Online Publication Date: 12 December, 2011

Publisher: Asian Economic and Social Society

Topographic Information System As A Tool For Environmental Management

E.O. Oriola (Department of Geography & Environmental Management, University of Ilorin, Ilorin. Nigeria.)
Asonibare S.O (Department of Surveying and Geoinfomatics Kwara State Polytechnic Ilorin, Nigeria.)

Citation: E.O. Oriola**,** Asonibare S.O (2011): " Topographic Information System As A Tool For Environmental Management " Journal of Asian Scientific Research , Vol.1, No.8,pp.441-450.

Journal of Asian Scientific Research, Vol.1 (8), pp.441-450

Topographic Information System As A Tool For Environmental Management

Author (s)

E.O. Oriola
Department of Geography & Environmental Management, University of Ilorin, Ilorin. Nigeria.
E-mail: lolaoriola2003@yyahoo.com

Asonibare S.O.
Department of Surveying and Geoinfomatics Kwara State Polytechnic Ilorin, Nigeria.
E-mail: asonibaretunde@yahoo.com

Key words: Topography, Attribute data, Information, Decision, Planning.

Abstract

This paper is a pilot study to examine Topographic Information System as a tool for environmental management. A part of Kwara State Polytechnic, Ilorin, Kwara State Nigeria was used for the pilot study. Locational and Attribute data of features were collected for the study. The usefulness of the Topographic Information generated was highlighted. Topographical map revealed the existing locations and areas for future development; Aspect map shows sun facing surfaces for agricultural sun drying process and information for building construction in the study area. The ruggedness of the landscape was presented for amount of solar radiation received in a given area. The information is also available for query that will assist in the physical planning of the area under study. The study concludes that Topographic Information System is essential for physical planning and accurate decision making. The system allows easy updating of information and quick retrieval of information for better planning and environmental management.

Introduction

Land surveying is the first point of reference in all meaningful land development projects. Provision of infrastructures; planning of towns and cities; management of hazardous natural events and human actions such as erosion, flooding, earthquakes, and subsidence; coastal management; exploration and exploitation of minerals; sitting of industries; resources exploitation on the land and on the sea all are dependent on Land Surveying products.

Topography of an area describes the surface characteristics of relief features of such area as depicted by hills, valleys and plains. It can be used to study and represent, as a surface, any characteristic that has a continuously changing value other than elevation. For instance, population, geo-magnetic data and geo-chemical data. Topographical Surveying involves the acquisition of topographic data of the features on the earth's surface, both man-made and natural in three-dimensions. This employs the techniques of plane surveying and other special techniques to establish both horizontal and vertical controls.

The implications of the above is that no meaningful development can be embarked upon by an individual, government and any other agencies without information about the topography of the land in the area where such development is to take place. Topographic Information System can be derived from the topographical data with the employment of the analytical capabilities of Geographic Information System (GIS).

According to Burrough (1986), GIS is a tool for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. In short, GIS can be used to add value to spatial data (Sharma et al 2006). This is by allowing data to be organized and viewed effectively, by integrating them with other data, by analysis and by the creation of new data that can be operated on in turn to create useful information that can help decision making. The uniqueness of GIS is in its ability to integrate data from a variety of sources. A GIS can thus be described as a form of spatial decision support system. This objective of this paper is to create topographic information system for adequate management immediate physical environment.

Topographic Information System

Digital technology was successfully introduced in the field of mapping in the late 1960's as means of speeding up map production. (Perera and Shanta, 2002). With the change in technology in the last two decades and the growth in the number of spatial information systems, the concept of topographic database has been introduced in several mapping-surveying organizations in the world, in order to deliver more Geo-information to the user community.

Topographic Information System is very crucial in this present age in other to be able to update maps and retrieve necessary data at any given time with minimal efforts. Topographic Information System can be explained as the combination of human effort and computer-based tools for the collection, storage, analysis, manipulation and retrieval of various kinds of data relating to geographic features (man-made and natural) on the surface of the earth (Lexicon Universal Encyclopedia , 1989).

In view of this, it is necessary to create Topographic Information System for different locations because the information generated from such system can be used for various purposes in physical planning and decision-making in such locations. Some of the usefulness and advantages of this digital database for such system over the conventional maps include:-

a) Possibility of fast amendment and dynamic updating of data
b) Fast capturing of data with Total Stations or GPS
c) Analysis of many important spatial problems
d) Versatility in integrating data collected from various sources
e) Flexibility output possibilities
f) Provides bases for additional information with relative ease for production of maps.

The Study Area

This study was carried out at the permanent site of the Kwara state Polytechnic, Ilorin. Ilorin is located within longitude 08°29' 21"E latitude 04°30' 50"N and 08°29' 43"E latitude 04°31' 01"N. It is the capital of Kwara State. It has been experiencing rapid urbanization since 1967 when it became the capital of Kwara State (see fig 1). The extent of its built-up area in 1967 was about 8.37km² but it has today increased by about sixty percent in the year 2000. In general, the city grows mainly along the major arteries of river Oyun and its numerous tributaries drain the city (Oyegun, 1983). The largest of the tributaries is Asa River which actively divided the city into almost two halves.

The Polytechnic is at kilometer 10 along the old Ilorin-Jebba Road. The polytechnic entrance is between Elekoyangan and Oke-ose village along the road. The Institution was carved out of the present Moro Local Government area of the state. The State Polytechnic is having boundary with Ilorin East Local Government and Moro Local Government areas (see fig 2).

