OSUN GEOGRAPHICAL REVIEW

Journal of the Department of Geography,
Osun State University, State of Osun, Nigeria

Volume 5, 2022

ISSN: 2695 - 1959

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Published by the
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Published by the Department of Geography, Osun State University, State of Osun, Nigeria
ISSN: 2695 - 1959 Volume 5, 2022; 194 - 203

ASSESSMENT OF THE IMPACT OF URBAN GROWTH ON AGRICULTURAL LANDS IN ZARIA AND ITS ENVIRONS

[1]R. E. Agbo, [2]E. Ikpe and [1]A. Mayowa
[1]Department of Geography, Federal College of Education, Okene, Kogi State, Nigeria
[2]Department of Geography, Federal College of Education, Odugbo, Benue State, Nigeria
**Corresponding author e-mail: odehevelyn@gmail.com*

Abstract
Agricultural activities are an important industry on earth. Human civilisation depends on agriculture because it provides food for man, feeds for animals, and raw materials for industries. The essence of increasing land for agricultural activities in Zaria is to produce more food to cater to the increasing population and ensure food security. Hence, urban growth is competing for arable space for agricultural activities. Therefore, this study assessed the impact of urban growth on agricultural lands in Zaria and its environs from 1970-2009 (40 years) and its implication on agricultural activities. Remote sensing and GIS techniques were used to determine the spatial expansion of built-up areas in Zaria from 1970-2009. Four satellite images of four epochs, LandSat Multi-Spectral Spectrometer (MSS) image of 1973, Landsat Thematic Mapper (TM) images of 1990, LandSat Enhance Thematic Mapper (ETM) images of 1999 and NigeriaSat-1 image of 2009 were obtained and used for the study. The results show a gradual increase in the land areas covered by built-up, scattered and wetland cultivations; there was a general decrease in the land areas covered by bare surfaces and shrubland; the built-up area showed a gradual increase from 14.52km^2 1973 to about 37.13km^2 in 2009 which represents approximately 39.11% increase. Furthermore, while urbanisation is taking over previous agricultural lands, agricultural lands take over shrublands, wetlands, plantations, bare surfaces and forest lands. Urbanisation influenced the availability of arable lands that should have been cultivated for crop production. However, the study recommended the need to encourage urban agriculture; policymakers, urban planners and individual landowners should adopt a policy that will suit agricultural lands in Zaria toward profitable agricultural activities and food security.

Keywords: Agricultural activities, Climate change, Spatial expansion, Urbanisation, Wetlands

Introduction

The process of urban growth is closely related to the size distribution of cities. Cities and urban areas are critical components of global sustainability as loci of sustainability progress and drivers of global transformation, especially in terms of land use, energy efficiency, climate change adaptation, and social innovation. However, urban ecosystems have not been incorporated adequately into urban governance and planning for resilience despite mounting evidence that urban growth and well-being are closely tied to agricultural activities, food security, quality, quantity, and diversity of urban ecosystem services (UN-HABITAT, 2018). Urban growth can have positive and negative effects, but adverse effects are projected to predominate on agricultural lands for much of the world. This will adversely affect people's livelihoods (Abaje, Sawa, and Ati, 2014).

Urban growth refers to the process of growth and decline of economic agglomerations. It is the spreading out of a city toward non-built-up areas at the periphery of an urban area. This process involves the conversion of other land use categories into built-up, developed land over time. According to Environmentalists, the actual amount of urbanised land is an important overall measure of urban land expansion (Akpu, Adamu, David and Bala, 2017). Cities worldwide are experiencing rapid spatial expansion mainly due to rapid population growth, economic development and infrastructure initiatives (Jat, Garg, & Khare, 2008). In the year 2000, the urban built-up area in the world consumed about 400,000 square kilometres, amounting to about 0.3% of the total land area (Angel, Sheppard, Civco, Buckley, Chabaeva, Gitlin et al., 2005). This is projected to reach 1,100,000 (about 0.85%) by 2030 if the same growth rate is sustained. The authors pointed out that cities in less developed countries would account for more of this growth. If such an increase is not adequately planned and controlled, it would adversely affect the environment, converting arable lands into human settlements, disrupting the ecosystem and consequently, leading to different forms of hazards with attendant consequences on both the human and natural environment (Akpu, Adamu, David and Bala, 2017). In most cases, agricultural lands are greatly endangered with their attendant challenges on farming activities and food security.

According to Akpu, Adamu, David and Bala (2017), vegetation in a city sometimes signifies the presence of nature in a predominantly man-made environment. Urban vegetation is vital for sustainable development, environmental conservation and the urban planning process of a city. However, this is the most endangered component of the world's ecosystem, particularly in Nigeria. Many vegetation and vegetative areas in Zaria and its environs have been deliberately cleared and used for infrastructure expansion and development. This rapid urban growth has led to the clearing and conversion of arable farmlands into residential and infrastructural development areas.

