Assessing the Impact of Anthropogenic Activities on Land Cover in Guinea Savannah Region of Nigeria Using Multi-Temporal Landsat Data

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Abstract: ***This paper examines changes on natural landscape as a result of anthropogenic activities in Nigeria. To achieve that an areas was selected within the guinea Savanna region of the country. Land sat Data were obtained for 1986, 1999 and 2006 and Land use land cover images were produced from the three data sets. The study established a decline in natural vegetation from 308,941.48 hectares in 1986 to 278,061.21in 1999 and then to 199,647.81 in 2006. Consequently cultivated area continue increasing from 259,346.80 hectares in 1986 to 312,966.27 hectares in 1999 and then to 341.719.92 hectares in 2006. There was also gradual increase of built up areas. In addition bare surface and rock out crops also increases due to reduction in vegetative cover which give raise to weathering processes. The paper concluded that there is drastic lost of vegetatative cover and high weathering process due to the fact that more rocks out crops were exposed to the surface. Therefore there is the need to protect and preserved forest cover in the region because anthropogenic activities such as fuel wood gathering, charcoal production and farming activities is seriously putting pressure on the already decline state of the vegetative cover.***

Keywords: Chnage Detection, classification, data, images, land use, natural vegetation

1. Introduction

Several regions around the word are currently undergoing rapid, wide-ranging changes in land cover. Much of this activity is centred in the tropics in such countries as Brazil, Columbia, Indonesia, Mexico, the Ivory Coast, Venezuela and Zaire [1] [2]. These changes in land cover, in particular tropical forest clearing, have attracted attention because of the potential effect on erosion, increased run off and Flooding, increasing CO2 concentration, climatological changes and biodiversity loss [3] [4] [2]. Remote sensing provides a viable source of data from which updated land-cover information can be extracted efficiently and cheaply in order to take an inventory and monitor these changes effectively. Change detection has become a major application of remotely sensed data because of repetitive coverage at short intervals and consistent image quality.

Land-cover refers to the physical characteristics of earth's surface, captured in the distribution of vegetation, water, soil and/or artificial structures [5]. Most of the time the planning and management tasks of the environment are troubled due to insufficient information on rates of land cover/land use changes. The land cover changes occur naturally in a progressive and gradual way, however some times it may be rapid and sudden due to anthropogenic activities [6]. It provides the spatial distribution of features and qualitative and quantitative information of features changes. The quantitative analysis and identifying the characteristics and processes of surface changes is carry through from the different periods of remote sensing data. It involves the type, distribution and quantity of changes, that is the ground surface types, boundary changes and trends before and after the changes.[7]

2. Impact of Land Cover Changes due to Anthropogenic Activities

The Land cover reflects the biophysical of state of the earth's surface and immediate surface, including the soil material, vegetation and water. Landuse on the other hand, refers to the use of land by humans. It is the alterations done to Landcover as a result of human activities such as farming, road construction, etc [8]. Landcover refers to the natural surface of the earth undisturbed by human activities. It represents vegetation, natural or man-made features and every other visible evidence of Landuse e.g. forest, cultivated/uncultivated land, settlements, etc.

Land use refers to utilization of land resources by human beings and land cover changes often reflects the most significant impact on environment due to excessive human activities. Land use and land cover is dynamic in nature and is an provides a comprehensive understanding of the interaction and relationship of anthropogenic activities with the environment [9]. Land use/cover changes also involve the modification, either direct or indirect, of a natural habitats and their impact on the ecology of the area. Land use/cover change has become a central component in current strategies for managing natural resource and monitoring environmental changes [10].

Degradation of forest connectivity in between landscapes occurs due to fragmentation and anthropogenic activity, which causes biodiversity decline. Conservation of wildlife corridors requires a complete knowledge of species habitat requirements. It also requires past and current area under different land use practices such as agriculture, forestry and human habitations that alter vegetation cover, land surface, biochemistry, hydrology and biodiversity [11]. Vegetation forms an integral component of terrestrial ecosystem and wildlife habitat [12].

