

ASSESSMENT OF LAND USE AND LAND COVER CHANGES OF SELECTED AIRPORTS SURROUNDING FOREST IN NIGERIA

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Abstract

Rapid population growth and increasing economic activities have resulted in unsustainable exploitation and rapid decline in the spatial extent of forest reserves in Nigeria. Studying land use dynamics of surrounding forest is essential for analyzing various ecological and developmental consequences over time. This paper aims at assessing changes in land use/land cover of selected surrounding airport forest in Nigeria using remote sensing and GIS techniques. The study determined the dynamics of change in the spatial extent of surrounding airport forest between 1983 and 2023 using multi-temporal datasets (Landsat TM 5&7 2000 and OLI/TIRS 2015). The imageries were classified using ArcGIS 10.0 version with support of ground - truthing data and Land use matrices in analyzing the pattern and trend of change. The results of Land Use and Land Cover Changes (LULCC) of the study area showed that the study locations have been partially disturbed by anthropogenic activities such as logging, farming and encroachment particularly between 1983 – 2003. The corresponding vegetation loss are: Benin (from 64.49– 6.71km²); Ibadan (245.16 – 22.88km²); Lagos (316.05 – 292.23km²) while the exception was recorded in Akure (11.8 – 32.91km²) before the adoption of proper protection and prohibition such as fence for demarcation of airports boundaries. The results of this study concluded that the four airports surrounding forest assessed were haven for biological diversity particularly Ibadan and Benin surrounding forest, therefore conservation of tree species in the surrounding forests of airports is recommended.

Keywords: Land Use, Land Cover, Deforestation, Anthropogenic, GIS

Introduction

Vegetation loss is a complex global challenge driven purposely by anthropogenic factors or activities. Its impacts can be felt by human as well as agriculture and environment (Maurya and Vivek, 2025). To combat indiscriminate land use and vegetation loss, urgent and proactive assessments of our institutional forest are needed. Land use and land cover assessment play a crucial role not only in planning, but also promoting awareness and policy guidelines, which ultimately will contribute to the lowering of CO₂ emission and climate change mitigation (Wang, 2024). The rising global demand for timber, agricultural space and industrialization resulting from population explosion, however have transitioned many forested areas to bare land, as well as the acceleration of GHG in the atmosphere (Lamb *et al.*, 2021; Matthew *et al.*, 2018).

Vegetation loss through industrialization and expansion for instance, results in CO₂ escape to the atmosphere (Lamb *et al.*, 2021), which added to the accumulation of GHG which poses a serious health risks to both human and animal health at the long run (Kiehbardroudzinezhad *et al.*, 2024). Upon deploying many security outfits and awareness, the available forest still suffers anthropogenic defeats, leads to subtle decrease in both flora and fauna, thereby compromising the ecosystem balance and food chain (Rhind, 2009). While losing these environmental components may not pose a serious threat at the beginning, it may have a capability of causing a great havoc such as flooding, heat, pest and disease etc. at the long run. This menace is taken a subtle means, and as a single biodiversity is disappearing gradually, the transition to species extinction according to IUCN is inevitable (Paul *et al.*, 2013).

Globally, accumulation of GHG (particularly CO₂) has constituted a health crisis (Matthew *et al.*, 2018), particularly in developing countries such as Nigeria, where there is a high record of loss in Africa (Aikhiombare, 2015).

While Nigeria is committed to global action plan to reduce GHG (Framework Policy Brief, 2021), most attention is focused on the reduction of deforestation, despite evidence of its impacts irrespective of gender or location or parastatals (Basiru, 2023). As a consequence, there have been little research into further understanding the role surrounding airports forest can play in CO₂ sequestration (Ogunlusi, 2025), this is in part due to the difficulties of conducting a detailed studies in Governmental property surrounding forest (Ghana Forestry Commission, 2002). Evidence collectively suggests that personal and government collective effort can be a game changer in protecting our forest and remain the most important cornerstone in the sustainable management of the natural resources (Nigerian Conservation Foundation, 2002). The forest is closely linked to our day-to-day means of survival either directly or indirectly (Mfon *et al.*, 2014), playing a significant role in terms of livelihood enhancement and income generation (David *et al.*, 2019).

Although, there is a record of many surrounding airport forests in Nigeria (Agbogidi, 2011; Ahmed and Taiwo, 2023), what has not been studied is the land use and land cover changes particularly for southern part of the country, and suggest how to prevent vegetation loss if there is any. The absence of a clear assessment and baseline information of the forest mosaic in our airport surrounding forest have denied government to make a good policy and

sustainable use available land within different sectors of the economy, leading to confusion. This has led to a more tussle where land allocation and usage have been as development for one sector and setback for others (Enoguanbhor *et al.*, 2021). In Nigeria, forest deforestation guidelines were predominantly focused on cutting the trees in the gazette forest reserves (Isikhuemen, 2014). However, assessment of other subtle anthropogenic activities that can contribute to the accumulation of GHG which has a great tendency of affecting life and properties does not exist.

