GROWTH DYNAMICS OF LAND USE/ COVER CHANGE AND SPATIAL DISTRIBUTION PATTERN IN LAPAI, NIGER STATE.NIGERIA

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Abstract

The study explores the temporal and spatial characteristics of urban expansion and land use/cover change between 2001 and 2013 in Lapai and environs. The aim of this research is to analyses the extent of land-use changes between 2001, and 2013 in Lapai and environs, using remote sensing data. To achieve this aim both primary and secondary data were obtained. Landsat 7 ETM+ satellite images of 2001 and 2006 of Niger state was obtained from the Global Land cover Facility (GLCF) an Earth Science Data Interface, while 2013 was obtained from the National Space Research and Development Agency in Abuja (NASRDA). Digital image-processing software Arc GIS 9.3 and ILWIS 3.3 were used for analysis and integration of spatial data, and to generate the false colour composite, by combing near infrared, red and green in bands 4, 3, 2 for both images. Temporally, the expansion shows fast growth stages; with the high-speed growth area shifting to the east and west side of the Town. The result of the analysis shows in table 2, 2a, and 2b represents the static area of each land use category for each study year. Built-up area in 2001 occupies 4.21% of the total classes. Farm land occupies 54.31% of the total classes in year. In 2006, there is an increase in built up areas occupies about 6.54% and decreased in farm lands to about 43.49%.In table 2b, between 2001 and 2013 there is reduction in farm land,while built-up land increased by 26.87% , the dense vegetation decreased by 3.96%, 17.11%, and 5.35%, respectively. It is concluded that the total physical expansion of the town increased by the built up areas from 4.21% to 31.08%.

KEY WORDS: Growth, Land use/ change and Distribution Pattern.

Introduction

In recent decades, research on land use/land cover change has become an important aspect of global change, or global warming studies, since land use/land cover change is a major factor for global change and because of its interactions with climate, ecosystem processes, biogeochemical cycles, biodiversity, and, even more important, human activities (L opez , 2001; Aguilar, 2003).

Urban growth has been a major factor that has altered natural vegetation cover, due to anthropogenic activities. The results of these have left significant effects on local weather and climate. In remote sensing technology, change detection refers to the process of identifying differences in the state of land features by observing them at different times. Singh (2002) defined change detection as a process that differentiates an object or phenomenon at different times. This is because Land use and land cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands and loss of fish and wildlife habitat(Rahman et al,2004). One of the prime prerequisites for better use of land is information on existing land use/ cover patterns of changes in land through time. However, many local agencies need current comprehensive inventories of existing activities on public lands combined with the existing changing to improve the management of public lands. Local agencies also need land use data to assess the environmental impact resulting from the development of energy resources, to manage wildlife resources and minimize ecosystem conflict for national policy formulation, and to prepare environmental impact statements and assess future impacts on environmental policy (**Lillesand TM and Keifer W 1994).**

Study area

Lapai is located within latitude 9° 03" N and longitude 6° 34" E, it is about 18km west, its 56km East of Minna Niger state capital. Lapai covers an area of approximately 3,051km^2 whose population was estimated to be about 12,859(2006 census). Lapai local government area is one of the twenty-five main local governments in Niger State.

The study area is located in a tropical climate which is characterized by two distinct seasons in a year, the wet and dry seasons. The area has an annual rainfall of less than 1000mm, were rainy season which occurs between April and September with Peak Periods between October and March, a period of six months. The temperature in lapai varies within the seasons, during the dry seasons the area record high temperature between 30°c and 36°c which last from December to April, while the rainy season experience low temperature of between 26°c and 30°c. Highest daily temperature within the season occurring at mid-day between May – July.

The natural vegetation of the study area belongs to the parkland guinea savanna vegetation characterized by a mixture of tree, shrubs and tall grasses forming a natural habitat or game and provides for a beautiful land scale and scenery, examples of common trees found in this area are: Gmelina spp, Locust Bean, Shea Butter trees, Isoberlina etc. several years of cultivation coupled with effect of soil erosion have profoundly reduced the density of vegetation cover.

The study area also has annual growth of 3.4% (national population commission, 2006) .The people are predominantly Nupe speaking with farming as the main occupation.

