FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 6, December, 2023, pp 227 - 233
DOI: https://doi.org/10.33003/fjs-2023-0706-2120

CHANGE IN LAND USE/LAND COVER USING REMOTELY SENSED IMAGES IN KAFANCHAN AREA OF KADUNA STATE, NIGERIA

Akeem O. Olaniyi, Mercy Richard, Bulus Sule, Deborah Abasha and *Mande, K. Hosea

Department of Environmental Management, Faculty of Environmental Science Kaduna State University, Kaduna State

*Corresponding authors' email: hosea.mande@kasu.edu.ng

ABSTRACT

Vegetation cover in Kafanchan has been on the decrease which has suffered more and undue depletion and degradation. This research assessed the change of land use/land cover for the span of 45 years (1988-2023). This study made use of LANDSAT 2, 4, 8 and 8 images of the year 1988, 1998, 2016 and 2023 accordingly. The images were processed using Arcmap 10.3. For the secondary data collection, the area was demarcated into bare land, water bodies, vegetation and built-up areas. The results shows that there has been an increase of built-up areas from 28.19% of the study area in 1988 to 44.73% in 1998 and 45.98% in 2023. Vegetation land use has also shown a decrease from 49.75% in 1988 to 30.54% in 2023. Water bodies decreased from 12.3% in 1988 to 10.92% in 2023. Vegetated land was the most dominant land cover class in the study area but decreased to 28.84% in 1998, and increase from 28.84% in 1998 to 30.54% in 2023 this is supported by the continuous decline of high-end Normalized Difference vegetation index (NDVI) values from 1988 (0.536), 1998 (0.411), 2016 (0.380) and 2023 (0.280) implying that vegetation cover in Kafanchan is steadily being depleted. The applications of RS and GIS will promote better understanding in the monitoring of land use-land cover interactions to aid planning, management and enterprise.

Keywords: Images, land cover, land use, LANDSAT, vegetation

INTRODUCTION

Land is required for different uses both in urban and rural areas of human societies. It is a major factor of production and vital element for socio-economic development of any country or society (FMHUD, 2006). Man has been modifying land to obtain basic essentials for thousands of years, but current rates, extents and intensities of land use and land cover change are far greater than ever in history, driving unprecedented changes in ecosystems and environmental processes at local, regional and global scales. These land uses exert pressure on the obvious finite land resources in urban centres. Hence, land is fast becoming a critical resource, its demand remains a fundamental issue of both academic and policy discourse (Ejaro and Abdullahi, 2013). Ejaro and Abdullahi (2013) also noted that due to poorly planned human interference, many African countries have witnessed untold environmental degradation and ecological deterioration in the past century, with little or no real solution to alleviate many of these concerns.

Changes in the environment, modifications in ecosystem structures and the loss of biodiversity are affecting the whole planet, arousing worldwide public concern. Scientific and political debate on these issues both nationally and internationally stated since the beginning of the 20th century (Boletta et al., 2000).

Enisan and Aluko (2015) presented that the Nigerian problems of land used change is annexed to urban Sprawl, outward swell of built-up areas caused by urbanization. Unchecked urban sprawl may join cities into conurbations. Similarly, the problem of deforestation the indiscriminate cutting or/and over-harvesting of trees for lumber or pulp, or to clear the land for agriculture, ranching, construction, or other human activities.

Historically, the two most common reasons people cut forests are to clear land for agriculture and settlement and to use or sell timber for lumber, paper products, or fuel (Botkin and Keller, 2011).

The blessing of variety across landscapes have distributed ecological races (populations adapted to ecological dissimilar habitats that build species vigour and/or lead to speciation) unique to its habitat (Soper et al., 1997). Monitoring land use/cover change had become an important theme of research due to extent to which these change influence global fluid system, the atmosphere, the world climate and sea level change (Meyer and Tuner II, 1992). The aim of the research is to determine the rate of change of land use/land cover in Kafanchan from remote sensed images from 1988 to 2023

Materials and methods

Study Area

Kafanchan is the headquarters of Jema'a Local Government Area of Kaduna. It has a geographical coordinate between latitude 9º33 '30"to 9º36 '30"North and longitude 8º 16' 0" to 8º 20' 0"East (Figure 1), with an elevation of 739km (2,425 feet) and a time zone of WAT (UTC+1). It is a junction station of the Nigerian Railway Cooperation connecting port-Harcourt, Enugu, Kuru, Bauchi and Maiduguri. It is located relative to Sabo in the North-east, Ungwan Madaki Northwards, Kwarabe and Gigira South-eastwards (Musa et al., 2016).

