

Peri-urban Development and Food Crop Loss in Ibadan, Nigeria (1986-2019)

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Abstract

This paper quantifies the loss in agricultural land with regard to cassava and maize production in peri-urban Ibadan from 1986 to 2019. Landsat images of four local government areas – Akinyele, Ido, Egbeda, and Oluyole – from 1986 to 2019 were used, while crop loss per hectare was calculated based on the average tons produced in Nigeria. The agricultural land loss occasioned by peri-urban development was 36,238.15ha, 59,930.23ha, 13,353.035ha, and 33,638.23ha in Akinyele, Ido, Egbeda, and Oluyole LGAs respectively. Consequently, between 1986 and 2019, 3,418.69 tons of cassava and 22,648.84 tons of maize were lost in Akinyele, 5,653.80 tons of cassava and 37,456.39 tons of maize in Ido, 1,259.72 tons of cassava and 8,345.65 tons of maize in Egbeda, and 3,173.42 tons of cassava and 21,023.89 tons of maize in Oluyole LGAs. To curb further decrease in crop production, investment in spatial vertical development is imperative.

Keywords: Peri-urban development, food crop loss, Ibadan

Introduction

Uncontrolled urban development decreases agricultural land and poses a great threat to urban food security. This is evident in the intractable urban spatial and demographic growth which is leading to increasing demand for food, housing, and transportation routes (Adelekan et al., 2014). In Nigeria, urban sprawl is conspicuously encroaching on most agricultural land in and around urban centres (Lynch, Bins & Olofin, 2001; Brinkmann et al., 2012). The consequences of urban expansion into

surrounding agricultural land will not only lead to disengagement of farmers, loss of livelihood and bio-diversity but will also aggravate food security challenges. Diminishing agricultural land is common globally. In Trnava city, Slovakia, agricultural land reduced from 90.1% in 1838 to 70.4% in 2015 within a total land area of 7153.2 ha (Adelekan et al., 2014). Similarly, the total agricultural land area that diminished in Bengaluru city, China from 2007 to 2014 was 610.64 sq. km, amounting to about 16.31% of the total land area of 3743 sq. km (Adelekan et al., 2014). Agricultural land loss is also being experienced in African countries such as Ethiopia, Kenya, Malawi, Uganda, Rwanda (Simon, McGregor & Thompson, 2006), and Nigeria inclusive (Kumuyi, 1999).

In Nigeria, peri-urban development in Osogbo reduced agricultural land from 14799.24 ha to 9277.71 ha (62.7%) in 1986, and further to 7995.33 ha (54.0%) in 2014 (Adelekan et al., 2014). One of the enablers of agricultural land loss in the peri-urban area of Ibadan is the increasing demand for housing and subsequent movement of residents and activities from the inner-city to the sub-urban areas (Areola, 1994; Fourchard, 2003). Before 1970, Ibadan city was surrounded by rural areas with insignificant peri-urban development. However, since the oil boom of the 1970s, Ibadan has grown progressively both in population and physical size (Abumere and Oluwasola, 2001). The national economic development that was influenced by the oil boom as well as transport development and the establishment of several educational and research institutions in the city significantly engendered the urban development process (FAO, 2012).

Similarly, migration into the city of Ibadan by traders in the 1950s and 1960s was facilitated by the trade routes from the South that linked Ijebu, Abeokuta and Lagos to Ibadan city; Ogbomosho-Ilorin routes to the North; and Ife-Akure to the East. Consequently, Ibadan grew and established itself as a large commercial centre in the entire Western Region of Nigeria (Olajide-Taiwo et al., 2010). The construction of motor ways greatly influenced urban development in the city. For instance, the greatest urban sprawl in the eastern and northern parts of the city was influenced by the construction of the Ibadan-Lagos expressway in the 1980s. Also, the western part of Ibadan witnessed significant expansion as a result of the construction of the Eleyele expressway, which has further spread to both Akinyele and Egbeda LGAs (Wahab, Popoola & Magidimisha, 2018). The dearth of a development plan for the city as at

December 2018 coupled with inadequate housing provision is responsible for the irregular urban development into agricultural land (Adelekan et al., 2014). Although urban sprawl is a common phenomenon in cities in developing countries (Jaiyebo, 2003), the case of Ibadan is unique owing to the geometric growth rate with no discernible pattern of development into suburban areas (Abumere and Oluwasola, 2001).

Until 1970, Ibadan was the largest city in sub-Saharan Africa. According to the United Nations World Population Prospects (2021), the population of Ibadan was 980,000 in 1975 with a 3.92% annual growth rate. By 2006, it had risen to 2,567,000 but with an annual growth of 2.31%. The projection for 2021 is 3,649,000. According to the land cover maps, the city's built-up area increased from 84 sq km in 1975 to 528 sq km in 2013 (Cotillon, 2017). New development occurred particularly along the major road axes, such as the Ibadan-Lagos expressway to the south of the city and the Eleyele expressway to the northwest (Fourchard, 2003). By 2013, the cities of Moniya and Agudu were already parts of the Ibadan metropolis. If the present rate of expansion continues, surrounding towns such as Idi Ayunre (to the south), Ikire (to the east), Fiditi (to the north), and Ilugun (to the west) will be linked to the built-up areas of the sprawling metropolis (Fourchard, 2003). The rapid sprawl has eaten into forested areas, savanna, farmland, fallow lands, and river floodplains. Forests and wetlands have been degraded. In the Eleyele wetland – a modified natural riverine wetland in the northwest quarter of Ibadan – an estimated 66 percent of the wetland riparian forests were lost between 1984 and 2014 due to spatial urban expansion (Famuyide et al., 2018).

Residents of peri-urban communities in Ibadan engage majorly in subsistence farming practices and cultivate maize, cassava, plantain, sweet potatoes, vegetables and yams. While root crops such as cassava, sweet potatoes, and cocoyam are largely produced in Akinyele and Ido LGAs, maize production is common in Oluyole and Ona-Ara LGAs (Osalusi et al., 2019). In Nigeria, close to 84% of the domestic cassava produced is consumed locally and only the remaining 16% is available for industrial production (Nwokoro, Orheruata, Ordiah, 2002; Kormawa and Akoroda, 2003). According to the International Institute of Tropical Agriculture (nd.), maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. More than 300 million Africans depend on maize as their main staple food crop. Maize accounts for 30–50% of low-income

household expenditure in Africa. Over 30% of the caloric intake of people in sub-Saharan Africa comes from maize. Maize is also consumed as a vegetable and it is rich in dietary fiber and other nutrients. Many studies have confirmed the intractable spatial growth of Ibadan City and established the implications on housing (Mabogunje, 1962; Abdulrahman, 2018), municipal solid waste management (Olaseha, Sridhar and Oyewo, 2005; Ogwueleka, 2009), transportation (Adeniji, 1983), food security (Szabo, 2016; Obayelu, and Oyekola, 2018), crime (Afon and Badiora, 2018), disasters (Adelekan, 2020), and infrastructural development (Mabogunje, 2006). This study therefore quantifies the affected agricultural land and the consequent food crop losses with emphasis on cassava and maize production in Peri-urban Ibadan from 1986 to 2019.

