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Land Administration and Management using Geographical Information System (GIS): A Case Study of Bethel Estate, Enugu State, Nigeria

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Abstract
Land information is prime requisite for making decisions related to land investment, development and management. Information reduces uncertainty by helping to identify and analyze problems. Strategies to overcome them may then be prepared and implemented. The value of the information and the effectiveness of the decision making process are directly related to the quality of the information and the manner in which it is made available. Land records are very important because these form the basis for assignment and settlement of land titles, these must stand against legal scrutiny. It helps to create more reliable and all-embracing tool for decision- making about land especially with the recent Land reform efforts of the Federal Government of Nigeria. The paper presents an overall framework for understanding the role of the multi-purpose cadastre in facilitating an efficient land market as well as an effective land-use administration. Bethel estate located in Enugu state is used as a case study. The procedure include: data collection, scanning, geo-referencing and digitizing. The attributes of features were created in the database, results were obtained by querying the database and finally the results were analyzed and presented.
Keywords: Land Reforms, Multi-purpose Cadastre, geo-referencing, Land-use administration, Land Information.

1.0 Introduction

1.1 The Concept of Cadastre

The cadastre is an inventory of land object. It provides a wide inventory of local, regional, state, and national land objects such as parcels, properties, natural resources, environmental and legal aspects. The cadastre is normally up-to-date in which land information is systematically identified. The cadastre shows present conditions of lands. Cadastral systems must serve a multi-purpose use and thereby meet the challenge of a modern GIS and IT environment and of course Land Reform efforts. The cadastre is seen as the basic infrastructure for providing economic, social and environmental benefits. This cadastral infrastructure will permeate through the land administration and land management systems. According to Rekha (2013), "in countries in Western Europe like The Netherlands, Germany, United Kingdom, Austria and Switzerland cadastre systems not only provide information about the ownership and value of land but may also include information on land use, legal restrictions, regulations concerning land use and the registration of important assets or infrastructure, such as utilities."

1.2 Statement of the Problems

The traditional method of data management has proved to be ineffective and cumbersome. It is faced with problems such as: Redundancy (the unnecessary repetition or duplication of data), High maintenance costs, long learning times and difficulty in moving from one system to another, the possibility that enhancements and improvements to individual files of data will be made in an ad hoc manner, data-sharing difficulties, lack of security and standards and the lack of coherent corporate views of data management.

1.3 Objectives

Data collection from the project site, Scanning and geo-referencing of the analogue plans of the estate showing the buildings, their types and other existing structures in the site, Data capture by digitizing, Production of Digital map of the estate, Assignment of unique identifiers to each parcel, Creation of attributes of individual parcels in the estate, Queries and Analysis of database

1.4 The Role of the Cadastre

A cadastral vision of the future, as presented in the UN Bogor Declaration 1996, is to: "develop modern cadastral infrastructures that facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management".

A vision for the future role of the cadastre in a global land management perspective should reflect the scenario of IT development. This means that the cadastral systems must provide adequate information on the land parcels to be presented in a variety of interfaces. The design and maintenance of cadastral systems must

reflect this multipurpose use.

1.5 Benefits of Multipurpose Cadastre

- A flow of standardized data for updating federal maps and statistics for use in national-wide census to efficiently manage federal assistance to local programs such as community housing and developments can be achieved.
- State maps could be related with other detailed maps and databases available from private firms and local governments. State governments could also easily share information between themselves and local governments.
- This is because an MPC allows for better data to be used in any public transactions with the local governments. Local governments in turn have access to other related geo-information using a MPC. Higher accuracy data when needed is available through existing connectivity with other geo-information repositories. The production of new themes or datasets
- may not be necessary because local governments and government authorities may collectively agree to share land related resources through the MPC. As a result, a MPC will dramatically reduce costs of maintaining separate map systems and land information.
- Private sectors will also benefit from the MPC through efforts such as the production of standard and regulations, sharing of themes and datasets and large-scale maps, amongst others.
- Academic institutions will continue to contribute through extensive research and education into areas such as human interaction with the MPC, feasibility studies and the data transfer formats
- Faster access to records affecting individual rights, such as planning control, native title and land title issues could be achieved. The MPC is also expected to clarify minor boundary disputes through simultaneous access to planning, cadastral, title and customary land title databases. Ultimately, the public's attitude towards the administration of local governments programs may improve.

2.0 Theoretical Framework

2.1 Principal Components of a Multipurpose Cadastre

- A reference framework consisting of a geodetic network,
- A series of current, accurate large-scale maps,
- A cadastral overlay delineating all cadastral parcels,
- A unique identifying number assigned to each parcel that is used as a common index of all land records in information systems,
- A series of land data files, each including a parcel identifier for information retrieval and links to other data files.

