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Remote Sensing Dynamics of Land Cover Changes in Abeokuta Metropolis from 1986 To 2016

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Abstract

This study is required to ascertain the rate at which land cover features such as vegetation, cash crop, water bodies have been replaced by artificial structures, and also to reveal the extent of urban sprawl and industrialization in the study area. In this study, Satellite images of Abeokuta metropolis were downloaded to map various Land Cover classes. Landsat TM and ETM+ imageries having groups 4, 3, and 2, all images were geographically referenced and Landsat's OLI TIRS having 5, 4, and 3 groups were used to create false color composite images, respectively. These land cover maps for the Abeokuta North, Abeokuta South and Odeda local governments were then generated using a supervised classification method of remote sensing operations using Erdas Imagine 2014 where each pixel is assigned to one of the different categories. All paved areas, including homes, businesses, and industrial facilities, as well as roads and other forms of transportation, mixed-use communities, and bare ground, are referred to as developed regions. Results revealed that land cover has changed significantly from 1986 to 2016, using three years (1986, 2001 and 2016). The 81% vegetation cover in 1986 increased to 93% cover in 2001 while the same reduced to 82% cover in 2016. The water body that covered 14% of the three local governments in 1986 was reduced to about 1.2% cover in 2001 while it maintained almost the same cover of 1.1% in 2016. A significant increase was noticed in built-up area coverage from 4.90% cover in 1986 to 6.1% cover in 2001 and 17.2% cover in 2016.

Keywords: Abeokuta, Landsat, Land cover, Remote sensing, Urban sprawl

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Introduction

An urban center is a conglomeration of people centered on things other than agriculture. According to Mabogunje (1974), metropolitan areas are classified according to how well-equipped their citizens are to carry out specific duties, such as contributing to public services. In different countries, civic centers are specified based on demographic numbers. At least 30,000 persons live in a city in Japan, 50,000 reside in cities in the US, 10,000 reside in cities in Greece, 1,000 live in an Australian city, and 250 reside in cities in Denmark (Aluko, 2010). A city deemed to be an urban center in the 1952 Nigerian census had a population of more than 5,000 people. The population range for cities in many states varies considerably. New York State, for instance, has 62 incorporated cities, but only 5 have populations of more than 100,000 (Ocejo *et al*.,2020). Throughout Nigeria, the Census of 1963 established a population of 20,000 or more for an urban center.

Urbanization is the term used to describe the aggregation of a significant number of people in one region on the surface of the planet (Olotuah & Adesiji, 2005; Onyemelukwe, 1977; Agbola, 2004)). Population growth as it is seen from the perspective of developing countries is reflected in the earlier school of thought, whereas urbanization as it is seen from the

perspective of the developed world is reflected in the later school of thought. Whereas the "push" of rural areas and the "pull" of metropolitan centers are the causes of modernization in Nigeria, as in the majority of emerging nations (Aluko, 2010). This push and pull in this regard originate from the population and might be linked to the consequences of regional disparities. It is hardly surprising that development has severe negative effects in Nigeria and other emerging nations given the population growth involved in the process. For Nigeria, where population growth is a measure of urbanization, migration from rural to urban areas dominates over organic growth. This rapid growth has brought concerns to urban communities as living conditions have reduced significantly (Fitzgerald, 2017). Several academics believe that rural-urban migration is the root of all subsequent urban growth issues worldwide (Onokerhoraye, 1976; Wahab, et al. 1990; Agbola, 2004; Olotuah & Adesiji, 2005; and Aluko, 2010).

Urban growth is the expansion of a city's population at a given rate. Urban expansion is characterized as growth that extensively uses the land for the erection of structures and impervious areas. Natural population expansion, the categorization of urban and rural systems, and rural-urban migration are the main causes of urbanization (Agbola, 2004). According to estimates, 100 million people would live in Nigeria's metropolitan areas by the year 2020, reducing from 5.7% in 1985 to 4.0% in 2018.

