SPATIO-TEMPORAL ANALYSIS OF LAND COVER PATTERN OF IBAFO AND ITS ENVIRONS

[1]Adedeji Kehinde Tella & [2]Abdulganiy Ola Shittu.
[1]Department of Surveying and Geoinformatics
Department of Surveying and Geoinformatics, Faculty of Environmental Science, Osun State College of Technology, Esa Oke.
[2] SG Geomatics Company Limited
Corresponding Author's E-mail: -tellakenny@gmail.com

ABSTRACT

Land use change has taken place in many developing cities in Nigeria such as Ibafo and its environs over the past few decades. This study aims at a geospatial analysis of the land use and land cover pattern of Ibafo and its environs with the use of remotely sensed data and Geographic Information System techniques (GIS). Information on the land use and land cover pattern of Ibafo and its environs is of paramount importance because land use / land cover pattern information is indispensable for sustainable urban land use planning and development particularly Ibafo that is very close to Lagos state and is experiencing urbanization. The study also presents the effectiveness of the use of remotely sensed data to study land cover, change detection and analysis. Thirty metres (30m) resolution Landsat 8 imageries at four epochs of the years 1984, 2002, 2006 and 2018 were utilized in this study. Arc GIS 9.3 and Environment for Visualizing Images (ENVI 4.7) were used for image classifications, image enhancements and data analysis. These tools have been able to reveal evolving trends in land cover within the study area; the pattern of such trends as well other relevant information. The results show that built up areas show a steady increase from 0.9% in 1984 to 43.29% in 2018. The reverse is the case for forest which shows a decline from 67.77% in 1984 to 24.79 % in 2018. Open grassland increases from 31.33% in 1984 to 42.77% in 2002 and then decreases to 41.45% in 2006 and 31.91% in 2018. Land cover projection for 2023 was predicted at 16.88 Sq.km, 7.96 Sq.km and 7.59 Sq.km for built up areas, Forest and open grasslands respectively; corresponding to 51.68% for built up areas in 2023; 24.37% for forests and 21.61% for Open Grasslands. Data gathered from this study serves as a basis in which effective land use policies, laws and other regulations will be implemented.

Keywords: *Ibafo, Land Use, Land Cover, Prediction, Remote Sensing, Spatio-temporal*

1.0 INTRODUCTION

Available data on land use and land cover changes can provide critical input to decision-making of environmental management and planning the future (*Fan, et. al.*, 2003). The growing population and increasing socio-economic necessities create a pressure on land use/land cover. This pressure results in unplanned and uncontrolled changes in land use/land cover (Seto, 2002). Remote sensing and Geographical Information Systems (GIS) are powerful tools to derive accurate and timely information on the spatial distribution of land use/land cover changes over large areas. Past and present studies conducted by organizations and institutions around the world, mostly have concentrated on the application of land use and land cover changes. GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection. Remote sensing imagery is the most important data resources of GIS. Satellite imagery is used for recognition of synoptic data of earth's surface (Yomralıoğlu, 2000).

Landsat 8 imagery data have been broadly employed in studies towards the determination of land cover since 1984. (Muttitanon.et.al 2005) stated that the aim of change detection process is to recognize land use and land cover on digital images that change features of interest between two or more dates. There are many techniques developed in literature using post classification comparison, conventional image differentiation, using image ratio, image regression, and manual on-screen digitization of change principal components analysis and multi date image classification (Lu, et.al, 2005). A variety of studies have addressed that post-classification comparison was found to be the most accurate procedure and presented the advantage of indicating the nature of the changes (Mas 1999). In this study, attempt was made to determine the land use / land cover pattern of Ibafo and its environs using satellite image and Geographic Information System Techniques (GIS). This study aims at geospatial analysis of the land use and land cover pattern of Ibafo and its environs with the use of remotely sensed data and Geographic information system techniques (GIS).

The following specific objectives will be pursued in order to achieve the aim above.

