Assessment of Urban Development Planning using Supervised Classification of remotely sensed Imageries and GIS, A Case study of Independence Layout (Part of), Enugu, Nigeria.

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Keywords: Urban development, Supervised Classification, Remote Sensing, Geographic Information System.

SUMMARY

Adequately planned urban development is a key to achieving sustainable environment. Urban planning therefore becomes important as we develop our urban areas. For us to maintain the land use allocation pattern/scheme of our urban areas, we need to assess, monitor and control the trend and the pattern of development as they occur as uncontrolled development (slum developments) may mar the beauty and sustainability of the urban Area. This paper focuses on assessing and analyzing urban development using Object Based classification of remotely sensed satellite imageries of part of Independence Layout, Enugu urban, Enugu State, Nigeria. Using the Object based classification, a supervised classification of urban structures and other recent physical developments in the study area were achieved. Comparative Analyses were carried out between the classified image of Independence layout Enugu and the original Town Planning design in order to determine the difference between current land use pattern of independence layout Enugu and what it was designed to be. A Quickbird image of 2012 and the original town planning design of Independence Layout were used as primary data; Erdas Imagine 9.2 was used for the object based image classification while ArcGIS 9.3 was used for the analyses. The results show the spatial, graphical (map) as well as statistical analyses of recent developments and changes in the design of the study area. The results of this study are relevant in development control by governmental authorities across the globe.

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1. BACKGROUND

This paper is focused on a very vital study. In this study, urban development in Independence layout, Enugu, Nigeria was assessed using its original town planning design and an object based supervised classified remotely sensed imagery of its present state of development. Urban development is the process of building up of urban areas, it requires enforcement of designs and the control of land use which can be political and often technical. It requires researches, strategic thinking, urban and regional planning of communities, the design of a blue print for the physical development as well as an enforcement process to ensure that the development controls are observed.

Geographic information system (GIS) is a computer aided system which is designed and assembled to capture, store, manipulate, analyze, manage, and present many types of geospatially referenced data. GIS gives positional information pertaining to physical features for informed decision making. GIS tools and applications are applied by users to create interactive queries in order to analyze spatial information. (Burrough, *et al*,1998).
Remote Sensing is the process of obtaining information or carrying out observations on an object without making any physical contact with the object. This is done using what are called sensors. The major process involved in extracting this information from the remotely sensed image is called image classification, in this process; we use computer based image processing software to label each pixel to particular spectral classes in order to obtain high accuracy. There are two varieties of classification procedures; they are supervised classification and unsupervised classification.

The supervised classification is the essential tool used for extracting quantitative information from remotely sensed image data (Richards, 1993, p85). In this method, representative parameters are generated for each class of interest using sufficient pixels through the process of training.

2. STUDY AREA

Independence layout is located at a pivotal part of Enugu metropolis; it is a low density part of Enugu urban, Enugu state, Nigeria (See Figure 1), in Enugu North Local Government Area of the State. It is located within 335261.719E and 338025.822E; and 713511.702N and 710461.335N in the UTM Zone 32 N coordinate system.

The layout is the location of the Enugu state Government as well as other key government offices such as the high Court, Appeal Court, Judicial Headquarters, etc. and It has an area of about 200Hectres and a population of up to 120,000 residents.