The effects of Nigeria's rapid urbanization include those on jobs, human and food security, the economy, waste management, infrastructure, and services. In light of this, the goal of this research is to assess the present state of urbanization and forecast future issues in Nigeria while also proposing strategies to significantly lessen the challenges in order to ensure sustainable development in both urban and rural parts of Nigeria.

The population of towns and cities is growing quickly throughout Nigeria, as it does in most emerging nations. The migration of people from rural areas to urban areas has been impossible to stop, especially in the fast-growing cities of Ogun State including Abeokuta, Ota, Ijebu Ode, Sagamu, and many others. In cities, the pace of natural population growth has always been high. The government has acquired land to build social infrastructure facilities as a result of the demand for urban land, which has been the most obvious effect of the rapid urban population expansion. The need for fundamental services like schools, hospitals, postal and telecommunication services, recreational facilities, and so on increased as more people were living in metropolitan areas.

Furthermore, the need for stores, offices, industries, banks, and other forms of workplaces is driven by the requirement that urban dwellers have a source of income. Agboola (1994) argues that cities are a fortress of culture, imagination, and aspiration because of this. The majority of human activities that are detrimental to the environment, according to Adeagbo (2008), are concentrated in urban areas. Changes in land usage were the inevitable effect of this pressure on the available land.

On the other side, Hendricks (2013) noted that the high population density in metropolitan areas has led to several new or aggravated issues, such as increasing demand for land and natural resources. Ayoade (2012) asserts that the modification of the earth's surface is a component of the urbanization process. As a result, urbanization alters and generates new natural channels for energy and matter in the environment.

In the history of global expansion, terrestrial use, geomorphology, and the pattern of change all played significant roles. Population growth is therefore considered to be one of the main forces behind land use changes. As a result, it is known as the process of transformation from a traditional agrarian society to a contemporary urban society, which is accompanied by substantial changes in social and economic systems.

Development attractors are one of the elements influencing land-use change. These are the physical qualities that promote the growth of new residential and commercial areas. Because additional growth is likely to occur nearby, main roads, already-developed

areas, and utilities like power, postal services, industrial development, and potable water supplies serve as development magnets. Changes in land use and land cover are likely to have a complex impact on natural resources and ecosystems, as well as urban human activities. To ascertain the effects of land use and land cover change, it is necessary to comprehend past land use practices, current land use and cover patterns, and projections of future land use and cover as influenced by human institutions, population size and distribution, economic development, technology, and other characteristics. It is imperative to study the trend and pattern of urban growth just like in this study to serve as a planning tool for prediction and better urban management.

In many developing countries like Nigeria, the spread of slums has become the primary issue associated with urbanization. In addition to shanty growth, unplanned growth also happens at the upper end of residential development, when land grabbing and the quick conversion of massive new neighbourhoods (including gated communities) from farmland frequently takes place outside of permitted urban expansion regions.

City-states in Ogun have seen quick growth and extension since the return of democratic rules in 1999, to the point where urban development has expanded beyond the government's projections.

So due to a lack of up-to-date, reliable, and accurate information about the spot, length, pace, and determinants of urbanization, it has always been an ongoing problem implementing adequate, sustainable, and efficient planning policies and municipal management. This study is required to determine the rate of depletion of vegetation, cash crop farm, and wetland land cover that has been replaced by residential buildings, industrialization, and recreational centers, as well as the extent of urban sprawl. Abeokuta is a tropical rainforest city located between latitudes 07^0 05' and 07^0 20' N and longitudes 03^0 17' and 03^0 27' (Onakomaiya, 2000). Between 120 to 180 meters above sea level, the elevation varies. Ogun State's capital, Abeokuta, is located in southwest Nigeria. It covers about 100km^2 and covers three (3) Local Government Areas in the state (Abeokuta North, Abeokuta South, and Odeda Local Governments).

