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Remote Sensing Studies on Urban Change Detections

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Abstract: **The studies monitor the change in urban growth in Kano, northern Nigeria between 1999 and 2003. The Landsat imageries with 30m resolution were used as for detecting changes using both supervised and unsupervised classification. The images for the two periods were downloaded, layer stacked and corrected before the main processing work. Envi 4.8, ArcGIS 10.0 Idrisi for Taiga 17.0 and excel application of Microsoft office 2007 were used for data processing and analysis. The results were presented in maps, tables and charts. For the supervised classification four land cover classes (ie vegetation, bare lands, built up and water body) were used for the classification. The results have shown that the only bare lands had increases within period of study. Vegetation, water body and built up area had all decreases. However in some area especially in GRA vegetation has increase and this has been attributed to urban greening. To distinguish between farm land and tree canopy the study further used five classes by breaking the vegetation classes into two and the results shows that while farmland had decreases, the dense tree canopy has increase in the area for the period of study. The accuracy assessment has shown that the result is between 86 and 99 percent. The study recommended among other things the need for policy makers to look critically into the issues of urban planning and development in the area.**

Keywords: **Remote, sensing, urban, change, detection, information, system, Kano.**

I. INTRODUCTION

Urban growth is a global phenomenon that is caused by Man action with current reduction of agricultural land (Lopez, et al. 2001), deforestation (Alphan, 2003), that reduces plants growth. This is due to the population growth, cities expansion that converted rural areas and agricultural lands into urban areas particularly in the developing countries of the world (UN-Habitat, 2003). It is clear evidence in case of China and other Asian countries that they experience high increase in urban growth. Nigeria is among the developing countries with rapid population growth and very high urbanisation in some major cities. Kano is a commercial centre in northern Nigeria with rapid urbanisation which is associated with urban problems like, unemployment, inadequate water supply, and traffic congestion.

Urban expansion requires development of Land Use and Land Cover Change (Musa, 1994).Very high urbanisation and towns expansion in most of developing countries has been discovered as the major causes of land use and land cover (LU/LC) changes (Odjo, 2007, Oyinloyye, and Adesina, 2006). As urbanisation is the major agent of land use and land cover (LU/LC) change detection of some important information that are needed in the process of monitoring cities using GIS and remote sensing application for analysis in the process of projecting the trends of future land use and land cover changes, and the causes of urbanizations in most of developing countries particularly in Africa. This is because of unawareness of data sources in government organisations and institutions of higher learning. There are serious limitations of remote sensing, and Geographical Information Systems (GIS), in developing countries particularly in the area of technical know-how on how to get a good data for GIS analysis which will be use for extracting meaningful information

from the data, (Okpala, 1983, Adesina, 2005). However, according to Stren, (1994) there was a setback of economic resources in the academic institutions of higher learning particularly universities to conduct a research in remote sensing and Geographical Information Systems, (GIS). The second reason is political instabilities in some developing countries which hinder the successful development of Remote Sensing, GIS application and data sources as well as data collection, with main advantage of monitoring urban growth and the provision of themat ic mapping so as to provide the bedrock of development with good information to policy makers, administrators which will be used for other development control, planning review of urban area. That is why the remote sensing (RS) and Geographical Information Systems (GIS) are needed. The data capture and analysis with the use of these powerful tools to achieve the objectives. Data capture, analysis and evaluation will be used to provide thematic maps and graphs of the study area. The result will serve as a useful information to policy makers and urban studies of both land use and land cover change (Geneletti, and Gorte, 2003). The use of land sat ETM+ of 1999 and land sat ETM+ of 2003 to assess the rate of changes in Kano metropolis with the change detection discovered at eastern bypass of the study area and some other changes within the study period. Some supporting data apart from images used as reference guide as well as data capture and data collections, the result of unplanned growth in Kano affect the spatial shape of the land use. This is because of the uncontrolled development and lack of information technology of data acquisition like Remote Sensing and GIS (Ikhuoria, 1995).

