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Topographic Information System as a Tool for Environmental Management, a Case of Part of Delta State Polytechnic Ogwashi-uku, Aniocha South, Delta State, Nigeria

Odo K.O[1], Idhoko K.E[1], Oha C.P[1], Okoro E.G[1] and Okafor C. E[1]
[1]*Department of Surveying and Geo-informatics, Faculty of Environmental Sciences, Nnamdi Azikiwi University, Awka. Nigeria.*

Abstract: *This paper examines Topographic Information System as a tool for environmental management. The Delta State Polytechnic Ogwashi-Uku has been without a proper road network and drainage system since its creation so there was need to construct a proper road network and a functional drainage system that will be able to address the perennial flood problem in the polytechnic. However, before the construction work started a comprehensive topographic survey of the school premises have to be undertaken so as to have an overview of the topography and existing details (both natural and manmade) on ground. The production of Topographic Information System was therefore carried out with the aim of producing a tool for effective planning and proper environmental management of the polytechnic. Field and office reconnaissance survey were carried out in order to be familiar with the nature of the terrain and plan the methodology and equipment to be used for the acquisition and assembling of spatial and attribute data. Total Station (KOLIDA K46346) was used to acquire spatial data (X, Y, Z coordinates) within the study area through the process of traversing, leveling, and detailing, which were simultaneously carried out. The data processing were adequately and effectively done with the used of AutoCAD 2013, ArcGIS 10.1 and Surfer 9.0 software using the data processing as the management phase, a spatial database was modeled and structured using the relational table format. The usefulness of the Topographic information generated was highlighted and map revealed the true configuration of study site and vacant areas for future development. A digital terrain model [DTM] was created to enhance further analysis on slope, aspect, hill shade and view shed analysis of the study site . The information is also available for query that will assist in the physical planning of the area under investigation. 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.*

Key words: *Topography, Attribute data, Information, Digital Terrain Model (DTM), Decision Making, Physical Planning.*

I. Introduction

Surveying has been described as an essential element in every human development activity since the beginning of recorded history. It has been discovered to be an imperative requirement in the planning and execution of every forms of meaning development (Bannister *et al*., 1986). Provision of infrastructure; 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 are dependent on land surveying products (E.O. Oriola, and Asonibare S.O, 2011).

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-dimension (x y z). This employs the techniques of plane surveying and other special techniques to establish 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 area where such development is to take place. Topographic information system can be derived from the topographic data with the employment of the analytical capabilities of geographic information system [GIS].

Geographic Information System (GIS) evolved as a new technology in surveying. It combines geographic data (location) and attribute data about object feature on the earth's surface with cartographic representation in order to perform spatial decision making using spatial analysis. 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. GIS is unique in its ability to integrate data from variety of sources. A GIS can thus be described as a form of spatial decision support system.

A digital terrain model (DTM) is a topographic model of the terrain relief that can be manipulated by computer programs (Ndukwe, 2001). The data files contain the spatial elevation of the terrain in digital format which are usually represented as a rectangular grid. Vegetation, buildings and other man made (artificial) features are removed leaving only the underlying terrain. Modeling terrain relief using DTM is a powerful tool in GIS analysis and visualization. DTM can be stored in GIS database in several ways: - As a set of contour vectors, a rectangular grid of equal spaced corner/point height or an irregularly spaced set of point connected in triangles (TIN-Triangular Irregular Network). The aim of this project is to create topographic information system for adequate management of immediate physical environment in Delta State Polytechnic Ogash-Uku, Aniocha South, Delta State.

II. 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:-

i. Possibility of fast amendment and dynamic updating of data
ii. Fast capturing of data with Total Stations or GPS
iii. Analysis of many important spatial problems
iv. Versatility in integrating data collected from various sources
v. Flexibility output possibilities
vi. Provides bases for additional information with relative ease for production of maps.

