LAND USE DYNAMICS ANALYSIS FOR SUSTAINABLE DEVELOPMENT PLANNING USING GEO-INFORMATICS TECHNIQUES: CASE STUDY OF OGBOMOSO TOWN, NIGERIA

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ABSTRACT

Land use and Land cover mapping is an important task to conserve natural resources and to recommend suitable management practices. Understanding land use dynamics will help countries in land management thus preserving their natural resources. Geo-Informatics has been increasingly used for mapping land use and land cover due to specific characteristics of remotely sensed data such as resolution, accessibility to remote areas and faster interpretation with higher degree of objectivity and reproducibility. This study thereby mapped land use dynamics of Ogbomosho North Local Government area using Geo-informatics techniques between year 1984 and 2016. ArcGIS software package was used for the supervised classification in the study. The total area covered by the assessed land is about 253 Km^2. The classification result of 1984 imagery showed that water body occupied 1.2% of the study area; shrub, 34.4%; arable land, 57.8%; built-up, 6.4% and bare land, 0.2% of the study area resulting into decrease in year 2000 and year 2016. The maps generated showed increase in water buddies, built-up area, pave and rocky areas and in vegetal and in other agriculture land, but decrease in forest land depicting loss of agricultural land, modification and alterations in the land use/land cover changes over time.

Keywords: Land Use; Dynamics; Sustainable; Area; Classification

INTRODUCTION

Land is definitely one of the most important natural resources, since life and developmental activities are based on it. Land use refers to the type of utilization to which man has put the land. It also refers to evaluation of the land with respect to various natural characteristics. But land cover describes the vegetal attributes of land. Land use and land-cover data are essential for planners, decision makers and those concerned with land resources management (Ndukwe, 1997; Ochieng *et al.,* 2013). Monitoring and analysis of the urban environment make use of up-to-date Land-use and Land-cover (LULC) information, for proficient and sustainable management of urban areas. Unfortunately, on the other hand, there is a general lack of accurate and current LULC maps in Nigeria (Ezeomedo, 2006).Land-Cover/Land-use, being the new concept developing with the remote sensing technology, has become a crucial item of basic tasks in order to carry through a series of important works, such as the prediction of land-use change, prevention of nature disaster, management and plan land use, protection of environment. With the more thorough development of remote sensing technology and Geo analysis model, using remotely sensed data to monitor the status and dynamical change of land-cover/land-use is become the one of the most rapid, credible and effectual method. Land-cover and Land-use are two different concepts in its intrinsic signification. Land-cover emphasize particularly on its nature properties and it is the synthetically reflection of various elements in global surface covered with natural body or manual construction. Using remote sensing classification method, whatever used or non-used covering object in surface can be separated. However, Land-use, emphasizing more on land's social properties, is the output of reconstruction activities that human adopts a serial of biologic, technologic measure to manage and regulate the land chronically and periodically accordingto determinate economic and social purpose (Otieno, *et al.,* 2013). Thus, land-use is a process of turning natural ecosystem into social ecosystem, and the process is a complicated procedure by the synthetic effect from nature, economy and society(Kumar and Kumar, 2012).Current technologies such as geographical information systems (GIS) and remote sensing provide a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics- detect, identify, map, and monitor differences in land use and land cover patterns over time, irrespective of the causal factors (Otieno, *et al.,* 2013).Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past. GIS has enormous possible as an environment for the conception of dynamic models of physical environmental processes (Jensen,1996).Studies have shown that there remain only few landscapes on the Earth that is still in their natural state. Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and man's presence on the Earth and his use of land has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use/land cover over time. Land use/ land cover studies have got a renewed emphasis as the process of agricultural use of land has been in a flux in the wake of fast changing national economy under the new global order (Otieno, *et al.,* 2013; Bello, *et al.,* 2018). Land use refers the purpose of the land serves, for example, recreation, wild life habitat, agriculture. Land use is a product of interaction between a society's cultural background, state and its physical needs on the one hand and the natural potential of land on the other hand (Ram and Kolarkar, 1993). According to Longley (2001), land cover refer to the physical materials on the surface of a given parcel of land, while land use refer to the human activities that takes place on or make use of land such as; residential, commercial, industrial. The study evaluated the Land use dynamics of Ogbomosho North Local Government area using Remote Sensing and Geographic Information System (GIS) for the period between years 1984 and 2016. This was achieved extracting the land use/land cover changes and categories of the study area, generating land use/ land cover map of the study area and showing the effect of temperature and rainfall method on land use/ land cover upon reports and maps, and the satellite images of the study area. The study thus mapped the land use/ land cover dynamics of Ogbomosho North Local Government, Ogbomosho, Nigeria between the years 1984 and 2016.

