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Road Network Analysis Moro Ipetumodu Metropolis, Ife North Local Government, Osun State, Nigeria, using Geospatial Techniques

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***Abstract* --** Nigeria has the largest road network in West Africa and the second largest south of the Sahara. The transport sector is the backbone to the economic growth of a nation and road network remains the basic and critical component of transport system in the country.

Road network analysis Used geospatial techniques to extract road network map from satellite imagery, it shows the streets map category and their corresponding names, the objective is to digitize all the roads and notable features within the study area, and categorize them accordingly and update information about the road extraction and extent of each road located at Moro Ipetumodu, Ife North Local Government, Osun, Nigeria.

Geographical Information System and remote sensing approach is a highly favored approach for the effective management of road network accessibility in the world,

The methodology employed involve the extraction of road networks from the satellite imagery which were compared with the existing topographic and road maps by overlay process, The topographic maps covering the study area at a scale of 1:50,000 sourced from the office of the survey General (OSGOF); Administrative map of the study area used to further explain the location of the study area. The primary spatial reference coordinates of the road network and notable features where using hand hold Garmin GPS device, also GIS and Non-GIS software packages were used. Development of new road network and establishment of GIS unit for regular updating of data on road network were among other recommendations made towards achieving improved connectivity.The road hierarchy used are highway, collector road, sub-arterial road and arterial road. The total number of road network were 366, the representative histogram of the road hierarchy, shows the street road of the research area it's notable features. Which are the road that lead to federal government girl college, INEC office, the NIM office, Court, and the palace area, also view ife Osogbo road, obafemi awolowo distance learning campus, foreign link campus, and the Moro main town. . This type of map can serve as a base map for several other projects and analysis that requires the name of place and position within a community e.g. emergency response analysis, crime mapping and accessibility analysis.

***Keywords*--** *GIS, Road network, Road accessibility, Connectivity, Extraction, Spatial, Update, Hierarchy, and High Resolution Image*

I. INTRODUCTION

Nigeria has the largest road network in West Africa and the second largest south of the Sahara, with the national network was currently estimated to be 194,200km of which 34,120km (17.6%) are federal roads, 30,500km (15.7%) state roads and 129,580km (66.7%) local and rural roads (newnigerian.blogspot.com). However, the federal roads network carries 70% of freight in the country. Road network have the most essential function than other transport means, it is the overall transportation network system in the world. Importantly, they provide us with access to home, offices, recreational areas, agriculture land, key buildings and other locations. They also often carry our essential services such as power, water and telecommunications. (Mansouri et. al., 2008) Transportation service is one of the important urban and rural amenities, which influence and impact on regional pattern of development, economic viability, environmental impact and helping to maintain socially acceptable level of life in an area (Murray et al., 1998). (Oche et. al., 2015). This type of map can serve as a base map for several other projects and analysis that requires the name of place and position within a community e.g. emergency response analysis, crime mapping and accessibility analysis. In this setting a geographic information systems (GIS) and remote sensing approach is a highly favored approach for the effective management of road accessibility in the country. Social science issues applicable to remote sensing exist, such as are urban growth and development, quality of life, and urban population density and structure. Identified areas where a road network map is useful such as planning enumeration areas by demographers, navigation for tourists, salesmen, firemen, security agents, tax collectors, postal services e.t.c. These improvements have enabled the development of more sophisticated analytical applications in accessibility field, (Nicholls, 2001). Over the past decade, GIS technology has been used by researchers for accessibility analysis.

Maps are specially designed to serve several purposes and answer specific questions such as street maps, utility maps etc. (Idowu et. al., 2016)

II. STATEMENT OF PROBLEM

The transport sector is the backbone to the economic growth of a nation and road network remains the basic and critical component of transport system in the country. Nigeria has the unsafe roads in Africa and has pursued an ambitious road expansion policy in the past ten years (WHO, 2015). Federal road safety commission corps marshal sites a road crash fatality rate of 143 deaths from 313 road crashes in two week but the real figure may be higher due to under report. (Fantahun, 2012). Main causes for these problems are linked to poor infrastructure especially on road and public transport network, poor interactive link between land use and transport planning, poor coordination between the cities urban infrastructure development and road transport plans, and facilities. Most of peripheral areas of the victims of the above problems. There are newly developed real estates, and areas that provide agricultural products to the city. Nigeria's road networks are poorly maintained and overused as alternative

