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APPLICATION OF GIS IN ASSESSING URBAN GROWTH AND THE PATTERN OF TRAFFIC FLOW IN GOMBE METROPOLIS, GOMBE STATE, NIGERIA

Serah Istafanus Department of Geography Gombe State University, Gombe, Nigeria. Email: <u>serahistifanus@gmail.com</u>

Abstract

Urbanization and uncontrolled heavy traffic flow in urban areas especially in developing countries affect economic activities on a daily basis due to inability of the road network to accommodate the increasing large number of vehicles flying the roads. This situation has resulted into various traffic problems. This study therefore assessed urban growth and pattern of traffic flow in Gombe metropolis using both primary and secondary data for the analysis. Primary data for the study included traffic count survey at 12 road junctions. Secondary data were sourced from Google Earth Maps, 1996, 2002, 2008 and 2015 Landsat Satellite images. Image data collected were analyzed using Geo-information techniques and geo-database was created for the road networks, with charts and tables. The study revealed that there has been considerable growth in built-up land use area from 1777.4ha in 1996 to 14698.7ha in 2015. Furthermore, the finding shows a percentage change of 2.9 in 1996-2002, to 7.9 in 2002-2008 and 18.3 in 2008- 2015. Consequently, this influenced the patterns of traffic flow in the metropolis as movement to and from and within the newly expanded areas increased. The study also revealed that traffic flow patterns as at 2015 were found to be higher during working days of the week and at peak in the morning hours. Road corridors that attracted high traffic density were found to be those that cut across areas of commercial activities, administrative and residential areas. The study recommends traffic management strategies and the reassessment of the city master plan to accommodate the newly expanded areas. Keywords: Geospatial, flow, Land-use, Metropolitan, Pattern, Traffic, and Transportation.

1. Introduction

The term urban growth, which is defined as lands that have lost their rural characteristics and yet cannot be defined as urban include specific uncertainties, results in various problems such as unplanned urban growth and use of non-agricultural purpose. Therefore, urban growth can be defined as the rate at which the population of an urban area increased. This resulted from urbanization, which is the movement of people from rural areas to urban areas. The efficient movement of people and goods is essential to the economic development of any urban area, particularly a rapid growing one Osoba, (2012). The fact that transportation is the basis from which every other sector of the economy relies upon for effective functioning, urban planning should allow interaction of land development and



transportation facilities so as to encourage the most desirable pattern and character of urban growth.

Transportation, which is the movement of people, goods and services from one location to another, is a major facilitator of any nation's economy. Transportation also has contributed in time, place and utility of services. goods and The physical development and shapes of urban centres are dependent on the availability and efficiency of transportation network and mobile facilities Ajibove and Afolayan, (2009). Road transportation for instance, is an identifiable route between two or more places and it is the dominant mode of transportation in most of the urban centres of the world.

Traffic flow, on the other hand, is the study of interaction between vehicles, drivers, pedestrians, cyclists, other travelers and infrastructure (including highway signage and traffic control devices), with the aim of understanding and developing an optimal network for efficient movement of traffic and minimal traffic congestion problems. Therefore, traffic phenomena are complex and non-linear depending on the interaction of the number of vehicles, and studying it requires closer attention due to the individual reaction of drivers. Vehicles do not interact simply following the law of mechanics, but rather show phenomena of cluster formation and shock wave propagation, both forward and backward, depending on vehicle density in a given area. The most common example is the physical use of roads by vehicles. When traffic demand is great enough, the interaction between vehicles slows the speed of traffic stream, this results in some congestion. Extreme traffic congestion sets in when vehicles are fully stopped for a long period. Flow conditions on the other hand, are considered "free" when less than 12 vehicles per mile are on a road. Note that flow is the number of vehicles passing a reference point per unit of time, vehicles per hour (Wikkipedia, 2015).