METHODOLOGY

Location of the Study Area

The study was carried out in Ogbomosho North Local Government Area of Ogbomosho, Oyo State, Nigeria. Ogbomosho is the second largest city in Oyo state and south west Nigeria. Ogbomosho is located between Latitudes 8° 2' 35.20" N and 8° 14' 34.25" N and Longitudes 4° 10' 52.92" E and 4° 19' 40.59" E. Ogbomosho is located within a derived savannah region, it is 104 Km North East of Ibadan, 58 km North West of Oshogbo, 57 Km South West of Ilorin and 53 Km North East of Oyo. The climate of the region is characterized by a fairly high uniform temperature, moderate to heavy seasonal rainfall and high relative humidity. The mean annual temperature is about27^{o}C. the lowest temperature are experienced in between August and February, which has a mean temperature of 25^{o}C and the highest in March, with a mean temperature of 29^{o}C.Ogbomoso North is experiencing both North East wind and South West wind. North East wind is known as the harrmattan wind and it is characterized by the dry North East trade and it is from Sahara, it occurs between November and February and it is cold type, dryness and also harsh weather condition. South West wind is from the Atlantic Ocean and it occurs between March and October, it brings mostly rain. Cultivate lands of the study area are primary used for farming activities. It includes food crops, horticultural crops and commercial crops of different kinds under and rained conditions, which are however grown under different, different farming activities and land use tenure system. The relative humidity is high the early mornings throughout the year with a marked decrease in the afternoons. The highest relative humidity occurs from July through September, also the lowest comes from December to February, cloud cover over the area extensive as a result of the relative humidity (Janssen, 2004). The map in Figure 1 shows Ogbomosho town in Oyo State, Nigeria.

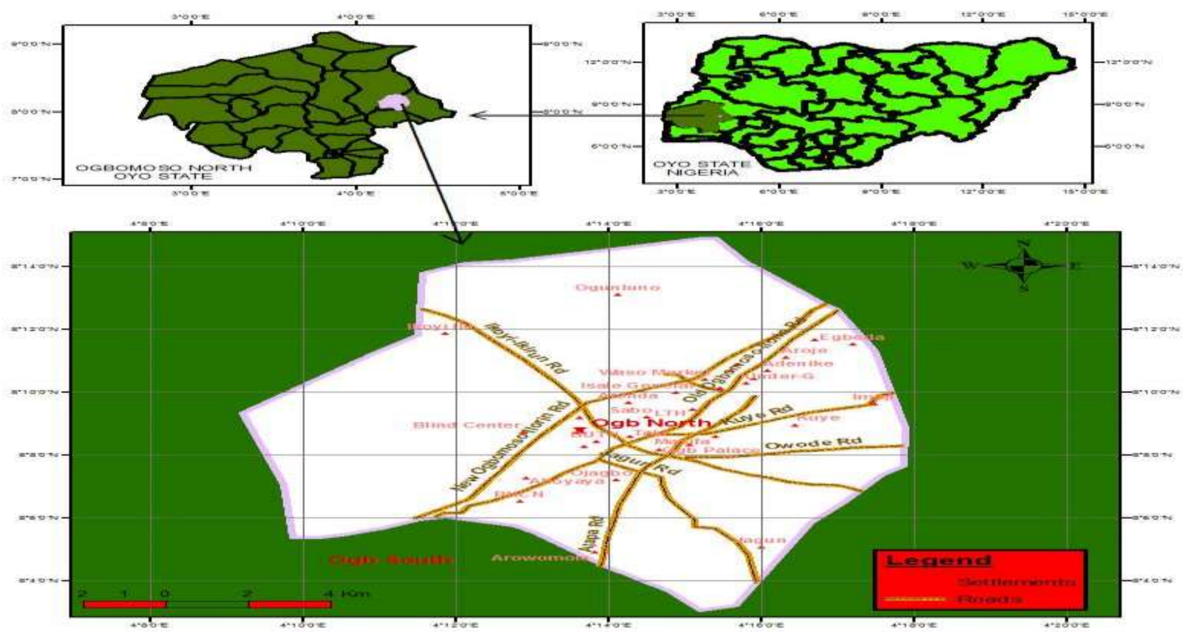

Figure 1: Map of Ogbomosho, Oyo State in Nigeria (adapted from Ojo & Olawale, 2014)

Data used

For the study, Landsat satellite images of Ogbomoso north were acquired only for two Epochs; 1984 and 2016. Both 1984 and 2016 was obtained from National Space Research and Development Agency in Abuja (NASRDA). It is also important to state that Ogbomoso north and its environs which were carved out using the local government boundary map and Nigerian Administrative map was also obtained from NASRDA. The primary data used for the study were LandSat TM 1984, LandSat ETM^+ 2016 and NigeriaSat-1. All the imageries were acquired between November and early February. The use of imageries of the same season for multi-temporal study is important for accurate change detection. Secondary data such as soil, land use, vegetation, climate and soil surveys information and data were imputed as used for the study. Administrative boundary map of Nigeria and the topographic map covering the study area on a scale 1:100,000 were also used while visual interpretation was carried out to determine the major apparent of land use/land cover patterns. The patterns was recognized and then used as inputs during the process of supervised classification. Final land use/ land cover maps were produced from ArcGIS using LANDSAT satellite images. The whole procedures are as highlighted in Figure 2 as flow-chat for land use dynamics mapping process, while other results were presented in percentage of area.

