USING GIS AND GOOGLE EARTH IMAGES FOR MAPPING OF TARABA STATE UNIVERSITY CAMPUS

ABSTRACT

We produced a Campus guide map for Taraba State University Jalingo. The data source for the study includes satellite images of the study area and field survey using a GPS device to collect coordinates of major ground control points. This research incorporated the use of geospatial techniques and functionalities such as geo-referencing, digitizing and geo-database creation to generate a campus guide map. The findings of this study reviewed that most of the structures and roads are not properly labeled/named for easy navigation. The study also showed that development is confined mostly to the North Western and south western part of the campus. We recommend structural planning and spatial development within the campus land cover in the future.

Keyword: Taraba State University, Campus Guide, GIS, Google Earth Images, Jalingo

Introduction

Over the years maps have evolved to be the most efficient way of representing and depicting spatial phenomenon as they appear on the earth surface. Street guides/maps over time have proved to be effective in guiding people/commuters in a particular environment (region) where they have never been before. This goes to show that there exists a cordial relationship between maps and finding locations (directions).

A map is a visual representation of an entire area or a part of an area, typically represented on a flat surface. The work of a map is to illustrate specific and detailed features of a particular area; a map is useful for both a layman and an educated person, as maps contain loads of information. It is up to an individual how he makes use of it. Maps are generally used for navigation, communication, collection, exploration, analysis, hypothesis stimulation, Control, planning and allocation of resources, map reading and storage of information.

The use of maps and mapping technologies in depicting of features that vary spatially cannot be overlooked. A Geographic Information System (GIS) is a system which is used to store, retrieve, map and analyze geographical data. These systems store any kind of information which is related to a geographical location. These spatial features are stored in a coordinate system which references a certain place on the surface of the earth.

Although navigation systems in cars are commonly used to reach designated locations, systems for pedestrian navigation are quite hard to find, thus the adaptation of maps and charts to showcase features in geographic locations (Benjamin, 2012).

Taraba State University has a land area of about 1084 Hectares (TSU Academic Brief, 2008). The University comprises of two campuses; the Main campus and the Mini campus, this study covers only the main campus where the Senate building, Faculties and Department are located and academic programmes are run. Developments on the campus covers a land mass of about 5.93 kilometers in perimeter and 238 hectares in area (Google Earth Delineation).The campus was regarded as 'the fastest growing university in North-East Nigeria' as at 2012 (Nigeria University Commission, 2012).

It has been observed that people find it difficult getting to their destinations with all the structures on ground and thus the need to ease navigation for the thousands of people that troupe into the campus. A map has the ability to provide answers to question like: where a road is; where it leads to; the distance and type, the best route between two points or the shortest point (Kolawole, Alaga, Ogunyemi, Popoola, and Oloko-Oba, 2016). Some of the uses of a map include location of houses and streets, car navigation, planning of transportation, trips and driving directions; and for planning of movement of goods and services (Network Analysis) and provision of facilities (Kolawole *et al*., 2016).

A university campus is a complex infrastructure such that new students and visitors find it difficult getting around and finding places (Benjamin, 2012). The university campus attracts thousands of people every day especially by offering admission to new intake (students), provision of jobs, health services and other mini-business transactions, however people find it difficult to navigate around the school. New streets emerge everyday as new structures are constructed for lectures, libraries, laboratories, fire station and restaurants as well as other purpose (Kolawole *et al.,* 2016).

The Taraba State university campus has many buildings of architectural excellence and more are being constructed as the years go by. However there is no known official map depicting the University campus, for easy accessibility by first timers. Thus the need for the use of Geographic Information System (GIS) and remotely sensed (RS) data to create a database that can be updated over time with relevant information about emerging roads, buildings and infrastructures on the campus. It is against this backdrop that this study seeks to generate a Guide Map of the Taraba State University using GIS and RS.

2 Conceptual Issues and Literature Review

2.1 Map

A map is a model of part of the earth surface showing the shape, and position of different countries, political boarders, natural features such as rivers and mountains, and artificial features such as roads and buildings. A map can also give you particular type of information about a certain area on the surface of the earth. A street map is a type of map that contains the position and names of streets. A street map is useful in areas such as: planning enumeration areas by demographers; navigation for tourists; salesmen; firemen; police; security agent; tax collectors, postal service etc. It can also be defined as a graphic portrayal of a town or city, showing the positions and names of all the streets; major/minor highways and roads, railroads, tracks and other points of interest and the general road network. It is a form of map that details roads and transport network. It can be made so simple and specific that it shows direction of travel from one place to another (Kolawole *et al.,* 2016).

Reconnaissance technologies such as aerial photograph and satellite based sensing have come to man's aid in quest to understand and preserve his environment. This advancement has given the map makers new tools for creating and updating maps as well as allowing mapping in details which is of great use most especially in planning of urban areas (Abbas, Adamu, and Ukoje, 2009). Maps are specially designed to serve several purposes and answer specific questions such as street maps, utility maps etc.

2.2 The effectiveness of maps in representing spatial phenomenon.

From the earliest civilization, maps have been used to portray information about the earth's surface Navigators, land surveyors, town planners, military architects, etc. use maps to show spatial distribution of important geographic features (Bashir, 2001). An urban environment has complex spatial compositions—dense collections of physical structures such as buildings, trees, and roads, as well as urban open spaces such as parks or a public city square (plaza). Street guides are produced to show road information that is current especially to visitors and researchers (Ogunleye and Obiniyi, 2007). Street guides are not only important for aiding navigation within the city, but are also useful in planning enumeration areas by demographers, and are equally useful to tourists, salesmen, firemen, police, security agents, tax collectors, postal services etc

2.3 Evolution of GIS as a Mapping Platform

GIS is rooted in the digital nature of computerized map making, with emphasis onmapping tools and techniques such as Google Earth, web mapping, satellite image processing and environmental impact assessment. The early 1970's saw computer mapping as a high-tech means to automate the map drafting process. The points, lines and areas defining geographic features on a map are represented as an organized set of X, Y coordinates. These data sets can rapidly be drawn in a variety of colors, scales, and projections (GeoWorld, 2006). During the early 1980s, spatial database management systems (SDBMS) were developed this linked computer mapping capabilities with traditional database management capabilities. In these systems, identification numbers are assigned to each geographic feature, for example, a user is able to point to any location on a map and instantly retrieve information about that location (Berry and Mehta, 2009). As Geo-technology continued its evolution, the 1990s emphasis turned from descriptive "geo-query" searches of existing databases to investigative Map Analysis. Today, most GIS packages include processing capabilities that relate to the capture, encoding, storage, analysis and visualization of spatial data (Berry and Mehta, 2009). Spatial Analysis extends the basic set of discrete map features of points, lines and polygons to surfaces that represent continuous geographic space as a set of contiguous grid cells. The consistency of this grid-based structuring provides a wealth of new analytical tools for characterizing "contextual spatial relationships," such as effective distance, optimal paths, visual connectivity and micro-terrain analysis. In addition, it provides a mathematical/statistical framework by numerically representing geographic space in a database.

