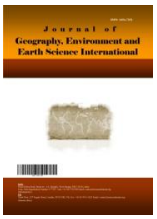

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Impact of Land Use Changes on Agricultural Land Use: Evidence from Jalingo Region of Taraba State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author YMB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EE and UJA managed the analyses of the study. Authors ARI and YI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study examined the integration of Remote Sensing and Geographic Information System (RS/GIS) for analyzing land use in Jalingo Region, Taraba State for the period 1996 to 2016; the image of 1996, 2006 and 2016 was used. The study employed a supervised digital image classification method using Arc GIS 10.3 software and classified the land use into residential, agricultural, commercial and transport. The images were made to pass through the processes of georeferencing, image enhancement, image resampling and classification and also descriptive statistics was adopted to analyze the findings on the effect of Urbanization on agricultural land use. Data for the study was the image of Jalingo Region of 1996, 2006 and 2016; also data was collected primarily by the administration of the questionnaire, and a total of 289 well-structured

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questionnaires were administered. Result show there was a significant loss of agricultural land from 180.46 km^2 to 135.66 km^2. It also revealed an increase of residential land use from 10.30% area coverage in 1996 to 28.07% in 2016, commercial land use increased from 0.20% area coverage in 1996 to 2.60% and transport increased from 0.39% to 2.84% in the same study period, with an annual rate of change of 7.82%, 35.81% and 46.95% respectively. This study shows that agricultural land use pattern has been greatly affected by transport, residential and commercial land uses. These results could help city planners and policymakers to attain and sustain future urban development. It is therefore recommended that government should encourage the people to expand and build towards the outskirts of cities, like Joroyinu, Lankaviri, etc through the provision of incentives and forces of attraction that is available at the city center in these areas to avoid the problem of overcrowdings.

Keywords: Impact; land use changes; agricultural land uses; Jalingo; Taraba; Nigeria.

1. INTRODUCTION

Land is an important natural resource on which agricultural activities are based. However, the land is being significantly altered by anthropogenic activity on the earth resulting in observable changes in the land use over time [1, 2]. Land use refers to use of land for activities such as agriculture, plantations, forestry for construction of buildings for various purposes and for road constructions etc. It can be broadly categorized into five areas according to the type of uses: economic, residential, recreational, conservational, and governmental purposes and consists of varied land covers[3] Rapid urbanization, industrialization, and major changes in human activities have remained the single most important factors of dramatic changes in land-use globally[4-6]. Although land use changes can be monitored by traditional inventories and survey, but, the use of satellite/aerial remote sensing provides a cost-effective way in land cover change detection and explicitly reveal spatial patterns of land cover change over a large geographic area recurrently and consistently.

Land use change is one of the central components for achieving appropriate strategies of managing natural resources and monitoring environmental changes. In most urban areas in Africa and indeed the world, comprehensive evaluation of land use is undertaken for optimum environmental development. Moreover, accurate and timely information about land use change and the trend of changes in the use of land resources in urban areas is fundamental if proper urban land management decision-making, ecosystem monitoring, and urban planning are to be advanced.

Although studies on the impact of land use changes have received high and persistent attention over the years particularly in developing countries yet, it remains a major concern of global environmental challenge as it increases the exploitation of natural resources with a resultant decrease in arable land, forestland and water bodies [7-9].

