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Research Article

Land use Change Detection using Remote Sensing and GIS in Rivers State; Eleme LGA

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Abstract: The study examined the landuse change using GIS and remote sensing in the northern part of Eleme Local Government Area of Rivers State, Nigeria. Landsat Tm of 1986, 1999 and landsat ETM of 2015 of 30m x 30m resolution were used for the landuse change analysis. Supervised classification was used to classify the imagery into major landuse of thick vegetation, built up area, swamp forest, farmland/sparse vegetation and waterbodies. Normalized Diffrence Vegetation Index (NDVI) was used to measure the status of vegetation health and classify the entire area into less/not vegetation landuse (LNV) and highly vegetation (HV) landuse. The entire study area was gridded into 10m x10m quadrat whereby 7 quadrats were randomly in LNV and 6 quadrats in HV. Findings revealed that thick vegetation reduced by 129.87% while built up area increased by 468.11% between 1986 and 2015. LNV covered 10.46 km^2, 12.02 km^2 and 17.89 km^2 while HV covered 22.44 km^2, 20.88 km^2 and 15.01 km^2 in 1986, 1999 and 2015 respectively.
Keywords: Landuse, lancover, remote sensing, GIS, data, vegetation.

INTRODUCTION

Remote sensing techniques is one of the most important new and emerging technologies which are rapidly expanding and will greatly enhance the productive capabilities and wealth of those nation and entities that are making appropriate investment on them [1]. Remote sensing in soil survey aids in production of maps of land, in such a good detail that involves so many significant factors. Remote sensing techniques provide data at intervals and also present physiographic features which cannot be shown on the base map in details. Remote sensing techniques aid to increase both speed and accuracy of the work of soil surveying [2].

Land use is the intended employment of land management strategy placed on the land cover by human agents or land managers to exploit the land cover and reflect human activities such as industrial zones, residential zones, agricultural fields, grazing, logging and mining among many others [3]. Land use change is a dynamic process taking place on the bio-physical surface that has taken place over a period of time [4]. Land use change dynamics are important element for monitoring, evaluating, protecting and planning for earth resources. Land use changes are the major issues and challenges for the eco-friendly and sustainable development for the economic growth of any area or region. Land use change is influenced by various natural and human activity processes. In order to improve the economic condition of any region without further deteriorating the bio-environment, every bit of the available land has to be used in the most rational way and this would require the present and the past land use data of the region [5]. Land use dynamics is a widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities which in turn drive changes that would impact natural ecosystem [6, 7]. Understanding changes and interaction between human activities and natural phenomena are essential for proper land management and decision improvement.

STUDY AREA

The study was conducted in the northern part of Eleme Local Government Area of Rivers State, Nigeria. The area is within the latitudes between 4° 47' 00''N and 4° 51' 30''N and longitudes between 7° 5' 30''E and 7° 8' 30''E (Figure 3.1 and Figure 3.2). The study area is bounded by Obio/Akpor LGA in the North, in the East by Oyigbo LGA, in the West by Port Harcourt City LGA and in the South by Okrika LGA and Gokana LGA.

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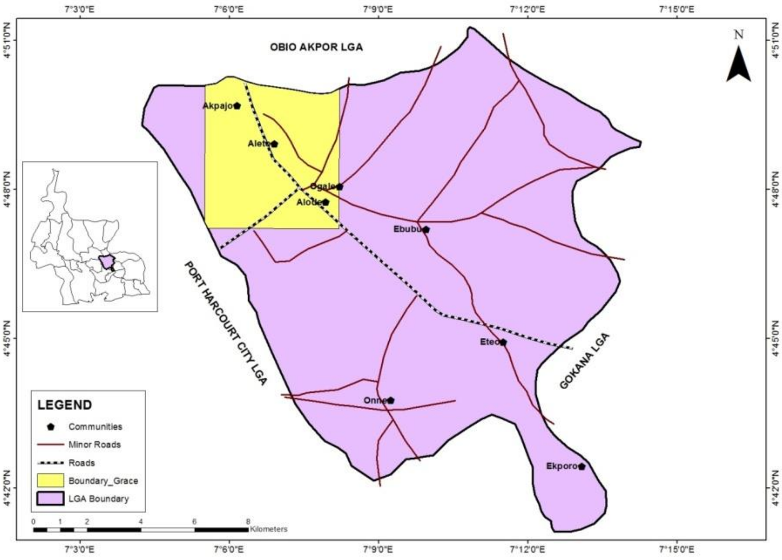