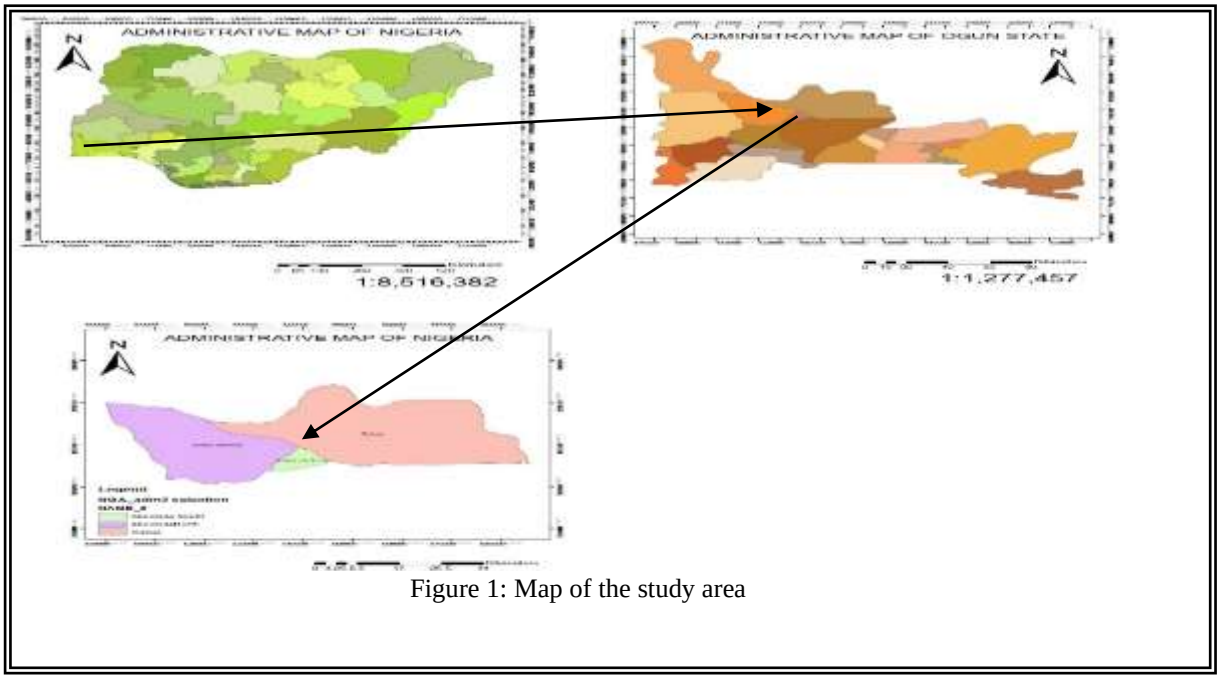


Figure 1: Map of the study area

Factors influencing dynamics in changes in land cover

Land as a component of nature is utilized by humans for life and uncountable activities. Land Use Land Cover (LULC) as a major concern to many nations of the world remains a very important system that supports development and national growth (Need *et al.*, (2021).

Land can be put to many different uses, including farming, forestry, quarrying, urbanism, and livestock. Some types of land cover include fields, woods, marsh, pastures, highways, and cities. Modifications in urban land use are mostly driven by the emergence of sprawl, which is now understood to be a global phenomenon. According to Besussi et al (2010)., expansion is a broad and vague term that refers to the trade-off between the desire to live as close to the city as feasible and the desire to buy as much acreage as possible while still enjoying the benefits of "urban" or "residential" lifestyle. Expansion grows as a consequence of increasing income and transportation technologies that allow for such suburban growth and reflect this tradeoff in urban morphologies. Understanding the dynamics of the processes that define such spatial interaction and land development is therefore essential. However, Researchers have suggested that if the land is used appropriately, changes in land cover brought on by land use do not necessarily indicate that the land is being degraded.

In Nigeria, people migrate for higher wages or employment opportunities, more finance, good amenities, a better climate, saner climes and security (Chukwudi, 2022). The primary driver of migration in Nigeria nowadays is financial. According to Adamu (2009), internal migration lowers the population of rural areas, which has a negative effect on the standard of living there. Remote regions are experiencing low economic activity as agricultural operations decline and young, energetic people move to urban areas.

It is impossible to overstate the effects of unrestrained urban expansion and the ramifications for socioeconomic activities. Urban sprawl, which is determined by several causes combined, is a key outcome. Anthony (2013) examined some indicators used to describe urban sprawl in his study of the issue, including leapfrogging development, low-density residential and commercial settlements, and the dispersion of control over land use among numerous tiny communities.

