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Creation of Cadastral Information System for Staff Quarters in Covenant University-Ota, Ogun State

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Abstract— *The numerous defects of analogue cadastre, consisting of paper maps and land register, have forced the improvement and upgrading of the cadastre, which can be observed in many countries. The aim of this study is to apply GIS in the creation of digital cadastre for staff quarters in Covenant University Ota, Ogun State. Nigeria. The spatial data and some of the attribute data used in this research is mainly of primary source. The spatial data in this research refers to the coordinates of the control stations and observations of temporary beacons, roads, etc that were taken using South Differential GPS H66 base and rover (receiver). Attribute data on parcel information and ownership of each plot in the study area plan were obtained from the Department of Physical Planning of Covenant University-Ota, as well as through social survey and field verification. The secondary dataset consists of spatial UTM coordinates of two control stations for reference which were obtained from the Surveying and Geoinformatics department; College of Environmental sciences of Bells University of Technology, Ota- Ogun. To confirm the positions of the control stations, control check operation was done using a South Differential GPS H66 base and rover (receiver). The observational data was also acquired using the Differential GPS and then plotted on AutoCAD. The plotted data was exported to ArcGIS environment to produce the spatial database. This was linked with the attribute data to create the digital cadastre in ArcGIS software. GIS processing, manipulating, database query, analysis and displaying of the required information were performed. The results were presented as digital maps (thematic maps) and composite map showing the existing allocation patterns of plots/parcels in the estate. The database showed detailed characteristics of parcels, buildings and owners. It is recommended that the digital cadastre created in this research should serve as a model to create a database for all landed properties in Covenant University, Ota.*

Keywords— ***Cadastral Information System, GIS, Data, Coordinates, GPS.***

I. INTRODUCTION

Land is the aspect which covers the totality of the environment and it's fundamental to man's survival. This is true because this provides us with working space, and also provides us with biological and natural capital in addition to other resources of land. It is also our source of food, clothing and a host of other raw materials. According to the Encyclopaedia Britannica, Land is the resource that encompasses the natural resources used in production. From it we obtain the food we eat, the shelter we need and the place to work. In the early century, land for settlement and cultivation was in abundant in direct proportion to the size of the population, there was little need for land-related information management and administration. But, with the growth of agriculture and competition for the available space, land rights and controls over land use began to emerge. Thus, the implementation of cadastres and cadastral surveys and/or mapping began.

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For decades, the traditional cadastral systems of mapping have enjoyed a reputation for their reliability and well-defined processes. Then, it was a very recognized guarantee of security to private ownership of land. Tremendous technological progress, social changes, globalization and increasing intercommunication of business relation with their legal and environmental consequences has put a strain on the traditional systems.

Over the years, the manual method of data handling has dominated cadastral information management in a disordered manner among various parastatals within the state or in the land tenure systems of private individuals. It is obvious that manual method of handling cadastral information can no longer cope with the increasing demand and requirements of users of such information. Hence there is a need for a well-organised plan to managing cadastral information. Cadastral is the method of registering land, designed to ensure the rights of individuals and the state of their property. Every activity in general and developmental project activity in particular, are associated with land and land transaction. Therefore, for planning purpose all land-associated information should be available in the form of a computer database, which can be easily accessed, manipulated by decision makers while formulating and executing a work. Such a database system is called Land Information System. A land Information System (LIS) is a geographic information system for cadastral and land-use mapping, typically used by local governments and even state governments.

A LIS consists of an accurate, current and reliable land record cadastre and its associated attribute and spatial data (that is, geographic data representing the location of objects; latitude and longitude, as well as height information) that represent the legal boundaries of land tenure and provides a vital base layer capable of integration into other geographic systems or as a standalone solution that allows data stewards to retrieve, create, update, store, view, analyze and publish land information. A Cadastre is normally a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests and often the value of the parcel and its improvements (FIG, 1995). Cadastral Survey Information is often an element in Geographic Information Systems (GIS) or Land Information Systems (LIS) used to assess and manage land and built infrastructure.

Computerization of land administration activities, involving the creation of a digital cadastre as part of Spatial Data Infrastructure (SDI), is considered necessary to improve data access, usability, and coordination of land related activities (Carter *et. al.*, 2007). Spatial Data Infrastructure is the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data (Office of Management and Budget OMB, 2002). Thus, digital cadastre is a tool for achieving land administration.

Traditional method of data management has proved to be inefficient and cumbersome. It is faced with problems such as redundancy (unnecessary repetition or duplication of data), high maintenance costs, difficulties in moving from one system to another, difficulties in data sharing, lack of security and standard, lack of coherent corporate views of data management among others. An ideal land administration must be able to include the provision of information on land in an effective and efficient way to correctly identify those people who have interest in real estate and providing information about these interests (such as duration of leases). It must also allow easy access to land for development where it is needed, increase efficiency in land use management through good planning, and promote greater social equity. It should also allow for revenue generation to the government (taxation), maintenance of environmental quality, and provide security of tenure (Usman, 2010). An analogue map cannot necessarily provide the following listed above effectively and efficiently. Hence there is need to design and create cadastral information system for the staff quarters in Covenant University Ota, Ogun state to demonstrate the advantages of digital mapping in land administration and planning.

II. MATERIALS AND METHODS

The senior staff quarters and professor's village estate is located within covenant university, Ota-Ogun State. The geographic location of the study area is within 737098.19 mN and 517721.62 mE with an area and perimeter of approximately 103,834 square meters and 1265 meters respectively as ascertained from Google Earth. Covenant University opened on 21st October 2002 in Canaan land, Ota, with a Pentecostal Christian mission ethos. It was

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founded by David Oyedepo, the presiding Bishop of Living Faith Church Worldwide, who is chancellor of the university. Covenant University (CU) is located in Ota, Ogun State in Nigeria. It is a private Christian university, affiliated with Living Faith Church Worldwide and a member of the Association of Commonwealth Universities, Association of African Universities and National Universities Commission.

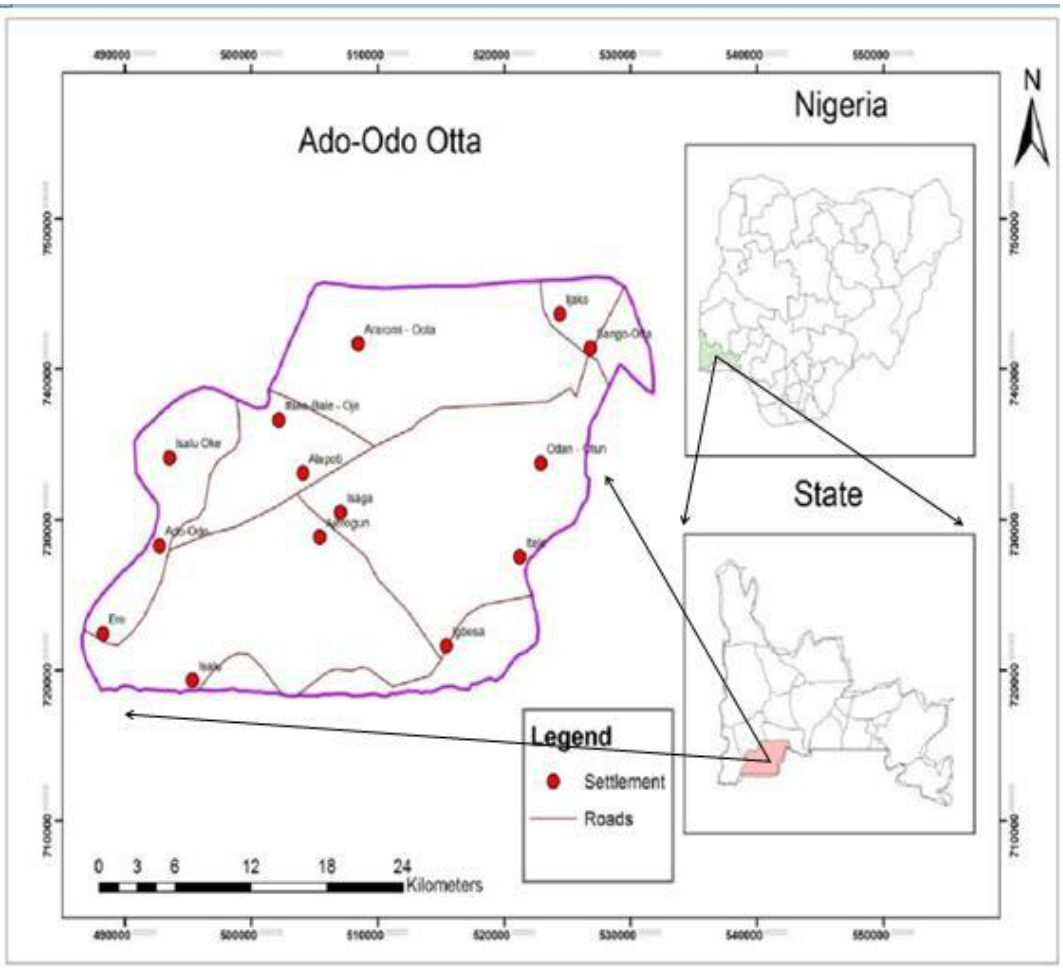

Fig. 1.0 Map showing Nigeria , ogun state and Ado-odo/ota LGA

2.1 Data Acquisition

Data is a set of values of subjects with respect to qualitative or quantitative variables. Data is measured, collected and reported and analysed, whereupon it can be visualized using graphs, images or other analysis tools.

