GIS - BASED CADASTRAL INFORMATION SYSTEM FOR TENEMENT RATE PURPOSE: A CASE STUDY OF AGBARA ESTATE, BADAGRY, LAGOS STATE

Olagoke Emmanuel, Awodumi[1] and Abiodun Akeem, Audu[2]
Department of Urban and Regional Planning, University of Ibadan, Nigeria
gokeemmanuel@gmail.com

Abstract

It is obvious that the present system of tenement rate administration in the country is based on manual method which is inefficient, hard to update, time-consuming, prone to error and abuse. This study, modeled parcel-based Cadastral Information System (CIS) of Agbara Estate, a portion of Badagry Local government Area of Lagos State. This examined the capability of Geographic Information System (GIS) for the effective and efficient collection of tenement rates at Local Government level. In other to achieve this aim, GIS database design, acquisition of geometric data through ground survey methods, acquisition of attribute data, database creation, and spatial analyses were adopted. Parcel, road and boundary layers were created in AutoCAD Land-development environment and integrated into ArcGIS. This study shows the capability of Geo-database for providing accurate and reliable information to local government tax officers, town planners and decision makers in digital format. This also shows the amount to be expected annually from each parcel and this will drastically alleviate corruption and embezzlement in the system. It is therefore recommended that government at all level should adopt Geographic Information System for digital capturing, storage and updating of land related data and for decision support system for effective tenement record.

Keywords: Cadastral Information System, land administration, GIS, Tenement rate and Database system

1. INTRODUCTION

Housing and demand for land in mega cities such as Lagos is on the increase on daily basis, this makes housing, land acquisition and record more cumbersome. And majority of the land processes and charges are done on analogue format, this has led to forging of land document, misplacement of land records, record damages land and housing racketeering. Thus, a developed Cadastral Information System can help to store land information in local government or at state government level in digital format (Jean and Markus, 2012 and Igbokwe et al, 2012). Enemark and Sevatdal (1999) recognized that digital cadastral information systems must be tailored to facilitate an efficient land market as well as effective land use administration and generally promote economic and sustainable development.

Local Government Area councils have many sectors which perform various functions and manage different revenues like tenement rate on properties within their geographical areas. Administration and Tenement rate collection is digitally achievable through tools available in Geographic Information System (Iyiola *et al*, 2013). For instance, Orisakwe and Bakari, (2013) developed a parcel-based Cadastral Information System (CIS) of part of Kofare Government Residential Area (GRA) of Jimeta – Yola and mainly for property and tenerate rate taxation. Autocad was used to georeferenced and digitized the parcels and roads and integrated into ArcView environment. Emengini, Akpata and Ejikeme, (2017) created Cadastral Information System for the study of Asade Estate, Abuja. The study was carried out using KOLIDA 445R Total Station and the data were plotted in AutoCAD Land Development 2009, digitizing and layout design were carried out in ArcGIS 10.1.

Iyiola *et al*, (2013) examined the use of Geographic Information System (GIS) for efficient and effective tenement rate administration in Local Government Area councils. Spatial database were created through ArcGIS 9.3 and various spatial operations to demonstrate the use and application of GIS for revenue generation at local government level.

Geographic Information System is an integration of computer hardware, software and data for capturing, managing, analyzing and displaying all forms of geographically referenced information (ESRI, 2012). Geographic Information System is very useful and applicable in Local Government administration, most especially in tenement rate collection.

The international Federation of Surveyors (FIG, 1995) defines a cadaster as a parcel based and up to date land administration system containing a record of interests in land. The outlines of these land parcels are normally shown on large scale maps, are linked to textual land title registers and provide a spatial reference for other spatial or aspatial, parcel related data (Effenberg, 2001). Iyiola *et al*, (2013) opined that the contemporary system of tenement rate administration and collection in Nigeria is based on analogue method which is less effective, time-consuming and prone to error and abuse. Some document in analogue format get misses while some are not properly maintain, in this process, some vital information concerning lands owners and administration for the purpose of tenement tax collection are missing. With the introduction of Geo-database system, this information is well secured, managed, queried and can be updated when needed.

