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Full Length Research Paper

Land Use Land Cover Change Detection through Remote Sensing Approach in Kano State Nigeria

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Abstract

This study examines the use of land satellite imageries for 1985, 1991 and 2003 for mapping land use land cover in Kano so as to be aware of the changes that have taken place within these periods. Supervised classification technique was carried out using maximum likelihood method with the help of Google earth and prior knowledge of the study area. The results of the study revealed that built-up area increased from 1985 to 2003 with 11.80% in 1985, 17.90% in 1991 and 26.20% in 2003 while vegetation cover and bare surface are highly decreasing.

Keywords: Land Use, Land Cover, Land satellite image.

INTRODUCTION

Remote sensing data consists of satellite observations of the earth surface features that is biosphere, atmosphere, lithosphere, solid earth, hydrosphere and land surface combined with historical records and predictions from the ecosystems models, it offer the opportunity to study, determine and predict how the earth is changing and analyze the factors that causes this changes and also allow us to predict future changes. One important area where remote sensing plays a vital role is the study of land use land cover change detections especially the conversion of natural land cover into human dominated cover type, e.g. urbanization which is becoming more significant source of altering earth's surface. Studies have shown that there remain only a few landscapes on the Earth surface that is still in their natural state. Due to human activities, the Earth surface is being altered in some manner and mans presence on Earth and his use of land has significant effects upon the natural environment thus resulting into an unobservable pattern in land use.

Land Cover, is defined as the gathering together of biotic and abiotic components on the earth's surface, it is one of the most vital properties of the earth ecosystem. Land cover is that which covers the surface of the earth while land use describes how the land cover is being modified by natural and mans activities on the earth. Land cover includes: bare soils, water bodies, grasslands and forested areas, and Land Use includes built up land, agricultural lands, recreation area, etc. It important to note that Land cover reflects the biophysical situation of the earth's surface and its immediate subsurface, thus comprising the vegetation, water and soil materials, on the other hand Land use refers to man's activities on the land that are directly or indirectly related to altering the land cover. Land use and land cover are dynamic and always changing these may be attributed by spatial and time aspects. Land use and Land cover changes also involve the modification, either direct or indirect, of natural habitats and their impact on the ecology of the area.

There are many different ways of approaching the use

Figure 1. Nigeria showing the study area

of satellite imagery for determining land use land cover changes. Yuan *et al.,* (1998) divided the methods for change detection and classification into pre-classification and post-classification techniques. The imagery data of very high resolution as well as the innovative methods of their proceeding contributed to integrated urban studies (Donnay *et al.,* 2001). The disposal of multi temporal satellite imagery data also enabled the recognition and prediction of change patterns in urban environment (Guel *et al.,* 2005). Several change detection are applied on images of different dates in order to detect the changes that took place through the years under consideration.

Therefore, in this study is aimed at producing a land use land cover map of Kano at different significant time period in other to detect the changes that have taken place between the years 1985-2003 and to determine the land use land cover changes that occur.

Study Area

Kano State is located on latitude 11°31'N and longitude 8°30' E, in the North-Western part of Nigeria. Created on May 27, 1967 from part of the Northern Region, Kano state borders Katsina State to the north-west, Jigawa State to the north-east, and Bauchi and Kaduna states to the south. Kano state covers an area of 20,131 sq kilometer making it the 20th largest area in Nigeria and is located at about 481 meters (or about 1580 feet's) above sea level. Kano state has the population of 9,383,682 and is the most populace state in Nigeria.

Most of the people of Kano state are mainly farmers producing cash crops like cotton, groundnuts and food crops like maize, millet, rice and guinea corn. Kano state as a whole has three types of vegetation. The first which is the northern guinea savannah is well known for its rich biodiversity and luxuriant growth of taller trees it is found in the extreme southern part of the state, the second type of vegetation is called the Sudan savannah which is characterize with sparse distribution of trees and much of grasses and shrubs and the last is the Sahelian vegetation this mostly found in the extreme northern parts Kano. However, Human beings have seriously interfered with these natural vegetation due to their activities on the land.

The temperatures in Kano is as high as 38° C during the rainy season and an average of about 13°C in the harmattan season, the amount of rainfall received ranges between 0.0 to 732mm/annum, sunshine hours are longer in March and October and wind speed highest in May and June

METHODOLOGY AND MATERIALS

This is concerned with the methods, procedures and techniques used in data acquisition, analysis and interpretation of results:

Data acquired and sources

Three landsat images of the same area with different acquisition dates were used for this study. The images were drawn from the landsat TM 4 & 5 and "L7 SLC-on (1999-2003)" which are downloaded from the Earth Explorer website. The table below shows the data source and the acquisition dates of the images used.
These images have different band 1 – 7 and each band records wavelength that are used for different purposes. Generally, each band is made into colors for interpretation, it should be noted that band 6, is mostly not used because of its coarse spatial resolution of 120m. Any 3 of the 6 visible or reflected IR may be

DATA TYPE	ACQUISITION DATE	SOURCE	Cloud cover
Landsat TM	15-FEB-1985	Earth Explorer	0 %
Landsat TM	07-JAN-1991	Earth Explorer	0 %
Landsat ETM+	30-APR-2003	Earth Explorer	0.01 %