1. To establish the base land cover condition of the area in the 1984 and how the land cover pattern has evolved over time up 2018.
2. To analyse the land cover changes over the period and creates a land cover classification scheme.
3. To forecast the future pattern of l a n d cover in the area for 2023 and to evaluate the socio- economic implications of the predicted change.

2.0 LITERATURE REVIEW

2.1.1 Modelling Land-Use and Land-Cover change

Models are used in a variety of fields, including land change science, to better understand the dynamics of systems, to develop hypotheses that can be tested empirically, and to make predictions and/or evaluate scenarios for use in assessment activities. Modelling is an important component of each of the three foci outlined in the science plan of the Land-use and -cover change (LUCC) project (Turner et al. 1995) of the International Geosphere-Biosphere Program (IGBP) and the International Human Dimensions Program (IHDP). Firstly, Comparative land-use dynamics, models are used to help improve our understanding of the dynamics of land-use that arise from human decision-making at all levels, households to nations. These models are supported by surveys and interviews of decision makers. Secondly, they emphasize on development of empirical diagnostic models based on aerial and satellite observations of spatial and temporal land-cover dynamics. Finally, the study focused on the development of models of land-use and -cover change (LUCC) that can be used for prediction and scenario generation in the context of integrative assessments of global change. Given space limitations, we focus on spatially explicit models of LUCC. Because the majority of models of this sort are implemented at relatively local scales – sometimes called landscape scales (e.g., 1-100,000km^2), we focus on these scales. These models, therefore, may not be appropriate for scaling up to continental and global scales.

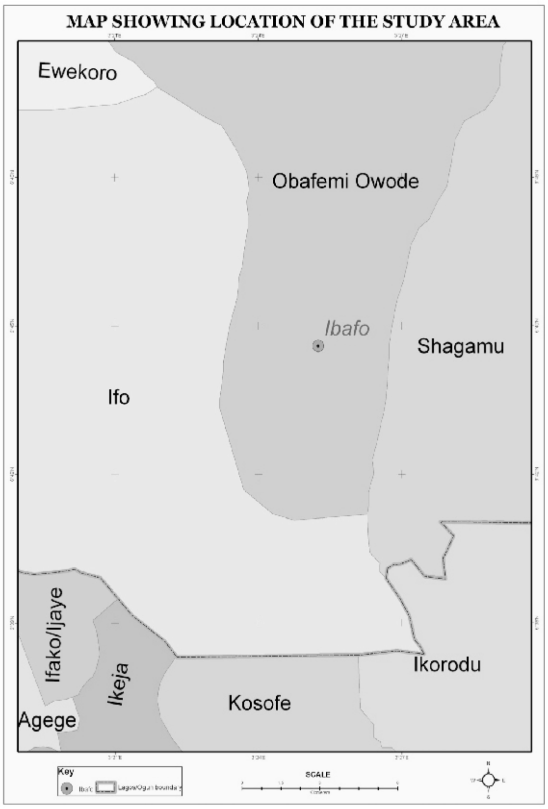
Literally hundreds of models of LUCC have been described in the literature on landscape ecology, geography, urban planning, economics, regional science, computer science, statistics, geographic information science, and other fields. Because of differing disciplinary perspectives, as well as differing methodological approaches, data availabilities, and modelling goals, attempts to categorize models are complicated by a relatively large number of dimensions on which the models vary. A number of reviews of LUCC models have been produced in recent years, each from their own perspective and producing a number of different typologies.

Perhaps the first of these reviews was published by Baker (1989) in the context of landscape ecology, so its focus was on land-cover change. Models were grouped according to the goals of the models. Whole landscape models seek to model change in some aggregate attribute or state of the landscape over time. Distributional moddescribe changes in the proportion of the landscape in each of a number of land-cover classes. Spatial landscape models describe the location and configuration of changes in land cover. A pair of publications had been reviewed in the 1990s, the review by Lambin (1997) described models of observed land-cover change that used mathematical, empirical/statistical, and spatial simulation models.

