Mapping And Analysis Of Transportation Network Of Port Harcourt, Rivers State Using Geographic Information System (GIS) And Remote Sensing

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ABSTRACT
The level of urbanization in developing world indicates that, there are more people living in cities than before. This pattern induces pressure on traffic flow and makes living in urban area difficult. The situation has started to manifest in Port Harcourt city, which is the capital city of Rivers State This study was carried out by applying Geographic Information System (GIS) and Remote Sensing to investigate traffic congestion patterns in the city, and determined the management techniques suitable for their reduction. High resolution satellite imagery (Quick bird) and the GPS coordinates of all the places of interest in Port Harcourt were acquired and processed to produce the base map on which the major analyses were based. Major entities influencing creation of spatial database of up-to-date roads network were identified and modeled. Secondary data collected were in form of spatial transportation pattern in some selected major roads in Port Harcourt and were also processed and analyzed. The results show two major ways by which GIS can provide solutions to traffic congestion in Port - Harcourt city. The first is the determination of the closest facilities within the study area. This information will enable commuters and motorists to take rational decisions as to which route to take during peak hour travel. The second is the determination of appropriate queries and analysis that can evoke graphical response, which could be used to manage traffic congestion, for example use of shortest and alternative routes. The study shows that GIS is a veritable tool that can be used to sustain an endurable flow of traffic in Port-Harcourt city, provided it is built on a properly designed database, which must also be amenable to constant updating. The study recommends that a GIS structure in addition to existing traffic management techniques should be put in place to monitor traffic congestions in the city.

Keywords: Transportation, GIS, Remote Sensing and Mapping

INTRODUCTION
In spite of the importance of Port Harcourt urban area as the oil city of Rivers State, there has been no attempt to study the dynamics of the transportation network its distribution system, traffics, road congestion, and changes in physical development of the oil city. The dynamics of the transportation network has to do with spatial data infrastructure (SDI) where a database on transportation network such as existing spatial distribution of roads and their possible links to the roads of neighboring states has been created and up dated using remote sensing and GIS like in advanced country of the world (Igbokwe, 2010). It is known facts that the developments have taken place in Port Harcourt and its environs since the last time the Port-Harcourt street Maps were produced. Because new roads have been constructed and some expanded, the oil City growth has increased and so many other infrastructure changes has taken place. These new changes need to be documented accurately in such a way that its packages can easily be updated, analysis, queried, managed manipulated and displayed for the purpose of solving complex physical planning, management and development problem (Ejikeme, 2013). This is very important, as the
city is rapidly undergoing physical development and upgrade with remarkable change, in road junctions, bus-stops, congestion, bus routes, stress, loss of travel time. Therefore there is urgent need to map and analyze the transportation system of Port Harcourt for improved service delivery by professionals in the area of planning, physical development, construction, and environmental management as well as efficiently public utility service delivery

Study Area
The study area, Port-Harcourt city is one of the major cities in Rivers State of Nigeria which is situated between longitude 07° 00’ East and 07° 15’ East of Greenwich meridian and latitude 04° 30’ North and 04° 45’ North of the equator (See Fig.1a and 1b) and elevation between 1.00m and 3.00m above sea level. The city area is 664kmsq with metropolitan area of 934sqkm and is linked to the outside world by land, sea and air.

The main city of Port Harcourt is the Port Harcourt city in the Port Harcourt Local Government Area, consisting of the old Government Reservation Area (GRA) and New Layout Areas. The Port Harcourt Urban Area (Port Harcourt metropolis) is made up of the city itself and parts of Obio /Akpor Local Government Area. Port Harcourt city, which is the capital of Rivers State, is highly congested as it is the major city of the state. A law was recently passed by the past State house of assembly to spread development to the surrounding communities as part of the effort to decongest the Port Harcourt metropolis.

The Greater Port Harcourt urban area spans eight local government areas that include Port Harcourt local government, Okrika, Obio/Akpor, Ikwerre, Oyigbo, Ogu/Bolo, Tai and Eleme local governments. Port Harcourt features a tropical monsoon climate with lengthy and heavy rainy seasons and very short dry seasons. Only the months of December and January truly qualifies as dry season months in the city. The harmattan which climatically influences many cities in West Africa is less pronounced in Port Harcourt. Port Harcourt” heaviest precipitation occurs during September with an average of 370mm of rain. December on average is the driest month of the year; with an average rainfall of 20mm. Temperature throughout the year in the city are relatively constant, showing little variation throughout the course of the year. Average temperatures are typically between 25°C -28°C in the city.