Materials And Methods

For the purpose of this pilot study, the following data were collected from both primary and secondary sources: previous analogue map covering the area, previous control points at the vicinity of the project area and coordinates of points at the vicinity of the project. Others are Coordinates of points and features on the field.

Vector approach of data acquisition was used that is, x, y, coordinates of the objects of interest were acquired using Total Station in a computerized electronic instrument which has a combination of EDM and Theodolite was used for measuring distances, angle, fixing of details and determination of coordinates of points.

It is a basic rule in surveying that for a new area, reference must be made to old existing controls by way of connecting the new survey from the existing one. The Surveying rule of working from whole to part was employed. This is the basis for carrying out the perimeter traverse first before the detailing and spot heightening. Heights of instrument and target were measured and stored in the memory of the instrument after the perimeter traversing which started from the control point KWPT 02 and closed back to the point KWPT 04. All the detailing and spot heightening were done by orienting with the coordinated boundary marks/Stations.

Results and Discussion

The major characteristic that differentiates GIS from other information systems is the spatial analytical capability; especially overlay operation, buffering, spatial search, topographic operation, and neighborhood and connectivity operations. GIS uses this spatial analytical capability to answer fundamental generic question of location, condition, trend, routing, pattern and modeling by the manipulation and analysis of input data. The major analyses performed in this project were overlay operations, topographic operations and spatial search.

Overlay Operation

In this study the contour map was overlaid on detailed map of the study area to produce the topographic map of the area, which shows the relationship that exists between the various spatial entities in the study area. This result can be used to determine area that need access road to be built or other facilities.

The contour map of the study area is shown in fig 4. This map assists in planning and control of erosion in the study area, while the detailed map of the area under investigation can be used to ascertain area that are available for future developments.