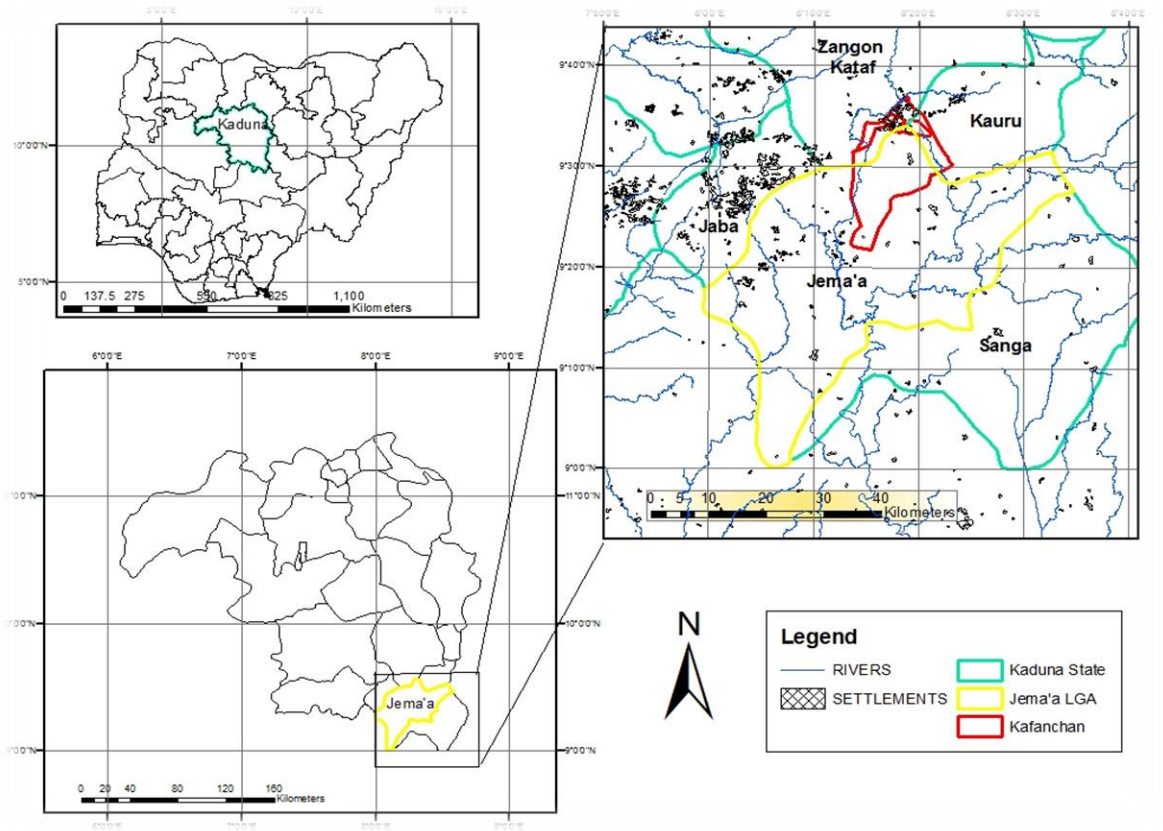

Figure 1: Map of Study Area

METHODS OF DATA COLLECTION

Land Use/Land Cover Analysis

LANDSAT 2, 4, 8 and 8 images of the year 1988, 1998, 2016 and 2018 respectively were downloaded from United States Geological Survey (USGS; www.glovis.usgs.gov) and Earth Explorer websites at path 188 and row 53. The land use/land cover analysis show interaction between land uses. The result of the change detection is to determine the percentage change in vegetation cover to other land use/land cover classes. The classification used is a modification of Anderson et al.,(1976). The land-use/land-cover classes include Bare land, which composed of farm lands, open fields and cleared sites; Built-up land, compose of settlements and paved surfaces; Water bodies, composing all river channels and surface water, and vegetation comprising forest, grasslands, and shrub lands. The analysis was performed in the computer environment of Environmental System's Research Institute's (ESRI's) Arcmap 10.3.1.

