Gombe Metropolis Road Network Mapping – An Intergrated Approach

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Abstract

Advancement in technology has greatly facilitated the requisition of data for all forms of research. Recently, remote sensing and GIS have become powerful technologies for regenerating geospatial data about geographic features. In this research, satellite imagery, ground survey data and Arc GIS software were used. The research revealed that Gombe Has a network of mesh road pattern (i.e. net or interlocking structures) major road forms about 11.5% of the road network and are restricted to the city center. While minor and access roadforms 22.9% and 65.6% respectively. The peripheral district are served with foot path and few bush traces. Conclusion is drawn on the need to construct more roads networks and establishment of GIS unit to aid future planning, maintenance and analysis of the metropolis road network.

Keywords: mapping, remote sensing, GIS, Gombe, Arc GIS

1. Introduction

Road network literarily refers to the framework of routes within a system of location. According to Rodrique et al (2006) transportation network are of various types of links between points along which movement can take place. Samadzadegen et al (2004) noted that road network is of prominent elements of urban transportation life lines which directly affect the urban city life. Rao and Jayasree (2010) expressed that a proper skeleton of road network creates a promotional impact of land use activity in the urban centers.

Rodrique et al (2006) categorized road network structure into two based on the accessibility they provide. The centripetal network favors a limited number of locations. The centrifugal network on the other hand does not convey any specific network connection advantages.

The arrangement and connectivity of transport network is known as its typology. Road network can also be classified based on their typological attributes. Rodrique identified several criteria for such classification among which are; orientation and extent, mode and terminals, type of traffic, volume and direction or pattern of network.

Rodrique et al (2006) noted that the spatial continuity and typology of road network depends on three conditions including;

- Ubiquity: the possibility to reach any location on the network that is general access
- Fractionalization: the possibility of a traveller or a unit of freight to be transported without depending on a group.
- Instantaneity: the possibility to undertake transportation at the desired or most convenient moment.

Adequate road network is known to facilitate the movement of persons and goods in urban areas. It is in this regards that transport planners intend for road network to be maintained ina collective way at the lowest cost of development. This research is aimed at developing digital map of road network so as to enhance circulation in Gombe metropolis.

1.1 The Study Area

Gombe is a city in north eastern Nigeria (and a local government area) it is the capital city of Gombe state and has an estimated population of 261,536 people(2006 census). Gombe metropolitan area has an area of 52sqkm and situated between latitude 9° 30' and 12° 30'N and longitude 8° 45' and 11° 45' E of the Greenwich meridian. It has two distinctclimates, the dry season (November-March) and the rainy season (April-October) with an average rainfall of 850mm.

Gombe is a confluence of economic activities by its position as the meeting point for business people from the surrounding states. The states includes: Borno to the north, Yobe to the east, Taraba and Adamawa to the south, and Bauchi to the west. This advantages have made the state vibrant in all aspects. Numerous banks, filling stations and hotels exist in the town to support the commercial activities. Another factor that led to the growth of the town is rural - urban migration experienced from the surrounding towns and villages. Moreover, the town has become a center of learning with numerous tertiary and secondary institutions established in the metropolis. Fig1 shows the satellite image of the study area.

Figure 1: Satellite imagery of Gombe metropolis, 2014.

2. Literature Review

According to coops and Waring (2001) satellite image data have been interpreted by a computer to produce a land use map that can be "read into" the GIS in raster format. Verma et al (2008) revealed that remotely sensed data from various sensors can be used for road land use mapping. The application of GIS to transportation issues is labeled as GIS-T. According to Rodriguez et al (2006) and Ahmed (2010), GIS-T application are currently used broadly by transportation analyst and decision makers in different areas of transportation planning and engineering. GIS-T is applied for transportation infrastructure planning, design and management, traffic safety analysis, transportation impact analysis, public transit planning and operation and intelligent transportation system (ITS).

Alterkawi (2001) revealed that prior to GIS, paper maps were the only medium available for visualizing the network and identifying coding errors. But currently GIS is capable of displaying graphics, while linking features to attribute table. This has become a valuable tool for maintaining and updating roadway and network files.

GIS has also become an effective and efficient tool for observing relationship between the spatial and physical attributes of road way facilities. The use of GIS in displaying road network has facilitated identification of error in link connections and trip loading from traffic analysis zones.