modes of transport are poorly developed. After various failed interventions to address the need for the maintenance of the federal roads network, the Federal Roads Maintenance Agency (FERMA) was created in November 2002 (Establishment Act 2002) to monitor and maintain the federal roads network Overloading The Highway Code says how much load is allowed for various types of vehicles, the road worthiness of vehicles and who is qualified to drive on the road, among others. Many trunk roads in Nigerian are designed to carry 30 tons maximum axle loading. Roads of lesser capacity, such as state and local roads are incapable of bearing such weight. However, we all know that many transporters or their drivers and many road users obey the High Code only in breach, not in compliance. Many trucks do as much as 50 tons axle loading, nearly twice as much as allowed! Refuse dumping, a rogue vogue

Sad and incredible as it seems, refuse dumping on our highways in both big and small settlements is on the increase

(FERMA 2011.) new thinking for effective road maintenance as enunciate involves the management of the scheme has in place a mechanism for gathering reports on 24-hour basis with regards to all developments on the federal highway network, including emergencies.

Major goals of preventive maintenance and road surveillance. The broad aim of the programme is to protect the road, prevent bad habits and abuses, such as drainage blockage, illegal excavations, spillage of destructive chemicals on bituminous surfaces, building on road shoulders, abandoning of damaged vehicles, vehicle repairs on the carriage ways driving on kerbs among others. Street map is made possible with the use of Remote Sensing and GIS technology (Paulsson, B. 1992) (Vernar, R.K. el at 2008). This is because of the ability of remote sensing technology to capture high resolution satellite images of the surface of the earth showing various features and infrastructures. Some studies have shown that major roads and railways are easily identified on high resolution satellite images with the accuracy between 90 percent and 100 percent (Manning, J.el at 19880. Due to tree canopies or weak contrast of the satellite image, Minor roads and tracks are not easily visible with the accuracy ranging from 23 percent to 64 percent depending on categorization. It was also noted that the accuracy of urban street mapping using satellite imagery depends on the image geometric accuracy and extractable map scale based on adopted standards and its information content, street map is made possible with the use of Remote Sensing and GIS technology (Vernar, R.K. el at., 2008). This is because of the ability of remote sensing technology to capture high resolution satellite images of the surface of the earth showing various features and infrastructures. Some studies have shown that major roads and railways are easily identified on high resolution satellite images with the accuracy between 90 percent and 100 percent (Salge, F.el at 1988). Due to tree canopies or weak contrast of the satellite image, Minor roads and tracks are not easily visible with the accuracy ranging from 23 percent to 64 percent depending on categorization. It was also noted that the accuracy of urban street mapping using satellite imageries depends on the image geometric accuracy and extractable map scale based on adopted standards and its information content.

III. AIM

The aim of the research is to generate the road network map and analyses for further studies improvement.

IV. OBJECTIVES

1. Digitise all the roads and notable features within the study area, and categorize them accordlly.
2. Update information about the road extraction and extent of each road.
3. Present map showing road network using semi-automated road line extraction and analyse for further improvement of road hierarchy.

A. Study Area

Moro, Ipetu is under ife North Local Government Area, Osun State. also known as ife, is the ancestral traditional city of Yoruba people who live in Nigeria in west Africa. The local government lies approximately between longitudes 7^0 30', 7^0 35'N and latitudes 4^0 30', 4^0 35'E. Original, the area was located within the tropical maritime (MT) and tropical continental (CT) belt. The region enjoy two major seasons, which are the Dry and the Wet seasons. The dry season is between November and March while the wet season is between March and October.

