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Research paper

Monitoring land cover change and population growth, A study case of Obio/Akpor Local Government Area, Nigeria

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Abstract

Remote Sensing provides earth surface data use in mapping and monitoring the built environment and other land uses. This work aims to monitor land cover change and Population growth in Obio/Akpor LGA, Rivers State, Nigeria using Global Land cover 30 data and Worldpop data between2000 and 2020 for land cover and 2010 to 2020 for population. Global Land cover30 of 2000 - 2020 used to map and detect land cover change while the Worldpop of 2010 and 2020 used to map population growth. The outputs of the work show that artificial surfaces (built-up area) increase by 33.75 % from 2000 to 2020, similarly built-up area population will increase by 38.66 % between 2000 and 2020.Bare land recorded the highest expansion of 418.71% from 2000 to 2020. Wetlands reduce by 1.36% and forest also reduces by 37.05%, the effect of deforestation on climate change continues. Change detection techniques using Geographic Information System (GIS) and remote sensing remain the most cost effective way of monitoring the environment for better planning and informed decision making.

Keywords: *Change Detection; Landcover; Population; Obio/Akpor LGA; GIS.*

1. Introduction

Urban growth occurs as a consequence of increase in city population and economic activities resulting in infrastructure expansion (El-Magd et al., 2015). According to El-Magd et al., (2015), urban growth is a planned development or projected city expansion while urban expansion is unplanned development. Urban sprawl takes place in most of the third world cities. Oil and explorations and exploitation in Nigeria Niger delta led to increased population & urban sprawl as a result of higher economic activities within the region. Obio/Akpor local government area is one of the four council's area that made the Greater Port Harcourt city master plan. Urbanization always leads to change in land cover and land use. Obio/Akpor local government area rapid urbanization problems face adequate monitoring data for effective planning and development control. Urban expansion (sprawl) leads to increased demand for land and changes to quality of life (Al-Bilbisi, 2019). Remote sensing technique is useful for characterization, mapping and monitoring urban expansion and growth (Al-Bilbisi, 2019). Information on land cover and land use are fundamental in measuring human activities over time (Al-Awadhi and Azaz, 2009). Land use and land cover (LULC) changes are important concerns for global environmental change (Andualem et al., 2018). Changes in land use and land cover and population growth are factors in determining urban growth and distributions of economic resources and development (GAF, 1999). Therefore, knowledge of land use and land cover change is important for integrated modeling and assessment of distribution of social amenities. Thus, in order to understand population growth human activities pattern, a good knowledge of the changes is important to identify the possible location where human communities need intervene in other not to alter the impact on the environment (GAF, 1999).

According to GAF (1999), there were approximately over 5.8 billion people living on Earth in 1999. This doubles the world population of 1950. The world's major population of about 4.7 billion lives in third world countries, in addition about 1.1 billion for industrialized nations (Population Reference Bureau 1997: GAF, 1999).
Interest in the environment is wide and takes place at various levels and scales, from local to regional, from national to international and global. Overpopulation impacts are (GAF, 1999);

- Short in the supply of food and water which leads to famines and diseases
- Increased flooding caused by wrong use of the land, particularly wetland
- Pollution of water, air and land
- Rural urban migration leading to shanty and slums

The migration of people to urban areas is a common feature especially in the underdeveloped areas of the world (GAF, 1999). Change detection is use in remote sensing by comparing between two or more images in time. According to Bhatta (2011), these changes can be seasonal and annual changes. This study uses Global land cover 30 dataset of 2000, 2010 & 2020 and World pop dataset gridded global population product of same period.

This work aims to map land use change and estimate population growth in Obio/AKpor Local Government area, using GIS and satellite data for 2010 and 2020.

