

Detecting Subtle Land Use Land Cover Changes at Small-Scale Using Landsat 8 Imagery in Ilorin East Local Government Area, Kwara State, Nigeria

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Abstract

This study assesses the dynamic impact of both human and natural phenomena on land use land cover (LULC) changes between 2014 and 2020 in Ilorin East Local Government Area of Kwara State using Landsat 8 Operational Land Imager (OLI) satellite imagery. The images of the respective year were trained and classified into six classes: built-up area, barren land, dense vegetation, sparse vegetation, rock, and water bodies, using the supervised Maximum Likelihood Classification (MLC) method. Subsequently, changes in LULC that has taken place within the study area was determined using post-classification comparison technique. The study

revealed that between the years 2014 and 2020, the water body and sparse vegetation decreased by 2% and 3%, respectively, whereas the dense vegetation increased by 5%. Also, the rock decreased by 3.8%, while barren land and built-up area increased by 5% and 1.4%, respectively. Rainfall amount, environmental and anthropogenic activities, agricultural practice, increasing population, and urbanization are all traced to the pattern of changes detected.

Keywords: Subtle, Land use, Land cover, Small Scale, Imagery.

1.0 INTRODUCTION

The land is one of the most important natural resources; life and developmental activities are based on it. Humans have consistently been modifying land cover in different ways since ancient time through agriculture, shelter, and livestock. In the past two centuries, the impact of human activities on the land has grown immensely, altering entire landscapes and ultimately impacting the earth's nutrient, hydrological cycles and climate (Oladele & Oladimeji, 2011). Land use land cover is a general term used for how human activities modify the earth's surface. Though humans have been modifying land to obtain food and other essentials from time immemorial, current rates, extents, and intensities of land use and land cover (LULC) change are far greater than ever in history. This has resulted in unprecedented changes in ecosystems and environmental processes at different scales (Ujoh & Ifatimehin, 2011).

Issues of Land use dynamics are now of international concern. Understanding its evolution and addressing questions regarding changes in the Spatio-temporal patterns of intra- and inter-urban forms are still primary objectives in urban and academic research (Nnaji, Njoku & Peter, 2016). Understanding the trend, the nature, extent, and pattern of land use dynamics of an area is significant to planning and development (Long, Wu, Wang & Dong, 2008).

Mapping land use/land cover is a standard way to monitor changes (Berlanga-Robles

& Ruiz-Luna, 2002). Characterizing a landscape and quantifying its structural changes has received a considerable boost from developments in geospatial technologies; Remote Sensing (R.S) and GIS. Remote sensing provides an efficient tool to monitor and detect land use/land cover changes worldwide for the past three and half decades, by providing high spectral, spatial, and temporal resolution data (Myint, Gober, Brazel, Grossman-Clarke & Weng, 2011). With repetitive satellite coverage, the rapid evolution of computer technology, and the integration of satellite and other spatial data, the development of environmental monitoring applications such as change detection have become ubiquitous (Blaschke, 2010).

To detect a land cover change, a comparison of two or more remotely sensed images collected at different times is usually employed to evaluate the differences that have occurred temporally or spectrally (Tso & Mather 2009; Yuan, Elvidge & Lunetta, 1998; Zubair, 2006). Assessing urban land-use change, a change detection analysis is needed to determine the nature, extent, and rate of land cover change over time and space. Given the increase in environmental degradation caused by human activities on the earth's surface LULC has become an important requirement in planning at local, regional, and global scales. Therefore, this study evaluates subtle LULC changes in the Ilorin East Local Government Area of Kwara State (Nigeria) between 2014 and 2020 using Landsat 8 OLI imagery.

2.0. MATERIALS AND METHODS

2.1. Study Area

This study was carried out in the Ilorin East Local Government Area of Kwara State. Geographically, Ilorin East which has Oke Oyi as its headquarters is located within latitude $08^{\circ}36'29''\text{N}$ and longitude $04^{\circ}47'23''\text{E}$ with an elevation range of 95 m to 313 m (above m.s.l.) covering an area of 473.7km^2 . According to the 2006 census, the local government has a population of 204,310 people projected to be 280,000 by 2016. Farming is the main occupation of the early inhabitants but the rapid development and expansion of the Ilorin metropolis have converted the eastern part of the area into an urban settlement. The area experiences wet and dry seasons with a temperature that typically varies from 18°C to 35°C and is rarely below 14°C to 38°C (Ajadi, Adeniyi & Afolabi, 2011).

