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GIS TECHNIQUE APPLIED TO SURFACE WATER SURVEY IN SOUTH WESTERN NIGERIA: A CASE STUDY OF ELEYELE DAM IBADAN.

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ABSTRACT

A GIS is used to study the surface water in Ibadan Data which relates to the physical parameters of the study area, were used in this study These included a SPOT-multispectral imagery, topographic and geological maps of Ibadan, which were analyzed and interpreted

The enhancement of the digital image (SPOT- multispectral imagery) was by linear contrast stretching in standard colour composite showing vegetation as red, settlement as blue, and wate: bodies as black, thus making it possible to vectorize the raster dam of Eleyele by manual digitizing for GIS processing.

Spatially overlaying objects of hydrographic network features on the digital elevation model (DEM) and the geologic map, revealed that the Eleyele valley from the topographical point of view has all the topographic and physical structures conducive for the location of an effective dam The geological conditions are adequate for proper water impoundment while the non-porous nature of the rocks and absence of faults in the enclosing rocks ensure that the impounded water is retained.

KEYWORDS: Band, Colour composite , Pixel Raster, Vector

INTRODUCTION

The universally accepted definition of a GIS is an automated system that allows for the input, management manipulation, analysis and display of geographic data in digital from (Greenlee, 1980). Geographic nature of the objects found in a GIS can be related to some location and often by multiple attributes that further describe characteristics of the objects.

Study of earth surface features and the process that lead to their formation presents a problem of scale. Mountain ranges, plateaus, and drainage basins are too large to be seen from any simple viewpoint. In studying of such large features for decision – making in management, it is often necessary to integrate various types of data, including topographic maps and remote sensing imagery (Ataman 1988,and Meijerink 1988). Each component is in a real sense a type of scale model showing various aspects of size. shape and spatial relationships of the surface features of the earth. The values of these models are that they provide a regional perspective from a vertical view representing the reduction of vast amounts of data to a model in the size of a piece of paper that can be analysed and managed easily. Geographic Information System (GIS) are tools that enhance our ability to integrate, anlalyse, through advances in computer processing, graphics and database capabilities, more importantly to help solve the problems of spatial data integration and analysis.

The area investigated lies within the Basement Complex of South-Western Nigeria (Fig. I) and located between Longitudes $3^0$45'E and $4^0$5E' and Latitudes $7^0$15'N and $7^0$34'N. Potential for the development of surface water resources exists in Eleyele where and constant supplies are available, which facilitated the building of a dam to impound surface water.

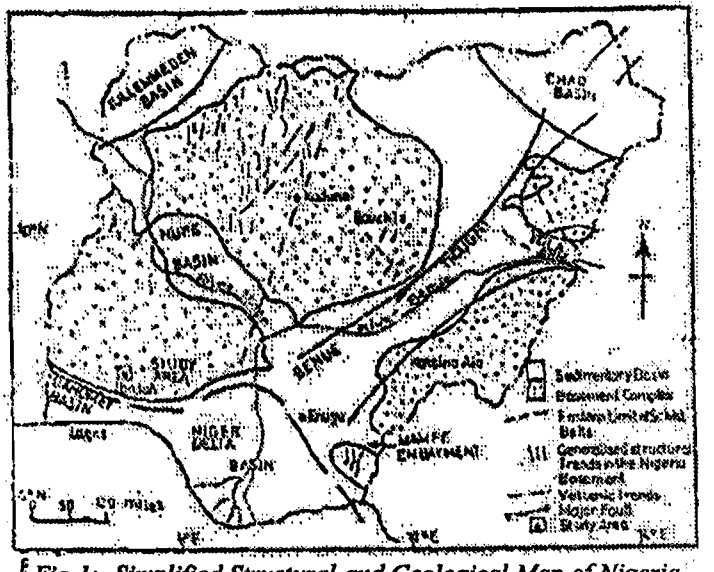

Fig 1: Simplified Structural and Geological Map of Nigeria (modified after Rahman 1981)

GIS TECHNIQUE'S BASIC OUTLINE

A GIS, according to Greenlee (1980), Short (1982) and Marble et al. (1983), is built around a framework of five basic elements namely:

(i) Encoding
(ii) Data Input
(iii) Data Management
(iv) Manipulative Operations, and
(v) Output Products.

Encoding

Spatial entries that are portrayed as points, lines or polygons can be encoded using two position indexing systems-

(i) grid-cell or raster coding is conceptually a matrix system super imposed over the geography such as a systematic array of grid squares or cells (Fig. 2) Grid cells are functionally identical to the picture elements or pixel that compose a digital image.

(ii) with polygon coding, the perimeter of each area unit containing the desired attribute data is digitally encoded and stored. One type of polygon indexing is topological coding.