1.1. Objectives

- To estimates the various land cover population growth between 2010 and 2020 within the study area.
- To determine the sizes of various Land cover of 2000, 2010 and 2020, and
- To detect changes of various Land cover between 2000, 2010 and 2020

1.2. Planning and urban growth

The growth in human population and the increase in our technical capabilities have brought about an important qualitative change in the processes that affect the earth surface. The many and varied problems which affect our environment are in most cases interdisciplinary in nature GAF (1999). Planning the use of the Earth's resources must always consider the interests and demands of widely different user groups and the change in environmental paradigms over time GAF (1999). Interest in the environment is wide and takes place at various levels and scales, from local to regional, from national to international and global(Campbell, 2002). The demand for geo-spatial information for planning is tremendous at all levels. The major role of remote sensing data is that it can provide spatially continuous data and information for the mapping and monitoring of the physical environment, which in turn can serve to protect our environment (Campbell, 2002). Information on land cover and land use are fundamental to many environmental protection and planning activities.
According to Campbell (2002), Changes in land use (LU) and land cover (LC) have an impact on the interactions between land and atmosphere; they contribute to changes in the biogeochemical cycles of the Earth and the atmospheric levels of greenhouse gases. Therefore, knowledge about land use and land cover change is important for integrated modelling and assessment of environmental issues in general. Thus, in order to understand global environmental change, a firm understanding of the changes is necessary to identify the possible sites where human communities can intervene and alter the impact on the environment.

1.3. Landuse/ landcover (LULC)

Image classification is the process to recognize the geographical features in the digital remotely sensed images and categorizing all pixels into classes (Campbell, 2002). Image classification process is carried out automatically using software tools or mathematical programs. The tools treat each pixel as an individual unit with values in several spectral bands.
LULC classifications act as input data for many further applications (e.g. regional planning, hydrologic modelling etc.) and LULC classification schemes contain land cover classes as well as land use classes (Hofmann, 2015). Land Use is defined as the use of land by humans, usually with emphasis on the functional role of land in economic activities (Gilbes, 2016).
Land Cover indicates the physical features that occupy the surface of the Earth, such as water, forest, and urban structures (Gilbes, 2016). According to Gilbes, (2016), in a much broader sense, land cover designates the visible evidence of land use, to include both vegetative and non-vegetative features and example is dense vegetation, grass, urban structures, and parking Lots. Land cover includes water, ice, bare rock, and sand surfaces (TEMS, 2001).

Gilbes (2016) has divided the significance into three:
State Level: It is vital for making important decisions.
National Level: It is an important element in forming policies regarding economic, demographic, and environmental issues.
International Level: It focuses upon today's major concerns considered at their broadest possible scales.
According to (FAO 2005), a classification describes the systematic framework with the names of the classes and the criteria used to distinguish them, and the relation between classes. Classification thus necessarily involves definition of class boundaries that should be clear, precise, possibly quantitative, and based upon objective criteria (FAO 2005). According to FAO (2005) basic principles adopted in the new approach is that a given land cover class is defined by the combination of a set of independent diagnostic attributes, the so-called classifiers and increase of detail in the description of a land cover feature is linked to the increase in the number of classifiers used. That is, the more classifiers added, the more detailed the class and emphasis is no longer on the class name, but on the set of classifiers used to define this class.

2. Study areas

A Obio/Akpor LGA is one of the Twenty-one local government areas of Rivers State and its administrative headquarters at Rumuodomaya. Obio/Akpor LGA was created on May 3, 1989 by the former military leader Ibrahim Babangida from Port Harcourt city council. The native speak the Ikwerre dialect and major economic ventures are farming and fishing with an estimated population of 228,828 (NPC, 2006).
Obio/Akpor LGA lies within latitude 4.938920N to 4.772673N and longitude 6.880542E to 7.142855E. The equatorial location of the study area is located within the equator with average temperature average of 25°c to 28°c and annual precipitation of 2000mm - 2500mm between April to October (Richard and Agnidé, 2020). The high temperature throughout the year causes higher humidity because of its latitudinal location (Eludoyin et al, 2011).The local vegetation is a typical Niger delta such as mangrove forest, raffia palm, and tropical rain forest (Oludoyin et al., 2011; Richard and Agnidé, 2020), and mangrove within the coastal areas(Eludoyin et al, 2011). The hydrology is characterized by salt water and tributaries into the Atlantic Ocean, non-salt water exists within the upland streams and canals (Richard and Agnidé, 2020). The soil types are mainly nitisols, fluvisols, and ferralsols (Sonneveld 1996; Richard and Agnidé, 2020).