Food crop loss: Implications for food insecurity

The concept of crop loss is currently rooted in production and supply chain upheavals. Globally, it is attracting more attention owing to its negative impact on developmental efforts. It is considered as the average losses caused by diseases, insects and weeds during the processes of production, storage, and transportation (Pimentel et al., 1991). In conceptualizing crop loss, some of the associated concepts employed in measuring crop loss and their clarifications as presented in Figure 1 according to Forrest, Paul and Matthew, (1993) include, "maximum attainable yield". This is the theoretical yield that could be achieved if the crop is grown under optimum environmental conditions along with the use of all available crop protection tactics to also alleviate the effects of biotic pests. Genetic yield potential – not biotic pests or environment – is the primary factor that limits the maximum attainable yield. "Attainable yield" is the yield obtained at a specific location when all available crop protection tactics are used to alleviate the stresses caused by biotic pests. Thus, attainable yield is site-specific and it is the yield obtained when biotic pests are alleviated but environmental (abiotic) factors such as soil fertility, water availability, temperature among others, may still be limiting yield.

In contrast, "economic yield" is the achievable yield that provides the highest net return on expenditure while "actual yield" is the production level achieved when producers utilize pest management programmes currently recommended for a crop or cropping system; yet several factors such as environment, weeds, diseases and insects are still

limiting yield. The difference between actual and attainable yield is the method used by the Food and Agriculture Organization (FAO) to report crop losses (Chiarappa, 1981). "Primitive yield" is the yield achieved when no disease or pest control measures are utilized. The difference between primitive yield and actual yield represents improvements in crop protection presently achieved by the deployment of accepted pest management practices. Thus, "crop loss" is a function of one or more biotic factors, each of which may be contributing to a reduction in yield (Forrest, Paul and Matthew, (1993).

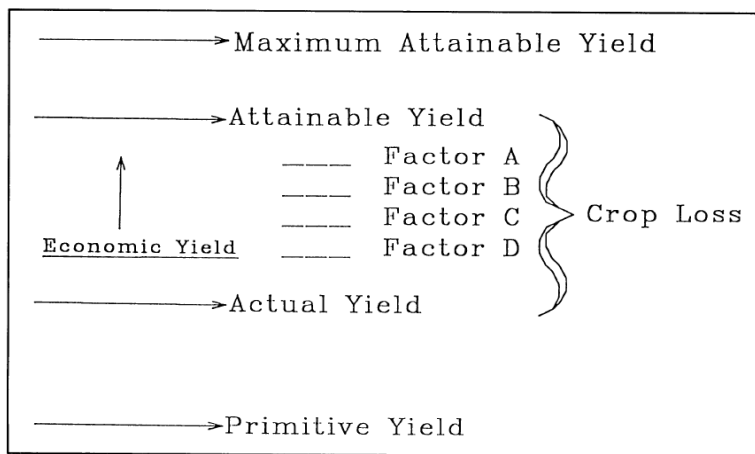


Figure 1: Reference points for crop loss assessment.

Source: Forrest, Paul and Matthew, 1993.

However, in this study, crop loss is considered as the non-production of food crops occasioned by the conversion of agricultural land to other uses for urban development. Development in peri-urban areas of Ibadan have disturbed food crop production, thereby contributing to soaring prices of food crops and in turn engendering food insecurity, particularly among the poor (Obayelu and Oyekola, 2018). Food insecurity is the lack of access to enough food and can be either chronic or temporary. In chronic food insecurity, which arises from lack of resources to produce or acquire food, the diet is persistently inadequate (Adeoti, 1989: 117).

A country is food-secure when the majority of its population has access to food in adequate quantity and quality, consistent with decent existence at all times (Reutlinger, 1985:7; Idachaba, 2004:2). What is

implied in this definition is that food must be available to the people to an extent that it will meet some acceptable level of nutritional standards in terms of calorie, protein and minerals supplement which the body needs and the possession of the means by which the people acquire i.e., have access to it in reasonable continuity and consistency in its supply (Davies, 2009:4). In other words, food security can be taken to mean access by all people at all times to sufficient food for an active, healthy life (Reutlinger, 1985). Its central elements are: (a) the availability of food; and (b) the possession of the ability for its acquisition (Adeoti, 1989:117).

Location and Methods

Location

Ibadan, capital city of Oyo State, Nigeria, located on seven hills on an average elevation of 700 feet (200 metres) is about 100 miles (160 km) from the Atlantic coast. It is one of the most populous cities in Nigeria. It is geographically situated within latitude 7.37756 and longitude 3.90591 (Figure 2). The city has 11 local government areas (LGAs) out of which six, namely Akinyele, Ido, Egbeda, Oluyole, Ona-Ara, and Lagelu are rural areas (Figure 2). The other five, namely Ibadan North, Ibadan North-East, Ibadan South-East, Ibadan North-West, Ibadan South-West, are core urban LGAs. Akinyele LGA is within latitude 7.7°N and longitude 3.8°E of the equator. It occupies a land area of about 464.892 sq.km (Ogunwale et al., 2020). Ido LGA is located between latitudes 7°45'N, 7°15'N and longitudes 3°30'E, 3°50'E. The total land area of Ido LGA is about 986 sq.km. It has a population of about 272,000 people (Ogunwale et al., 2020). Egbeda LGA covers a land area of 191 sq.km. and is situated between latitudes 7°21'N, 8°00'N and longitude 4°02'E and 4°28'E; it has a population of about 281,573 people (Abegunde, Adedeji and Tope-Ajayi, 2015). Oluyole LGA occupies an area of 629 sq.km., has a population of 202,725 and is situated approximately within longitude 3°42' to 4°3' East of the Greenwich Meridian, and latitude 7°3' to 7°21' North of the Equator (Ogedengbe and Akinbile, 2011). The LGA has the largest number of registered exotic farmers in Oyo State. Generally, the rainforest traits of annual rainfall of between 1800mm and 2870mm, temperature range of 25°C to 35°C, and soil characteristics that favour the cultivation of cassava, maize, yam, oil palm, cocoa and fruits such as orange, mango, banana, pineapple, and tomatoes (Figure 2), make Oluyole LGA one of the food crop hubs in Oyo State, Nigeria.