Urban growth and expansion are closely associated; as cities get bigger, they spread out to the surrounding areas. Conversely, expansion is more explicit, being defined as "uncoordinated growth": the development of a community without taking into account the consequences or the effects on the natural world. It is the scattering of new development on remote tracks that are geographically distant from other locations (Acho 2001). This usually comprises the development of homes and businesses on undeveloped grounds outside of cities, in rural areas, or both. Urban sprawl, according to Ogbasi (2000), is the formless distribution of crowded metropolitan regions with little to no attention to the interrelation of issues like mobility, job, medical, and leisure demands.

The massive issues and difficulties brought on by Nigeria's quick urbanization are immense. General human and environmental poverty, declining quality of life, and untapped as well as underutilized human resource wealth are more obvious and potentially terrifying. The quality of homes and associated utilities (such as water, power, and trash collection) is appalling. Millions of people reside in slums, which are characterized by poverty and horrendously inadequate social amenities, including a lack of schools, subpar medical facilities, and few options for amusement, among others.

Materials and Methods

The majority of the information used in this research was data collected, which is effectively comparable to Landsat imageries of the study region from over epoch years, that is, 1986, 2001 and 2016 from the USGS website. The scene of images captured is Path 91/055. Images from satellites were Supporting Overall Scanner (Multispectral satellite) 2001, Thematic for Landsat (TM) 1986, as well as 2016 downloaded to map various Land Cover classes. As one of the most

widely used satellites remote-sensing data sources, Landsat is essential for monitoring due to its long-term continuous availability, cheap cost, and timeliness. Detailed data on Spatial information has generally been given in several literatures (Modica and others, 2016; Roy et al., 2014; Chander, Markham, & Helder, 2009; Markham & Helder, 2012; Modica *et al*., 2009). The details along with remotely sensed information used for this research are listed in Table 1.

Table 1: The details of the Landsat data utilized in this investigation.

Satellite Monitor	Route	Data Obtained	LULC Name	Layout	Spectral bands	Geographical Solution
TM Landsat	191/55	August 1986	LULC 1986		7 Bands	30m
Landsat ETM+	191/55	August 2001	LULC 2006		7 Bands	30m
Landsat OLI-TIRS	191/55	August 2016	LULC 2016		11 Bands	30m

All images were referenced to WGS 84 zone 31 north and projected to Universal Transverse Mercator (UTM) projection scheme (EPSG: 32,631).

The land cover change analysis was carried out to reveal the changes that occurred within the periods. It shows the developmental alteration of classes of features in the study area. Maps and statistics are used to display the results.

Furthermore, statistics of Land Cover changes and illustrations were created depicting changes in the region over time, including gains and losses by feature classes. The contribution to the changes in the built-up area showed a reduction in vegetated areas over the periods.

A database created in this study could serve as input for further research where other queries, searches and analyses on the study area can be performed. This shows the support for interoperability in the research. The maps can also be used as a basis for future studies, queries, decision making and information searches.

A sample of the attribute table created is shown in Figure 2.

Table

1986 Land Cover Map

OBJECTID *	Shape *	GRIDCODE	SUM_GRIDCODE	Shape_Area	Land_Use
7	Polygon	4	88840	3854006.224744	Vegetation
9	Polygon	5	82635	812821548.755781	Vegetation
4	Polygon	4	88840	79818459.348888	Vegetation
3	Polygon	4	88840	169464355.527894	Vegetation
5	Polygon	4	88840	382250781.553091	Vegetation
11	Polygon	6	103530	204083872.198891	Water Body
2	Polygon	4	88840	269092179.500609	Vegetation
8	Polygon	5	82635	76593132.945212	Vegetation
1	Polygon	3	49965	109099763.499078	Built Up Area
6	Polygon	4	88840	48783589.345042	Vegetation
10	Polygon	6	103530	101359787.565804	Water Body

Figure 2: Attributes Table for 1986

Results and Discussion

Following the classification process with the Erdas Imagine program, the resulting images were imported into the ArcGIS environment and converted from raster to polygon for querying and classification of the land cover features.