RESULTS AND DISCUSSIONS

Result of Image Classification

The land cover maps generated after running a maximum likelihood supervised classification presented in figure 2 below. As shown from the figures, there has been an increase of built up areas with respective values 28.19% of the study area in 1988 to 44.73% in 1998 and 45.98% in 2023 (table 1). Vegetation land use have also shown a decrease from 49.75% in 1988 to 28.84% in 1998, then and increase from 28.84% in 1998 to 30.54% in 2023 (table 1). However, there was increase of water bodies' land class from 12.3% in 1988 to 25.64% in 1998, then a decrease to 10.92% in 2023. In 1988 vegetation land cover covered 49.7% of the study area. From figure 2 and table 1, vegetated land was the most dominant land cover class in the study area but decreased to 28.84% in 1998, and increase from 28.84% in 1998 to 30.54% in 2023. Because of the decrease of vegetated areas, built up areas dynamically increased from 28.19% in 1988, 44.73% in 1998 and to 45.98% in 2023, making built-up land the dominant land cover in 2023 (Figure 2).

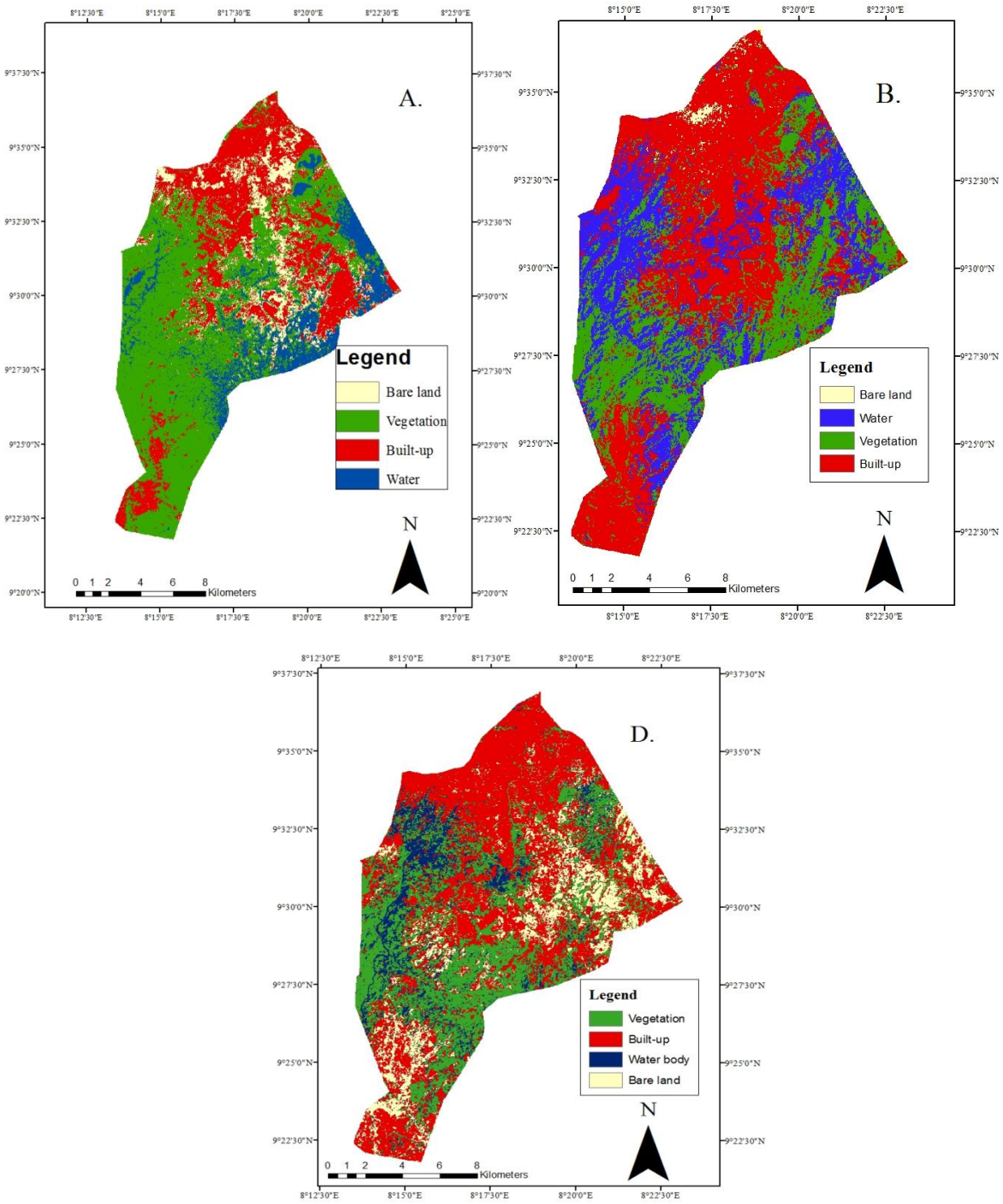

Figure 2: Classified map of kafanchan for 1988 (a), 1998 (b) and 2023 (d).

