ASSESSMENT OF SPATIOTEMPORAL LAND COVER CHANGE IN CALABAR MUNICIPALITY

Eteng, E.O*

Offiong, R.A.

Ekpe, I.A.

ABSTRACT

The study examined the spatiotemporal land cover changes that are currently taking place in Calabar Municipality. Spatiotemporal features like urban green areas, wetlands, riparian forest and other forest and grassland ecosystems are currently giving way for new roads construction, residential and industrial layouts, recreation and amusement parks etc. This is attributed to the current trend of rapid economic, social, cultural and political development that is taking place in Calabar. Data for the study was obtained from aerial photographs and was considered from 2004 – 2012. An irregular interval between 2005 to 2009 and 2010 – 2012, was adopted in determining the changes that have occurred alongside effects on the spatiotemporal features. Remote sensing and geographic information systems (Arc view GIS 9.3 software) technology was used in change detection analysis. From the study, it was revealed that the population of Calabar Municipality has witnessed asteady upward trend from 143,089to 179,392within the periods of 1991 and 2006, and the amount of built up area has increased from 91.55 square kilometers within 2005 – 2009 to 98.712 square kilometers between 2010 and 2012. Hence, about 33.68 square kilometers of spatiotemporal Land cover change have taken place. However,land cover changeswere more accelerated between the periods of 2005 – 2009 with an average of 5.304 square kilometers per annum as compared to 2010 – 2012 which had an average of 2.39 square kilometers per annum. This continuous removal of natural vegetationwould pose several environmental consequences. Therefore, caution should be applied in this phase of urban rapid growth and development.

Key Words: Calabar Municipality, Land coverchange, Urbanization, Spatiotemporal features.

* Dept. of geography & Environmental Science, University of Calabar, Nigeria

Introduction

Urbanisation has been identified as one of the most powerful and visible anthropogenic forces on earth (Dawson, Hall, Barr, Batty, Bristow, Carney, Walsh, 2006, 2006; United Nations Habitat Report, 2011; Oloke, Ijasan, Ogunde, Amusan & Tunji-Olayeni, 2013). It is a process and outcome of social changes, in-flow andconcentration of people and activities in cities (Adeniji & Ogundiji, 2009; Oloke et al. 2013). The dynamics of the process is drivenby changes in population, employment opportunities associated with industrialization, consumption patterns,international migration and accessibility (Dawson, et al., 2006; Oloke et al. 2013).Within the last two and a half decades, Calabar municipality has experienced unprecedented urban growth. This has led to alternation and alteration of several land uses. These land use alternation and alteration has impacted negatively on the spatiotemporal Land cover features such as urban green areas, wetlands, riparian mangrove forest and other forest and grassland ecosystems;which are currently giving way for the construction of new roads, new residential and industrial layouts, recreation and amusement parks etc. (Hansen et al. 2005; Oka, 2009). This phenomenon has triggered conspicuous land cover changes. According to Atu, Offiong, Eni, Eja, &Esien, (2012), in the past decade, the city's built up area burst outward in an explosion of sprawl that consumed former agricultural land at a break-neck pace. Thousands of hectares of…lands are covered by concrete and asphalt as new roads are created and existing ones are extended. Over 5,200.09 hectares of…land at Ekorinim, Esuk Utan, Edim-Otop,…and Ikot Efanga have been converted to low density residential, commercial and industrial uses as these areas are merged with the urban areas. This development is consequent on the growth of the population of Calabar. For instance in 1991, the population of Calabar Municipality was 143,089, with a density of less than a thousand person per square kilometer. In 2006, the population recorded was 179,392 with a population density of above a thousand persons per square kilometer (Cross River State Economic Blueprint 2007-2008).

The current status of Calabar as a tourism destination in Nigeria and the entire West African sub – region has attracted continued influx of people and investors into the towns that make up the Calabar metropolis, this has added to the already existing population increase induced by the Calabar Port, TINAPA business resort, the Calabar, Free Trade Zone, The University of Calabar Community and now the ongoing construction of the International Conference Centre with a seating capacity 2000 persons. As a matter of concern all the key areas

of interest are located in Calabar Municipality, adding to its already existing economic and political roles as the Central Business District (CBD) of Calabar. Thishave led to the continued buildup of pressure on the available land resources, leading to continual landcover change and the consequent loss of important ecological spatiotemporal featuressuch as earlier mentioned.

