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Assessment of Property Changes Evaluation using Spatial Data with GIS: A Case Study of Apapa, Lagos (Nigeria)

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Abstract:

Property use changes continuously, hence planning based on this information is a continuous process that can be very critical. In Nigeria, information depicting past and present changes in property use for environmental planning, monitoring and socio-economic development is often inadequate. Therefore, there is a need of new tool such as GIS, to analyze changes in properties in Apapa, Nigeria. The method adopted in achieving the result of this work includes collection of both spatial and ancillary data of year 1968 and 2007. Both spatial data with GPS locations of additional information were integrated using ArcGIS to update the 2007 data. The study revealed that initial plan for each property as at 1968 showed that 136 were been used for properties. Year 2007 information revealed 246 existing properties when query analysis was performed to display property information or status. Changes in property uses between 1968 and 2007 were identified in the study; some plots were merged while others have more than two properties within a single plot. The rate of change was simply determined by few parameters in last 39 years. Total properties and individual properties changes, percent dynamics change and rate of changes have been demonstrated in the study.

Keywords: Property Usage, GIS, Land use, Property Management, Query analysis

1.0 Introduction:

Properties or parcels are the most basic "business elements" in a County or City (Huong, 2010). Every day, planners, assessors, public works, fire, police, elections officials, school districts, and many other county/city personnel need access to parcel maps and related information such as addresses, related permits, maps, documents, tax rate areas, voter precincts, relation to flood zones and other natural hazards, etc. Improving the quality, validity, and temporal currency of parcel maps is a critical and cost-effective way to improve the effectiveness and efficiency of local government. In a developing country like Nigeria, information to depict the past and the present changes in properties in an area for physical environmental planning and socio-economic development is inadequate. The increasing economic activities in Apapa area have resulted to changes in property usage along the corridors. Despite these changes describe in above, there seems to be lack of proper acquisition and handling of accurate and comprehensive up to date spatial and non-spatial property data. Lack of such information and maps to depict the past and the present changes in properties in an area can lead to ineffective policies, poor physical environmental planning, loss of tax/revenue and uncontrolled physical developments. The increasing economic activities in Apapa have resulted to changes in property usage along the corridors. An essential pre-requisite to any development effort is to appraise the existing property situation and how the situation has been changing over time to enable authorities and planners make policy decisions for planning and revenue/taxes (Abler 1997). It has been found that adoption of new innovative technology such as GIS in administrative system will deliver unusual results as well as enhance economic and administrative competiveness (Campbell, 1999). Thus, most of the quantitative geographical studies were carried out using GIS platform (Longley, 2000).

The aim of this study is to use GIS as a tool to analyze changes in property uses in the area that occurred overtime. The objective of the study is to identify existing properties in the study area as of 1968, 2007 and to analyse changes in properties

over the period (1968-2007). This study incorporated the use of Satellite imagery in combination with GIS, database to assess the properties increase and changes.

1.1 GIS for Local Authority Property Management Information

A GIS provides a means of managing information digitally and in a geographical context. Many property management decisions require consideration of location, geography and space. The technology is well suited to this, but constructing a GIS-based property information system that records the complex interests in land and property is a daunting task. The volume of spatial data is often enormous and the cost of establishing and maintaining a database will be prohibitive unless a means of utilizing existing resources can be developed. Historical property data can be hard to trace due to the poor quality and maintenance of some records, property interests are heterogeneous. There has been attempt to link the spatial location and regional scale objects information with GIS (Laurini and Thompson, 1992; Masser and Campbell, 1995; Obermeyer and Pinto 1994). Some authors conveyed the importance of GIS and spatial data handling at different applications with review on the future significant potential in new area of research (Goodchild, 1992). They showed effectiveness of GIS in real practice with management (Campbell and Masser, 1995) and also evidence of GIS monitoring in local government and practices (Campbell et el., 1994). Furthermore, it has been proved that pace of GIS incorporation at regional, or national scales indicated considerable importance at different contexts (Campbell and Craglia, 1992; Campbell and Masser, 1992). Thus, GIS use varies considerably at different level of work (Campbell, 1996).

