

APPLICATION OF REMOTE SENSING TO LAND ENCROACHMENT IN LAGOS STATE UNIVERSITY, OJO, NIGERIA

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Abstract

Land use procurement and its proper usage is one of the major challenges facing most of public institutions in developing cities, Lagos State University (LASU) is a state owned university established in 1983 with main campus at Ojo Area of Lagos State, it covered an area of 831,101 hectares, divided into three parcels- A, B and C, the detail survey reveals a total of 153.242 hectares for parcel A, 219.451 hectares for parcel B and 179.536 hectares for parcel C, LASU built-up area is located on parcel C with 141.721 ha (79%) of the total 179.536 ha has been utilized by LASU main campus and the remaining 37.815 ha (21%) of parcel C has been encroached by Land grabbers. This Study employed remote sensing and GIS techniques to examine the extent of land encroachment in LASU parcel C. The remote sensing data used was generated using UAV inspire I Drone image Ariel survey (150m Alt). The mosaic imagery with the aid of pix4D was overlaid on the surveyed parcel C to determine the extent and the volume of properties involved. ArcGIS 10.6 was used for land use classification for the encroached portion. Results revealed 97 buildings for current LASU built-up area. In contrast, there are 2,512 buildings in encroached sections of parcel C. Similarly, residential land use occupied (60%), mixed land use (30%) and (10%) commercial land use Landuse Land cover change detection, Multi criteria evaluation (MCE) and time series analysis was used for final map of the land encroachment analysis. The implication of this is that most of the land set aside for future use by LASU has been taken over by individuals. Underlying reason for land take over by individuals need to be investigated by future studies.

Keywords: *Land use categories, encroached land, remote sensing, GIS*

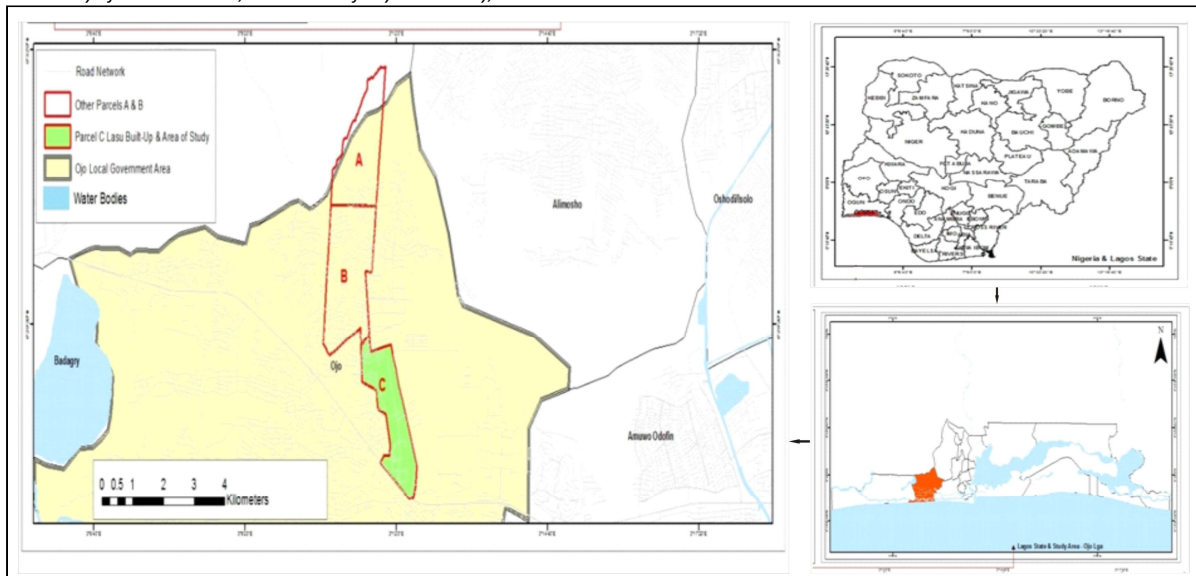
Introduction

Encroachment is a term used to describe advancement beyond proper limit, and may connote different meanings depending on the context. For the purpose of land encroachment on public institutions, any land use development, being residential, commercial and mixed that extends beyond boundaries and encroaches on the adjoining land of another, is considered encroachment. Lagos State University (LASU) is a state owned university in Lagos, Nigeria. It was established in 1983 with main campus at Ojo Area of Lagos State. It covered an area of 831,101 hectares, divided into three parcels- A, B and C. The detail survey reveals a total of 153.242 hectares for parcel A, 219.451 hectares for parcel B and 179.536 hectares for parcel C. The Built-up area is located on parcel C, with 60% of the total 179.536 being utilized by LASU main campus, the remaining 40% of parcel C and the entire A and B have been encroached by Land grabbers.

