

Application of GIS in Estate Management (A Case Study of Araromi Phase IV, Oyo, Nigeria)

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Key Words: GIS, Estate, Database, Analysis, Arcview 3.2a

SUMMARY

The aim of the project is the application of Geographic Information System in the effective management of Estate and its resources. While the objectives included capturing of geometric and attribute data about the estate features, such as road, parcel building, electric poles, wells, land use, ownership and address, design of a database for the estate, perform spatial analysis and product presentation. The geometric data acquisition was carried out using GPS and Total Station while oral interview was used for attribute data acquisition. The processed data was drafted with AutoCAD 2002 software while the database was designed using Arcview 3.2a. Database (Extraction) queries were generated in Arcview 3.2a and the result of these queries is a useful tool towards decision making. These queries are useful tools for the management of the Estate by the local government authority towards effective tax collection and provision of basic amenities. The job was successfully executed with the result obtained at the end.

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1. INTRODUCTION

According to Lexicon Universal Encyclopedia (1989 vol. 7E), an Estate is a property to which a person is lawfully entitled. In traditional law, the word referred to property in land; a person's Estate consists of the interest or rights that the person held in land.

Funk and wagnals new Encyclopedia states that "the term estate is also used in amore general sense to denote the whole property possessed by an individual i.e. the total belongings of a person".

Encyclopedia Encarta premium Suite (2004) describes real estate as Land and everything built on it, and the nature and extent of ones interest therein. Though, chiefly an American usage, the term has the advantage of distinguishing between such landed property and the broader classes of property in general unlike the common British usage. The word "Real" as it's relates to the property, means land as distinguished from personal property; and estate is define as the interest one has in property. Real estate may be acquired, owned and conveyed by individuals, business corporation, charitable organization, religious organization, etc. (Encyclopedia Encarta Premium Suite 2004)

It is obvious that everything that concern estate is all about property/properties that one possessed on a parcel(s) of land.

The United Nation (UN) ad hoc Group of Expert on cadastral Surveying and Mapping claimed that "Land is the bedrock of all forms of human activity, from it we obtain our daily food, the shelter we need, the space we work and the room to rest.

As the world population increases every second, our Urban Centres are been faced with the problems of inadequacies of basic facilities such as water supply, drainage, electricity, good housing as a result of over population, rural-urban migration, etc. hence, there is an increase demand for the construction/ setting of new estates with infrastructures so as to make life easier for the citizens.

2. GIS AND REAL ESTATE

The following geographical elements play an important role in the development of an estate. The factors to be considered are as follows;

The topography of the area of an estate is important as the highest of the property above the sea level can result in pleasing vistas, clean air, an identify value and other advantages that suit a residential purpose. Flat, low lying land may be easier to build upon but there is difficulty to drain the water.

Availability of resources is also a characteristic of an estate. The dominant character of an estate is based on the availability of resources and facilities such as water supply, drainage, electricity, good roads, etc.

Estates location is the most principal factor in an estate geographical setting. Before an estate could be sited, the catchments area for tenants in case of residential, shoppers in case of commercial and labour supply in case of industrial must be considered.

The determination of boundaries of influence is always difficult because of some competing interests. Many estates are characterized by a definable boundary such as a coast line, river, major road, railway line or any other artificial barrier as boundary.

Effect of neighbourhood in an estate is an area exhibiting a high degree of uniformity in use, age of its buildings and social status. A large estate might itself comprise neighbourhood while small individual house properties will usually follow in use value and character of the neighbourhood which they form part.

The historical background of an estate seems not to be necessary but past events will always have an effect on the setting of an estate. The early history of an estate usually follows the course determined by its geographical setting. The earliest setting e.g. the road of an estate, ownership (tenure) and use are also historical elements.

Site selection is also necessary in an estate setting. Firstly, there is need to consider whether the site to be used is sufficient for the purpose of the proposed development. Obviously, the site must fit the permitted density allowed by the local planning authority.

Management is an integrating process by which an authorized individual create, maintain and operate an organization, establishment or set-up in the selection and accomplishment of its aims.

From the two words “Estate” and “Management”, one can say that Estate Management is the responsibility or the ability to plan, organize, lead and control the activities of an estate or a landed property towards effective management and decision making. For proper management of an estate, the strategy for social/economic planning is highly required.

