MAPPING AND ANALYSIS OF LAND USE AND LAND COVER FOR SUSTAINABLE DEVELOPMENT USING HIGH RESOLUTION SATELLITE IMAGES AND GIS TECHNIQUE

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Background

- Land is definitely one of the most important natural resources, since life and developmental activities are based on the it.
- Land use refers to the type of utilization to which man has put the land. It also refers to evaluation of the land with respect to various natural characteritics. But land cover describes the vegetal attributes of land.
- Land use and landcover data are essential for planners, decision makers and those concerned with land resources management Ndukwe, (1997).
- However, the advent of air-and space-borne remote sensing has made it possible to acquire pre-and post-project landuse and landcover data in consistent manner. In addition, the advent of geographic information system (GIS) has made it possible to integrate multisource and multidate data for the generation of landuse and landcover changes involving such information as the trend, rate, nature, location and magnitude of the changes Adeniyi et al (1999).
- The main goal of this paper is to apparised the integration of multisource archival remote sensed data and GIS in the mapping and evaluation of landuse and landcover changes within the Onitsha metropolis using a well known application. The information obtained will serve as a base for decision making.

Definition of some terms

Planning is the assessment for the future and making provision for it.

Land use is the various ways in which land is put into use. That is, conversion from one land cover category to another (Riebsame, et al, 1994).

Remote sensing (R/S) is the method of acquiring information about an object (target) without making physical contact with the object.

Geographic information system (GIS) is a computerized information system for capturing, storing, integrating, manipulating, analyzing, checking and displaying data, which are spatially referenced to the earth and while

Sustainable Development: This means meeting the needs of present generation without compromising the ability of future generation to meet their own needs.

Purpose of the study

- In most developing countries, especially Nigeria, availability of relevant and current information about our environment and how it changes over time has been lacking, Ezeomedo, (2006). This problem therefore, has consequently been affecting the achievement of change detection and sustainable development, and as such, requires research for accurate and timely information, which is needed for environmental monitoring, planning and forecasting.
- Although, series of works have been done in a conventional system to produce some information on the LULC of some cities in Nigeria, but no much studies have been done using Remote Sensing and GIS technique in its mapping and analysis. Therefore, the application of GIS using remotely sensed data for change detection analysis of Onitsha and its environs would definitely enhance the available data for a sustainable development.

Significance of the study

Why do we need to monitor or analysis the environment?

1. Population Expands
2. Land Values Appreciate
3. Natural Resources needs to be delicately study
4. Human activities continue to stress the quality of our land, water and air and etc.
5. The need for monitoring urban development has become imperative to help curb the problems of urban growth and
6. Monitoring and analysis of the urban environment make use of up-to-date Landuse and Landcover (LULC) information, for proficient and sustainable management of urban areas.

Methodology

Data Used

- This study involved primary data collection and secondary data collection.
- The object-oriented approaches was used for mapping detailed land uses. This approach considers group of pixels and the geometric properties of image objects. It segments the imageries into homogenous regions based on neighbouring pixels' spectral and spatial properties. It is based on a supervised maximum likelihood classification. Thus, an object-oriented method has been applied in this project in to avoid the mixed pixel problems.

Methodology Contd

Data Processing and Analysis

The pre-processing and post image processing and analysis were carried out to enhance the quality of the images and the readability of the features using the spatial analysis tools of Integrated Land and Water Information System (ILWIS 3.3). The scanned and digitized old Topographical map of 1964 and satellite images of SPOT-5, 2005 and IKONOS, 2008 were geometrically corrected and the projection was set to Universal Transverse Mercator (UTM) projection system, zone 32. The spheroid and datum was referenced to WGS84. All the images were geometrically co-registered to each other using ground control points into UTM projection with geometric errors of less than one pixel, so that all the images have the same coordinate system. The nearest neigbourhood resampling technique was used to resample the Topographic map and SPOT-5 into a pixel size of IKONOS during the image-to-image registration.

