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Temporal Change Detection of Vegetation Cover in Mubi Metropolis and Environs, Adamawa State, Nigeria

Enosh Sheriff
Department of Survey and Geoinformatics,
Federal Polytechnic, Mubi, Adamawa State, Nigeria

Abstract

Vegetation is an important point for sustainable development, environmental conservation and urban planning process of a city. This research analyses the temporal change detection of vegetation cover in Mubi metropolis. Landsat ETM+ (1999 and 2010) and Landsat TM (1988) were the satellite imageries used to classify the changes in vegetation between 1988 and 2010. Global positioning system was used for ground-truthing; IDRISI TAIGA software was used for image classification and area calculation while ARCGIS 10.1 was used for cartographic visualization. The study reveals that a lot of physical changes occurred in the vegetation cover of Mubi town between 1988/2010 and 1999/2010. It is therefore recommended that vegetation studies should be encouraged by the government to forestall further depletion of the environment as a result of anthropogenic activities.

Keywords*: Vegetation, Changes, Classification, Landsat*

Corresponding Author: Enosh Sheriff

Background to the Study

Urban growth is a global phenomenon and one of the most important processes affecting both natural and human environments through many ecological and socio- economic processes (Mandelas*et al.*, 2007). As human and natural forces continue to alter the landscape, various public agencies are finding it increasingly important to develop monitoring methods to assess these changes (Levien et al., 1999). Natural vegetation is facing a general decline in the spatial extent and connectivity of wetlands and wildlife habitat owing to fast urbanization. These problems can generally be attributed to increasing human population (Khan, 2000). Urban vegetation can be an important part of sustainable development, environmental conservation and urban planning process of a city (Rahman, 2009). Chigbu et al. (2011) analysed landuse and landcover changes in the Aba urban area between 1991, 2000 and 2005 using medium resolution satellite images (2000Landsat ETM+, and 2005Nigeria Sat-1, of). The results reveal that from 1991, to 2005, water cover increased from 15.1% to 22.1% and to 22.4% due partly to increasing activities within and around the waterways, built-up area increased from 21.7% to 26.8% and to 36.5%. Consequently, vegetation landcover decreased from 63.2% in 1991 to 51.1% in 2000 and in 2005 it further decreased to 41.1%.

Oluseyi (2006) performed urban land use change analysis of the metropolitan city of Ibadan within the periods of 1972 and 2003 and discovered that the land use types that are subject to major changes are vegetal covers and sprawl development. Developments in Ibadan are similitude of the building types in the tradition core and the transition zones. It was also obvious that the city was growing at such an alarming rate using up all the green and other forms of soft landscape in the city. Ujoh et al. (2011) analysed urban expansion and vegetational cover loss in and around Abuja with the use of Landsat imageries between 1987 and 2006.

The study revealed that as built-up area increased, vegetation cover decreased at rapid rate. Using population figures of the study area for 1987, 2001 and 2006, the Land Consumption Rate (LCR) and Land Absorption Coefficient (LAC) were determined. Increasing population and expansion in the Federal Capital City (FCC) resulted in land degradation including loss of vegetational cover, indiscriminate waste disposal, and contamination of surface water, farmlands/fallow lands and the surrounding secondary forest. Within that period, mangrove forest was reduced by 50 per cent. Other forest covers in the area also changed, threatening food security and climate among others resources.

