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ECONOMIC IMPLICATIONS OF LAND USE CHANGE IN LAGOS STATE USING GIS-BASED DATA

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Abstract: **This paper focuses on land which is a crucial determinants of production and social progress. It has a significant influence on government policies relating to demographic patterns, spatial economy, transport network and commuting preferences. This study employed GIS and remote sensed data to detect land use change and how this change affects the economy of Ikeja local government of Lagos state. The study used three Landsat satellite imageries, which are Thematic Mapper for 1984, Enhanced Thematic Mapper for 2000, and Operational Land Imager for 2016 and 2021. This study revealed that between 1984 and 2000, there was 5.6% increase in the urbanization, while forest cover and wetland/scrubland reduced by 5.1% and 0.6% respectively, implying that urbanization due to 65.5% population increase have been the major factor responsible for reduction of green space within the period. A continuous trend was witnessed between 2000 and 2016 3.2% land developed, 2.5%, forest cover while 0.8% decrease in wetland/scrubland. The study further discovered between 2016 and 2021 that the earth terrestrial of the spatial resolution scene of Ikeja depicted urban settlement increment by 18.5% whilst retrospectively forest vegetation and wetland patterned the reduction trend with 14.9% and 3.5% decline respectively, spurred 17.1% increase in population, reflecting envisaged continued development increase in the study area at the parcel out of vegetation. This study shows that land use change will continue to affect the economy of Lagos if not properly monitored.**

Keywords: **GIS data, Land use change, Lagos state, Landsat, Urbanization.**

1. INTRODUCTION

Land, one of the key factors of production in the mainstream classical economics (along with labor and capital), is a crucial input for housing and food production. Land use change is an important concern for global environmental sustainability. It has significant influence on government policies relating to demographics patterns, spatial economy, transport network and commuting preferences. It has direct and indirect effects on the economy, environment and society at different spatial as well as temporal levels. Various studies have examined tradeoff between alternative land use decisions. Some used variants of agricultural or environmental resource model (Marshall *et al*., 2017; Liu, 2018 and Briassoulis, 2020)

Government at various level are struggling to deal with the rate of urban development and the high demand for land. In all urban communities, the demand for land is far ahead of it supply which is limited. Lagos is one of such cities with stress on land facilities, with the land area of about1,171 square kilometers, with population estimate of about 21 million people and with 6,871 population density. By 2050, it is expected that the population of Lagos doubles which potentially makes it the third largest city in the world (Shittu and Adeosun, 2020).

In order to analyse economic implications of land use dynamics, it is necessary to first characterize the land use pattern using geospatial tool such as Geographic Information System (GIS). Ikeja is in the mainland area of Lagos, located between longitude of $2^0 42'$ E and $3^0 42'$ E, and latitude of $6^0 22'$ N and $6^0 52$. It became Lagos state capital in the year 1796, at the Western region, Ikeja local government shares land boundary with Alimosho, Agege and Ifako-Ijaye local government areas while in the Eastern region with Kosofe local government area, to the South, Oshodi/Isolo and Mushin local government areas while it shares boundary with Ogun state to the North (Olayiwola, Olaseni and Fashina, 2014; Rahman *et al*., 2017)

Ikeja is one of the economic hubs of Lagos and indeed the southwestern Nigeria. It has overtime enjoyed accelerated growth. Ikeja host Nigeria busiest International Airports. It is also blessed with serval heavy industrial establishment, making the area a manufacturing hub. Furthermore, Ikeja Computer Village has served as the gateway to technological (both software and hardware) import to the country as a whole. Among the heavy industries in the area include 7-up, Eleganza and Coca-cola at Oregun; Vita foam, Guinness brewery, Nigerite, Tower aluminum and building products, and Berger paint at Oba Akran Avenue (Oduwaye and Enisan, 2011; Akpomrere and Nyorere, 2012). In term of health services, Ikeja also host the state hospital, the Lagos State Teaching Hospital making it a foremost destination in search of quality healthcare services. The presence of these industries and amenities makes Ikeja important economically to the state, therefore the need to have a proper land use system in place.

