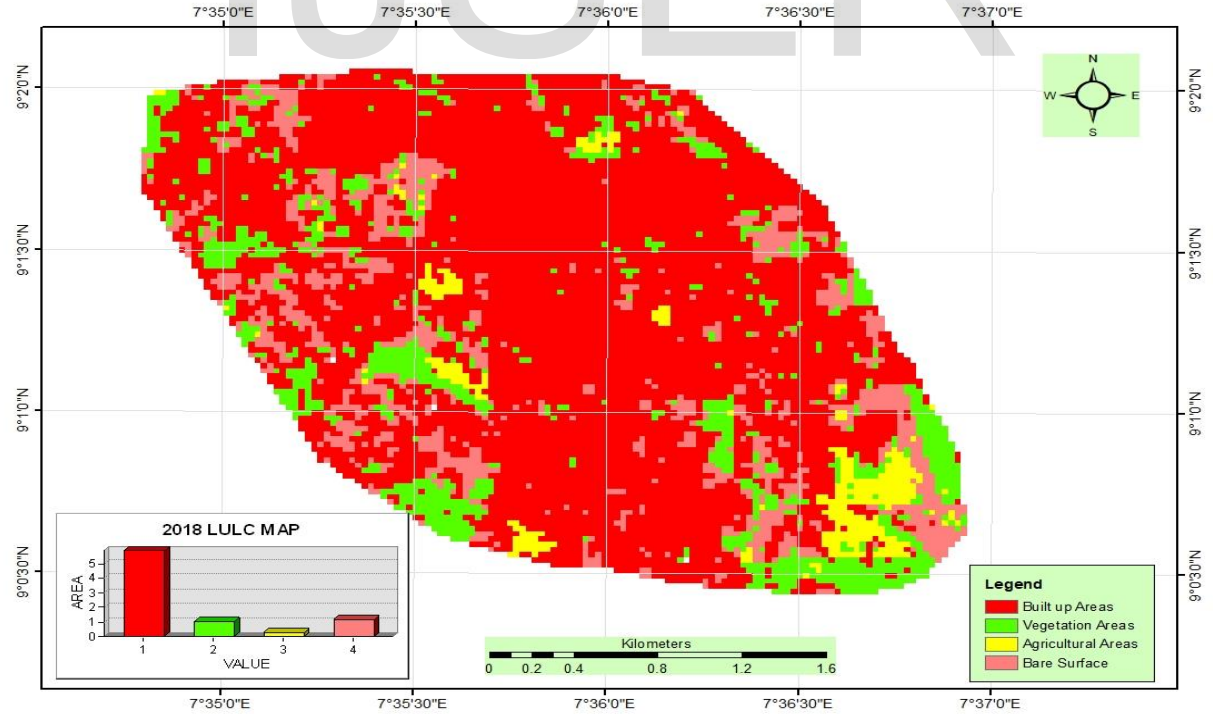

Figure 4. Classified land use/cover map of study area in 2018. Source: Authors Analysis, 2019

Pattern and extent of growth in the study Area

The extent of urban land use has been progressively increasing throughout the study period as shown on table 4.1. The year 1998 which represents the development that took place prior to democracy of 1999, had the least extent of urban land which constituted 1.1178 km² (13.31%), an extent of 3.0177 km² (35.95%)

Table 4.1: The Extent of Urban land cover change in 1998, 2008 and 2018

S/N	Year	Forest Area	(%)
1	1998	1.1178	13.31
2	2008	4.1355	49.26
3	2018	5.8716	69.88

This was preceded by the years 2008 (10 years later) where the extent of urbanization rapidly increased to 4.1355 km² (49.26%). With urban extent of 1.7361 km2 (20.62%). This rapid increase could however be accounted for by the increase in housing facilities for local government staff, academic institutions, Health centers as well as the influx of the rural population coming to seek for a greener pasture and business opportunity in the urban area. More urban expansion resulting from continuous dividends of democracy which increased administrative and commercial activities resulted in an increase in the extent of urban area to 5.8716 km² (69.88%) in 2018. With an expansion of 4.7538 km2 (56.57%) within the 20 years period as observed by Balzerek (2003) that high construction activities and its structural as well as functional development lead to a yearly increase in built-up areas every year, just as in the case of Mararaba which is not exceptional.

growth across the 20 years period. It indicates that urban areas has increased from 13.31%

Perception on the Environmental Impacts of Urban Sprawl in the Study Area

To further support the geospatial analysis for this study, it is important to consider the perception of people living in the study area on the environmental impacts of the urban sprawl, this was achieved by employ the liker scale form of measurement to elucidate information from the respondents, keeping in view the technology and techniques used in this research. It was thought to be a better idea not to rely solely only on remote sensing and GIS approach to examine the sprawl but also to assess its impact on the environment. Respondents were asked the impacts of urban sprawl in Mararaba in order to identify possible effects other than the changes in land use classes as observed using the GIS techniques and their responses are presented. Figure 4.5 reveals the trend of urban

in 1998 prior to democracy to 69.88% to 2018 due to continuous influx of people to the area.

