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# Geospatial Assessment of Spatio-temporal changes in Carbon ($CO_2$) emission and absorption in Akure Airport and Environs

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***Keyword:***
Assessment, Aviation, Carbon Emission, Geospatial, Land Use

**Abstract**
The scope of the research was the geospatial assessment of spatio-temporal changes in carbon ($co_2$) emission and absorption in akure airport and environs in Akure North Local Government Area, Ondo state, using remote sensing method. Data-sets acquired were Akure Airport acquisition boundary and Landsat imageries of different epochs (2020, 2014, 2000, and 1990). Development around aviation land use was mapped over different epochs using maximum likelihood algorithm of pixel based supervised classification. The level of Carbon ($CO_2$) emission in the area was mapped over the study years, in order to determine if these emissions have been increasing over the years, and at what extent it has affected the health of inhabitants. The future extent of non-aviation land use was carried out using linear trend method in order to determine the probable future development and also the Carbon ($CO_2$) emission. The result showed that land use and land cover controls carbon emission and absorption, as the higher the urban area, the higher the carbon emission while the higher the vegetation, the higher the carbon absorption and vice versa. The results showed that the built environment is the major source of carbon in the study area due to several human activities and the net carbon for the year 2030 will be a carbon emission, as the amount of estimated carbon

emission of 3400.09 tonnes will be more than the amount to carbon absorption in the study area.

## Introduction

Airport, also called air terminal, aerodrome, or airfield, site and installation for the take-off and landing of aircraft. Airports are built to have paved runways and maintenance facilities and serves as a terminal for passengers and cargo (Ashford, 2020). Airports, with the facilities and services they provide, are considered as one the most important parts of the infrastructure required for the regular operation of aircraft. Airports considerably contribute to local economy and employment. However, together with the socioeconomic benefits they offer, environmental costs and impacts are the inseparable results of the operation of airports. Following the increasing demand for air travel of passengers and cargo globally, aviation industry is anticipated to grow further and this means more incentives and driving forces for building new airports or expanding the existing ones, and this will intensify the significance and complexity of environmental and sustainable development concerns (Sameh and Scavuzzi, 2016). According to Wiebusch (2014), airports provide positive contribution to the economic welfare of the region, such as: triggering investments (e.g. runways, buildings, train lines) in a region; providing direct and indirect employment; providing sources of tax revenues (Income, trade, VAT and fuel taxes from the companies/consumers) for regions etc. Airports also provide negative impacts to the environment such as noise, emissions, waste, infrastructure congestions etc., in which one of the most dangerous negative impact is emission of $CO_2$, which have a very negative impact on the global warming.

The anthropogenic negative effects on the Earth's climate are one of the most important environmental issues the aviation industry has faced (Maurice and Lee, 2009). Emissions of greenhouse gasses ($CO_2$) from aircraft, both at ground level and at altitude, can give rise to numerous negative effects on air quality, climate and the ozone layer. The gases and particles emitted from aircraft engines can cause harmful effects in different stages of the flight, from the ground to higher altitudes. At ground level, where airports are involved, one of the adverse effects of aircraft emissions is degradation of the air quality, which may directly impact human health (Andre, 2004). According to the environmental reports and assessments, particulate matters, NOx, HC, SOx, and CO from aircraft engine emissions can affect air quality, health and welfare. Aviation-related emissions in the ground level and airport vicinities do not limit to aircraft emissions; ground support equipment are other contributors. This means that air pollution from the airport ground-service vehicles, as well as the airport surface access systems should be considered as part of the environmental burden of the airports (Sameh and Scavuzzi, 2016).

Greenhouse gases trap heat and make the planet warmer (United States Environmental Protection Agency, 2019). According to the European Centre for Medium-Range Weather Forecast (2017), there are both natural and human sources of carbon dioxide emissions. Natural sources include decomposition, ocean release and respiration. Human sources come from activities like cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas. Due to human activities, the atmospheric concentration of carbon dioxide has been rising extensively since the Industrial Revolution and has now reached dangerous levels not seen in the last 3 million years. Human sources of carbon dioxide emissions are much smaller than natural emissions but they have upset the natural balance that existed for many thousands of years before the influence of humans. This is because natural sinks remove around the same quantity of carbon dioxide from the atmosphere than are produced by natural sources.. This had kept carbon dioxide levels balanced and in a safe range. But human sources of emissions have upset the natural balance by adding extra carbon dioxide to the atmosphere without removing any. Since the Industrial Revolution, human sources of carbon dioxide emissions have been growing. Human activities such as the burning of oil, coal and gas, as well as deforestation are the primary cause of the increased carbon dioxide concentrations in the atmosphere. 87% of all human-produced carbon dioxide emissions come from the burning of fossil fuels like coal, natural gas and oil. The remainder results from the clearing of forests and other land use changes (9%), as well as some industrial processes such as cement manufacturing (4%)

Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source of greenhouse gas emissions from human activities is from burning fossil fuels for electricity, heat, and transportation United States Environmental Protection Agency, USEPA (2019). It was further stated by USEPA, (2019) that transportation generated 29% of 2019 greenhouse gas emissions, which is the largest share of greenhouse gas emissions. Greenhouse gas emissions from transportation primarily come from burning fossil fuel for our cars, trucks, ships, trains, and planes. Over 90% of the fuel used for transportation is petroleum based, which includes primarily gasoline and diesel. Electricity production generated 25% of 2019 greenhouse gas emissions, which was the second largest share of greenhouse gas emissions. Approximately 62% of electricity comes from burning fossil fuels, natural gas etc. Industry generated 23% of 2019 greenhouse gas emissions, which primarily came from burning fossil fuels for energy, as well as greenhouse gas emissions from certain chemical reactions necessary to produce goods from raw materials. Commercial and Residential generated 13% of 2019 greenhouse gas emissions from businesses and homes arise primarily from fossil fuels, generators, the use of certain products that contain greenhouse gases, and the handling of waste. Agriculture generated 10% of 2019 greenhouse gas emissions, which was from livestock such as cows, agricultural soils, and rice production.