Remote sensing data acquired from satellites and piloted aircraft are powerful tools for measuring the state and trends of environmental changes associated with natural processes and human-induced alterations of the environment. For many situations, data from these platforms provide the only way to measure features or processes on the Earth's surface

and in the atmosphere, and to evaluate how they are changing. To address the growing demand for data on the state of the environment, the science of remote sensing is continually advancing in aerial data acquisition. The conventional airborne and satellite remote sensing platforms upon which most sensors are mounted have not always met the demands of researchers and environmental professionals. For many environmental applications these platforms pose challenges or require trade-offs, such as high cost, lack of operational versatility, and poor spatial and temporal resolution. The LIDAR technology efficiency has been approved by the market which has led to increasing needs and demands. Unfortunately, LIDAR systems used to be heavy (usually from 20 to 100 kg) and were previously only operated from manned planes or helicopters. Due to the prohibited costs of such operations, these kinds of sensors were not cost efficient enough and thus, not attractive for small-area surveying (of less than 100 hectares). Generally low-cost high resolution imagery such as eco-drones was characterized with capturing capability due to advancement in remote sensing techniques and creates the potential for them to fill the data gap between satellites imageries and ground surveying due to their coverage limitations and cost implications. Similarly, eco-drones can do much more than image acquisition, occasionally, they are advantageous over typical satellite or aircraft image acquisition. In addition to image capture, eco-drones can function as a real-time monitoring mechanism for disaster events or illegal surveillance. Hopefully, LIDAR sensors manufacturers have developed a compact and lighter version that can be embedded on unmanned aerial vehicles (UAVs). For a couple years already, the aerial LIDAR scanning by UAV sector has been experiencing a dynamic and effective growth. The main advantages of this method are the undeniable cost reduction compared to helicopters, the elimination of the endangering human lives risk and the speed of implementation of this solution. However, remote sensing techniques enable researchers to perform, monitor, identify and map landcover and land encroachment all over the world. Land encroachment and forest area are detectable via remote sensing tools and capability to sense data at few meters and kilometers, small scale enable researcher to identify and map small district area and also perform a large scale analysis. With synoptic sensor, the multi-temporal data possession allows data monitoring, acquisition illegal and hard-to access locations and violent areas at different intervals; monthly, quarterly and yearly. The aim of this study was use GIS and remote sensing techniques to monitor and detect the illegal land encroachment of parcel C of Lagos State University main campus, Ojo, Lagos Nigeria and the specific objectives were:

- i. assess the pre and current encroachment scenarios,
- ii. identify, delineate and map the encroached area,
- iii. examine the encroachment activities impact on the institution
- iv. suggest remedies that will reduce encroachment and pave way for the university future development.



Source: Author's, 2017.

Fig. 1: Study area.

Material and Method

The Study Area

The study area is Lagos State University main campus, Ojo Lagos, Nigeria as shown in (figure 1). Located along the Badagry expressway. It is located within $3^{\circ} 12' 17''$ 11.409° E- $6^{\circ} 27' 34''$ 11.42° N, $3^{\circ} 11' 44''$ 11.809° E- $6^{\circ} 31' 52''$ 11.864° N, $3^{\circ} 11' 36''$ 11.198° E- $6^{\circ} 29' 49''$ 11.684° N and $3^{\circ} 10' 40''$ 11.319° E- $6^{\circ} 29' 12''$ 11.241° N respectively. The project area was chosen due to the land encroachment issues and conflict and the need for the University to expand from non-residential to a residential institution. Areas such as Igbo-Elerin excision axis, the Great Challenge Road, Isashi and Onikoyi are where the major encroachment scenario has occurred. This study area consists of various types of landuses such as buildings, road network, water bodies and marsh land.

Materials

This research primarily used primary sources of data and information obtained from the field as well as secondary data of Saaty Analytical hierarchy process for multi criteria evaluation (MCE) in orderly ranking the encroached facilities based on the option of any possible demolition on account of limited time and resources, GIS softwares such as ArcGIS 10.6, mapsource data extraction, pix4Dmapper for image preparation and processing were used for analysis of the spatial and non-spatial data and their symbolization with a multi criteria evaluation (MCE).

