Post-millennial Urbanisation Dynamics of the Traditional Inner City Core of Ibadan

Bamiji Michael Adeleye. [1], Hangwelani Hope Magidimisha-Chipungu. [2], Lovemore Chipungu. [2], Chukwudi Bernhard Ohadugha. [1], Hassan Shuaibu Liman.[3], and Ayobami Abayomi Popoola.[2]
[1] Department of Urban and Regional Planning, Federal University of Technology Minna, Nigeria
[2] SARChI Chair for Inclusive Cities, University of KwaZulu-Natal, South Africa
[3] Department of Property, University of Auckland, Auckland, New Zealand
Corresponding Email: Ayobami.popoola@yahoo.com

DOI: https://dx.doi.org/10.4314/sajg.v14i2.5

Abstract

The rate of urbanisation has been fast-tracked by post-millennial occurrences within traditional cities. In understanding urbanisation trends in cities in Africa, such as Ibadan, limited evidence and study have documented the post-millennial changes in the organic and traditional inner city landscapes. Despite the unplanned and uncoordinated urbanisation that is characterised by the influx of people into the inner city core of Ibadan, knowledge in respect of the spatial growth of the inner city local government areas (LGAs) is lacking. The aim of this study was to analyse the form, trends and intensity of urban expansion in the traditional inner city core of Ibadan between the years 2000 and 2020. To attain the aim of this study, three sets of satellite imageries (the Enhanced Thematic Mapper for 2000 and the operational Land Imagers for 2013 and 2020) were subjected to a maximum likelihood supervised classification. The study revealed that four types of urban expansion intensity (highly rapid, rapid, moderate, and very low) were identified as the areas of expansion in the built-up environment −from 6603.12ha to 10287.54ha. The study also revealed that for the period, 2000 - 2013, all the local government areas within the core of Ibadan experienced edge expansion, while leapfrogging was identified in two) local government areas, namely, Ibadan North and Ibadan Northeast, and edge expansion in three, namely, Ibadan Southwest, Ibadan Southeast, and Ibadan Northeast for the period, 2013 - 2020. The study further revealed varying urban densification areas within the local government areas in the core of Ibadan, where the urban intensity and expansion types were being influenced by the urban densities recorded in each local government area in the Ibadan core. This study concluded that swift urban planning is required to address the urban sprawl at the edge of each of the inner city LGAs of Ibadan.

Keywords: *Ibadan, Inner City, Traditional City, Urban Densification, Urban Growth and Expansion*

1. Introduction

The increased size and the evolving dynamics of cities across the globe have been attributed to unprecedented urbanisation (United Nations Human Settlements Programme, 2009; Zeng, Deng, Dong, & Hu, 2016; Das and Das, 2019; Chatterjee and Chattopadhyay, 2020; Wang et al., 2020). Studies (UN-Habitat, 2009; United Nation, 2015; Dasgupta, Raven, & McIvor, 2019) further envisaged that about 10 million new megacities and 20 million populated hyper-cities would emerge by the year 2050. With an estimated 37.2 million residents (Agarwal, Ruchi, & Choudhary, 2021), the United Nations states that by 2028, the Indian capital, New Delhi, is projected to become the most populous city on the planet. This is in addition to Tokyo (37 million), Shanghai (26 million), Mexico City (22 million) and São Paulo (22 million) inhabitants. Popoola *et al*. (2020) indicate that city urbanisation and growth is expected to increase exponentially. This is buttressed by the United Nations' (2019) forecast that 68 percent (a 13% increase from the report of 55 % of the world's population currently residing in urban areas will occupy urban areas by the year 2050. These new growth trends are expected to occur in the cities of developing countries (United Nations, 2014; Wahab & Popoola, 2019; Das & Das, 2019; Castells-Quintana & Wenban-Smith, 2020; Kookana, Drechsel, Jamwal, & Vanderzalm., 2020). This implies that natural spaces would be converted into built-up areas for residential, circulation, industrial, and commercial land uses (Xie, Huang, Claramunt, & Chandramouli, 2005). It is worth noting that the conversion of land and its numerous types of land cover into various land use types tends to change the urban landscape of a region (Folorunsho, Balogun, Adediji, Olumide, & Abdulkareem, 2017).

Evidence of the increasing population over the millennial era is more common in traditional cities and inner city cores. Van Noorloos and Kloosterboer (2017) wrote that the urban growth dimension across Africa is marked by the emergence of new cities, towns, and estates − planned and unplanned − emerging along city peripheries, and also, the urban evolution of city centres, characterised by upgrades, renewal and land-use conversions. The argument has been that while the trajectory of millennial city development shows the growth of cities in peri-urban areas (Lasisi. Popoola, Adediji, Adedeji, & Babalola, 2017; Adeleye, Ayangbile, Popoola, & Ndana., 2018), the increasing densification of traditional core and inner cities cannot be ignored. In fact, the Hirohara, Alden, and Cassim (1988) study expresses the pre-historic evolution of the inner city across central cities along Western metropolitan regions across the globe.

In their study, Hirohara *et al*. (1988) showed that, as experienced in Japan, the dynamics of these city inner spaces were posing global planning problems, even as far back as that decade. This phenomenon, also currently applicable, is further complicated by land-centred urbanisation (Lin, 2007), resulting from rural-urban migration, rural land abandonment and loss, and urban land financing. Godfrey and Julien (2005) further posited that the 21st century

would be characterised by various social and physical structures, all within a few kilometres of one another. These components would include, amongst others, inner city regeneration projects, which would often lead to exclusive housing beyond the reach of all but the very privileged.

In China, Shin (2014), reported that current major mega-cities, such as Beijing and Shanghai, are subjected to the redevelopment of their inner city cores as part of their attempt to use space more efficiently and maximally, and to transform the cities into 'world cities'. This redevelopment process involves the attraction of specific types of urbanites (highly skilled professionals) and the displacement of low-skilled workers and low-end service industries. It has been recorded that the urbanisation of the inner regions of China is taking place − away from the coastal areas of the country.

Despite that undoubted positive and negative effects and evidence of inner city regeneration and re-urbanisation across the globe, there still exist a gap in knowledge − and the lack of indisputable evidence − in respect of continued factors driving inner city densification and urbanisation (Firman, Kombaitan, & Pradono, 2007; Seo, 2002; Shin, 2014). Although, studies have attributed urban inner city growth to population growth, economic growth, industrialisation, the characteristics of the environment, the level of transportation, the demand for more living space, and the physical and geographical properties of the concept, "location" (Bhatta, 2010; Abdullahi, Pradhan, & Al-sharif, 2017). All these factors have also influenced the growth of the core of Ibadan and the surrounding peri-urban areas (Ido, Akinyele, Lagelu, Egbeda, Ona-Ara, and Oluyole) of Ibadan (Adelekan *et al*., 2014). In recent times, the core of Ibadan has experienced rapid growth from economic migration (Wahab, Popoola, & Magidimisha, 2018; Wahab & Popoola, 2019; Alabi, Babalola, & Popoola, 2021). This has translated into an increase in land cover conversions for physical development. This phenomenon has brought significant changes to the landscape and to the pattern of urban growth in the city's inner core (Fabeku *et al*., 2018).

To monitor the changes that have occurred in the various types of land cover in the Ibadan core, previous studies (Oladele & Oladimeji, 2011; Agbola, Kasim, & Coker, 2014; Anibaba, Durowoju, & Adedeji, 2019) have effectively analysed the spatial-temporal changes in the land cover (for change detection) of the Ibadan core and made projections concerning the future trends to be expected in the land cover. However, the study on change detection in urban areas has recently shifted from mere detection, to the measurement of the speed of change, the patterns of urban expansion, and the quantification of urban change (Al-sharif, Pradhan, & Abdullahi, 2017). While there are numerous studies on urban growth in Ibadan (Oluseyi, 2006; Oladele & Oladimeji, 2011) (in the context of all the eleven LGAs), few have considered the urban dynamics and evolution of the Ibadan core (five urban core LGAs) (Abiodun & Bayode,

2014), with limited focus on the urban dynamics of the new millennium. The argument that this paper supports considers both the organic and traditional inner city LGAs of Ibadan.