The ground control points (GCPs) are konwn ground points whose positions can be accurately located on the digital imagery. Such features include road intersections, corners of open field or lawns. Co-ordinates of GCPs were obtained using Global Positioning System (GPS). A sufficient number of such pionts is used to solve the transformation coefficient. A geometric transformation of map-to-map were used for the scanned/digitized topographical map of the study area, in the other hand, an image-to-map transformation were applied to the remotely sensed data of SPOT and IKONOS using Affine transformation, the result of the excercise was checked using Root Mean Square (RMS) error which is the process of measuring the deviation between the actual location and the estimated location of the control points in geometric transformation and was found to be 0.7 pixel.

Methodology Contd

Classification and Post-Classification Overlay

- Classification and post-classification overlay was carried out and thematic land-cover maps for the year 1964, 2005 and 2008 were produced for the study area by supervised classifications using a maximum likelihood classifier. Four major landcover classes were mapped:Built-up areas (BA), open/bare lands (OP), vegetations (VG) including the cultivated and uncultivated land and water bodies (WB); to be able to detect possible details, change trajectory of post classification comparison was used to map the patterns and extents of landuse and lancover in the study area as well as determine the magnitude of changes between the years of interest, 1964, 2005 and 2008, respectively.

Assessment of Classification Results Using Error Matrix

- The error matrix-based accuracy assessment method is the most common and valuable method for the evaluation of change detection results. Thus, an error matrix and a Kappa analysis were used to assess change accuracy, (as in Figure 7). Kappa analysis is a discrete multivariate technique used in accuracy assessments (Congalton and mead, 1983; Jensen, 1996).

The Study Area

- Onitsha and its environs lies in the north-western part of Anambra State, in South-Eastern Nigeria. The settlements covered by the study include: Onitsha, Obosi, Nkpor, Okpoko and Iyiowa Odekpe (see figure 1 to 3). It is located between Lat. 06^0 38' 34''N and Log. 06^0 59' 30''E and Lat. 06^0 02' 56''N and Log. 06^0 37' 30''E.
- The area is about 3,063 square kilometer. It serves as the gate way between the South-Eastern and South-Western part of Nigeria.
- The population figure of Onitsha Metropolis according to 1991 and 2006 population census of Federal Republic of Nigeria is presented in Table 1.
- The metropolis since it is found about 1680, has been a center of commercial activities, an ecclesiastical center and an administrative center Mozie, et al (2008).
- Onitsha and its environs constitute one rapidly urbanizing region. The urbanization process was correctly anticipated by Ezeomedo, (2012), while investigating and modelling the urban sprawl pattern of Onitsha.
- The vegetation of the study area is a sub-climax of the original rainforest, having been virtually cleared due to development. The area mean annual temperature is between 22˚c to 27.5˚c and Mean annual Rainfall is between 1,500mm to 2,500mm. South west monsoon harmattan winds are experienced around January, May and September respectively.

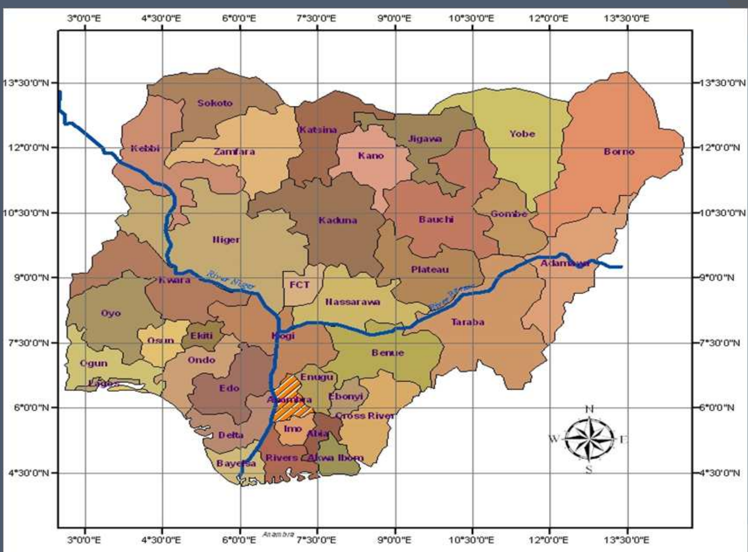


Figure. 1. Administrative map of Nigeria Showing Anambra state.