Table 1

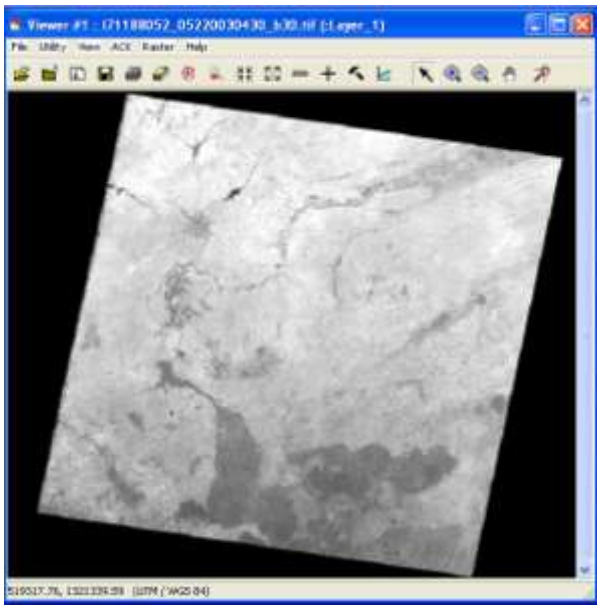


Figure 2 TIFF format image

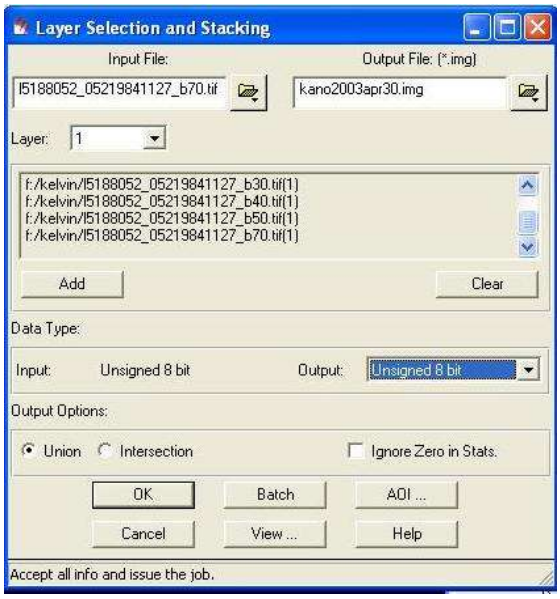


Figure 3 Layer Stacking

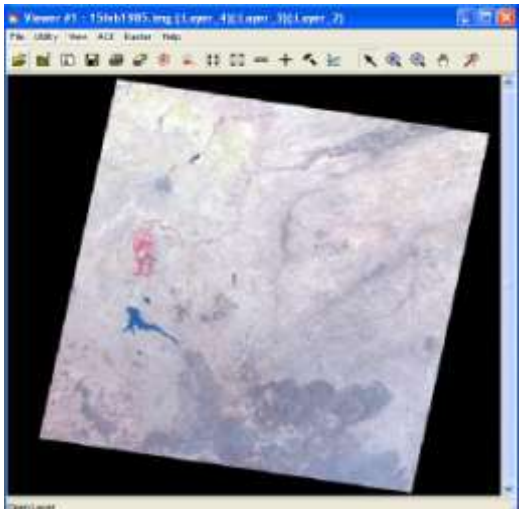


Figure 4 Stacked Images. (.IMG format)

combined in blue, green and red to produce a color image, and there are 120 possible color combinations.

Layer Stacking

The images obtained for this study were of .TIFF format, even though these files are readable by ERDAS, but they are of individual bands that have to be stacked together in order to obtain one image file with all the bands for ERDAS software to be able to read the image and use it for analysis and interpretation.

Image sub setting

Landsat images contain different layers and cover a very large area this includes areas that are not of interest.