The increase in the land area of water bodies (Figure 2 and table 1) from 12.3% of the study area in 1988 to 25.64% in 1998 and a decrease to 10.92% of the study area in 2023 attributed to the close association vegetation and water bodies have in the study area. Due to the decrease cover of vegetation surface reflectance as registered by the pixel values in each of the years (figure 3). Table 1 below presents a summary of areas and percentage of land cover classes in the last 40 years. In Idowu et al., (2018) and Musa et al., (2016), the streak similarity of decrease in vegetation cover, uncover the decrease of vegetation from 1988 (49.75%) to 28.84% in 1998 and 30.53% in 2023 (Table 1 and Figure 2).

Table 1: Area statistics of land use and land cover units from 1988 to 2023

Land Use Type	1988		1998		2023	
	Area (Ha)	Percentage (%)	Area (Ha)	Percentage (%)	Area (Ha)	Percentage (%)
Bare land	2428.92	9.76	197.82	0.79	3129.21	12.57
Vegetation	12383.73	49.75	7178.58	28.84	7599.51	30.53
Built-up	7015.59	28.19	11131.11	44.73	11445.12	45.98
Water body	3060.45	12.3	6381.18	25.64	2714.85	10.92
Total	**24888.69**	**100**	**24888.69**	**100**	**24888.69**	**100**

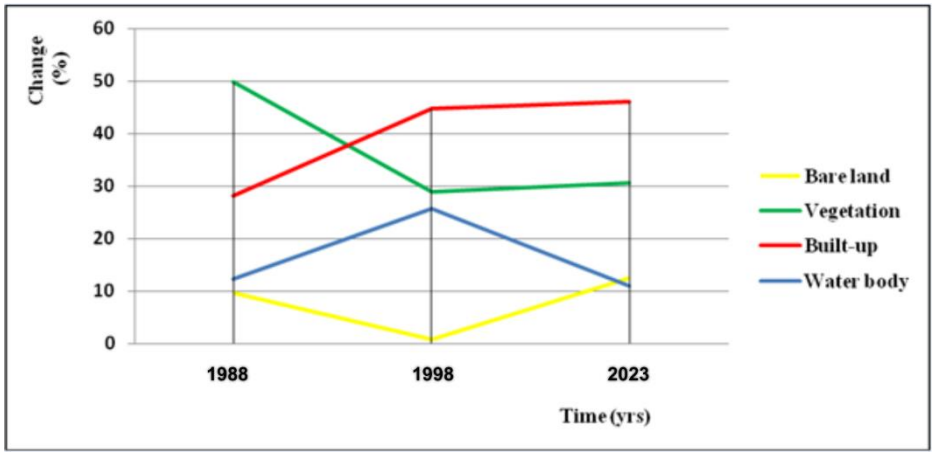

Figure 3: Time series of land use/land cover change from 1988-2023.

Result of normalized difference vegetation index

Thematic maps of Kafanchan produced from their satellite imageries using ArcGIS 10.3.1 software, green area index generated for the study area (Figures 4 and 5). The maps show the boundary of the five wards together. Greenness indices determine the level of greenness of the wards. The greenness indices of the study area calculated from 1988, 1998, 2016 and 2023 Landsat imageries. The 1988 image (Figure 4, A)NDVI value was found to be highest at 0.536 and at the lowest high value for year 2023 0.280 (Figure 5, D). NDVI value recorded in 1988 was highest at 0.536 and lowest at -0.048 (Figure 4, A). NDVI value in 1998 was highest at 0.411 and lowest at -0.126. In year 2016 (Figure 5 C) while it was highest at 0.380 and lowest at -0.046, year 2023 (Figure 4, D) NDVI value was highest at 0.280 and lowest at -0.224. The continuous decline of high-end NDVI values from 1988 (0.536), 1998 (0.411), 2016 (0.380) and 2023 (0.280) implies that vegetation cover in Kafanchan is steadily being depleted.