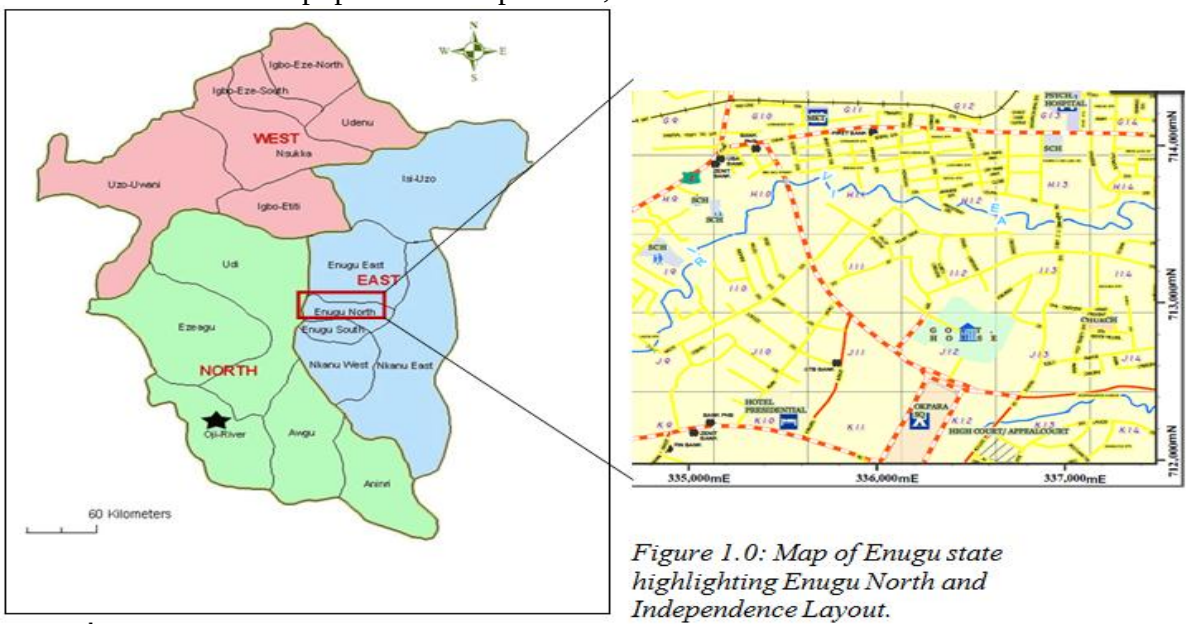


Figure 1.0: Map of Enugu state highlighting Enugu North and Independence Layout.

3. DATA

The primary data used in this study were hard copy of Independence Layout town planning design (made in 1960s) obtained from the town planning the Enugu State Ministry of Lands and Urban Development, and a high resolution (0.6m resolution) Quickbird imagery of 2011 covering the study area. The secondary data includes the ground coordinates observed for georeferencing as well as those observed during ground truthing.

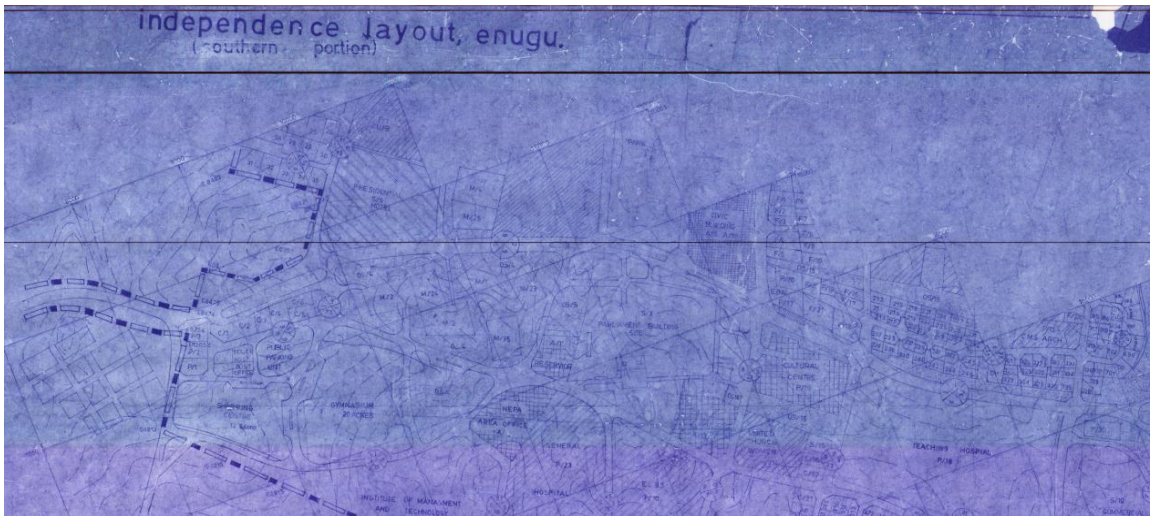


Figure 2 Data: a section of the blue print of the original town planning design of Independence layout, Enugu.

Figure 3 Data: a section the Quickbird imagery of Independence Layout.