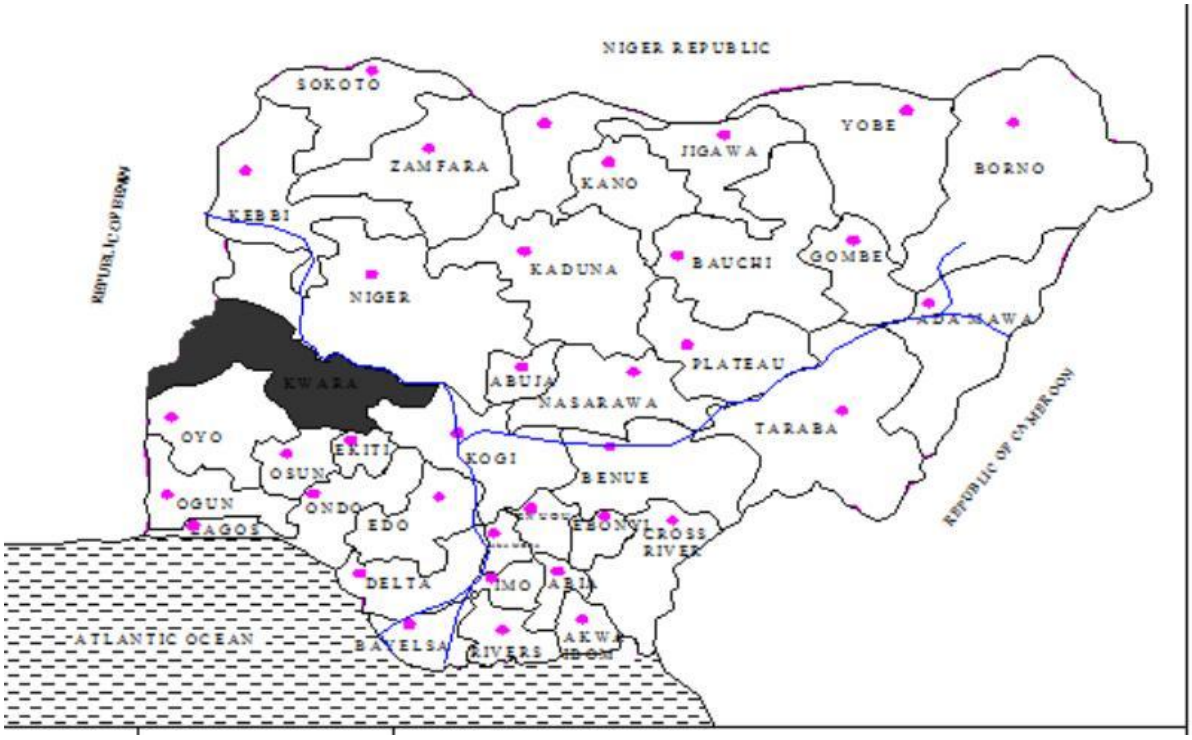


Fig 1 Map of Nigeria showing Kwara State

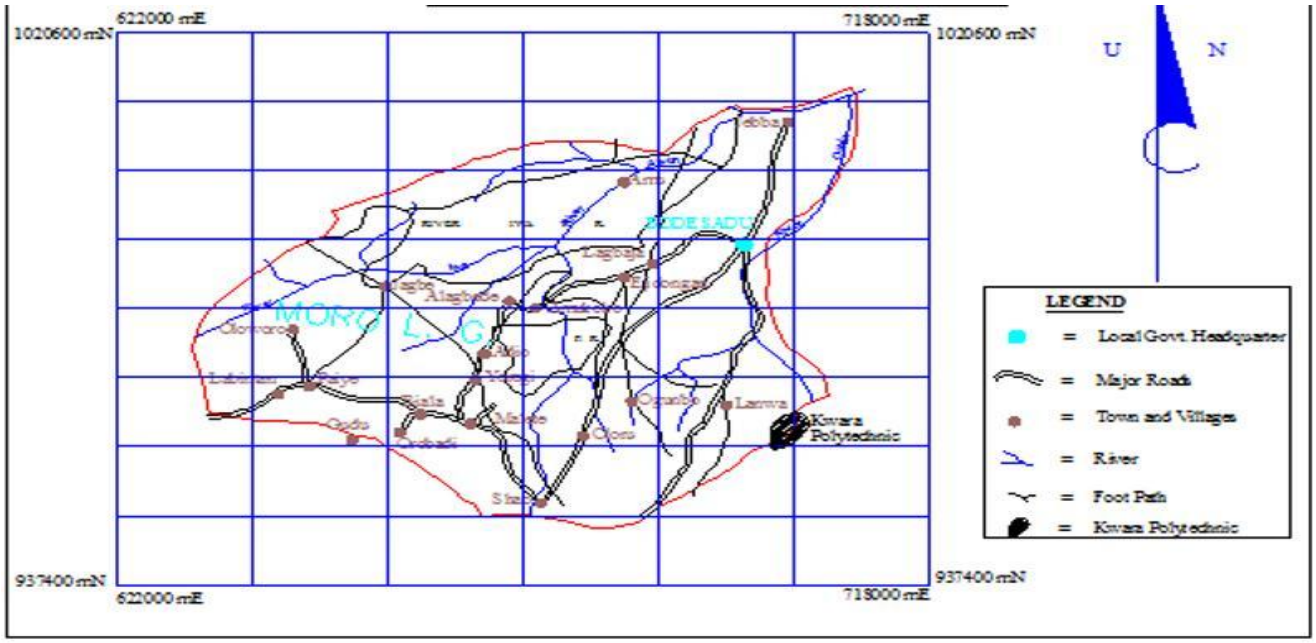


Fig 2. Location of Kwara State Polytechnic.

