

Urban Transformation and Road Infrastructure Development in Gwagwalada, F.C.T., Abuja

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Abstract

Population growth and migration has been asserted as the major driver of urbanization, with 2.8% annual growth rate and 5.5% per annum of urban areas in Nigeria and studies have asserted the concentration of urban population in the periphery of the Nigeria cities, all these attributes make urban transformation state in Nigeria to be of great concern. Transportation was noted as an integral tool for city development and functioning, and without adequate provision of transportation infrastructure in urban transformation processes, sprawl settlements will evolve. Abuja the Federal Capital Territory of Nigeria conceived in 1976 based on the Newtown concept and central place theory was planned with the incorporation of satellite towns to accommodate envisage growth from the main city. After the movement of Nigeria's capital seat to Abuja city in 1991, the city has been recorded to be experiencing rapid growth including the satellite towns. Poor planning of the Cities and deplorable state of Infrastructures among others has been identified as challenges of urban growth in Nigeria. The study investigates land-use changes in respect to road infrastructure transformation in Gwagwalada Township, Gwagwalada Area Council of Abuja. The study is based on geospatial analysis of existing Gwagwalada township base map including acquired 1m resolution IKNOX satellite imagery of 2019, 2009 and 1999 were used to prepare updated cadastral maps for urban expansion and transportation growth analysis and ASTRA satellite imagery was acquired for land use land cover analysis for 2019, 2009, and 1999. The analysis shows that there is spatial growth in Gwagwalada Township without corresponding growth in the transportation network. There is a high disparity in the level of urban growth and transportation infrastructure in the study area, hence the need for intervention for the development of road networks to save the satellite settlement from turning into sprawl.

Keywords: settlement, sprawl growth, development, city

Introduction

Since the 19th Century, the population growth and urbanization have surged. Despite the fact that cities and towns make just a small percentage of the overall land area on the planet, they are home to nearly half of the world's inhabitants (United Nations 2001). Due to its consequences, urbanization has been a prominent topic of controversy for the last three decades. According to the United Nations, the number of people living in cities will double

by 2050 (from 2.4 billion to 5.5 billion in 2025); by 2030, the major developing world regions will have more urban than rural residents; and by 2050, two-thirds of the population will likely live in cities. Nigeria with a 2.8% growth rate is a developing country with urban growth of 5.5% is at the alarm state site. The United Nations (2006) reported that over 50% of Nigerians population lives in the cities. Aguda & Adegboyega (2013) noted that much of the

urban population is located on the periphery as the cities, which lead to sprawl.

With the high rate of urbanization, population growth and migration have been asserted as the majors' driver of urbanization, with a 2.8% annual growth rate of Nigeria and 5.5% per annum of urban areas (Alabi, 2009). The concentration of the urban population on the periphery of the Nigeria cities attributes to urban transformation problems (Aliyu, 2011). Ever since the period of industrialization that brought about separation in an industrial area and residential area, transportation infrastructure has become a unifying factor between the two land uses. Transportation problems have been caused concerned too many urban/city managers, which is multidimensional, such as air pollution, traffic congestion/holdup, accident and road social vices have impacted the social, economy and wellbeing of the people. Poor planning of the Cities and deplorable state of Infrastructures among others has been identified as challenges of urban growth in Nigeria (Abonta, 2016).

The connectivity of a city is determined by its transportation network; without a good transportation system in urban transformation, sprawl settlement is prevented. Transportation, according to Solanke (2013), is an important tool for city development and operation. According to Aluko (2000), transportation is the ability to move people, products, and services across space to attain some social, economic, political, or psychological goal. Transportation looked at the behavioural and socioeconomic components of a systems approach to transportation development, economic, environmental, and social systems, as well as their interconnected implications on development (TRB 1997).

According to Solanke, (2013) transportation is a city life, while functioning adequately, the city enjoys tremendous growth, without good transportation set-up, cities bound to animate and function. Aljoufie *et al*, (2011)

in Jeddah city of Saudi Arabia, revealed that the relationship between urban growth and transportation is give-and-take in nature and transport infrastructure expansion strongly correlates with population growth, spatial expansion, and land-use change. However, in Nigeria (Abuja in context) the rate of urban/city expansion has been on increase, resulting in high demand for transportation infrastructure to ease the rate of urban deterioration across the nation. This study assesses the urban expansion of road infrastructure expansion of Gwagwalada area council.

Transportation infrastructure most especially land transportation infrastructure as (the medium of migration, upon which urbanization rides, promote and sustain the liveable city. The concept of Newtown and satellite towns was developed on the transportation model, transportation is a yardstick for city functioning (maker a breaker city). Gwagwalada is one of the five area councils (Satellite towns) and Federal Capital City FCC as the city centre (Newtown). The study of urban transformation of the Gwagwalada Area Council as FCC and transportation infrastructure will establish the relationship between the city growth and the transportation growth over the thirty (30) years.