Figure 5. Subset

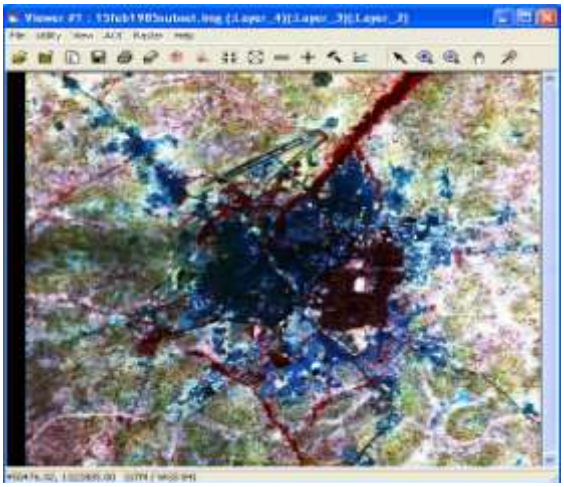


Figure 6. Subset showing study Area

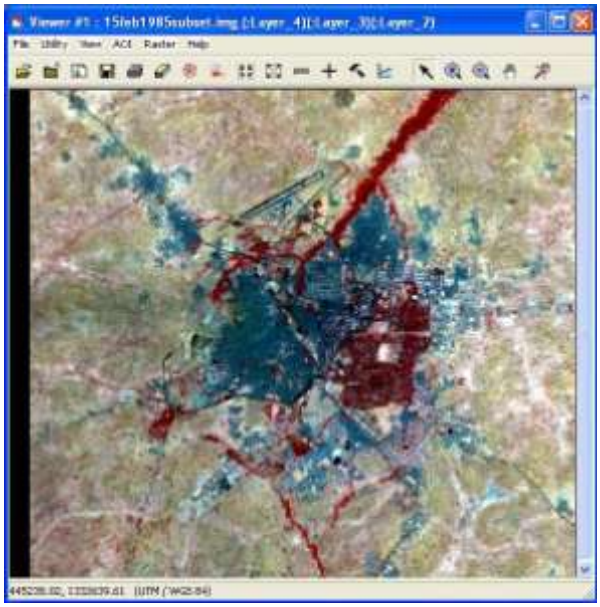


Figure 7. Before Histogram Equalization 1985

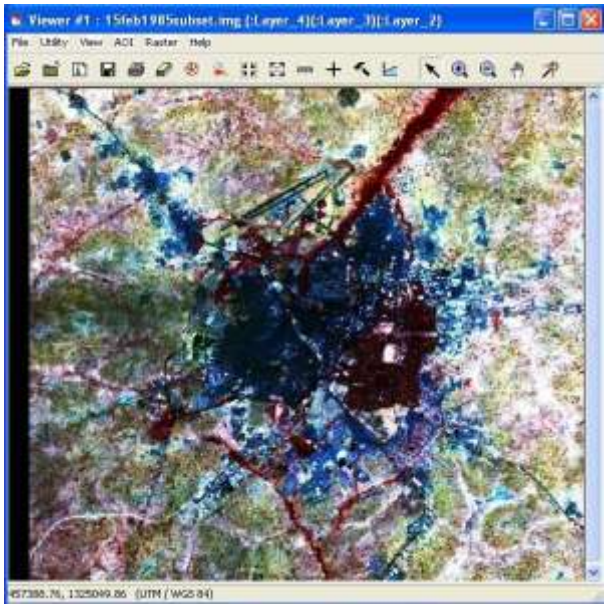


Figure 8. After Histogram Equalization 1985

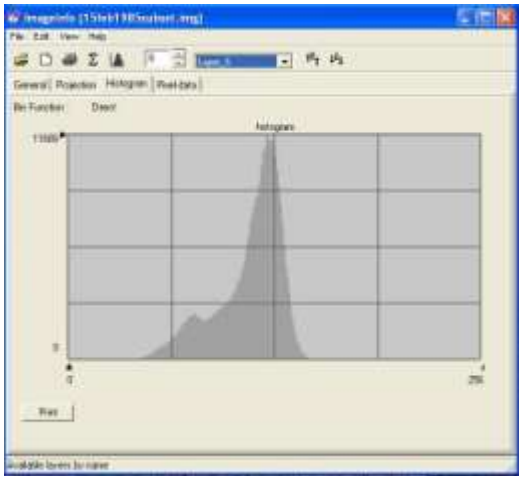
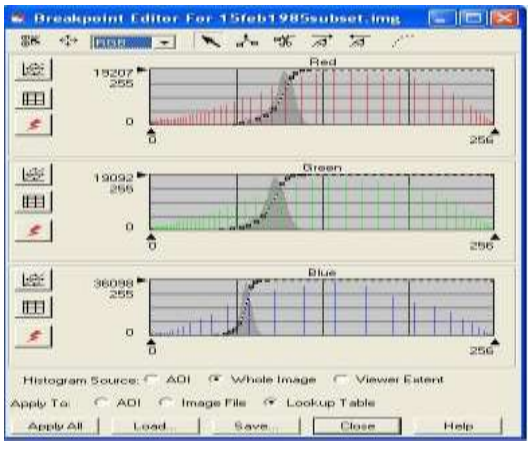


Figure 9. Histogram before equalization



F**igure 10.** Histogram after equalization

Figure 11. Image Classification Polygon Creation AOI.

Signature Editor (supervisedclassification85.sig)

File Edit View Evaluate Feature Classify Help

Class #	>	Signature Name	Color	Red	Green	Blue	Value	Order
1		built-up area		0.000	0.128	0.224	1	1
2	>	builtup area2		0.000	0.147	0.310	2	2
3		built-up area3		0.210	0.450	0.551	3	3
4		built-up area4		0.000	0.036	0.146	4	4
5		built-up area5		0.000	0.221	0.369	5	5
6		built up area6		0.000	0.126	0.226	6	6
7		built-up area7		0.000	0.224	0.424	7	7
8		builtup area8		0.378	0.474	0.639	8	8

Figure 12: showing signatures selected

The table below show the land covers classification design in the study area

Land Cover Classes	Description
Built-up Areas	Residential, Commercial, Industrial, Transportation networks.
Bare Surface	Areas with no vegetation, Uncultivated Agricultural lands
Vegetation cover	Trees, Grasses etc

Table 2. Land covers classification

Therefore, there is a need to process the images to cover only the specified area of interest in order to enhance productivity and better handling of the image. The preparation and cropping of the images to cover the specified area required was achieved using subset. The same area was selected in the three images with coordinates ULX 438465.0 ULY 1335885.0 and LRX 458025.0 LRY 1318425.0.

IMAGE ENHANCEMENT

Image enhancement improves the quality (clarity) of images for human viewing.Removing noise and blurring, increasing contrast, and revealing details. An image enhancement technique helps to improve the appearance of the image to assist visual interpretation and analysis. Landsat images have DN values from 0-255 in different bands but the satellite sensor can record this intensity within a shorter spectral range (Sabins 1997)

There are different ways in which image can be enhanced this includes contrast stretching, standard deviation stretching and histogram equalization stretch among others. With histogram equalization a darker pixel is assign a DN value of 0 (black) while the higher pixel is assign a DN value of 255(white) and the remaining pixels are linearly assign DN values ranging from 1-254.(Sabins 1997).

Visual interpretation

Analysis of satellite images involves the identification of various targets on the image. Recognizing targets is the key to interpretation and extraction, observing the difference between target and their backgrounds involves comparing different bands on any or all the following visual elements of tones (or hue), texture, shape, shadow, size and pattern (Olson, 1960). Identifying targets in remotely sensed images is base on these visual elements, which allow for further interpretation and analyses.

Image Classification

One of the main purposes of satellite remote sensing is to interpret the experiential data and classify features. Image classification involves sorting the image pixels into a specified number of classes or categories based on the intensity values of the data file. Images can be classified in two ways which includes unsupervised and supervised classification (Lillesand 2004).

Unsupervised Image Classification

The Unsupervised image classification method is a very fast method that does not give the exact classes that are required. Unsupervised classifications do not use training areas as a base for classification; instead it uses algorithms which observe the unknown pixels of an image. These pixels are then aggregated together into a number of classes based on the natural grouping or clusters present in the images spectral class. In unsupervised classification, the whole classification is automatically carried out by grouping all pixels in an image into land cover classes they belong to (Lillesand 2004).

Supervised Classification:

Supervised classification is unlike the unsupervised classification. In supervised classification, training areas are manually digitized for each class. Based on prior knowledge of the study area and use of Google earth as reference three land use land cover classes are classified in the study area: Built-up areas, bare surface and vegetation cover. Natural Resources Canada (2011) “supervised classification can be achieved through field work, study of aerial photographs or other independent sources of information”. According to Lillesand (2004), there are three basic steps in supervised classification namely the training stage, the classification stage and the output stage. In this study training areas were acquired with the use of polygon creation and region growing tools in AOI.