The management of property information is not just about computer systems but about the spatial information (Laurini and Thompson, 1992). There are human, information and commercial issues to be considered while collecting spatial information, storing and using it for generating results (Longley et al, 1999). Even a project has been clearly specified and system and data requirements outlined, access to certain information may not be possible due to confidentiality constraints or legislative barriers. There comes the need of information strategy for GIS which needs to be linked with management plan for successful implications (Hendriks, 1998). Certain land and property spatial information is commercially and personally sensitive and must be handled accordingly. The spatial data must be worked carefully to avoid any positional inaccuracies (Kiiveri, 1997). The laws of copy right and data protection regulation must be adhered to other constraints are integration of data for analysis may not be compatible due to data formats variations. The use and applications of GIS technology proved important demands on spatial data link with existing resources. This has challenged and transformed the conventional techniques of mapping (Masser, 1998) which changed spatial data handling capabilities at local governmental level. This may include using database, planning and spreadsheet software in combination with GIS (Drummond, 1995).

The necessity of Geographical Information Systems (GIS) to manage information and link databases to geographic locations is increasing every day. Organizations that have implemented a GIS have found that one of its main benefits is improved management of their own organization and resources. Because GIS has the ability to link data sets together by geography, it facilitates interdepartmental information sharing and communication, further increasing productivity. Local government can collect and store a substantial amount of data, the majority which is geographically referenced. GIS also appropriate for local authorities because they need to consider proximity issues (typically planning and development control) and they are responsible for discrete geographical areas (Ehlers and Amer, 1991). Local government is one of the largest users of GIS and in 1993, 29 percent of local authorities had a GIS compared to 16.5 percent in 1991 (Masser and Campbell 1994). Later surveys by the Royal Town Planning Institute (RTPI) were carried out in 1995 (Allison and Weston, 1999; Reeves, 2004).

The survey in 2000 showed that 94% of authorities had either implemented, or were implementing, a GIS. This compares with 64% of authorities in 1995 and indicates that GIS has consolidates its position as a mainstream technology within local government shows that around 57% of councils considered that they had a fully operational GIS (compared to 30% in 1995). In 1995, 8.3% authorities had no plans to introduce GIS; this figure is now 1%. This reduction may in part be attributed to the increased accessibility and affordability of pc based GIS in the advancing GIS worlds (Wegener and Masser, 1996).

In its memorandum of evidence to the Audit commission the Royal Institute of Chartered Surveyors RICS (1997) recommends that (i) Local authorities should adopt a more corporate approach to property management, (ii) a central property department be established in each authority, (iii) a central database of property owned and leased by the authority is essential to allow performance indicators to be constructed and to permit more informed decision making, and, (iv) a central property database could be used for estate management, development and by maintenance and service department. The RICS felt that the property portfolio is a key area of management policy within a local authority and therefore property information system, rather than having the property functions dispersed among legal, treasurers environmental services and more informed property decisions to be made. This type of geographical information is well scented to input and analysis using GIS and many authorities now use this technology to maintain their land territories. The advantages of GIS-based land terrier over paper-based systems are described by (Wyatt and Ralphs 2003) as an ability to handle changes in features overtime, geographical analysis of property information, high-quality map production, provision of authority-wide access to a corporate resources and an opportunity to tailor the DB to suit different types of users.

The objective of the study is to identify the different properties located in the Apapa Nigeria, and link the goal of an information strategy with GIS to overall use, increase, and changes in time period. It includes the increase in the different properties, their increase, change dynamics as well as change rate of individual properties and overall properties with time period.

