# Managing Emerging Land use Pattern in Developing Nations: A Focus on ONDO, Nigeria

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***Abstract—*** *The study assesses the urban expansion and landuse pattern of Ondo Township between 1986 and 2014. It also carried out intensive analysis of the urban land use and land cover types between the study period and identified the major factors contributing to the rapid expansion of the township. The study made use of primary and secondary data sets. The primary data sets include field observations for developing image-to-ground concordance, GPS data of 100 points of interest. The secondary data sets include Landsat imageries of 1986, 2002 and 2014, topographic map at scale 1:50000 covering the study area. The imageries of 1986, 2002 and 2014 were processed using the ENVI software. Supervised classification employing the maximum likelihood algorithm was carried out on each imagery. Furthermore, relevant urban expansion parameters including Land Consumption Rate (LCR) and the Land Absorption Coefficient (LAC) were computed while spatial overlay of the built-up areas of 1986, 2002 and 2014 were performed. The study also determined the average rate of expansion between 1986 and 2014. The result shows that Ondo town has expanded at a very fast rate increasing in surface area from 1324.96 ha in 1986 to 1743.48 ha in 2002 and 3444.64 ha in 2014 giving an expansion rate of 3.9% per annum. The land consumption rates for 1986, 2002 and 2014 are respectively 1.4%, 1.2% and 1.0 indicating a progressive compactness in the built-up area of the town. The residential landuse (built-up) area gained and colonized the adjoining vegetation areas in each period. The study concluded that Ondo urban has been expanding radially outwards from urban Centre. The study recommends proper monitoring of urban area, development of small towns around city area to reduce people migrating to urban centre and effective urban land use management in the city centre.*

***Keywords— Urban expansion, Landuse/landcover, GPS, Landsat imageries, ENVI software.***

## I. INTRODUCTION

Urbanization in Nigeria is characterized by a large number of social and physical problems. These include overcrowding, inadequate housing, disjointed physical growth, pollution, unregulated sewage and drainage system inadequate infrastructural facilities and their incessant failures, urban poverty and insecurity. However, Nigerian urban centers also have attractive characteristics such as pipe-borne water, electricity, educational institution, good health facilities, intra-city linkage; industrial and commercial activity that provide industrial products for good living and leisure, small and medium scale industries as well as government establishment which create employment and job opportunities, among others (Oyinloye, 2003 and Ajaegbu, 1994). These characteristics stimulate urban growth and development leading to rapid urban expansion. Studies shows that the magnitude and rate of urban expansion is alarming, as population in developing-country cities is expected to double in the next thirty years from 2 billion in 2000 to almost 4 billion in 2030 (UN, 2004). Similarly, Angel *et al*. (2005) in their study estimated that cities with populations in excess of 100,000 contained 1.7 billion people in 2000. The size and scale of urban population growth and the concomitant urban land-use change pose major challenges to local and regional ecosystems and ultimately the global environment (Grimm *et al.* 2008; Seto *et al.*, 2010). Population growth is one of the most important driving forces of change in any urban system. If urban population swells, the city must expand upward or outward. Along with economic development and technologies (mainly transport and communication) revolution, rapid urban growth can be characterized by the development of suburban expansion and new development in the city center.

Since land use and land cover change is a major factor for global change because of its interactions with climate, ecosystem processes, biogeochemical cycles, biodiversity and even more important, human activities (L´opez *et al*., 2001). Land use land cover change researches have become an important aspect of global change studies in recent decades, much more attention has been paid to urban land use land cover change in the last couple of decades, because ecosystems in urban areas are strongly affected by human activities and have close relations with the life of almost half of the world's population.

Over the years, remote sensing has been used for land use/land cover mapping, Accurate and up-to-date land cover change information is necessary to understand, assess and monitor the environmental consequences of land cover changes of an area. (Jesuleye, 2012). Remote sensing techniques and the availability of free to less expensive data sources of satellite imagery

and their temporal frequency has greatly enhanced the potential for monitoring urban growth, urban land use dynamics and urbanization (Cabral, 2011).

Remote sensing (RS) and Geographic information system (GIS) are now providing new tools for advanced ecosystem management. The collection of a remotely sensed data facilitates the synoptic analysis of earth- system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Jesuleye 2012; Wilkie & Finn, 1996).In view of this, this study assesses the urban expansion and land use pattern of Ondo Township between 1986 and 2014. It also carried out intensive analysis of the urban land use and land cover types between the study period and identified the major factors contributing to the rapid expansion of the township.

The aim of this study therefore is to assess the urban expansion and land use pattern of Ondo between1986 and 2014 with a view to suggesting urban landuse management strategies for the third word cities. The objectives are to:

(i) Examine the land extent of the study area in the years 1986, 2000 and 2014;
(ii) Assess the different land use land cover of the study area at this periods interval;
(iii) Examine the urban expansion of the study area between 1986 and 2014 using Landsat data sets;
(iv) Analysis and determine urban land use and land cover change between the periods of study.