Data acquisition is the first step in the execution of any digital cadastral project after the preliminary stage of planning and reconnaissance. Data acquisition is the process of digitizing data from the world around us so it can be displayed, analysed, and stored in a computer. It refers to the processes in acquiring data needed for the project (creation of digital cadastre for staff quarters in covenant).

In this work, both spatial and attribute data were collected and used in information production and management. The source and manner of acquisition of such data are very critical to any meaningful decision-making activity. Data is classified either as primary or secondary.

2.1.1 Primary Source

A satellite imagery obtained from google earth was used to get a general idea of the size and shape of the study area as

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well as describe its location sufficiently. Drawn pathways are used to show the project site area and perimeter as seen in figures 2.1 and 2.2.

Attribute data on parcel information and ownership of each plot in the study area plan were obtained from the Department of Physical Planning of Covenant University, Ota- Ogun state. These include owner names, address, sex, occupation, parcel number, etc. Social survey (personal interview) method both with Officials and on site was used to acquire facts about spatial attributes of features in the study area such as the name of street and other parcel information. Information such as road names was verified through oral interview with the parcel owner available on site.

The spatial data in this study are the coordinates of the control stations and observations of temporary beacons, roads, etc that were taken using South Differential GPS H66 base and rover (receiver). Survey procedures and principles were duly noted and strictly adhered to. The road; Gentleness Street, Faith Avenue, Goodness Road and Peace Way, surrounding the study area was first observed as the boundary. After which the observations of the features within the boundary were then taken.

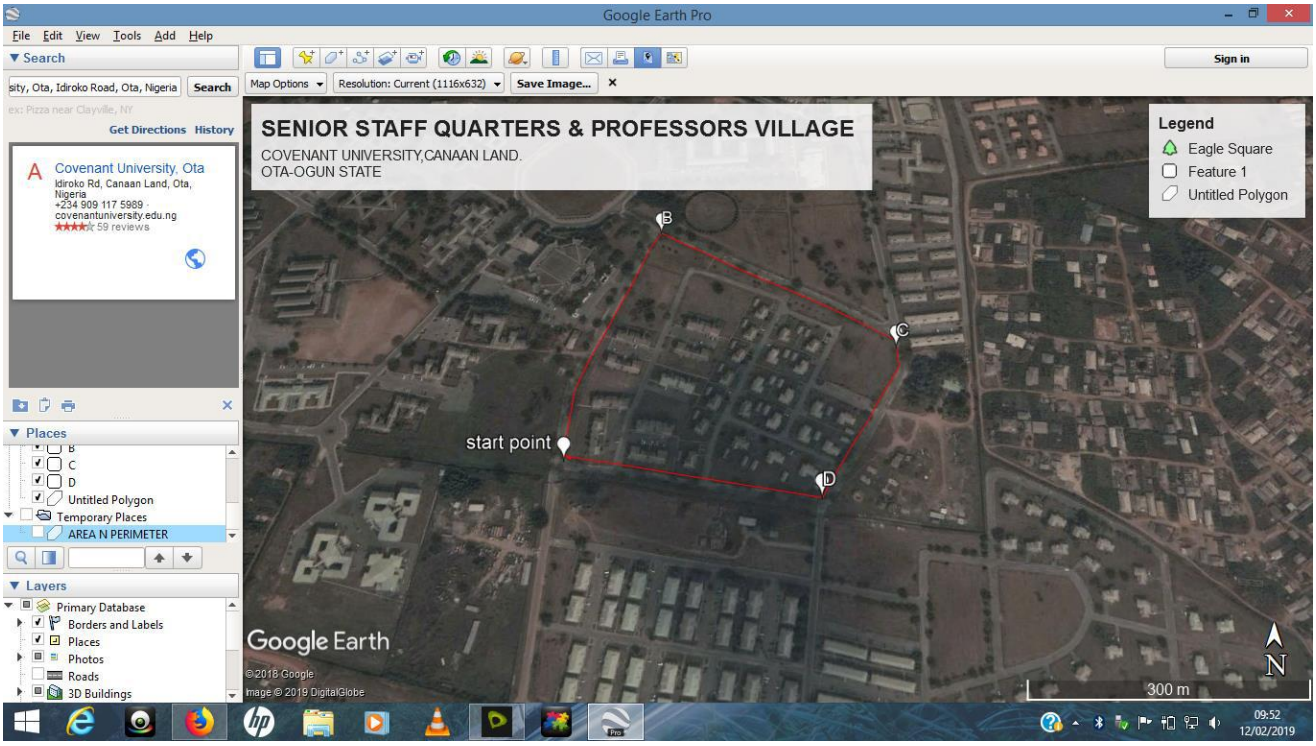

Fig. 2.1 Overview of Senior staff quarters and Professors village – Covenant University, Ota.

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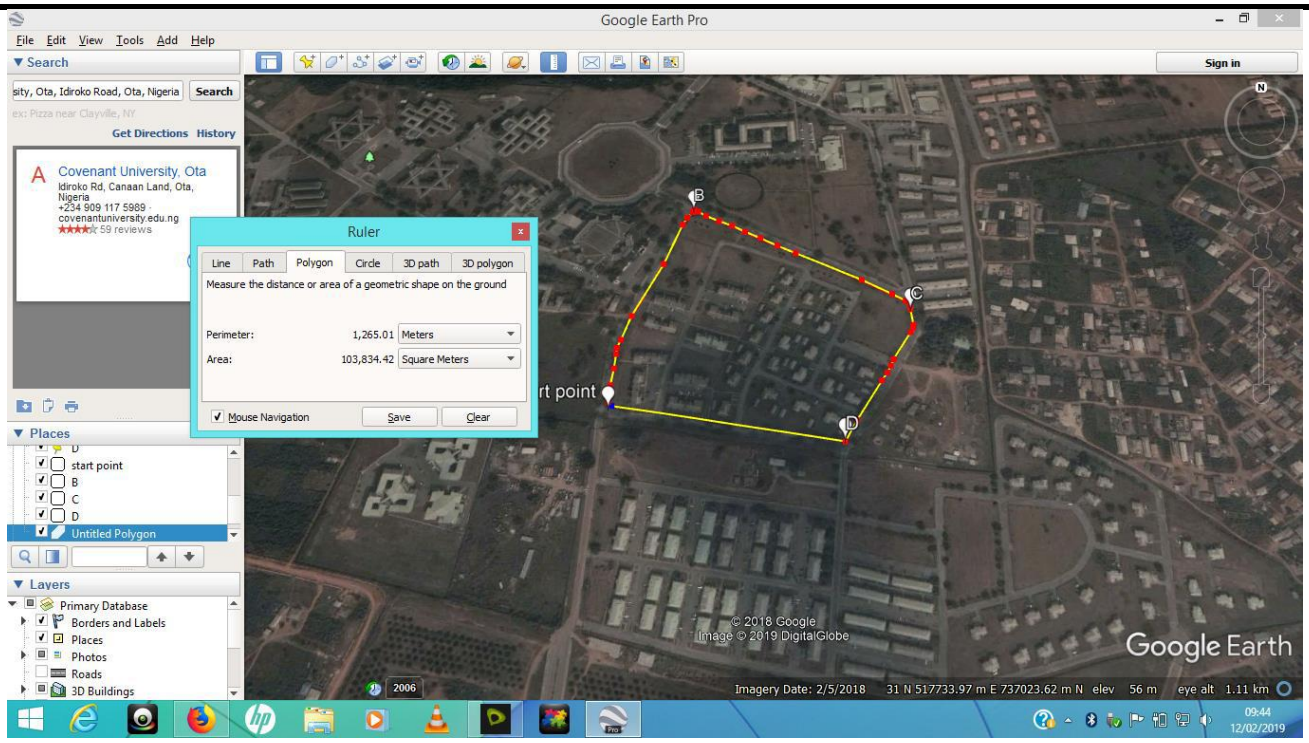

Fig. 2.2 Area and Perimeter of study area (Approximate)

2.1.2 Secondary Data:

Ground Control Point (GCP) UTM coordinates of some three selected pillars were requested and obtained from the Surveying and Geoinformatics department; College of Environmental sciences of Bells University of Technology, Ota- Ogun state which were used for check of instrument; control check of control stations around/on the site; and the extension of control stations to the site. These coordinates, according to the relevant authority, were obtained directly on site using appropriate and effective surveying method.