B. Map of the Study Area

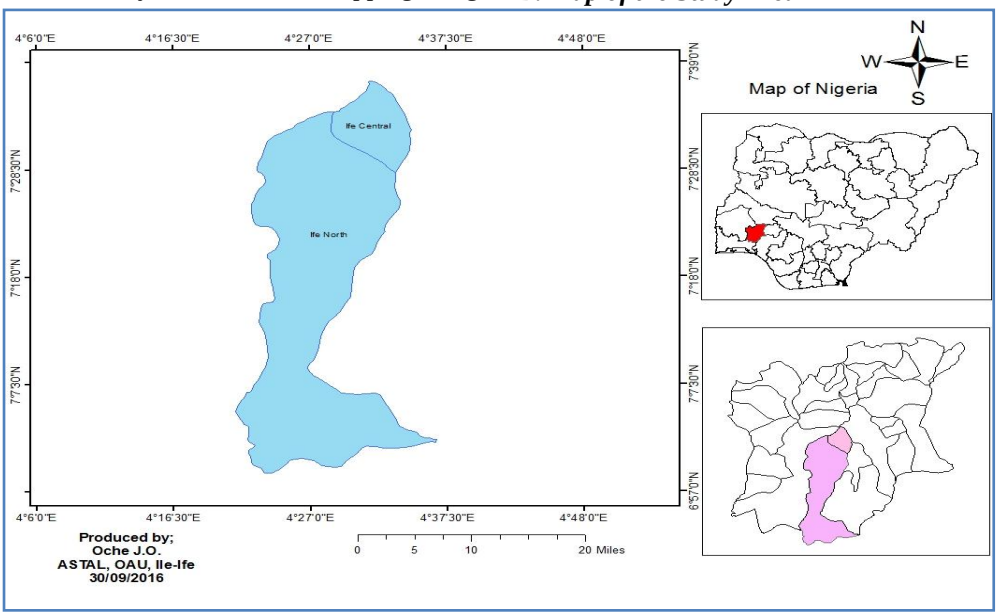

Figure 1: Study Area Map

C. Material and Methods

a. Data Types and Processing

In order to achieve the objectives of the study, both the primary and the secondary data which contain both spatial and non-spatial attributes were used. The secondary data are; The topographic maps covering the study area at a scale of 1:50,000 was sourced from the office of the survey General (OSGOF); Administrative map of the study area used to further explain the location of the study area. Extracted High resolution Google Earth Image covering the area using universal map download (UMD) ; Periodicals, social statistics and necessary demographic data containing the area. The primary spatial reference coordinates of the road network and notable features where using hand hold Garmin GPS device, also GIS and Non-GIS software packages were used. Study Area Delineation: the study area for this project is Moro Ipetu town in Ife North Local Government Area (LGA) of Osun State. To delineate the study area, the topographic and administrative maps covering the study area were scanned and geo-referenced coordinate point acquired during the reconnaissance survey of the study area was inputed into notable features attribute. The satellite image data used for this project is extracted from Google earth image (geoeye 2016). This was exported into ArcGIS where it was geo-referenced and digitized for proper analysis.

Table 1: Methodological Table

Data Set	Nature of Data	Data Source
Topographic map	Spatial	Data generated from Field Work using the hand-held GPS device
Administrative Map of Nigeria	Spatial	OSGOF
High Resolution Satellite Imagery of the Study Area	Spatial	Google Earth (2016)