This study aimed at assessing the level of urban transformation in Gwagwalada township, with the view to determine its impact on road infrastructure development in the satellite town of the Federal Capital Territory of Nigeria. The objective for the study has to do with the examination of the rate of urban transformation in Gwagwalada between 1999 to 2019; to assess the road infrastructure/ network changes between the period of 1999 to 2019 and determine the effect of spatial transformation on the road infrastructure development in the study area.

The Study Area

The Federal Capital Territory Administration of Abuja was established on February 3rd, 1976. The Federal Capital

Territory of Nigeria is located at 8050'N 7010'E. Kaduna State borders it on the north, Kogi State on the south, Niger State on the west, and Nassarawa State on the east. The FCT has a land area of 7,135km² (2,824 square miles) and is immediately identifiable by a hill, which accounts for around 250 square kilometers of the total land area of the FCT; the rest land area is used for development (IPA Abuja Master Plan, 1977). The total area is 7,135 square kilometers (2,824 square mile). In 2011, the population was estimated to be 2,238,000 people. Area council under Abuja include Abaji, Abuja Municipal, Gwagwalada, Kuje, Bwari and, Kwali. Figure 1.1 shows study area map.

Methodology

Secondary data was used in this study. These data comprise of existing Gwagwalada township base map, population data, processed 1m resolution satellite imagery for baseline mapping and Processed ASTRA satellite imagery for land use land cover analysis for 2019, 2009, and

1999. The population data was sourced from the National Population Commission to examine population growth; the satellite imagery will be acquired from the United State Geological Survey website. Existing Gwagwalada base map was obtained from Abuja Geographic Information System (AGIS) office. In this study spatial-temporal analysis of the study area was carried out at an interval of 10 years between 1999 – 2019. A metre resolution IKONOS satellite imagery and existing Gwagwalada township base map were used to prepare the cadastral maps for the road infrastructure and urban expansion. Processed ASTRA satellite imagery was acquired for land use land cover analysis for 2019, 2009, and 1999. Supervised image classification was used to determine spatial expansion of Gwagwalada township, while buffer spatial proximity analysis was used to determine influence of transport infrastructure in spatial temporal growth of Gwagwalada township. Mapping/geometry calculation of road length was employed to determine growth on transportation infrastructures.

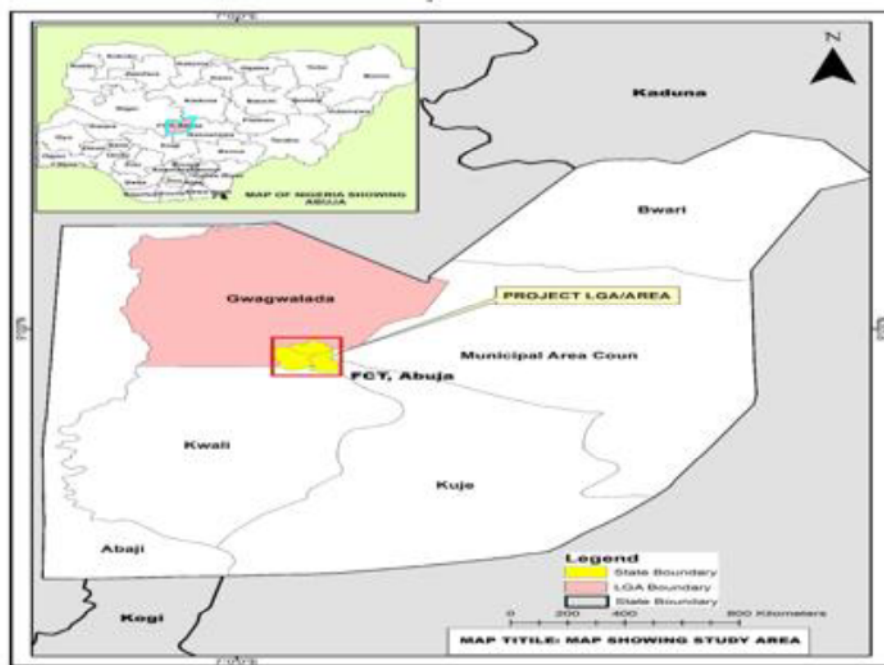


Figure 1: Map of FCT Showing Location of Gwagwalada Township

Results Discussions

Assessment of Urban Transformation in Gwagwalada

This section of the analysis explains the extent of urban transformation in the study area. On the course of this, the land use /land cover of the town was estimated between 1999, 2009 and 2019, respectively, thereafter, the extent areal of the built-up area was deduced, to develop reference on the trend of development that had occurred in the study area under the period covered by this study.