2.0 Study Area and Methodology (add figure of location)

The methodology includes data sources and collection process. Data are observation made from monitoring the real world. They are collected as facts or evidence that may be processed to give them meaning and turn them into information. Spatial data are characterized by information about position, connection with other features and details of non-spatial characteristics (Burrogh, 1986). Personal visit to the study area was carried out to assess and count each individual properties located within the study area. The Geo-spatial (Geometric) data of the properties were acquired using the Global Positioning System (GPS) within the area for geo-referencing the maps. The data for this research project based on the master plan of Apapa (1968) showing the layout of the plots, roads and density areas. Apapa is one of Nigeria's 774 Local Government Areas and is located to the west of Lagos Island, across Lagos Harbour (Lagos State Government, 2012). The layout shows proposed various land uses. The spatial data conversion process normally begins with the identification of the data source for the land base. These sources of information may range from extremely accurate surveyed maps containing no ground control references. Source data may also be existing in the computer files in deferent formats. Before starting the creation of database the source data has to be updated and verified so as to generate the accurate existing data. Sometimes the data is not clear enough to distinguish the features, which create problems for the operator and inaccurate data may get generated. As the decisions of a planner are based on the data, the inaccuracy in the database may create problems to the planner too. So the map has to be made distinguishable before considering it as source data.

As illustrated in Figure 1, a scanned copy of the Apapa Master Plan (1968) used a based map of the study work. To carry out this study, master plan of year 1968 has been used as base map of the town as illustrated in the Figure 1 (a). Various land use and land cover which were extracted from the master plan of 1968 were demonstrated in the Figure 4. These extracted land use land cover were used to identify individual and commercial properties. This also helps in identification of properties with their initial uses based on the master plan 1968. The use of IKONOS satellite imagery in the study is to extract the properties in the year2007 using GIS. The specification of IKONOS satellite imagery is shown in the Table 1. The location map of the study area is shown in Figure 2.

Figure 4 shows various land uses in plots layout extracted from the master of 1968 (Figure 1), it was used to identify individual properties showing initial uses based on the master plan. The total number of properties (Plots) shows that there are 136 plots in the study area, commercial uses accounted for 30 plots, industrial -44, military barracks -1, police barracks -1, residential-57 and drainages-3.