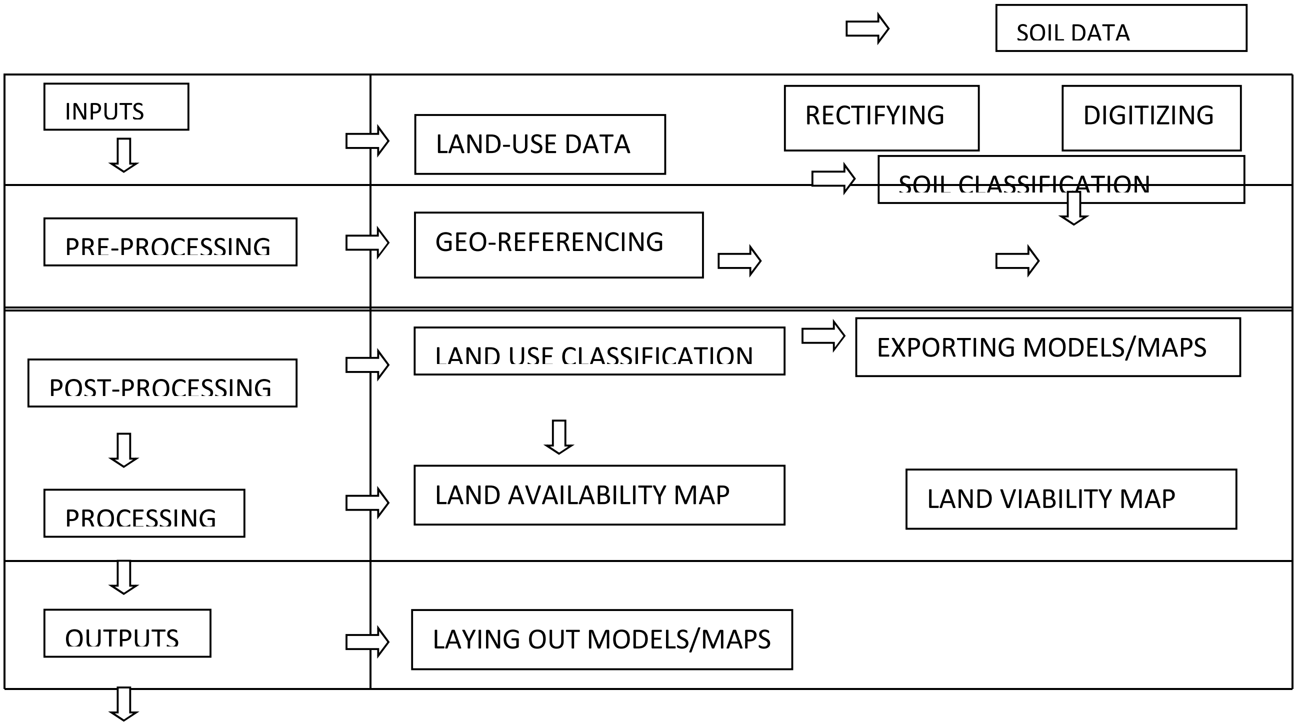

Figure 2: Flow-Chat for Land use dynamics mapping process modified after Ojo & Olawale (2014)

mean of local survey reports, local maps and site visits as supervised classification in this study (Richards, 1986; Ojo, 2013).ArcView 3.2 software was also used for processing, enhancement of the images obtained and carving out of Ogbomoso north region from the whole Oyo State imagery using the government maps and displaying of maps, while IDRISI 32 software was used for the development of land use / land cover classification and subsequently for change detection analysis of the study area.

Development of a Classification Scheme
Based on the priori knowledge of the study area and a brief reconnaissance survey with the processed images, a classification scheme was developed for the study area after Ojo (2013) and Otieno (2013) as depicted in Table 1. The definition of wasteland as used in the study denotes land without scrub, sandy areas, dry grasses, rocky areas and other human induced barren lands.

Table 1: Land use land cover classification scheme

CODE	LAND USE DYNAMICS CATEGORIES
1	Farmland
2	Waste land
3	Built-upland
4	Forestland
5	Water bodies

RESULTS AND DISCUSSION

Land Use / Land Cover Distribution

The static land use dynamics distributions for each study year as derived from the maps are presented in the Table 2. The figures presented in the Table 2 represented the static area of each land use dynamics category for each study year. Five major land cover types were identified in the study area. They are water body, shrub, arable land, built-up area and bare land. The classification result of 1984 imagery showed that water body occupied 1.2% of the study area; shrub, 34.4%; arable land, 57.8%; built-up, 6.4% and bare land, 0.2% of the study area as showed in Table 2. Built-up area in 1984 occupies 6.40% of the total classes and its increase to13.6% in the year 2000 and also increases to 20.3% showed that in the study area, there are changes or development making people to move into the area either to live, for business and other reasons (Otieno *et al*., 2013). Also, Ladoke Akintola University of Technology (LAUTECH) was established in 1991 in the area brought rapid growth to the area. Also, arable land which is use to practices agriculture seems to be available very much at that time (1984) because of the rate of buildings on land at that time and in addition, the rate at which people practiced agriculture at that time was higher as almost everybody practiced agriculture for living then thus, the arable land in 1984 has highest in the study area which is 57.8% at that time but which decreased in the year 2000 and also in the year 2016, due to reasons like afforestation, built up area and also water body. This is in agreement to the study by Bello *et al.,* (2018) that human activities affect the land dynamics. The pattern of land use land cover distribution in 2016 changes to the pattern in 1984. Arable land still occupies a major part of the total land but there is changes in Built-up area because its increase and also increased in the water body, bare land maintains the least position in the classes whilst shrub occupies 13.5% of the total class.