Methods

The institution of Physical Planning unit made the survey of the entire university parcel using remote sensing by flying unmanned aerial vehicle to identify and map illegal land encroachment. Similarly, this made the study possible by the appearance of Unmanned Aerial Systems (UAS) that was programmed and remotely piloted to perform autonomous flight on the targeted parcel of the area at 150m altitude. Generally, UASs requires a ground-control station, sensor suites and communication devices for carrying out flight missions. But remote sensing study was characterized with one weakness that cannot be overcome but can only be minimize i.e (cloud cover) when ever unmanned aerial vehicle flew at 150m altitude. However, the Anderson landuse classification method was used on landsat image to dictate the expansion of encroachment over 20 years. Data analysis was carried out using vector data

format derived from unmanned Aerial Vehicle (UAV), the impact of this encroachment on institution is carry out using multi criterial evaluation of the encroached facilities and the output were integrated using the advancement tools of remote sensing and GIS techniques, which allow for simple area computation and composite overlay operations. Through the overlay operations, encroachment activities were detected and map. However, analysis of geo-spatial identification and documentations of encroached facilities were carried out using handheld GPS.

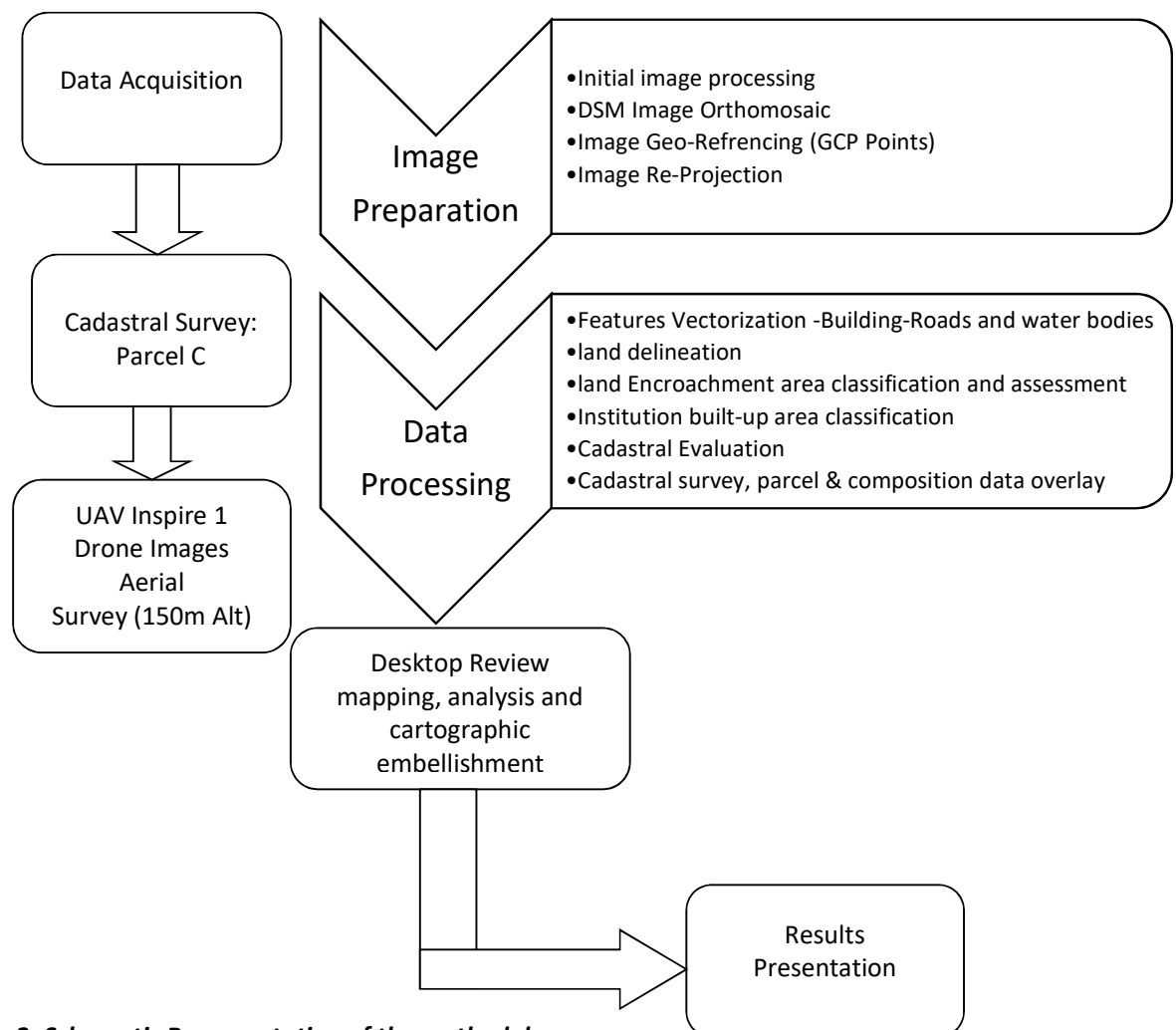


Fig. 2: Schematic Representation of the methodology.