Source: Ezeomedo, (2012).

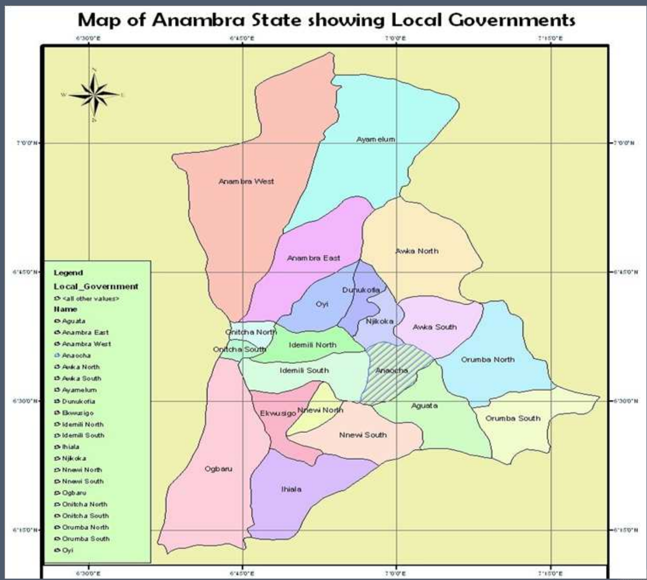
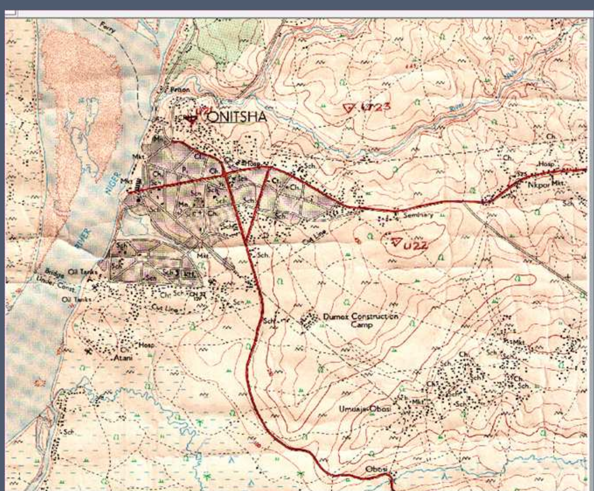


Figure. 2. Map of Anambra State Showing Local Government Areas.

Source: Ezeomedo, (2012).



06⁰ 38′ 34′′N

N

06⁰ 02′ 56′′N

06⁰ 37′ 30′′E

06⁰ 59′ 30′′E

Figure 3: The Study Map of Onitsha Metropolis.

Source: Ezeomedo, (2012).

RESULTS AND DISCUSSION

Result of land cover mapping

- The outcome of the data processing and analysis were presented in form of digital maps, layout and attribute tables. The area covered by the three-class land cover maps of 1964, 2005 and 2008 are shown in Figure 4, 5 and 6 respectively, figure 7 shows the accuracy of the assessement in terms of average User's accuracy, average producer's accuracy and overall accuracy, and while figure 8 shows trend analysis of the land cover types.

Change Detection Results

- In LULC mapping, the post comparison technique is the only method that resulted in a change matrix that provided ''from-to'' information. The land cover changes were computed between 1964 and 2005 and between 1964 and 2008, table 4 and 5 depicts what happen between 1964 to 2005 and between 1964 to 2008 respectively, the capability of the resampled topographic map was assessed from the results of SPOT- 5 and IKONOS images. The overall result of change detection shows that as urbanization is increasing, the vegetation is decreasing as depicted in figure 8.