Transition Probability Matrix

The transition probability matrix records the probability that each land cover category will change to the other category. This matrix is produced by the multiplication of each column in the transition probability matrix be the number of cells of corresponding land use in the later image. For the 5 by 5 matrix Tables 2 and 3 showed the rows represented the older land cover categories and the column represents the newer categories. Although this matrix can be used as a direct input for specification of the prior probabilities in maximum likelihood classification of the remotely sensed imagery, it was however used to showed land use dynamics between year 1984-2016.Row categories represented land use dynamics in 1984 whilst column categories represented 2000 classes in Table 2 and the row categories represented land use dynamics in 2000 whilst column categories represented 2016 classes. As seen in the Table 2, the arable/vegetal land has a 369980 probability of remaining arable/vegetal land and a 1497 of changing to bare land in 2000 and also in Table 3 arable /vegetal has a 35664 probability of remaining arable land and a 507 of changing to bare land in 2016. This showed an understandable probability because there is no undesirable change, with a probability of a change which is lower than the stability. Also, in Tables2and 3 showed that arable land have 369980 and 356664 probability of remaining arable land and a 6775 and 54845from year 1984-2016 respectively. This depicted undesirable change (reduction) with a probability of change which is normal at the Table 2 to stability and in Table 3 the probability is much higher than stability. On the other hand it's showed that there will be a decrease in forest land to built-up area shows that there might likely be a high level of instability forest land as times goes on and the shrub has 202272 and 76501 probability to remain as shrub as showed in Tables2 and 3, and a 176908 and 356664 to arable/vegetal land which signifies stability of vegetal land. All these agreed to the findings by Otieno (2013) and Bello *et al.,* (2018).

Table 2: Land Use Dynamics (1984, 2000, 2016)

Land Use Classification	1984		2000		2016	
	AREA (HA)	AREA (%)	AREA (HA)	AREA (%)	AREA (HA)	AREA (%)
Water body	3.0300	1.20	7.8400	3.10	15.360	5.70
Shrub	86.990	34.4	89.520	35.4	34.140	13.5
Arable Land	146.16	57.8	120.87	47.8	115.78	45.0
Built-up area	16.310	6.40	34.520	13.6	86.460	35.3
Bare land	0.5100	0.20	0.2500	0.10	1.2600	0.50
Total	253.00	100	253.00	100	253.00	100

Post Classification Comparison

The post-classification comparison approach is very advantageous when using data from different sensors with different spatial and spectral resolutions (Alboody *et al*., 2008; Ojo, 2013). It was employed for detection of land use/cover changes, by comparing independently produced classified land use/cover maps. The main advantage of this method is its capability to provide descriptive information on the nature of changes that occurs (Mundia and Aniya, 2005; Ojo, 2013). It is important to note that this method depends on the results of the classification of all images and data stored in GIS database as GIS analysis allowed the post-classification comparisons, and facilitated qualitative assessment of the factors influencing urban expansion. There is five land use dynamics classes of interest in central part of Ogbomoso north, which are: Urban/ built up areas, Water body, bare land, Arable land and shrub. The spatial distributions of these classes were extracted from each of the land use/cover maps by use of GIS spatial analysis. The statistic land use/land cover distribution for the two time series (1984 and 2016) as derived from the maps are presented in Figures 3 and 4.The built-up area class increased from 6.4% in 1984, to 13.6%in 2000 and then to 35.3% in 2016. Arable land class, however, decreased significantly from 57.8% in 1984 to 47.8% in 2000 and remained with slight changes of 45.0% in 2016. In contrast bare land class took up the least percentage with just 0.50% in the total classes of the three time series. The spatial distributions of the five classes were extracted from each land use dynamics of year1984 and 2016 as shown in Figures3 and 4.