Results and Discussion

Cadastral parcel data for this study area as shown in (Figure 3) below was acquired from Lagos State University Physical Planning unit and it is up to date. This working document contains detailed information about the land ownership in the study area. However, cadastral parcel data together with aerial photograph from unmanned aerial vehicle (Drone) were used to detect encroachment upon the institution land. With Cadastral parcel data, an overlay was performed on the classified result to ascertain if the land use development activities had advanced beyond legal limits or not.

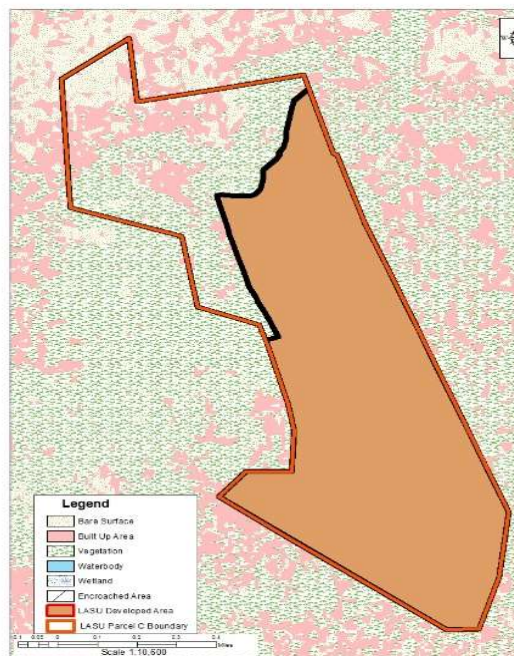
identified feature shape extracted from the images.

The result of the manipulation of vector data was able to detect and compile changes of buildings within the boundary and the encroachment area. The imagery acquired from unmanned Aerial Vehicle (UAV) (2017) was able to detect buildings and other features within 179.536 ha of land area for parcel C. The vector data for 1994, 2004 and 2014 were used to perform a time series analysis for land loss in 30 years for this study area. This land loss, as mentioned before, is due to illegal human activities. Cadastral data, landsat data and aerial images was used in this study to detect encroachment. The summary of change detection analysis and encroachment over the year were shown in table one below (Table 1.)

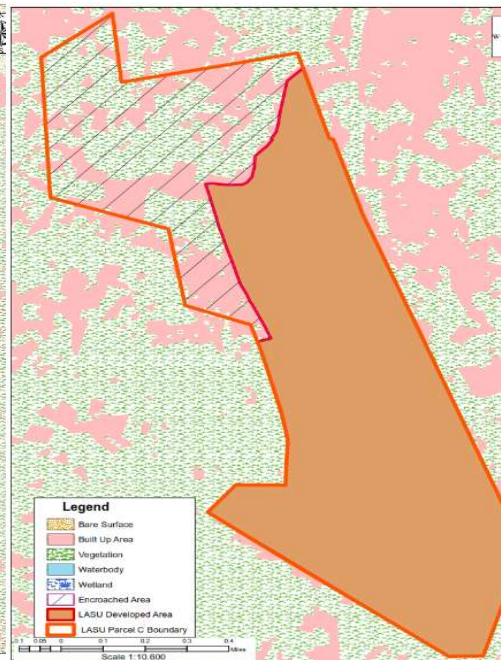
Table 1. Results and summary of the land encroachment change detection analysis.

	Description	1994 (Ha)	2004 (Ha)	2014(Ha)
1	Built up Area	28.566	30.125	34.151
2	Bare Surface	4.890	3.758	1.999
3	Vegetal Area	32.310	27.792	22.211
5	Wetland	3.892	2.984	1.297
	Total Land Area	69.659	69.659	69.659

