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Land Use Land Cover Dynamics of Faculty of Agriculture and Forestry Practical Demonstration Site, Ileogbo, Osun State, Nigeria

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Abstract

Information on land use and land cover is very essential for change detection and monitoring especially where anthropogenic activities prevail like the Faculty of Agriculture and Forestry Practical Demonstration Site at Ileogbo (FAFPDSI). Such information will help in the management of the site. However, detail information on these changes over time is lacking. Therefore, the land use land cover dynamics of the FAFPDSI was investigated over time in this study. This was with the view of providing information for the sustainable management of the site. Sketch map of Ileogbo was obtained from Physical Planning Unit of University of Ibadan, Ibadan, Nigeria. Landsat 7 Enhanced Thematic Mapper imagery of 2002, 2017 and historical image of 2013 were obtained. These imageries were subjected to spectral enhancement and geometric corrections. The imagery was subjected to supervised classification method using IDRISI Taiga where four land use types were discovered. The four land use types are forest, bare-land, farmland and built-up. The results showed that natural forest reduced from 104.76 ha in 2002 to 81.41 ha in 2013 and to 71.51 ha in 2017 with a percentage change of -31.74%. Farmland, on the other hand, increased from 60.89 ha in 2002 to 66.04 ha in 2013 and to 68.28 ha in 2017 with a percentage change of 12.09%. The rate of deforestation was recorded at 2.22 ha/yr. The forest land in the study area is reducing at an alarming rate. Bare-land and farmland are replacing the forest. The study has revealed the efficiencies of remote sensing and GIS techniques for data capturing to produce reliable information on the land use/land cover and the changes that has occurred over time.

Keywords: satellite imageries, geographical information system, supervised classification and change detection.

Introduction

Land use dynamics is an important driver of climate change, which affects many parts of human environmental system over the years (Lambin, 1999). Land use change which includes the conversion of forestland into agricultural land, not only accelerates land degradation, but also intensifies carbon-dioxide (CO_2) emissions and loss of biodiversity (Kremen *et al.*, 2000; Jackson *et al.*, 2007; Erik *et al.*, 2012). Degradation of natural resources, especially land and forest, has become a serious concern in developing countries, where most rural people depend on these natural resources for sustenance (FAO, 1999). Land cover and land use are the biophysical attributes of the earth's surface which can be detected directly from aerial imagery or satellite-borne sensors and the purpose for which the land is used (Lambin *et al.*, 2001). Land use is defined as the series of way in which land has been put to use, mainly on the functional role of land for economic activities while land cover is the physical characteristics of the earth's surface distributed in form of vegetation, water, soil and other physical features of the land which are created by human activities (Lambin *et al.*, 2003; Zubair, 2006). The land use and land cover pattern of an area depict nature and socio-economic factors of the area and its utilization by man (Zubair, 2006).

The development in remote sensing technology and Geo-Analysis model, recently making use of remotely sensed data in monitoring the status land use and land cover changes, has become one of the most rapid, credible and effective method (Swapan and Kumar, 2012). Modern technologies such as remote sensing and GIS provide some of the most accurate means of measuring the extent and pattern of changes in landscape conditions over a period of time (Miller *et al.,* 1998). Remote sensing is useful in quantifying land use and land cover changes especially from arable land to impermeable surface (Milessi et al., 2003). It also monitors the spatio- temporal and dynamics changes. Remotely sensed data along with Geographic Information Systems (GIS) increase the means to analyze the human impact on the environment in quantitative and qualitative forms (Aadil *et al.*, 2014). Remote sensing techniques, which include the use of conventional aerial photography can be used effectively to complement surveys based on ground observation and enumeration. Remote sensing (RS) and Geographic Positioning System (GIS) provides a reliable source of data for assessing and monitoring spatial and temporal land use and land cover changes. A combined use of RS and GIS technology can be invaluable to address a wide variety of resource

management problems (Tekle and Hedlund, 2000; Billah and Rahman, 2004). Hence, remote sensing techniques can be used to develop land use classification mapping. This is a useful and detailed way of improving the selection of areas designed for agriculture, urban and industrial areas of a region (Selcuk, 2003).

