

# Analysis of Urban Growth Agents in Jos Metropolis, Nigeria

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## Abstract

*Jos metropolis is a mid-sized city under the pressure of urban growth. Timely and accurate assessments of urban growth scenarios and associated environmental impacts are crucial for urban planning, policy decision, and natural resource management. Four medium resolutions Landsat images (1984, 1991, 2003 and 2014) were used to derive urban land use/land cover change patterns. Non-built up account for 92.8% of the total landscape in 1984. After 30 years, Jos metropolis changed significantly, with a rapid urbanization at the cost of losing non-built up land. Builtup land increased significantly from 5.9% to 24.8% (1984-2014). The major factors responsible for the changing patterns of urban growth were analyzed based on community perception. The growth of Jos in the past 30years is obvious as 54.1% of the respondents view it as rapid, manifesting in increasing economic activities and expansion of urban areas. In the early period (before 1984), settlements in northern region - Angwa Rogo, Angwa Rukuba, Gangare and Tudunwada dominated by 29.4%, 23.5%, 30.6% and 18.8% respectively in terms of land development. This could be attributed to the presence of the University of Jos in the northern region which attracted students and individuals from every part of the country and also due to the fact that the central business district is situated in the northern region with various socioeconomic activities. Settlements that scored low in the early periods (Lamingo, Rantya and Rayfield) benefited from the wave of crises and unrest (from 2001-2010) in the areas mentioned earlier that result to shift in direction. The settlements had the highest rates of land development with a sharp increase of 60%, 51.8% and 57.6% respectively. The major problem of population growth identified is heavy traffic subduing every other problem with a count of 28.*

**Keywords:** Change agents; Jos metropolis; Urban growth; Remote sensing

## 1 Introduction

The unprecedented population growth coupled with developmental activities in Jos has led to urbanization. Increase in urban population growth is a global trend. Urban population increased from 14 percent in 1900 to 50.5 percent in 2010 (Seifolddini and Mansourian, 2014). Urban growth, especially in its undesirable form has negative impact on the environment, natural resources, human health and has caused some socio-economic problems. Decrease in agricultural lands, wild forests and open spaces are considered as some impacts. The spatial configuration and the dynamics of urban growth are important topics of analysis in the contemporary urban studies (Bhatta, 2012). Moreso, to have knowledge of the change agents for a particular domain is necessary. Because of continuous change in structure and pattern of urban growth, change drivers have been in continuous focus of researchers (Seto and Fragkias, 2005).

While temporal dynamics information provides insights to the urbanization pattern (i.e. property, complexity and size of the existing urban area), which helps the sustainable regional development (Hill *et al.*, 2004; DeFries, 2008; Bhatta, 2009a; 2009b; and Ramachandra *et al.*, 2012), information on change drivers will support policy making for an effective urban planning with natural resources conservation. The rapid rate of urbanization being experienced in Jos, Plateau State Nigeria, has created serious environmental problems noticeable along the Jos metropolis. There is unguided and uncontrolled expansion without due consideration to interrelated factors such as transport, employment and health, to mention a few. The city is experiencing

expansion in all directions resulting in large scale urban growth and change in urban land uses. This study will demonstrate the potential of multi-temporal Landsat data to provide an accurate, efficient means to understand the urban growth trends of Jos metropolis and identify the major driving forces of urban growth. The questions this paper seeks to address are: what are the major driving forces of urban growths in the study area? How do these factors influence the urban growth process and pattern? Therefore, this study envisages accounting for a variety of forces that shape urban areas in Jos.

1.1 The study location

The investigated area is Jos metropolis, Nigeria. It lies within latitudes 9°45'00"N to 09°57'00"N and longitudes 8°48'00"E to 8°58'00"E. Jos is the administrative capital of Plateau State. The study covered parts of Jos North and Jos South Local Government Areas (LGAs). Jos North and South have population of 429,300 and 306,716 respectively based on the 2006 National Census. Jos metropolis covers an area of 249.7km<sup>2</sup>. At an altitude of 1,217m (3,993ft) above sea level, Jos enjoys a more temperate climate than much of the rest of Nigeria. The climate is the wet and dry type classified as tropical rainy climate and characterized by a mean annual rainfall of 1,250mm, peaking between July and August. The mean annual temperature is about 22°C but mean monthly values vary between 19°C in the coolest month of December and 25°C in the hottest month, April. The city of Jos is the largest settlement in Plateau State. It owes its origin to the introduction of tin mining on the Jos Plateau and railway lines linking it with Port Harcourt and Lagos, thus bringing the area into the orbit of the world economy. The tin mining led to the influx of migrants, mostly Hausas, Ibos, Yoruba's and Europeans who constitute over half of the population of the town, making it a highly cosmopolitan.