The advent of industrialized and information age which was as a result of the advancement in Information and Communication Technology has brought us to a point where maps can better be used to represent information about a phenomenon on the earth surface with less stress and skills This was not so in some decades ago because of the complexities and skillfulness involved in map making which makes it to be restricted to a privileged few such as surveyors, cartographers and geographers. Some of these maps which can either be static or dynamic, presenting information which represents the spatial distribution of geographic features in nature that can be used by navigators, researchers, town planners, architects, marketers etc. It is also noted that some of these maps (static) do not give the user perfect information representing what is obtainable on the surface of the earth after it has been produced because of the time factor involved

2.4 The effectiveness of Geospatial techniques over other mapping methods

Remote sensing involves the use of aircraft or satellites to collect photographs or scanned images of the Earth's surface. Remotely sensed imagery is just one of many types of geographically-referenced datasets that can be processed using a GIS. The origins of remote sensing date back to a photograph taken from a balloon in 1858. By World War I, the aeroplane had become the main platform from which aerial photography was collected (Areola, 1986; Teeuw, Whiteside, McWilliam, Zukowskyj, Hourigan, Mount & Jonathan, 2005).

During the inter-war period, film chemicals were developed that allowed colour and infrared photography: the latter was of particular interest to the military, as it highlighted camouflaged features. Since the 1950s, black and white aerial photography has been the basis of most Earth surface mapping. In the past, the processes used for mapping and revision of maps had been the classical land surveying method (Ezra and Kantiok, 2007). Later in the Nineteen Century, aerial photographs were used to extract data for producing and revising topographic maps. These methods proved to be time consuming and inefficient for delineating large study areas and limited in the ability to conduct frequent updating and revision (Ndukwe, 2001). Fortunately, remote sensing, a fast means of acquiring data about the environment without physical contact with the features has made significant advances over the past twenty years in providing cost effective data for mapping. The importance of Remote Sensing and Geographic Information System in map making cannot be undermined because of its ability to integrate spatial data with non-spatial data and also communicate the resulting information in a way that everyone would understand. These techniques have been used in various times and at different stages to study characteristics of Earth features, monitor natural and physical phenomena and also produce street maps of different places. The map making process can be a daunting and challenging process; however, improvements made in computer hardware and software technology have tremendously improved both the speed and quality of map making process as a whole. It has increased the value of the map as a source of environmental information for all types of planning and decision making. Furthermore, there has been an increase in the demands for high quality hardcopy and digital maps in recent times (Environmental Systems Research Institute, 2004). Thus the need for the capability or capacity of producing high precision and quality maps within a reasonable time frame and at a greatly reduced production cost. Unfortunately, traditional mapping processes cannot sustain such current demands. Among the advantages of GIS over traditional methods are the following:

i. Flexibility in the mapping process (Morrison,1988).
ii. Reduced vulnerability of maps to dimensional distortion (expansion or shrinkage)
iii. Capacity to respond to the increasingly complex and diverse requirements of planners and decision makers with respect to geo-information products (Morrison,1988)

iv. Simplified and faster map revision process. (United Nations, 2000)

v. Quick and easy linkage to databases (Burrough and McDonnel, 1998).

2.5 Satellites and Remote Sensing Technology

Since data from satellites became available for commercial use, they have served as a useful means of monitoring our environment .The availability of the new generation satellite imageries have opened a new era and signaled promising futures for producing and updating digital maps. Satellite remote systems provide a synoptic view of large portions of the earth surface as an entity rather than in small bits. These images allow a view and the analysis of different features of the environment (and even road network) on regional and global scale (Fasote, Kolawole, Adewoyin, Mohammed,Alaga, Halilu, and Muibi, 2016).

GIS and remote sensing in map production allow for the combination of data from different sources as well as the interpretation, manipulation, management, analysis and accurate presentation of map information. This approach also gives optimal benefits as the advantages of both technologies are combined in the mapping process. This however has been ascertained by many scholars and researchers. For instance, Abbas, Adamu and Ukoje (2009) concluded that street mapping using remote sensing data and GIS technique is less tasking compared to the traditional map making and is also cost effective and time saving. Thereby, positing that remotely sensed data provides repetitive, synoptic view and accurate information that can be used to obtain up-to-date maps. Other research also demonstrated that the use of satellite imagery together with computer hardware and software technology (GIS) in street map production have tremendously improved both the speed and quality of map making as well as increase the precision, accuracy, quality and productivity. This has enhanced the capability/capacity of producing high precision and quality maps (street map) within a reasonable time frame and at a greatly reduced production cost.

2.6 GIS and its shortfalls in Nigeria

The advent and advances made in computer technology in the twenty-first century has generally increased the speed and the capacity of various Geo-information and the map-making processes. The improvements have revolutionized the map-making process, GIS has tremendously transformed the traditional (analogue) method of map-making. Round the world, GIS is continuously being applied in achieving high precision street guide maps for a variety of purposes. However, in some developing countries like Nigeria, the full potentials of such modern technologies and science are yet to be realized. The use of maps in developing countries is relatively low compared to what is obtainable in developed countries. This is strongly linked to the dearth of accurate and up-to-date maps, which could be linked to the non-adoption and application of recent advances in map making process. In this study, GIS is being advocated as a way forward in the map making processes in developing countries with a goal to quicken and improve map production process through increased precision, accuracy, quality, and productivity, among other things. This study aims at stimulating interest in the adoption of GIS technology in the state, as well as boosts the use of maps, through continuous update and map revision.

2.7 Related studies

Nnam, Bernard, and Obinna (2012), demonstrated in their work that the use of satellite imagery together with computer hardware and software technology in street map production have tremendously improved both the speed and quality of map making as well as increase the precision, accuracy and quality of maps. This has enhanced the capability / capacity of producing high precision and quality maps (street map) within a reasonable time frame and at a greatly reduced production cost. The use of the computers alongside the techniques of Remote Sensing and Geographical Information Systems (GIS) have provided advancement in the process of attainment, storage, publishing, access, and interaction with several cartographic products such as maps, satellite images, aerial pictures, among others (Peterson,1999).

These techniques have been used in various times and at different stages to study the characteristics of Earth features, monitor natural and physical phenomena and also produce street maps of different places. Fortunately, remote sensing, a fast means of acquiring data about the environment without physical contact with the features has made significant advances in providing cost effective data for mapping.GIS and remote sensing in map production allow for the combination of data from different sources as well as the interpretation, manipulation, management, analysis and accurate presentation of map information. This approach also gives optimal benefits as the advantages of both technologies are combined in the mapping process (Kolawole *et al.,* 2016). This however has been ascertained by many scholars and researchers. For instance, Abbas *et al.,* (2009) concluded that street mapping using remote sensing data and GIS technique is less tasking compared to the traditional map making and is also cost effective and time saving.

