

# ANALYSIS OF URBAN EXPANSION AND ROAD NETWORK DEVELOPMENT IN ILE-IFE, NIGERIA: 1968 - 2019

BY

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## ABSTRACT

Cities of the world have continued to witness remarkable modifications of their municipal area, population and road transportation network. This study examines urban expansion and road network development in Ile- Ife, Osun State, Nigeria between 1968 and 2019. The study used secondary sources of data. The data employed include 1968 topographic map covering the area, multi date (1986 and 2007) Landsat imageries, 2014 of the *Satellite Pour l'Observation de la Terre* (SPOT) image and 2019 Google earth imagery of the area. The imageries were georeferenced and digitized in ArcGIS environment to extract and calculate the area and length of urban area and road network respectively in the study area for each of the studied years. The results showed that the urban area expanded from 5.71km<sup>2</sup> in 1968 to 103.99 in km<sup>2</sup> in 2019. Road network also increased from 34.26km in 1968 to 944.51km in 2019. The study revealed that a significant positive relationship exists between road network development and urban expansion in Ile-Ife between 1968 and 2019 ( $r= 0.956$ ,  $p<0.05$ ). The findings of the study provide important reference for the understanding of urban expansion and road network development in Nigerian cities. The study recommends that government should provide enabling environment that would guaranty strict compliance with regulations guiding physical urban expansion (physical planning) and roads network development as the two are positively related.

**Key words:** Development, Road network, Urban expansion

## INTRODUCTION

The world has increasingly become urban. The global urban population increased from 13% in 1900 to 29% in 1950, 49% in 2005 and it is estimated that by 2030, 60% of the population will live in the cities (UN, 2015). The rate of urban growth is alarming and this has posed severe problems to urban infrastructures and city planners. The rapid rate of urbanization has led to unplanned construction, inadequate transport, extreme poverty, uncontrolled urban sprawl and haphazard physical development in urban centres (UN-Habitat, 2013; Horne and Pope, 2014; Malawi and Haitian, 2014).

Urban progress is intensely connected to transportation (Bhatta, 2010). Transportation assumes a crucial part in the advancement of urban centres as it gives versatility to persons, merchandise and influence progress and levels of financial achievement through land openness. To guarantee

sustainable advancement in urban areas, a proficient transport network is fundamental. However, transport developments may lead to changes in the pattern of land use in an urban center as many activities engaged in by man make or break cities (Ogunsanya, 2000; Bala, 2015). One aspect of transport development that exhibits parallel development trend with urban expansion is road networks. As cities expand in land area, the road network also expands to provide necessary access to emerging land uses.

Studies on urban growth and land use changes in Nigeria abound with many largely centering on urban land use changes, while little attention is accorded to the understanding of the relationship between urban growth and road network development. For example, studies carried out by Ajala and Olayiwola (2003), Balogun, Adeyewa, Balogun, and Morakinyo (2011), Enaruvbe and Atedhor (2015), only used Geographic Information Systems (GIS) tools to map out the land cover, land use changes from remote sensing data. Others analyzed the growth in urban sprawl and the impacts of urban growth (Xiao et al., 2006; Orimoogunje, Adegboyega and Olawole, 2013; Oloukoi et al., 2014).

Different aspects of the association between urban expansion and road network development have been examined by several studies (Adaramo, 1990; Bala, 2015; Yakubu, 2016; Afolabi et al., 2018; Adesuyi and Olawole, 2018; Abbas and Hashidu, 2019; Uzoho, 2021). For instance, Bala (2015) provided an insight into the effects of road transport development on urban growth and commercial activities in Gombe city. Afolabi et al. (2018) used questionnaire survey of 545 respondents and descriptive statistics to examine the implications of highway development and expansion on urban residents in Abeokuta city. Abbas and Hashidu, (2019) assess road transport network development in North-eastern Nigeria between 1961 and 2011 using connectivity and accessibility indices. The results indicated that there was significant increase in road connectivity and accessibility in north-east Nigeria from 1961 to 2011.

Bala (2015) examined the effects of road transport development on urban growth and commercial activities in Gombe Metropolis over three periods (1996, 2005 and 2014). The results revealed that urban growth always determines the development of road network in the study area. Survey results showed that 95% of the respondents revealed that improvement in road network affects commercial activities in the study area.