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whereby connecting nodes forms arcs and polygons formed by connecting the arcs (Fig. 3)
(iii) polygon coding more accuracy defines boundaries and requires less computer storage space than does the grid-coding structure.

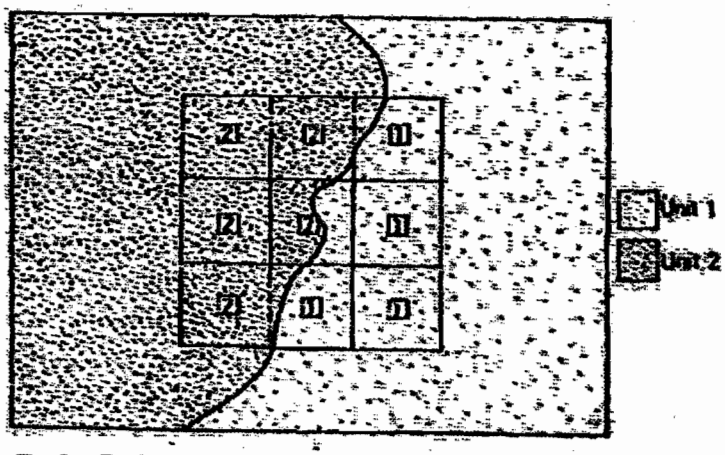

Fig 2: Grid-cell coding (Adopted from Greenlee, 1979)

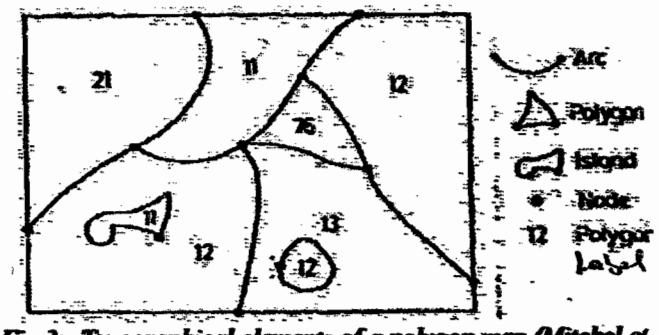

Fig 3: Topographical elements of a polygon map (Mitchel et al, 1977)

Data Input
Analogue information, usually hard-copy map data, is converted to digital domain by the digitization process for GIS input. Data acquisition methods are usually carried out manually or hand-tracing, scanning, digitizing (e.g. tablet or table digitizers) and automatic digitizing (e.g. drum or laser beam scanners).
It must be noted that data already in digital form (e.g. SPOT satellite image used in this work) usually have to be reformatted and scaled to match the geometry of the GIS reference map projection.

Data Management
Database management includes file storage, capacity building, controlling use and access to files for reading, modifying and archiving purpose. Data management provides standard methods for entering, updating and retrieving data. The move towards open GIS- systems, large databases and multi-user environments has created a growing desire for controlling GIS data by a kind of data management system.

Manipulative Operations
GIS is capable of performing two kids of automated analysis; (1) surface analysis and (2) overlay analysis. Surface analysis applies to intra-variable relationships that exist within one data plane. Most surface analysis produces new variables that can be applied to other surface or overlay analysis procedures.
One of the most common uses of overlay analysis is to derive statistical data and special maps describing shared characteristics. For example, given the database of land use and land cover and a topographic slope, one could ascertain how many hectares of agricultural land exceed a particular slope. An interpretative map could also be integrated with other database (e.g. soil type, land ownership) for additional analysis (McFarland 1982).
With the help of quantitative interpretation and weighing techniques, data bank variables can be used with two types of prediction models. For examples, evaluative models can be developed to asses environmental characteristics (e.g. wild life habitat, forest fire potential, ground water contamination, accessibility to transportation systems), and allocative models can be developed to indicate area best suited for specific land uses e.g. irrigated agriculture development, (Johnson and Thomas 1980).

Output Products
A GIS can retrieve and display data in graphic or tabular forms, or both. Most systems are capable of producing hard-copy charts, scatter diagrams, tables, and maps in various sizes.

ANALYSIS AND INTERPRETATION

Databases and Data Sets
GIS – databases are normally conceptualized as series of thematic layers, containing the geographic information. The vector and raster data used in this work with the aid of a large memory high-speed digital electronic computer consist of the following:

- Topographic layer of drainage pattern in Ibadan: 1:50,000 map sheet
- Elevation layer of Ibadan. 1:50,000 map sheet
- Remotely sensed satellite, multispectral imagery of SPOT, of Ibadan 1:50,000.