With Rapid changes in land cover over large area, remote sensing technology is an essential tool for monitoring vegetation condition because the remote and inaccessible nature of many forest area give challenge to ground - based inventory and monitoring processes. Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times [13]. Detection of land use-land cover (LULC) changes is one of the most important factors for monitoring, management and planning issues.

Supervised classification has been widely used to detect land use types. In supervised classification, spectral signatures are collected from specified locations (training sites) in the image by digitizing various polygons overlaying different land use types. The spectral signatures are then used to classify all pixels in the image. The supervised classification is generally followed by knowledge-based expert classification systems depending on reference maps to improve the accuracy of the classification process [2] [14] [15]

3. Global Perspectives of Vegetation Change Detection Techniques

[16]. In their study they used Intergrade Land Sat Thematic Mapper (TM) and Spot High Resolution Geometry (HRG) Images to detect vegetation changes in Brazilian Amazon, using the image differencing approach based on the TM and HRG fused image and the corresponding TM image. A rule-based approach was also used to classify the TM and HRG multispectral images into thematic maps with three coarse land-cover classes: forest, non-forest vegetation, and non-vegetation lands. A hybrid approach combining image differencing and post-classification comparison was used to detect vegetation change trajectories. The Result shows promising vegetation change techniques, especially for vegetation gain and loss, even if very limited reference data are available. The hybrid approach provides such change information as forest degradation and non-forest vegetation loss or gain which indicates that the conversion from forest to non-forest vegetation or from non-forest vegetation to non-vegetation land accounts. The approach is especially valuable when same sensor data and reference data are not available hence may not be applicable for a dry region like the Sahel savannah region. Conversely [17] Used multi-temporal satellite imagery to detect land cover changes in El Rawashda, Gedaref State of eastern part of Sudan where they applied two different change detection techniques in order to assess land cover changes in El Rawashda forest, Sudan, by comparison of classification and multivariate alteration detection. Firstly, they acquired two satellite imagery, in 2003 by Landsat ETM+ and by ASTER in 2006, and were classified into four main land cover classes namely grass land, close forest, open forest and bare land. A change matrix was created in order to map the land cover changes from 2003 to 2006. The results show a noticeable increase in area on both close forest and open forest areas with decrease in grass lands within the period 2003-2006 they discovered that more than one third of grassland (36%) was converted to close forest, one fourth (24%) to open forest areas. In the three-year period, 9079 hectares of open forest, (8% of the investigation area), were transformed to close forest It has also been found the MAD transformation to be good unsupervised change detection method for satellite images and it can be applied on any spatial and/or spectral subset of the full data set which may likely not be suitable for supervised classification and shrubs or young vegetative cover. While [18] compared Techniques of Forest Change Mapping Using Landsat Data in Karnataka, India. They analyzed imagery of 1986 and 2003 using two change detection techniques: (1) image differencing of the Normalized Difference Vegetation Index (NDVI), the second principal component (PC2), and the Kauth-Thomas greenness index (KT-G), and (2) post-classification comparison (PCC). As field validation data did not exist for 1986, extensive visual assessment was conducted to locate and identify errors of commission and omission in the change maps. The image difference vegetation maps did not display obvious errors of omission, but they discovered that NDVI difference performed better than KT-G and PC2 differences in terms of errors of commission. Furthermore [19] used Multi-temporal Landsat image classification and change analysis of land cover/use in the Prefecture of Thessaloiniki, Greece. They used Nine different land cover/use categories, namely coniferous, broadleaves and mixed forest, agriculture lands, rangelands, grasslands, water bodies, urban areas and others uses. The overall classification accuracies were 85% for the three years, and the change detection accuracy was 88-91%. The classifications have provided an economical and accurate way to quantify, map and analyze changes over time in land cover. [20] In their research, they used normalized difference vegetation index (NDVI) differencing and classification to analyze land use-land covers changes methods in southern part of Ardakan, they used two Landsat ETM+ images of the years 1990 and 2006 to derive NDVI images and perform image classification. At first stage, differences between two correspondent NDVI images of the area was calculated to demonstrate the areas with 10% increase or decrease in NDVI values. From the results, 18.83% of the region's NDVI values have decreased by about more than 10% from 1990 to 2006, while only 1.38% of it has increased at the same time period. At second stage, supervised classification was performed and outputs of the two time periods were compared to derive information on changes that occurred over a period of time. During the study period, urban areas were increased from 10.68% of the total land in 1990 to 17.16% in 2006 whereas, the agricultural lands were decreased from 30.15 to 21.76% in the same period. This approach will be adopted in this paper with little bias on vegetation since the paper will look into afforestation project.