2.8 Brief History of Taraba State University

Taraba State University, Jalingo was established on 24th January 2008. The idea of establishing the school was muted in 2004, when Rev. Jolly T. Nyame was the State Governor. Feasibility studies were conducted but the proposal was never implemented until 14th June 2007 when Pharm. Danbaba Danfulani Suntai (the then Governor) set up a technical committee on the establishment of the University. The report of the technical committee was accepted by the government on 24th January 2008, The Taraba State University was established by law No. 4 2008, passed by the Taraba State House of Assembly. The (then) executive Governor, Pharm. Danbaba Suntai accepted the law on 28th January 2008. (University Handbook, 2015)

The university commenced academic session in the 2008/2009 academic session with over 1000 students at the School of General and Preliminary Studies. Fulltime undergraduate programme commenced in the 2009/2010 academic session with over 40 academic staff and 500 students registered across 8 departments. The university has witnessed significant growth since 2008. At the beginning of the 2011/2012 academic session the academic staff strength was over 100 while student enrolment was about 2300 (University handbook, 2015).

The pioneer Vice Chancellor was Dr. Ahmed Usman Jalingo who served from 2008 to 2012 academic session. Dr. Ahmed U. Jalingo died in March 2013 and was replaced by Prof. Noku Micheal who served as Acting Vice Chancellor until January 2012, when Prof. Yahaya Mohammed Sani was appointed to serve as the Vice Chancellor (University Handbook, 2015). He was succeeded in 2016 by Acting Vice Chancellor Dr. Catherine Musa who handed over to the present Vice Chancellor; Prof. Vincent Ado Tenebe. The current administration has introduced academic rigour, monitoring and evaluation, administrative competence checks geared towards positioning the University to truly harness natures' gift to the nation.

3 Materials and Methods

3.1 The Study Area

Taraba State University is found on longitude11°18'50.35"E and latitude 8°53'51.50"N and is located in Jalingo the capital city of Taraba State which lies approximately between longitudes 11^0 09'E to 11^0 30'E and latitude 8^0 47'N to 9^0 01'N (Oruonye, 2012). The Local government lies in the north of Taraba state. It is bounded to the north by Lau L.G.A, to the east by Yorro L.G.A, and to the south and west by Ardo-Kola L.G.A. Jalingo has a total land mass of about 195.071km^2 (Oruonye, 2011).

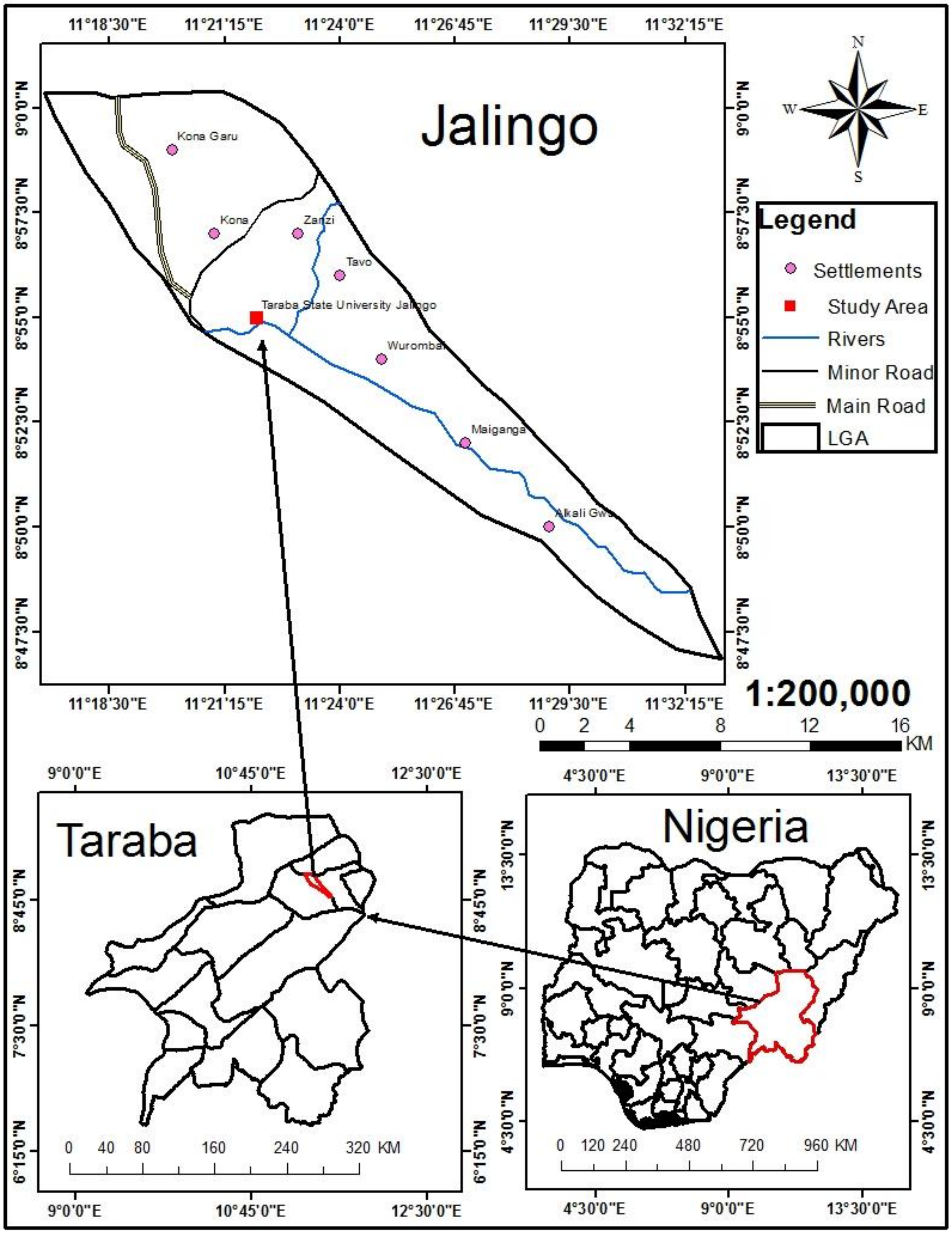

Fig 1: Map of Nigeria showing the study area.

Source: Author's GIS Analysis (2017)

Jalingo has a Tropical Continental Climate well marked by wet season which begins in April and ends in October and a dry season begins in November running through March. The dry season is characterized by the prevalence of the North-East trade winds from the Sahara desert. Jalingo has a mean annual rainfall of about 1200mm and mean temperature of about 29°C (Oruonye, 2011).