Galtima (2002) identify three factors responsible for travel demand as (i) the nature of the land use activities and accessible, (ii) Transport system within the mobility area. (iii) The demographic character and socio-economic characteristic of the population. The inter play of these factors creates the pattern of urban trips which vary according to cities depending on their peculiarities. Studies on urban trip generation and attraction have centered on land use and socio-economic characteristics of the people. Cities are made up of land uses, this land use constitute the origin and destination of urban trips. The more complex the land use the more complex the movement. Uncontrolled heavy traffic flows in urban areas especially in developing countries affect economic activities on a daily basis due to inability of the road network to accommodate the increasing large number of vehicles plying the roads (Emeasoba 2012; Aworemi, Abdul-Azeez, Oyedokun, and Adewoye 2009). Consequently, this



situation has resulted into various traffic flow problems, such as traffic congestion, accident, and noise pollution. This phenomenon has manifested in the rapidly growing city of Gombe.

Furthermore, land use development pattern has been another major factor contributing to traffic flow not only in Gombe metropolitan area but in many other cities of Nigeria (Ogunbodede, 2006; Savannah Landev Konsult, 2002.). This is worsened by the issue of inadequate transport facilities such as bad roads, lack of pedestrian walkways, and absence of street parking facilities, as well as roadside business, hawking and illegal parking of vehicles are among the major causes of traffic flow problems in the urban centre of Gombe.

Therefore, determination of growth and taking measure against it is quite important for sustainable urban growth. In many studies, the most important reason of urban growth is indicated as the increase of demand for dwelling at low-density areas. Because of insufficient demand for dwelling in city centers, there is an increase in building houses at city boundaries (Slaev and Nikiforov, 2013).

2. STUDY AREA

Gombe is located on latitude $10^0 15$ 'N to $10^0 19$ 'and longitude 11^06 'E to 11^013 'E (Figure 1 and 2). It has an average altitude of about *500m* above sea level and covers an area of *175.94km*². (Street map of Gombe Metropolis 2015). Gombe

With the increase in demand for movement and rapid urbanization, which posed a lot of pressure on our roads, a powerful tool known as Geographic Information System (GIS), a computer based system, has been developed to capture, store, manipulate, analyze, manage and present all types of spatial, geographical and crossroad operational data infrastructure. The tool having no restrictive boundaries is employed in the advance countries to mitigate the various problems associated with transportation. A specific branch of this tool applied to transportation issues, is commonly labeled as GIS-T, which refers to the principles and applications of applying GIS to solving transportation problems (Ventzas, Adam, kokkinas and Evangelidis, 2014). It is against this background that the study assessed urban growth and traffic flow using geospatial techniques.

The study aimed at assessing urban growth and traffic flow patterns in Gombe Metropolitan area. In achieving the aim, a geo-database of the existing road network map of the study area was produced, the land use growth pattern of the metropolis was examined and the pattern of traffic flow in the study area was assessed.

metropolis is well linked by road to other regional centers like Biu/Maiduguri, Potiskum/Damaturu, Bauchi/Jos, Kari/Kano and Kumo/Yola. A single gauge railway on the Bauchi-Maiduguri route is also another transport link, even though the railway system is at its lowest utilization



rate due to poor maintenance and management. An airport is also constructed at Lawanti, which provides air travel from Gombe to other parts of the country and beyond. The metropolis cut across 14 wards which includes; Kumbya-Kumbiya, Pantami, Jekadafari, Shamaki, Dawaki, Herwagana, Bolari West, Bolari East, Ajiya, Bajoga, Nassarawo, ,Garko, Liji and Akko.

Furthermore, the extension of rail transport to Gombe from Bauchi, in 1962, then to Maiduguri, further uplifted the town, and boosted socio-economic activities (Tiffen, 1974).

Many ethnic groups inhabit the town. The ethno-linguistic composition includes

among others Fulani, Tangale, Waja, Tera, Bolawa, Kanuri, Pero, Shongom, Tula, Cham, Lunguda and Dadiya. There are also immigrants from Kanalauru, Hausa, Igbo, Yoruba and Ibibio. The town serves as state headquarters and therefore possesses all forms of economic and administrative activities such as businesses trading in goods and services, federal, state and local government administration, agricultural production services, rearing of domestic animals, poultry farming, importing and exporting of farm products to the various parts of the country, as well as operating banking and finance facilities (Tiffen, 1974; Ventzas et al, 2014).