## II. THE STUDY AREA

Ondo town lies between latitudes $7^{o}$ 01'N and $7^{o}$ 10'N and longitudes 4° 46'E and 4° 55'E with a population of about 283,672 (NPC, 2006) over a total land area of 970$km^2$ (DRS, 2010). Ondo town consist of hills which develop over the basement of complex rock which is 250-500 above the mean of sea level (Smith and Montgomery, 1962). Many streams takes their origins from these hills, among the important streams are: Aogo, and Lisaluwa, Agbeda, Mode, and Aride. The streams have small basins and they drain into the river which empties into the Atlantic Ocean (see figure 1).

The soil of the study area is generally Ondo association (Smith and Montgomery, 1962) sub-divided into sedimentary, hill creep and hill-wash soils. The Ondo association is derived from medium grained granitic rocks and medium grained gnesis (Smith and Montgomery, 1962). The soil supports the development of low land rainforest and suitable for growing tree crops particularly cocoa, kola, rubber and oil-palm (Ekanade, 2007). The town falls within the zone of tropical humid climate characterized with two distinct seasons, the rainy season, (April-October) and dry season (November – March) with slight variations from year to year. The annual rainfall varies from 1,150mm in the northern parts to 2,000 mm in the southern area. During the dry season, the north-east (NE) trade wind prevails; whereas the southwesterly wind dominates during the wet season. The average annual rainfall is about 1220mm. The monthly mean minimum temperature is about 22.49$^{o}$C while the monthly means maximum temperature is about 31.29$^{o}$C with an average yearly temperature of about 26.6$^{o}$C. Also, the average yearly relative humidity is about 76.05%. (Oyinloye, 2003; Federal Office of Statistics 1988).

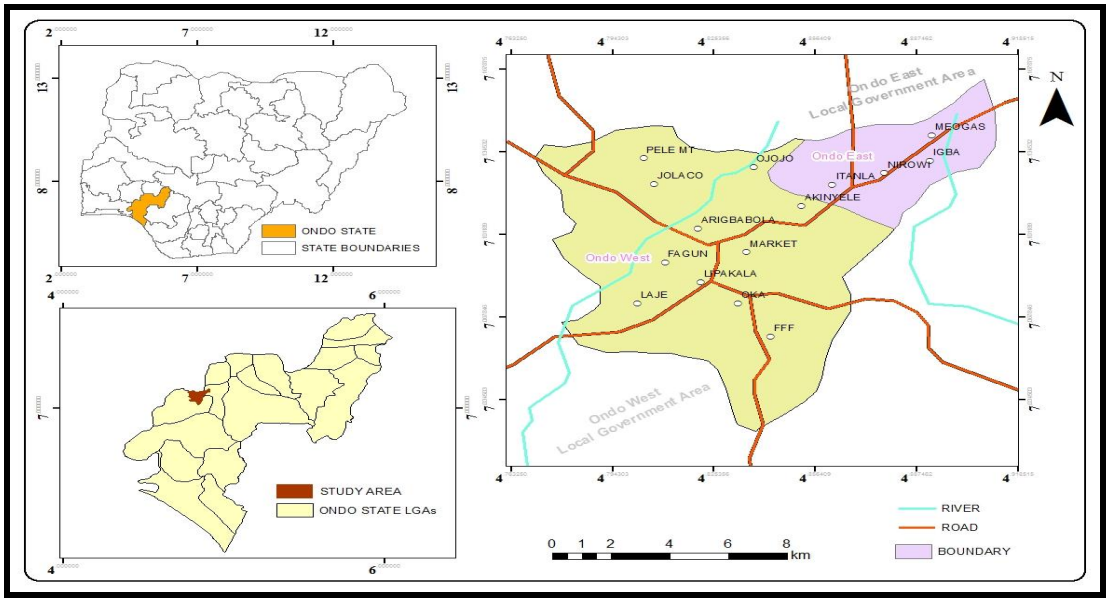


**FIGURE 1: MAP OF NIGERIA SHOWING ONDO STATE AND THE STUDY AREA**
Source: Source: http://www@googleearth.com (Digitized by the authors).

## III. REVIEW OF LITERATURE

### 3.1 Urban Expansion

Nigerian urban centers have attractive characteristics such as pipe-borne water, electricity, educational institutions, good health facilities, intra-city linkage; industrial and commercial activities that provide industrial products for good living and leisure, small and medium scale industries as well as government establishments which create employment and job opportunities, among others (Oyinloye, 2003; Ajaegbu, 1994). These characteristics stimulate rural-urban migration which leads to urban expansion which in turns causes the land use land cover change pattern leading to biodiversity loss proximately caused by factors including intensification of agriculture, livestock extension and cropland expansion where environmental frugality is linked to periodic drought, poor soil or steep slopes (Agbo *et al*, 1993; Isibor, 2013) the latter includes the extension of human settlement, road extension and the spread of irrigation technologies such as boreholes and watering points.