The review of literature clearly shows GIS techniques have been deployed in developing Cadastral Information System and management in various sphere of land administration. However, less of these literature project how existing analogue land administration records can be upgraded into Digital Cadastral Information Systems. And despite growing interest in this field, studies appear to be less aware of development of Geo – database for tenement rate acquisition and record. This study therefore contributes to the literature by upgrading analogue data of Agbara Estate, Badagry, Lagos through development of Digital Geo database to analyze the special case of landuse activities, in the study area, while considering secondary data from Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State.

1.1. Study Area

Badagry (traditionally Gbagle) is a coastal town and local government area (LGA) in Lagos State, Nigeria. It is situated between the city of Lagos, and the border with Benin at Seme. As of the preliminary 2006 census results, the municipality had a population of 241,093. Founded in the early 15th century on a lagoon off the Gulf of Guinea, its protected harbour led to the town becoming a key port in the export of slaves to the Americas, which were mainly to Salvador, Bahia in Brazil. Badagry is a monarchy headed by the Wheno Aholuship, a kingship head by the Akran of Badagry and his seven white cap high chiefs. The first educational system of Nigeria as a British colony started in Badagry where the first primary school was established by the Wesleyan mission (Methodist Church) in 1843 and named Nursery of Infant Church which later became St. Thomas' Anglican Nursery and Primary School, founded by Rev. Golmer of the Church Missionary Society (CMS) in 1845, inside the first storey building in Badagry. The first secondary school in Badagry was built over one hundred years later called Badagry Grammar School in 1955 due to misunderstanding between the Missionaries and the natives that made them leave the town unceremoniously.

In terms of economic activities, Badagry subsists largely on fishing and agriculture, and maintains a small museum of slavery. The town inhabits dwellers from all over the country doing different business in the town. Some trade in clothing, food items, used cars from overseas and other imported goods. The town is just few kilometers from Seme a border town to Republic of Benin and generates the highest Nigeria Customs duties income till date. This is the building commonly called the first storey building in Nigeria, overlooking the Marina waterfront. It was built in 1842 by Rev Bernard Freeman and other missionaries. Although it was built thousands of years after the first story building was constructed in Nigeria, with many still standing multi-storey buildings, the name has stuck. Epe, Age Mowo, Magbon, Zeal Multi Hall, Edu Town, Badagry, Morogbo and Agbara. Agbara is located in Badagry local government area. The study area, Agbara, is located between Latitude 510,028.877 E and longitude 719,550.357 N (UTM) (See figure 1). Agbara estate shares boundary with Zeal Multi Hall, Morogbo in the north, Edu town in west, and Igbesa in the North.