Fragkias *et al*. (2013:409) iterate that for the period 2000 - 2030, the percentage increase in global urban land cover will be over 200%, whereas the global urban population will only grow by a little over 70%. The conditions accounting for this phenomenon include the expansion and impact of the sociopolitical and mobility service spheres, *in-situ* and mega urbanisation trends, city governance changes, and the rural depopulation and urban demographic change that characterised the year, 2000 (Firman, Kombaitan, & Pradono, 2007; McGranahan & Satterthwaite, 2014; Firman, 2017; Mortoha & Yigitcanlar, 2022). Thus, Seto, Guneralp, and Hutyra (2012) alluded to the relevance of the year 2000 in the context of global urbanisation. Against this background, this study, through spatio-temporal change and pattern analysis following the application of remote sensing procedures and geographic information systems, the study investigates the dynamics of urban expansion in the inner city core of Ibadan for the period 2000 - 2020. The specific objectives were (1) to analyse the trend of urban expansion and densification in the core of Ibadan between the years 2000 and 2020, and (2) to determine the intensity and types of urban expansion in the inner city core of Ibadan for the same period.

2. The Study Area

The core of Ibadan consists of five local government areas (Ibadan North, Ibadan Northeast, Ibadan Northwest, Ibadan Southeast, and Ibadan Southwest), together totalling a land area of 135.95Km^2. The inner city of Ibadan is located within latitudes 7º 20′N and 7º 30′N of the equator and longitudes 3º 45′E and 4º 00′E of the Greenwich Meridian (See figure 1). Since the oil boom of Nigeria in the 1970s, the core of Ibadan has grown significantly in both population and in physical size (Adelekan *et al*., 2014). The upsurge in these two aspects has turned the core of Ibadan into a large sprawling urban area with no definite pattern of growth (Adelekan *et al*., 2014). According to the 2006 population census, the inner city core of Ibadan had a population of 1,338,659 at that time (National Population Commission, 2006). In fact, it is often referred to as the largest indigenous metropolitan area in sub-Saharan Africa. Its unplanned growth is reported to have initiated the inception of the core in 1829 (Onibokun & Kumuyi, 1999). Transport development (railway tracks and road expansion), and the establishment of education and research institutes have influenced the growth of the core of Ibadan (Adelekan *et al*., 2014).

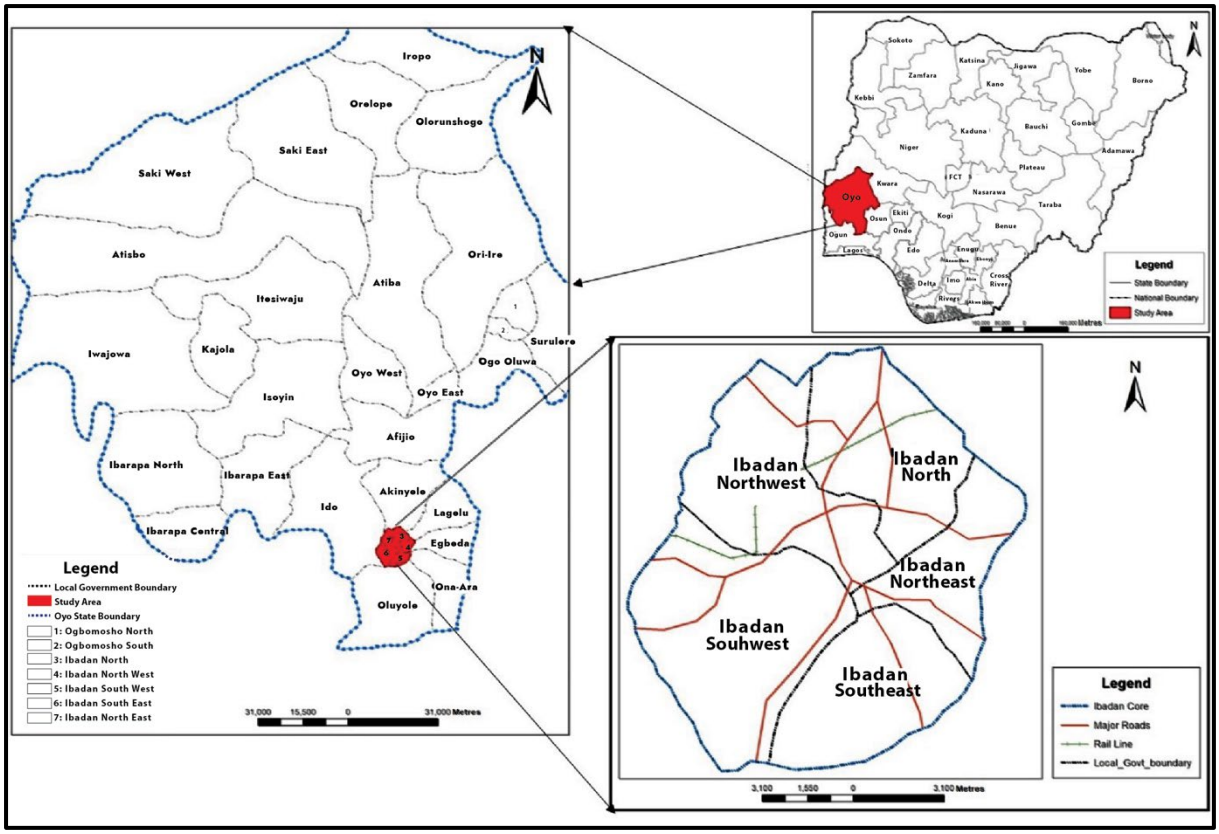

Figure 1: Ibadan Core and its Peri-urban Area

3. Research Methodology and Data

Based on their availability, three different sets of Landsat satellite imageries (ETM 7 for 2000, OLI for 2013 and 2020) were used for this study. The imageries used were the Enhanced Thematic Mapper for the year 2000 (Landsat 7) and the Operational Land Imagers (Landsat 8) for the years 2013 and 2020 (Table 1). Each of these imageries was clipped to the area of interest (the Ibadan core) (Figure 2). The 10-year average irregularity apparent in the 2010 image was due to cloud cover. All satellite imageries used in this study were cloud-free.

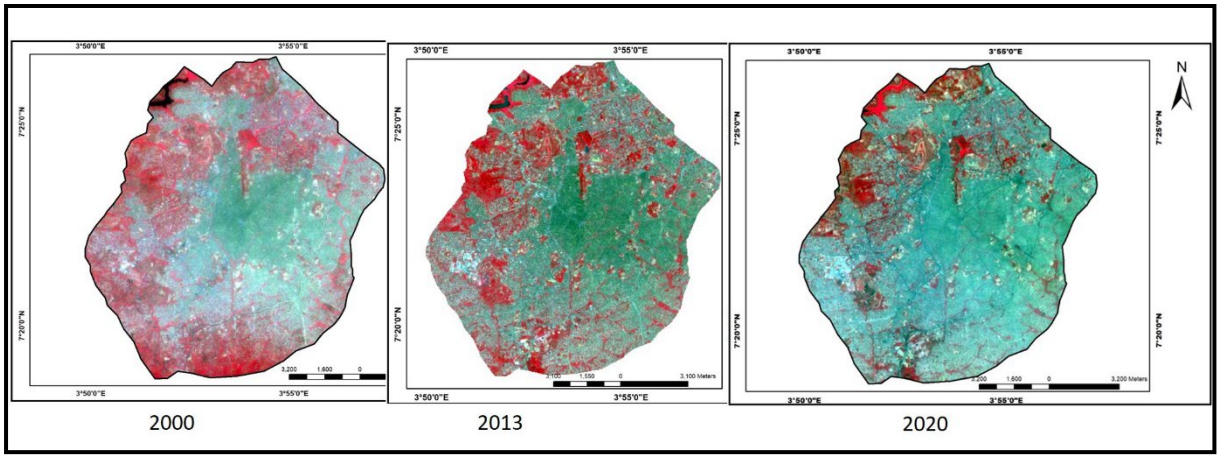

Figure 2: False Colour Composites for the Core of Ibadan in 2000, 2013, and 2020, respectively

(Source: United States Geological Survey, 2020)

Since the Landsat imageries come in multispectral bands, false colour was formed using multispectral bands suitable for urban studies in the respective years under study. Bands 4,3,2 and 5,4,3 were combined to form the false colour composite for the Landsat Enhanced Thematic Mapper for the year 2000 and the Operational Land Imagers (2013 and 2020), respectively. (Both the bands 4, 3, 2 and the false colour composite bands 5,4,3 proved to be suitable for urban studies.)