The specific aim of this study was to assess and provide a baseline information of land use and land cover changes of selected surrounding airport forests in Southern part of Nigeria. This study had the ultimate goal of reducing deforestation and anthropogenic activities if exist. This will also serve as a baseline information for other parastatals that surrounded by forest. In achieving these aims, the study aspiration was aligned to Sustainable Development Goal “15”, target 15.5 (Bhatt, 2023; Arora and Mishra, 2024), and its desire to strengthen the capacity of a developing country in reducing vegetation loss intervention in response to a global environmental issue. This paper presented the assessment and baseline information on the land use and land cover changes of surrounding airport forests in Lagos, Ibadan, Akure and Benin City respectively for over four decades.

Study Area

The study was limited to the surrounding forest around Murtala Mohammed International Airport Lagos-Ikeja Airport, Ibadan Airport, Akure Airport and Benin Airport.

Akure Airport, Akure, Ondo State.

Akure airport is located in Akure North Local government area of Ondo state. The airport falls on Latitude 7.2510°

N and Longitude 5.2997° E with an altitude: 337.718m (Ogunrayi *et al.*, 2016).

Climate and Vegetation

The area has both dry and wet seasons. The dry season lasts from November to March while the wet season commences from April and ends in October with highest rainfall records between July and August. Average daily temperature ranges between 21°C and 29°C almost throughout the year. The mean annual rainfall varies from 2000mm in the southern area to 1500mm in the Northern area with relative humidity of 80-85% annually experienced in the Southwest (Ogunrayi *et al.*, 2016).

Geology and Topography

The ferricluvisol soils are formed as a result of continuous weathering of the crystalline rock which feature mostly in the typical uplands soils in many parts of Southwestern is present. The relief pattern is low lying elevation ranges from 216m to 504m. The underlying rock is crystalline and gneiss. It is slightly neutral; pH of 6.7 – 7.3 and sandy-loam in nature. The soil of the area supports the growth of many tree species (Ogunrayi *et al.*, 2016).

Ikeja Airport, Lagos State

Murtala Muhammed International Airport is an international airport located in Ikeja Local Government area of Lagos State, Nigeria, and is a major airport serving the entire state. The area falls between Latitude and Longitude of 6.5818° N and 3.3211° E with an altitude of 41.148m respectively (Ogundele, 2012).

Climate and Vegetation

Lagos metropolitan area has a humid tropical climate (Koppen climate classification Aw) bordering a monsoon tropical climate (Koppen climate classification Am) (Peel *et al.*, 2007) thus

characterized by two wets (April to July and October and November) and dry (August and September and December to March) seasons (Ogundeke, 2012). Mean annual rainfall varies between 1381.7 mm and 2733.4 mm with an average of 2500 mm while monthly rainfall ranges between 25 mm to over 400 mm (Ogundeke, 2012). Maximum temperature ranges between 29°C and 34°C and minimum ranges between 24°C and 28°C (Ogundeke, 2012).

Geology and Topography

The topography of the state is of gentle rolling lowland in the south, rising to a plateau of about 40meters. The state is well drained with rivers flowing from the upland in the North-South direction. (Ojo *et al.*, 2014).

Ibadan Airport, Ibadan Oyo State

Ibadan Airport is an airport located in Egbeda Local Government, Ibadan, the capital city of Oyo State, Nigeria. The Airport is located at Alakia and falls between Latitude: 7.3584° N and Longitude: 3.9751° E with an altitude of 221.894m respectively (Ojo *et al.*, 2014).

Climate and Vegetation

Oyo State has an equatorial climate with dry and wet seasons and relatively high humidity. The dry season lasts from November to March while the wet season starts from April and ends in October. Average daily temperature ranges between 25°C 77.0°F) and 35°C 95.0°F, almost throughout the year. The vegetation pattern of Oyo State is that of rainforest in the South and Guinea Savannah in the North. Thick forest in the South gives way to grassland interspersed with trees in the North. (Ojo *et al.*, 2014).

Geology and Topography

Oyo State is underlain by three lithological units of crystalline basement complex comprising: (i) Migmatite-Gneiss Complex (quartzite, gneissic

rocks; (ii) Low to medium grade meta-sediment (Green schists facies, namely quartz schist and mica schists. (iii) The Pan African Granitoids (older granites) which are synonymous to late tectonic intrusions (Ojo *et al.*, 2014).

Benin Airport, Benin City Edo State

Benin Airport is located in Oredo Local government in Benin, the capital of Edo State, Nigeria, with an area of 112,622 km² (43,484 m²). Benin, a narrow, key-shaped, north-south strip of land in West Africa, lies between the Equator and the Tropic of Cancer. The area falls between Latitude and Longitude of 6.3172° N and 5.6037° E respectively (Balogun *et al.*, 2023).

Climate and Vegetation

The Benin City lies on 86m above the sea level and has a tropical climate. In winter, there is much less rainfall than in summer. The Köppen-Geiger climate classification Aw. The average annual temperature is 26.1°C 79.0°F in Benin City. About 2025 mm, 79 inches of precipitation falls annually. The driest month is January with 9mm 04 inches of rainfall. Most precipitation falls in September with an average of 338mm, 13.3 inches. The warmest month of the year is April with an average temperature of 27°C, 81.5°F. In July, the average temperature is 24.5°C 76.1°F. It is the lowest average temperature of the whole year (Balogun *et al.*, 2023).

Geology and Topography

Some areas in the southern fringes of Edo State swampy mangrove forest with numerous creek and rivers dissecting the land area. In the southwest, there are sandy plains with many rivers and streams. This portion which is the Benin Lowlands has a hill and the land is drained by the Ikpoba, Orihionmwon and Osse (Balogun *et al.*, 2023).