4. METHODOLOGY

This section describes the technical processes undergone in this study.
As primary data, the satellite image was already georeferenced, but the accuracy of the positions on the imagery was confirmed by comparing its coordinates observed on the ground; in order to eliminate the little discrepancies noticed, the image was further adjusted through rubber-sheeting. Then it was saved in the .tiff format. The hard copy of the original town planning design of the study area, Independence layout was obtained from the town planning authorities; it was scanned into a picture format (tiff.), and was the georeferenced to the same coordinate system (UTM Zone 32 N) as the satellite imagery using the observed coordinates of some ground control points and ArcGIS 9.3. After georeferencing, shape files were created for different land uses and the design was vectorised. After the vectorisation of the design, the current land use was vectorised from the satellite imagery and information about their uses was sourced from the field through. The already georeferenced image was imported into Erdas Imagine 9.2, this was then converted from .tiff format to .img format for to be used for segmentation. The image segmentation was carried out on the image using user defined constraints which controls the segmentation of different image objects into independent objects. Segmentation is the division of an image into spatially continuous, disjoint and homogeneous regions, i.e. the objects (Jensen, J.R., 1996). After the segmentation the image objects are given meaning or identification by carrying out training which is based on information obtained during ground truthing pertaining to the objects. (Nnam U. G, 2012). The image objects were diligently trained before the actual supervised image classification. In the classification process, classes were assigned to the image objects as well as the different land uses.

During the process of ground truthing, ground coordinates of image points of the different themes (classes) were recorded as well as the different land uses, this information enabled us to check the accuracy of the image classification process that was carried out. At the end of

the process, the classified image showed the present land use pattern on ground. At this stage, using ArcGIS 9.3, the classified (actual use) image was overlaid on the original design of the study area as vectorised from the land use design made by the Enugu state town planning Authorities. See figure 4 as below.