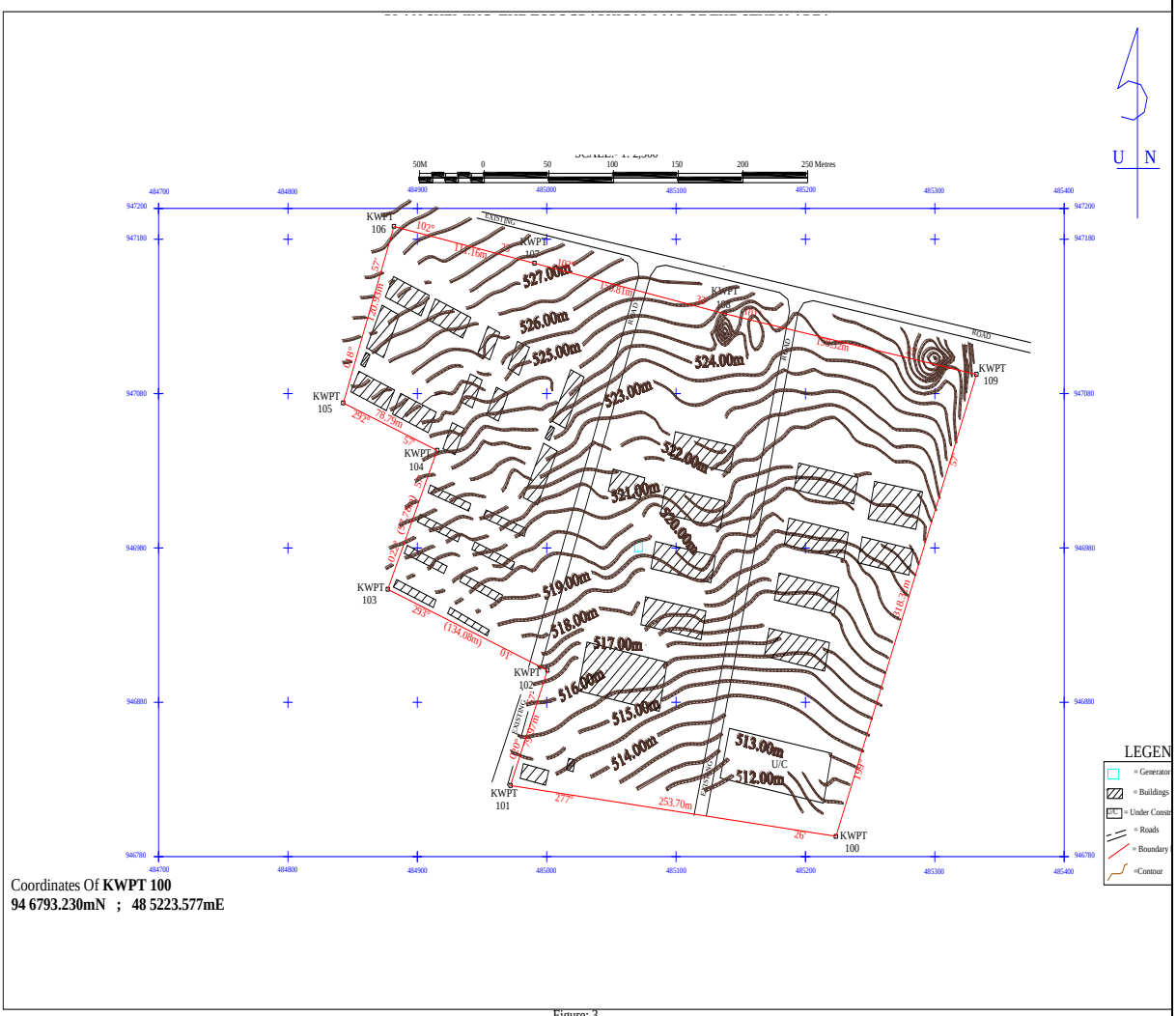


Figure: 3

Fig 3 Topographic Map of the Study Area

Topographic Operations

This operation was performed from digital elevations model generated using Arc View GIS 3.2a version. The earth is 3-dimensional, most GIS applications include some element of 3- dimensional analysis of which topographic operations and analysis of surface terrain becomes paramount. Slope, Aspect and other DTM generations are considered as the most common uses in application of terrain model use in GIS. The analyses were performed using Arc View GIS 3.2a version and the products generated are as follows:-

1. Hill shade map of the project site is presented in fig 5. This can be used to determine the best part of a farmland to be reserved for drying of crops after harvesting, in fact, hill shade is used to portray relief difference and terrain morphology in hilly and mountainous area.

Furthermore, Aspect map of the area is very essential for the determination of intensity of sun that can be received. This information can be used for sitting of houses where they will get enough sunlight. Aspect maps can also be used to determine where different crops will perform best, the values for aspect are in degrees, 0º of true north, 90 º for east, 180 º for south and 270 º for west (fig 6).

2. Slope map of the project site presented in fig 8 is an important map for soil erosion analysis of a given area and Triangulated irregular network (TIN) map of the project site as shown in fig 8 is basically used to connect points of equal heights. Different colours in the map depict the different ranges in the study area. It is a tessellation model which allows recording topographic data as points in a regular or irregular grid. When a three dimensional view is necessary the grid can be converted to the crystalline shape. In addition, the point data can be used for performing the surface as a series of contour lines with all interpolation procedures needed for surface analysis.

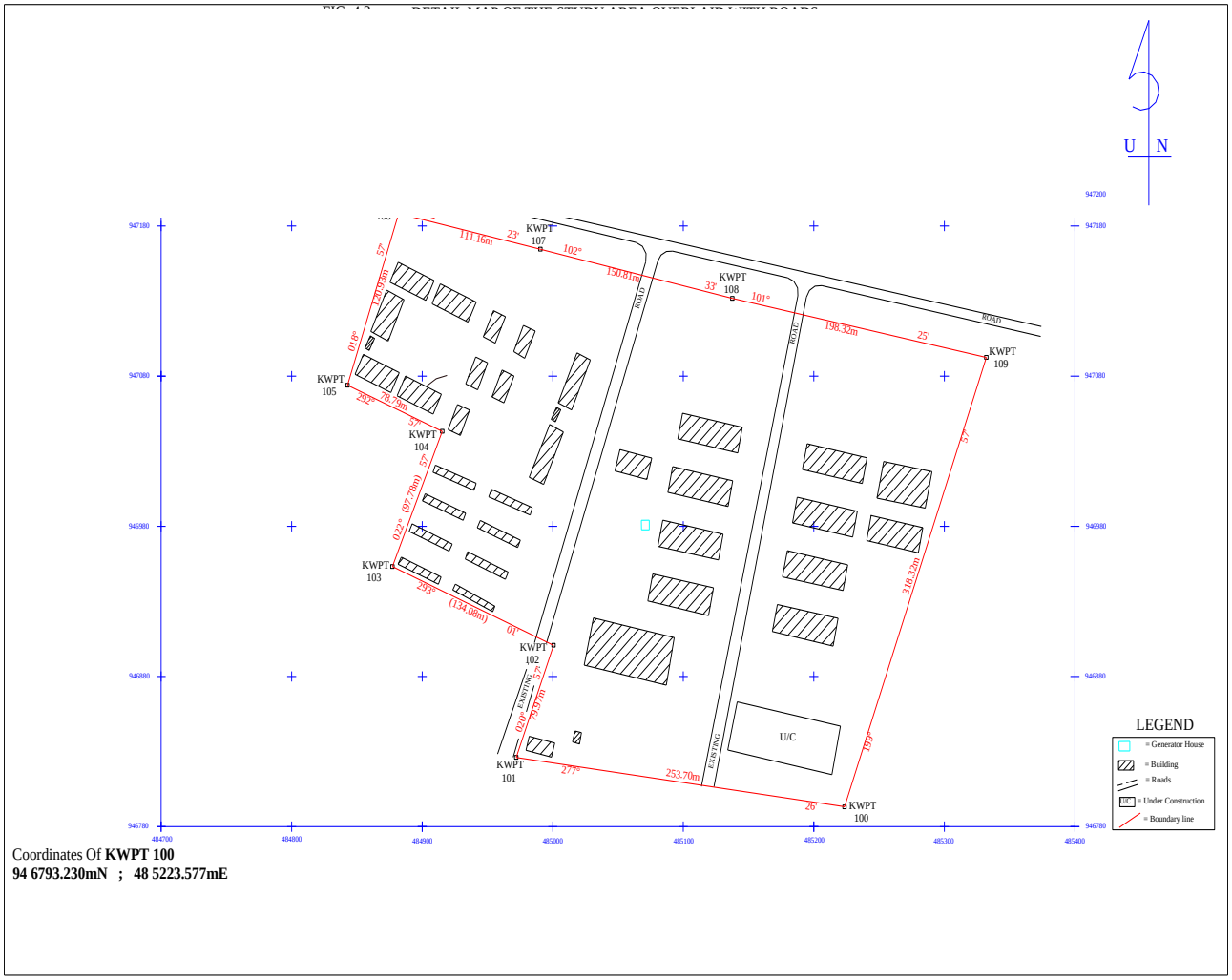


Fig 4 Detail Map of the Study Area

Query and presentation of analysis

The most fundamental of all tools provided by a GIS are those involved with database query and its ability to perform complex spatial analysis and modeling operations in support of environmental management planning and mapping. Queries may be Simple or Multiple.

