DEVELOPING LAND-USE INFORMATION SYSTEM FOR DETECTING DISTURBED LAND-USE IN PART OF AKURE, ONDO STATE, NIGERIA

Abiodun Daniel Olabode

Adekunle Ajasin University

Abstract

Land-use dynamics in Akure South, Ondo State, Nigeria was analyzed using land-use based map of the area with ArcGIS 9.2 software. The land-use map was classified as industrial, commercial, agricultural, residential land-uses, and open space. The selection of land use period covers 10years to identify land use changes over the years. Global Positioning System (GPS) was used for taking the spatial reference points of the study area. Land-Use Information System (LUIS) were created through the generated coordinate data. The results attributes past land-use with higher proportion of 65.2% for agricultural, 3.8 percent for industrial, 1 percent for commercial, while residential and open space have 15 percent respectively. Contrarily, the present land-use situation depicts 3.51 % for agricultural activities and 48.79%, 45.6% and 2.1% land areas were occupied by industrial, residential and open space respectively. Generally, the Geo-database created reflects agricultural land-use as rapidly disturbed in expense of industrial, commercial, and residential activities in the study area. It is therefore recommended that; the geo-database created should be regularly up-dated to know what is obtainable in a particular space through a link between geometric and attribute data. This will enable the decision-making bodies to have access to information on each feature under consideration and at the same time improve upon them.

Keywords: Land-Use, Agriculture, GIS, Disturbed-Land, Sustainability, Database

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Introduction

In most of the developing countries such as Nigeria, increasing pressure to use land for economic development is leading to loss of agricultural farmlands. Land conversion to develop recreational resources is another major challenge facing the management of sustainable agricultural development in Nigeria today. Increases in population and demand for resources have led to this. As human beings continue to alter the environment on a vast scale, so also the effects of this is obvious on man. The question is, should farmland around the edges of a town be built over? This question bothers on some numbers of people who are directly involved in the use of land over the years without adequate monitoring land activities. For instance, agricultural activities are the bedrock of the economy of Ondo state, where the study falls. Farming occupation boomed in the past and served as the major source of food and income for the people. Recently, the economic returns of agricultural practices have declined. This is as a result of competition on land for buildings, transportation among others.

The ability to develop Land-Use Information System (LUIS) for monitoring land-use conditions depends on the ability to understand the past and present land-use. These two scenarios are capable of determining the future state of the land use status. As observed by National Research Council (NRC, 2001), this ability is enabled through the use of Geographical Information System(GIS) through which valuable information could be provided on natural resources like land, water, forests, urban areas and infrastructure facilities such as road network, river network among others.

Geographic Information System provides the medium for the integration of spatial data. This has been widely recognized as an effective tool for planning and decision-making. According to Michalak (1993) and Trotter (1991), GIS allows for effective storage, manipulation, and analysis of geographical data. In addition, satellite image data provides the potential to obtain land-use information at more frequent intervals and more economical than those obtained by traditional methods (Treitz et.al, 1992).

Generally, land is being misused/mismanaged in the developing countries and due to this; it is becoming a scarce commodity. Not only this, agricultural land-use has been taken over by other

human activities. Hence, information on land use conditions and possibilities for their optimal use is essential for the selection, planning and implementation of land-use schemes to meet the increasing demands for basic human needs and welfare.

It is obvious that the system of land in Nigeria is bad because the land which are being used for agricultural practice might not be suitable for agriculture but for another activities like industries or residential buildings. This is because, land-use information is still difficult to obtain when quality, relevance, and newness are considered as major criteria (Fresco, 1994). The development of Land-Use Information System (LUIS) as a monitoring tool for proper land-use management has been the focus of the study.

Therefore, using Geographical Information System to monitor the conditions of land-use will definitely contribute to the development and conservation of land resources. The study serves as impetus to help government deal with issues concerning land-use planning, monitoring, and management. It also enables a strategic design solution through LUIS, which helps government formulate and update the land-use plan.

However, this study is limited to the development of land-use condition in one of the major parts of Akure, Ondo state. This is not about land-use or physical planning per se but about developing an information system to support land-use activities in the selected part of the city and forecasting future condition of land-use in this area.