4. Study Area

Toro is a local government area in Bauchi state, north eastern part of Nigeria. It covers an area of 6,932km^2 with a population of 350,404. It is neighboring Bauchi, Ningi Dass and Ganjuwa Local Government areas, it is located in southern part of Bauchi state, it lies within latitude 9.824^{0}E longitude 8.711^{0}N and maximum latitude 10.861^{o}E, Longitude 9.667^{0}N. The decision for the study is informed by the level of community participation in logging and charcoal production which served a major producer of charcoal in northern Nigeria. Toro L.G.A lies within the guinea savannah which is characterize by grass lands with scanty trees which are deciduous in nature (shading leaves during the dry season) the crops grown in this region are predominantly maize, rice, potatoes, sorghums and millet.

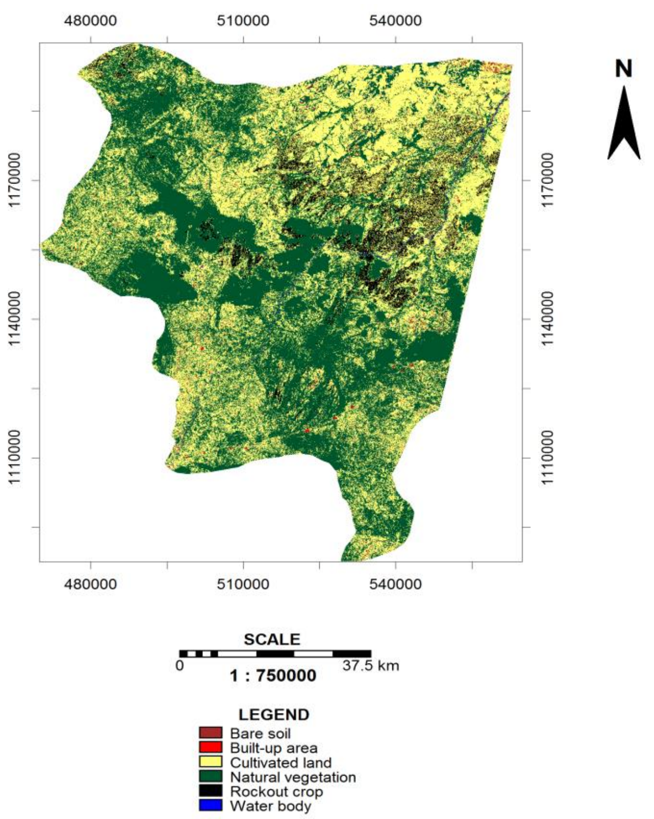

Figure 1: Vegetation Zones of Nigeria
Source FAO 1993

5. Methodology

Three land sat data were obtained from Space Application Department of National Center for Remote Sensing (NCRS) Jos, Plateau State Nigeria. The data have the following information. 1986 was chosen becosue that is almost the time charcoal production begin in the research area.

Table 1: Data information

Date	Source	Date of acquisition	Resolution
1986	Land sat TM	10/2/1986	30x30
1999	Land sat ETM +	11/2/1999	30x30
2006	Land sat ETM +	12/5/2006	30x30

Source: NCRS Lab

A supervised classification was carried, the image was classified base on classified based on bare soil, built up areas, cultivated land, and natural vegetation, Rock out crop and water bodies.