The Study Area

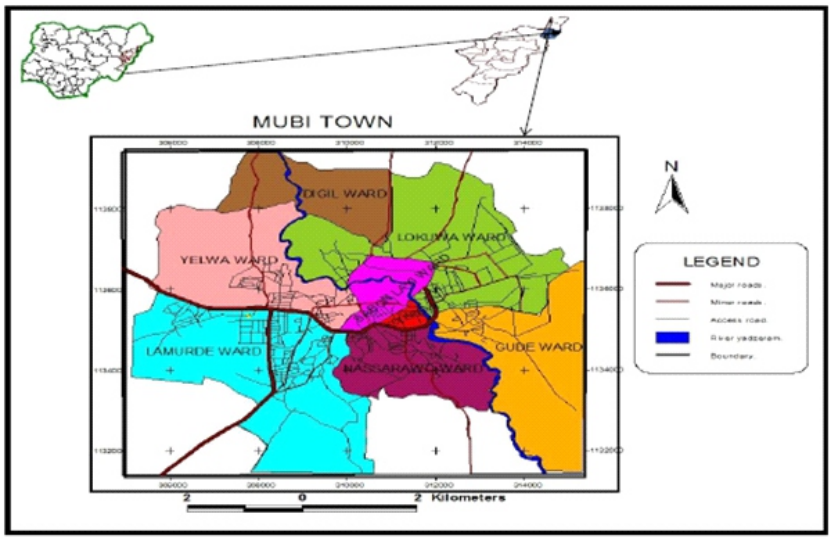

Figure 1. The study area
Source: GIS LAB., ADSU, MUBI.

Location and Extent of Mubi Town

According to Adebayo (2004), Mubi metropolis, is a geo-political area comprising of two Local Government Areas; Mubi North and Mubi South. The metropolis is located between latitudes 10◦ 05' and 10°30'N of the equator and between longitude 13°12' and 13°19'E of the Greenwich meridian. The two local government areas (L.G.A) occupy of 192,307Km^2 and support a total population 260,009 people (National Population Census, 2006). The area shares a boundary with Maiha L.G.A in the south, Hong L.G.A in the west, Michika L.G.A and Cameroon Republic in the east (Figure 1). The vegetation of Mubi and its environs fall within the Sudan savannah belt of Nigeria. The vegetation zone is referred to as cambretaceous woodland savannah. About 70% of the vegetation is grasses and weeds with few scattered woody plants which make up part of the natural vegetation and the exotic which were brought from other areas into the region.

However, the natural vegetation has been altered by human activities such as cutting of trees for fuel, settlement expansion, and farming activities, bush burning, and local lumbering. Despite of the existence of forest reserves, grazing areas and plantation form part of the landcover in various locations especially Mayo-Bani, Betso and Vimtim (Yohanna, 2004). The growth of Mubi town is traced to the agricultural, administrative and commercial functions it performs. By 1902, Mubi was a German base from where the neighbouring tribes (i.e Fali, Gude, Kilba, Higgi, Margi and Njanyi) of the region were subjugated. On 1st April 1960, Mubi was made the native authority headquarters. The same year, July 1960, the town became provincial headquarters of the defunct Sardauna province. In 1967, Mubi was made L.G.A headquarters while in 1996, the town was splinted into Mubi-North and Mubi-South Local Government Areas. Currently, the town is the seat of Mubi Emirate Council and is the headquarters of the Adamawa-North

Senatorial District. Mubi is geographically well placed and functions not only as the centre of commerce in the region but also extends its sphere of influence to countries such as Cameroun, Central Africa Republic and Chad. Numerous banks, filling stations and hotels exist in the town to support the commercial activities. Another factor that led to growth of the town is rural-urban migration experienced from the surrounding villages. More over the town has become centre of learning with numerous tertiary and secondary institutions established in the metropolis.

Methodology

The materials that were used for this study involve both primary and secondary data.

Primary Data

These data were collected through field observation and the use of Global Positioning System (GPS) to collect the coordinates of features in the study area for ground truthing. The data where was integrated into the Geographic Information System (GIS) for error matrix in order to ascertain the accuracy level of the images classified according to classes under study such as bare- surfaces, built-up area, vegetation and rock-out crop and farm land.

Secondary Data

Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) Landsat images of the study area for three epochs; 1988, 1999 and 2010 were obtained from the Global Land Cover Facility (GLCF) an Earth Science Data Interface. Table 1 shows the characteristics of the images of the study area.

Hardware and Software

i. **Hardware**: A HP 530 Laptop, HP colour printer and hand held GPS (Garmin 72) and Global positioning system (GPS) were the main hardware used for this study.
ii. **Software**: IDRISI Taiga was the GIS software package that was used to manipulate and perform feature identification, recognition and classification. It was also used for calculation of area and statistical analysis. ARCGIS 9.3 was used for map visualization.

