



Application of GIS in the Assessment of Spatial Distribution of Mineral Resources in Enugu State, Nigeria

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Abstract - Mineral resources are valuable assets of any country; they are and will always be the source of wealth for any nation endowed with them. The posterity of any nation is often directly related to the development and utilization of its resources. Nigeria is endowed with enormous mineral resources which when properly harnessed can lead to its industrial development and prospects. However because of the lack of comprehensive and reliable information; the management of Nigeria's mineral resources is neither accurate nor efficient. GIS, with its capabilities for spatial analysis and modelling of diverse data, can enhance the ability to address several mineral resource management and associated environmental issues that have spatial component. This paper aimed at applying GIS in mineral Resource management in Enugu state. To accomplish this, topographic map of Enugu State (4 sheet mosaic) and Administrative map of the state at a scale of 1:100,000 was scanned and digitized; NigeriaSat1 imagery with a resolution of 32 m was also digitized, geocoding and georeferencing was carried out using ILWIS 3.6 software and necessary coordinate transformation done using geocalc before data was extracted to Arcview 10.0. Attribute data from the Nigerian geological Survey agency and states ministry of survey was used to design a database for mineral resources. The result of analysis revealed that Enugu state has 8 mineral types with occurrence in 32 locations. Recommendation for the Geological Survey Agency to employ remote sensing techniques to discern the reserve of mineral deposit for the various Mineral resources was given, a need for more government participation in the mineral sector and availability of information on Minerals in the country.

Keywords: Database, Geographic Information System (GIS), Mineral Resources, Spatial Query.

I. Introduction

Nigeria is endowed with enormous mineral resources which when properly harnessed can lead to its industrial development and prospects. It is a known fact that countries abundantly endowed with mineral resources become great industrial nations (Okpanachi, 2004). While on the other hand, the level of greatness of a nation is often a reflection of how its resources have been planned, managed and utilized (Gotan, 2004). The occurrence of mineral resources in commercial quantities alone does not however guarantee optimum benefit, factors such as technological capacity, finance and market are also equally important hence information on the variability and distribution of mineral resources and associated mineral resource problems is needed to enhance decision making in Mineral resource management and potential analysis. Use of conventional methods for mapping and estimating mineral potential areas is relatively costly and time consuming and is subject to a variety of errors. Recently, however, advances in computing power and the increasing availability of remote sensing data have renewed interest in using GIS to address a wide range of Mineral resource issues and questions. However the basic problem in Enugu state is the availability of spatial information on mineral resource occurrence, its quantity and distribution; The main challenge in Enugu state is how to make use of the sparse data available from different sources, discern their commercial value and reserve as well as the EIA of subsequent mining of these minerals when addressing mineral resources management and optimization.

II. Study Area

Enugu State is one of the thirty six states of the Federal Republic of Nigeria; it's a mainland state in South-Eastern Nigeria, created in 1991 from the old Anambra State. Enugu state is located between latitudes $5^{\circ} 53'$ to $7^{\circ} 05'$ N of the equator and longitude $6^{\circ} 46'$ to $7^{\circ} 52'$ E of the Greenwich meridian and the state has an area of 7,627.20km²

III. METHOD

The methodology used in this paper is shown in figure 1

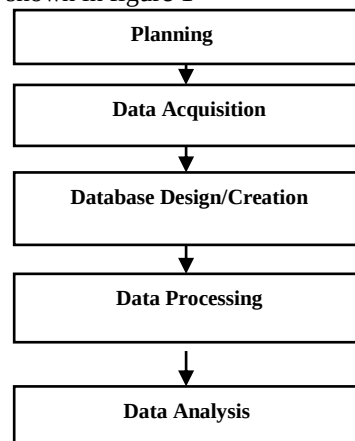


Figure 3.0: Flowchart of Methodology Adopted

A. Data Acquisition

The data used for the research is grouped

- 1 Nigeriasat-1 satellite imagery (2005) was acquired from the Office of the Surveyor General of the Federation (OSGOF), and digitized to show different layers such as road network, areas and others, using ArcGIS10.0 software. This low resolution imagery is used against the Ikonos imagery because of the scope of area covered and the objective of the work
- 2 Shuttle Radar Topographic Mission (SRTM) (30m) of the study area was obtained and the digital elevation map (DEM) generated to give us a visual impression of the topology of the state
- 3 Detail map of Nigeria at the scale of 1:10,000,000
- 4 Administrative map of Enugu State
- 5 Topographic map of Nigeria (4 sheet mosaic together). Scale=1:100,000

B. 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.

b. Logical Design
This is another stage of the database design in which all the real world entities conceptualized were modelled 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.