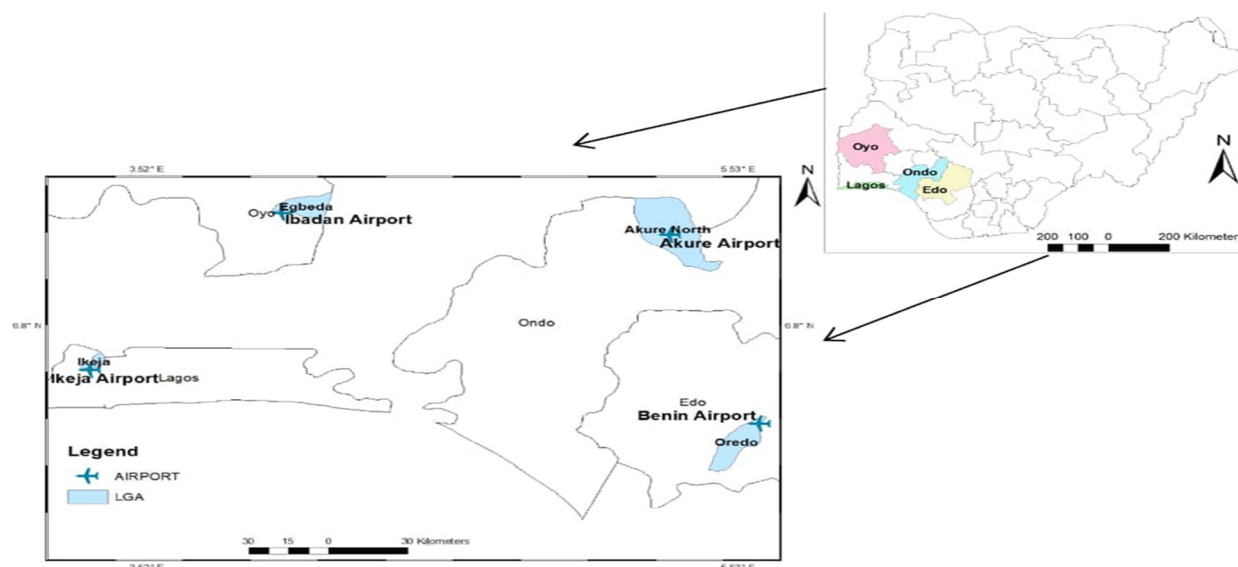


Figure 1: Map of Nigeria showing the states and Local Government of the study areas

Materials and Methods

Image Processing

Data Acquisition

The primary and secondary data were acquired and used for this study. The primary data collected were majorly coordinates to identify different land cover types for effective image classification. These coordinates were collected using a hand-held Global Positioning System (GPS) of 3m accuracy level.

The secondary data include the administrative maps of four airports (Benin, Akure, Ibadan and Lagos) in Nigeria. The remote sensing data used for this study include Landsat TM, ETM and OLI for 1983, 2003, and 2023 of the study areas. These data were downloaded from the site of Earth Explorer (<http://earthexplorer.usgs.gov>). Three classifications were identified for this study (Table 2).

Table 1: Land Use/ Land Cover Classification

S/N	Category
1	Built up
2	Vegetation
3	Bareland

Mapping the Land Use Land Cover Types and Changes

Land use and land cover patterns for 1983, 2003 and 2023 were mapped by the use of Landsat TM, ETM and OLI data, which have a 30-m ground resolution with the exception for the thermal IR bands (band 6) and (10), which have 100m resolution bands.

Image Preprocessing

In raw remote sensing data, each pixel has digital number value that corresponds to a raw measurement required by the sensor (Giannini *et al.*, 2015). In order to obtain quantitative information from images, digital number was converted to physical quantities, radiance and brightness temperature. The images used in this study were first converted to Top of Atmosphere (TOA) radiance using Equation 11 (Giannini *et al.*, 2015).

$$L\lambda = \left(\frac{L_{MAX}\lambda - L_{MIN}\lambda}{Q_{CAL}\lambda} \right) Q_{CAL} + L_{MIN}\lambda \quad (\text{Equation 1})$$

Where:

$L\lambda$ = Spectral radiance at the sensor's aperture [$W/(m^2sr\mu m)$]

Q_{CAL} = Quantized calibrated pixel value [DN]

Q_{CALMIN} = Minimum quantized calibrated pixel value corresponding to L_{MIN} [DN]

Q_{CALMAX} = Maximum quantized calibrated pixel value corresponding to L_{MAX} [DN]

$L_{MIN}\lambda$ = Spectral at-sensor radiance that is scaled to Q_{CALMIN} [$W/(m^2sr\mu m)$]

$L_{MAX}\lambda$, = Spectral at-sensor radiance that is scaled to Q_{calmax} [$W/(m^2sr\mu m)$].

The Equation 11 does not consider the atmospheric effects, therefore there is need to convert images from radiance to reflectance measures, using equation 12 (Giannini *et al.*, 2015).

$$\rho\lambda = \frac{\pi.TOA.r.d^2}{E_{SUN}\lambda.Cos\theta_{sz}} \quad (\text{Equation 2})$$

Where:

$\rho\lambda$ = Planetary TOA reflectance (unitless)

π = mathematical constant approximately equal to 3.14159 (unitless)

$L\lambda$ = Spectral radiance at the sensor's aperture [$w / (m^2sr \mu m)$]

d^2 = The earth-Sun distance (Astronomical unit)

E_{SUN} = Meanexo atmospheric solar irradiance [$w / (m^2sr \mu m)$].