Spatiotemporal features must be planned along with other city policies because they are important spaces that maintain the quality of the urban environment. The pattern of urbanization, especially with cities in the developing world, has negatively influenced these features and, as a consequence, reduced the environmental benefits provided by them (Gomes & Moretto, 2011; Sun, McNulty, Myers, & Cohen 2008; Oka, 2009; Polyakov and Zhang, 2008).

Materials and Methods

This study employed data from the 1991 and 2006 censuses of Nigeria, as published by the National Population Commission (NPC). This is because the use of census data is based on the fact that census is a compendium of population information, and therefore, constitutes a useful framework for population analysis and the interpretation thereof, [in this case on the spatiotemporal Land cover change of Calabar Municipality] (Ottong et al., 2010). Also, this paper relied on the 2011 urban and housing data collected from the Cross River Ministry of Lands and Survey. The, the Arc View GIS 9.3software was used in the processing Land cover change imageries from 1980 to 2010.

Study Area.

Calabar Municipality lies between latitude 04° 15' and 5° N and longitude 8° 25' E. The town is bounded by Odukpani L.G.A in the north, Akpabuyo L.G.A, to the south by Calabar South and west by Calabar River. It has an area of 158.902 square kilometers. Calabar municipality is the centre of major economic and commercial activities, as part of it constitute the central business district (CBD) of Calabar. The town also connects the city to the outside world through the Margaret Ekpo International Airport.

Calabar Municipality is generally affected by the weather conditions due to its unique coastal location and high rainfall associated with the tropical rainforest. It is characterized by rainfall which starts from the month of April to October, reaching its climax in the month of June and September. The remaining four month make up the dry season with the Harmattan wind

blowing over the area. The rain falls averagely at 172mm with temperature of 290^{C} at warmest and 17^{o}C at coldest (www.google.com Calabar weather report 2011). The vegetation of the study area is mainly riparian and fresh water swamp forests. Also, a few derived savanna vegetation, cultigens and ornamental/avenue tree/shrub species are present in the area. The dominant soil type is the clayey- loamy soils. The topography of the study area is the low lying coastal plain of the Calabar River and Great Kwa River. It is relatively undulating with a few hills and valleys running east-west wards. Several rivers/streams exist in the area and are basically drained by the aforementioned rivers. The Geology of the area is mainly sand stone.

Procedure for Data Collection

Data was collected using stratified sampling. This was based on an 8 yearperiod from 2004 – 2012, with 2004 serving as the reference point. This was achieved through the aid of aerial photographs of the area, obtained from the department of Geography and environmental science cartography unit, university of Calabar, Calabar.

Furthermore, the remote sensing and the geographic information system (GIS) technology and applications were applied in the determination of the land cover changes. The stepwise methodology was also used for careful examination of aerial photographs, development of an interpretation key, plotting of the green areas boundary, geo-referencing of digital data, interpretation of data, collecting of ground truth data, editing, finalizing of maps and extraction of statistical data for the different land cover (Njungbwen and Njungbwen, 2011; Singh and Loshali, 2005; Gourmelon, Bioret, & Le Berre, 2004; Acevedo et al., 2003, Ashbindu, Foresman, & Eugene, 2001; Geomatics International Inc. 1996).

However, the Arc view GIS 9.3 software was used for the analysis of topology which was established among the lines and polygons and the coding of the various land cover. Appropriate colours were given to the different land covers. Layouts were developed for them and the final maps produced. Quantitative data for the different land cover for the different time periods were then extracted. The change detection analysis was carried out. This was done by subtracting the values of the previous inventory data from the current one and the rate of the changes was determined by calculating their respective percentage values (Woodwell et al. 1984, Williams 1984).