Conventionally, the estate mangers based the management of an estate on the basis of physical visitation to the estate and taking of inventory of the facilities in the estate. The location of the estate is presented on a paper map in a graphical form and in the process of representing features, many details or data were gradually reduce in its pictorial form and many real details often filtered away.

Moreover, data retrieval is not cheap. In most cases where there are large volumes of information to be represented, they are shown in more than one map. The printed is only a static qualitative document and is extremely difficult to attempt qualitative spatial analysis with the unit specified on the thematic map.

It is quite obvious that there is no “Management without Measurement”. An effective management can only be realized if there are data about the features in an estate. In order to overcome the inherent problem of limitation in the old system of management of an estate, hence the invention of the Geographic Information System (GIS).

What is GIS? Kufoniyi (1998) described geoinformatics as a body of knowledge that deals with the acquisition, processing and management of geoinformation, that is, science and technology for the acquisition, storage, analysis, manipulation and dissemination of geoinformation. He defined GIS as a computerized tool for capturing, storing, checking, integrating, manipulating, analyzing and displaying of data which are spatially referenced towards an effective decision making.

The American Society of Real Estate counselors also opined that GIS is a marriage between computerized mapping and database management system (DBMS). GIS entails creating database for both geometric and attribute data.

Worboys (1995), defined database as “a unified computer based collection of data showed by authorized users with the capability for controlled definition to access, retrieval, manipulation and presentation of data within it. The geographical database is a combination of spatial and non spatial data. Its components are;

- Positional data representing the Easting, Northing and Height (X, Y, Z) coordinates (vector) or cells defining the location of spatial objects represented in the database.
- Relationships existing among the objects i.e. topology.
- Attributes which are the observed facts about the objects.
- Conventions and operations.

GIS make use of the spatial database which constitutes one of the five major components of GIS; the others include Hardware, Software, Procedure and Expertise.

Kufoniyi (1998) further stated that GIS performs three fundamental operation of database; query, derivative mapping and process modeling.

GIS has enhanced capability of executing proximity analysis, various site selection model such as trade area analysis, spatial interaction, location factors, etc. (ESRI, 2005)

C.P. Lo and K.W. Yeung (2003) argued that at the application level, GIS is often called by different names e.g. practitioners in land surveying, land administration and real estate commonly used the term Land Information System (LIS) to denote those information systems used in support of land management activities. Land management refers to the decision making and implementation of decisions about the land and its resources. Broadly speaking, Land management includes decision making associated with property conveyance, assessment, and

development; management of land and water resources, as well as the formulation of land laws and land use policies.

There are many benefits derived from GIS application in Estate management, few cases are illustrated in the next paragraph. It is of interest to note that these applications were successful as a result of the production of the digital estate management information of the study area.

Gilbert Castle also emphasizes on application of GIS in estate management activities in the following areas; market monitoring and ranking, site selection, brokerage, property management, portfolio management, appraisal, property tax assessment, management of publicly owned real estate assets, sales of data layers by public agencies, etc.

The applications are not exhaustive; GIS has more advantages than the analogue way of keeping the tracks of information in an estate because the spatial database is directly linked to the spatial entities on the map of the estate. Estate information managed with GIS is more versatile because it can be subjected to many applications without introducing errors. Among the many benefits derivable from application of GIS in an estate are; New and Flexible form of output (customized mapping), quick and easy access to large volume of data about the features in the estate, selection of terrain details through answering some spatial problem, ability to merge one dataset to another, capability of speedy updating and the ability to answer complex land related questions.

Another way in which GIS has revolutionised the real estate industry is the area of Internet GIS whereby the Estate Managers display their services on the internet thereby enabling the customers to see the properties of their choice, its price, location, amenities in the estate and its neighbourhood influence without visiting the manager's office.

Although, the project work is another medium of realizing and appreciating the importance of GIS. Since spatial data deals with location, its addresses, what where and when questions.

Both spatial and non spatial (attribute) data organised together for the creation of the database. It is believed that the database will serve as a model for decision making. It then means that the database generated for Araromi phase IV, Araromi can be updated at any point in time since the estate is yet to be fully developed and it is liable to undergo more development.

