International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2016 IJSRCSEIT | Volume 1 | Issue 2 | ISSN : 2456-3307

Geospatial Analysis of Landuse and Landcover Dynamics In Ado-Ekiti, Nigeria

***Fasote Oluwabunmi[1], Adewoyin Joan[1], Abayomi Alaga[1], Alaigba Debora[2]**

[1]Cooperative Information Network, National Space Research and Development Agency, Mathematics Building, Obafemi Awolowo University, Ile- Ife, Nigeria

[2]Regional Center for Training In Aerospace Surveys (RECTAS), Ile Ife, Nigeria

ABSTRACT

Remote Sensing and GIS techniques was used to analyse the landuse and landcover dynamics of Ado-Ekiti LGA, the Ekiti State capital, for a period of twenty nine years (29yrs) in this study. Multi-temporal and multi-source satellite imageries of Landsat 1986, 1991, 2002 and 2015 were used. The study employed supervised digital image classification method using ENVI 5.3 software and five landuse and landcover types which include settlement, bare surface, cultivation, forest and water body were detected and captured as polygon. The area in square kilometers of each land use type in each year was calculated and thereafter the change was determined by subtracting the area of the same land use type in 1986 from 2015, the percentage and magnitude of change are therefore calculated. The results obtained shows that the settlement has increased by 47km^2 (79%) while cultivation, forest and water body reduced by 45.53km^2 (9.98%), 61.7km^2 (13.79%) and 0.03Km^2 (6.5%) between 1986 and 2015. The statistics also reveals that substantial land use/land cover changes have taken place and that the settlement and baresurface areas have continued to expand over the study period while the forest and farmland have decreased. The study also notes that the expansion of the urban settlement areas has resulted into reduction of the land under agriculture and other natural vegetation, thereby affecting the natural ecosystems habitat quality, which has consequently led to environmental degradation.

Keywords : Landuse, Landcover, Remote Sensing, Satellite Imageries, Change Detection.

I. INTRODUCTION

The landuse/landcover pattern of a region is an outcome of natural and socio- economics factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure, hence an analysis of the nature and rate of environmental change over recent decades is essential for a proper understanding of why present environment problem have arisen Landuse/landcover encompasses the biosphere and includes biota, soil, topography, water body, habitat and exposed rock surfaces (12). While landcover could be described as the biophysical state of the earth's surface and immediate subsurface, landuse can be described to include both manner in which the biophysical attributes of the land are manipulated and the purpose for which the land is used (3). (6) assume that landcover relates to the type of feature present on the surface of the earth which may include urban buildings, lakes and maple trees while landuse relates to the human activity that is associated with a specific piece of land. Alternatively, landuse can be described as an abstraction that is not always directly observable by even the closest inspection (4). Land has been going through tremendous transformation due to sprawls in agricultural activities, industrialization and urbanization. The changes in landuse affect the ecosystem in terms of landcover, land quality and capability, weather and climate, quality of land that can be sustained and in fact the whole population and socio-economic determinant (http://www.gisdevelopment.net).

In some instances, land use land cover change may result in environmental, social and economic impacts of greater damage than benefit to the area (10).Therefore data on land use change are of great importance to planners in monitoring the consequences of land use change on the area. Such data are of value to resources management and agencies that plan and assess land use patterns and in modelling and predicting future changes.

Land use affects land cover and changes in land cover affect land use. A change in either however is not necessarily the product of the other. Changes in land cover by landuse do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (10).

Land cover can be altered by forces other than anthropogenic. Natural events such as weather, flooding, fire, climate fluctuations, and ecosystem dynamics may also initiate modifications upon land cover. Globally, land cover today is altered principally by direct human use: by agriculture and livestock raising, forest harvesting and management and urban and suburban construction and development. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (9).

Hence, in order to use land optimally, it is not only necessary to have the information on existing land use land cover but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape.

Several studies have been conducted with the integration of remote sensing and geographic information systems to analyze and monitor land cover changes. For instance, (8) merged the remotely sensed data with geocoded information. This was achieved by first classifying the images, applying 5*5 neighborhood functions, then transforming the results into vector layers. The layers were imported into GIS environment for area analysis.

