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Integrating Remote Sensing and GIS Technologies In Evaluating Land-Use Dynamics In The Pre Covid And Post COVID Era: The Case Study Of Obokun LGA, Osun State, Nigeria.

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ABSTRACT

Land use mapping is important for the evaluation, management, and conservation of natural resources of an area and the knowledge of the existing land use is one of the prime pre-requisites for suggesting better use of land. In this study, Land use dynamics are investigated by using Remote Sensing and Geographic Information Systems (GIS) in Obokun LGA, Osun State, Nigeria. For this purpose, supervised classification technique is applied to Landsat images acquired in 1990 and 2020. Image Classification of six reflective bands of two Landsat images is carried out by using the maximum likelihood method, the extracted land use map was classified into five major groups, namely forest, agricultural land, bare/rocky land, settlement and wetland/water bodies. With the aid of ground truth data, the second part which focuses on the dynamics of land use by using change detection comparison (pixel by pixel).The research work discovered that settlement has been on a rapid development over the years with a net increase change of 68% over the 30 years of study. Forest cover is losing at a rate of 8% for the period of 30 years, which is equivalent to 1241.91 hectares of forest land cover, this is a serious matter that calls for forest conservation and management practices. About 197.099 hectare of bare land has been lost to either settlement, or wetland encroaching, same is observed as 5% of wetland has also been lost; it is quite encouraging to have a 7% growth in agricultural lands. Recommendations were thus made based on these results.

Keywords: Remote Sensing, GIS, Technologies, Land-Use, COVID Era, Obokun LGA, Nigeria.

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1. BACKGROUND TO THE STUDY

The changes observed in the landscape are as a result of land use/land cover changes, it has the ability to modify the nature and structure of both biotic and abiotic factors of the environment. Man feeds or lives on vegetation and live-stocks as a means of living, so their exploration has led to the various changes observed in the ecosystem, It has been reported that a larger section of the observed changes in land use /land cover are human-induced in nature, whether in their constructive or destructive activities. Borisade et al., (2021) describes such activities as anthropogenic, they include deforestation, farming, logging and urbanization. Systems that scan provide a temporal form of data that can also create tools for measuring the changes over time is therefore important for effective management. In order to use land optimally, it is necessary to have the information on existing land use land cover.

It is also important to have capability of monitoring the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape. Remote sensing is a system that obtains continuous information about geographic feature without direct contact with it, using principles relating to the transfer, detection and recording of electromagnetic energy. Once the data has been acquired, GIS create tools and systems for analyzing, querying, updating, manipulating, presenting, retrieving and storing such information. This could offer a foundation for systematic and effective land use planning, management and ecological restoration for socioeconomic development (Liping et al. 2018).

Temporal data could thus be measured quantitatively and interpreted to detect and map changes in geographic features or phenomenon over the years. One of such analysis is known as Land use/ Land Cover analysis LULC change studies are widely used to monitor human-induced changes in the environment. Many studies conducted all over the world acknowledge that land use and land cover change (LULCC) is the result of complex anthropogenic-environmental interactions (Goswami et al. 2019; Issa 2018; Qader et al. 2016).

As rapid urbanization is observed in Obokun Local Government Area, Osun State Nigeria, this study seeks to use remote sensing and GIS to map the changes in geographic features and phenomenon and the effect of such changes over both the biotic and abiotic factors of the locality.

1.1 Statement of Problem

As urbanization and migration increases over the years, there is a significant change in the land use and land cover component, which has often cause imbalance in the structure of the environment, the effect of which are seen as flooding, land slide, climate change, increase in average temperature and other environmental hazards. Failure to monitor and manage such effect may lead to loss of lives and properties. In order to manage this, it is important to know the rate at which things have changed the current state of the environment and most likely the future implication of such occurrence. Obokun Local Government Area is one of the fast growing local governments in Osun State, with various functions varying form agriculture, to educational, social infrastructure and cultural heritage to preserve, the risk pose by these land changes and its management forms the basis and serve as a problem for this research. The aim of this research is to carry out an assessment of land use/land cover changes of Obokun Local Government area, Osun State for 30 years, using GIS and remote sensing

1.2 The Study area

Obokun local government area is a local government located in the North-western part of Osun State and geographically lies within $7^05'$ to $9^00'$North and $4^033'$ to $6^08'$East, it has a land mass area of 527km2, a projected population of 144,980 in 2019 (National Population Census, 2006) and a density of $280/km^2$. Its major occupant and dwellers are the Ijesha people (Occupying 97% of the total area, it largest town is Ibokun, other towns are EsaOke, Imesi-Ile, EsaOdo, and Ilase and among others, as schematic view is seen in Figure 1.0. The climate pattern is tropical. Obokun local government is dominated by the rainy season from March, the dry harmattan season around December till February and supported by rainfall during March. The mean annual temperature ranges from 39,00c in December to 27.2 in June. Human activities in the state include; Hunting, Fishing, Farming, Fuel wood harvesting, Grazing/Livestock and Urbanization among others (Wahab *et al*, 2015).

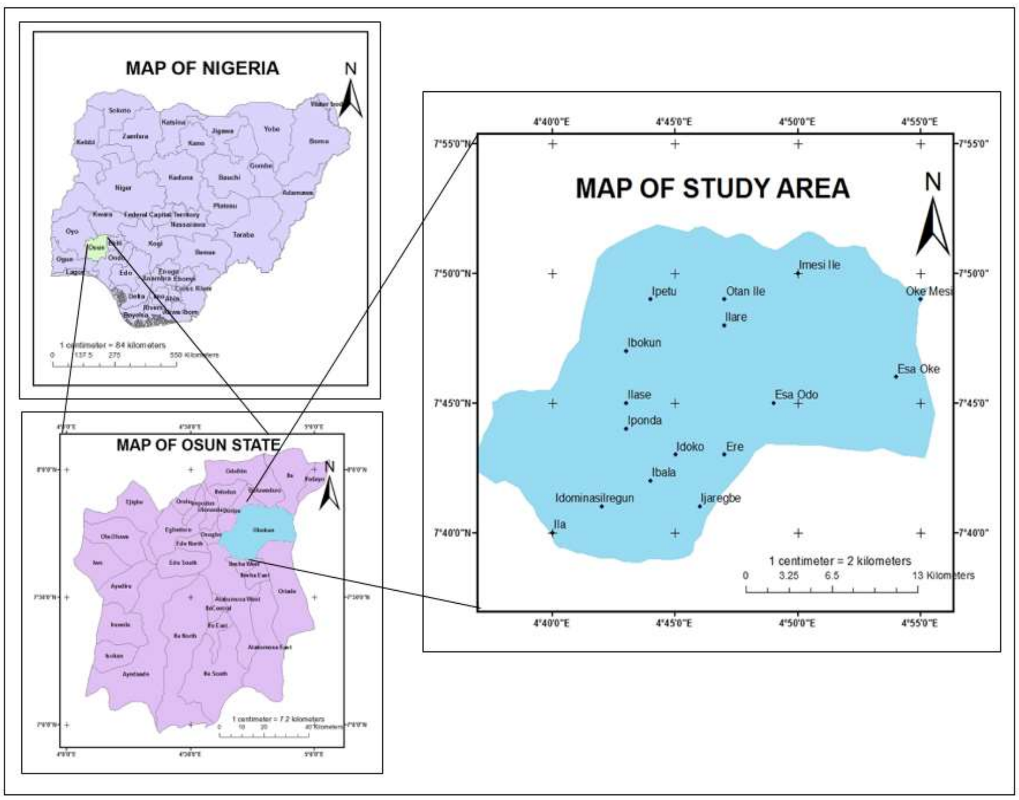

Figure 1.0: Map showing the study area

2. RESEARCH FRAMEWORKS

2.1 Theoretical framework

Land Use/Land Cover

All human activities are majorly conducted on the land, the term 'land use' is use to describe the various purposes that land serves for human use, it varies from food production, provision of shelter, recreation, extraction and processing of materials (Parveen, 2018). It is also important to know that aside human influence on the land, the biophysical characteristics of land itself also influences the changes (Abolfathi *et al.*, 2015).