Remote sensing techniques for forest cover change and monitoring has been used to assess the differences in the forest cover over two or more period of time by environmental and human activities. Quite a number of researches have been carried out in this regard. For example, Adeniyi and Omojola (1997) mapped the land use and land cover change of Sokoto-Rima Basin using landsat and archival remote sensing procedures. Damizadeh *et al.*, (2000) use satellite images to study changes in vegetation cover in southwestern part of Iran. Similarly, Zubair, (2006) examined the use of GIS and Remote Sensing in mapping land use/land cover in Ilorin between 1972 and 2001 which provided information on the changes that have taken place in the study area between the periods. Ejemeyovwi (2009) studied the land use pattern and its attendant effects in Abraka Urban, Delta State. He identified seven distinct units from the classification and land use pattern analysis namely commercials, communication and utilities, industrial, institution, recreation, residential and vacant land. The residential unit accounts for over 80% of all the land use types. Land use dynamics of Ikere forest reserve was delineated to ascertain the level of deforestation in the reserve between 2011 and 2016 using geographic information system (Alo and Akindele, 2016). Ileogbo practical demonstration site, which is 217ha in size, was given to the Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria by the rural community of Ileogbo in Ayedire Local Government Area of Osun State. This land was acquired as practical demonstration site for research and development with the aim of providing solution to food and fibre security and also to help alleviate poverty in Nigeria. This land was abandoned since the date it was acquired until 1986. The objectives were to ultilise the land for teaching and research under the auspices of the seven Departments in the Faculty, create world class field laboratory for teaching and research where staff and students can develop their professional skills and become worthy in character and teach students on how to be self-sustained and propel the vision of entrepreneurship.

Since the inception of activities in Faculty of Agriculture and Forestry practical demonstration site at Ileogbo, information on the land use land cover dynamics has not been document. Therefore, this research is designed to determine the land use land cover dynamics of this site over time with a view to providing information for the sustainable management of the site.

Methodology

The Study Area

The FAFPDSI is situated in Ayedire Local Government Area of Osun State along with Kuta, Oluponna, and Oke-Osun communities and found within Latitude 7°36'41.69"N and 7° 35' 10.98"N and longitude 4°15' 38.61" E and 4°16' 40.55"E. It is located in North-Western part of Osun State within derived Savannah zone of Nigeria, at the southern part of Ogbagba and North-Eastern of Iwo communities (World Bank, 2014). The soil is highly ferruginous tropical red soils, which is associated with basement complex rocks. As a result of the dense humid forest cover in the area. The soils are generally deep and of two types, namely, deep clayey soils formed on low smooth hill crests and upper slopes. The vegetation of the area is mostly short grasses and timber grade trees. Every parts of the forest had natural lowland tropical rainforest vegetation which gives way to secondary forest re-growth due to fuel wood production, road construction and traditional farming practices. The mean annual rainfall varies from 231.75 mm in the southern part to 206mm and highest rainfall is usually recorded in the months of July and August. Mean maximum ambient temperature values range between 33.84°C in February and 28.8°C in August, while mean minimum temperatures range between 25.18°C in March and 23.0°C in August. Higher temperatures were recorded at the peak of the dry season, between November and May, while lower temperatures were recorded in the rainy season (ESMP, 2014).

Method of Data Collection

Map of the study area was collected from the Physical Planning Units, University of Ibadan, landsat imageries for 2002 and 2017 of the study area were downloaded from the Global Land Cover facility web site (http://glcfumd.edu.umiacs./index.shtml) and historical imagery for 2013 was also collected from google earth. To verify the different land use and land cover types observed on the satellite images (Ground trothing), data were collected on the vegetation cover; land use land cover type and the topography of the study area with the use of GPS to take coordinates at several locations.

Table 1: Data Type and characteristics

Data	Type	Path and Row	Date of acquisition	Resolution
Landsat-ETM+2002	Spatial	190/55	2002-01-03	30m
Landsat-8 2017	Spatial	190/55	2017-01-04	30m
Historical image	Spatial	190/55	2013-01-12	

Method of Data Analysis

The images were geometrically corrected to rectify the satellite scenes to UTM map projection which were also registered into the Universal Transverse Mercator (UTM) zone 31N. This is because all the remotely sensed data are geo-coded to UTM projection. The Satellite imageries for years 2002, 2013 and 2017were subjected to Principal Component Analysis to improve the interpretability of the images, reduce information redundancy and extract information from the data which is not readily visible in it raw form. The Landsat imageries were converted from the Tag Image File Format (TIFF) to imaging format using IDRISI for compatibility. These imageries were loaded into Taiga IDRISI software where they were subjected to supervised image classification method for the interpretation of the imageries.