Adaramo (1990) examined the pattern and structure of road network evolution in Ilorin and how they have affected the morphology of the city. The study showed that in 1897, the pattern of the city was concentric in form and by 1963 the pattern has changed to that of radial. The spatial pattern of road development in the city reveals that the number of road segments in the city increased from 17 in 1963 to 30 in 1973. The number of road segments increased to 68 by 1982 while by 1988 the number had risen to 72. Findings on length of road network reveal that in 1963, the length was only 12km while by 1973, the length has risen to 22.7km. By 1982, the total length of road network was 67km while the figure rose to 86km by 1988.

Similarly, extensive studies on the relationship between urban growth and transport expansion exist in other parts of the world (Zhao and Lu, 2011; Niyonsenga, 2012; Aljoufie, 2013; Malawi and Haitian, 2014; Aljoufie, Brussel, Zuidgeest, Delden and Maarseveen, 2016; Shi et al., 2019). These studies confirmed that positive association exists between urban expansion and road network development.

The foregoing review indicates that few studies in Nigeria used remotely sensed data combined with GIS to explore the relationship between urban expansion and road network development. These studies are relevant as they provide framework for this study. However, they are inadequate to provide detailed information on the association between road network development and urban expansion for planning and policy formation purposes in the country as some of them are outdated (Adaramo, 1990) while others used descriptive methodology in their analyses (Bala, 2015; Afolabi et al., 2018).

Therefore, there exist a need to further examine the relationship between urban expansion and road transport development in the country. This study employs remote sensing (RS) and GIS techniques to explore urban expansion and road network development between 1968 and 2019 in Ile-Ife, Osun state, Nigeria. It also examines the relationship between urban expansion and road network development in the city.