(1) carried out a study on landuse/landcover mapping of Panchkula, Ambala and Yamunanger districts, Hangana State in India. They observed that the heterogeneous climate and physiographic conditions in these districts has resulted in the development of different land use land cover in these districts ,an evaluation by digital analysis of satellite data indicates that majority of areas in these districts are used for agricultural purpose. The hilly regions exhibit fair development of reserved forests. It is inferred that land use land cover pattern in the area are generally controlled by agro-climatic conditions, ground water potential and a host of other factors.

(8) investigated the advantages of remote sensing techniques in relation to field surveys in providing a regional description of vegetation cover. The results of their research were used to produce four vegetation cover maps that provided new information on spatial and temporal distributions of vegetation in the study area and allowed regional quantitative assessment of the vegetation cover.

Similarly, (15) used image processing and analysis in a GIS environment to assess spatial change in urban land use patterns and population distribution. Here, unsupervised classification was used to classify the images into land use classes. With census data in a GIS, census polygon was constructed into various sets of units, and then comparison made with the classified image population in surface areas.

In 1985, the U.S Geological Survey carried out a research program to produce1:250,000 scale land cover maps for Alaska using Landsat MSS data (5).The State of Maryland Health Resources Planning Commission also used Landsat TM data to create a land cover data set for inclusion in their Maryland Geographic Information (MAGI) database. All seven TM bands were used to produce a 21 – class land cover map (EOSAT 1992). Also, in 1992, the Georgia Department of Natural Resources completed mapping the entire State of Georgia to identify and quantify wetlands and other land cover types using Landsat Thematic Mapper data (ERDAS, 1992). The State of Southern Carolina Lands Resources Conservation Commission developed a detailed land cover map composed of 19 classes from TM data (EOSAT, 1994). This mapping effort employed multi-temporal imagery as well as multi-spectral data during classification.

An analysis of land use and land cover changes using the combination of MSS Landsat and land use map of Indonesia (7) reveals that land use land cover change were evaluated by using remote sensing to calculate the index of changes which was done by the superimposition of land use land cover images of 1972, 1984 and land use maps of 1990. This was done to analyze the pattern of change in the area, which was rather difficult with the traditional method of surveying as noted by (11) when he was using aerial photographic approach to monitor urban land use in developing countries with Ilorin in Nigeria as the case study.
Also, (2) in their land use land cover change evaluation in Sokoto – Rima Basin of North – Western Nigeria based on Archival Remote Sensing and GIS techniques, used aerial photographs, Landsat MSS, SPOT XS/Panchromatic image Transparency and Topographic map sheets to study changes in the two dams (Sokoto and Guronyo) between 1962 and 1986.The work revealed that land use land cover of both areas were unchanged before the construction while settlement alone covered most part of the area. However, during the post-dam era, land use /land cover classes changed but with settlement still remaining the largest.

In similar studies(13) used satellite imageries of 1978 and 1995 and updated topographical maps of 2003 to study urban expansion of Ogbomoso town, Oyo State. Also (12) studied the spatial growth of Akure, Ondo State using the satellite imageries of 1972, 1986 and 2002. The results of both cities showed that there has been a rapid conversion of agricultural areas to urban (non-agricultural) land uses. Urban expansions of these cities have destroyed fertile agricultural land uses. Urban expansion of these cities have destroyed fertile agricultural land which cannot be recovered, the residential land use continues to spread to and beyond the hitherto distant location relative to the city core.

1.2 Aim and Objectives of the study

The aim of this research is to determine the extent of changes and intensity of use to which land has been put between 1986 and 2015 through the assessment of landuse/landcover dynamics while the objectives are to:

- ✓ generate landuse/landcover maps of the study area
- ✓ evaluate the trend and spatial pattern of landuse/landcover in the study area.
- ✓ evaluate the degree of landuse/ landcover changes of Ado-Ekiti LGA over a period of 29 years using multidate satellite imagery.