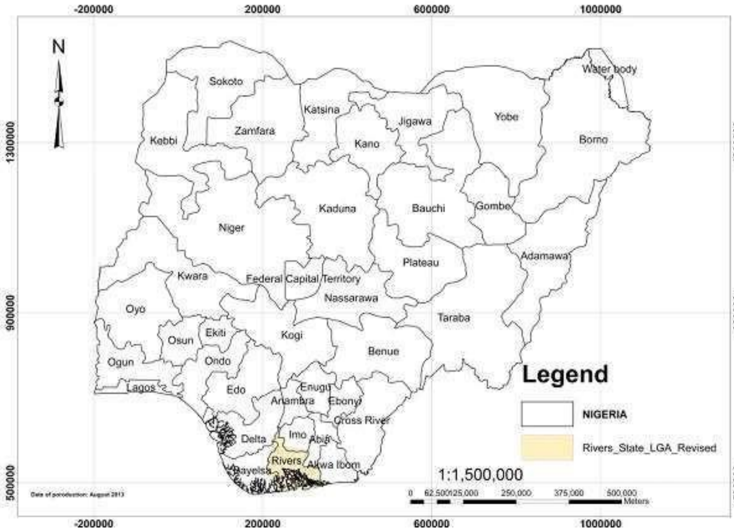

Fig. 1: Situation Map of Rivers State and Location of Obio/ Akpor LGA.

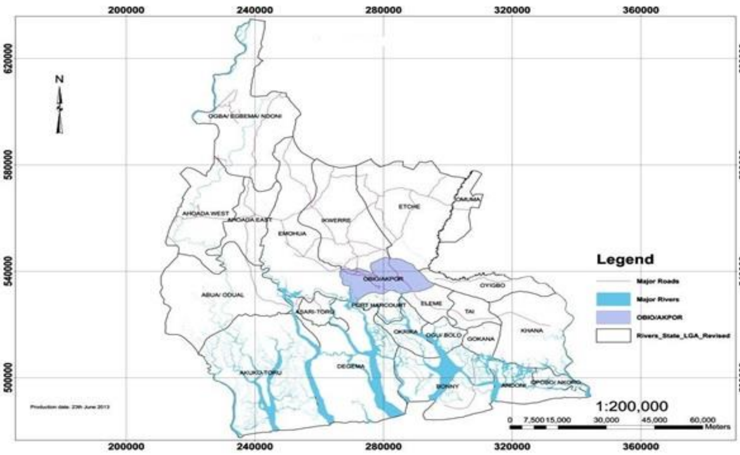

Fig. 2: Situation Map of Rivers State and location Obio/ Akpor LGA.

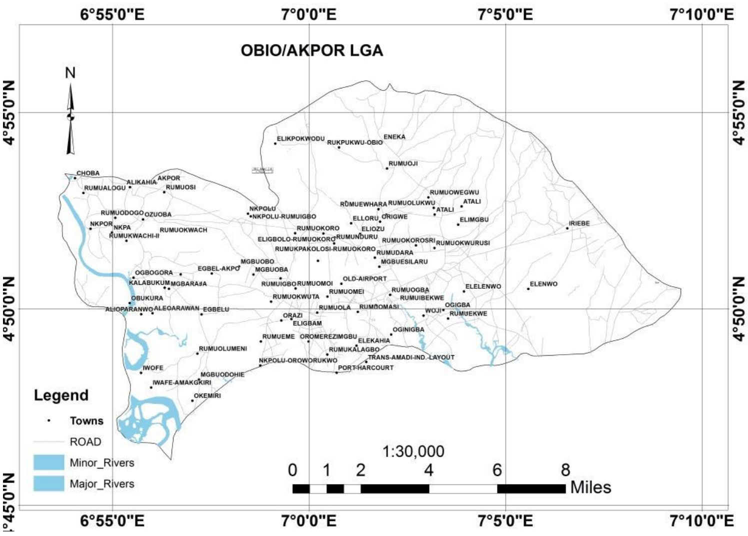

Fig. 3: Situation Map of Obio/ Akpor LGA.