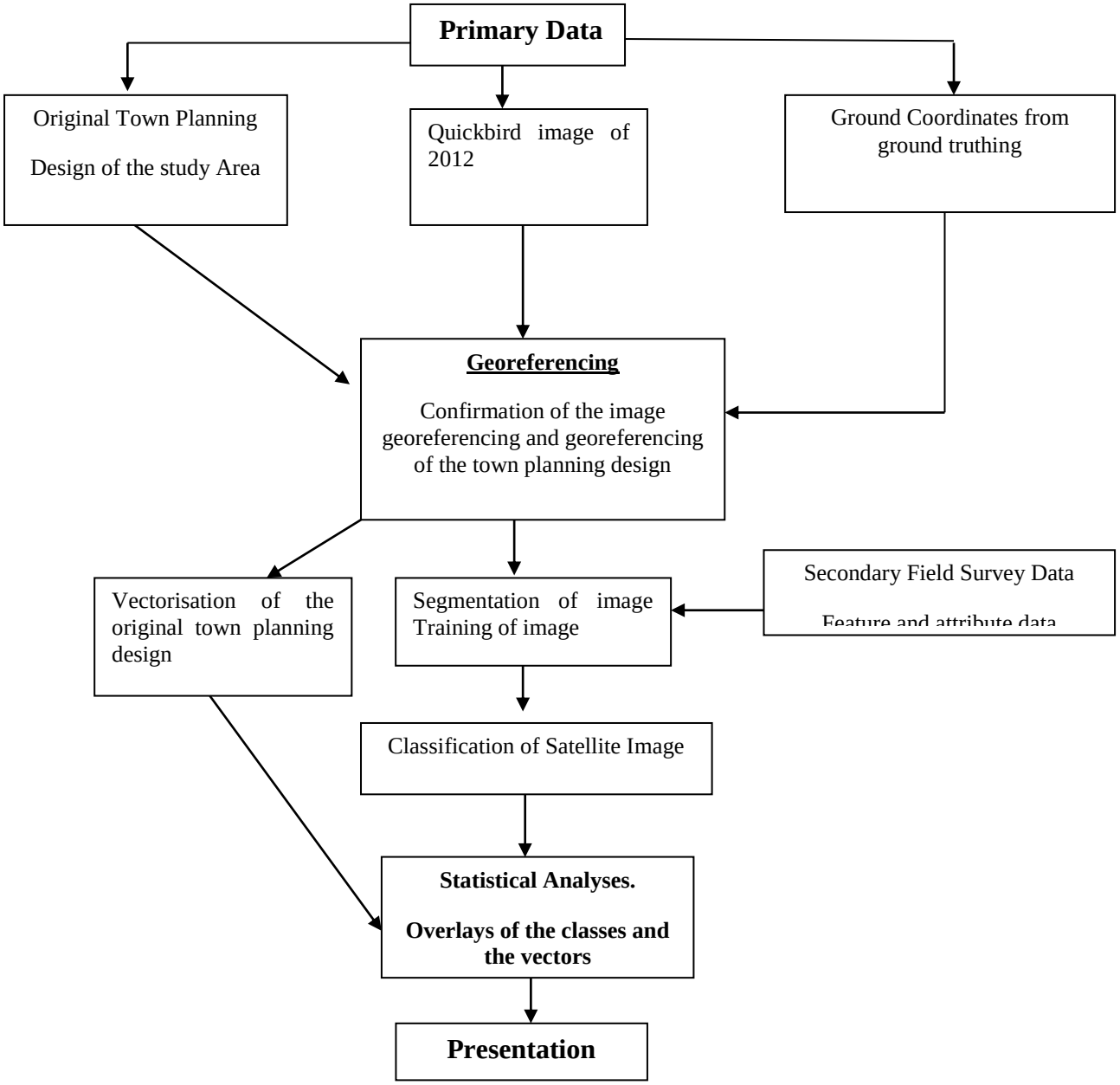


Figure 4 The work flow diagram of the methodology of the study.

5. RESULTS

This study was able to achieve the following end results;

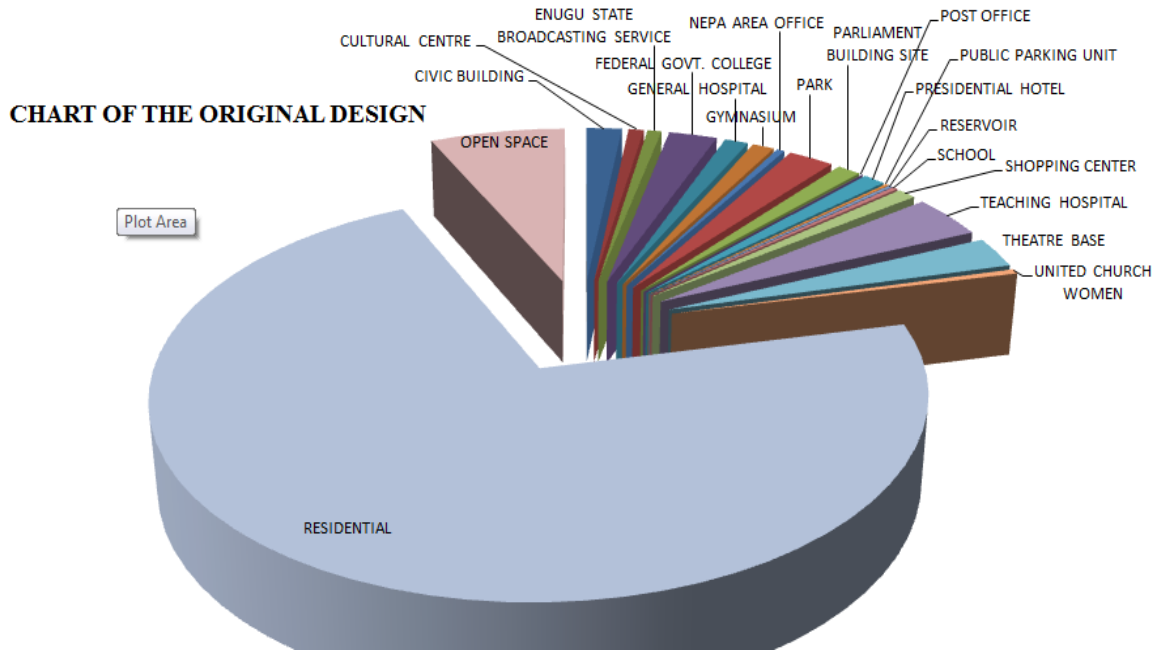
a) A vector map of the original town planning design of the study area.
b) A vectorised map of the present land use pattern in the study area.
c) A classified raster image of the study area.
d) Statistical analyses (pie charts) showing changing in the designed land use and the actual land use.
e) Overlays and comparative analyses between the actual land use and designed land use.