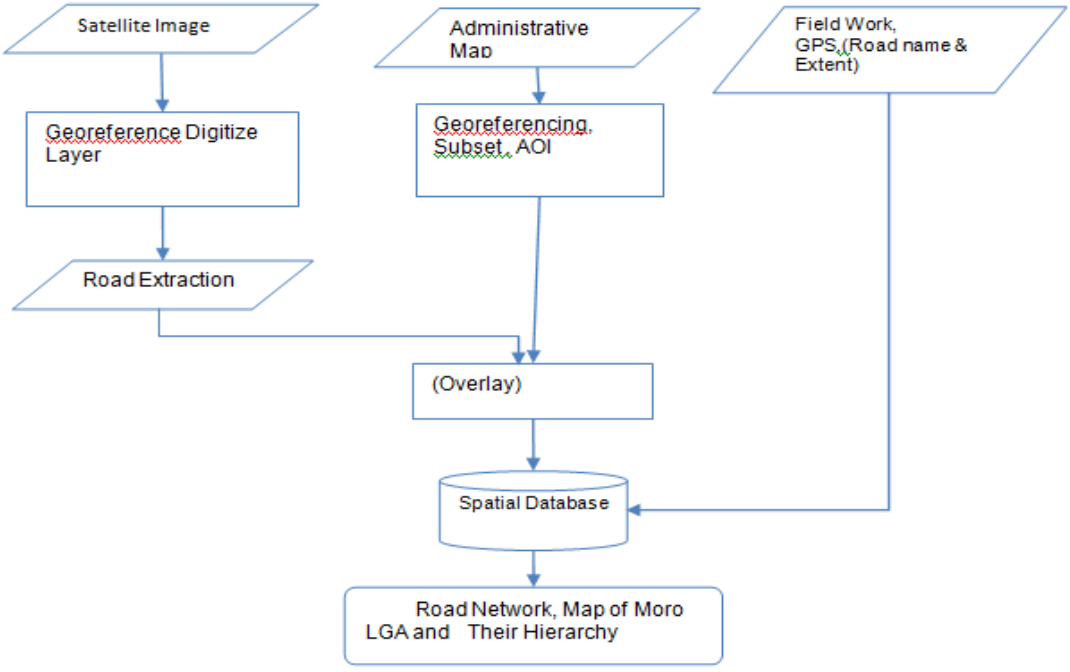

Figure 3: Methodological flow chart

D. Understanding the road network

The role of the road network is to allow the movement of goods, services and people. A network is made up of road corridors that perform different functions, known as the road hierarchy. The function of each road corridor within the hierarchy is determined by the type of service it provides.

Highways: These serve federal and nationally significant transport movements and carry longer distance traffic through the region. They serve as primary freight and dangerous good routes. They generally have a posted speed of 80 – 100+ km per hour. For example: Ilesha-Ibadan Express,

Arterials: These carry the majority of traffic movements to, from and within urban areas. They serve as major public transport and freight routes and have limited intersections with local connectors. For example: Moro-Osogbo

Sub-arterials: These carry major traffic movements within and between suburbs and onto the arterial road system. They do not

cater for longer distance regional trips and typically finish at arterial roads. For example: Agbel road, power road

Collectors: These allow the movement of traffic within a local area. They are generally located within a suburb and do not serve as a 'through traffic' route.

Streets: Lane ways and streets that serve the local neighborhood. The road hierarchy plays an important role in a safe and efficient road network. In the study area, connectors is the second majority of road

V. ANALYSIS AND DISCUSSION

The Road Network in Moro Ipetu area and connectivity of roads have mesh pattern that is net or interlocking structure (Fig1). However, some few districts portray random road network pattern. This factor might be responsible for the inadequate distribution of motorways in the area.

Table 2: The table below shows the road network hierarchy within the study network

S/No	Type of Road	Number of Each Frequency
1.	Highway	1
2.	Collector	50
3.	Sub-Arterial	2
4.	Street	309
5.	Arterial	4
	Total	366