Table 1: Characteristics of the acquired satellite images

S/N	Image	Sensor	Resolution	Date of Acquisitions	Source	Band
1	Landsat 7	2010	ETM + 30x30m	07/02/2010	GLCF	7 bands
2	Landsat 7	1999	ETM + 30x30m	10/12/1999	GLCF	7 bands
3	Landsat 7	1988	TM 30x30m	07/11/1987	GLCF	7 bands

Radiometric Correction

The Landsat scenes used in this research were radio metrically corrected so there is no need to repeat the process that may reduce the quality of the spectral data. Landsat TM 1988 was acquired at 8-bit data whereas the Landsat ETM 2010 was captured as 16-bit

data. For later processing Landsat ETM 2010 was synchronized to 8-bit data by rescaling the image. The images were normalized. The spectral distribution of bands of Landsat ETM 2010 was normalised to Landsat TM 1988, which was chosen as a standard scene. The radiometric correction was conducted because it is impossible to obtain radiometric measurements for historical Landsat images. The images of the study area were extracted from Landsat ETM+ 1999 and 2010, and Landsat TM 1988. All the images were sub-mapped using the following The X and Y coordinate: Top left X=303851.47 and Y=1138946.14 Bottom Right X=318971.22 and Y=1130372.38 and the window extracts sub-image automatically from the original image. This was done to all the images of the study year. Colour composite: This was performed for the purpose of enhancing the images, as it allow for simultaneously visualization of information from three separate bands of the images. Training sites were developed in Idrisi Taiga user interface with unique value to each of the classes. (1= built-up area, 2= bare surface, 3= vegetation, 4= Rock outcrop and 5= farmland) after which the images were classified using maximum likelihood classifier for each epoch (1988, 1999 and 2010) as shown in Figures 2a, 2b and 2c respectively. The classify images were then reclassified using the Boolean method. Vegetation was assigned the value 1 while all other classes were assigned the value 0. This leave us with only the vegetation cover of each epoch (1988, 1999 and 2010) as shown in Figures 3a, 3b and 3c.

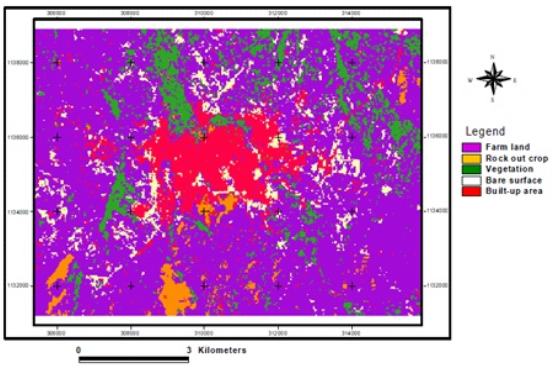

Fig. 2a: Classified Landsat ETM+ of Mubi 1988.

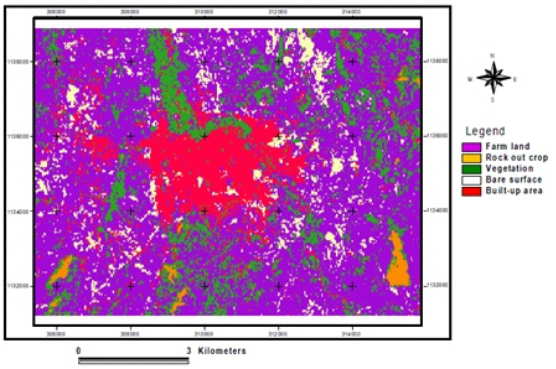

Fig. 2b: Classified Landsat ETM+ of Mubi 1999.

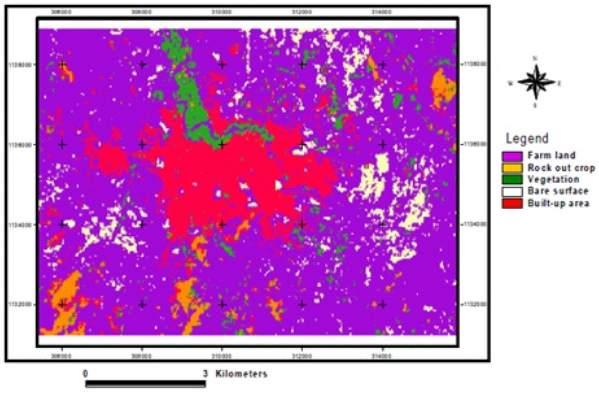

Fig. 2c: Classified Landsat ETM+ of Mubi 2010.

