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Topographic Information System of Federal School of Surveying, Oyo East Local Government Oyo State Nigeria

Ojiako J.C., Jimoh S. O.

Abstract— *The need for the production of Topographic Information System (TIS) of Federal School of Surveying, Oyo arose due to the absence of Topographic Information System for proper planning of the school. Therefore, TIS was carried out with the aim of producing a tool for effective planning and land management of the school. Field and Office reconnaissance were carried out in order to be familiar with the terrain and do proper planning on the methodology and equipment to be used for the acquisition and assembling of spatial and attribute data. The geometric (spatial) data were acquired by ground survey method using Total station (South S74301) through the process of traversing, detailing and obtaining spot heights which were carried out simultaneously. The data processing were adequately and effectively done using Leica Geo Office Tools and South NTS Software for Data downloading, Notepad and Microsoft Excel for editing and preprocessing, AutoCAD 2016 for draughting, Surfer 11 for generating the Digital Terrain Model (DTM) and 3D Wireframe Map while ArcGIS 10.0 version was used for spatial analysis, query generation and information presentation. A model database was created and structured using the relational table format. The interpretation of the maps and queries produced, supports decision making policy needed by the Land surveyors, Architects, Engineers, Urban and Regional planners to plan, design and execute vital infrastructural projects in the school. It was recommended that TIS should become a lasting tool for decision making and management of land and its resources for effective and sustainable development.*

Keywords—Mapping, Geographic Information System, Database, Topography.

I. INTRODUCTION

The demand for topographic information for various needs and applications by numerous users is on the increase. From a global point of view, there is no meaningful development embarked upon by an individual, government and agencies without information about the topography of the area to be developed. In recent past, classical and conventional techniques were used to produce topographical maps, whereas the configuration of the terrain can be shown in form of contour lines (Jimoh, 2014).

Topography is generally known as the study of earth surface, and its features and shape. It also gives the description of the features (such as surface, shapes, vegetation cover & elevations), depicted in maps. In essence, topography mainly concerned with local details such as vegetative and man-made features including local history and culture. More specifically, topographic surveying involves the gathering information on terrain, three dimensional details of the surface including recognizing the specific landforms. In modern terms, it is the generation of data digitally or electronically. The outcome of topographic survey is the graphic representation of a given land parcel on a map using several techniques such as contour lines, Hypsometric tints and relief shading (i.e. topographic maps). There are varieties of methods used in topographic surveying. For example, direct surveying, remote sensing, aerial and satellite imagery, photogrammetry, radar and sonar. The most appropriate method to be used depends on the scale, size (extent of the area of interest), purpose and complexity of the subject to be study. Also, it depends on the accessibility and the quality of existing survey information (Olaniyi , 2013).

Understanding the topography of the land around and beneath any type of structure is essential when it comes to changing an existing property or even building an entirely new one. Federal School of Surveying, Oyo as an academic institution has undergone rapid development and the existing topographical map covers only the built-up area. So, there is need to produce a complete topographic information system based on the existing topographical data in order to determine the topographic variation of the land surface, to ensure effective socio-economic development and to produce an updated map in digital format thereby displaying the shortcomings of the analogue map. it is also imperative that a comprehensive database be created, which

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will serve as a source of information for future development, hence the necessity of this research.

II. STUDY AREA

The project site was the Federal School of Surveying located along Oyo-Ogbomoso road in Oyo East Local Government Area of Oyo State. It lies between latitude 07° 50' 24.42''N and 07° 50' 43.07''N and longitude 03° 56' 5.5''E and 03° 57' 16.06"E. The area of the project site was found to be 33.266 hectares. The project area is a developing area with features like buildings, roads, trees, electricity lines, street lights, and masts e.t.c.