The use of fire while hunting has contributed to the extinction of many terrestrial mammal and birds' species (Groombridge and Jekins 2000; Isibor, 2013). These prehistoric human activities have speedily affected specie loss also the advent of large scale agriculture have increased the rate of species extinction. Urban expansion has surface interaction with weather and climate which affects the temperature and humidity level in the lower atmosphere this affects the vegetation pattern and soil moisture level and affects cloud formation and preparation through convection i.e. the spontaneous rise of air. Certain land cover types such as bare ground heat more rapidly and transmit radiant heat to the overlying air. As air rise it also cools and the moisture in the air condenses and eventually forms clouds, leading in some cases to precipitation. Research conducted under the Hydrological-Atmospheric field Experiment in the Sahel (HAPEX-Sahel), the semi-arid region of West Africa, found positive feedbacks between land surface and climate after initial rainfall events in the Sahel, (Taylor,2001; Isibor, 2013).

### 3.2 Consequences of Urbanization

The phenomenon of urban heat islands has become a growing concern. Incidence of this phenomenon as well as concern about it has increased over the years. An urban heat island is formed when industrial and urban areas are developed resulting in greater production and retention of heat. In cities, where there is less vegetation and exposed soil, the majority of the sun's energy is absorbed by urban structures and asphalt. Hence, during warm daylight hours, less evaporative cooling in cities results in higher surface temperatures than in rural areas. Vehicles and factories release additional city heat, as do industrial and domestic heating and cooling units (Park, 1987). As a result, cities are often 1.8 to 5.4 °F (1 to 3 °C) warmer than surrounding landscapes. World Economic and Social Survey (WESS, 2013) added that Impacts also include reducing soil moisture and a reduction in re-uptake of carbon dioxide emissions.

Migration away from rural areas reduces the prevalence of destructive subsistence farming techniques, such as improperly implemented slash and burn agriculture. In July 2013 a report was issued by the United Nations Department of Economic and Social Affairs, however warns that with the additional 2.4 billion people by 2050, the amount of food produced will have to increase by 70 percent straining food resources, especially in countries already facing food insecurity due to changing environmental conditions (WESS, 2013). The mix of changing environmental conditions and the growing number of people living in urban regions, according to UN experts, will strain basic sanitation systems, health care, and potentially cause a humanitarian and environmental nightmare (Tamar, 2013).

As cities develop, effects can include a dramatic increase and change in costs, often pricing the local working class out of the market, including such functionaries as employees of the local municipalities. One problem these migrant workers are involved with is the growth of slums (Ursula, 2008). In many cases, the rural-urban low skilled or unskilled migrant workers, attracted by economic opportunities in urban areas, cannot find a job and afford housing in cities and have to dwell in slums (Michael, 1969). Urban problems, along with infrastructure developments, are also fuelling suburbanization trends in developing nations, though the trend for core cities in said nations tends to continue to become ever denser. Urbanization is often viewed as a negative trend, but there are positives in the reduction of expenses in commuting and transportation while improving opportunities for jobs, education, housing, and transportation. Living in cities permits individuals and families to take advantage of the opportunities of proximity and diversity (Nowak, 1997; Edward, 1998). In the developing world, urbanization does not seem to translate into a significant increase in life expectancy (Kohler, 2014). Rapid urbanization has brought increased mortality from non-communicable diseases associated with lifestyle, including cancer and heart disease (Allender *et al.*, 2008)

### 3.3 Land use Land cover

Land use, land cover and its pattern of change is a major element that is very important in the history of global expansion and land use and cover change (LUCC) with its impacts on the environment has been one of the increasing focus of global changes (Chase *et al.*, 2000 ; Oladele and Oladimeji, 2011). According to Anderson et al., 1976 pointed out that urban area still takes up a very small part of the Earth's surface. However, expansion of human settlements and its accompanying activities, especially the rapid urbanization occurring in the developing countries, play an important role in global land use and cover change, causing changes in the ecological processes at both local and global scales. Land use activity is a major challenge for town and country planners as well as the environmentalists to design the Eco friendly and sustainable economic growth. The human activity for development is forced against environment, which result in consequences such as soil erosion, global warming, pollution, etc. (Oyinloye, 2003). The cause for the change in land use type activity may be due to socio-economic development or due to change in environment or may be both. For example, an increase in total export for particular agriculture product will be translated into increase in demand for land for this particular product whereas increase in tourist influx will result in increased demand of land for constructions. Land can be gained by conversion of agricultural field or by clearing the forest. In both cases the consequence will be different (Singh, 2003). One of the factors driving land-use change includes what can be called 'development attractors.' These are physical features that promote new residential and commercial development. For example, main roads, existing developed areas, and utilities such as electricity, postal services, industrial development and potable water supply are development attractors because new development is likely to occur in their vicinity. Land use and land cover change is perhaps the most prominent form of global environmental changes since it occurs at spatial and temporal scales and is very relevant to our daily existence. The changes in land use and land cover are likely to affect natural resources and ecosystems as well as urban human activities in complex ways. The National Research Council recently identified Land Use Dynamics as one of the grand challenges for environmental research (NRC, 2001).