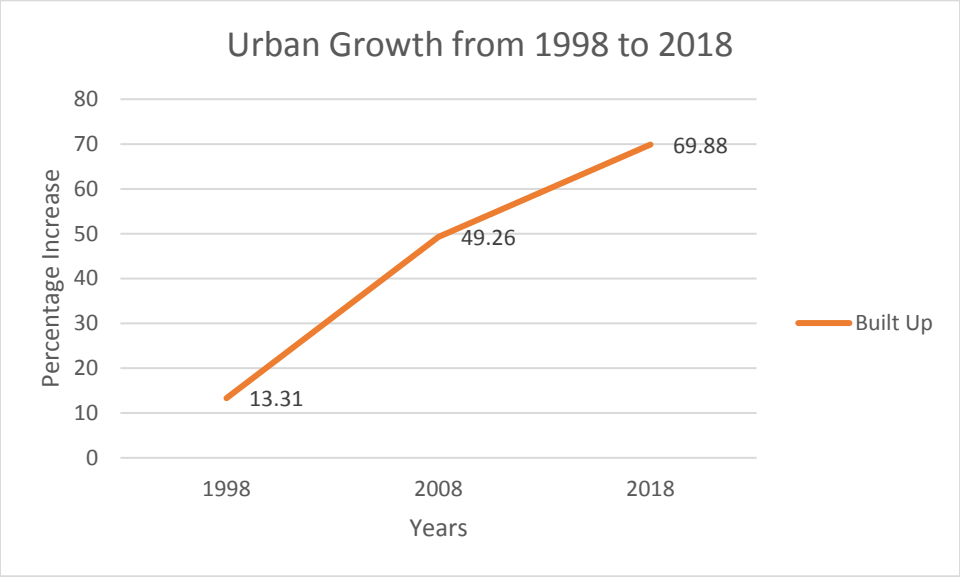

Figure 4.5: Trend of spatial growth of Mararaba from 1998 to 2018. Source: Author's Analysis, 2019

Perception on urban sprawl and its consequences in the study area

(a) General perception:

Majority of the respondents from the study area were aware of urban sprawl and the intensity in the study area before the survey. 32 respondents (21.33%) strongly agree that there is urban sprawl while 94 respondents (62.67%) agree that there is urban sprawl. In addition 6 (4%) Strongly disagree 7(4.67%) disagree and 11(7.33%) Indifferent .also majority of the residents agree that urban sprawl is human induced 27 (18%) strongly agree, 89 (59.33%) agree, 18 respondents (12%) undecided that the urban sprawl is triggered by human activities, 10(6.67%) disagree while only 6 respondents (4%) Strongly Disagree. Furthermore,35 respondents (23.33%) Strongly Agree that urbanization is one of the major human activities that initiates/triggers the sprawl, 88 respondents (58.67%) Agree, just about 14(9.33%) undecided, while 8 respondents (5.33%) Disagree and 5 respondents (3.33%) strongly disagree.37 respondents (24.67%) Strongly Agree, 78 respondents (52%) Agree that the level of urban sprawl is severe, 16 respondents (10.67%) indifferent, 11(7.33%) disagree and 8 respondents (5.33%)strongly disagree that they have been severe urban sprawl which also has severe effects on the people and environment with 25 respondents (16.67%) strongly agree,45(30%) agree,59 respondents(39.33%)indifferent, 14(9.33%) disagree while 7 (4.67%) strongly disagree. The implication of these urban sprawl is that it will have increased pressure on the environment and the people, it will also have diverse effect on the health of the residents.

(c) Environmental impacts of urban sprawl

With regards to concern about the environmental impacts of urban sprawl on the populace 28 respondents (18.67%) strongly agree that pollution (air, water and land) and other health diseases are environmental effects of urban sprawl whereas 87respondents (58%)agree. In addition, 17 respondents (11.33%) are undecided about the environmental effect of urban sprawl,10 (6.67%) disagree and 5(3.33%) strongly disagree. Furthermore, 81 respondents (54%) strongly agree that there is traffic congestion due to urban sprawl, 45 respondents (30%) agree, 11(7.33%) indifferent, 8(5.33%)disagree while 5(3.33%)strongly disagree . These can be attributed to high pressure on the land and stress on the health of the populace.

Conclusions and Recommendations

This research work demonstrates the ability of geospatial techniques in the analysis of urban sprawl. The results obtained from this study revealed that there has been a continuous increase in built-up areas throughout the study period. There has also been a progressive increase of urban sprawl in terms of spatial extent throughout the study period. The most dramatic increase and the continuous expansion experienced in built-up area are shown between 2008 and 2018. The upsurge in population of the area was enhanced in recent time by the desire of the state government to restore Mararaba to its master plan as the most closet settlement the Federal Capital Territory by the demolition of all forms of illegal structures within its territory. However, other specific land uses are also identified such as commercial land use comprising of banks, markets and shopping complexes, serviced oriented activities such as retailing finished products and petrol filling stations. Industrial land uses include privately owned informal businesses like welding, furniture making, and general electrical and engineering works. It is difficult to determine the spread of these informal industries. The period of thirty (20) years from 1998 to 2018 witnessed considerable increase in population in the study area; this can be inferred from the fact that the land area covered by built-up area, comprising of residential, commercial, industrial and institutional land uses is on the increase, thereby affecting other land use/cover categories such as farmland, bare surface and vegetation in the study area.