θ_{sz} = the solar zenith angle (degree). The cosine of this angle is equal to the sine of the sun elevation θ_{SE} . therefore, $\theta_{sz} = 90 - \theta_{SE}$.

These are rescaling factors given in metadata.

Image Classification Algorithm

The images have been classified, with the aid of VIs, using a supervised classification algorithm called BAYCLASS classifier. BAYCLASS is one of a group of soft classifiers in IDRISI software system.

The analysis of data was carried out using ArcGIS and Landsat imageries using ArcGIS Pro Software. Changes that have occurred within the study areas were determined using a land use and land cover change procedure called change rate analysis (Basiru, 2023)

Land Use Land Cover (LULC) Pattern of the Study Area

A supervised maximum likelihood classification was carried out for the imageries used in this study and the final classification products provide an overview of the major land use land cover features of the study areas for the years, 1983, 2003 and

2023. Three categories of land use/land cover were identified; these are Built-up, Vegetation, and Bareland. Figures in forms of maps were used to show the land use/land cover maps for the years considered.

Results

Land use and land cover classification changes from the year 1983 to 2023

Monitoring and assessing the dynamics of land use and land cover changes happened to be one of the most immense and transformations of the earth's surface. Thus, to efficiently and effectively assess, mapped and monitor the dynamics of the land use and land cover change of the study area, there's the need to know the past, present, and possible future changes especially when sustainable land use is desired. Accordingly, the details of the land use and land cover information within the study area during the selected years (1983–2003; 2003–2023) are shown in figures below. From the results of the land use and land cover information, the Benin airport study area showed a trend that the area occupied with built-up (57.54ha to 49.68ha) and vegetation cover (64.49ha to 6.21ha) between 1983 and 2003 reduced drastically which is equivalent to 4.13% loss, while only bareland increased (67.97ha to 134.11ha) which represent increment of bareland by (34.81%) in reverse order. Built up increased from 49.68ha in 2003 to 59.64ha which is equivalent to 31.39% increment. Also, there is an increment of 4.71% for the vegetation cover (from 6.21ha to 15.16ha, while bareland reduced from 134.11ha in 2003 to 115.20ha in 2023, representing 9.95% reduction (Figure 2, 3, 4).

Out of 309ha of Akure airport surrounding forest, vegetation accounted for 11.84ha, built up 44.60ha and bareland 252.56ha with corresponding 3.83%, 14.43% and 81.74% respectively. Built up suddenly increased from 44.60 in 1983 to 102.48ha in 2003 which represent 33.17% increment. The

same trend was observed for vegetation cover (11.84ha to 32.91ha) while there is reduction in bareland coverage between 1983 and 2003 (252.56ha to 173.61ha) that represented 25.56% reduction. Furthermore, between 2003 and 2023, there was a reduction as well for both vegetation cover and built-up area (102.48ha to 70.00ha) and 32.91ha to 27.35ha) respectively, only bareland had an increased from 173.61ha in 2003 to 211.65ha in 2023 representing 12.32% in negative trend (Figure 5, 6, 7). Based on the result obtained in the year 1983 to 2023, in Ibadan airport surrounding forest for land use and land cover changes, it revealed that only bareland increased from 45.21ha to 342.03ha with a geometric progression of 10.64% (1983), 58.87% (2003) and 80.48% in 2023 respectively. Built up area increased from 1983 to 2003 with corresponding values of (132.63ha to 151.92ha), while there is a record of reduction in vegetation cover from (245.16ha to 22.88ha). Also, built up area

was reduced 151.92% representing 35.75% in 2003 35.39ha in 2023 accounted for 8.33 reduction percentages. Comparing the built up to vegetation cover for the year 2003 and 2023, there was an opposite trend where there was a record of an increment in vegetation cover from 22.88ha to 47.58ha i.e. an increment from 5.38% to 11.19% respectively (Figure 8, 9, 10)

Lagos airport surrounding built up areas between 1983 and 2023 decreased from 870.28ha to 800.38ha (4.60%) reduction, likewise the vegetation cover reduced from 316.05ha to 292.23ha (1.57%), but later increased between 2003 and 2023 with an increment of 130.91ha accounted for 8.62%. The bareland followed the vegetation cover trend with an increase in coverage from 332.67ha in 1983 to 409.52ha in 2003 and later decreased from 295.48ha in 2023 representing a reduction of 7.51% (Figure 11, 12, 13).