3.0 The Study Area

Ibafo is a developing town in Obafemi Owode LGA, Ogun state and on the outskirts of Lagos. Due to the increased urban population density in central Lagos, people now move to the suburbs, and mandatorily travel down to urban centres (Lagos Metropolis) in any available means of transportation, at exorbitant charges. The study area encompasses an area of about 33 sq.km.

Ogun state is located in the south-west of Nigeria. It is contained within longitudes 2°45'E and 4°45'E; and latitudes 6°15'N and 7°55'N. It is bounded on the west by the Republic of Benin, to the south by Lagos state and a 20 kilometre stretch of the Atlantic Ocean, to the east by Ondo and Osun states, and to the north by Oyo state.



Source: Obafemi Owode LGA

Figure 1.1: Location of the study area

4.0 RESEARCH METHODOLOGY

4.1 Data Collection

DATA TYPE	SOURCE	YEAR	RESOLUTION / SCALE
LANDSAT TM	USGS PORTAL	1984	30m
LANDSAT ETM	USGS PORTAL	2002	30m
LANDSAT ETM	USGS PORTAL	2006	30m
LANDSAT 8 OLI	USGS PORTAL	2018	30m

The satellite images used in the study are presented below.

Figure 3.1: The 1984 Landsat imagery

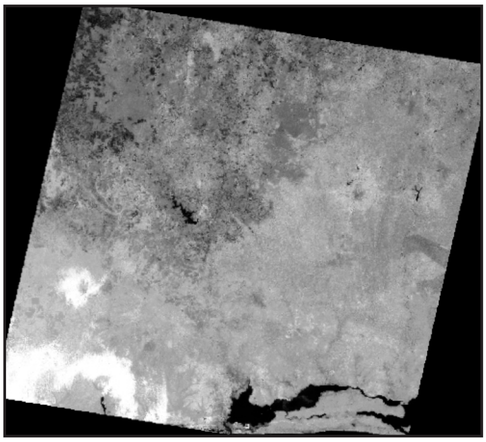


Figure 3.2: The 2002 Landsat imagery

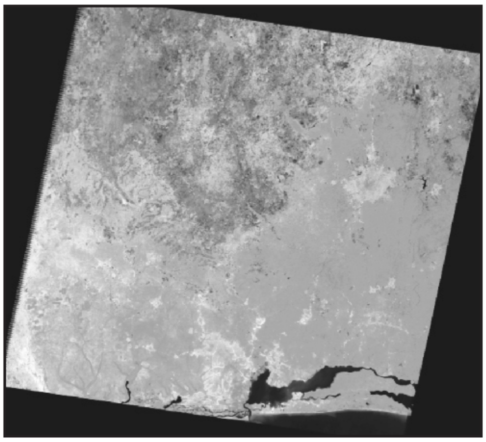


Figure 3.3: The 2006 Landsat imagery
Source; NASRDA

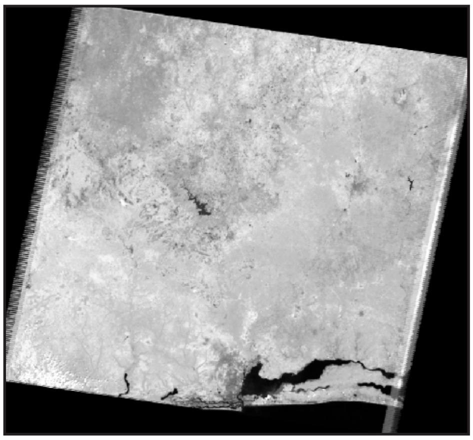
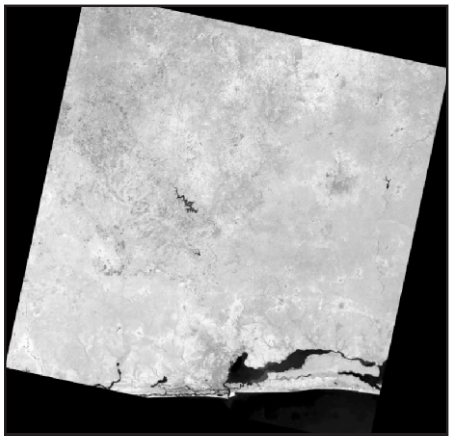