3. Methodology

3.1 Data Acquisition

3.1.1 Geometric and Satellite Imagery

Geometric data were acquired using handheld GPS. The coordinates of six different points observed within Gombe

metropolis include: Main market roundabout (0738882, 1137888), union bank roundabout (0738824, 1137213), Emirs palace roundabout (0737369, 1138670), Cross roundabout (0737238, 1137968), Government House roundabout (0737172, 1137557) and Federal college of education roundabout (0734846, 1140695). These coordinates were used for ground truthing and geo-referencing the satellite imagery of Gombe metropolis.

3.1.2 Data Processing

Data encoding for this research involved geo-referencing, digitizing and layering the final map product. It was done using HP laptop computer and ArcGIS software.

3.1.3 Geo referencing

The GPS coordinates obtained for Main market roundabout, Union bank roundabout, Emirs palace roundabout, Cross roundabout, Government House roundabout and Federal College of Education roundabout were used as tie points to geo-reference the Gombe imagery. The X and Y minimum and maximum values of the coordinates were used to create map boundary. Then the values of the tie-points were inserted one after the other to ensure the true coordinates of these points.

3.1.4 Digitization of Road Network

There were three categories of route-major roads, minor roads and access roads identified and traced in Gombe town. Each of the route categories was digitized as independent line thematic layer using ArcGIS software.

4. Result and Discussion

4.1 The Road Network in Gombe Metropolis

The general arrangement and connectivity of road in Gombe have mesh pattern that is net or interlocking structure (figure 2). However, some few districts portray random road network. The western part of the town is hilly. This factor might be responsible for inadequate distribution of motorways in the area.

The fast growing districts such as Bagadaza and Nayinawa (south west) of the town, Checheniya and London Maidoraya (north west), Gagarawal (north east) and AnguwanMadaki (south east) also lack coherent motorways.

4.2 Road Category

The motorways in the study area are classified into three based on their function and surface condition.

4.2.1 Major Road

Major roads also called primary or arterial roads are routes that carry long distance through traffic to specific areas in urban centers. Figure 3 shows the distribution of the major roads in Gombe town. This category of roads form only 11.5% of the roads network and cover only the central district (Sabonlayi, Jekadafari, Tudunwada, Herwagana and Kumbiya-kumbiya wards) of the metropolis. The peripheral district has scarce major roads.

4.2.2 Minor Roads

These routes are also referred to as secondary or sub-arterial roads. They carry through traffic between specific or local areas and major roads. The minor roads form about 22.9% of the road network in the study area. It is more widely distributed in the town than the major roads (figure 4). However, minor roads are also predominantly concentrated in the city center, extending to parts of Federal low-cost and Bubashongo (mid-north of the town) and New/old G.R.A (mid-south of the town).

4.2.3 Access Roads

These are routes that connect local areas or specific land use to major and minor roads in urban areas. Access roads are numerous and well spread in all parts of the town as shown in figure 5. Access roads forms about 65.6% of the motorways in the study area connecting both the major and minor roads with dwelling, public places and utilities.

Generally, the distribution of motorways in Gombe needs to be improved. Some of the roads like old and new market roads are narrow due to the activities of street traders and on-street trading. This often results to traffic hold-up at peak hours of the day. Construction of new motorways to the fast-growing peripheral wards and up-grading some minor roads will go a long way in curtailing the problem of mobility demand in the study area.

5. Conclusion

The transportation network is an important infrastructure in an urban setting. It allows connectivity and movement of people, traffic and goods both within and between urban centers. This makes it expedient to preserve urban transportation network in good working condition. Satellite remote sensing and GIS are powerful new technologies used to update information about road transportation which is required for mapping, planning and maintenance of urban road network. Hence transportation planners need to integrate land-use transportation models with satellite remote sensing-GIS technique for effective planning and management of transportation network.

6. Recommendation

In order to have good road network connectivity and efficient movement of people in Gombe metropolis, the following recommendations are proffered:

- A road network needs to be developed in such a way that the travel demands of the people in Gombe metropolis are met to the maximum extent in a collective way at the lowest cost of development.
- To achieve the above stated objective, Gombe state Government should direct the state ministry of works and in collaboration with the office of the surveyor General to review the current road network in Gombe town and undertake strategic development of optimal functional accessibility based network in the entire metropolis.
- The Gombe state Government need to establish GIS unit in the office of the surveyor General, employ professionals, train and retrain staff and provide them with hardware, software and other equipment. The unit should use satellite remote sensing- GIS technique on road network in Gombe metropolis and other major towns of the state.

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