Africa is going through rapid urbanisation. The United Nations estimated the annual average growth rates as 4.7% and 4.6% between 1960 and 1980, and 2000, respectively (Mabogunje, 1968). Nigeria is the most urbanised country on the African continent. The annual urbanisation rates in Nigeria were 4.9%, 5.13% and 6% in 1965-1970, 1970-1975 and 1975-1980, respectively (United Nations, 1975). Based on the 1952/1953 census, Abumere (2003) observed that of the 54 towns with a population of 20,000 and over, as high as 31 were in the southwest, while only 13 and 10 were in the north and southeast, respectively. In the 1963 census, of the 183 such towns, 84 were in the southwest, while 67 and 32 were in the north and southeast. Clearly, the southwest is far and away the most urbanised in Nigeria. By 1991, 66% of the population of the southwest was urbanised compared with 22.8% in the north, 28.8% in the east and 38.8% in the mid-west region. In the 1991 census of Nigeria, the number of settlements with populations of 20,000 or more was 359. Estimates for the year 2002 put this number at 680. The number of cities with a population of a million or more is estimated to be 18 by 2002. By the year 2030, it was expected that there would be more people in the urban than in rural areas in Nigeria.

Urbanisation and urban growth are considered a modern way of life, bringing economic growth and development; however, it has encountered several ecological problems, particularly on agricultural land. In developed nations, urban expansion and industry with technological advancement, economic development and social transformation had a close relationship in developed nations which triggered, diffused and boosted the whole socio-cultural conditions of the society. This indicates that urbanisation is the main reason for the rise in living standards. Unlike third-world countries, urbanisation appears to be more of a function of rural push factors. In other words, while Nigeria's urban population is increasing, the resources to manage the cities are dwindling. This mismatch between rapid urban growth and the growth in resources is at the root of the pervasive urban decay in Nigeria, characterised by urban poverty, inadequate infrastructure, ill-managed urban environment and severe urban insecurity (Abumere, 2003).

Urbanisation has a great impact on the environment. According to Odjugo and Ikhuoria (2003), converting agricultural lands into other land uses has severe implications for the people's livelihood, reducing viable agricultural lands and crop production, and leading to food shortage. This has prompted massive emigration and resettlement of people to areas less threatened by desertification. Such emigration gives rise to social effects like loss of dignity and social values (Ikpe & Ejeh, 2018).

Deforestation, the deliberate destruction of vegetation due to human activities and domesticated animals, have altered the vegetation of the study area so much that the natural vegetation or climatic climax vegetation no longer exists today. Instead, one finds Plagio-climax vegetation, secondary forest, derived vegetation, plantations of tree crops and cultivated lands (Abaje, 2007). Deforestation is one of the factors that cause climate change.

The anticipated conversion of agricultural land to urban land use is responsible for the price of farmland with increasing distance from the city since the price of farmland decreases sharply with decreasing distance towards the city and increases gently away from the city (Cavailhès and Wavresky, 2003). Proximity to the market is also vital in urban agricultural decision-making as it affects transportation costs (Drechsel and Dongus, 2010).

Urban land use expansion typically displaces urban agriculture not only within the cities but also from the periphery of cities to some distance further away (Bittner and Sofer, 2013). The continuous shifting of urban agriculture is a result of intense competition for the use of land occupied by urban agriculture. Despite this continuous shifting, patches and/or relics of urban agricultural land use still characterise some isolated localities in cities where conditions are favourable or near favourable for survival.

Zaria's development and growth are attributed to its location in the centre of vast and fertile agricultural land. Agriculture is by far the most critical activity of the working population of Zaria and its region. Approximately 50 per cent of Zaria's working population derives their principal means of livelihood from agriculture (Ahmadu Bello University, 2000). Under rapidly increasing population and economic growth, other activities such as housing for various use (residential, educational, health, commercial, recreation) and industries tend to compete with agriculture for land. Because housing and industries pay higher rents, they tend to compete with agriculture for land, except where official land use policies give agriculture privileges over other uses and are strictly followed (Ariyo, 1991). In Northern Nigeria, despite the long-existing law which gives the government control over all lands, there is no strict law enforcement in urban and rural areas for which no development scheme has been developed. This has led to an informal land market with more speculative land holdings, and agricultural lands tend to be more easily converted into other uses (Ariyo, 1991). Typical examples of such haphazardly developed areas in Zaria are Zango, Grace land (Hanwa) and Hayin-Dogo.

Zaria and its environs have been experiencing rapid urban growth over the last four decades. However, the land being used for agricultural production around a rapidly growing urban centre will most likely be converted to non-agricultural uses. Therefore, this paper assesses the impact of urban growth on agricultural lands in Zaria and its environs, while the fundamental objective of this paper is to determine the spatial expansion of built-up areas in Zaria and its environs between 1970 and 2009. Therefore, the problem of this study was to assess the impact which the growth in the population and range of functional activities in Zaria and its environs has had on agricultural lands in the area since the 1970s.