Table 3: The imagery classification results of year 1984 and 2000

1984/2000	Water body	Shrub	Arable Land	Built-up	Bare Land	Total
Water Body	1337	16500	15935	369	26	34167
Shrub	3645	202272	176908	6775	393	389993
Arable Land	7350	135222	369980	10911	1497	524960
Built up	819	24424	71369	52093	580	149285
Bare Land	0	195	830	163	49	1237
Total	13151	378613	635022	70311	2545	1099642

Table 4:The imagery classification results of year 2000 and 2016

2000/2016	Water body	Shrub	Arable Land	Built –up	Bare Land	Total
Water body	7215	10930	20998	1169	0	40312
Shrub	5895	76501	57611	6695	63	146765
Arable Land	18654	241529	356664	54845	507	672199
Built up	1679	54098	77847	85349	617	219590
Bare land	19	1114	3444	694	51	5322
Total	33462	384172	516564	148752	1238	1084188

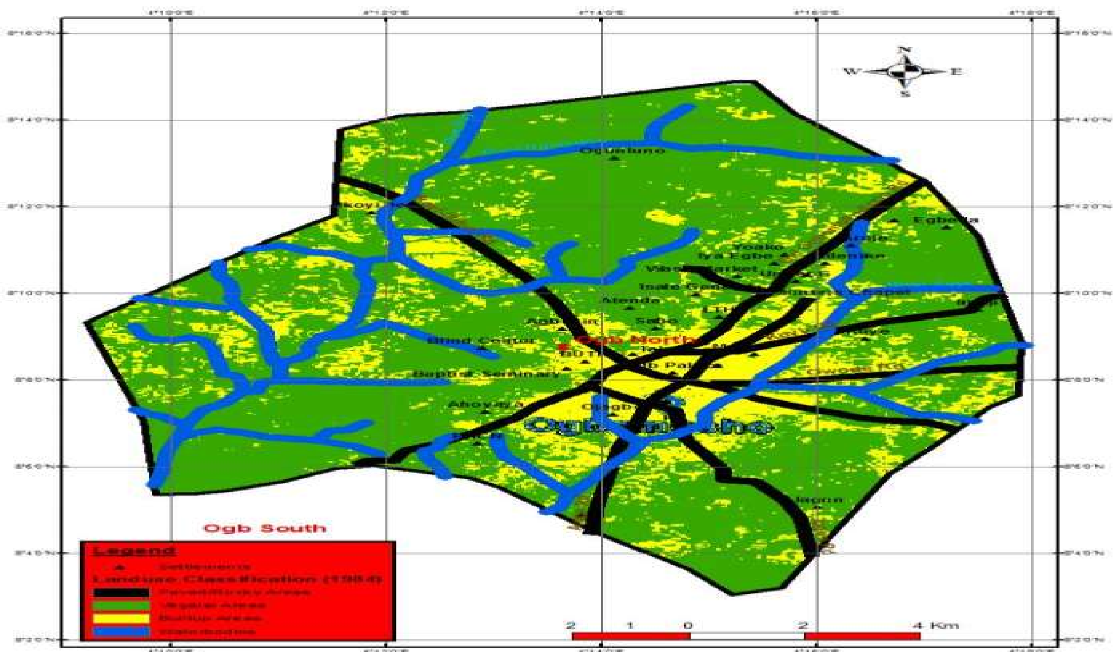

Figure 3: Classified map of the study area- year 1984

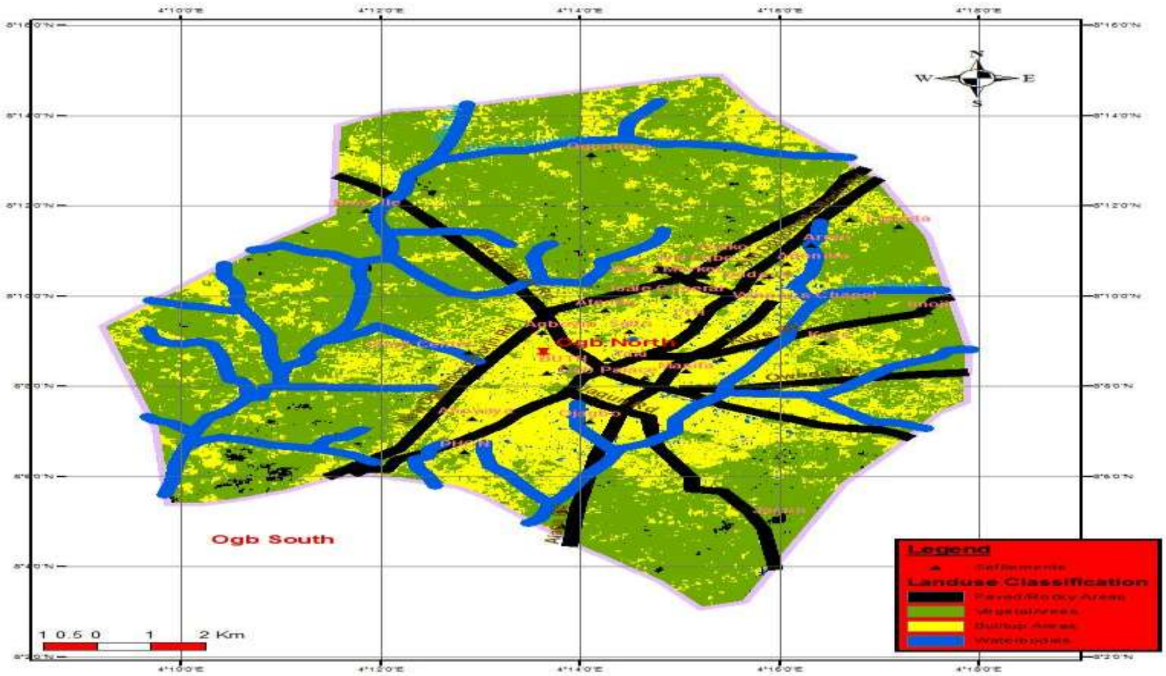

Figure 4: Classified Map of the study area – year 2016

Land-use Map

The land-use classification map of Ogbomosho North local Government Area showed in Figure 5. The total area covered by the assessed land is about 253 Km^2. The green part represents the arable