Digital Image Processing (DIP)
The multispectral imagery of SPOT has a full range of spatial resolution of 20m and spectral resolution over the ranges of 0.51-0.5um, 0.61-0.68um, ad 0.7-0.89um. in the case of a standard false colour composite (Fig. 4), two visible bands were passed on the blue and green colour planes and the near infrared band passed on red colour plane. The result shows vegetation in red colour, settlements as blue colour and water bodies as black, for which the Eleyele dam clearly stands out.

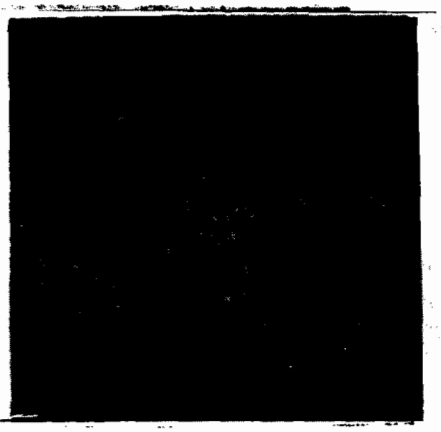

Figure 4: SPOT Imagery of Ibadan, Southwestern Nigeria.

GIS - Processing

The GIS system employed in this work is the Integrated Land and Water Information systems Software (ILWIS), and the Image Processing System used in the "Multiscope". Manual digitizing was done to trace the dam in question as it appears on the SPOT – multispectral imagery.

A similar method was employed to create the polygon of the geological layer, elevation layer and topographic layer of drainage in Ibadan. A digital elevation model (DEM) is an image or data representing the spatial distribution of elevation above some arbitrary datum in the landscape lines to obtain the rasterize surface of topography. An overlay of the (DEM) with the hydrographic network (Fig. 5) show that the study area is composed of three principal landforms, namely, highlands, plains and valleys. The highlands occupy the north-western, the north-eastern and the south-eastern parts of Ibadan. The plains are well drained by small rivers originating from the highlands. Three major narrow valleys are prominent. The first at Eleyele trends NE-SW and the other two, in the southern part of the study area, trend N-S direction. The drainage pattern of the study area is sub-dendritic to dentritic and tributaries are well drained.

Potentials for the development of surface water resources exists in Eleyele area. As a result of topographical and geological influence (Figs. 5 and 6), surface water body in a capacious valley has been relatively easily sealed off by a dam in areas of impermeable rock so that water does not percolate and seep away, in areas free from geological faults which allow seepage or can make dam construction problematic.

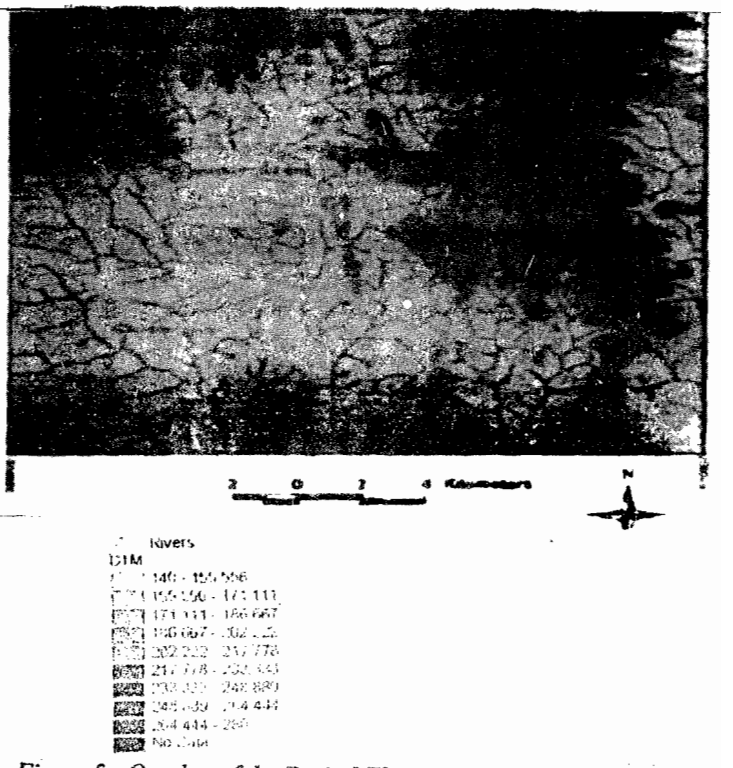

Figure 5: Overlay of the Digital Elevation Model (DEM) and the Draingae pattern.