1.3 The Study Area

Ado-Ekiti, the nucleus of the ancient Ewi kingdom is located between latitude 7^0 32'11" and $7^0$40' 28" North of the equator and longitude $5^0$6'18" and $5^0$24'0" East of the Greenwich Meridian. It covers an approximate area of 265square kilometre. Its longest north-south extent is about 16km, and its longest east-west stretch is 20km.The population of Ado-Ekiti LGA has increased tremendously in the last one decade. This is due to its new status of being the capital of Ekiti State, carved out of the old Ondo State in 1996. It has therefore witnessed an influx of people from far and near and emergence of many Industries. Hence, there has been an increase in water demand by the people in the area for both domestic and industrial usage.

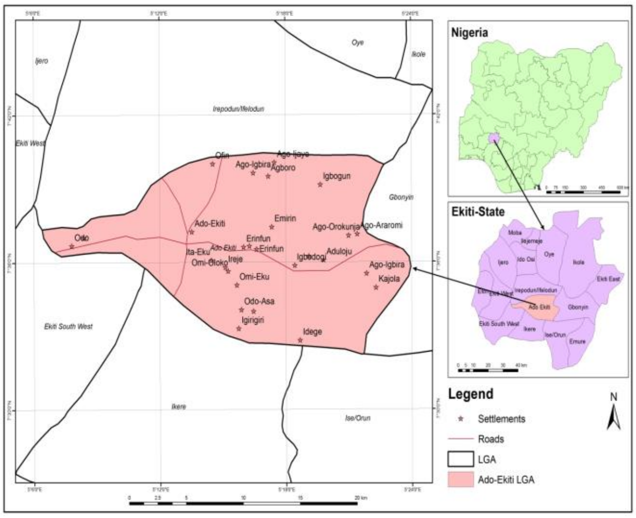

Figure 1. Study area

1.4 Data Acquisition and Data source

Table 1: Data and their Source

S/N	Data Type	Year	Resolution	Source
1	Landsat Image (MSS)	1986	30m	USGS
2	Landsat Image (TM)	1991	30m	USGS
3	Landsat Image (TM)	2002	30m	USGS
4	Landsat Image	2015	30m	USGS

	(ETM)			
5	Topographic map (Sheet 244)		1:50,000	Office of Surveyor General, Ekiti State.

In addition the multi-temporal Landsat satellite imagery constitutes one of the base data layer from which the landuse and landcover maps were derived. The appropriate selection of imagery acquisition dates for change detection is an integral component of the project success and care was taken in acquiring the images.

II. METHODS AND MATERIAL

2.1: Data Acquisition and Sources:

In carrying out this project, the following was undertaken: need assessment, data collection, data preparation and data analysis. Both primary and secondary data with spatial and non-spatial attribute were utilized. Ground control point acquired using handheld GPS, ground truth information and LandSat images of 1986, 1991, 2002 and 2015 were use.