The relief of Jalingo LGA consists of undulating plain interspersed with mountain ranges. Between Kwaji-Mika to the east and Kona to the west, stretching to Kassa Gongon to the south exist a range of compact massifs of rock outcrops. The mountain ranges run from Kona area through the border between Jalingo and Lau LGAs down to Yorro and Ardo Kola LGAs in a circular form to Gongon area, thus giving a periscopic semi-circle shape that is almost like a shield to Jalingo town (Oruonye, 2012). Jalingo local government area is underlain by basement complex rocks with feldspar crystals, quarts and mica as some of its dominant mineral constituents. The soil is characterized by hydromorphic and ferruginous soil derived from the parent materials (Oruonye, 2011).

Jalingo is drained by two rivers; Mayogwoi and Lamurde which empty their content into the Benue River System at Tau village. The valleys of these rivers are dotted with ox-bow lakes which are as a result of depositional activities (Oruonye, 2012). The soil of Jalingo LGA is predominantly sandy and loamy which is considered as porous withrapid drainage (Oruonye, 2012).Jalingo is located within the Guinea Savanna vegetation type characterized by grasses interspersed with tall trees and shrubs. Some of these trees include; locust bean, shear butter, eucalyptus, baobab and silk cotton trees (Oruonye and Abbas 2012).

Jalingo L.G.A has a juvenile population structure with a total population of 140,318 (National Population Commission, 2006) and a projected population of 162,210 as at 2011. The major ethnic groups are; Fulani, Mumuye, Jukun, Kona, others include; Jenjo, Hausa, Wurkum, Yandang. Hausa language is widely spoken as a medium of communication for social and economic interactions (Oruonye, 2011).The ethnic groups of Jalingo includes; Jukun, Chamba, Itchen, Kuteb and Tivs. There also exist a significant number of Igbo and Yoruba in the state.

The diversity of people of Jalingo in terms of ethnic, religious, social, and economic affiliation is consistent with the position of Jalingo as the capital of Taraba State. A significant number of the population is engaged in civil service, others include farmers, shop keepers, providers of services like barbing saloons, hair dressing, restaurants, hotels and petroleum product business etc. In addition a significant part of the population is engaged in produce and livestock trade, to cope with demand for food and meat for the populace.

3.2 Methods

To provide reasonable result the following research procedures were employed. The data required for this study was collected from Primary and Secondary sources.
Data collected from the Primary source include; (a) Google Earth Image (High resolution Satellite image) (b) Field survey (GPS coordinates) (c) Oral interview (Attribute information i.e names of buildings) while the Secondary sources include: Text books, journals, internet, published and unpublished projects, Scientific and Geographical Journals.

To produce the street guide, primary data acquisition was employed, whereby data was obtained by ground surveying and remote sensing. This entails;

i. **Image acquisition:** The acquisition of high resolution satellite image i.e Google Earth satellite Imagery of 2016 with resolution of 2meters
ii. **Field work:** This involves the picking of Coordinate of major ground control around the school using a GPS device.

Various cartographic and GIS procedures were employed in this research, these include:

i. **Geo-referencing**; This is the process of assigning geographic information to an image establishing relationship between the digital map elements and real world geographic coordinate i.e. tying a place to its original position on the earth surface.

ii. **Creation of Database:** This involves the assigning of feature classes and population of the database to provide geometric and attribute information.

iii. **Digitizing:** This entails the generation of feature classes consisting of point, line and polygon features such as streetlights, rivers, roads and buildings from the downloaded Google Earth image.

iv. **Cartographic generalization:** This involves generalization of features to present a more understandable picture of the study area to the general public.

v. **Map composition;** this simply relates to preparation of maps for publication/printing. To achieve this, some important map elements were included such as the North arrows, scale bars, scale text, and legend.

The data for this research work was processed and analyzed using the following software.

i. ARCMAP10.3 Software: ARCGIS is ESRI's leading application when it comes to mapping geographic data. ARCGIS has a whole range of geo-statistical tools and functionalities used in the analysis and manipulation of geographic data. Such operations includes database creation, geo-referencing, digitizing and cartographic visualization and generalization. ARCGIS is a basic for spatial data modeling.

ii. Google Earth: This is a high resolution satellite image (2m) used in high precision mapping of geo-features such as buildings, roads and other visible relevant geographic features

iii. Microsoft Visio: This application is used to show the flow chat and methodology employed in this research (Fig 2)

ii. Microsoft word: This is Microsoft's Office major application used for typing and word processing. This application was employed in this research work.