For this study, present land use and its characteristics was assessed for significant planning and management purpose. The training sites were defined into four classes. The various classes are vegetation, built-up, water bodies and farmland

Change Detection Analysis

Comparison of land use land cover statistic method was adopted as stated above. The area analysed involves the analysis which highlighted the trend and the rate of land use and land cover changes over the period under investigation. This help in identifying the percentage change, trend and rate of change between 2002, 2013 and 2017. In achieving this, the first task was to develop a table showing the area in hectares and the percentage change for each of the selected years (2002, 2013 and 2017) measured against each land use land cover categories. Percentage to determine the trend of change was then calculated by dividing observed change by absolute sum of change (Singh, 1989).

$$\%\,\Delta = \frac{OC}{ASC} \times 100 \quad (1)$$

$$\%\,\Delta \text{ in year} = \frac{Y_2 - Y_1}{Y_1} \times 100 \quad (2)$$

$$\text{Average Rate of } \Delta = \frac{Y_2 - Y_1}{T_2 - T_1} \quad (3)$$

$$\%\text{ average Rate of change} = \frac{Average\ Rate\ of\ change\ \left(\frac{ha}{yr}\right)}{Difference\ in\ year} \times 100 \quad (4)$$

Where:

OC = observed change

ASC = absolute sum of change i.e. fixed year (starting year)

Y_2-Y_1 = observed change

Y_2 = ending year

Y_1 = starting year

T_2-T_1 = periodic interval between the initial period and the final period.

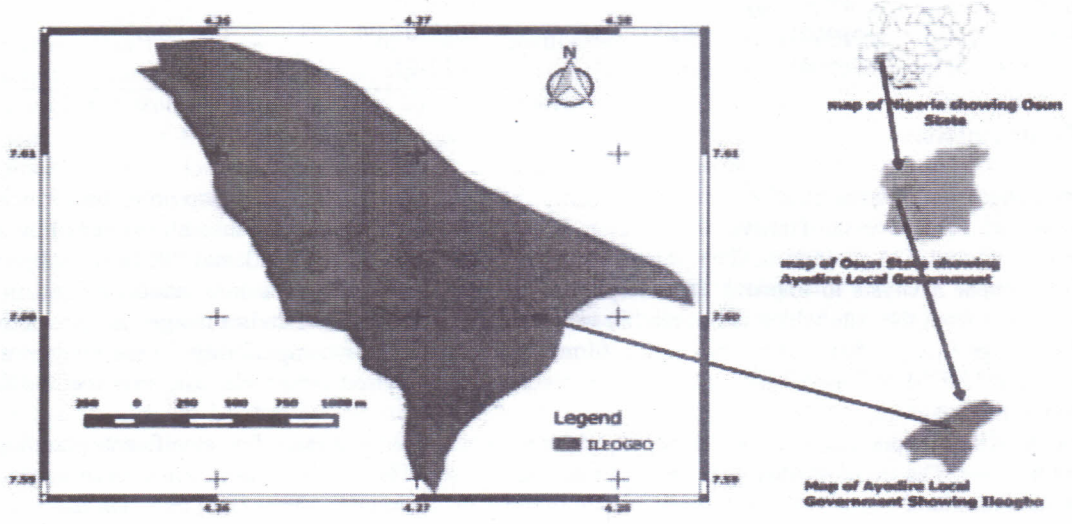

Figure 1: Practical and demonstration site of the faculty of Agriculture and Forestry, Ileogbo

Results and Discussion

Land Use/Land Cover of the Faculty of Agriculture and Forestry Practical

Demonstration Site

The results of the analysis are presented in tables and maps format. The land use land cover description is presented in Table 2. From the table; evergreen deciduous and wetland forest vegetation were referred to as forest, land use for agricultural purposes were referred to as farmland, land area not under agricultural uses during the study were referred to as bare-land while built up area were the residential areas.
About 51.35 ha, which represent 24% of the total land area was bare-land in 2002 while the forest covered about 104.76 ha accounting for 48% of the total land area (Table 3). That same year, forest was concentrated towards the northwest down to the southwest through the western part of the practical demonstration site (Figure 2).