6. ANALYTICAL STEPS

In the course of the study, the following analytical steps were taken in order to asses the results listed above.

6.1 Analytical step one : Statistical Analyses

These analyses evaluate the degree at which land uses and purposes vary between the design and the actual use. This analysis was carried out using the statistical analyst of ArcGIS 9.3. The pie charts were generated from the vector of the design and the vector of the actual use. See figures 5.0 and 6.0 below. If the sectors of the pies be observed diligently, it is clear that the sector for residential purposes in the design is larger than the sector for residential purposes in the actual use, this shows that the government is acquiring more land in that area as a result of increased government activities there. We can also observe a reduction of open spaces between the design and actual use, which means that some open spaces are being subdivided for other purposes. The pies show a great variation between the design and the actual use.



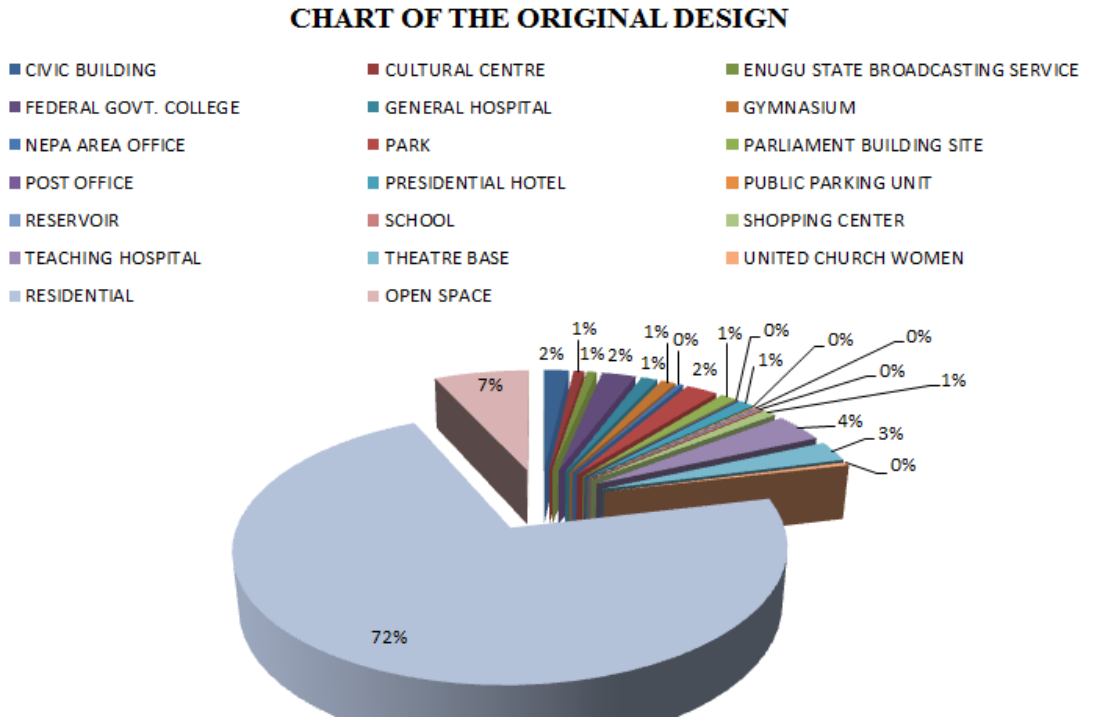


Figure 5 Pie Charts Showing the allocations in the Original design of study Area

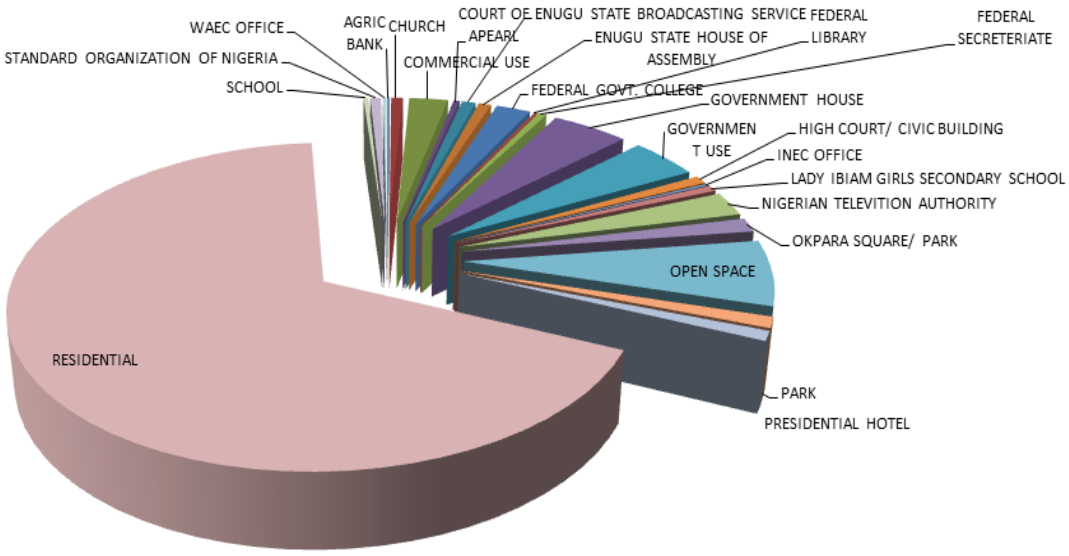


CHART OF ACTUAL LAND-USE AS ON GROUND

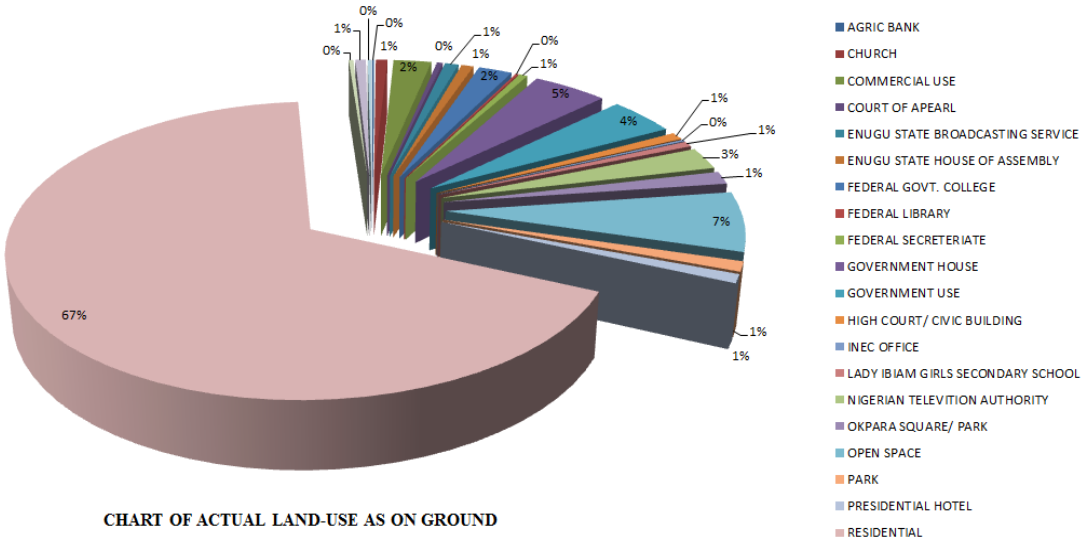
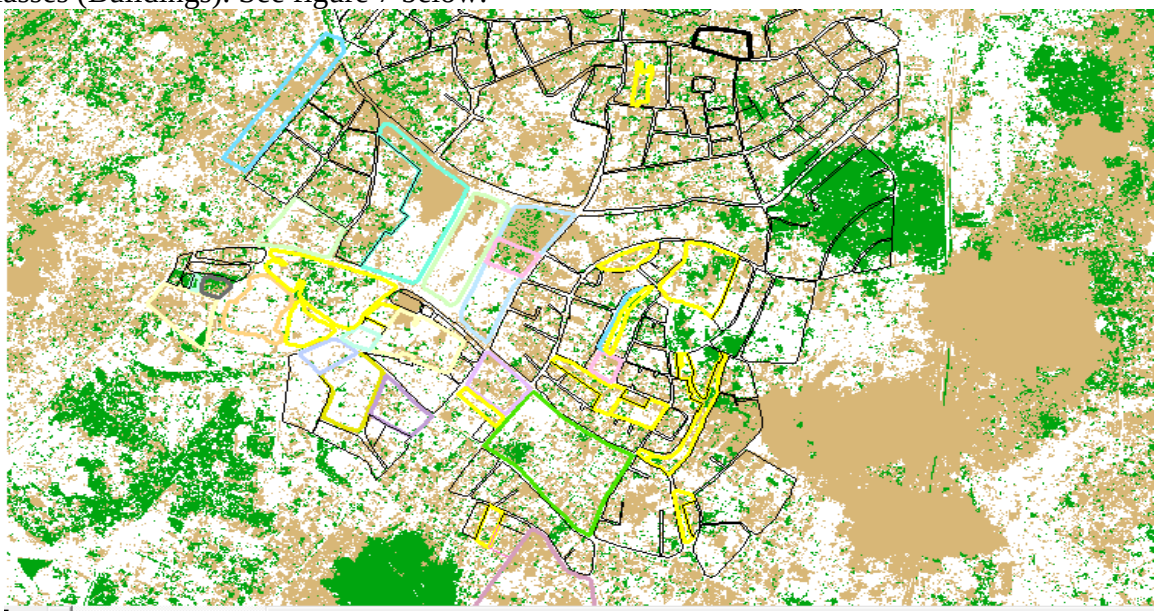