2.2 Data Processing and Image Classification

This study employs the medium resolution Landsat 8 satellite imageries of 2014 and 2020 acquired on the 1st of October for the respective year. The Landsat imageries were downloaded from the United States Geological Survey (USGS) data archive. After all necessary pre-processing, the images were classified into six land use land cover classes: water, sparse vegetation, dense vegetation, barren land, rock, and built-up areas (Table 1), using the supervised Maximum Likelihood Classification (MLC) algorithm (Blanchke, 2010; Zhao & Pitman 2002). The classification accuracy for each map was determined using the error matrix (Yadav, et al., 2013).

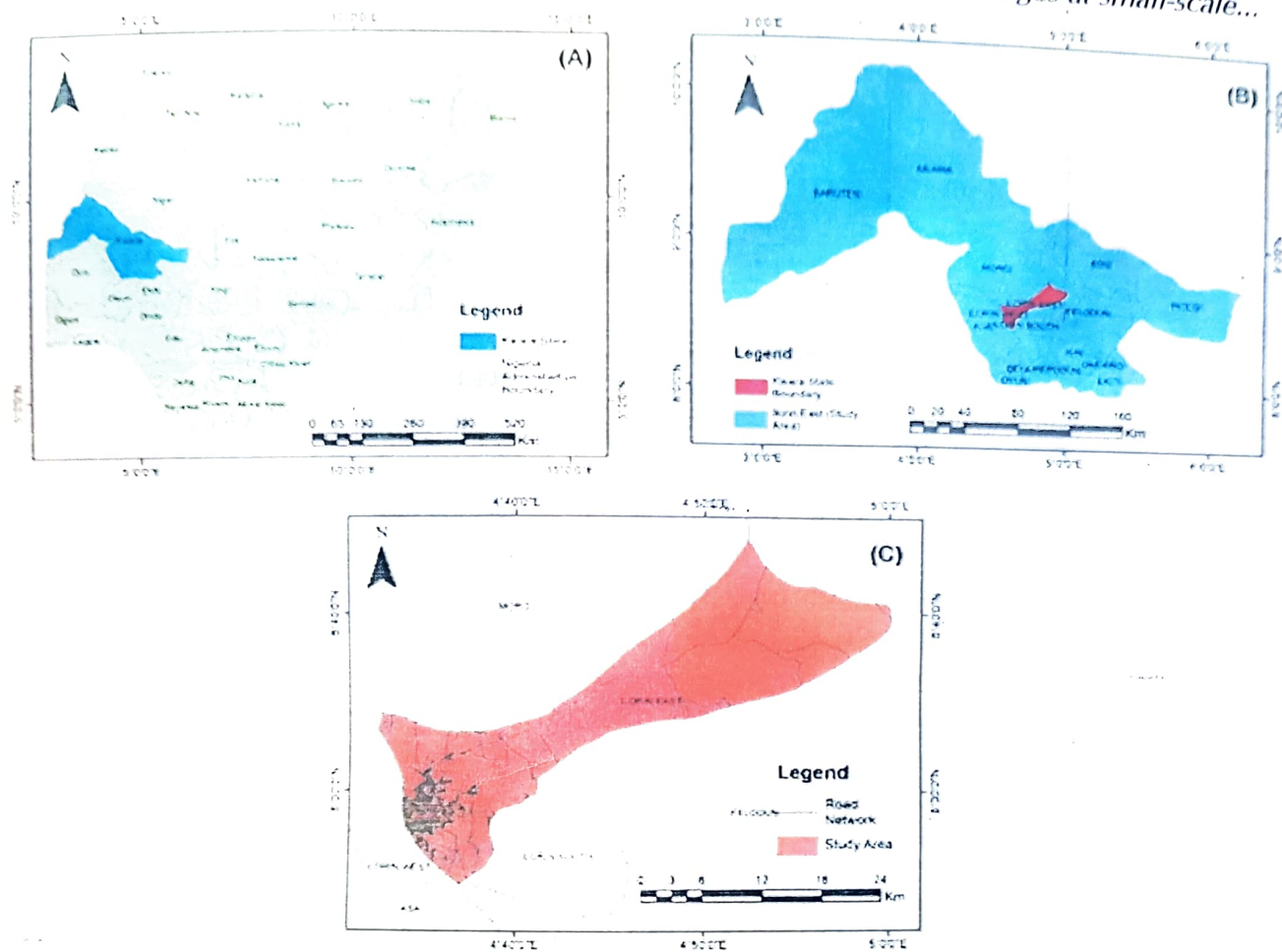


Figure 1: Location of the study area: (a) Nigeria Administrative map (b) Kwara State Administrative Map (c) Ilorin East Local Government Administrative Map with the Road Network.