2.2 Managing Attribute Data

Data about our world are being produced continuously. They are being collected by difference means. This data are best managed by using a database approach. Database offer more than just a method of handling the attributes of spatial entities, they can help to convert data into information with value. Information results from the analysis, or organization of data. In a database, data can be ordered, re-ordered, summarized and combined to produce information.

The traditional method of data management has proved to be ineffective and cumbersome. It is faced by the following problems:

- Redundancy (the unnecessary repetition or duplication of data)
- High maintenance costs
- Long learning times and difficulty in moving from one system to another
- The possibility that enhancements and improvements to individual files of data will be made in an ad hoc manner.
- Data-shearing difficulties
- Lack of security and standards and

The lack of coherent corporate views of data management.

2.3 Advantages of Computer-Based Databases

1. Different data access methods will be possible.
2. Data are stored independently of the application for which they will be used.
3. Redundancy will be minimized
4. Access to data will be controlled and centralized
5. A computer database is relatively easy to maintain and updating is possible

6 Simple query systems and standardized query languages are available.

3.0 Research Methodology

3.1 Development of a Multipurpose Cadastre

The cadastre is an inventory of land object. It provides a wide inventory of local, regional, state, and national land objects such as parcels, properties, natural resources, environmental and legal aspects. The cadastre is normally up-to-date in which land information is systematically identified. The cadastre shows present conditions of lands. The methods used for the project are listed below.

3.2 Data Sources

Primary Sources of Data

- Coordinates of some pillar numbers obtained with GPS receiver to be used for geo-referencing of the plan.
- Ground truthing. Attribute data collected during the ground truthing to confirm the type of buildings present in the site.

Secondary Sources of Data

- Analogue Plan of the layout
- Analogue plan of the As-built Survey
- Coordinates of the boundary pillars
- Building plan of the site
- Attribute of the plots

3.3 The Project Practical Procedures

In this project the practical steps taken for the development of multipurpose cadastre are listed below and they include the following:

Scanning of the Analogue Plans

The analogue plans of the estate i.e. the layout plan and the building plan was scanned with an A_0 HP scanner and saved as an image file in jpeg format.

Geo-referencing.

The map was geo-reference following the procedure of the application software.

Digitizing

- The basic spatial entities used in digitizing are the point, polyline and polygon entities. Points are used to represent features that are too small to be represented as areas, for example beacons. Polylines are used to represent features that are linear in nature, for example roads and river. Polygons are represented by a closed set of lines and are used to define features such as fields, buildings, parcels or administrative areas. The spatial entity to be used depends on the features present in the plan and the scale in which it will be represented. The spatial entities used in the project are represented bellow:
- **Point** – beacons
- **polyline** – roads, center lines and fence
- **Polygon** – parcels, buildings, blocks and security posts.

3.4 Database Creation / Building Attribute

Database is a collection of data organized for storage in a computer memory and designed for easy access by authorized users. The data may be in the form of text, numbers, or encoded graphics. Since their first, experimental appearance in the 1950s, databases have become so important in industrial societies that they can be found in almost every field of information.

In GIS, two types of data are handled – the graphical data and non spatial attribute data. These types of data are normally stored in a database.

During digitizing the attributes of each feature class are added to the features so that it can be easily identified and to enable querying. This can be done before digitizing or after digitizing. The procedures for digitizing are stated as follows:

1. Right-click the layer in the table of contents.
2. Click Open Attribute Table
   The Attributes of the table will display three columns named FID, Shape, and ID, all of which were created by ArcMAP.
3. In the Attributes table click Options, Add Field.
   If you are unable to select this option, go back to the Editor Toolbar, click Stop Editing, and then try again to add a field.
4. In the Name field, type PLOT NO, choose Short Integer From the Type drop-down list, then click OK
5. Click Editor, Start Editing, click in the top cell of the PLOT NO field, type 1, and press Enter
   Pressing Enter will not take you to the next cell. To activate the next cell for data entry, place your

mouse cursor over it and click.
6. In sequential order, continue numbering the remaining cells in the PLOT NO field.
7. Click Editor, Stop Editing.
8. Click Yes to save your edits

The same procedure was used to add the attributes of other feature classes.