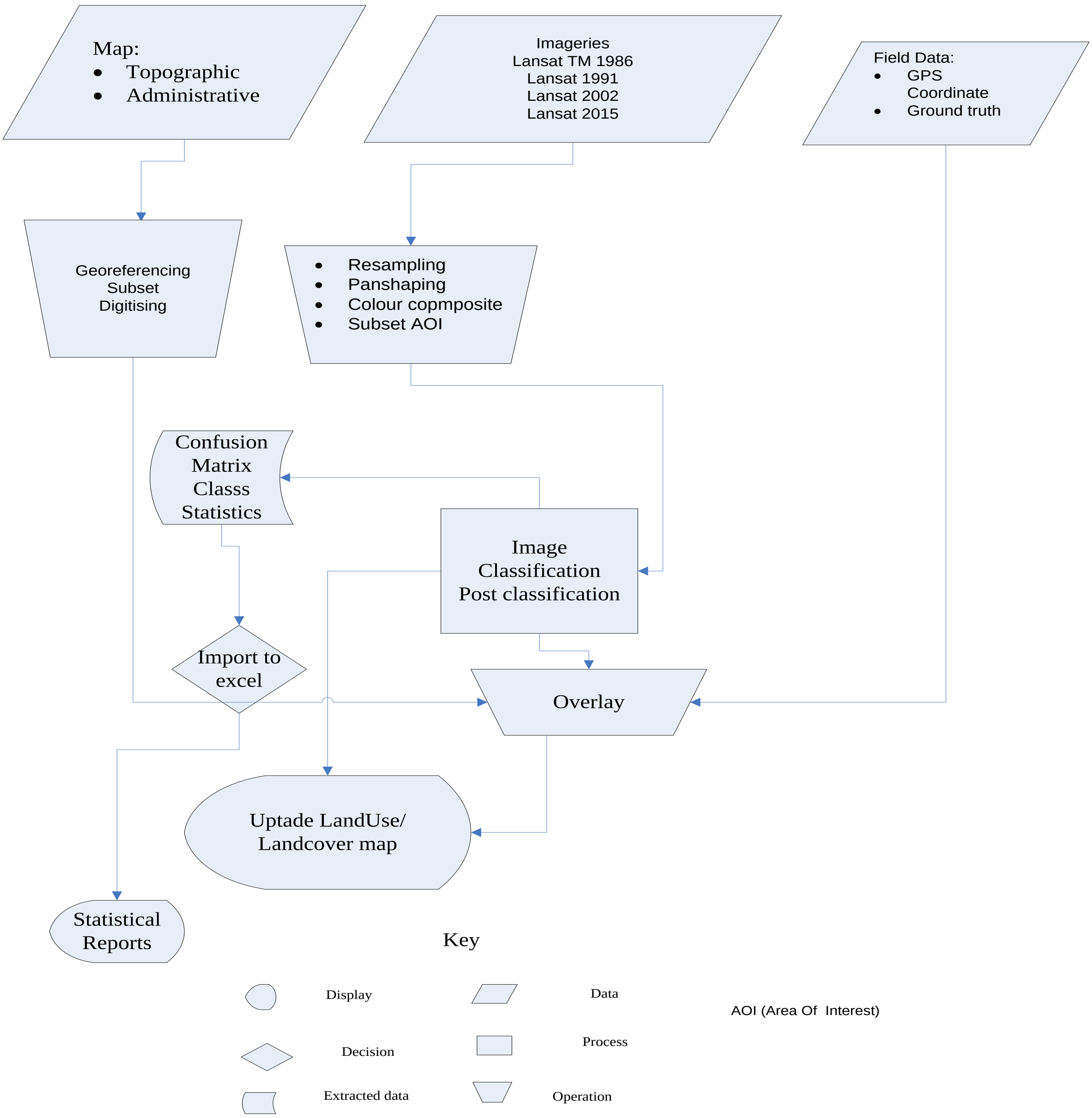

Figure 2. Flow chart

2.2: Software Requirement

Ground control point acquired using handheld GPS, groundtruth information and LandSat images of 1986, 1991, 2002 and 2015

2.3: Data Processing

The image processing procedures used for the study includes delineation of the study area, image pre-processing, the design of classification scheme, image classification, accuracy assessment analysis of the land use/land cover dynamics as well as the comparison of the changes between different years under consideration.

2.4: Image Classification

Landuse/landcover classification used in this study was based on five categories which are settlement, baresurface, cultivation, forest and water bodies. The visible and NIR bands 2,3,4 was used for image analysis. Supervised classification through maximum likelihood algorithm was applied to perform image classification.

2.5: Change Detection Methods of Land Use/Land Cover

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times The changes in land use/land cover occurred in the study area in the period from 1986 to 2015 have been calculated by the subtraction processes.

III. RESULTS AND DISCUSSION

In order to achieve the set objective for this work different data analysis processes was carried out as specified in the methodology in the preceding chapter. Landuse/landcover types were analyzed, delineated, mapped and presented in form of maps, table and charts.

Four different satellite imageries acquired in 1986, 1991, 2002 and 2015 within the same period were classified with an average kappa coefficient and overall accuracy of 0.9760 and 98.40%

Table 3.1: Image classification Kappa coefficient and overall accuracy of different image used

Year	Kappa Coefficient	Overall Accuracy (%)
1986	0.9387	95.87
1991	0.9910	99.35
2002	0.9832	98.87
2015	0.9921	99.51
Average	0.9760	98.40

The main categories of landuse/landcover classification scheme developed for the study are: Settlement, Forest, Cultivation, Baresurface and Waterbody. See figure 3.1, 3.2, 3,3 and 3.4 for the classified image.

