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Remote Sensing and GIS for Assessing Land Use Land Cover Change: A Case Study of Jos and environs, Plateau State Nigeria

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Abstract

Given current population trends and projections in Nigeria, it is anticipated that substantial intensification of agricultural cropland is certain within the next decades. In the absence of adoption of improved technologies poor rural populations in this region will continue to degrade and mine the natural resources to ensure their livelihood. With pressure of increasing population, however, more agricultural land is needed and urban areas will expand.
As a result, forest areas have already declined at an alarming rate. In response to this, there has been increasing research and development for sustainable forest management.
This study has been conducted to assess the loss of forests (natural vegetation) and the alteration of land use cover in Jos and its environs using satellite based data sources between 1986 and 2007. The results of the analysis showed a tremendous decrease in natural vegetation from 33.59 % in 1986 to 27.09 % in 2002 and 9.70 % in 2007 which is attributed to population upsurge, climate change and poverty. The results of the study also reveal an increase in built up areas from 9.16 % in 1986 to 20.29 % in 2002 and 36.81 % in 2007 and also an increase in cultivated areas from 22.77 % in 1986 to 40.01 % in 2002 and a slight increase to 41.75 % in 2007.
The study suggests that extents and intensities of land cover change in Jos is as a result of chronic hunger and a high level of poverty, which is accelerated by uncontrolled increase in population growth combined with negative impact on the vegetation cover. The study confirms the need for timely and reliable information based on the integration of remotely sensed data for management decisions and national policies aiming at preventive and remedial vegetation conservation and protection in Jos plateau State Nigeria.

Keywords: Jos, land use land cover, Nigeria, remote sensing

Introduction

Changes in LULC have contributed substantially to the increase in CO_2 content of the atmosphere, exacerbate loss of vegetative cover and have changed the biogeochemical cycles of the earth. Changes in LULC are largely related to changes in the exploitation of land (Dolmam et.al; 2003). In Nigeria the demand for agricultural land has increased, mainly triggered by the growing and food demand from the ever-increasing population. Demand for agricultural land continues to be one of the main driving forces for land –cover changes such as deforestation of

tropical rain-forests, and cultivation of marginal lands which has resulted in additional environmental stress including climate change and biodiversity loss.
Land utilization has lead to all areas of the earth being modified (Harris et al. 1996). Extensive depletion of forest resources, primarily as a consequence of agricultural expansion and increasing allocation of logging, has accelerated during the past decade (FAO 2001; GFW 2000; Myers 1989). Large area of dense forest have either been converted into agricultural land and other non-forest cover (i.e., deforested) or modified into areas with low-tree cover (i.e., degraded or bared). Growing human populations exert increasing pressure on the landscape as demands multiply for resources such as food, water, shelter, fodder, timber products and fuel. Monitoring and mediating the negative consequences of LULCC while sustaining the production of essential resources has therefore become a major priority of researchers and policymakers around the world. Thus changes in LULC due to anthropogenic and/or natural activities can be observed using current and archived remotely sensed data. This technique is perhaps the only method for obtaining the required data from inaccessible regions on a cost and time effective basis.
The aim of this research is to analyze the LULCC in Jos and its environs using remotely sensed data.

Material and Methods

Description of the study area

Jos which is selected as the study area is situated in the middle belt of Nigeria with a total population of about 3,206,531(NPC, 2006). It lies between latitude 9°55'N and Longitude 8°53'E and has a near temperate climate with an approximate mean high temperature of 22°C and mean minimum low temperature of 18°C. The mean annual rainfall varies from 131.75 cm in the southern part to 146 cm in the north.

Remote sensing and ancillary data

The methods of land-change science include remote sensing and geospatial analysis, together with the interdisciplinary assortment of natural and social scientific methods. To analyze changes in LULC and spatial pattern of the study area over time, a set of three remote sensing satellite scenes were acquired for the years 1986 (Landsat TM), 2002 (Landsat ETM), and 2007 (NigeriaSat-1). In order to carry out a quantitative comparison of the imagery in the present study, the original images were resample and global positioning system (GPS) were used for the ground truthing.

Pre-processing of the satellite data

The three satellite imagery of the study area was geometrically, radiometrically and topographically corrected before they were used to assess the LULC changes (Fig.1 shows the false colour composite images).