3. STATEMENT OF PROBLEM

Absence of effective digital map to manage the Estate of Araromi Phase IV necessitates the embankment of the project. Araromi Phase IV is in Oyo East local government area, and it is a block in Araromi layout. The production of a digital map and a functional database of the area will render solution in the following areas;

- i.) Updating and modification of information concerning land parcels, building, social amenities, etc in the area.
- ii.) Faster and easier retrieval of information for instantaneous use of recipient such as government agencies, demographers, tourists and individuals.
- iii.) Identification of the amenities in the Estate so as to know which other ones they need.

4. AIMS

The aims of the project are as follows;

- i.) Using GIS to manage an Estate (Araromi Phase IV).
- ii.) To test the knowledge of the students on the use of digital equipment for data acquisition in the design and creation of spatial database in an Estate.
- iii.) To serve as part of the pre-requisite for the award of Higher National diploma in surveying and Geo-informatics.
- iv.) To test the ability of students in executing GIS project using land surveying techniques without overlooking the basic principles in surveying.

5. OBJECTIVES

The processes that led to the achievement of the aims stated above are as follows;

- i.) Capturing of the geometric and attribute data for parcels, buildings and other amenities such as electric poles, well, drainage system using land surveying method.
- ii.) Creation of database (spatial/attribute) for the features in the area under study.
- iii.) Performing spatial analyses on the databases created.
- iv.) Information presentation based on the analyses performed.

6. SCOPE OF THE PROJECT

The scope of the project covered the following operations;

- i.) Reconnaissance: -
- ii.) Establishment of horizontal ground controls using GPS.
- iii.) Capturing of locational and attribute data using Total Station and Social Surveys respectively.
- iv.) Data downloading from both GPS and Total Station using SKI 2.3 and Leica Survey Office respectively.
- v.) The design and creation of spatial database using Arcview GIS 3.2a.
- vi.) Perform spatial analyses i.e. query generation using Arcview GIS 3.2a.
- vii.) Presentation of the required information in form of customized map.

7. STUDY AREA

The area under study is Araromi Phase IV. It is located in Oyo East local government area, Oyo, Oyo state. It covers a block in the Araromi layout. It is located between latitude 078 49' 30.37"N to 078 49' 37.98"N and longitude 038 55' 47.89"E to 038 55' 55.20". Araromi phase IV is mainly a residential area characterized by a lot of bungalows and few storey buildings. It is

surrounded by roads. It is bounded in the south-west by NESTO College and Araromi Nursery and Primary School in the South.

8. METHODOLOGY

8.1 Database Design

A database is an organized, integrated collection of non-redundant data stored so as to be capable of use by relevant applications with the data been accessed through some logical path. Database referred to is a spatial database and it is the heart of GIS. This is the process whereby real world entities and their interrelationships are analyzed and modeled in such a way that maximum benefits are derived while utilizing minimum amount of data. The two (2) interrelated phase of database design was followed while deigning the database for this project. The two interrelated phases are;

- a. The design phase
 - b. The construction/Implementation phase.
- The design phase consists of four (4) stages namely;

- (i.) View of reality
- (ii.) Conceptual design
- (iii.) Logical design
- (iv.) Physical design

8.2 View of Reality

This is the mental abstraction of the reality that is relevant to the application at hand. The process formalizes the description or view at different level of data abstraction. Since the real world is made up of complex spatial objects and phenomena, it is practically impossible for a single data model to represent everything that is present. The application in this case is an estate management which consists of boundary, buildings, parcels, electric poles, wells, and drainage systems.

8.3 Conceptual Design

This is the presentation of human conceptualization of reality. It deals with the identification of the basic terrain objects together with the spatial relationships that exist among them. Conceptual design is carried independently of software and hardware that will be used to implement the database. The spatial relationships consist of metric and topological relationship. In designing the model, Entity-Relationship (E-R) model was used. The entities of interest such as node, arc and area were identified and analysed. The relationship that exists among such entities and their attributes were also identified and analysed. The figure below illustrates the Entity-Relationship diagram and the conceptual designs of the spatial database for the estate.