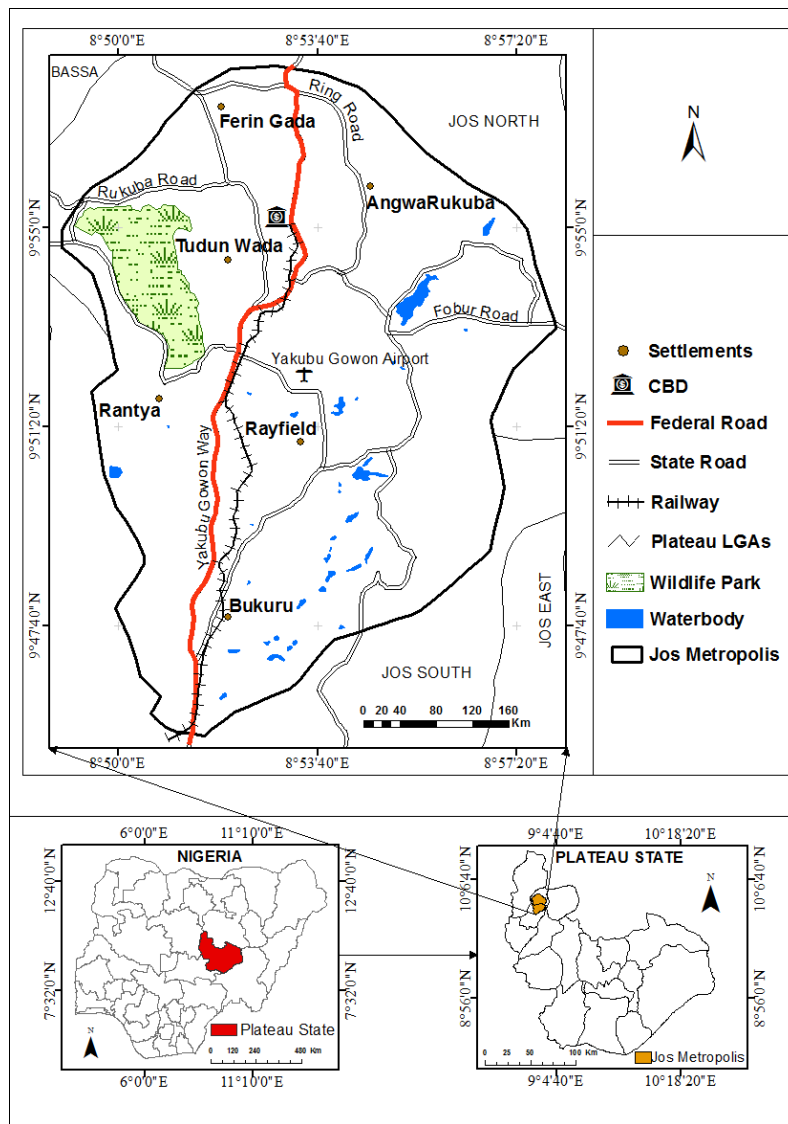


Figure 1: Jos metropolis

The focus of the study is to investigate the agents of urban growth in Jos metropolis. But first, it is important to understand the spatio-temporal pattern and dynamics of Jos. Remote sensing and descriptive statistics methods are engaged in the analysis of data.

### 2.1 Land use/cover analysis

Four multi-temporal medium resolution Landsat images are used to analyze the urban growth trends and patterns of Jos metropolis for the past 30 years. Supervised maximum likelihood classification algorithm was applied in ENVI 5.1 software environment. Accordingly the images were classified in to different land cover classes which finally ended up generating four different year land cover maps of the study area. The land cover maps are composed of three major land cover classes namely; built up, non-built up and water body. The built up area consists of commercial, residential, road and impervious features, industrial and commercial units, road and railway networks, parking lots, sport and leisure facilities, etc. while the non-built up area includes cropland (agriculture land), parks, grasslands, forests, green spaces, bare soil and others. Water body includes dams, river, abandoned mining ponds etc. The overall classification accuracy was assessed using ground truth region of interest.