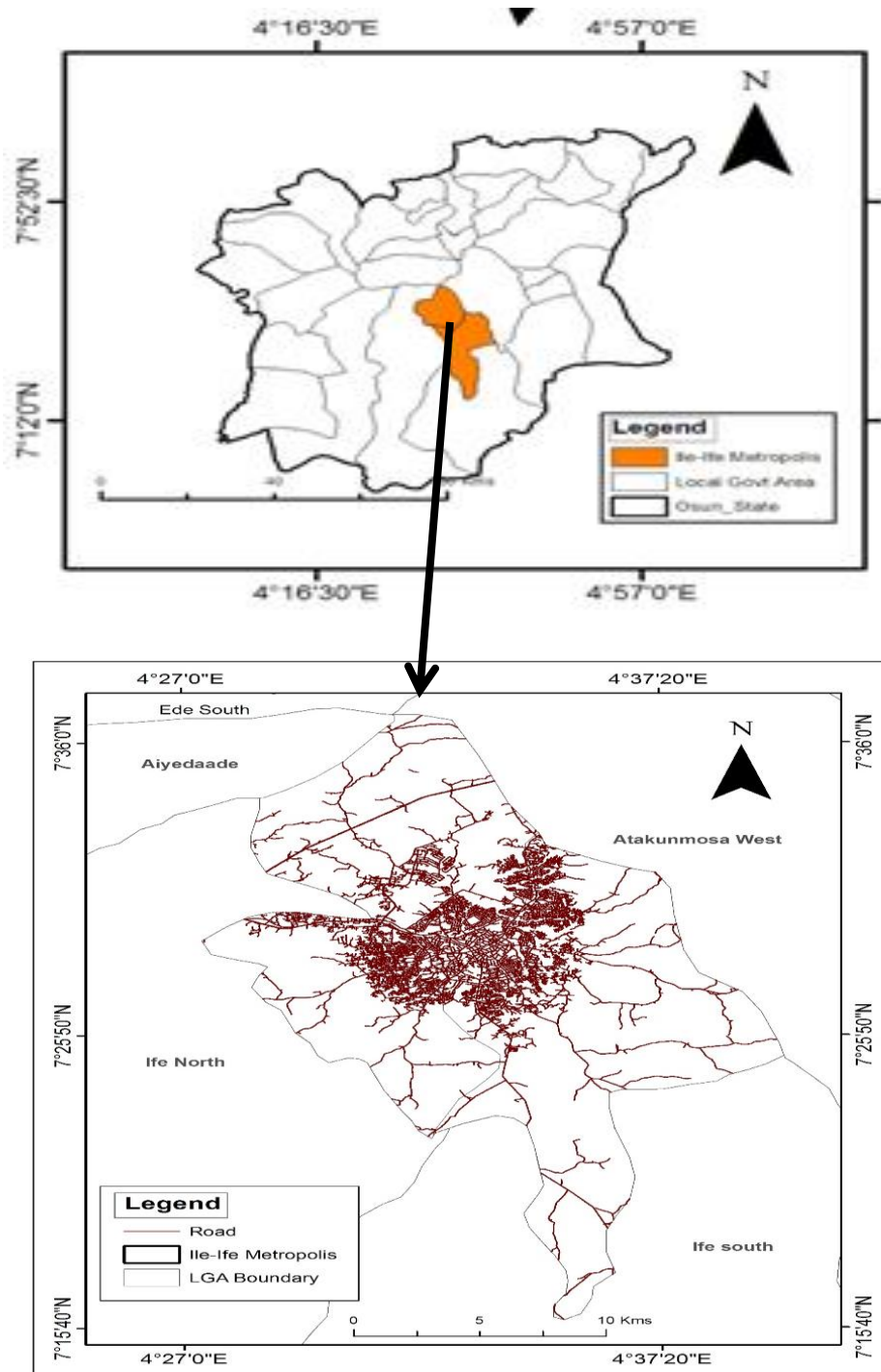
## **THE STUDY AREA**

The study area, Ile-Ife, lies between Latitudes 7°28'N and 7°46'N, and Longitudes 4°36'E and 4°56'E (Oloukoi, Oyinloye and Yadjemi, 2014). It is located in the Southwestern part of Nigeria at the intersection of roads from Ibadan (64km west) and Ilesa. It is 56 kilometers from Osogbo, apital of the State of Osun and 200 kilometers from Lagos state (Figure 1). The study area occupies an area of, 373.50 km<sup>2</sup> and extends over parts of Ife Central, Ife East and Ife East area office, Modakeke with a population of 644,373 inhabitants in 2006 (NPC , 2009).

Over the years, the study area grew in area extent to annexed settlements that are once in the frontiers of the city. Some of the settlements include Opa, Ile-fifun, Oranife, Idita, Ajebamidele, Kosere, Falolu, Kanmi, Ireunmi, Oke-Ogbo, Oniyarin, Apata, Sasa, Owoeye, Ita Osa, Modomo, Esuyare, Olorunsogo, Olojede, and Aserifa.

Road transportation is the main mode of transport in the city. Road networks in Ile- Ife are categorized into three namely: primary roads (Federal roads), secondary (State roads) and the tertiary (community/LGA roads). There are more secondary road and tertiary road than the federal roads. In all, there are 111.48km of federal roads (OAU community inclusive), 36.42km of secondary roads and 796.62km of tertiary roads in the city (Olapoju, 2016).

Walking, private cars, commercial buses, mini buses and commercial motorcycle are means of mobility in Ile-Ife, with minute population riding bicycles. The commercial buses are registered under the National Union of Road Transport Workers (NURTW) or Road Transport Employees Association of Nigeria (RTEAN). The commercial bus ply the major route (Ede road) that runs from Obafemi Awolowo University, through Sabo and Obafemi Awolowo University Teaching Hospital Complex to Opa and the Ibadan Ondo road that runs from Ondo road round about through Urban day secondary school in Modakeke to Ibadan-Ilesa-Akure bypass. Ile-Ife is characterized by heavy traffic congestion on its major roads, especially at Lagere, Sabo and Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) road (Olapoju, 2016).



**Figure 1: Location of the Study Area – Ile-Ife city, Osun State, Nigeria**  
Source: Adapted and modified from administrative map of Osun state

## **MATERIALS AND METHODS**

In the quest to analyze the relationship between urban growth and road network expansion, both primary and secondary data were collected. The primary data include Ground Control Points (GCPs) of important landmarks such as schools, road intersections; markets etc. collected using Global Positioning Systems (GPS) for the purpose of ground-truthing and geo-referencing. The secondary data used in this study include topographical maps of Ilesha SW (Sheet 243 SW) and Ondo NW (Sheet 263NW) on a scale of 1:50,000; Landsat 5 & 6 ETM+ (path 190, row 55) images for 1986, 2000 and 2007; and Spot 5 panchromatic Satellite image at a resolution of 5 meters for 2014 and 2019. Census data for 1963, 1991 and 2006 sourced from National Population Commission were used to project the population figures of the years studied. The administrative map of Ife metropolitan area was also acquired from the two Local Government Areas (LGAs).