Table 1: Properties of the Imageries

Programme	Sensor	Year	Path and Row	Resolution	Date Acquired
Landsat 7	Enhanced Thematic Mapper (ETM)	2000	P191/R055	30M	06/02/2000
Landsat 8	Operational Land Imager (OLI)	2013	P191/R055	30M	05/03/2013
Landsat 8	Operational Land Imager (OLI)	2020	P191/R055	30M	05/02/2020

(Source: United States Geological Survey, 2020)

On these bands, vegetation appears in shades of red, waterbodies appear in blue, and built-up areas in cyan. Four different sample sets were created on the three false colour composite bands combined for the understudy for each of the years. The four sample sets created for this study included built-up areas, undisturbed vegetation, waterbodies, and disturbed vegetation. These sample sets were subjected to a maximum likelihood supervised classification on ARCGIS 10.2 software. The sample sets created are described in Table 2.

Table 2: Description of the Sample Sets created for the core of Ibadan

Sample Set	Description of Sample Set
Built-up Area	Land used for residential purposes, roads, institutions, and other impervious surfaces
Undisturbed Vegetation	Land covered by trees with dense canopies, grass, and shrub-dominated areas
Waterbody	Land covered by water
Disturbed Vegetation	Cultivated lands, burnt areas, and degraded areas

The annual average rate of change for this study was calculated using a Shifaw *et al*. (2020) mathematical model for the intensity index for the category of urban expansion, which is expressed as $[A_2 – A_1/ A_1]*1/N*100$, where; A_1 represents the urban areas at the beginning of

a period, A_2 represents the urban areas at the end of an epoch, and N represents the number of years for the period, $A_2 - A_1$.

The annual average urban expansion intensity index (UEII) for the core of Ibadan was calculated by dividing the urban expansion intensity index into five indices. These indices are very low [< 0.1], low [0.1 – 0.2], moderate [0.2 – 0.4], rapid [0.4 – 0.7] and highly rapid [≥ 0.7] (Qiuying *et al*., 2015). A mathematical model adopted from Shifaw *et al*. (2018) was used to compute the annual average urban expansion intensity index of the core of Ibadan. This model was expressed as $[A_2 - A_1/N]*100/TA$, where A_2 represents the urban areas at the end of the period; A_1 represents the urban areas at the beginning of the period,;N represents the number of years for the period, A_2 and A_1, and TA represents the total land area.

The urban expansion types are generally classified into three classes, namely, leapfrogging, edge expansion, and infilling (Bhatta, 2010; Yu & Zhou, 2017; Shifaw *et al*., 2018). To determine the forms of urban expansion in the core of Ibadan, these three classes (leapfrog, edge expansion, and infilling) were used with indices of 0, representing leapfrogging, 0 <, ≤ 0.5, representing edge expansion, and 0.5 <, ≤ 1, representing infilling (Yu & Zhou, 2017). These indices were calculated using the Yu and Zhou (2017) equation for urban expansion type, which is expressed as Lc/Pn, where Lc represents the length of the common boundary between the newly expanded urban patches and the existing urban patches and Pn represents the newly developed patches.

The population figures for the understudies for the relevant years were determined by projecting the 1991 population census figures for the local government areas within the core of Ibadan to the year 2000. At the same time, the 2006 population census figures for the local government areas that constitute the core of Ibadan were projected to the years 2013 and 2020, respectively. The exponential population projection formula was used to compute the projected figures. The exponential projection formula is expressed as:

$$\mathrm{PT} = \mathrm{Po}\left(1 + \frac{r}{100}\right)^{n}$$

where Pt and Po are the estimated population numbers and the base year population numbers, respectively, r represents the annual growth rate, while n stands for the difference in the time lag between the present population and that for the target year. The projected figures and the growth rates used are presented in Table 3. The methodology flow chart for the study is presented in Figure 3.

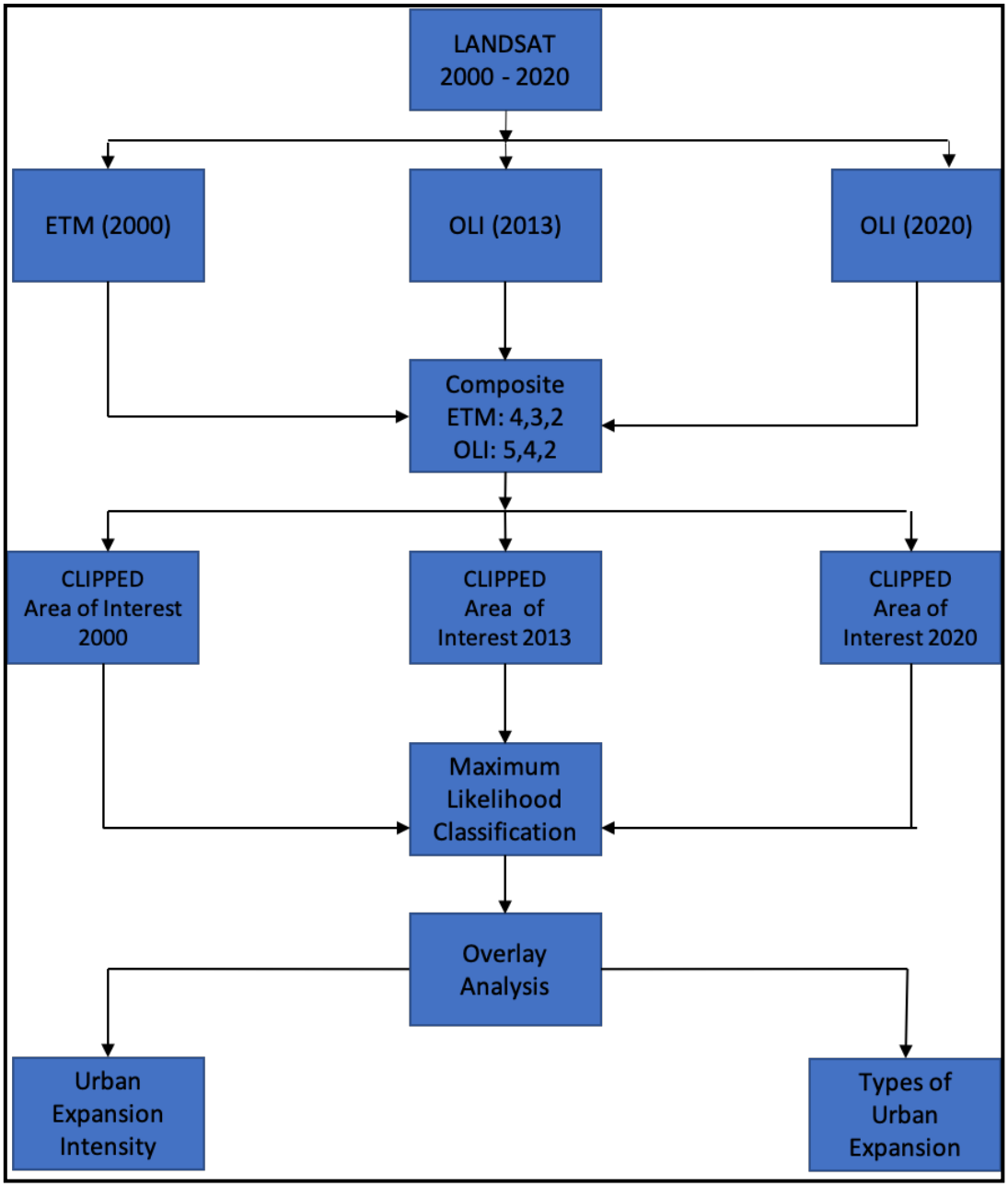

Figure 3: A Flow chart of the Methodology

Table 3: Projected Population Figures for the Ibadan Core for the period 2000 − 2020

	LGA (Urban)				
Population Change	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
2000	305,293	308,702	150,876	250,638	261,104
2013	309,862	360,135	154,362	289,990	316,495
2020	311,090	396,478	157,419	313,934	353,231
Growth Rate (%)	0.1	1.3	0.2	1.2	1.6

* The population for the year 2000 was projected from the 1991 population census, while the respective populations for the years 2013 and 2020, were projected from the 2006 population census.