Figure 3.4: The 2018 Landsat imagery



3.2 Land Cover Classification Scheme, Source NASRDA

Visual analysis of the Landsat images revealed three prominent features namely:

(i) Bitus areas (ii) Open grassland /shrub (iii) Forests

The land cover classification scheme was based on these three (3) classes

3.3 Data Analysis

In handling these data, two softwares were used extensively:

1. ArcGIS 9.3, and ENVI 4.7 (Environment for Visual Imaging) Remote sensing software.

A uniform coordinate system was adopted for all the datasets used – WGS84 UTM Zone 31 North. The Landsat satellite imageries downloaded from USGS came already orthorectified.

3.3.1 Supervised Classification

ENVI 4.7 software was used to implement supervised classification for the three sets of imageries using the Parallelepiped Classification Technique.

3.4.1 Software Used

(i) ENVI 4.7 ArcGIS 9.3 (ii) Microsoft Office Suite 2007 (Excel and Word)

ENVI 4.7 was used for classification and processing of the Landsat imageries. ArcGIS 9.3 was used for setting coordinate system parameters, editing the classified images and also for area computation amongst others while Microsoft Office 2007 was used for creating tables and reports.

3.5 Data Manipulation and Processing Technique

A polygon defining the area of interest (AOI) was overlaid on the Landsat imageries so that the study area could be clipped out

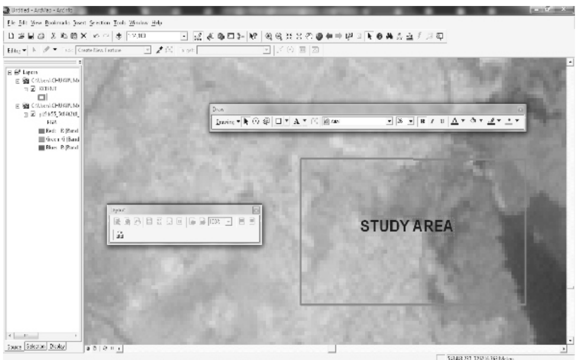


Fig 3.5: Overlay of study area on Landsat image

1. The Landsat images were inputted on ENVI 4.7 software
2. For each feature class, a region of interest (ROI) was specified using the R O I Tool dialog.
3. Parallelepiped classification was then carried out.
4. Post-classification was then performed to vectorise this classified area and it was exported as a shape file for editing on ArcMap.
5. Using the image as a guide, error checking and editing of the shape files was performed.
6. The entire procedure was repeated several times to extract the different feature classes. The outputs were brought together.
7. The edited features were well symbolised, put on a layout and a Land cover map of the area produced.
8. The areas of each feature class were generated on the attribute table.

The methodology involve data acquisition of Landsat imageries of 1984,2002,2006, and 2018. This follow selection of land cover classification, Training class selection using supervised classification, the editing was done ArcGIS, Creation of land cover maps, Computation of area, follow by analysis of results and data presentation.

4.0 RESULTS AND ANALYSIS

4.1 Spatial Changes in Land Cover over time (1984 – 2018)

A comparative analysis was done on the different image datasets and three distinct land cover classes were marked out:

1. Built up areas
2. Forest
3. Open grassland/ shrubs

Their distribution in the study area is shown in Table 4.1

Table 4.1: Land Cover Change over time (1984 - 2018)

	1984		2002		2006		2018	
	AREA		AREA		AREA		AREA	
	(Sq. km)	(%)	(Sq. Km)	(%)	(Sq. Km)	(%)	(Sq. Km)	(%)
Built up area	0.294	0.90	10.085	31.20	11.089	33.91	13.987	43.293
Forest	22.136	67.77	8.413	26.03	8.057	24.64	8.010	24.795
Open grassland	10.233	31.33	13.824	42.77	13.556	41.45	10.309	31.911
Total	**32**	**100**	**32**	**100**	**32**	**100**	**32**	**100**

Source: Classified images (1984, 2002, 2006 and 2018)

Table 4.1 above shows the land cover changes from 1984 - 2018. It is noticed that built up areas show a steady increase from 0.294195 sq.km in 1984 to 13.9872 sq.km in 2013. The reverse is the case for forest which shows a decline from 22.136249 sq.km in

1984 to 8.0107 sq.km in 2013. Open grassland increases from 10.233538 sq.km in 1984 to 13.824 sq.km in 2002 and then decreases to 13.5567 sq.km in 2006 and 13.9872sqkm in 2018.