II. LITERATURE REVIEW

A. Remote sensing Application in land use and land cover change:

Urban landscape change using remote sensing application and techniques is useful in environmental changes particularly in this study of urban land use and its infrastructure. The remote sensing application will be used for extracting changes that occur over period of time in the study area and may be use for global or regional studies such as global monitoring vegetation cover, global food change as well as regional resource management using change detection analysis in remote sensing application by the Global Monitoring Report 2013(MDG, 2013). Available at http://econ.worldbank.org

Remote sensing techniques are very good in data capturing and analysis in the process of quantifying the nature of urbanization and rapid growth. An image resolution of both temporal and spatial are now an important methods of challenging urban problems by creating a thematic mapping for the general environment within the study periods by producing outcomes from the study and guides to policy makers, (Miller and Small, 2003).

Remote sensing has significant role in urban studies and its capable of monitoring changes in the general environment. Base on the image resolution, remote sensing images provide quality data particularly a very high resolution image which provides successful mapping of an urban area. Generally, the applications requires two different date images for comparison in the process of monitoring changes and bring out good result for decision making in solving some problems related to the urban growth and town plan against the uncontrolled development

B. Image Transformation:

This is an important techniques in remote sensing that are very relevant and useful to land use and land cover studies when the principal component analysis, (PCA) has good advantage and capable of reduction of data redundancy that are usually within image bands in order to have component information. These famous techniques point out areas in the process of identifying changes on the two different date images. One of the shortcomings of principal component analysis is very difficult to interpret the change detection about the details information obtained and the information on the transform output images.

C. Geographical Information Systems (GIS), Application in LU/LC Change:

The Geographical Information Systems (GIS) application, plays significant role in Urban change detection of land use and land cover studies that involves the use of GIS software of both remote sensing and GIS techniques with powerful tools that has the capacities of incorporating different data set particularly in this study. When historical map of the study area was collected during the data collection at the study area, the collected data was processed in GIS techniques as a source data in line with the objectives of this study of identifying the land use and land cover changes in the study area. This Geographical Information Systems (GIS) application has important advantage of using powerful function with good

example of ArcGIS software that has good tools for multi-source data processing of the change detection studies to the Geographical Information Systems (GIS) .This analysis involves data accuracy and those formats that usually affect the change detection analysis results.

D. Study Area:

Kano is semiarid region in sub-Sahara West Africa. It is dominantly commercial centre in the whole in Nigeria (Sani, and Sulaiman,2011). Kano share common boundary with some Northern States in Nigeria at East with Jigawa state, West with Katsina state, North with Bauchi state and border with Kaduna state at the southern part with the coverage area of 20,760 KM2 and 1,754,200 hectares. It is dominantly agricultural land use with total of 75,000 hectares area Forest cover and Animal grazing land (UNDP,2004). The Geographical location is between latitude 110 5N to 120 7N and the longitude of 80 23E to 80 5E with the elevation of 400m to 500m above the mean sea level of the terrain topography. The main climate of Kano is Wet and Dry seasons of 160C to 210C in the month of December and January as the lowest temperature and the highest temperature period of 300C to 400C in March to end of May (Olofin, 1987.The seasonal rainfall of tropical region According to Schoeniech,(1998), is 800mm to 1000mm that usually start in the beginning of May and stop in the month of October with natural vegetation cover of savannah type vegetation with the different characteristics of trees species with bold canopies. Usually, the vegetation cover of the study area is in extinction due to the act of deforestation of natural forest as the result of population growth which leads to the high demand of fire wood and the urban expansions in the area. Regarding to vegetation cover of the area, special recommendation should be made to government and other planning authorities to improve forestation programme in order to enhance the vegetation growth in this study area. In view of Normalized Different Vegetation Index (NDVI), It is important methods of change detection of vegetation cover.

III. METHODOLOGY

Landsat ETM+ Level-I imagery of the study area for the two periods (1999 and 2003) were downloaded from USGS website (www.glovis.usgs.gov). The image consists of seven bands covering the visible, near infrared and Thermal infrared wavelengths (0.45µm- 12.5µm). The images have 30m that make them suitable medium scale studies.