III. The Study Area

The project site is located along Issele – Azagba and Ogwashi-Uku Road which falls in Aniocha South Local Government area of Delta State, Nigeria and within the mid belt zone of Nigeria Traverse Mercator (NTM) projection system.

The project site lies between longitude 6^0 33 45 and 6^0 13 33 east of the Greenwich Meridian covering a total area of 41.586 Hectares. See fig 1. for location map.

IV. 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 Theodolites 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 PBS 8679and closed back to the point PBS 8701. All the detailing and spot heightening were done by orienting with the coordinated boundary marks/Stations.

V. 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.

VI. 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 3. 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.

VII. Topographic Operation

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. Further analysis using ArcGIS10.1 could generate products such as Contour map, Hill shade map, Aspect map, Slope map etc, to further enhance sustainable physical development of the study area.

VIII. 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 modelling operations in support of environmental management planning and mapping. Queries may be simple or multiple. Based on the Database created for this study, it is easy to query for land use/land cover, its size; show building and use [bungalow and lecture room].

IX. Application Of Topographic Information System [Tis] Products

The various products generated in the study can be very useful for planning purposes and decision making. The topographical map of part of Delta State Polytechnic Ogwashi-Uku, Aniocha South, Delta State, Nigeria, shows all features as they exist on the ground and other available areas for future development. Some of the products that could be generated include slope, aspect and hill shade maps. These are maps that are very essential for taking good decision on environmental issues.

a) Aspect map shows the direction the surfaces 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 vest part of 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 mountains area. 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. [Oriola, 2011].

c) View shed analysis: TIS is useful in visibility studies, that is, determining what is visible on a surface from a set of one or more location.

d) TIS are also use in the evaluation of land use land cover for effective appraisal of the environment.
e) Other products generated from the query can be used for physical planning, decision making, and solution of some spatial problems of part of Delta State Polytechnic Ogwashi-Uku, Aniocha South, Delta State, Nigeria. These products are all very essential for environmental management and easy analysis of our physical environment.

X. Conclusion

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

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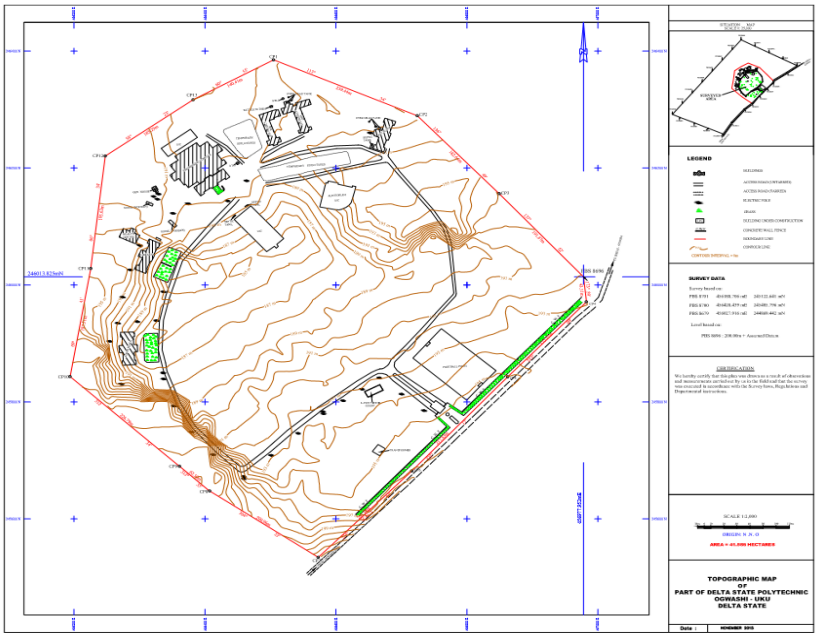