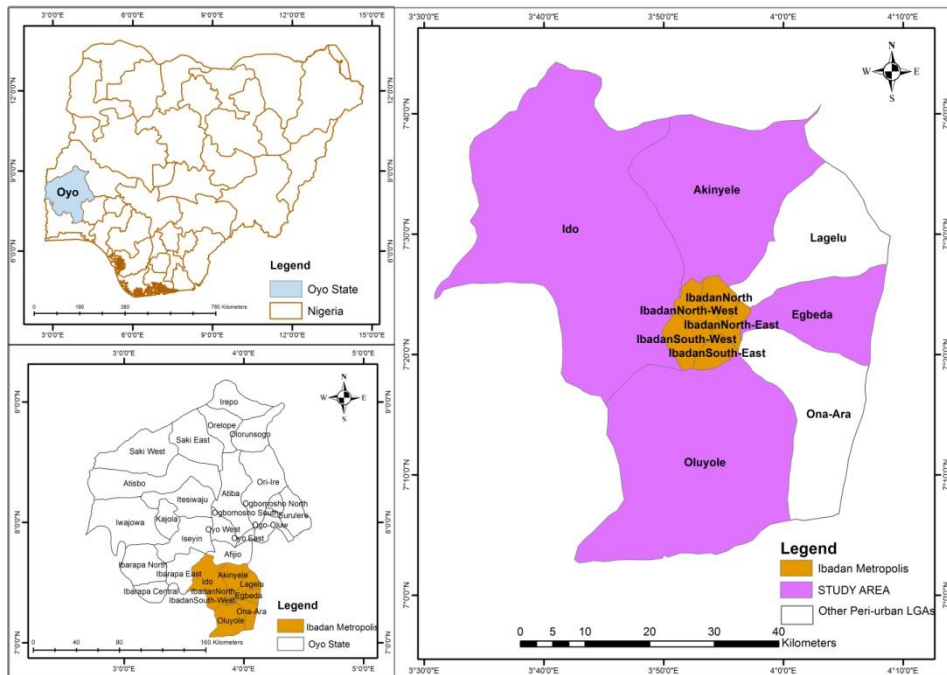


Figure 2: Study area in national and local settings.

Source: Department of Urban and Regional Planning, University of Ibadan, 2019.

Methods

For apt representation of the four geographic cardinal angles of Ibadan city, four out of the six peri-urban LGAs were selected for this study, namely Akinyele, Ido, Egbeda, and Oluyole (Figure 2). Geographic Information Systems (GIS) and Remote Sensing (RS) techniques were employed to process Landsat satellite imagery of the four LGAs for the year 1986 and 2019. The imageries were downloaded from the website of the United States Geological Survey (<https://earthexplorer.usgs.gov>) on 13/02/2020. Both sensors have spatial resolution of 30m. However, the Landsat imagery acquired for the year 2019 was Pansharpened by Landsat8 band 8 that has 15m resolution for better visualization. ArcMap 10.3 software was used to analyse the satellite imagery. The imageries were classified into land cover classes. Six land-use/land-cover (LULC) classes were identified namely; Rock/Bare soil, Forest, Open Space, Built Up, Grassland and Water Body. Ground-truthing was subsequently conducted on the produced LULC maps for confirmation of outputs. After completing the land cover classification, the area of each class was

determined and converted to square kilometres and percentages. Based on the classification, the red colour depicts the built-up areas, dark blue for water body, dark green for forest, light green signifies grassland, brown for rock/bare soil and yellow for open space. LULC change was carried out over the 33-year period of study to determine the change in extent of the identified LULC classes.

The quantities of cassava and maize crop losses per hectare were calculated based on the average tons per hectare produced in Nigeria over the years. According to the Agricultural Research Council of Nigeria (2020), cassava production in Nigeria is, on the average, 10.6 tons per hectare, while that of maize is 1.6 tons. Forests, grassland and water bodies LULC that are amenable to food crop farming obtained from LULC change analysis in square kilometres were summed and converted to hectares to obtain food crop loss between 1986 and 2019.

Results and Discussion

Landuse Landcover Change in Akinyele LGA (1986-2019)

Spatial development in Akinyele LGA as at 1986 revealed that forested areas covered 382.04 sq.km which is 79.9% of the entire LGA (Table 1). Grassland covering 28.2068 sq.km (5.9%) was dominant in the south. Patches of grassland were also found in the northern part of Akinyele LGA. Open space of 29.8893 sq.km (6.3%) was the third highest land cover found in the southern part. The built-up area was 33.6363 sq.km (7.0%) making it the second largest land cover in the southern part. Water body was 0.65932 sq.km. (0.1%) and rock/bare soil was 3.72535 sq.km (0.8%), as shown in Figure 3.

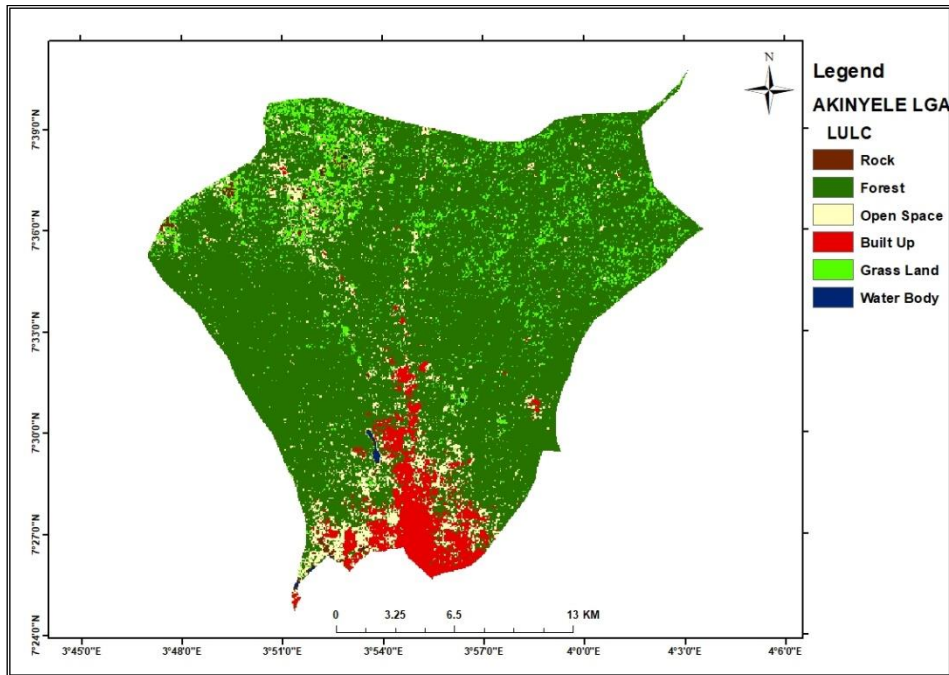


Figure 3: Landuse landcover change of Akinyele LGA in 1986.

Source: Authors' Analysis 2020.

Analysis of the LULC for Akinyele LGA in 2019, as presented in Figure 4 and Table 1, revealed that grassland had reduced significantly to 0.2% (1.117714 sq.km) of the entire land area from 5.9% (28.20675 sq.km) in 1986; built-up area had increased to 24% (246.9141 sq.km) from 7%; and rock/bare soil increased to 14.2% (114.6307 sq.km) from 0.8%. The forestland cover reduced to 47.40646 sq.km (10.0%), while the open spaces have been totally consumed, and the water body has reduced to sq.km (0.2%) of the total land area. As the urban sprawl spread from the South to the North, forestland disappearance was inevitable. Therefore, rock outcrops/bare land that were hitherto covered by forest in 1986 were completely exposed in 2019. This indicates that urban sprawl into agricultural areas in Ibadan is significant.