### **Image Processing**

The topographic maps were scanned and imported into the ArcGIS software environment. The maps were then georeferenced, resampled and the submap of the study area was extracted, digitized and incorporated into the database (Oloukoi et al., 2014). These maps were all brought to the UTM projection system. Also, the orthorectified satellite images (from source) of Landsat TM and ETM+ were similarly imported into ArcGIS software environment. The sub-scene of the area was extracted and overlaid on the respective images in order to assess the coverage. Bands 4, 3 and 2 were combined in red, green and blue (RGB bands) and the contrast enhanced using the same software. This allows for better visualization of elements of interest and digitization of urban area and road network in the study area.

### **Measuring Relationships**

The type of relationship between urban expansion and road development in the area was examined using correlation technique to compute correlation coefficients. Correlation coefficients are indicators of the strength of the linear relationship between two different variables, x and y. A linear correlation coefficient that is greater than zero indicates a positive relationship. A value that is less than zero signifies a negative relationship. Finally, a value of zero indicates no relationship between the two variables x and y. Using statistics generated from image analysis on urban expansion and road network development, correlation coefficient of the relationship between urban expansion and road network development in Ile-Ife was computed with IBM SPSS version 23 software.

## **RESULTS AND DISCUSSION**

### **Urban Expansion between 1968 and 2019**

Ile Ife city experienced a continuous spatial expansion through the period 1968-2019 (Table 1). Figure 2a shows the extent of the city in 1968 covering an area of 5.71 km<sup>2</sup>. The city witnessed a percentage increment of 455.17% from 1968 to 1986. The high percentage increase in land area under built-up maybe attributed to the siting of the University of Ife (Now Obafemi Awolowo University (OAU)) and (Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) in the city. In addition, the expansion of the city into adjoining settlements also contributed to the growth of city. The

far north division of the city where the University is located formed the centre of expansion during this period (Figure 2b).

Between 1986 and 2000, the city witnessed the lowest, spatial expansion of 8.57 km<sup>2</sup> or 27.03% increase in urbanized area (Figure 2c). Subsequently, from 2000 to 2007, Ile- Ife experienced a continuous increase in both population (45.43%) and in city size (88.61%). This growth coincides with the establishment of several commercial banks along Aderemi/Lagere/Ondo road axis which serves as the central business district (CBD) in the city. Also, the spatial growth in this period was influenced by the development of road network and increase in commercial activities in major road axes in the city. With this, two forms of expansion were revealed: outward expansion and infill development (Figure 2d).

Further city expansion occurred between 2007 and 2014 with about 26.66% increase in urban area (Figure 2e). The city's progression and enlargement at this period followed the varying pace of both the commercial developments and the city's population growth. A noticeable spatial expansion was witnessed in the North East, South-West of Ile-Ife from 2014 to 2019 (Figure 2f). In all, about 40.41 % increase occurred between 2014 and 2019 (Table 1).

**Table 1: Urban Expansion Characteristics: 1968 to 2019**

Characteristics	Years					
	1968	1986	2000	2007	2014	2019
Urban growth (in km <sup>2</sup> )	5.71	31.7	40.27	58.47	74.06	103.99
% Change in Urban growth	–	455.17	27.03	88.61	26.66	40.41
% Change in Population	–	39.18	32.08	45.43	17.59	12.90