FINDINGS

Unsupervised classification

The unsupervised classification was carried out using two different classes (4 & 10) the propose was to show the different in result when using different classes because

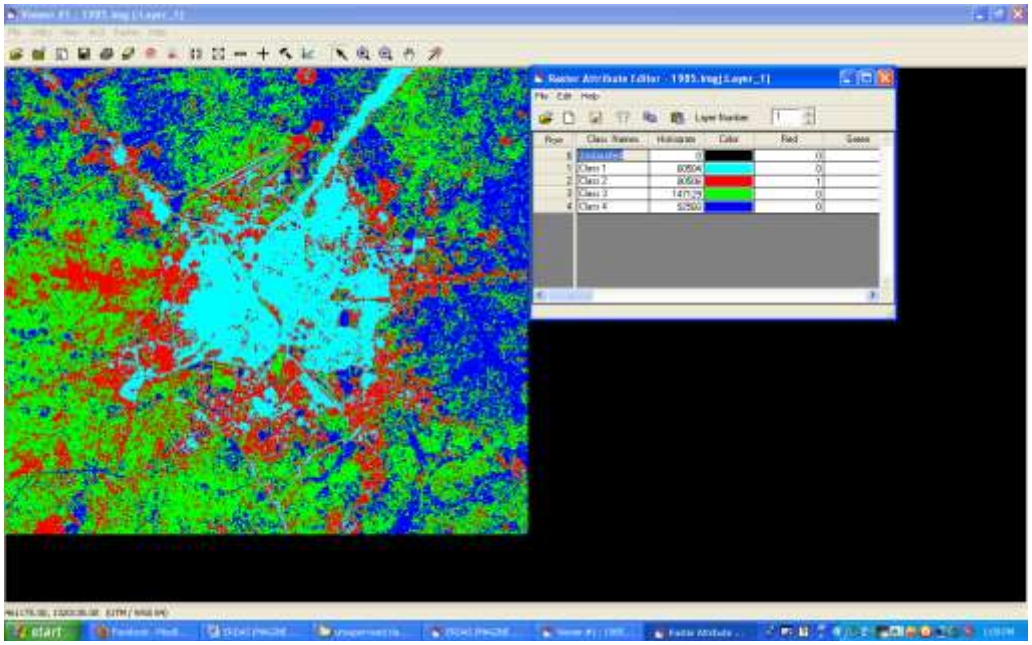


Figure 14. 4 classes' unsupervised classification 1985

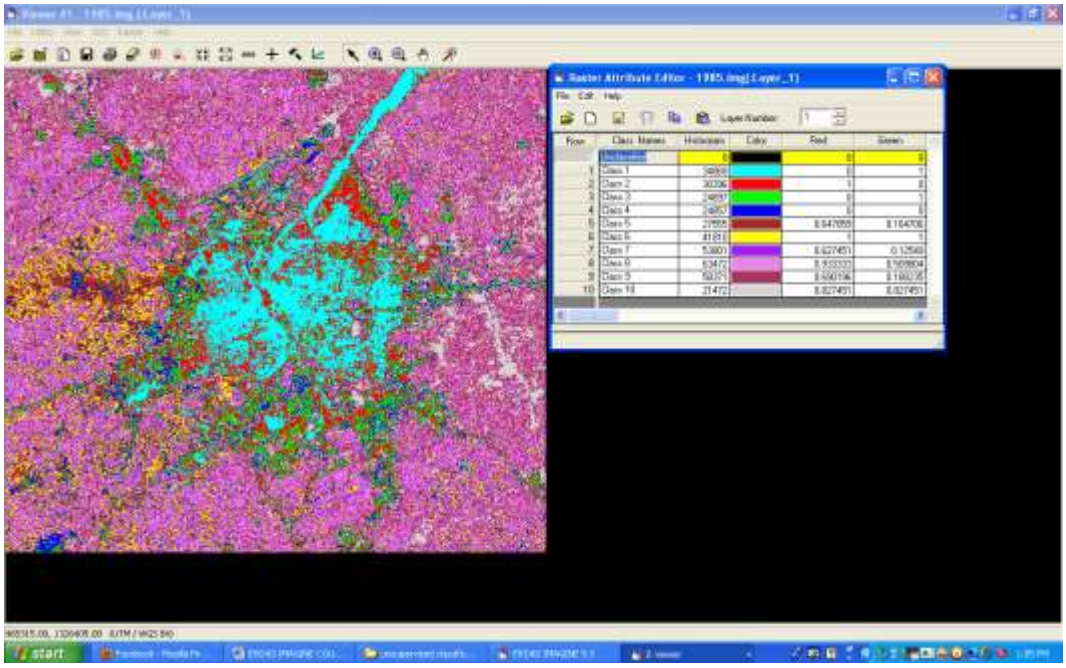


Figure 15. 10 Classes Unsupervised classifications 1985

the use of few classes does not give a good result as pixels with similarity are classified together as one class. The figures below show the unsupervised classification using the two different classes for the three images.

From the above figures it was seen that when few classes are specified other classes that are not specified are grouped alongside other pixels with similarities and classified as one class, the result obtained from unsupervised classification cannot therefore be completely trusted as pixels are not completely grouped in their actual classes.