Land Use and Forestry generated 12% of 2019 greenhouse gas emissions), as land areas can act as a sink (absorbing $CO_2$ from the atmosphere) or a source of greenhouse gas emissions.

Kazmeyer (2018) stated that carbon ($CO_2$) is a natural result of life, and a vital part of the growth cycle of plants, too much of it in the atmospheric bubble that surrounds the Earth traps the heat from the sun, raising temperatures on Earth. CO2 is not harmful to health at low concentrations. It is not flammable and will not support combustion. However, at high concentrations $CO_2$ is a recognised workplace hazard where it can cause headaches, dizziness, confusion and loss of consciousness. Carbon dioxide becomes a poisonous gas when there is too much of it in the air human breathe which can lead to central nervous system damage and respiratory deterioration in humans and other breathing creatures.

## The Study Area

Akure airport (Figure 1) is located in Akure North Local Government Area (LGA) of Ondo state, which lies within lies within latitudes and longitudes (7° 15' 40''N, 5° 16' 8''E), (7° 16' 8''N, 5° 19' 3''E), (7° 12' 46''N, 5° 18' 53''E), and (7° 12' 14''N, 5° 17' 19''E). It is bounded by communities which are Oba-Ile, Owode, Eleyewo, Bolorunduro etc. The total land acquired for aviation land use is approximately 32 Sq.km, in which approximately just 3.1Sq.km is being utilized for aviation purpose (Figure 1.1), as calculated from the Akure airport land acquisition map. Akure environs was produced by creating a buffer of 2km from the airport land acquisition, which is regarded as the immediate environs of Akure airport, with a total area of 89 Sq.km. The study area has an average elevation 338 m above the mean sea level. The average annual temperature is 25.3°C. The rainy period of the year lasts for 10 months of the years, with an approximate annual rainfall of 1455mm (Climate-Data, 2020).

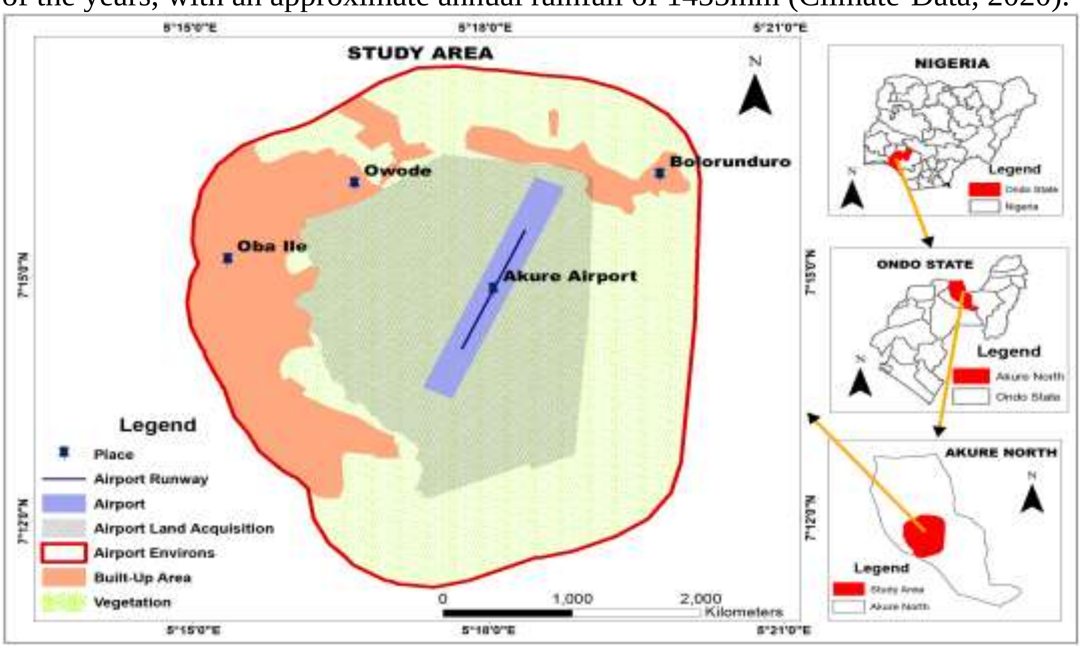


Figure 1.1: Study area map showing Akure airport and its environs.

**Materials and Method**

The dataset used for the research are shown in Table 1 below:

Table 1: The Adopted Data and their Attributes

| **Data** | **Source** | **Year** | **Resolution/Scale** |
|---|---|---|---|
| LANDSAT OLI/TIRS | United State Geological Survey (USGS) | 2020 & 2014 | 30 m |
| LANDSAT ETM+ | United State Geological Survey (USGS) | 2000 | 30 m |
| LANDSAT TM | United State Geological Survey (USGS) | 1990 | 30m |
| Worldview 3 image | Google Earth | 2019 | 1.24 m |
| Administrative map | Office of the Surveyor General of Ondo State | 1978 | 1:1,300.000 |
| Akure airport land acquisition map | Office of the Surveyor General of Ondo State | 1979 | 1:15,000 |
| GPS coordinates | Field Survey | 2020 | - |