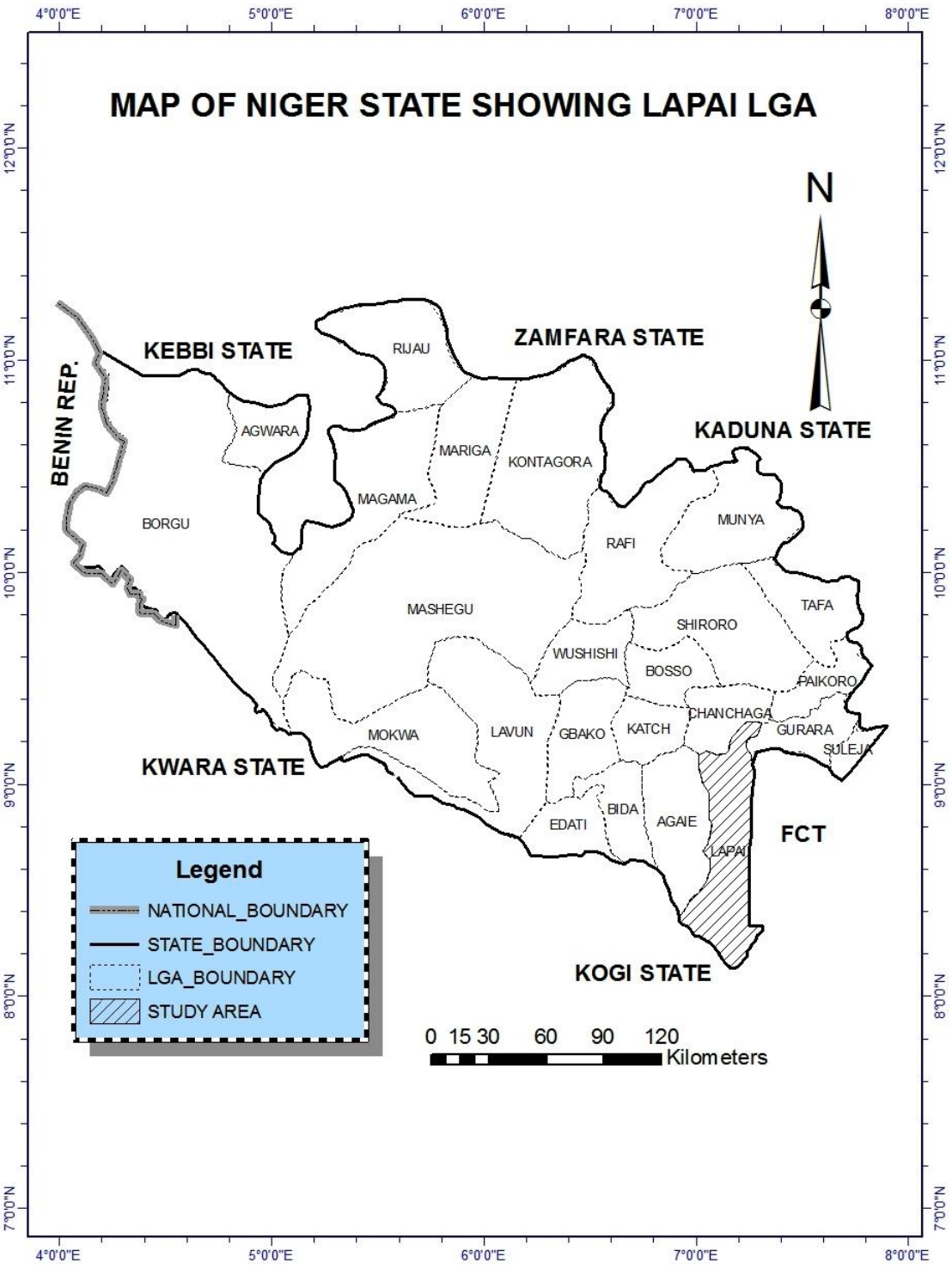

FIG 2: Map of Niger State

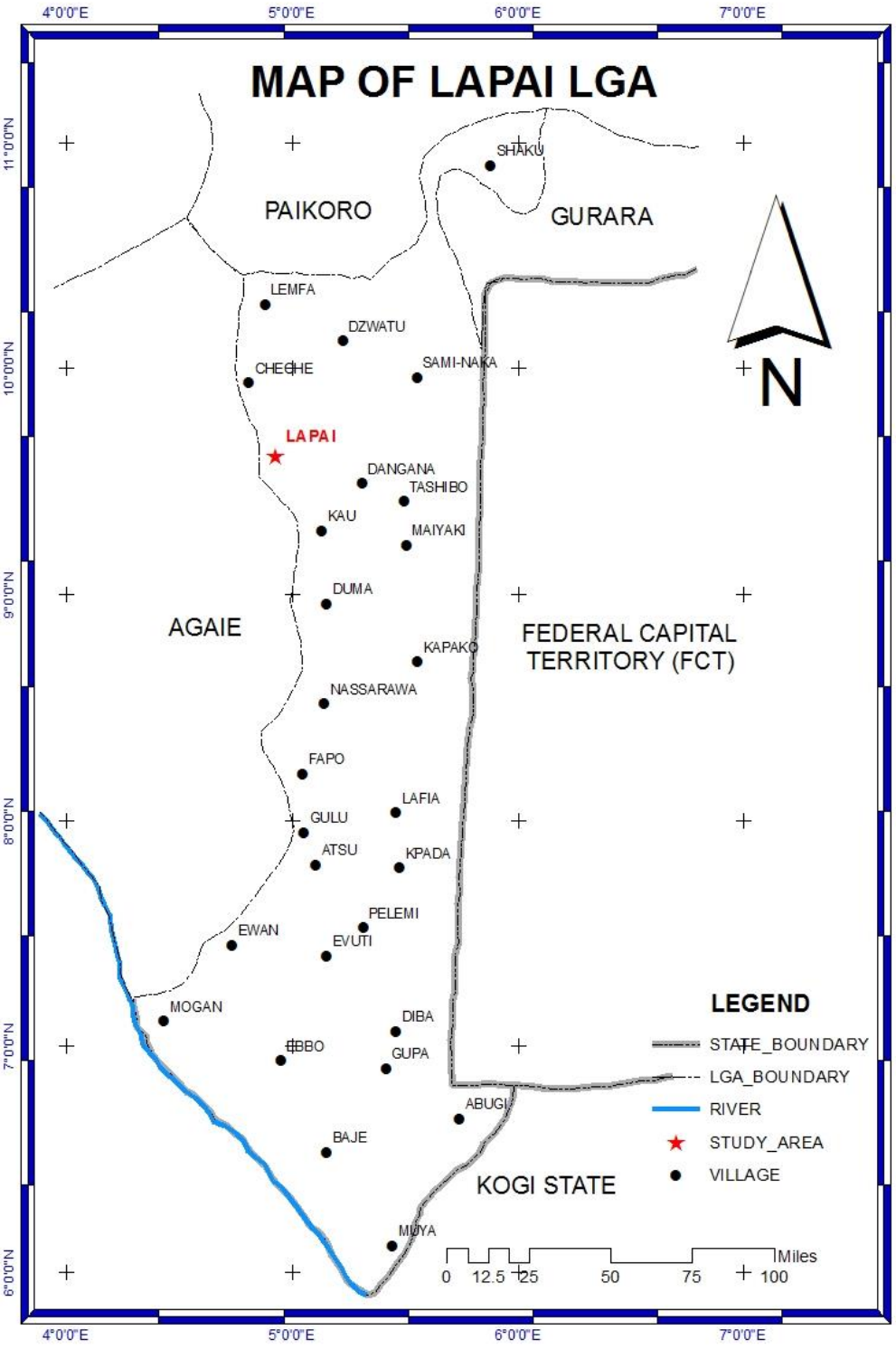

FIG 3: Administrative Map of Lapai LGA

RESEARCH METHODOLOGY

Source of data.

The main goal of this study is to reveal vegetation change using multi- temporal satellite data, in order to extract changes. Digital image-processing software Arc GIS 9.3 and ILWIS 3.3 were used for the processing, analysis and integration of spatial data to reach the objectives of the study. ILWIS 3.3 was used to generate the false colour composite, by combing near infrared, red and green which are bands 4, 3, 2 together for both images.

Image Preprocessing.