C. Data Processing

The map acquired was scanned into ILWIS 3.6 for georeferencing and digitized together with the Ikonos image and then exported to ArcGIS 10.0 where data pertaining the location distribution of mineral resources was collected and database was created so that spatial analysis would be performed. These data were processed and

queried to provide useful information for monitoring and assessing the spatial distribution of mineral resources in Enugu State.

D. Data Analysis

With the aid to show the applicability of GIS as a tool in monitoring and assessing mineral resources in Enugu State, Nigeria, spatial queries were conducted.

IV. Results

To ensure the efficacy and flexibility of the database, it was tested. This was through some query analysis shown in the following sub sections:

A. Query of Mineral Resources Found In Enugu City

Enugu Metropolis is regarded as the urban area of Enugu state made up Enugu North, Enugu South, Enugu West and Nkanu west a GIS operation can be carried out to confirm the number of Mineral locations in the area, type of mineral, location of mineral as well as attributes of these mineral by a query operation as shown below in fig. 4.0

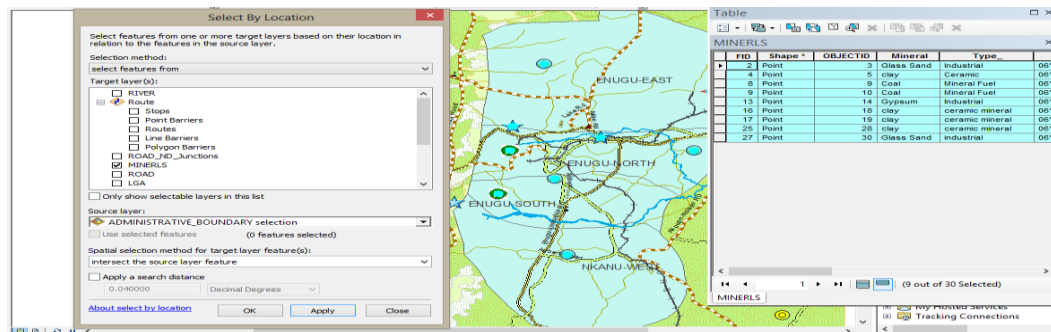


Figure 4.0 Query result showing mineral resources found in Enugu City

From the query results, there were nine minerals located in Enugu city, which includes coal, clay, gypsum and Grass sand, as found Enugu City.

B. Query by Attribute of Minerals Resources Found In Enugu North L.G.A

This query was performed to determine mineral resources in Enugu North L.G.A as shown in figure 4.1

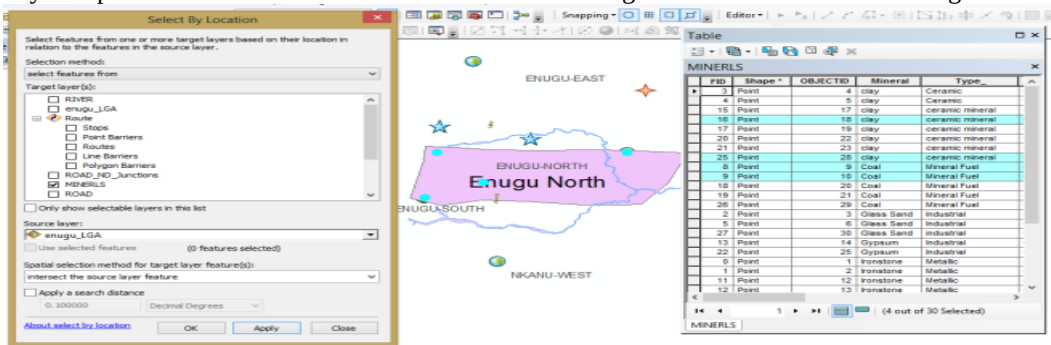


Figure 4.1: Query result showing mineral resources in Enugu North L.G.A

The query results shows a total of four minerals were found in the Local government area, which includes Clay and coal minerals.