3. Methodology

Geospatial concepts: Zonal Statistics: Zonal statistics algorithm calculates and summarizes statistics of the raster dataset layer of each feature or entity of an overlapping polygon vector layer and output in a table. That is, the digital number statistics of values of the input raster within the zones of another dataset is calculated. Zones are cells of a raster dataset with the same value, whether contiguous or not. Various geospatial concepts such as clip analysis, masking, dissolve, expressions and vectorization etc., was used in data processing and matching.

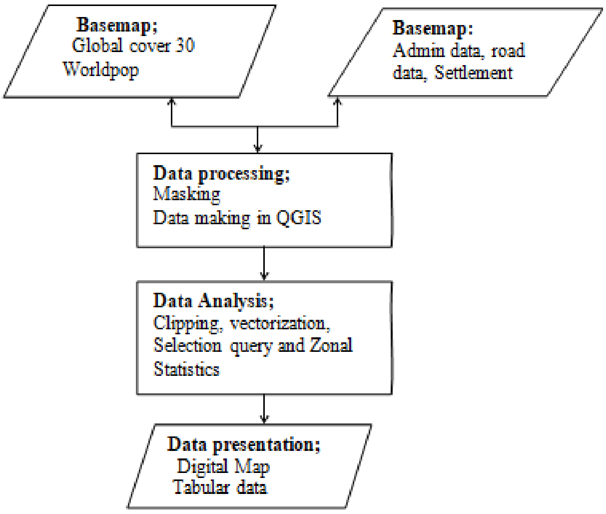

Fig. 4: Situation Map of Obio/ Akpor LGA.

Methods: QGIS was used to process data from different sources. Global cover 30 data of 2000, 2010, and 2020 along with Worldpop dataset of 2010 and 2020 were used to determine various land cover and change detection and population of various land cover. The datasets were up to date and therefore useful for the classification in a straightforward manner. The various Landover were simply classified since it was a post-classification dataset with digital number (DN) and vectorised. Change detection analysis carried out on the land cover spatial temporal data between 2000, 2010, and 2020. The vectorised datasets were used to extract the population of each land cover in QGIS from the Worldpop dataset of 2010 and 2020.

Methodology major workflow:

- Administrative and other Base maps dataset.
- Data processing and matching
- Data analysis.
- Tabular data and raster visualization

4. Results and discussion

Various results were obtained from the data analysis and presented in this section in the form of raster continuous surfaces (see Fig. 5 & 6) and Table 1 & 2. The Artificial surfaces (built-up areas) land cover was 24.23% in 2000, 24.07% in 2010 and 32.40% in 2020 the highest size of the Landover area between the periods of study. Furthermore, shrubs were the lowest in 2000 and 2020 with 1.33% and 2.42% respectively, water bodies were the lowest in 2010 with 2.47%. Changes were detected in all the land cover within the study area. The Artificial surfaces (built-up areas) class recorded an increase of 33.75% between the periods of 2000 to 2020. Under the same period of 2000 to 2020 bare land class increased by 418.71%. Deforestation question continues as forest class reduces by 37.05%. Water bodies increase by 10.88% indicating the possibility of flooding. The population of the artificial surfaces (built-up areas) increases by 38.66% between the periods of 2000 to 2020. Post-classification data (land cover) was used in this work. Hence, ground truthing and in-situ data needed for future research.

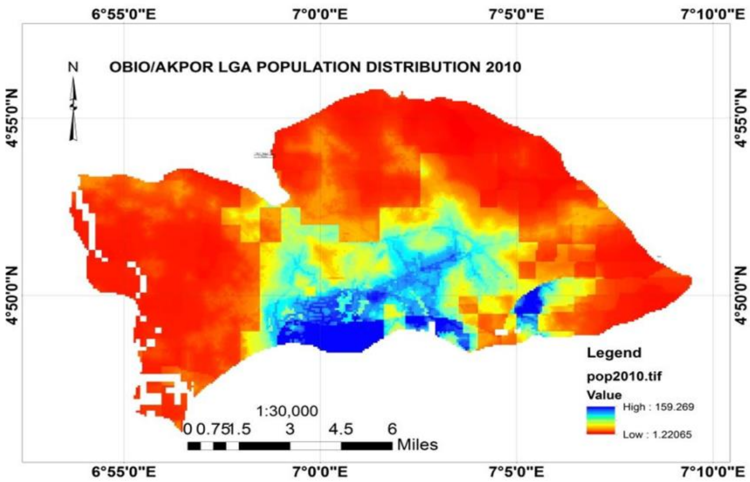

Fig. 5: Map of Obio/ Akpor LGA with 2010 Land Covers Distribution.