4.0 Analysis and Results

4.1 Geospatial Database Queries

These involve the extraction of relevant information from sets of spatial and attribute data. Queries offer a method of data retrieval, and can be performed on data that are part of the GIS database. The following queries were performed on the database and they include:

- Summary of Property Attributes. Fig3
- Which properties have a building type of "3 Bedroom Detached bungalow" Fig4.
- Which properties have an area that is greater than 557.479 sq. meters? Fig5.
- Which properties have not paid their annual ground rent? Fig.6
- Which properties are used for commercial purposes? Fig.7
- Which properties have not been sold?
- Which properties have a market value that is less than N5, 500,000.00? Fig.9
- Instrument hyperlinked to a parcel. Fig.8

A query was performed on the database to find the parcels with building type of 3 Bedroom detached bungalow. The result of the query shows that 52 buildings are 3 Bedroom Detached bungalows. Only the parcels with the building type of 3 Bedroom detached bungalow are displayed.

The result of the query to determine the parcels with area greater than 557.479 sq. meters are shown above. The parcels with area greater than 557.479 sq. meters are highlighted on the attribute table and on the map respectively.

The field (Rent Status) and the value (not paid) are used to construct a definition query using the query builder.

From the result the parcels that their annual ground rent have not been paid are displayed above including their attributes. (See Fig.6)

From the query performed in the database, the parcels that are used for commercial purposes are displayed above with their attributes. The layer used was *parcel,* the field used was *property type* and the value used was *commercial.* (See Fig.7)

The instruments that are associated with the individual parcel are hyperlinked to them. This helps to locate and manage the documents for each parcel. The instrument that is associated with plot 45 is displayed above.

The result of the analysis shows that seven parcels was valued less than N5,500,000.00 and they include : plot 8, 9, 38, 46, 54, 59 and plot 89 (Fig. 9).

5.0 Summary, Conclusions and Recommendations

5.1 Summary

The importance of GIS application in the development of multi-purpose cadastre cannot be over emphasized in the management and administration of land. This is due to the fact that efficient management of land cannot be achieved using the manual or analogue method. Cadastral systems are necessary for sustainable social and economic development. Cadastre started simply as a public register of boundaries and later went on to include the various other interests in land which lead to the development of the concept of multipurpose cadastre. This is a system designed to record, store and retrieve not only land-tenure data and land valuation information but also a wide variety of information that can be functionally related to and referenced by property parcels. The objective of the development of multi-purpose cadastre is to be able to take property inventories, as well as help in utility management, school management, population estimates, disaster management, computerization of land records, property tax generation and monitoring. This project shows a prototype of how MPC can be implemented using Bethel Estate as case study. The major software used for the project is ArcGIS which enables for data capture, integration, storage, retrieval and analysis. The themes created are: road, building, parcel, pillar number and block themes. Attributes of the features were created and queries were performed on the database and results were analyzed and reported. The result of the queries and analysis showed that: 52 properties houses a 3 Bedroom Detached Bungalow, 4 properties has an area that is greater than 557.479 meters, the annual ground rent of 18 properties has not been paid, 9 properties are used for commercial purpose, 25 properties have not been sold and 7 properties are valued less than N5, 500,000.

5.2 Conclusions

An attempt had been made in this project to illustrate how a multi-purpose cadastre can be implemented and to show some of its potentials in the management and administration of land. At the end of the project it was found out that computer based MPC is far more efficient and easy to handle than using the manual method.

So, why not to try a judicious mix of a minority of strategically placed electronic competencies with a majority of well-managed manual work. The technologies available will not only allow to integrate the various spatial and non-spatial datasets, but will enable online gathering, recording, warehousing, retrieving, disseminating & employing the data, which will lead to improve the effectiveness and efficiency of land management both from the perspective of the common man as well as that of decision makers implementing land based development activities at grass root level.

5.3 Recommendations

A new perspective is presented for implementing a multipurpose cadastre. The driving forces for modernizing the former structure of cadastre in Nigeria include new customer needs, new global changes, technological evolution, and country requirements. Various approaches were discussed for modernizing cadastral systems.
In spite of the humble achievements in the past decade the idea of distributed database net of public administration is of good perspective. Present isolation of the cadastre should be broken and the system open. The cadastre as one of the basic registers of the whole system plays an indispensable role. It is a great challenge for surveyors to make the most of it. Government and policy makers are also advised to adopt MPC for all land administration and management issues.

Bibliography

Abdul Majid, 2000. “Benefits and Issues of Building a Multi-Purpose Cadastre”. International Remote Sensing and Photogrammetry XIX, Amsterdam, p. 8.

Brown, P.M. and D.D. Moyer (1990-1996). “Multipurpose land information systems” The guidebook. Federal Geodetic Control Committee. (NOAA).

Dale, R.F. and J.D. McLaughlin (1988). “Land Information Management.” Clarendon Press, Oxford Chrisman, N.R. 1987. "Design of Geographic Information Systems Based on Social and Cultural Goals." PE&RS, 53(10):1367-1370.