4. Findings and Discussion

4.1. The trend of Urban Expansion in the Core of Ibadan between the year 2000 and the year 2020

The three sets of imageries classified (2000, 2013, and 2020) depict the urban expansion of the core of Ibadan from 2000 - 2020. The colour red was used to represent the built-up areas; the colour green, undisturbed vegetation, while the colours blue and yellow were used to represent waterbodies and disturbed vegetation, respectively. The classified imageries of 2000, 2013, and 2020 are shown in Figures 4 to 6.

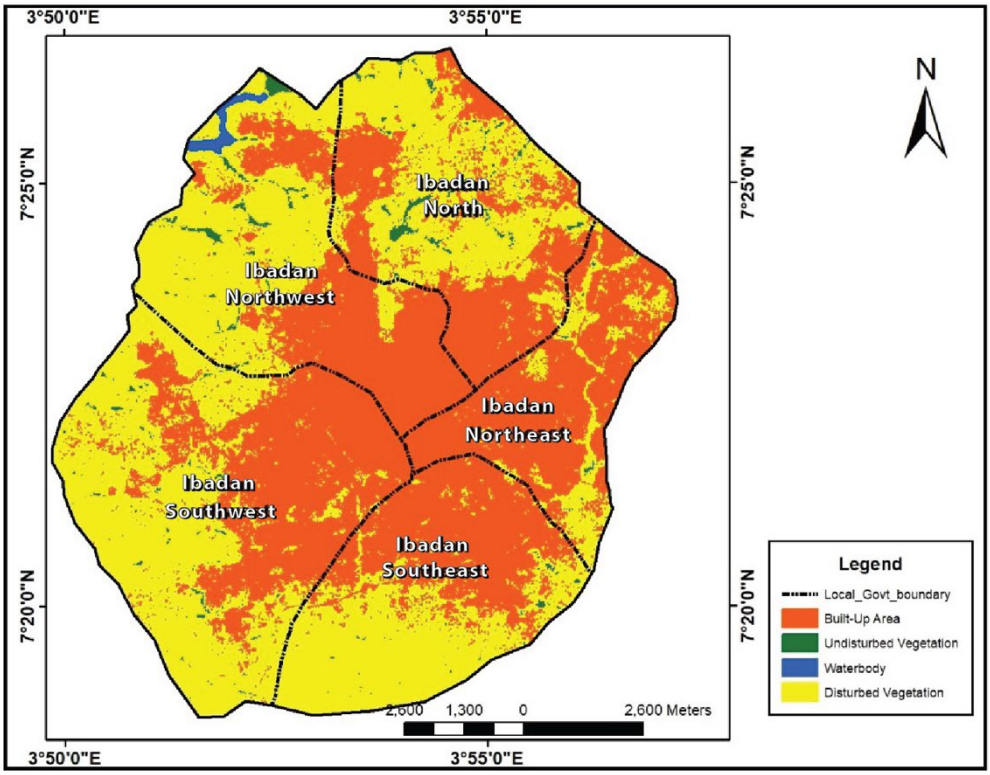

Figure 4: Classified Imagery of the Core of Ibadan in 2000

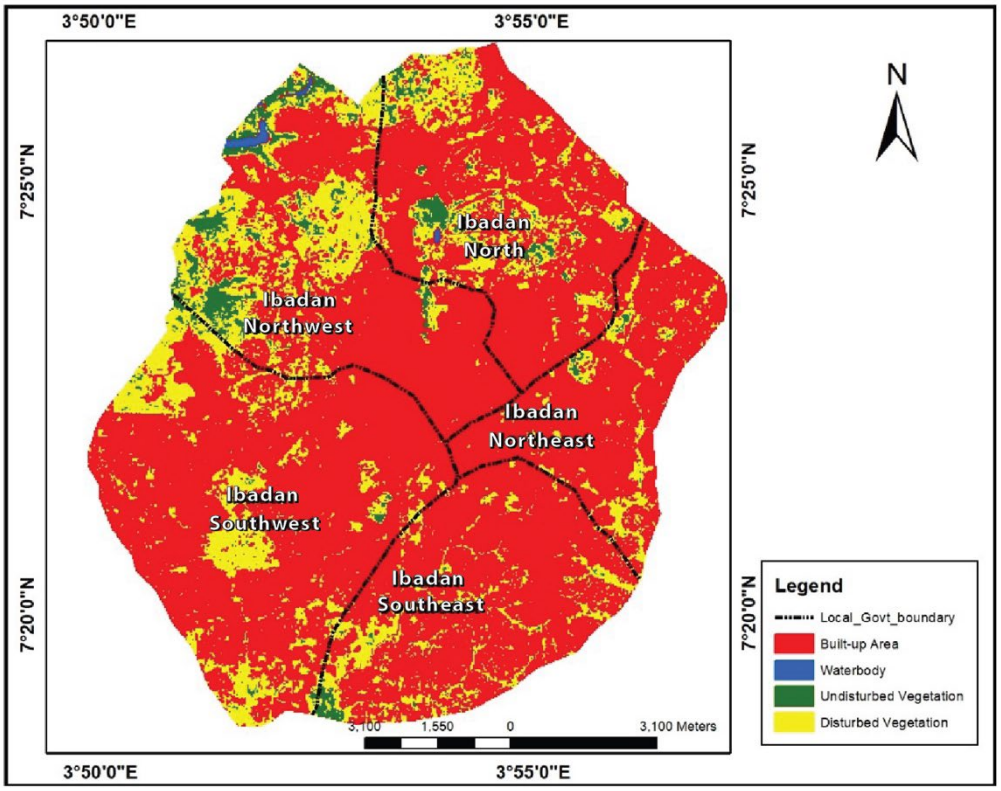

Figure 5: Classified Imagery of the Core of Ibadan in 2013

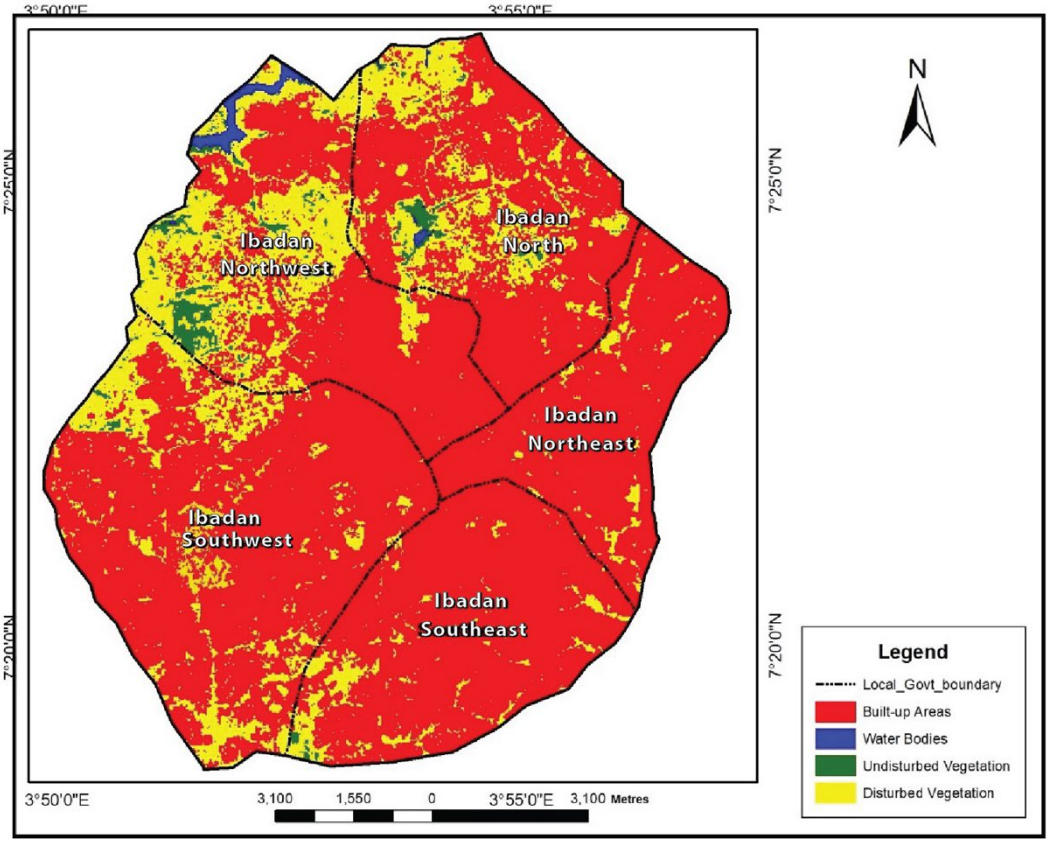

Figure 6: Classified Imagery of the Core of Ibadan in 2020

Table 4: Land Cover Types for the Core of Ibadan in the Year 2000

	Year 2000					
Sample Set	Ibadan North (Ha.)	Ibadan Northeast (Ha.)	Ibadan Northwest (Ha.)	Ibadan Southeast (Ha.)	Ibadan Southwest (Ha.)	Grand Total (Ha.)
Built-up area	1136.16	1330.92	1186.83	1169.91	1779.3	6603.12
Water body	-	-	54.63	-	-	54.63
Undisturbed vegetation	65.16	6.93	67.41	9.99	31.95	181.44
Disturbed vegetation	1430.1	342.27	1547.73	1236.6	2197.62	6754.32
Total	2631.42	1680.12	2856.60	2416.50	4008.87	13,593.51