Land cover on the other end, describes the physical state of the earth, it deals with the quantity and type of surface vegetation, water and other man-made erected structure. The term land cover originally referred to the type of vegetation that covered the land surface, but has broadened subsequently to include other aspects of the physical environment also, such as soils, biodiversity and surfaces and groundwater (Adeleke et al., 2013).

Understanding Land use/land cover changes is important as it does not only cause physical changes, various climate and weather changes have been traced to continuous changes in land use/ land cover. It has been traced to have a large contribution to various forms of disasters and hazards. Much broader range of impacts of land-use/cover change on ecosystem, goods and services were further identified (Aderele *et al.*, 2020). As human activities and rapid exploitation increases, the changes observed in land use and land cover has brought unprecedented changes in ecosystem and environmental processes at local, regional and global scales (Ajala and Olayiwola, 2013). Presently, land use/land cover changes encompass the environmental concerns of human population including climate change, biodiversity depletion and pollution of water, soil and air. Today, the monitoring and mediating the adverse consequences of land use/land cover change while sustaining the production of essential resources has become a major priority of researchers and policy makers around the world (Ajibola*et al.*, 2021).

2.2 Conceptual framework

Land Use/Land Cover Changes Studies

Anderson et al. (1983) develop a framework of a national land use and land cover classification system, LULC can be National, regional and/or local in nature, depending on the area of study. An open-ended system was developed, that makes Federal, regional, State, and local agencies have flexibility in developing more detailed land use classifications at the third and fourth levels in order to meet their particular needs and at the same time remain compatible with each other and the national system.

Golmehr (2009) examined four mapping approaches (unsupervised, supervised, fuzzy supervised and GIS post processing) to identify, demarcate and map the agricultural land use categories in the Northern parts of Kolhapur district, India. A fuzzy *c*-means clustering algorithm for supervised classification approach was applied to prepare multi-layer class map and distance map. For the accuracy assessment a random stratified sampling method was used to allocate the sample size for each land use based on its spatial extent. The extracted land use map was classified into six major groups, namely forest, cultivated land, range land, waste land, water bodies and built-upland. He discovered that the land use types of the area comprise forest, 14.07% of total surface area and about 26.33% of the area is occupied by fallow land, and uncultivated or not available land for cultivation. The remaining surface area was under cultivation

Orimoogunje et al. (2009) use land use/land cover mapping to assess thee changes in wetlands within Ilesha between 1986 and 2008 and to determine the causes of degradation in wetlands, using LandSAT and GPS data, they found out that the most significant contributor to wetlands degradation in the study area is the use of wetlands for settlement and agriculture. All these have got ecological and socio-economic consequences on the functioning of the wetlands. Maximum likelihood supervised classification and post-classification change detection techniques were applied to map land cover changes in the study area.

Collected ground truth, during several field trips conducted between 2003 and 2008, and topographic map of 1991 were used to assess the accuracy of the classification results. The results show that during the study period, the high capable soils (Class I) decreased from 683.2 to 618.5 Km2. The moderate capable soils decreased from 100.5 to 93.8 Km2, while the marginally capable soils decreased from 209.1 Km2 to 198.3 Km2 during the same period. It is noticed that urban encroachment over the non capable soils are very limited, as their coverage was found stable during the period 1993 – 2009.

Adeleke et al., (2013) use remotes sensing to determine the habitats of mosquito fauna and possible impact of land use/land cover changes on the epidemiology of mosquito-borne diseases in Osogbo Metropolis, Southwestern, Nigeria. The accessible land use/ land covered of the study area between 1986 and 2009 showed that the wet land coverage and settlement area increased from 0.19 to 9.09 hectare and 1.00 to 2.01 hectare respectively while the forest area decreased from 60.18 to 50.14 hectare.

Ajala and Olayiwola (2013) in their study examine the use of GIS and Remote Sensing in monitoring the growth and development pattern of Ile-Ife, Osun State, Nigeria over a period of 21 years with a view to predicting its direction of growth. Data for the study were generated from both primary and secondary sources. Remote Sensing Imagery of Landsat TM 1986, Landsat ETM 2002 and ALOS 2007 were used to measure the extent of growth and to show the effects of this growth on other Land use/Land cover types. The results showed the growth of Ile-Ife and its effects on other land use classes. Pixel analysis revealed that changes occurred in the magnitude and rate of urbanization in the study area between 1986 and 2007.

Alawamy *et al.*(2018) observed that a wide-range of changes of land use/land cover in northeastern Libya, due to the conversion of natural resources for food purpose, urbanization and other socioeconomic benefits. They used Land use/Land Cover classification to quantify this and found out that between 1985 and 2017, using four Landsat images 1985,2000, 2010 and 2017, the natural Mediterranean forest has lost over 9018 ha within 32 years, which is 39% of its total area, whereas urban and built up area has doubled between the years of study. Results also indicates an unstable trend of bare and low vegetation lands which generally increased by about 50%.
Morakarinyo et al. (2019) examine the changes in Land cover types at 6 gas flaring sites in Rivers State Nigeria and also to estimate the emissivity values between 1986 to 2013.They use Landsat, imagery which is a Remote sensing data to carry out an unsupervised k-means function on MATLAB for classification. Although a field work regarding emissivity had been carried out on the site, The results showed that remote sensing method can also be used for emissivity determination as the fieldwork observation for ground validation of Landsat 5 TM and Landsat 7 ETM+ in the Niger Delta and the Land Cover types obtained from satellite data are the same with those observed during the fieldwork.

Aderele et al. (2020) In their study, assessed land use/land cover changes in the Ago-Owu Forest Reserve, Osun State, Nigeria. Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI were acquired for 1986, 2002 and 2017 respectively. The three scenes corresponded to path 190 and row 055 of WRS-2 (Worldwide Reference System). The results show that during 1986 and 2017, there is a dramatic increase of build-up areas with a change of 55.65 km2 and sparse vegetation (farmland and grassland) with a change of 53.97 km2, while a dramatic decrease of dense vegetation (forest areas) with a change of 109.61 km2. They identified increase in population and logging actvities as one of the causative factor

Ajibola *et al.* (2021) in their study focus on how to apply remote sensing principles to land use and its management in Nigeria. Secondary data, the literature on land use, and remote sensing were adopted in the study. The study revealed that in the South West land use for settlements increased from 107.3ha in 1986 to 210.96 in 2003, while other land uses reduced in sizes – cropland (6021ha to 5,351.10ha). In Abuja, urban/built-up land increased from 36.8km^2 (1987 to 385.4km^2 (2017). The study further revealed that land management, using remote sensing, fosters inventory and management, periodic monitoring, and effective allocation and coordination of land resources

3. MATERIALS AND METHODS

This includes the data source, data acquisition, equipment used and data processing. The chart for the methods and materials used are shown in figure