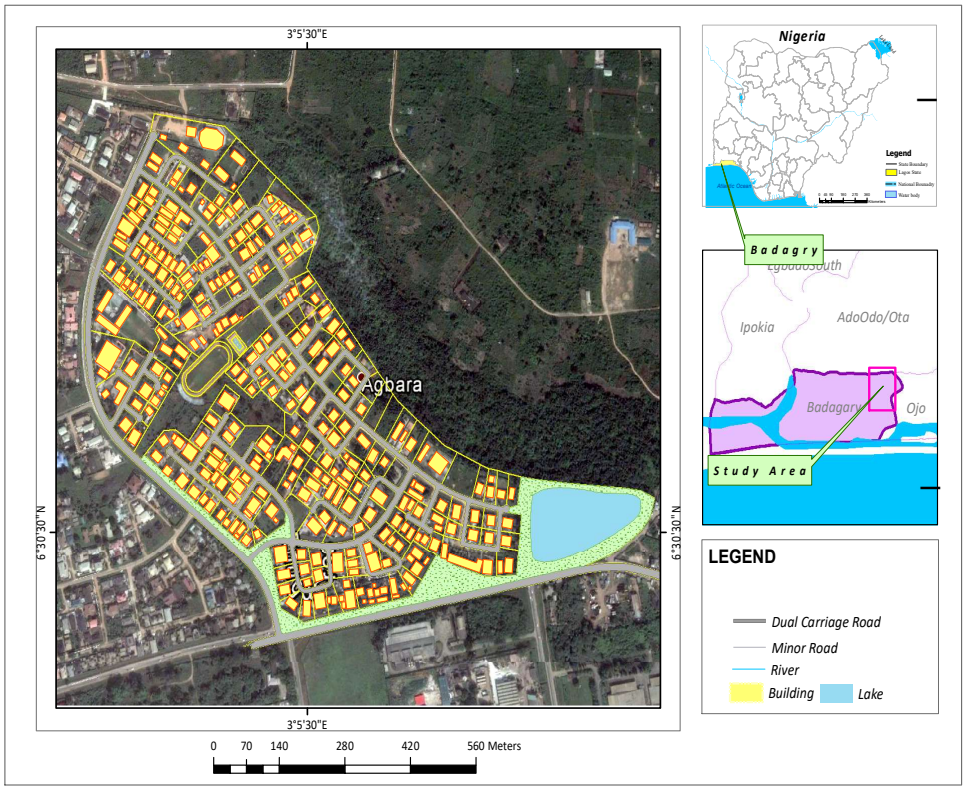

Figure 1: Agbara Estate, Badagry.
Source: Authors' work

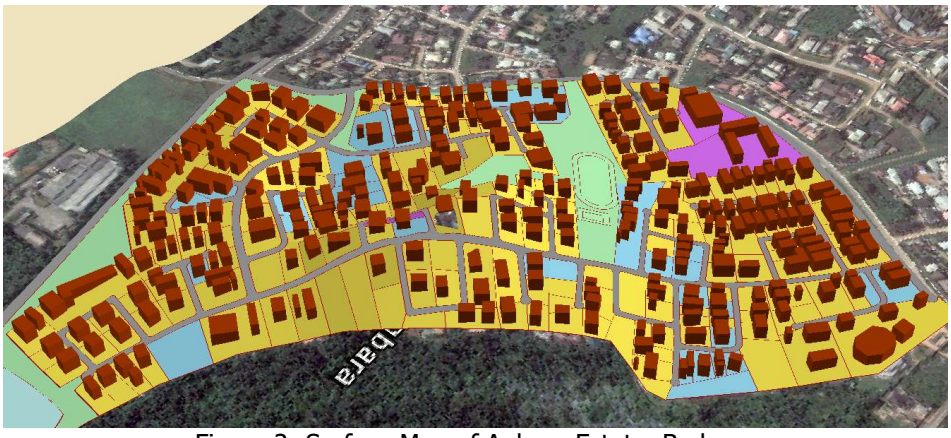

Figure 2: Surface Map of Agbara Estate, Badagry
Source: Authors' compilation

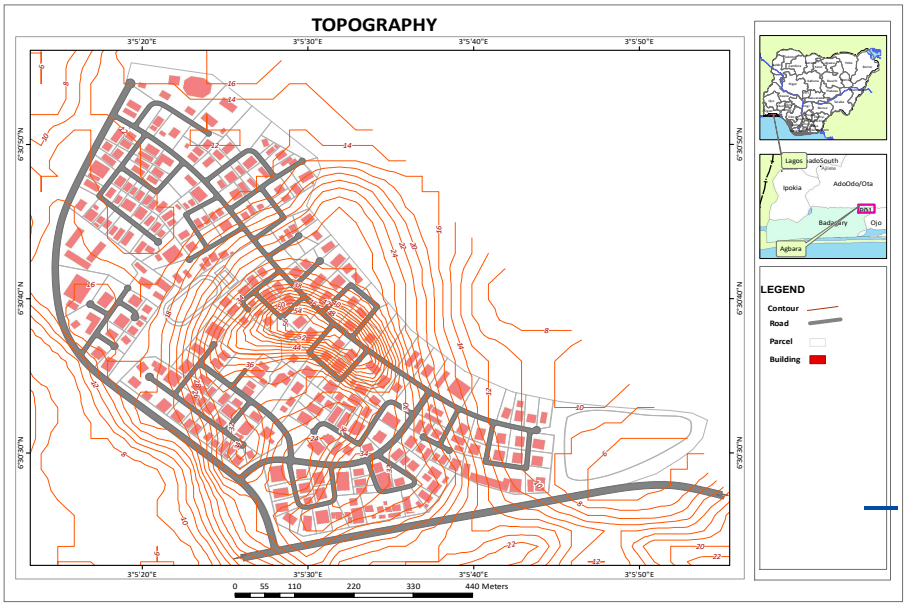

Figure 3: Topography of Agbara Estate, Badagry
Source: SRTM

2. METHODOLOGY

2.1 Method and Data Acquisition

Secondary data and ground truthing were employed in this study. Satellite images were downloaded from Google Earth. Downloaded image scene that formed a composite image of the study area was utilised for classification of features into points, lines and polygon which were later used to create a geo – database in ArcGIS. SRTM data was used to generate the topography of the study area. Secondary data for this research was sourced from Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State.