Most urban center in Nigeria is now engulfing agricultural land use at the peripheries without any adequate planning for such development. Most areas that were once designated for industrial activities have merged with the growing urban center forming conurbation, which may have negative impacts on the health of the residents

### 3.4 Techniques of Change Detection

Change detection ascertains the changes of specific features within a certain time interval (Jesuleye, 2012) and provides the spatial distribution of features and qualitative and quantitative information of features changes, analyzing and identifying the characteristics and processes of surface change is carried through from the different period of remote sensed data (Shaoqing and Lu, 2008: Jesuleye, 2012)

Change detection techniques have been used over the last two decades. (Singh, 1989; Coppin & Bauer, 1996; Zubair, 2006; Isibor, 2013; Jesuleye, 2012) recognizes some change detection algorithms which include: mono-temporal change delineation, delta or post classification comparisons, multidimensional temporal feature space analysis, composite analysis, image differencing, multitemporal linear data transformation,change vector analysis, image regression, multi-temporal biomass index, background subtraction, Image ratioing and Image subtraction.

## IV. DATA ACQUISITION AND METHODOLOGY

Geographic Information System (GIS) was basically used for this study to analysis the rate of expansion and land use changes in the study area. The secondary data used include Landsat TM image of 1986, $ETM^{+}$ OF 2002 and OLI-TRIS of 2014 of path 190 and row 055 downloaded from GLCF website. Another source of secondary data was the topographic map at scale 1:50000 covering the study area which was obtained from the Office of the Surveyor General of the Federation, (OSGOF), Abuja, Nigeria and other relavent. The Topographic map covering Ondo was scanned and georeferenced using GCS_WGS_1984, Datum: D_WGS_1984. Name of places and roads were extracted from the topographic map and also from the field work. The topographic map was then overlaid on the digitized Ondo town shape file which was used to clip out of the study area portion from the georeferenced topographic map. The satellite images were processed using ENVI 5.1 and Arc Map 10.2 software; digital image processing was carried out in order to improve the picture quality of the image for easy interpretation. The digitizing of the false composite image to get the extent of the urban area (Oloukoi *et al.*, 2014), A sample set was created in ENVI environment and afterwards the image was trained or digitized. This is the process of assigning clusters of pixels to classes (Campbell, 2002). This was done by pairing group of similar pixels into classes to form mosaic of uniform parcels, images or areas on map.

The following land use and land cover types were identified and the layers created: built-up area, bareland, vegetation, and rock outcrop and water body. The area of interest was carved out for each year of the remotely sensed data sets using the digitized boundary of the study area from the Landsat OLI-TIRS image of 2014**.** Supervised classification via the maximum likelihood algorithm was used to classify the image. (Shalaby & Tateishi, 2007; Wu *et al.*, 2006; Yuan *et al.*, 2005; Jesuleye, 2013; Oloukoi *et al.*, 2014). Classification in remote sensing involves clustering the pixels of an image to a relatively small set of classes, such that pixels in the same class are having similar properties. The majority of image classification is based on the detection of the spectral response pattern of land cover classes (Brito & Quintanilha, 2012; Isibor, 2013). The change detection technique comparing the supervised classification results of the images giving areal coverage of each theme was used. The annual rate of change was calculated for each LULC theme. This is a process of indicating the differences between the feature classes of 1986, 2002 and 2014 classified image to determine the hectares using the compound interest formula adapted from (Jesuleye, 2013; Oyinloye and Adesina, 2006) which was used to determine the rate of expansion(r) of Ondo town between 1986 and 2014 and the average of the rate of expansion between 1986 and 2014. The compound interest formula was also used to project the estimated spatial expansion ($P_n$) of Ondo town by 2050. The compound interest formula states that:

$$P_n = P_o (1 + r/100)^n \quad (1)$$

Therefore

$$r = 100 (P_n / P_o)^{1/n} - 1 \quad (2)$$

Where

$P_n$ = estimated are (in ha) $P_o$= known area (of a particular year)

r = rate of expansion (in %) n = number of years

Table 1 was used to describe the relevant characteristics of the images and other datasets used in the study area.

**TABLE 1**
**DATA SET USED FOR THE STUDY**

| S/N | DAT Name of Data | DAT Production Date | SOU Source | SPA Spatial Resolution/SC |
|---|---|---|---|---|
| **1** | Topographic Map | Published in 1964 500/426/1964 (Aerial Photos Dec. 1962) | Office of the Surveyor General of the Federation (OSGOF) | 1:50,000 |
| **2** | LanLsat 5t TM P190R055 | 18/12/1986 | Global Land Cover Facility, Website. www.glcf.com | Pixel Size 28.5m |
| **3** | Landsat 7t ETM+ P190R055 | 06/02/2000 | Global Land Cover Facility, Website. www.glcf.com | Pixel Size 28.5m |
| **4** | Landsat L7 ETM+ P191R055 | 11/05/2014 | Global Land Cover Facility, Website. www.glcf.com | Pixel Size 30m |
| **6** | Geographic Positioning System (GPS) | 30/08/2014 | Researcher's Field Work | 3m |

***Source: Author's Field Work, 2015***

## V. RESULTS AND DISCUSSION

Post-classification comparison analysis which is a GIS approach of overlaying two or more images was adopted in this study. Since the aim of the paper is to analyze the landuse/landcover, multi-date remote sensing images and ability to create overlays in the GIS environment, the post-classification comparison method appears to be the best approach for this study.