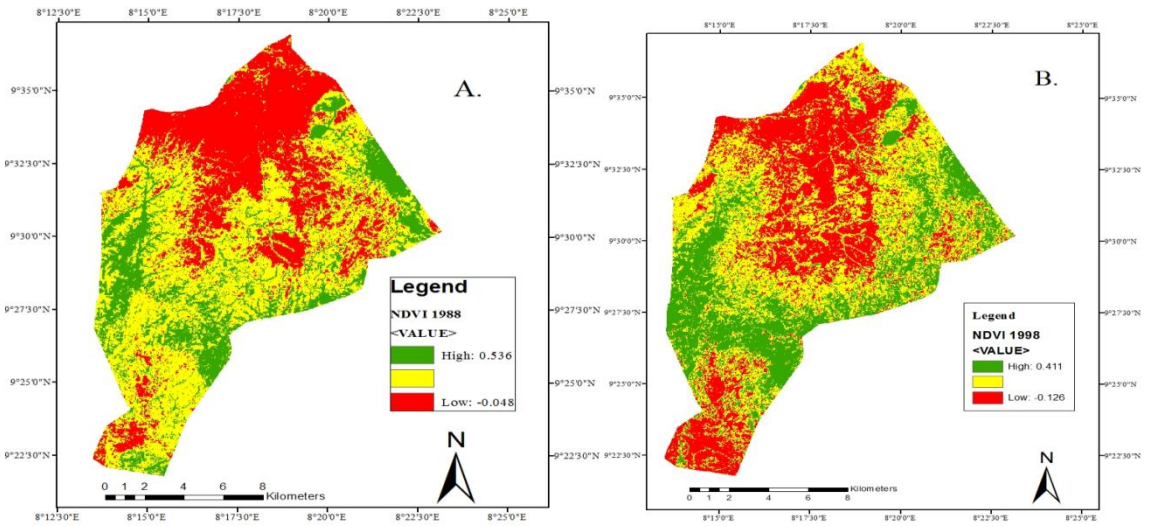

Figure 4: Map of Kafanchan showing NDVI layer for 1988 (a) and 1998 (b).

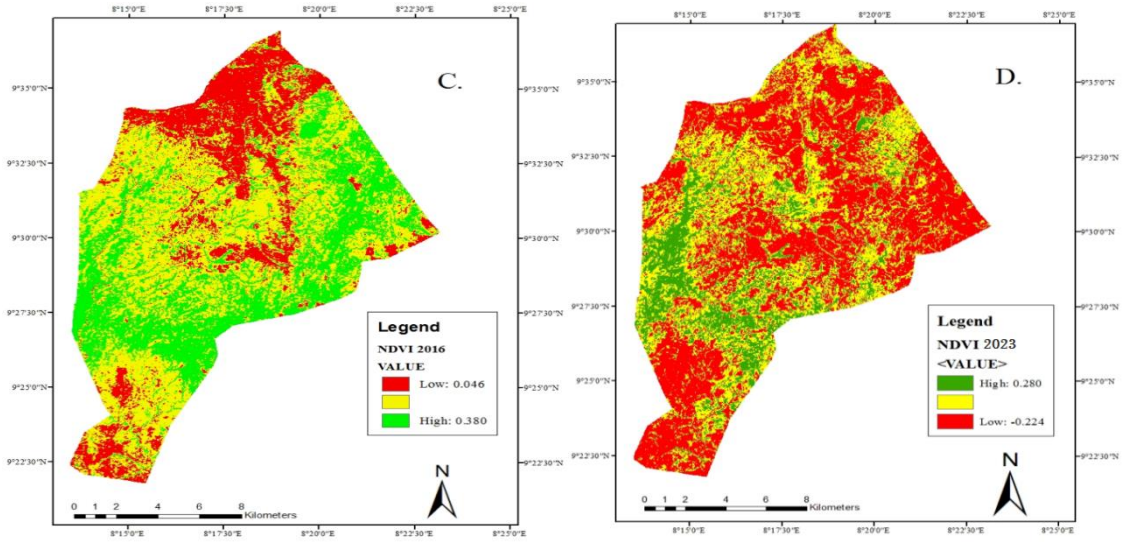

Figure 5: Map of Kafanchan showing NDVI layer for 2016 (c) and 2023 (d).