Table 2: Land use Land cover description

Land use land cover classes	Description
Forest	This includes; evergreen, deciduous and wetland forest vegetation.
Farmland	This involve land use This is land use for agricultural purposes.
Bare-land	These are land area not under agricultural uses during the study.
Built-up	They are residential are These are area residential area, roads networks etc.

Bare land on the other hand was concentrated towards the northeastern part of the site. Farmland was distributed partly at the center and partly at the southwest across the site with dirty green colour. The result from 2013 shows that the highest land area was still forest which cover about 38% and cover land area of 81.41ha of the total land area. This indicated that forest is reducing yearly. This was followed by bare-land with land area of 68.03ha by 31% of the total land area while farmland covers 66.04ha with 30% of the total land area (table 3). Forest area is concentrated at the western and southern part of practical demonstration site with dark green colour (Figure 3). Bare-land is distributed in all part of the study area while there is farmland concentration at the Eastern part of the site.

Also, analysis on the 2017 imagery shows a drastically reduction in the vegetation cover where bare-land accounted to be the highest land area with a 35% of the total land area as shown in (Table 2). This was followed by forest (33%) and the least was the farmland (31%). In that same year, forest has gradually withdrawn towards to

southwester part of the study area with a little pocket at the centre while the farmland was seen as scattered across the entire site (Figure 4). Bare-land on the other hand has dominated the entire land from the northern fringe to the southwestern fringe and extends to the southern part. Unlike 2002, some structures were identified at the southeastern part of the study area.

The results from Table 3 showed that, faculty of agriculture and forestry practical and demonstration site which is located at Ileogbo is predominantly dominated by four different land use land cover types which were; forest land, farm land, bare land, and built-up area.

Table 3: Area and percentage of each of the land use land cover for the difference years

Classification	2002		2013		2017	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Forest	104.76	48	81.41	38	71.51	33
Bare-land	51.35	24	68.03	31	75.72	35
Farmland	60.89	28	66.04	30	68.25	31
Built-up	0	0	1.52	1	1.52	1
Total	217	100	217	100	217	100

The FAFPDSI is mostly dominated by forest and farm land, occupying about 48% and 28% respectively in the year 2002, while in 2013, bare-land and farmland occupying 31% and30% respectively while 38% was recorded for forest area in the same year. Bare-land increased from 24% to 31% in 2013 and to 35% in 2017 and farm land increased from 28% to 30% in 2013 and to 31% in 2017. But forest land decreased from 48% to 38% and to 33% in 2002, 2013 and 2017, respectively. Built-up area remained at 1% throughout the period selected for this study. This shows that, over the years, anthropogenic activities (farming and building) within FAFPDSI might have led to decrease in forest land as observed in this study. The decrease in the forest area was in accordance with Alo and Akindele, (2016). These authors reported that the natural forest in Ikere forest reserve was reduced to farmland, and grassland. They also concluded that the rate of deforestation was at 7% of the total land area of the study area.

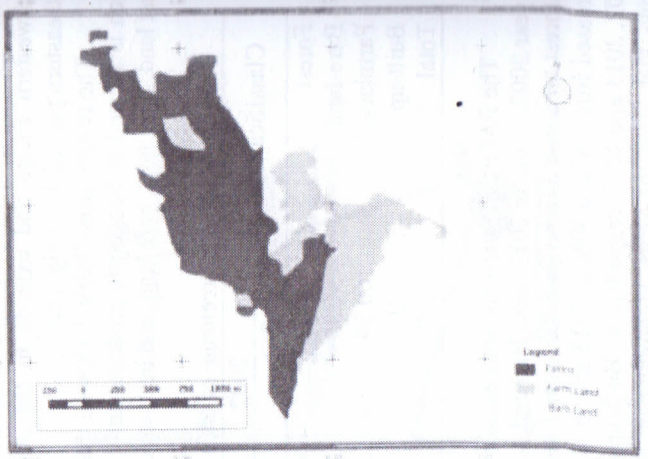

Figure 2: Land use of FAFPDSI in 2002.