Two sensor data, Landsat-7 ETM+ of the year 2001 and 2006 and Nigeriasat-2 images of the year 2012 were used in this research. The ETM+ image with 30-meter spatial resolution has six bands, covering three visible bands (blue, green, and red), one near-infrared (NIR) band, and two shortwave infrared (SWIR) bands. The Nigeriasat-2image has three bands, covering two visible (green and red) bands, one NIR band with 32-meter spatial resolution.

Image registration and atmospheric calibration are two important aspects in the image preprocessing procedure. The importance of accurate registration of multi-temporal images is obvious because spurious results of change detection would be produced if mis-registration were to occur (Townshend *et al*., 1992; Dai and Khorram, 1998). An image-to-image registration between ETM+ and Nigeriasat-2 images was performed. The ETM+ image was used as a reference image, and the Nigeriasat-2 image was registered to the ETM+ image to the Universal Transverse Mercator coordinate system.

The nearest-neighbor algorithm was used to resample the Nigeriasat-2 image into pixel sizes of 28.5 m by 28.5 m, in order to be consistent with ETM+ data and to make use of the rich spatial information inherent in the higher spatial resolution of ETM+ data during the Nigeriasat-2 and ETM+ data fusion

procedure. Thus, all ETM+ and Nigeriasat-2 data had the same pixel size of 28.5 m X 28.5 m.

Data analysis

Vegetation maps of the study area produced from the different satellite image was used in describing the various vegetation changes that has occurred between 2001 to 2013. The analysis was based on the land cover map produced and the NDVI values obtained. The results are presented in the tables below, these include the static, change and accuracy of each image.

Table 2: Showing the extent of land cover between 2001 - 2006

Land cover types	2001Areas in hectares	% of the area	2006Areas in hectares	% of the area	% change between the years
BUA	309.87	4.21	470	6.54	2.33 increase
EL	2327.26	4.3	247.25	3.36	0.94 decrease
DS	411	5.58	193.72	2.61	2.97 decrease
SOB	2327.26	31.6	3202.13	43.49	11.89 increase
GCL	4000.41	54.31	3241.28	44.01	10.3 decrease
WB	0	0	0	0	

Table 2a: Showing the extent of land cover between 2006- 2013

Land cover types	2006Areas in hectares	% of the area	20013Areas in hectares	% of the area	% change between the years
BUA	470	6.54	2289.25	31.08	24.54 increase
EL	247.25	3.36	283.40	3.85	0.49 increase
DS	193.72	2.61	119	1.62	0.99 decrease
SOB	3202.13	43.49	1067.30	14.49	29

					decrease
GCL	3241.28	44.01	3606.39	48.96	4.95 increase
WB	0	0	0	0	0

Table 2b: Showing the extent of land cover between 2001- 2013

Land cover types	**2001Areas in hectares**	**% of the area**	**20013Areas in hectares**	**% of the area**	**% change between the years**
BUA	309.87	4.21	2289.25	31.08	26.87 increase
EL	2327.26	4.3	283.40	3.85	0.45 decrease
DS	411	5.58	119	1.62	3.96 decrease
SOB	2327.26	31.6	1067.30	14.49	17.11 decrease
GCL	4000.41	54.31	3606.39	48.96	5.35 decrease
WB	0	0	0	0	0

The figures presented in table 2, 2a, and 2b above represents the static area of each land cover category for each study year.

Built-up in 2001 occupies the least class with just 4.21% of the total classes. This may not be unconnected to the fact that the town (lapai) was not yet made the town to be sited the state university. Also, farming seems to be practiced moderately, occupying 54.31% of the total classes in 2001. This may be due to the fact that the city is still in a traditional setting where farming seems to form the basis for living.

In 2006, there is an increase in built up area and savanna orchard bush which occupies about 6.54% and 43.49% respectively, causing a decrease in the rest of the land cover type and this can be attributed to the starting face of the establishment of the state university, some of the dense vegetation are converted to a savanna orchard bush.

From table 2b, there seems to be a negative change i.e. a reduction in farm land between 2001 and 2013. This may not be unconnected to the change in the economic base of the city from farming to other white collar jobs as a result of the establishment of the state university. Subsequently, built-up land increased by 26.87% whiles the dense vegetation, savanna orchard bush, and grassland/cropland and expose land decreased by 3.96%, 17.11%, 5.35%, and 0.45 respectively. Many projects were embarked on after the establishment of the state university and this result to the attraction of a lot of people to the area thus contributing to the physical expansion of the town as evident in the increased built up area from 4.21% to 31.08% of the total class.