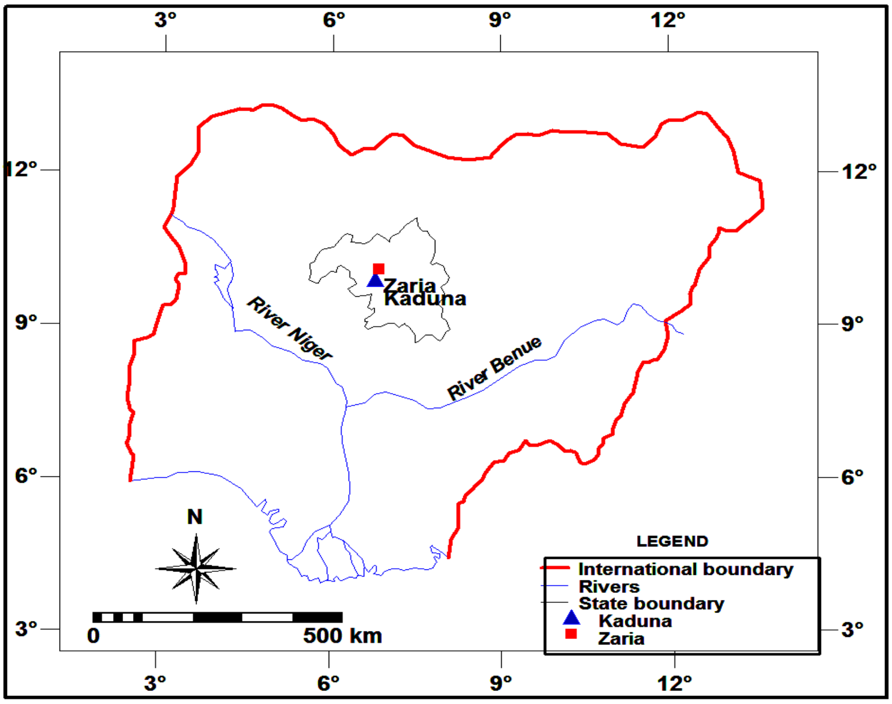

Figure 1: Location of Zaria in Nigeria
Source: Modified Administrative of Nigeria

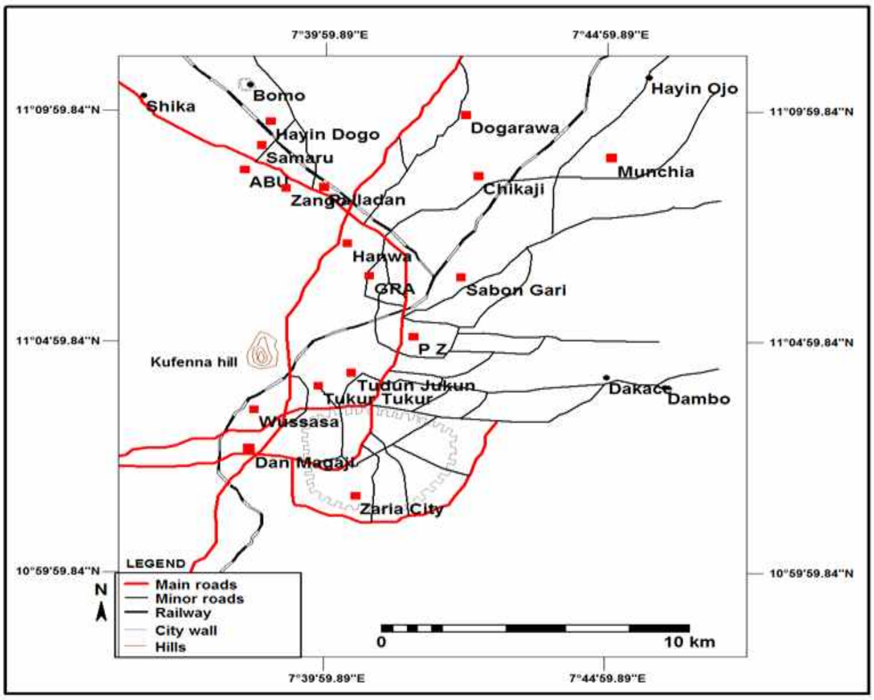

Figure 2. Zaria and its Environs
Source: Adopted and modified from Zaria Topo Map Sheet 102

The Study Area

Zaria, the study area, lies Latitudes 11°00'10.08 "N - 11°11'53.50 "N and longitudes 7°35'54.89 "E - 7°47'16.48"E (see figure 1 and 2) in the Kaduna State of Nigeria, and is located within the undulating high plains of Hausa land of northern Nigeria (Musa, 1993). The area lies about 762 metres above sea level (Ogunleye, 2006). Zaria comprises several suburbs such as Samaru (which Includes Ahamadu Bello University), Hayin-Dogo, Zango, Palladian, Hanwa, Chikaji, Munchie, Government Reserve Area, Sabon-Gari, Gyellesu, Tudun-Wada, Tudun-Jukun, Tukur-Tukur, Zaria City and Wusasa (See figure 3.2) these suburbs grew differently, but have almost merged together to become an urban centre known as Zaria. (Ogunleye, 2006).