Source: Author's, 2017



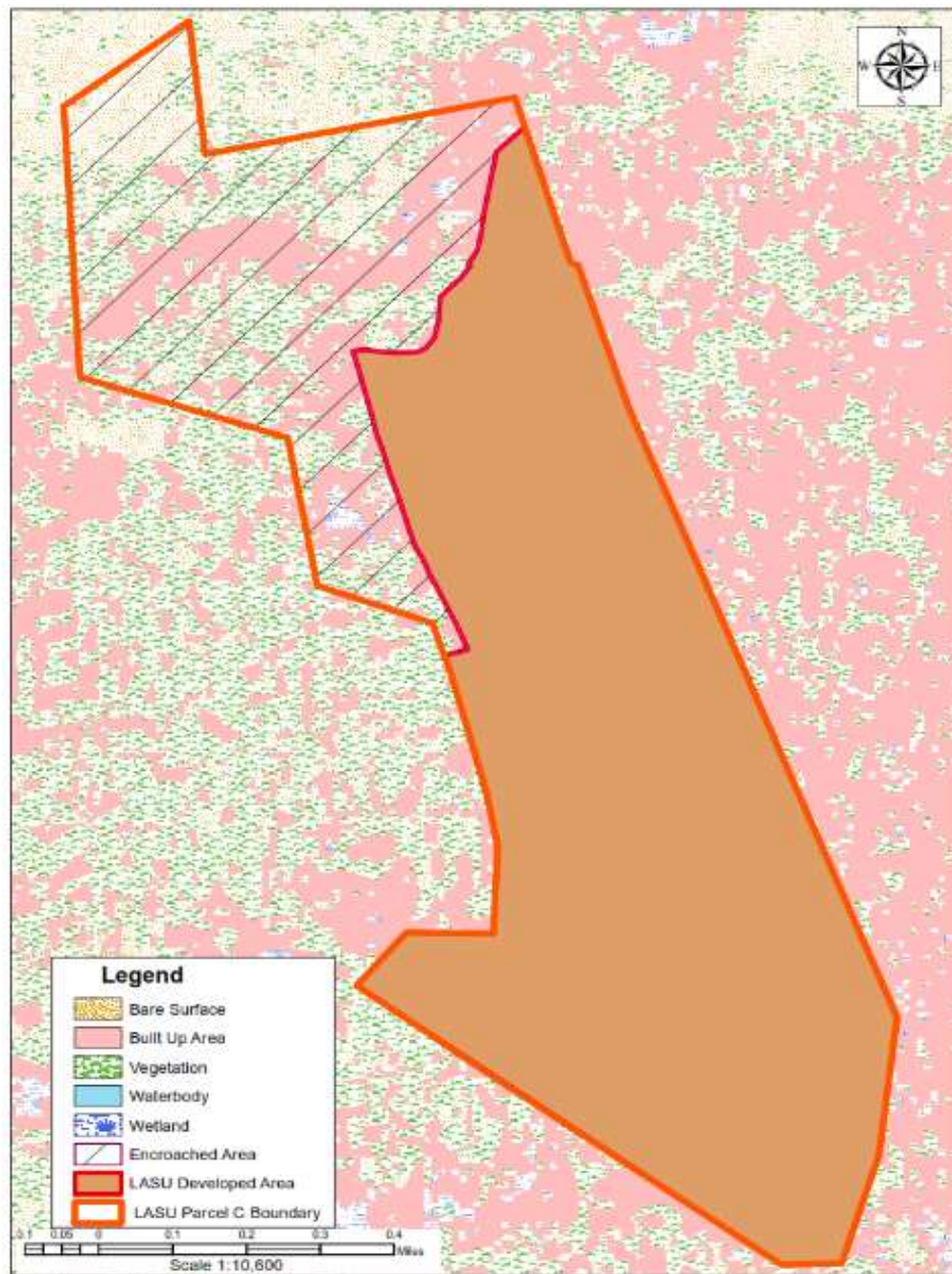
Source: Author's, 2017



Source: Author's, 2017

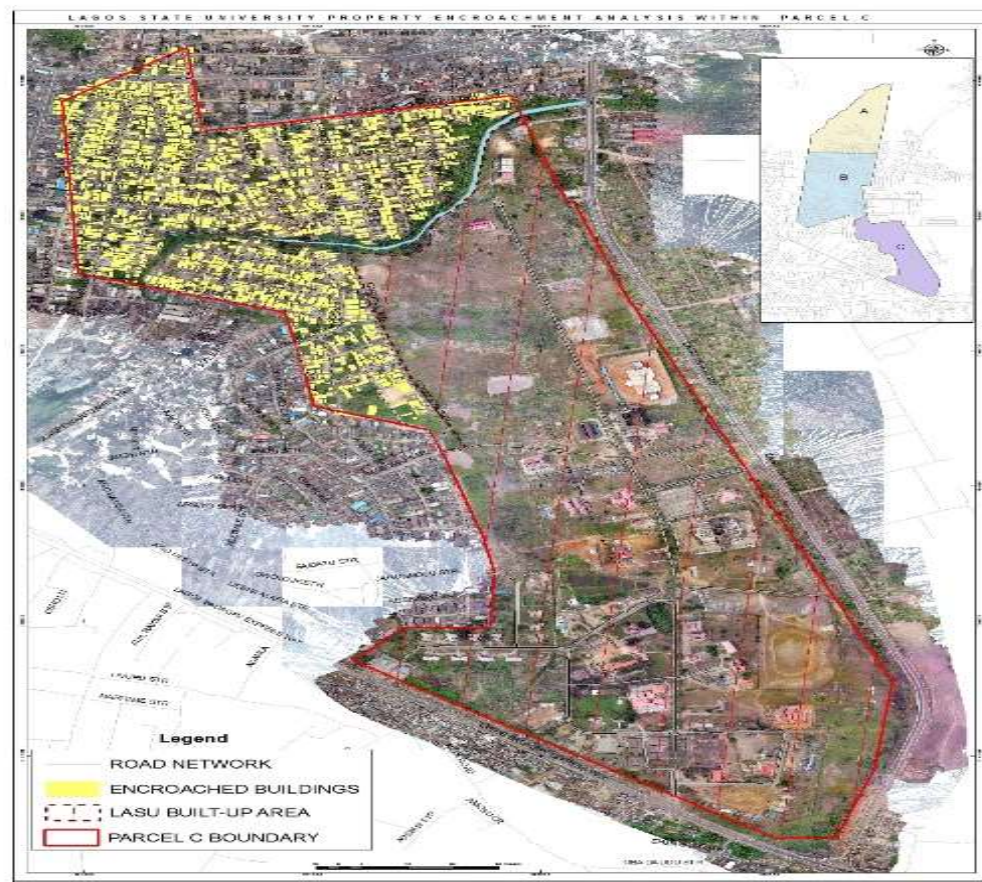
Fig.5:Landsat5 image Landuse landcover 1994.

Fig. 6: Landsat5 Landuse landcover 2004.



Source: Author's, 2017

Fig. 7: Landsat8 Landuse landcover 2014.



Source: Author's, 2017

Fig: 8 Overall results of Composite data Overlayed on UAV Drone image

Landuse Land cover change detection analysis data manipulation was done mainly by using ArcGIS software to integrate the data from different sources and overlay it to obtain the land use land cover of the study area base on Anderson land use classification method, There are 37.815 ha of public land encroached that had been detected through the use of aerial photograph data. And from landuse landcover change detection analysis, the results revealed encroachment had already started since 1994. And there has been progressive expansion up till 2017 (Figure 8). From fig: 5 1994 analysis, 28.566 ha of land was encroached upon, fig: 6 30.125 in 2004, fig: 7 34.151 ha in 2014 and 2017 as indicated in (Figure 8).

Impact of the encroachment on the Institution

The impact of the encroachment activities on the institution was evaluated using multi-criteria evaluation (MCE), Data manipulation was done mainly by using ArcGIS software to integrate the data from different sources and overlay it on study area layout with other secondary data, the multl criterial evaluation of the data for the encroachment analysis was performed and ranked the facilities based on the least cost analysis, economic issue, road, utilities and equal weight analysis base on the order of their importance in case of any option of possible demolition i.e (When its 1= is classified as lowest and 3= is the highest) as described by Saaty Analytical hierarchy process for multl criterial evaluation as shown in (Table 2) below, the cartographic model for the data manipulation process is also shown in (Table 3) below:

Table: 2 Multi-criteria evaluation parameters and rankings.

	Building type	Total number	Economy	road	Utilities
1	Health Facilities	2	5	3	2
2	Hotel	1	6	3	3
3	Communication mast	1	8	1	7
4	Education institution	14	2	1	1
5	Religion Centre	35	2	1	1
6	Residential	2397	2	1	1
7	Total	2450	25	10	15

