Forces Engendering Land Use Dynamics in Abeokuta Metropolis, Southwestern Nigeria: The GIS Perspective

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SUMMARY

The study analyzed land use patterns between 1960 and 2005 and looked at the factors that influenced land use change in the study area. In order to predict the future pattern of land use and land cover change in the Abeokuta metropolis for a healthy and sustainable environment, it also identified the hot regions of land use and land cover change. The maps of land use and land cover for Abeokuta, Nigeria, were created using aerial photographs from 1960 and a collection of satellite data from 1975 to 2005. Ground control points were established with the aid of GPS, and the images' geometry was adjusted to conform to the coordinate systems found in the current world. The land use pattern and change detection were calculated using linear regression, and the data was processed using ILWIS 3.6 software. Results showed that settlement land use increased from 3% in 1972 to 16% in 1984 and then by a factor of ten to 27% in 2005. Farmland declined from 19% in 1972 to 15% in 1984 to 8% in 2005. The predictive model reveals that while non-wooded areas, farmlands, forested wetlands, and light forests decreased, settlement, bare ground, shrubs, and water bodies increased by 60.30%, 57.68%, 53.79%, and 8.03%, respectively. The study concluded that, for sustainable development, it is essential to control the LULC dynamics and preserve land resources using a controlled land-use planning strategy combined with GIS and remote sensing technology.

1. INTRODUCTION

According to earlier research, the emergence of changes in land use and cover is a worldwide phenomenon and may be the biggest regional anthropogenic environmental disturbance of the 20th century. According to Adegboyega (2010), cities and towns throughout the globe are expanding to some extent due to the rapid acceleration of population increase, technological advancement, and solid economic growth. Globally, among other important changes in human activity, rapid urbanization, industrialization, and large-scale agriculture may be primarily responsible for the dramatic changes in land cover and land use patterns. As opposed to normally requiring millennia, this allows for significant changes in land use and cover to happen within a few decades. According to research, deforestation is happening more quickly in Africa. The consequence of competing land uses, such as agriculture and human habitation, is to hasten the decline of forest and woodland regions (Orimoogunje et al., 2021).

The increased demand for fuels like wood and charcoal is the primary driver of deforestation (Orimoogunje, 2005). Certain wild species are in decline because of overharvesting, increased agricultural output, and uncontrolled bush burning. Nonetheless, urbanization and agricultural expansion are the two primary variables influencing how land is used and covered (Geist et al.,

2005; Reid et al., 2005). Human activities have significantly changed the natural form, structural features, species composition, species density, and distribution pattern of the original vegetation. The global trend toward growing urbanization and growth has consequences for particular areas of the world in addition to its overall effects (Marzluff, 2001; Alberti et al., 2003). Moreover, studies have shown that the number of places on Earth that still exist in their natural state has decreased significantly. The earth's surface is being profoundly changed by anthropogenic activities in some way. A discernible pattern in land usage and land cover through time may be attributed to man's impact on the environment through his presence on earth and use of land (Zubair, 2006). Moreover, there are both short- and long-term uses for a piece of land. Unlike the transitory use of agricultural land for cash crop plantings or forest reserves, urban growth leads to persistent and typically irreversible changes to land use. This is because it involves building homes, extending roads, and expanding industries.

Currently, unforeseen changes in land use brought on by urbanization processes in our major cities, together with the ensuing, nearly irreversible changes in land use, are on the rise. Global disparities in regional and national vulnerability and resilience are highlighted by the diverse ways that environmental variability impacts land use practices around the world. No longer are local encroachments on wooded areas for agricultural or high subsistence use, or even for illicit logging, the main cause of land use change brought on by deforestation in East Africa and other portions of the African continent (AJAR, 2008). In an effort to offset declining export revenues and debt loads, several governments have also tried to enhance the exploitation of natural resources and cash crop production. Due to rural communities' forced cultivation of fragile and marginal areas, this has also resulted in extensive environmental harm (UNEP, 2002).

Natural plant cover and other forest-related land uses have been significantly reduced in favor of human-induced land uses that masquerade as urbanization. This uncontrolled urban development has harmed several cities around the world, both old and new, in both developed and developing countries. Like many other state capitals and significant cities in Nigeria, Abeokuta has historically seen constant expansion from its foundation in 1830 to the extent where the British Government recognized it as the headquarters of the Egba Unified Government in 1839 (Adenekan 2000). Since then, Abeokuta has expanded quickly. Its expansion has been monitored and documented in a number of ways, including the compilation of topographic maps and aerial photographs. It has typically experienced impressive expansion, growth, and development activities, including the construction of homes and businesses, roads, deforestation, and many other anthropogenic activities. When Ogun State was established in 1976, these rates of growth drastically rose with the assumption of capital city status. As a result, there has been a rise in the consumption, modification, and transformation of land without any meaningful attempt to monitor the ongoing changes or assess the quality of the land as it changes through time. These environmental issues have major long-term and immediate effects. In the short term, food security, human vulnerability, health, and safety are in danger; in the long term, the earth's sustainability is at risk (Briassoullis, 1999).