Source: Authors Computation

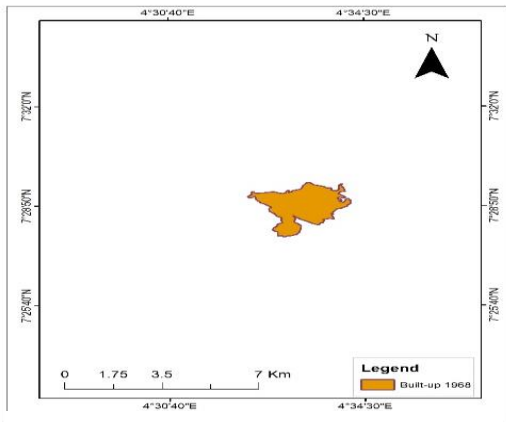


Figure 2a: Urban Growth 1968

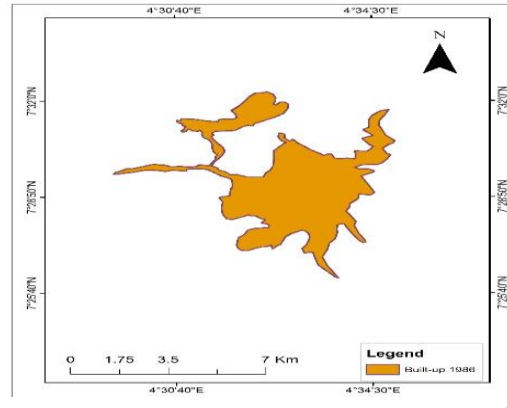


Figure 2b: Urban Growth 1986

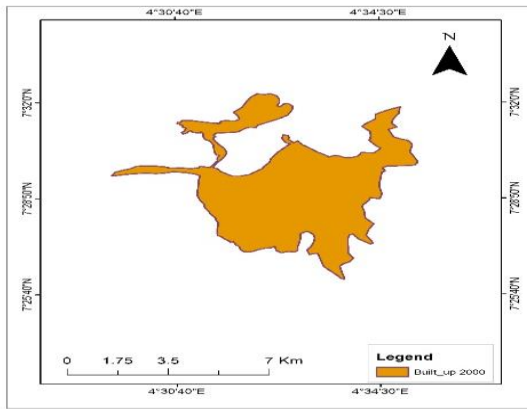


Figure 2c: Urban Growth 2000

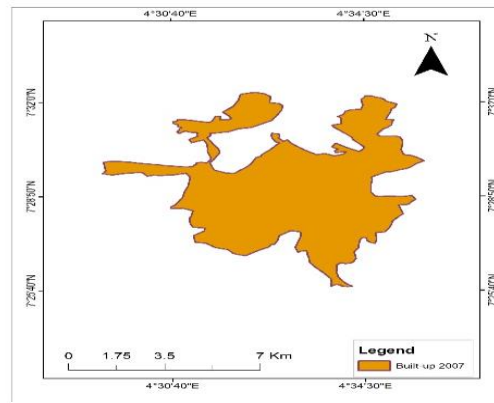


Figure 2d: Urban Growth 2007

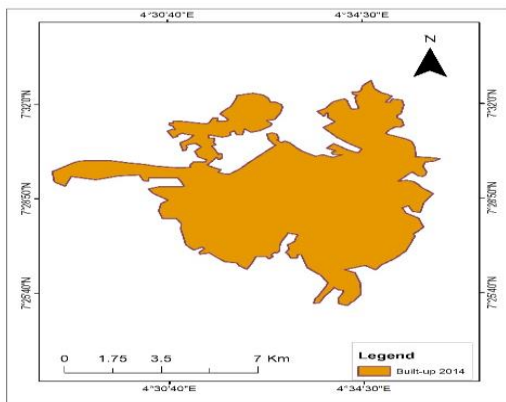


Figure 2e: Urban Growth 2014

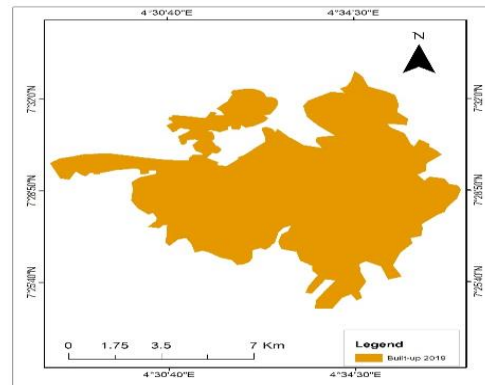


Figure 2f: Urban Growth 2019

**Road Network Expansion between 1968 and 2019**

Road network constitutes an important element in urban development as roads provide accessibility to the different land uses in an urban area (Adaramo, 1990, P.196). Road transport is the dominant mode in major cities in Nigeria and in the study area (Ogunbodede, 2008), hence road network expansion aligned with urban expansion trend between 1968 and 2019 in the study area. Table 2 shows statistics of road network expansion in Ile-Ife. In 1968, the length of road in the city was 34.26 km (Figure 3a). The length of road network increased by 1007.53%, from 34.26km in 1968 to 379.44km in 1986 (Table 2). It increased to 560.22km in the next 14 years (1986 to 2000) amounting to 47.83% increase. By 2019 the total length of roads in Ile-Ife was 944.52km. Figures 3c to 3f present the spatial expansion of road network in the study area. Table 2 also shows that the number of road segments also increase as the network expansion. It increased from 39 segments in 1968 to 4,165 segments in 2019.

