

Analysis of Urban Expansion and Land Cover Changes in Lagos Metropolis, Nigeria

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Abstract

Nigeria in recent times has been experiencing uncontrolled urban expansion which poses significant threat to physical planning, socio-economic development, health risk and sustainable metropolitan management. There is dearth in literature and empirical studies in analyzing urban expansion and land cover changes in Lagos metropolis. The paper seeks to examine the nature and trend of urban expansion from 1995, 2000 and 2015 in Kosofe Local Government Area (LGA) of Lagos Metropolis. The study uses Landsat imageries for 1995, 2000 and 2015 collected from United State Geological Survey (USGS) for analyzing the land use and land cover in the study area. The Landsat images were classified using supervised classification. Results reveal that between year 1995 and 2000, the land use land cover shows that there is less than 20% built up areas and more than 70% significant change in the land use land cover for bare ground, vegetation and water body respectively. In contrast, in the year 2015, there was more than 40% increase in built up areas and less than 60% bare ground, vegetation and water body respectively. At the aggregate level, there was more than 20% increase in built up areas between 1995, 2000 and 2015 and 8% decreased in bare ground between 1995, 2000 and 2015. I recommend effective physical planning measures in addressing the uncontrolled urban expansion in the study area.

Keywords: Urban expansion, Land use Land cover, Urbanization, Spatio-temporal Changes

INTRODUCTION

There are numerous varied conceptual understandings associated with urbanization, urban growth and urban expansion. More often, scholars in the related disciplines of urban studies have erroneously linked the three concepts to refer to the same thing. However, they differ in meaning, but interrelated, especially within the context of sub-Saharan Africa (SSA) where urban population growth rates are generally high but overall urbanization rates relatively low (Bloch, Fox, Monroy, and Ojo, 2015). According to Bloch *et al.* (2015), urbanization is associated with an increase in the proportion of a country or region's population living in urban settlements, while urban growth refers to an increase in the absolute size of a country or region's urban population. The term urban expansion refers to the spatial or physical enlargement of built-up areas. This generally accompanies urban growth, but the dynamics of urban expansion also depend upon the nature of physical developments and the population densities they promote. Bloch *et al.* (2015) further argue that it is possible, for example, for a city to experience urban growth without expansion if this growth is absorbed within existing settlement boundaries. Conversely, expansion can occur without growth where new developments are created to facilitate lower population densities for an existing community. Bloch *et al.* (2015) posit that there are many criteria for classifying urban area, which are population size, density, administrative status and employment composition, amongst others. In Nigeria, a settlement is generally classified as urban if it comprises 20,000

people or more, which is a relatively high minimum population threshold compared to many other countries (Bloch *et al.*, 2015).

Urban expansion is a global phenomenon in both developed and developing countries, but it takes unprecedented and uncontrolled rate in developing countries. As revealed by UN-Habitat (2015), there are numerous factors responsible for urban expansion in developing countries which ranges inadequate affordable housing at the city-centre, unemployment, and rapid urbanization. Other factors are associated with natural increase and rural-urban migration. UN-Habitat (2015) further revealed that urban expansion has ripple effects on uncontrolled urban growth, spread of slums and about 32% of population lives in informal settlements as a result of urban expansion.

According to UNDP (2003), urbanization due to rural-urban migration is one of the major drivers of urban expansion in recent times. Africa has the highest levels of urbanization, but the least urbanized when compared with other regions of the world. In 2009, almost 40% of African population lived in urban areas (UN-HABITAT, 2010). By 2050, the Africa's urban population is estimated to triple to over one billion. It is projected by 2050 that the Africa's urban population will triple to over one billion (UN-HABITAT, 2010). In most developing countries, a high rate of urbanization combined with consistent economic decline over the last two decades has resulted in a rapid increase in the number of urban poor. In sub-Saharan African countries, it is estimated that more than 40% of urban residents are living in poverty (Aluko and Amidu, 2006).