Study Area

Akure is the capital city of Ondo State in Nigeria. The city comprises of three Local Government Areas, which formally referred to as Akure Division pre-1976 Local Government Councils creation in Nigeria. The Local Government Areas are, Ifedore, Akure North, and Akure South with corresponding land area of 583.1, 676.7 and 318.0 km^2 respectively (figures 1a-1c). The state is bounded with Osun, Ogun and Ekiti states at the West, Kwara and Kogi state at the North, Edo and Delta at the East and at the Southern part by the Atlantic Ocean (Ogunsote, 2007).

Akure has a tropical climate and belongs to the equatorial rain forest belts. As a result, several attractive varieties of vegetations emerged in Ondo state (figure 1d). Timber is one of the important source of wealth of this area. Trees like Iroko, Mahogany, Obeche, Danta, and Opepe are commonly found here. The trees usually big in girth and of freight, sometimes up to 15 to 20 metres, which provides the basis for the prosperous lumbering and wood processing industries in the state. According to National Population Commission (NPC, 2006), Akure South, where the study area falls, has 360,268 population figure with a land mass of about one, 5000 square kilometers.
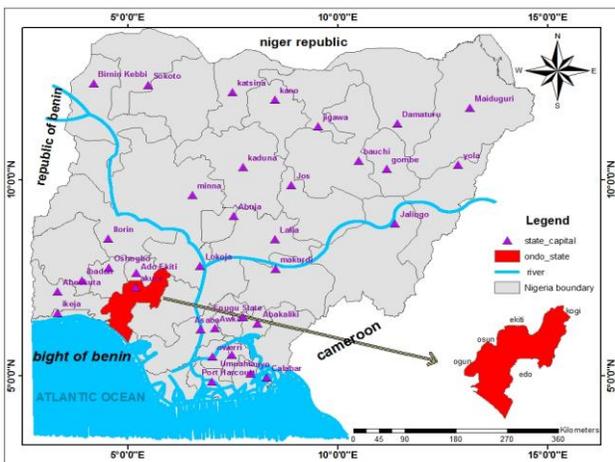

Figure1a: Map of Nigeria Showing Ondo-State
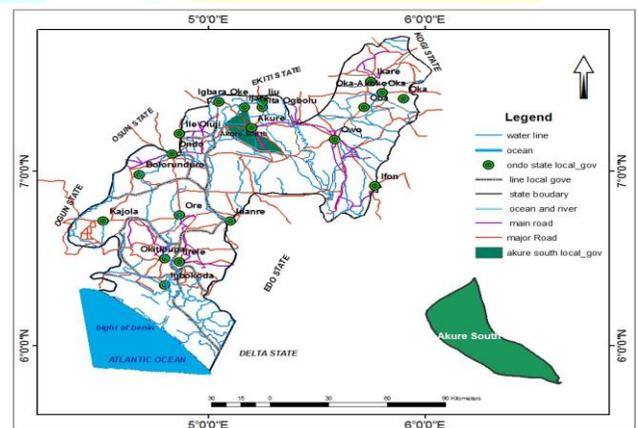Source: Ministry of works, Akure & Authors' survey, 2013

Figure 1b: Map of Ondo-State Showing Akure South Local Government
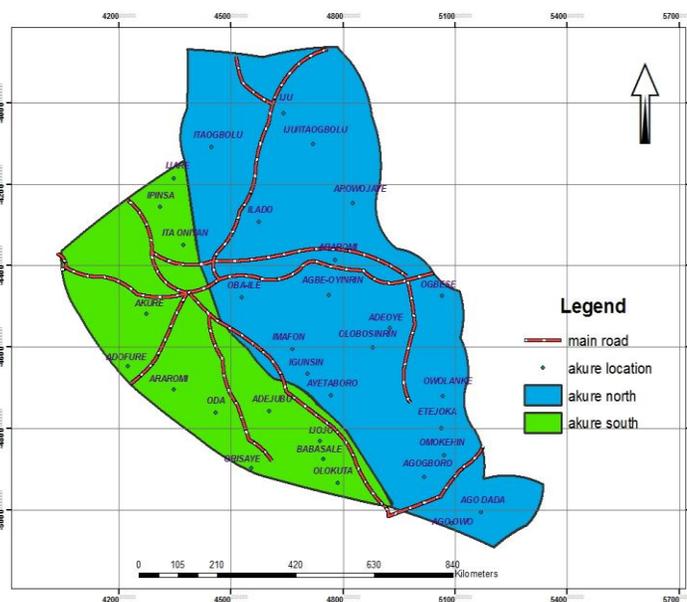Source: Ministry of works, Akure and Authors' survey, 2013