According to Table 4, built-up areas in the core of Ibadan covered a total land area of 6603.12ha in the year 2000. In the same year, waterbodies and undisturbed vegetation covered a total land area of 54.63ha and 181.44ha, respectively, while disturbed vegetation occupied a total land area of 6754.32. Table 4 further reveals that the disturbed vegetation cover was more prevalent across the five local government areas of the core of Ibadan than for the undisturbed vegetation cover. This could be attributed to the anthropogenic activities in these areas.

Table 5: Land Cover Types for the Core of Ibadan in the Year 2013

	Year 2013					
Sample Set	Ibadan North (Ha.)	Ibadan Northeast (Ha.)	Ibadan Northwest (Ha.)	Ibadan Southeast (Ha.)	Ibadan Southwest (Ha.)	Grand Total (Ha.)
Built-up area	1890.90	1451.7	1732.68	1994.22	3218.04	10287.54
Water body	2.97	-	25.65	-	-	28.62
Undisturbed vegetation	124.65	15.03	269.73	32.22	36.99	478.62
Disturbed vegetation	612.90	213.39	828.54	390.06	753.84	2798.73
Total	2631.42	1680.12	2856.60	2416.50	4008.87	13,593.51

The significant increase in built-up areas for all the local government areas within the core of Ibadan in 2013 is evident from Table 5. A total of 10287.54 ha was recorded for the built-up areas at this time (2013). The decline of 28.62 ha in waterbodies recorded in the core of Ibadan in 2013 as against that of 54.63ha, as recorded in 2000, − is significant. This decline in the land areas covered by water can be attributed to the increase in anthropogenic activities, such as farming and wetland developments around the waterbodies. A decline in vegetation cover was recorded in 2013, which also indicates an increase in anthropogenic activities. Totals of 478.62ha and 2798.73ha were recorded for the land areas of undisturbed vegetation and disturbed vegetation, respectively, for the year 2013.

Table 6: Land Cover Types for the Core of Ibadan in the Year 2020

	Year 2020					
Sample Set	Ibadan North (Ha.)	Ibadan Northeast (Ha.)	Ibadan Northwest (Ha.)	Ibadan Southeast (Ha.)	Ibadan Southwest (Ha.)	Grand Total (Ha)
Built-up area	1958.44	1584.90	1754.34	2190.42	3460.43	10948.43
Water body	11.79	-	72.18	-	0.09	84.06
Undisturbed vegetation	63.45	0.81	148.86	9.0	17.10	239.22
Disturbed vegetation	597.74	94.41	881.22	217.08	531.25	2321.70
Total	2631.42	1680.12	2856.60	2416.50	4008.87	13,593.51

The built-up areas in the core of Ibadan continued to increase, to ultimately result in a total area of 10948.43ha in the year 2020 as against the 10287.54ha that was recorded in the year 2013 (Table 6). The increase in built-up areas can be attributed to an increase in physical developments, such as road construction, and an increase in other impervious surfaces undertaken by the government of Oyo State over the period 2013-2017 (Udodiong, 2017). Within this period (2013 - 2020), a decline was recorded in the size of the respective areas occupied by waterbodies and covered by vegetation (Table 6). The area of waterbodies in the core of Ibadan increased from 28.62ha to 84.06ha, while the area under vegetation (both undisturbed and disturbed) decreased from 3277.35ha to 2560.92ha. These aspects can be attributed to the increase in anthropogenic activities in all the local government areas in the core (Table 6).

4.2. Intensity and Types of Urban Expansion in the Core of Ibadan between the Year 2000 and the Year 2020

Table 7: Rate of Urban Expansion and its Intensity in the Core of Ibadan for the period 2000 - 2013

Period 2000 – 2013					
Local Government Areas in the Core of Ibadan	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
Annual Average Rate of Change (%)	5.11	0.70	3.54	5.42	6.22
Urban Expansion Intensity Index (UEII)	0.41	0.07	0.29	0.44	0.77
Category of UEII	Rapid	Very low	Moderate	Rapid	Highly rapid

The intensity of urban expansion in the core of Ibadan between 2000 and 2013 revealed that Ibadan North and Ibadan Southeast experienced intensely rapid urban expansion, with an annual average rate of change of 5.11% and 5.42%, respectively (Table 7). A very low urban expansion intensity index was recorded in Ibadan Northeast, with an annual average change of

0.70%. The very low intensity index of urban expansion in this local government area is attributed to the lack of available space for physical development within the local government area (Figures 4 and 5). Within this period (2000-2013), a moderate urban expansion intensity index was recorded in Ibadan Northwest, with an annual average rate of change of 3.54%. Moderate urbanisation in this local government area of Ibadan can be attributed to infilling urbanisation, up-and-coming new sites, and the emergence of estates and commercial activities (Agunbiade, Rajabifard, & Bennett, 2012; Lamond *et al*., 2015). Ibadan Southwest presented with the highest average annual rate of growth of 6.22% during this epoch. Also, a highly rapid urban expansion intensity index was recorded in this local government area which stands in contrast to those of the other local government areas in the core of Ibadan (Table 7).

Table 8: Rate of Urban Change and Expansion Intensity in the Core of Ibadan (2013-2020)

Period 2013-2020					
Local Government Areas in the Core of Ibadan	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
Annual Average Rate of Change (%)	0.51	1.31	0.18	1.41	1.08
Urban Expansion Intensity Index (UEII)	0.07	0.13	0.02	0.20	0.25
Category of UEII	Very low	Low	Very low	Moderate	Moderate

Owing to the unavailability of space for physical development in the core of Ibadan, changes were noticed in the urban expansion intensity index between the years 2013 and 2020. Within this period, Ibadan Southeast and Ibadan Southwest presented with moderate urban expansion intensity indices, and with annual average rates of change of 1.41% and 1.08%, respectively (Table 8). Very low urban expansion intensity indices were recorded in Ibadan North and Ibadan Northwest, with annual average rates of change of 0.51% and 0.18%, respectively. An annual average rate of change of 1.31% was recorded in Ibadan Northeast, with a low urban expansion intensity index (Table 8).

Table 9: Types of Urban Expansion in the Core of Ibadan for the Period 2000-2013

Period 2000-2013					
Local Government Areas in the Core of Ibadan	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
Indices	0.4	0.1	0.3	0.4	0.5
Urban Expansion Types	edge expansion	edge expansion	edge expansion	edge expansion	edge expansion

The scarcity of and pressure on land for physical development in the Ibadan core LGAs have forced physical developers to carry out their developments on the edges boundaries of the respective LGAs. This phenomenon is responsible for the edge expansion of all the LGAs within the core of Ibadan for the period 2000-2013 (Table 9). The edge expansion of each of

these local government areas within this period can also be explained in terms of the overlay map of the study area (Figure 6) which shows urban sprawl at the edge of each local government area.