Figure 6 Pie Charts Showing the Actual Uses in the study Area.

6.2 Analytical Step two: Comparative Analyses between design and actual use

Here, the original land use design (in vector form) of the study area was contrasted with the actual land use (classified image). In this analysis, it can be observed that many blocks have been converted to used other than the designed. For example, different land uses as can be seen in the block verged with a green line which was formerly reserved for Teaching hospital which have been subdivided into residential blocks; other places such as the General Hospital (Verged Orange), Public parking spaces (verged brown), Shopping Centre (Verged Milk colour) have been converted to government offices. Most of the open spaces have been converted to residential areas as we can see in area verged yellow (Open spaces) over brown classes (Buildings). See figure 7 below.



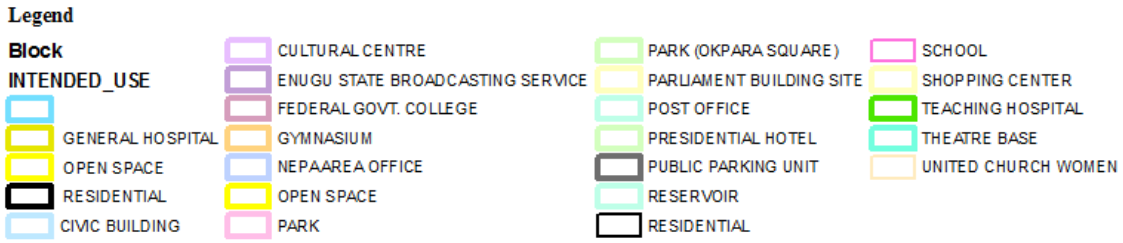


Figure 7 Comparative analyses between the vector of the land use design and the classified image of the current use.

6.3 Analytical step three: Development Controls in the Study Area

This analysis was carried out in order to assess the degree of development control in the study area. If the Vector/Raster overlay in figure 8.0 below is observed, it will be noticed that the road network design have been altered to a great extent particularly in the southern part of the study area. From the classified raster, it will be noticed road network is narrower than the originally designed road width; this indicates that developers encroach into public lands and roads. This may be as a result of little or no development control; the problem stern from the institutional organization of urban planning in Nigeria and such leads uncontrolled development.