The loss in vegetation cover is due to the urban expansion that was experienced within the metropolis. This urban expansion is facilitated by the developmental projects embarked upon by the government for the past 10 years. The waterbody was reduced within the study year period. The years during the years of study. The reduction rate of the waterbody observed between 1986 and 2001 is estimated to be 0.8% i.e., 37103.60Ha of water cover was lost due to land reclamation processes mainly for farming and other purposes. This is evident in the maps of the geospatial analyses carried out as shown in Figure 3

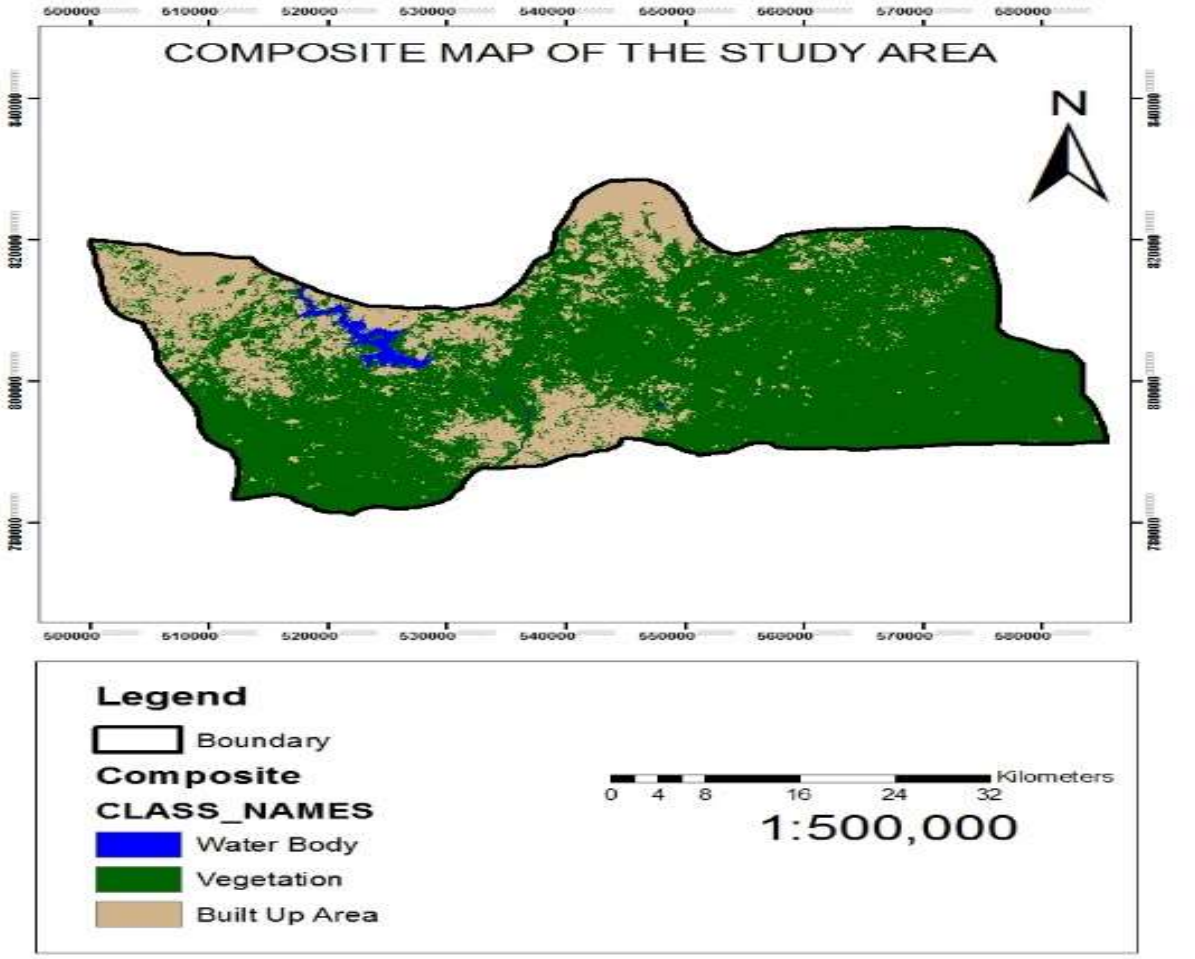


Figure 3: Composite Map of the region under study.