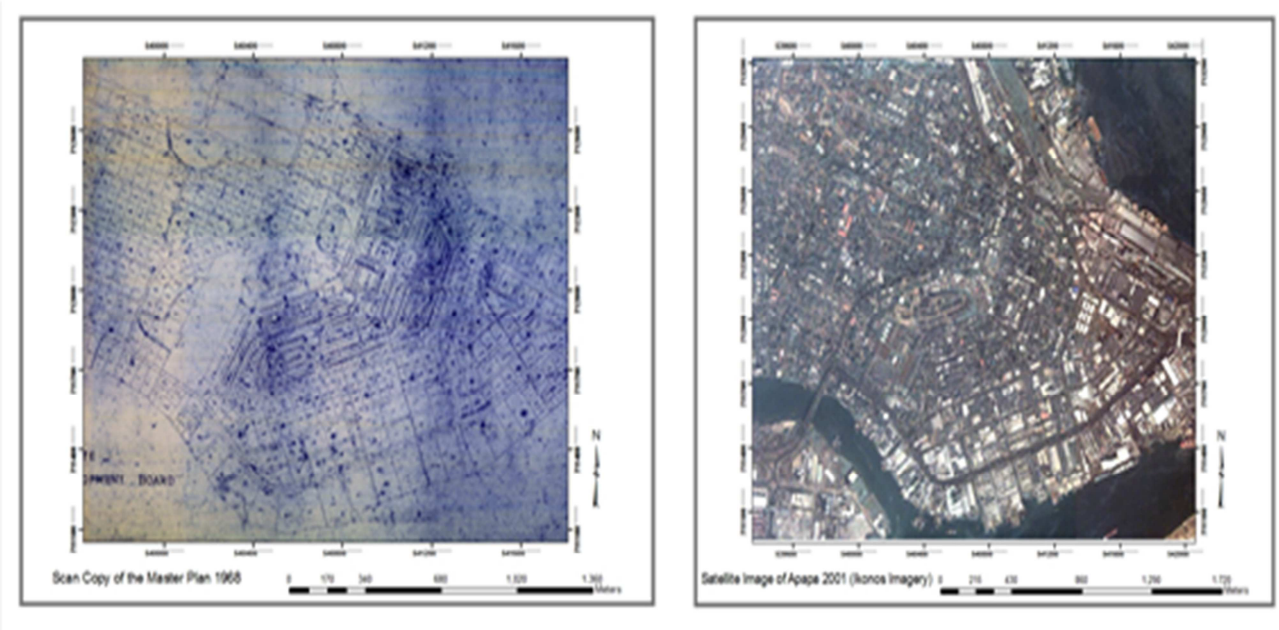

Figure 1: (a) The Scanned Master plan of year 1968 and (b) IKONOS Satellite image of the study area acquired in 2001.

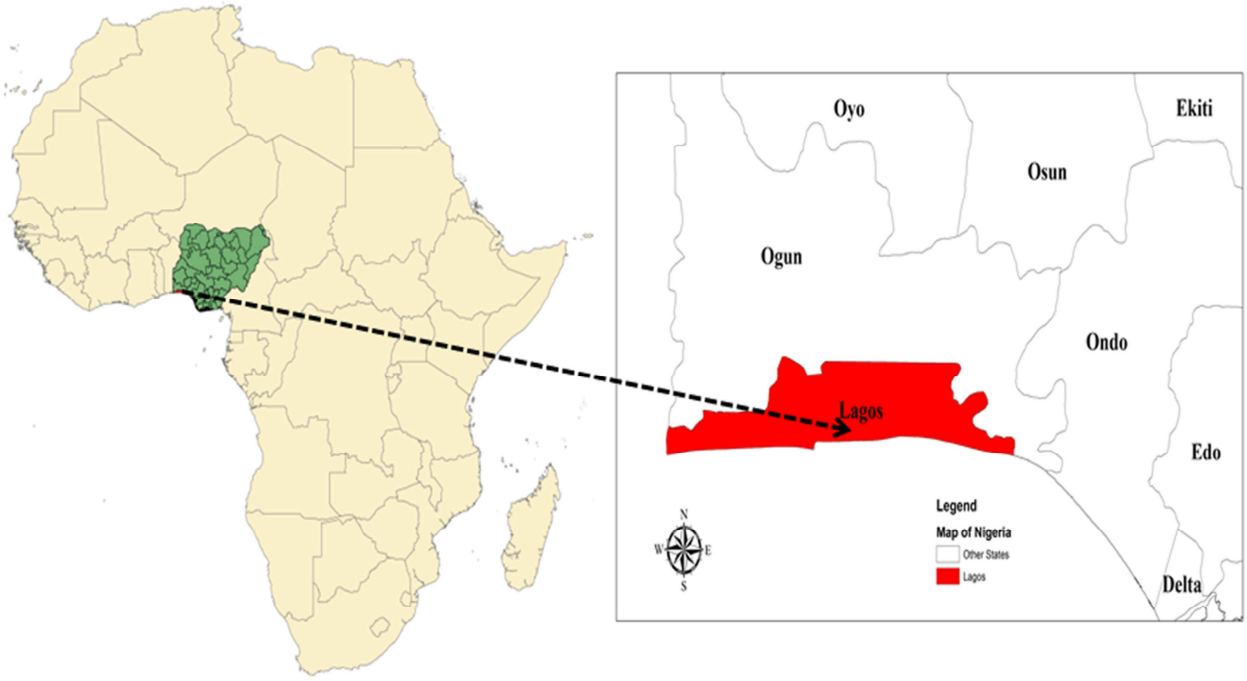

Figure 2. The location map of the study area, Apapa, Lagos in Nigeria

The database was created using Microsoft Excel to store attribute information such as type of property (ID), location, initial plan and present use of the property. The obtained images and maps were scanned (a high resolution scanner for image to raster format) e.g. maps were geo-referenced using AUTOCAD into TIFF format compatible with the GIS software package, and imported into the GIS environment (Arc view 3.3 as well as Arc GIS 9.2) were both used. The raster images are then vectorised using on screen digitizing to represent polygon – properties and lines - roads. The digitized images were converted and stored in shape files**.** This was performed in ArcView package through the use of the ArcView polygon attribute table (PAT). Maps and tables were generated from the data. The map of the Apapa Master Plan was generated using ArcView 9.2