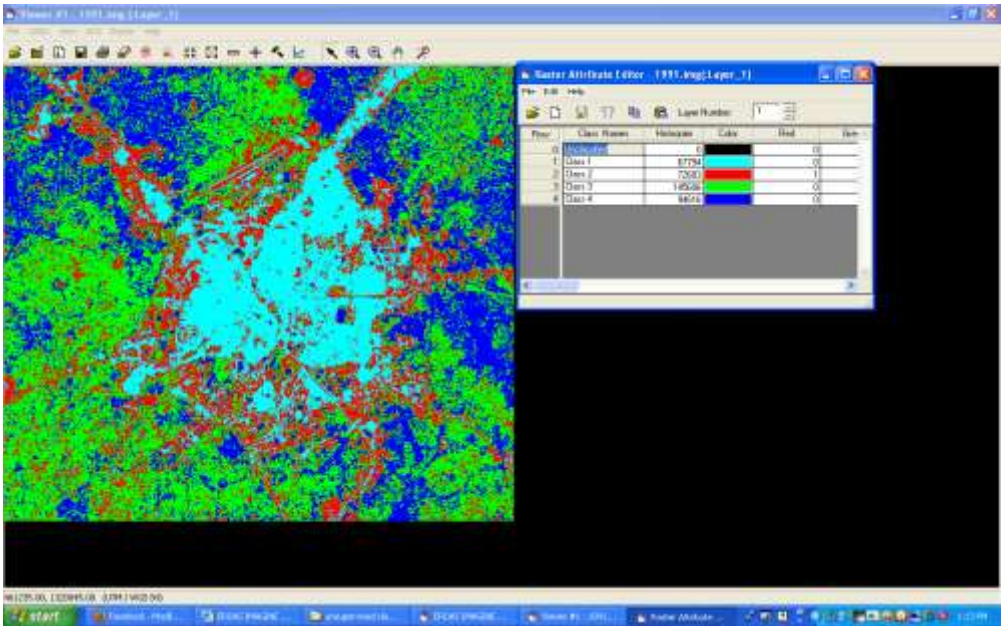


Figure 16. 4 classes' unsupervised classification 1991

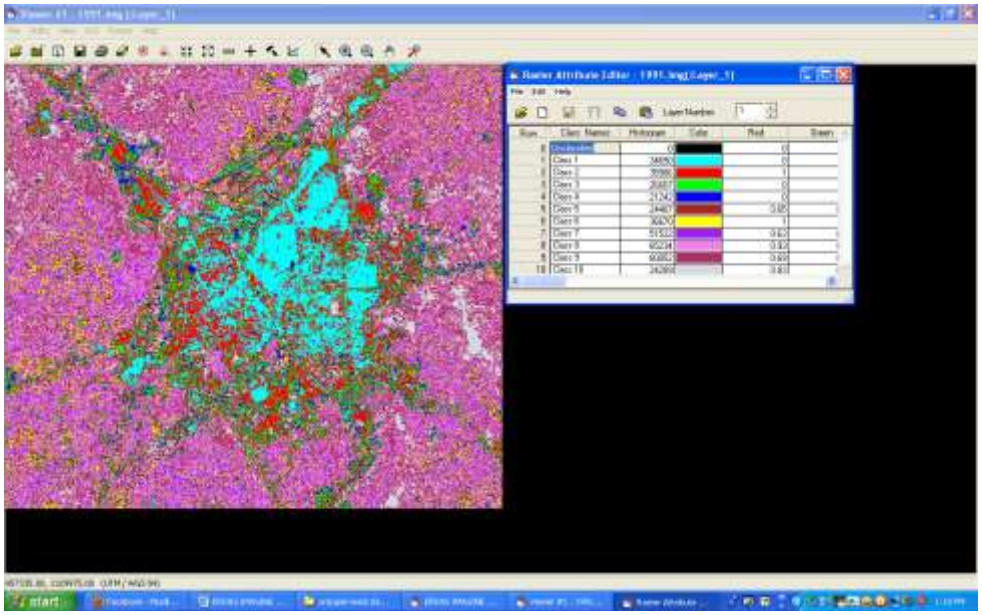


Figure 17. 10 classes' unsupervised classification 1991

RESULT, DISCUSSION AND ACCURACY ASSESSMENT

The supervised classification result was shown below it was achieved with the use of training areas. The supervised classified may not be perfectly accurate, but it is far better than the unsupervised.

From the above table and chart it can be seen that there seems to be a negative change i.e. a reduction in vegetation cover and this may be connected to the fact that Kano is the centre of commercial activities of Nigeria thereby attracting people from different area to come and settle, as it can be seen the built-up area is increasing rapidly from 11.8% in 1985 to 26.2% in 2003.