Fig-1: Eleme LGA showing the Study Area

Source: Rivers State Ministry of Land and Survey, 2016; GIS Laboratory, University of Port Harcourt, 2016

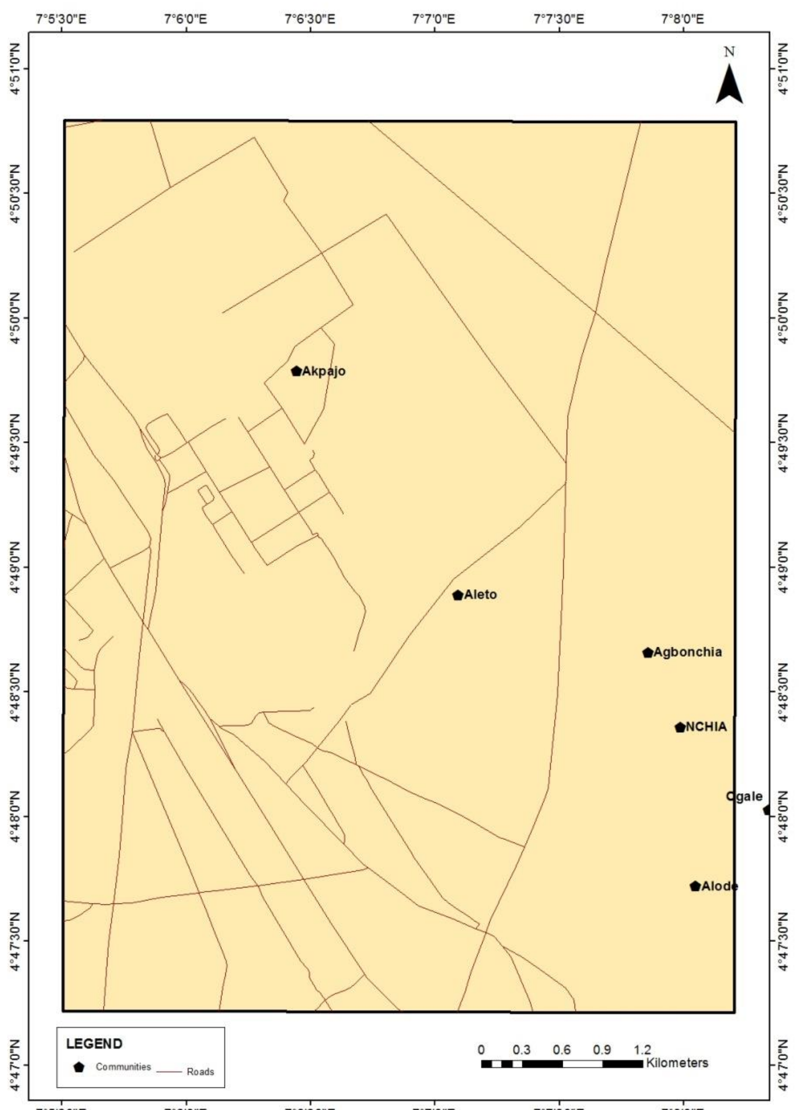

Fig-2: Study Area

METHODOLOGY

Reconnaissance Survey

Reconnaissance survey was done to the study area whereby the preliminary sight seen was carried out in order to ground-truth the various landuse in the area by tracking them with the use of global positioning system (GPS). The exercise also gave room to familiarise with the situation of the study area.

Image geo-processing and landuse change analysis/ Vegetal Cover

Landsat TM of 1986; 1999 and landsat ETM of 2015 were utilized for the landuse change analysis. The satellite images used in this study were obtained from the Global Land Cover Facility (GLCF). The descriptions of the images are presented in Table 1. Each of the images has 7 bands (1,2,3,4,5,6,7). The bands were combined and composite image was obtained for each year. The adequate composite image bands used were 3, 4 and 7. The shape-file of the boundary of the study area was used to clip the composite image in order to cut out the study area only from the entire imagery. Supervised classification using maximum likelihood algorithm was used to classify the imagery into major landuse (thick vegetation, built up area, swamp forest, farmland/sparse vegetation, water-bodies).