### 5.1 Land Extent of the Study area

Figure 2 shows the land extent of Ondo town between 1986 to 2014.It was observed that, the land the land covered as at 1986 was about 2898.2 ha, in the year 2002 it was about 4532.5 ha while in the year 2014, it was about 7949.9 ha .The implies that the study area has experienced expansion as the years went by from 1986 to 2014.The implication of this is that there is increase in the rate of urbanization in the study area over the year, this may be as a result of the influx of people from the neighboring rural area of Ondo town.

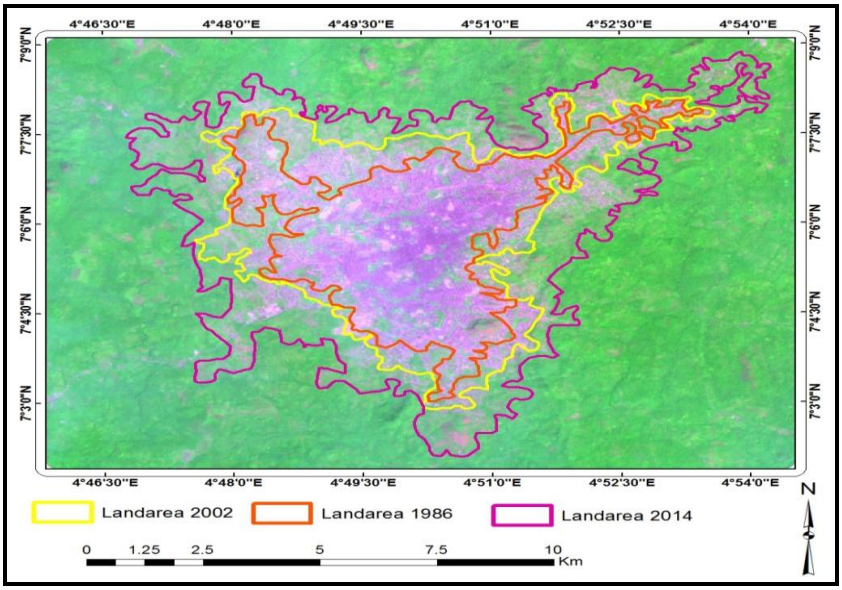


**FIGURE 2: THE LAND EXTENT OF ONDO TOWN BETWEEN 1986 TO 2014**
(Source: Global Land Cover Facility, www.glcf.com)

### 5.2 Land Use and Land Cover Change

Figure 3, shows the Land Use Land Cover of Ondo town in 1986 to be about 2898.2 ha. Observation from table 2 shows that vegetation (5755.95ha, 72%) and built-up (1324.96 ha, 16.66 %) areas occupy the major land use out of the study area in the year 1986 in relation to the present land coverage of 7949.94 ha of the study area. Figure 4, shows the land coverage of the study area as at the year 2002 to be 4532.5ha. As the year 2002, Observation from table 3 shows that vegetation (4255.99 ha, 53.5%) and built-up (1743.48 ha, 21.93 %) areas occupy the major land use out of the study area in the year 1986 in relation to the present land coverage of 7949.94 ha of the study area. Figure 5 shows the land extent of the study area as the year 2014 to be 7949.9 ha. Observation from table 4 shows that vegetation (3496.14 ha, 43.9%) and built-up (3444.64 ha, 43.3 %) areas occupy the major land use out of the study area in the year 1986 in relation to the present land coverage of 7949.94 ha of the study area.