Analogue layout plan (Architectural plan) of the study area in scale 1:3000 was obtained from the Architectural Department through the Office of the head of the department of Physical Planning. The layout plan obtained was the block layout plan showing all the plots, roads and buildings as well areas of each parcel.

2.2 Data Processing

The data is edited and saved as a script file (e.g. Akunna. Scr) for plotting and all other analysis required using the AutoCAD civil Land desktop companion. The completed plan is then imported from AutoCAD into the ArcGIS environment for further processing and creation of database. The project goes so far as to include attributes/information about the staff quarters being considered. Since the project is partially GIS based, it has a database entity that can be modified, edited, updated, stored and processed as many times as is necessary.

2.2.1 Exportation of CAD data to ARCGIS

In the AutoCAD drawing (plan), layers were created for each of the plotted features. The AutoCAD drawing was then moved to a working folder created in c: drive on the Hp laptop being used for the project. This working folder is connected to the ArcGIS environment and is used to store all data used or created in ArcGIS. The ArcGIS software is then launched.

Once there, the coordinate system used in the AutoCAD drawing is set up for all layers added. The AutoCAD drawing is then added by clicking on the 'add data' icon and selecting the desired file. After which the 'polyline' feature from the added AutoCAD file is exported to ArcGIS format (shapefile) and saved as an individual layer. However in this project, each layer from the AutoCAD drawing was saved as individual drawings and moved to the working folder. They

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were then added to the ArcGIS environment and the 'polyline' or 'point' features exported individually and later renamed to proper markers.

2.3 Creation of Attribute and Spatial Database

On importation of the AutoCAD file into ArcGIS and accompanying its exportation to shapefiles, a table was automatically created by the software for the creation of attribute database. This attribute table was then filled with the parcel information gotten from the Physical Planning and Development Department of Covenant University, Ota-Ogun state. Among the attribute data obtained were the name of allottee (parcel owner), plot allotted (plot number), type of building occupied, etc. In ArcGIS, the unnecessary information that accompanied the AutoCAD features were deleted from the attribute table and new fields created to suit the needs of the project.

III. RESULTS AND DISCUSSION

3.1 Query Analysis

Queries are used for different functions in a database. The most common one is to retrieve specific data from the tables depending on a user's purpose. The data needed by a user is usually spread across several related tables, and queries allow one to view it in a single datasheet. Also, queries let you add criteria to "filter" the data down to just the records you need in order to aid in decision making. The spatial/attribute query results in the study are shown in figures 3.1-3.17. The spatial queries were classified as single criteria queries and multiple criteria queries. Using the ArcGIS software, the listed query below were generated and discussed:

Single-criteria Query:

I. Query by Parcel/Plot Area
II. Query by Parcel Building Type
III. Query by Building Occupancy
IV. Query by Building Vacancy

Multiple-criteria Query:

I. Query by Damaged Buildings and Year of Damage
II. Query by Building Vacancy and Apartment Allocation
III. Query by Tenant Educational Qualification and Building Type

The single-criteria queries refer to parcels greater or equal to 1509.6524sqm- a unique value from the database, in area; plots or parcels where 4 bedroom duplexes are located; houses or apartments whose number of tenants exceeds the maximum capacity for occupants it can hold; and buildings or apartments that do not have designated owners (vacant houses or apartments). The multiple-criteria refers to the apartments and houses with current structural damage in the year 2019; apartments that are vacant on the first and second floors; and for parcels allocated to professors with 4-bedroom duplexes (houses).

3.1.1 Single-Criteria Database Query

In carrying out a single-criteria spatial query, only one selection condition is specified.

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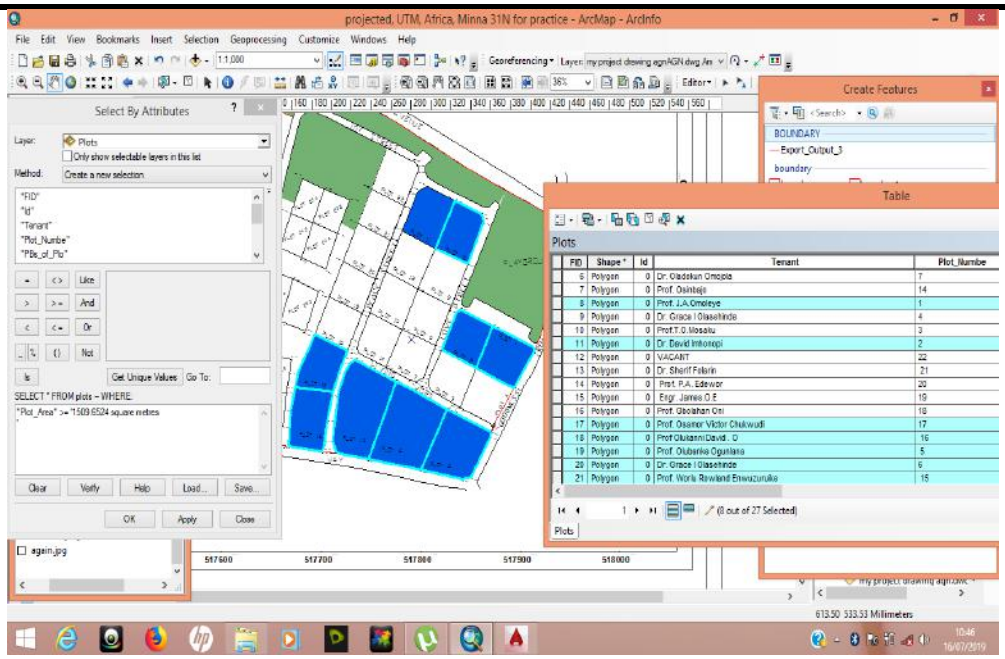

Fig 3.1: Screen Print Showing Parcel in the Layout Greater or Equal To 1509.6524 Sqm

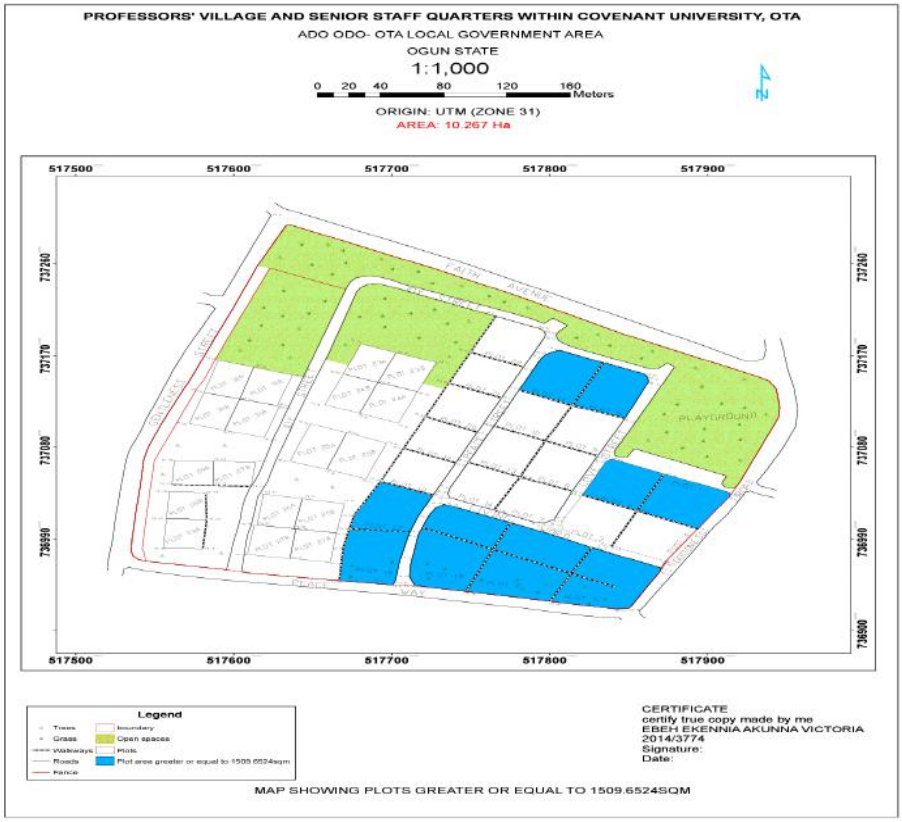

Fig3.2 Map Showing Plots Greater Or Equal To 1509.6524sqm

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Discussion of Result:

In figure 3.1, the query builder is to the left, the attribute table and the digital cadastral plan to the right all show that 9 of the total of 40 plots in the layout are greater or equal to 1509.6524 square metres. This information will aid the Estate management department and The Department of Physical Planning in Covenant University in determining the prices for rent of each of the allocated parcels according to the computed extent of the landed property. It may also serve the purpose of validating various land improvements that can be made on the land. The formatted map of the selected parcel is presented in figure 3.3.