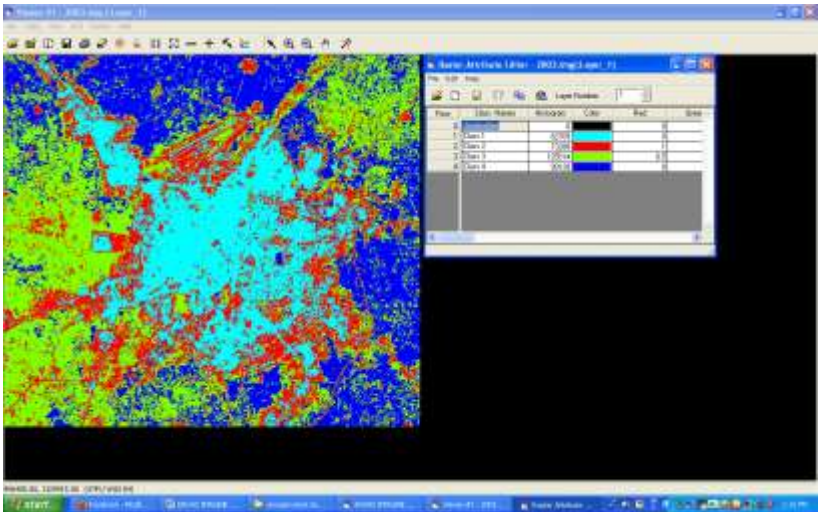


Figure 18. 4 classes' unsupervised classification 2003

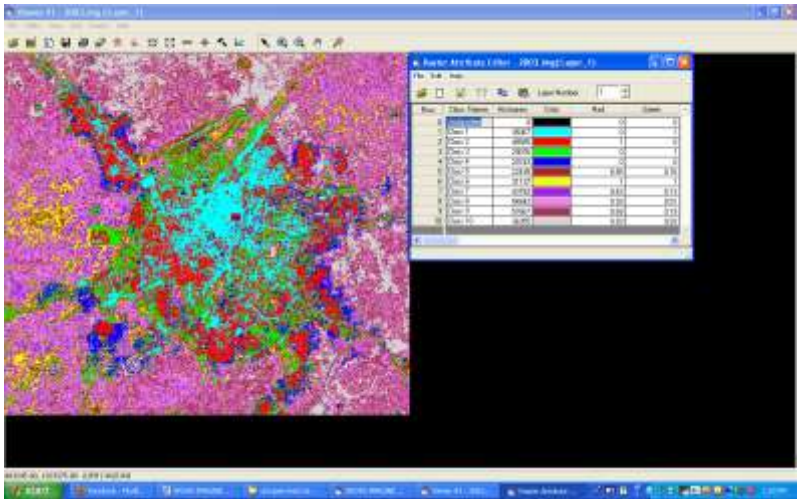


Figure 19. 10 classes unsupervised Classification 2003

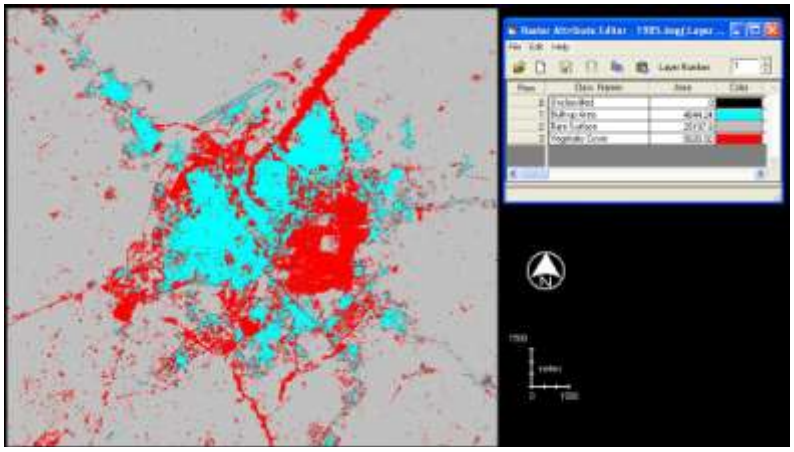


Figure 20. 1985 supervised classification

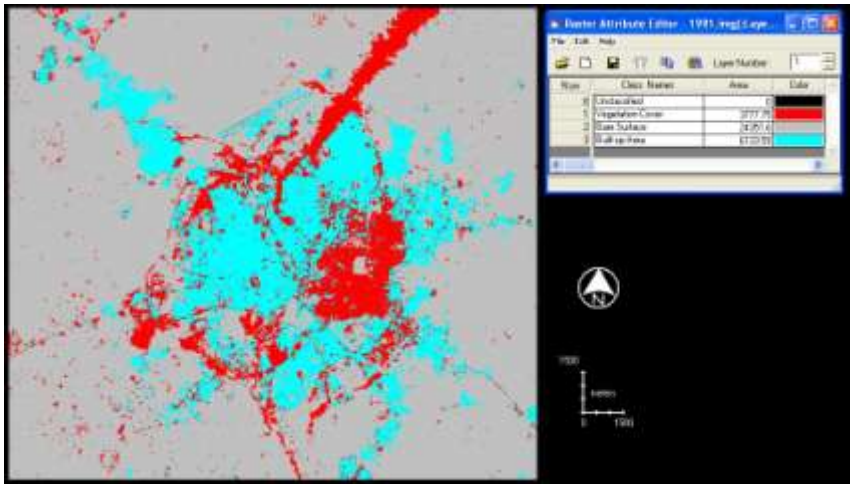


Figure 21. 1991 supervised classification

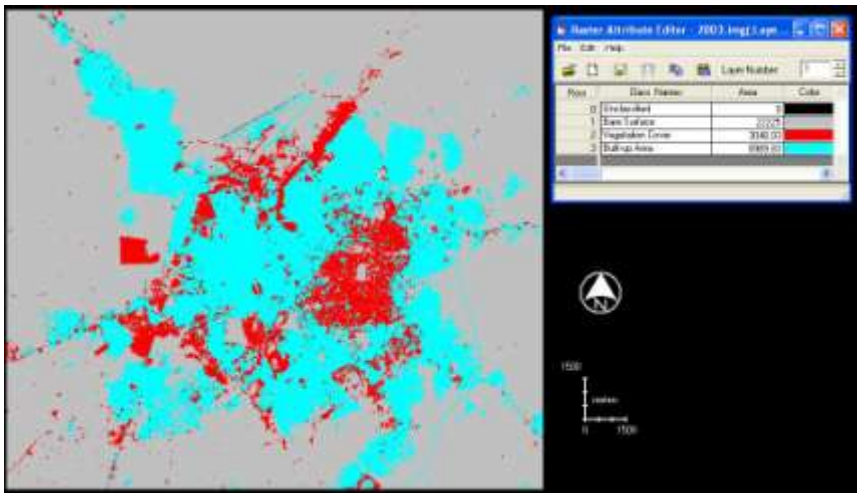


Figure 26: 2003 supervised classification

Land use, lands cover distribution and change analysis

The static land cover distribution for each study year as derived from the maps was presented in the table below

Landuse / Land cover Classes	1985		1991		2003	
	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)
Bare Surface	25197.8	73.5	24351.6	71.1	22225	64.9
Vegetation Cover	5020.92	14.7	3777.77	11.0	3048.13	8.9
Built-up Area	4044.24	11.8	6133.59	17.9	8989.83	26.2
Total	34262.96	100	34262.96	100	34262.96	100

Table 3. Land use/land cover distribution

Accuracy assessment

Accuracy assessment is important for image generated from remotely sensed data. Error matrix is the most common way to present the accuracy of classification results. The overall accuracy, users and producers accuracies were derived from the error matrices. “A classification is not complete until its accuracy is assessed” (Lilesand 2004).