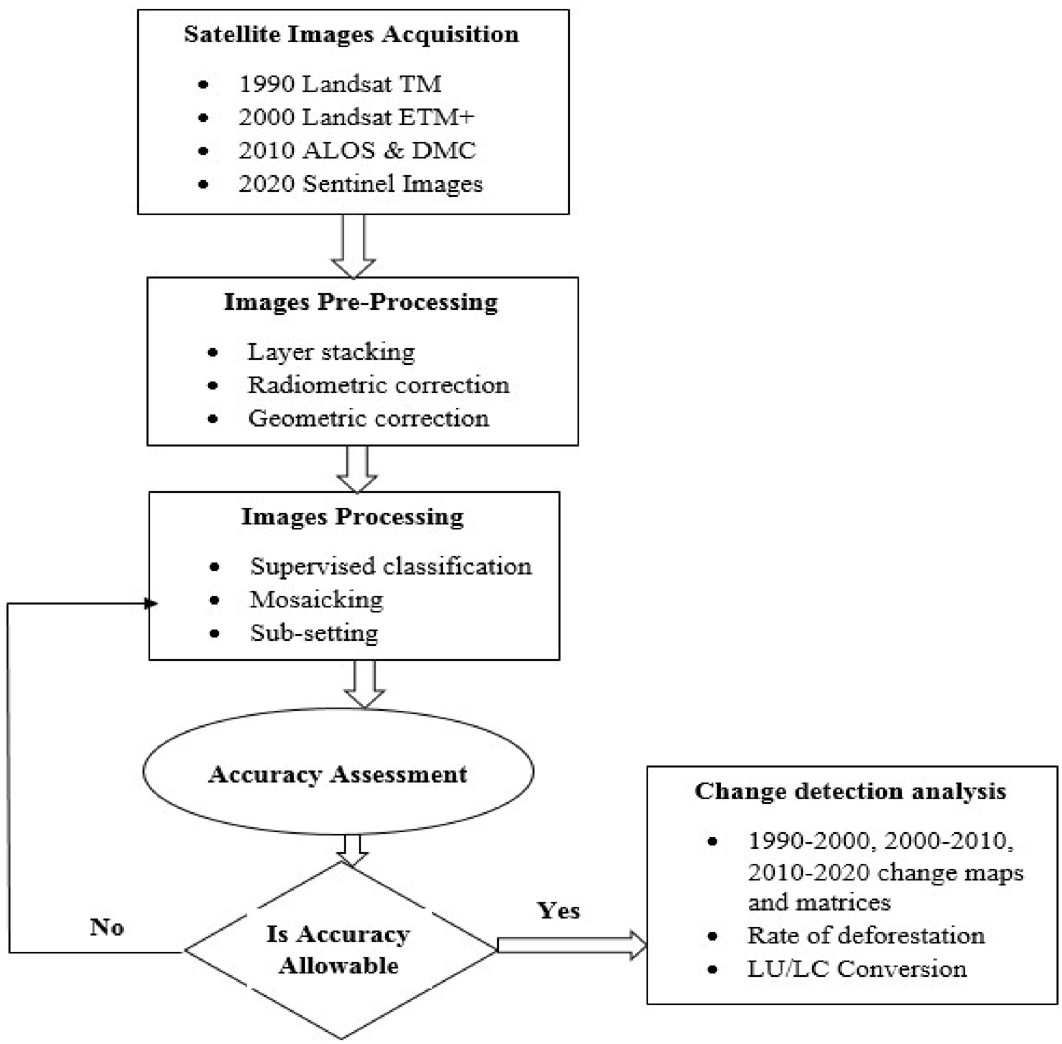

Figure 2.0: Methodology flow chart

3.1 Data Acquisition

This was categorized into two: EO (earth observation) data and reference data, and has employed multi-temporal satellite images of Landsat, TM (thematic mapper) and ETM+ (enhanced thematic mapper plus) images of scene 194/55 and 194/56 acquired in the years 1990 and 2000, 2010 ALOS of three scenes (Scene 38, 39 and 50) and one scene of 2010 DMC images and one scene of 2020 Sentinel image. The Landsat and Sentinel data were downloaded from the USGS (U.S. Geological Survey) database using its Glovis facility. These images were selected on the basis of availability, season and cloud coverage as seen in the table.

Table 1.0: Classification of Land use classes

Land Use	Feature
Forest	These include forest covers, stands and woods
Agriculture	Cropped land which may be rice, maize, yam or any other types of farms structure
Built up	All the developed land, including social utilities such as transportation infrastructure (roads and highways), built up areas, bare grounds and human settlements of any size.
Water	Lands covered with waters, lakes, rivers, reservoir and ponds
Bareland	Land that are open and free from vegetation

4. DATA ANALYSIS AND FINDINGS.

Composite Image

The bands downloaded and preprocessed for the respective years were then stack together to form a composite image. 7 bands were stacked for each year of observations, and composite images were formed as shown in Figure respectively.