Table 1: LULC Classes and Description

S/N	Class	Description
1.	Water	Areas with water e.g., River, waterlogs, ponds
2.	Dense Vegetation	Comprises of heavy green areas, thick forest, and trees.
3.	Sparse Vegetation	Includes low vegetated areas, farmlands, and grassland
4.	Barren land	Includes sand plains, little or non-vegetated areas and. unpaved roads are also considered bare lands.
5.	Rock	Includes hills, mountains, and other high plains.
6.	Built-up Areas	Includes residential, academic, commercial Services, transportation, Communications

2.3 Change Detection Analysis

The change analysis was performed using the post-classification comparison method (Agbor, Aigbokhan, Osudiala & Malizu, 2012; Long et al. 2008; Melesse 2004;). First, the classified maps of 2014 and 2020 were converted to a polygon with several polygons of the same class merged as a single entity using the Dissolve tool in ArcGIS 10.4. This allows appending the LULC classes and computation of the areas covered by each class. Thereafter, the interclass changes between the early year (LULC 2014) and the latter year (LULC 2020) were determined utilizing the Intersect geoprocessing Tool. Subsequently, the change attributes were computed which allowed analyzing features in a particular class in the early year that has changed to another class in the later year in map and chart form.

3.0. RESULTS AND DISCUSSION

The Landsat 8 images of both years were respectively classified into 6 land use/cover classes, namely, rock, sparse vegetation, dense vegetation, barren land built-up area, and water body (Figure 2).