Land use /Land cover of Gwagwalada Between 1999 and 2019

In 1999 (Table 1), the Gwagwalada the extent areal of the built-up area was estimated of 400.4skm which was over

11%, the vegetation cover of the area was calculated to almost be 40% of the total land masses, the water body 25%; cultivation land (23%). Figure 2 reveals the graphical outlook of the extent of the study area in 1999.

Table 1 and Figure 3 shows the land use land cover of Gwagwalada in 2009. The analysis reveals that the built-up area was over 22% of the total land coverage, vegetation land use 23%; water body 18%; bare soil less than 1% and cultivated land has the total areal 35%. This analysis implies that the built-up was increased compared to the report of the previous period of 1999. In the similar view, the vegetation cover was drastically reduced, while the waterbody gained an increase in the total areal coverage and the cultivation area increased as well.

Table 1: Land use/Land Cover of Gwagwalada between 1999 and 2019

Land Use	1999		2009		2019	
	Area (Km ²)	%	Area (Km ²)	%	Area (Km ²)	%
Built-up Area	400.3	11.35	811.13	22.99	1636.14	46.37
Vegetation	1400.88	39.71	812.41	23.03	204.57	5.8
Waterbody	900.05	25.51	653.05	18.51	87.24	2.47
Bare Soil	15.12	0.43	13.63	0.39	491.84	13.94
Cultivation	811.67	23.01	1237.85	35.09	1108.29	31.41
TOTAL	3528.09	100	3528.09	100	3528.09	100