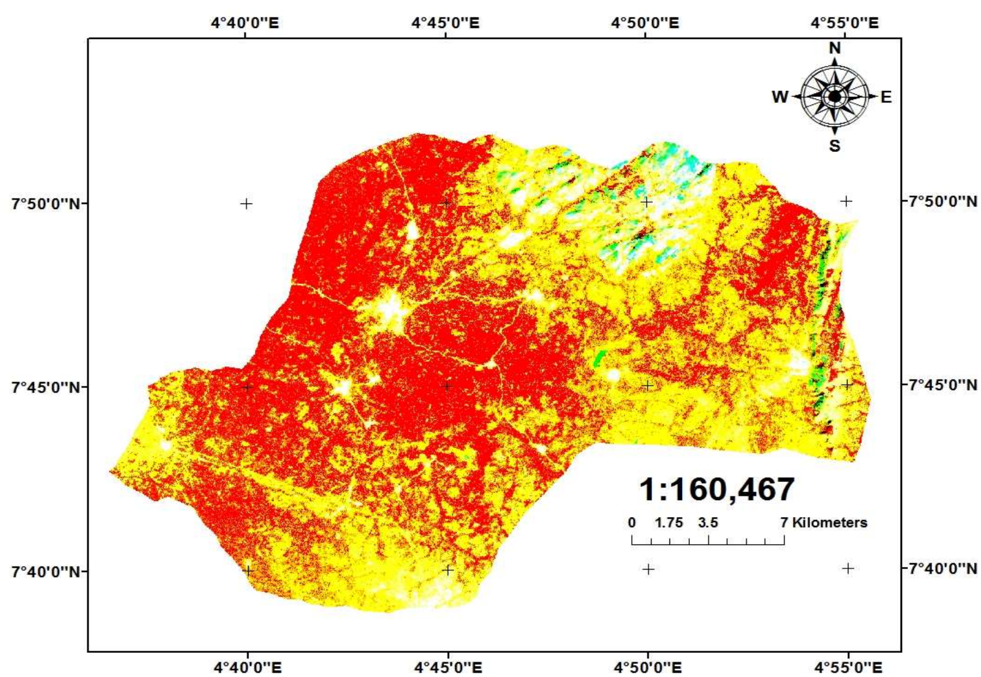

Figure 2.1: Composite image of 1990

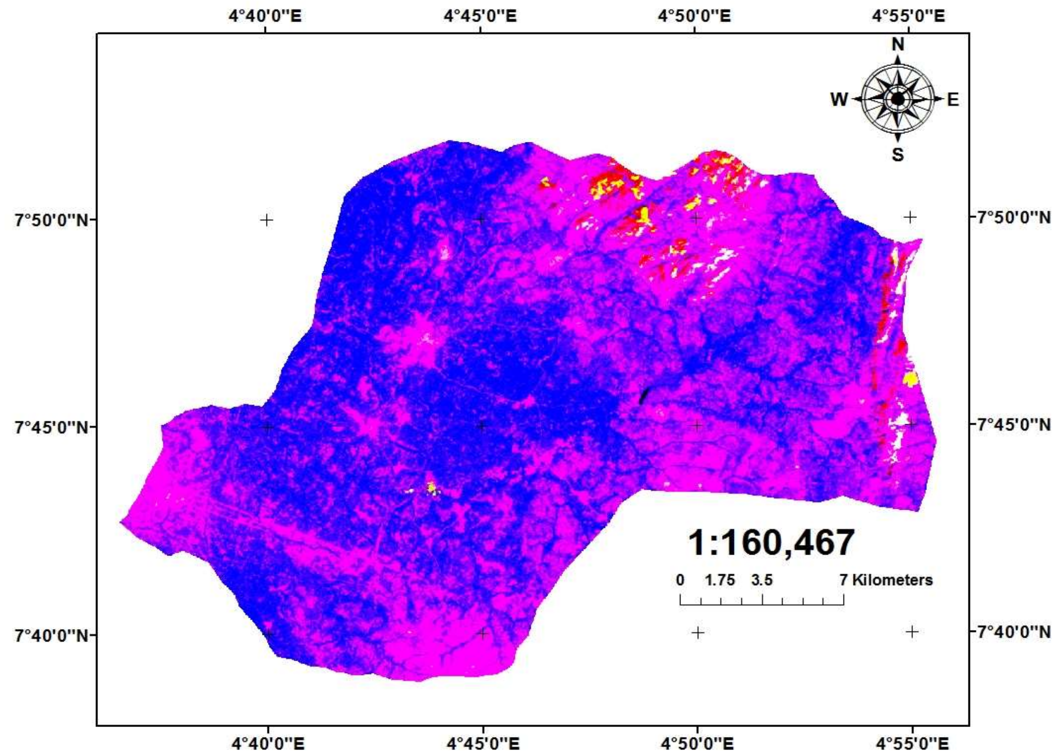

Figure 2.2: Composite image of 2005

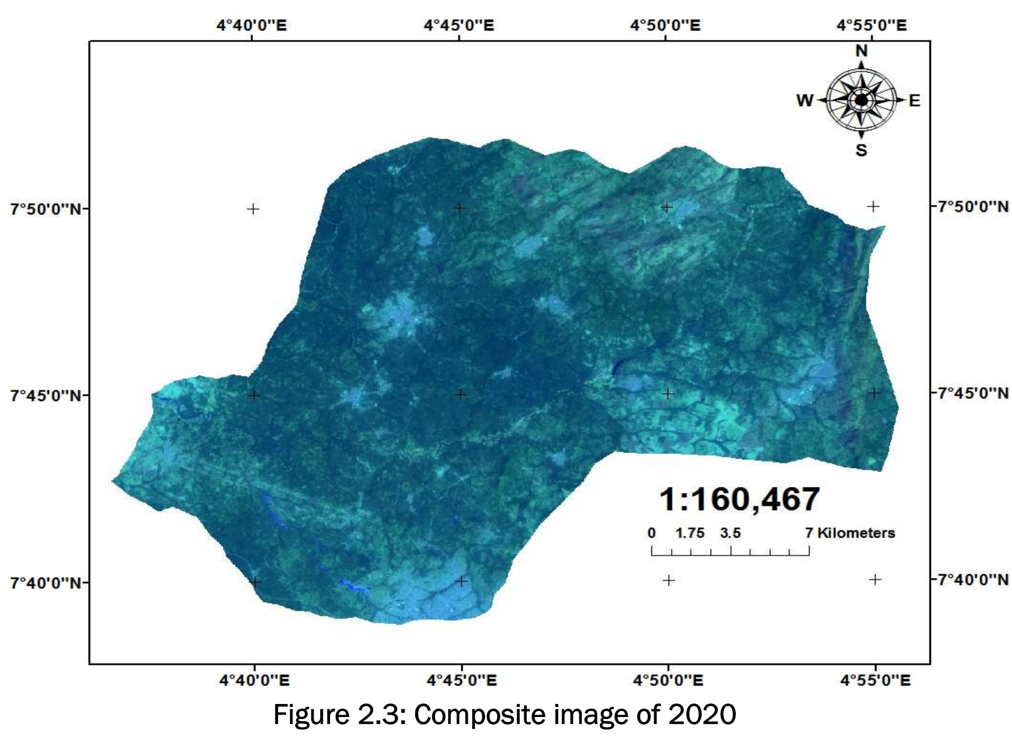

Figure 2.3: Composite image of 2020

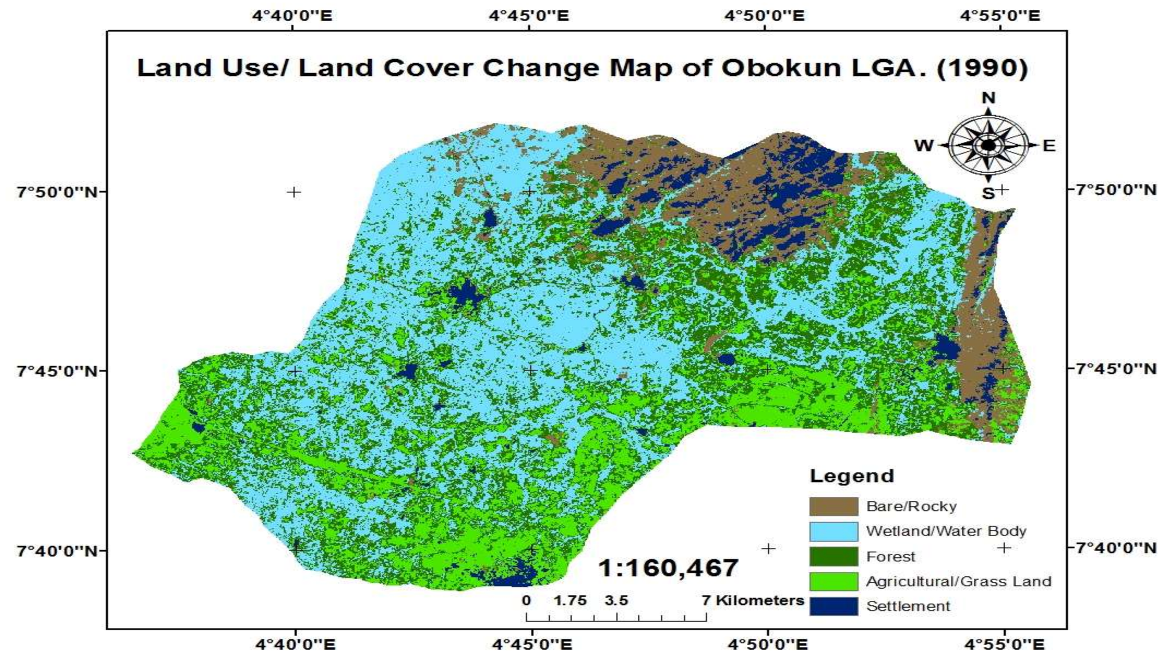

Figure 3.1: Land use/Land Cover Map of Obokun LGA Osun State (1990)