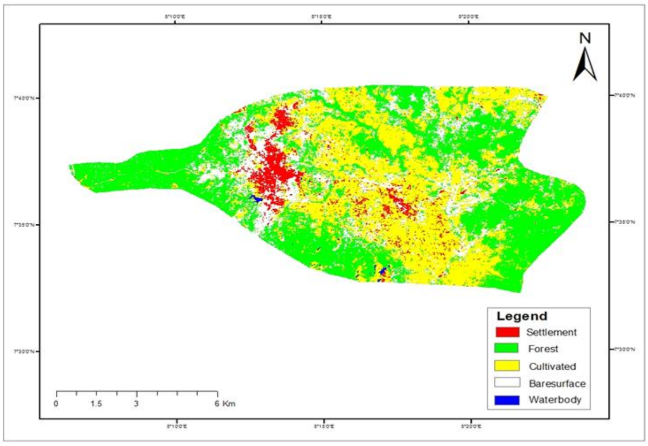

Figure 3.1: 1986 Landuse/Landcover for Ado-Ekiti Local Government Area

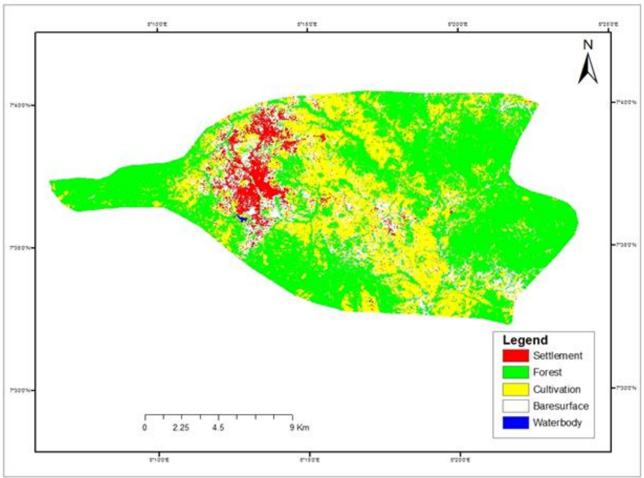

Figure 3.2: 1991 Landuse/Landcover for Ado-Ekiti Local Government Area

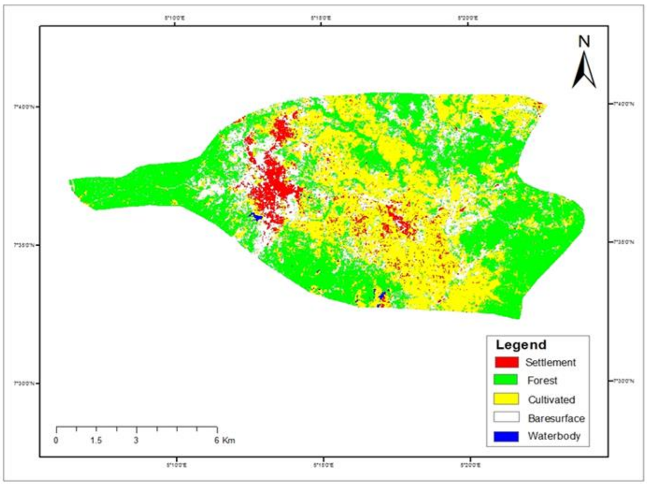

Figure 3.3: 2002 Landuse/Landcover for Ado-Ekiti Local Government Area

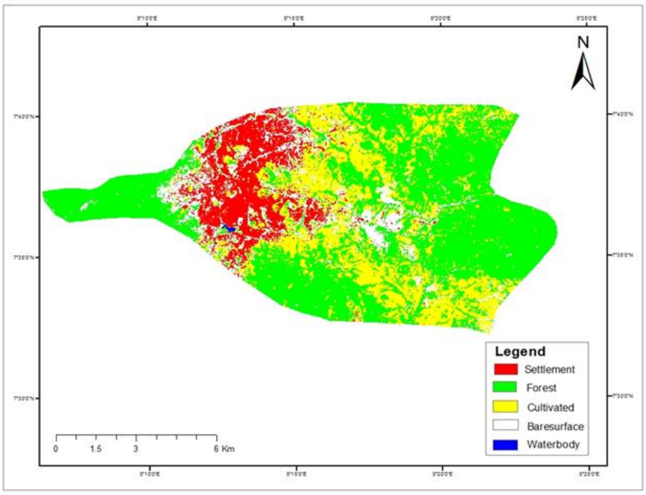

Figure 3.4: 2015 Landuse/Landcover for Ado-Ekiti Local Government Area

Table 3.2 : Class statistics in Square Kilometre (Km^2) and Percentage (%)

Classification Categories	1986		1991		2002		2015	
	km^2	%	km^2	%	km^2	%	km^2	%
Settlement	6.25	1.25	16.49	3.29	44.40	8.88	53.35	10.67
Bare Surface	33.66	6.73	62.37	12.48	0.73	0.15	2.76	0.55
Cultivation	205.30	41.06	118.00	23.60	128.33	25.69	250.83	50.17
Forest	254.51	50.90	302.61	60.52	325.93	65.25	192.81	38.56
Water Body	0.25	0.06	0.50	0.11	0.58	0.03	0.22	0.05
TOTAL	499.97	100	499.97	100	499.97	100	499.97	100

Table 3.2 shows that in 1986, settlement occupied about 1.25% (6.25Km^2) of the total 499.97 Km^2 of the study area. Bare surface occupied 6.73% (33.66Km^2), cultivation and forest cover 41.06% (205Km2) and 50.9% (254.51Km^2) respectively while water body cover 0.06% (0.25Km^2).

The results for 1991 shows that settlement has increased to 3.29% (16.49Km^2), bare surface also increased to 12.48% (62.37Km^2), water body increased to 0.11% (0.50Km^2) while arable land reduced to 23.6% (118Km^2). In 2002, the results shows that settlement increased from 3.29% in 1991 to 8.88% (44.40Km^2) while cultivation and forest cover 128.33Km^2 and 