Land Use and Land Cover (LULC) was mapped using pixel based classification method. This was carried out using a supervised classification method on the Landsat images. The zipped Landsat images were extracted using WinRAR software, in order to assess the Landsat image bands. Band composite involved the combination of three Landsat image bands to produce a composite image which displayed information (Land use/Land cover) about the area of study on the image using colour codes and interpreted using a visual interpretation. In the research, a false colour composite, which consists bands 7, 5, 3 on Landsat TM/ETM+ and its bands 7, 6, 4 equivalent on Landsat OLI/TIRS was used for mapping the urban areas in the study area, because of its ability to display urban area and other land cover types distinctively (Karanam, 2018; Zha et al., 2003; Prasomsup et al.,2020;Mst-Ilme and Bo (2018). According to USGS (2014), using 7,5,3/7,6,4 band composites, vegetation appeared in shades of dark and light green during the growing season; urban features appeared in white, gray, cyan or purple; sands, soils and minerals appear in a variety of colors. The resultant composite image was 30m resolution. The panchromatic band (Band 8), which has a 15metres resolution, was used to pan-sharpen the low resolution image (composite image), to increase its resolution from 30metres to 15metres, which aided visualization and interpretation of the image during image classification. The boundary in shape file (.shp) format of the Study Area was produced by digitizing the raster image (Akure airport land acquisition plan), in order to obtain a vectorized format of the boundary of Akure Airport. A 2km buffer of the vectorized boundary was then created using the "Buffering Tool" in the ArcGIS environment, which served as the environs of Akure Airport The 2km buffer was then used in sub-setting or clipping the derived images of the various index based algorithm, using ArcGIS software in order to focus on the study area only. A maximum likelihood supervised classification method was used for classifying the land cover types in the image into built environment, bare land, forest, shrub and grass land. Training samples were created for each land cover type by selecting pixels samples for each land cover types. The training samples were then converted into spectral signatures, which was then used to create landcover classes having the same pixels values.

Accuracy assessment was carried out to compare the classified image to ground truth data, in order to determine the level of accuracy of the classified image. This was done using 50 locations (10 samples for each LULC Class). These locations were the points picked with a differential GPS receiver and from a higher resolution image (Worldview image 3) to determine how accurate of classified built-up areas.

## Results and Discussion

Estimation of Carbon Emissions

Land-use carbon emissions was estimated using Equation. 1 in accordance with Cui *et al.*, (2018):

$$\boldsymbol{E_i = \sum e_i = \sum S_i \times \delta_i \times \frac{MCO_2}{M_C}}$$

Equation **1**

*Where;* $\boldsymbol{E_i}$ *= carbon emissions from land use;* $\boldsymbol{i}$ *=refers to the type of land-use;* $\boldsymbol{S_i}$ *= is the area of land i**;** and* $\boldsymbol{\delta_i}$ *is the carbon emission coefficient for LULC type (Table 2), whose positive values indicate carbon emission while negative values indicate carbon absorption;* $M_{CO2}/M_C$ *is the ratio of the mass carbon dioxide molecules to a carbon atom, which is 44/12*

Table 2: Carbon emission coefficients for the land-use types

| S/N | Land-Use Types | Carbon Emmision Coefficient (kg (C)*m$^{-2}$ a$^{-1}$) |
|---|---|---|
| **1** | Forestland | -0.0586 |
| **2** | Shrub | -0.0586 |
| **3** | Grassland | -0.0021 |
| **4** | Bare land | -0.0005 |
| **5** | Built Environment | 2.38 |

Source: Cui *et al* (2018); Rong *et al* (2020).

**Forecast for the probable future extent built-up areas and the value of land**

The probable future spatial extent of land use and land cover types, the value of land and carbon emission/absorption was carried out using the linear trend method of forecasting on Microsoft Excel, in order to determine their respective states in the year 2030

**Assessment of the Spatio-temporal Changes in the Carbon Emission/Absorption in the study area from 1990 to 2000.**

Table 2 shows the land use and land cover (LULC) data of the study area. Based on the data in Table 2, the land-use specific carbon emissions (Carbon Sources) and absorptions (Carbon Sinks), the total carbon emissions and absorptions, and the net carbon emissions (which is the total carbon emissions minus the total carbon absorptions) were estimated and shown in Table 3.

Table 2: Area of Coverage of LULC within Akure airport and its environs

| Land Cover | Area (Sq.km) 1990 | % | Area (Sq.km) 2000 | % | Area (Sq.km) 2014 | % | Area (Sq.km) 2020 | % |
|---|---|---|---|---|---|---|---|---|
| Bare Land | 7.0 | 7.9 | 5.1 | 5.7 | 7.3 | 8.2 | 14.4 | 16.2 |
| Built Environment | 5.8 | 6.5 | 8.0 | 8.9 | 9.6 | 10.8 | 12.6 | 14.2 |
| Forest | 59.8 | 67.2 | 24.2 | 27.2 | 32.8 | 36.9 | 23.4 | 26.3 |
| Grass Land | 5.0 | 5.7 | 22.2 | 25.0 | 18.1 | 20.3 | 16.8 | 18.8 |
| Shrub | 11.3 | 12.7 | 29.5 | 33.2 | 21.2 | 23.8 | 21.8 | 24.5 |
| **TOTAL** | **89.0** | **100.0** | **89.0** | **100.0** | **89.0** | **100.0** | **89.0** | **100.0** |

**Table 3: Carbon Emission (+) / Absorption (-) in Tonnes**

| Year | Forest | Shrub | Grass Land | Bare Land | Built Environment | Total Carbon Emission | Total Carbon Absorption | Net Carbon Emission/ Absorption |
|---|---|---|---|---|---|---|---|---|
| 1990 | -13552.18 | -2560.86 | -3.88 | -1.30 | 5107.48 | 5107.48 | -16118.22 | -11010.74 |
| 2000 | -5487.61 | -6686.71 | -17.25 | -0.94 | 7008.43 | 7008.43 | -12192.51 | -5184.07 |
| 2014 | -7444.84 | -4796.38 | -14.07 | -1.35 | 8414.40 | 8414.40 | -12256.63 | -3842.24 |
| 2020 | -5301.60 | -4941.20 | -13.02 | -2.66 | 11113.00 | 11113.00 | -10258.48 | 854.52 |

The positive carbon values correspond to carbon emission (carbon discharge), while negative values correspond to carbon absorption (Carbon sink). Figure 2 to 5 showed the distribution of LULC specific carbon emissions and absorptions of Akure airport and its environs.