Dueker, K.J. 1987. "Multipurpose Land Information Systems: Technical, Economic, and Institutional Issues." PE&RS, 53(10): 1361-1366.

Dueker, K.J and D. Kjerne. 1989. "Multipurpose Cadastre: Terms and Definitions." Technical Papers, 1989 ACSM-ASPRS Annual Convention, Vol. 5, pp. 94-103.

Enemark, S. (1997*). Concepts of Cadastral Systems – General Overview and Examples from throughout the World*. Department of Development and Planning, Publication Series no 214, Aalborg University, Denmark.

Enemark, S. (1998*a*). “Updating Digital Cadastral Maps – The Danish Experience*.” Proceedings of FIG Commission 7, the FIG XXI International Congress*, Brighton, UK, pp 426-437.

Enemark, S. (1998b) Cadastral Systems – the Nordic Approach. Landinspektoren*, The Danish Journal for Mapping and Land Use,* no 5/1997, pp 464- 471.

Enemark, S. (1999) *The EU Compendium of Spatial Planning Systems and Policies: Denmark.* Regional Development Studies, The European Commission, Luxembourg, Office for the Official Publications of the European Community (to be launched during the autumn 1999).

International Federation of Surveyors (1995) *Statement on the Cadastre*. FIG publications no 11, Canberra, Australia.

Kuhlman, K. 1993. "Building a Framework to Characterize Land Records Modernization." URISA 1993 Annual Conference Proceedings, vol. 2, pp. 146-151.

National Research Council (1983). “Procedures and Standards for a Multipurpose Cadastre”. National Academy Press, Washington DC

Rekha, B. (2013). Cadastre & Land Administration: Living in a Two-Speed World. Geospatial World. http://www.geospatialworld.net/Paper/Cover-