Simple criteria analysis

"Show all buildings that are used for Laboratory".
Query command and syntax: {[B_Use] = "Laboratory"}.Here the only condition requested in the query is the **USE** of the buildings which are for LABORATORY. This is shown in figure 9 and figure 10 with its attribute data

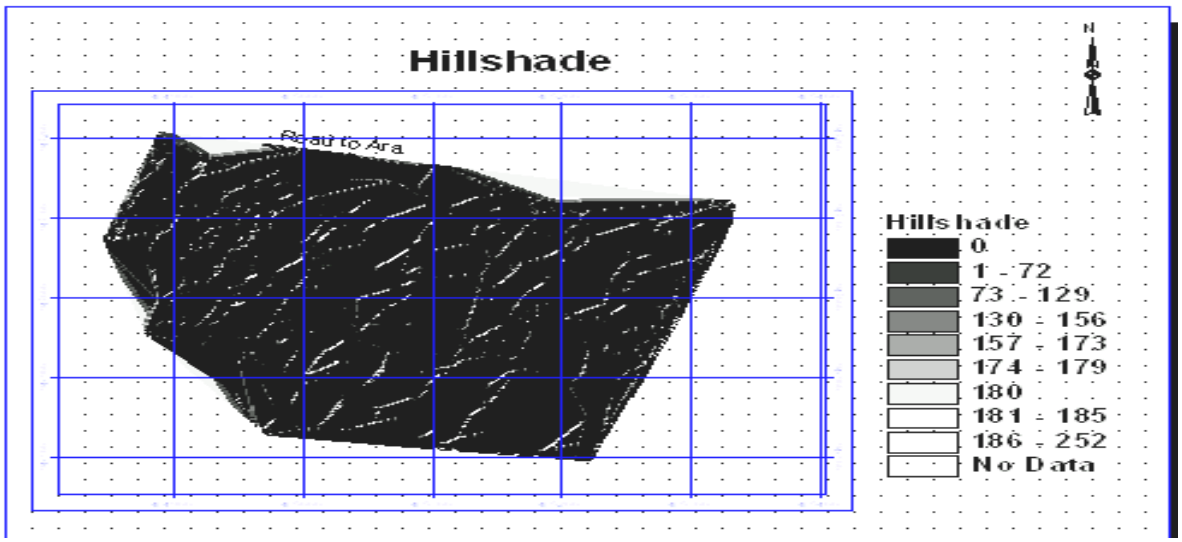


Figure 5 Hill shade of the Study Area

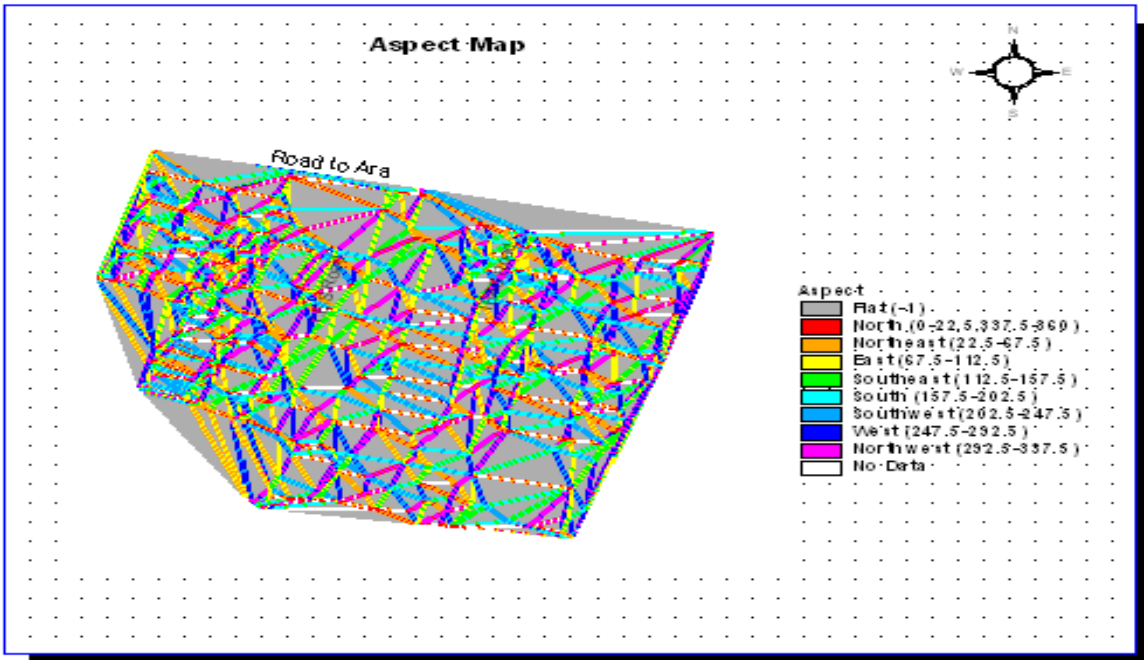


Figure 6 Aspect map of the Study Area

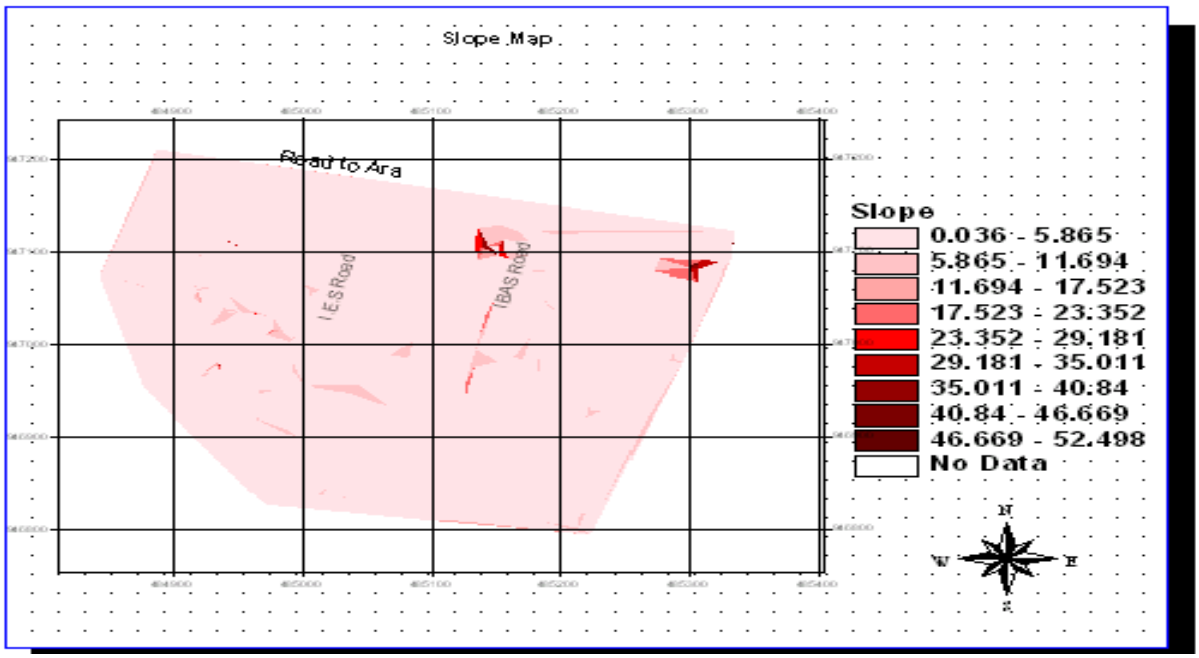


Fig 7 Slope map of the Study Area

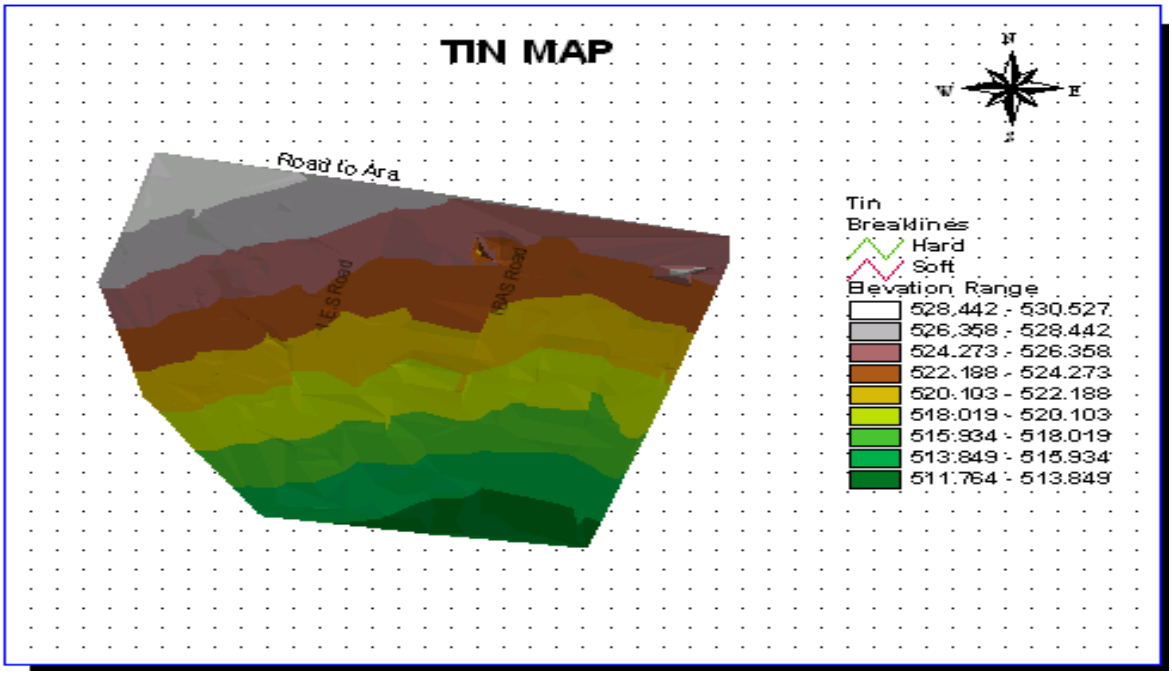
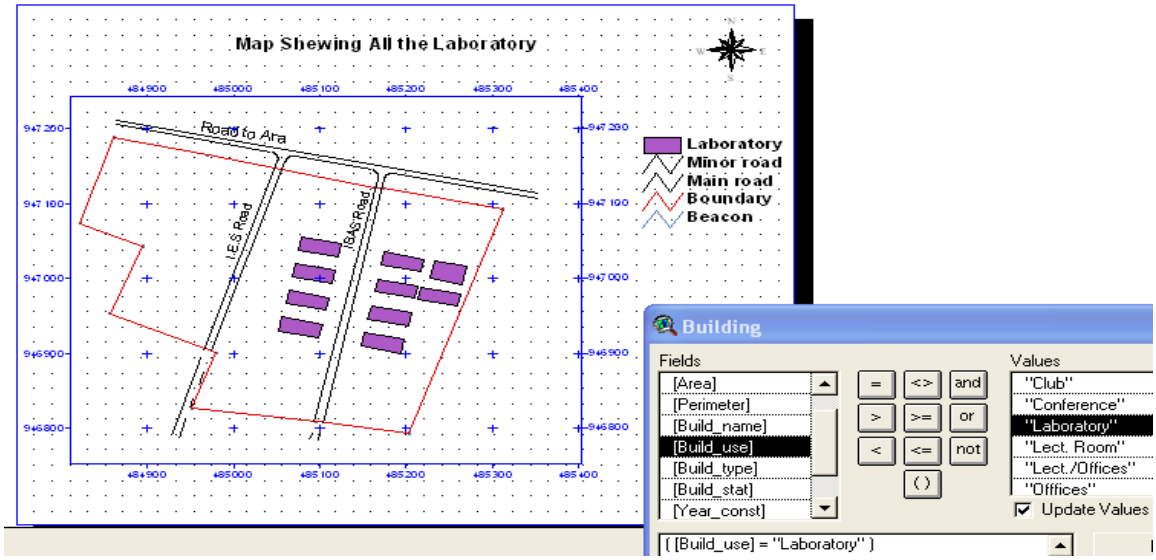