Furthermore, recent literature analysis of other urban areas of Nigeria and other sub-Saharan African cities revealed an inconsistent association between the impact of land use changes on agricultural lands.[10-12], reported a positive association, suggesting that if a city is expanding there will be a corresponding decrease in agricultural lands. However, several other studies, including those of [3, 5, 13], reported a negative association between city growth and agricultural land uses. Perhaps the main reason for an inconsistent association is that most studies are essentially either on an appraisal of the publics' perception of the impacts of land use changes on the agricultural land use which is qualitatively derived from reconnaissance surveys or quantitative derived from natural sciences analytical approach. Therefore, to bridge this gab, the present study was more holistic and embraced both quantitative and qualitative approaches. The goal of the multiple methods was to obtain more information about the same fact and to increase the validity and reliability of the data obtained. The vision was to understand and come up with a valid and well-substantiated conclusion about the impact of land uses changes on agricultural land use in the study area. Moreover, Land use changes are dynamic and vary from place to place and over time depending on the prevailing ecological, economic and socio-cultural characteristics. Hence, results from elsewhere cannot be extrapolated for Jalingo Region. Thus, this study is predicated on the following research objectives to:

i. Appraise people's knowledge and perception about the impact of land-use changes on agricultural lands
ii. Map out Land use of 1996, 2006, and 2016 using multispectral satellite imagery.
iii. Analyze land-use changes from multi-temporal data.

2. MATERIALS AND METHODS

2.1 The Study Area

The study region is located on latitude 8°54ˈ to 9°01ˈN and longitude 11°22 ˈ to 11°30ˈE. It's bordered to the north by Lau, East by Yorro, south, and west by Ardo-Kola LGAs (Fig. 1). It has a total land area of about 204,073 km² with an altitude of 351 meters above sea level [14, 15]. The relief configuration consists of undulating plain interspersed with mountain ranges extending from the Kona area through the border between Jalingo and Lau LGA down to Yorro and Ardo-kola LGAs in a circular form to Gongon area [16]. Two major rivers; Mayo-gwoi and Lamurde drain the study region, which takes their source from the mountain ranges in Yorro LGA and emptied their content into the Benue river system at Tau village. The mean annual rainfall range and the temperatures are 217mm-958mm and 27.9°C respectively. In terms of vegetation the study region is located within the Northern Guinea Savanna Zone and is characterized by grasses interspersed with tall trees and shrubs [17, 18]. However, the vegetation cover is declining mainly in favour of physical development due to the rapid expansion of the city. The study region had a total population of 167,548 people in 2017, with a projected annual growth rate of 3.0% (NNPC 2018). About 72% of the population in the metropolis lives in unplanned settlements. Politically and administratively, there are ten (10) wards in Jalingo metropolis, which are: Turaki "A", Turaki "B", Sintali "A", Sintali "B", Majidadi, Sarkin Dawaki, Kachalla Sembe, Barade, Kona, and Yelwa (Fig. 2).

2.2 Methods

2.2.1 Data used

Three sets of satellite imageries captured in 1996, 2006, whose spatial resolution was 80 m (Landsat Multispectral Scanner (TM) and 2016 Nigeria-Sat 1.Nigeria with 32 m resolution), questionnaire/oral interview and field observation were used for the study. The Nearest neighbor resampling method was used to resample the 1996 and 2006 imageries to 32 m resolution to bring all the datasets to a common resolution and projections. This was necessary to make it possible for overlay operations to be carried out. Also used are the Jalingo base map, Population figures of 1996 and 2016, obtained from Taraba State Ministry of Land, Housing and Town Planning and National Population Commission respectively, as well as other relevant journal articles, research papers, textbooks, and the Internet.

2.2.2 Data collection

Data were collected using different techniques. Firstly, data were collected through field transects walks (observation) regarding the socio-economic and geophysical environments of the study area and informal interview with some individual residents. Secondly, data were collected through a formal questionnaire administered to 298 respondents representing various categories of land uses in the study area. The questionnaire was posed to collect information regarding various demographic characteristics of peoples and their perceptions about the impact of land use change on agricultural land use. The third and fourth phases and which constituted the major components of the research methodology were achieved through Image classifications and Analysis and Change Detection/ Overlay Operation. The four phases were conducted to collect differently, but complementary data on the same topic to increase the validity and reliability of the data obtained.