Unsupervised classification of the two images (1999 and 2003) were done using both k-mean and iso-data classification. In each of the case four classes were used. The results displays

IV. ANALYSIS AND FINDINGS

Land Classification Using Supervised Classification:

For land classification this study adapted four classes, these are built-up, bareland, vegetation and water. However this classes is generalised it contain sub-classes which have explained in chapter three. The two images classified were presented in figure 4.3.

The results have shown that vegetation, water bodies and built up area had decreased between 1999 and 2003. On the other ahnd the bare land has increased at the expensed of the other used. This can be attributed to many issues. Water body has decreased probably due urbanization and issues related to draught. Reasons that can be attributed to decrease in built-up area which is used as a urban uses are the mass demolition and government policy. It is important to note that land policies especially issue pertaining to illegal development where taken for granted in the past. However with transition to democracy in 1999 government discourages illegal development and sprawl through mass demolition and building permits, which reduced the urban, increased. In addition there were existing small villages at the fringes of the urban area which were initially captured as built up, however due desertification and draught these small villages ceased to exist because the settlers either in cooperate into the proper city or move to surrounding villages which are outside the area of study. Another reason is the issue of urban greening that took place in the area. This is true especially in the low-density area of urban Kano known as GRA (Government Reservation Area). In these areas due vegetation canopy that covers structure, the pixels were classified as vegetation.

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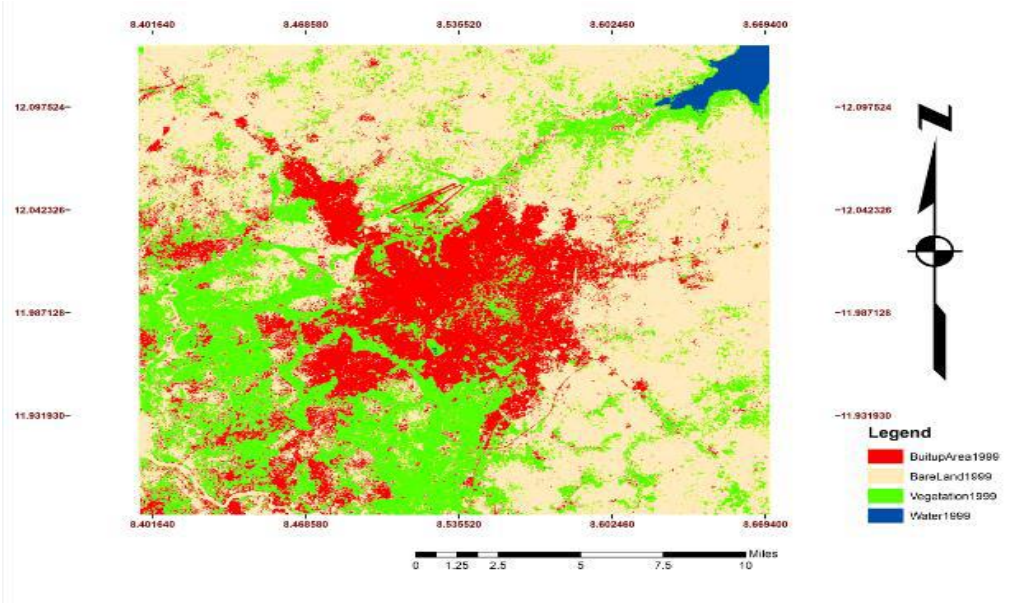