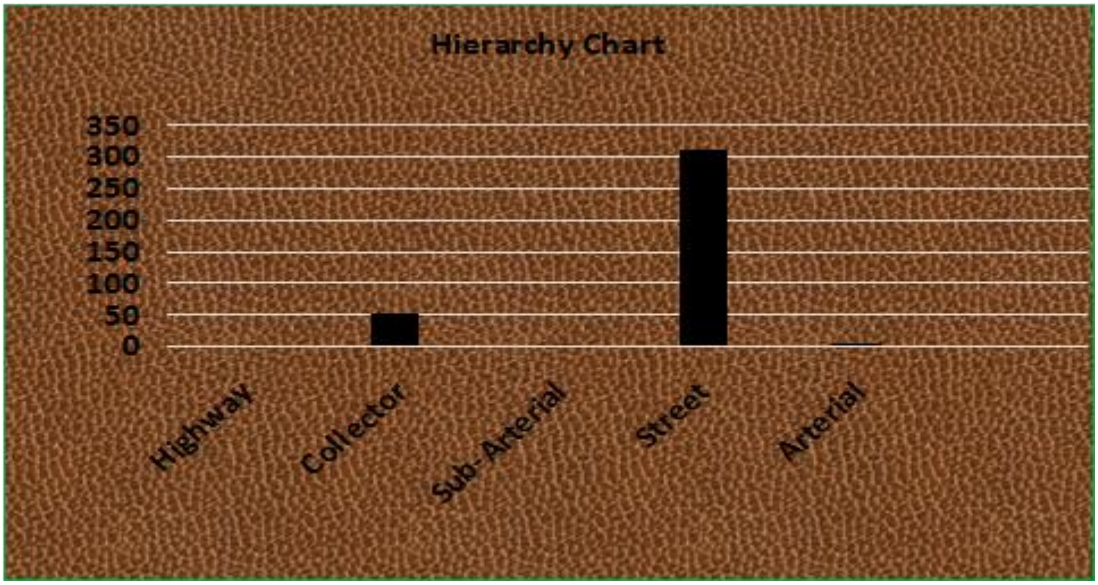

Figure 4: Representation histogram of road hierarchy

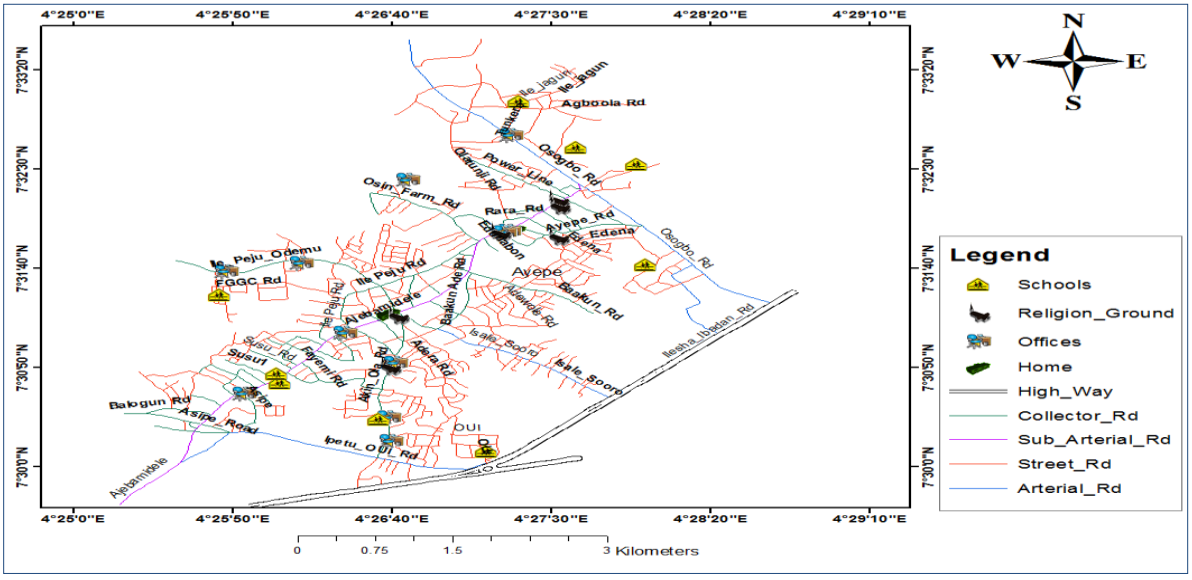

Figure 5: Map showing the road network of the study area