3.1.1.2 Query by Parcel Building Type

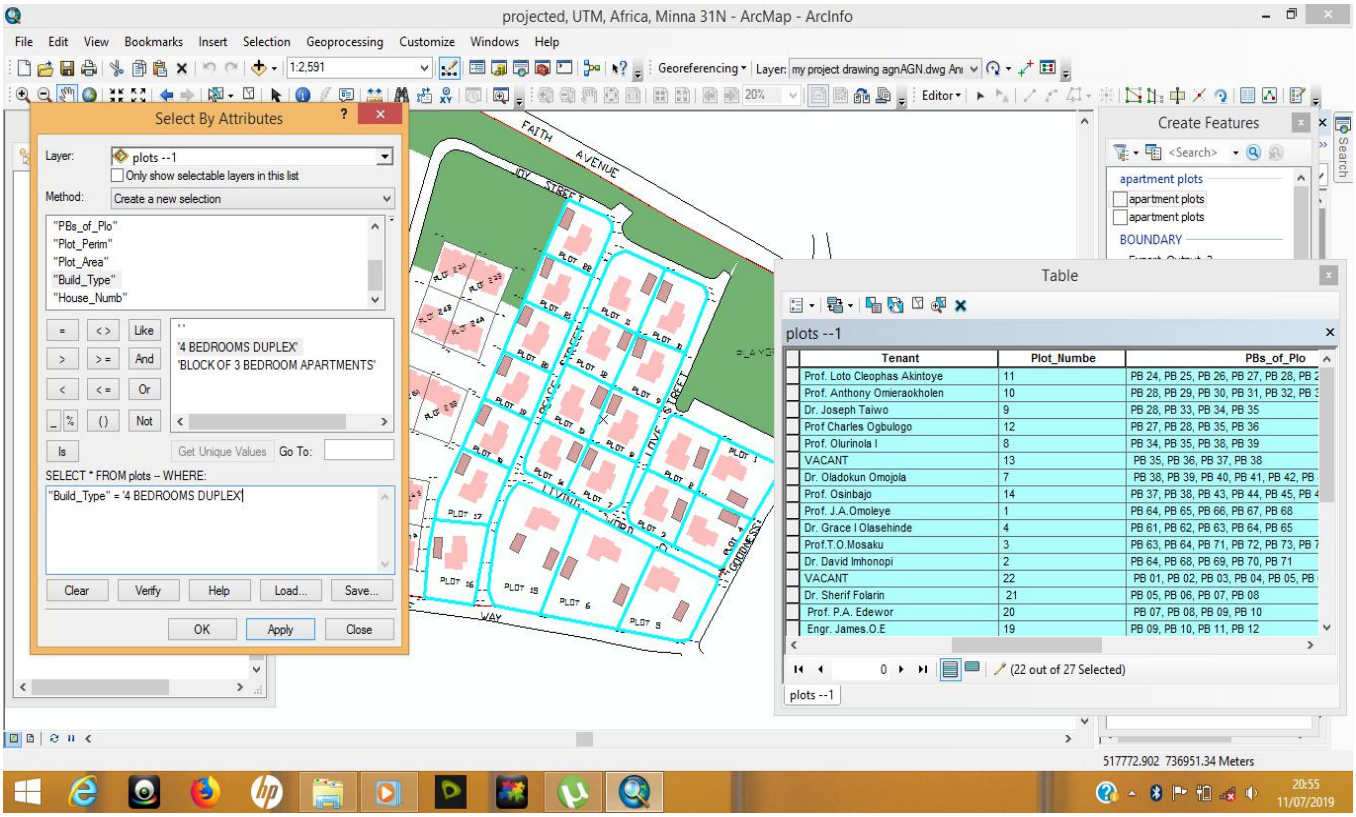

Fig 3.3: Screen Print Showing Parcels with Duplex Houses

Discussion of Result:

In figure 3.3, the query builder is to the left, the attribute table and the digital cadastral plan to the right show that 22 of the total of 40 plots in the layout have duplex houses as their built property. This information will aid the Estate management department in Covenant University in rent determination and property allocation, especially in cases of big families. The query is saved as a layer and the map of the selected plots is presented in fig 3.4.

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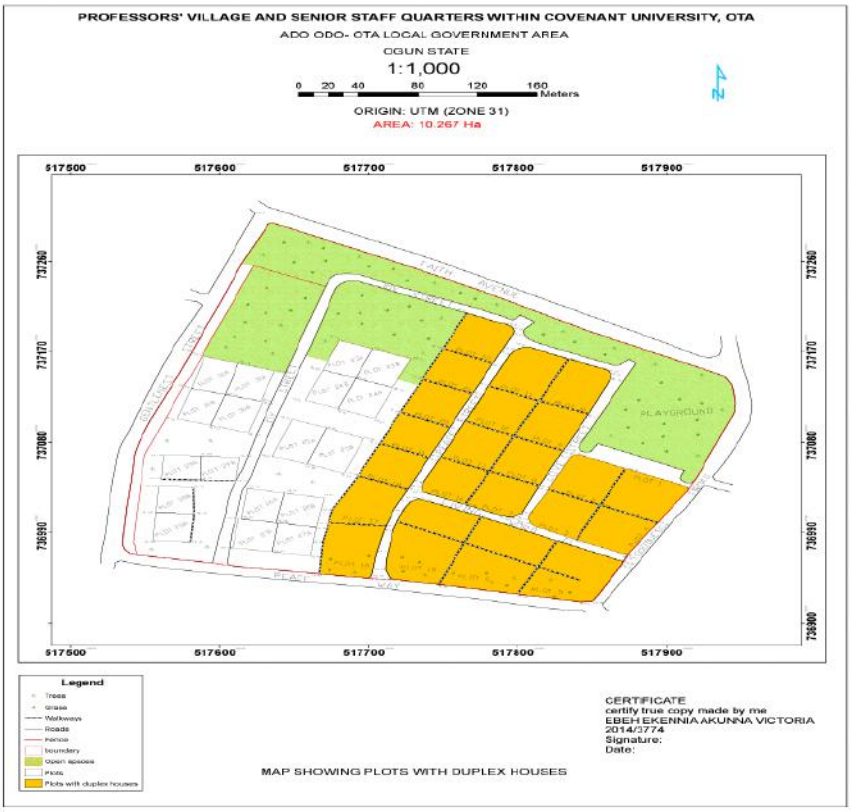

Fig3.4 Map Showing Plots with Duplex Houses

3.1.1. 3 Queries by building occupancy

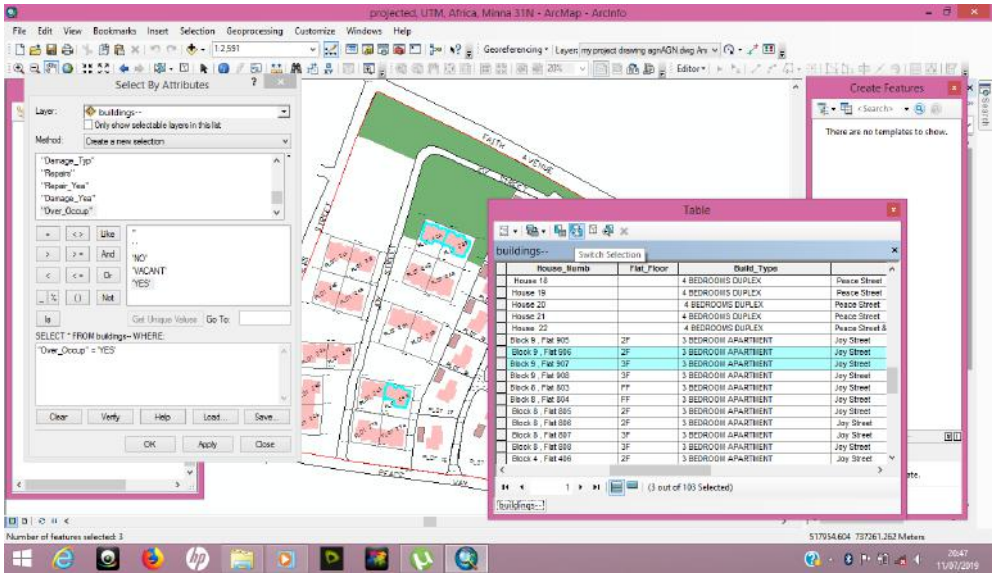

Fig 3.5: Screen Print Showing Apartments Surpassing Its Maximum Tenant Number

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Discussion of Result:

In figure 3.5, the query builder is to the left, the attribute table and the digital cadastral plan to the right show the 3 apartments that have overcome the maximum number of tenants that should be housed there. For this study the maximum capacity for the apartments is 3-6 persons and for the duplexes, it is 6-10 persons. This aids the tracking of overcrowded apartment buildings or duplex houses. Overcrowded buildings could present as potential hazards in cases of emergencies such as fire outbreak. The identification of the risks associated with the hazard aids in the implementation of operational controls that are necessary to manage these risks; a successful evacuation procedure is an example of operational control. The query is saved as a layer and the formatted map of the selected apartments/houses is presented in figure 3.6.