8.4 Logical Design

In order to implement the database design as defined by the system independent conceptual model, it is necessary to map in a system-specific model. Logical data modeling is the process by which the conceptual schema is consolidated, refined and concerted to a system-specific logical schema. It could also be termed as a database structure. Generally, there are several approaches to the structure, they are hierarchical structure, network, relational and object oriented approach.

In this project, relational database structure was used. The data are stored in simple relations known as tables. Each table contain item of data called fields about a particular object. The objects area arranged along the rows and the field (attribute values) arranged along the column. The data structure was executed using Arcview 3.2a. The relational schemas are shown below;

Table 1: Node entity and its Attribute

NODE

Station_Id	Northing	Easting	Node_Id
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Table 2: Parcel Entity and its Attributes

PARCEL

P_Id	O_Id	CofO	L_Pa	R_Pa	B_Type	P_Add	Use	Area	Value
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Table 3: Arc Entity and its Attributes

ARC

Arc_Id	B_Node	E_Node	Line Object
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Table 4: Owner's Entity and its Attribute

OWNER

O_Name	O_Add.	Sex	Age	L.G.A.	State	Occupation
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9. PROJECT SCHEDULING

After the completion of the field reconnaissance, the proposed data acquisition, processing and information presentation period was put into phases so as to meet up with project date line. The execution of the project was scheduled/ planned as follows;

Table 5: Activity List Table

ID	TASK	DURATION	DATE
1.	Office reconnaissance	2 days	30 th July, 2005
2.	Field reconnaissance	2 days	1 st August, 2005

3.	Control establishment using GPS	1 day	3 rd August, 2005
4.	Processing of GPS data	1 day	4 th August, 2005
5.	Traversing, Detailing and Social Survey	3 days	5 th August, 2005
6.	Data downloading	1 day	8 th August, 2005
7.	Editing and Draughting using AutoCAD	5 days	9 th August, 2005
8.	Analysis/Queries using Arcview 3.2a	3 days	14 th August, 2005
9.	Report writing	15 days	16 th August, 2005
10.	Typing of report	3 days	2 nd Sept., 2005
11.	Project defence	1 day	8 th Sept., 2005