Figure 2: Topographic Map Of Part Of Delta State Polytechnic Ogwashi-Uku

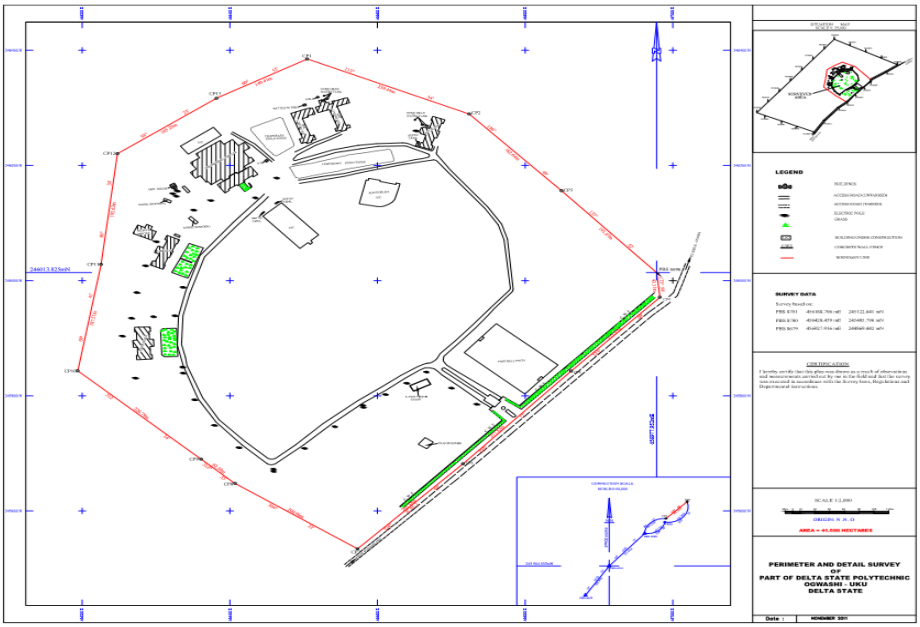

Figure 3: Perimeter/Detail Map Of Part Of Delta State Polytechnic Ogwashi-Uku

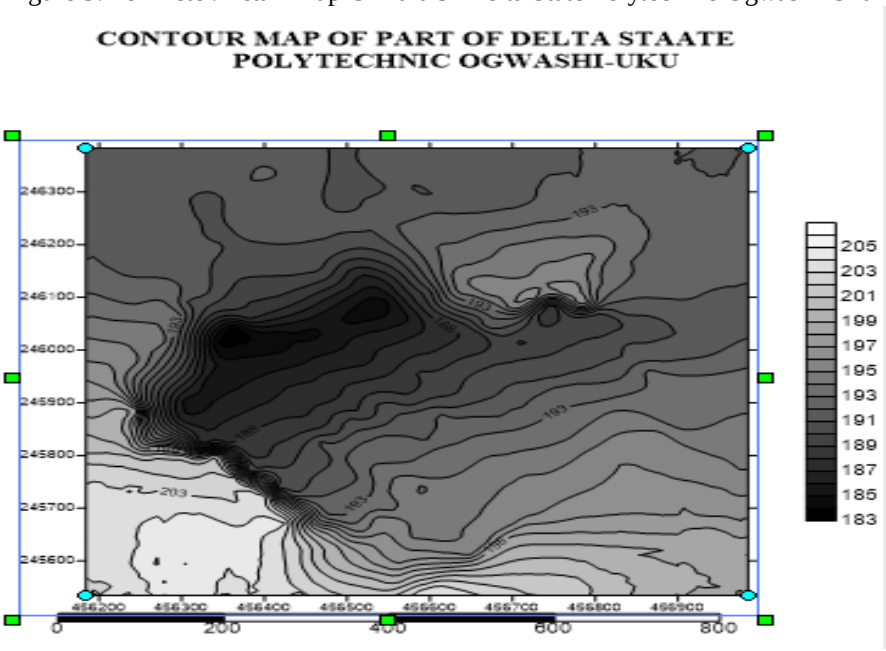

Figure 4: Contour Map Of Part Of Delta State Polytechnic Ogwashi-Uku