2.2 Database Design

The study applied one of the latest advancement in GIS technique, ArcGIS 10.6 and AutoCAD Land development, to analyze the special case of landuse activities in the study area, while considering secondary data from Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State. Autocad was used to geo - referenced and digitized the parcels and roads. The digitized parcels and roads were integrated into ArcGIS environment. The attributes of each parcel were integrated and analysed in ArcGIS 10.6.

Obtaining a GIS database required two main phases; the design phase and the construction or implementation phase (Kufoniyi, 1998)

The design phase (data modeling) consists of three levels, namely:

- Conceptual design
- Logical design

- Physical design

2.3. Conceptual Design

Conceptual design is the representation of human conceptualization of reality, in this research; the reality was represented in a simplified manner and still satisfies the information requirement of the organization concerned. Also, the vector approach was adopted. The vector data structure is that model in which point, line, and polygon is used to represent the real world (Iyiola *et al*, 2013).

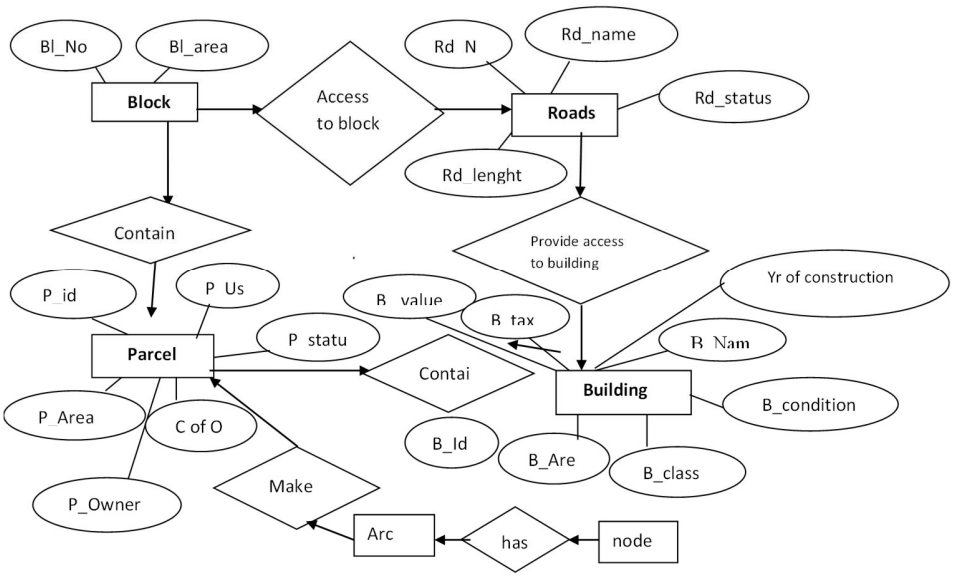

Figure 4: Entity Relationship for Fiscal Cadastre**.**
Source: Authors' compilation

2.4. Logical Design Phase

The conceptual data model developed in this project was translated into the relational data structure. In a relational data model, data are separated into tables. They are found along rows and the fields along columns. The conceptual model was translated into a logical data structure and the following relations were derived.

Table 1: Parcel Table Source: Author

Field name	Description
P_Id	Parcel identifier
P_use	Parcel Use
P_area	Parcel Area
Status	Parcel status
B_id	Building Identifier
P_owner	Parcel Owner
C of O	Certificate of occupancy
Tenure	Tenure

Source: Authors' compilation

Table 2: Building Table Source: Author

Field name	Description
P_Id	Parcel identifier
B_use	Building Use
B_area	Parcel Area
Bclass	Building Class
B_facilities	Building facilities
B_condition	Building Condition
Yr_Construct.	Year of construction
Bvalue	Building value
Tax_Rate	Tax Rate for each class
Tax	Tax Payable

Table 3: Road Table

Field name	Description
R_id	Road identifier
R_name	Road name
R_status	Road status
R_length	Road length

Source: Authors' compilation

2.5. Geo-database creation

A geo - database was created to enforce topological and geometric rules on the resulting feature classes. The feature classes created was based on the identified features on the imagery and the outcome of the ground truthing carried out earlier on. ArcGIS 10.6. In ensuring that the image and feature class do not have spatial reference conflict, the same projection was sustained, that is, Universal Traverse Mercator (UTM) Zone 31 for the geo - databases.