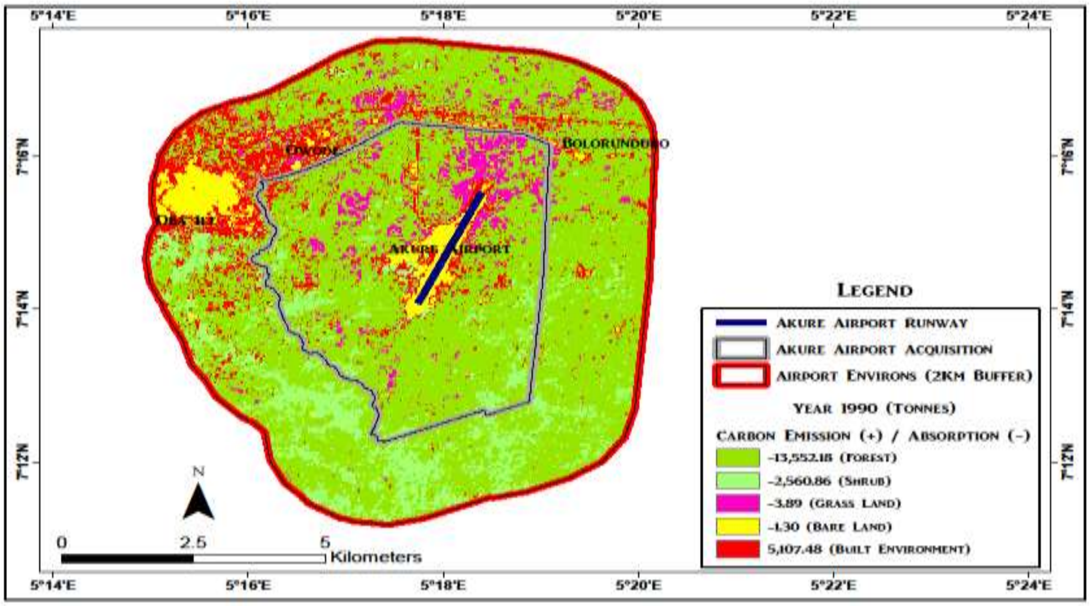


Figure 2: Map showing the distribution of carbon emission and absorption in the study area for the year 1990

Figure 2 showed the distribution of carbon emission and absorption in the year 1990, which showed carbon absorption are larger within and outside Akure airport due to the dominant vegetation (Forest, shrub and grassland), while carbon emission were dominant in the built environment (Oba Ile, Owode and Bolorunduro). It was deduced that forest had the highest carbon absorption with -13,552.18 tonnes of $CO_2$ which are located within and outside the airport. The second LULC with the highest $CO_2$ was shrub with -2560.86 tonnes. Grass land and bare land has -3.89 tonnes and -1.30 tonnes respectively. Built environment was the only LULC with carbon emission with 5107.48 tonnes.

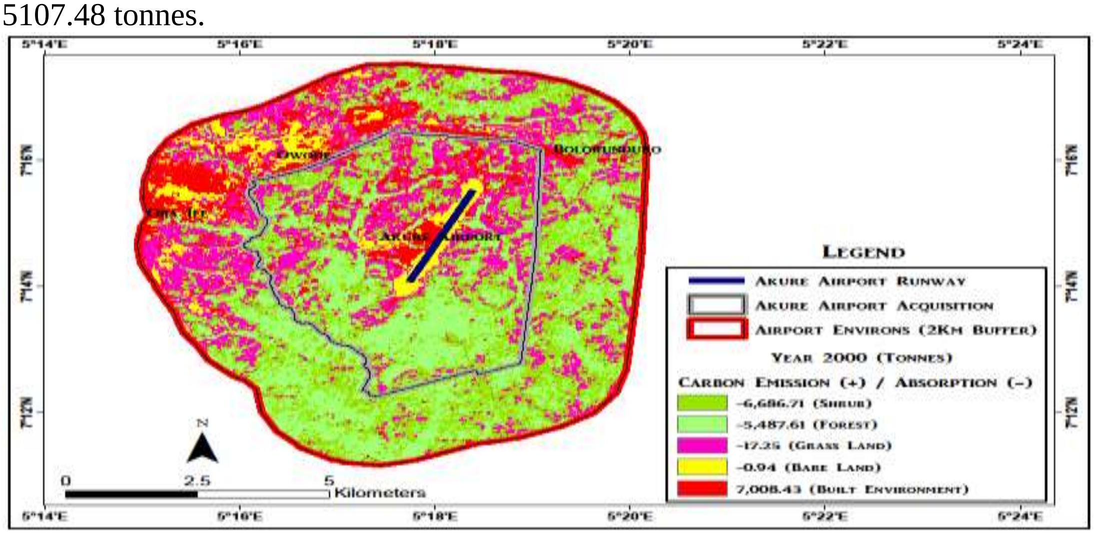


Figure 3: Map showing the distribution of carbon emission and absorption in the study area for the year 2000

Figure 3 showed the distribution of carbon emission and absorption in the year 2000, which showed carbon absorption were also larger within and outside Akure airport due to the dominant vegetation (Forest, shrub and grassland), while carbon emission were dominant in the built environment (Oba Ile, Owode and Bolorunduro).