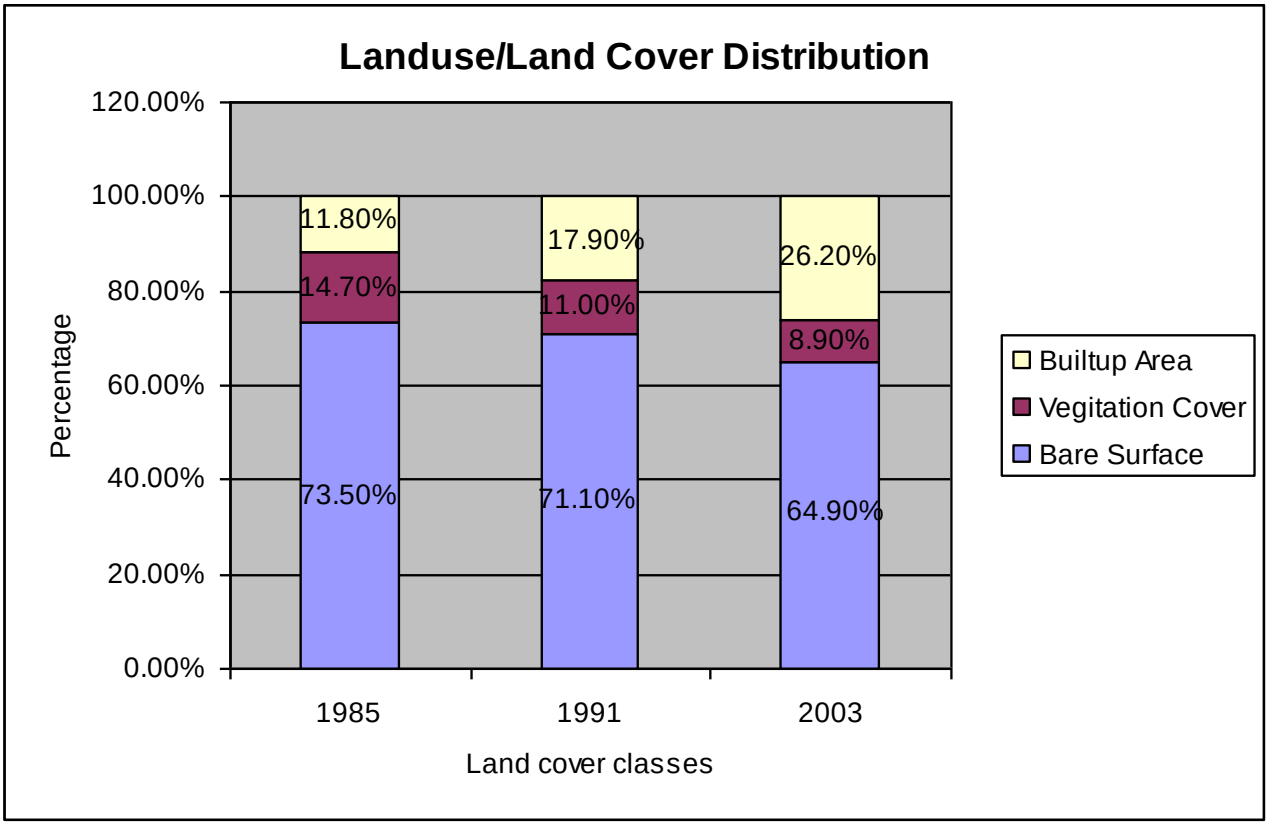


Figure 23. Land use/Land Cover Distribution Chart

ERROR MATRIX

Classified Data	Reference Data: Built-up A	Vegetation	Bare Land	Row Total
Built-up A	3502	3	0	3505
Vegetation	67	3158	31	3256
Bare Land	1	28	1997	2026
Column Total	3570	3189	2028	8787