According to the UN, Nigeria's urban population reached 69 million by 2010 while the Africapolis estimate is only 50 million. By 2020 the UN projects an urban population of 108.7 million while the Africapolis project is just 61.8million. These divergent projections reflect significant differences in the assumed rate of urban growth, with the UN anticipating a rate of roughly 4.3percent and Africapolis expecting something closer to 2.1percent. The growth of Nigeria's urban population in both absolute and relative terms is being characterized by the expansion of existing built-up areas and the emergence of new identifiably urban settlements (Bloch *et al.*, 2015).

It is expected that the physical expansion of built-up areas is expected to continue in the coming decades, although there is considerable uncertainty about how much expansion will take place. The key variables are population growth and, critically, population density. As shown by Angel (2012), an estimated 464,192 hectares of land were covered by large urban settlements in 2000. Assuming that urban population densities remain constant, urban land cover is expected to triple by 2030; assuming a 2percent decline in urban population density as urban population grows, urban land cover is forecasted to grow five-fold, reaching roughly 2.3 million hectares. Angel (2012) further argued that the rates of urban expansion have exceeded rates of urban population growth in West Africa. If this precedent holds, it is likely that population densities will decline somewhat resulting in greater physical expansion (Bloch *et al.*, 2015).

Nigerian cities have witnessed uncontrolled urban growth, and about 43% of Nigerians live in urban centres as a result of unprecedented high rate of urban population growth resulting to urban expansion (Aluko and Amidu, 2006). This creates a breeding ground for poor accommodation, illegal and informal settlements, slums, high rate of unemployment among others. Uncontrolled urbanization as characterized by increased human population and rural-urban migration has

resulted to demographic, economic and environmental challenge of the 21st century (UN and UNCHS, 2010). However, in many developing countries like Nigeria, rural-urban migration is one of the major contributory factors responsible for urbanization that in the long run leads to urban expansion.

Lagos metropolis is characterized by decayed in basic amenities, and provision of public infrastructures for enhancing conviviality and healthy-living among its inhabitants (Jameson, 2003). As shown by Gandy (2006), Lagos metropolis in the last two decades has witnessed increased in the population growth, leading to shortage in the provision of basic services such as water, housing, and public transit for its growing population and extensive economic decline (Gandy, 2006). George (2010) associated the increasing spate of urbanization in Lagos metropolis to the degeneration in the state of the city, especially since the post-independence euphoria of the early 1960s, through the era of the 1990s when Lagos was regarded as one of the worst cities in the world, up to its present transitional state.

Studies have established that the major drivers of uncontrolled urban expansion; especially during the post-colonial periods in Lagos metropolis were as a result of inadequate coordination between employment opportunities and affordable housing for the teeming growing population (Ayeni, 1977). Lagos urban area provides accommodation to approximately 33% of the Lagos State population (Sunday and Ajewole 2006). As revealed by Adelekan (2009), Lagos experienced an influx of over 7 million people from 1990 to 2004. By 2010, the population is projected to surpass 20 million. According to City Mayors (2009), from 2006-2008, the annual projected growth rate stood at 4.44%, which had a ranking of the 7th fastest growing urban area in the world. Lagos metropolis has witnessed urban expansion as a result of conversion from rural to urban area accounts for approximately 75% of population growth of Lagos' metropolitan area (Sunday and Ajewole 2006). The study further showed that between 1986 and 2002, the developed area in Lagos Coastal Area increased by 13% (from 43% in 1986 to 56% in 2002), while swampland decreased by 11% and water area decreased by 3%.

There are not enough studies toward understanding the nature and trend of urban expansion and land cover changes in Kosofe LGA of Lagos Metropolis. In the same vein, there are numerous challenges associated with urbanization and urban expansion with its attendant effect on inadequate physical infrastructure to accommodate the population explosion, giving rise to insecurity and rising crime wave (Fekade, 2000). However, the challenges of urban expansion have persists in many Nigerian cities, partly because most of the earlier measures put in place are not designed within the peculiarity of the nature and trend of the urban expansion and land cover changes of a given city. Hence most of these measures could not find sustainable, inclusive and tailored-made solutions to the problems of urban expansion through understanding the nature and trend of urban expansion and land use changes in Lagos metropolis.