Figure 1: Gombe showing study area

Source: Digitized and clipped from administrative Database/Nigerian Shapefile





Figure 2: Road network of the study area (2015) Source: Digitized and clipped from street map of Gombe Metropolis, ministry of land and survey (2015)

3. Methodology

In carrying out this research, data used are; spatial and non-spatial data both from primary and secondary sources. The primary sources include information on road structure, road network and traffic density. These data were obtained through physical observations/field survey that involves traffic counting. The Global Positioning System (GPS) coordinates of twelve cross junctions purposely selected were collected through field survey for map geo-referencing and then the Google earth map is digitized to create the geodatabase of the existing road network map of the study area, (table 1).

While data on traffic flows for the twelve selected road junctions were collected using manual traffic count instrument from Ministry of Transport, Gombe for assessing pattern of traffic flow in the study area (figure 3).

The secondary data used include 1996, 2002, 2008 'and 2015 Landsat (30metres resolution), satellite images of the city of



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Gombe collected from National Centre for Remote Sensing, Jos, google earth map for production of road map of the study area, topographical and street guide maps, which were collected from the Ministry of Works and Planning Gombe.

The imagery data acquired were analyzed using geo-information procedures which include; supervised classification technique of the 1996, 2002, 2008 and 2015 Landsat TM satellite imagery of the study area to produce landuse maps for change detection, GIS for digitizing road networks and creation of the Geodatabase/processing of the maps/charts and tables. The result obtained were finally displayed in, tables and GIS Maps.

Station No.	Road Name				
1.	Tashan Bauchi - Specialist				
2.	Jekadafari – Cross				
3.	SabonLayi– State lowcost				
4.	Bank road – Liji street				
5.	State lowcost – Madaki				
6.	State lowcost - Main market				
7.	Mainmarket Roundabout – Idi street				
8.	TashanDukku – FCE (T) Roundabout				
9.	Cross – Bypass junction				
10.	Emirs's Drive – Gombe State University				
11.	Cross – Emirs drive				
12.	Tashan Bauchi – Tumfure				

Table 1: Selected Ro	oad Junctions
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Source: Fieldwork (2016)

4. Results and Discussion

4.1 Landuse Development in Gombe Metropolis

Analysis of Gombe Metropolis Urban growth from 1996, 2002, 2008 to 2015, reveals that there has been a considerable growth in built up areas from 1777.4ha(17.7%) of total built up area in 1996 to 4698.7ha(47%) of total built up area in 2015 as shown in tables 2,3 and

due to high rate of urbanization caused by rural to urban migration, road construction, increase in administrative functions and institutional structures. The study revealed that Gombe metropolis

The study revealed that Gombe metropolis had a percentage increase of 2.9 percent between 1996 and 2002 (table 3). Urban

figure 4. The decrease in other landuse areas of bare surface and vegetation, as

observed from the analysis was a result of

their transitions to the built-up land class

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growth of the metropolis was witnessed in Tunfure, mainly residential and commercial land- use to the west. Gombe metropolis also expanded in Arawa and Mallam Inna to the north. Institutional land use area of Federal College of Education Technical Gombe (FCET) and Federal Medical Centre (FMC) has also expansion. contributed to the Consequently, this influenced the pattern of traffic flow that resulted in the extension of roads that link Tumfure, FMC and FCET. During the period of 2002 - 2008 the percentage increase of the growth of Gombe was 7.9 percent. The period witnessed the establishment of Gombe State University, further extension of Tumfure and Arawa, the new built area Sabon Pegi and the construction of a bypass at the southern part of the metropolis. This development of Gombe urban growth also influences the pattern of traffic flow by increasing the need for movement to Table 2: Landuse dynamics of the study area and from and within these areas for daily activities. This leads to the extension of access roads from Gwannan Yobe Street to Sabon Pegi and from Gombe State University to Arawa.