Image classification

The satellite imageries were classified using ILWIS 3.1 Academic software and Geographical Information system package. Different land use and land cover categories were delineated on the basis of tone, texture, colour, and pattern. The statistical decision criterion of Maximum Likelihood was used in the supervised classification to assist in the classification of overlapping signatures, in which pixels were assigned to the class of highest probability.

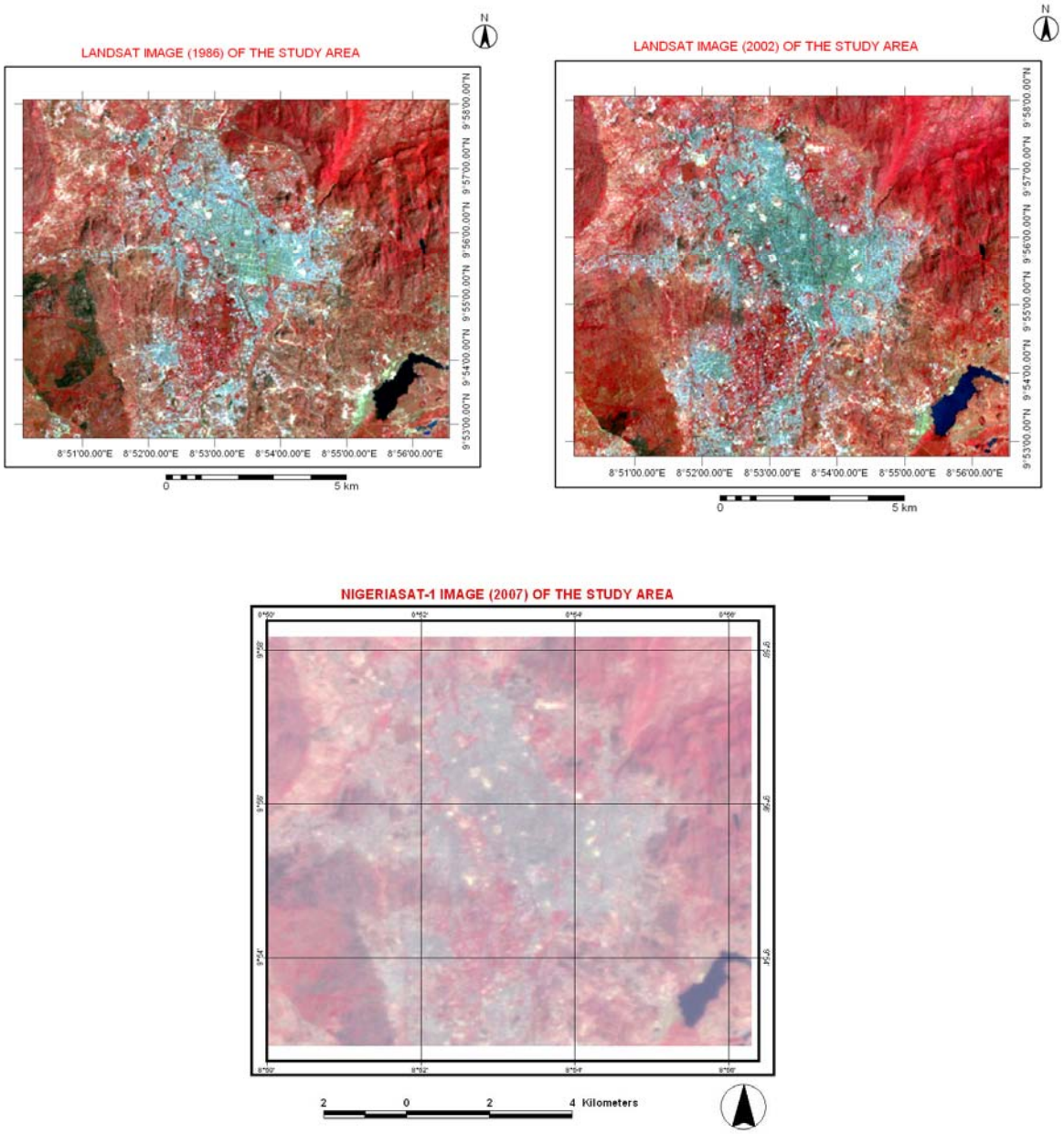

Figure 1 False colour composite (*FCC*) image / unclassified image of Jos, Nigeria.