areas while the red, yellow and blue parts represent the shrub areas, built-up area, bare-land areas and water-bodies respectively. The green part which is the arable/vegetal areas covers majority of the assessed area, this is followed by built-up areas and lastly the bare land areas.

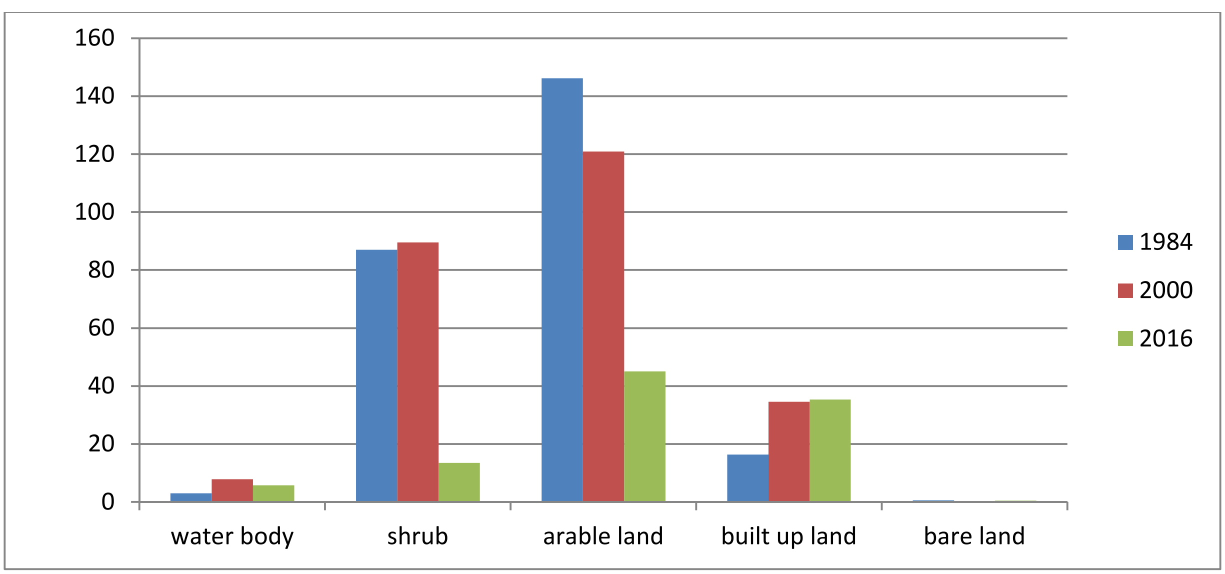

Figure 5:Trends in land use/cover changes for built-up areas, arable-land, shrub, water body and bare land during 1984, 2000 and 2016

Digital Elevation Map

The Digital Elevation Model (DEM) of Ogbomosho North local Government Area is as shown in Figure 6. Settlements in the middle part of the map are of higher elevations while the surrounding parts are of lower elevations. The elevation variation reduces in a north-western direction. The classification of the DEM of Ogbomosho North local Government Area into different landforms is show in Figure 7. Lowlands are categorically more suitable for agricultural purpose as compare to normal lands or highland. This is because crops planted on low lands have faster access to nutrients such water in soil and highlands are usually rocky making them poorly suitable for agricultural purpose.