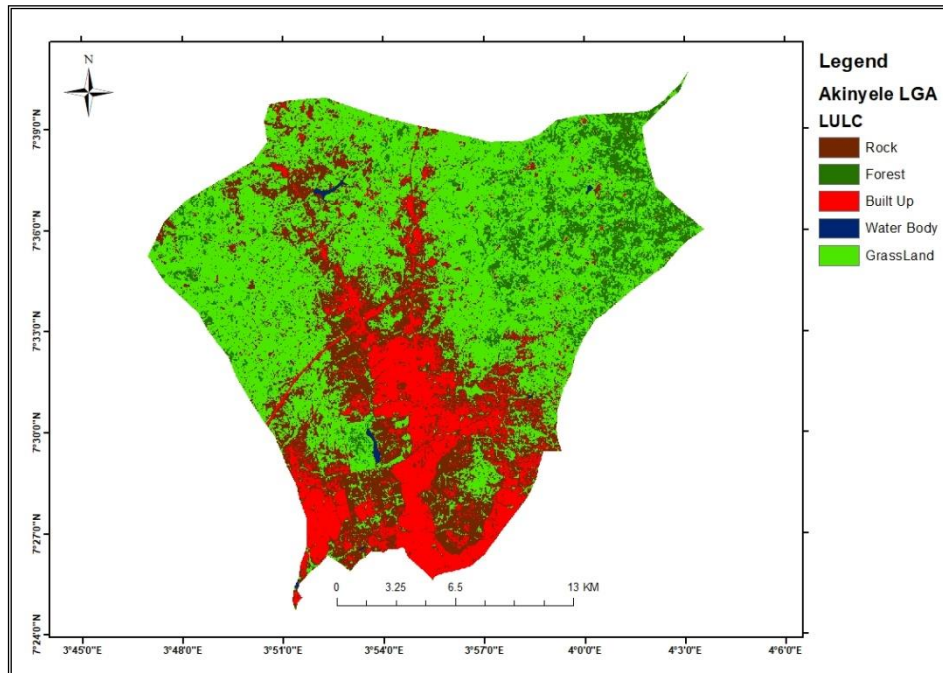


Figure 4: Landuse landcover change of Akinyele LGA in 2019.

Sources: Authors' Analysis 2020.

A comparison of the areas of the six land cover classes over the 33-year period in Akinyele LGA revealed abrupt increment, with the exception of forest land cover and open space (Table 1). Rock/bare soil increased from 0.8% (3.725352 sq.km) of the total landcover in 1986 to 24.0% (114.6307 sq.km) in 2019. This was an increment of 2,977.043%, an indication of absolute exposure of soil to disintegration and the consequent erosion which makes land unsuitable for agricultural practices. Open space which was 6.3% (29.88928 sq.km) in 1986 increased to 14.2% (68.08754 sq.km) in 2019, an increment of 127.7992%. Similarly, built-up area increased by 634.07%. It was 7.0% (33.63625 sq.km) of the entire land area in 1986, but increased to 51.6% (213.2779 sq.km) in 2019. However, forested land reduced from 79.9% (382.0396 sq.km) to 10.0% (47.40646 sq.km), a loss of 87.591%. Grassland decreased by 96.037%. It was 5.9% (28.20675 sq.km) of the entire land in 1986, and decreased to 0.2% (1.117714 sq.km) in 2019. This shows that 27.08904 sq.km of grass and shrubs had been depleted. Spatial expansion into the peri-urban areas had reduced landcover (forest, grassland, and waterbody) amenable to agriculture from 85.9% (410.9057 sq.km) of the entire landcover in 1986 to

10.2% (48.52417 sq.km) in 2019, a whopping loss of 183.728% (362.381462 sq.km) within a 33-year period. Therefore, 362.381462 sq.km (36,238.15ha) of agricultural land was lost to peri-urban development.

Consequently, 3,418.69 tonnes of cassava and 22,648.84 tonnes of maize were probably lost between 1986 and 2019 to peri-urban development (Table 1). Assuming cassava and maize crops were grown on the available agricultural lands 410.905672 sq.km (41,090.5672ha) in 1986 alone, 3,876.47 tonnes of cassava and 25,681.6045 tonnes of maize would have been produced.

Table 1: LULC of Akinyele LGA and Food Crop Loss (1986-2019)

| LULC Classes | 1986 | | 2019 | | 1986/2019 | |
|------------------------------------|------------------------------------|------------|--------------------------------|------------|-----------------------|---------------------|
| | Landcover (Km2) | % | Landcover (Km2) | % | Area Difference (Km2) | % Increase/Decrease |
| Rock/Bare soil | 3.725352 | 0.8 | 114.6307 | 24.0 | 110.9053 | 2,977.04 |
| Forest | 382.0396 | 79.9 | 47.40646 | 10.0 | -334.6331 | -87.591 |
| Open Space | 29.88928 | 6.3 | 68.08754 | 14.2 | 38.19826 | 127.80 |
| Grassland | 28.20675 | 5.9 | 1.117714 | 0.20 | -27.08904 | -96.037 |
| Built-Up | 33.63625 | 7.0 | 246.9141 | 51.6 | 213.2779 | 634.07 |
| Water Body | 0.659322 | 0.1 | 0 | 0 | -0.659322 | -0.1 |
| Total | 478.1566 | 100 | 478.1566 | 100 | | |
| Food Crop Loss | | | | | | |
| Agricultural Land Loss (ha) | Cassava Loss (10.6/ tonnes) | | Maize Loss (1.6/tonnes) | | | |
| | 36,238.15 | | 3,418.69 | | 22,648.84 | |

Source: Authors' analysis, 2020.

Landuse Landcover Change in Ido LGA (1986-2019)

The classified maps (Figures 5 and 6) of Ido LGA, Oyo State within a period of 33 years (1986-2019) reveal the level of alteration in landcover in the LGA. In 1986, 55.17% (588.0286 sq.km.) of the total land area was covered with forest, making it the dominant land cover in the LGA as the time. Forest cover was found basically in the northern and eastern part of

the LGA. Coming after forest was rock/bare soil (Table 2) with 17.03% (181.5954 sq.km.) of the total coverage area. This was followed closely by built-up area, which was 15.94% (169.9411 sq.km.) of the entire landcover in the LGA. Open space constituted 9.58% (102.1476 sq.km) of the total land area, while grassland and water body covered respective land areas of 1.86% (19.81512 sq.km.) and 0.41% (4.375749 sq.km.). Water bodies are scattered in the northern part of the LGA, and also available in the southern part, while grassland is dominant in the southern part.