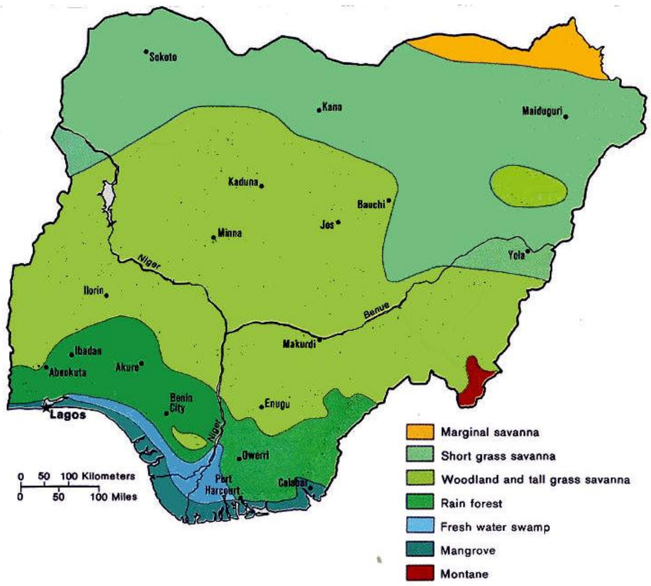

Figure 2: LULC of Land Sat TM 1986

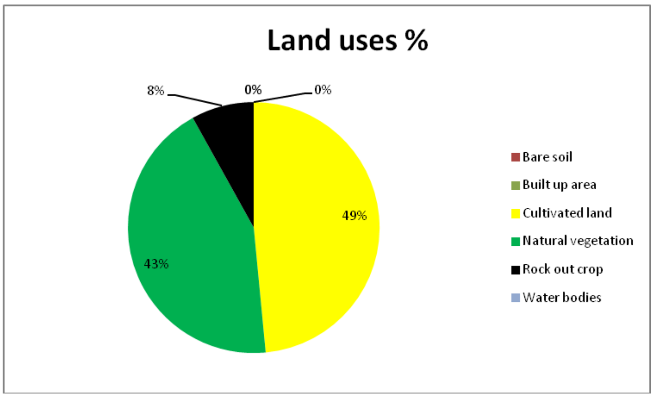

Figure 3: Land Cover Budget for 1986

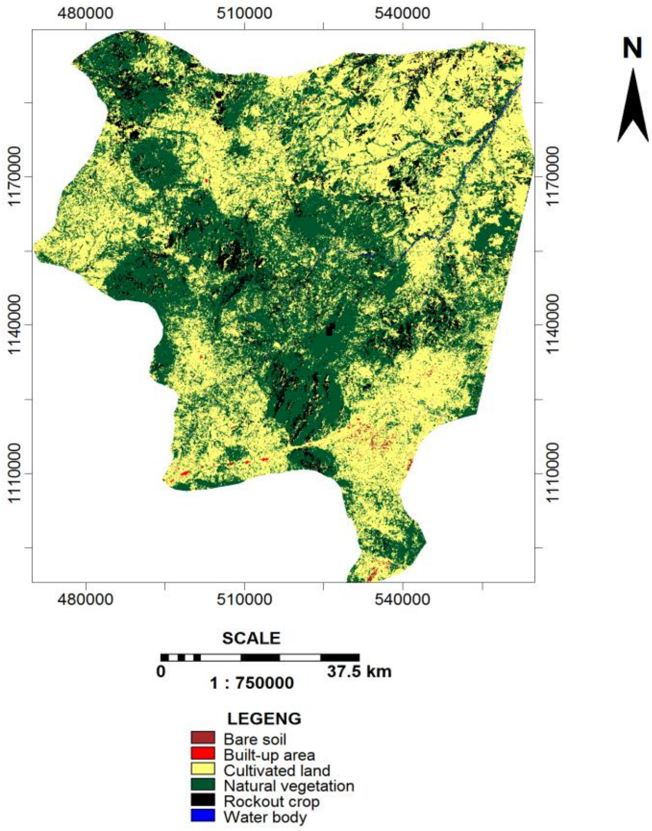

Figure 4: LULC Image of Land Sat EMT+ 1999

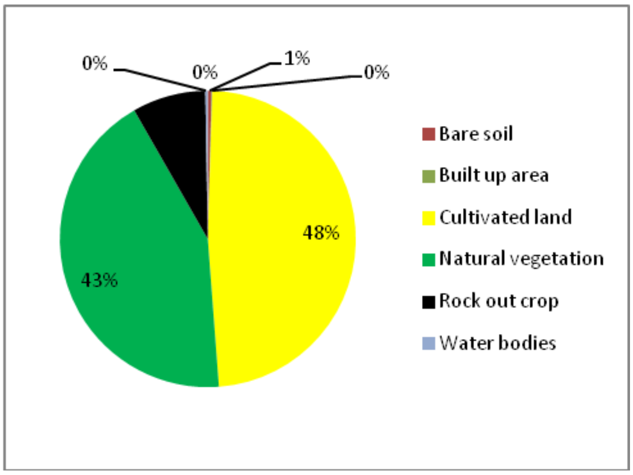

Figure 5: Land Cover Budget for 1999

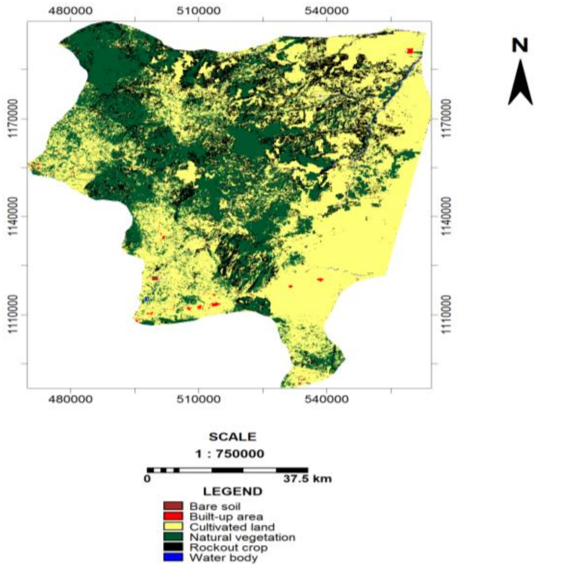

Figure 6*:* LULC image of Land Sat ETM+ 2006

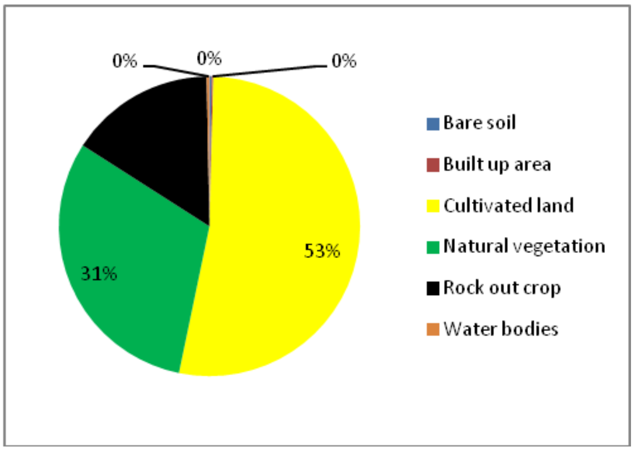

Figure 7: Land Cover Budget for 2006

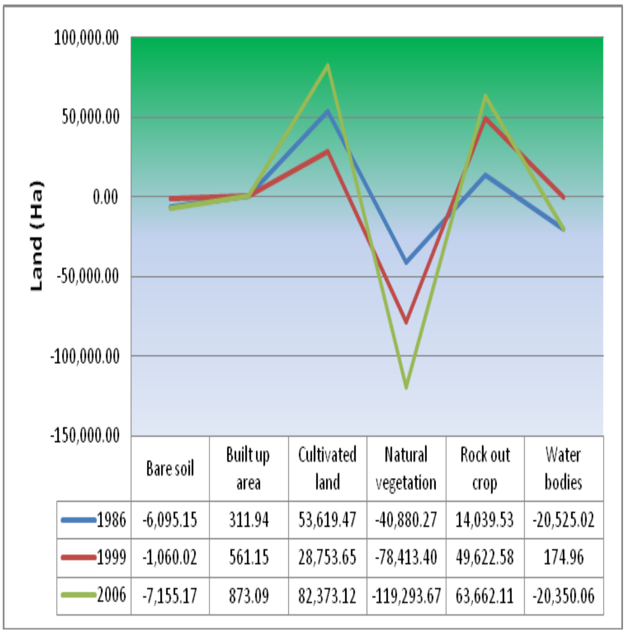

Figure 8: Land Cover Changes Between 1986 to 1999 to 2006

Table 2: Land use Changes between 1986 to 2006

Landuse	*1986* *Area (HA)*	*2006* *Area (HA)*	*Change*
Bare soil	8,726.57	1,571.70	-7,154.87
Built up area	368.3	1,131.67	763.37
Cultivated land	259,346.80	341,719.92	82,373.12
Natural vegetation	318,941.48	199,647.81	-119,293.67
Rock out crop	37,794.80	101,456.91	63,662.11
Water bodies	22,300.00	1,949.94	-20,350.06
Total	647,477.95	647,477.95	

Source: Authors

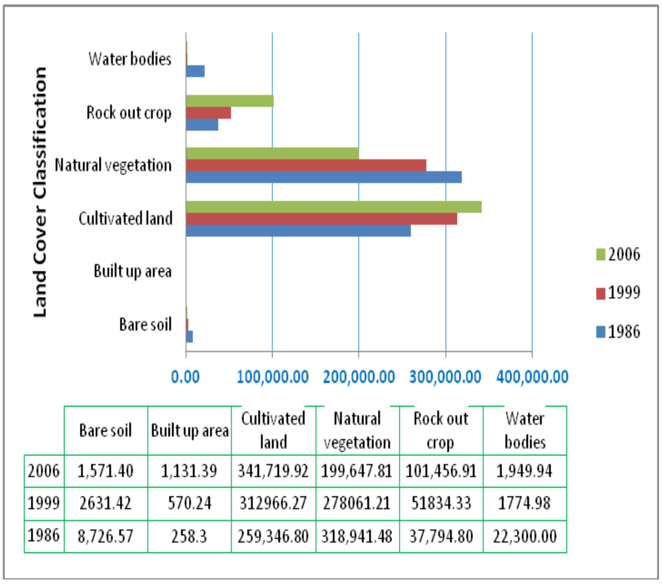

Figure 9: Land use Land cover changes analysis for 1986, 1999 and 2006

6. Results and Disscustions