In addition, going with the geographic bearing of Lagos metropolis as increasing human population, epicenter of economic activities and commercial hub of the nation, Lagos metropolis has uncontrollably experienced urban expansion in recent times. This paper is a deliberate scholarly attempt to bridge the gap. Thus, this paper seeks to analyze nature and trend of urban expansion and land cover changes in Kosofe LGA of Lagos Metropolis with a view to provide sustainable metropolitan management.

METHODOLOGY

Data

The Landsat Imageries of the study area for 1995, 2000 and 2015 were collected from United State Geological Survey Agency (USGS) (Table 1). Lagos land use and land cover map (used as a guide together with Google Earth imagery in training the data and crosschecking the random reference points used for accuracy assessment). The Satellite imageries were imported into ArcGIS 10.3 environment. The images collected from USGS were layer stacked using the “composite band tool” in ArcGIS and merged as one image so as to have the information covered by bands in a single combine image of all bands (layer stacked). This process was repeated for all the images. Using the “mosaic to new raster tool” in ArcGIS, the image of the scene of 1995, 2000, and 2015 were then merged in to one mosaic image in order to overlap the edges of the images. A subset covering the area of interest was extracted from the larger mosaic scene of the three mosaic images using the “Clip tool” in ArcGIS prior to classification.

Table 1: Types and Sources of Data

Types of Data	Year of Acquisition	Sources of Data	Spatial Resolution
Landsat 7 ETM ⁺	1995, 2000	United State Geological Survey (USGS)	30m
Landsat 8 OLI	2015	”	”

Maximum likelihood Supervised classification technique was employed in classifying the images into various classes. This method is preferable because of having better knowledge about the study area for the classification of land use land cover of the study area. The nature and trend of land use land cover was based on bare ground, built-up areas, vegetation, and water body adapted from (Jensen, 2005).

Table 2: Land cover Classification Scheme

Classification of land use land cover	Measures of Variables
Built Up Area	Land covered by buildings and other man-made structures. Residential, industrial area mixed urban and built-up land
Bare Ground	Lands with exposed soil, rocks, sand and never have more than 10% vegetation. Bare ground, barely exposed rocks.
Vegetation	A land dominated by grasses, shrubs and trees.
Water Body	Lakes, reservoirs streams, rivers and swamps. The area covered by open water such as a river, waterlogged area.

Source: Jensen (2005)

Method

We examine the nature and trend of land cover changes from 1995, 2000 and 2015 with focus on built up areas as a proxy index to measure urban expansion. ArcGIS was used to process the images in order to determine land use land cover changes that have resulted from identified land cover classification in relation to bare ground, built-up areas, vegetation and water body was extracted

and calculated. The resulting values were converted into percentages and used as absolute data for the presentation of land use land cover changes and to also determine the rate of land use land cover changes in the area from 1995 and 2015. The land cover changes were calculated in hectares of the resulting land cover types for each study year and subsequently comparing the results. Furthermore, annual Rate of Change – percentage change divided by 100, multiplied by the number of study years expressed as % Change of Study years and the recode to extract built-up areas out of the remaining classes since is the primary focus of the paper and accuracy assessment was performed.

RESULTS AND DISCUSSION

Land use land cover classification for 1995

The paper shows the land use land cover for the year 1995 and reveals that there is less than 20% built up areas in the study area for the year 1995, while there is more than 70% significant change in the land use land cover for bare ground, vegetation and water body respectively (Figure 1 & 3).

This indicates that there is slow pace of urban expansion in the year 1995 in the study area. The major factors that could be responsible for the observed pattern could be associated with the relative low level of low population size, low urban residents that reduced the demand for housing and development of new urban settlements. This may also influence the observed pattern of the land use land cover of bare ground, vegetation and water body respectively which may be associated with the slow pace of urbanization in the study area for the year 1995. Other factor may be associated to the fact that Lagos State is an aquatic environment that featured large volume of water bodies and enhanced vegetal cover with relative slow pace of urban expansion.