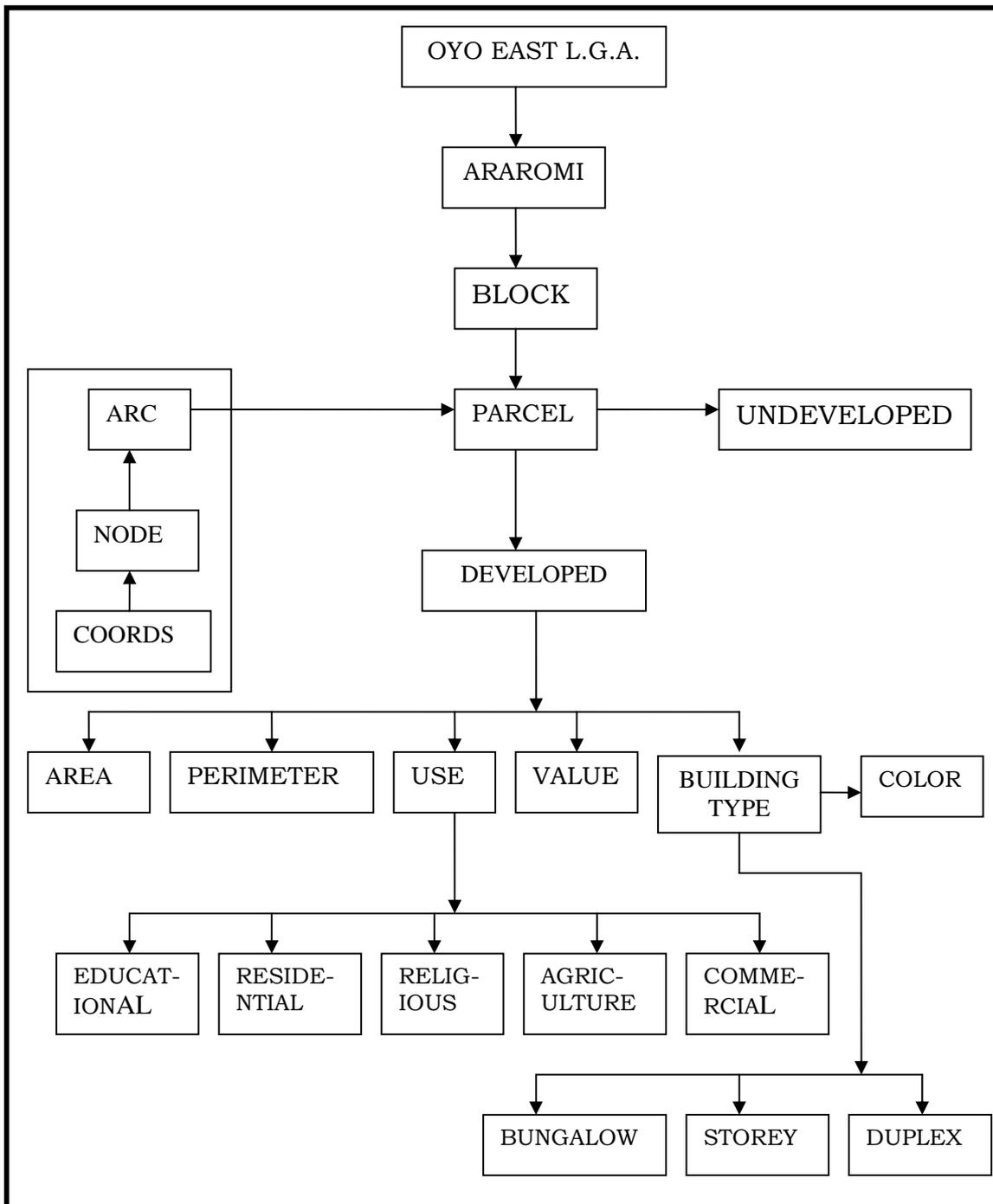


Fig. 1: Entity Relationship diagram (E-R Schema) of Araromi Phase IV Estate

TS 7 – GIS and Valuation

10/17

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10. DATA ACQUISITION

This is the process or method of acquiring/ obtaining the data required on the site using various data acquisition techniques such as land surveying, photogrammetry, etc. These involved both geometric and attribute data using method of questioning. All the data acquired on the site are primary data. Prior to the data acquisition, reconnaissance was carried out. Reconnaissance constitutes an important aspect of survey project. The sequences of data acquisition include reconnaissance, Using GPS and Total Station for locational data-set and collection of attribute data.

11. RECONNAISSANCE

This is an important aspect of surveying that involve both planning and preliminary inspection of the area before the commencement of the actual data acquisition on the project site, for the purpose of planning how to execute the project, fixing station, locating controls, etc. Its value prior to the real survey work cannot be underestimated and it enables the surveyor to obtaining the picture of the whole area in his mind so as to work economically in term of time, energy and fund. The two (2) phases of reconnaissance carried out are;

- (i.) Office reconnaissance
- (ii.) Field reconnaissance

12. SYSTEM SELECTION

This comprises of both the hardware and software used in the project execution. It includes the hardware and software used for data acquisition, management and information presentation.

HARDWARES

Data Acquisition

- (i.) 1 (one) No. of Leica (TC 305) Total station and its accessories
- (iii.) 1 (one) No. of Leica reference GPS and its accessories
- (iv.) 1 (one) No. of Leica rover GPS and its accessories

Data Processing

- (i.) 1 (one) No. of GPS processing Key.
- (ii.) A Personal Computer with the following configurations;
 - (a.) Intel Pentium III processor
 - (b.) 512 MB of RAM
 - (c.) 1.33 GHz Speed
 - (d.) 15" Monitor

Information Presentation

- (i.) 1 (one) No. of Hp deskjet 3650 (A4 size) Printer

SOFTWARES

- (i.) Onboard software of Leica Total Station for data acquisition and storage
- (ii.) Onboard software of Leica GPS for data acquisition and storage.
- (iii.) Leica Survey Office (v1.31) for data downloading from Total Station.
- (iv.) Leica SKI (v3.1) for data downloading from GPS.
- (v.) Microsoft Window XP professional 2002 (Operating System).
- (vi.) AutoCAD 2002
- (vii.) Arcview 3.2a
- (viii.) Notepad