Table 4: Content of the Geodatabase

Feature Type with Name Assigned	
Feature Type	Feature Name
Line/Polyline	Expressway
	Minor Road
Polygon	Block
	Parcel
	Building

Source: Author's compilation

2.6. Digitizing

The satellite image was digitized through AutoCad Land Development and was later transfer into ArcGIS environment. The features class was added to the ArcGIS 10.6 data view for vectorization. To ensure precise point snapping, the snapping tips option was also enabled. While for the topology purpose, landuse layer was identified and created for proper topology analysis and for edge merging purpose. The auto complete polygon was also incorporated in order not to duplicate edges during topology data creation.

3. SPATIAL SEARCH AND ANALYSIS

Spatial search was used to test the database created by looking for certain attributes within the neighbourhood, which must be logically and systematically defined. This gave rise to querying the database towards answering questions related to the application. The basis of any property taxation is valued and used. Industrial and commercial properties are taxed at 10 percent and then residential properties at about 3-5 percent of rate - able values (or assessed values). Real property is taxed based on its classification. Classification is the grouping of properties based on similar use. Properties in different classes are taxed at different rates.

Table 8: Real property tax rates adopted for Agbara Housing Estate

Badagry Axis	(Class B) Residential	Premium Ground Rent Devt. Charges Stamp Duty Registration	=N= 300/m2 =N= 50/m2 =N= 25/m2 2% of Premium 3% of Premium	=N=257,400.00 @ =N=396.00 per square meter
	(CLASS A) Commercial, etc			=N=514,800.00 @ =N=792.00 per square meter

Sources: Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State.

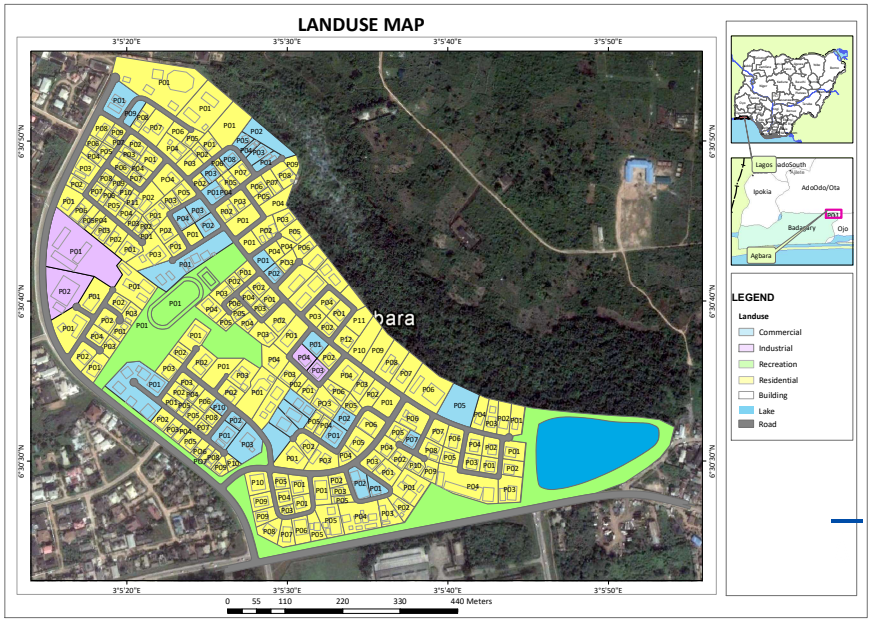

Figure 5: Landuse type for Agbara Estate
Source: Authors' work

Query 1: Select by attribute from parcel, Parcel that are within Classc'A'.
Syntax "CLASS" = 'CLASS A'