C. Query by Attribute of Coal minerals resources found in the Enugu state

This query was performed to determine Coal mineral resources in Enugu State as shown in figure 4.2

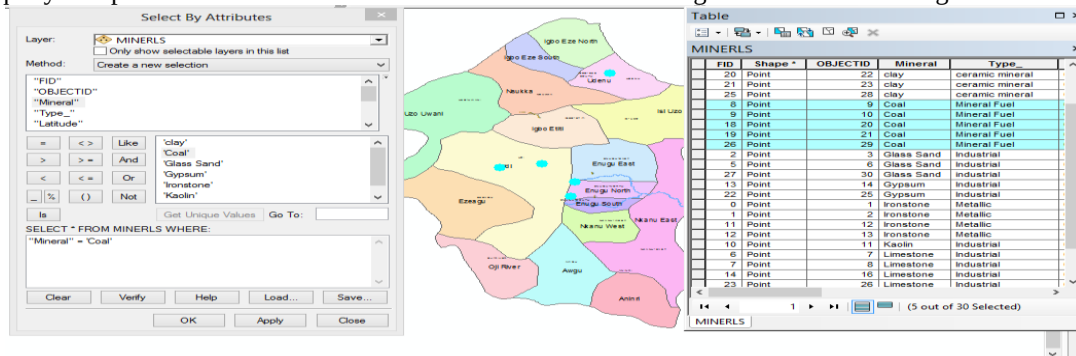


Figure 4.2: Query result showing Coal mineral resources in Enugu State

The result shows a total number of five coal minerals were found in Enugu State, these can be found in Udi, Udenu, Enugu north and Enugu south.

D. Query by number of Artisanal mineral sites found in Enugu state

This query was performed to determine Artisanal mineral resources in Enugu State as shown in figure 4.3

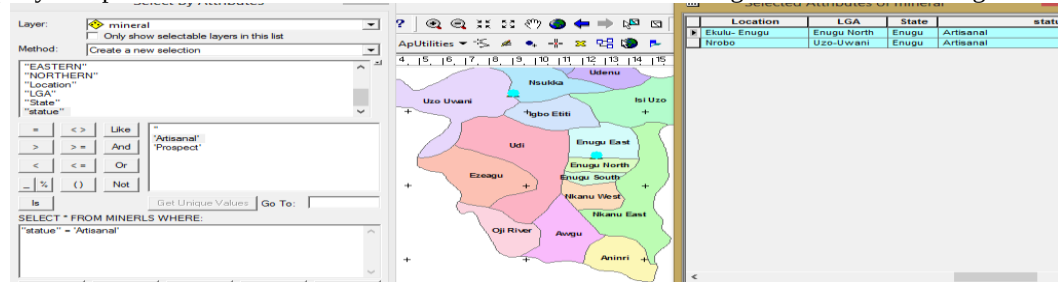


Figure 4.3: Query result showing number of Artisanal mineral in Enugu State

The result shows two Artisanal minerals found in Enugu State which includes grass, sand and clay minerals.

V. Summary & Conclusion

This project was primarily carried out to map mineral resources in Enugu state using Remote sensing and GIS Technique, and show the application of these techniques in the management of Mineral resources in the state. Attribute data of mineral resources were sought from survey agencies, within the state, hence the Author absolves himself of any representation or misrepresentation that might result from the use of these information.

The application of the research paper is not limited to the queries analysis shown in results as GIS tool can be used to analyse several question as regards mineral resources in the state.

With governments renewed drive to diversify its income source and not be over reliant on crude, there is need to have a foolproof and dynamic information system driven by a robust database platform to enable suitable investors have quick and easy access on information to aid decision making.

Most of Nigeria's Mineral resources are hugely untapped and if investors are to participate actively in this sector a project like these done for Enugu state would have to be made available. On a state by state basis, this would end up giving us a national scope on our mineral resources potentials.

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