package. Also, through ArcView software data base were created for the properties and other related information that are very useful for the research. The data collected were analyzed and presented in maps and tables. The results obtained during the course of the study were analyzed using maps, queries and tables. The change dynamics of land use land cover were illustrated in previous studies (Sharma et al., 2012). The authors postulated the change dynamics and change percentage for land use land cover in different time period. This study focused on the change and percent change of different properties existed in 2007 and increased from 1968.

Table 1: Specification of IKONOS satellite imagery

Sr. No	Specifications	Properties	
1	Spatial resolution	0.8 m PAN 4 m MSS	
2	Spectral resolution	PAN -0.45–0.90 µm	
		MSS-	0.445- 0.516 µm
			0.506–0.595 µm
			0.632–0.698 µm
			0.757–0.853 µm
3	Temporal Resolution	3-5 days off-nadir 144 & days true-nadir	
4	Radiometric resolution	11-bit	
5	Swath	11 km × 11 km (single scene)	

Different property uses in the study area has been determined using properties change in time period. Further, the rate of change of these properties can be assessed using rate of change of the properties per year. These above work can be clear from the equation 1, equation 2, and equation 3 shown below for calculating properties changes and rate of change. The formula for calculating Total Properties change ΔY in the study area is given below:

$$\Delta Y = P2 - P1 \qquad \text{Equation 1}$$

Where, P_2=*Total Property in Use in year 2007 and,*
P_1=*Total Property in Use in year 1968.*

Percent increase can be assessed using the equation mentioned below:

$$\Delta I = \frac{P2 - P1}{T} * 100 \qquad \text{...Equation 2}$$

Where, P_2-P_1=change of properties in time period, T= total time difference.

The formula for Rate of Change (Per Year) ΔR change is calculated by using a simple formula given below:

$$\Delta R = \Delta Y / T \qquad \text{Equation 3}$$

Where, ΔY=*Total Property changes between* $P_2 - P_1$ *(Total changes 110)*

T =Total Time Duration between $P_2 - P_1$ *(Total number of year- 39)*

Therefore using the above equation 1 and 2, ΔY was calculated as 110 and ΔR was found to be 0.35 per year.

3.0 Results and Discussion:

In the Figure 1 a satellite image of (Apapa 2001) showing the area understudy. It was used to identify different existing individual properties as at 2001 which would be updated to 2007 (*See* Figure *2b).* In Figure 3, existing properties identified were extracted from master plan (shown in Figure 1) which was updated through a field validation in 2007, the total properties identified were 251: commercial with 51, industrial 76, residential 118 and institutional 1.Properties layout were extracted from the master plan/ satellite imagery of the study area as shown in Figure 3 (*c)*, this is to ascertain that the layout is properly overlapped on the base map (master plan). Figure 3(*b*) demonstrate the extracted existing individual properties from Figure 1 (2001) and validated with field survey performed in 2007, was overlaid on the extracted properties in Figure 1 which was used as a base map of the study. There is increase in the property changes from 1968 to 2007 as illustrated in Table 2. The property usage were comprised of different sectors of domestic, governmental and commercial activities like drainage (1), police (1) and military (1) barracks (1968), and institutional (1). The total properties in 1968 are 136 while it increases to 246 in 2007, hence the giving a significant difference of 110 property constructed in 40 years' time duration. Queries displaying individual land use properties for the area for commercial, Industrial, Residential and banks as shown in Figure 4.

Maximum changes took place in residential properties which accounts for 118 in 2007 as compared to 57 residential properties in 1968. This shows an increase of 61 in number in 39 years of time period. Similarly, industrial properties showed an increase in number from 44 in 1968 to 76 in 2007 thus contributing additional 32 properties in 2007. Next to it, minimum changes took place in the commercial properties with 21

additional properties in 2007 (51 in numbers) as compared to 1968 (30 in numbers). Commercial properties' share in percent of total properties decreased from 22.06 to 20.32% in 2007. Though, commercial properties showed an increase in number from 30 to 51 in 2007 from 1968, it showed decrease in the percent shared by all properties in increase or decrease percentage (refer Table 2 and 3). It has change dynamics of -1.74 as per 39 time-period duration and its percentage contribution to properties in 1968 is 22.06 and in 2007 is 20.32.