325.93Km^2 respectively. In 2015, the results shows that settlement cover 53.35Km^2 which is 10.67% of the total area, bare surface increased from 0.73Km^2 in 2002 to 2.76Km^2 in 2015. cultivation and forest cover 250.8Km^2 and 192.81Km^2 which are 50.17 and 38.56 percent of the total area.

Table 3.3: Land use/land cover changes of Ado-Ekiti LGA between 1986 and 2015

Class. Categories.	1986-1991		1991-2002		2002-2015	
	Diff. in Area		Diff. in Area		Diff. in Area	
	(Km^2)	%	(Km^2)	%	(Km^2)	%
Settlement	10.24	2.04	27.91	5.59	8.95	1.79
Bare surface	28.71	5.75	- 61.64	-12.33	2.03	0.14
Cultivation	-87.30	-17.46	10.33	2.09	122.5	24.48
Forest	48.1	9.62	23.32	4.73	-133.12	-26.69
Water body	0.25	0.05	0.08	- 0.08	- 0.37	0.02
Total	0	0	0	0	- 0.01	- 0.26

3.1 Interpretation and Analysis of Change of LULC between1986 and 2015

Land cover change is a gradual and constant process in every given geographical unit. In Ado-Ekiti, (the study area) land use/landcover change is visible and well pronounced using remote sensing techniques. The multidate satellite imageries of Ado-Ekiti between 1986 and 2015 were also used.

Table 3.4, 3.5, 3.6 and 3.7 present the magnitude, annual frequency and percentage change. The magnitude of change for different year interval (1986-1991, 1991-2002 and 2002-2015) was calculated by subtracting the area of each landuse/landcover type of recent year from the former i.e 1991-1986. The percentage of change was calculated by dividing the magnitude of change of each landuse/landcover category by the value of the base year, then multiplying the result by 100.