Fig. 1: Location of the Study Area (Source: Google Earth)

III. METHOD

The method used in this research is shown in figure 3

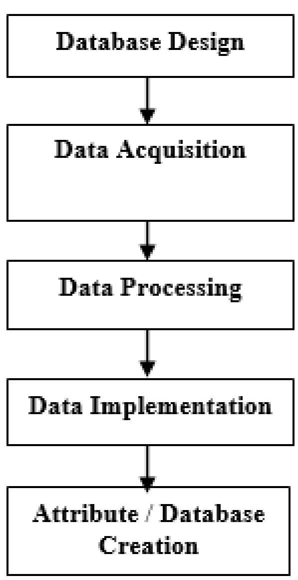

Fig.2: Flowchart of method adopted

3.1 Database Design

The creation of a structured, digital database is the most important and complex task upon which the usefulness of the cadastral information system depends. Database design is the process of producing a detailed data model of a database (Hernandez, 2012). The design phase consists of three levels (Kufoniyi, 1998):

a) Conceptual Design
b) Logical Design
c) Physical design

a. Conceptual Design

Conceptual design is the first step in database design where the contents of the intended database are identified and described. It deals with the identification of the basic terrain objects together with the spatial relationship that exist among them. It is human-oriented, often partially structured, model of selected objects and process that are though relevant to a particular problem domain. Conceptual design is carried out independent of the software and hardware that will be used to implement the database.

Since parcel is the main focus of this research, vector data modeling was considered appropriate for this application because its best represent parcel.

b. Logical Design

This is another stage of the database design in which all the real world entities conceptualized were modeled into the real world using logical design. It is the representation of the conceptual design to reflect the recording of the data in the computer system using a relational database management system (RDBMS) (Effiong and Alagbe, 2012). In this phase, the entities, their attributes and their relationships were represented in a single uniform manner inform of relation in such a way that would be no information loss and at the same time no unnecessary duplication of data.

c. Physical Design

This involves the translation of the real world entities into the computer compactable forms of the chosen structuring model such as relational, geo-relational, network, and hierarchical. For this project, relational (table) structuring method was used due to its easy implementation and management.

All geospatial and non spatial (attribute) data were structured and actualized to form a database in a format acceptable by the implementing software and hardware. Thus, point, line and polygon layers were created for spatial objects on the digital map. Attribute data needs of the database were also structured as shown in the following tables.

3.2 Data Source

The primary data collected include the coordinates of some pillar around the study area of known description for the purpose of geo-referencing the plan.

The secondary data used include a hard copy layout plan of the project area and attributes of the plots.

3.3 Data Processing

The layout plan of the project area was scanned and then exported to ArcGIS 10.2 for georeferencing and digitized, so that spatial analysis would be performed. Attribute data were used for the creation of spatial database. These data were processed and queried to provide useful cadastral information.

IV. RESULTS

The major spatial attribute results in the study area are shown in figures 4.0- 4.5. These spatial queries were classified as single criteria queries and multiple criteria queries. As shown below

4.1 Query to show all buildings that are used for academic purpose using the query syntax:- *"b_use = "academic"*

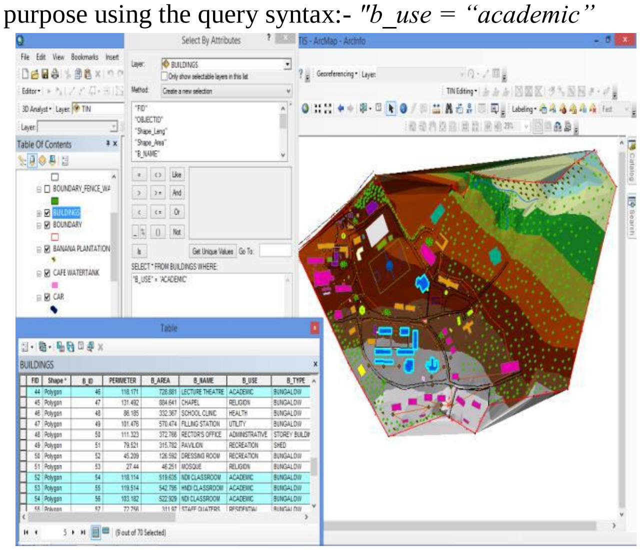

Fig. 4.1: Buildings that are used for academic purpose.