Methodology

Types and sources of data

Both primary and secondary sources of data were used for this study. These include the following:

i. Satellite Images: All the satellite images covering the study area were obtained from the NCSR, Jos. They are as follows; Ortho-rectified Landsat Multi-Spectral Scanner (MSS) images of 7/12/1973 (75m resolution).

ii. Topographic map of Zaria (sheet 102) scale 1:100,000 second edition produced by Federal Surveys Nigeria in 1965. This was used to delineate and identify the study areas. The map was obtained from the Department of Geography, Ahmadu Bello University, Zaria.

iii. The Land use policy and market policy were obtained from the Ministry of Land and Survey Office, Kaduna. The Zaria Master Plan was obtained from the Urban and Planning Department, Ahmadu Bello University. These datasets are official documents of the Kaduna State Government on land use policies.

iv. Relevant published and unpublished literature were sourced, used and appropriately referenced.

v. Field data (oral interview)

During the fieldwork, a hand-held Garmin GPS map 76 csx was used to mark all the locations that were visited or checked in the field. In addition, personal interviews were conducted using a purposive sampling technique. According to Railway (2005), the purposive sampling technique is a technique whereby a researcher selects his samples in such a way as to provide him with the types of data or information he needs. With this method, data relating to land use changes and underlying factors

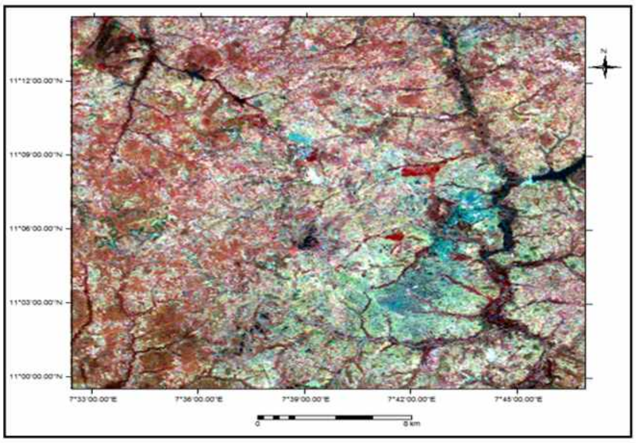

Fig. 3: False Colour Composite of 1973 Landsat MSS
Source: EarthExplorer (usgs.gov)

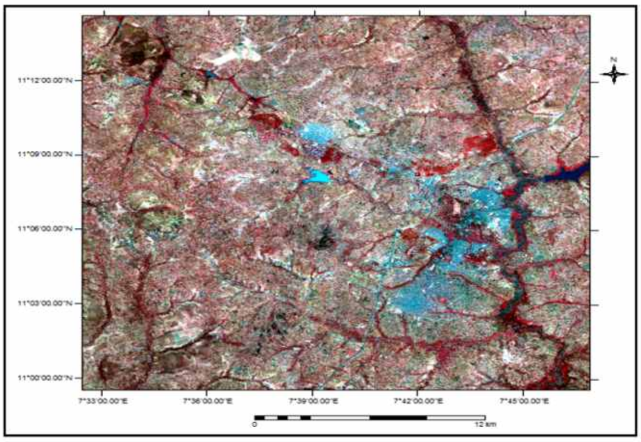

Fig. 4: False Colour Composite of 1990 Landsat TM
Source: EarthExplorer (usgs.gov)

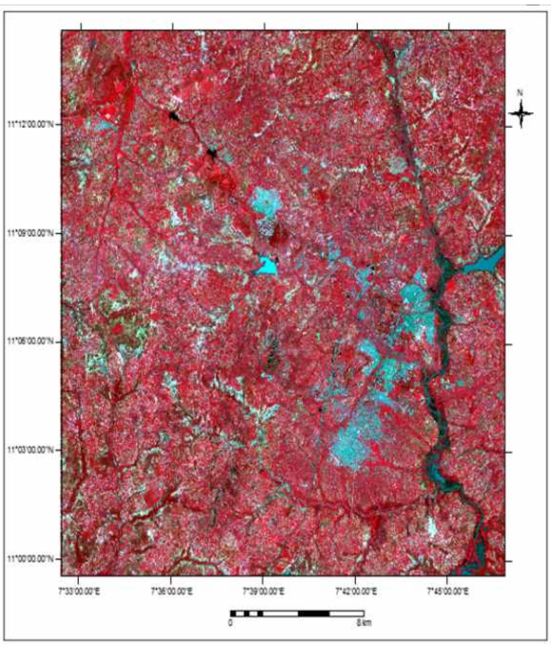

Fig. 5: False Colour Composite of 1999 Landsat ETM
Source: National Centre for Remote Sensing (NCRS)