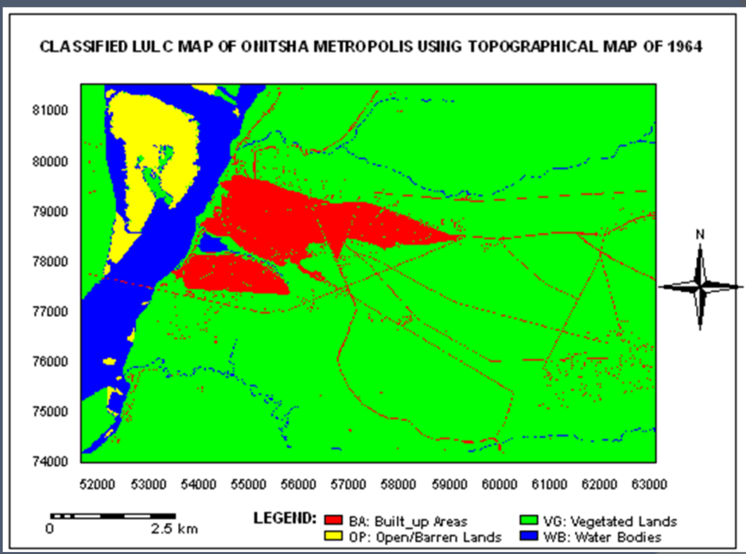


Figure 4: Classified Topographical Map of 1964.

Source: Ezeomedo, (2012).

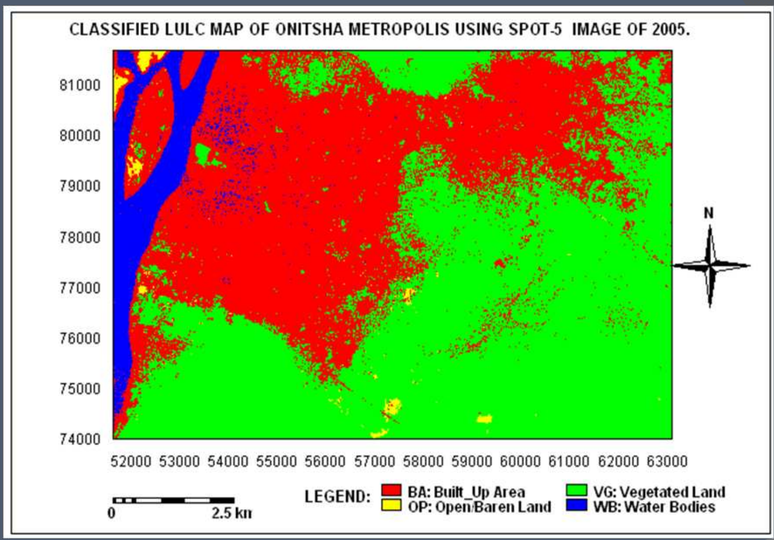


Figure 5: Classified **SPOT-5** of 2005.

Source: Ezeomedo, (2012).

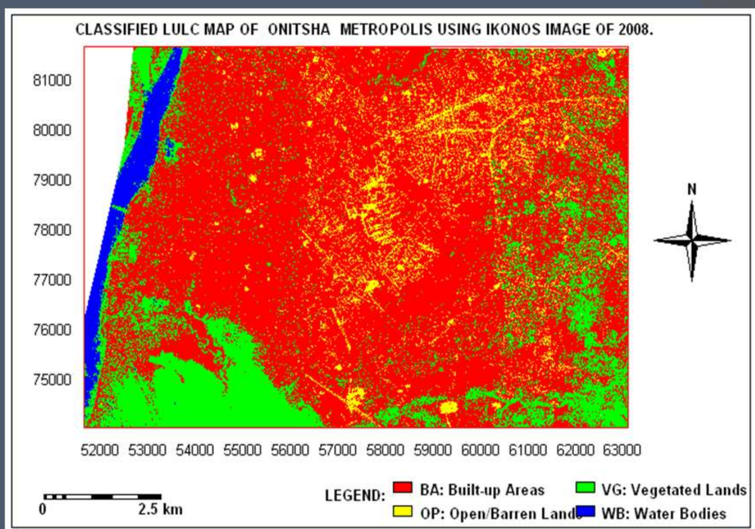


Figure 6: Classified **IKONOS** (2008).

Source: Ezeomedo, (2012).