Post-classification comparison technique was used to produce growth/change map, in ArcGIS 10.1. The resulting land cover maps were then visually compared and change areas are simply those areas which are not classified the same at different times. Following this method, maps were produced to show the newly built up area between each subsequent years (i.e. 1984-1991, 1991-2003 and 2003-2014). Spatial extent and rate of urban growth over time was quantified in the study area. In this context, urban growth is considered as an increase in the physical extent of the built up (urban) area.

### 2.2 Factors responsible for urban growth in Jos Metropolis

An important task of the field work is to collect relevant information about factors of urban growth in the study area. This task was carried out in the form of questionnaire using the stratified and random sampling method. In line with Ader and Mellerbergh's (2008) suggestion that sample size should be small in order to improve quality and accuracy of research work, only 100 copies of questionnaire were administered to respondents drawn from all over Jos. Jos metropolis comprises of two Local Government Areas, Jos North and Jos South. The population of Jos North and Jos South Local Government Areas as indicated in the 2006 census was 429,300 and 306,716 respectively. Jos metropolis was first stratified into two areas based on LGAs. Then copies of the questionnaire were divided based on population density, 60 copies for Jos North LGA (more densely populated) and 40 copies for Jos South LGA (less densely populated). A total of 100 copies of questionnaire were administered and 85 copies were retrieved.

## 3 Results and Discussion

Landsat data of four dates were classified. The multi-temporal satellite images were classified into built up, non-built up and water body (Table 1). Results of image classification are given in Figure 2. The overall accuracy of all images was found to be greater than 85% which is considered as a good result for remote sensing image based analysis (Herold *et al.*, 2005).

**Table 1:** Land cover change pattern

Class	1984		1991		2003		2014	
	km <sup>2</sup>	%	km <sup>2</sup>	%	km <sup>2</sup>	%	km <sup>2</sup>	%
<b>Built-up</b>	14.8	5.9	21.77	8.7	29.86	12	61.94	24.8
<b>Non-builtup</b>	231.67	92.8	224.43	89.9	217.37	87	185.35	74.2
<b>Waterbody</b>	3.24	1.3	3.5	1.4	2.48	1	2.42	1
<b>Total Area</b>	249.7	100	249.7	100	249.7	100	249.7	100
<b>OA</b>	99.973		99.848		99.754		98.886	
<b>K</b>	0.999		0.993		0.991		0.996	

**Note:** OA- Overall Accuracy, K- Kappa's Coefficient

In 1984, the main LULC type was non-built up land accounting for more than 90% of the total landscape. After 30 years, the LULC in Jos metropolis changed significantly, with a rapid urbanization at the cost of losing non-built up land (such as agricultural land, parks, grasslands, forests, green spaces, bare soil etc.). Non-built up land decreased from 92.8% of the total area in 1984 to 74.2% in 2014., while the built up land increased significantly

from 5.9% in 1984 to 24.8% in 2014 (Table 1). The increase in built up land reflects the accelerated urban expansion with population and economy growth, opening up a large amount of land pending construction.