13. GEOMETRIC DATA ACQUISITION

This involved the process of acquiring the locational data, which are the Easting(X) and Northing(Y), coordinate of the control beacon, the boundary points of the Estate and other features such as building, road, well, etc. The geometric data acquisition was carried out in two phase;

- (i) Establishment of controls using GPS
- (ii) Traversing and detailing using Total station

14. ATTRIBUTE DATA ACQUISITION

Attribute data are observed fact about any entity of interest and it is one of the basic components of a spatial database. According to the content of the project, that is Estate management, attribute data acquired are street name (parcel address), Land use, Ownership, Building type, Owner's occupation, sex, C of O, Age and State of Origin. An oral interview method of questionnaire was adopted and this was achieved through oral interview of the resident.

14.1 Data Processing

As an effective management is measurement dependent, the data acquired were duly processed for further information presentation and analyses.

Data downloading

This is the process of transferring the captured locational data stored in the memory (PCMCIA card) of the digital equipment (GPS and Total Station) via the RS 232 port of the equipment through the cable (downloading cable) via the communication port (COM) to the computer. Both the GPS and Total Station data were downloaded respectively.

GPS data download and processing

Data captured with the GPS were downloaded into the computer system from the two controllers (reference and rover) via the cable using SKI 3.1 software and its processing key. The coordinate obtained are in WGS 84 ellipsoid, hence the need to transform the coordinate to NTM (local coordinate system) using AJIB DATUM 2 conversion software.

15. PHYSICAL DESIGN

This involved the representation of the data structure in the format of the implementation software i.e. Arcview 3.2a.

The basic input data sets also had to be put in place. Since the data source was primary in nature with attribute data obtained by social survey method, the table created were then populated with the data acquired from the field (geometric and attribute) after taken care of necessary formatting and editing.

The entities identified are used to form a relation database in Arcview 3.2a. The relation name and its attributes are as follows;

Node (Station_Id, Northing (m), Easting (m), Node_Id)

Parcel (Parcel_Id, Owner_Id, C of O, LParcel, RParcel, BType, PAddress, Use, Area, Value)

Owner (O_Name, O_Address, Sex, Age, L.G.A., State of Origin, Occupation)

16. DATABASE IMPLEMENTATION

Implementing a GIS database design simply mean the creation of both the necessary attribute relation and the graphical layers as set out by the design specification. Implementation involved linking of both the attribute and spatial data together and generating queries that can solve spatial problems. Arcview 3.2a was used for this purpose of database implementation.

17. SPATIAL SEARCH/ QUERY GENERATION

The distinction between Geographical information System and other Information Systems is in the area of spatial search/spatial analyses. Search operation is a GIS tool that is essential for processing or manipulating of data to suit user's need.

The spatial search operation for this project was carried out through query generation to retrieve information stored in the database pertaining to certain systematically defined attributes within the database to answer some spatially related questions. This operation involved the link between the database and the composite map of the study area. Queries were generated to provide answer to the application use of GIS in managing Araromi Phase IV estate and the results displayed in form of hardcopy map.

18. QUERIES AND PRESENTATION

Database query can be referred to as the selection of various combinations of various tables for examination; it involves the retrieval of information stored in the database using structured query language (SQL). However, the queries generated are basically through database extraction in Arcview 3.2a.