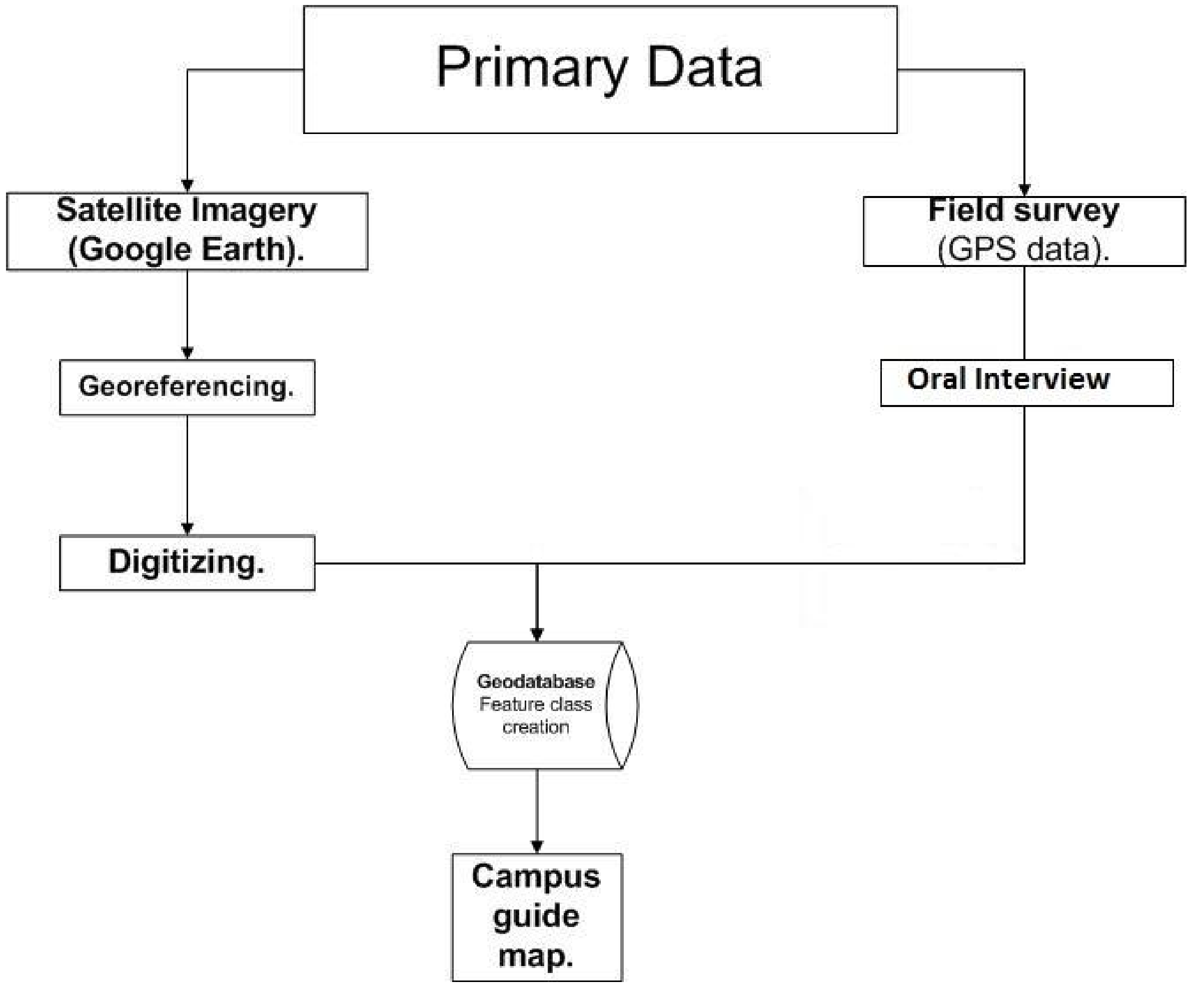

Fig 2: Flow chart showing Research Methodology.

4 RESULT AND DISCUSSION

4.1 Road classes

The results generated from digitizing the roads on the campus shows that, there exist three major road classes on the campus viz; Major road, Minor road and Footpaths. These are shown in Figure 3.

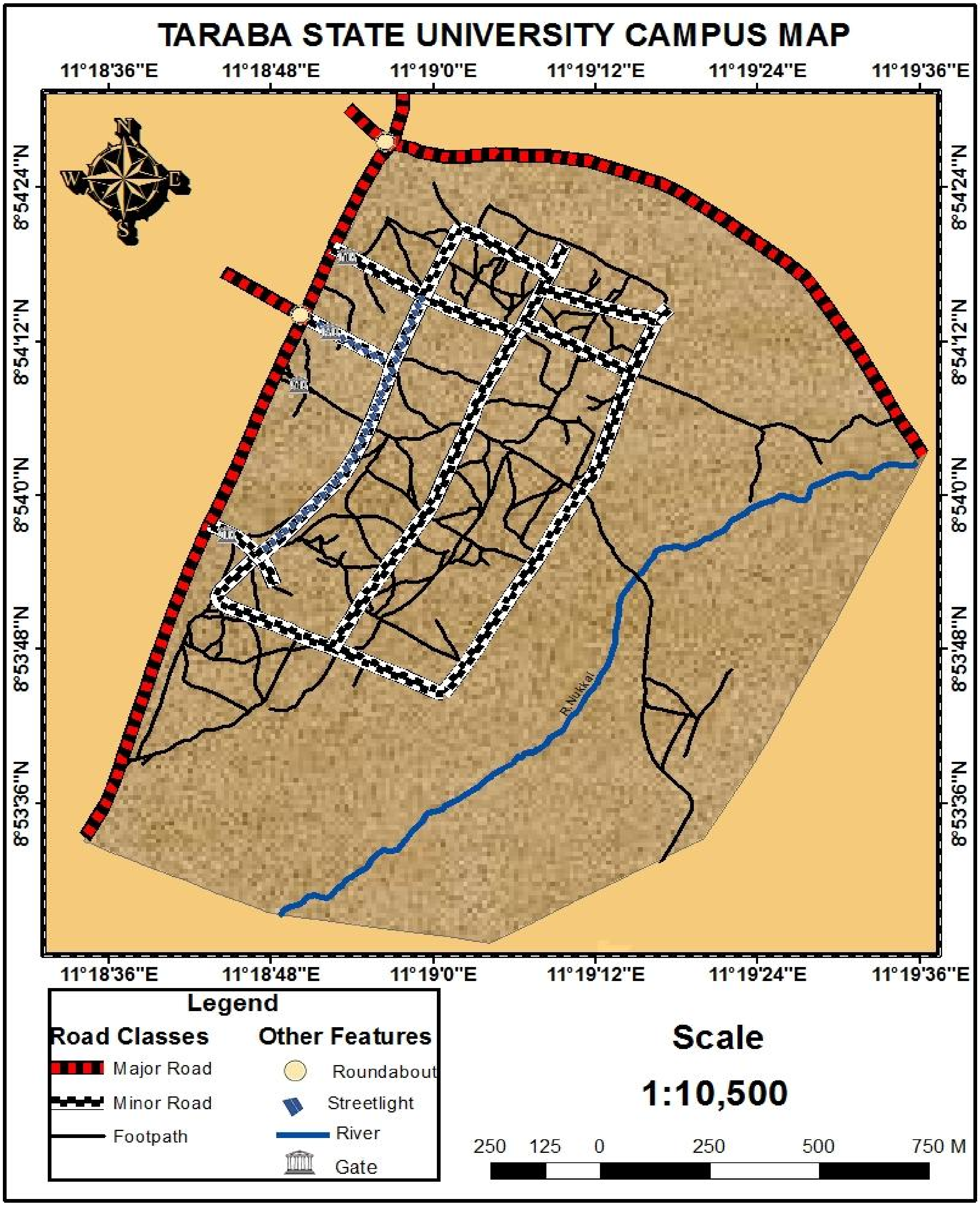

FIG 3: Map Of TSU Showing The Major Road Classes.

Source: Author's GIS Analysis (2017).

4.2 Building statistics

The result of the database generated for the University, showed that the total number of buildings on the main campus is about 872 consisting of 57 huts and 816 houses as shown in Figure 4.