Table 10: Types of Urban Expansion in the Core of Ibadan for the Period 2013 - 2020

Period 2013 - 2020					
Local Government Area in the Core of Ibadan	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
Indices	0.0	0.1	0.0	0.1	0.1
Urban Expansion Types	leapfrog	edge expansion	leapfrog	edge expansion	edge expansion

However, the narrative of the dynamics of the core of Ibadan changed a little between the years 2013 and 2020 (Table 10). Ibadan North and Ibadan Northwest both experienced a leapfrogging type of growth, while other local government areas (Ibadan Northeast, Ibadan Southeast and Ibadan Southwest) experienced edge/boundary growth. The overlay of the three epochs in respect of the core of Ibadan further explains the dynamics of urban expansion in the 20-year period of this study (See Figure 7). The dominating edge expansion and leapfrogging in the core of Ibadan are indications that the core is experiencing urban sprawl. This result affirms the findings of He, He, Song, Wu, Yin and Mou, (2018); Horn and Van Eeden (2018); and Shukla and Jain (2019) that edge expansion leapfrogging (outlying) is associated with urban sprawl.

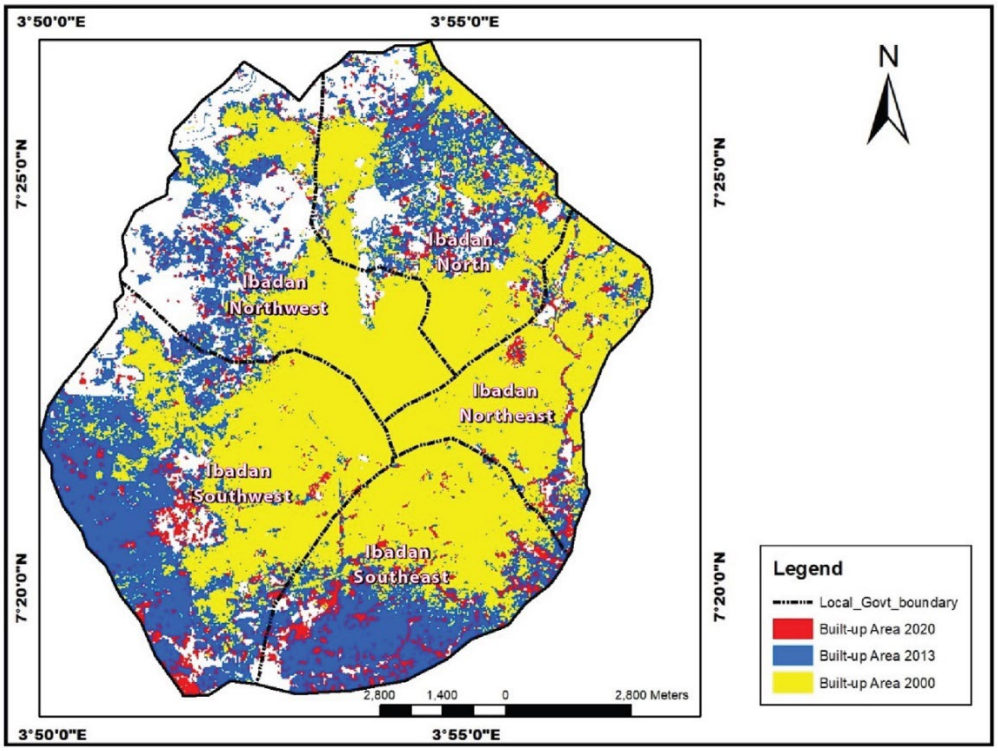

Figure 7: The Overlay of the Three Epochs under Study

4.3. Urban Land Densification in the Core of Ibadan between the Year 2000 and the Year 2020

Table 11: Percentage Population Increase for the Period 2000 - 2020

	LGA (Urban)				
	Ibadan North	Ibadan Northeast	Ibadan Northwest	Ibadan Southeast	Ibadan Southwest
2000	305,293	308,702	150,876	250,638	261,104
2013	309,862	360,135	154,362	289,990	316,495
2020	311,090	396,478	157,419	313,934	353,231
% increase between 2000 and 2013	1.5	16.66	2.31	15.70	21.21
% increase between 2013 and 2020	0.40	10.09	1.98	8.26	11.61

The population dynamics and percentage increase in the core of Ibadan for the period 2000 -2020 are presented in Table 9. A progressive increase in the population growth of the local government areas within the core of Ibadan was noticed for the 20-year period of this study (Table 11). For the period, 2000 -2013, the population of Ibadan North increased by 1.5%. Ibadan Northeast, which is often referred to as Ibadan Central (NPC, 2006), experienced a population increase of 16.66%, which is the second-highest percentage increase for the period 2000 - 2013. Within this period (2000 – 2013), a 2.31 and 15.70 % population increase was recorded for Ibadan Northwest and Ibadan Southeast, respectively. The highest population increase for the period 2000 - 2013 was recorded in Ibadan Southwest (21.21%). A slight decline (owing to urban “push” and “pull“factors was noticed in the percentage of population increase in the local government areas within the Ibadan core between 2013 and 2020 as compared to the percentage of population increase recorded within the Ibadan core between 2000 and 2013 (Table 11). The studies of Adams *et al*. (2024) and Adelekan (2016) reported on the urban sprawl of the city area and the peri-urbanisation of the bordering rural LGAs (Akinyele, Egbeda, Ido and Oluyole) during this period. Ibadan Southwest also recorded the highest population increase (11.61%) for the period 2013 - 2020. Ibadan Northeast (Ibadan Central) also recorded the second-highest rate of population increase (10.09%) amidst the other local government areas of the Ibadan core for the period 2013 - 2020. Population increases of 1.98% and 8.26% were recorded for Ibadan Northwest and Ibadan Southeast, respectively, for the period 2013 - 2020. The lowest population increase (0.40 %) was recorded in Ibadan North. The population increase in the inner city core of Ibadan for the period 2000 - 2013 revealed that all of the local government areas in the core of Ibadan vary in terms of their population growth percentages (Table 11).

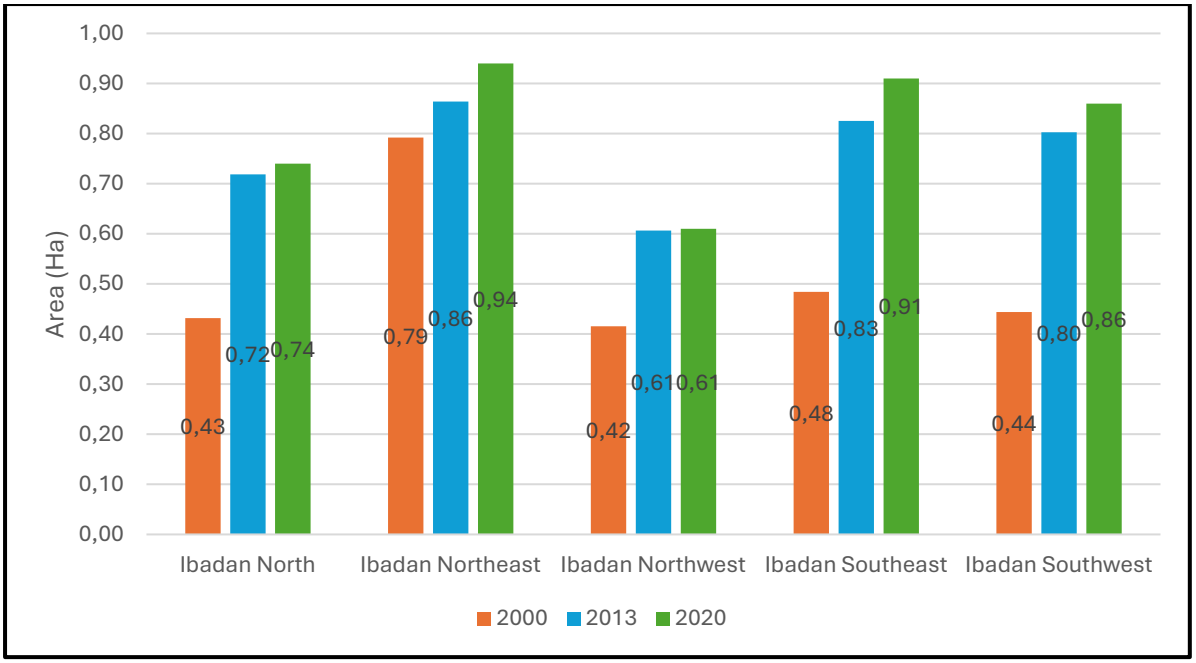

Figure 7: The Post-millennial Urbanised Area Density of the Ibadan Inner City Core

Urban densification can be attributed to the impacts of the economic, social and logistical viability aspects of urban development within a region (Shifaw *et al*., 2018). Figure 7 reveals that while the urban area density indices in some local government areas were increasing over the entire period of study (2000 - 2020), other local government areas (Ibadan North and Ibadan Northwest) were experiencing sedentary urban area density indices for the period 2013 - 2020. The inconsistent urban densification pattern points to uncontrolled urban growth in the inner city core of Ibadan, which may lead to urban decay.