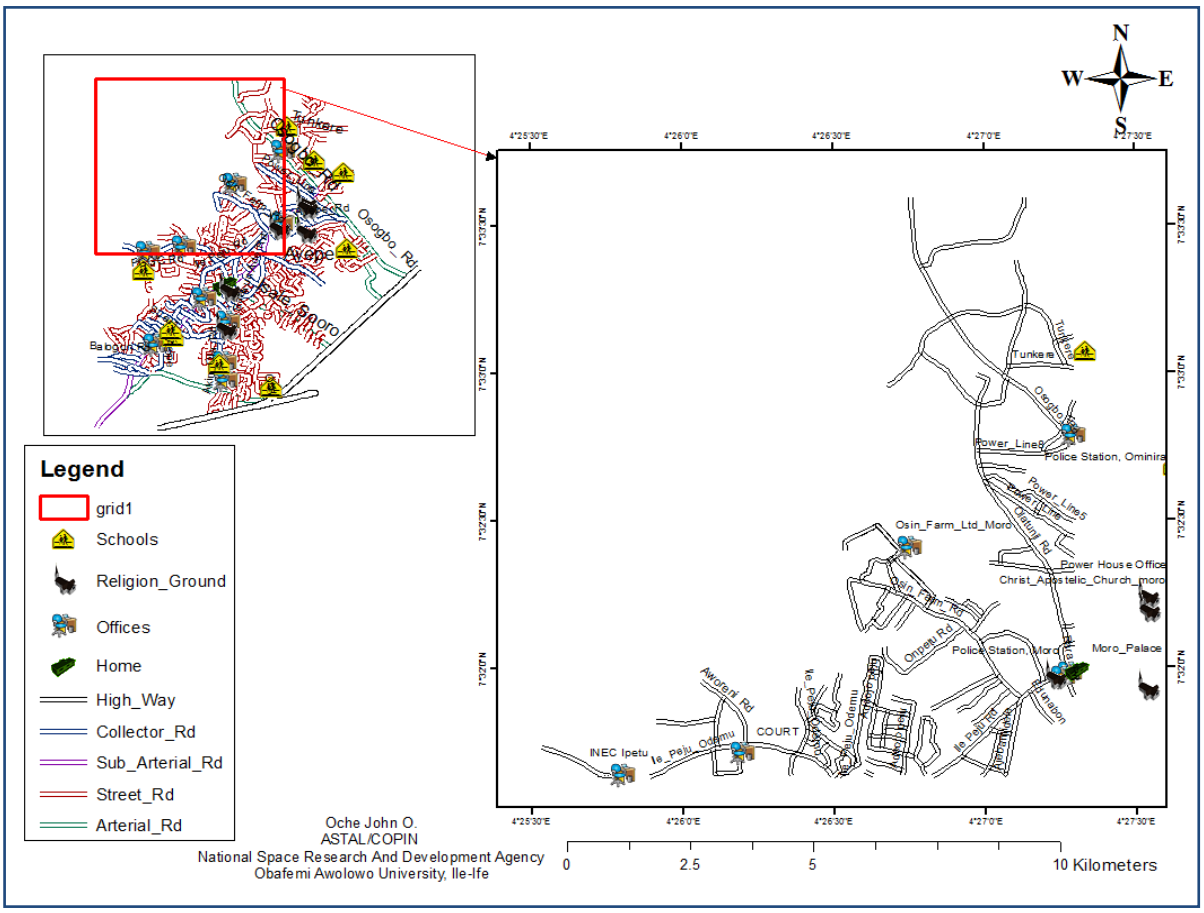

Figure 6: Map viewing road lead to Federal government girl collage, Court, INEC, NIM office, Ipetumodu palace, and Osin farm limited moro