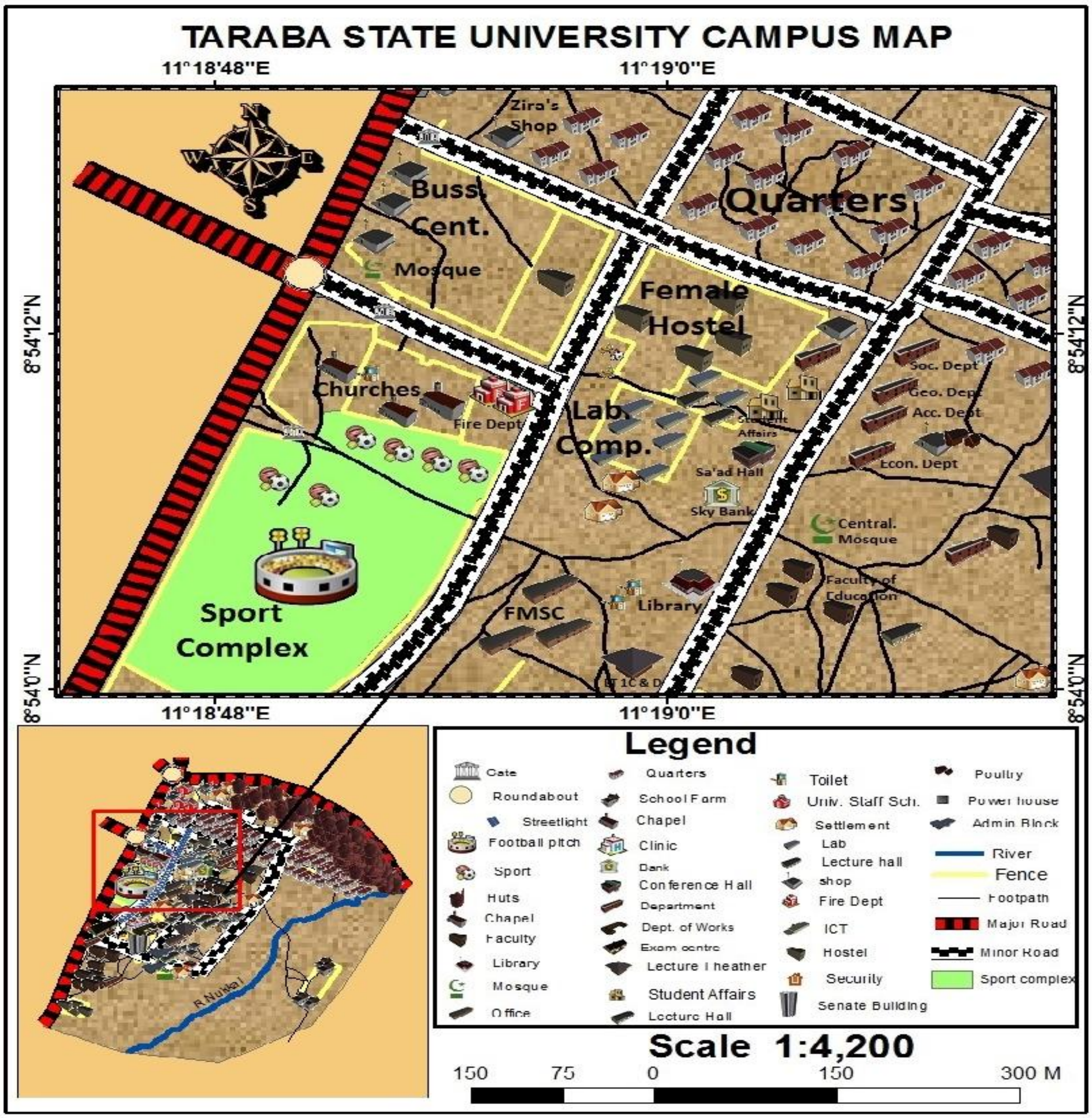

Fig 4: Map of TSU Showing Some MajorBuildings (3D).

Source: Author's GIS Analysis (2017).

4.3 Land use class

Geometric (geographic) information about structures on the campus was collected and given attribute information (Name) based on their current landuse. The following landuse types

(Figure 5) were discovered; Administrative landuse, Agricultural landuse, Commercial landuse, Educational landuse, Recreational landuse, Religious landuse, Residential landuse and other landuses.

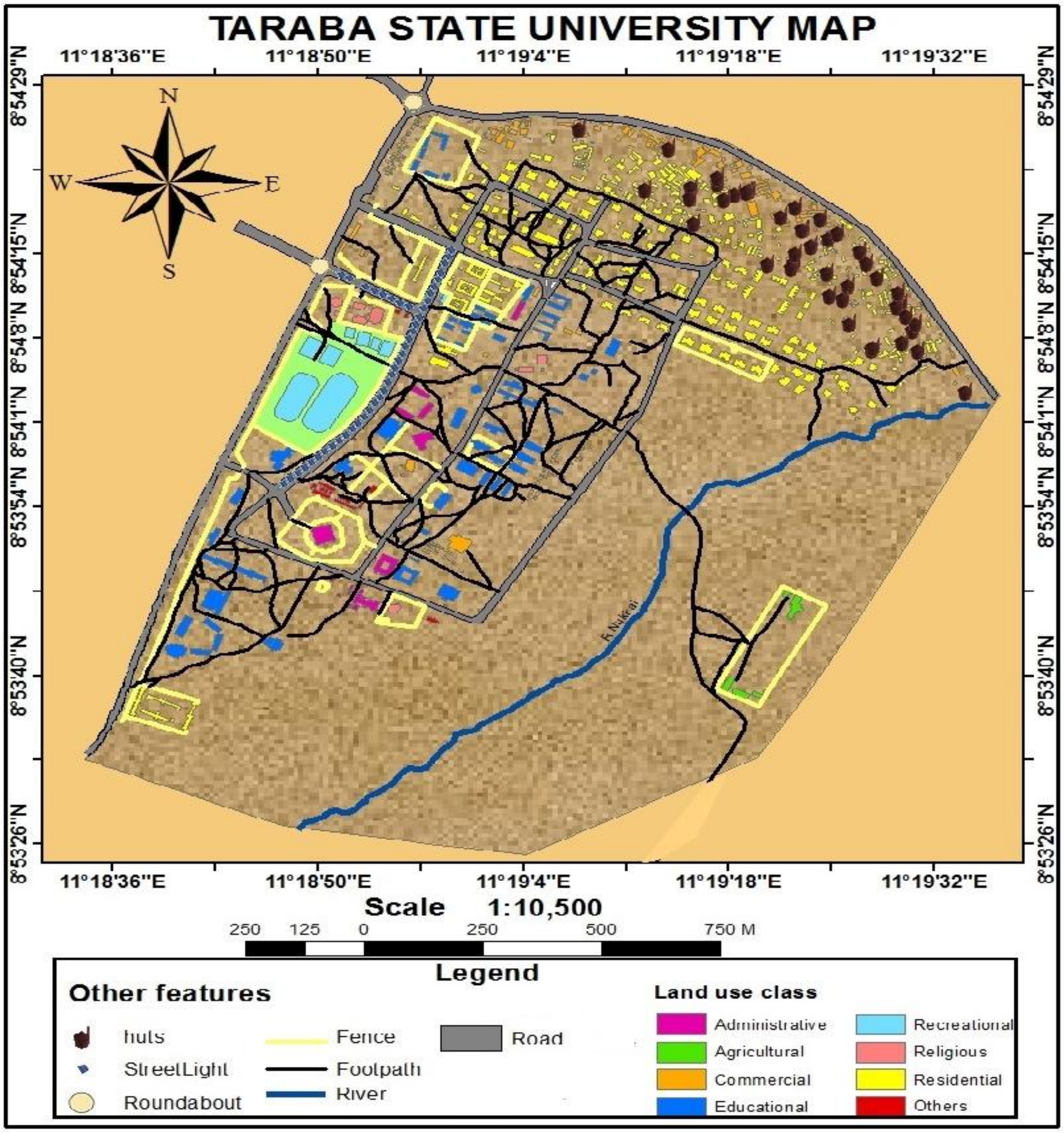

FIG 5: Mapof TSU Showing the Major Landuse Classes (2D).

Source: Author's GIS Analysis (2017).