Furthermore, the 2008-2015 period witnessed a percentage increase of 18.30 percent with further extension of Arawa to kundulum to the north, commercial and residential area of by-pass to the south. The period also witnessed an increase in the residential area of BCGA, Nassarawo, Doma and Ligi to the east and Central Bank of Nigeria to the west. These expansions and in others areas influenced the pattern of traffic flow in the metropolis by increasing linkages in these areas. Thus, result in the construction of more roads to connect the various areas, which include the various streets in Ligi, New mile three and Ligi round about.

Land use	1996		2002		2008		2015	
	area in (ha)	%						
Bare surface	2187.4	21.8	2919.4	29.2	1504.1	15.0	1783.2	17.8
Built up	1777.4	17.7	2073.0	20.7	2866.3	28.6	4698.7	46.9
Outcrop	191.3	1.9	321.3	3.2	760.7	7.6	440.4	4.4
Vegetation	5858.9	58.5	4701.3	46.9	4884.0	48.8	3092.7	30.9
Total	10015.0	100	10015.0	100	10015.0	100	10015.1	100

Source: GIS Analysis, (2017)





Figure 4: Landuse changes 1996 to 2015 Source: GIS analysis 2017



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Figure 5: Classified Landuses of the study area Source: GIS Analysis, (2017)

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4.2 The Traffic Flow Pattern

The analysis of traffic flow pattern in some selected road junctions for three days of the week (Monday, Wednesday and Saturday) for two weeks as shown by figures. 6, 7 and 8 respectively, reveals that on Monday's traffic are higher along Gombe main market with about 7,601vehicle counts per hour. This value is expected to be so because it is a commercial land use area, which attracts many people on the road for various socio-economic activities. The Jekadafari road with about 6597 counts per hour is a road corridor that links the CBD (Central Business District) with the outskirt area of the metropolis like the Tunfure, Shongo Housing Estate, Orji Estate and the Mile 3 area with people moving in and out of the metropolis for their daily activities. Furthermore, a road cuts across areas of commercial, administrative and residential land use. The roads with less traffic density are the Gombe State University road and TashanDukku/FCE(T) road due to the fact that they are roads in an institutional land use area where majority of the students stay within the campus and commercial activity is less pronounced.

Likewise, the Wednesday traffic flow pattern reveals that traffic situation is higher on the road corridors of Gombe central round about which is also known as the old market street and Gombe main market. The reason is not farfetched from the fact that it is an area of commercial

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activities with the old market, main market, Gombe Line Motor Park, all located along that axis. The next area with high traffic volume is the Jekadafari-Specialist Hospital road with many people going to and from their offices. The roads that have less traffic density are the ones that lead to the institutional land use areas of Gombe State University and Federal College of Education, and the Emir's Palace. On the other hand, the Saturday traffic pattern reveals that traffic is less 6045pcu compared to the working days of the week having higher than 7248pcu. The traffic is higher around the market road, which is expected to be, because most people use the weekend days as their shopping and visitation days. Figure 8 reveals that movements are high along the roads that link and cuts across the various residential areas. The traffic on Saturdays remains less along the institutional land use areas.



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Figure 6: Monday Traffic Flow Pattern/landuse overlay Gombe Source: GIS Analysis 2017





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Source: GIS Analysis 2017 Figure 7: Wednesday Traffic Flow Pattern/landuse overlay Gombe





Figure 8: Saturday Traffic Flow Pattern/landuse overlay Gombe Source: GIS Analysis 2017

The summary of the traffic flow pattern per hour for the three days of the week, shows that traffic flow pattern in Gombe metropolitan area is highest around commercial land use areas due to the socioeconomic activities along the road corridors of Gombe main market central round about, Tunfure and Jekadafari. This is next followed by the residential areas of Federal Low Cost, Pantami, Bolari, Tudun Wada, Bagadaza, Herwagana and Bogo(BCGA), area as well as the administrative land use areas of Tudun



Wada, Ajiya, Dawaki, TashanDukku and Federal Low Cost.