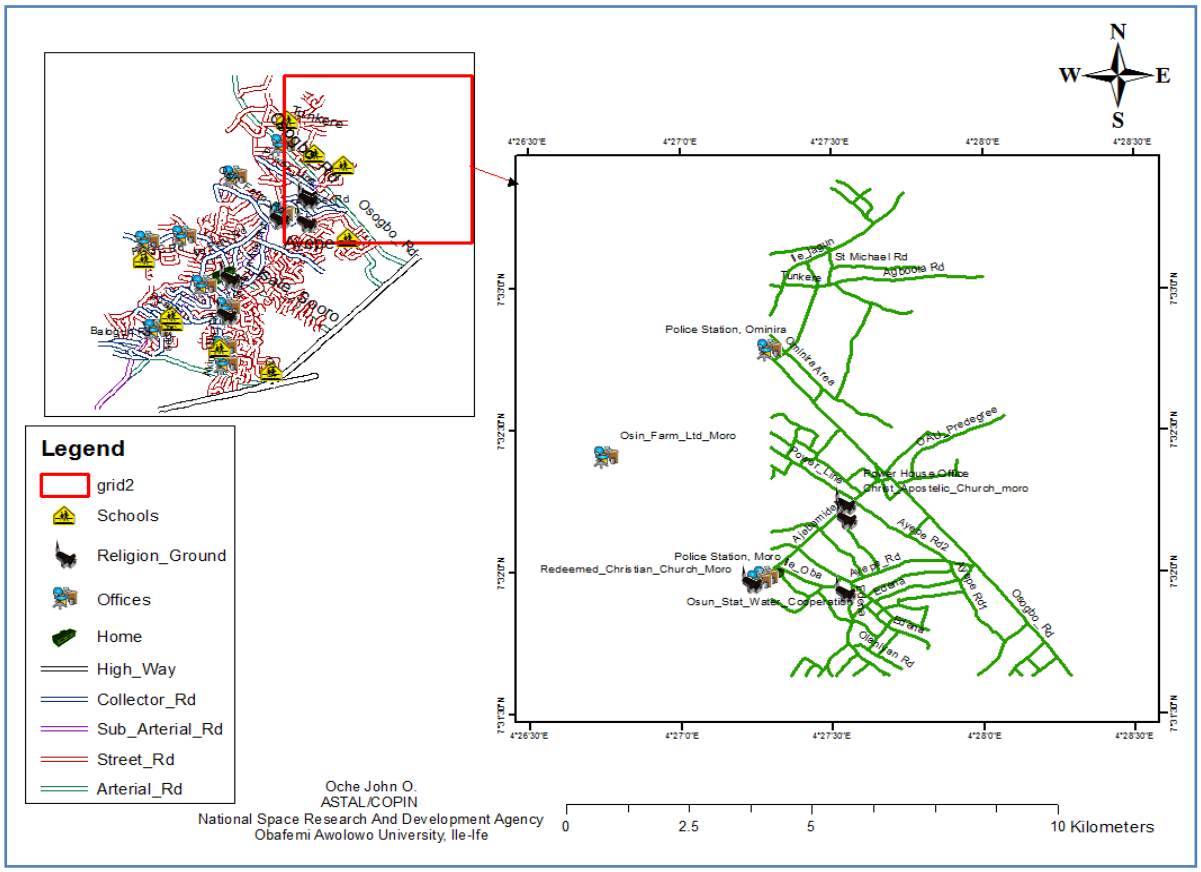

Figure 7: The view of main Moro town, Moro-Osogbo road, Distance learning OAU campus, Foreign link campus, and moro palace