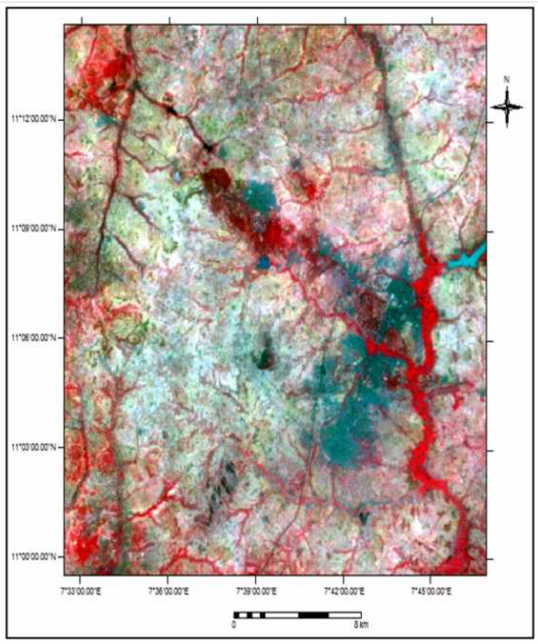

Fig. 6: False Colour Composite of 2009 Nigeriasat-1

over the study period were collected via interview. The selected population include; farmers, land owners, house owners, and estate agents in Zaria.

Satellite data processing:

Satellite data sets were made compatible in terms of their geo-referenced coordinates, accuracy and resolution and processed as follows;

i. Image Resampling; all the images were ortho-rectified with the same geo-referenced parameters as the satellite images. Landsat TM and ETM were compatible at a resolution of 28.5m.

ii. Resampling was performed for Landsat MSS and Nigeriasat-1 satellite image data to make them compatible with the Landsat TM and ETM.

Image Classification was done appropriately and classified as: preliminary and supervised classifications. This classification was done in ILWIS 3.7 software. Eight major land use and land cover features in the study area were identified, and the images were classified accordingly;

i. Bare surface: refers to all bare land devoid of any cover or use in settlements (such as courts and playing grounds), construction sites, farmlands, river beds and even forests.

ii. Built-up areas: represents all developed lands such as; residential, administrative, industrial, educational and commercial land buildings and pavements (including tarred roads.)

iii. **Forest plantation**: include natural forest reserves and artificial or forest plantations.

iv. **Rock outcrop**: includes visible rocks outcropping and devoid of vegetation.

v. **Agricultural lands**: referred to scattered cultivation, particularly rain-fed agrarian lands.

vi. **Shrub land**: areas covered with small and scattered trees that cannot be classified as forests, and the vegetation consists of mostly scattered stunted-growth trees without a single, defined stem and often not more than 2 meters tall.

vii. **Water bodies**: surface water in streams, dams, ponds, rivers and reservoirs visible in the satellite images.

viii. **Wetland mainly consists** of cultivation along flood plains and upland marshes for irrigated agriculture.

Statistical analysis

After the supervised classification, the statistics from all the classified images were obtained. These data were used to carry out the statistical analyses as follows:

a. Descriptive analyses using graphs, percentages and tables between 1973 and 2009.