It is clear from the ongoing that a thorough understanding of land use dynamics is required to investigate the various ecological and developmental implications of long-term land use change. As a result, a better understanding of historical land use and land-cover patterns is

needed to assess complex causes and reactions and better predict future trends of human activities and changes in land use and land-cover. Therefore, this study examined the land use patterns between 1960 and 2005 in the Abeokuta metropolis, identified the areas where these changes were most noticeable, examined the factors that contributed to these changes, and forecasted how land use and land cover will develop in the future. In order to track human activities for a sustainable and healthy environment and develop a forecast model for changes in land use in the Abeokuta metropolis

2. METHODS AND MATERIALS

2.1 Study area

Abeokuta township is the research area (Figure 1). It has a population of approximately 593,100 and a 100-square-kilometer area (National Population Census, 2007). It is located between latitudes 07^0 05^1 and 07^0 20' N and longitudes 03^0 17^1 and 03^0 27^1 E, within the tropical rain forest area (Onakomaiya, 2000). The height is between 120 and 180 meters above sea level.

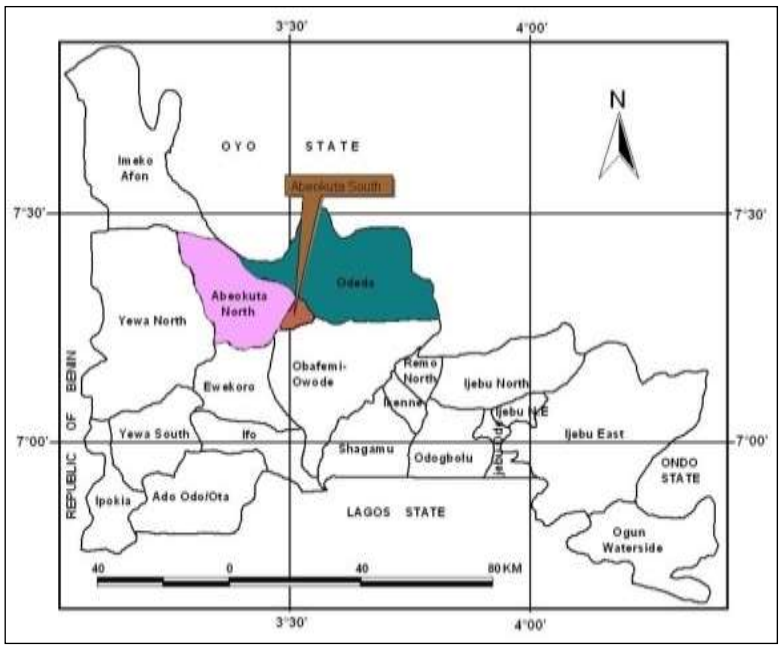

Figure 1: Map of Ogun State showing the Study Area

The Ogun River, which normally runs from north to south, is the most prominent feature in the region. Several major and minor rivers, including the Ona-Ibu River in the southeast, the Osun in the east, the Yewa in the west, and the Ewekoro and Adiyan Rivers in the south-west, drain significant areas of the area (Iloeje, 1981). With rainfall ranging from 1016 mm to 1270 mm and distinct wet and dry seasons, Abeokuta has a tropical climate. Both the Cretaceous sedimentary formation and the crystalline basement rocks support it. Abeokuta is located in a tropical rainforest with tall evergreen trees like the *Swietenia genus, Triplochiton scleroxylon, Diospyros, Lianas, Milicia excelsa, Entandrophragma cylindricum,* and *Juglans genus*, as well as an undergrowth of lians and other climbing plants that can become so tangled as to prevent penetration of rainfalls.

2.2 Data Collection and Analysis

For the study, both primary and secondary data were used. Among the key pieces of information are ground control points with GPS-established coordinates. They were employed to translate the visual geometry into coordinate systems seen in the actual world. Six hundred fifty questionnaires were used in perception research to represent all Abeokuta Metropolitan inhabitants (10% for populations under 500; 5% for populations between 500 and 1000; and 2.5% for populations exceeding 1000). For the administration of the questionnaire among the five traditional neighborhoods of Egba, Owu, Egba Oke-Ona, Gbagura, and Ibara (Adenekan, 2000), stratified sampling and simple random sample procedures were used. Secondary data were gathered from a series of aerial photos of Abeokuta taken in 1960 that were scaled to 1:50,000 and kept in the Federal Surveys of Nigeria's archive, as well as a collection of multidate satellite images taken between 1960 and 2005. These multidate satellite images include the Landsat Scanner (MSS) of 1976 with an 80 m x 80 m resolution, the Landsat Thematic MapperTM (TM) of 1991 with a 30 m x 30 m resolution, and the Landsat ETM+ of 2005 with a 30 m x 30 m resolution. They were gathered through the Earth Science Data Interface and the Global Land Cover Facility (GLCF). The images are subsequently processed using supervised classification to determine land use patterns (which include vegetal covers like forests, shrubs, and plantations or agriculture; built-up areas like settlements and road networks; bare ground or rock-out crops); change detection using the overlay operations function of the ILWIS 3.6 software package; and linear regression using variables derived from annual area coverage.

The ground control points set up during the field survey were used to identify characteristics that helped with the processing and analysis of the satellite images. Figures 3, 4, and 5 show the results. Simple linear regression equations were used to estimate the anticipated future changes and trends in land use and land cover. ArcGIS software 9.6 versions were used to produce maps of the expected geographical areas' land use and cover. The National Population Commission (NPC), Abeokuta, provided the 1991 and 2006 census data, which were used to estimate the population for the years 1972, 1984, and 2005 using the recommended growth rate of 2.86%. This allowed for prediction for the future land use and land cover status in the study area. A population estimate for 2020 was also acquired for this purpose. In order to ascertain the socioeconomic repercussions of change, the dynamics of the population's values and LULC between 1972 and 2005 were studied and examined alongside the administered surveys.