The composite image of each year was subjected to further geo-processing analysis of Normal Difference Vegetation Index (NDVI). The NDVI was calculated using band 4 (infrared band) and band 3 (red band). The status of vegetation health can be more appropriately measured in near infrared and red bands [8]. The results of the analysis classified the study area to less/not vegetated and highly vegetated landuse types. The spatial coverage was computed using simple arithmetic. The computation helped to understand the difference in the vegetal cover in the different periods (1986, 1999 and 2015) considered in this study. The analyses were done in Erdas Imagine and ArcGIS 10.1.

Table-1: Details of Landsat Satellite Images

Year	Date Acquired	Sensor	Cloud Cover (%)	Path	Row	Resolution
1986	19/12/1986	Landsat 4 Thematic Mapper (TM)	0	188	057	30m x 30m
1999	17/12/1999	Landsat 5 TM	0	188	057	30m x 30m
2015	09/01/2015	Landsat 8 Enhanced Thematic Mapper (ETM)	0	188	057	30m x 30m

Source: US Geological Survey, 2016

Method of Data Analysis

Result of the analysis were subjected to descriptive statistics (mean and standard deviation) to explain the soil properties (physical and chemical properties). Percentages were also used to explain the landuse/ land cover change. All the analyses were carried out using Statistical Package for Social Sciences (SPSS) 20.0 version and Microsoft Excel 2007 version. Results were presented using tables and graphs.

RESULTS AND DISCUSSION

Landuse/ Land cover change analysis

The landuse/land cover change in the study area is presented in Table 2 & 3 Figure 3, 4 and 5 between 1986 and 2015. The analysis shows that in 1986, thick vegetation had a spatial extent of 20.52 km^2 (62.37%), built up area covered 1.85 km^2 (5.62%), swamp forest covered 0.03 km^2 (0.09%) and farmland/sparse vegetation covered 10.50 km^2 (31.91%). In 1999, thick vegetation covered 12.07 km^2 (36.69 %) of the total landuse while built up area, swamp forest, farmland/sparse vegetation and waterbodies covered 7.64 km^2 (23.22%), 2.03 km^2 (6.17%), 11.11 km^2 (33.77%) and 0.05 km^2 (0.15%) respectively. In 2015, thick vegetation covered 9.53 km^2 (28.97 %), built up area covered 10.51 km^2 (31.95 %), swamp forest covered 2.10 km^2 (6.38 %), waterbodies covered 0.04 km^2 (0.12 %) while farmland/ sparse vegetation covered 10.72 km^2 (32.58 %).

Table-2: Land use spatial pattern in 1986, 1999 and 2015

Land use	1986 (km^2)	Percentage (%)	1999 (km^2)	Percentage (%)	2015 (km^2)	Percentage (%)
Thick vegetation	20.52	62.37	12.07	36.69	9.53	28.97
Built Up Area	1.85	5.62	7.64	23.22	10.51	31.95
Swamp Forest	0.03	0.09	2.03	6.17	2.10	6.38
Farmland/Sparse vegetation	10.50	31.91	11.11	33.77	10.72	32.58
Water bodies	0.00	0.00	0.05	0.15	0.04	0.12
Total	32.90	100.00	32.90	100.00	32.90	100.00

Source: Researcher's analysis, 2016

Magnitude, Trend and Percentage of Change of Landuse/Land cover"

The percentage changes of landuse/land cover in the study area between 1986 and 2015 are shown in Table-2. Thick vegetation decreased between 1986 and 1999 by 8.06 km^2 (39.28%) and by 3.32 km^2 (26.65%) between 1999 and 2015. Built up area increased between 1986 and 1999 by 5.79 km^2 (312.97%); and between 1999 and 2015 by 2.87 km^2 (37.57%). Also, the spatial extent of swamp forest, farmland/sparse vegetation and waterbodies increased between 1986 and 2015.