The pattern of changes as presented in figure 11 aand 12 and table 2shows that natural vegetation decline drastically within the twenty years 1986 to 2006. The vegetation reduces from 318,941.48 hectares equivalent to about 49.27% of the total land to 199,647.81 hectares equivalent to about 30.83% of the land area this show that forest vegetation decline by about -119,293.67 hectares of land conversely the cultivated area appears to benefit from the decline of natural vegetation because it gain from 259,346.80 hectares equivalent to 40.06% of the total land area to 341,719.92 hectares (52.78%) gaining about 82,373.12 hectares by 2006. The resultant effect it that there is strong indication of increase in weathering process through the in the exposure of rock out crops and more human settlements are also expanding.

7. Conclusions

From the finding of these research it shows the potential threat facing the country's natural environment which is also a threat to socio economic development of our societies. Poverty, poor infrastructural facilities and ignorance are responsible for the unfortunate development. The magnitude of the of natural vegetaion decline, indicated that there is no close monitoring of the charcoal producers activities in the area by agencies responsible for fofrest monitoring. There is therefore the need to seriously enforce monitoring by forest guard in the area. Areas that are already distory by the activives of anthropogenic activities like farming, fuel wood gathering and charcoal production, effort should therefore be put reclaim it or protect the reming vegetaion. It is good to know that continue exploitation of vegetation resources without careful planning to ensure its continue existence could give birth to degradation of the natural environmental. Poverty reduction strategy should be put in place among the communities in the pheriprey of the forest as these will give other alternatives as their source of livelihood thereby reducing pressure on the forest.

8. Acknowledgment

The Authors would like to sincerely acknowledged the Sponsorship given for this research by Abubakar Tafawa Balewa University Bauchi, Nigeria. Through the Tertiary Education Trust Fund (TET Fund). The Authors also thank the Management of National Center for Remote Sensing Jos, Plateau State Nigeria for their support.