3. RESULTS AND DISCUSSION

Table 1 shows that semi-rural settings were most prevalent in 1972 (the period from 1960 to 1975), with settlement lands accounting for the lowest classes at 1253.12 hectares (2.66%) and farmlands at 8751.21 hectares (18.66%) (Figure 3). The highest class was found in the case of non-forested wetlands, which covered a total of 10906.08 hectares (23.18%), and forested wetlands, which covered 6480.61 hectares (13.77%). Table 6 makes it clear that all of these numbers show a rural area with a reduced population of 172,090 people who were primarily farmers. When the population reached 301,440 and 527,803 in 1984 and 2005, respectively, there was a corresponding decline in agricultural and other land uses related to the forest, but

settlement lands continued to rise with time. This validated Harcourt's (1992) contention that Kenya's population growth was a contributing factor to deforestation.

However, there was a significant departure from the results attained in 1972 when Abeokuta was given the title of state capital (1976–1991). Both the settlement area and the population significantly increased during this time, rising from 1253.12 hectares with 172,090 people in 1972 (2.663%) to 7684.27 hectares with 301,330 people in 1984 (16.33%). This confirmed the ITC's 2005 prediction that by 2005, more than five billion people will reside in urban settings, with cities in developing nations accounting for 80% of those urban dwellers. An increase in land use conversion from forest cover to settlement and other damaging human activities will result from urbanization of this magnitude. The United Nations Food and Agricultural Organization (FAO) also confirmed this assertion, stating that native (sometimes referred to as "old growth") African forests are being cleared at a rate of more than 4 million hectares annually, which is double the global average rate of deforestation. More than 10% of the continent's total forest cover was lost as a result of this situation between 1980 and 1995 alone (AJAR, 2008).

Table 1: Areal Extent of Each Land Use/Land Cover Classes between 1972 and 2005

	1972 LULC Area		1984 LULC Area		2005 LULC Area	
LULC Types	Ha	%	Ha	%	Ha	%
Settlements	1253.12	3.66	7684.27	16.33	12842.11	27.30
Non-Forested Wetlands	10906.08	23.18	9165.54	19.48	7888.13	16.77
Farmlands	8751.21	18.60	7144.32	15.19	3824.80	8.13
Forested Wetlands	6480.61	13.77	5101.5	10.84	4164.42	8.85
Shrub	2932.47	6.22	3695.03	7.85	5953.66	12.65
Bare Surface	6853.8	14.57	3342.4	7.10	2239.66	4.76
Light Forest	4681.5	9.95	3634.24	7.72	2065.87	4.39
Water Body	5191.07	11.03	7282.56	15.48	8071.21	17.16
TOTAL	**47049.86**	**100.00**	**47049.86**	**100.00**	**47049.86**	**100.00**

According to the foregoing, urban growth is putting strain on the environment because households have increased faster than the population, reflecting a trend toward smaller families and invariably a drop in the average number of persons per home (Figure 4). Farmlands decreased by a similar amount, 9165.54 hectares (19.48%), non-forested wetlands decreased by 5101.5 hectares (10.84%), and forested wetlands decreased by 7144.32 hectares (15.18%). In 1984, the area covered by bare surface lands decreased by 3342.4 hectares (7.1%), continuing an emerging trend intended primarily to provide more land for housing units and other city development projects. This was supported by the findings of Glin (1998), who examined the new patterns of escalating settlement encroachment on agricultural and natural land regions. He predicted that, among other negative effects, there would be extensive deforestation that would result in population-related pollution. During this time, bare surfaces and light forests covered the least amount of land, accounting for 3342.4 and 3634.24 hectares of the total land area, respectively.

The amount of land occupied by settlements increased from 7684.27 hectares in 1984 to 12,842.11 hectares (27.29%) in 2005 (the period 1991–2005). This suggested that more homes were being built and that areas that had previously been used for various purposes were being invaded. Figure 5 clearly shows that agricultural lands suffered the greatest damage, with a drop in land coverage from 7144.32 hectares in 1984 to 3824.80 hectares in 2005. Other land uses were not spared from the settlements' rampage of encroachment because of the increased urbanization that was taking place. Between 1984 and 2005, the percentage of non-forested wetlands decreased from 19.48% to 16.77% of the total land area. This might be the result of increased vegetable gardening and/or cultivation to meet the town's need for fresh vegetables.

Forested wetlands and light forest occupied 4.76 percent and 4.39 percent of the total land surfaces, respectively, in 2005. This, according to Fritts (2005), highlighted the costs placed on society and the environment as a whole by urbanization, which included the loss of wetlands that offered flood control and waste water rehabilitation, ecosystem degradation, and the loss of agricultural areas. Between 1984 and 2005, the area covered by shrub land increased from 3695.03 hectares to 5953.66 hectares. The need to beautify towns through the planting of decorative plants and orchard cultivation may have increased, which may have contributed to the increase of shrub land. The loss of wetlands that provided flood control and waste water renovation, as well as a decrease in the soil's ability to retain water, have led to an increase in runoff and sporadic flooding. It is clear from the results that the area of water bodies has also increased, from 7282.56 hectares to 8071.21 hectares. This outcome was in line with Fritts' (2005) findings. One is curious about the prevalence of persistent flooding during torrential downpours in several areas of the metropolis of Abeokuta in recent times.