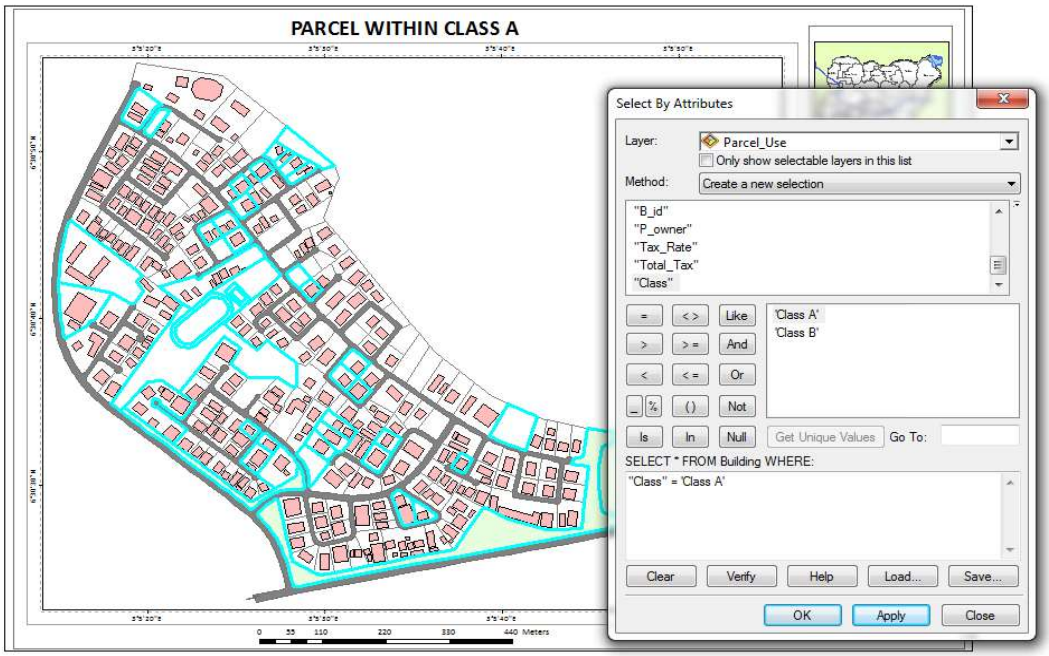

Figure 6: Query for parcel that fall within Class A. Syntax "CLASS" = 'CLASS A')

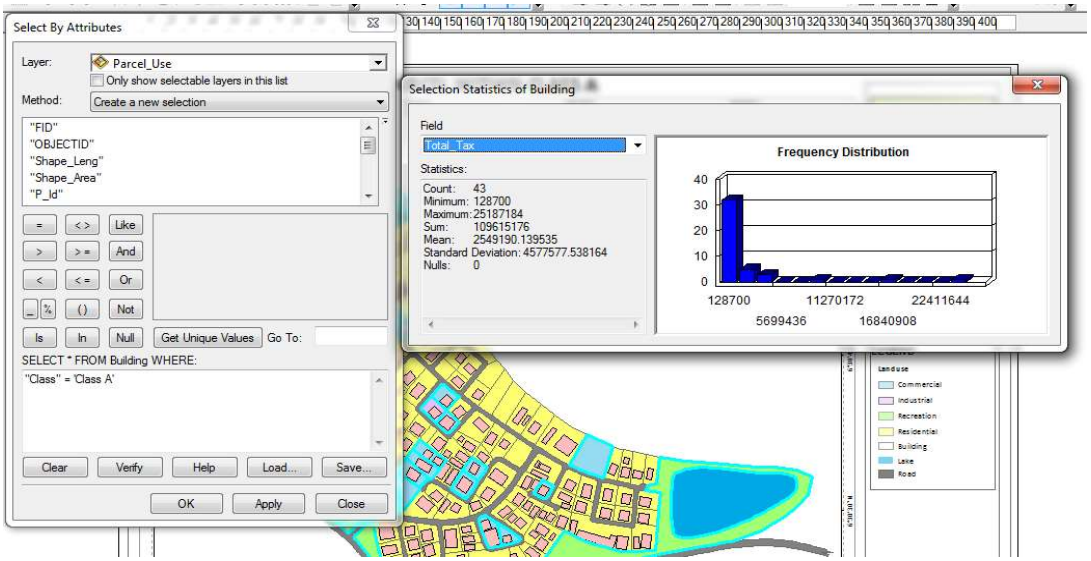

Figure 7: Result of parcel that fall within Class A (Total Tax revenue for class A)
Source: Authors' work