Figure 1c: Map of Akure showing Akure South Local Government
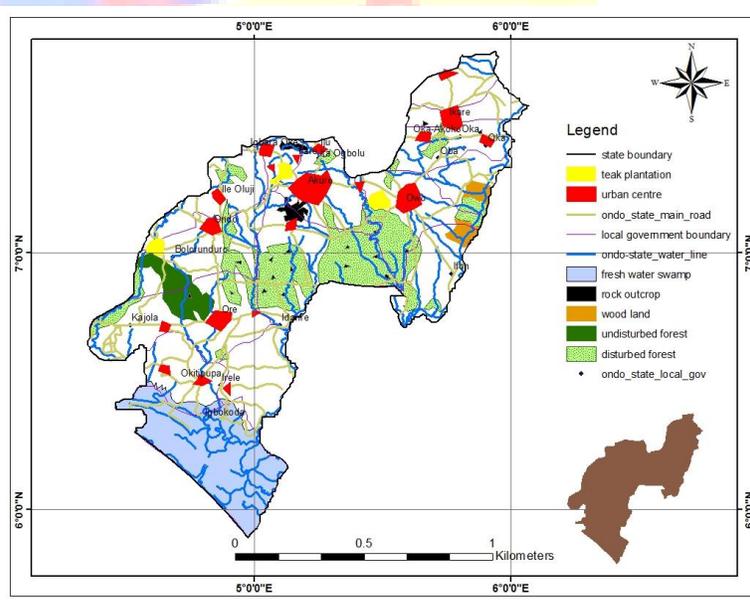Source: Ministry of works, Akure & Authors' survey, 2013

Figure 1d: Land Use and Land Cover Map of Ondo-State.
Source: Ministry of Works, Akure & Authors' survey, 2013

Materials and Methods

Data for this study were collected through primary source. Purposive sampling was used in selecting Federal University of Technology in Akure, Nigeria. This area was selected because of its rapid development that induces different land-uses which include commercial, industrial, agricultural, residential, and open space. Global positioning system was used to collect spatial reference data at every respective land use type. Also, the conversion of analog base map of the study area into digital format through scanning and vectorizing the maps using on-screen digitizing method with ArcGIS version 9.2 software was essential part of the study. The map of Akure South Local Government Areas was extracted, Geo-referenced and digitized from the 1:50,000 topographical map of Ondo State from the period of 1990 and 2004, 2002 and 2012 that represent past and present land-use map were considered in this study.

Results and Discussion

Land-Use Status in Akure South

 The study observed that conditions of land-use in the study area have changed significantly over the years considering higher proportion of 65.2% of predominantly agricultural activities, while industrial has 3.8 percent, commercial has 1 percent, residential and open space have 15percent respectively within the period of 1990 and 2004 (table 1). However, the present land-use status in the study area indicates contrary situation due to various socio-economic activities that have emerged within the recent years. This observation generally shows that agricultural land-use is being taken over by industrial, commercial, and residential activities at a faster scale. The study revealed that 3.51% of land area in the study area is available for agricultural activities where 48.79%, 45.6% and 2.1% were occupied by industrial activities, residential and open space respectively (figure 1). The reason for this could be attributed to some observed drastic developments which emerged because of the academic institution that serves as a convergence of human activities in this area. This assertion is supported by the findings of Oyinloye (2010), where land resources are changing due to the developmental activities over the years.