The study area is made up of the sedimentary formation similar to Ewekoro/Ilaro rock formation (i.e. cemented sandstone) coupled with elements of coastal plain (and especially in the South Eastern part of the region of Ogun state). The sedimentary geologic formation encourages well water around the study area, since large quantity of water is allowed to percolate great depths. Ikeja is majorly drained by river Ogun, which rises in the Iganran Hills (EL. 503 m) east of Saki, flows southwards for a distance of 410 km and empties into the Lagos Lagoon. Oyan river is the main tributary to river Ogun which has Ofiki and Opeki rivers as major tributaries (Olayungbo, 2021; Ikudayisi, and Taiwo, 2021)

The study area is under humid tropical climate while the mean annual presipitation in the region ranges from 500mm to 2000mm. Rain falls for about eight months of the year in the area. The hydrological regime is influenced by the dry and wet seasons. Overall, the average annual rainfall is about 1,970mm. The study area is located in the high agricultural soils formed from materials weathered out of quartzite and sandstone formations of ridges (Afolabi, Oluwaji, and Fashola, 2017). The soil generally carries low rainforest which in some places have been cropped continuously leaving only secondary rainforest types. The alluvial plain soil is used for intensive agriculture based mainly on market gardening, horticulture, and poultry keeping aimed at the expanding urban markets of the study area. The major crop grown on the alluvial plain soil is the rain feed rice (Famuyiwa, Lanre-Iyanda, and Osifeso, 2018).

The study area is totally located in swamp forest of the dry lowland rain forest zone. Both climatic and soil condition adequately support luxurious evergreen forest that dominate the region as shown in Figure 1 (See Appendix). Based on this backdrop the study seeks to employ GIS and remote sensed data to detect land use change before using it to understand related economic situation in Ikeja Local Government area of Lagos State. The article thus proceeds as follows: section two presents a brief literature review, section three describe the materials and method of analysis, section four contains discussion of findings while section five is the conclusion.

2. LITERATURE REVIEW

Remote Sensing (RS) and Geographic Information System (GIS) are contemporary methods for collecting data for ecosystem management (Wilkie and Finn, 2006; Islam, and Sarker 2016; Buba *et al*., 2021). Conventional ground methods of land use mapping have become outdated and impracticable in many instances (Sikakwe *et al*., 2015). The major useful classification system to extract relevant data from remote sensing device is by Anderson *et al* (1972). Most of the alternative classification systems are its variants. The first remote sensing satellite, Landsat-1, was launched in 1972. Remote sensing data gathering is repeated over time in order to identify the changes (Xiaomei and Rong, 1999;

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Usman, Abdullahi, and Opara, 2020). According to Moshen (1999) the changes might have more negative impact than positive on the economy of the area. Arvind, Pandy and Nathawat (2006) analysed land use pattern in three districts of Hangana State, India and concluded that the land use dynamics in the area was mainly controlled by agro climatic conditions and ground water potential.

Research focusing on the comparative performance of land use dynamics detection methods has identified comparative analysis of independently produced classifications and simultaneous analysis of multi-temporal data as the two leading approaches (Lu *et al*., 2004; Oumer, 2009; Jones *et al*., 2017). The second method has lower errors as it uses advanced methods like change vector analysis and principal component analysis (EPA, 1999; Atkinson *et al*., 2008; Manandhar, 2010).

Adeniran, Otokiti and Durojaye (2020) while examining the effect of climatic changes to ever-increasing urban areas siting Ikeja Lagos as case study concluded that population growth in the region had adverse effect on climatic condition in the region. Through the use of GIS, the study also established that built up area in Ikeja local government have gone up from 10.75% of the total coverage of the local government in 1980 to 92.11% in 2019. Leading to more human activities, and the adverse effect increasing population brings such as traffic congestion.

Babalola and Akinsanola (2016). Set to explore the changes on land surface temperature and land use land cover over Lagos Metropolis, using five local government of Alimosho, Agege, Ifako Ijaye, Ikeja and Oshodi/Isolo. The study found that in these areas, land cover has witness rapid decline over the last 30years from 70.04% to 10.13% resulting in differences in the Microclimate and the Urban Heat Island intensity of the areas. Figure 2, 3 and 4 in the Appendix show the land use in proportion to vegetation on period of time and how much settlement and urbanization have displaced the green vegetation of the region over time.