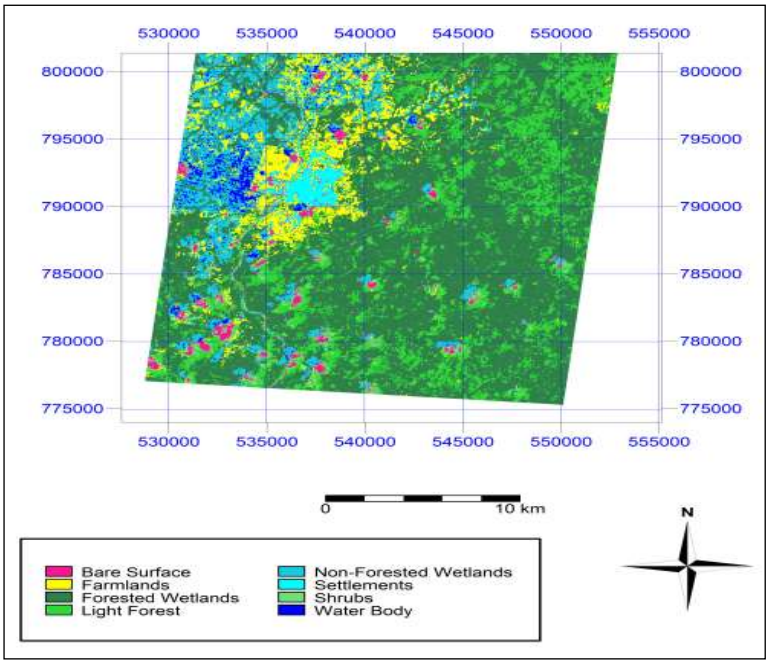

Figure 3: LULC of the Study Area in 1972

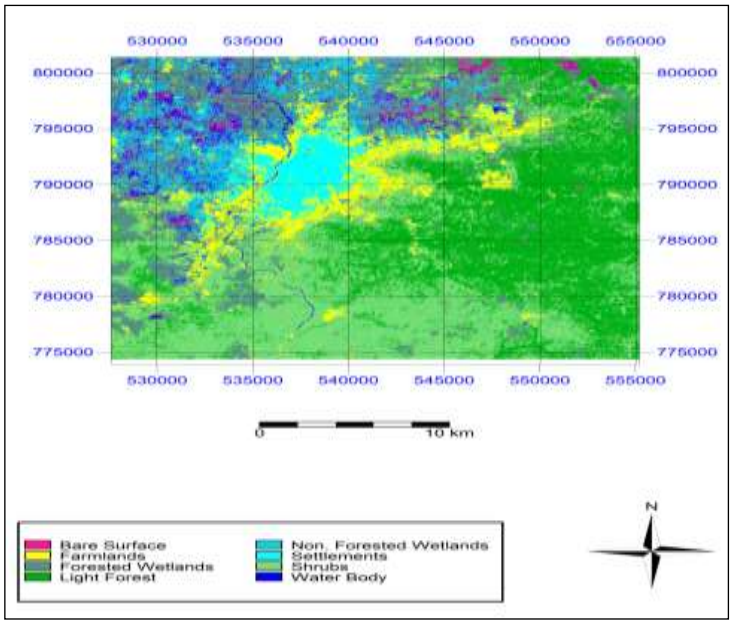

Figure 4: LULC of the Study Area in 1984

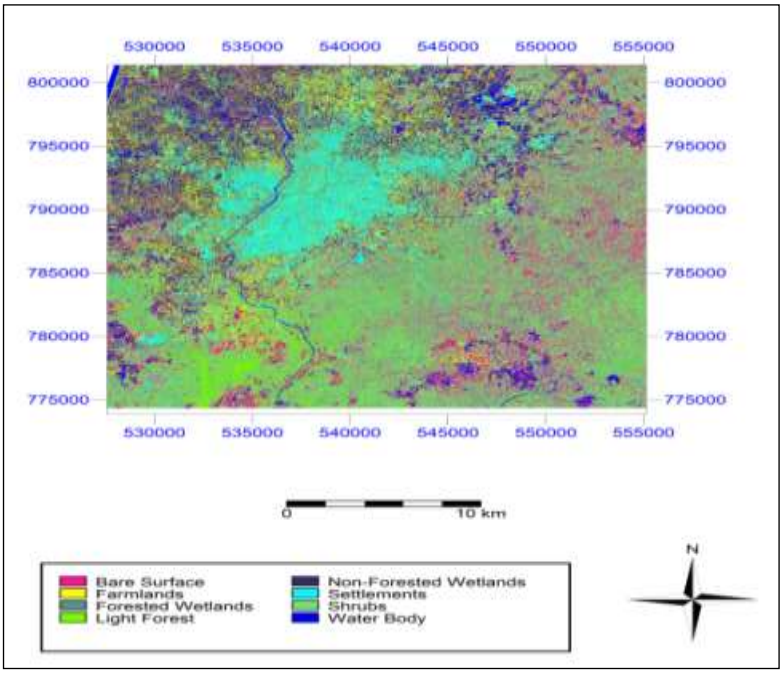

Figure 5: LULC of the Study Area in 2005

3.1 Dynamism of Change in Landuse / Landcover in the Study Area

Table 2 displays the trend, rate, and type of changes that have occurred. The rates of land use change in absolute and percentage terms from 1972 to 1984, 1984 to 2005, and 1972 to 2005 are displayed. According to Table 2, there was a negative shift, with farmlands decreasing by

1606.89 hectares (18.36%) between 1972 and 1984. This might be because the city's economic foundation has shifted from agriculture to other sources of income, such as white-collar work. This type of socioeconomic change can be attributed to Abeokuta's urbanization when Ogun State was established in 1976. This was accompanied by a matching increase in settlement lands of 513.21% and a corresponding decline in bare surface and light forest of 51.23% and 22.37%, respectively. The aforementioned studies supported the rapid urbanization of cities in the developing countries proposed by Oyinloye (2003) and Menon (2004).