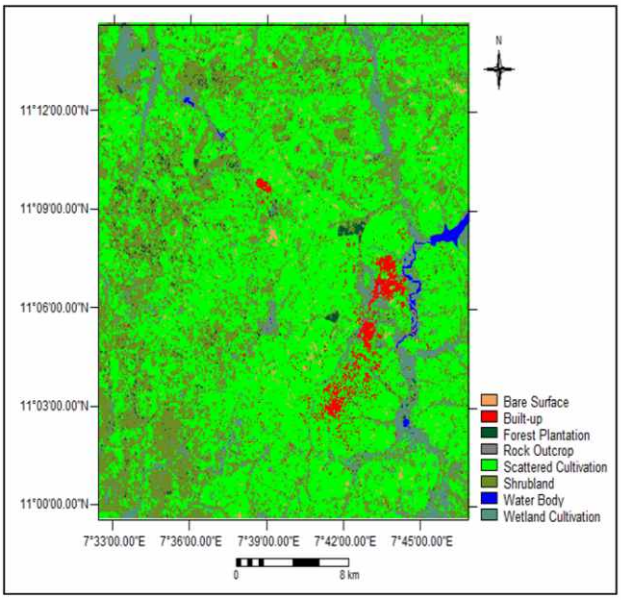

Figure 7: Classified Landsat MSS Image of 1973

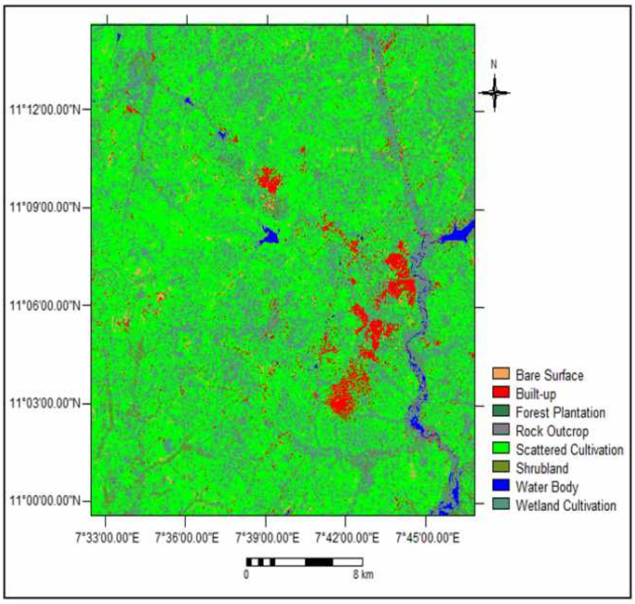

Figure 8: Classified Landsat TM Image of 1990

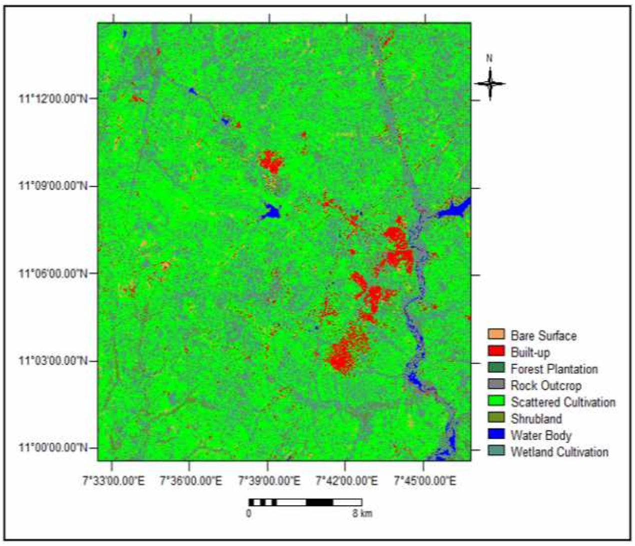

Figure 9: Classified Landsat ETM Image of 1999

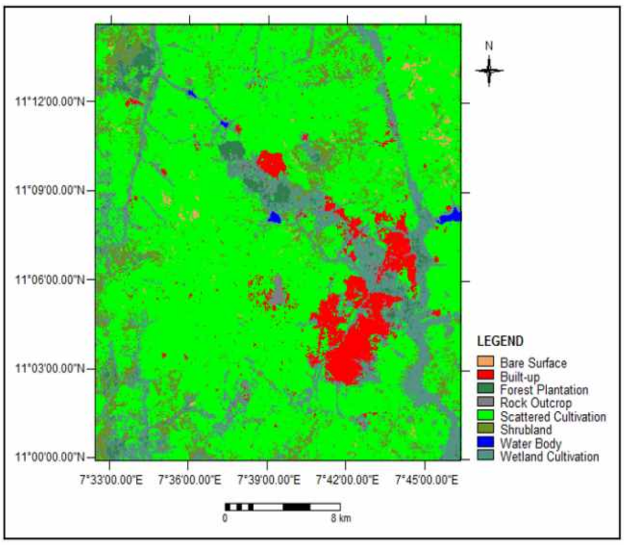

Figure 10: Classified Nigeriasat-1 Image of 2009

b. Temporal Change Analysis using satellite image graphs to detect the changes that have occurred in the study area.

c. Accuracy Assessment. To assess the accuracy of the image classification in ILWIS, a confusion matrix was created. In the confusion matrix, the classification results are compared to additional ground truth information, which enables identification of the nature of the classification errors, their quantities, and the overall accuracy of the classification. The raster map of the ETM image classification was used as the available classified image to obtain a confusion matrix. Then, a new raster map was created with the same domain and geo-reference as the classified image as a Test Set. Ground truth data from the field was used as input data in the test set Image. After that, a Cross operation with the ground truth map and

Table 1: Comparative Statistics

LULC TYPE	MSS 1973	TM 1990	ETM 1999	NIGSAT 2009
	Area (Km^2)	Area (Km^2)	Area (Km^2)	Area (Km^2)
Bare Surface	8.9	20.19	18.52	5.14
Built-up	14.52	18.08	29.5	37.13
Forest Plantation	9.64	19.44	13.7	14.06
Rock Outcrop	1.27	2.48	3.18	5.65
Agricultural Land	442.58	381.46	492.43	504.21
Shrub lands	205.85	231.44	152.58	59.86
Water Body	3.59	2.74	4.43	2.13
Wetland Cultivation	49.2	59.72	21.21	107.37
TOTAL	**735.55**	**735.55**	**735.55**	**735.55**