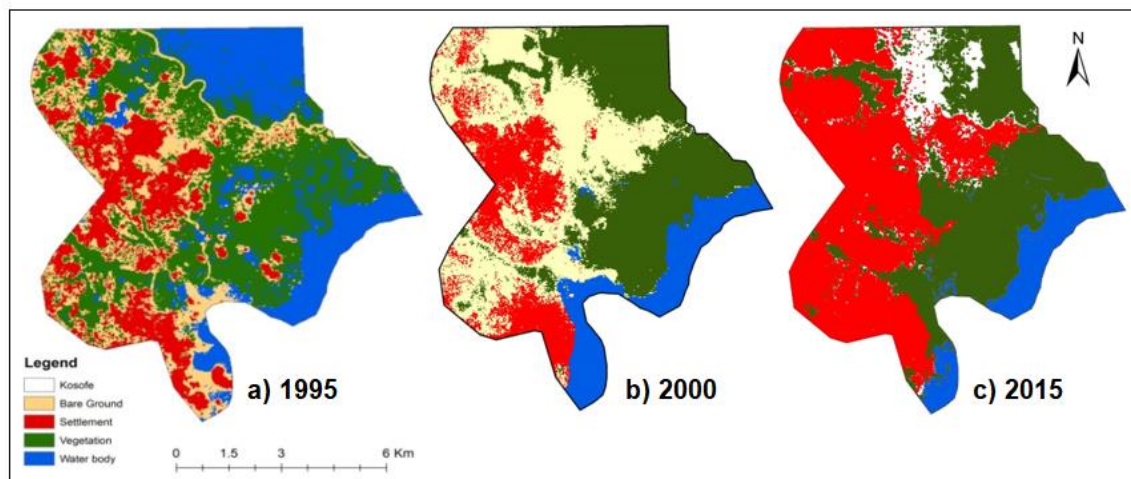


Figure 1: Land use land cover classification for the three years. Data is from Landsat 7 ETM⁺ and Landsat 8 OLI.

Land Use Land Cover for 2000

The paper shows the land use and land cover for the year 2000 and reveals that there is less than 20% built up areas in the study area for the year 2000, while there is more than 70% significant

change in the land use land cover for bare ground, vegetation and water body respectively (Figures 1b, 3). Between 1995 and 2000, there was 15% increase in bare ground and 12% decrease in water body. The 12% decrease in water body could be associated with different efforts in erecting structures on floodplain and reclamation of water body for dwellings and other physical infrastructure to accelerate residential development. This indicates that there is no appreciable urban expansion between 1995 and 2000. The factors that could be responsible for the observed pattern could be linked with the relatively low level of low population size, low urban residents that reduced the demand for housing and development of new urban settlements.

This present study agrees with Onilude and Vaz (2021) revealed that in 2000, forests grew by 7.09% from 2000 and 2010 in Lagos lagoon. The study further argued that the increased in forest resources in Lagos metropolis could be linked to deliberate efforts for planting of trees, development of parks and other ornamental plants. In the same vein, Lagos State Government Ministry of Environment (2020) associated increased to forest growth to planting of trees to address the ripple effects of global warming and enhance environmentally friendly urban environment. This present study agrees with Bariweni and Andrew (2017) found out that Wilbefore Island, Bayelsa is majorly dominated by forest and more than 80% of the areas are dominated by vegetation in 2002.

This study agrees with Onilude and Vaz (2021) where grassland with a covered area of 236.61km² (5.23%) in 2000 presented large reduction, i.e., to 41.52 km² (0.92%) in 2010, showing a loss of 4.31%. Additionally, shrub land, wetland, and water bodies showed reductions in the quantities of area that they covered. The decrease in water bodies concurs with the report of Obiefuna *et al*, (2013), that the reduction in water bodies could have occurred because of land filling of Lagos lagoon for residential development.