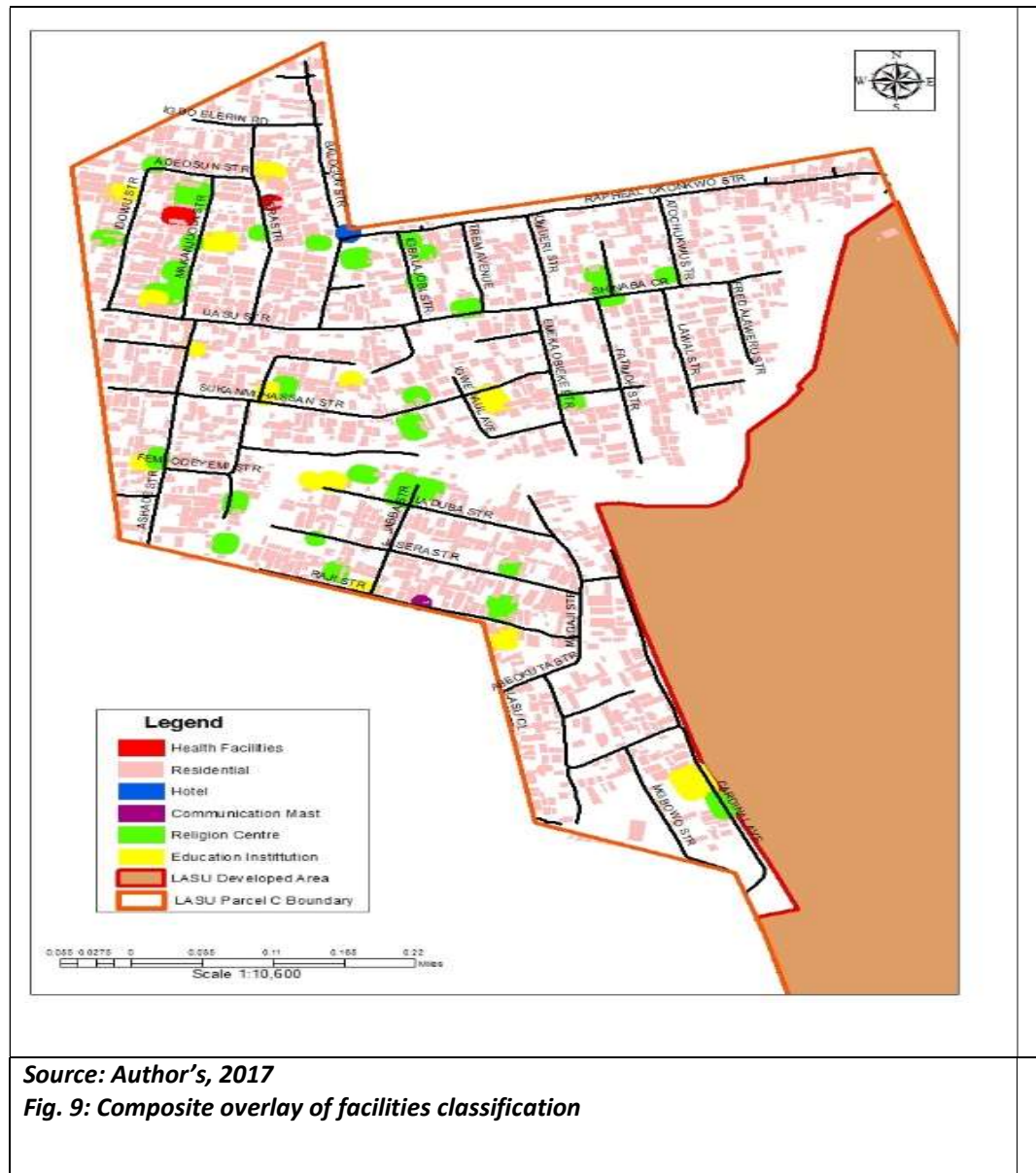
Source: Satty MCE Ranking

Table 3: Landuse land cover classifications

S/N	Public Land Type	Area/m²
1.	Barren (Open public land)	56111
2.	Road	34192
3.	Stream	22786
4.	Pond	2172
5.	Building	2670
6.	Nursery	8194
	Total	126126