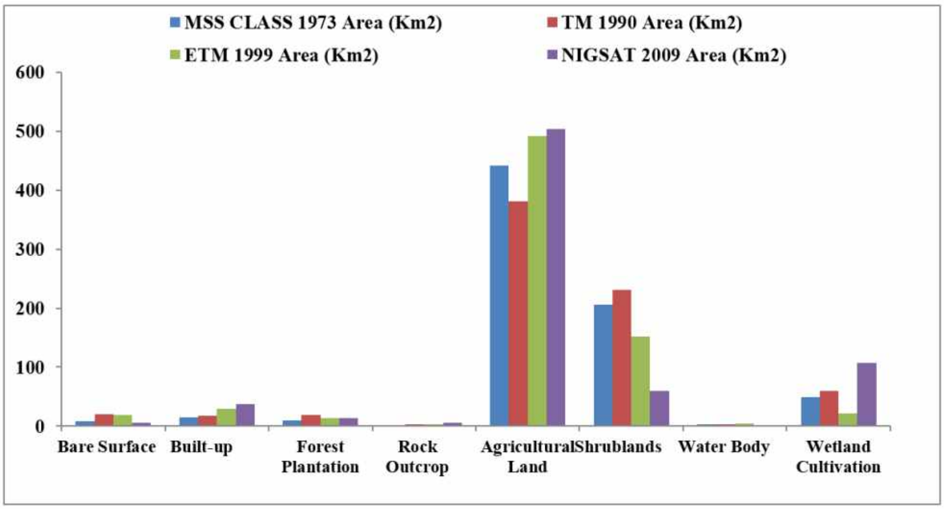

Figure 11: Histogram of Comparative Analysis.

Table 2: Change Analysis

LULC Type	1990-1973 $(km)^2$	% change	1999-1990 $(km)^2$	% change	2009-1999 $(km)^2$	% change
Bare Surface	11.29	126.85	-1.67	-8.27	-13.38	-72.25
Built-up	3.56	24.52	11.42	38.71	7.63	25.86
Forest Plantation	9.80	101.66	-5.74	-29.53	0.36	2.63
Rock Outcrop	1.21	95.28	0.70	28.23	2.47	77.67
Agricultural Lands	-61.12	-13.81	110.97	29.09	11.78	2.39
Scrublands	25.59	12.43	-78.86	-34.07	-92.72	-60.77
Water Body	-0.85	-23.68	1.69	61.68	-2.30	-51.92
Wetland Cultivation	10.52	21.38	-38.51	-64.48	86.16	406.22
Total	**0.00**	**344.63**	**0.00**	**21.35**	**0.00**	**329.85**

the classified ETM image was performed to obtain a cross table. From the Cross Table, the Confusion Matrix was generated, depicting the classification's accuracy.

Results and Discussion

The results of the image classification of satellite images are shown in figure 7 to figure 10. In contrast, the statistical information derived from the classified images is shown in Table 1, and the histogram is shown in figure 11. The information in Table 1 shows a gradual increase in the land areas covered by built-up, agriculture or scattered and wetland cultivation. At the same time, there was a general decrease in the land areas covered by bare surfaces and shrubland. For example, the built-up area gradually increased from 14.52km^2 ^{in} 1973 to about 37.13km^2 in 2009, representing about a 39.11% increase. Likewise, agricultural land use was about 442.58km^2 in 1973 and increased to about 504.21km^2 in 2009, representing approximately an 87.78% increase. These show that between 1973 and 2009, population growth increased the demand for food; hence, the conversion of other land uses to agricultural land was not too much because the study area population was not large then.

Dependent Table "Test_Accuracy" - TableCross(Accuracy_Test.mpr,ETM2020class.mpr,Test_Accuracy,IgnoreUndefs) - ILWIS

File Edit Columns Records View Help

	Accuracy_Test	ETM2020class	NPix	Area
Built_up * Built_up	Built_up	Built_up	87	78300
Built_up * Rock Outcrop	Built_up	Rock Outcrop	1	900
Wetland Cultivation * Wetland Cultivation	Wetland Cultiva	Wetland Cultiva	56	50400
Scattered Cultivation * Scattered Cultivation	Scattered Culti	Scattered Culti	15	13500
Scattered Cultivation * Bare Surface	Scattered Culti	Bare Surface	1	900
Bare Surface * Built_up	Bare Surface	Built_up	2	1800
Bare Surface * Bare Surface	Bare Surface	Bare Surface	9	8100
Bare Surface * Forest Plantation	Bare Surface	Forest Plantati	1	900
Water Body * Water Body	Water Body	Water Body	36	32400
Forest Plantation * Forest Plantation	Forest Plantati	Forest Plantati	1	900
Shrubland * Wetland Cultivation	Shrubland	Wetland Cultiva	4	3600
Shrubland * Scattered Cultivation	Shrubland	Scattered Culti	10	9000
Shrubland * Bare Surface	Shrubland	Bare Surface	1	900
Shrubland * Shrubland	Shrubland	Shrubland	6	5400
Rock Outcrop * Built_up	Rock Outcrop	Built_up	9	8100
Rock Outcrop * Rock Outcrop	Rock Outcrop	Rock Outcrop	1	900
Min			1	900
Max			87	78300
Avg			15	13500
StD			24	21984
Sum			240	216000