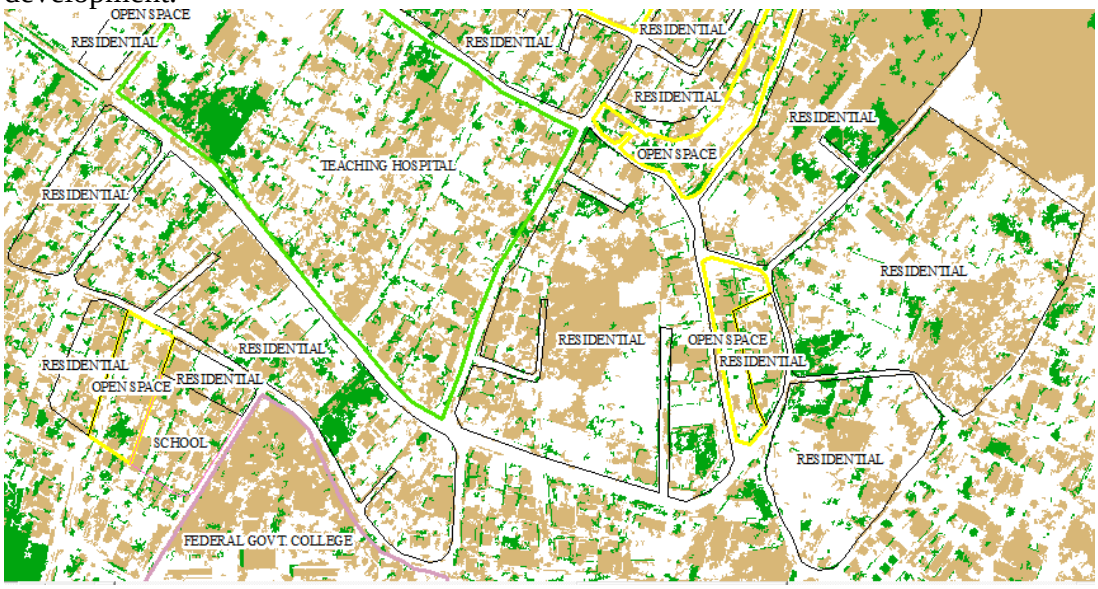


Figure 8 Developments in the study Area.

7. CONCLUSION

In conclusion, this study is timely and relevant considering the present land reform issues in Nigeria. The study has highlighted the benefits of assessing urban development using supervised classification of remotely sensed imageries and GIS. The methodology

demonstrated in this study can be applied by the town planning and lands officers in development control, urban planning, land allocation, re-allocation, etc. This method employs a quick and cost effective way that underscores its advantages over the traditional methods of town planning and development control currently being applied in the study area currently.

7.1 Conclusion-Discussions

So many observations have been made in this study and salient issues were noted. The research team deemed it necessary to discuss the following points as regards the application of this study;

a) Urban development in Nigeria should be assessed from time to time and Town planning designs updated from time to time using the methods demonstrated in this study. This is because it was observed that there was no update in the planning design of independence layout scheme since the first design was made.
b) Proper measures should be put in place by the appropriate Government Authorities in order to enforce development controls, as little or no development controls were observed in the study area.
c) New layouts should be planned by the Government and communities in undeveloped areas instead of mutilating or further subdividing the already planned areas. These practices may turn planned cities into slums.
d) Surveyors and geoinformatician should insist on government approved town planning designs/schemes before carrying out any cadastral or layout survey for any client.
e) It was observed that the problems of urban planning in Nigeria stern from the Land tenure system; that is what differentiates the implementation of the Land Use Act in the Northern Nigeria and that of the Southern Nigeria. Land tenure system remains a barrier to the institutional context of urban development planning and control in Nigeria.

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BIOGRAPHICAL NOTES

GeoSynergy Services LTD is one of the Leading companies in the 21st century geoinformatics and surveying professional practice. It is based in Enugu, Nigeria. GeoSynergy applies cutting edge computer aided geomatics in supplying a wide range of client base with geoinformation for informed decision making pertaining to earth related problems.

Hon. John Okwor Nnam is the Founding father and Chairman of GeoSynergy Services LTD. He has wealth of field experience in cadastral surveying after about thirty years of practice. His major interest is in Cadastral surveying and Estate Development. He is happily married with Grand children.

Surv. Victor Chukwuemeka Nnam is the principal Consultant of GeoSynergy Services LTD. He is registered with the Surveyors Council of Nigeria (SURCON). He holds a Masters Degree in Surveying and Geoinformatics and is currently a PhD student researching in remote sensing in University of Nigeria, Enugu. Victor is an Associate Member of the Nigerian Institution of Surveyors, and a member of the FIG Young Surveyors' Network. He is presently an Adjunct Lecturer II at Enugu State University of Technology (ESUT), Enugu Nigeria. He has a special interest in Surveying, GIS and Remote sensing. He is happily married.

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