3. MATERIALS AND METHOD

The Landsat data used for this study were acquired from the global land-cover website at the University of Maryland, USA (URL; http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp). The images used are: The Thematic Mapper (TM) image acquired on 18th December 1984; the Enhance TM image of 6th February 2000; and the Operational Land Imager (OLI) of 5th of February 2016 and 12th May 2021. All the images were pre-processed at https://www.usgs.gov/ in order to rectify any geometric or radiometric distortions. The satellite imageries were subjected to radiometric and geometric correction. A supervised classification was performed by creating a training sample to identify settlement, vegetation; cultivation and water body for years 1984; 2000, 2016 and 2021 respectively. Ground trothing was done to ensure robustness of the resulting classification. Economic data relating to population, total revenue receipt and total staff post for Ikeja local government were obtained from the local government statistics extract.

The areas of the different categories of classified land use were calculated using the Calculate Geometry Tool of Arcmap 10.4.1 The statistical tools that were used to analyse the data collected, include descriptive statistical tool, involving the simple percentages. Descriptive statistical method of analysis was adopted because its ability to concisely present results for evaluation. The analysis of data was aided with the use of the computer software, Microsoft Excel sheet.

4. RESULTS DISCUSSION

4.1 Land use types in the study area

Table 1 shows the land use types in the study area over time. The table shows that the land use types that could be identified in the area were developed area, forest, and wetland/scrubland. In 1984, the developed area covered an area of 28.6 square kilometers (57.2%), Forest covered an area of 15.5 square kilometers (31.02%), while wetland/scrubland covered an area of 5.9 square kilometers (11.78%). This shows that developed area covered a larger part of the area in 1984. Population in the study area accounted for 3.32% of the state demography. Total revenue receipt and total staff by post indices accounted for 5.9% and 14.1% respectively.

In 2000, developed area covered an area of 31.4 square kilometers (62.82%), Forest covered an area of 13.0 square kilometers (25.97%), while wetland/scrubland covered an area of 5.6 square kilometers (11.29%). This shows that developed area covered a larger part of the area in 2000. Population in the study accounted for 3.53% of the state demography. Total revenue receipt and total staff by post indices accounted for 1.74% and 14.14% respectively.

In 2016, developed area covered an area of 33.0 square kilometers (66.09%), forest covered an area of 11.7 square kilometers (23.52%), while wetland/scrubland covered an area of 5.2 square kilometers (10.39%). This shows that developed area covered a larger part of the area in 2016. Population in the study area accounted for 3.70% of the state demography. Total revenue receipt and total staff by post indices accounted for 0.1% and 2.51% respectively.

Table 1: Land Use Types in the Study Area in 1984-2021

	1984	2000	2016	2021
Developed Area	28.6 **km²** (57.2%)	31.4 **km²** (82.8%)	33.0 **km²** (66.1%)	42.2 **km²** (84.6%)
Forest	15.5 **km²** (31.0%)	13.0 **km²** (26.0%)	11.7 **km²** (23.5%)	4.3 **km²** (8.5%)
Wetland/Scrubland	5.9 **km²** (11.8%)	5.6 **km²** (11.2%)	5.2 **km²** (10.4%)	3.4 **km²** (4.9%)
Population	324,417	537,006	888,903	1,040,526
Total Revenue (₦'million)	1.81	35.52	698.73	9,615.81
Total Staff Post	1,017	1,607	2,524	2,910

Source: Authors' Computation (2022)

By 2021, developed area covered an area of 42.22 square kilometers (84.61%), forest covered an area of 4.26 Square kilometers (8.54%), while wetland/scrubland covered an area of 3.42 Square kilometers (4.85%). This shows that developed area covered a larger part of the area in 2021. Population in the study accounted for 3.75% of the state demography. Total revenue receipt and total staff by post indices accounted for 3.04% and 2.51% respectively

4.2 Changes in land use types over time

The results indicate that between 1984 and 2000, the area covered by urban development, which was about 28.6 Square kilometers in 1984 had increased to 31.4 square kilometers in 2000 with a percentage increase of 5.6%. Forest , which covered about 15.5 square kilometers of the area in 1984 had decreased to 13.0 square kilometers in 2000 with a percentage decrease of 5.1%. Wetland/scrubland which was about 5.9 square kilometers in 1984 had reduced to 5.6 square kilometers in 2000 with a percentage decrease of 0.6%. The economic implication however, reflected from 0.21% increase in population share of the state whilst revenue receipts and total staff share changed by -4.16% (In absolute terms the total revenue increase substantially) and +0.04% respectively. In addition, it could be observed that as the developed area increased, vegetation and wetland/scrubland which constituted green space significantly decreased.