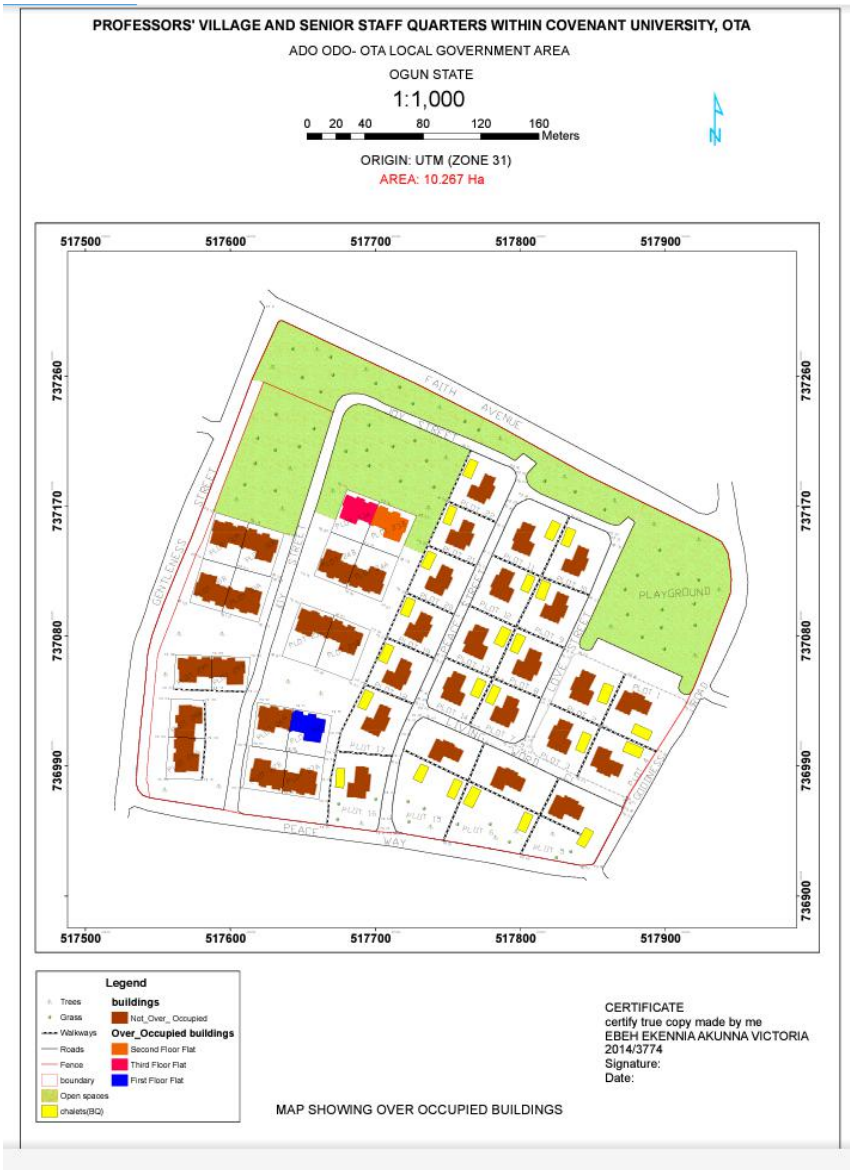

Fig 3.6 Map Showing Over Occupied Buildings

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3.1.1.4 Query by Building Vacancy

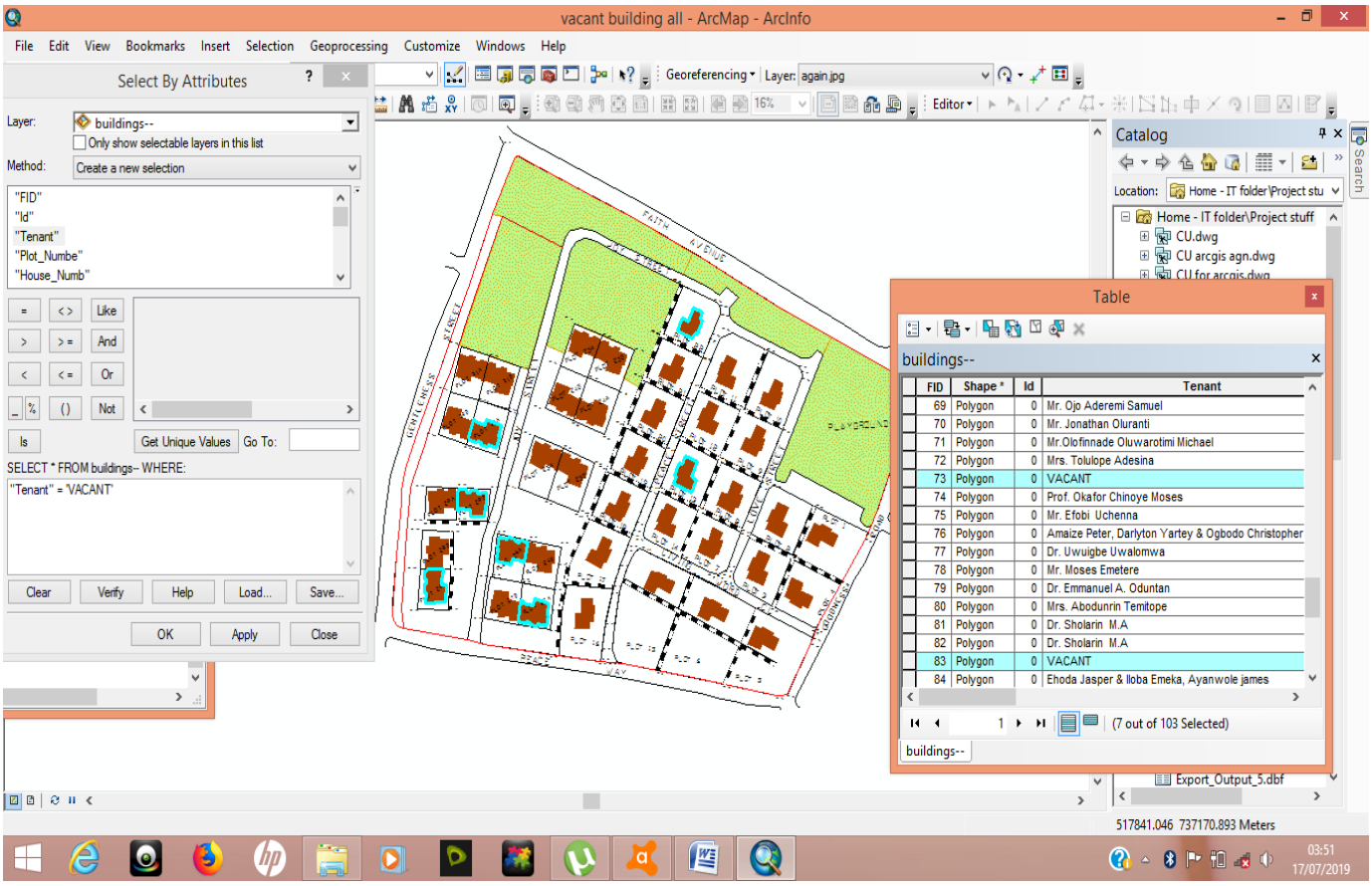

Fig 3.7: Screen Print showing Apartments/Houses that Are Vacant

Discussion of Result:

The result of syntax modelled, the attribute table as well as unformatted map of vacant buildings in the digital cadastral plan. The layout shows that 5 apartments from the blocks of apartments and 2 duplex houses are vacant. This information will aid the Estate management department in Covenant University in rent determination and property allocation as well. The query is saved as a layer and the formatted map of the selected apartments/houses is presented in figure 3.8.

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Fig 3.8: Map Showing Vacant Apartments/Houses

3.1.2 Multi-Criteria Query

3.1.2.1 Query by damaged buildings and year of damage

Here, the query was carried out by using the “AND” and “OR” SQL statements in the select by attributes dialogue box. The expression used to carry out the query is as follows: "Repairs" = 'NO' AND "Damage_Yea" ='2019'

Where “Repairs” signifies whether or not the repairs to the buildings with structural damage have been made; and "Damage_Yea" states the year the damage occurred. The query gives the results for the buildings currently with structural damage in 2019; it shows that 7 apartments and 3 duplex houses are yet to be repaired. The query is saved as a layer.