Annual frequency of change was obtained by dividing the magnitude of change of each landuse/landcover category by the number of years between the periods under consideration. (See table 3.4, 3.5, 3.6 and 3.7)

1986 landuse/landcover area = x_1, 1991 landuse/landcover area = x_2

2002 landuse/landcover area = x_3, 2015 landuse/landcover area = x_4

Year Interval = a, Base Year = b

Therefore;

Magnitude of change = x_1-x_2 ,

Annual frequency of change = $\frac{x_1-x_2}{a}$

Percentage change = $\left(\frac{x_1-x_2}{b}\right) \times 100$

Table 3.4: Magnitude, Annual frequency and Percentage of change between 1986-1991

	1986	1991	Magnitude	Annual Frequency	Percentage of Change
Class. Category	(%)	(%)	(Km^2)	(Km^2)	(%)
Settlement	1.25	3.29	10.24	2.05	45.03
Baresurface	6.73	12.48	28.71	5.74	29.9
Cultivation	41.06	23.6	-87.3	-17.46	-27
Forest	50.9	60.52	48.1	9.62	8.63
Water Body	0.06	0.11	0.25	0.05	33.33
TOTAL	100	100	0	0	89.89

The above table shows that between 1986 and 1991, only cultivation recorded a negative magnitude and annual frequency of change. This further shows that settlement, bare surface and forest gain more land from other land use while cultivated area, loosed land to other landuse with respect to their magnitude of change. The comparative changes are shown in the different satellite image data set of 1986 and 1991 (see fig. 3.1 and 3.2) and table 3.4.

Table 3.5: Magnitude, Annual frequency and Percentage of change between 1991 and 2002

Class Categories	1991	2002	Magnitude	Annual Frequency	Percentage of Change
	(%)	(%)	(Km^2)	(Km^2)	(%)
Settlement	3.29	8.88	27.91	2.54	45.84
Bare Surface	12.48	0.15	-61.64	-5.6	-97.69
Cultivation	23.6	25.69	10.33	0.94	4.19
Forest	60.52	65.25	23.32	2.12	3.71
Water Body	0.11	0.03	0.03	0.007	7.41
TOTAL	100	100	-0.05	0.007	- 36.54

The table above indicates that bare surface loose land area to other land use, while settlement, cultivation and forest gain more land. (See table 3.5 and figure 3.3)

Table 3.6 : Magnitude, Annual frequency and Percentage of change between 2002 and 2015

Class categories	2002 (%)	2015(%)	Magnitude of change (Km^2)	Annual Frequency (Km^2)	Percentage of Change (%)
Settlement	8.88	10.67	8.95	0.9	9.16
Bare Surface	0.15	0.55	2.03	0.2	58.17
Cultivation	25.69	50.17	122.5	12.25	32.31
Forest	65.25	38.56	-133.12	-13.31	-25.66
Water Body	0.03	0.05	-0.37	-0.04	-46.84
TOTAL	100	100	-0.01	0	27.14

This indicates that settlement and cultivation increase while forest and water body reduced.

Table 3.7: Magnitude, Annual frequency and Percentage of change between 1986-2015

Class Categories	1986	2015	Magnitude of Change	Annual Frequency of Change	Percentage of Change
	%	%	Km^2	Km^2	(%)
Settlement	1.25	10.67	47.1	1.81	79.02
Bare surface	6.73	0.55	-30.9	-1.19	-84.84
Cultivation	41.06	50.17	45.53	1.75	9.98
Forest	50.9	38.56	-61.7	-2.37	-13.79
Water body	0.06	0.05	-0.03	-0.001	-6.52
TOTAL	100	100	52.47	-0.001	-16.15

The table above figures indicate that between 1986 and 2015, bare surface, forest and water body recorded negative, annual frequency and percentage of change. This further shows that settlement, and cultivation gain more land from other landuse while forest and bare surface loosed land to other landuse with respect to their magnitude of change.(See table 3.7 and fig 3.4) Table 3.7 further shows that within 29years period, settlement and cultivation gained 79.02 and 9.98% of land and 47.10 and 45.53(km2) magnitude of change. All other land use classes, bare surface, forest and water bodies lost land to settlement.