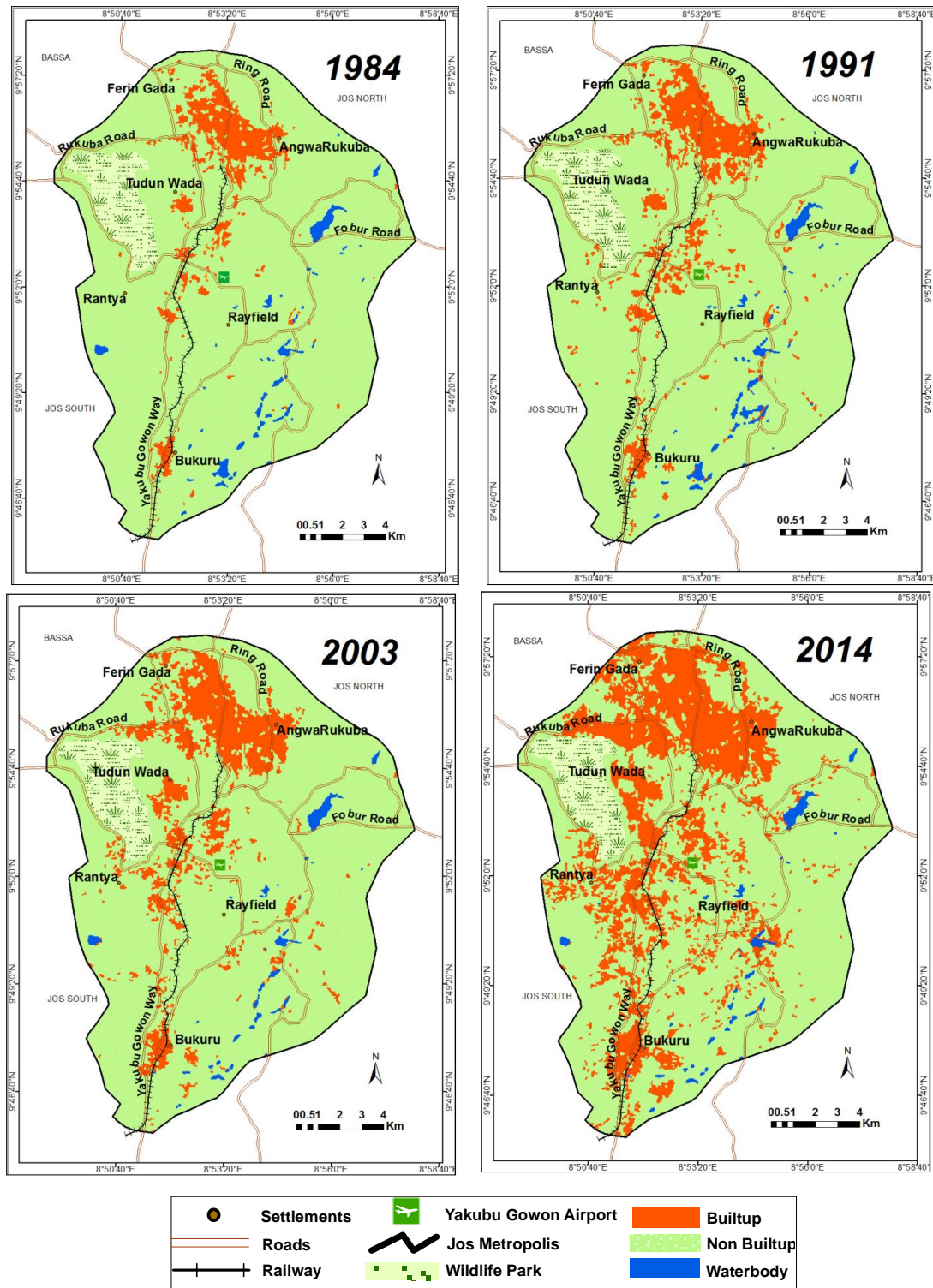
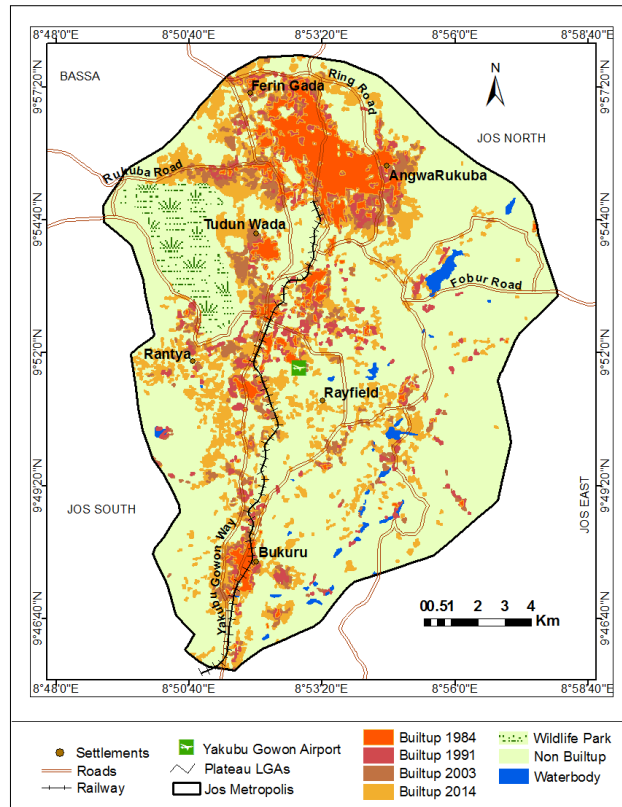