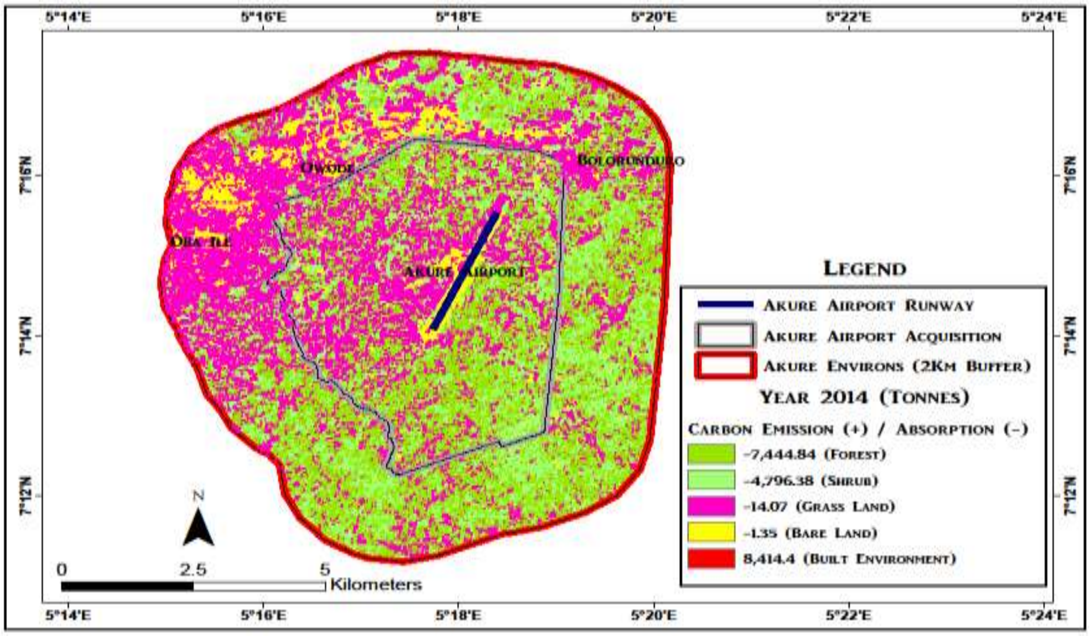


Figure 4: Map showing the distribution of carbon emission and absorption in the study area for the year 2014

In the year 2000, it was deduced that shrub had the highest carbon absorption with -6686.71 tonnes of $CO_2$ which are located within and outside the airport. The second LULC with the highest $CO_2$ was forest with -5,487.61 tonnes. Grass land and bare land had has -17.25 tonnes and -0.94 tonnes respectively. Built environment was also the only LULC with carbon emission with 7008.43 tonnes.

Figure 4 showed the distribution of carbon emission and absorption in the year 2014, which showed carbon absorption were larger within and outside Akure airport due to the dominant vegetation (Forest, shrub and grassland), while carbon emission were dominant in the built environment (Oba Ile, Owode and Bolorunduro). In the year 2014, it was deduced that forest had the highest carbon absorption with -7444.84 tonnes of $CO_2$ which are located within and outside the airport. The second LULC with the highest $CO_2$ was forest with -4,796.38 tonnes. Grass land and bare land had has -14.07 tonnes and -1.35 tonnes respectively. Built environment was also the only LULC with carbon emission with 8,414.4 tonnes.

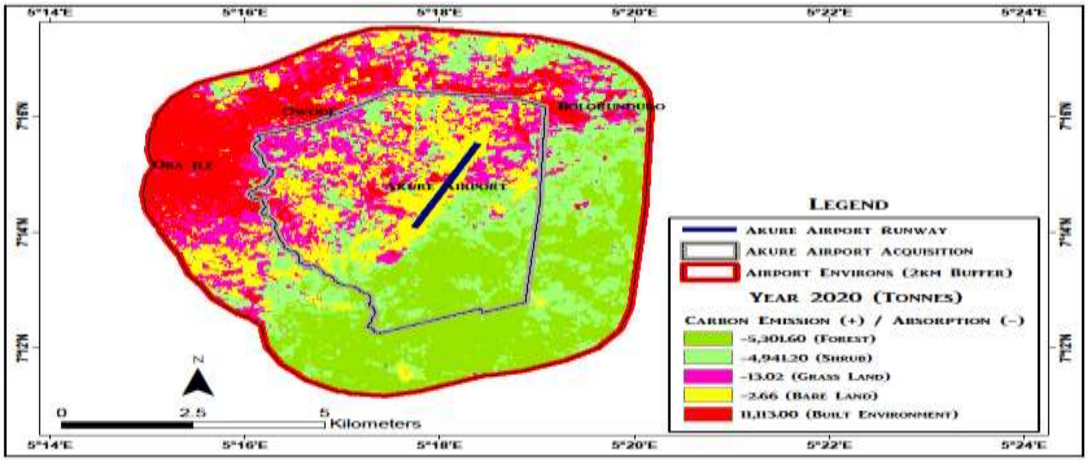


Figure 5: Map showing the distribution of carbon emission and absorption in the study area for the year 2020

Figure 5 showed the distribution of carbon emission and absorption in the year 2020, which showed that higher carbon absorption were larger in the western part of the study area due to the dominant vegetation (Forest, shrub and grassland), while carbon emission were dominant in the built environment (Oba Ile, Owode and Bolorunduro). In the year 2020, it was deduced that forest had the highest carbon absorption with -5301.60 tonnes of $CO_2$ which are located within and outside the airport. The second LULC with the highest $CO_2$ was forest with -4941.20 tonnes. Grass land and bare land had has -13.02 tonnes and -2.66 tonnes respectively. Built environment was also the only LULC with carbon emission with 11,130.00 tonnes.

**Trend of Carbon Emission and Absorption in Akure Airport and Environs.**

In the year 1990, the carbon absorption for forest was -13552.18 tonnes, and it reduced to -5487.61 in the year 2000, then increased to -7444.84 tonnes in the year 2014 but decreased to -5301.60 tonnes in the year 2020 (Figure 6).