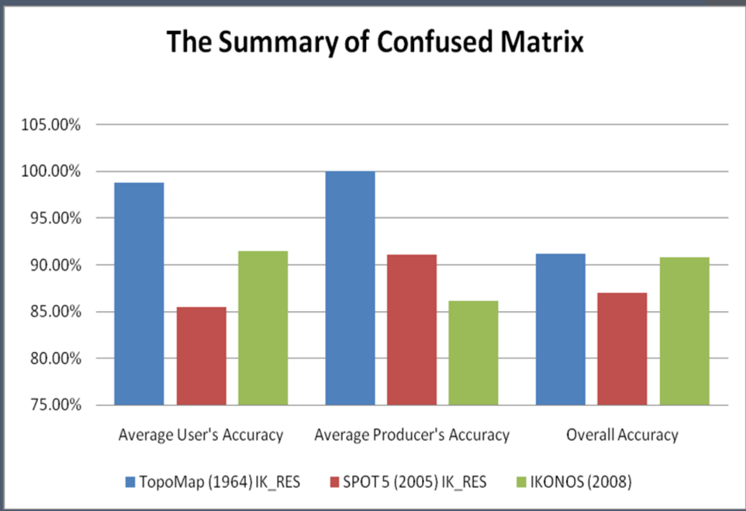


Figure 7: The Evaluation of Classification Results using Error Matrix.

Source: Ezeomedo, (2012).

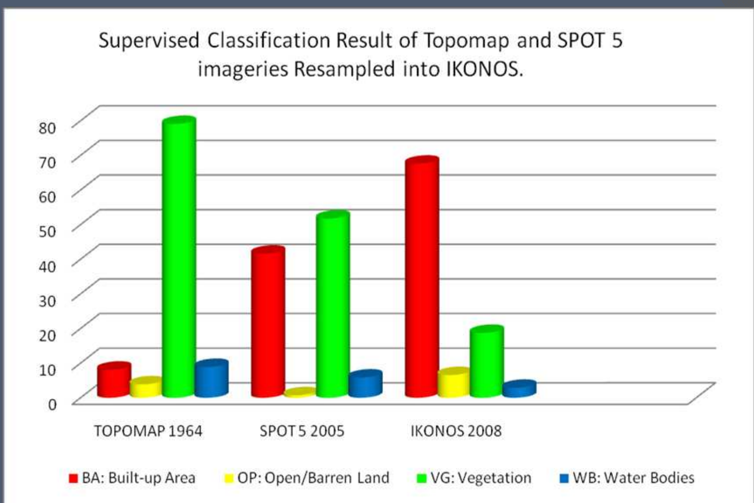


Fig. 8: The Summary of LULC Classification using High Resolution Imagery.

Source: Ezeomedo, (2012).

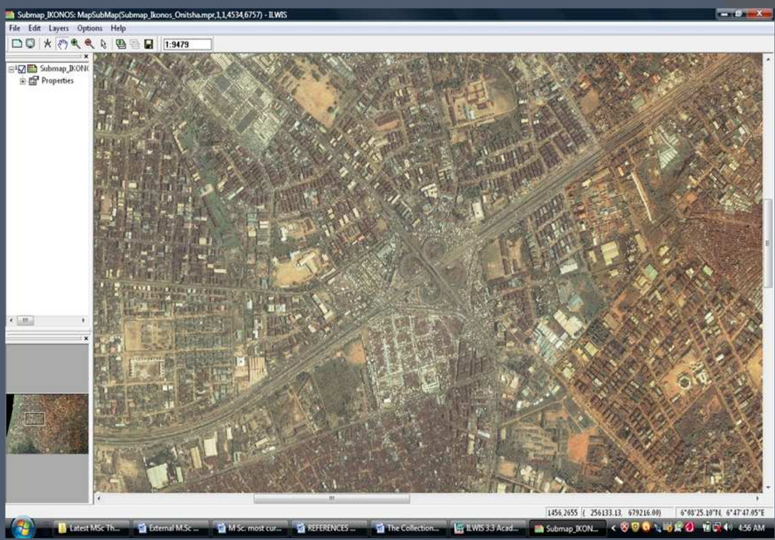


Figure 9: **IKONOS** (2008) image of Onitsha, Showing the CBD.
Source: Ezeomedo, (2012).