Table 2: Comparison of Land Use/Land Cover Change between 1972 and 2005

LULC Types	Change between 1972 & 1984		Change between 1984 & 2005		Change between 1972 & 2005	
	Ha	%	Ha	%	Ha	%
Settlements	6431.15	513.21	5157.84	67.12	11588.99	924.81
Non-Forested Wetlands	1740.54	-15.96	1277.41	-13.94	3017.95	-27.67
Farmlands	1606.89	-18.36	3319.52	46.46	4926.41	-56.29
Forested Wetlands	1379.11	-21.28	937.08	-18.37	2316.19	-35.74
Shrub	762.56	26.00	2258.63	61.13	3021.19	103.03
Bare Surface	3511.4	-51.23	1102.74	-32.99	4614.14	-67.32
Light Forest	1047.26	-22.37	1568.37	-43.16	2615.63	-55.87
Water Body	2091.49	40.29	788.65	10.83	2880.14	55.48

There was a decrease in the rate of the city's physical expansion when comparing the years 1972 to 1984 to the years 1984 to 2005. Settlement lands only increased by 67% in this scenario, compared to 513.21% growth from 1972 to 1984 and 924.81% growth from 1972 to 2005; cropland, bare ground, and light woodland all decreased by 46%, 33%, and 43%, respectively. The city was therefore still growing physically, albeit more slowly. The water body's size increased by 7.88% during the periods, suggesting that it is able to maintain its increased potential. In addition, settlement lands continued to grow during this period, reaching 11,588.99 hectares, an increase of almost 925.81% from the previous period. Negative growth was seen in 3017.95, 4926.41, 2316.19, 4614.14, and 2615.63 hectares of farmland, forested wetlands, bare surfaces, light forest, and non-forested wetlands, respectively. However, there are gains in shrub and water body lands of 3021.19 and 2880.14 hectares, respectively.

Table 3 showed how land use had evolved between 1972 and 2005, with settlement lands growing at the expense of other land-use types. The survey's findings showed that 300 (47%) respondents agreed that the extensive conversion of farmlands to settlement land projects over the past thirty years had been the most significant change in land use in the city. When asked what they believed to be the biggest shift or change in land usage over the past thirty years, this was their response. In relation to this, 190 (29%) of the respondents agreed that farming and other primary occupations had been purposely relocated outside of the city. The demands of other urban land use groups, particularly those who prioritize settlement lands, are what led to

this. The majority of respondents (85%) also agreed that mining, rock quarrying, and waste land reclamation and developments are the most significant land use shifts, while only 75% thought that indiscriminate forest clearing is the most significant land use shift. Overall, the findings of the picture categorization and analysis suggested that land use is changing, which was also corroborated by the survey results. The dynamism observed among the land use classifications in the study region has been attributed to a number of causes that have been identified from prior studies. These pressures come from a variety of sources, including but not limited to the urbanization processes brought on by rapid population growth and increased housing demand. In order to accommodate the uncontrolled rush of people into the region and improve the recently founded state capital, this became required. Due to settlements' effective encroachment on all farmlands near cities, these activities have led to a significant loss of land uses associated with forests, and agricultural regions were not excluded.

Based on the results of the interview, Table 4 lists the common land-use types in the city. For example, according to 400 respondents (61%), the majority of metropolis land areas now inhabited by settlements were formerly used as farms; 150 respondents (23%), attributed this to forest/plantation land-use; and 50 respondents (8%) each gave the following explanations: rock outcrops/waste land-use and water bodies/waterlogged land-use. The prior investigation suggested an agrarian society, and it was established that the spaces now occupied by structures were once used for agriculture-related activities, most notably farming and possibly other primary ones.

Table 3; Major Landuse Changes in the last 30 Years in the Metropolis

Landuse Change	Frequency	Percentage %
Conversion of Farmlands to Settlement lands	300	46
Indiscriminate Forest removal	75	12
Rock Outcrops Quarrying/Mining	85	13
Deliberate relocation of Farming to the Outskirt	190	29
Total	**650**	**100**

Table 4: Prevailing Land-use Types before Settlements Encroachment

Land use Types	Frequency	Percentage (%)
Farmlands	400	61
Quarry/Rock outcrops	50	08
Forest/Plantation	150	23
Water logged/Body	50	08
Total	**650**	**100**

Table 5 confirmed the dominance of settlement land growth and encroachment on other types of land-use, as demonstrated by the image classification results in Table 1. It showed settlement lands to be the highest single land use category of all time over the period under consideration, with the exception of the time before 1972. In line with the image classification results, 429 (66%) of the respondents agreed that settlement land developments, the dominant land-use category in the metropolis, were responsible for the observed land-use changes. A total of 119 respondents concurred that, after settlement land developments, farms constitute the area's

second-most significant land use. Of the 650 respondents, 71 (11%) thought quarry or mine land was the most significant land cover in 2011. Since there are numerous quarry sites in Abeokuta right now, the justification for this remark may not be too far-fetched. Yet, in the same order, 5% (31 respondents) of the sample agreed that the city's main land cover for the year was water bodies. In essence, it is evident from the statistics so far that settlement land development has continued to be the dominant land use class in the metropolis that has benefited from other land uses with a direct correlation to the expansion of the city's population.