Factors of Land Use/Land Cover Change

Residential property use is the dominant land use in Kafanchan (72.8%) although not the fastest growing land use. Land is devoted to the use that generates the highest potential profitability reflected in land rents (Chomitz and Gray, 1996; Irwin and Geoghegan, 2001; Munroe et al., 2001; Nelson et al., 2001). Hassan (2018) enunciated that the ownership of residents gives 44.3% rented households, government quarters 17%, 11.4% inherited and 7.3% are owner occupied. Residential land use is a fast growing land use (26.7%) according to the respondents, second only to agricultural land use (58.6%). At Kagoro forest Ati el al., (2009) and at the Nimbia forest Lekwot et al., (2014) posited that decrease in forest areas are as a result of cultivation for agricultural purposes and illegal felling of wood and farming activities respectively. A concord of findings is observed in Agbedeyi et al.,(2012) who inferred that within the year (2014 – 2016), food production has increased due to economic recession, which implies that many have ventured into Agriculture (farming notably). An analogous situation is observed that economic recession as a major cause of decreasing forest and vegetated areas for either agricultural purposes (91.4%) or residential development (88.6%). Shahata et al., (2014) noted that the pattern of political changes, shift in economy, and an increase in population has resulted in an increased urban area. There is a definite increase in the population of Kafanchan (Musa el al., 2016), however, crises that have occurred in 1987, 2011 and 2015 (Iruonagbe, TC 2009). 72.4% of responses affirm that crises have opened new areas to residential development. The overhaul consequences of increasing agricultural cultivation means that forest/vegetated land are being cleared. 89.1% of responses assent that deforestation opens forest areas to development and agricultural activities. These developments include establishment of new institutions (82.8%), commercial activities (71%) and planting of economic trees for economic activities (71.9%).

Similarly, between the period of 2001 and 2009, Idowu et al., (2018) reveal across country degradation of forest resources and savannah land cover from the change detection results. The effects of climate change, farming, logging activities, woods for domestic uses construction and other anthropogenic factors are key highlights they enunciated. Idowu et al (2018) advanced decrease of savannah cover from 56% in 2001, to 44% in 2005 because of agricultural activities and increased to 47.91% in 2009 due to high gain from forest cover. The loss in savannah could affect agriculture especially if it is lost to barren lands. Musa et al., (2016) between 1986 and 2014 reveal the highest amount of change Vegetation and Built-up, Vegetation decrease seriously from 56.5% in 1986 to 25.3% in 2014, Bared surface drastically decreases from 39.3 in 2000 to 19.5% in 2014. In Kafanchan, the survey revealed a miniature of deductions of Lambin et al., (2001), Musa et al., (2016) and Idowu et al., (2018) that agricultural activities, commercial activities, crises (civil unrests), development of residential buildings, flooding, and tree planting for economic reasons are lead causes of land use change. Vegetation land use has shown a decrease from 49.75% in 1988 to 28.84% in 1998, then and increase from 28.84% in 1998 to 30.54% in 2023. There was increase of water bodies' land class from 12.3% in 1988 to 25.64% in 1998, then a decrease to 10.92% in 2023. Built up areas dynamically increased from 28.19% in 1988, 44.73% in 1998 and to 45.98% in 2023, making built-up land the dominant land cover in 2023.

Normalized Difference Vegetation Index

There has been continuous decline of NDVI values from 1988 (0.536), 1998 (0.411), 2016 (0.380) and 2023 (0.280), which implies that vegetation cover in Kafanchan is steadily being depleted. Ahmed (2016) in his study of vegetation cover of the Ethiopian highlands where rainfall average is 1447 mm obtained NDVI maximum values of 0.9 in 1986 and 0.16 in 2023. The NDVI result for Kafanchan in 2023 (0.280) despite continuous decrease of NDVI values are observed to be higher than the 2015 NDVI values of Minna (0.210) and Abuja (0.042) as shown in the study by Agbelade et al., (2016) while comparing the vegetation index between Minna and Abuja. Olutoyin et al., (2017) in their across country vegetation studies between 1981 and 2010 obtained NDVI low (-1.0) and high (0.5) values. In the view of Olutoyin et al., (2017), points where NDVI values peaked (Akure, Calabar, Ikeja, Owerri and Warri) experience high rainfall of about 3,000 mm a par with 1800mm mean average experienced in Kafanchan. Davenport and Nicholson (1993) showed strong similarity between temporal and spatial patterns of NDVI and rainfall when annual rainfall was below l000 mm and monthly rainfall below 200 mm. Tailing from Niasse (2005), the region of West Africa has experienced a dent decline in rainfall from 15 to 30% depending on the area following the

IPCC, rainfall was seen to have decreased to 29-49% between 1968-1997 (McCarthy et al., 2001). The trend of continuous decline in rainfall conditions was paused by a brief return in 1994, however decline of rainfall average continued to 2008 (Abeje et al., 2010). As NDVI values are directly proportional to rainfall average, there is a correlation between the findings of Olutoyin (2017) and the results obtained from 1988 to 2023, since the interruption of 1994 average rainfall was a one-time extreme.

Research Findings

Most major metropolitan areas face the growing problems of urban sprawl, loss of natural vegetation and open space, and a general decline in the extent and connectivity of wetlands and wildlife habitat (USGS, 1999). Lambin et al., (2001) in their study involved 26 researchers, from a variety of disciplines evaluating case studies around the world, to assess the causes of land change enunciated: tropical deforestation, rangeland modifications, agricultural intensification and urbanization.