Table 1: Past and Present Land-Use Area (ha)				
Land-Use Type	**1990-2004 (Past Land-Use)**		**2005-2012 (Present Land-Use)**	
	Area/Extent (ha)	**%**	**Area/Extent (ha)**	**%**
Industrial	380	3.8	4879	48.79
Commercial	100	1.0	2500	25
Residential	1500	15	4560	45.6
Open space	1500	15	210	2.1
Agricultural	6520	65.2	351	3.51
Total	10,000	100	10,000	100
Source: Authors' survey, 2013				

Map Analysis and Land-Use Condition in Akure South

In addition, the base map of the study area was processed and converted to digital format through scanning and vectorizing in ArcGIS version 9.2 environment (figures 3 and 4). Land–use status in this study was categorized with blue colour that specifies the industrial land use, where agricultural land use was represented by green colour, and yellow colour stands for residential land use, and red colour, white colour are for commercial land use and open space respectively. It was revealed that land use changes occurred over the years as a result of overwhelming socio-economic activities in the study area. The agricultural land-use was observed totally given up to industrial and residential land-use activities. Figure 4 revealed that industrial, residential and commercial land-uses were of minor impact in the past indicating green colour with wider coverage on the map. This when compared with figure 3, it is evidently clear that greener lands that represent agricultural land-use activities has become minor where all other land-use activities examined in the study were majorly represented.

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Figure 3: Map of Present Land-Use of Southern Part of FUTA, Akure.
Source: Authors' Survey, 2013

Table 2: Database showing Present Land Use Status in the Southern Part of Akure

Id	Country	State	City	Lga	Location	X	Y	Present_landuse
1	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.149	7.293	Commercial
2	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.201	7.291	Commercial
3	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.130	7.091	Commercial
4	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.121	7.211	Commercial
5	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.210	7.241	Commercial
6	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.029	7.223	Commercial
7	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.141	7.251	Residential
8	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.110	7.212	Residential
9	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.301	7.140	Residential
10	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.009	7.300	Residential
11	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.100	7.712	Residential
12	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.233	7.344	Residential
13	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.410	7.201	Residential
14	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.322	7.101	Residential
15	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.311	7.602	Residential
16	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.151	7.366	Residential
17	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.142	7.261	Agriculture
18	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.109	7.402	Agriculture
19	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.211	7.121	Agriculture
20	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.412	7.202	Agriculture
21	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.220	7.252	Agriculture
22	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.321	7.542	Agriculture

Source: Authors' Survey, 2013.

Figure 4: Map of Past Land-Use of Southern Part of Akure.
Source: Authors' survey, 2013

Id	Country	State	City	Lga	Location	X	Y	Past_land
				Table 3: Database showing Past Land Use Status in the Southern Part of Akure				
1	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.149	7.293	Residential
2	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.201	7.291	Residential
3	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.130	7.091	Residential
4	Nigeria	Ondo	Akure	AkureSouth	FUTA AREA	5.121	7.211	Agriculture
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Source: Authors' survey, 2013.

The coordinates of the map were stored in a relational database, which consist of core dataset to which the associated spatial data (X, Y coordinates) were linked to the map and stored in tables that were prepared with ArcGIS software using Universal Trasverse Mercator Projection Coordinate System of the dataset (see tables 2 and 3). The Land-Use Information System indicates twenty-two GPS points spreading over the entire land-use area. In order word, this geo-database created reflects past and present land-use status in the study area, where more of agricultural activities were identified in past period than new. Residential and commercial activities are the predominant features of the study area at present. This shows that lands in this area are subject to changes in view of developmental activities.