Table 5: Land-use constituting the largest covering in the Year 2011

Landuse Types	Frequency	Percentage
Settlements Developments	429	66
Agricultural/Farm Lands	119	18
Water Body	31	05
Quarry/Mine Lands	71	11
Total	**650**	**100**

The population growth in the metropolis at the time of the highest rate of settlement expansion is shown in Table 6. The total population was 172,090 in 1972, and during that time, settlements occupied a total of 1253.12 hectares of land. The population did, however, increase significantly in 1984, by 129,350 individuals (75.16%). This was followed by a matching increase in settlement land growth, which increased by 7684.27 hectares (513.21%) from the previous year's 1253.12 hectares. These trends continued into the year 2005, when the city's population increased from 301,440 people in 1984 to 527,802 (75.09%) people in 2005. At the same period, a 12,842.11 hectare (67.12%) increase in settlement area coverage was seen. In Abeokuta, especially after it attained the status of the capital city, urbanization due to settlement proliferation was observed, along with the accompanying population growth due to the influx of people and other indirect population growth mechanisms like an increased birth rate and decreased death rate as a result of improved health facilities and public awareness. All of these elements together make up the primary causes causing the observed land-use patterns in Abeokuta during the investigational period. This supports the assertions made by Hardoy et al. (2002) that recent trends in the size and population of cities and towns in developing countries have been unprecedented. According to Harcourt (1992), deforestation in Kenya was a result of population growth. Additionally, levels of per capita resource consumption, water and air pollution, and soil degradation and contamination have rapidly grown along with the growth in urban populations in developing nations (UN-HABITAT, 1996).

Population has always been crucial to the dynamics of land use. Therefore, an effort was made to pinpoint it as the primary reason behind the alterations, as evidenced in Table 7. Here, it is shown that as populations increased, it led to instability in the diverse uses of the land. For instance, in 1972, when Abeokuta had a population of only 172,090, only 1253 people lived there. 12 hectares of land were needed to suit the needs of the people for settlement, and 8751.21 hectares were used for farming, a situation that resembled an agrarian town. When the population increased from 172,090 in 1972 to 301,440 in 1984, the corresponding growth in

settlement lands increased from 1253.12 hectares in 1972 to 76,184 hectares. 27 hectares of agriculture, non-forested wetlands, and forested wetlands also occurred. Due to the population increase, high forests also lost a number of hectares to settlements, making them vulnerable to the invasion of settlements.

Table 6: Population / settlements growth of Abeokuta in 1972, 1984 and 2005

Year	Population/1000	Population change (%)	Settlements/ha	Settlements change (%)
1972	172,090	_	1253.12	_
1984	301440	75.16	7684.27	513.21
2005	527,802	75.09	12842.11	67.12

Table 7 Population and land-use patterns of Abeokuta in 1972, 1984 and 2005

Yr	PPN	SET	NFW	FRL	F W	SHB	BS	LF	WB
1972	172090	1253.12	10906.08	8751.21	6480.61	2932.47	6853.8	4681.5	5191.07
1984	301440	7684.27	9165.54	7144.32	5101.5	3695.03	3342.4	3634.24	7282.56
2005	527802	12842.11	7888.13	3824.80	4164.42	5953.66	2239.66	2065.87	8071.21

Source: Derived from 1991 and 2006 Census and Image Classification Analysis
PPN-Population; SET- Settlements; NFW - Non-Forested Wetlands; FRL – Farmland; FW- Forested Wetlands; SHB: Shrub-land; BS- Bare Surface; LF= Light Forest; WB-Water Body

When the population increased in 1984 from 172,090 to 301,440, the corresponding growth in settlement lands from 1253.12 to 7684.27 hectares of farmlands, non-forested wetlands, and forested wetlands also occurred. High forests also suffered from the encroachment of settlements as a result of population growth, losing a number of hectares to them. In a similar trend, the population continued to grow, reaching 527,802 individuals in 2005. The settlement lands expanded from 7,684.27 hectares in 1984 to 12,842.11 hectares. Other land-use types were also impacted, either by having more or less of them. From 1984 to 2005, there was a reduction in all coverage pertaining to forests. Even cropland decreased due to human occupation from 7,144.32 hectares in 1984 to 3,824.80 hectares in 2005. Other land-use types, like shrubs and water bodies, saw a rise in coverage in 2005, reaching 5,933.6 and 8,071.21 hectares, respectively. In 2005, there were 2,239.66 hectares of barren ground, down from the initial 6,853.8 hectares in 1972. This reduction might not be unrelated to the city's extensive development, which exploits the already scarce opportunities for municipal expansion. There is more demand for land for housing and related services as a result of the growing urban population (Devas and Rakodi, 1993).