**Table 2: Road Network Expansion Characteristics**

Characteristics	Years					
	1968	1986	2000	2007	2014	2019
Number of road segments	39	1784	2357	3303	4090	4165
Total Length (km)	34.26	379.44	560.92	697.52	892.27	944.52
% change	–	1007.53	47.83	19.58	27.91	5.85
% annual rate of change	–	55.97	3.42	2.8	3.99	1.17

Source: Authors Computation

The development of the three categories of roads, primary (Federal roads), secondary (state roads) and tertiary (LGAs roads), in the study area is as shown in Table 3. Tertiary roads increased from 18.8km in 1968 to 796.62 km 2019. Secondary roads expanded in length from 11.52km in 1968 to 36.42km in 2019. The third category of road (Primary roads) increased in length from 3.92km in 1968 to 111km in 2019 (Table 3).

**Table 3: Road expansion characteristics by road types: 1968 to 2019**

Road Type	Characteristics	1968	1986	2000	2007	2014	2019
Primary	Segment of Road	2	300	302	352	412	416
	Length (km)	3.9	73.54	84.87	88.44	108.6	111.48
	Percentage	11.38	19.38	15.13	12.68	12.17	11.8
Secondary	Segment of Road	8	30	31	32	35	38
	Length (km)	11.52	21.84	26.16	26.8	31.3	36.42
	Percentage	33.63	5.76	4.66	3.84	3.51	3.86
Tertiary	Segment of Road	29	1454	2024	2919	3643	3711
	Length (km)	18.84	284.06	449.89	582.28	752.37	796.62
	Percentage	54.99	74.86	80.21	83.48	84.32	84.34

Source: Authors Computation



Assessment of Farmers' Perception of Effectiveness of Adaptation Strategies to Climate Change in Northwestern Nigeria