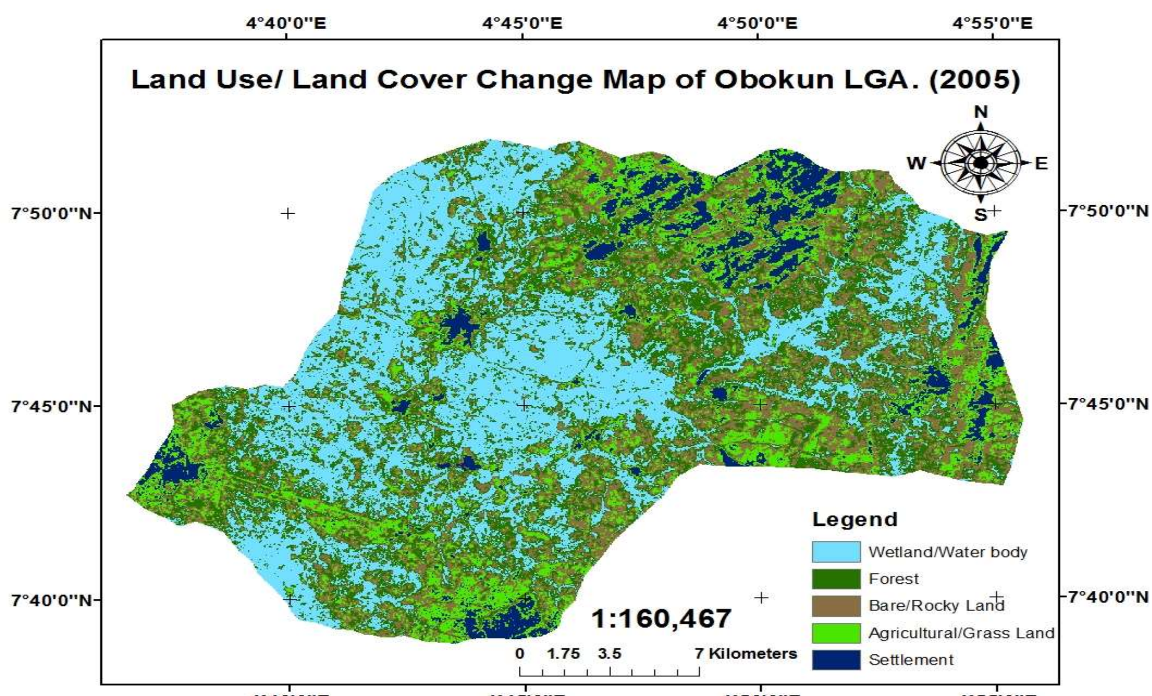

Figure 3.2: Land use/Land Cover Map of Obokun LGA Osun State (2005)

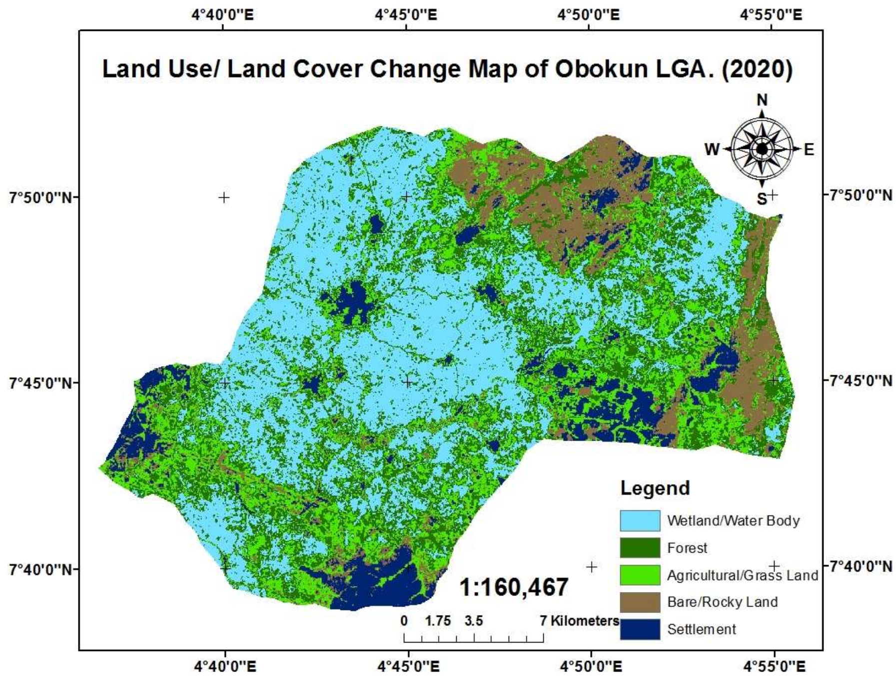

Figure 3.3: Land use/Land Cover Map of Obokun LGA Osun State (2020) post covid era.

From the chart in figure it could be observed that bare/rocky land experience a steady exposure between 1990 and 2005, but decline in 2005, while the wetland/water body drop between 1990 and 2005 a steady increase was observed between 2005 and 2020, forest cover has been depleting over the years, agricultural land also experience a decline between 1990 and 2005 while it increases between 2005 and 2020. Settlement has been on the rise since 1990 till 2020.The area in hectares of the various land use/land cover category are shown in Table 2.0

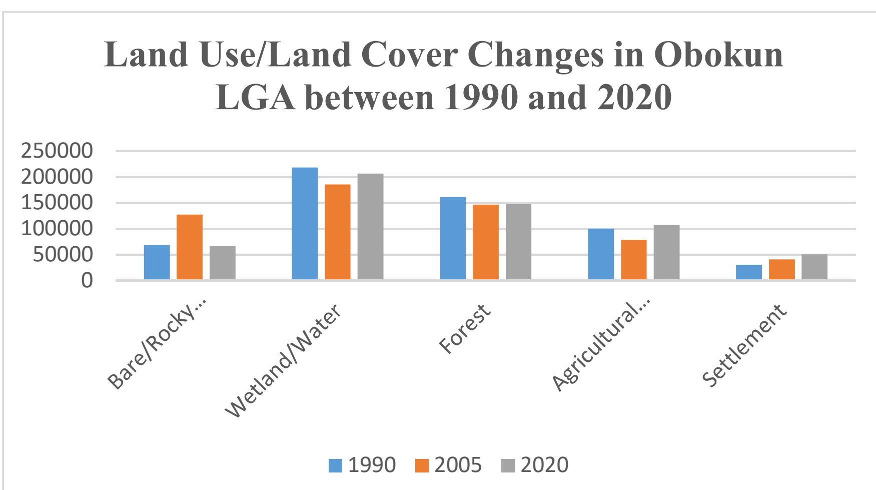

Figure4.0: Land Use/Land Cover Changes in Obokun LGA between 1990 (pre- covid) and 2020(post- covid).

Table 2.0: Land use/Land covers Distribution (1990, 2005 and 2020)

Factor	Area in Hectares-1990	Area in Hectares-2005	Area in Hectares-2020
Bare/Rocky Land	6176.143369	11465.07	5979.044
Wetland/Water	19633.17713	16664.81	18575.5
Forest	14503.01095	13177.4	13261.1
Agricultural land	8986.205802	7031.681	9636.274
Settlement	2693.062748	3652.64	4539.678
	51991.6	51991.6	51991.6

This accuracy check was used to ascertain how valid or reliable the results of the classified data can be for the purpose of analysis and decision making. Comprehensive details of the user's accuracy and producer's accuracy can be seen in the table shown below.