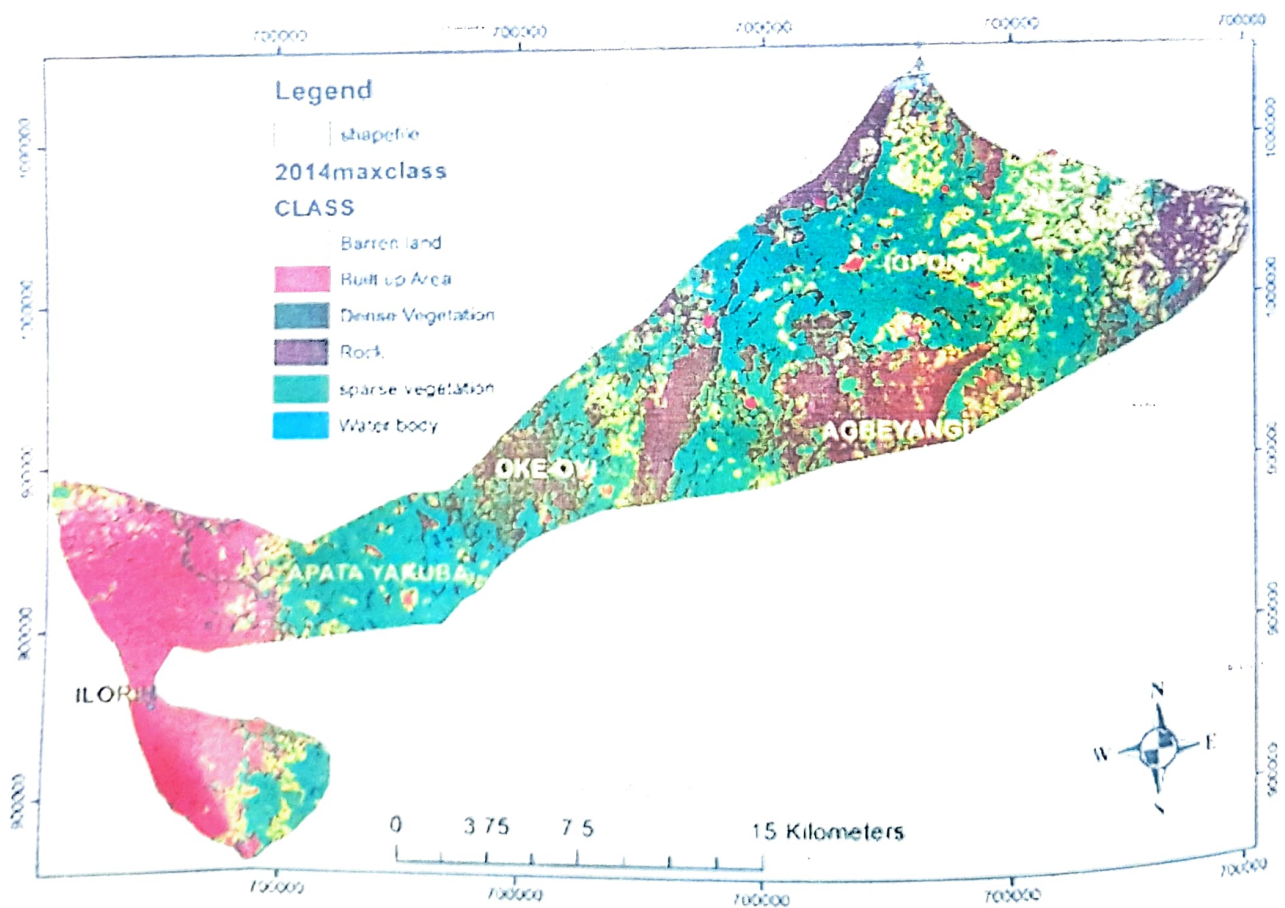


Figure 2: Classified Map of 2014.