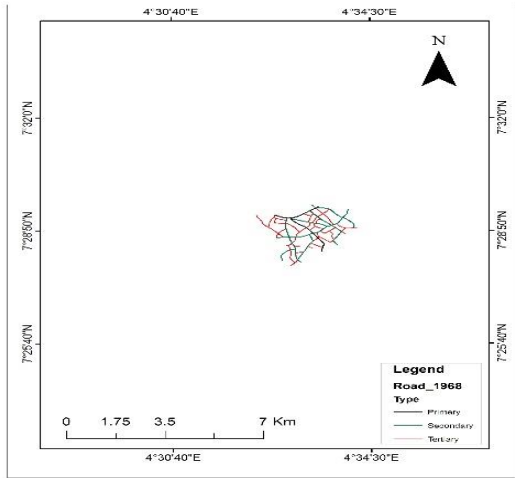


Figure 3a: Road Network 1968

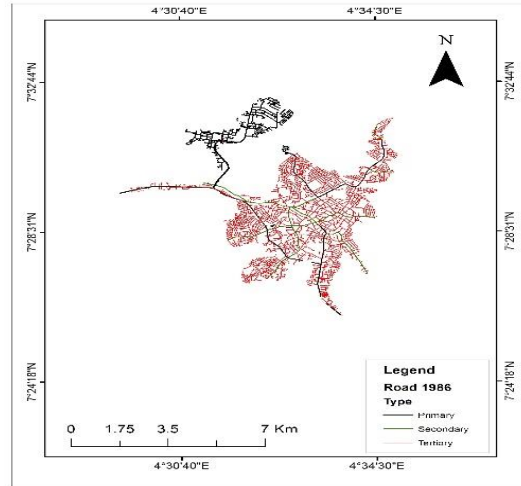


Figure 3b: Road Network 1986

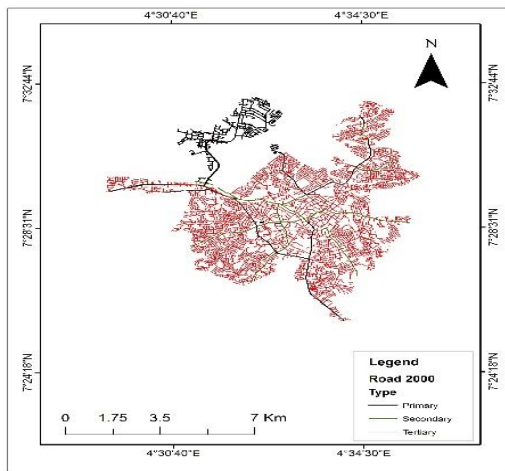


Figure 3c: Road Network 2000

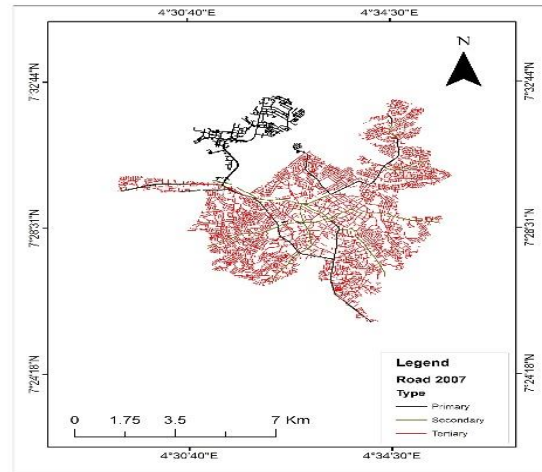


Figure 3d: Road Network 2007

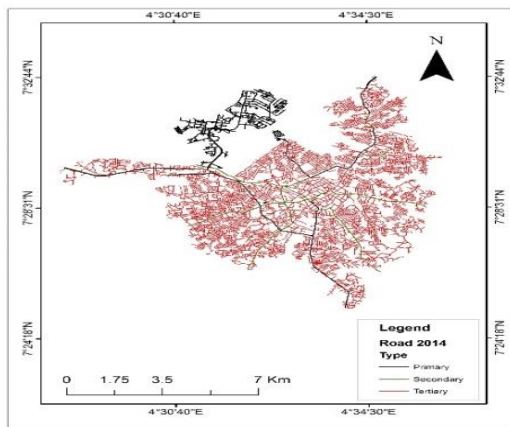


Figure 3e: Road Network 2014

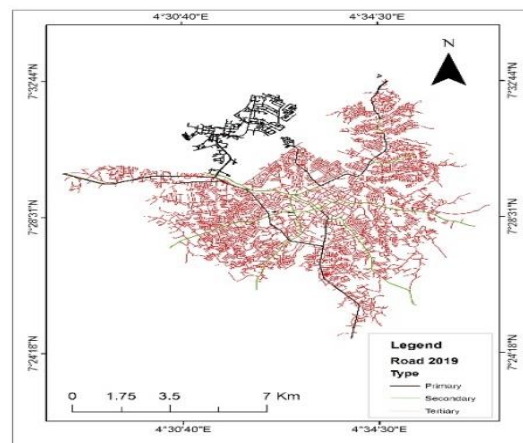


Figure 3f: Road Network 2019

### Relationship between Urban Expansion and Road Network Development in Ile-Ife

Pearson correlation analysis (Table 4) shows a significant positive relationship between road development and Urban land expansion in Ile-Ife between 1968 and 2019, ( $r = 0.956$ ,  $p < 0.05$ ).