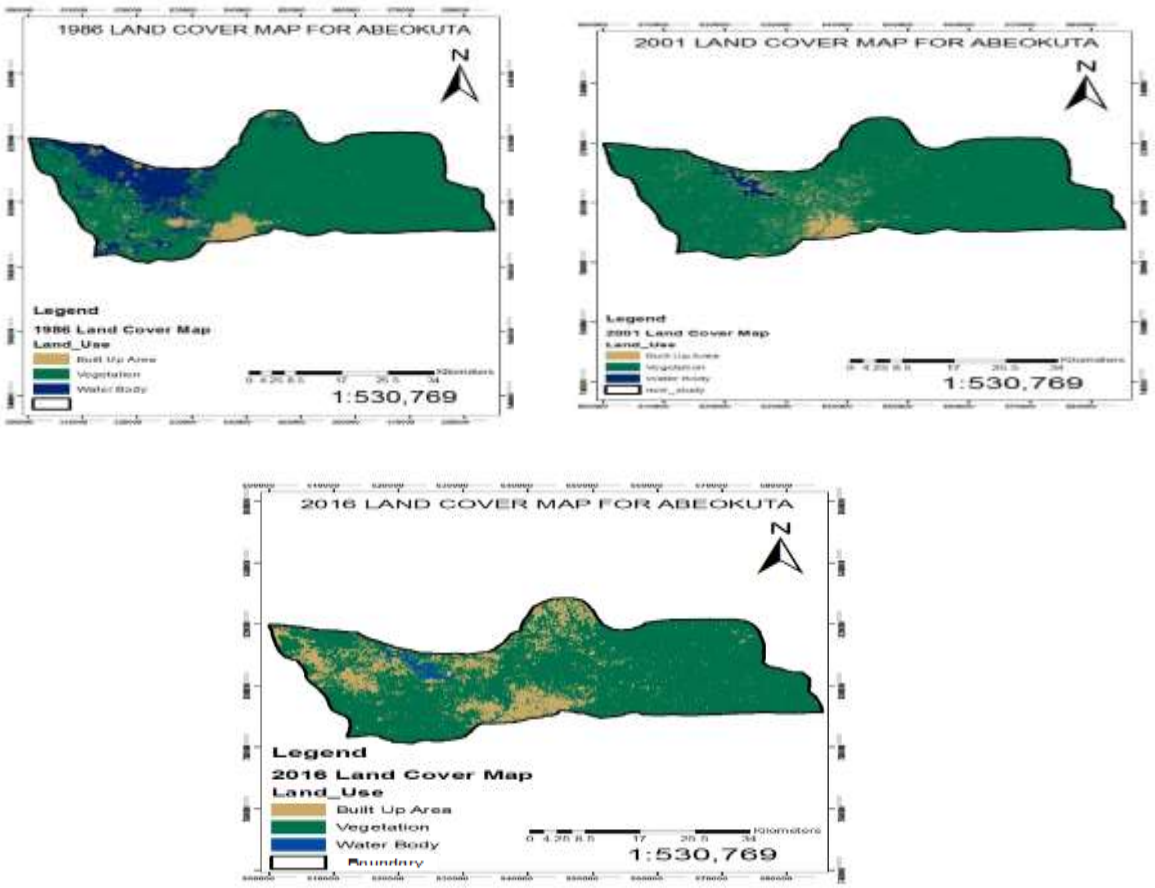
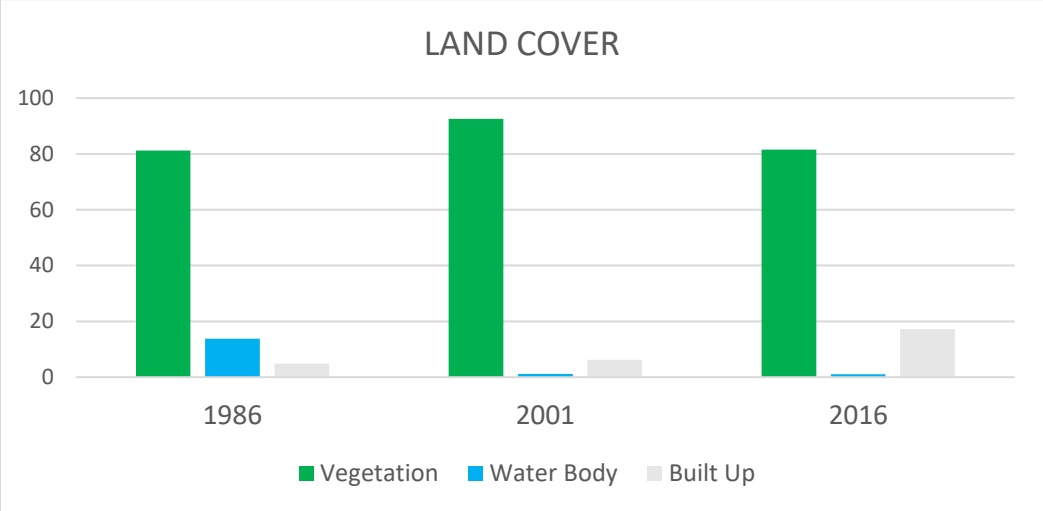