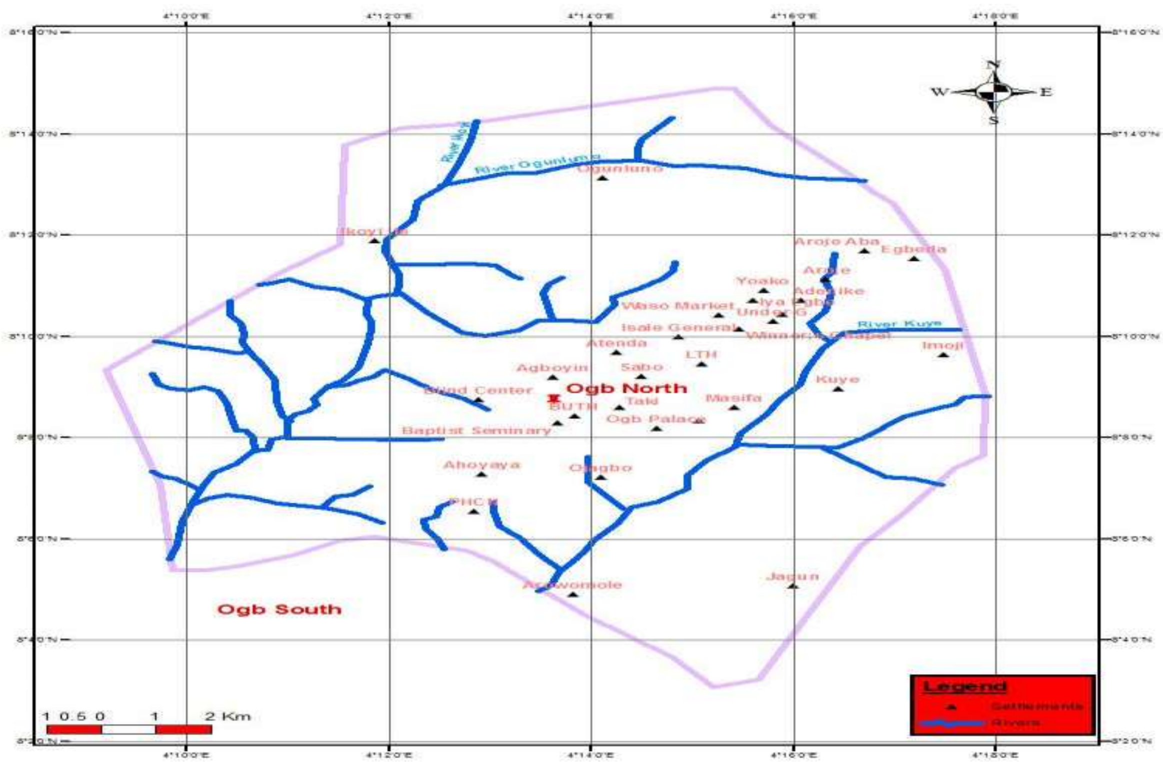

Figure 6: Ogbomosho North local Government Area Digital Elevation Model (DEM)

Land suitability

Land suitability map of Ogbomoso North Local Government based on the weighted overlay of Ogbomoso North local Government Area land-use, landforms and slope maps as displayed in Figures 7 and 8. There are four classes of land suitability- unsuitable, slightly suitable, suitable and highly suitable (Otieno *et al.,* 2013; Ochieng, *et al.,* 2013). The unsuitable class is represented by brown colour code. The slightly suitable areas are of yellow colour code while the suitable and highly suitable areas are of green and blue colour codes respectively. Settlements such Takie and Masifa are unsuitable for agricultural purpose, because the area is been occupied by structures. Aroje, Adenike, Yuacco, Waso market, Saw mills and Kuye areas are slightly suitable for agricultural purpose. Ogunlono, Ikoyi-ile, Egbeda, Imolo and Jagun are highly suitable for agricultural purpose, perhaps because they are flatlands and lowlands. In Figures7 and 9 showed the area covered by each suitability class. It should be noted that these regions of land in Ogbomosho North local Government Area should be adequate utilize for agricultural purpose and other slightly suitable agricultural lands should also be improved upon to increase the available lands suitable for farming.