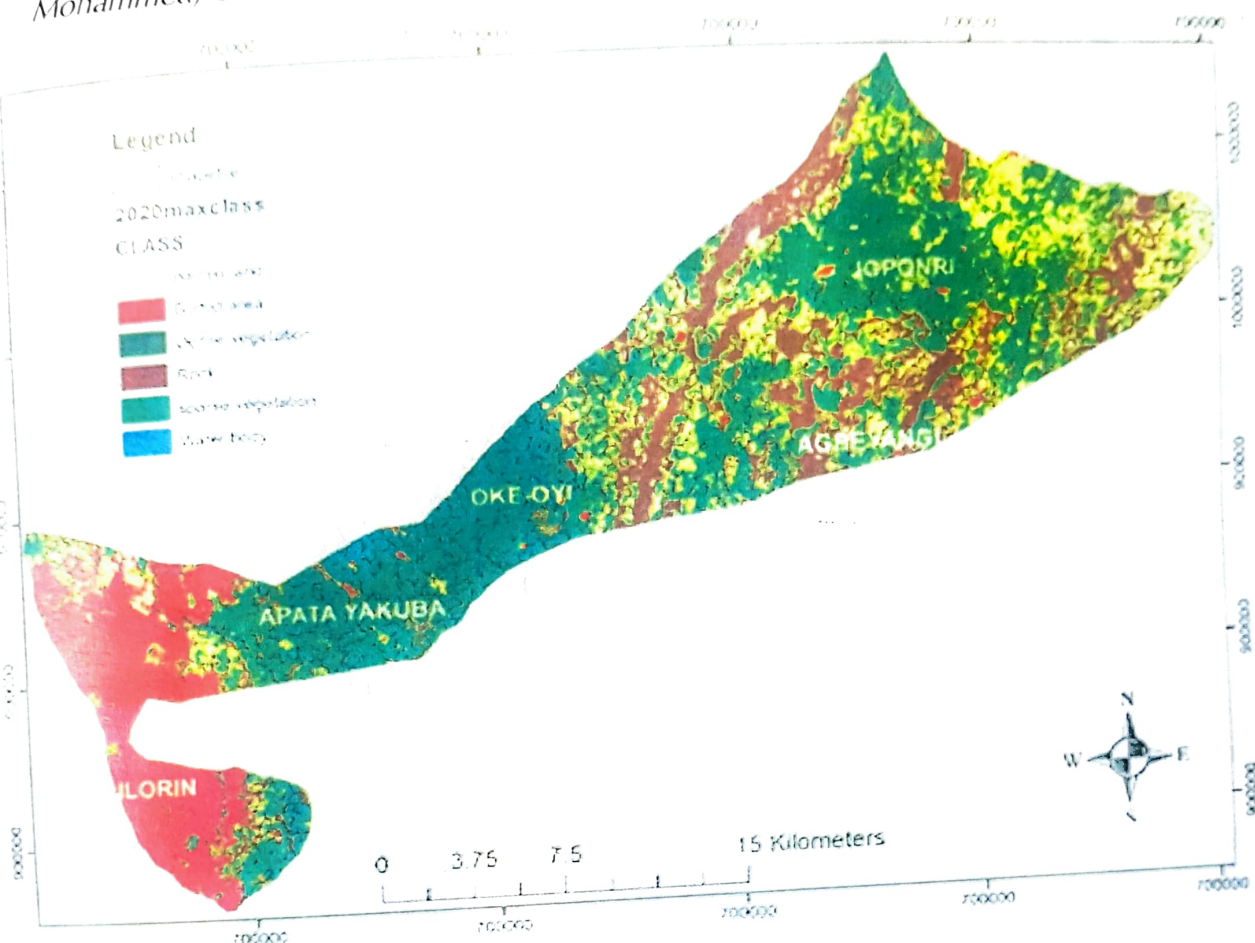


Figure 2: Classified Map of 2020

The classified maps provide a visual assessment of the state of the study area in 2014 and 2020, while analysis of area coverage (Table 2) provides quantitative evaluation generally revealed in the percentage area (Figure 3).

Table 2: LULC class area statistics

LULC Class	Area (2014)	Area (2020)
Rock	5780436	4667735
Sparse vegetation	9393448	8658994
Dense Vegetation	1345884	3464764
Barren land	10655820	13175865
Built up Area	8076088	8207328
Waterbody	1178352	375984