In Kafanchan, the survey revealed a miniature of deductions of Lambin et al., (2001) that agricultural activities, commercial activities, crises (civil unrests), development of residential buildings, flooding, and tree planting for economic reasons are lead causes of land use change. Findings supports the results obtained from the NDVI which show that vegetation cover in Kafanchan has been on the steady decrease and its of much concern at the start of recession in 2016 (NDVI highest value:0.38) and 2023 (NDVI highest value: 0.28). In Idowu et al., (2018) and Musa et al (2016), the general similarity of decrease in vegetation cover, uncover the decrease of vegetation in Kafanchan from 1988 (49.75%) to 28.84% in 1998 and 30.53% in 2023.

CONCLUSION

Consequence of urban growth capable of transforming rural areas to urban, and towns to metropolis, there is always increased competition as well as demand for land for different purposes. The evidences show first that there is significant change in vegetation land cover between 1988 and 2023. This revealed the impact of land use change in Kafanchan area of Kaduna State and the infamous decrease in vegetation land cover is of great concern since vegetation is key in the ecological stability of any area.

REFERENCES

Abeja I.B., and Usman S.U. (2010): "An Analysis of Rainfall Trends in Kafanchan, Kaduna State, Nigeria." *Research Journal of Environmental and Earth Science* 2 (2): 89-96. Maxwell Scientific Organization.

Abgedeyi O.D, and R.U. Adigwe (2018): A Statistical Analysis of the Impact of Economic Recession on Food Production in Nigeria. Global Scientific Journal 6(2): 153-164

Adaaja B.O. (2015): Diversity and Geospatial Distribution of Trees and Shrubs in Gurara Forest, Kaduna State. Unpublished Thesis in the Department of Biological Sciences, Ahmadu Bello University, Zaria.

Agbelade A.D., Onyekwelu J.C. and M.B. Oyun (2016): Tree Species Diversity and their Benefits in Urban and Peri-urban Areas of Abuja and Minna, Nigeria. Applied Tropical Agriculture 21(3): 27-36.

Al-Amin M.A. (2014): Urban Vegetation Study of Kaduna Metropolis Using GIS and Remote Sensed Data. Journal of Natural Sciences Research 4 (2).

Anderson, J.R., Hardy, E.E., Roach, J.T. and Witmer, W. E. (1976). *A Land-use and Land-cover Classification System for Use with Remote Sensing Data* (No. 964). Reston, Virginia.

Ati O.F., Sheyin T., Abass I., and Mohammed S.O. (2009): Assessing Changes in Kagoro Forest, Kaduna State Nigeria Using Remote Sensing and GIS. Research journal of Applied Sciences, Engineering and Technology 2(2): 121-132.

Boletta, P.E., Ravelo A.C., Planchuelo A.M., and Grilli, M. (2006): Assessing Deforestation in the Argentine Chaco. Forest Ecology and Management. 228. 108-114.

Botkin D.B. and Keller E.A. (2011): Environmental Science: Earth as A Living Planet. Hohn Wiley and Sons, inc.

Chomitz K M, Gray D A, (1996): Roads, land use, and deforestation: a spatial model applied to Belize the World Bank Economic Review 10: 487-512

Davenport, M. L., and S. E. Nicholson, 1993: On the relation between rainfall and the Normalized Difference Vegetation Index for diverse vegetation types in East Africa. *Int. J. Remote Sens.,* **14,** 2369–2389

Ejaro, S. P. and Abdullahi, U. (2013): "Spatiotemporal analysis of land use and land cover changes in Suleja, Niger State, Nigeria." *Journal of Environment and Earth Science, 3* (2)

Enisan G. and Aluko E. (2015): Process of Urban Land Use in Nigeria. International Journal of Education and Research Vol. 3(8).

Federal Ministry of Housing and Urban Development (FMHUD, 2006): Sustainable Human Settlements Development. In *Nigerian National Urban Strategies*, Abuja; Federal Ministry of Housing and Urban Development.

Hassan H.E. (2018): Assessment of Housing Quality in Kafanchan, Kaduna State". Unpublished Dissertation in Department of Environmental Management, Kaduna State University.

Idowu I.A., Bello O.M., and Hannatu A. (2018): Mapping and Analyzing the Land Use-Land Cover of Nigeria Between 2001and 2009. MOJ Ecology and Environmental Science.