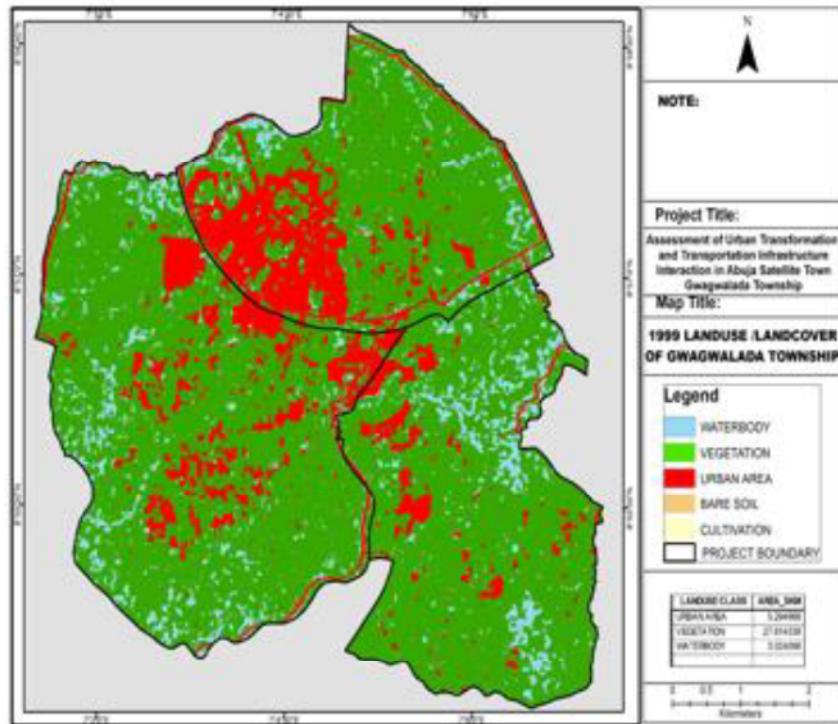


Figure 2: Land use /Land cover of Gwagwalada 1999

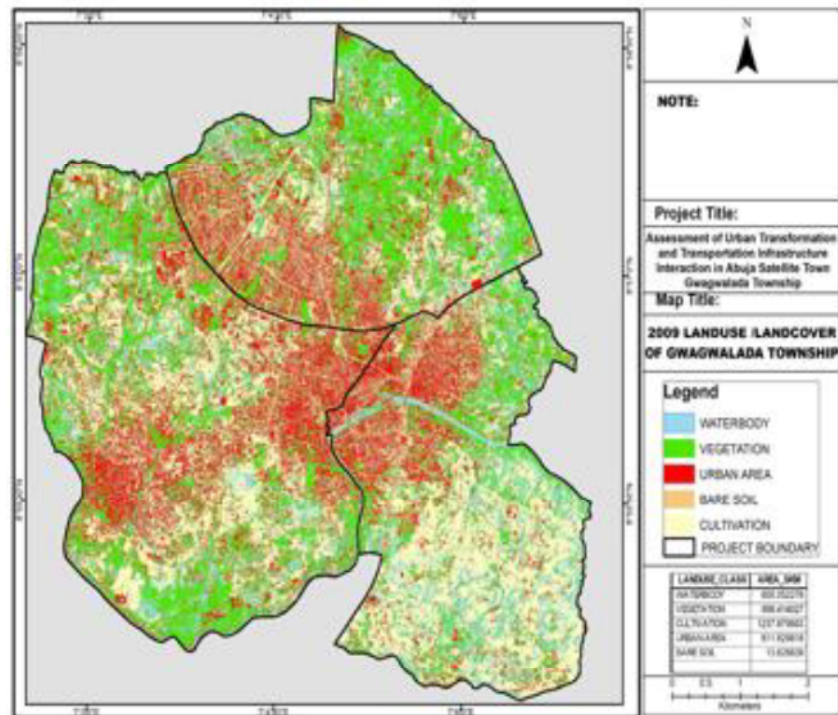


Figure 3: Land use /Land cover of Gwagwalada 2009

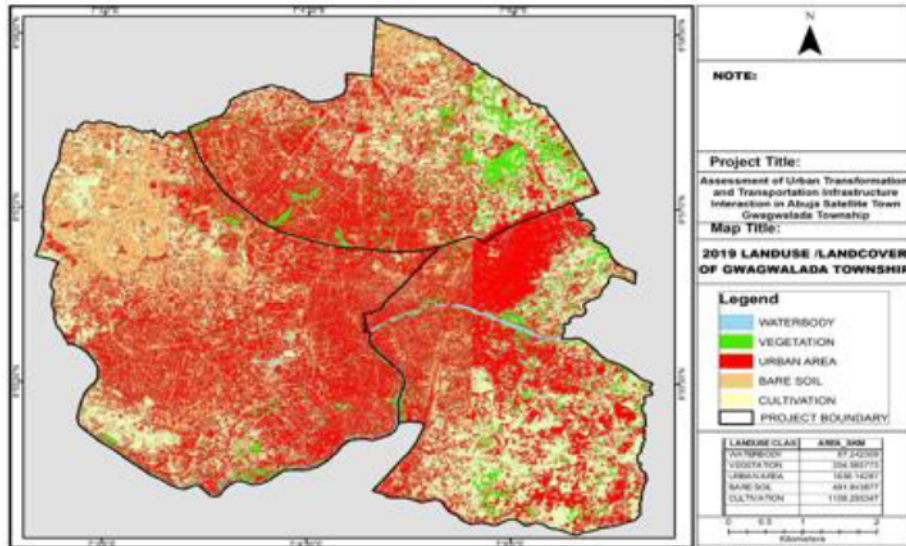


Figure 4: Land use /Land cover of Gwagwalada 2019

According to Table 1 of the land use/ land cover of Gwagwalada in 2019, the built-up area was estimated to have drastically increased above 46%, while the vegetation area reduced to 5%, also the waterbody decreased less than 3% and there were more of the bare land to the tune of 13%, the cultivation land in the study was also observed to decreased to 31%, all as revealed in Figure 4.

Trends of the Land use/Land Cover of Gwagwalada (1999 and 2019)

Figure 5 exhibits the trends in the LULC of Gwagwalada between the periods undertaken in this study. For the built-up area: there was a steady increased throughout the periods, from just little

above 400km² to above 811km² and to 1636km² in 1999, 2009 and 2019, respectively. The vegetation cover of the area during the period steadily declined from 1,400km² to 812km² and to 204km² within the said period. For the waterbody: the coverage area slightly reduced within the first two periods (900km² and 653km²) but was drastically declined at the third period (87km²). The bare soil of the study area, which was just little above 15km² in 1999 slightly decreased to 13km² in 2009 and sharply increased to 491km² in 2019. The cultivation area of Gwagwalada, which was just at 811km² in 1999, increased sharply above 1,200km² in 2009 and slightly reduced to 1108km² in 2019

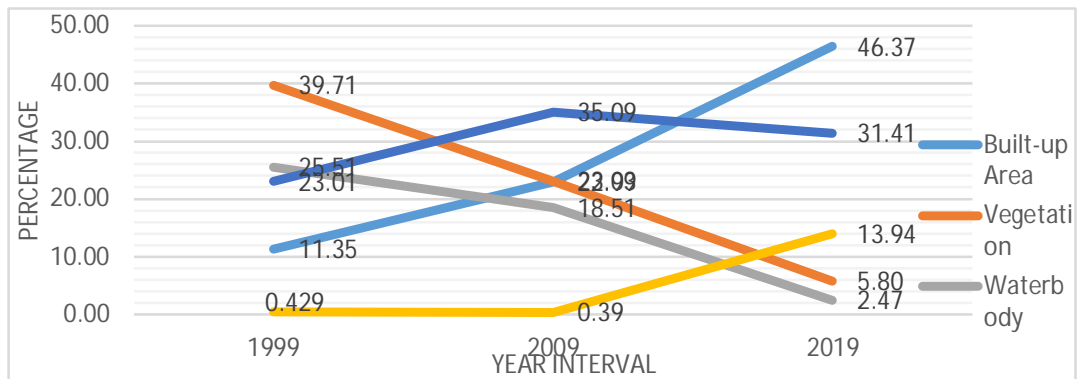


Figure 5: Analysis of land use /land cover of Gwagwalada in 1999 and 2019

Rate of Changes in the Built-up Area

The changes that occurred in the built-up area of Gwagwalada between 1999 and 2019 is summarized in Table 2. There was an over 11km² of built-up area by 2009 and the area also over 23km² in 2019. This indicates an over 100% increase in the in the built-up area within the periods covered by this study.