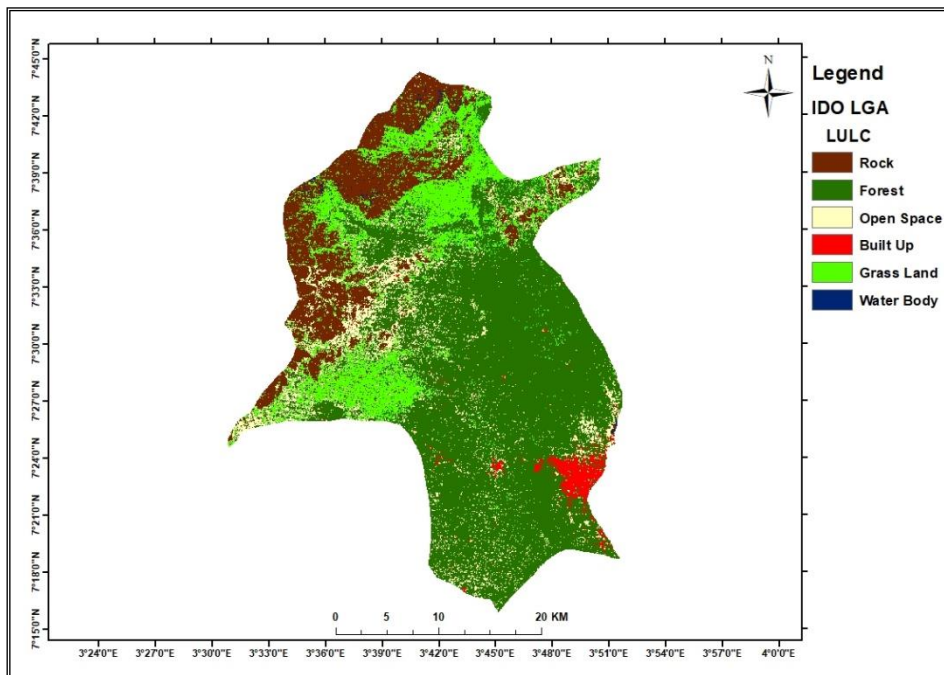


Figure 5: Classified map developed for Ido LGA based on Landsat-5 for the year 1986.

Source: Authors' analysis, 2020.

However, in 2019, as against the forest cover that was prominent, rock/bare soil dominated LULC in the LGA with 48.82% (520.3245 sq.km) of the land coverage (Table 2). Built-up area increased to 40.80% (434.89 sq.km.) of the total land area. The dominance of both rock/bare soil and built-up area in the LGA could be attributed to human modification of land for a variety of purposes. As revealed in Figure 8, built-up area gained more dominance in the eastern part of the LGA. However, some patches of built-up area, scattered around the northern and western parts

of the LGA, were equally observed. A drastic decrease in forest cover was observed in the LULC classified map of 2019 compared with the 1986 map for Ido LGA. Forest covered only about 2.6% (27.76245 sq.km) in 2019, with some patches scattered in the eastern and northern parts of the LGA. Water landcover slightly declined from 9.58% (102.1476 sq.km) to 7.75% (82.63519 sq.km) in 2019. All open space has been totally used up for development.

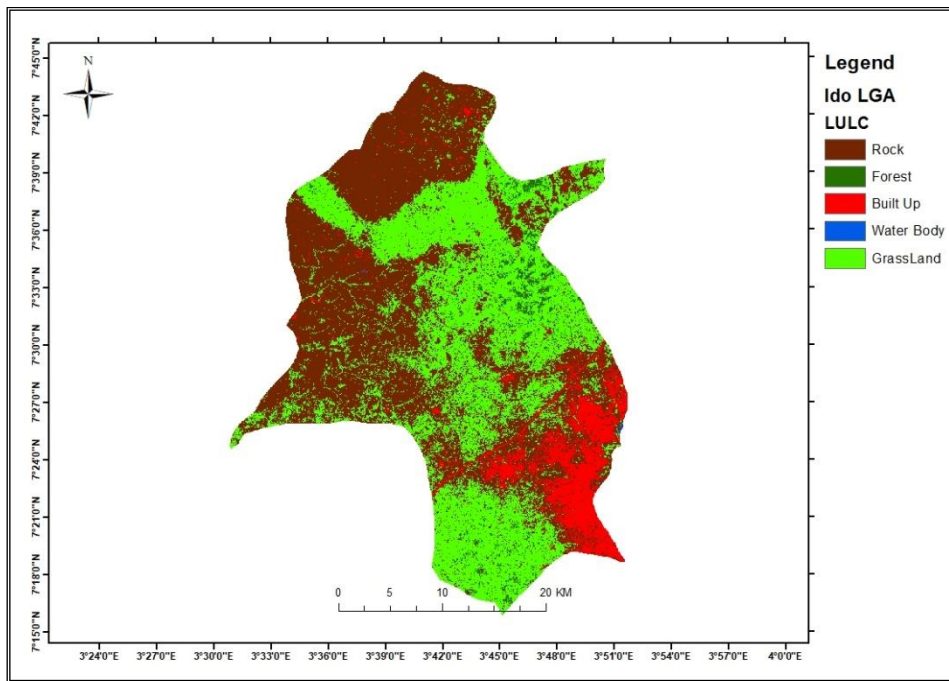


Figure 6: Classified map developed for Ido LGA based on Landsat-8 for the year 2019.

Source: Authors' analysis, 2020.

In an attempt to determine the quantity of agricultural land loss in the LGA, the LULC map of 1986 was compared with that of 2019 and the changes are presented in Table 2. It was revealed that the rock/bare soil and built-up LULC classes experienced increases in land coverage while forest, water body and open space declined abruptly. Both the rock/bare soil and built-up LULC classes soared significantly. While rock/bare soil increased from 17.04% (181.5954 sq.km) in 1986 to 48.82% (338.7291 sq.km) in 2019, built-up changed from 15.94% (169.9411 sq.km) in 1986 to 40.80% (434.89 sq.km) in 2019. The increase of rock/bare soil within Ido LGA was

largely due to the increased built-up lands in the study areas. The more the spatial expansion, the more the other LULCs were converted to another LULC.

Table 2: LULC of Ido LGA and Food Crop Loss (1986-2019)

| LULC Classes | 1986 | | 2019 | | 1986/2019 | |
|------------------------------------|--------------------|------------------------------------|--------------------|--------------------------------|-----------------------------|----------------------------|
| | Landcover (Km2) | % | Landcover (Km2) | % | Area Difference (Km2) | % Increase/ Decrease |
| Rock/Bare soil | 181.5954 | 17.03675 | 520.3245 | 48.81534 | 338.7291 | 186.5296 |
| Forest | 588.0286 | 55.16715 | 27.76245 | 2.604593 | -560.2662 | -95.2787 |
| Open Space | 4.375749 | 0.41052 | 0 | 0 | 0 | -100.0000 |
| Grassland | 19.81512 | 1.858997 | 0.291424 | 0.027341 | -19.5237 | -98.5293 |
| Built Up | 169.9411 | 15.94339 | 434.89 | 40.80013 | 264.9489 | 155.9063 |
| Water body | 102.1476 | 9.583195 | 82.63519 | 7.752595 | -19.5124 | -19.1022 |
| Total | 1065.904 | 100 | 1065.904 | 100 | | |
| Food Crop Loss | | | | | | |
| Agricultural Land Loss (ha) | | Cassava Loss (10.6/ tonnes) | | Maize Loss (1.6/tonnes) | | |
| 59,930.23 | | 5,653.80 | | 37,456.39 | | |

Source: Authors' analysis, 2020.