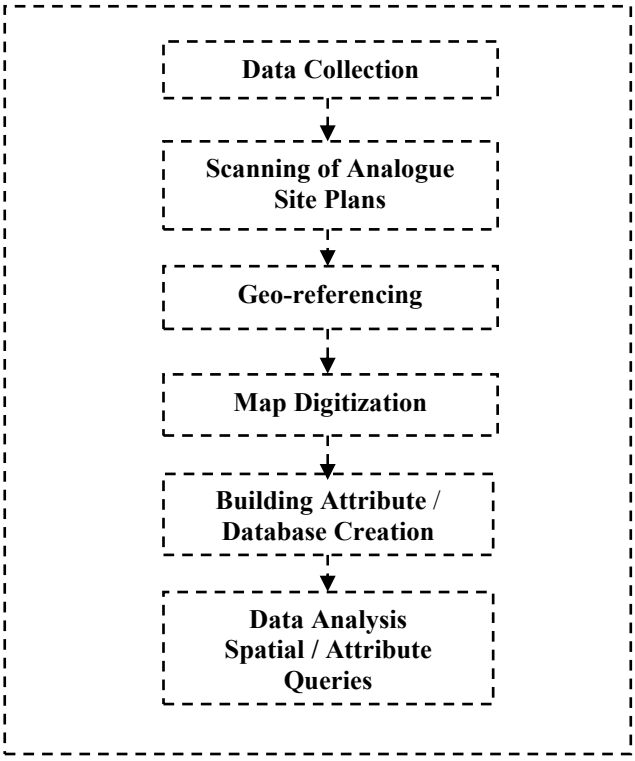

Figure 1. – Flowchart of procedures

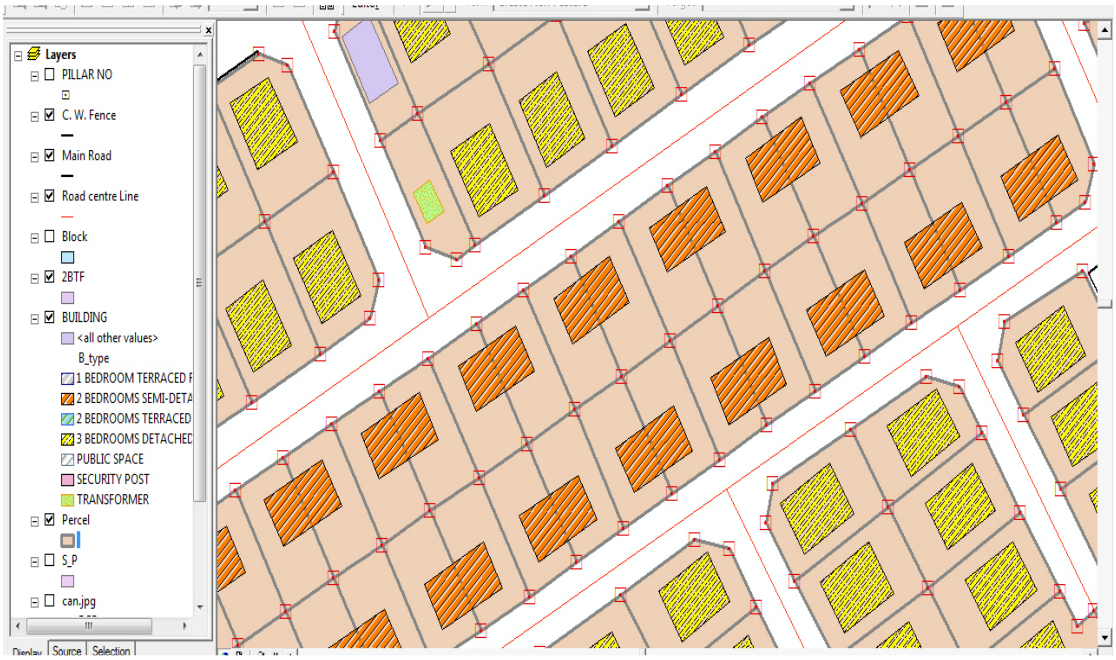

Figure 2. – showing digitized features

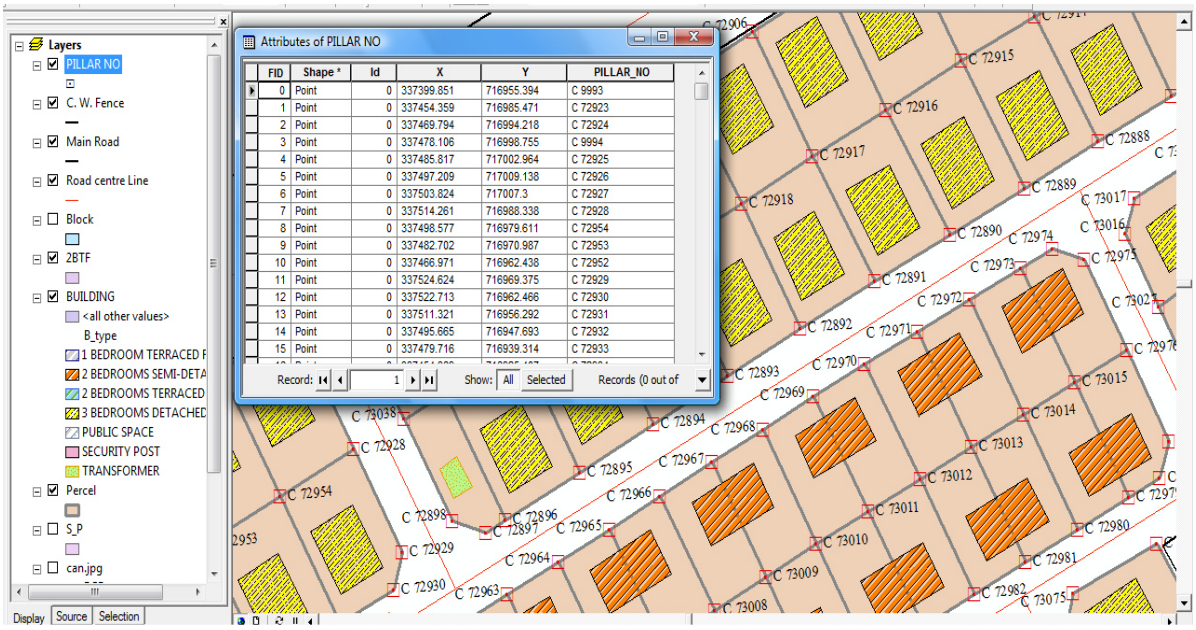