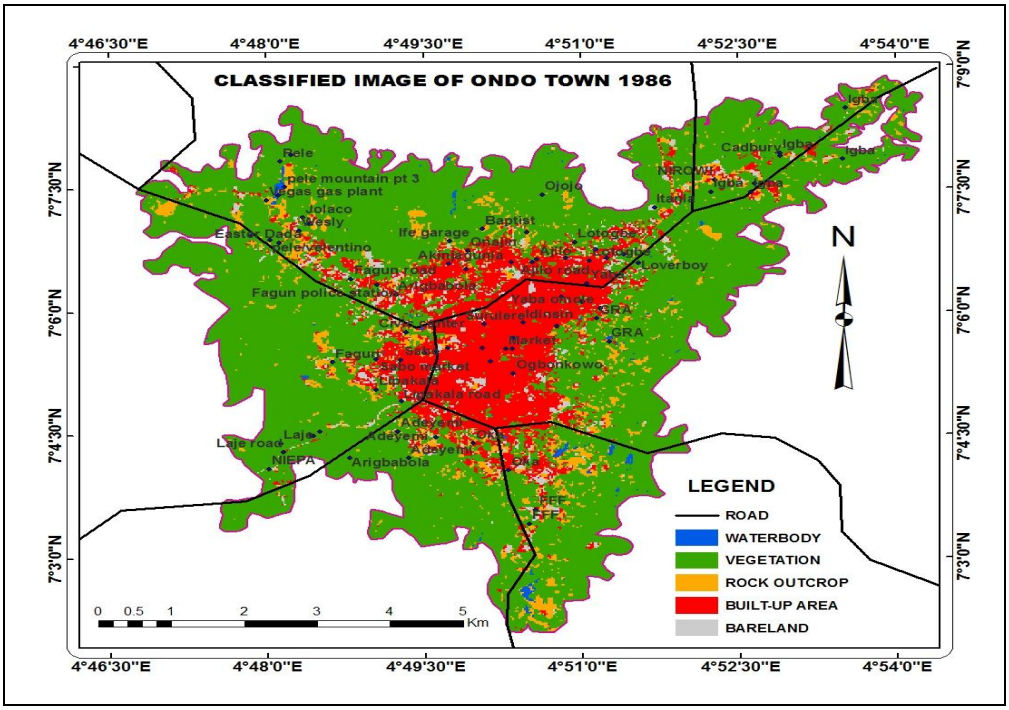


**FIGURE 3: THE LAND USE LAND COVER OF ONDO TOWN IN 1986**
**Source:** Global Land Cover Facility, www.glcf.com

**TABLE 2:**
**THE LAND USE LAND COVER OF ONDO TOWN IN 1986**

| Land use | Area in hectares (ha) | Percentage (%) |
|---|---|---|
| **Water body** | 39.19 | 0.49 |
| **Vegetation** | 5755.95 | 72.40 |
| **Rock outcrop** | 559.24 | 7.0 |
| **Built-up Area** | 1324.96 | 16.66 |
| **Bare land** | 270.57 | 3.40 |
| **Total** | 7949.94 | 100 |