Road Infrastructure Development in Gwagwalada between 1999 and 2019

The nature of road infrastructure in Gwagwalada in during the period were more of untarred access, few metres of drainages, culverts and narrow bridges (see Table 3). From the imagery analysed on road network in 1999 (Figure 6), the extents of road access during the period were just about 130km², while the untarred roads were estimated to slightly be above 105km², the value that constitutes a higher percentage (above 80%) of the entire access roads of the town. The tarred roads, also, was estimated to slightly above 25km², which the percentage was below 20%. This implies that there were limited physical development available in the areas as at the period analysed.

Between 1999 and 2009, the nature of roads in Gwagwalada was fairly enhanced in the year 2009 with an increase in road development compared to the previous year in 1999. In 2009, the entire road network in the study area increased more above 160km² as against the total estimate of road network of 130km² in 1999 (Table 3). In this view, the untarred stood at 116km², which is above 60% of the entire roads network and the percentage of the roads in the same area was estimated to slightly increase above 51km², the percentage which stood at 30% of the entire road network for the period of 2009. As observed, there were more numbers of roads developed after between 1999 and 2009 (Figure 7), which was aided by rapid increase in physical developed of residential buildings and other commercial activities which sprang up in the area. The impact of the location of the University of Abuja, which is not far from the town was quite noticed, as numbers of staff and students resides in the town. Within this period, a serious demolition exercise by the Federal Government at the FCT, influenced the swift movement of large numbers of people into Gwagwalada area council and by extension, into Gwagwalada town.

Table 2: The Rate of Changes in Built-up Area

Year	Built-up Area (km)	Change in Built-up (km)	Rate of Change (%)
1999	11.346	-	-
2009	22.990	11.64	102.6
2019	46.375	23.38	101.7

Table 3: Nature and Extent of Road Network Development Between 1999 and 2019

Nature of Road	1999		2009		2019	
	Extent of Road (km)	%	Extent of Road (km)	%	Extent of Road (km)	%
Tarred Roads	25.56	19.55	51.1	30.52	76.91	20.81
Untarred Roads	105.21	80.45	116.31	69.48	292.7	79.19
Total	130.77	100	167.41	100	369.61	100

Table 3 reveals the nature and extent of road network of Gwagwalada in 2019. The analysis shows that in the year 2019, the extent of road developed stood at 369km², which is quite increased compared to the previous 2009. The extent of untarred road network at the period was considerably higher from the previous period, which implies that there are quite areal of land used as built-up area. Nevertheless, within the same period, the extent of tarred road also

got increased at above 75km², at about 20% of the total land areal in 2019 (Figure 8). The impact of increased in housing development and road construction were on the increased, hinterland was opened, the boost in commercial activities due to the location and proximity of government establishments and projects were among the factors that influenced the rapid spatial transformation.