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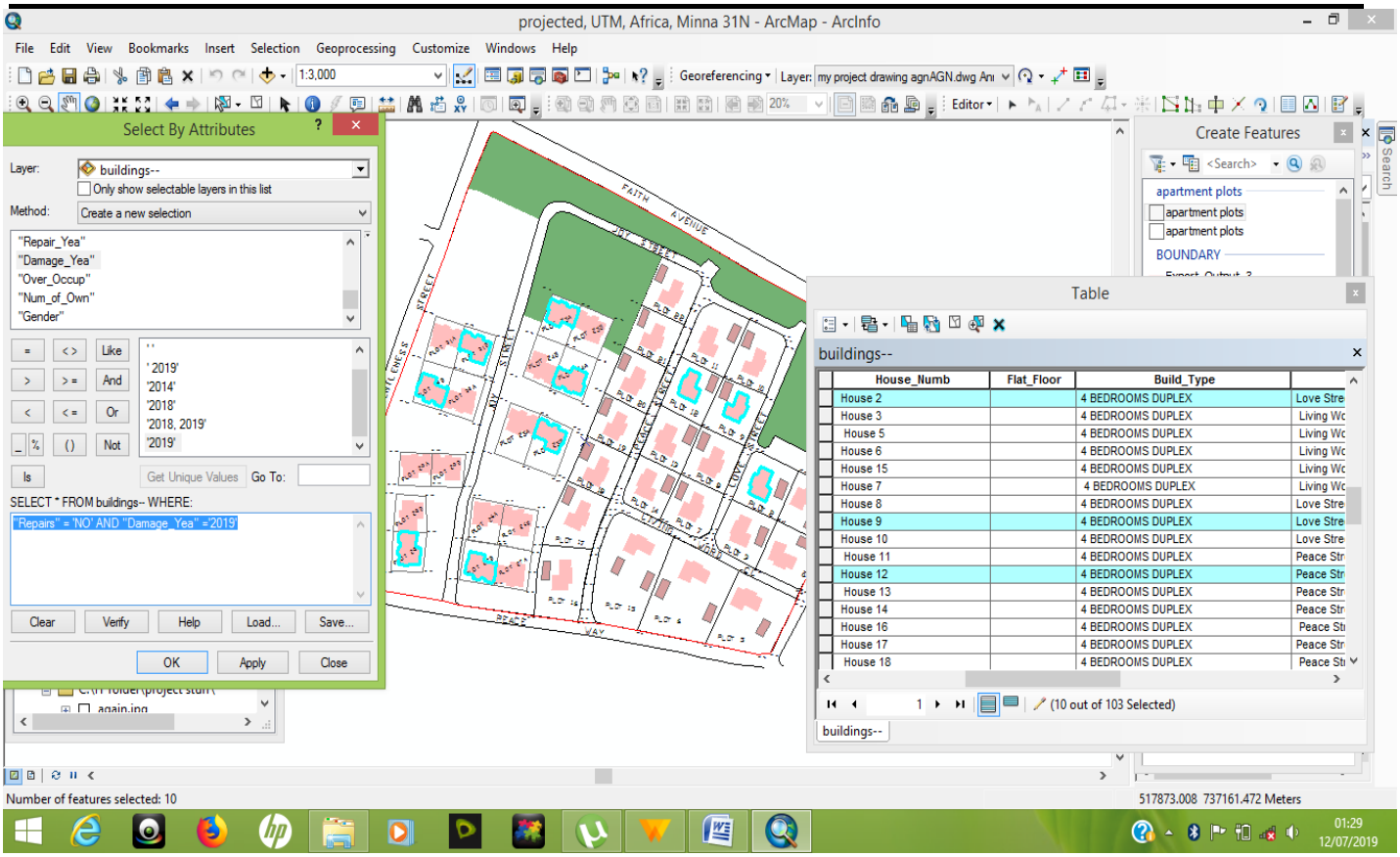

Fig 3.9: Screen Print Showing Damaged Houses & Apartments (2019)

Discussion of Result:

Figure 3.9 shows the syntax model or query builder, attribute table of buildings and the queried damaged buildings highlighted in blue-green colour in the digital cadastral plan of the area. About 14% of the duplexes and10% of the apartments is currently damaged. This will help The Department of Physical Planning in Covenant University to keep track of buildings that need repairs and/or renovations. It will also aid in locating these buildings for said repairs. The map of damaged apartments and houses is presented in figure 3.10.

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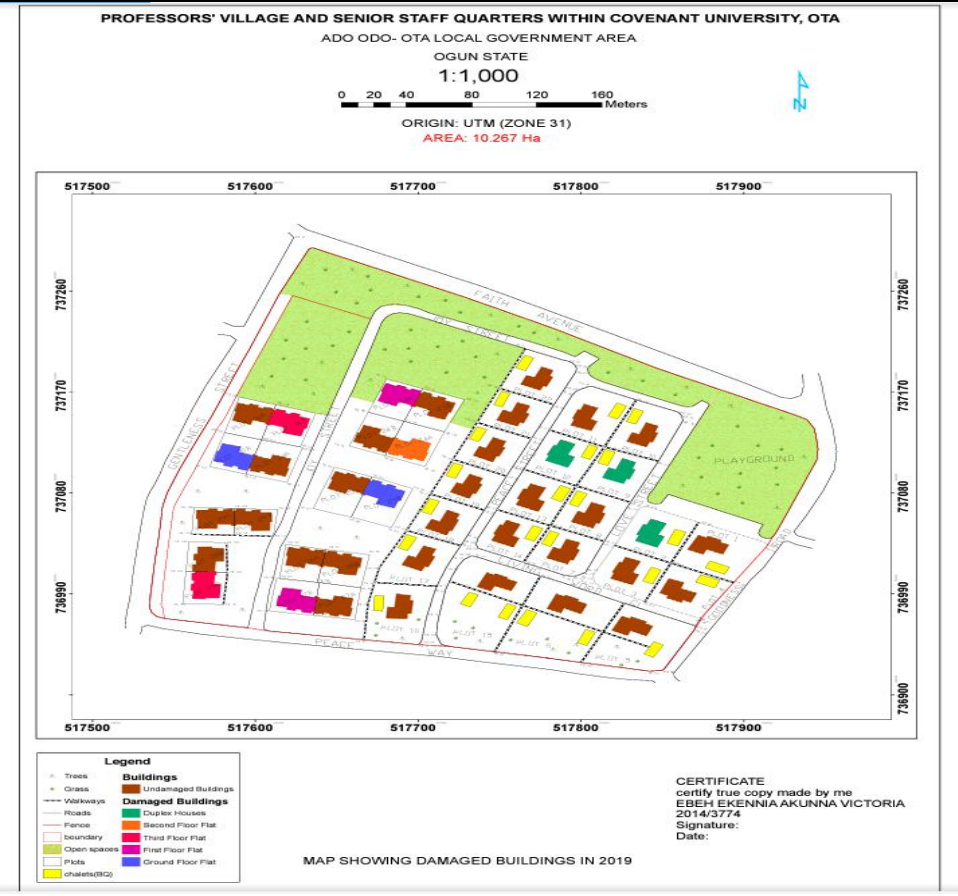

Fig 3.10: Map Showing Damaged Buildings In 2019

3.1.2.2 Query by Building Vacancy and Apartment Allocation

Following the same procedure in the query for damaged apartments or duplexes, the query was carried out using SQL statements in the select by attributes dialogue box. The expression used to build the query is as follows: "Tenant" = 'VACANT' AND "Flat_Floor" = 'FF' OR "Tenant" = 'VACANT' AND "Flat_Floor" = '2F'. Where FF and 2F are first and second floors respectively.