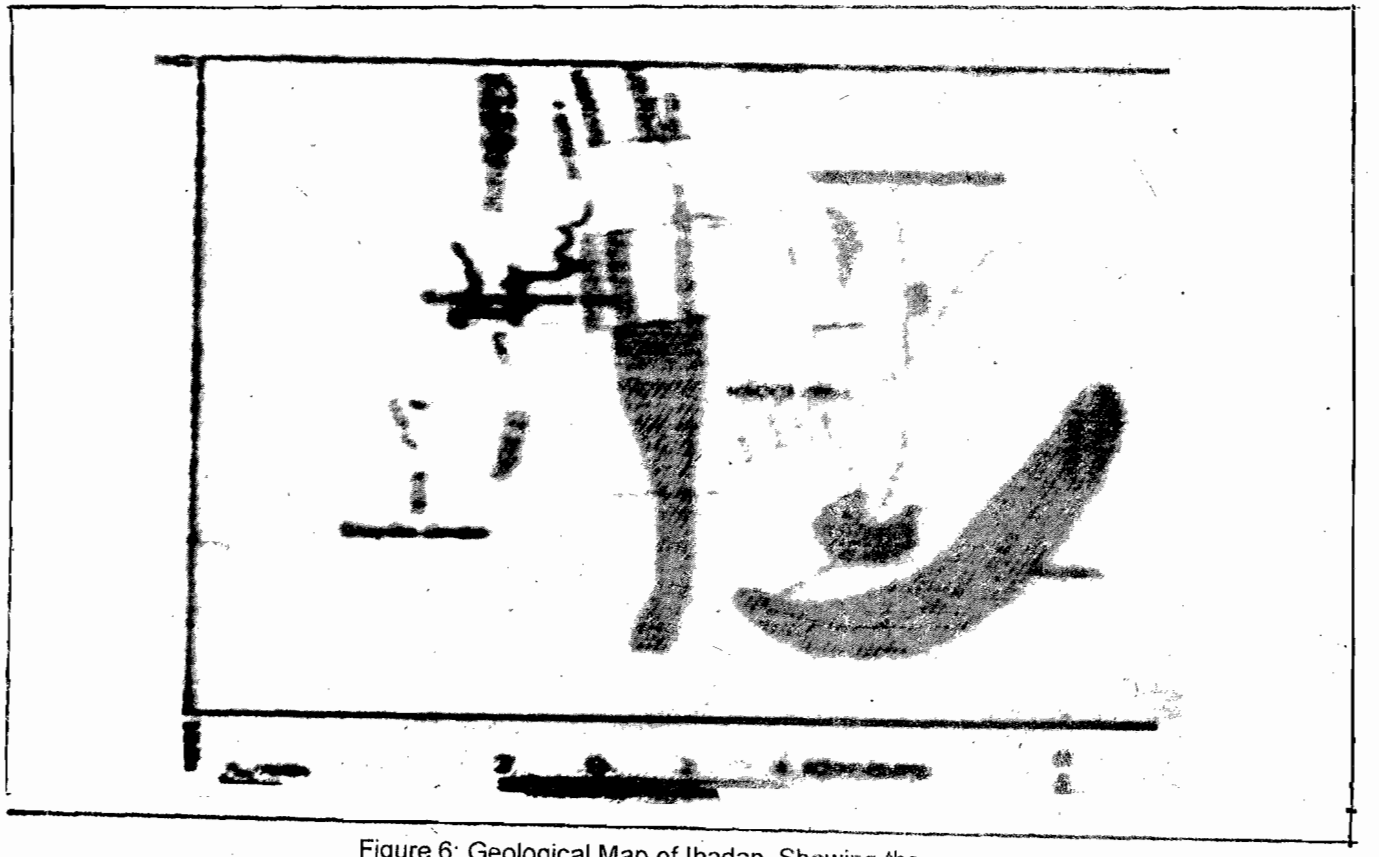

Figure 6: Geological Map of Ibadan, Showing the Location of the Dam

SUMMARY AND CONCLUSIONS

Ibadan city which is presently the capital of Oyo State, was a settlement that grew rapidly under the protection of series of warlords, and when the British rule was imposed in 1890, Ibadan has extended over an area of about 40skkm. The city encloses a sizeable potion of farmlands, forestland and foodplains used to be the headquaters of the defunct Western Region up till 1967, and Western State up till 1976 Increasing urbanization and rapid growth in urban population as well as leap in economic an industrial activities have enhances this growth. (Filani et al 1984). The study area is underlain by pre-Cambrian gneissic and migmatitic rocks of the Basement Complex of southwestern Nigeria. This study is largely devoted to the role computerized Geographic Information System (GIS) can play in inventory and data handling activities. The process of surface water resource planning and management have been divided into four chronological phases; awareness and organization, inventory and data handling, decision making and converting plans to actions.

Many users of GIS are concerned with non-geologic subjects, such as land use, environment, or forestry, but an understanding of geology will contribute largely to the overall understanding and in finding answer to such questions which require overlaying several different kinds of maps, since the terrain is a direct expression of geology of land areas. Therefore, the drainage system that develops on a regional surface of Ibadan is controlled by slope of the surface and the types and attitudes of the underlying rocks.

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