Fig. 4.1 showed all buildings that are used for academic purpose. The displayed attribute table confirmed that all the buildings falls within the Middle-belt hemisphere of the school. Also, there are eight (8) buildings that falls into this category.

The result of this query will aid the location of the academic buildings. Presently, the school is growing massively in terms of student's intake i.e. the number of student keeps growing on a yearly basis. However, the query will help the school management to consider if more academic buildings need to be built due to the rapid increase in the number of admitted students so that academic activities will be passed across to students in a conducive and spacious environment.

4.2 Query to show all buildings that are used for administrative purpose using the query syntax:- *"b_use" = "administrative"*

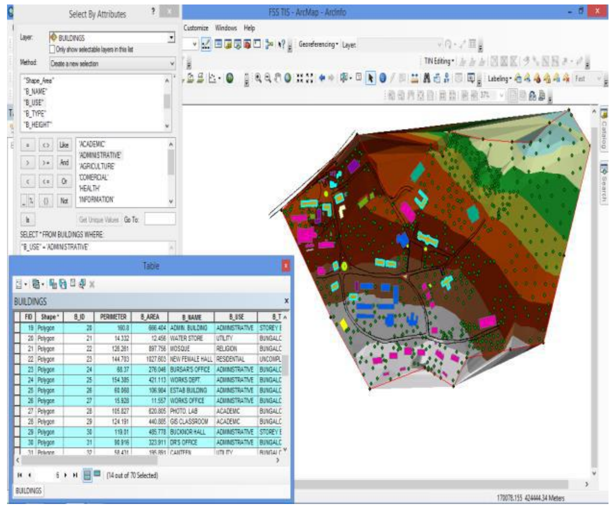

Fig.4.2: Result of query shows buildings that are used for administrative purpose.

Fig. 4.2 showed all buildings that are used for administrative purpose. The displayed attribute table confirmed that all the buildings falls within the North-western and Middle-belt hemisphere of the school. Also, there are thirteen (13) buildings that falls into this category.

The administrative buildings is an integral part of the school from where, most administrative activities and decisions are made. The results of this query will assist the new students or visitors in locating the administrative buildings.

4.3 Query to show the elevation of points that are less than or equal to 300m using query syntax:- *"heights_m_" <= 300*

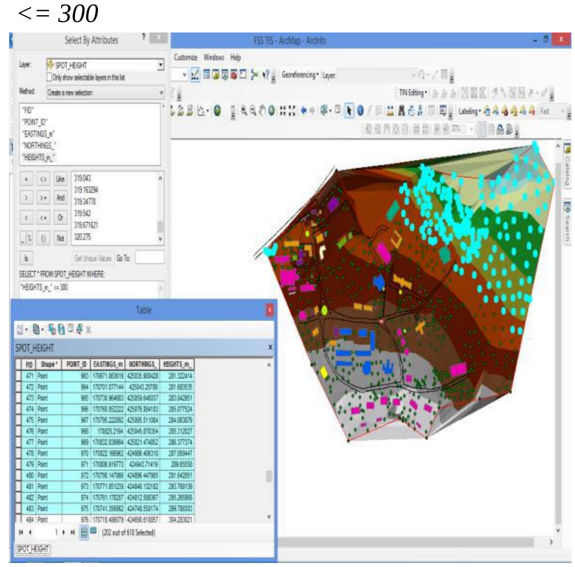

Fig.4.3: Result of query shows the elevation of points that are less than or equal to 300m.

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Fig 4.3 showed the elevation of points that are less than or equal to 300m. The displayed attribute table confirmed that North-eastern part of the school had the lowest elevation.

Height is an important factor when considering the surface or slope of the terrain. The North-eastern part of the school had the lowest elevation which is very prone to erosion. Buildings that will be sited in that region must have a very high foundation above the ground level. The result of the query will afford the school management to decide concisely the terrain characteristics and the kind of building that should be built in every region of the project area looking critically at the terrain of the area.