Table 3.0 The achieved accuracy of classification of 1990

	Wetland/ Water land	Bare/Rocky land	Agricultural land	Forest	Settlement	Total	User Accuracy
Wetland/Water land	7	1	0	0	0	8	67.50
Bare/Rocky land	1	17	3	0	0	21	80.95
Agricultural	0	1	75	4	1	81	92.59
Forest	0	4	0	31	0	35	88.57
Settlement	0	0	3	0	15	18	83.33
Total	8	23	81	35	16	163	
Producer Accuracy	87.50	73.91	92.59	88.57	93.75		
Overall Classification accuracy: 88.96							
Kappa statistics: 0.84							

Table 3.1: The achieved accuracy of classification of 2005

	Wetland/ Water	Bare/Rocky land	Agricultural land	Forest	Settlement	Total	User Accuracy
Wetland/Water	5	0	0	0	0	5	100.00
Bare land	1	10	2	0	0	13	76.92
Agricultural land	0	1	73	7	3	84	86.90
Forest	1	1	2	30	0	33	90.91
Settlement	1	0	0	0	10	11	90.91
Total	6	12	78	37	13	146	
Producer Accuracy	83.83	83.33	93.59	81.08	76.92		
Overall Classification accuracy: 87.67							
Kappa statistics: 0.80							

Table 3.2: The achieved accuracy of classification of 2020

	Wetland/Water	Bare land	Agricultural	Forest	Settlement	Total	User Accuracy
Wetland/Water	6	0	0	0	0	6	100.00
Bare land	0	7	2	0	0	9	77.78
Agricultural land	1	1	78	2	2	84	92.86
Forest	0	0	3	17	0	20	85.00
Settlement	0	0	1	0	11	12	91.67
Total	7	8	84	19	13	131	
Producer Accuracy	85.71	87.50	92.86	89.47	84.62		
Overall Classification accuracy: 90.84							
Kappa statistics: 0.83							

4.1 Change Map And Statistics

After the accuracy check has been done, a change detection analysis and maps were generated to visually map the effects and changes over the years of study (1990- 2020).

4.2 Change Detection

Bare/Rocky Land has experience an 86% exposure between 1990 and 2005, and has also decline by 48% between 2005 and 2020, probably due to settlement, agricultural land use or wetland encroachment, with an overall decline of 3% between 1990 and 2020. Wetland/Water body has experience a 15% decline between 1990 and 2005, and has experience an increase in coverage of 11% between 2005 and 2020, this may account for the recent flooding in the area, with an overall decline of 5% between 1990 and 2020. Forest Land has experience a 9% decline in their coverage between 1990 and 2005 probably due to deforestation, the 1% increase between 2005 and 2020 is largely small compare to the 8 % change between 1990 and 2020 this may be due to the influence of settlement, agricultural land use or wetland encroachment and other man activities.

Agricultural Land has experience a 22% decline between 1990 and 2005 as urbanization increases, people tends to leave farming activities to settle in the city thereby increasing the rate of urbanization, but recently, there has been a large input and participation of the mass in large and small scale farming, this was revealed in the 37% increase in the agricultural lands between 2005 and 2020, and also a net increase in agricultural lands between 1990 and 2020 at a rate of 7%.Settlement has increase rapidly over the years at a rate of 37% between 1990 and 2005, and also at a rate of 24% between 2005 and 2020. This is as a result of urbanization and development in the study area. It is so surprising to see that settlement experience a net increase of 68% between 1990 and 2020. These can be seen in table 4.4., Figure 4.10, 4.11, and 4.12 shows the chart representing the net changes observed in the year of study.

Table 4.0: Changes in Land Use/Land Cover between 1990 to 2020

	1990-2005		2005-2020		1990-2020	
Factor	value	%	value	%	value	%
Bare/Rocky Land	5288.926	85.63476	-5486.03	-47.8499	-197.099	-3.1913
Wetland/Water	-2968.37	-15.1192	1910.695	11.46545	-1057.68	-5.38719
Forest	-1325.61	-9.14022	83.69977	0.635176	-1241.91	-8.5631
Agricultural land	-1954.52	-21.7503	2604.593	37.04083	650.0682	7.234068
Settlement	959.5774	35.63145	887.0376	24.28483	1846.615	68.56933