Figure 2: Image classification (1984 and 2014)

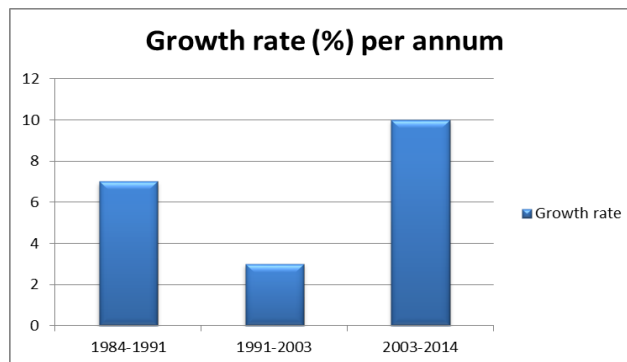


**Figure 3:** Spatio-temporal growth map

Growth analysis of the total built up area was conducted in order to determine growth rate. The average growth rate of 6.7% (Table 2) was observed. The period (from 2003 to 2014) was seen to experience more rapid urbanization (107%) compared to the other two periods.

**Table 2:** Analysis of Built up area expansion based on Total Area metrics

Study period	Change (ha)	Change (%)	Time span	Growth rate (%)
1984-1991	697	47	7years	7
1991-2003	809	37	12years	3
2003-2014	3208	107	11years	10
<b>Average</b>				<b>6.7</b>



**Figure 4:** Built up area growth rate

### 3.1 Driving forces of urban growth

The major factors responsible for the changing patterns of urban growth in Jos were analyzed based on people and community perception. The participatory data was captured through field survey. About 85 copies of

questionnaire was retrieved and used in the study. Findings from the field survey revealed that 69.4% of the respondents were males. Most of the respondents (68.2%) were between the ages of 30-59 years with 96.5% as residents in Jos metropolis.

It was observed that the population growth of Jos is recent because 48.2% of the sample has stayed in the town for 11-29 years while 36.5% have settled in the town for 30 years and above, consequently regarding Jos as a place of permanent residence. This is good for the analysis given that this study is taking into account 30 years of urban growth (1984 to 2014). This means that their responses would be much valid due to the fact that they have experienced various forms of urbanization in Jos metropolis. The educational attainment of the respondents suggests that 89.4% have their education at the tertiary level. In contemporary Nigeria, there is a limited urban employment opportunity, therefore available positions are rationed by educational and professional skills; only those with 'good' educational qualifications have a chance of securing jobs. 17.6% of the respondents are unemployed while 65.9% are civil servants. This implies that there is an improvement in the occupation of the respondents and consequently their standard of living. The distribution of the level of income among the respondents whereby 29.4% earn above N100, 000 and 37.6% earn less than N50, 000 per month is an indication of the socioeconomic status of the people in the town.

3.1.1 Urban growth of Jos Metropolis

The growth of Jos metropolis in the past 30 years is obvious as 54.1% of the respondents view it as rapid manifesting in increasing economic activities and expansion of urban areas. 28.2% of the respondents believed that the growth is normal while 16.5% indicated slow urban growth as shown in Figure 5.

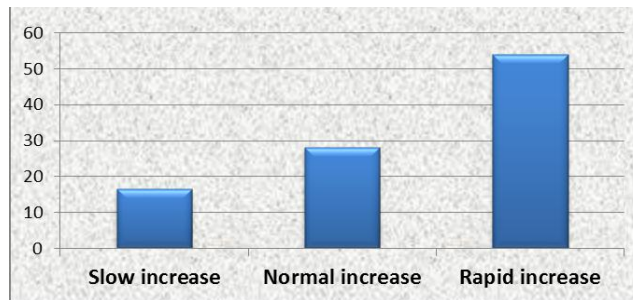


Figure 5: Rate of urban growth in Jos metropolis according to respondents

Jos metropolis has continued to experience unprecedented growth both in population size and spatial coverage due to rural-urban migration, educational development, economic growth residential development and pattern of transportation routes. This rapid growth has made the urban area of Jos to encroach into some of the rural lands. Field survey findings revealed that 87.1% of the respondents believed the rate of land development in Jos metropolis for 30 years has increased. Results for the rate of land development in Jos metropolis considering selected urban settlements is given in Table 3 while Figure 6 shows the spatial pattern of the rate of land development.