3.1. Analysis of result:

The analysis shows the parcel that falls within class A. A total of 43 parcel exists within the study area. The parcel has commercial uses, and the minimum assessed value is

128,700 while maximum value is 25,187, 184. Virtually all the parcel and buildings are commercial. The wall material is mainly block. The tax rate is #792.00 per square meter. The yearly tax revenue from building in this class is given in table 8 above**.** The total yearly tax revenue from class 'A' parcel is in the sum of N109, 615,176

Query 2: Select by attribute from parcel, Parcel that are within Classc'B'. Syntax [CLASS] = 'CLASS B'

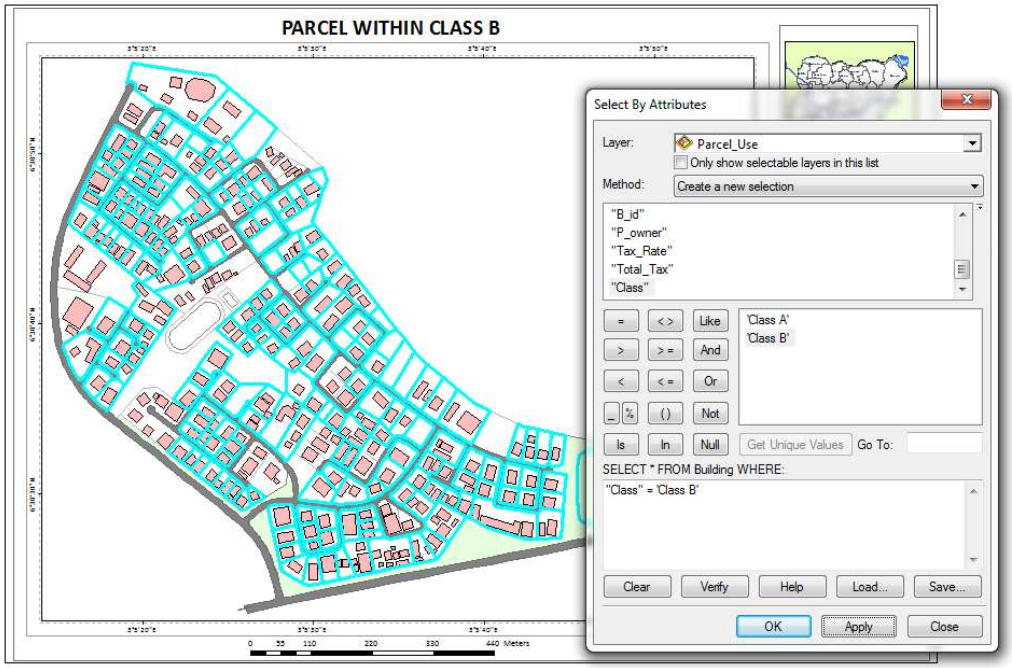

Figure 8: Map of buildings that fall within Class B (residential)
Source: Authors' work

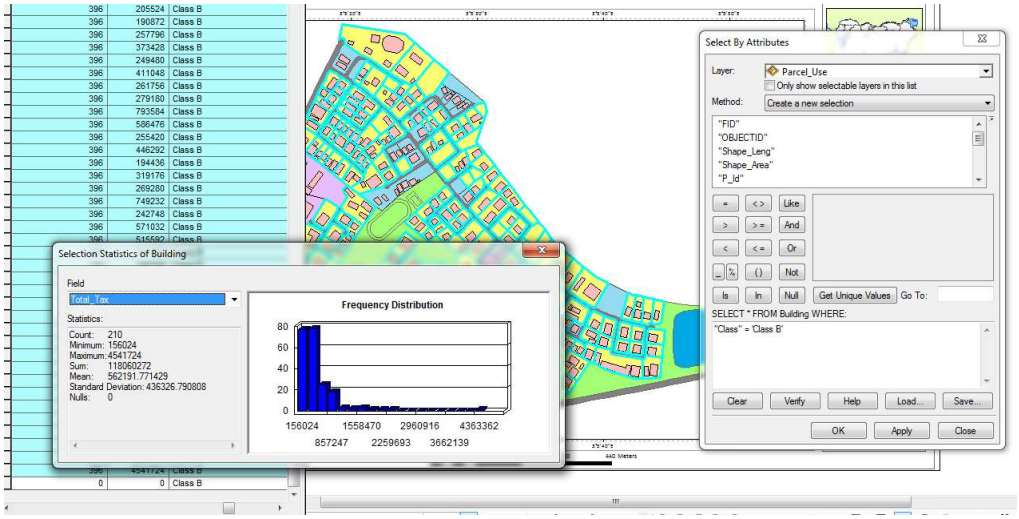

Figure 9: Result of buildings that fall within Class B (Total Tax revenue for class B)