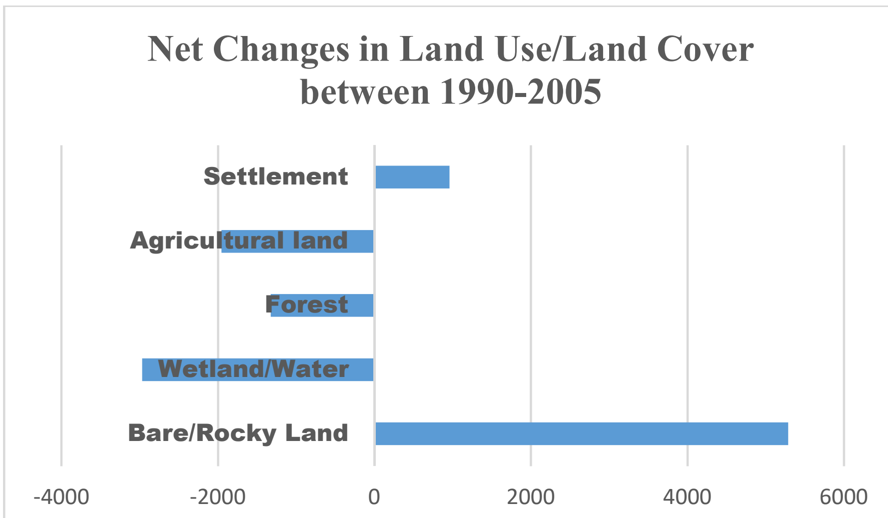

Figure 5.1: Net Change in Land Use /Land Cover between 1990-2005

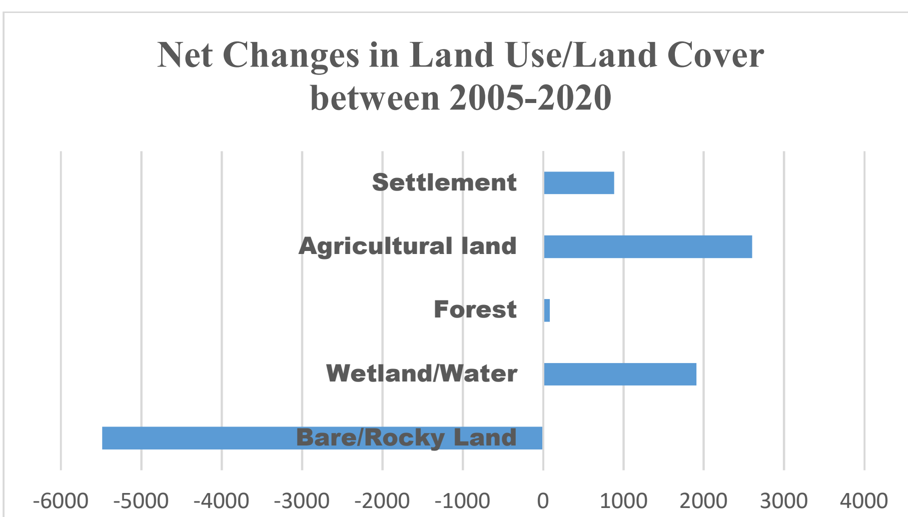

Figure 5.2 Net Change in Land Use /Land Cover between 2005-2020

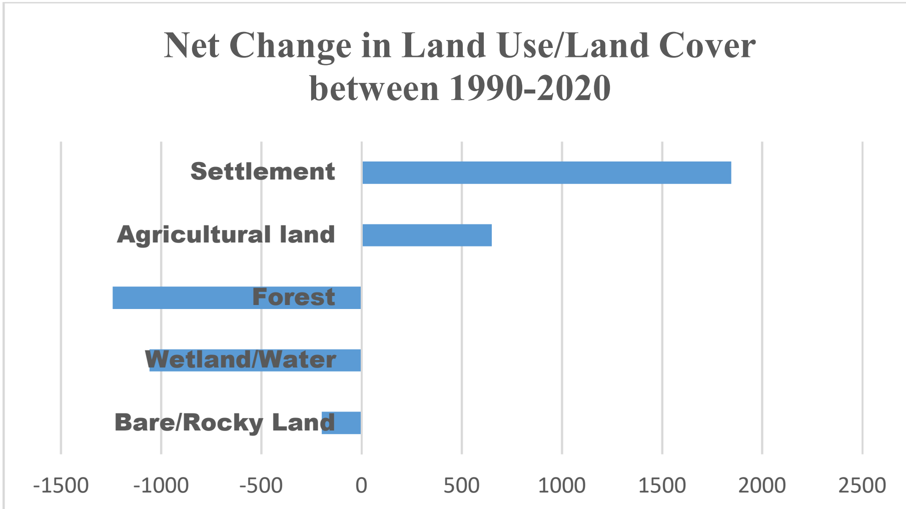

Figure 5.3: Net Change in Land Use /Land Cover between 1990-2020

Figure, 6.1.6.2 and 6.3.6.4 and 6.5 represent the map of changes in various land use/land cover categories, varying from settlement, bare/rocky land, Agricultural land, Forest and Wetland/Water body respectively, while red represent 1990 features, green represent 2005 features and blue represent 2020 features respectively.

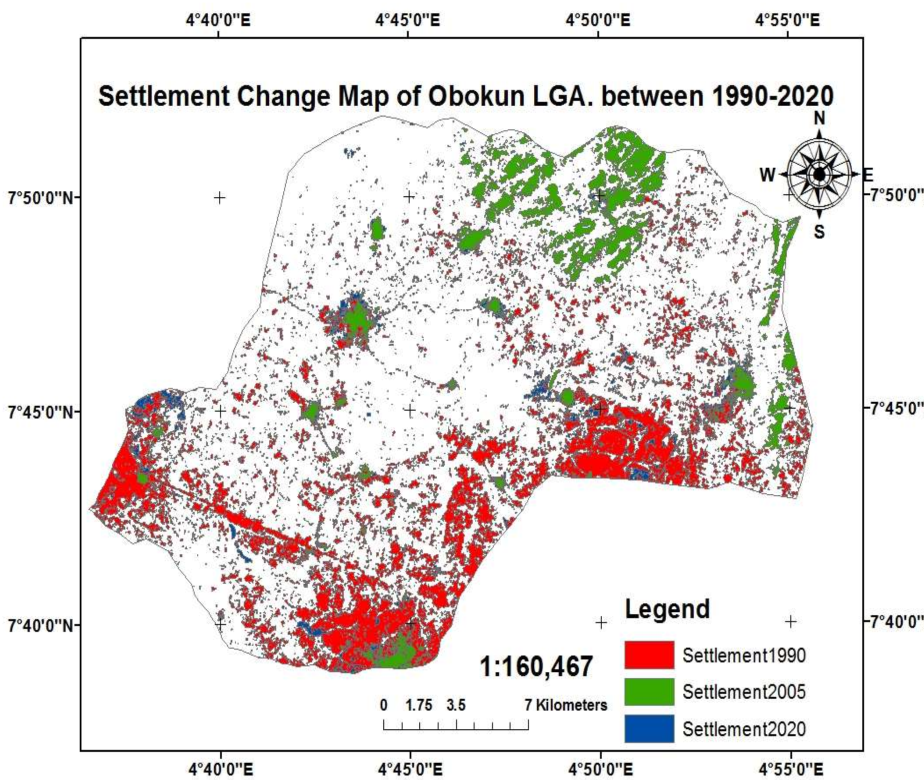

Figure 6.1: LULC Change map for settlement (1990-2020)

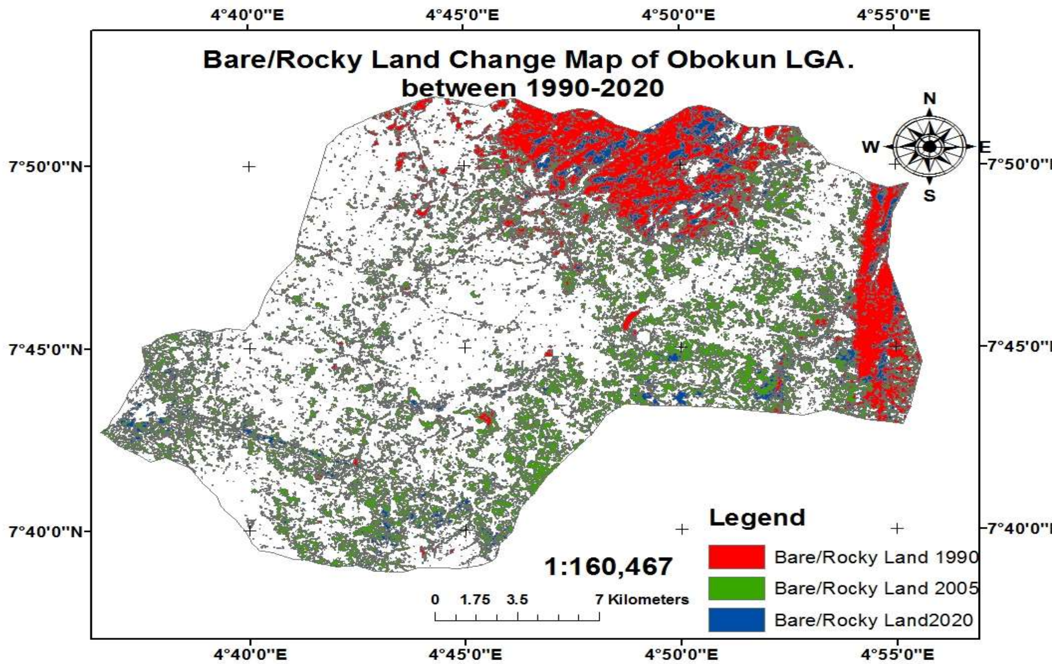

Figure 6.2: LULC Change map for Bare/Rocky Land (1990-2020)