2.2.3 Image classifications and analysis

The land use mapping was restricted to four (4) land use; residential, agricultural, commercial, and transport land use. The choice and use of the four land uses were based on the fact that Jalingo is more of a settlement completely covered by farmland and the study looks at the implication of the landuse changes on the agricultural lands. The area of both the residential, transportation, agricultural and commercial land uses was measured in kilometer square (km²).

Multispectral data was used to perform the classification, and the spectral pattern present within the data for each pixel was used as a

numerical basis for categorization. Two types of classification were employed: Supervised and unsupervised classifications. A supervised classification was performed using maximum likehood algorithm on false-colour composites (bands 4, 3 and 2) into the land use and land cover classes; agricultural land, built-up area, natural forest, water body, and bare surfaces. Information collected during the field survey was triangulated with the digital topographic map developed for the study area and used to assess the accuracy of the classification. Accuracy assessment was carried out to evaluate the image classification. Accuracy assessment indicates the extent to which the classified map meets acceptable standard. Sample points were obtained in the field using a hand-held Global Positioning system (GPS). The points were downloaded and added to the GIS database as a theme which was converted into data layer and used as a base for verifying the accuracy of the classified image. The overall accuracy of the land use map derived from the 2016 satellite imagery was 86.9%. The producer accuracy ranges between 71.8 and 100 percent while the user accuracy falls within 78.6 and 93.8 percent. The minimum acceptable overall accuracy level for such study is 85% with not less than 70% for each class. On this basis, the overall accuracy level of 86.9%. with a minimum class accuracy of 71.8% obtained was acceptable

2.2.4 Change detection/ overlay operation

This method was achieved through a pixel-to-pixel comparison of the study year images through the overlay. The images generated were overlaid, and a visual representation of the extent of changes that occurred in the period for each of the land cover classes was obtained. Thus, the exact location and the extent of the changes were determined.

2.2.5 Data analysis

A descriptive statistical analysis of the questionnaire data was performed using the Statistical Package for Social Sciences (SPSS 22) software. The analysis method used descriptive statistics, primarily cross-tabulation, to summarize the data.

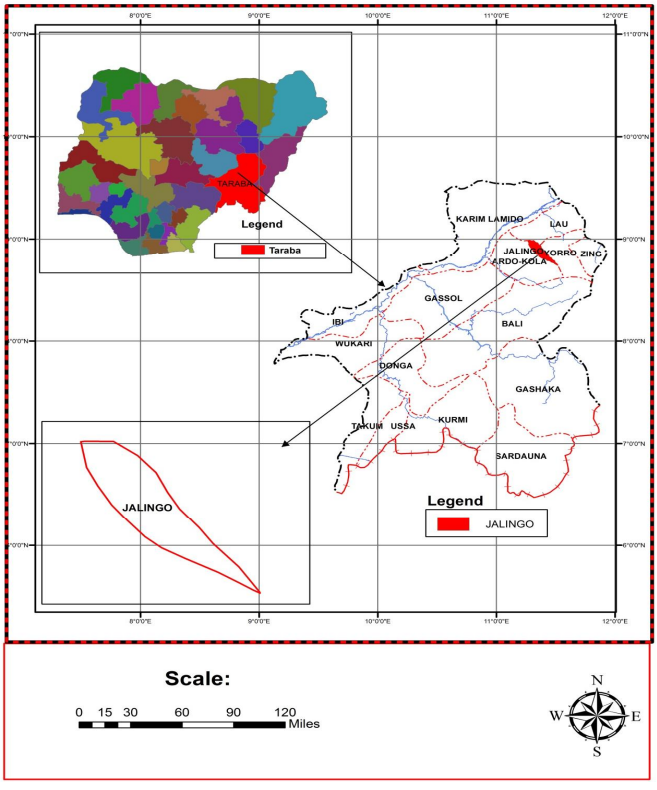

Fig.1. Map of Taraba state showing the study Area (Jalingo)