Table-3: Magnitude, Trend and Percentage of Change of Land use between 1986 and 2015

Land use	1986 (km^2)	1999 (km^2)	Change (km^2)	% Change	1999 (km^2)	2015 (km^2)	Change (km^2)	% Change	Total Change (km^2)	Total % Change (1986-2015)
Thick vegetation	20.52	12.46	-8.06	-39.28	12.46	9.14	-3.32	-26.65	-11.38	-129.87
Built Up Area	1.85	7.64	+5.79	+312.97	7.64	10.51	+2.87	+37.57	+8.66	+468.11
Swamp Forest	0.03	2.03	+2.00	+6666.67	2.03	2.10	+0.07	+3.45	+2.07	+6900.00
Farmland/Sparse vegetation	10.50	10.72	+0.22	+2.09	10.72	11.11	+0.39	+3.64	+0.61	+5.81
Waterbodies	0.00	0.05	+0.05	+0.00	0.05	0.04	-0.01	-20.00	+0.04	-

Source: Researcher's analysis, 2016

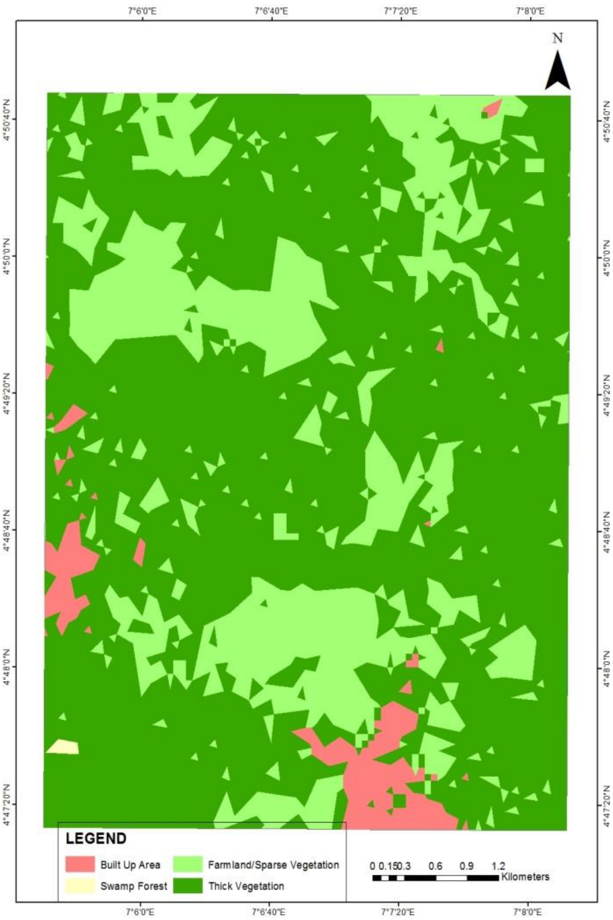

Fig-3: Landuse/ Land cover in 1986

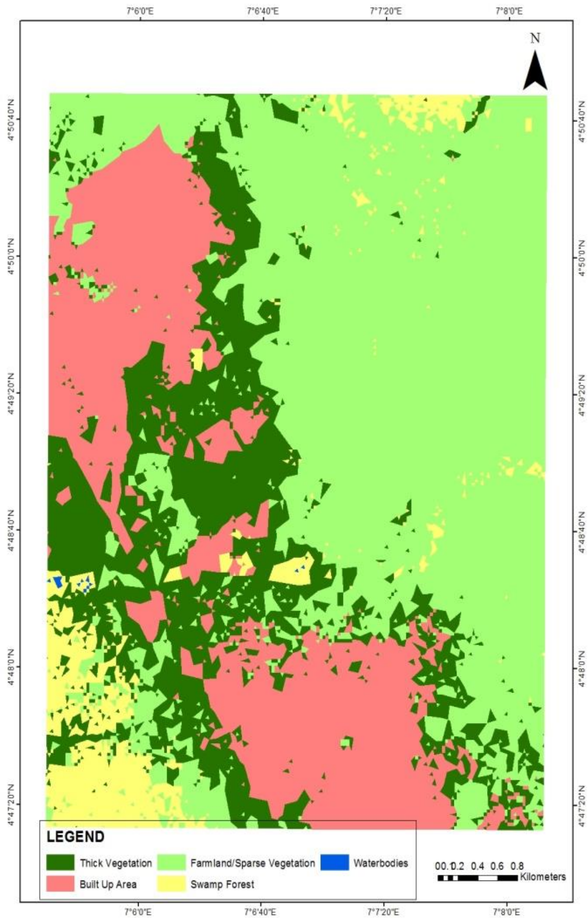

Fig-4: Landuse/ Land cover in 1999

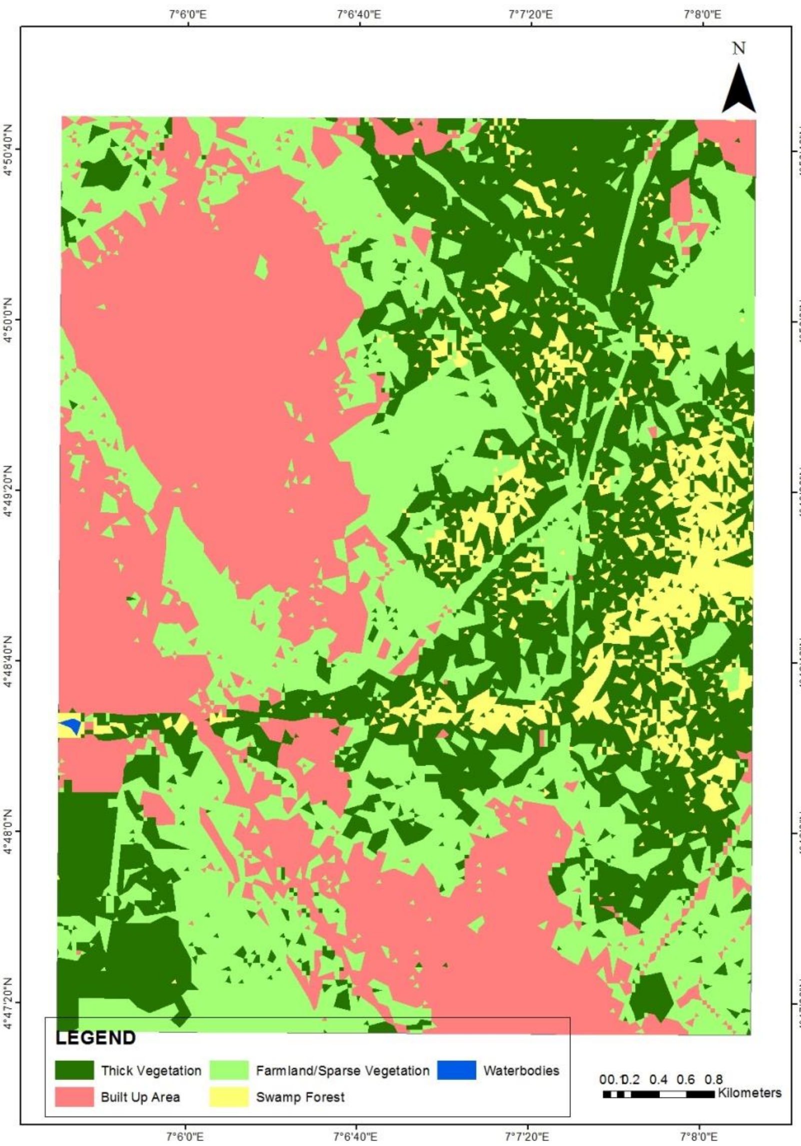

Fig-5: Landuse/ Land cover in 2015

DISCUSSION OF FINDINGS

Landuse change Percentage Change

Findings show that spatial coverage of thick vegetation decreased between 1986 and 2015. This is similar to the study of Gessesse [9] that revealed that forest cover changes from time to time because of population growth, urbanization, industrialization and other form of exploitation. Johnson *et al*., [10] reported that overall changes in the landscape show an increased trend for urban development with non-forested vegetation suffering the consequences. The reduction in the thick vegetation may have negative influence on wildlife conservation and biodiversity management.

Built up area increased between 1986 and 2015 in the study area and this could be attributed to rapid urbanization being experienced in the developing world. Rapid urbanization is known to generate negative impacts on the environment as it leads to changes in landscape patterns, ecosystem functions and the capacity to perform functions in support of human populations [11].

The farmland/sparse vegetation between 1986 and 2015 increased in terms of spatial extent. This could be attributed to the fact that more people engage themselves in farming especially subsistence farming which is meant to produce food for the family only.

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