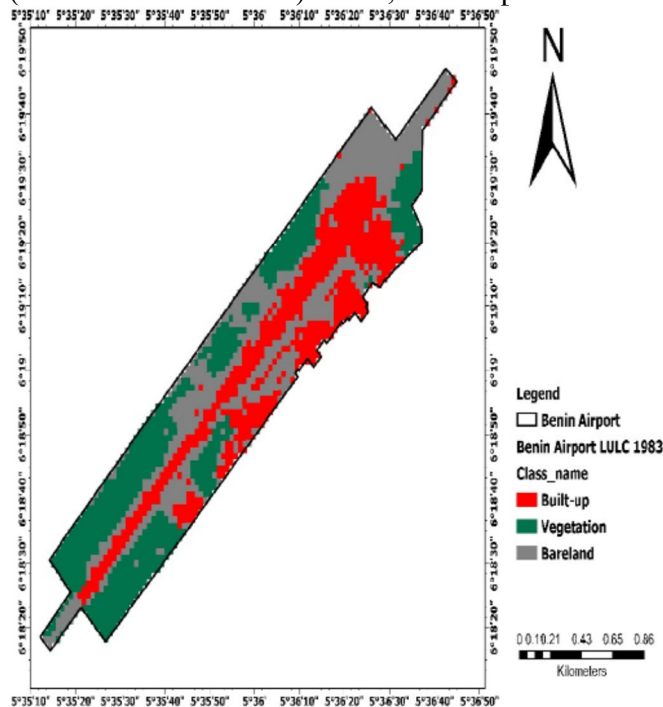


Fig. 2: Land Use Land Cover Change of Benin Airport for year 1983

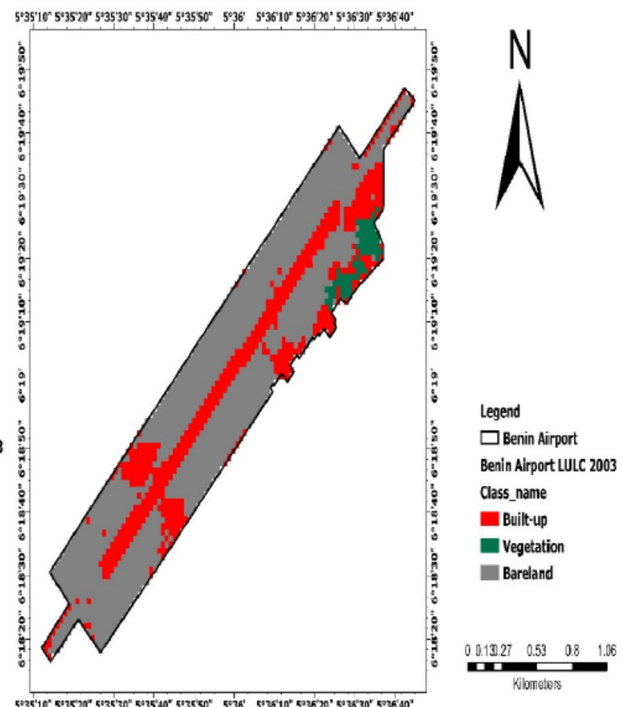


Fig. 3: Land Use Land Cover Change of Benin Airport for year 2003

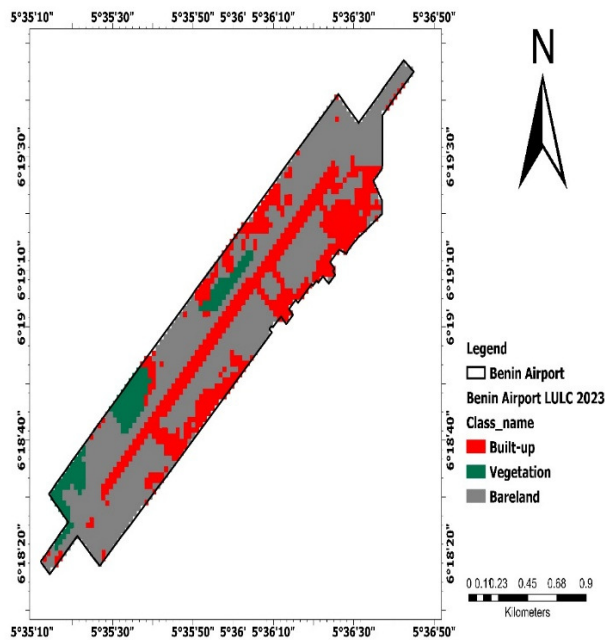


Fig. 4: Land Use Land Cover Change of Benin Airport for year 2023

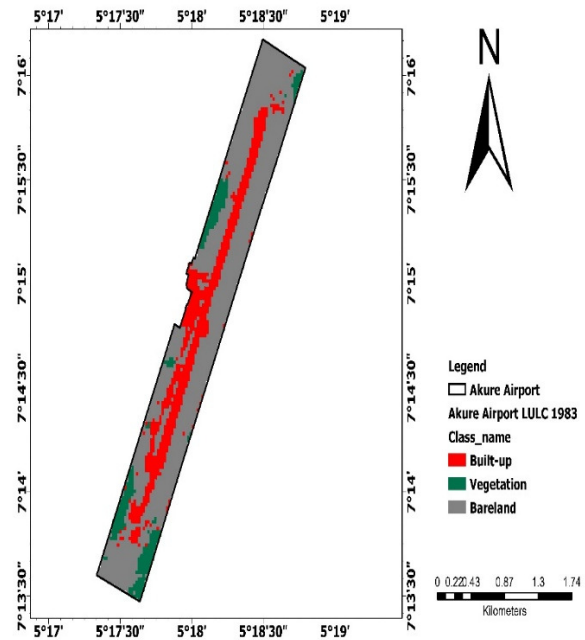


Fig. 5: Land Use Land Cover Change of Akure Airport for year 1983

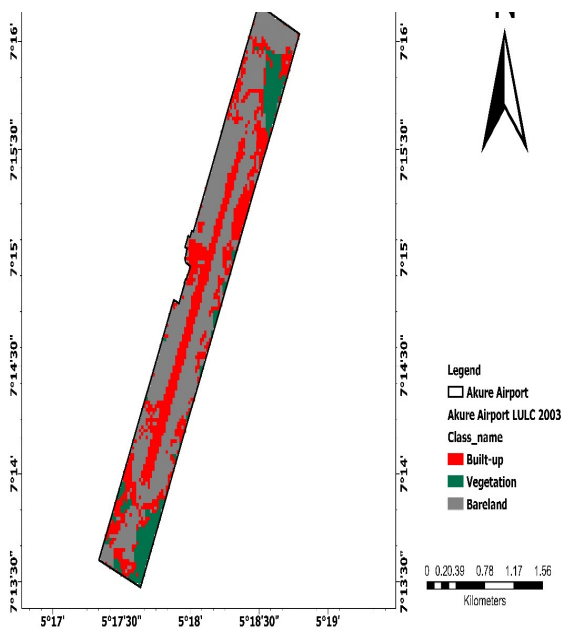


Fig. 6: Land Use Land Cover Change of Akure Airport for year 2003

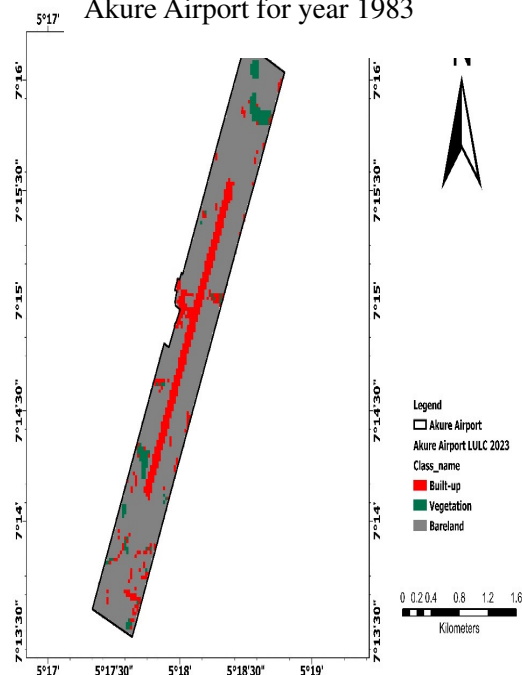


Fig. 7: Land Use Land Cover Change of Akure Airport for year 2023

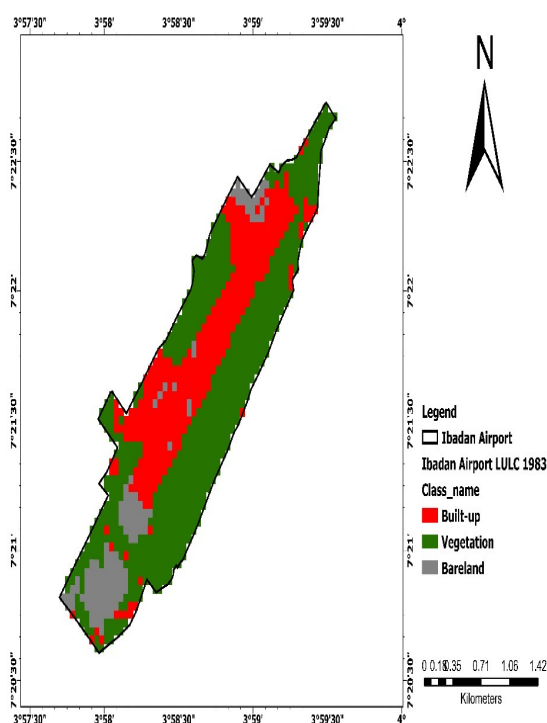


Fig. 8: Land Use Land Cover Change of Ibadan Airport for year 1983

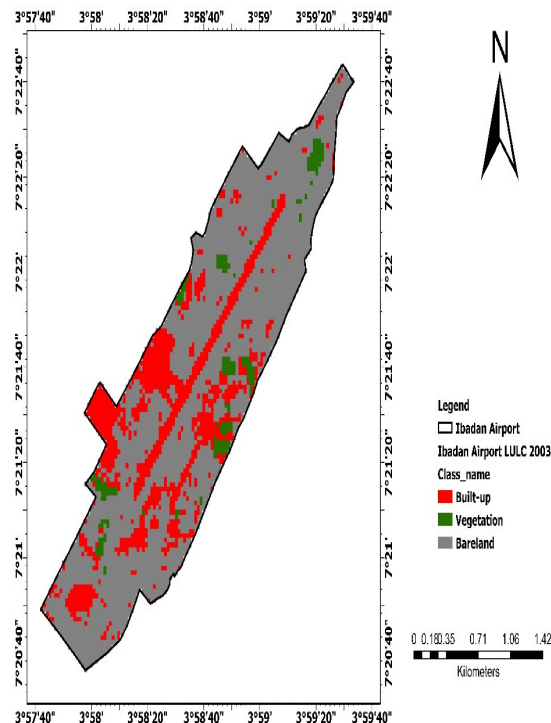


Fig. 9: Land Use Land Cover Change of Ibadan Airport for year 2003

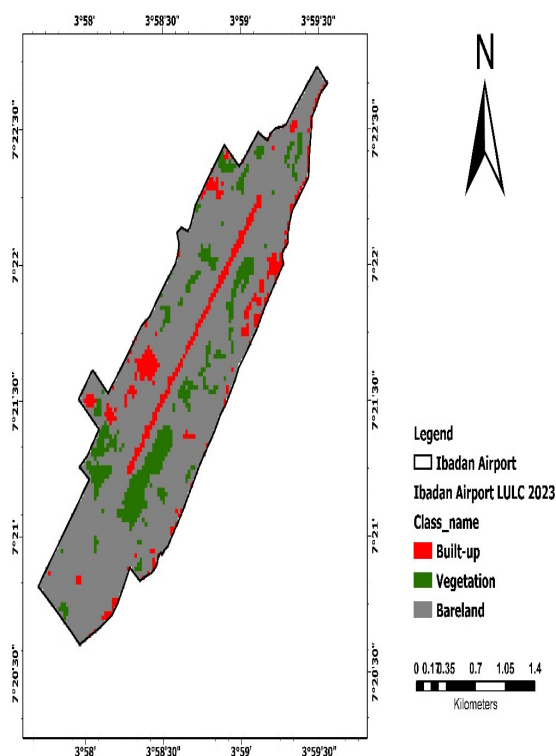


Fig. 10: Land Use Land Cover Change of Ibadan Airport for year 2023

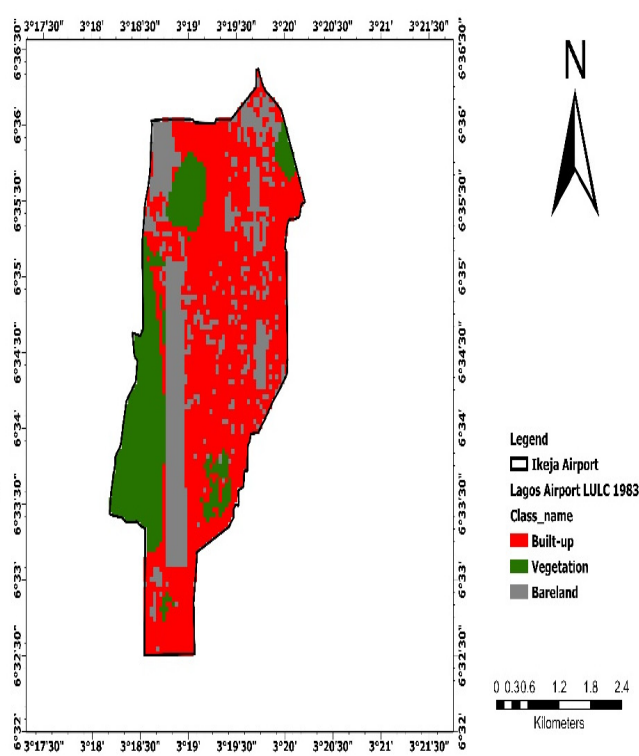


Fig. 11: Land Use Land Cover Change of Lagos Airport for year 1983

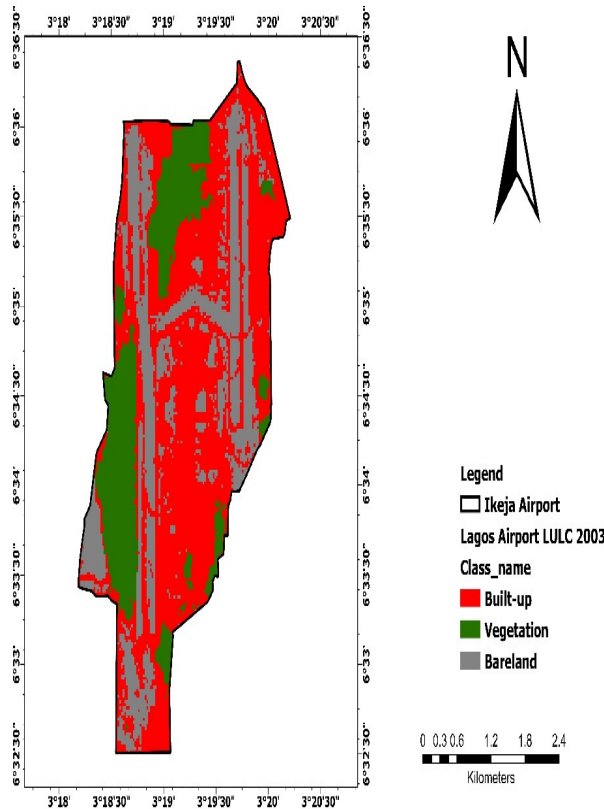


Fig. 12: Land Use Land Cover Change of Lagos Airport for year 2003

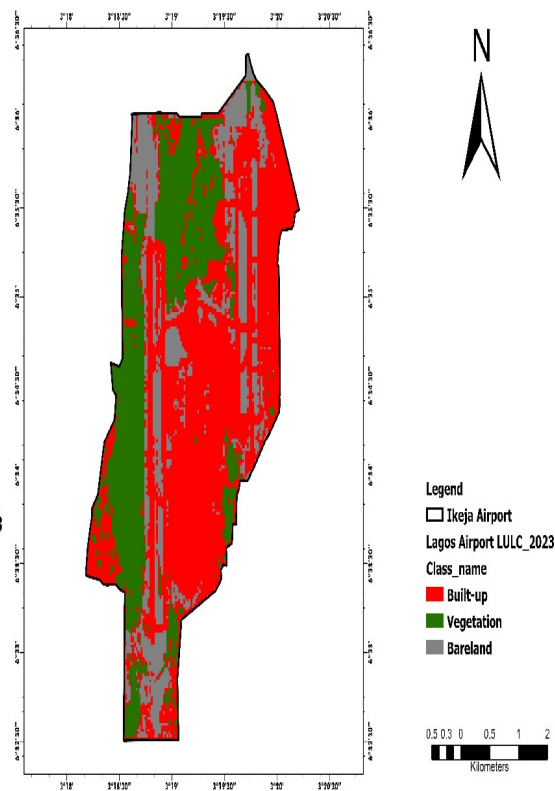


Fig. 13: Land Use Land Cover Change of Lagos Airport for year 2023

Discussion

According to Badamfirooz and Mousazadeh (2019), Land Use Land Cover Changes (LULC) change analyses serve as an important technique for assessing and monitoring LULC changes at global, regional, and local scales. Assessment of LULC changes using previous to current LULC knowledge is vital and efficient to understand, evaluate, and predict different social, economic, and ecological changes (Hussain, 2018).