The spatial extent of water body decreased slightly from 9.58% (102.15 sq.km) in 1986 to 7.75% (82.63519 sq.km.) in 2019. However, forest, grassland, and water body were the most exploited LULCs for agricultural activities. Forestland reduced by 95.28%. While it was 55.17% (588.03 sq.km) of the entire land cover of Ido LGA in 1986, it declined to 2.60% (27.76245 sq.km) in 2019. Grassland had reduced by 98.53% in 2019. It was 1.86% (19.81512 sq.km) of the total land cover in 1986, but became 0.2914 sq.km in 2019. Water body slightly reduced to 7.75% (82.6352 sq.km) in 2019 from 9.58% (102.1476 sq.km) in 1986.

The 33-year change detection analysis revealed that urban spatial expansion into the periphery LULCs has depleted agricultural land (forest, grassland, and water body) to the tune of 599.3023 sq.km

(59,930.23ha). Therefore, 5,653.80 tonnes of cassava and 37,456.39 tonnes of maize might have been lost to built-up LULC between 1986 and 2019 in Ido LGA alone, as presented in Table 2.

Landuse Landcover Change in Egbeda LGA (1986-2019)

The land cover generated from LULC analysis (Figure 7) revealed that in 1986, forest occupied the largest land area coverage in Egbeda LGA with 61.83% (116.4437 sq.km.) of the total land area (Table 3). Forest was found predominantly in the northern, southern, eastern and western parts of the LGA. Open space had the second largest coverage with 15.90% (29.95463 sq.km) of the total land area. Though patches of open space were scattered around the LGA, they were found predominantly in the northern and western parts of the LGA. Built-up area was next with 10.79% (20.3139 sq.km) of the total land area while grassland covered 7.40% (13.9396 sq.km). Rock/bare soil was the fifth largest land cover class in the LGA in 1986; it covered 3.34% (6.298448 sq.km) of the total land area. Water had the least areal coverage and was found mainly in the eastern part of the LGA. It covered just 0.74% (1.393238 sq.km) in 1986.

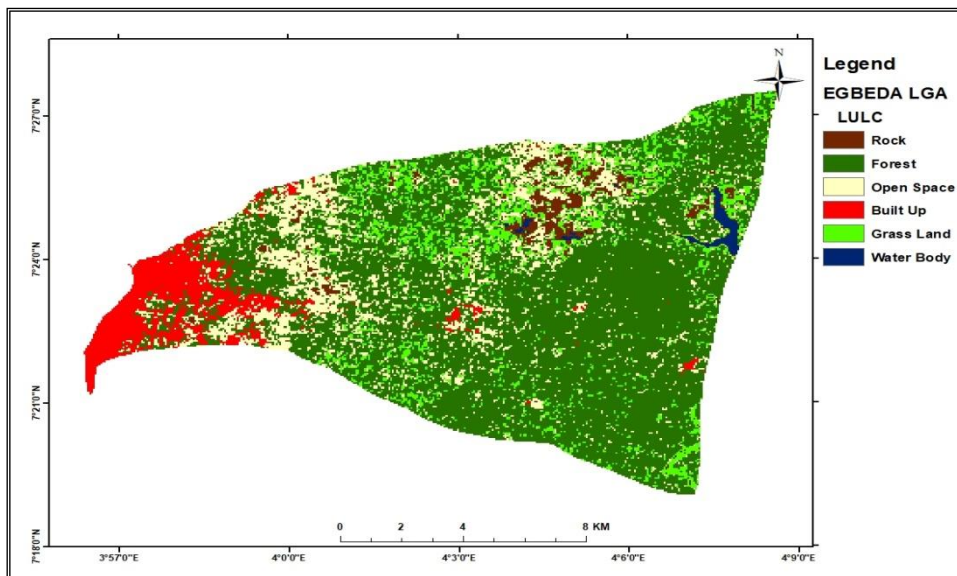


Figure 7: Classified map developed for Egbeda LGA based on Landsat-5 for the year 1986.

Source: Authors' analysis, 2020.

In 2019, the LULC change in Egbeda LGA, as shown in Figure 8 and Table 3, revealed that built-up area occupied 43.20% (81.3691 sq.km.), which made it the largest LULC class. Rock/bare soil had increased to 25.36% (47.7709 sq.km) of the entire LULC in 2019. The analysis showed that grassland occupied the largest space in the eastern part of the LGA with 23.86% (44.93544 sq.km). A larger percentage of the forested area had been taken over by grass, shrubs, and other plants of lesser height. This was an indication that farming activities were prominent in the east, while built-up development was extending eastward from the west. Rock/bare soil LULC patches were found intermittently within the built-up LULC, thereby reducing more agricultural lands in Egbeda LGA. Forest and open space LULC had reduced to 6.22% (11.71534 sq.km) and 0.72% (1.352636 sq.km) respectively, while water body slightly reduced to 0.63%.

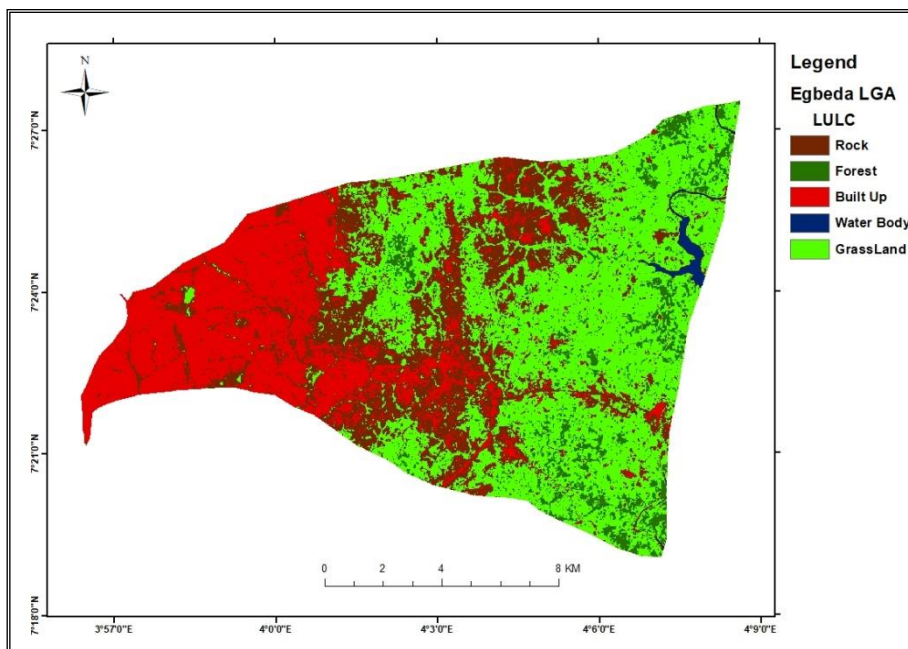


Figure 8: Classified map developed for Egbeda LGA based on Landsat-8 for the year 2019.