Figure 4: showing the maps of the land cover at the three (3) epochs; 1986, 2001 and 2016

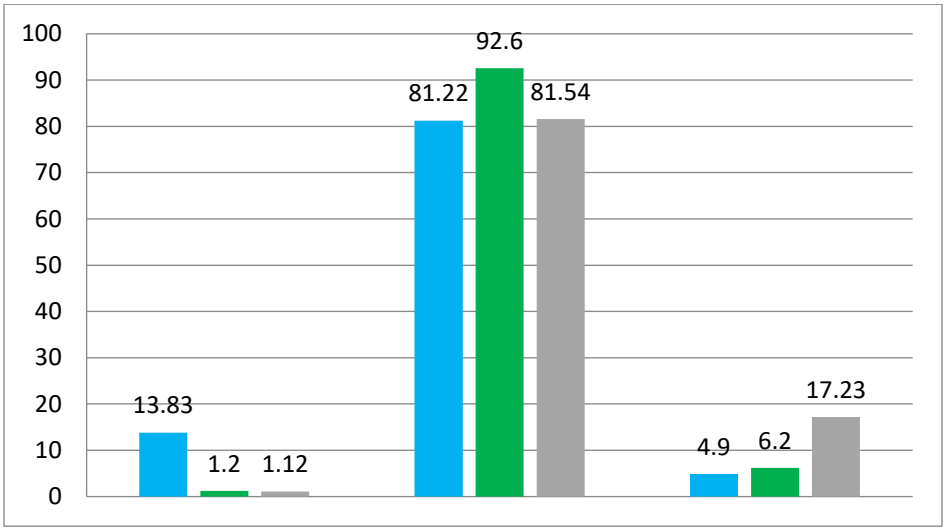
Graphs 1 and 2 and Tables 3 use the percentage of area covered to describe the epoch-year land cover:



Graph 1: Graphical representation of 1986 Land Cover

Table 3: Juxtaposition of land cover of 1986, 2001 and 2016

	1986 land Cover		2001 Land Cover		2016 Land Cover	
Land Cover	Ha	%	Ha	%	Ha	%
Water Body	40725.82	13.83	3622.22	1.20	3391.10	1.12
Vegetation	239185.92	81.22	278573.84	92.60	245304.11	81.54
Built-Up Area	14546.63	4.90	18636.12	6.20	51844.41	17.23
Total	294458.40	100	300832.18	100	300539.62	99.90



Graph 2: Water body, Vegetation, and Built-up for 1986, 2001 and 2016 in hectares.