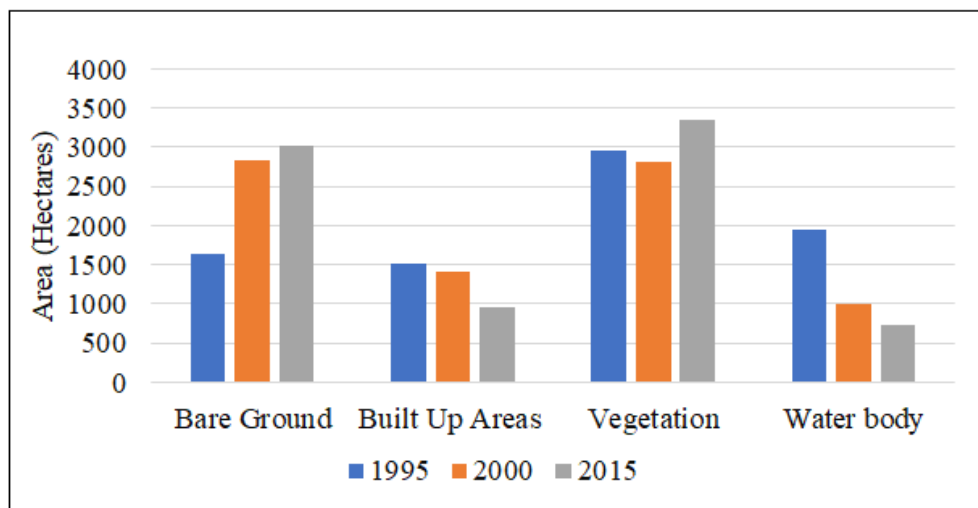


Figure 2: Land use land cover area coverage in hectares for the three years. Data is from Landsat 7 ETM⁺ and Landsat 8 OLI.

Land Use Land Use Land Cover for 2015

The paper reveals that the land use land cover for the year 2015 reveals that there is a more than 40% built up areas, while there is less than 60% significant change in the land use land cover for

bare ground, vegetation and water body respectively (Figures 1c, 3). At the aggregate level, from 1995 and 2015, there was more than 20% increase in built up areas from 1995, 2000 and 2015. In the same vein, between 2000 and 2015, there was 23% decrease in bare ground, and 3% decrease in water body and appreciable 24% increase in built up areas which could be linked to increasing population growth and urban expansion.

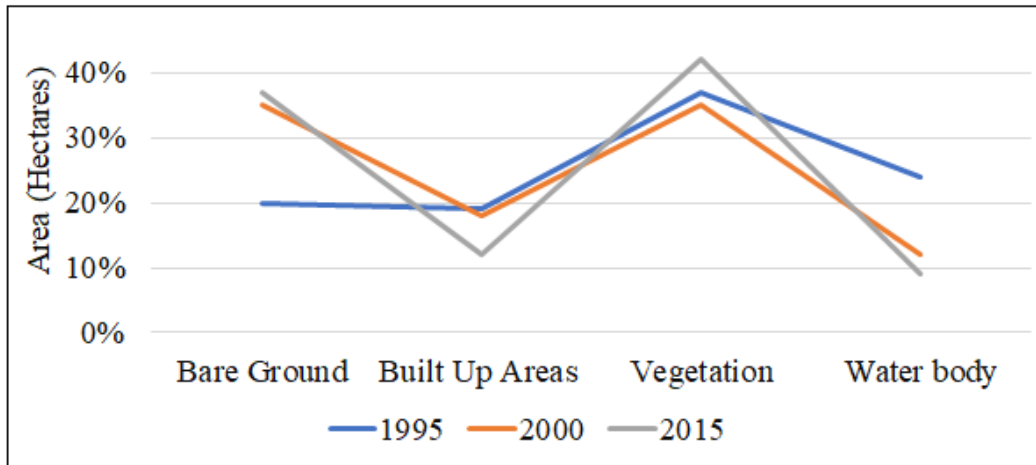


Figure 3: Land use land cover percentage (%) area coverage in hectares for the three years. Data is from Landsat 7 ETM⁺ and Landsat 8 OLI.