Results and discussion

The land use and land cover change of the study area (Jos) was generated from the statistical findings of the supervised classification of the three images (Landsat TM, 1986, Landsat ETM, 2002 & Nigeriasat-1, 2007). Five major primary land cover types were delineated using satellite data viz., bare surface, built up areas, cultivated areas, natural vegetation and water body.

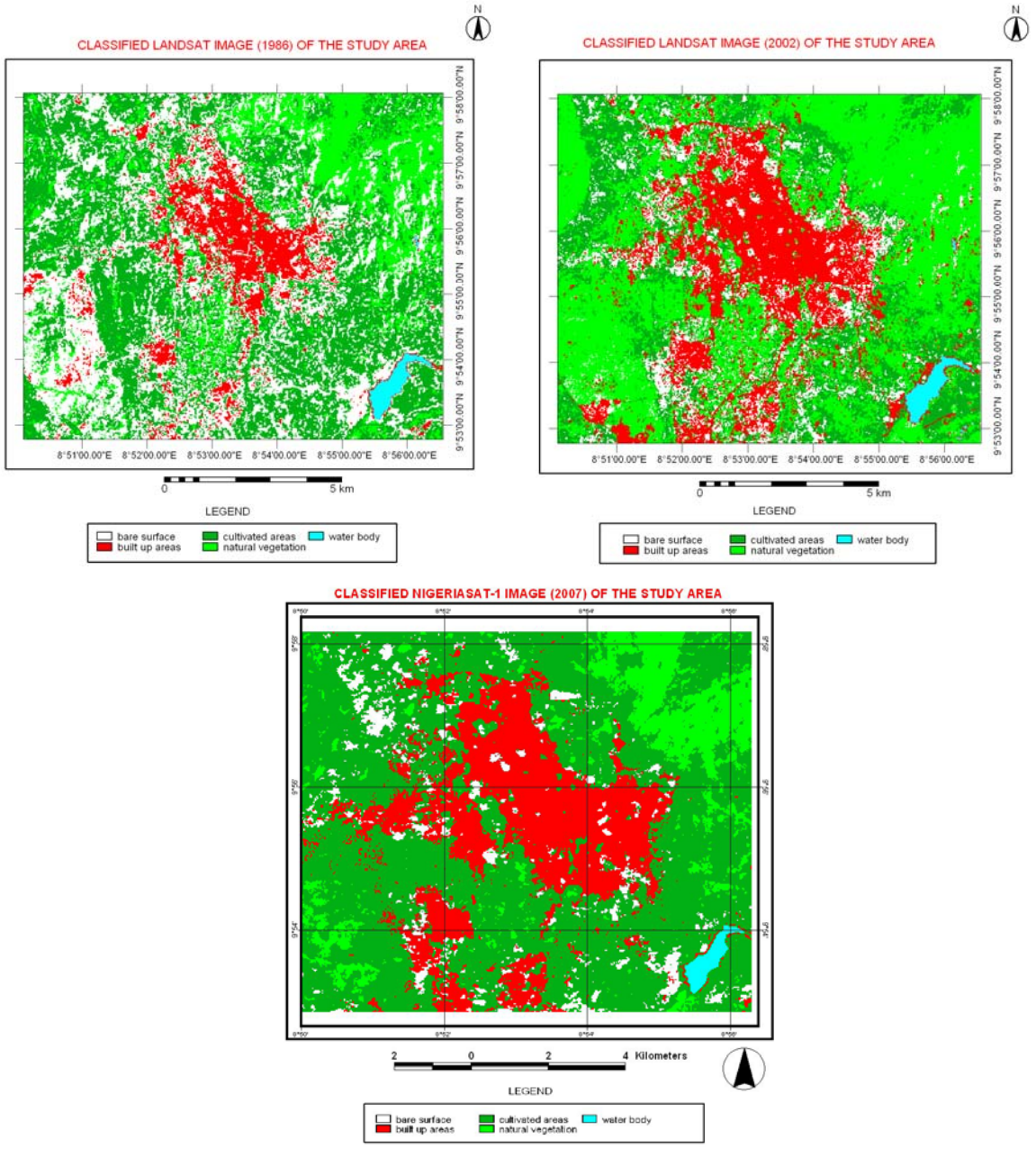

Figure 2 Classified map of Jos and environs showing LULCC

The total area coverage for the study area is 115.00 km^2 for the three images. Thus, it is ascertained through time series analysis that there has been a significant land cover change particularly the conversion of natural vegetation to cultivated area and built up area as shown in Table 1. By making comparison of the classification output of the three satellite imagery, it is deduced that:

Table 1 Distribution of land use/land cover areas from 1986 to 2007 (areas in square kilometer)

Land cover classes	1986	% of area in 1986	2002	% of area in 2002	2007	% of area in 2007
Bare surface	38.66	33.61	13.43	11.68	11.43	9.94
Built up area	10.54	9.16	23.33	20.29	42.33	36.81
Cultivated area	26.19	22.77	46.01	40.61	48.01	41.75
Natural vegetation	38.63	33.59	31.15	27.09	11.15	9.70
Water body	0.99	0.86	1.08	0.94	2.08	1.81
Total	115.00	100	115.00	100	115.00	100

There was a tremendous decrease in natural vegetation from 33.59 % in 1986, to 27.09 % in 2002 and 9.70 % in 2007. It is evident from the result of this study that there has been a drastic deforestation rate over the three periods. The decrease in vegetative cover (forest) can thus be attributed to various factors ranging from human interference as a result of demand for energy, expansion of farmland for cultivation, settlement; and also variation in climatic condition.
Result of the analysis showed that there was an increase in cultivated area from 26.19 km^2 (22.77 %) in 1986 to 48.01 km^2 (41.75 %) in 2007; this indicate that there is expansion of farming areas which is as a result of population upsurge and means of improving the people's livelihood in the study area. The land use change originated from intensive cultivation without sustainable management of forest resources.

There was a noticeable increase in built up area from 9.16 % in 1986 to 20.29 % in 2002 and 36.71 % in 2007. The result shows that there was increase in population density over the past 21 years in the study area. This is evident in the result of the national population commission of Nigeria which shows an increase in population from 2,104,536 in 1991 to 3,206,531 in 2006. Hence, increase in population has negative impact on the vegetation cover as more vegetation is lost due to human interference.

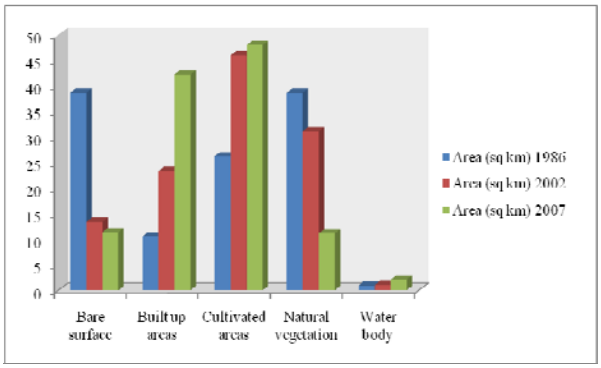

Figure 3 LULC change area of 1986, 2002, 2007

The change analysis shows that the major changes are taking place in the proximity of agricultural lands due to high anthropogenic pressure (Fig. 3). About 21.82 km2 of agricultural area was increased over a period of 21 years. There has been a significant land cover change, particularly the conversion of natural vegetation to built-up area and agricultural land as shown in table 1.

Conclusions and Outlook

This study has succeeded in quantifying the major land use land cover changes in Jos and environs, and in assessing the substantial vegetative loss over 21 years. The research applies standard remote sensing methods in conjunction with spatial pattern analysis to an unaddressed area of Jos. In this study, satellite datasets coupled with field surveys provided accurate information about deforested areas (natural vegetative cover depletion), increase in cultivated areas and built up area. The information obtained is valuable for formulating policies for conserving native vegetation and reducing deforestation processes at regional level. There is an urgent need for rational management of the remaining natural vegetation (forest) if it is going to survive beyond the next few decades. Special attention should be given to forest recovery and reforestation programmes with native species and encouragement of agro-forestry practices.

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