These changes could have been as a result of urbanization, which has both direct and indirect impacts on land use transformation and industrialization vis-à-vis residential development. This is in line with the results obtained by Ejaro *et al* (2013). From the foregoing, economic transformation has spurred increase in internally generated revenue, tax, rates etc. Furthermore, it can be concluded from the rate of change that since the rate of increase in developed area of 0.33 % Y_{-1} (where Y is the years) is approximately equal to the rate of decrease in forest and wetland/scrubland, urbanization has played a major role in the land use dynamics of the study area. This has a direct correlation with the rate of change in the economic indices.

Considering the land use change between 2000 and 2016, the results show that the area covered by urban development, which was about 31.4 square kilometers in 2000 had increased to 33.0 square kilometers in 2016 with a percentage increase of 3.2%. Forest, which covered about 13.0 square kilometers of the area in 2000 had decreased to 11.7 square kilometers in 2016 with a percentage decrease of 2.5%. Furthermore, the results also show that wetland/scrubland which was about 5.6 square kilometers in 2000 had reduced to 5.2 square kilometers in 2016 with a percentage decrease of 0.8%. It can be observed that as developed area increased, other land use types decreased in the area. The reduction of wetland and scrublands in the study period goes in line with the conclusion of Ajibola *et al*. (2012) that wetland losses are a direct result of economic activities engaged in by man. The economic indices portray 0.17% increase in population in relation to the entire state. Total revenue and total staff employment share of the state decrease by -1.64% and -11.63 respectively.

This consequent from the large increase in coffers, because in absolute terms revenue and staff by post increase from 35.5m and 1607 respectively to 698.7m and 2504 respectively. This therefore has a direct correlation with the rate of change in the economic indices vis-à-vis the geo remote sensing data.

Land use changes between 2016 and 2021 is such that the area covered by urban development, which was about 33 square kilometers in 2016 had increased to 42.22 square kilometers in 2016 with a percentage increase of 18.51%. The results also show that forest, which covered about 11.7 square kilometers of the area in 2016, had decreased to 4.26

square kilometers in 2021 with a percentage decrease of 14.96%. Wetland/scrubland which was about 5.2 square kilometers in 2016 had reduced to 3.42 square kilometers in 2021 with a percentage decrease of 3.35%. It can be observed that as developed area increased, other land use types decreased in the area. The reduction of wetland and scrublands in the study period goes in line with the conclusion of Lin and Ho (2005). The population share increased by 0.05% from 2016 to 2021 in relation to the state.

The revenue share had gone up by 3.84%, whilst staff employment contributes nothing to the state, but in absolute values increase from 2524 to 2910 between 2016 and 2021. The rate of change portrayed that the combine reductions in forest vegetation and wetland/scrubland concertedly translated into the increase in urban settlement.

4.3 Discussion of the results

The result of the study shows that wetland/scrubland that could have been used for agricultural development is constantly on the decrease, while urbanization increases. The identified classification of land cover and its economic effects in Ikeja Local Government Area showed significant variation during the three periods, 1984 to 2000, 2000 to 2016 and 2016 to 2021. The spatio-temporal analysis of the area revealed that there was an observable increase in development in the study area, which denotes persistent urbanization which could have resulted from increase in population from migration, hence its impact on the economics of the study area. This is in agreement with the findings of Kahsay (2004). Another factor which could have been responsible for the increase in settlement in the study period was competing land uses from human alterations. This is in agreement with Ishaya and Ifatimehin (2009).

The comparison of land use categories in the study area also suggests that loss of vegetation. This is in agreement with Marland *et al*. (2003). Environmental degradation as a result of land use change has negative impact on the economy of the study area (Musa, 2010). In line with Ogboru and Anga (2015), the mismanagement of the environment due to land use change has negative impact on the economic development of Ikeja.

5. CONCLUSION

This study explored the land use change of Ikeja Local Government area of Lagos State in relation to recognizing related economic situation in Ikeja. The rate of urbanization is on the continuous increase in the area; however, this has not been matched with the investment, infrastructure and services need to allow the area flourish tremendously. Land use planning which is a schematic approach of achieving orderly use of land, was found to take the limelight among other land use categories of the study area between 1984 and 2021. In practice, this have been confirmed to have various environmental consequences in terms of air pollution, water pollution, traffic congestion, urban runoff and flooding to mention few, which in turn has high impact on the economic status of the study area. Furthermore, land use change will continue to have effect on the ecological and environmental condition of Ikeja, if it is not properly monitored.