5. Discussion

The slight decrease in the growth of the population in the local government areas of the Ibadan core for the period 2013 - 2020 can be attributed to the urban renewal programme implemented by the Oyo State government. Roelofs (2021) affirmed this claim by expressing that in a bid to restructure the urban area of Ibadan, the large-scale demolition of roadside shops and some shanties was carried out to make way for modern infrastructures. This development led to the eviction of some of the dwellers of the inner city core to the peri-urban areas of Ibadan. The government's urban renewal programme implies that government policies will influence the changes occurring in the inner city core of Ibadan.

The highly intense and rapid urban expansion recorded for the period 2000 - 2013 in the already overcrowded core of Ibadan has led to an edge expansion emanating from the limited space in the inner core. The crowded nature of the inner core area has been responsible for the outward expansion of Ibadan North and Ibadan Northwest. This finding concurs with that of

Wu *et al*., 2017, who opined that owing to the high population density of Hangzhou's urban centre, urban expansion was more likely to be experienced in the city's peripheral areas, with a significant population density increase virtually being the immediate consequence. This phenomenon is responsible for the edge and leapfrogging expansion in the core of Ibadan.

The urban edge expansion, which predominated in the core of Ibadan for the period 2000 - 2020 is also an indication that residents prefer to live closer to their workplaces and where services can be accessed. This assertion was shared by Taiwo (2022), who opined that if the trend for the residents of Ibadan to stay close to their workplace and services continues, the result would be that urban compactness, rather than urban sprawl, would be achieved for the entire city. The urban compactness concept concerns the proximity of urban services that can be accessed by walking and cycling, and through public transportation.

The population dynamics of the core of Ibadan further suggest that the local government areas in the core are hotspots for urban expansion, which has proved to be consequential to the edge and leapfrogging/outlying expansion recorded in the study epochs. The edge and leapfrogging expansion are indications that the population density in the suburbs of the inner city core of Ibadan is increasing significantly. Furthermore, the inconsistent urban densification experienced in the core of Ibadan shows that the higher the urban density, the greater the level of expansion in the built-up area. The epoch presenting with sedentary urban density, as reflected in the low urban intensity indices recorded in Ibadan North, Ibadan Northeast, and Ibadan Northwest, respectively, between 2013 and 2020, indicates that there were no significant increase built-up areas.

6. Conclusion

This paper used three sets of Landsat images to analyse the trends of urban expansion and densification in the inner city core of Ibadan for the period 2000 - 2020. During this period, the urban expansion in the core of Ibadan was predominantly associated with edge and leapfrogging expansion, which are indications of urban sprawl. The intensity and types of urban expansion in the core of Ibadan were further determined within the study epochs. In fact, the urban intensity and expansion types were influenced by the urban densities recorded in each local government area in the core of Ibadan.

This paper, therefore, recommends that control should be exercised in development projects and that swift urban planning be required to address the issue of urban sprawl at the edge of the local government areas within the core of Ibadan. Furthermore, compact urban planning should be encouraged to address the changes in the urban density of the core. This will be key to managing urban sprawl and improving urban land and spatial governance in the city’s core

area. Future studies on urban densification in the core of Ibadan can be carried out by modelling the implications of urban density on access to infrastructure.

7. References

Abdullahi, S., Pradhan, B. & Al-sharif, A. 2017. Sprawl *versus* Compact Development. In Pradhan, B. (ed) Spatial Modelling and Assessment of Urban Form, Analysis of Urban Growth: From Sprawl to Compact using Geospatial Data: Springer:32 – 58

Abiodun, O. & Bayode, T. 2014. Monitoring and modelling of urban sprawl: a case study of Ibadan Inner City. *International Journal of Remote Sensing and GIS*, 3(*4*): 64-71.

Adams, A., Eshete, E.S., Iddi, H., Adeola, O.B., Kigozi, J., Thiedeitz, M. & Mohamed, F. 2024. Relationship between Historic Evolution, Urbanization, and Mobility in Ibadan, Nigeria. *Tanzania Journal of Engineering and Technology*, 43*(3)*: 51-61.

Adelekan, I.O. 2016. Ibadan City: Diagnostic Report. *Urban Africa: Risk Knowledge*, 4(*1*): 1-21.

Adelekan, I., Olajide-Taiwo, L., Ayorinde, A., Ajayi, D. & Babajide, S. 2014. Building Urban Resilience: Assessing Urban and Peri-urban Agriculture in Ibadan, Nigeria. [Padgham, J. and J. Jabbour (eds.)]. United Nations Environment Programme (UNEP), Nairobi, Kenya.

Adeleye, B., Ayangbile, O., Popoola, A. & Ndana, M. 2018. Urban Transformation: a

Changing Phase of Minna Central Area, Nigeria. *International Journal of Architecture and Urban Development*, 8(*1*): 25-32

Agarwal, M., Ruchi, F. F. & Choudhary, K. 2021. A sustainable model of urbanization for Indian cities: a case study of New Delhi. *International Journal of Engineering and Research and Technology*, *10*(*3*): 82-90.

Agbola, S., Kasim, O. & Coker, M. 2014. Dynamics of Land Use and Land Cover Change in Ibadan Region, Nigeria. In: Bičík, I., Himiyama, Y., Feranec, J. & Kupková, L. (Eds). Land use/land cover changes in selected regions in the world: Volume IX. IGU/LUCC, Faculty of Science, Charles University, Prague, and Hokkaido University of Education, Asahikawa: 43-48.

Agunbiade, M.E., Rajabifard, A. & Bennett, R. 2012. The dynamics of city growth and the impact on urban land policies in developing countries. *International Journal of Urban Sustainable Development*, 4(*2*): 146-165.

Alabi, M., Babalola, T. & Popoola, A. 2021. Tenure insecurity and incremental housing development in the peri-urban interface of Ibadan, Nigeria. *CIDADES, Comunidades e Territórios*. 43 (Dec.2021): 185-206. DOI: 10.15847/cct.21000

Al-sharif, A., Pradhan, B. & Abdullahi, S. 2017. Urban Sprawl Assessment. In Pradhan, B. (ed) Spatial Modelling and Assessment of Urban Form, Analysis of Urban Growth: From Sprawl to Compact using Geospatial Data: Springer: 61 -92

Anibaba, B., Durowoju, O. & Adedeji, O. 2019. Spatial Characteristics of Urban Heat Island Intensity across Different Land Use Types in Ibadan Metropolis, Nigeria. *African Journal of Sustainable Development,* 7(3): 37-62

Bhatta, B. eds. 2010. Analysis of urban growth and sprawl from remote sensing data. Springer: London.

Castells-Quintana, D. & Wenban-Smith, H. 2020. Population dynamics, urbanisation without growth, and the rise of megacities. *The Journal of Development Studies*, 56(*9*): 1663-1682.

Chatterjee, A. & Chattopadhyay, R. 2020. Growth of Metropolises and Megacities with Focus on the Global South. In *Satellite Towns in Neo-metropolitan Development in India:* 1-28. Springer, Singapore.

Das, M. & Das, A. 2019. 'Dynamics of Urbanization and its Impact on Urban Ecosystem Services (UESs): A study of a medium-size town of West Bengal, Eastern India', *Journal of Urban Management*, 8(*3*): 420-434.

Dasgupta, P., Raven, P. & McIvor, A. (Eds.). 2019. *Biological extinction: New perspectives*. Cambridge University Press.

Fabeku, B., Balogun, I., Adegboyega, S. & Faleyimu, O. 2018. Spatio-temporal Variability in Land Surface Temperatures and its Relationship with Vegetation Types over Ibadan, South-Western Nigeria. *Atmospheric and Climate Sciences*, 8: 318-336

Firman, T., Kombaitan, B. and Pradono, P 2007, 'The dynamics of Indonesia's urbanisation,
1980 - 2006', *Urban Policy and Research*, 25(*4*): 433-454.

Firman, T. 2017. The urbanisation of Java, 2000–2010: towards 'the island of mega-urban regions. *Asian Population Studies*, 13(*1*): 50-66.