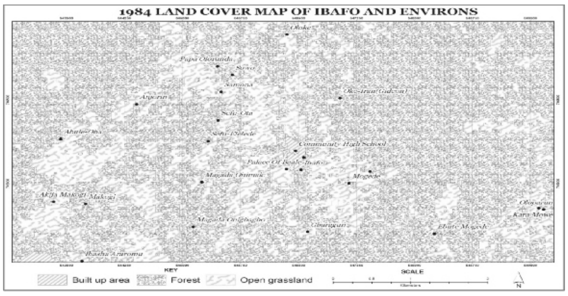
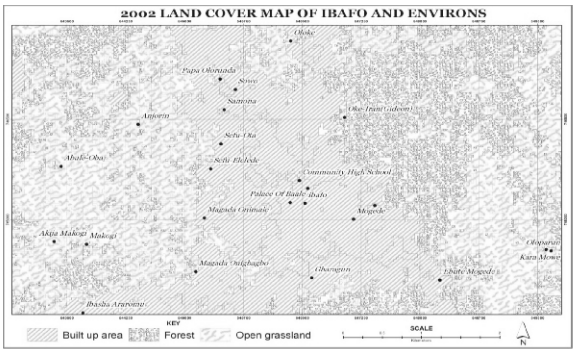


Fig. 4.1: Land Cover map of Ibafo and environs, 1984,
Source: NASRDA

Forest is very dominant as it occupies 67.77% of the area which corresponds to 22.136249 square kilometres. Open grassland comes next with 31.33% corresponding to 10.233538 square kilometres while built up areas account for only 0.9% (0.294195sq.km) of the entire area.



Source : NASRDA
Fig. 4.2: Land covermap of Ibafo and environs, 2002

Forest is less dominant this time as it occupies only 26.03% of the area which corresponds to 8.4132 square kilometres. Built up areas increase from 0.9% in 1984 to 31.2% in 2002 (10.0854 square kilometres). Open grassland now occupies 42.77% of the area (13.824 sq.km).

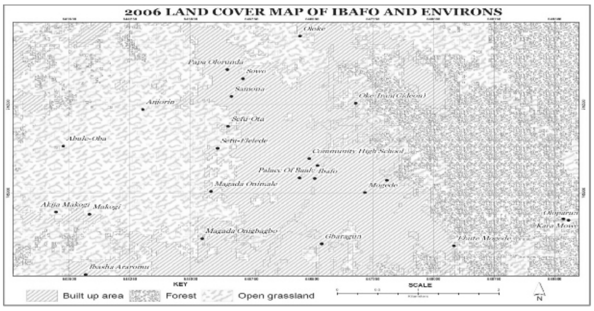


Fig. 4.3: Land cover map of Ibafo and environs, 2006

Built up areas occupy 33.91% of the total area (11.0898 square kilometres) coverage. Forests account for 24.64% (8.0577 square kilometres) of the area while open grassland/ shrubs take up 41.45% of the entire area.

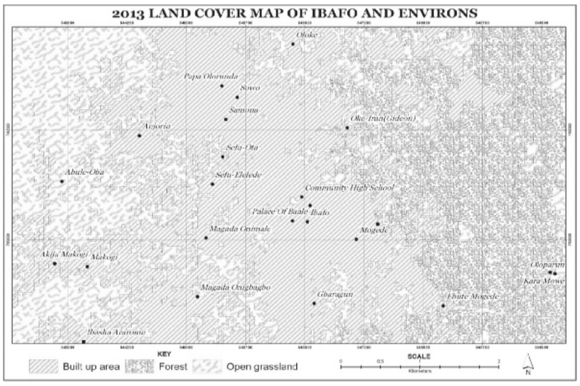


Figure 4.3: Land cover map of Ibafo and environs, 2018.