In questionnaire surveys on the processes and variables influencing the observed changes in land use, population growth was named as one of the primary causes. According to Table 8, 381 respondents (58%) said that population growth and the need for housing were the primary causes of the land use changes in the study area. But 151 respondents (24%) noted that the changes were brought on by an uptick in economic activity. Additionally, 59 respondents (9%)

agreed that the planned exodus of farming and other fundamental industries to the periphery was the major factor, and another 9% concurred that the founding of the state and Abeokuta's selection to serve as the capital were the primary factors. The data above clearly demonstrate that a significant contributor to the observed changes was the population expansion that led to a rise in housing requirements. Because of this, settlement lands have increased at the expense of other urban landuse patterns. The outcomes of the image classifications and other scholarly assertions made over time support this position (Orimoogunje et al., 2021).

Table 8; Factors / Forces Responsible for the Land-use Changes

Forces of Change	Frequency	Percentage
Population Increase and Settlement needs	381	58
Relocation of Farmlands to the Outskirt	59	09
Creation of State and assumption of Capital Status	59	09
Increase Economic Activities in the Town Centre	151	24
Total	650	100

3.2 Predictive Models of Wetlands Utilization

The predictive model created for this research project illustrates the relationships between wetland exploitation, nearby elements contributing to the observed dynamic, and the resulting traits that may be seen on the landscape (Figure 6). The model is split into seven sections, as shown below: Segment 1 depicts the region's original land cover, a forested wetland, as well as the preferred land cover of the locals. In segment 2, it was demonstrated how human activity in the initial wetland area had led to changes in the environment. Rainfall intensity, which regulates the pace and availability of water accessible inside the wetland region, is one of the factors that segment 3 demonstrates are the key regulators of the direction of wetland exploitation. Segment 4 displays signs of human activity in the wetland area (i.e., the visible features). Segment 5 represents the wetland's subsequent human use and how that has affected the local soil's physical and chemical composition, while segment 6 shows the effects of that use depending on whether the wetland is lost permanently or if it is feasible to restore the original land cover (forest). In segment 7, you can see the two main outcomes of all land use in the research region. According to how long it spends in the bottom tray, fallow land eventually returns to its natural state as forest cover, in contrast to the built-up region, which signifies a permanent loss of wetland (non-forested wetland). As expected, lands that were either used for farming or any other land use devoted to permanent human-induced development, such as villages, highways, or other forms of built-up regions, are gone. The return of temporary land uses to forests was allowed, starting with farming and moving through fallowing to non-forested wetlands and forests depending on how long they were used. In addition, with the recovery of forests, the destructive cycle is restarted with haphazard invasions and the cutting down of forest trees.

3.3 Implication of the Study

It was found that the interactions between the various land use and land cover categories in the research area from 1972 to 2005 were typically unstable during the course of the time period.

In particular, only 1253.12 hectares (2.663%) of the research region's total area was occupied by the settlement. Agriculture accounted for around 18.6% of the total land area in 1972, in comparison. Given the proportion of the land devoted to farming and other similar activities during the study period, the study area was mostly in a rural context. When Abeokuta was designated as the state capital city in 1984, the events between 1976 and 1991 took on a new meaning. Due to a rise in housing demand from residents who likely migrated to the city in quest of white-collar work. On the other hand, the amount of farmland adjacent to the city has decreased. The percentage of settlement lands rose to 12842.11 hectares in 2005, while the loss of cropland continues. It's possible that this has anything to do with the requirement to provide housing for the populous, given the population's continued increase.

According to Wildgen (2004), urban growth is still dispersed and disorganized on the periphery, and it is encroaching dangerously quickly on rural agricultural areas. This pattern also holds for other land uses, which underwent continuous change during the time period under study. In addition, the city's growth was primarily in its periphery. As they contribute to the highest concentration of settlement developments, these places are appropriately referred to as "hot spots." Osiele, Panseke, and Camp Area are a few of these places. Numerous housing developments exist, including Asero, Olomoore, Laderin, and Obasanjo Hill Top, among others. The way the terrain is changing, with a focus on how settlement land is encroaching on other land use classes, shows how rapidly the city is growing.

3.4 Dynamism of Land Use Projection

Due to the estimated populations of 749,478 and 20,586.35 for settlement land-use, there would be fewer non-forested wetlands and farmlands, respectively, by 2020. According to the responses to the field survey and questionnaire administration, it is clear that these types of land use practices would exacerbate occupational changes (Tables 3, 6 & 8). According to 46% of respondents, the largest shift in land use over the previous 30 years was the widespread transition from agricultural to urbanization. According to 29% of the respondents, it was the shifting of farming and other primary activities to the periphery of the city. Such conversions and relocations may result in a loss of man-hours and higher costs to reach the fringes due to the city's quick growth and dynamic nature, but they are transient and will only further distance such places.

As a result, settlement growth has resulted in the loss of a significant amount of economically valuable and productive land that would have been used for agriculture (Table 3). It's interesting to observe that, according to 61% of respondents, farming predates settlement encroachment as the most prevalent land-use type, whereas 66% indicated settlement development currently predominates (Tables 2 & 7). Due to population expansion, increasing vehicle ownership, and increased traffic, it had a detrimental influence on land usage, resulting in the loss of man hours in gridlock. According to 69% of respondents, high traffic conditions are more frequent today than they were thirty years ago. Given that 70% of responders had lived in Abeokuta for more than 30 years, this may not be incorrect. This implies that the city's growth during the following three decades would have driven a large portion of the agrarian population from their homes

(Table 10). Therefore, if allowed unchecked, it would encroach on other sites designated for forest-related land use by pushing farmlands out into the periphery. Generally speaking, it is seen that urbanization, which is made possible by rapid population expansion, has played a vital role in the development of Abeokuta.