Hotlink Analysis for of Land-Use in Akure South

At this point, it is evident to note that agricultural land-use is mostly a "disturbed land-use" in the study area with the view that land-use has been converted over the years. The conversion was induced by the increasing emergence of residential, commercial, and industrial activities.
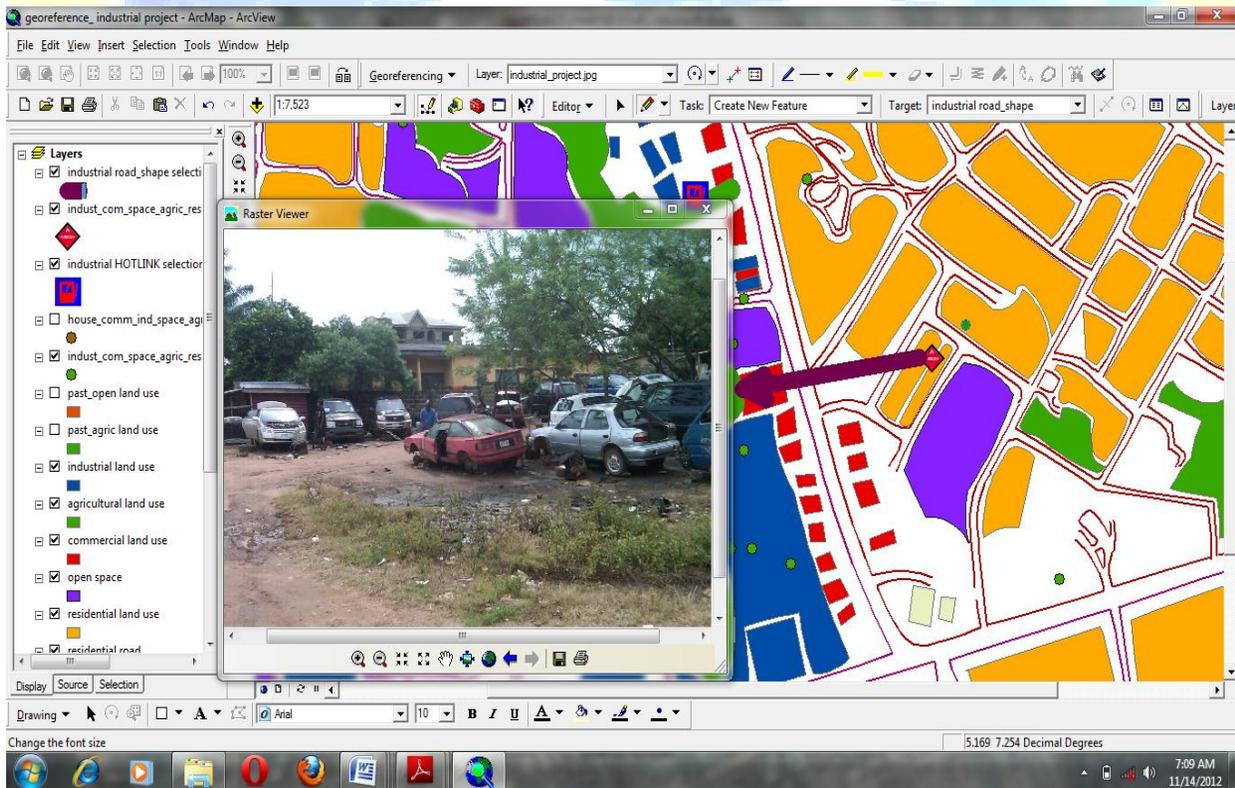

Figure 5: Converted Agriculture Land-Use to Industrial Land-Use
Source: Authors' survey, 2013.

Figure 5 is an ArcGIS hotlinks that identified human activities in the study area as one of the major conditions of loss in farmlands. For instance, the displayed portion of land in figure 5 is an indication that mechanic activities has rendered the location useless for agricultural activities though, formerly occupied by farmers. This situation explained the vulnerable status of the identified land space which might be no longer suitable for crop growth because of the effect of engine oil on soil in the location. The finding of Ajibade and Ojelola (2004) shows that the effects of automobile mechanics activities on soil; where there are significant changes in the pH ratio, organic matter content and nitrogen of the soil samples at a depth of 0-15cm could destroy soil and reduce agricultural productivity.