Built up areas occupy 43.29% of the total area (13.9872 square kilometres) coverage. Forests account for 24.80% (8.0107 square kilometres) of the area while open grassland/ shrubs takes up 31.91% of the entire area.

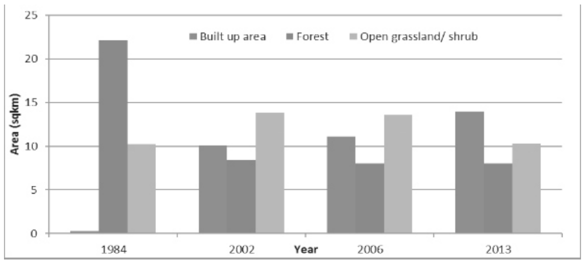


Fig. 4.4: Comparison of 1984, 2002, 2006 and 2018 Land cover classes

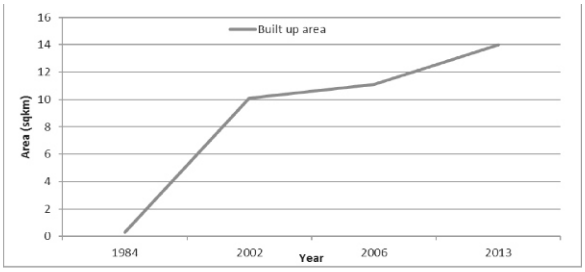


Fig 4.5: Change in Built up areas from 1984 – 2018

3.4Land Cover Change: Trend, Rate and Magnitude

LAND COVER	1984 - 2002 AREA (sq.km)	2002 - 2006 AREA (sq.km)	2006 - 2018 AREA (sq.km)
Built up area	+9.80	+1	+2.90
Forest	-13.72	-0.36	-0.05
Open grassland/shrub	+3.59	-0.27	-3.25

\+ indicates an increase - Indicates a decrease

LAND COVER	1984 – 2002 (%)	2002 – 2006 (%)	2006 – 2018 (%)
Built up area	3331	10	26.15
Forest	-62	-4.3	-0.62
Open grassland/ shrub	35.1	-2	-23.97

\+ indicates a percentage increase - Indicates a percentage decrease

Table 4.2: Trend in land cover change for Ibafo and Environs (1984 – 2018)

From Table 4.3, it can be seen that there was an enormous increase of 3331% in the total area occupied by built up areas from 1984 – 2002. From 2002–2006, it again increased by 10%. This is suggestive of an increase in population in Ibafo over these years. The expansion of the built up area will lead to increased anthropogenic activities such as deforestation and land and water reclamation thus leading to reduction in vegetation cover (forests and open grassland). In the year intervals, 1984 – 2002 and 2002 - 2006, forest reduces by 62% and 4.3% respectively.

As population increases, the built up areas expand. Forests and open grassland are cleared to pave way for construction. Over the years, built up areas take over these vegetation areas with time.

4.3 Nature and Location of Land Cover Change

It is important to examine the nature of the land cover change overtime. This is done by overlaying successive land use classes of different years over each other for close examination.

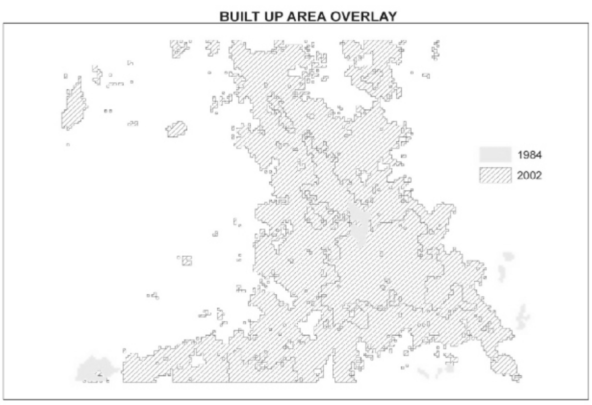


Fig. 4.4: Overlay of 1984 and 2002 built up areas.