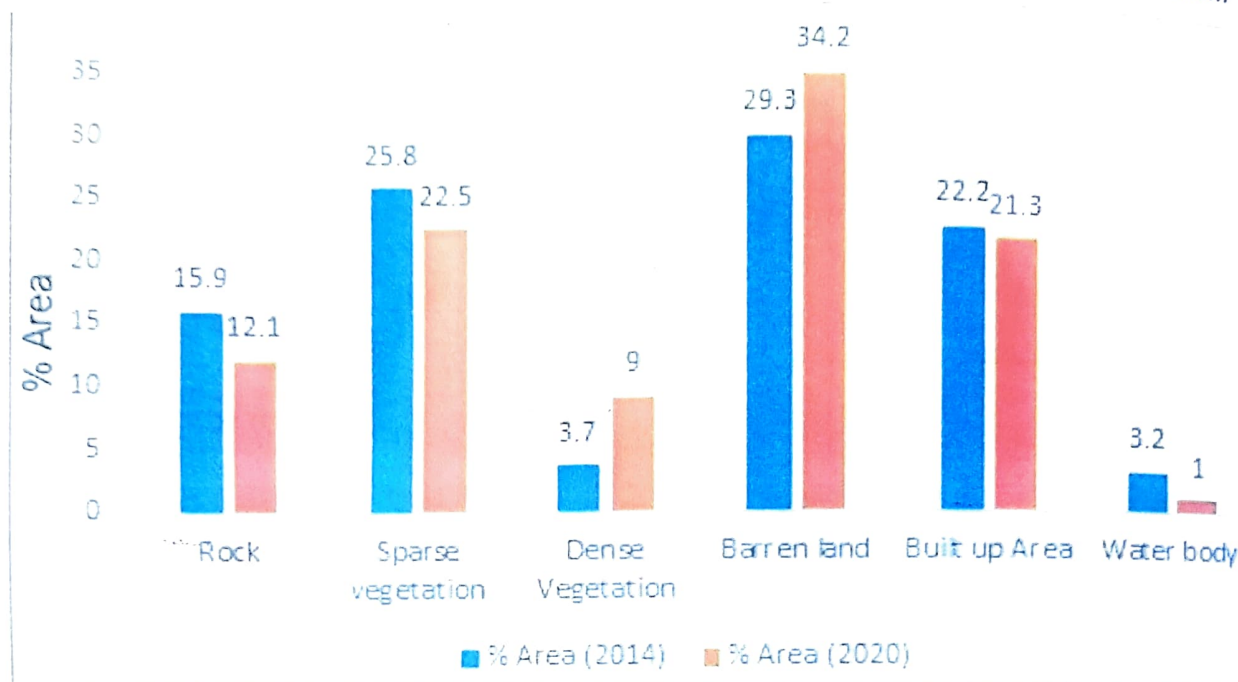


Figure 3: Comparison of class percentage area

Generally, for all the classes, little changes could be observed, some positive and others negative. The dense vegetation and barren land showed a slight increase in the area whereas the classes of rock, sparse vegetation, and waterbody revealed a slightly significant decrease. The study revealed that between the years 2014 and 2020 the water body decreased by 2% due to a decrease in rainfall amount and other environmental factors. The sparse vegetation reduced slightly by 3% given way for new buildings and other human activities (Burnnett, fall, Temppo & Kalliola, 2003; Long et al. 2002). Also, the dense vegetation increased by 5% attributable to the shifting cultivation farming practice and rural-urban migration (Agbor, et al., 2012). It is also observed that rock decreased by 3.8%. Balogun (2019), attributed intense mining and weathering activities are most likely responsible for this phenomenon. The study equally showed that barren land and built-up area increased by 5% and 1.4%, respectively, obviously resulting from an increase in population and urbanization (Nnaji et al. 2016; Zubair 2006).

Analysis of the interclass changes (Figure 4) further indicates the relative land use/cover transformation. From the figure, it can be seen that much of the areas mapped as rock changed to other classes except the waterbody. Similarly, the sparsely vegetated land in 2014 has been taken over by other land cover types whereas the densely vegetated land lost some land to sparse vegetation. Also, the barren land conceded a significant portion to sparse vegetation but the built-up area and water body maintain some degree of the constant state. Map of the class-to-class changes is presented in Figure 5.