Figure 6: Road Development Network in 1999

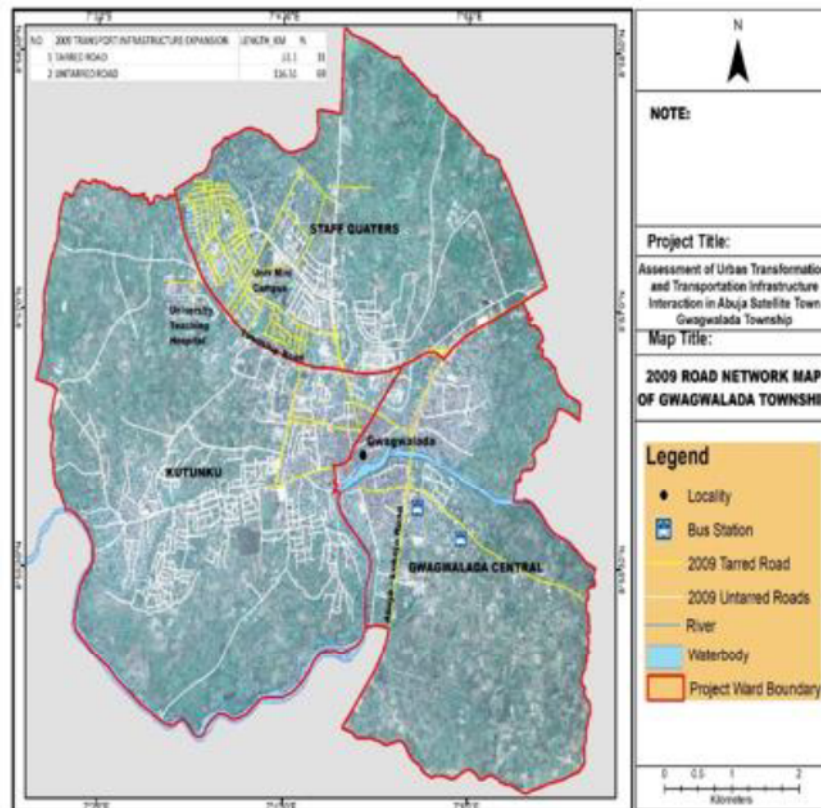


Figure 7: Road Development Network in 2009

Impact of Urban Expansion and Road Infrastructure on Gwagwalada Population Growth, Spatial and Road Development in Gwagwalada

With the population of Gwagwalada which stood above 66,000 in 1999, the spatial development of the town then was just little above 11km² (Table 4). The nature of road infrastructure was majorly (80%) untarred.

They are without drainages, culverts were few, and bridges that run over the available rivers were few. The tarred road that existed in 1999 were more concentrated within the University Staff Quarters area, the town itself, recorded a very low development in road infrastructure. The effect of urban transformation is the increase in number of untarred roads in most of the settlements around the area (Figure 9).

Table 4: Population and Spatial Development in Gwagwalada (1999 – 2019)

Year	Population ('000)	Growth	Built-up Area (km ²)	Road Developed (km ²)
1999	66,458		11.35	400.29
2009	158,588		22.99	811.12
2019	378,000		46.37	1636.14