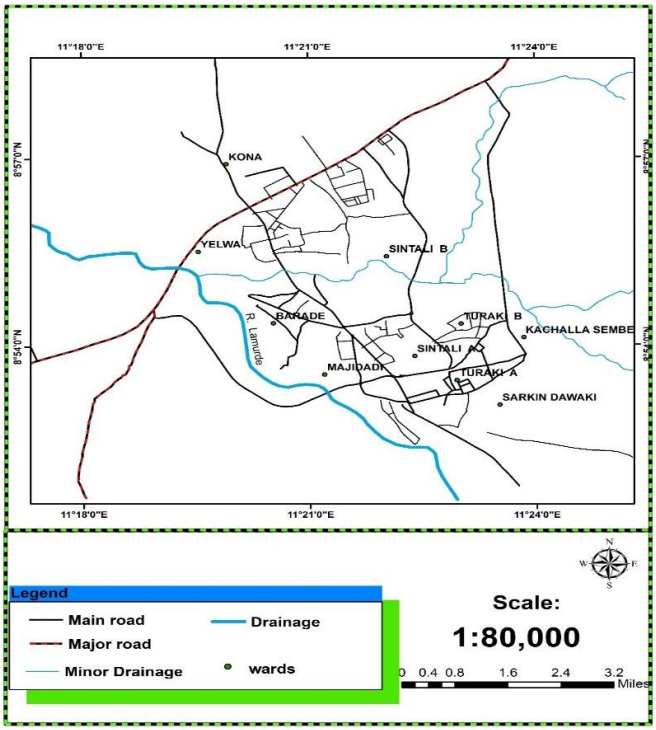

Fig. 2. Map of the study area (Jalingo)

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics of the Respondents

Of the 298 people interviewed, a larger number (65.7%) were male and married (75.2%). The age of the respondents ranged from 20 to 50 years and above, with the majority (48.3%) within the age range of 40-49 years. A significant proportion of the respondents (97.7%) had some form of formal education. Farm ownership indicated that approximately (69%) of the respondents owned their landholdings and the majority (69.3%) had more than 10 years of farming experience (Table 1).

3.2 People's Perception of the Impact of Land Uses on Agricultural Land Use

Peoples' perceptions about the impact of changed land use on agricultural land use practices are the most significant social factors that determine their degree of understanding of the incidence, the rate, and trend of the changes on agricultural land use [14, 19]. The impacts of land use changes on agricultural lands are important anthropogenic and physiographic variables that affect agricultural output, particularly in the urban areas. However, in this context, the evaluation of peoples' perceptions is based exclusively on the impact of land uses on agricultural land use as indicators of reduction in farmland sizes.

To assess how peoples perceived the impact of land-use changes on agricultural land uses in the study area, peoples were asked two major questions: 1. Do they see land-use change as a problem on agricultural land uses in the study area? (1= yes, 2= no), and 2. What was there perception about the rate of the impact over the past 10 years? (1=increasing, 2= no change, 3= decreasing)?

The results show that people are generally aware and see the impact of land use changes on agricultural land use in the study area as a problem (Table 2). This proportion of people (89%) is significant (X^2=13.617, df =7, *P*=0.040). This significant result emphasizes a generally high-level of awareness among peoples regarding the impact of land use on agricultural land use in the study area and is consistent with similar results reported across different parts of Nigeria [13, 16, 20]. Residential encroachment that impacted a significant proportion of the cultivated farms in the study region was

observed during the field survey. This observation explains the general awareness among peoples of the negative impact of changed land use practices on agricultural land uses.

People also indicated their perception and observations on the rate of land uses changes in agricultural land uses over the past 10 years (Table 2). Overall, the results indicate that more than two-thirds (84.9%) of the sampled respondents had a high level of perception that the rate is increasing, which was highly significant (p<0.01). These results are similar to those reported by [8] in Egypt, [2] in China and by other studies in Nigeria [5, 21-24]. Rapid urbanization, socio-economic activities and sprawl development were the reasons listed by peoples for the increase in the rate.