5. Conclusion

The study Assessed urban growth and the pattern of traffic flow in Gombe metropolitan area. The result reveal that there is a considerable growth in built up landuse area from 1777.4ha (17.7%) of total built up area in 1996 to 4698.7ha(47%) of total built up area in 2015 which is in line with the findings of Gadiga and Galtima (2017). The findings show a percentage change of 2.9 in the period of 1996-2002, 7.9 in 2002-2008 and 18.3 in 2008-2015. These changes in growth pattern of the metropolis considerably influence the pattern of traffic flow which in-turn result to the extension, expansion and construction of more roads network in the metropolis. These include the by-pass, the Tumfure- FMC road, the various streets in Liji, new mile 3 and Liji round about among others. The study further reveals that traffic density is higher during the working days of the week and at peak during the morning hours. It also shows that the road corridors that attract high traffic are those that cut across areas of commercial landuse activities and some residential and

References

- Ajiboye, A., and Afolayan, O., (2009). The impact of transportation on Agriculture production in developing country: *International journal of Agricultural Economics and rural Development* vol. 2. No 6,pp 49-5
- Aworemi, J. R., Abdul-Azeez, I. A., Oyedokun, A. J. and Adewoye, J. O.,

administrative landuse areas. Therefore, there is a need for improvement in traffic management systems and a review of the city master plan to accommodate the expanded areas of the metropolis and mitigate any traffic flow challenges/problems that comes with rapid Urbanization.

6. Recommendations

Consequent upon the findings, the study recommends the reassessment of the city's master plan and the present land uses by town planners in order to evaluate any evolving non-plan land uses, with due considerations to traffic flow pattern in the metropolis. In addition, Government should make provision for more traffic lights/wardens at all junctions for effective management of traffic. Lastly, further research on spatio-temporal variation in traffic flow pattern and its associated problems is recommended. This will go a long way in helping government, transportation various agencies and individuals in taking rational decisions in managing traffic problems in the metropolis.

> (2009). A study of the causes, effect and Ameliorative measures of road traffic congestion in Lagos metropolis: *European journal of social science*, 11(1): 199-127.

Emeasoba, U., (2012). Management of Urban Traffic Congestion in Enugu metropolis for Sustainable Economic development: Journal of http://www.gojgesjournal.com

Serah

Environmental Management and Safety, 3 (2): 38-53

- Gadiga, B.L., and Galtima, M., (2017), Analysis of landuse/ Cover Dynamics in a rapidly urbanizing city: the case study of Gombe metropolitan area, Nigeria. *Journal of Geographic information system*, 637-647.
- Galtima, M., (2002). Estimating Disaggregate Trip Generation and Attraction in Maiduguri Metropolis; *Department of Geography, Federal University of Technology Yola. Annals of Borno*17/18(2000-2001): 86-100.
- Ogunbodede, E.F., (2006): Application of GIS to the management of traffic `congestions in Akuke, Ondo State, Nigeria:An unpublished PGD project submitted to Regional center in Technology and Aerospace (RECTAS), Obafemi Awolowo University, Ile-Ife, Nigeria.
- Osaba, S. B., (2012). A geographical analysis of intra-urban traffic congestion in some selected local government areas of Lagos metropolis: *Journal* of Geography and Regional Planning. 5(14): 362-368

- Savannah LandevKonsult Nig. Ltd, (2002) Gombe Master Plan 2030.
- Slaev, A.D. and Nikiforov, I.(2013) Factors of urban sprawl in Bulgeria,Spatium, no. 29, pp. 22-29.
- Tiffen, M., (1974). The Enterprising peasant economic development in Gombe emirate

1900-1968; Oversea Research Publication No. 21.

Ventzas, D., Adam G., Kokkinos C., and Evangelidis G., (2014). An Enhanced GIS for Traffic Crossroads. Traffic Big Data needs:*International Journal of Emerging Technology and Advanced Engineering*, vol. 4, issue 11.

Wikipedia (2015): traffic flow, https:// en.m.wikipedia.org 28:11:2015