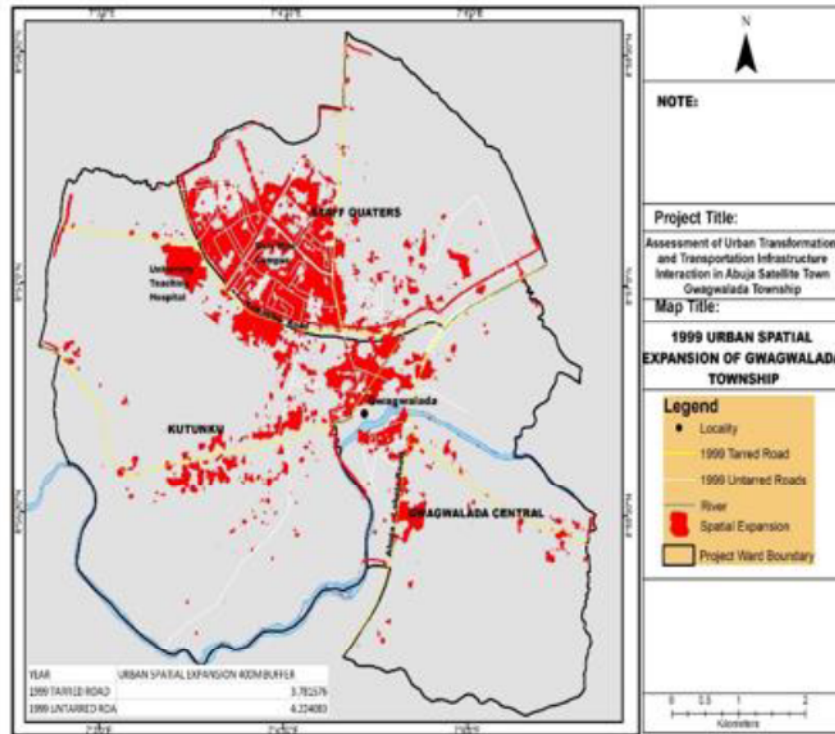


Figure 9: Road Development in Gwagwalada, 1999

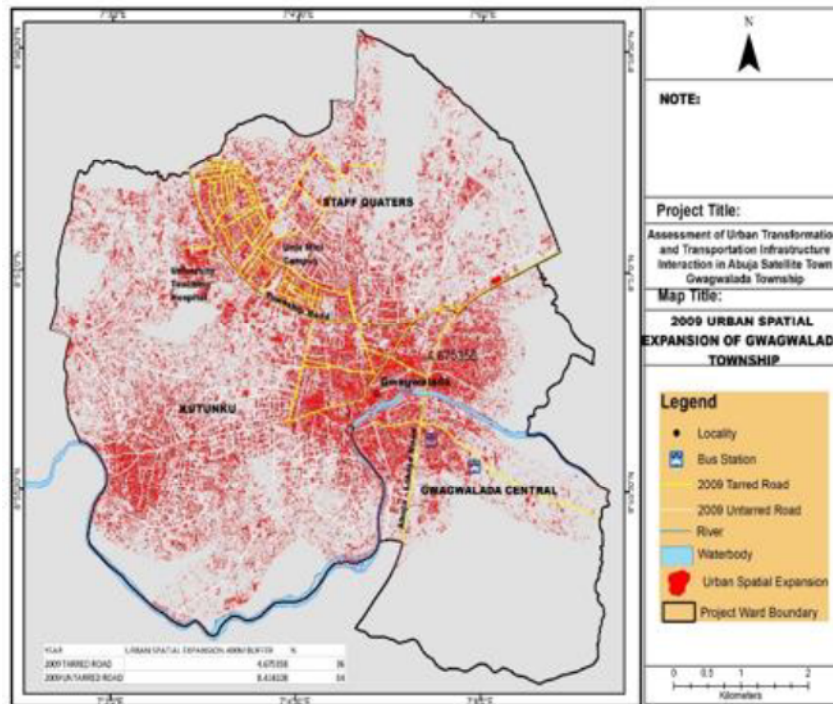


Figure 10: Road Development in Gwagwalada, 2009

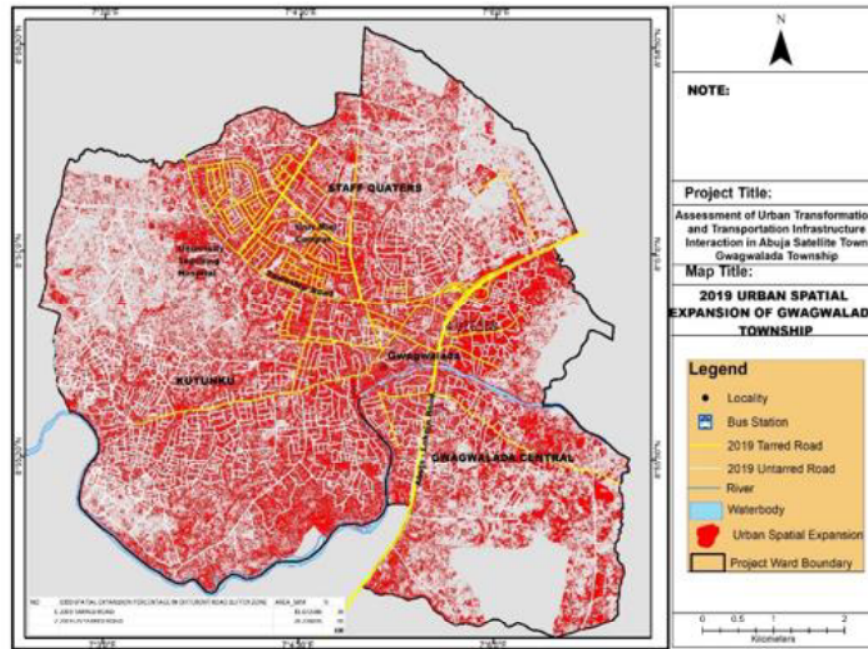


Figure 11: Road Development in Gwagwalada, 1999

As observed the spatial changes that occurred in the study area as a result of population changes between 1999 and 2019. Between 1999 and 2009, while the study area recorded a rapid increase in population from 66,458 – 156,588 people, the spatial expansion of the area also increased from 11.35km² – 22.99km² within the period. Considerably, road development within the period experienced a sharp increase with a bit over 811km². Although, there were more of road development, as the numbers of houses increasingly spread to the previously vacant space within Kutunku and Gwagwalada Central (Figure 10), but most of these roads were untarred, narrow and without other supporting infrastructure.

Gwagwalada in 2019 was characterized by a huge population increase (378,000 people), which doubled the previous population (158,588 people) of 2009 (see Table 4). With the extent of development of Gwagwalada, in 2019, the growth was twice of its previous expansion, a total coverage which stood at 46.4km². Based on road infrastructure of the area, the road construction that were noticed to be higher, were more of untarred access way. From the analysed imagery (Figure 11), Kutunku, Gwagwalada and other spaces were now

filled up with houses and other forms of development, to support these expansion, road infrastructure (1600 k^m²) spreads through all the areas.

Conclusion and Recommendations

The investigation on the spatio-temporal changes conducted on Gwagwalada between 1999 and 2019 revealed in the areal coverage of the town over a period. The analysis shows that the town steadily increase as the population changes from 11km² – 46km² between 1999 and 2019, indicating an over 400% increase in spatial development. The road infrastructure development in the study area was also on the increase for the period of the study. Although, there were more road construction, at different period, these, however, did not reduce the rate of the increase in untarred road infrastructure. Results indicate a strong increase in spatial expansion of Gwagwalada township as urban area increase in geometry progression, while there is no corresponding growth in transportation infrastructure. The study revealed most roads in Gwagwalada township are untarred.