In summary, there was a generally high level of awareness with a negative perceived impact of land use changes on agricultural land use with increased rate of the impact over the last decade.

3.3 Land Use

Land is natural resources and the main source of national wealth. The human needs of land resources give rise to land use, which varies with the purposes it served (Ademiluyi*et al.,* 2008). Land-use change is a consequence of natural and socio-economic factors and their utilization by man in time and space [2, 25]. Land-use change has remained a major concern of global environmental challenge as it increases the exploitation of natural resources with a resultant decrease in arable land, forestland and water bodies. Therefore, it is on these premises the section of study seeks to provide information on the impact of land use changes on the agricultural land uses in the study area using GIS.

Table 1. Demographic characteristics of the respondents

Gender	Respondents	Percentage (%)
Male	195	65. 8
Female	103	34.2
Total	**298**	**100**
Age		
20 and below	29	9.7
30-39	101	33.9
40-49	144	48.3
50 and above	24	8.1
Total	**298**	**100**
Marital Status		
Single	49	16.4
Married	224	75.2
Divorced/ Widow	25	8.4
Total	**298**	**100**
Educational Status		
Non-formal education	6	2.3
Primary education	102	34.2
Secondary education	114	38.3
Tertiary education	76	25.5
Total	**298**	**100**
Farming experience.		
0-5	25	8.3
6-10	67	22.4
11-15	98	32.9
16-20 and above	108	36.4
Total	**298**	**100**
Farm ownership		
Yes	204	68.5
No	94	31.5
Total	**298**	**100**

Source: Field Study 2018

Table 2. Peoples' perception about the impact of land use on agricultural lands

Question		Respondents	Percentage (%)
Do they see land use changes as a problem on agricultural land uses in the study area?	Yes	265	89
	No	33	11
How did they perceive the rate of the impact over the past 10 years?			
Increasing		253	84.9
No change		31	10.3
Decreasing		14	4.8

Source: Field Study 2018

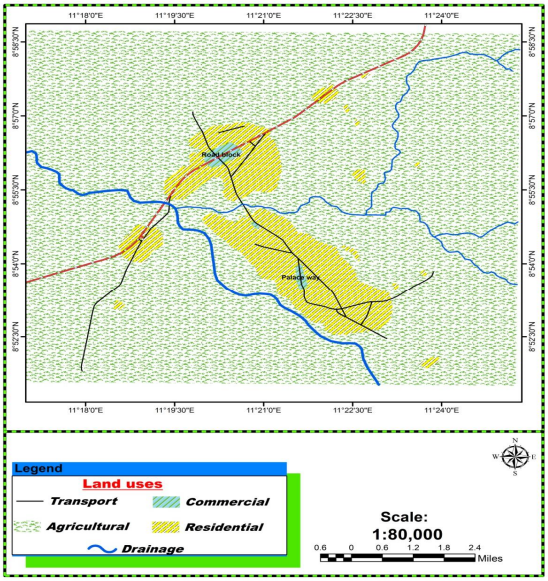

Fig. 3. Land use map of Jalingo 1996

Findings in Table 3 and Fig. 3 revealed that in 1996, of the total land area under study area 89.11% were put into agricultural uses. Residential, commercial and transportation land uses covers were 10.30 %, 0.20% and 0.39% respectively. This implies that the major land use predominant in the area was agricultural. This could not be unconnected with the fact that Jalingo, which served as both the state and local government headquarters of Taraba state, was predominantly agrarian, and had not been long created as the state capital and developmental activities had started on a rather slow pace.