Data Analysis

The data obtained was analyzed using tables and maps. The size and area of the land cover changes were calculated and represented in square kilometers. Also, the Aerial photo imageries were processed using the Arc View GIS 9.30 software package.

Result and Discussion

Sequel to the general objective of this study, it was generally observed that there was an exponential growth in the city population from 143,089 in 1991 to 172,392 in 2006, which have led to the quest for land, housing and other facilities/infrastructures that have given rise to spatiotemporal Land cover change. As presented in the table 1below, the total land area of Calabar Municipality is 158.902 square kilometers. From the data obtained it is observed that 33.68 square kilometer of wetlands, urban green areas, riparian forest and other forest vegetation Land cover , combined together, have been removed for urbanization.However, the land cover change was more accelerated between the periods of 2005 – 2009 with an average of 5.304 square kilometers per year as compared to 2010 – 2012 which had an average of 2.39 square kilometers per year.

Table 1: LandCover Change status of Calabar Municipality (2004 - 2012)

Year	**2004**		**2005 - 2009**		**2010 – 2012**	
	(Area Sqkm)	**%**	**(Area Sqkm)**	**%**	**(Area Sqkm)**	**%**
Vegetation Cover	93.87	59.07	67.35	42.39	60.19	37.88
Built up Area	65.032	40.93	91.55	57.61	98.712	62.12
Total Area	**158.902**	**100**	**158.9**	**100**	**158.902**	**100**
Land Cover Change			**26.52**		**7.16**	

Source: Ministry of Lands and Survey, 2012.

It is the periodswithin 2000 to 2012 that Calabar Municipality has witnessed several economic, social, cultural and political transformations and this has attracted more people to the town. From

the population statistics, the population of Calabar Municipality alone has increased by 54,303people between 1991 and 2006; this further explains the continuous upward trend in Land cover change. This continual removal have several environmental consequences and therefore cautioned should be applied in this phase or urban rapid growth and development.