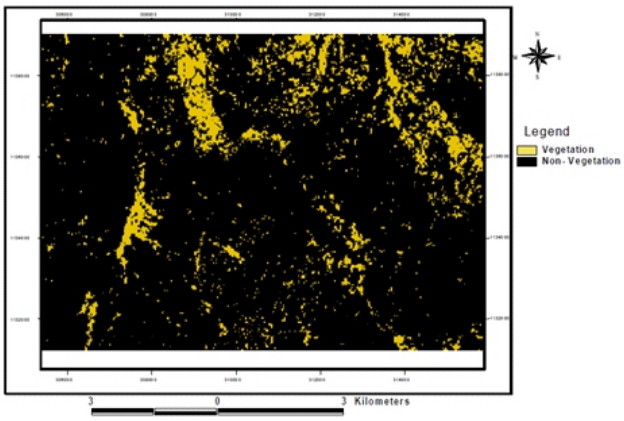

Fig. 3a: Vegetation in 1988.

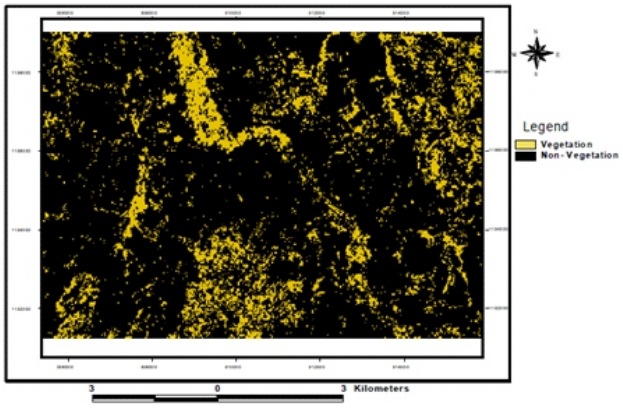

Fig. 3b: Vegetation in 1999

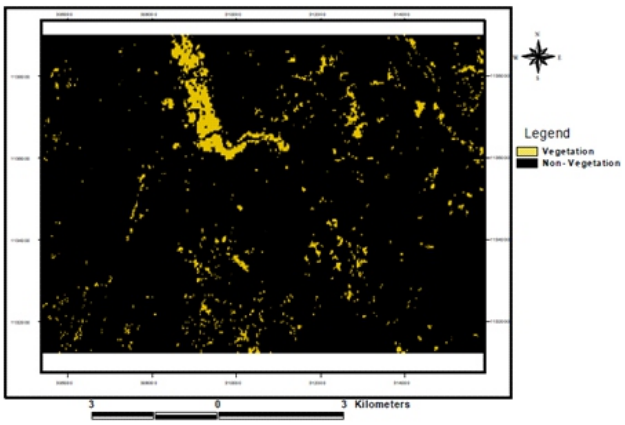

Fig. 3c: Vegetation 2010

Results and Discussion

Land use Land Cover Distribution

The classified images classes show the distribution of each land cover type in the study area of 1988, 1999 and 2010 as shown in Figure 2a, 2b and 2c respectively. The land use land cover distribution for each study year as derived from the maps are presented in Table 2. Table 2 reflects that in 1999 vegetation cover increased to15.96% as compared to 10.6% more than 1988 due to the fact that knowledge of gardening is becoming prominent as shown in figure 3a and 3b. In 2010, vegetation decreased to 4.55%, the reason for the decrease is mainly base on anthropogenic activities such as farming, and expansion of built-up area as a result of increase in population. The creation of Adamawa State University is also one of the contributing factors for the decrease in vegetation as shown in Figure 3c.

Conclusion and recommendation

This study has demonstrated the potential of remote sensing in carrying out changes in vegetation. The images of the three epochs (1988, 1999 and 2010) were classified into five classes and reclassed to map vegetation alone. This research shows that decrease in vegetation cover is a result of anthropogenic activities. It is therefore recommended that vegetation studies should be encouraged by the government to forestall further depletion of the environment as a result of anthropogenic activities.

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