The findings in Table 3 and Fig. 4 revealed that in the year 2006, agricultural land use covered 83.18%, residential land use 15.75%, commercial and transportation land uses 0.46% and 0.61%. In terms of increased/decreased in size of the land uses, the agricultural land use decreased by -12.02 km^2 representing -5.94% change in total land area. While, both the residential, commercial, and transport land uses have witnessed a positive change of 11.05 km^2 representing 5.46%, 0.52 km^2 representing 0.26% and 0.45 km^2 representing 0.22% respectively between the year 1996 to 2006.

This means that the trend in land use changes in Jalingo is rising at a faster rate to the negate of agricultural land use. These findings concurred with the explanation provided by [4, 22, 26, 27], that in most emerging capital cities particularly in the developing countries, changes in land use result in changes in radiance values of Agricultural lands. Similarly, the finding as to the changing trend agreed with the appraised perception of the people of the study area where more than two-thirds (84.9%) of the sampled respondents perceived the change in the trend as increasing. The rapid increase in population/ urbanization and other developmental activities in the city are the other factors responsible for bringing the change in land use pattern.

Table 3. Extent and rate of Land use and areal coverage in Jalingo between 1996 -2016

Land Use	Period												
	1996		2006					2016					
	Area (km²)	% Coverage	Area (km²)	% Coverage	Increase/ Decrease (Km²)	% Change	Annual Rate of change (%)	Area (km²)	% Coverage	Increase/ Decrease (Km²)	% Change	Annual Rate of change (%)	Annual Rate of Change from 1996 to 2016
Agricultural	182.02	89.11	170.00.	83.18	-12.02	-5.94	-0.66	137.22.	66.99	-32.78	-16.19	-1.95	-1.24
Residential	20.85	10.30	31.90	15.75	11.05	5.46	5.30	56.84	28.07	24.94	12.32	7.82	8.63
Commercial	0.41	0.20	0.93	0.46	0.52	0.26	12.68	4.26	2.60	3.33	1.64	35.81	46.95
Transport	0.79	0.39	1.24	0.61	0.45	0.22	5.7	5.75	2.84	4.51	2.23	36.37	31.39
Total	204,073	**100**	204,073	**100**				204,073	**100**				

*Source: Field Study 2018*Transport (Tarred road network); Annual rate of change* $r = \left(\frac{U_b - U_a}{U_a}\right) \times \frac{1}{T} \times 100\%$ *where* U_a *is class area at the beginning of study period and* U_b *is class area at the end of the study period in view, T is the study period (Ding, Liu and Wang, 2014)*