The land cover for 1986 reveals that 14%; 40725.82Ha, is covered by water bodies: 81%; 239185.92Ha is covered by vegetation and 5%; 14546.63Ha is covered by designated regions.

The land cover in 2001 reveals that 1.2%; 3622.22Ha, is covered by water bodies: 92%; 278573.84Ha is covered by vegetation and 6%; 18636.12Ha is surrounded by spaces.

While land cover map for 2016 revealed that 1.1%; 3391.10Ha, is covered by water bodies: 82%; 245304.11Ha, is covered by vegetation and 17%; 388833134m2 is covered by developed regions.

The vegetation cover maps of the study area from 1986 to 2001 revealed the rate of increase to be 0.8% i.e., 39,387.92Ha of vegetation cover was added due to various policies of the government to encourage farming activities. From 2001 to 2016, an estimated 0.73% reduction rate was noticed. That is, 33,269.73Ha was lost from vegetation cover of about 278573.84Ha in 2001 to 245304.11Ha vegetation cover in 2016. The loss in vegetation cover is attributed to urban expansion that was experienced within the metropolis. This urban expansion is facilitated by the developmental projects embarked upon by the government in the last 10 years.

Water bodies were reduced between 1986 and 2001 and are estimated to be 0.8% i.e., 37103.60Ha of water cover was lost due to land reclamation processes mainly for farming and other purposes. Furthermore, from 2001 to 2016, an estimated 0.005% change was noticed. That is, 231.1400044Ha was lost from water cover of about 23622.22Ha in 2001 to 3391.078303Ha water cover in 2016. The marginal water cover loss is due to urban expansion towards the upland part of the metropolis other than the riverine area. More so, there was a concerted effort by the government to discourage encroachment into the water body that passes through the developed region.

Developed area territory usage increased over the years by 0.8%. The amount of vegetation change between 1986 and 2001 is estimated to have increased by 0.08%, or 14546.63513Ha, primarily as a result of urban growth brought and an economic boom. Furthermore, from 2001 to 2016, an estimated 0.7% increment was noticed. This implies that 33208.29404Ha land was converted to settlement from 18636.12376Ha of settlement cover in 2001 to 51844.4178Ha in 2016. As stated earlier, the

increment in built-up area is due to urban expansion within and around the metropolis. This expansion is brought about by increased economic activities within and around the town, rural-urban migration of people from neighboring towns into Abeokuta and the increase of physical development within the state capital.

The most notable urban growth is seen around the Abeokuta metropolis towards Odeda local government axis. This is due to the overcrowding being experienced in the metropolis. More so, the Ogun StateGovernments' Urban Renewal Policy Program seeks to expand urban growth beyond the Abeokuta metropolis, hence urban expansion towards places like Camp/FUNAAB locality within Odeda Local government is encouraged.

Conclusion

This study adopted the RS method to analyze land cover changes in Abeokuta and has shown that 81% vegetation cover in 1986 increased to 93% cover in 2001 while the same reduced to 82% cover in 2016. The water body that covered 14% of the three local governments in 1986 was reduced to about 1.2% cover in 2001 while it maintained almost the same cover of 1.1% in 2016. A significant increase was noticed in built-up area cover from 4.90% cover in 1986 to 6.1% cover in 2001 and 17.2% cover in 2016. The results from the analyses gave a projection of the future land cover of the study area. It has revealed the likely threats of urban spillage in the nearest future. This study has given accurate information useful for decision-makers to prepare or provide measures to forestall issues that may arise.

Recommendation

As seen in the results given from this study, urban sprawl as a general phenomenon is evident in the area. This has caused an increment in built-up areas whereas vegetation reduced. Since a balance in the land cover is important to socioeconomic stability, the government should find of protecting the vegetated areas by enforcing urban agents to adhere strictly to land use policies and approval. To sustain the environment, policymakers need to create systems that will reduce stress on vegetation and water.

The provision of basic amenities in rural areas will reduce migration into urban areas experienced recently. Rural settlers move to the urban cities to find facilities and opportunities missing in their communities.

It is therefore advised that change agents enforce policies that provide sustainable land use which supports the protection of the human ecosystem and biodiversity.

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