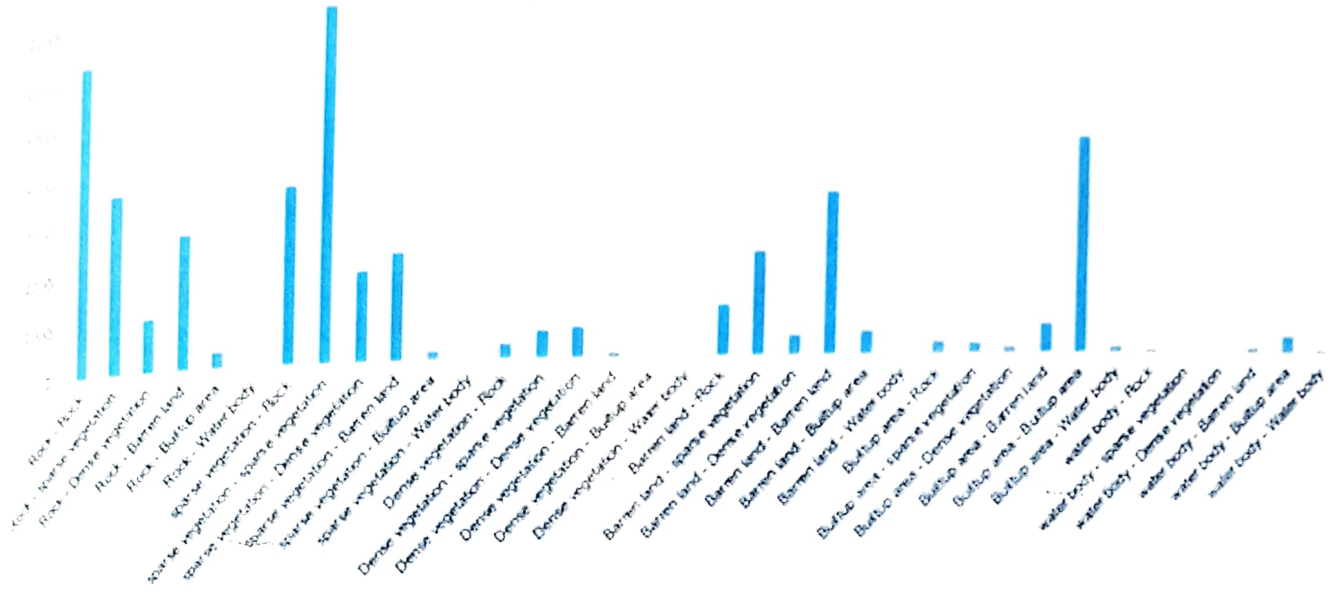


Figure 4: Chart of the interclass changes between 2014 and 2020

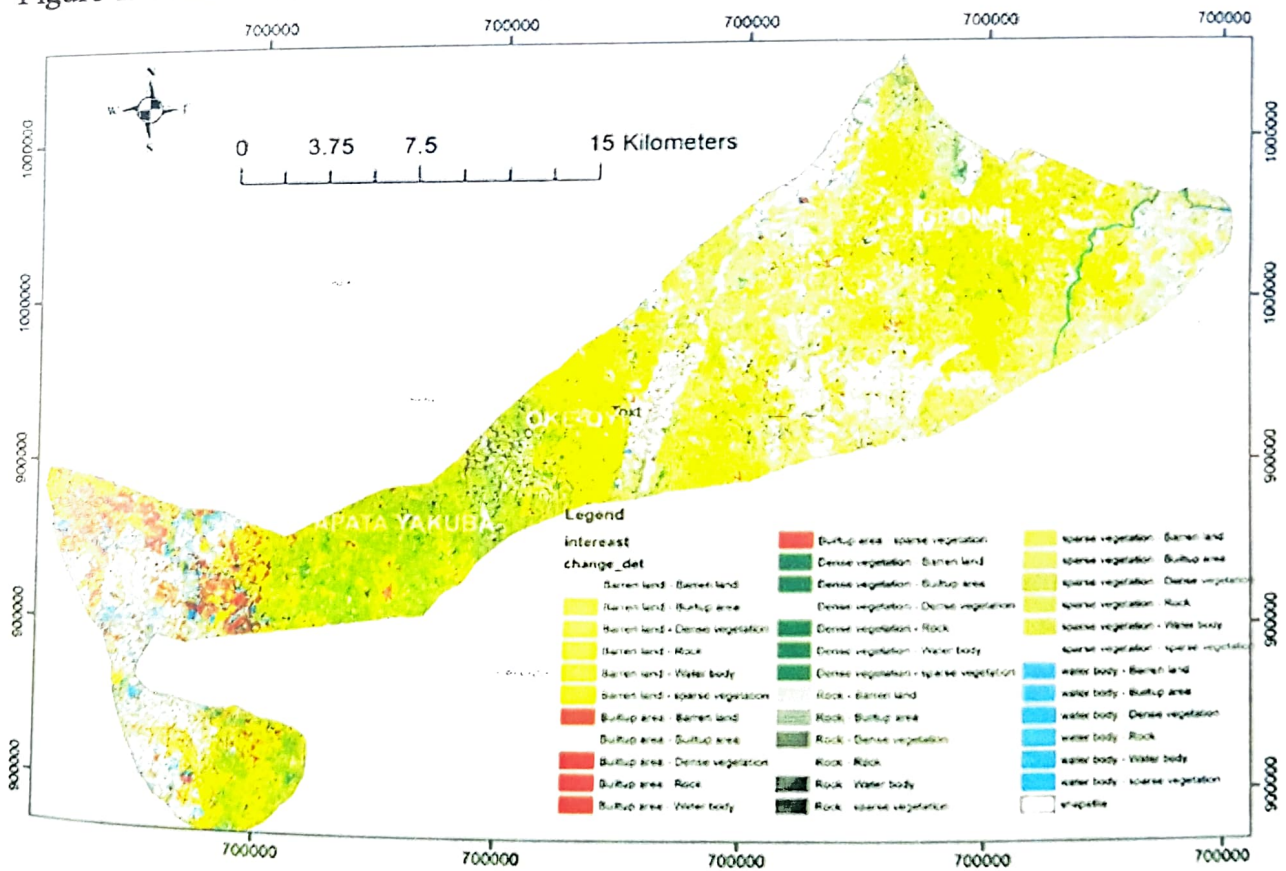


Figure 5: Class-to-Class Change Map between 2014 and 2020

4.0 CONCLUSION AND RECOMMENDATIONS

Monitoring the environment, particularly assessing land use land cover change, is an important aspect of evaluating the degree of human impact on the environment and quantifying the attendant consequences. This study utilized remote sensing and GIS techniques to detect subtle land use land cover changes across Ilorin South Local Government Area between the years 2014 and 2020. The study has shown that amount of sparse vegetation available in 2014 has reduced by 3% in 2020. It has also been detected that the barren land has increased in area by 5% in 2020 over what is obtainable in 2014. Over 6 years, it has also been estimated that the study area has lost 2.2% of its water body. This transformation is traceable to the impact of human activities and climate change. Future studies will investigate the impact of microclimatic factors and other indicators on the rate and degree of change. It is recommended that the government revises the land use plan of the study area so as to monitor proper use land as planned. This will ensure that land allocated for agricultural use are preserve to ensure sustainable crop production.

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