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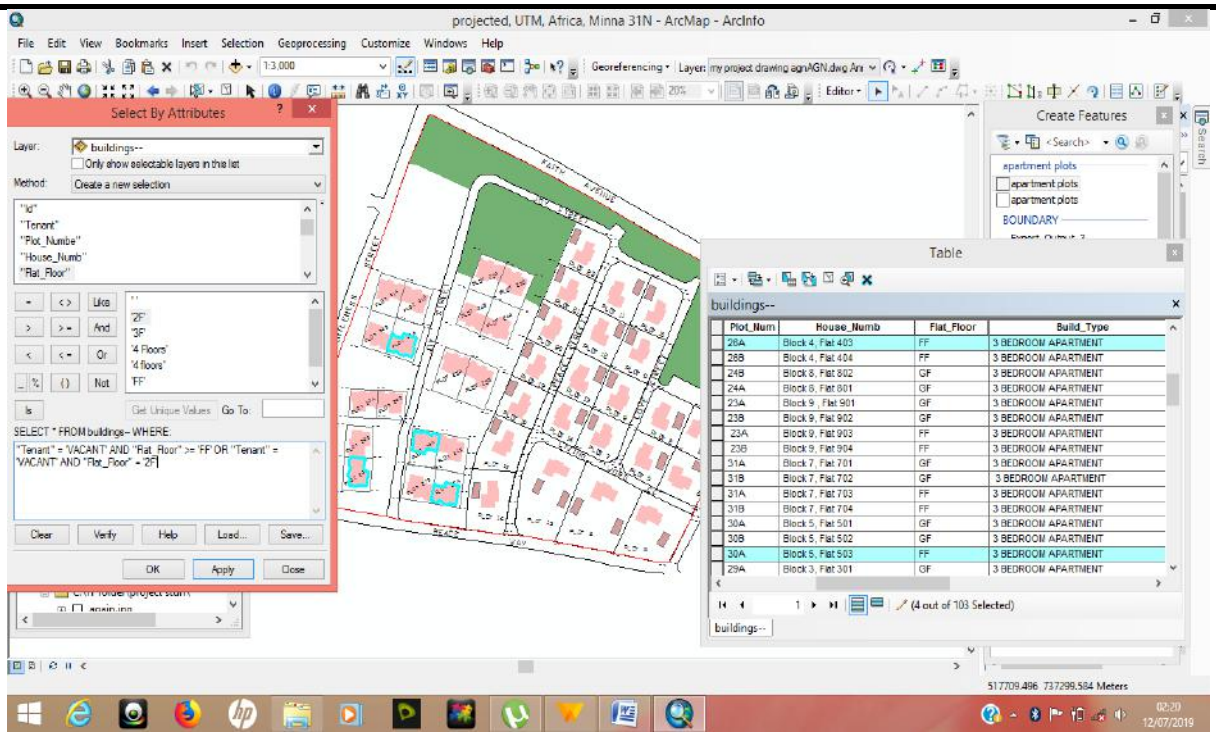

Fig 3.11: Screen Print Showing Vacant 1st & 2nd Floor Apartments

Discussion of Result:

Figure 3.11 shows the result of syntax modelled, the attribute table as well as unformatted map of vacant apartment buildings on the first and second floors. This is target specific and show cases the database's flexibility in information retrieval and storage. It also can be used in property allocation. The map of vacant apartment buildings on first and second floors is presented in figure 3.12.

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Fig 3.12: Map Showing Vacant 1st & 2nd Floor Apartments

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3.1.3 Query by Tenant Educational Qualification and Building type

Since there is an area of buildings allocated specifically for professors, I decided to query for those plots whose buildings are actually designated to professors. A similar expression to the one above was used and is as follows:

"EDU_QUALII" = 'Professor' AND "Build_Type" = '4 BEDROOMS DUPLEX'

Where "EDU_QUALII" refers to educational qualification and "Build_Type" is the building type. The 'AND' is the command in the expression that links the two statements together.

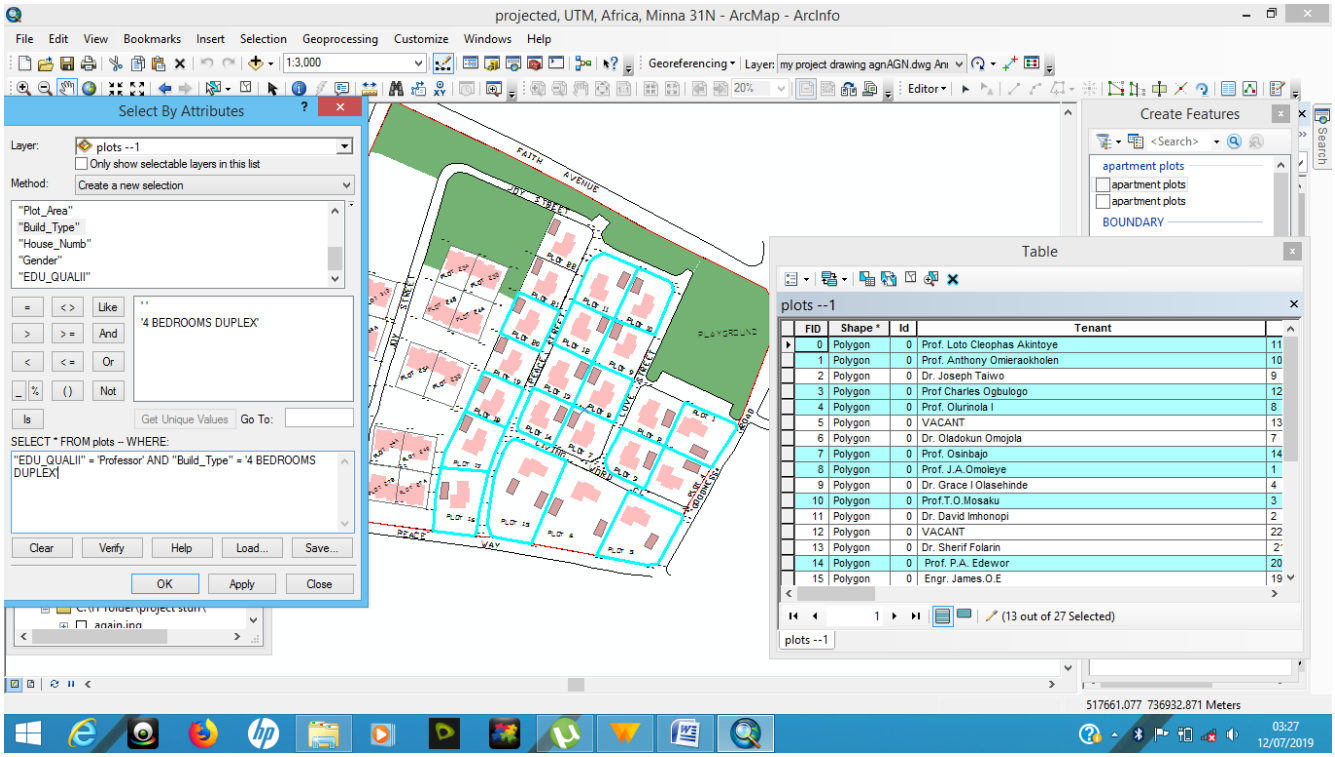

Fig 3.13: Screen Print Showing Parcels Allocated to Professors

Discussion of Result:

Figure 3.13 shows syntax model, the attribute table of parcels and the cadastral plan with the plots allocated to professors clearly highlighted. This is also a target specific query. The table shows that all 13 parcels are being occupied by professors. The non-professors that hold the remaining landed property are 8 Doctors in their respective fields and 1 Engineer. Thus, only 59% of Professors' village is actually designated to professors; 36% is held by Doctors and 5% by an Engineer.

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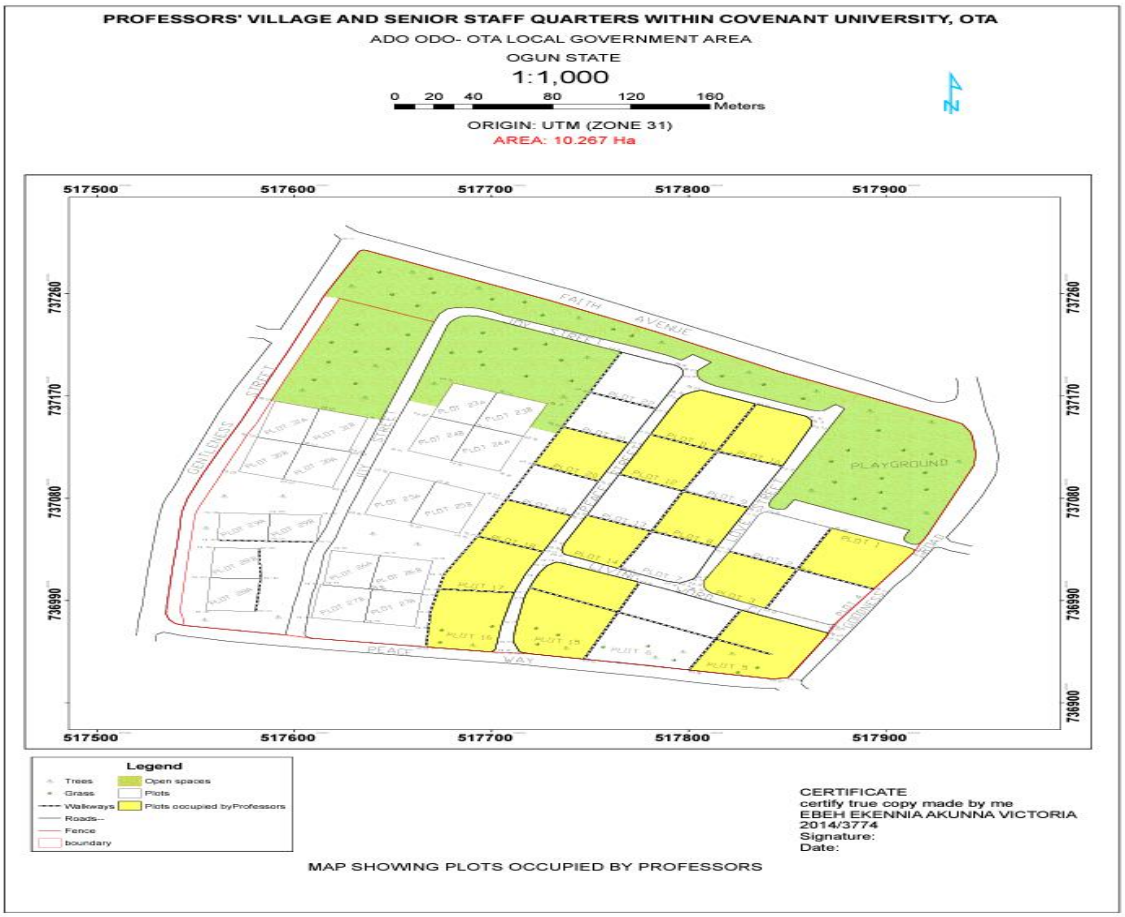