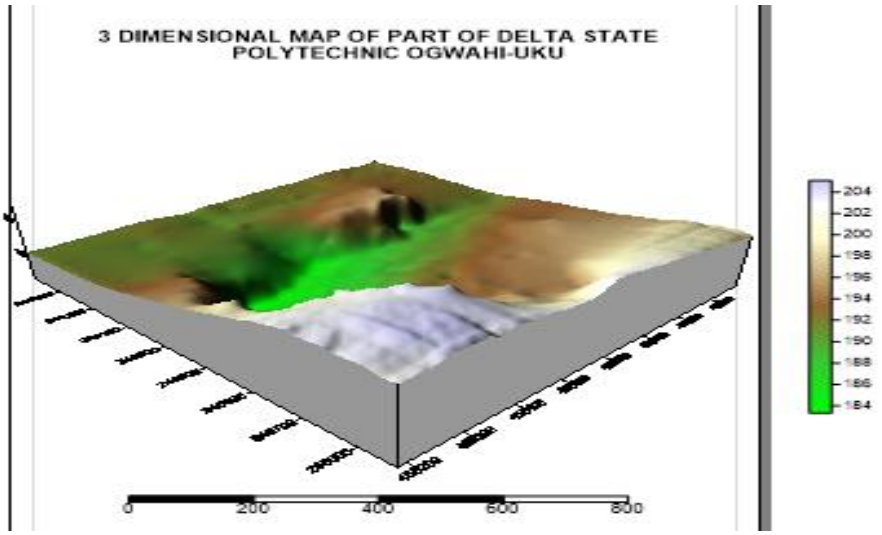

Figure 5: 3 Dimensional Map Of Part Of Delta State Polytechnic Ogwashi-Uku

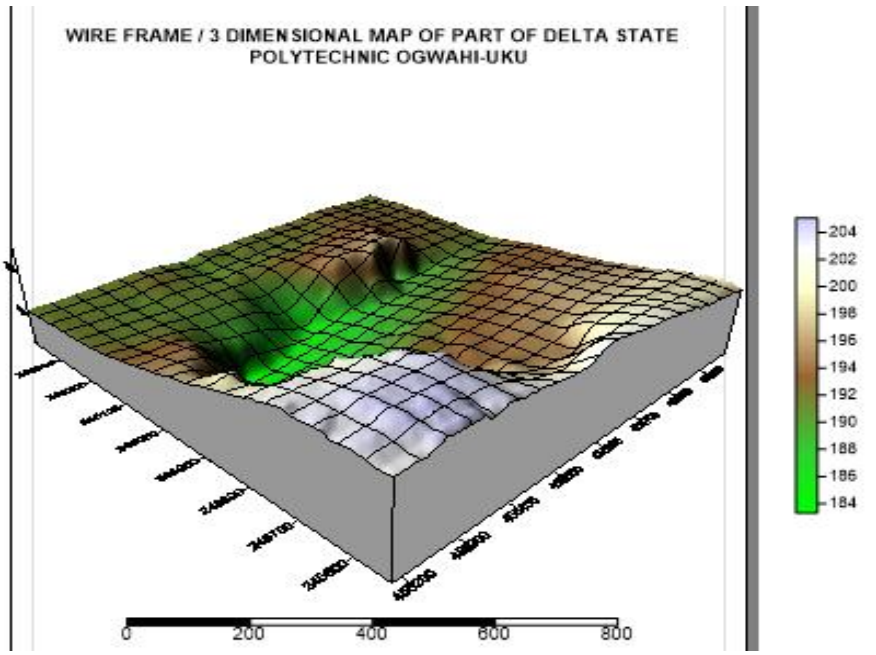

Figure 6: Wire Frame/3 Dimensional Map Of Part Of Delta State Polytechnic Ogwashi-Uku