Likewise, Industrial properties showed an increase in number from 1968 to 2007 i.e. the number increased to 76 in 2007 from 44 in 1968. This represents that 32 properties were added during 39 years and contributed almost 29.09 percent among increased properties in 2007. The percent changes showed negative trends as contribution of industrial properties were 30.28 % of all properties in 1968 and it declines to 32.35 % of total properties in 2007. It represents a decline in -2.07 percent changes. The industrial properties confirms rate of change of properties at 29.09 per year, among all properties. The rate of change of different properties were found to be 0.53 for industrial, 0.82 for commercial properties, 1.56 for residential properties, and 0.03 for other properties. Thus, it has been found that for all properties together, the rate of change came to be 2.82 properties per year (refer Table 3 and Equation 3).

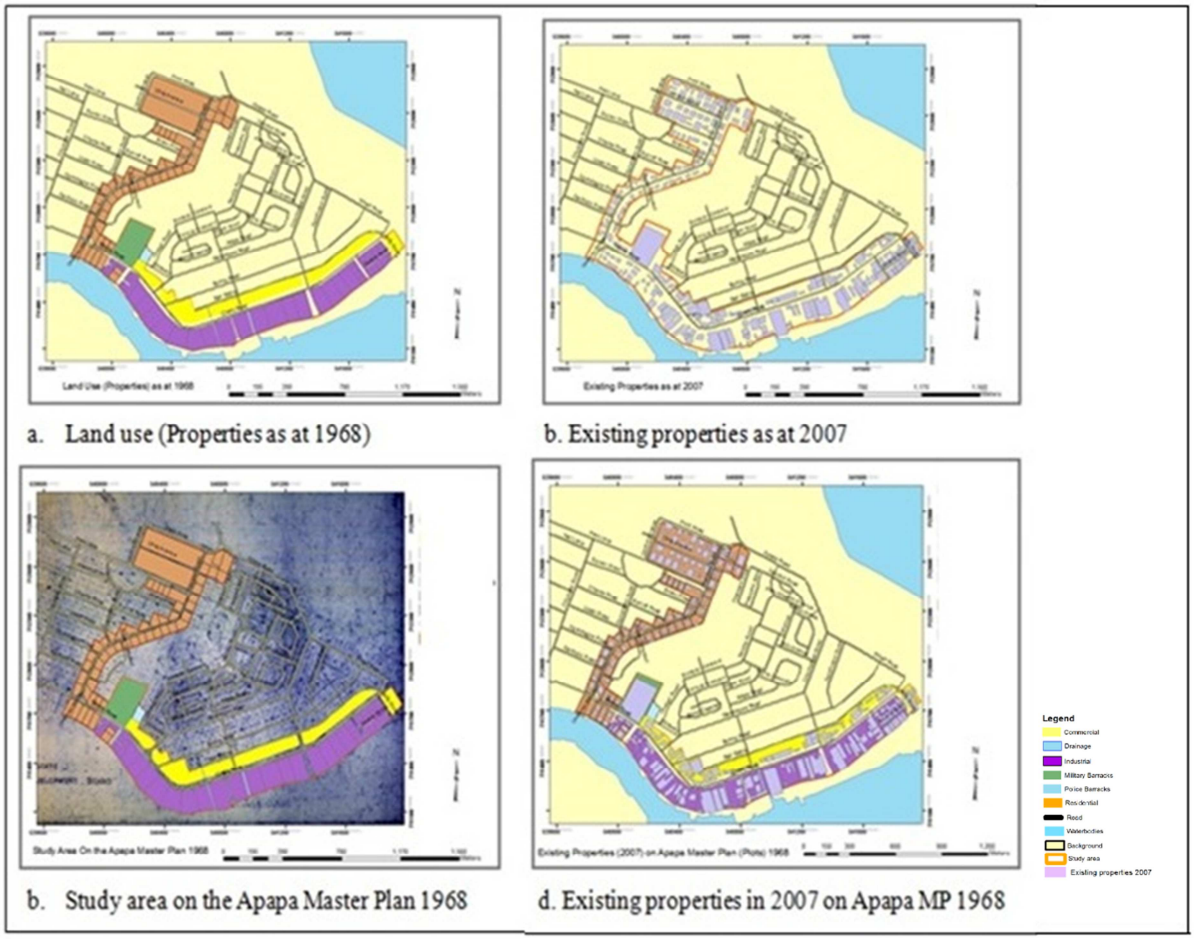

Figure 3. Property map of Apapa (Nigeria) in year 1968 and 2007

Table 2: Property Usage, in year 1968 and 2007 and percent increase in properties over time duration

Property Usage	Properties in Use 2007 (P_2)	Properties 2007 (in %)	Properties in Use 1968 (P_1)	Properties in 1968 (in %)	Changes 1968-2007 (P_2- P_1)	Percent contributed in increased properties
Commercial	51	20.32	30	22.06	21	19.09
Industrial	76	30.28	44	32.35	32	29.09
Residential	118	47.01	57	41.91	61	55.45
Others	6	2.39	5	3.68	1	0.91
TOTAL	251	100	136	100	110	100

Table 3: Change dynamics and change rate of the different properties over time duration

Property Usage	Properties 2007 (%)	Properties 1968 (%)	Percent changes dynamics~ ΔI	ΔY ~ (P_2- P_1) from 2007-1968	Rate of Change (Per Year)
Commercial	20.32	22.06	-1.74	21	0.53
Industrial	30.28	32.35	-2.07	32	0.82
Residential	47.01	41.91	5.1	61	1.56
Others	2.39	3.68	-1.29	1	0.03
TOTAL	100	100	-	110	2.82