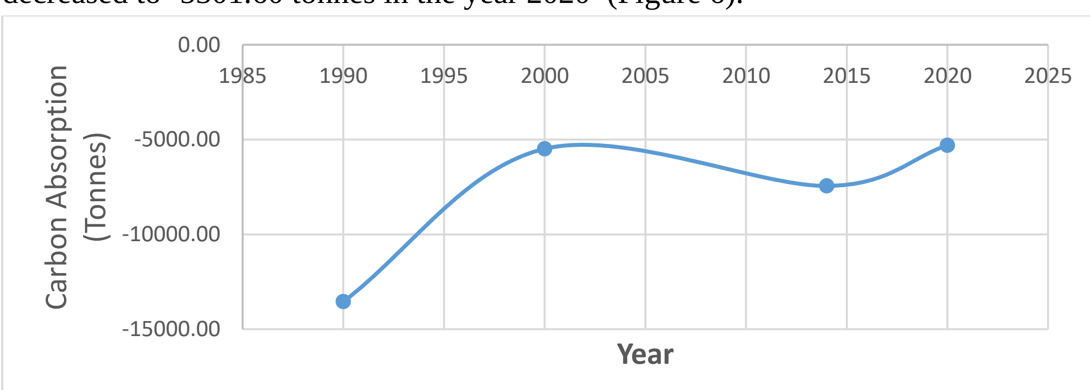


Figure 6: Carbon absorption of forest from 1990 to 2020

In the year 1990, the carbon absorption for shrub was -2560.86 tonnes, and it increased to -6686.71 in the year 2000, then decreased to -4796.38 tonnes in the year 2014 and slightly increased to -4941.20 tonnes in the year 2020 (Figure 7).

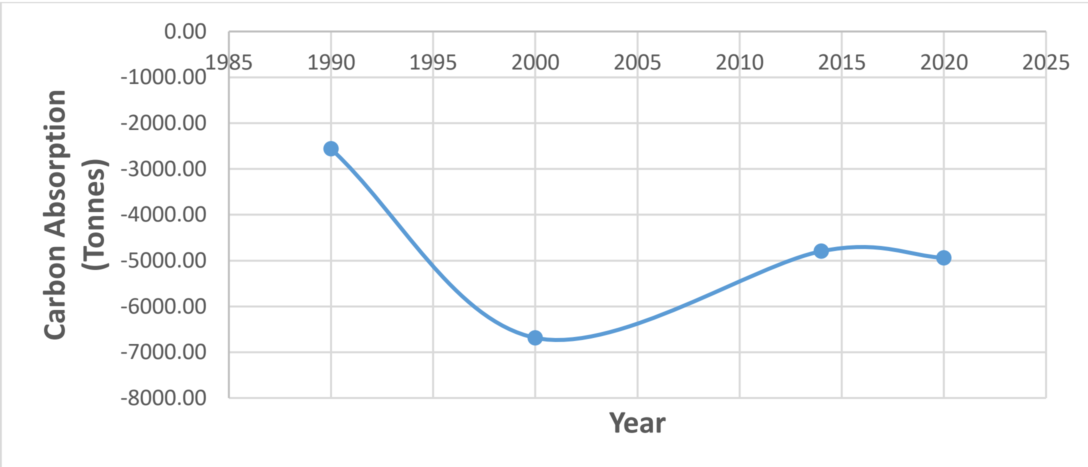


Figure 7: Carbon absorption of shrub from 1990 to 2020

In the year 1990, the carbon absorption for grass land was -3.88 tonnes, and it increased to -17.25 in the year 2000, then decreased to -14.07 tonnes in the year 2014 and further decreased to -13.02 tonnes in the year 2020 (Figure 8).

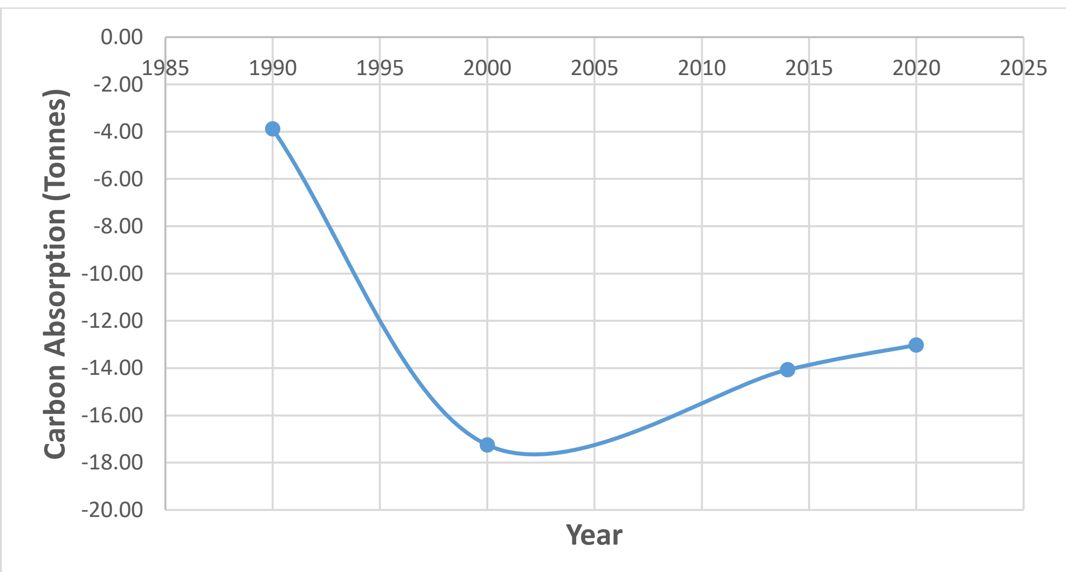


Figure 8: Carbon absorption of grass land from 1990 to 2020

In the year 1990, the carbon absorption for bare land was -1.3 tonnes, then it decreased to -0.94 in the year 2000, but it increased to -1.35 tonnes in the year 2014 and further increased to -2.66 tonnes in the year 2020 (Figure 9).