Figure 3: Land use of FAFPDSI in 2013

Figure 4: Land use of FAFPDSI in 2017

Extent of change in the study Area between 2002 and 2017

The extent and rate of change of identified land use land cover in the study area are presented in Table 6 and the rate at which land cover change progresses from 2002 to 2017, as well as trend in land use land cover shows a drastic decrease in the forested area from 104.76 ha accounting for 48% of the total land area in 2002 to 81.41ha accounting for 38% of the total land area in 2013 and finally to 71.51 ha accounting for about 33% of the total land area in 2017. Bare-land increased from 51.35 ha accounting for about 24% of the total land area in 2002 to 68.03ha accounting 31% of the total land area in 2013 and to 75.72 ha, accounting 35% of the total land area in 2017. Bare-land gained about 24.37 ha of land. However, built-up area was observed in 2013 and 2017 to occupy an area of 1.52ha (1%).Whereas in 2002, there was no evidence of any structure in the study area. Furthermore, farmland also increase from 60.89ha accounting for 28% in 2002 to 66.04 accounting for 30% in 2013 of the total land area and 68.25 ha accounting for 31% in 2017. The rate of increase by the bare-land and the farm land and the reduction in the forest area per year is shown in Tables 4 and 5. The reduction in the forest area is as a result of the conversion of the forested area to other land use type such as farming and some human influence in the study site. This resulted into an increase in the bare-land and farmland. Also from Table 5, it was revealed that if the study area is left with the trend it is now without any proper monitoring and management, after some time, the whole forest in the study area would have been taken over by other land uses. But if the Faculty can actualize the proposed Agricultural Institute it will go a long way to conserve the forest in the area.

Table 4: Land use land cover classes and rate of change in between 2002 and 2013

	2002	2013	Change		Average rate of change		
Classification	Area(ha)	Area(ha)	Area(ha)	%change	ha/yr		
Forest	104.76	81.41	-23.35	-22.29	-2.12	Decrease	
Bare-land	51.35	68.03	16.68	32.48	1.52	Increase	
Farmland	60.89	66.04	5.15	8.46	0.47	Increase	
Built-up	0	1.52	1.52	100	0.14	Increase	
Total	217	217					
Summary							
Forest land	104.76	81.41	-23.35	-22.29	-1.56	-52.30	14.97
Non-Forest land	112.24	135.59	23.35	20.80	1.56		

Table 5: Land use land cover classes and rate of change in between 2013 and 2017

	2013	2017	Change		Average rate of change	Remark
Classification	Area (ha)	Area (ha)	Area (ha)	% change	ha/yr	
Forest	81.41	71.51	-9.9	-12.16	-2.48	Decrease
Bare-land	68.03	75.72	7.69	11.30	1.92	Increase
Farmland	66.04	68.25	2.21	3.35	0.55	Increase
Built-up	1.52	1.52	0	100	0	Increase
Total	217	217				
Summary						
Forest land	81.41	71.51	-9.90	-12.16	-0.66	
Non-Forest land	135.59	145.49	9.90	7.30	0.66	

Table 6: Land use land cover classes and rate of change in between 2013 and 2017

Classification	2002 Area (ha)	2017 Area (ha)	Change Area (ha)	% change	Average of change Ha/yr	Remark	
Forest	104.76	71.51	-33.25	-31.74	-2.22	Decrease	
Bare-land	51.35	75.72	24.37	47.46	1.62	Increase	
Farmland	60.89	68.25	7.36	12.09	0.49	Increase	
Built-up	-	1.52	1.52	100.00	0.10	Increase	
Total	217	217					
Summary							
Forest land	104.76	71.51	-33.25	-31.74	-2.22	-32.26	14.97
Non-Forest land	112.24	145.49	33.25	29.62	2.22		

Supervised classification for 2002 (b) Supervised classification for 2017

Figure 5: Supervised classification for study area for 2002 and 2017

Conclusion

The study has revealed the reduction in vegetation cover, especially the forest area, from 2002 to 2017 as a result of increase in anthropogenic activities in the study site over the years. The forest has given way to basically agricultural activities and decreasing at the rate of 2.22 ha/year. This study also discovered the capabilities of remote sensing and geographic information system techniques in capturing, integrating and analyzing vegetation imagery data of an area over a long period of time in other to provide useful information on the land use land cover pattern of the area. Therefore, in other to effectively manage the practical site and to increase the forested area, there should be regeneration and massive afforestation programme especially on the area allocated to the Department of Forest Resources Management.

There is also the need for proper designing of a workable policies and strategies by the Faculty of Agriculture and Forestry for proper management and maintenance of the practical site to achieve the goals for which the study area was acquired. There should be consistent monitoring of the study area through higher resolution satellite such as spot and Ikonos to detect subtle encroachment in the study site.

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