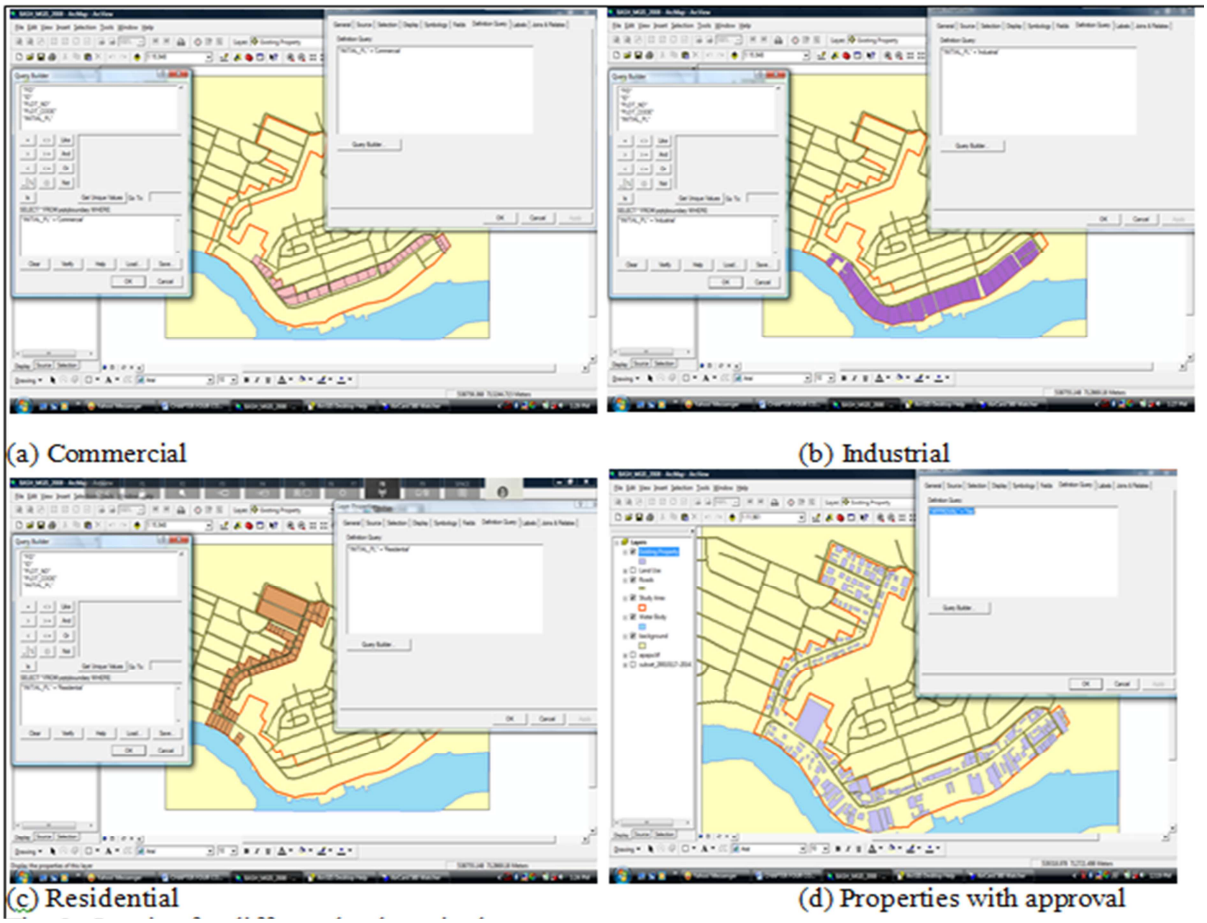

Figure 4. Queries analysis generated from different land use in the study area

To cope with the study, some corridors were selected within the study area (Marine road, creek Road, liverpool road, park lane, point road, child avenue, lander close, child close and park closed). The reason for the selection of these areas is to cut across all the land uses and some of the busy places within the study area, as well as time frame. To seek solution to the problem, the researcher conducted extensive field work. The use of data such as master plans and satellite imagery is to see the changes that occurred overtime.

The purpose of this study was to identify existing properties in 1968 and 2007 using master plan of 1968 and satellite imagery with query database in 2007, to analyze changes that have occurred over time in Apapa area, Nigeria using GIS approach (Ooi, 1990). Accurate and retrievable information using GIS as a tool in monitoring and assessing property change over period of time would enhance government decision making in the area of physical planning control, socio-economic/revenue targets and planning etc. This work has concentrated more on little section of Apapa, subsequent work may be extended further to a wider coverage using more high spatial resolution or high spectral resolution with feature extraction methods. This work may extend to multi-temporal data acquisition instead of single image data would greatly enhance the quality of the work.

4.0 Conclusion:

From the Table 2 and Table 3, it can be concluded that the changes took place for each of the properties classes including commercial, industrial, residential, and others in the period of 39 years in Apapa, Nigeria. This is all due to development and advancement of the technology. The increase in population of people in Apapa Nigeria may have impact on the changes, as people need residential properties to live, commercial and industrial properties to sustain their lives using products used in daily life like markets, educational institutions etc. Thus, 39 years of time period has shown tremendous increase in the different properties with different percent increase, different percent changes.

- The Apapa Master Plan (Figure 1a) identified total of 136 properties as of 1968 and 251 properties has been identified in 2007 using the satellite images and GIS analysis. Thus, the satellite imagery with GIS revealed 251 existing properties in 2007.
- Some of the existing properties have no approval which can be displayed when a query is run to show approval status of the property (Figure 4 d).
- Changes in property usage were also identified within the study area; some plots were merged while some plots are having more than two properties.
- Increase in number of properties from 1968 to 2007 has been identified and counted, percent changes and change dynamics has been assessed for the different properties and overall properties in 2007 from 1968.
- The rate of change in property uses in the study for the period of 39 years (1968-2007) is 2.82 per year.

5.0 Acknowledgement:

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