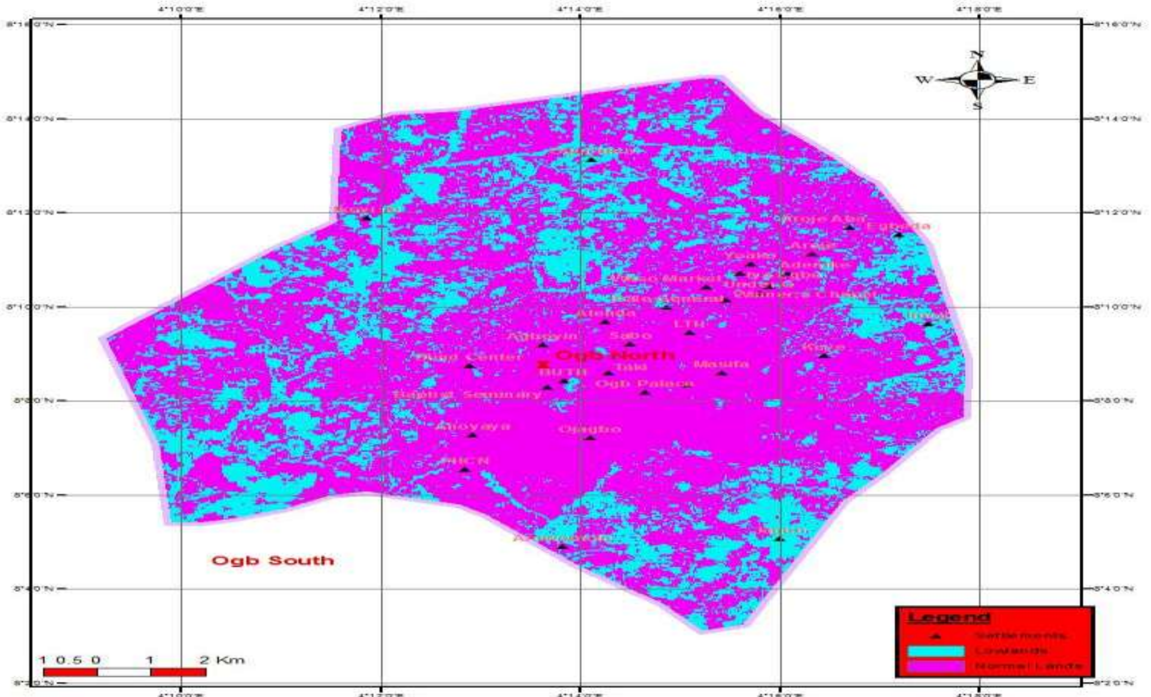

Figure 7: Landforms Map of the study area

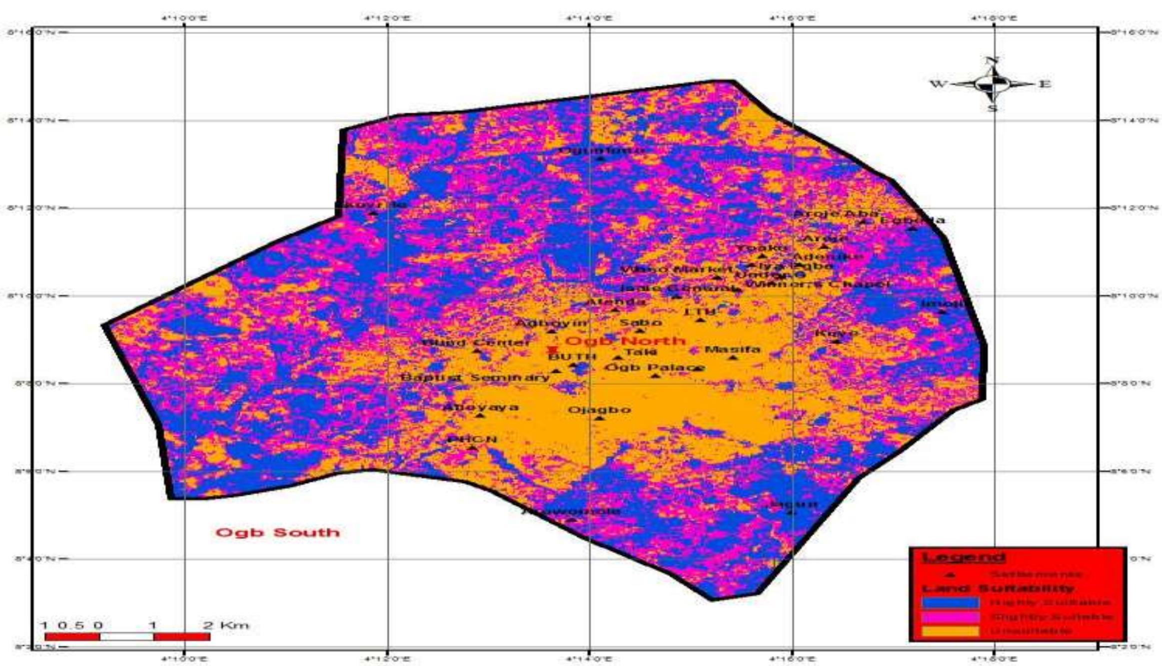

Figure 8: Land Suitability Classification Map of the study area

CONCLUSIONS

The study has addressed geospatial assessment and monitoring of the dynamics of urban expansion of Ogbomosho North local Government, Oyo state Nigeria. The aim of which is to use Remote Sensing and GIS technology to have knowledge of the urban expansion of the area. Guiding objectives are to evaluate the LULC characteristics of the environment of Ogbomoso North local Government; also, to assess the urban development of Ogbomosho North area between 1984 and 2016; and thirdly to determine the rate of urban expansion of Ogbomosho North. Synergy was formed with Landsat imageries of 1984 and 2016 of the environment. The datasets were subjected to supervised image classification using ARCGIS software. Results for 1984 and 2016 classifications were cross-tabulated for LULC change detection. It could be deduced from this study that the settlements in the study area kept growing (spatial expansion) which is as a result of the rapid increase in population. The rate of urban expansion in the study area was found to be significantly high.GIS and Remote Sensing techniques is a powerful technique for mapping and evaluating the Land Use and Land Cover study in coastal environment. This basic study shows how to classify land use and land cover from satellite imagery, The land use and land cover map clearly shows that area of cultivate land is higher than others. The maps showed clearly that there is increase in water buddies, built-up area, pave and rocky areas and in vegetal and in other agriculture land, forest area is decreased.Some recommends as a way forward towards ensuring viable and suitable landsusageare suggested; there should be deliberate control of urbanization in Ogbomosho North local Government Area to maintain the agricultural suitable lands.There should be improved comprehensive mapping of lands in Ogbomosho North and in Oyo State at large for proper planning, awareness and land management. Thus, there is need for proper urban planning so as to avoid the current infrastructural failures in the area. .

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