Accuracy of Image Classification

The overall accuracy of the land cover classification for the 2001, 2006 and 2013, are 94.24%, 97.70% and 95.25% respectively. Generally, the frequency of confusion of classification was low but did occur. Savanna orchard bush were sometimes confused with both dense Forest and Grassland/cropland.

Table 3: Confusion matrix for 2001 classification

	BUA	**DV**	**EL**	**GCL**	**SOB**	**WB**	**ACCURACY**
BUA	539	0	0	10	0	0	0.98
DV	0	116	0	1	4	0	0.96

EL	0	0	50	0	0	0	1
GCL	3	0	0	601	15	0	0.97
SOB	0	59	0	12	395	0	0.85
WB	0	0	0	0	0	0	0
RELIABILITY	0.99	0.66	1	0.96	0.95	0	

***Note** *BUA-Built up Area, *DV-Dense Vegetation, *EL-Expose Land, *GCL-Grass/Cropland, *SOB-Savanna Orchard Bush, *WB- Water Body.*

Average Accuracy: **95.18%**

Average Reliability: **91.49%**

Overall Accuracy: **94.24%**

Table 3a: Confusion matrix for 2006 classification

	BUA	**DV**	**EL**	**GCL**	**SOB**	**WB**	**ACCURACY**
BUA	540	0	0	9	0	0	0.98
DV	0	117	0	1	3	0	0.97
EL	0	0	50	0	0	0	1
GCL	4	0	0	686	15	0	0.97
SOB	0	7	0	0	264	0	0.97
WB	0	0	0	0	0	0	0
RELIABILITY	0.99	0.94	1	0.99	0.94	0	

***Note** *BUA-Built up Area, *DV-Dense Vegetation, *EL-Expose Land, *GCL-Grass/Cropland, *SOB-Savanna Orchard Bush, *WB- Water Body.*

Average Accuracy: **97.96%**

Average Reliability: **97.16%**

Overall Accuracy: **97.70%**

Table 3b: Confusion matrix for 2013 classification

	BUA	**DV**	**EL**	**GCL**	**SOB**	**WB**	**ACCURACY**

BUA	1539	0	0	1	0	0	1
DV	0	94	0	0	4	0	0.96
EL	0	0	178	1	0	0	0.99
GCL	3	0	0	378	51	0	0.88
SOB	0	5	0	64	395	0	0.85
WB	0	0	0	0	0	0	0
RELIABILITY	1	0.95	1	0.85	0.88	0	

***Note** *BUA-Built up Area, *DV-Dense Vegetation, *EL-Expose Land, *GCL-Grass/Cropland, *SOB-Savanna Orchard Bush, *WB- Water Body.*