Consequently, the study recommends that there is urgent need for stakeholders such as environmentalist, planners and engineers to see to achieving the sustainable development goals as urbanization continues to increase in the study area and its attendant economic effects as exemplified in the area. Due to the large population associated with the area as more lands are used, modern innovative solutions to traffic congestion, flooding, environmental pollutions should be adopted to improve the economic returns on land use in the area.

This study is limited in scope to the central business district are area of Ikeja Lagos and considered the land use for economic activities overtime. Further study can investigate how land had been put to use in other business and industrial area such as the Apapa area of the state, focusing on the environmental effects of land use and economic activities in the area.

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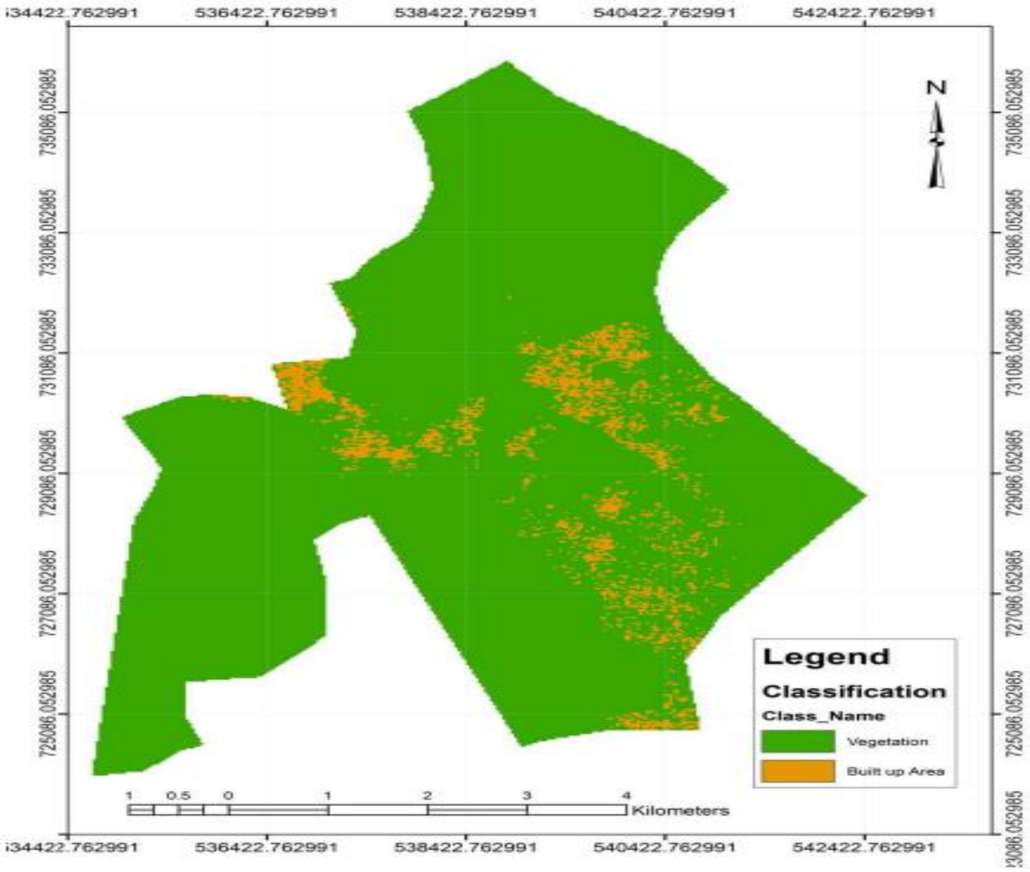
APPENDIX - A

Figure 1: Map showing Ikeja Local Government.

Source: Google.