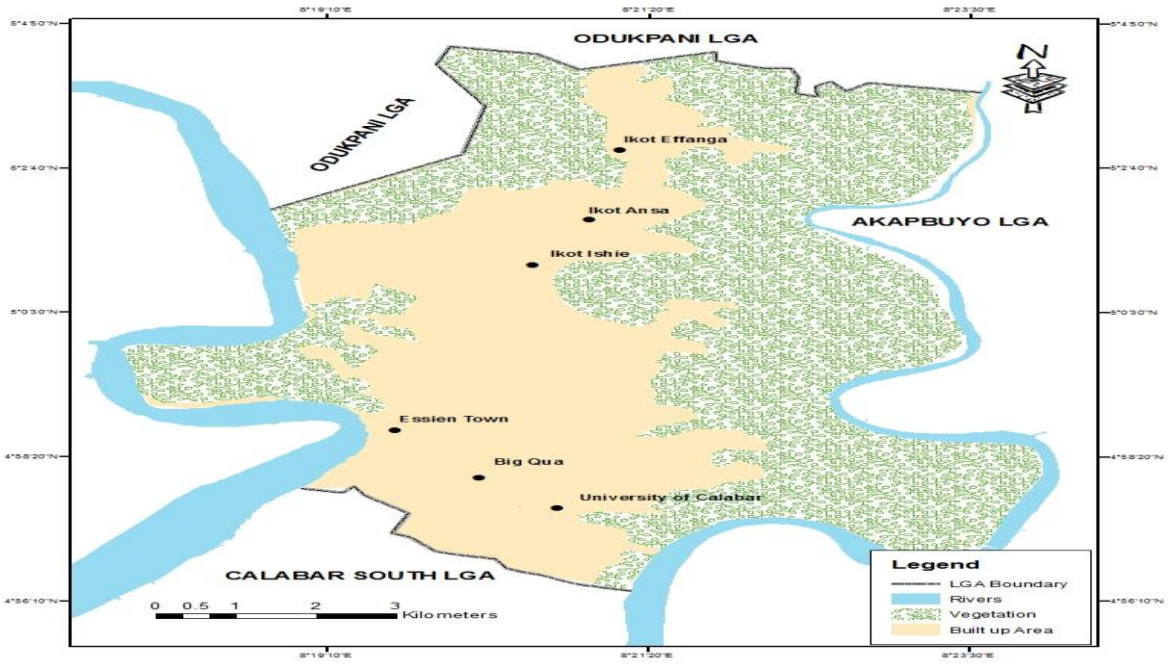

Figure1: Calabar Municipality Land cover/Land cover change 2004

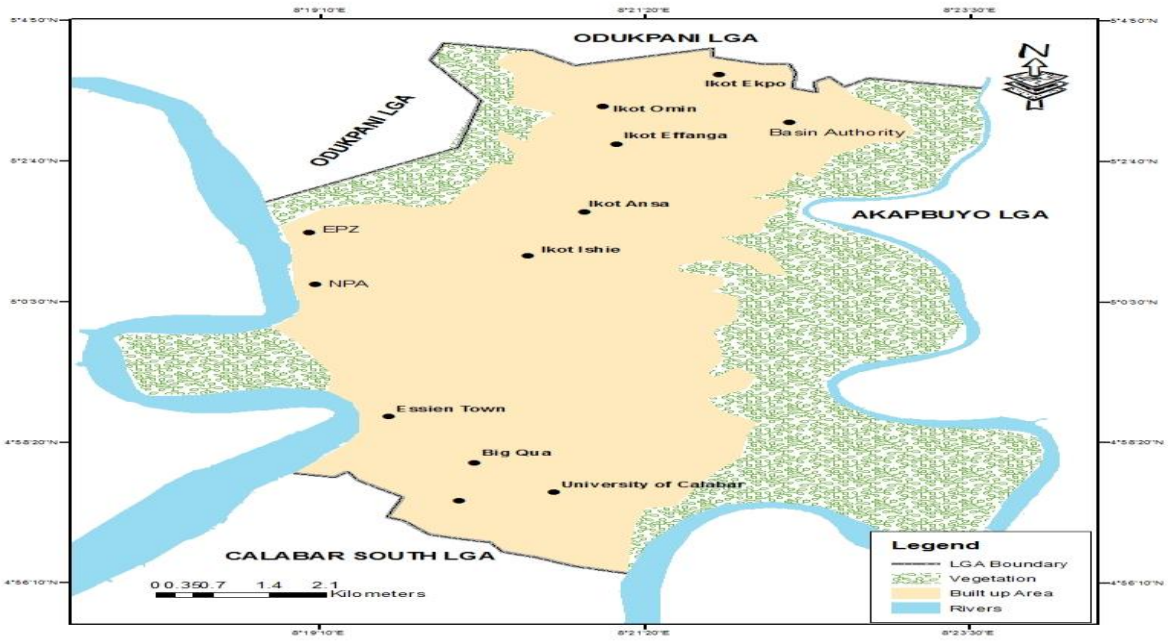

Figure 2: Calabar Municipality Land cover/Land cover change 2005 - 2009

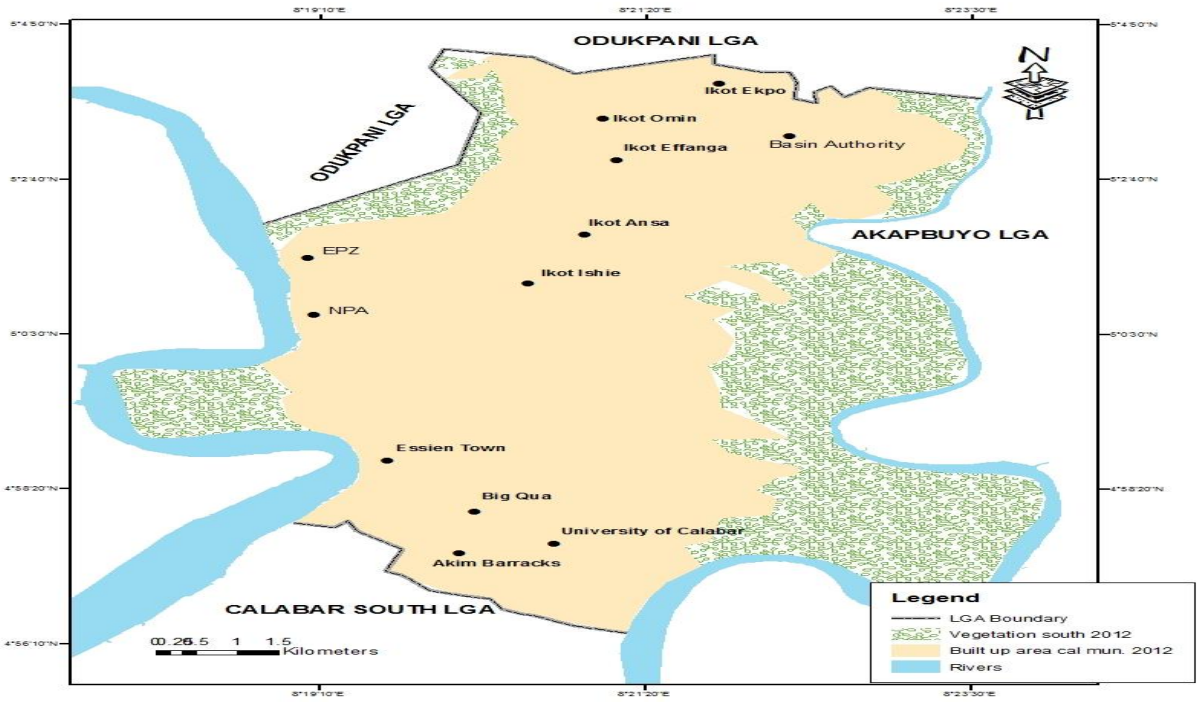

Figure 3: Calabar Municipality Land cover/Land cover change 2010 - 2012

Conclusion

In this paper, the changes in land cover from vegetation to built-up areas (Housing and industrial facilities) as determined by an integrated method using remote sensing and GIS and land use data showed that urban settlement expansion is on the increase from 2004 to 2012. This expansion has led to drastic loss in the spatiotemporal features such as urban green areas, wetlands, riparian forest, and other forest vegetation. Out of a total area of 158.902 square kilometers, only 60.19 square kilometers that still has the above mentioned spatiotemporal Land cover features. This and other environmental factors have contributed to the current environmental challenges experienced in the area within the last few years.

In the same vein, since the urban population is on the rise, viz-a-viz quest for land, there is a possibility for further conversion of land for urbanization purpose. With the estimation of a double increase in the population size of the area by 2025, it calls for concern as none of these natural ecosystems will still be left.Therefore, the ministries of lands and housing, commerce and industry, and ministry of environment should proffer a solution to this by encouraging the development of new residential layouts outside Calabar metropolis with access roads linking them to enable the ease of access for people working in the metropolis but living outside the metropolis. The department of public transport should also come up with efficient and affordable public transport systems that connectwith Calabar sub-urban areas. Also as an immediate solution, the ministry of lands and housing should regulate housing and industrial development in Calabar Municipality in order to ensure sustainable urban naturally natural ecosystem.

References

Acevedo, W., Gaydol, L., Tilley, J., Mladinich, C., Buchanan, J., S., Kruger, K., and Schubert, J. (2003). Urban land use change in the Las vegas Valley. U.S. Geological survey, Johnson controls world services (1-5). Retrieved March 25th, 2004 from *htt://geochange.er.usgs.gov/sw/changes/anthropogenic/population/las vegas/.i.*

Adeniji, G., & Ogundiji, B. (2009). *Climate adaptation in Nigerian cities; Regularising informal and illegal settlements in Ibadan*. A paper presentation for the World Bank's 2009 Urban Symposium, June 28-30,Marseille, France.