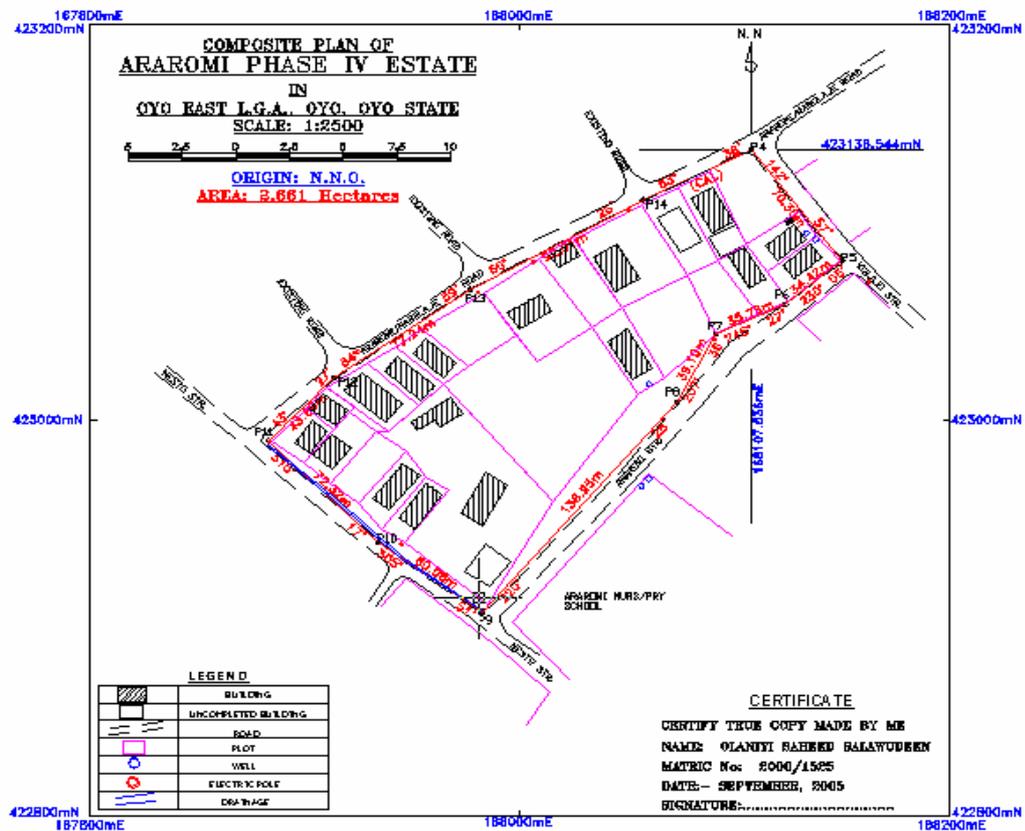


Fig. 2: Composite Map of the Study Area

19. APPLICATION OF PRODUCTS

It is hoped that the thematic map obtained from the queries will aid the decision makers and the general public in taking decisions. The composite map of the study area (Araromi Phase IV) shows the parcels, buildings, boundary, roads, drainages, wells and electric poles in the area and this will aid the assessors like estate valuers, etc to know the elements in the estate and also it will help the local government authorities to know which type of amenities to provide in the estate. Also, the authorities that are saddled with the responsibility of the management of the estate can easily know those parcels that has certificate of occupancy as well as those owners that has violated the estate land use law vis-à-vis the building type. Also, with the buffer generated on the roads, the Estate managers would know the amount of compensation to be paid if there is need to expand the estate road in the future

20. PROBLEMS ENCOUNTERED

The major problem encountered during data acquisition is the vehicular problem. The non-cooperative attitude of the residents as regards provision of reliable information about estate features during the social survey. Data processing and analyses was hampered by incessant power failure. The vehicular problem was solved by taking a taxi to the project site while the problem of the residents not willing to give reliable information was solved by a brief enlightenment about the importance of the project been carried out. The problem of incessant powers failure was solved by hiring a generating set to power the computer system.

21. RECOMMENDATION

Considering the cost of this project and the accuracy achieved in the accomplishment of this project, I hereby recommends as follows;

- (i) Documentation Publication of the project with a view of attracting a high value consultancy jobs from both the private and public sector.
- (ii) Creation of a central database for Araromi/Mabolaje area while students' final project will serve as an input into the database.
- (iii) This type of project should be carried out in collaboration with local government authority survey department so as to create more awareness on the use of GIS as a tool for decision making.

- (iv) The public should be enlightened on the usefulness of control beacons and cost of establishment so as to minimize the occurrence of pillars dislevelment and total removal

22. CONCLUSION

Creation of a spatial database for Araromi Phase IV estate resulted in the creation of a spatial database which can be manipulated to answer basic generic questions in GIS. Customized maps which is application based can now be produced at will when the need arises while the database created can serve as a model for subsequent work within the area that will involve the use of GIS basic analysis functions like buffering and overlay. The database created can be updated when the need arises.

With the introduction of GIS, Surveying Practice has been made easier, faster and more efficient, no wonder why Surveyors are been referred to as the only manager of information about land and the development on it, hence, Surveying is the bedrock of a meaningful development.

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