**Overall accuracy = 94.48%**
Source: Author's Field Work, 2015

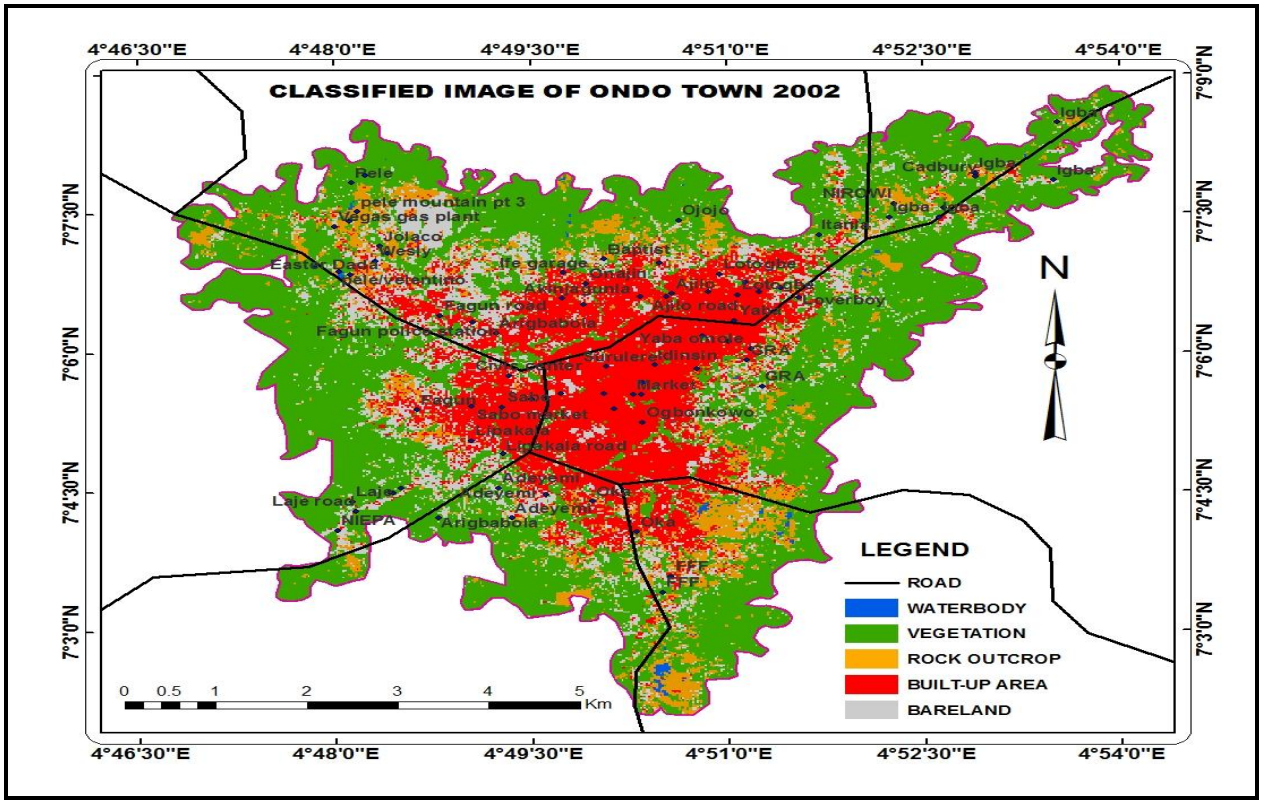


**FIGURE 4: THE LAND USE LAND COVER OF ONDO TOWN AS AT 2002**
Source: Global Land Cover Facility, www.glcf.com

**TABLE 3**
**LAND USE LAND COVER OF ONDO TOWN IN 2002**

| Land use | Area in hectares (ha) | Percentage (%) |
|---|---|---|
| **Waterbody** | 21.20 | 0.26 |
| **Vegetaion** | 4255.99 | 53.53 |
| **Rock outcrop** | 794.57 | 9.99 |
| **Built-up Area** | 1743.48 | 21.93 |
| **Bareland** | 1134.67 | 14.27 |
| **Total** | 7949.92 | 100 |

**Overall accuracy = 94.00%**
Source: Author's Field Work, 2015

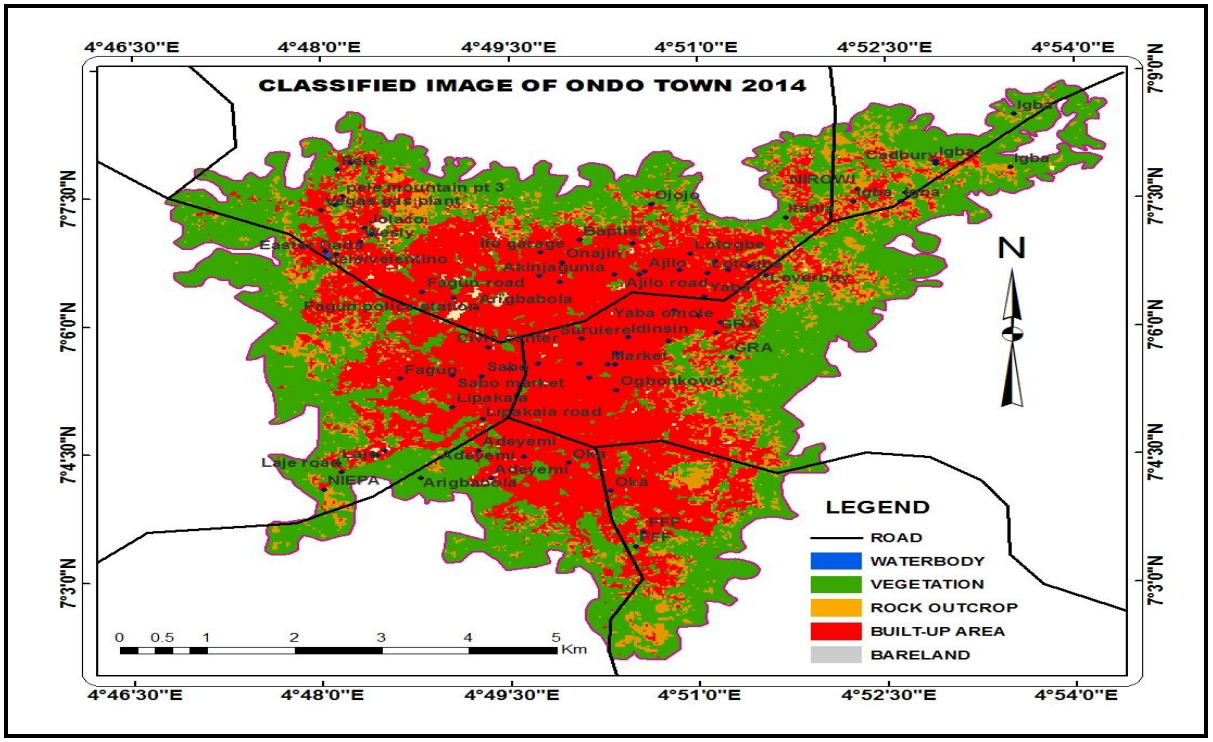


**FIGURE 5: THE LAND USE LAND COVER OF ONDO TOWN IN 2014**
Source: Global Land Cover Facility, www.glcf.com

**TABLE 4**
**THE LAND USE LAND COVER OF ONDO TOWN IN 2014**

| Land use | Area in hectares (ha) | Percentage (%) |
|---|---|---|
| **Waterbody** | 0.99 | 0.01 |
| **Vegetation** | 3496.14 | 43.97 |
| **Rock outcrop** | 952.00 | 11.97 |
| **Built-up Area** | 3444.64 | 43.32 |
| **Bareland** | 56.16 | 0.70 |
| **Total** | 7949.9 | 100 |