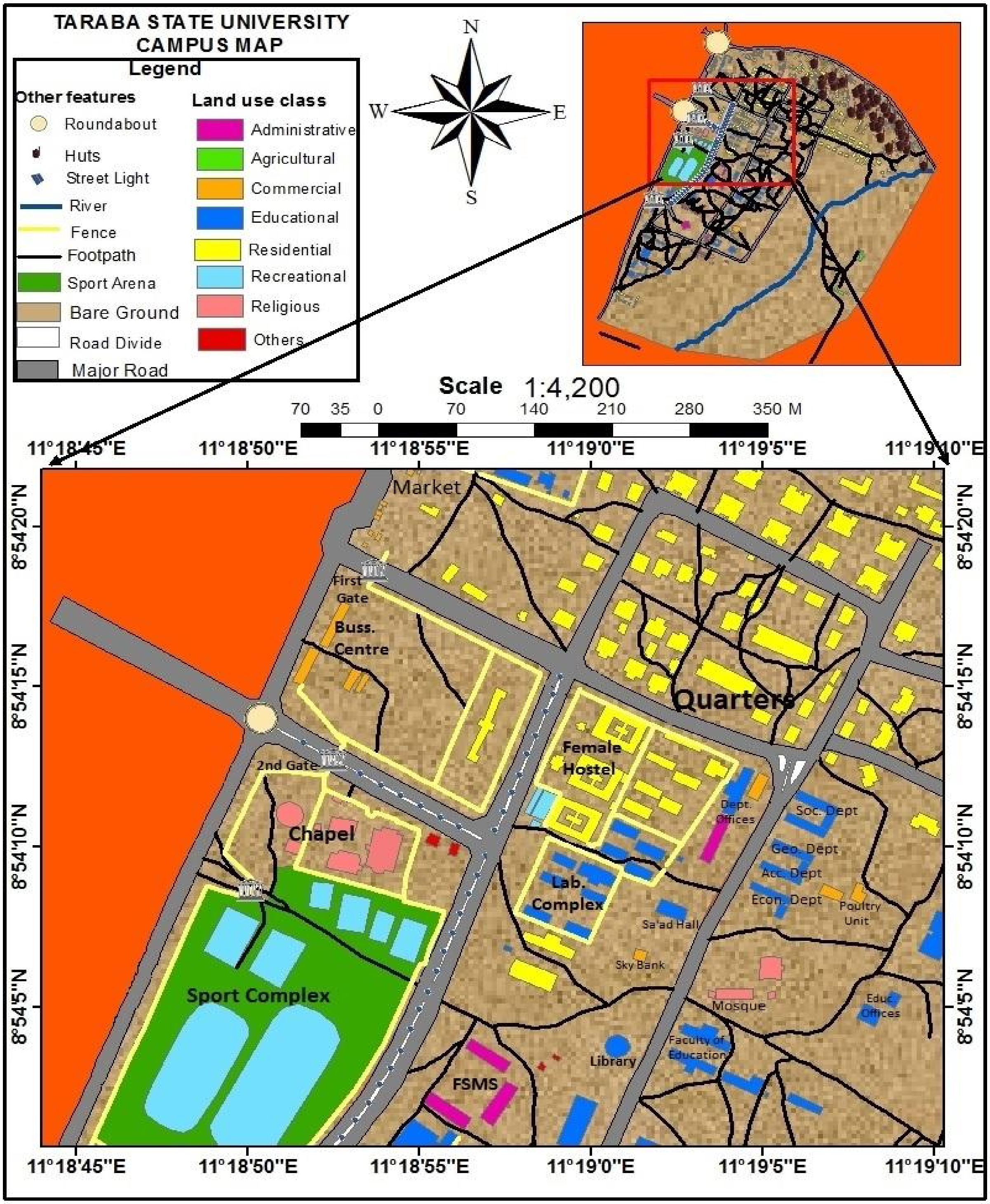

FIG 6: Map of TSU Showing the Major Land use Classes (2D Zoomed view).

Source: Author's GIS Analysis (2017).

4.4 Campus Guide (Map)

Guide maps usually show the spatial distribution of infrastructures across as tudy area and how people can get to their intended destination After a wide range of analytical operations using GIS and Remote Sensing techniques, the final map of the Taraba State University (Figure 7) was generated with some form of generalization to make the map understandable to a lay man at a glance. Generalization was employed to enhance the visual quality of the map and to highlight the aesthetic design of features depicted on the map.