Table 1: Result of Change Detection between 1964 and 2005.

Classes	Topographical map (1964)	SPOT-5(2005)	Change Detection (1964-2005)	Annual Rate of Change	Projection (2021)
Built-up area	08.12.%	41.64%	33.52%	00.81%	54.72%
Open/Barren Land	03.88%	00.74%	-03.14%	-00.07%	00.38%
Vegetation	79.10%	51.78%	-27.32%	-00.66%	-41.12%
Water Bodies	08.90%	05.84%	-03.06%	-00.07%	-04.72%

Source: Ezeomedo, (2012).

Table 2: Result of Change Detection between 1964 and 2008.

Classes	Topographical map (1964)	IKONOS (2008)	Change Detection (1964-2008)	Annual Rate of Change	Projection (2021)
Built-up area	08.12.%	67.62%	59.50%	01.35%	85.17%
Open/Barren Land	03.88%	06.57%	02.69%	00.06%	07.35%
Vegetation	79.10%	18.74%	-60.36%	-01.37%	-00.93%
Water Bodies	08.90%	02.88%	-06.02%	-00.14%	-01.00%

Source: Ezeomedo, (2012).

DISCUSSION

- The result of the land use/land cover change as was analyzed using object-oriented approach which was based on a supervised and Gauss maximum likelihood classification method. Statistical means shows that there was both positive and negative change as depicted below.
- —**Built-Up Areas:** They were a great positive change in the built-up areas, the built-up areas formerly occupied a proportion of 8.12% in 1964 and increased to 41.64% and 67.62% in 2005 and 2008 respectively. Its a clear indication of increase in population and infrastructure development in the metropolis.
- —**Open/Barren Land:** This class recorded both positive and negative change over the year under study. Bare surface proportions were 3.88% in 1964 but were decreased to 0.74% in 2005 and were increase again to 6.57% in 2008. This can be attributed to human activities, which includes, over grazing, indiscriminate bush burning, fire wood extraction which are some of the characteristics of most regions of Nigeria. Although, it was observed that development that are recent and their roofing was done with white aluminum roofing sheet have a conflicting spectral signature with this class.
- —**Vegetation:** Agricultural lands also regardless of type of crops and their level of intensity; cultivated or uncultivated show a negative increase. In 1964, it was 79.10% and while in 2005 its 51.78%, again in 2008 were declined to 18.74%. This can be as a result of built-up areas above, which include construction of all capacity.
- —**Water Bodies:** The water bodies recorded a negative change although very minimal in nature. In 1964 result shows 8.9%, while in 2005 and 2008 this class represents a proportion of 5.84% and 2.88% respectively. This may be due sand deposit, land reclamation and other developmental activities along the coast, again, the available NigeriaSat-1 imagery were slightly smaller in size around the water body's area.
- The capability of the digitized and classified topographic map shows that it can serve as basemap for monitoring the constant changes in the built environment.
- Planners and Urban Developers will find it very useful as reference for monitoring and planning the built environment for *a Sustainable Development*

CONCLUSIONS

- The present study demonstrates the usefulness of satellite data for the preparation of accurate and up-to-date land-use/land-cover maps depicting existing land classes for analyzing their change pattern for Onitsha metropolis by utilization of digital image processing techniques.

- Result of classification clearly shows constant positive increase in urbanization and balanced decline in the urban vegetation.

- LULC map is expected to be useful for formulating meaningful plans and policies so as to achieve a balanced and sustainable development in the region. Satellite imagery can be very effective and fast in change detection of landuse and landcover changes.

RECOMMENDATIONS

- It is suggested that Government should encourage its personnel through funding, so that changes in landuse at regular interval will be detected. If such funds are made available, more research should be focus towards the use of modern application; such as satellite imagery, GIS and digital equipment to obtain fast and accurate digital data or information.

  Since ground survey methods are not convenient and aerial or photographic maps production are very expensive and time consuming

- The study also recommended that the Government and public agencies concerned should develop policies and strategies to achieve a balanced, coordinated and sustainable development in the urban area and its environs.


THANKS!
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