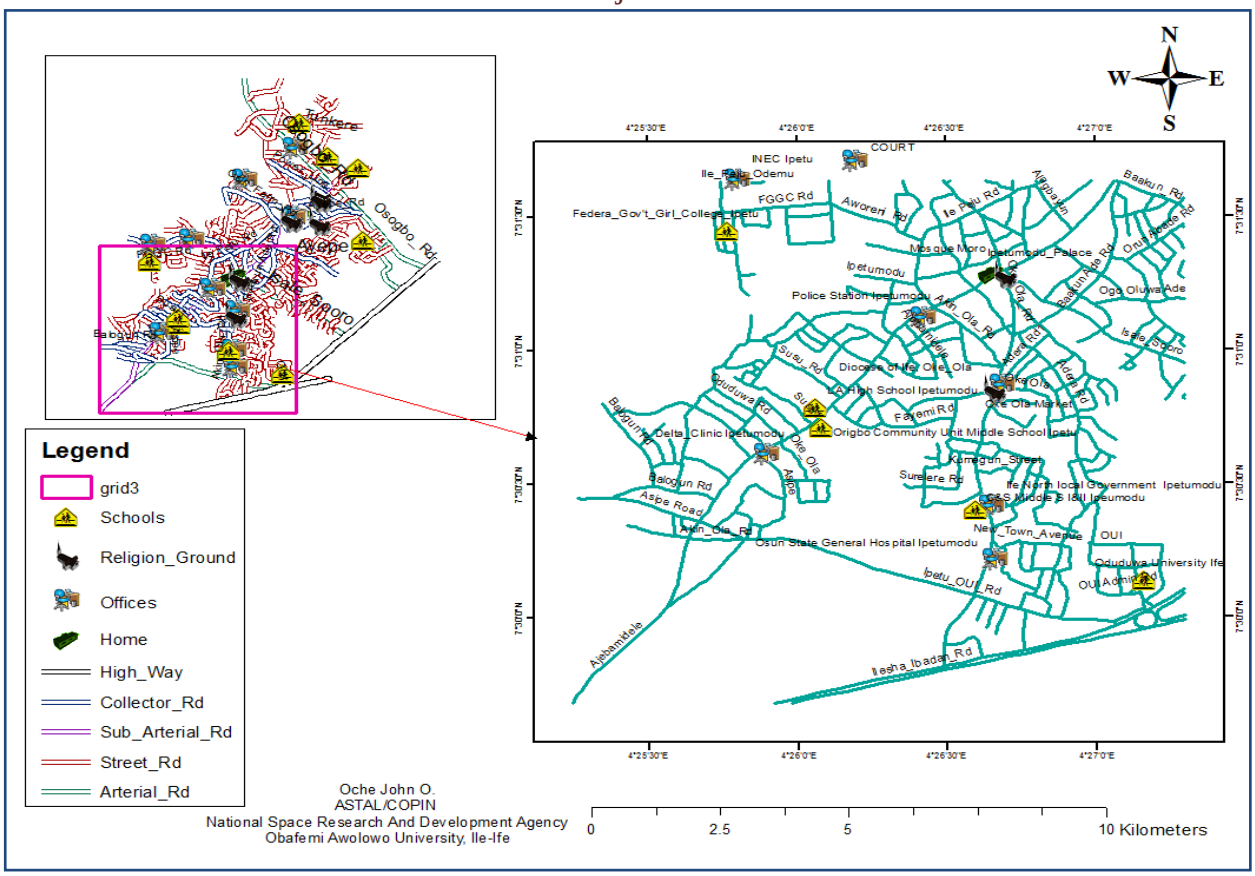

Figure 8: The view of Oduduwa university ife, ipetumodu main town, Osun Sate General Hospital Ipetumodu, Ife-Ibadan road, Akin Ola Market Road

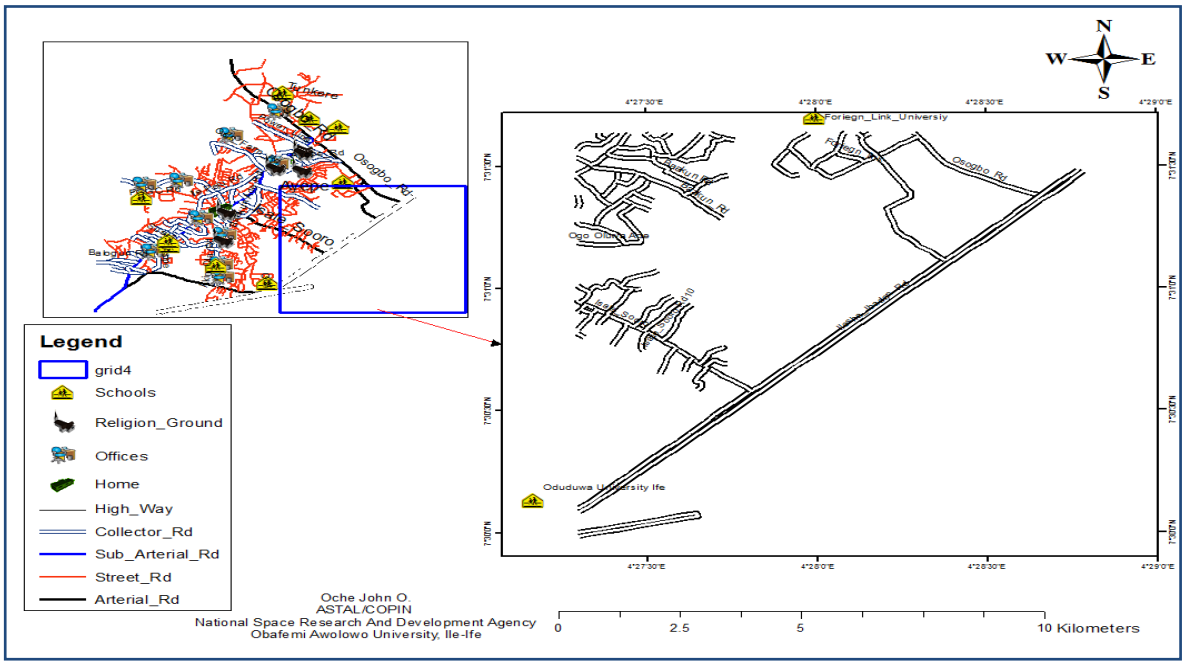

Figure 9: The view of Ilesha-Ibadan express road, Ife-Ibadan road.

CONCLUSION

In this research, a semi-automatic road extraction method is used GIS expert to update road network maps in urban/suburban area using remote sensing data. It is very much useful for urban planning, 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 places. The study area has just 1 major highway road , arterial road has 4 rout within the study area, sub-arterial has 2, collector has 50 roads and street has the majority road 309. 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.

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