4.4 Query to show the elevation of points that are greater than or equal to 300m using query syntax:- *"heights_m_" >= 300*

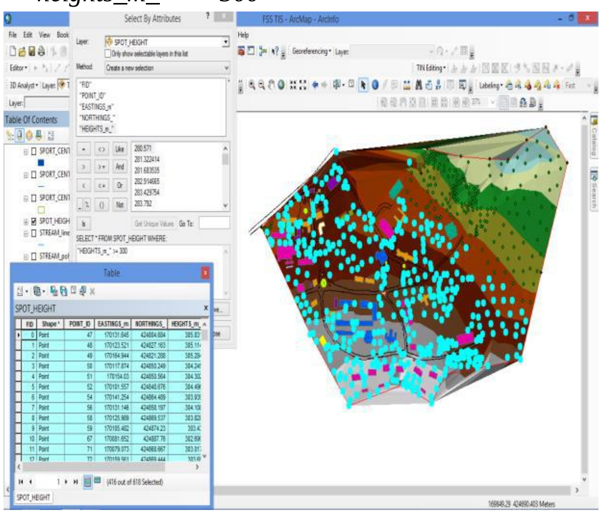

Fig. 4.4: Result of query shows the elevation of points that are greater than or equal to 300m.

Fig. 5.12 showed the elevation of points that are greater than or equal to 300m. The displayed attribute table confirmed that the Western, Middle-belt and Southern parts of the school had the highest elevation. It can be deduced from the query that all developments that existed in the school occurred in these regions.

Elevation has a lot to do in topographic mapping. The highest elevated portion of the school seems as an advantage for the school because structures will be constructed with ease and erosion will not be a menace. The result of the query will help the school management to understand the terrain characteristics and the kind of development that fits each region considering the relief of the regions.

4.5 Query To show all cultivations within the study area using Selection by Location (Select features from Target layer "Cultivation" on Source layer "Boundary" where "Target layer features intersect the Source layer feature")

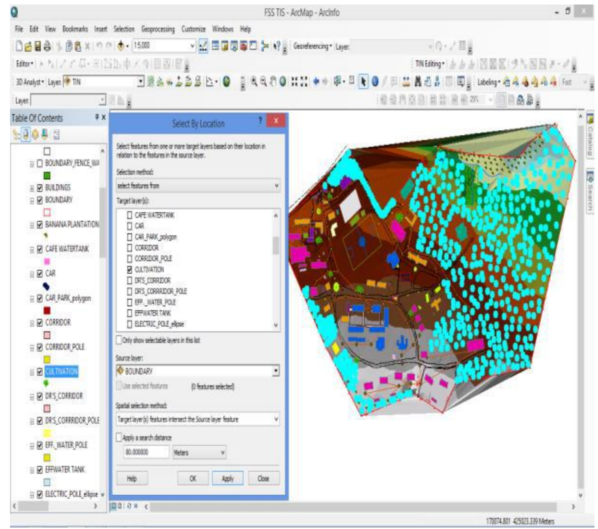

Fig.4.5: Result of query shows all cultivations within the study area

Fig 4.5 showed all cultivations within the study area. The query confirmed that most of the cultivations fall within the Eastern region of the school.

This query helps in determining the extent of land used for agricultural purposes and this implies that the schools still have more extent of land which has not been developed. However, the query will help the school management in estimating the undeveloped areas thereby enhancing proper future planning.

4.6 Query to show buildings whose condition are good and their height is greater than or equal to 5. using query syntax:- *"b_conditn" = 'good' and "b_height" >= 5*