Fig. 4.4 shows the overlay of 1984 and 2002 built up areas. It can be seen that there was a massive growth in built up areas within this period. The growth spread radially outwards from the centre.

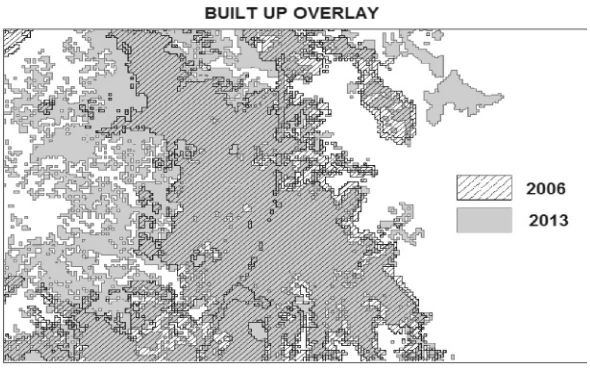


Fig. 4.5: Overlay of 2006 and 2018 built up areas.
Fig. 4.5 both show that built up areas still increased between years 2002 and 2006 and between years 2006 and 2018 respectively.

4.4 Land Cover Projection for 2023

By computing the rate of change of the epoch (2006 – 2018), the land cover distribution can be near – accurately predicted for later years. The land cover projection for 2020 will be calculated using the formula.

Rate of change =

$$\frac{\text{Observed change X Time difference (2013 – 2023)}}{\text{Time difference (2006 – 2018)}}$$

Time difference (2006 – 2018) =12 years
Time difference (2018 – 2023) =5 years

This value when added to the land cover value for 2018 will give us the land cover figures for year 2023.

The observed changes are given in Table 3.3

Built up area	=	+2.90
Forest	=	-0.05
Open grassland	=	-3.25
For Built up area:		(+2.90 /12) x 5
		= 1.21

The figures are presented in Table 4.3

Table 4.3: Land Cover Projection for 2023

	Land Cover Class	Built up area	Forest	Open grassland /shrub
2023	AREA (sq.km)	16.8872	7.9607	7.0597

Analysis of the above table shows that in the year 2023, built-up areas will increase to approximately 16.8872 square kilometres while forest and open grassland/ shrub will both decrease to 7. 9607sq.km and 7. 0597sq.km respectively.

4.5 The Socio–Economic Implications of the Predicted Change

Ibafo has witnessed an unprecedented growth rate in the past 34 years between 1984 and 2018, both in terms of human and infrastructural development. This however poses serious challenges for the area because it has to deal with the problems associated with urbanization such as urban sprawl, decline in the extent of important ecosystems such as the forests and wildlife habitats and a general loss of vegetation and open space.

A major contributory factor to the rise in built up areas is the increased influx of people into the area over the years.

5.0 Conclusion and Recommendations

In conclusion, this study has demonstrated the effectiveness of the use of remotely sensed data to study land cover change detection and analysis of such land cover using Geographic information system (GIS). These tools have been able to reveal evolving trends in land cover within the study area, the pattern of such trends as well other relevant information. The study reveals that urbanization is largely responsible for the significant changes and modifications in land use and land cover in Ibafo and its environs. These land use and land cover changes lead to environmental degradation, biodiversity loss, infrastructure overload, etc. To curb these impacts there should be constant monitoring of urban growth and changes in land use and land cover pattern to be in place appropriately to response to the mechanism in line with the towns and regional master plan to maintain sustainable development. As a result of the need for sustainable development of Ibafo and its environs the following recommendations are made;

- ✓ A master plan should be made for Ibafo and its environs and if available should be strictly followed
- ✓ The existing map should be revised and put to effective use
- ✓ Illegal conversion of land to other uses other than what is meant for in the master plan should be stopped
- ✓ Measures for sustainable development should be accelerated to preserve the natural environment to avoid environmental degradation.

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