Open Column Management dialog box

Figure 12: Test Accuracy Table

MatrixConfusion(C:\ZARIA\ZARIALANDSAT\Test_Accuracy.tbt,Accuracy_Test,ETM2020class,NPix) - ILWIS

File Edit View Help

Average Accuracy = 75.77 %
Average Reliablity = 77.99 %
Overall Accuracy = 87.92 %

	Bare Sur	Built_up	Forest P	Rock Out	Scattere	Shrublan	Water Bo	Wetland (	UNCLASSI	ACCURACY
Bare Surface	9	2	1	0	0	0	0	0	0	0.75
Built_up	0	87	0	1	0	0	0	0	0	0.99
Forest Plant	0	0	1	0	0	0	0	0	0	1.00
Rock Outcrop	0	9	0	1	0	0	0	0	0	0.10
Scattered Cu	1	0	0	0	15	0	0	0	0	0.94
Shrubland	1	0	0	0	10	6	0	4	0	0.29
Water Body	0	0	0	0	0	0	36	0	0	1.00
Wetland Cult	0	0	0	0	0	0	0	56	0	1.00
RELIABILITY	0.82	0.89	0.50	0.50	0.60	1.00	1.00	0.93		

Wetland Cultivation

Figure 13: Accuracy Assessment Table

The land use and land cover comparative statistics for the study area between 1973 and 2009 are presented in Table 1.

The results of the change analysis are presented in Table 2. The result shows that between 1973 and 1990, there was a 13.81% decrease in agricultural land use and land cover and a 24.52% increase in built-up land use land cover. Between 1990 and 1999, agricultural land increased to 29.09% and built-up areas to 38.71% and then in 1999 and 2009, agricultural land increased by 2.63% while built-up increased by 25.86%. This result agrees with the findings of Akpu, Tanko, Jeb and Dogo (2017), who reported an increase in urban land use by 207.4% between 1973-2009 in Kaduna.

The result shows that as urban growth in the study area increases, agricultural land also increases because of the loss of shrubland, wetland cultivation, forest plantation and bare surface into agricultural land. Unlike previous researchers (Salah and Robert, 1975; Fasal, 2000; Ajibade, 1999; Ndabula, 2006), increased urbanisation results in the loss of agricultural lands. These findings reveal that while urbanisation expansion takes over previous agrarian lands, agricultural lands take over shrub lands, wetlands, plantation lands, bare surfaces and forest lands. Also, changes in wetland cultivation, which is carried out mostly in the dry season of the year, depends mostly on the crops grown, market forces and the acreage of land cultivated. This finding is probably due to the essential nature of agricultural lands. It usually takes over available bare surfaces as urbanisation encroaches into original agrarian lands.

Results of accuracy assessment

The results are shown in Figure 12 and figure 13, respectively.

The accuracy assessment results (Figure 13) show that the image classification average accuracy was 75.77%, the average reliability was 77.99%, and the overall accuracy was 87.92%. It could be seen from Figure 12 that most of the errors were from rock outcrops being classified as built up, Shrubland as Scattered Cultivation and Shrubland to wetland. In addition, there was very high reliability in the information classified as Shrubland, Water Body, Wetland, Built-up Area and Bare Surface. There was low reliability in the classified information as rock outcrop due to spectral mixing between rock outcrop and Bare surface.

Impacts of urban land use on agriculture in the study area

The respondents' answers during the interview on the impacts of urban growth on agricultural land in the study area were in line with the results of the statistical data records. The respondents confirmed an increase in the diversity of functional activities and growing demand for land for residential housing and other land-based activities, forcing agriculture to compete with other land uses.

Conclusion

This study assessed the impact of urban growth on agricultural lands in Zaria and its environs. Findings of the study established that an increase in urbanisation results in the loss of farmlands and a shortage in agrarian lands due to the rapid growth in urban development, which has led to the encroachment and conversion of arable farmlands into residential and industrial areas. Land use characteristics and patterns significantly influence some factors that affect urban agricultural practice. Land use affects the cost of land acquisition, distance to water, market, and plot size. More so, agricultural land is taken over by built-up areas, and more shrubland is also taken over by agriculture. This has led to a shortage of land for agricultural activities, and vegetative environments are being converted to agricultural lands, resulting in deforestation.

Based on the above findings, the study recommended a proactive and far-sighted action to exploit the opportunities that urbanisation offers in Zaria fully. More so, since growth is inevitable, there is a need for the Zaria administration to develop timely policies that will turn potential crises into opportunities; failure to act fast might be devastating.

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