Ashbindu, H. S., Foresman, T. and Eugene, A. F. (2001). Status of World's remaining closed forest: An Assignment using Satellite Data and Policy Options. *Ambio. A Journal of the Human Environment, Vol. xxxNo.1,67-69.*

Atu, Joy E, Offiong R A, Eni, D I, Eja, E I, Esien, Obia E.(2012). The Effects of Urban Sprawl on Peripheral Agricultural Lands in Calabar, Nigeria. *International Review of Social Sciences and Humanities* Vol. 2, No. 2 (2012), pp. 68-76.

CR-SEEDS (Cross River State Economic Empowerment and Development Strategy, 2005-2007).

Dawson, R. J., Hall, J. W., Barr, S., Batty, M., Bristow, A., Carney, S., … Walsh, C. (2006). *A blueprint for the integrated assessment of climate change in cities (Draft, Version 1.2)*. Tyndall Working Paper 104.

Geomatics International Inc., (1996). The Assessment of Land use and vegetation changes in Nigeria between 1978-1993/95. Forest Resources Management Evaluation and Consultancy Unit, Ibadan.

Gomes, C S & Moretto, E M (2011). A framework of indicators to support urban green area planning: a Brazilian case study. *Proceedings of the International Academy of Ecology and Environmental Sciences*, 1(1):47-56

Gourmelon, F., Bioret, F. R. and Le Berre, I., (2004). Historic land use changes and implications for Management in a Small protected Island at Ushant, France, Patuxent wildlife Research centre, USGS.

Hansen, A. J. R., Knight, R. L., Marzluff, J. M.,Powell, S., Brown, K., Gude, P. H. and Jones, K.,(2005). Effects of Exurban Development on Biodiversity: Pattern, mechanism and research needs. *Ecological Application* 15:1893-1905.

National Population Commission (1997). The 1991 Population Census of Nigeria Federal Republic of Nigeria official Gazette, (2007) 94 (24) B183.

National Population Commission (2010). 2006Population and Housing Census of the FederalRepublic of Nigeria, Cross River State Priority Tables, Volume 1.

Oka, P O (2009). Managing the Impact of urbanization on biodiversityin emerging urban fringe settlements: the case of Satellite Town, Calabar, Nigeria. *Global Journal of Social Sciences* Vol 8, No. 1: 13-20.

Oloke O. C., Ijasan K. C., Ogunde A. O., Amusan L. M. & Tunji-Olayeni P. F. (2013). Improving Urban Residents' Awareness of the Impact of HouseholdActivities on Climate Change in Lagos State, Nigeria. *Journal of Sustainable Development*; Vol. 6, No. 4;

Ottong J. G., Ering S. O., & Akpan F. U. (2010). The Population Situation in Cross River State of Nigeria and Its Implication for Socio-Economic Development: Observations from the 1991 and 2006 Censuses. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)* 1 (1): 36-42

Polyakov, M. and Zhang, D (2008). Impact of Population Growth and Urban Sprawl on Land Use and Forest Type Dynamics along Urban-rural Gradient. *Journal of Agricultural and Applied Economics*, 40,2649–666

Singh, A. and Loghah, D. C. (2005). Land use mapping in Kotla Khad using Remote sensing Technique. *Environment and Ecology 23(1): 7-12.*

Sun G, McNulty S G, Myers J A M, & Cohen E C (2008). Impacts of Climate Change, Population Growth, Land Use Change, and Groundwater Availability on Water Supply and Demand across the Conterminous U.S. *Watershed Update* Vol. 6, No. 2

United Nations Human Settlements Programme; UN-Habitat. (2011). *Cities and Climate Change.* Global Reporton Human Settlements, Earthscan, London.

Williams, J. H. (1984). Forestry, Remote sensing and monitoring change. University College of North Eases, p.47. department of Forestry and Wood Science.

Woodwell, G. M., Hobbie, J. E., Honghton, R. A., Melillo, J. M., Mole, B., Park, AB., Peterson, B. J., Sharer, G. R. (1984). Measurement of changes in the vegetation of the Earth by Satellite Imagery. In: Woodwell (ed), the Role of Terrestrial vegetation in the Global Carbon Grade: measurement by Remote Scope Reporter Wiley, New York.