IV.CONCLUSION

The analysis reveals that urban areas have expanded significantly leading to degradation of the natural vegetation such the forest and farmland leading to ecological disruptions. This study has shown that lack of relevant spatial information, crucial for planning, may be alleviated with remote sensing data that can provide opportunities for periodical survey of land use/land cover changes and their spatial distribution.

V. RECOMMENDATION

Because of the spatio-temporal changes in the land use and land cover of the study area and its effects on the biodiversity, the following recommendations should be adopted for policy makers for better decision-making.

- ✓ The use of satellite remote sensing techniques for adequate monitoring should be encouraged in Ekiti-State, so that research on issues regarding the physical environment can be carried out effectively.
- ✓ Forest guards should be employed if they are not yet on ground but if they exist, more should be employed and they should be exposed to more training on protecting the forest.
- ✓ The people in the study area should be enlightened or educated on how to manage and protect the environment.
- ✓ Effort should be made by the Ekiti-State government in acquiring more recent maps, satellite imageries and gathering of land use and land cover environmental data from time to time to enable proper monitoring and location of land use.

VI. REFERENCES

[1] Arvind, C. Pandy and M. S. Nathawat (2006). Land Use Land Cover Mapping Through Digital Image Processing of Satellite Data – A case study from Panchkula, Ambala and Yamunanagar Districts, Haryana State, India.

[2] Adeniyi, P.O. and Omojola, A. (1999). Landuse landcover change evaluation in Sokoto – Rima Basin of North Western Nigeria based on Archival of the Environment (AARSE) on Geoinformation Technology Applications for Resource and Environmental Management in Africa. Pp 143-172

[3] Briassoulis, H. (2000). Analysis of Land Use Change: Theoretical and Modelling Approaches. The Web Book of Regional Science. www.rri.wvu.edu/WebBook/ Briassoulis/chapter4(models6).

[4] Cambell, J. B. (2002). Introduction to Remote Sensing. New York, The Guilford Press, A Division of Guildford Publications, Inc. 72 Spring Street, New York NY 10012

[5] Lambin, E.F., Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. PNAS108(9):3465–3472.

[6] Lillesand T. M., R. W. Kiefer, (2000). Remote Sensing and Image Interpretation. New York:John Wiley and Sons, Inc.

[7] Macleod & Congalton. (1998). A Quantitative Comparison of Change Detection Algorithms for Monitoring Eelgrass from Remotely Sensed Data. Photogrammetric Engineering & Remote Sensing. Vol. 64. No. 3. p. 207-216.

[8] Musaoglu N. Kaya, S. Seker, D.Z. and Goksel, C. (2002). A case study of using Remote Sensing Data and GIS for Land Management. Catalca Region. FLG XXII

[9] Meyer, W.B. (1995). Past and Present Land-use and Land-cover in the U.S.A.Consequences. p.24-33.

[10] Moshen, A. (1999). Environmental Land Use Change Detection and Assessment Using with Multi – temporal Satellite Imagery. Zanjan University.

[11] Olorunfemi, J. F. (1983). Monitoring Urban Land – Use in Developed Countries –An aerial photographic approach, Environmental Int.9, 27 – 32.

[12] Oyinloye, M.A. (2010). Spatial Analysis of Urban Growth in Akure, Nigeria. PhD. Thesis, Department of Urban and Regional Planning, Federal University of Technology, Akure.

[13] Riebsame, W. E., W. B. Meyer, B. L. Turner, (1994). Modeling Land-Use and Cover as Part of Global Environmental Change. Climate Change. 28, 45.

[14] Singh, A. (1989). Digital Change Detection Techniques Using Remotely SensedData. International Journal of Remote Sensing. Vol. 10, No. 6, p. 989-1003.

[15] Zhi-Yong Yini Dona, J.S., Stevan, B and Jared, T.M. (2005): Changes in Urban built-up surface and population Distribution Patters during 1986-1999. A case study of Cairo, Egypt. Computer, Environment and Urban Systems 29 (2005); 595-616.