The implication of forest cover loss in the study has been to anthropogenic, farming and human settlement (Basiru, 2016). The increased in built up areas from 1983 to 2003 and subsequent reduction in 2023 for Akure and Ibadan airports and its surrounding forests might be an indication of erected buildings and airports infrastructural developments. Also, the

vegetation cover increment between 1983 and 2003 and corresponding decreased in bareland might be due to proper protection and prohibition around the airport's properties and surrounding forests. Furthermore, the sudden increase in bareland and sharp declination of vegetation cover can be attributed to physical structures and anthropogenic activities. The result of this study agrees with Basiru (2016) and Onoghejuho *et al.* (2016) that both unstable increase and decrease of forest cover is a result of changes in governance and political influence on forest management. This significant vegetation cover loss to both built-up area and bareland is an indication of man's dominance of the landscape of the studied airports mainly in the year 2003.

In Benin airport and its surrounding forest, land use and land cover assessment reveals that built up areas as well reduced between 1983 and 2003 but later increased in 2023. The sudden increased of the built up areas might be due to expansion of the airport physical structure in terms of infrastructure development and subtle anthropogenic activities. Also, the increased in bareland in 2003 had a corresponding effect (reduction) in vegetation covers in 2003 and subsequent reduction in bareland in 2023. Consequently, an increase in vegetation covers of Akure airports surrounding forest was