Average Accuracy: **93.58%**

Average Reliability: **93.53%**

Overall Accuracy: **95.25%**

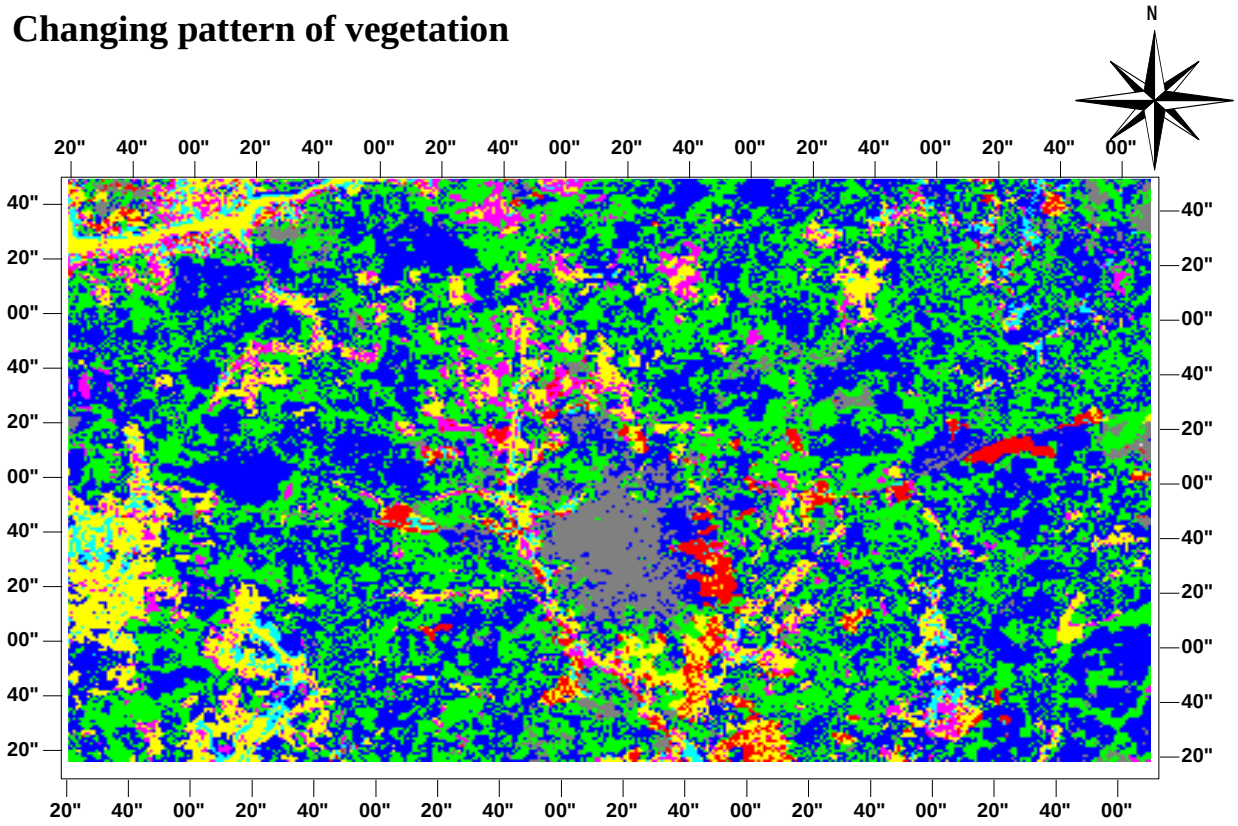

FIG 9: Overlay of 2001 and 2013 image

Table 4: vegetation change matrix per pixel (2001 - 2013)

	BUA	***DV***	***EL***	***GCL***	***SOB***	***WB***
BUA	2950	0	149	611	105	0
DV	360	1021	156	1792	1731	0
EL	1416	32	568	1539	344	0
GCL	18232	75	1872	25299	3773	0
SOB	5226	337	744	15158	7187	0
WB	0	0	0	0	0	0

***Note** **BUA-Built up Area, *DV-Dense Vegetation, *EL-Expose Land, *GCL-Grass/Cropland, *SOB-Savanna Orchard Bush, *WB- Water Body.*

Conclusion

Green coverage is one of the most important factors for sustaining life and the living environment for any rapidly growing town, like Lapai; not only for preserving sustainable human habitat but also for safeguarding from the detrimental effects of urban pollution and Urban Heat Island (UHI). Rapid depletion of vegetation coverage in recent past might result adverse condition in Lapai areas. Initiatives should have been taken to avert the area from the adverse effect of urban pollution and deforestation by various government and non-government organizations, but the situation seems to overdo the expected rate of change and expansion. Green space dynamics and spatial metrics analyses are imperative for understanding the landscape ecological conditions of urban green spaces. This study revealed that the green spaces of Lapai are decreasing its area over the course of time; about 1,945.98 hectares of vegetation lost has been lost

between 2001 and 2013, it is an alarming condition due to the high fragmentation of the increasing pace of human activity in this area. This activity is not only causing the destruction of landscape ecological processes and services, but is also degrading the biodiversity in urban areas. Moreover, consistent landscape fragmentation can result in a poor quality of life in the urban environment. Therefore, a comprehensive green space management strategy should be implemented for Lapai town that could support proper functioning of the ecosystem. As the reliable and updated data are greatly lacking in Niger State, the land cover maps produced in this study can contribute to the development of sustainable urban land-use planning decisions that target a sound and healthy urban environment. The study of temporal mapping of Lapai successfully demonstrates the shocking changes of decreasing vegetation coverage. Further study on the vegetation and biodiversity cover reduction will surely unveil and confirm the frightful changes throughout the area over the last decades.

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