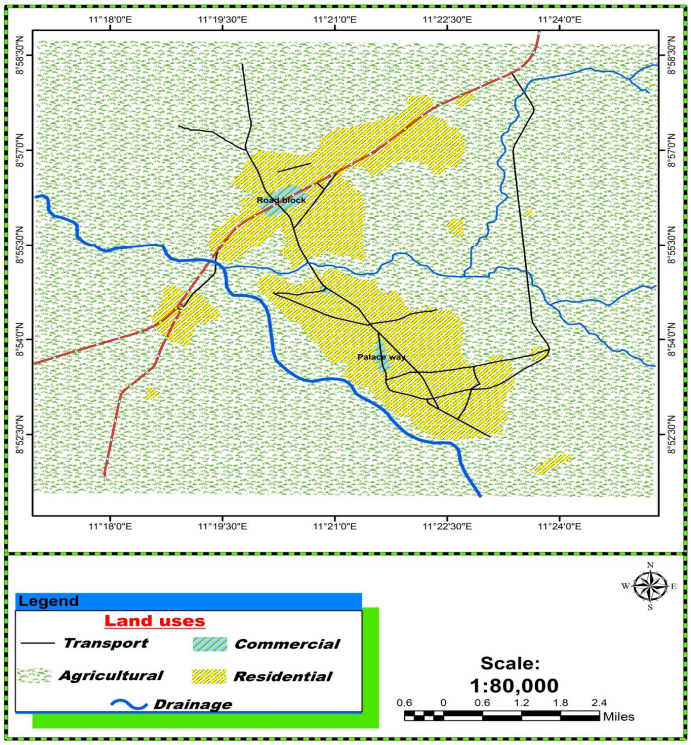

Fig. 4. Land use map of Jalingo 2006

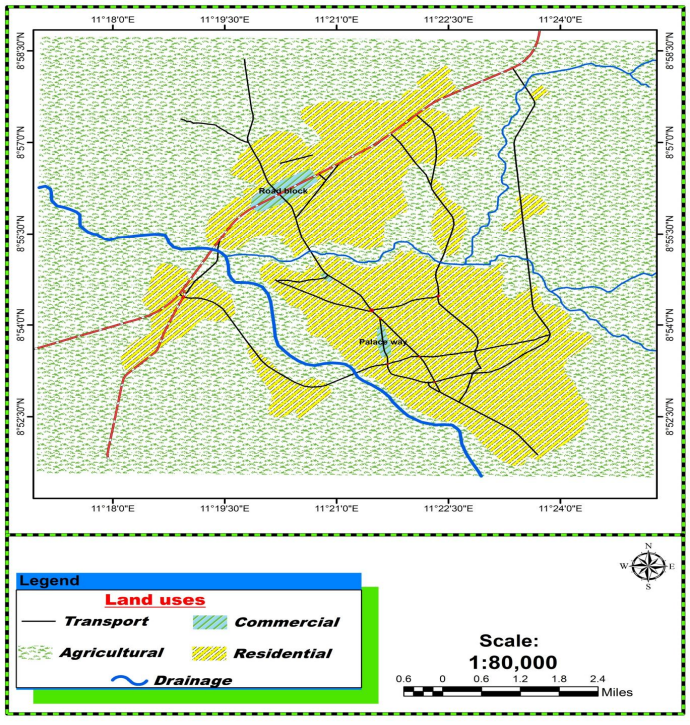

Fig. 5. Land use map of Jalingo 2016

From Table 3 and Fig. 5 it is evident that as of 2016, the residential, commercial, and transport land uses saw a positive increased. Agricultural lands, on the other hand, witnessed a negative change (-32.78 km^2). In terms of percentage change, a significant positive increase in the residential land use from 5.46% to 12.32%, commercial 0.26% to 1.64% and transport 0.22% to 2.23% from 2006 - 2016 were recorded. While agricultural land use witnessed an annual rate of change of -0.66 between 1996 and 2006 and in 2016 it further decreased to about -1.95%. This means that the study area is growing at a faster rate using up all the agricultural and other forms of green landscape in the city. Thus, the situation is bound to worsen if the current trend continues unabated, as more than half of the agricultural lands will be reduced by the year 2025.

The immigration of large number of people into the study area partly, due to the ethno-religious violence in the different parts of the state during the period, and partly due to economic, social, and administrative projects embarked upon after creation of the state, besides the expansion of the capital city in terms of massive road construction from 2007, during the regime of Governor Danbaba Suntai, could be the reasons for the decline in agriculture practices.

4. CONCLUSION

The study examines the impact of land-use changes in Jalingo area between 1996, 2006 and 2016 and the implications of these on Agricultural land uses. Both the descriptive statistic of SPSS and remote sensing and geo-information technology were used in analyzing the change in land-use change on agricultural land in the study area. The findings revealed that there is widespread awareness of the impact of land uses on agricultural land use. This awareness suggests that land uses changes on agricultural lands is a serious issue in the study area. The study also revealed that while the built-up area increased, agricultural landscape decreases in size at an alarming rate due partly to increasing economics, social, administrative and developmental activities in the study area. The study recommends therefore that the Projective planning mechanism should be considered by both urban planners and environmental managers in implementing and executing various urban development projects. Similarly, other factors, such as, institutional and technological factors, including the triggering effect of crises, which are likely more important to peoples' decisions on whether and how much is the trend and rate of change was not incorporated.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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