Source: Authors' Analysis 2020.

The spatial extent of forest, open space and water body within Egbeda LGA declined significantly in 2019 (see Table 3). Forest LULC reduced significantly by 89.93% (-104.72836 sq.km) of its total coverage

area. Similarly, open space and water body declined by 95.48% (-28.601994 sq.km.) and 14.34% (-0.2 sq.km.) respectively. The decrease in water body LULC between 1986 and 2019 was attributed to encroachment on wetland and river courses for all manners of physical development. However, grass land, rock/bare soil and built-up LULC increased in total areal coverage by 222.36%, 658.46% and 300.56% respectively. The increase in rock/bare soil was attributed to the irregular increase in built-up LULC. As revealed in Table 3, large expanses of agricultural land (forest, grassland, and water body) totaling 133.530354 sq.km (13,353.0354ha) in Egbeda LGA have been built-up during the 33-year period. Therefore, food crop loss analysis revealed that 1,259.72 tonnes of cassava and 8,345.65 tonnes of maize were probably lost between 1986 and 2019.

Table 3: LULC of Egbeda LGA and Food Crop Loss (1986-2019)

| LULC Classes | 1986 | | 2019 | | 1986/2019 | |
|------------------------------------|------------------------------------|------------|--------------------------------|------------|-----------------------|---------------------|
| | Landcover (Km2) | % | Landcover (Km2) | % | Area Difference (Km2) | % Increase/Decrease |
| Rock/Bare soil | 6.298448 | 3.344129 | 47.7709 | 25.3646 | 41.472462 | 658.4553 |
| Forest | 116.4437 | 61.82519 | 11.7153 | 6.2204 | -104.72836 | -89.9391 |
| Open Space | 29.95463 | 15.90426 | 1.35264 | 0.7182 | -28.601994 | -95.4844 |
| Grassland | 13.9396 | 7.401161 | 44.9354 | 23.8590 | 30.99584 | 222.3582 |
| Built Up | 20.31385 | 10.78554 | 81.3691 | 43.2040 | 61.05528 | 300.5599 |
| Water body | 1.393238 | 0.739733 | 1.19324 | 0.6336 | -0.2 | -14.35501 |
| Total | 188.3435 | 100 | 188.3371 | 100 | | |
| Food Crop Loss | | | | | | |
| Agricultural Land Loss (ha) | Cassava Loss (10.6/ tonnes) | | Maize Loss (1.6/tonnes) | | | |
| | 13,353.0354 | | 1,259.72 | | 8,345.65 | |

Sources: Authors' Analysis 2020

Landuse Landcover Change in Oluyole LGA (1986-2019)

The analysis of LULC in Oluyole LGA for 1986 (Figure 9 and Table 4) revealed that, forest LULC was dominant in the 761.544 sq.km of the

entire LGA. Forest LULC was not only 74.6% (568.0829 sq.km.) of 761.544 sq.km, but also spread all over the LGA. Open space covered 14.76% (112.429 sq.km.) of the total land area. It was dominant at centre, but patches of open spaces were observed across the area, thereby making it the second largest land cover class in the LGA in 1986. Grassland covered 9.38% (71.44973 sq.km.) in the LULC of Oluyole, but was pronounced in the eastern part. Built-up LULC was scanty and dispersed in the northern, western and southern parts of the LGA and covered only 0.96% (7.430138 sq.km.) of the total land area as at 1986. Rock/bare soil covered 0.28% (2.152252 sq.km.), while water body was completely buried under forest foliage in 1986.

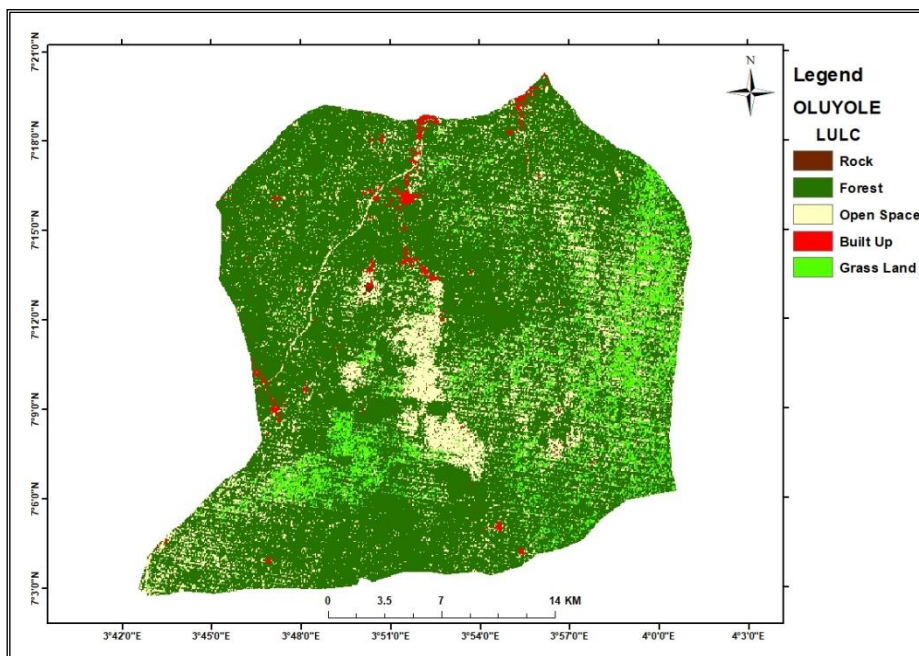


Figure 9: Classified map developed for Oluyole LGA based on Landsat-5 for the year 1986.

Source: Authors' Analysis 2020.

By 2019, a 33-year interval, the LULC has changed significantly. The visual and statistical dynamics are presented in Figure 10 and Table 4 respectively. The LULC change analysis revealed that grassland had taken over the vegetative sphere of Oluyole LGA. It covered 52.80% (402.0682 sq.km.) of the total land area. This was dominant in the southern part. Also, patches of grassland were observed in the western, northern and

eastern parts of the LGA. This was attributed to intensive agricultural activities, resulting from displacement of forest for grassland. Forest LULC has declined to 30.43% (231.7006 sq.km.) of the total land area and is conspicuous in the eastern part only. The rock/bare soil LULC has increased to 11.85% (90.26839 sq.km.) of the total land area. A larger percentage was found within the built-up LULC in the northern part of the LGA. The built-up LULC has expectedly increased to 37.20555 sq.km, but remained 4.89% of the total land area, owing to the spatial expansion of other LULCs, particularly grassland. The analysis revealed that water body LULC was non-existent in 1986, however, in 2019, it had surfaced and covered 0.04% (0.301317 sq.km). It was discovered during ground truthing that changes in forest LULC had exposed streams and artificial ponds being used for fish farming in the LGA in 2019.