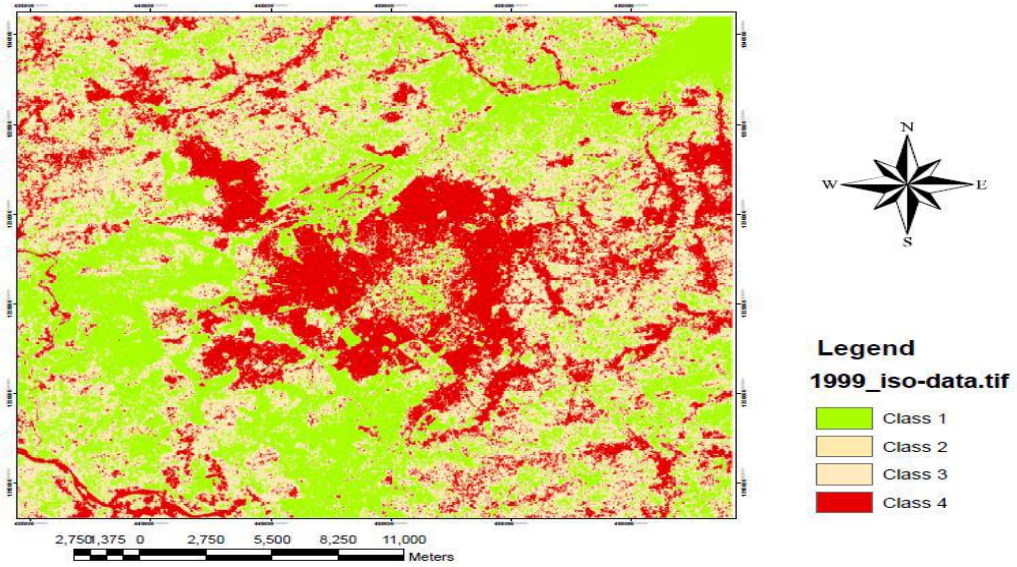

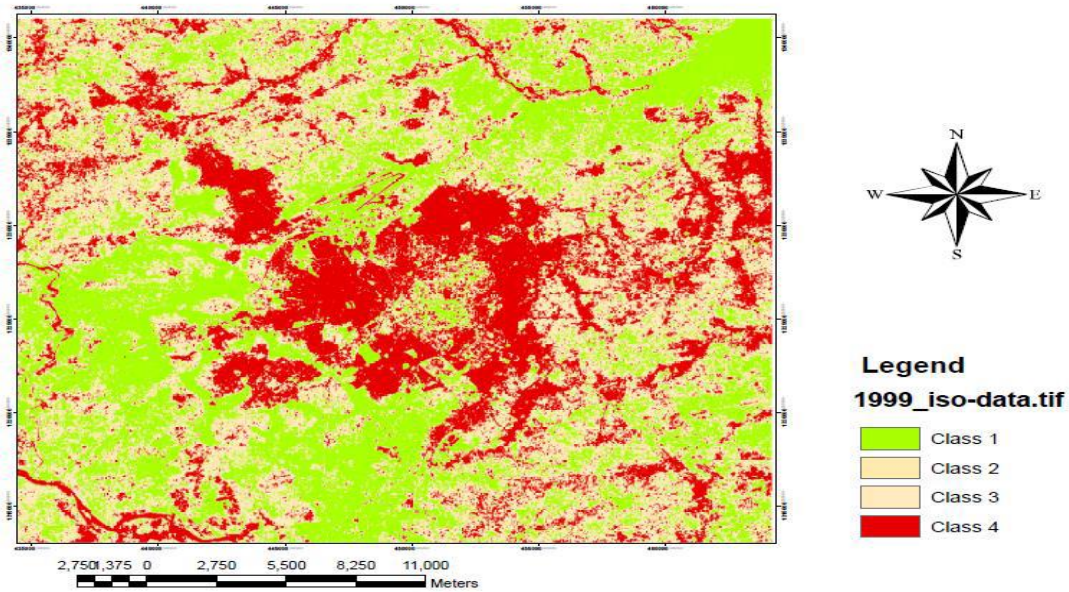

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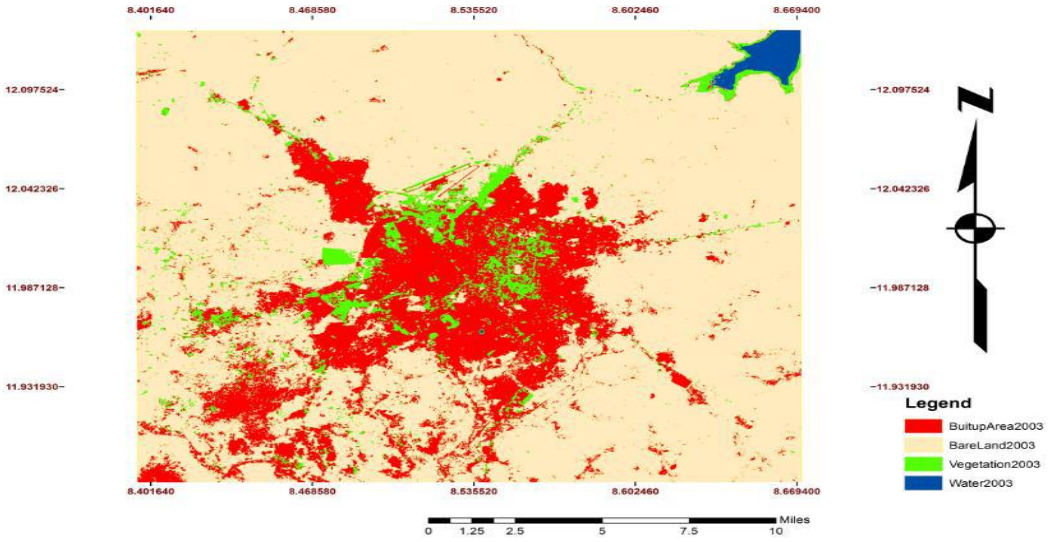

FIGURE 4.1: 1999 UNSUPERVISED CLASSIFICATION ISO-DATA TECHNICS FIGURE 4.1B: 2003

V. CONCLUSIONS

This study has demonstrated the use and application of remote sensing and GIS techniques as powerful tools to extract meaningful information for using thematic maps of the area for two different date. The study has shown, the build-up area has increase while the water body and vegetation have significantly reduced between 1999 and 2003. This is largely due to urbanisation. The study developed more emphasis on extension cause by built-up areas as a result of population increase. The study has also determined the use of land sat images for change detection with respect to many similar techniques of detecting changes in urban. Meaningful information has been reviewed in this work particularly under chapter two (literature review section) on change detection using both techniques of GIS and remote sensing to determine urban land use and the physical planning. The study has integrated remote sensing and GIS, benefiting from both of the tools to achieve its objecvtive. Chapter 3 was the implementation stage and data analysis processes and applications of both techniques was successful with refer to literature reviews of image change detection from image classification and classified classes of environment and its uses.

Remote sensing data result from the analysis of this study has provides a temporal data for the decision makers for future planning against the uncontrolled developments as results of rapid population increase in Kano which has affected the planning in the area. The study has demonstrated the use of two different date satellite images of the study area for the analysis of change detection of Kano which was very successfully with remote sensing and GIS environment. The objectives of measuring urban change detection of land use and land cover (LU/LC) in Kano has been met with the results from image classification. The study has improved the use satellite images data to provide spatial information to other GIS and remote sensing analysts.

GIS is needed in developing countries of Africa particularly Nigeria in the area of physical development and environmental programmes. There is the urgent need for remote sensing and the GIS techniques to Governments and private institution for implementation and decision making to improved their general physical and environmental policies, physical infrastructure and urban planning.

VI. RECOMMENDATIONS

This study has made special recommendations to the physical planning authority to improve their planning activities at both technical and management level. These include:

- The National Planning and Monitoring Agency should use the results of this study in their environmental and sustainable development programmes.
- The Urban and Development Planning Agency in Kano State should also use the results for development planning against the unplanned buildings in the study area.

- The local planning authority in the study area should improve their monitoring activities at the local government level in relation to the rates of changes that were detected in this study.
- The immigration agency should improve their policies in relation to the population growth in the study area.
- City planners should use the remote sensing data with good spatial resolution to improve their planning for development.
- The study has provided a different date data within the study period to decision makers for further implementations and future planning of the growing city to prevent uncontrolled developments area with reliable information for monitoring and evaluations for sustainable development of the general environment.
- This study has made some provisions for further urban studies in the area been recommended.
- This study has discovered land use changes within the study periods that need urgent attentions from the management level to implements relevant environmental policies for the development and land resources sustainability.

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