**Table 4: Correlation table**

		Road Network	Urban Expansion
Road Network	Pearson Correlation	1	.956**
	Sig. (2-tailed)		0.003
	N	6	6

This present study has attempted to examine urban and road network expansion in a city in Nigeria, using a mix of remotely sensed data and geographical information system. This study has shown that the urban expansion in the study area was very high between 1968 and 1986. The rate of urban expansion increased at decreasing rate from 2000 to 2019. The rate of expansion in the study area can be attributed to several factors. The establishment of the University of Ife (Now Obafemi Awolowo University) attracted physical development within the campus and areas adjacent to the campus. Sabo – road 7 and campus Mayfair- Sabo road were axes of immense physical development.

Results on urban expansion of Ile-Ife between 1968 and 2019 conform to similar studies carried out in Nigeria (Aguda et al., 2012; Ajala and Olayiwola, 2013). Although these studies considered the land use/ land cover dynamics of the different years rather than in terms of urban expansion, but reached an agreeable point of increasing land use. Oloukoi et al. (2014) in a study of Ile- Ife corroborate this finding by stating the spatial expansion in hectares between 1986 and 2009, increase from about 30.022km in 1986 to more than 50km in 2002 and more than 65km in 2009 respectively. This study and other studies such as Adaramo (1990) and Bala (2015) showed that urban expansion between the base year and the next study year are mostly rapid and higher than other periods.

This study also showed that total road network in the study area increased from 34.26km in 1968 to about 944.52km in 2019. The highest percentage change in road network occurred between 1968 and 1986. Similar expansion trend was also established with the three categories of roads in the study area (Bala 2015, Onokomaiya, 1978; Ogunbodede, 2008). This finding is supported by results of earlier studies. For instance, Aderamo (1990) observed that road networks increased in length in Ilorin from 12km in 1963 to 67km in 1982. Major factor that influenced road network development in Ile-Ife between 1968 and 2019 is the need to link up settlements in the frontiers of the cities that are now completely built-up due to rapid expansion of the city. Settlements in this category include Opa, Ile-fifun, Oranife, Idita, Ajebamidele, Kosere, Falolu, Kanmi, Irewunmi, Oke-Ogbo, Oniyarin, Apatata, Sasa, Owoeeye, Ita Osa, Modomo, Esuyare, Olorunsogo, Olojede, and Aserifa.

Akin to general increase in road network is the fact that the study found that length of tertiary road (local government road) increased rapidly than that of secondary and federal roads in the study area. The reason for this contrast is that, this study considered urban growth in a developing city, Ile Ife. Most of the roads in cities in Nigeria are local government owned and also serves as a main access routes to residential areas in the country and the study area in particular.

The major finding of this study is that urban expansion and road network development in Ile-Ife have strong and positive relationship. Increase in urban extend of the city induces further expansion of road network. Most of the frontier settlements that are part of the city now were once located along roads leading into or out of the city- thus contributing to linear expansion of the city.

The reason for the positive correlation between urban expansion and road network development in the study area can be attributed to the fact that efficient road networks are required as support for urban development and expansion. Also improved road networks plays a key role in affecting urban land use and guiding changes to the urban landscape. This finding is in agreement with finding of Aljoufie (2012) that shows a mutual connection exists between urban spatial increase and road transport network expansion in Jeddah. Similarly, Perveen et al. (2018) finding also agreed that transport has a relationship with urban growth.

The correlation between urban expansion and road network in the study area provides an important reference for the understanding of urban expansion and road network development in Nigerian cities. Understanding road network development and characteristics offer some predictive capabilities for urban planners and administrators and provides new ideas for addressing the transport related problems associated with urban expansion.

## CONCLUSION

This study used remotely sensed data and geographic information systems to examine changes in land area occupied by an urban settlement and corresponding changes in road network development in same settlement using Ile-Ife, Nigeria as the study area. The study also explores the relationship between urban expansion and road network development. The findings add relevance to findings of similar studies on urban expansion and road network development. The finding suggests that both urban area and road network are dynamic in nature as they change overtime. In addition, the study shows that there exists positive correlation between urban expansion and road network development study area and by extension in cities in the country. Therefore, the urban planners and administrative officers ought to take appropriate measures to understand their cities so as to proffer correct solution planning problems resulting from urban and road network expansion.

The findings of this study revealed that road transport network develops has urban growth expands. Given the methodology employed in this study, further studies on urban growth and road network development are required in other cities in the country using other methodologies in order to determine and proffer solution to problems associated with urban expansion and road network development across cities in Nigeria.

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