------ End of Error Matrix ------

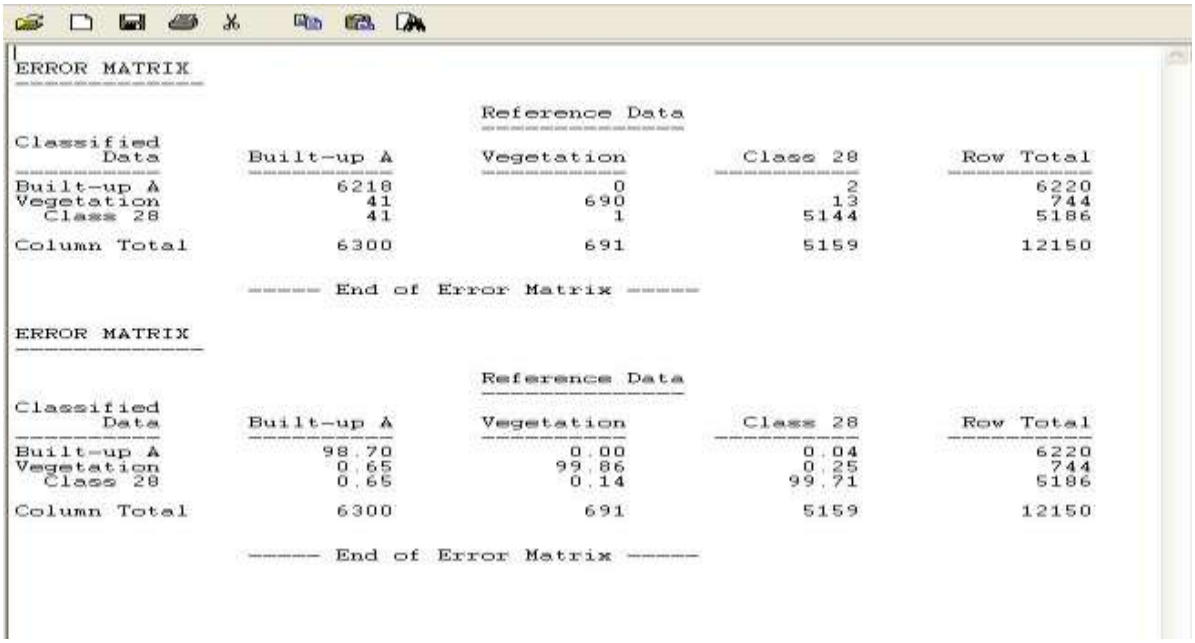
ERROR MATRIX

Classified Data	Reference Data: Built-up A	Vegetation	Bare Land	Row Total
Built-up A	98.10	0.09	0.00	3505
Vegetation	1.88	99.03	1.53	3256
Bare Land	0.03	0.88	98.47	2026
Column Total	3570	3189	2028	8787

------ End of Error Matrix ------

Figure 24. 1985 error matrix

User's Accuracy 1985
Built-Up Areas = 3502/3505 = 99.91%
Vegetation Cover = 3158/3256 = 96.99%
Bare Surface = 1997/2026 = 98.57%
Overall accuracy = (3502+ 3158+1997)/8787 = 98.52%



ERROR MATRIX

Classified Data	Reference Data: Built-up A	Vegetation	Class 28	Row Total
Built-up A	6218	0	2	6220
Vegetation	41	690	13	744
Class 28	41	1	5144	5186
Column Total	6300	691	5159	12150

------ End of Error Matrix ------

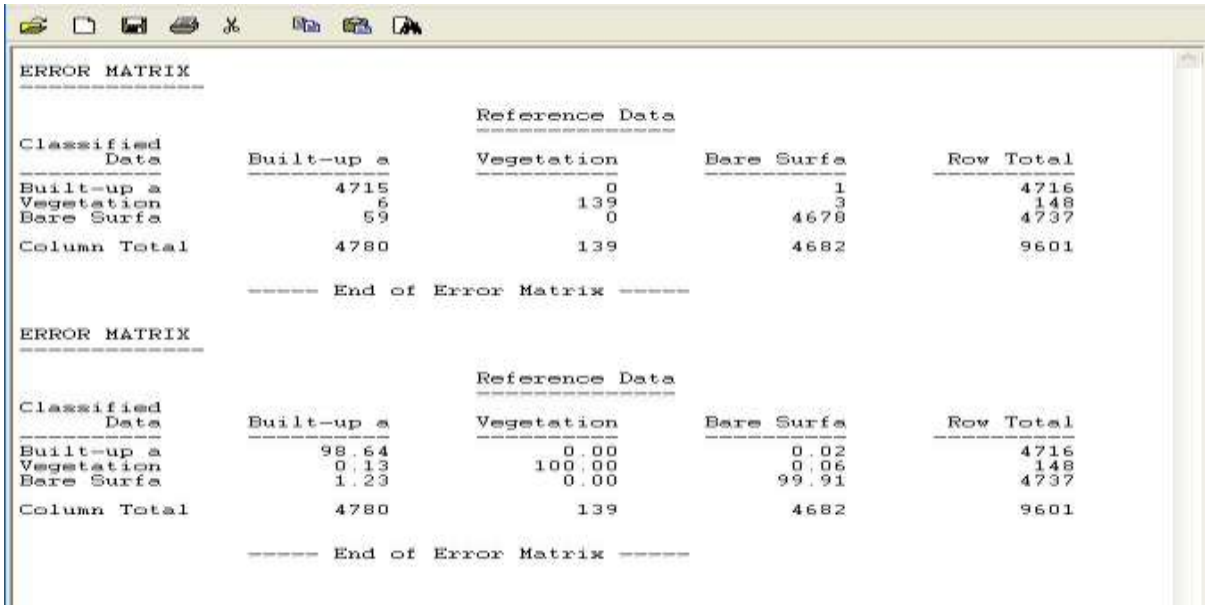
ERROR MATRIX

Classified Data	Reference Data: Built-up A	Vegetation	Class 28	Row Total
Built-up A	98.70	0.00	0.04	6220
Vegetation	0.65	99.86	0.25	744
Class 28	0.65	0.14	99.71	5186
Column Total	6300	691	5159	12150

------ End of Error Matrix ------

Figure 25. 1991 error matrix

User's Accuracy 1991
Built-Up Areas = 6218/6220 = 99.96%
Vegetation Cover = 690/744 = 92.74%
Bare Surface = 5144/5186 = 99.91%
Overall accuracy = (6218+690+5144)/12150 = 99.19%



ERROR MATRIX

Classified Data	Reference Data: Built-up a	Vegetation	Bare Surfa	Row Total
Built-up a	4715	0	1	4716
Vegetation	6	139	3	148
Bare Surfa	59	0	4678	4737
Column Total	4780	139	4682	9601

------ End of Error Matrix ------

ERROR MATRIX

Classified Data	Reference Data: Built-up a	Vegetation	Bare Surfa	Row Total
Built-up a	98.64	0.00	0.02	4716
Vegetation	0.13	100.00	0.06	148
Bare Surfa	1.23	0.00	99.91	4737
Column Total	4780	139	4682	9601

------ End of Error Matrix ------

Figure 26. 2003 error matrix

User's Accuracy 2003
Built-Up Areas = 4715/4716 = 99.98%
Vegetation Cover = 139/148 = 93.92%
Bare Surface = 4678/4737 = 98.75%
Overall accuracy = (4715+139+4678)/9601 = 99.28%

CONCLUSION

Land cover is a substantial material at the surface of the earth. It is very important to be considered in planning and decision making. This study demonstrated knowledge based image classification which is a new technique for image classification using landsat TM and landsat ETM+ satellite imageries as a helpful technique for classification and this provide an accurate and broad view of the land use land cover changes of Kano over the epoch years and the nature and extent of the changes.

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