Figure 3 – showing how to build attribute of feature

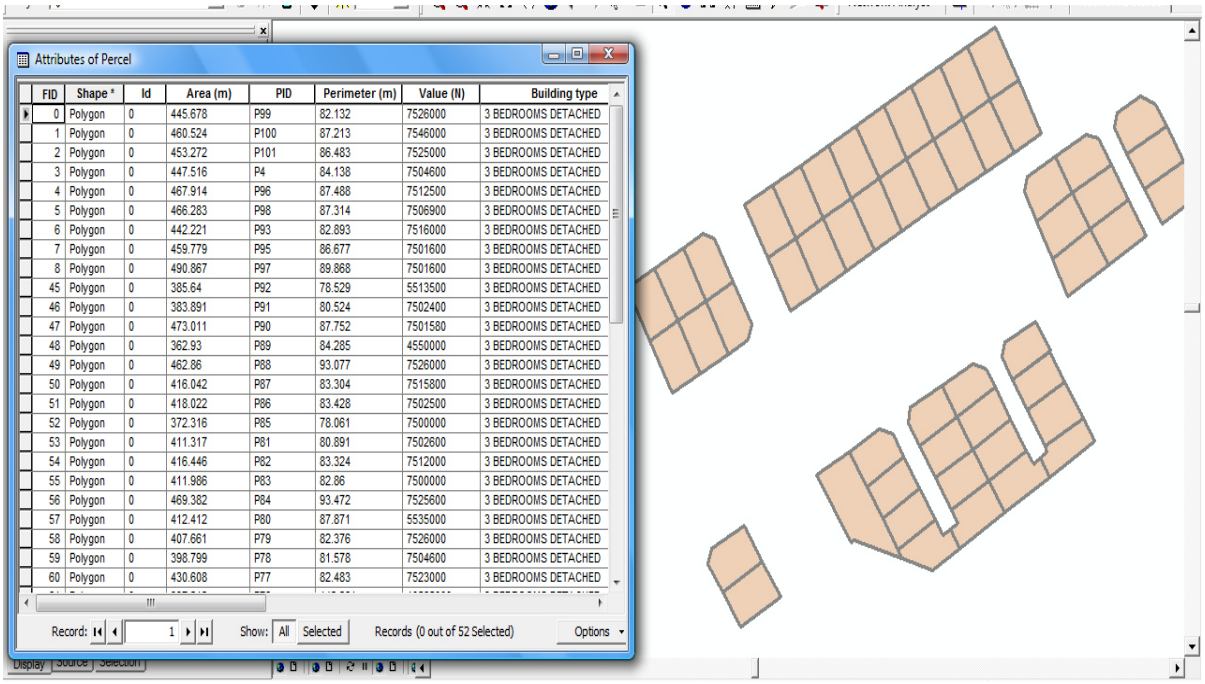

Figure 4. – showing properties with building type of "3 Bedrooms Detached Bungalow