Also, with regards to deforestation as an impact of urban sprawl on vegetation 27respondents (18%) strongly agree while 91 respondents (60.66%) agree that deforestation has occurred, 18 respondents (12%) indifferent,8(5.33%) disagree and 6(4%) strongly disagree.

With regards to loss of natural habitat and biodiversity, 8 respondents (5.33%) have strongly agreed that there is a loss of natural habitat and 81 respondents (54%) are agreeing that there's a loss of natural habitat which has led to loss of biodiversity, 46 respondents (30.67%)are undecided, 9 respondents (6%) do not agree which may be due to their location and cause some locations are still untilled due to distance from the road(accessibility) and 6(4%) strongly disagree which may be also due to inaccessibility.

Based on the findings of this study, the following recommendations are made

1) There is a need for regular monitoring of urban sprawl and development by the state Government in the study area especially with the aid of geospatial techniques for better decision making.

2) There is a need for all stakeholders like Ministry of Land and Survey, Ministry of Environment, State Development Board and NGOs in urban land use management to ensure strict adherence to urban land use legislations.

3) There is a need for a regular appraisal by the state government on analysis of urban dynamics and development using geospatial techniques so as to easily detect areas that are fast growing and need attention in the study area.

4) Government should encourage researchers to further carry out urban-related studies with socio-economic effect in the study area for a more in-depth understanding of the dynamics of urbanization.

References

Ade, M.A. and Afolabi, Y.D., (2013) Monitoring Urban Sprawl in the Federal Capital Teritory of Nigeria Using Remote Sensing and GIS Techniques. Ethiopian Journal of Environmental Studies and Management, 4, 82-95.

Andrew, N. R., Tsado, S. N., & Oguche, C. I. (2018). Mapping of Waste dumpsites using geospatial technique in Karu, Nasarawa State, North Central, Nigeria.

Atiqur, R., Maik, N., Alka, S. and Javed, M. (2009) Urban Population-Environment Dynamics in the Developing World: Case Studies and Lessons Learned. Committee for International Cooperation in National Research in Demography (CICRED), Paris, 316 p.

Balzerek, H. (2003) Achievements and Problems in the Evolution of Urban Centers in Nigerian Savannah: Case Study of Gombe. Symposium of the Sonderforschungsbereich 268', 29th May 1999, Frankfort/Main, Germany: Persistence and Transformation between Chad Basin and Benue

Chunwate, B. T., Yahaya, S., Amankwe, C. O., Samuel, A., & Madaki, B. R. (2019). Assessment of Urban Sprawl Using Geospatial Techniques in Awka Town, Anambra State, Nigeria. *Journal of Geographic Information System*, *11*(03), 359.

Hashidu, B. R., & Muhammed, B. U. (2018). Road Transport Development and Urban Growth in Gombe Metropolis, Gombe State, Nigeria. International Journal, 7(1), 2675-2684.

Isma'il, M., Ishaku, E., Yahaya, A. M., Tanko, M. A., & Ahmed, H. T. (2015). Urban growth and housing problems in Karu local government area of Nasarawa State, Nigeria. *Global J. Res. Rev*, 2, 45-57.

Kanayochukwu, E. C., & Dogo, B. (2019). Profiling the Characteristics of Karu Slum, Nasarawa State, Nigeria. *Journal of Service Science and Management*, *12*(5), 605-619.

KAPDA, 2001: Karu Planning Development Area Report. Nasarawa, Nigeria.

Malthus, T.R. (1798) An Essay on the Principle of Population, as It Affects the

Future Improvement of Society. With Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers. As Reprinted in Malthus (1960)

Mbaya, L.A. (2012) A Study of Inter-Relationships among Gully Variables in Gombe Town, Gombe State, Nigeria. Wudpecker Journal of Geography and Regional Planning, 1, 001- 006.

Nasarawa State, (2010) Department of Geography and Planning, University of Jos, Nigeria.

Nwafor, J.C., (2006) Environmental Impact Assessment for Sustainable Development: The Nigerian Journal on Agricultural and Food Security, 4, 9-16.

Rikko, S. L. (2013). Monitoring Urban Sprawl in Greater Karu Urban Area (Gkua), Nasaraw State, Nigeria.

Torrens, P.M. and Alberti, M. (2002) Measuring Sprawl. Paper Presented to the Association of Collegiate Schools of Planning (CSP), Atlanta, GA, 1-13

Torrens, P.M. and Alberti, M. (2006) Measuring Sprawl. Working Paper Series

Yari, K., Madziga, B., Sani, M., 2002: Karu Governance and Management Institutions, Landuse Management and Urban Services Management. Karu Cities Alliance Initiative Technical Report for the UN-Habitat Component of Karu Development Strategy