Table 3: Rate of land development in Jos metropolis

ID	Settlement	Before 1984 (%)	1985-2003 (%)	2004-2014 (%)
1	Angwa Rogo	29.4	24.7	10.6
2	Angwa Rukuba	23.5	23.5	22.4
3	Dadinkowa	12.9	27.1	23.5
4	Fobur	3.5	14.1	38.8
5	Gangare	30.6	20	7.1
6	Lamingo	4.7	9.4	60
7	Tudunwada	18.8	23.5	31.8
8	Rantya	1.2	17.6	51.8
9	Rayfield	3.5	16.5	57.6

It was observed that in the early period (before 1984) of development in the metropolis, settlements in the northern region - Angwa Rogo (29.4%), Angwa Rukuba (23.5%) Gangare (30.6%) and Tudunwada (18.8%) dominated in terms of land development. This could be attributed to the fact that the northern region being the capital of the state was involved and engaged in various form of socioeconomic activities. The central business

district (CBD) is situated in the northern region with the settlements in emphasis at close proximity thereby improving the urban development. Another reason could be the presence of the University of Jos in the northern region which attracted students and individuals from every part of the country. This led to developing land for accommodation and building of new hostels for rents. The low percentages obtained before 1984 for Fobur, Lamingo, Rantya and Rayfield could be due to the rugged terrain and the extensive land-dependent nature of its rural economy. The rate of land development in Dadinkowa was fluctuating. The development in Dadinkowa increased in the early periods but declined in the last period (2004-2014) because the settlement was also involved in the recent unrest in the metropolis. In the later periods 1985-2003 and 2004-2014, there was a drastic fall observed for Angwa Rogo and Gangare settlements indicating lack of land development. Areas such as Angwa Rogo, Gangare and Angwa Rukuba are known as hotspots considering the wave of crises and unrest in the metropolis in the later years (2001-2010). Therefore, security is not absolutely guaranteed in such areas hindering the urban development process. Further, this occurrence has led to a shift in the direction of urban development towards other parts of the northern region and the southern region. Settlements that scored low in the early periods benefited from this shift. Lamingo, Rantya and Rayfield settlements had the highest rates of land development with a sharp increase 60%, 51.8% and 57.6% respectively. This is believed to be as a result of residents relocating from the hotspot areas to settle in more peaceful locations.

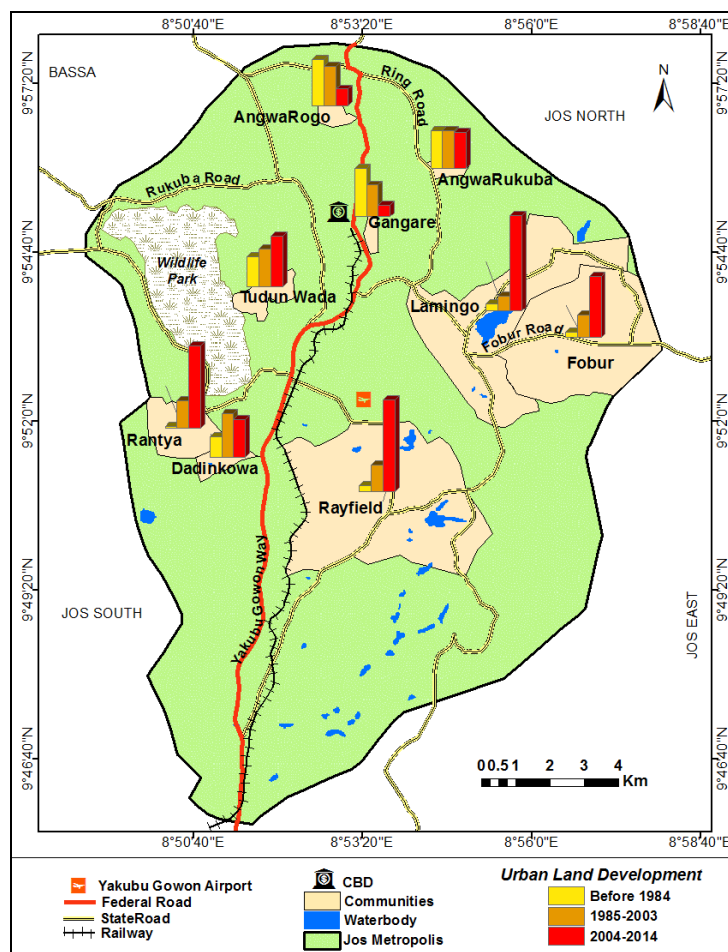
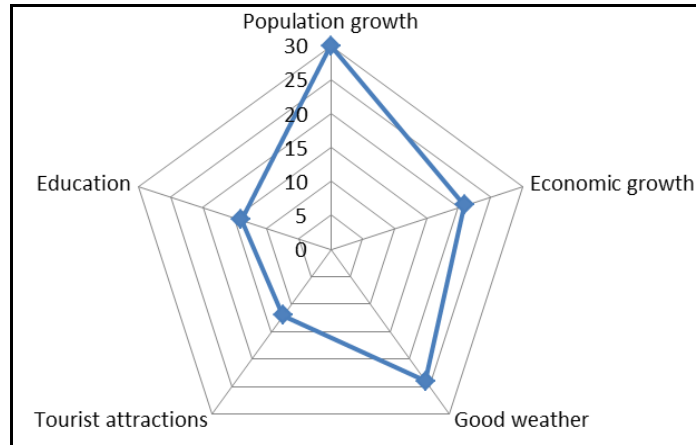