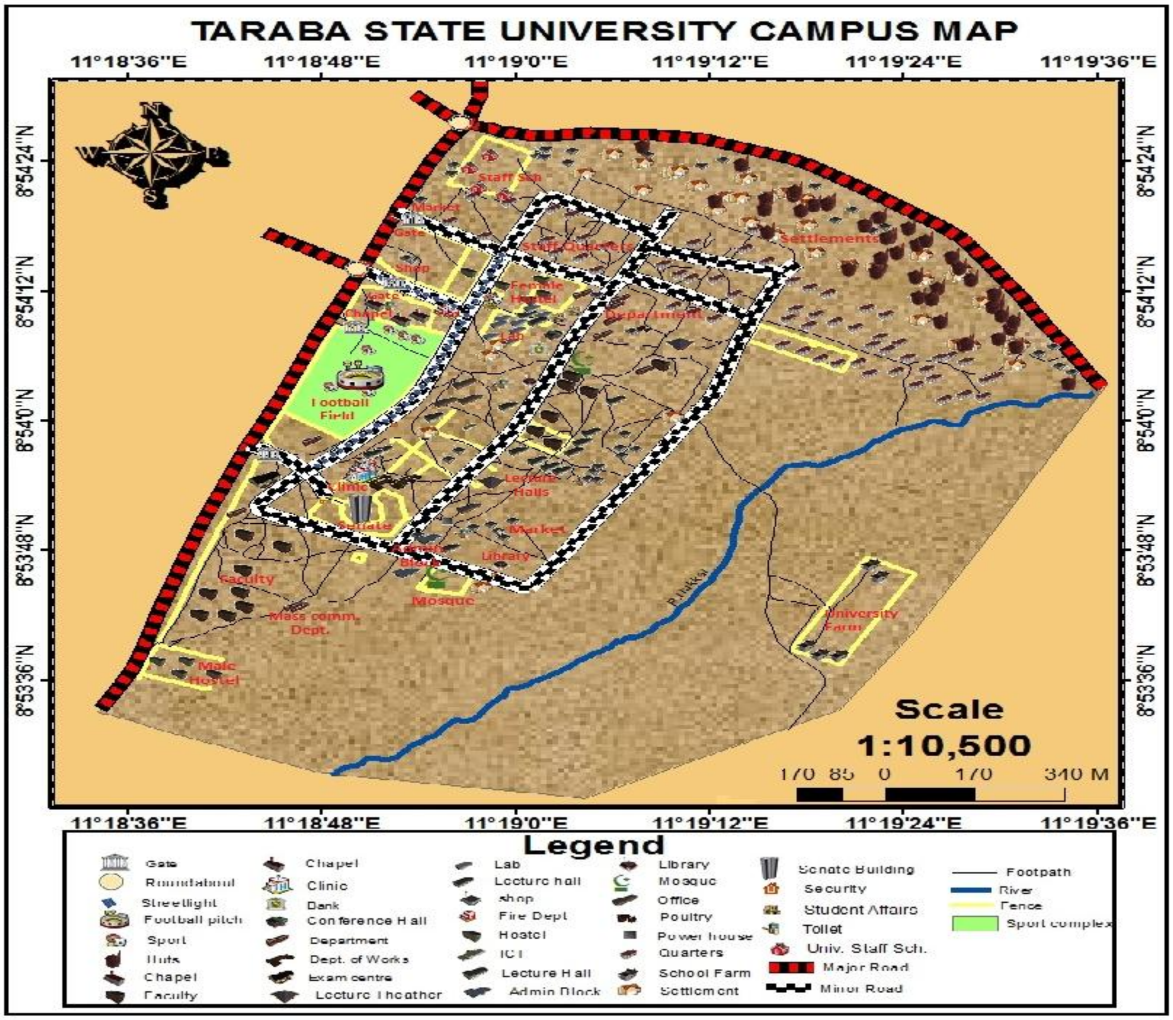

FIG 7: Taraba State University Campus Guide (3D).

Source: Author's GIS Analysis (2017).

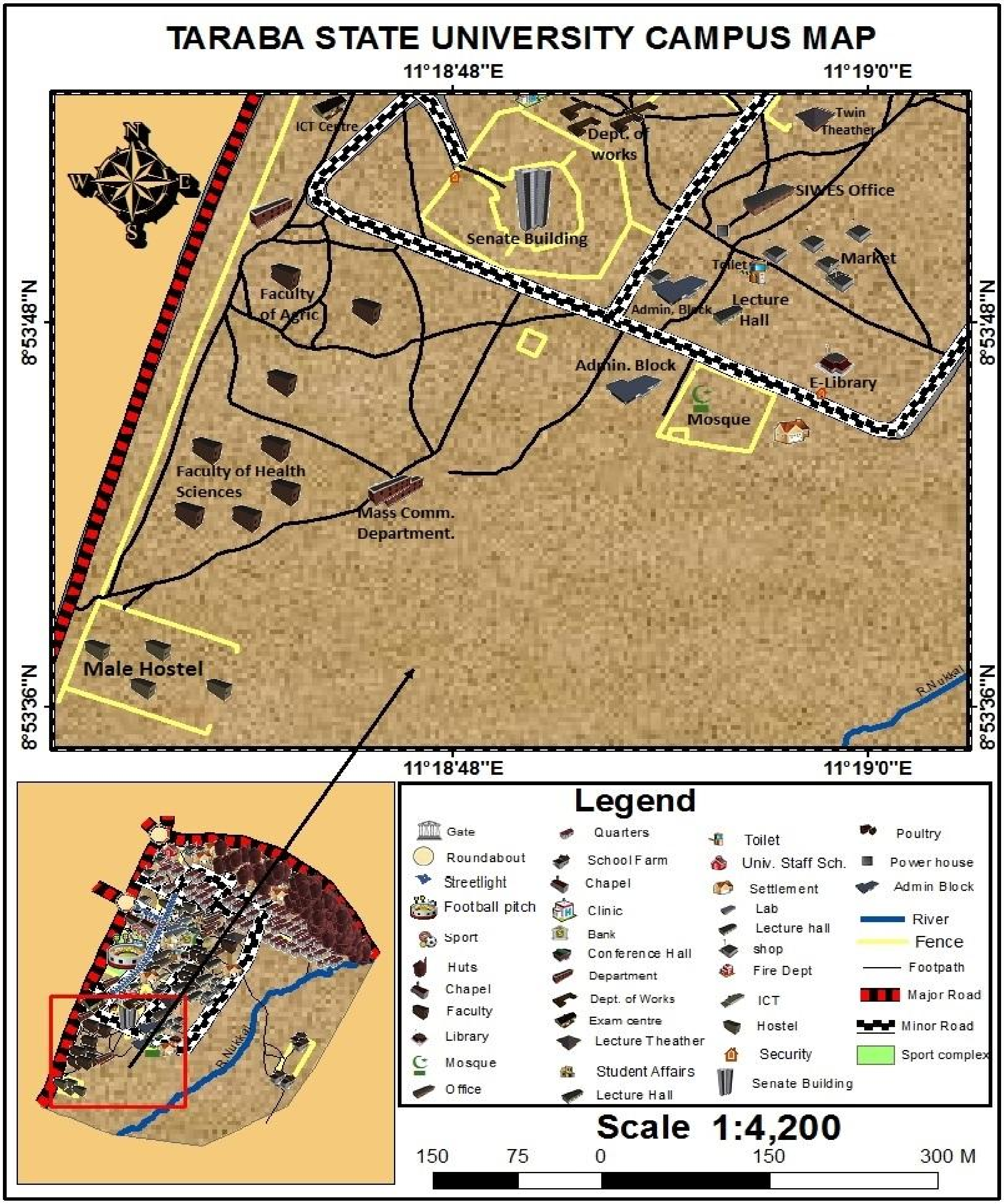

FIG 8: Taraba State University Campus Guide (3D Zoomed view).

Source: Author's GIS Analysis (2017).

5 Summary and Conclusion

The study mapped the spatial distribution of roads and buildings and other features within the Taraba State University Main Campus using remote sensing and GIS techniques. The study employed geo-techniques such as geo-referencing, digitizing, database creation, feature class delineation and cartographic generalization and presentation (composition) of the campus map.

This study revealed three (3) roads classes and eight (8) landuse categories on the campus. The study also shows that buildings and facilities on the campus are located majorly in the North-western corner of the University.

Map serves as visual representation of the earth surface and can therefore be regarded as the most effective means of depicting features and their location on the earth surface, the importance of a map cannot be overemphasized considering the fact that maps guide and give direction to people especially when they are visiting such areas for the first time.

This work has produced the campus guide of the Taraba State University using satellite image acquired from Google earth (High Resolution) and analyzed it using ArcGIS 10.3 to produce results. The map shows the extent of the university covering a land mass of about 238 Hectares (Google earth delineation, 2016). Based on the outcome of the study, the following recommendations are made;

i. The University Authority should consider establishing a GIS/ Remote Sensing Department to produce more projects of this capacity.
ii. There is a need to extend development (buildings and roads) to other corners of the university to ensure equal development across the university landmass
iii. A large portrait of the Campus guide should be produced and placed at strategic locations to aid navigation for students, staff and commuters within the University
iv. The study also recommends that satellite and remote sensing technology should be used to monitor the development on the campus so as to enable the update of the campus guide over time.

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