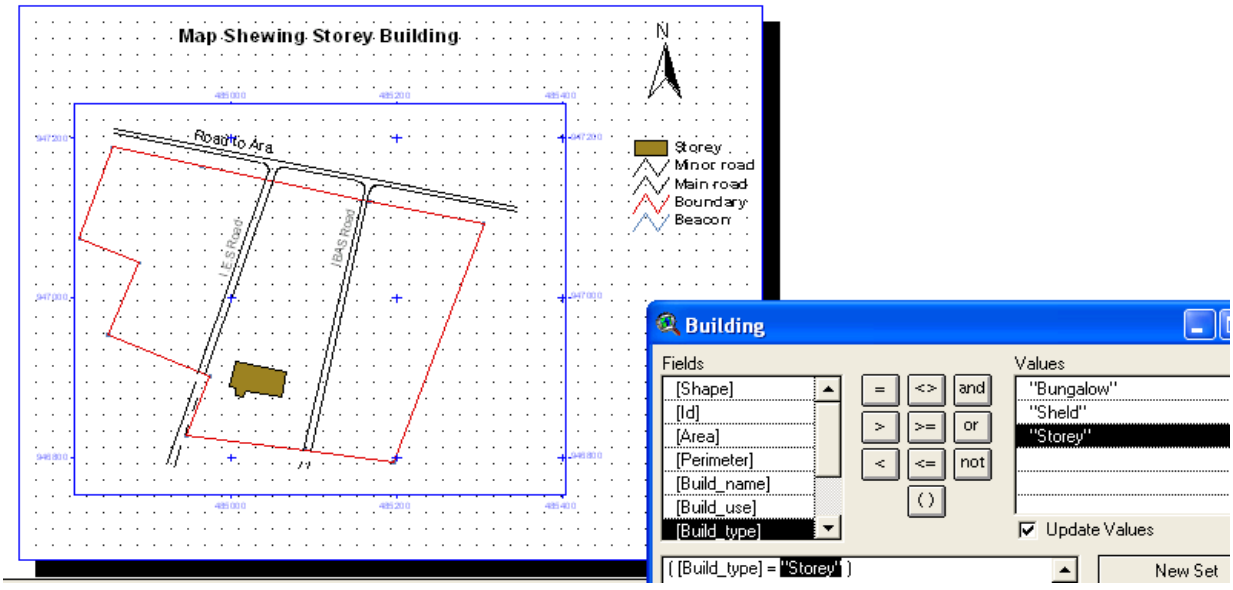
Fig 8 Triangulated Irregular Network (TIN) map of the Study

.