Figure 6: Rate of land development in Jos metropolis

3.2 Causes of urban growth in Jos metropolis

The first and foremost reason of urban growth is increase in urban population and this was verified by 30% of the respondents (Figure 7). Rapid growth of urban areas is the result of two population growth factors: (1) natural increase in population, and (2) migration to urban areas. Natural population growth results from excess of births over deaths. In the recent time, the movement of people from rural to urban areas within Jos metropolis (internal migration) is most significant. People move into urban areas mainly to seek economic opportunities. In Jos, especially Jos North LGA, there are better basic services as well as other specialist services that are not

found in the rural areas. Health is another major factor. People, especially the elderly are often forced to move to the city where there are doctors and hospitals that can cater for their health needs; the Jos University Teaching Hospital (JUTH) and Plateau state Specialist Hospital to mention a few are situated in the metropolis which provide such services. Other factors include a greater variety of entertainment (restaurants, Recreational parks- Jos Wildlife Park, Jos zoo, Solomon Lar’s amusement park etc.) and a better quality of education.



**Figure 7:** Causes of urban growth in Jos metropolis

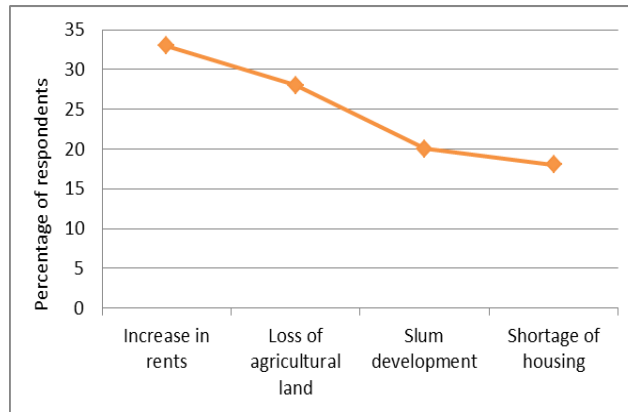
The huge growth in urban population may cause uncontrolled urban growth resulting in sprawl. The rapid growth of Jos strains the capacity to provide services such as energy, education, health care, transportation, sanitation, and physical security. The commercial mining activities which commenced in the early century brought an influx of expatriates and local labour from the surrounding areas onto Jos metropolis. This was the single most important activity in the history of Jos because it significantly altered the population composition, the landscape, the social and economic structure. The economic base of the Jos is predominantly dominated by commercial and public service employees. Another indicator of economic growth is the location of a market, a shopping centre or a corner shop in existence within the neighborhoods. This is an indication of high involvement of the populace in commercial ventures.