Iruonagbe T.C. (2009): Region and Its Attendant Conflicts in Nigeria: A Paradox. International Journal of Theology and Reformed Tradition 1: 152-168

Irwin E, Geoghegan J, (2001): ``Theory, data, methods: developing spatially-explicit economic models of land use change"Agriculture, Ecosystems and Environment 85: 7-24

Konecny (2003): Geoinformation: Remote Sensing, Photogrammetry and Geographic

Lambin E.F., B.L. Turner, H.J. Geist, S.B. Agbola, A. Angelsen,J.W. Bruce, O.T. Coomes, R. Dirzo, G.U. Fischer, C. Folk, P.S. George, K. Homewood, J. Imbernon, R.

Leemans, X. Li, E.F. Moran, M. Mortimore, P.S. Ramakrishnan, J. F. Richards, H. Skanes, W. Steffen, G.D. Stone, U. Svedin, T.A. Veldkamp, C. Vogel, J. Xu. (2001): The Causes of land-use and Land-cover Change: Moving Beyond the Myths. Global Environmental Change 11: 261-269.

Lekwot E.V., Musa I., Hussaini Y., Tukur Y.M., and Tudun-Wada M.I. (2014): Analysis of Forest Cover Changes in Nimbia Forest Reserve, Kaduna State, Nigeria Using Geographic Information System and Remote Sensing Techniques. Journal of Environment and Earth Science 4 (21).

McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White, (2001): Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, pp: 487-532. Cambridge: Cambridge University Press. Retrieved from: http://www.grida.no/climate/ipcc_tar/wg2/pdf/wg2TARchap 10. Pdf.

Meyer, W.B. and Tuner B.L. II, (1992): Human Population growth and global land use/ land cover change. Annual Review of Ecology and Systematic. (23) 39- 61.

Munroe D., Southworth J., and Tucker C. M., (2001): The dynamics of land-cover change in western Honduras: spatial autocorrelation and temporal variation, paper prepared for the 2001 American Agricultural Economics Association Annual Meetings, http://www.uncc.edu/dkmunroe/publications.html

Musa J.Y., M. Adamu., and A. Mohammed (2016): "Change Detection Analysis of Land Use Land Cover in Kafanchan, Kaduna State". *IOSR Journal of Environmental Science, Toxicology and Food Technology Vol 10: 1-10.*

Ndei C. (2014): Gendered Perspective of Cultural Factors that Influence Conservation of Useful Tree Species in Igembe Sub-county, Uper Eastern Region. Unpublished Dissertation in the Institute of Anthropology and African Studies. University of Nairobi.

Nelson G. C., Harris V., and Stone S. W., (2001): Deforestation, land use, and property rights: empirical evidence from Darien, Panama Land Economics 77: 187-205

Niasse, M., (2005): Climate-Induced Water Conflict Risks in West Africa: Recognizing and Coping with Increasing Climate Impacts on Shared Watercourses. An International Workshop organized by Centre for the Study of Civil War, International Peace Research Institute, Oslo (PRIO) and Centre for International Environmental and Climate Research at University of Oslo (CICERO) for the Global Environmental Change and Human Security Program (GECHS). Retrieved from: http://www.gechs.org/downloads/holmen/Niasse.pdf.

Olutoyin F., Olusola A. and Adedeji O. (2017): Geospatial Analysis of Changes in Vegetation Cover Over Nigeria. Bulletin of Geography Series 13: 17-28.

Shahata A., Banna E.F., and Saleh Y. (2014): Agricultural Land-Use Change ans Disappearance of Farmlands in Kaduna Metropolis-Nigeria. Science World Journal 9 (1).Adekunle, V. A. J. (2006). Conservation of Tree Species Diversity in Tropical Rainforest Ecosystem of Southwest Nigeria. *J. Tropical Forest Science 18(2):91-101.*

Soper R., Taylor D.J., Green N.P.O and Stout G.W. (1997): "Biological Science 1&2". Cambridge University Press

Takai A.R. (2011). An Assessment of the Current Ecological Status of Kagoro/Tsonje Riparian Forest, Kaduna State. *A Thesis Submitted To The School of Postgraduate Studies, Ahmadu Bello University, Zaria, Nigeria.*

Ulloa K.M. (2015): Exploring the Relationship beteen Urban Forests and Ethnicity in West Covina Using GIS and object-based Image Analysis. Unpublished Thesis in the Graduate School University of Southern California.

Wawira K.M. (2010): Assessment of Indigenous Tree Species Conservation in Subsistence Agricultural Production Systems: A case Study of Lari Sub-County, Kiambu County. Unpublished Dissertation in the Department of Geography and Environmental Studies, Univeristy of Nairobi, Kenya.