In another example, the hotlink analysis in figure 6 presents other human activities such as commercial and residential occupying an identified land area. The two land-use areas on the map were identified with point location with link arrow that pointed to the geographic features. The study shows that these particular land areas were once agricultural farmland few years ago but due to developmental influence, it has been adopted for other identified purposes.
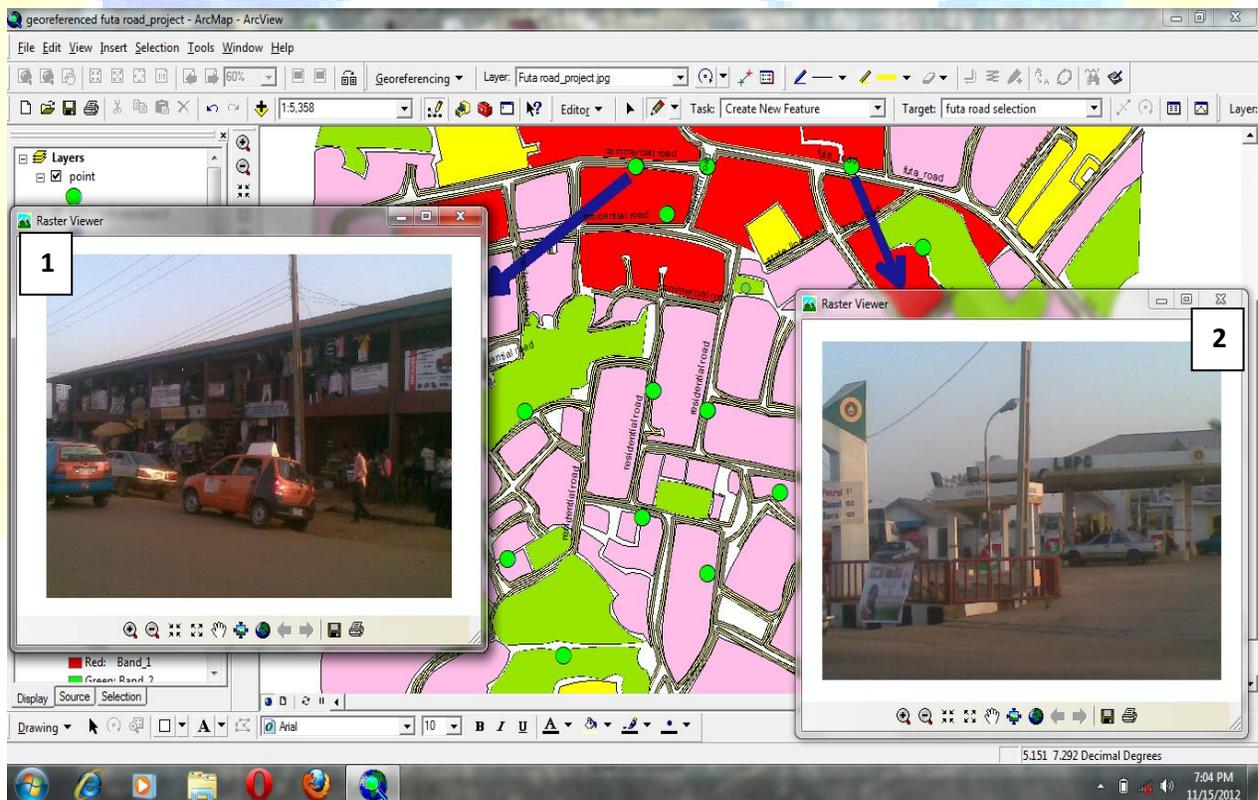

Figure 6: Converted Agriculture Land-Use to Commercial and Built-up Land-Use
Source: Authors' survey, 2013.

Conclusions

This study has developed Land-Use Information System for part of Akure in Ondo state, Nigeria. It examined land use practices in view of past and present land-use configuration. The study also aimed at allowing the planners and decision makers carrying out more research on what, where, and how best could land-use resources be sustainably managed. It is evident that that land-use status could be examined through GIS analysis, design, and database technology. This paper has presented the integration of Geographical Information System in land-use planning and development through creation of Land-Use Information System. Based on the results and conclusions, the study recommended that regular up-date of the geographic database through which specific site could be sought to know what is obtainable in that particular field or district through a link between geometric and attribute data. This will allow the decision making bodies to have access to information on each feature under consideration and at the same time improve upon them. Government should encourage the development of Land-Use Information System (LUIS) in every part of the nation for all kinds of land-use in the entire state and Nigeria as a whole.

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