Table 1: Obio /Akpor Local Government Area Land Cover Sizes

Land Cover	Area m²	%_2000	Area m²	%_2010	Area m²	%_2020
Cultivated Land	26766900	9.62	23700600	8.52	25749900	9.26
Forest	65115000	23.41	45162000	16.24	40989600	14.74
Grassland	87225300	31.36	64121400	23.05	53352000	19.18
Shrub Land	3808800	1.37	7280100	2.62	6729300	2.42
Wetland	11187900	4.02	11092500	3.99	11035800	3.97

Water bodies	6310800	2.27	6870600	2.47	6997500	2.52
Artificial Surfaces	67373100	24.23	66937500	24.07	90113400	32.40
Bare Land	10311300	3.71	52977600	19.05	43174800	15.52

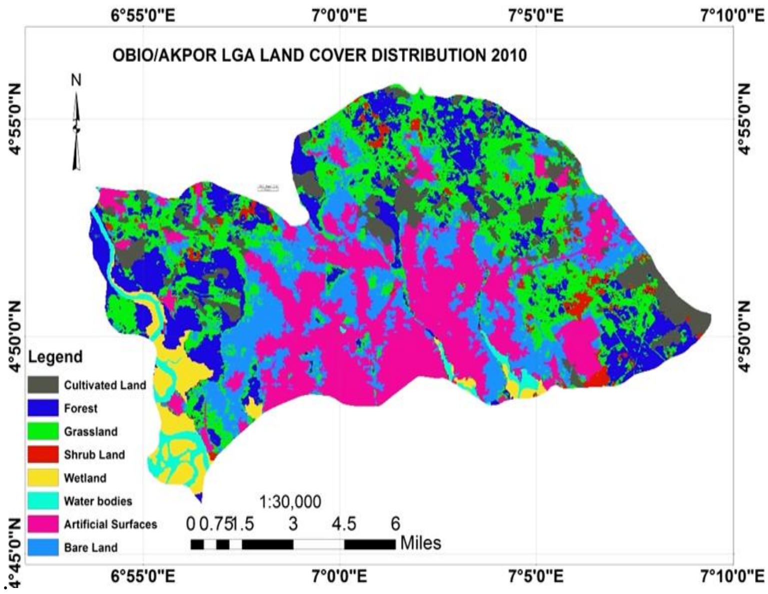

Fig. 6: Map of Obio/ Akpor LGA with Land Cover 2010.

Table 2: Obio/ Akpor Local Government Area Land Cover Sizes

Land Use/Cover	Pop2010_Sum	Pop2020_Sum	Growth_2010 -2020	%_pop_Growth
Cultivated Land	17390	19677	2287	13.15
Forest	29438	30140	702	2.39
Grassland	70777	71685	908	1.28
Shrub Land	8941	9804	862	9.64
Wetland	8666	9847	1181	13.63
Water bodies	6067	7314	1247	20.56
Artificial Surfaces	335065	464585	129520	38.66
Bare Land	144014	147146	3132	2.18

5. Conclusion

The results show that the different land cover experienced either expansion or reduction at various scales indicating change was detected; however, the biggest surprise was Bare Land with an increase of 418.71% between 2000 and 2020. The built-up area was found to expand by 33.75% between 2000 and 2020 with 38.66% increase in population from 2010 and 2020.The forest reduced by 37.05% while water bodies increased by 10.88%. This implies that urban expansion is proportional to deforestation while the increase in water bodies requires more investigation using precipitation index and tidal monitoring as a subject of further study.
Effective monitoring of the environment requires projections of land cover changes and will in turn offer a means for assessing the impacts of global environmental changes with respect to man activities. Historical spatial data used in this study show how the dynamics of natural and man-made processes in the environment requires the integration of several layers of spatial information.

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