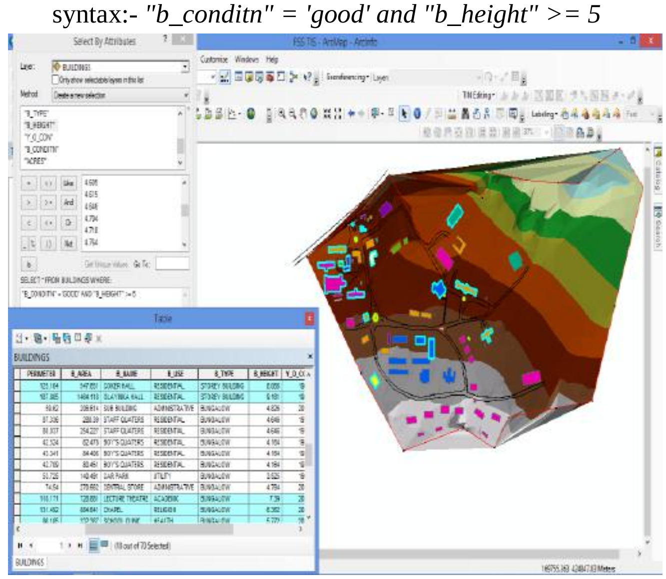

Fig. 4.6:- Result of query showing buildings whose conditions are good and their height is greater than or equal to 5.

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Fig. 4.6 showed the analysis of the result which is to query buildings whose condition are good and their height is greater than or equal to 5. The total number of buildings that falls in this category are 15. The displayed attribute table affirmed that all the buildings fall within the North-eastern and Middle-belt region of the school.

With the result of this query, the topography of the area will enable the school management to make decision on the positions where the buildings should be cited to avoid deformation or collapse as the case may be. The school management will make plans for future purposes because the eastern part of the school haven't witnessed any development and as time goes on, the master plan of the school will be revisited and proper utilization will be made of it.

4.7 Query to show residential buildings that are bungalow in nature using query syntax:- "*b_use" = "residential" and "b_type" = "bungalow"*

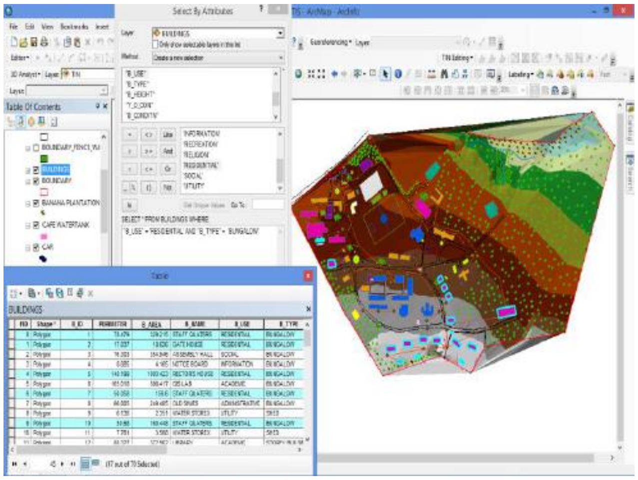

Fig 4.7:- Result of query showing residential buildings that are bungalow in nature

Fig. 4.7 showed the analysis of the result which is to query all residential buildings that are bungalow in nature. The total numbers of buildings that fall in this category are 17. The displayed attribute table affirmed that most of the buildings fall within the Eastern region and only two (2) falls within the Western region of the school.

The result of this query enables the user to quickly differentiate the residential buildings that are bungalow to that of the storey buildings for easy location. With this, the school management will thus be able to make a quick decision by determining if there is need to build storey buildings instead of bungalow to cater for the shelter need of the increasing students as well as the staffs.

V. CONCLUSION

The process of applying GIS solution involves land surveying method of capturing geometric data, interview and question method of capturing attribute data, designing of database, its management and information presentation using series of highly advanced equipment like computer system and human resources without any doubt will facilitate the quick access to information, efficient planning, the effective costing, prompt problem solving, development of an astute maintenance style and very intelligent manpower deployed in solving problems.

It could be seen that from the spatial database designed and created in this project, various spatial analysis were performed and a digital topographic map as well as digital terrain model were produced. Moreover, the database created can serve as model for subsequent work within the area that will involve the use of GIS basic analysis functions such as buffering and overlay. The database created is flexible to accommodate new changes within the area, that is, it is capable of being updated.

Conclusively, having arrived at the allowable degree of accuracy, it was concluded that the aims and objectives of the project were achieved. My role during the project execution would afford me the opportunity to cope with future challenges in relevant operation. It can be said that GIS has completely changed the surveying profession and the surveyor is now regarded as the provider and manager of information about land and the development on it.

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