Source: Authors' work

3.2. Analysis of result:

The analysis shows the parcel that fall within class B. A total of 210 parcels exists within the study area. The parcels have residential uses, and the minimum assessed value is 156,024 while maximum value is 4,541,724. Virtually all the parcels and buildings are residential. The wall material is mainly block. The tax rate is N396.00 per square meter. The yearly tax revenue from buildings in this class is given in Table 8**.** The total yearly tax revenue from class 'B' parcel is in the sum of N118, 060,272

4. DISCUSSION

This research focused on the use of Geographic Information System as a tool for developing cadastral information system for the purpose of parcel taxation in part of Agbara, Badagry Local Government Area of Lagos State. The image of the study area was extracted from Google Earth and the following layers were digitized: parcel, block, building and road, boundary, and a geospatial database were created for each of the map themes. The buildings were divided into classes and respective tax rates. The major software used is ArcGIS 10.3. The spatial analytical function of ArcGIS was employed to test the database created. Taxes were computed for each building except religious properties. The research reveals that there are 323 buildings in the study area of which 45 are commercial while 278 are residential building, 121 residential parcels and 48 commercial parcels and 58 blocks in Agbara estate. The total yearly tax revenue from residential parcel is expected to be N118, 060,272 while the total yearly tax revenue from class commercial parcel is in the sum of N109, 615,176

5. CONCLUSION AND RECOMMENDATION

Geographic Information System is an integration of computer hardware, software and data for capturing, managing, analyzing and displaying all forms of spatially referenced information. Information such as tenement rate on parcel and buildings can be captured, stored, queried, updated, manipulated and analysed in Geographic Information System. With this research model, the Local Government tenement tax collectors should adopt Geographic information Systems (GIS) into their day to day operation. With GIS the following objectives will be achieved without stress:

- Conversion from analogue to digital based system
- Data concerning changes in land, house or parcel owner can be easily updated
- Amount expected from each structure will be easily reviewed and this will reduce corruption in the system

REFERENCES

Effenberg, W (2001). *Spatial Cadastral Information: the maintain digital cadastral maps*, Department of Geomatics, Melbourne, Australia.

Emengini E.J., Akpata. S., Ejikeme J.O (2017): Creation of Cadastral Information System of Asade Estate, Abuja, Nigeria. *International Journal of Rural Development, Environment and Health Research, Vol 1, issue 4.* ISSN: 2456-8678.

FIG (1995). *"Statement on the Cadastre"* International Federation of Surveyors (FIG) Bureau, Canberra, Australia.

ESRI (2012): http://www.esri.com/what-is-gis/overview#overview_panel accessed on 04th October 2012

Iyiola, Effiong and Abubakar.(2013). *Application of Geographic Information System (GIS) in Tenement Rates Collection*. FIG Working Week 2013 Environment for Sustainability Abuja, Nigeria, 6 – 10, May 2013.

Jens R. Markus. S (2012): Challenges for the Multipurpose Cadastre, FIG Working Week, *Knowing to Manage the Territory, Project the Environment;* Evaluate the Cultural Heritage, Rome, Italy.

Kufoniyi, O. (1998): *Surveying and Information Technology,* A paper presented at the Quarterly Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State.

Lagos State Valuation Office and Local Government Inspectorate, Ministry of Local Government and Chieftaincy Matters, Lagos State

Luncheon series of the Nigerian Institution of Surveyors (NIS), Lagos State Branch, pp, 20

Orisakwe K.U and Bakari G (2013). *Development of Cadastral Information System for part of Kofare Government Residential Area of Jimeta-Yola in Adamawa State of Nigeria.* FIG Working Week 2013 Environment for Sustainability Abuja, Nigeria, 6 – 10 May 2013

Received: September 20, 2022,
Accepted: August 30, 2023