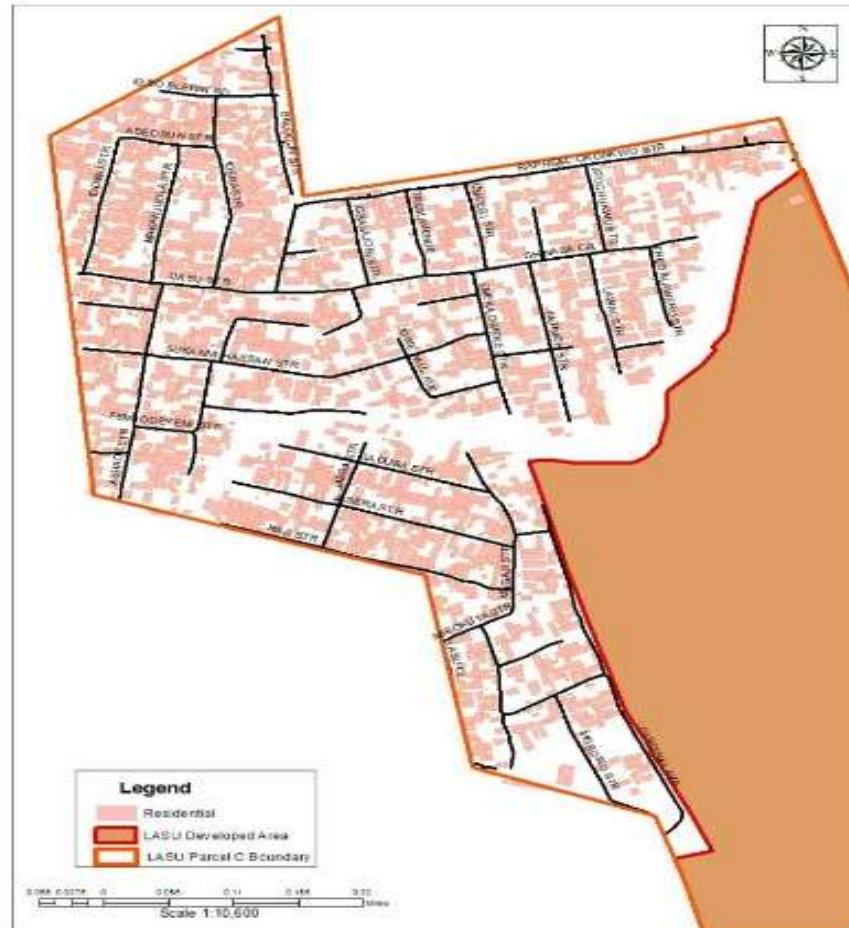
Source: Author's, 2017

The public land type classification was done with 56111 square meters of barren open land having the highest, stream and canal, 22786 as the medium and nursery, an agricultural landuse type with the lowest of 8194.



This depicts the composite overlay of fifty seven (57) facilities in parcel C, with churches having the highest of thirty three (33), one (1) clinic, two (2) hospitality centers, two (2) Telecommunication masts, fifteen schools (15) and four (4) mosques. The Fig: 9 above depict the pattern, spread and concentration of facilities within the study area

In this study, we have successfully detected facilities within the encroached portion of Lagos State University, Ojo. These facilities were ranked in line with satty analytical hierarchy process,(Figure: 9) while the illegal residential building withih the area are shown in fig 10 , defined encroachment activities.



Source: |Author's, 2017

Fig: 10 Residential houses within the encroached area

The results of the multi-criteria evaluation (MCE) weight analysis on utility, economy and road network, shows the less important, moderate less important, moderate important and more important facilities. In the wake of the university institution considering reclaiming of the encroached land area for university growth and development, using the utility weight analysis, as shown in figure: 9 &10, the residential are less important, the health facilities are moderately less important, the hotel is moderately important and the telecommunication mast is the most important. To reclaim the encroached portion of the land using the economy weight analysis, the residential building are less important, health facilities are moderately less important, the hotel is moderate important and the telecommunication mast more important. Finally, to reclaim the encroached portion of the university land area using road network weight analysis, the health facilities and the hospitality outfit, the hotel are more important while the buildings are less important. Having considered all weight analysis results, the buildings are less important and the university authority can do away with all residential buildings within 100m radius, using the road weight analysis result.

Conclusion and Recommendations

Successful delineation of land area using cadastral survey and vector derived data from the satellite imagery has led to the identified encroachment within the parcel C of Lagos State

University, Ojo main campus. The Landsat image classification using the Anderson third level landuse classification method was able to reveal the expansion of encroachment over twenty (20) years. Using the cadastral, GPS campaign and physical inspection of the study area, all illegal transgressions within government land were successfully detected. These illegal activities are assumed as encroachment since all happened outside private parcel and within LASU cadastral survey. Progressive encroachment was observed from changes of public institution to private residential buildings as the area was originally designed for government public institutional uses.

From this study, the encroachment analysis was successfully performed at 75% accuracy level by integration of cadastral survey, remote sensing imagery and GPS campaign. As per the detailed encroachment analysis results, revealed residential encroachment, LASU Built-up area is located on parcel C, with 141.721 ha that make up 79% of the total 179.536 ha has been utilized by LASU main campus, the remaining 37.815 ha that make 21% of parcel C has been encroached by Land grabbers. The increasing activities of land encroachment have limited the University expansion resulting into shrinkage of the total landuse. There is a widespread impunity and threat on the current university built-up area if urgent action is not taken. Appropriate unit of the University should wake up to their professional responsibility to monitor and arrest encroachment. What is important is the sustainability of the University land area over a long drawn period of time.

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