The various natural attractions unique to Jos, including its mild climate and attractively beautiful rock outcrops make Jos an attractive destination to both local and international tourists. In addition to the natural attractions, there are also various man-made features which include the famous Jos Zoo and Museum, Jos Wildlife Park, the game reserves, which impose dominant attractions to likely visitors to the metropolis. The Jos Wildlife Park is located about 4km along the Kufang-Miango road which covers approximately 8 sq. km and offers striking wild life experience to the visitors. The development of the tourism sector saw an expansion of the hotel services. New hotels sprang up mostly in and around Government Reservation Areas and the City centre, while existing hotels have been extensively renovated such as Hill-Station Hotel, Jos.

Some other factors were specified from key informants to be responsible for urban growth in the region. They are; relocation to the metropolitan area due to insecurity in the Northeastern part of Nigeria, improved transport systems such as good roads, government policy which includes street naming of Jos metropolis etc. Transportation routes open the access of city to the rural areas and responsible for linear branch development. The construction of expressways and highways cause both congestion in the city and rapid outgrowth. Development of urban economy and thereby job opportunities are directly dependent on the transportation facilities. Therefore, transportation facilities can never be suppressed; rather initiatives to impede linear branch development by means of government policies and regulations should be practiced.

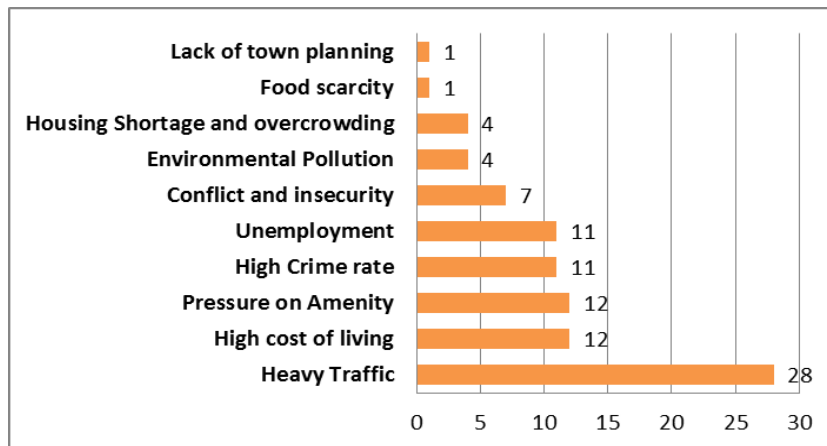
Effects of urban growth were identified by the respondents (Figure 8). The respondents indicated that the major effect of urban growth in Jos metropolis is increase in rents and loss of agricultural land. The increase in rents could result from the increase in population over the years. The influx of people into Jos metropolis has led to pressure on basic and social amenities. Residents of the core city lack sufficient living space. This encourages rural area development for more living space. People can buy more living space in the outliers than in the inner city, since the cost of property is less in the outliers. The increase in rents has also made residents to build structures in the outliers of the metropolis indicating pockets of and fragmented urban clusters.





**Figure 8:** Effects of urban growth in Jos

The loss of agricultural land is also related to increase in population leading to conversion of agricultural lands to built-up lands. To confirm this, building structures are seen springing up on agricultural lands at an alarming rate especially at Rayfield settlement and along Lamingo road. Another effect of urban growth is the development of slum noticeably at Angwa Rogo, Gangare, Angwa Rukuba and Tudunwada settlements. A slum is referred to as a poor area. This is caused by overcrowding. Other effects of urban growth revealed by the respondents include adequate water supply, good roads, environmental pollution, heavy traffic, high crime rate, Insecurity and low income. Results gotten from the respondents showed that population growth was the major driver of urban growth in the study area. Therefore, problems associated with population growth were identified by the respondents (see Figure 9). The major problem of population growth identified is heavy traffic subduing every other problem with a count of 28.



**Figure 9:** Problems of population growth in Jos metropolis

**4 Conclusion**

The study has shown that Jos has continued to experience unprecedented growth both in population size and spatial coverage due to rural-urban migration, educational development, residential development, economic growth and pattern of transportation routes. This rapid growth has made urban area of Jos to encroach into some of the rural lands. Similarly infrastructural facilities, which are regarded as agents of development, should be evenly distributed at various segment of the town so as to achieve a more balanced city growth. The major factors responsible for city growth apart from natural increase (population increase) are through rural-urban migration, economic growth, urbanization, transportation, tourist attraction, good weather and educational development.

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