Folorunsho, A., Balogun, I., Adediji, A., Olumide, A. & Abdulkareem, S. 2017. Assessment of Urban Heat Island over Ibadan Metropolis using Landsat and Modis. *International Journal of the Environment and Bioenergy,* 12(*1*): 62-87.

Fragkias, M., Güneralp, B., Seto, K. & Goodness, J. 2013. A synthesis of global urbanization projections. In *Urbanization, biodiversity and ecosystem services: Challenges and opportunities:*409-435. Springer, Dordrecht.

He, Q., He, W., Song, Y., Wu, J., Yin, C. & Mou, Y. 2018. The impact of urban growth patterns on urban vitality in newly built-up areas based on an association rules analysis using geographical 'big data''. *Land Use Policy*, 78: 726-738

Hirohara, M., Alden, J. & Cassim, M. 1988. The impact of recent urbanisation on inner
city development in Japan. *The Town Planning Review*, 365-381.

Horn, A., & Van Eeden, A. 2018. The application of an Urban Sprawl Index: comparing towns and cities in the Western Cape Province, South Africa. *South African Journal of Geomatics*, 7(*3*): 257-267.

Godfrey, R. & Julien, M. 2005. Urbanisation and health. *Clinical Medicine*, 5(*2*): 137-141.

Kookana, R. S., Drechsel, P., Jamwal, P. & Vanderzalm, J. 2020. Urbanisation and emerging economies: issues and potential solutions for water and food security. *Science of the Total Environment*, 732: 139057.

Lamond J., Awuah B. K., Lewis E., Bloch R. & Falade B. J. 2015. Urban Land, Planning and Governance Systems in Nigeria. Urbanisation Research Nigeria (URN) Research Report. London: ICF International.

Lasisi, M., Popoola, A., Adediji, A., Adedeji, O. & Babalola, K. 2017. City Expansion
and Agricultural Land Loss within the Peri-urban Area of Osun State, Nigeria. *Ghana Journal of Geography*, 9(*3*): 132–163.

Lin, G. 2007. Reproducing Spaces of Chinese Urbanisation: New City-based and Land-
centred Urban Transformation. *Urban Studies*, 44(9): 1827-1855.

McGranahan, G. & Satterthwaite, D. 2014. Urbanisation concepts and trends (vol. 220). International Institute for the Environment and Development.

Mortoja, M.G. & Yigitcanlar, T. 2022. Why is determining peri-urban area boundaries critical for sustainable urban development? *Journal of Environmental Planning and Management*, 66 (*1*): 67-96.

National Population Census (NPC). 2006. Details of the breakdown of the National and State Provisional Population Totals. *Official Gazette* 96 (2), 1–42. Abuja: Federal Republic of Nigeria.

Oladele, B. & Oladimeji, B. 2011. Dynamics of Urban Land-use Changes with Remote Sensing: the Case of Ibadan, Nigeria. *Journal of Geography and Regional Planning,* 4(*11*): 632-643.

Oluseyi, O. 2006. Urban land use change analysis of a traditional city from remote sensing data: The case of Ibadan metropolitan area, Nigeria. *Humanity and Social Sciences Journal*, 1(*1*): 42-64.

Onibokun A. &Kumuyi A. 1999. Ibadan, Nigeria. In: Onibokun AG (ed.) Managing the Monster: Urban Waste and Governance in Africa. International Development Research Centre, Ottawa: 49–100. Available at: https://idlbnc.idrc.ca/dspace/bitstream/10625/26364/1/114247_p49-100.pdf.

Qiuying, L., Chuanglin, F., Guangdong, L. & Zhoupeng, R. 2015. Quantitative measurement of urban expansion and its driving factors in Qingdao: an empirical analysis based on county unit data. *Journal of Resources and Ecology,* 6: 172–179.

Popoola, O, Durojaye, P, Bayode, T, Popoola, A., Olanibi, J. & Aladetuyi, O. 2020. Spatio-temporal variance and the urban heat island effect in Akure, Nigeria: A time-spaced analysis using the GIS Technique. *South African Journal of Geomatics*, 9(2): 365-378.

Roelofs, P. 2021. Urban renewal in Ibadan, Nigeria: World class but essentially Yoruba. *African Affairs*, 120(*480*): 391-415.

Seo, J. 2002. Re-urbanisation in regenerated areas of Manchester and Glasgow: new residents and the problems of sustainability. *Cities*, 19(*2*): 113-121.

Seto, K., Güneralp, B. & Hutyra, L. 2012. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, 109(40): 16083-16088.

Shin, H. 2014. Contesting speculative urbanisation and strategising discontent. *City*, 18(*4-5*): 509-516.

Shifaw, E., Sha, J., Li, X., Jiali, S. Bao, Z. 2020. Remote sensing and GIS-based analysis of urban dynamics and modelling of its drivers: the case of Pingtan, China. *Environment, Development and Sustainability*, 22(*3*): 2159-2186.

Shukla, A. & Jain, K. 2019. Modelling urban growth trajectories and spatiotemporal patterns: a case study of Lucknow City, India. *Journal of the Indian Society of Remote Sensing*, 47(*1*): 139-152.

Taiwo, O. 2022. Modelling the spatiotemporal patterns of urban sprawl in Ibadan metropolis between 1984 and 2013 in Nigeria. *Modeling Earth Systems and Environment,* 8: 121–140

Udodiong, I. 2017. First Phase of Ibadan Circular Road for Completion in 18 Months - Oyo Government. Available at: https://www.pulse.ng/news/local/ajimobi-first-phase-of-ibadan-circular-road-for-completion-in-18-months-oyo-gov/32p5hf0 (Date accessed: 10 September 2020)

United Nations Human Settlements Programme (UN-Habitat). 2009. Planning Sustainable Cities: Global Report on Human Settlements. Earthscan/International Institute for the Environment and Development.

United Nations. 2015. World Population Prospects: The 2015 Revision, Key Findings and Advanced Tables. Working Paper No. ESA/P/WP.241. New York: United Nations, Department of Economic and Social Affairs: Population Division.

United Nations. 2019. World Urbanisation Prospects. United Nations Office, New York.

Van Noorloos, F. & Kloosterboer, M. 2018. Africa's new cities: The contested future of Urbanisation. *Urban Studies*, 55(6): 1223-1241.

United Nations Department of Economic and Social Affairs. 2014. World Urbanization Prospects: The 2014 Revision. (ST/ESA/SER.A/352). United Nations Office, New York.

Wahab, B. & Popoola, A. 2019. Urban Farmers' Perceptions of and Adaptation Strategies to Climate Variability in Ibadan, Nigeria. In Cobbinah, P. and Addaney, M. (eds.), *The Geography of Climate Change Adaptation in Urban Africa:* 123-154. Palgrave MacMillan, Cham: Switzerland. ISSN: 978-3-030-04873-0. Available at: https://doi.org/10.1007/978-3-030-04873-0_5.

Wahab, B., Popoola, A. & Magidimisha, H. 2018. Access to Urban Agricultural Land in Ibadan, Nigeria. *Planning Malaysian: Journal of the Malaysian Institute of Planners*, 16(*4*): 161-175.

Wang, X., Yan, F. & Su, F. 2020. Impacts of urbanization on the ecosystem services in the Guangdong-Hong Kong-Macao Greater Bay area, China. *Remote Sensing*, 12(19): 3269.

Wu, Y., Fan, P., Li, B., Ouyang, Z., Liu, Y. & You, H. 2017. The effectiveness of planning control on urban growth: Evidence from Hangzhou, China. *Sustainability*, 9(*5*): 855

Xie, C., Huang, B., Claramunt, C. & Chandramouli, C. 2005. Spatial logistic regression and GIS to model rural-urban land conversion. In *Proceedings of Processus: Second International Colloquium on the Behavioural Foundations of Integrated Land-use and Transportation Models: frameworks, models and applications:* 12-15). University of Toronto.

Yu, W. & Zhou, W. 2017. The spatiotemporal pattern of urban expansion in China: a comparison study of three urban mega regions. *Remote Sensing,* 9(45): 1-18.

Zeng, C., Deng, X., Dong, J. & Hu, P. 2016. Urbanization and sustainability: comparison of the processes in "BIC" countries. *Sustainability*, 8(*4*): 400.