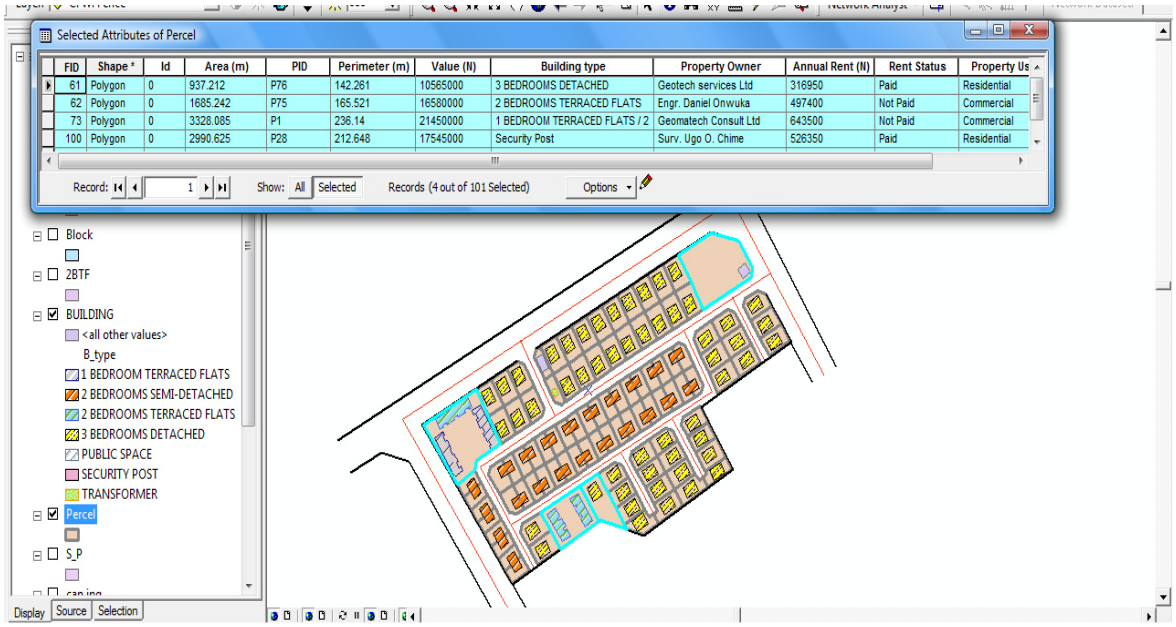

Figure 5. – showing properties with area that is greater than 557.479 sq. meters

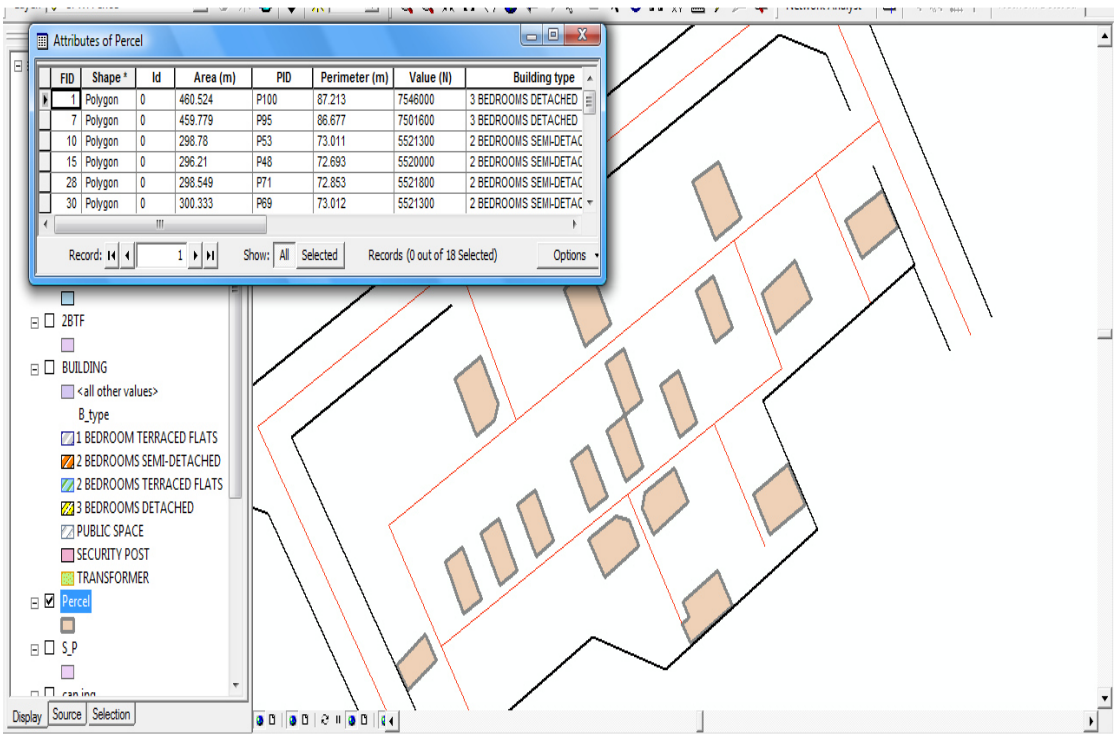

Figure 6. – showing properties that their annual ground rent have not been paid

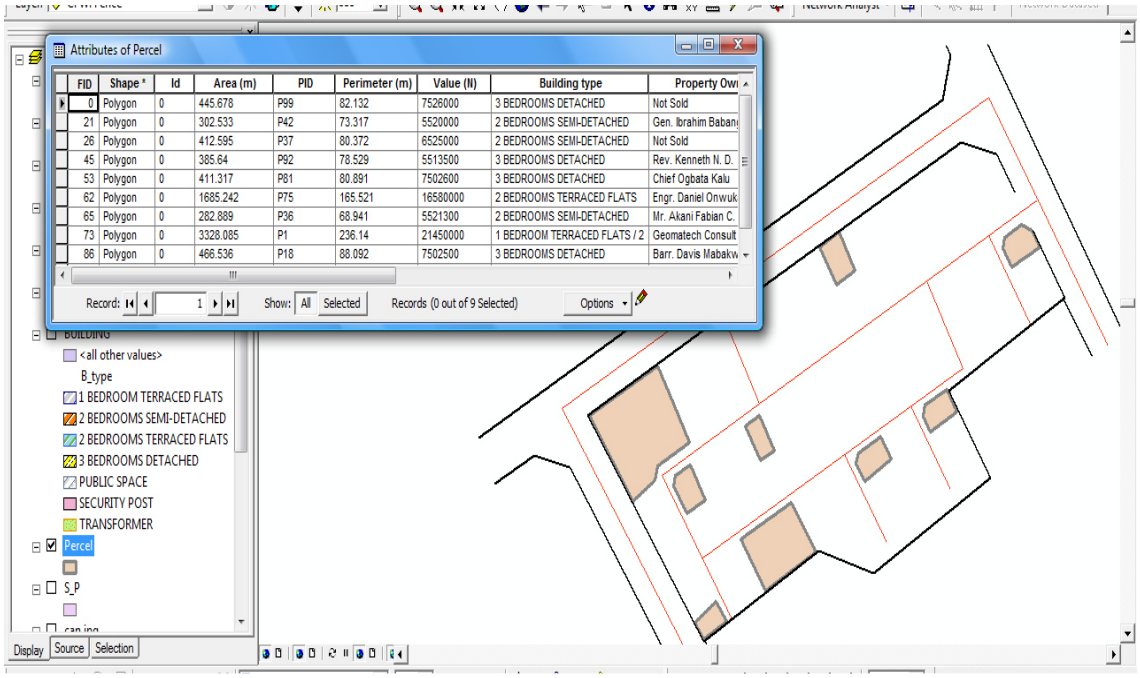