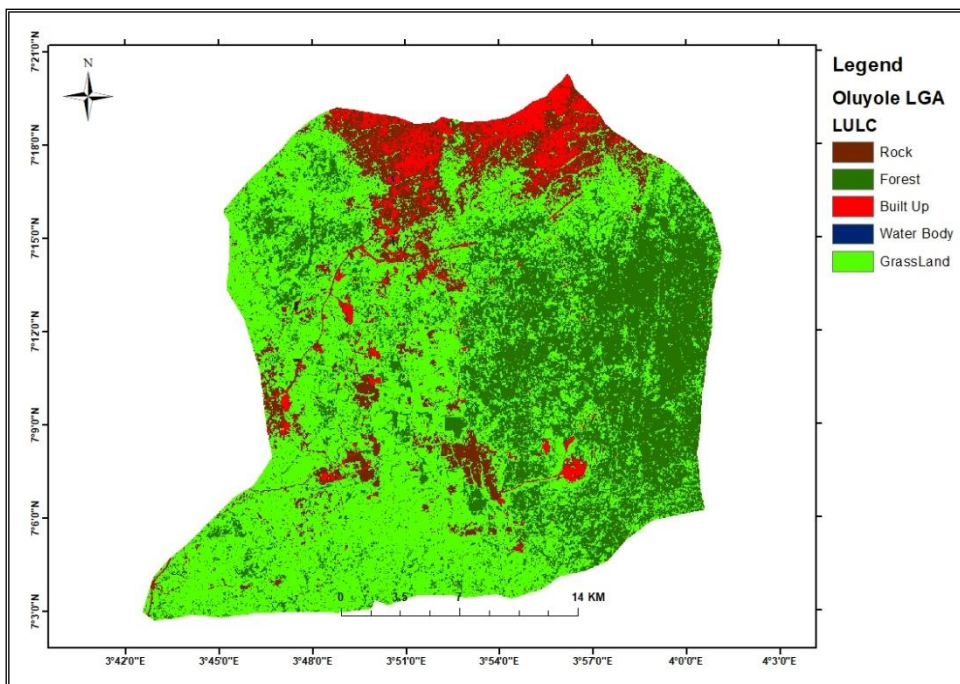


Figure 10: Classified map developed for Oluyole LGA based on Landsat-8 for the year 2019.

Source: Authors' Analysis 2020.

Forest and open space LULC declined significantly between 1986 and 2019. Forest lost 44% (336.3823 sq.km) while open space lost 14% (112.429 sq.km) to grassland, rock/bare soil, and built-up LULC. The

most significant positive change was experienced with grassland which expanded to 52.80% (402.0682 sq. km) in 2019 and thereby gained 43.41% (330.61847 sq.km). Rock/bare soil LULC also increased by 11.85% (90.26839 sq.km), thereby adding 11.57% (88.116138 sq.km). The increase in rock/bare soil in the LGA was attributed to the increase in built-up land which is accompanied by opening up of more areas to support built-up lands such as footpaths, roads, and setbacks. The difference between the built-up LULC between 1986 and 2019 was 3.91% (29.775302 sq.km). With the removal of forest and increased pond development, water body emerged and accounted for 0.03% (0.301317 sq.km). Urban development in Oluyole during the period of study engendered agricultural land loss and subsequent crop loss. Only forest LULC in Oluyole LGA accounted for agricultural land loss, because grassland and water body gained more spatial extent during the period of study. Therefore, the 336.3823 sq.km (33,638.23ha) of forest LULC lost to spatial dynamics probably led to non-cultivation of 3,173.42 tonnes of cassava and 21,023.89 tonnes of maize between the year 1986 and 2019 in Oluyole LGA.

Table 4: LULC of Oluyole LGA and Food Crop Loss (1986-2019)

| LULC Classes | 1986 | | 2019 | | 1986/2019 | |
|------------------------------------|------------------------------------|------------|--------------------------------|------------|-----------------------|---------------------|
| | Landcover (Km2) | % | Landcover (Km2) | % | Area Difference (Km2) | % Increase/Decrease |
| Rock/Bare soil | 2.152252 | 0.282617 | 90.26839 | 11.85334 | 88.116138 | 11.570723 |
| Forest | 568.0829 | 74.59619 | 231.7006 | 30.42511 | -336.3823 | -44.17108 |
| Open space | 112.429 | 14.7633 | 0 | 0 | -112.429 | -14.7633 |
| Grassland | 71.44973 | 9.382219 | 402.0682 | 52.79645 | 330.61847 | 43.414231 |
| Built-up | 7.430138 | 0.975667 | 37.20555 | 4.885542 | 29.775302 | 3.909875 |
| Water body | 0 | 0 | 0.301317 | 0.039567 | 0.301317 | 0.039567 |
| Total | 761.544 | 100 | 761.5441 | 100 | | |
| Food Crop Loss | | | | | | |
| Agricultural Land Loss (ha) | Cassava Loss (10.6/ tonnes) | | Maize Loss (1.6/tonnes) | | | |
| 33,638.23 | 3,173.42 | | 21,023.89 | | | |

Source: Authors' analysis, 2020.

Summary and Conclusion

This study analysed LULC changes in four out of six peri-urban LGAs in Ibadan. Emphasis was on agricultural land and food crop losses associated with urban spatial dynamism between 1986 and 2019. Using GIS and remotely sensed data, the study established increasing built-up LULC and decreasing forest, grassland, and water body in the study areas. The study revealed that Ido LGA has the highest areal coverage among the four selected LGAs, hence it lost the highest agricultural LULC of 59,930.23ha to peri-urban development. Therefore, 5,653.80 tonnes of cassava and 37,456.39 tonnes of maize were lost to built-up LULC between 1986 and 2019. The next high value of loss was captured at Akinyele LGA, where 36,238.15ha of agricultural land was lost to peri-urban development. Thus, 3,418.69 tonnes and 22,648.84 tonnes of cassava and maize respectively were probably lost. Oluyole LGA had 33,638.23ha of agricultural LULC loss, and consequent 3,173.42 tonnes of cassava and 21,023.89 tonnes of maize between the year 1986 and 2019. In Egbeda LGA, 13,353.0354ha of agricultural land was lost to built-up LULC. This might have led to the loss of 1,259.72 tonnes of cassava and 8,345.65 tonnes of maize between 1986 and 2019.

Peri-urban development has undoubtedly affected the cultivation of staple food crops such as cassava and maize. Consequent on the findings of the study, GIS and RS techniques should be employed by the Federal Ministry of Agriculture to map, identify, and separate lands that are more suitable for agricultural activities from others. Such lands should be solely designated for agricultural development.

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