This study also points out a strong significant influence of transport infrastructure on the spatial temporal expansion and land use change. Although majority of the roads are not tarred, urban expansion tends to grow along these roads as indicated in figures. also, the study shows that highways and main roads have stronger influence on spatial expansion and land use change in comparison with minor roads. The study recommends proper road planning and development in Gwagwalada township in order to stimulate economic development, reduce traffic congestion, avoid sprawl, and increase value of commercial, industrial, and residential development.

References

- Abonta, R. E. (2016). "City Growth: Issues and Challenges of Urban Sustainability in Nigeria" Being a text of the 46th Annual Conference Paper presented at the Conference of the Nigerian Institution of Estate Surveyors and Valuers.
- Agbola, T. (2004) "Readings in Urban and Regional Planning" Published by Macmillan Nigeria
- Aguda, A. S. & Adegboyega, S. A. (2013). Evaluation of Spatio-Temporal Dynamics of Urban Sprawl in Osogbo, Nigeria Using Satellite Imagery and GIS Techniques. *International Journal of Multidisciplinary and Current Research*. Sept/Oct 2013 issue. Accessed online at <http://ijmcr.com>.
- Alabi, M. O. (2009). Urban Sprawl, Pattern and Measurement in Lokoja, Nigeria. *Theoretical and Empirical Research in Urban Management*, 4 (13): 158 – 164.
- Aliyu, Y. B. (2011). *Analysis of the Pattern and Urban Management Implications of Sprawl in Kaduna Metropolis Nigeria*. Being a MSc Thesis Submitted to the Department of Urban and Regional Planning, Amadu Bello University, Zaria.
- Aljoufie, M. Brussel, M. Zuidgeest, M. & Maarseveen, M. (2013). Urban Growth and Transport Infrastructure Interaction in Jeddah between 1980 – 2007. *International Journal of Applied Earth Observation and Geoinformation*, 21: 493 – 505.
- Aluko O. K (2000). "A review of urbanisation and transport challenges in developing countries" *International Journal of Innovation Education and Research* www.ijer.net. 7 (4).
- Aluko, O. E. (2010) "The Impact of Urbanization on Housing Development: The Lagos Experience, Nigeria" *Ethiopian Journal of Environmental Studies and Management* 3(3).
- Burchell, R. W. & Mukherji, S. (2003). Conventional Development versus Managed Growth: The Cost of Sprawl. *America Journals of Public Health*, 93(9): 1534 – 1540.
- Dorina P. & Dominic S. (2018) Policy design for sustainable urban transport in the global south, *Policy Design and Practice*, 1:2, 90-102, DOI: 10.1080/25741292.2018.1454291
- Duranton, G., & Turner, M. A. (2012). "Urban Growth and Transportation". *The Review of Economic Studies*, 79 (4), 1407-1440.
- Harry T Dimitriou. (2012) "Urban transportation in the developing world" Cheltenham. Edward Elgar
- Jan K Brueckner. (1990) "Fare determination in airline hub-and-spoke networks" Urbana, Ill. College of Commerce and Business Administration, University of Illinois Urbana- Champaign
- Lloyd Wright. (2007) "Bus rapid transit planning guide" New York, N.Y. Institute for Transportation & Development Policy
- McCormick, K., Neij, L., & Anderberg, S. (2012). "Sustainable Urban Transformation and the Green Urban Economy". In R. Simpson, & M. Zimmermann (Eds.), *The Economy of Green Cities: A World Compendium on the Green Urban Economy* Springer. <http://www.springer.com/environment/sustainable+development/book/978-94-007-1968-2>

- Pojani D. & Stead, D. (2015) “Sustainable Urban Transport in the Developing World” *Beyond Megacities*. 7, 7784-7805.
<https://doi.org/10.3390/su7067784>
- Problems experienced and Counter Measures Initiated in the Philippines” Resource Material Series, No.68, by United Nations Asia.
- Robert Cervero. (2007) “Informal transport”: A global perspective *Transport Policy*, 6(14): 445-457.
- Roberto, C. (1998) “Sustainable urban development: definition and reasons for a research programme” *International Journal of Environment and Pollution*, 1(10):
- Roni, A. (1996) “Potential effects of vegetation on the urban thermal environment Atmospheric Environment. 3(30): 437-448.
- Solanke, M.O. (2005). “Intra-urban work and school trips characteristics in Ogun State, Nigeria” *International Journal of Development and Sustainability* www.isdsnet.com/ijds. 2(2): 987-997.
- UN-Habitat (2001). *The State of the World's Cities 2001: A World of Cities*. UN-Habitat Publications Unit, Nairobi Kenya.
- UN-Habitat (2006). *The State of the World's Cities 2006/2007: The Millennium Development Goal and Urban Sustainability: 30Years of Shaping the Habitat Agenda*. Earthscan, London.