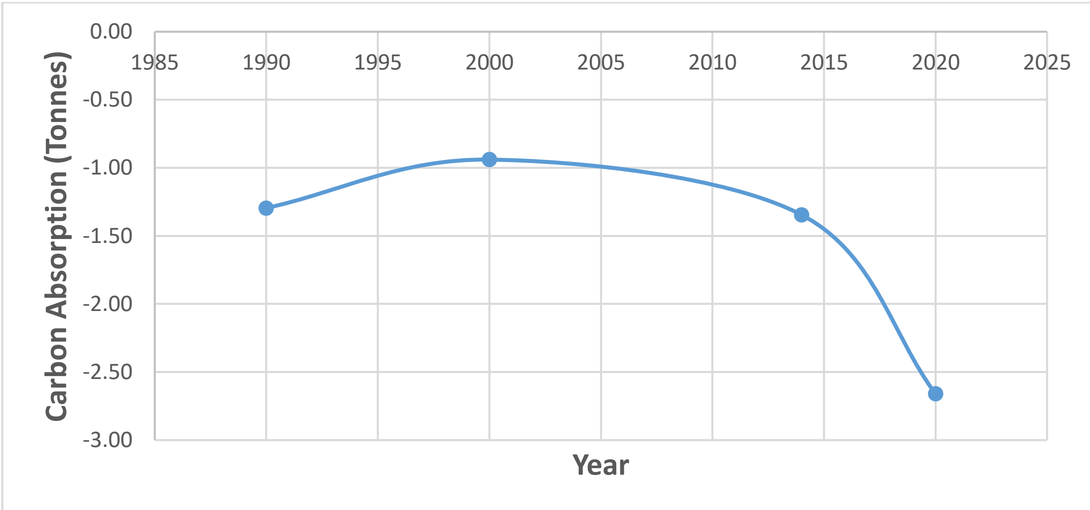


Figure 9: Carbon absorption of bare land from 1990 to 2020

In the year 1990, the carbon emission for built environment was 5107.48 tonnes, and it increased to 7008.43 tonnes in the year 2000, and further increased to 8414.40 tonnes in the year 2014 and finally increased to 11113.00 tonnes in the year 2020 (Figure 10).

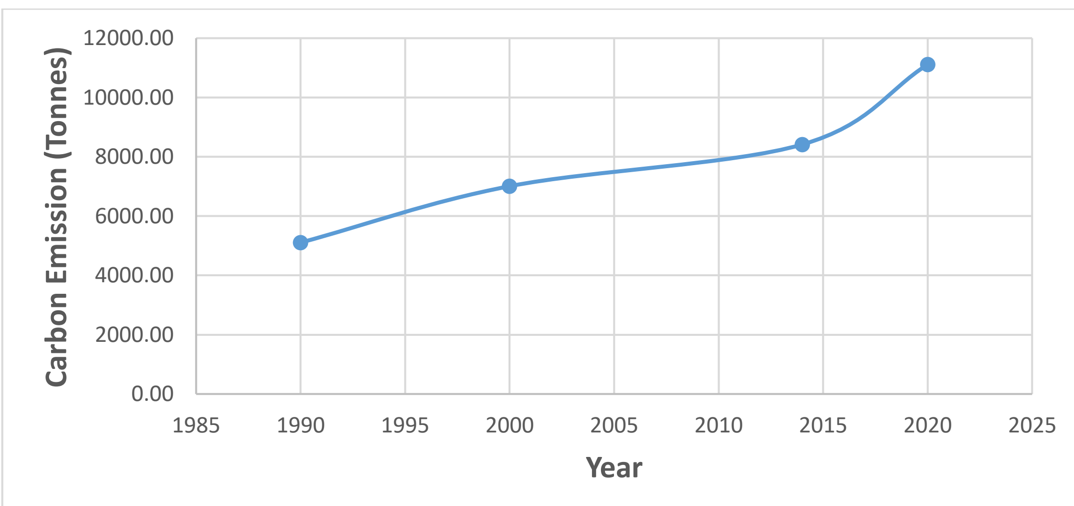


Figure 10: Carbon emission of bare land from 1990 to 2020

**Net Emission/absorption**

The net carbon emission/absorption in the year 1990 was -11010.74 tonnes (Table 3 and Figure 11) signified absorption in the study area due to higher coverage of vegetation (Forest, Shrub and grass land), as they are they absorb more carbon from the atmosphere.

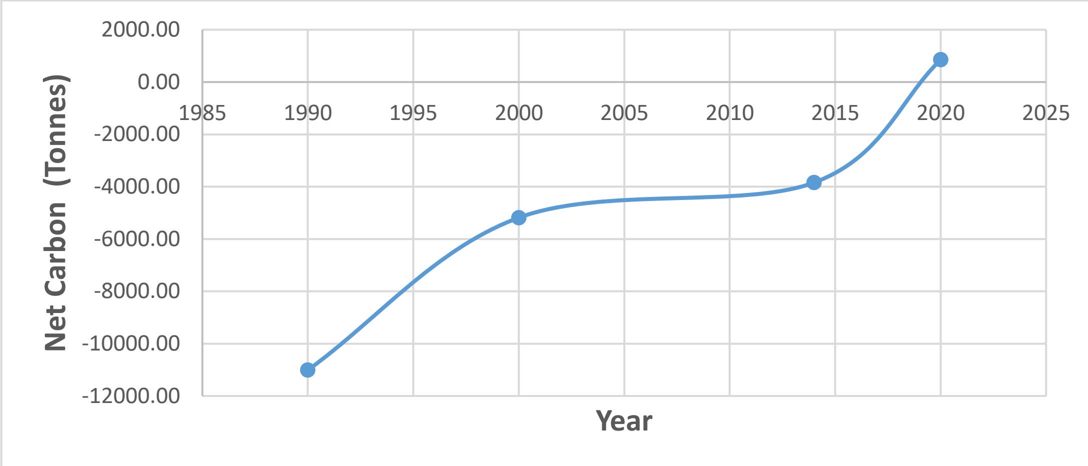


Figure 11: Net Carbon Emission/Absorption from 1990 to 2020 in the study area.

In the year 2000, the carbon was -5184.07 tonnes, which also signified carbon absorption but lower to the year 1990 due to gradual increase in built environment within the airport and its environs. In the year 2014, carbon absorption further declined to -3842.24 tonnes due to the decrease in vegetation and increase in urban land (Built environment), in which human activities such as consumption of fuel from automobiles and aircraft in the study area. In the year 2020, the net carbon 854.52 tonnes, which signified carbon emission, which implied that carbon emission was greater than carbon absorption. It signified that the carbon produced from human activities within Akure airport and its environs is greater than the amount of carbon absorbed by the vegetation within the study area. The result showed that land use and land cover controls carbon emission and absorption, as the higher the urban area, the higher the carbon emission while the higher the vegetation, the higher the carbon absorption and vice versa.