Figure 7. – showing properties that are used for commercial purpose

Figure 8 – Showing Instrument hyperlinked to a parcel.

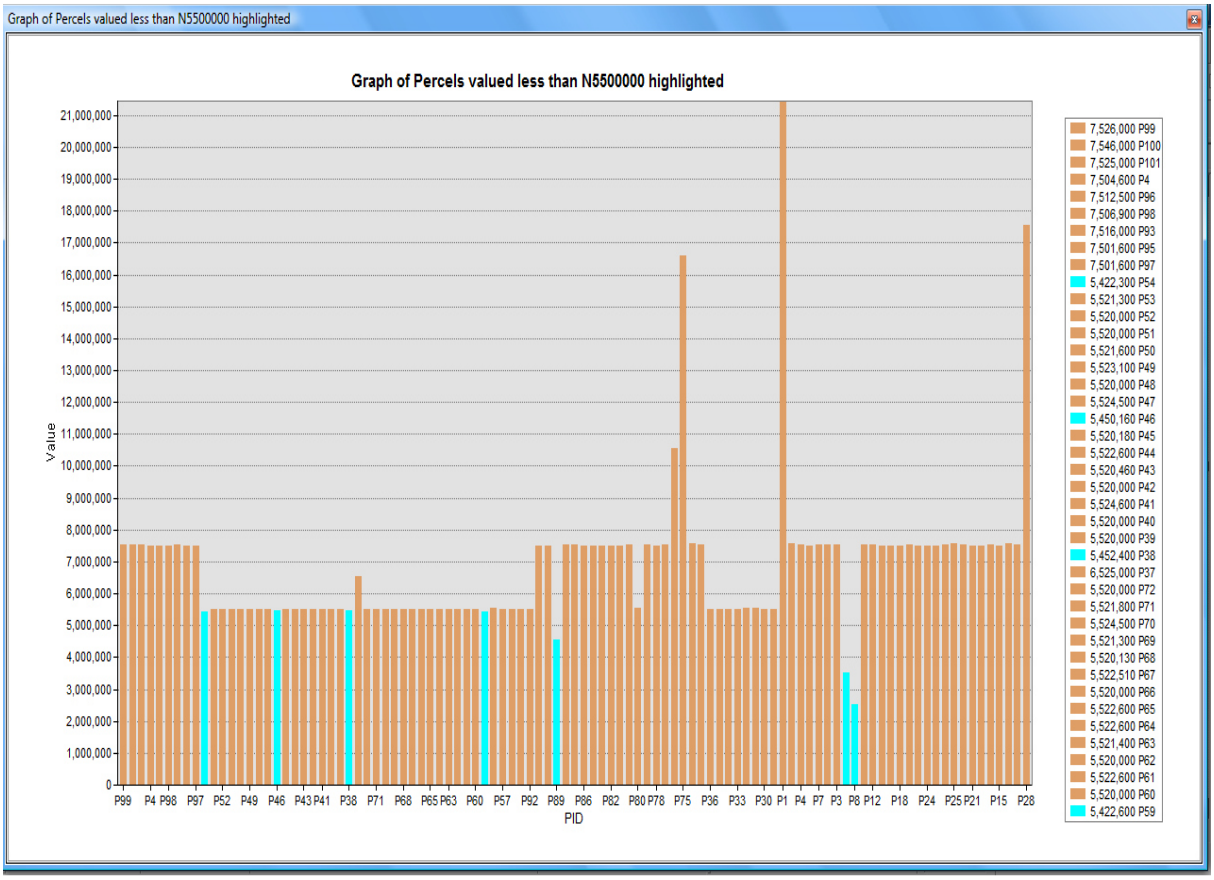

Figure 9–Showing properties with market value that is less than N5,500,000.00

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