**Overall accuracy = 96.13%**
Source: Author's Field Work, 2015.

### 5.3 Temporal analysis of Land Use Land Cover Patterns of 1986, 2002 and 2014

Table 5, shows the temporal analysis of land use land cover of the study area. The table shows that the different land uses of the study area and their changes over the years between 1986 and 2014, considering the years 1986, 2004 and 2014. Observations over the entire study period revealed that vegetation was the predominant land cover type due to the inclusion of the suburbs in the study area. In 1986, it was dominating the study area with a proportion of about 5155.95ha (72 %,) this was reduced to 4255.99 ha (53.53%) in the year 2002 and in the year 2014 vegetation has also reduced to 3496.14 ha (43.97%). Considering the built up area which is the second largest land use and land cover type of about 1324.96 ha (16.66%) in 1986, it increased to 1743.48 (21.93%) in 2002 and to 3444.64 ha (43.32%) in 2014. The analysis revealed that between 1986 to 2014, vegetation land use decreases by about 2259.81 ha (28.43%) while the built up (residential) land use increases by about 2119.68ha (26.66%). The implication of this is that the study area has expanded in land coverage as a result of increase in the number of dwellers and high rate of construction of buildings. Commercial, industrial, educational, governmental, hospital and religious land uses which necessitated the destruction of the vegetation in the study area. Some of the factors that necessitated urbanization in the study area are Infrastructural facility development e.g. expansion of roads Establishment of educational institutions i.e. primary, secondary and tertiary institutions like Wesley university of science and technology, good medical facilities and building of good and functioning hospital (such as the mother and child, trauma

center and diagnostic center, provision of social amenities (such as good roads and road network extension, good electricity distribution extension). Population increase caused by migration and increase in family size, affordable standard of living, adequate security.

**TABLE 5**
**TEMPORAL ANALYSIS OF LAND USE LAND COVER PATTERNS OF 1986, 2002 AND 2014**

| Land use/ land cover classes | Area (ha) in 1986 | Area (ha) in 2002 | Area (ha) in 2014 |
|---|---|---|---|
| **Water body** | 39.19 (0.49%) | 21.20 (0.26%) | 0.99 (0.01%) |
| **Vegetation** | 5755.95 (72.40%) | 4255.99 (53.53%) | 3496.14 (43.97%) |
| **Rock outcrop** | 559.24 (7.00%) | 794.57 (9.99%) | 952.00 (11.97%) |
| **Built-up Area** | 1324.96 (16.66%) | 1743.48 (21.93%) | 3444.64 (43.32%) |
| **Bare land** | 270.57 (3.40%) | 1134.67 (14.27%) | 56.16 (0.70%) |
| **Total** | 7949.9 (100%) | 7949.9 (0.49%) | 7949.9 (0.49%) |

**Source: Author's Field Work, 2015**

## VI. IMPLICATIONS OF URBAN LAND USE PATTERN IN ONDO

About 40% of the world landcover has extensively been modified or converted by human for production, construction and habitation. Consequently, the effect of these exert enormous influence on their hinterland, environment, social and economic life of the people. The adverse effects of this development include social ills such as poverty, poor quality housing, traffic congestion and overcrowding.

Another serious consequence of urban land use expansion is the loss of biodiversity (i.e., deforestation within the city and surrounding areas). Deforestation are cause principally by agricultural farming when forest cover or vegetation forest are cut down or burn down for cultivation thereby resulting tin excessive landuse/landcover change.

The tremendous expansion of Ondo has created environmental degradation. This has affected the quality of life of the people particularly the urban poor.

Lastly the impact of this expansion on landuse/landcover has resulted in loss of open spaces, lack of refuse disposal, high rate of urban crime long term food shortage, increase in transportation costs and high urban land prices just to mention a few.

## VII. CONCLUSIONS AND RECOMMENDATIONS

This study has demonstrated the relevance of geographic information science and remote sensing to urban planning, revealing the techniques that can be used to improve the understanding of phenomena of change and contributing to the process of decision making for urban planners so as to foresee or reduce the risk of urban sprawl, slums and environmental degradation and also contributed to the development of strategy for improving sustainable urban land management in Nigeria. This analytical method is found to be efficient and reliable to investigate the trend of urban expansion and to predict the urban expansion as well as identifying the driving forces contributing to the expansion of Ondo urban. Spatial information is the most effective way of describing events over space and time. In this study, Ondo urban was examined using time series geo-spatial data which were processed and analyzed using ENVI and Arc Map software.

The aim of every research is to provide scientific basis, which can be used to solve human, environmental and societal problems. The study therefore advances some recommendations to enhance the functionality of Ondo and reduce its social problems as revealed by this study. First there is need to control urban spread out to agricultural land as this will have serious repercussion on food production. Secondly, there is need for mainstreaming the process of master plan preparation that will guide and engender an efficient and integrated landuse development of Ondo urban area. Lastly, urban landuse/ land cover of Ondo needs to be assessed from time to time. Effort should be made to adopt and maximize the optimum use of GIS and Remote sensing techniques especially in planning stages and monitoring urban areas.

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