**A look at possible Net Carbon ($CO_2$) emission and absorption in Akure Airport and Environs for the year 2030**

As earlier discussed and shown in Table 3, the net carbon within Akure airport and its environs from year 1990 to 2020 was changing from carbon absorption to carbon emission, as the value for the net carbon in the study area was -11010.74 tonnes in the year 1990, which was carbon absorption, and it reduced to -5184.07 tonnes in the year 2000, and further reduced to -3842.24 tonnes in the year 2014, and the net carbon was converted to carbon emission, as total carbon emission was more than the total carbon absorption in the study area, in which the net carbon was 854.52 tonnes. In view of this, forecast of the trend of the net carbon emission/absorption for the year 2030 was carried out using the previous data, in which linear trend method of forecast was used (Table 4 and Figure 12).

Table4: Possible Net Carbon Emission and Absorption in the year 2030

| Year | Net Carbon Emission/Absorption |
|---|---|
| 1990 | -11,010.74 |
| 2000 | -5,184.07 |
| 2014 | -3,842.24 |
| 2020 | 854.52 |
| 2030 | 3,400.09 |

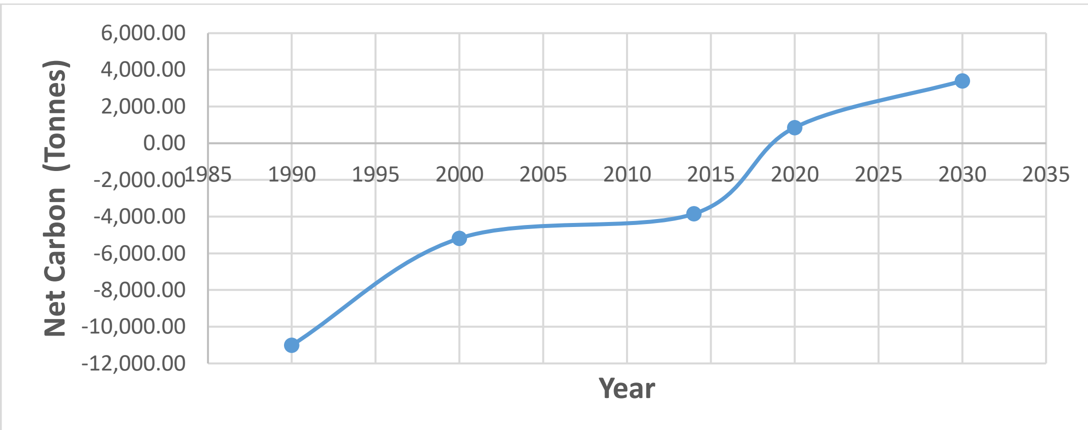


Figure 12: Possible Net Carbon Emission/Absorption in the year 2030

**Conclusion**

The results showed that the net carbon for the year 2030 will possibly be a carbon emission, as the amount of carbon emission will be more than the amount to carbon absorption in the study area. The net carbon emission for the year 2030 was estimated to be 3400.09 tonnes. From this result, it was further inferred that the higher the built environment, the higher the carbon emission, as built environment is the major source of carbon in the study area due to several human activities. As urban development was increasing in the study area, human activities was also increasing, in which these activities were sources of carbon ($CO_2$), which made the urban area the major source of carbon, which was regarded as carbon emission. From the results obtained, it was observed that in the year 1990, the carbon emission was far greater than carbon absorption, due to low urban areas in the study area and high vegetation (Forest, shrub and grassland), in which vegetation absorb carbon ($CO_2$), was predominant. Over the years (from years 1990 to 2000), development was on the increase within the airport as aircrafts are landing and taking off, and also, in the airport environs as residential, commercial, industrial land uses were springing up, which attracted more population and increased human activities such as burning of fuel and diesel through vehicles, usage of generators, use of gas cooker, human breathing out $CO_2$ etc,. therefore increasing carbon emission, and reduction of carbon adsorption from vegetation due to vegetation depletion. From the results obtained, it revealed that carbon absorption was reduced between 1990 and 2000 but increased slightly between year 2000 and 2014 and declined to its lowest in 2020 due to decline in vegetation, while carbon emission kept on increasing from 1990 to 2000, due to increased built environment and increased operation in Akure airport, and other human activities, which resulted in increased carbon emission. Finally, the net carbon emission/absorption table revealed that carbon absorption was dominant in 1990 within Akure airport and its environs but the dominance kept on reducing over the years, and in the year 2020, the carbon emission became dominant as carbon emission was greater that carbon absorption. It was thus concluded that increase in development was responsible for most of the carbon emissions in the Akure Airport and its environs, and according to Cui *et al.*, (2018), urban development is the major source of carbon emission, which is consistent with previous studies. Kazmeyer (2018) further explained that the major threat from the increased $CO_2$ is the greenhouse effect which traps the sun's heat energy in the atmospheric bubble, thereby warming the planet and oceans, which implied that increase in carbon emission in Akure airport and its environs will lead to increase in atmospheric temperature and deteriorate the climatic condition in the area.

## Recommendation

The obtained results of this study further revealed that in the year 2030, urban development (Built environment) will continue to increase, which will lead to increase in demand of land and increase in value of land. The increase will therefore lead to the increase in the net carbon emission within Akure airport and its environs in the year 2030**.** It is thus recommended that the inevitable urban expansion should be monitored controlled in the study area; control measures such reafforestation where lost vegetation are replaced such as tree planting, horticultural activities, and deforestation factors where bush burning of all types are strictly curtailed must be enacted. Vegetation are known to absorb carbon dioxide thus policies on carbon emission control in diversities are recommended to be put in place.

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