Fig 1a: Map of Nigeria showing Rivers State
Fig1b: Administrative Map of Rivers State, Showing the Study Area – Port Harcourt
METHODOLOGY
The methodology adopted in this study is represented in figure 2

Old Urban topographic Map (1986) -> GCP Collections

Scan and Geo reference Old Maps
Image Rectification and image map production

Image Interpretation
Superimpose Old Maps, Identification and Interpretation of results for updating Maps in vector format

Test of update Results
Data editing and Cleaning Topology and Building

Attribution Data Creation/Population and Modeling

GIS – Based Transportation Network Database

Visualization, Hotlinks, 3D Printing/Plotting of Maps and Results
Automated Mapping function Data management functions spatial analysis functions

Current Satellite Image (2011 Quickbird image)

Analysis Queries and Report Generation

Fig 2: Methodology adopted.
The analogue topographic map was digitized and updated using SPOT 5 satellite image. Before then, the satellite image was rectified. Positions of some prominent landmarks were obtained using GPS. Database was created and queries carried out.

RESULTS AND DISCUSSIONS
The street map of Port Harcourt obtained is shown in fig.4.1

Figure 4.1: Street Map of Port Harcourt City

The figure 4.1 shows the street map of Port Harcourt which is the study area. In this map the highways, major roads, minor roads, river, important features or places and areas like residential area were shown. Figure 4.2 shows the road map of Port Harcourt city showing the expressway and major roads.
Figure 4.2: Road map of Port Harcourt city

Some sample queries were performed to test the effectiveness of the GIS database. For example, figure 4.3 shows the query result of the shortest route to all police stations in Rumumasi district of Port Harcourt. Figure 4.4 shows the query result from Rumukpani police station to the closest hospital service-Meridian hospital. Figure 4.5 shows the query result showing the shortest route to district locations in Port Harcourt. Figure 4.6 shows the calculation of distance to Health Facility with respect to direction. Figure 4.7 shows the query result of the location of Rivers State University of Science and Technology (RSUST).
From the result generated, closest facility can be promptly obtained based on compromise between time and accuracy. It proves to be time efficient. For example, someone is sick and wants to get to a hospital.
The closest facility helps to estimate the nearest hospital. This is important so that the life of the person could be saved. On the other hand if the closest hospital is not considered, it will take more time to locate a hospital and the victim may not survive after moving over long distances.

Figure 4.5: Query result showing the shortest route to all district locations in Port Harcourt

Figure 4.5 shows the road map of Port Harcourt city displaying the shortest route to all Districts areas which serves as great guide to user of the map in determining the shortest route to apply in getting to any district area within a possible time. The government can also use it in decision making, likewise other institutions. This is the benefit of the use of GIS as a tool in decision making.
Figure 4.6: Calculation of distance to Health Facility with respect to direction

The result shows total distance to the closest medical facility from an accident hot-spot to be 4.8km. From this result, it can be observed that patients with critical medical conditions will have a slim chance to survive. This is one of the major objectives of this study.

Figure 4.7: Result showing Rivers State University of Science and Technology (RSUST)

CONCLUSION AND RECOMMENDATIONS

Conclusion
Results from the Street map production of Port Harcourt metropolis were analyzed from two different aspects. First, the application of Remote Sensing and GIS technologies where evaluated, this involve overlaying of the GIS databases and Remote sensing image, in addition, GPS technique where carried out to corroborate some places of interest, banks, junctions, bus stops and other important places of interest. Secondly the Street map was created, providing clearer, more precise and useful information about the road network and important places in the city. Several studies have investigated the effectiveness of Street map as a tool for communication.
This study produces an interactive street map of Port Harcourt city. People move from one location to the other and are dependent on automobiles, buses, trains, subways, or airplanes to arrive at a final destination. Most people would like to arrive at a destination in the least amount of time, least number of stops, and lowest cost. Not only do these transportation issues concern individuals, but businesses and governments as well.

Route analysis of the road network was carried out in this study to aid decision making and ease transportation problems. This study has demonstrated the effectiveness of GIS in solving transportation network problems.

**Recommendations**

The multimedia spatial street map database, street guide developed in this study should be posted on the website and also installed in the computers of both the government and private agencies dealing directly or indirectly with revision and updating of street maps. They should also be made available to transportation companies for a worldwide outreach to domestic and foreign road users who may wish to have information about streets network in Port Harcourt. The analogue version of the Street map, street catalogue and street directory should be conspicuously displayed in the offices and libraries of street mapping agencies. Street facility operators should be free to print many brochures and pamphlets from this GIS database.

**REFERENCES**