Fig 3.14. Map Showing Plots Occupied by Professors

3.2 Identifying a Feature Using the Identify Tool

The identify tool from the tool bar of ArcGIS software was used to display detailed information about the parcel contained in the database as shown in a popup table to left of the figure and an arrow pointing to the spatial position of the parcel.

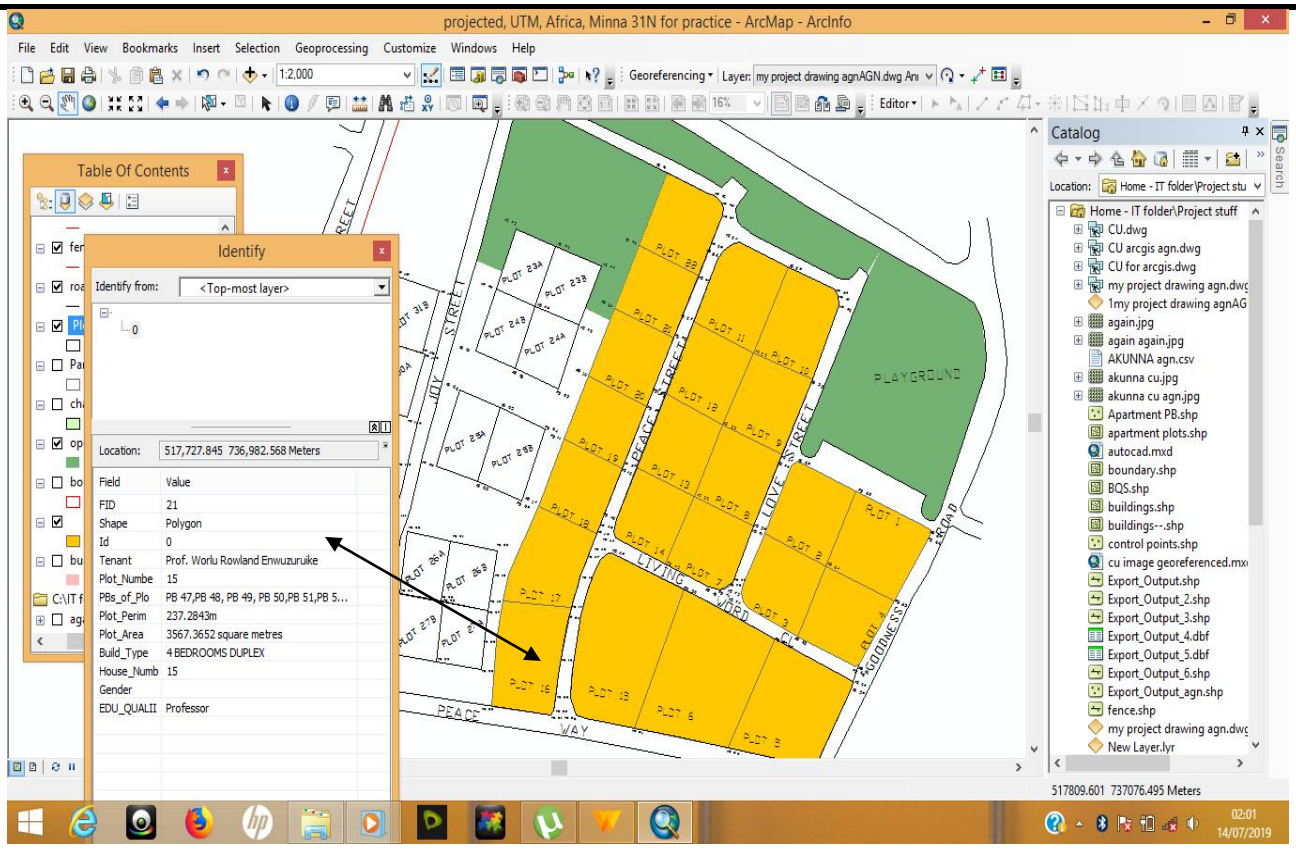

Fig 3.15: Identifying a Feature using identify tool

The screen-print shows the cadastral plan and the identity result of plot 15 of the staff quarters layout in Covenant University Ota, Ogun State. The table to the left shows all information about the plot contained in the database. It shows that parcel 15 is owned by Prof. Worlu Rowland Enwuzuruike, a Professor in Covenant University, Ota. Other information includes his property beacons, area and perimeter and unique identity number.

3.3 Research Findings

The significance of the results as depicted in some of the analyses and information are very exciting. These findings would be extremely important as it reveals issues and appraisal for the estate.

1. There was no real numbering system for the parcels. The problem was lack of proper parcel/plot identification which could hinder quick and easy property address of parcels in the layout. This was rectified by means of the unique identity numbers assigned to all parcels in the layout in the digital cadastre map created in this project.

2. There were no property beacons on ground or records of property beacons for the parcels. This was corrected by the creation of temporary property beacons for parcel delineation and identification of the locations for all the parcels.

3. There is no cadastral plan of the study area neither is there any geographic map or plan depicting the study area. A cadastral plan was produced during the course of this project showing the boundary, the property beacons, the plot numbers, the roads and other features on ground.

4. There is no Certificate of Occupancy of occupancy owned by the tenants since the land belongs to the University. The University grants the staff members (tenants) the use of the built property on the parcels by means of allocation letters. The costs incurred for the built property are subtracted from the staff salaries.

5. There are a lot of structural damages to the buildings ranging from 2014 to 2019 that are yet to be repaired. About 24% of the apartments and duplex houses are damaged in the year 2019 alone. The complaints from

tenants are mostly focused on leaky ceilings and shifted roof panels but include others such as water pipe damage, defective doors and door locks, broken floor tiles, plumbing issues, etc.

6. There are some buildings (apartments and chalets) that have multiple owners or property holders.

7. The estate is well developed and mostly follows the architectural layout designed for it; there are some changes on ground that does not reflect on the architectural design. The architectural plan should be revised.

8. Although there is an area designated for Children playground, it has not been developed. No improvements have been made on the land for the children of the estate.

9. The digital cadastre produced in this research is very realistic, reliable and updated and thus efficient for land administration as it also allows for future updates.

The development of the digital cadastre for the estate will help, to a greater extent, the relevant land and landed property management departments charged with the responsibility of handling land records perform their duties expeditiously. This research has also given the management authorities an opportunity to make some characteristic analysis in the evaluation of land use, building code violations; and the assessment of properties for issues. Lastly, it can also serve as an standard means of land information for prompt extraction of plot/parcel details through the single query or multi-query facility that was provided in the database which allow for individual users to collect data/information concerning land holding.

IV. CONCLUSION AND RECOMMENDATION

The successful implementation of land administration and management is predicated on the effective implementation of the technical strategies and structures considered in this project. The project has effectively established the use of GIS in Cadastral Management of the staff quarters within Covenant University-Ota, Ogun State. The potential of Information System in GIS to perform spatial search and produce answers to some question asked has been established. The database created was carefully tested and assessed with various queries put forward. The information it provides can assist in decision making in land and landed property management and administration by various authorities involved. Most importantly the goal of designing and creating an available, editable, efficient and reliable digital cadastre for the staff quarters (Professors' village and Senior Staff Quarters) in Covenant University-Ota, Ogun State was achieved. The digital cadastre created in this study should serve as a model to be followed and replicated in creating database for all landed properties which will be updated regularly. The digital cadastral database created in this project for the staff quarters (Professors' village and Senior Staff Quarters) in Covenant University-Ota, Ogun State is hereby recommended to the Estate Management Department and Physical Planning Department to form the basis for all official activity related to real estate in the layout.

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