Figure 2. Map showing Image classification for 1980



Adapted from Adeniran et al 2020

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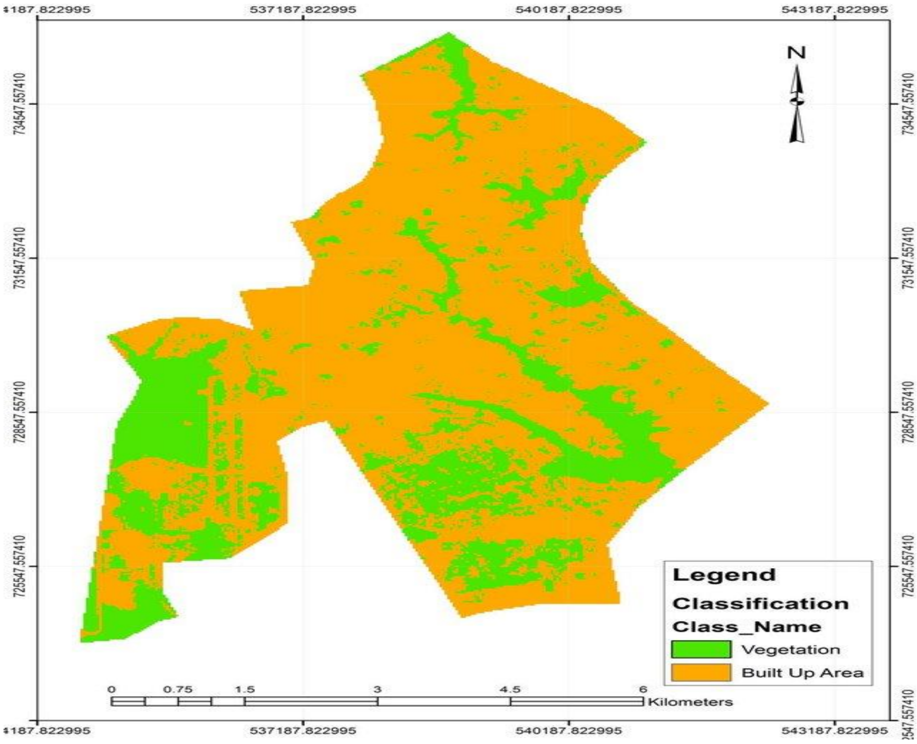
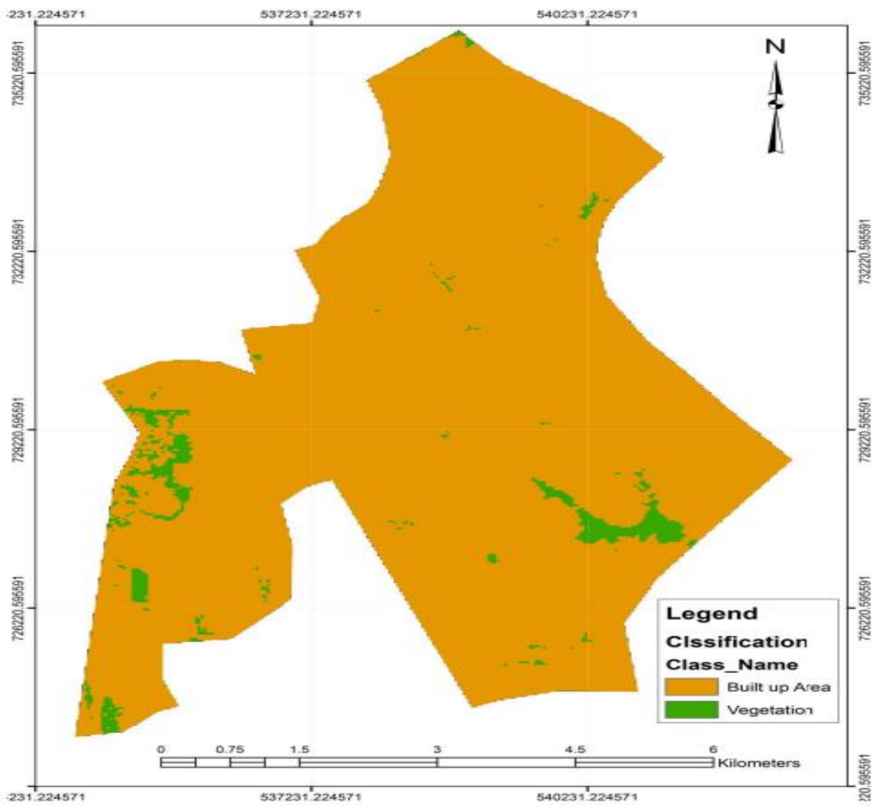
Figure 3. Map showing Image classification for 2000.



Adapted from Adeniran et al 2020

Figure 4. Map showing Image classification for 2019



Adapted from Adeniran et al 2020