4. CONCLUSION

The approach adopted in this study clearly demonstrated the potential of GIS and remote sensing techniques in measuring the change pattern of land use/cover in the Abeokuta metropolis, a region of southwest Nigeria. Land use patterns and their spatial distribution were discovered to be the major rudiments for the foundation of a successful land use strategy required for the appropriate development of any area. From the survey, a general lack of stability was observed among the land-use classes described, which was accompanied by socioeconomic change in the form of altered population status and growth, settlement development, occupational changes, and illicit logging. Despite this instability, settlement lands were the most dynamic land-use classes throughout this time, which helped to accelerate the rapid urbanization that was partly prompted by the emergence of states. For these reasons, it is necessary to discourage this tendency in order to prevent adverse effects on the landscape, which could result in the loss of certain arable areas and a significant reduction in the area covered by forests.

The study has shown that there is a need for a thorough analysis of human activity in Abeokuta and modifications to sustainable management that would prevent unchecked infiltration into other land use classifications, particularly by unchecked urban processes. This was in tune with Sustainable Development Goals (SDG) goals, with specific reference to SDG Goal 7, which states that "the natural resource base and ecosystems must be managed sustainably to meet people's food requirements and other environmental, social, and economic needs." Hence, land use and land cover studies are crucial to the growth of man's economy, society, and culture, and they should play a key role in monitoring and managing land resources. Therefore, it becomes imperative to manage the LULC dynamics and conserve land resources through a regulated land-use planning strategy coupled with GIS and remote sensing techniques for sustainable development.

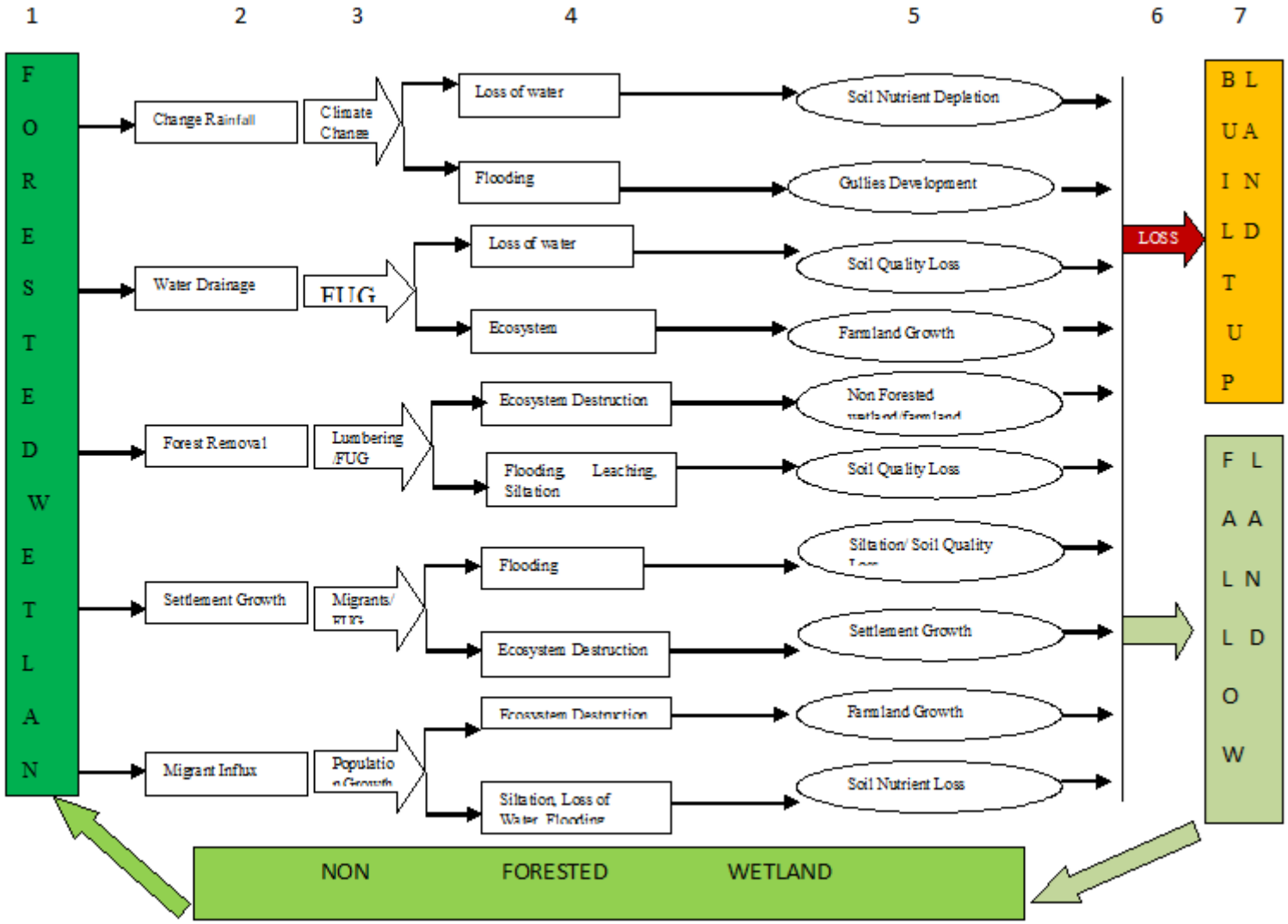

Figure 6: Predictive Model of Wetlands Utilization

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