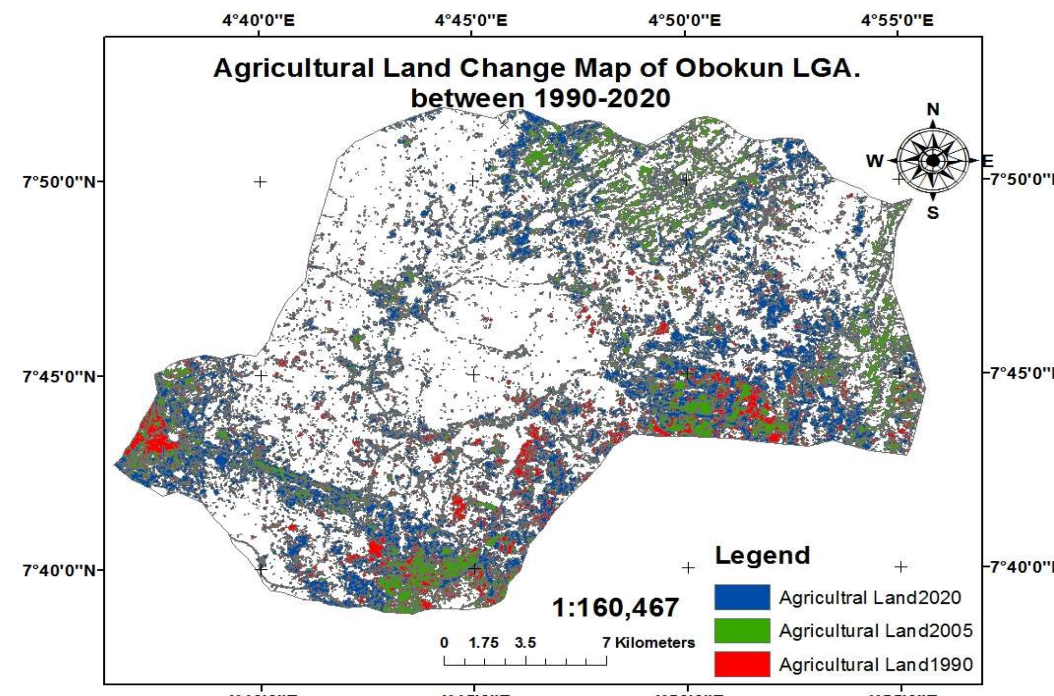

Figure 6.3: LULC Change map for Agricultural land(1990-2020)

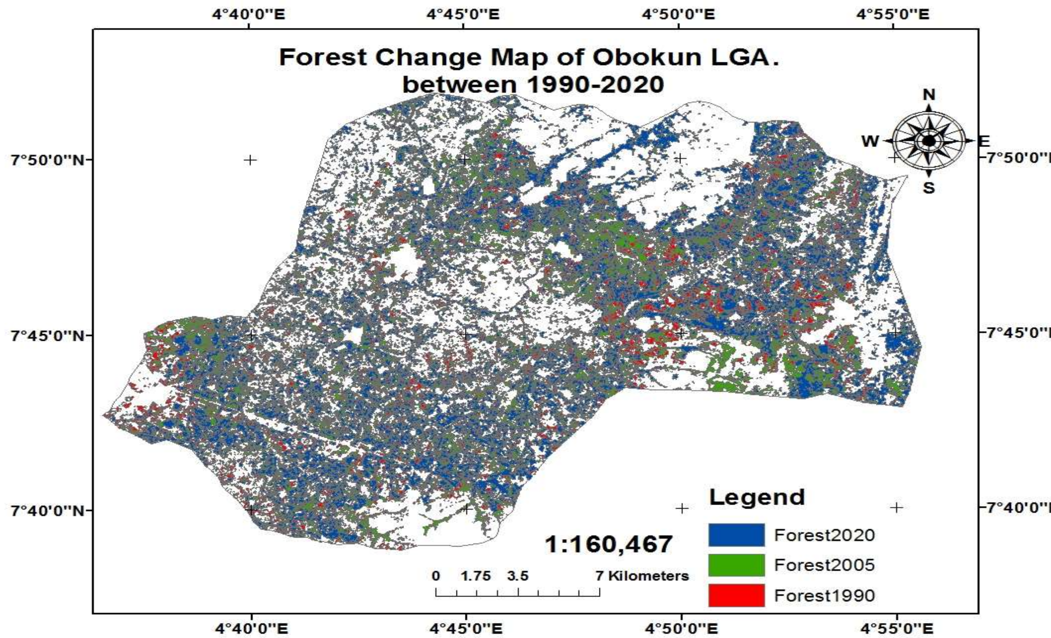

Figure 6.4: LULC Change map for Forest (1990-2020)

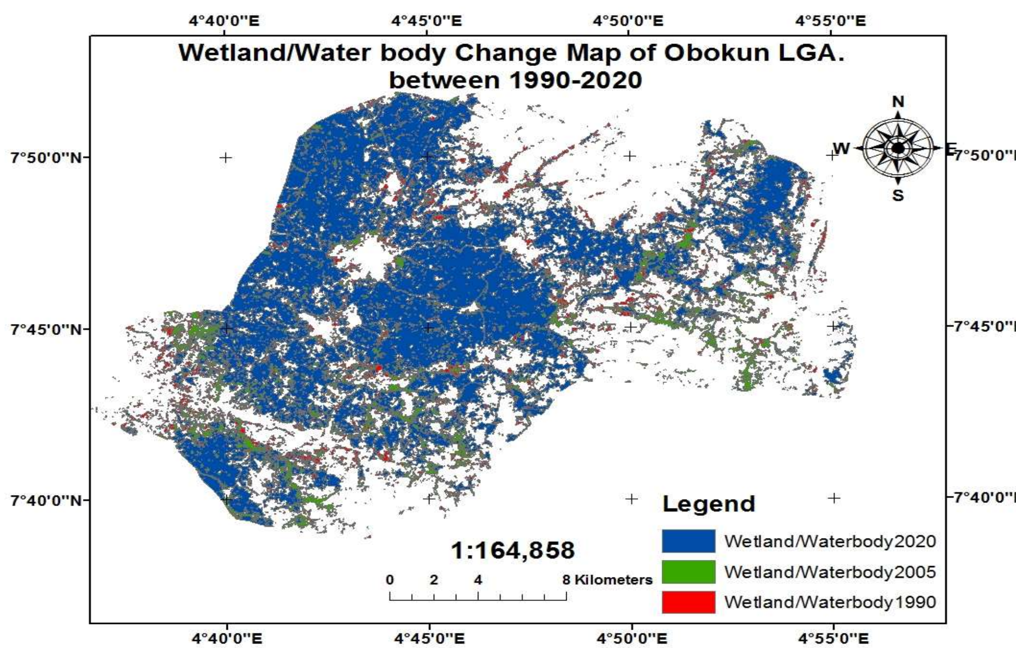

Figure 6.5: LULC Change map for Wetland/Water body (1990-2020)

The results were used to generate conclusions, recommendations and report was generated from the results.

5. CONCLUSION AND RECCOMENDATION

Understanding land use/ land cover changes is important in decision and policy making, the question of how much has been affected? How much or severe is the impact of geographic feature changes over time? And the question of what is the future implication of such uncontrolled occurrence? Can be well understood and answered in land use and land cover change analysis. The source of data must be a spatio-temporal source of data so that the effect of such changes can be monitored over time. This is the gap branched by remote sensing data, one of which is the Landsat imagery. This research work adopt data for the year 1990, 2005 and 2020 respectively. Geographic Information System (GIS) can thus be used as a tool and as a system to analyze, query, manipulate, update, store and visualize information about such geographic features. This is an important tools in change detection and prediction.

The research work discovered that settlement has been on a rapid development over the years with a net increase change of 68% over the 30 years of study. Forest cover is loosing at a rate of 8% for the period of 30 years, which is equivalent to 1241.91 hectares of forest land cover, this is a serious matter that calls for forest conservation and management practices. About 197.099 hectare of bareland has been lost to either settlement, or wetland encroaching, same is observed as 5% of wetland has also been lost, it is quite encouraging to have a 7% growth in agricultural lands. Based on this results, land use/land cover mapping is an effective tools for change detection and assessment. The following recommendations were thus made Government and other stakeholders should put necessary legal tools and education in place, towards checkmating the degradation effects which such anthropogenic activities could cause the natural environment.

Finding show the growing impact of urban agriculture on wetland ecosystem within the study area, manifesting in soil degradation and biodiversity loss. The implication of these findings is that the area is susceptible to devastating flooding which can culminate in the loss of lives and properties. This study recommends the development of effective land management information system and policies that will ensure sustainable management of fragile ecosystem.

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