acknowledged. This latest development might be related to the law, protection and prohibition of people from trespassing government properties to carry any activities, while the sudden increase in bareland in the year 2003 might due to anthropogenic activities around the airports before the pronouncement of the protection law. This result similar to Basiru (2023) assessment of REDD⁺ pilot sites in Cross River state, Nigeria.

In Lagos airports and its environed land use and land cover changes assessment, the city has grown into a compact urban agglomeration especially where built-up area has become bigger and more aggregated. There has been an extensive urban expansion across the city, ranging from development of new residential areas and modern infrastructural facilities such as roads, developed for residential, educational, commercial, industrial, shop-let, petroleum stations civic and cultural uses. The observed change in urban LULC pattern was quite significant especially in the built-up area which is not under 800ha between 1983 and 2023. The reduction in vegetation cover from 316.05ha in 1983 to 292.23ha in 2003 justifies the

corresponding increased bareland coverage 409.52ha in 2003 from 332.67ha in 1983. The subsequent increase in vegetation cover and reduction of bareland coverage in 2023 for Lagos airports and its environed changes might be attributed to strict law, penalty prohibition of populace from the airports for any activity. This result agrees with Muritala (2023) where there is improved vegetation cover in LAUTECH and some other schools in Ogbomosho compared to other unrestricted government parastatals in Ogbomosho metropolis due to conservation law and protection. Also, unexpected increase of bareland and its corresponding vegetation loss in 2003 suggests the domination of man in the study location for that period. This significant temporal change is attributable to increasing urban population growth, which is traceable to Nigeria's much improved socio-economic and political climate. This increase is attributed to increase demand for housing and other related urban land use for sustainable growth and development. The loss of vegetation cover to built-up area in terms of residential and official buildings, infrastructural facilities and industry development have to be put under check in order to balance the needs of the increasing population (Fanani *et al.* 2011; Ige *et al.* 2017).

Conclusion and Recommendation

Land use and land cover changes of some airports surrounding forests in Southwest and South-south geopolitical zones were studied. Vegetation is an integral component of ecosystem, which indicates the effects of changing environmental conditions in an obvious and easily measurable manner. Thus, careful analysis of vegetation types is used

as a means of evaluating useful information about other components and vegetation covers. The Land Use and Land Cover Changes (LULCC) showed that the study locations have been partially disturbed by anthropogenic activities such as logging, farming and encroachment particularly in the year 2003. Consequently, airport authorities in these for states have developed protection and prohibition law and initiative with the help of security arms of government for airports properties, surrounding forests and boundaries for the restoration of the deforested and degraded land in the airports.

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