The factors that could be responsible for the observed pattern could be linked with the increasing population size due to natural increase, rural-urban migration that enhanced urbanization, appreciable increasing in demand for housing and other socio-economic activities may have contributed to the urban expansion in the study area. These factors necessitate the need for Kosofe LGA to accommodate the growing population by developing more residential settlements (urban expansion) to provide residential areas for the increasing human population. This assertion is supported by Onilude and Vaz (2021) that the major drivers responsible for urban expansion in Lagos State could be as a result of appreciable increase in the growing human population. This necessitated the development of housing, transit facilities, industrial areas, urban green space to provide habitable and livable environment for the growing population in Lagos metropolis.

This present study is also in line with Nwokoro and Dekolo (2012) that showed drastic 30% loss of vegetation and increase in built up areas from 31% to 48% in Lagos metropolis. The study further revealed 1.3% loss of water bodies as result of different measures of land reclamation in relation to sand filling of water fronts, swamps and the Lagos lagoon for housing development.

In the same vein, Braimoh and Onishi (2007) revealed that construction of residential development along the peri-urban areas of Lagos metropolis as a result of increasing demand for urban land and housing. The study further argued that construction of road network to open up infrastructural facilities encourages residential development and has multiplier effect on urban expansion and residential development in Lagos decreases with an increasing distance from the water bodies. In the same vein, Oriye (2013) revealed that urban expansion in Ekiti occurred most between 1996 and 2006 as a result of increasing population growth, political and socio-economic changes of the urban dwellers.

CONCLUSION

The paper shows that there is less than 20% built up areas in the study area for the year 1995, while there is more than 70% significant change in the land use land cover for bare ground, vegetation and water body respectively for the 1995. It can be concluded that there is a slow pace of urban expansion in the year 1995 in the study area. Furthermore, the paper shows that there is less than 20% built up areas in the study area for the year 2000, while there is more than 70% significant change in the land use land cover for bare ground, vegetation and water body respectively. Between 1995 and 2000, there was 15% increase in bare ground and 12% decrease in water body. It can be concluded that decrease in water body could be associated with different efforts in erecting structures on floodplain and sand filling of water body for dwellings as a result of increasing human population. In the same vein, it can be concluded that there is a stable urban expansion from 1995 and 2000.

The paper further reveals that in 2015, there is more than 40% built up areas, while there is less than 60% significant change in the land use land cover for bare ground, vegetation and water body respectively for the year 2015. There was more than 20% increase in built up areas from 1995, 2000 and 2015. In the same vein, between 2000 and 2015, there was 23% decrease in bare ground, and 3% decrease in water body and 24% increase in built up areas which could be linked to population growth and urban expansion. Furthermore, there is an appreciable decrease in water body, bare ground, vegetation and appreciable increase in built up areas. It can also be concluded that increasing population size as a result of natural increase and rural-urban migration, infrastructural development projects, varied socio-economic and commercial activities may leads to appreciable increasing demand for residential development to provide housing needs for the growing population in Lagos State, this may thereby lead to urban expansion in the study area.

Based on the finding, the paper recommends the following in enhancing sustainable urban development. There should be urban governance framework for infrastructural development such as drainage, road network, health care facilities and other social amenities to support the growing population. There should be development control and land use zoning to monitor varied socio-economic activities in the study area. This will thereby reduce overpressure on the available infrastructural facilities among the inhabitants.

Furthermore, there should be massive investment in pro-poor mass housing scheme and employment opportunities to cater for the growing population, especially among the urban poor. This will reduce the growth of informal settlements among the poor urban dwellers that may not be able to afford expensive lifestyle at the city-centre. In the same vein, there should be proper monitoring and control of urban growth and expansion through the application of geospatial tools for adequate planning and infrastructural development for the observed pattern of urban expansion. Deliberate efforts should be made to develop fringes with needed infrastructural facilities and be incorporated into the mainstream urban centres. This will help to de-congest the city-centre and open up development at the adjoining urban fringes.

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