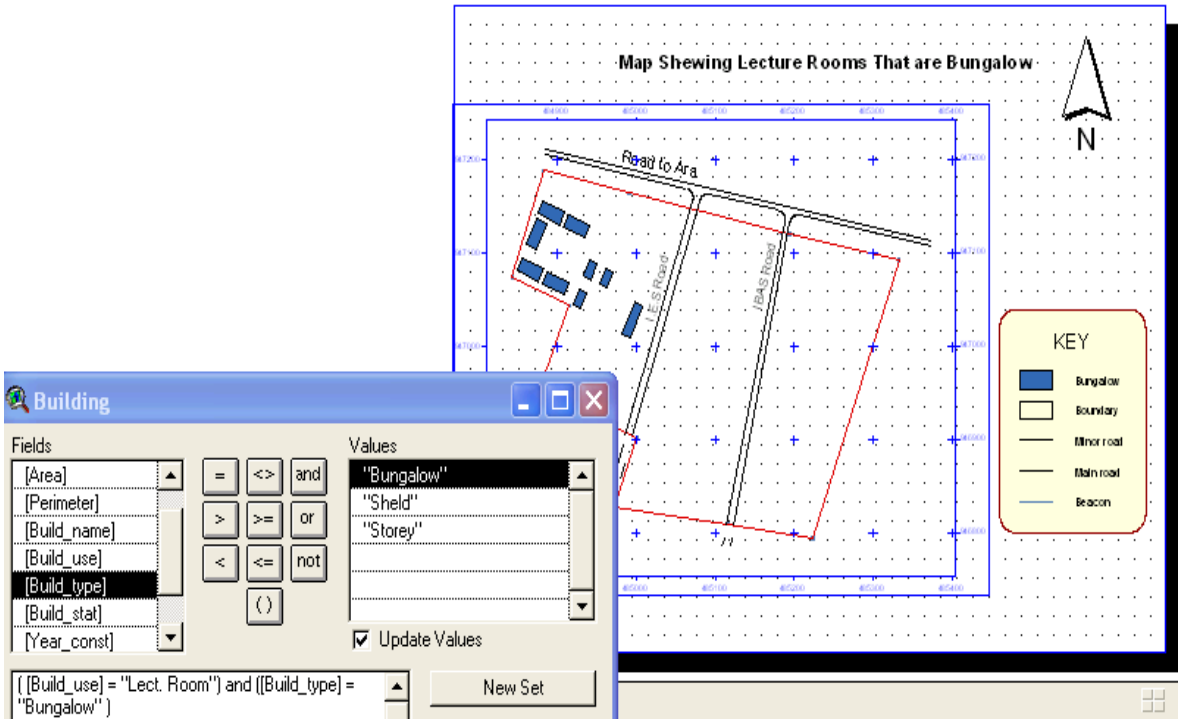
Syntax ((Building Use) = "Laboratory)
Query on Single Criterion

Fig 9 Map of Laboratories in the Study Area



Syntax {(Building type) = "Storey}
Query on Single Criterion

Fig 10 Map of Storey building in the Study Area



{(Building Use) = Lect Room} and {(Building type) = Bungalow}

Fig 11 Map of Lecture Room that are bungalow

Multi criteria analysis

Multi criteria analysis refers to a situation where more than one condition is used to query a database, for example, "show all building that are bungalows and used for Staff Offices".

Query command and syntax: {[B_Type] = "Bungalow"} and {[B_Use] = "Staff Offices'} here the conditions requested in the query are, the TYPE and USE of the building which are BUNGALOW and LECTURE ROOM (Fig. 11).

Query on Multiple Criteria.

Queries can be designed to select all objects, point objects, line objects, and polygon objects. The result of the queries is then analyzed. Planners can be guided by the results of the queries in deciding how many structures are needed in the area. Likewise Estate Surveyor can use the analysis or queries to determine the exact available property for rent without taking the client to the site. More importantly, the construction engineers can used maps generated to determine the best route for road connection.

Application of products

The various products generate in this study can be very useful for planning purposes and decision making. The topographical map of the Polytechnic shows all the features as they exist on the ground and other available areas for future development. Some of the products that were generated include Slope, Aspect and hill shade. These are maps that are very essential for taken good decision on environmental issues.

a. Aspect map shows the direction the surface faces. It is very useful in building construction and agricultural management. Aspect map is useful for drainage network. Its usefulness is pronounced in the laying of pipes where direction of flow is prominent.

b. Hill shade map is like aspect map it shows how rugged the landform is. It is used in hilly area to determine the amount of sunlight that will be received in a given area. It can be used to determine the best part of a farmland to reserve for drying of crops after harvesting, in fact, hill shade is used to portray relief difference and terrain morphology in hilly and mountainous area.

c. The colour tones in a hill shade raster represent the amount of reflected light in each location, depending

on its orientation relative to the illumination source. This illumination source is usually chosen at an angle of 45 above the horizon in the north-west direction.

d. Useful in the visibility studies, that is, determining what is visible on a surface from a set of one or more location.

Other products generated from the query can be used for physical planning, decision making, and solution of some spatial problems of the Polytechnic. These products are all very essential for environmental management and easy analysis of our physical environment.

Conclusion

This study has been able to showcase topographic information system as a necessary tool for managing environmental issues and abate some environmental related problems. With this system, it is now possible to amend and update data in the system, quickly analyse many important spatial problems in the area, produce output that is flexible and supply data for producing interactive maps of the area.

References

Burrough, P. A. (1986) 'Principles of Geographical Information System for Land Resources Assessment.' Oxford University Press, New York, Pp194

Lexicon University Encyclopedia (1989) Lexicon publication inc. New York N.Y (1989).

Oyegun R. O. (1983) Water Resources in Kwara State. Matanmi and sons publishing Co. Ltd. Ilorin. P7

Perera, S. and Shanta, K. O. (2002). "A Topographic Database for Geoinformation Process in the Survey Department of Sir Lanka".Pp 1-6

Sharma, H.S. (2006) Modeling through Geographical Formation system and Global System in Sharma, H.I, Ram, D.R Rara Prasad and Binda P.R (eds) Mathematical Modeling in Geographic Information System Global Positioning System and Digital Cartography. Concept Publication, New Delhi, India. P 2