References

[1] FAO, 1995, Evaluation des ressources forestieères 1990, Pays tropicaux. Etude Forèts no. 112.

[2] J. F. Mas Monitoring land-cover changes: a comparison of change detection techniques int. j. remote sensing, 1999, vol. 20, no. 1, 139-152.

[3] Myers, N., 1988, Tropical forests: much more than stocks of wood. *Journal of Tropical Ecology*, **4,** 209-221.

[4] Fontan, J., 1994, Changement globaux et developpement. *Nature- Sciences- SocieÂ teÂ s*, 2, 143-152.

[5] Meliadis Ioannis and Miltiadis Meliadis 2011 Multi-temporal Landsat image classification and change analysis of land cover/use in the Prefecture of Thessaloiniki, Greece Proceedings of the International Academy of Ecology and Environmental Sciences, 2011, 1(1): 15-25

[6] Butenuth M, Gösseln GV, Tiedge M, et al. 2007. Integration of heterogeneous geospatial data in a ederated database. ISPRS Journal of Photogrammetry and Remote Sensing, 62(5): 328-346.

[7] Zhang Shaoqing and, Xu Lu 2008 The Comparative Study Of Three Methods Of Remote Sensing Image Change Detection *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B7. Beijing*

[8] Njike Chigbu 2011, Analysis of Landuse and Landcover Changes of Aba Urban Using Medium Resolution Satellite Imageries FIG Working Bridging the Gap between Cultures Marrakech, Morocco, 18-22

[9] P. K. Yada, Mohnish Kapoor and Kiranmay Sarma 2012, Land Use Land Cover Mapping, Change Detection and Conflict Analysis of Nagzira-Navegaon Corridor, Central India Using Geospatial *Technology International Journal of Remote Sensing and GIS, Volume 1, Issue 2, 90-98*

[10] Tiwari, M.K. and Saxena, A. (2011). Change Detection of Land Use/ Landcover Pattern in an Around Mandideep and Obedullaganj Area, Using Remote Sensing and GIS,International Journal of Technology And Engineering System, 2(3).

[11] Singh, A. 1989. Digital change detection techniques using remotely-sensed data. *Int. J. Remote Sens.*, 10(6), pp.989-100.

[12] Ellis E., (2007). Land-use and land-cover change. In Pontius R., Cleveland C.J.(eds.). Encyclopedia of Earth.

[13] Khanna, V. Ravichandran, M. S. and Kushwaha, S. P. S. (2001). Corridor analysis in Rajaji-Corbett Elephant Reserve: A Remote sensing and GIS approach. Journal of the Indian Society of Remote Sensing, 29, 41- 46.

[14] Berberoglu S, Evrendilek F, Ozkan C, Donmez C (2007). Modeling Forest Productivity Using Envisat MERIS Data. Sensors 7:2115-2127.

[15] Xiaoling C, Xiaobin C, Hui L (2006). Expert classification method based on patch-based neighborhood searching algorithm. Geo-Spatial Inform. Sci. 10(1):37-43.

[16] Dengsheng Lu, Mateus Batistella, and Emilio Moran 2008 Integration of Landsat TM and SPOT HRG Images for Vegetation Change Detection in the Brazilian Amazon. Photogrammetric Engineering & Remote Sensing Vol. 74, No. 4, April 2008, pp. 421–430

[17] Wafa Nori, El Nour Elsiddig, Irmgard Niemeyer 2008 Detection of Land Cover Changes using Multi-Temporal Satellite Imagery *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B7. Beijing 2008*

[18] Ehsan Sahebjalal1 and Kazem Dashtekian 2013 Analysis of land use-land covers changes using normalized difference vegetation index (NDVI) differencing and classification methods Africa Journal of Agricultural Research Vol. 8(37), pp 4614-4622

[19] Ravinder Virk and Doug King 2006 Comparison of Techniques for Forest Change Mapping Using Landsat Data in Karnataka, India. *Geocarto International*, Vol. 21, No. 4, pp 49-57

[20] Meliadis Ioannis1, Miltiadis Meliadis 2011 Multi-temporal Landsat image classification and change

analysis of land cover/use in the Prefecture of Thessaloiniki, Greece

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