GEOSPASTIAL ASSESSMENT OF THE LAND USE/LAND COVER DYNAMICS OF LAGOS STATE, NIGERIA BETWEEN 2000 AND 2020.

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Abstract

The study assessed the effect of Land Use/Land Cover dynamics on the hydrological system of Lagos state, Nigeria. Landsat Operational Land Imager (OLI)/Thermal Infrared Sensor (TIRS), Enhanced thematic mapper (ETM) and Thematic Mapper (TM) for the years 2000, 2013 and 2020 were respectively acquired for the study. These were processed and maximum likelihood method of supervised image classification algorithm was used for classify the the study area into LULC types. Precipitation (Rainfall), Potential evapo-transpiration, and runoff were the selected hydrological components adopted for the study years. The hydrological variation in relation to the LULC dynamics in the study area were determined and analysed using trend analysis to know how the changes in LULC have been affecting the hydrological system in the study area over the years. The analysis of the land use/land cover types, shows that built environment experienced a continuous development and urban expansion. Also, of the three hydrological components examined, rainfall and surface runoff have increased in direct proportion over the study years, while potential evapo-transpiration decreased. It was concluded that the increase in built environment, the decline in the natural land cover classes and the increase in rainfall in the study area led to increase in surface runoff which led to water overflow (flood), while the increase in potential evapo-transpiration was due to increase in water body and forest land cover, and a decrease in built environment. The adoption of the findings to improve water drainage system in the study area were recommended.

Keywords: *Analysis, Classification, Dynamics, Hydrological System, Landuse/Landcover*

Introduction

Humans have exerted large-scale changes on the terrestrial biosphere, primarily through land-use/land-cover (LULC) and climate change (CC). Optimal and sustainable water resource management requires an understanding of the impacts of LULC and climate changes on the hydrological cycle and water balance (Xia and Yongqin (2001). The impacts of land-use/land cover changes (LULCC) on the ecosystem especially the land and atmospheric components of the hydrological cycle at regional and global climate levels are increasingly recognized (Ayeni *et al*, 2015, Ogunlade 2021). These impacts on may surpass those of climate change if those that are human-induced are not addressed and remedial action taken (Xia and Yongqin (2001). Over the years, increase in population and human activities such as converting one land use/land cover (converting the natural land such as forest, wetland etc. to impervious surfaces such as roads, buildings etc.) to the other which have been altering the natural process of ecosystem (Ogunlade et el., 2021a).

Land use research programs at a global scale have become central to international climate and environmental change research since the launch of land use and land cover (LULC) change project (Han *et al*, 2015). LULC has two separate terminologies that are often used interchangeably (Rawat and Kumar, 2015). According to Liping (2018), land cover refers to the biophysical characteristics of earth's surface, including the distribution of vegetation, water, soil, and other physical features of the land. While land use refers to the way in which land has been used by humans and their habitat, usually with an emphasis on the functional role of land for economic activities. Singh (2017) also stated that the terms land use and land cover are often used interchangeably, but each term has its own unique meaning. Land cover refers to the surface cover on the ground like vegetation, urban infrastructure, water, bare soil etc. (Table 2.1), and land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture (Singh, 2017). Singh, 2017 highlighted some land cover types and their respective land use classes. *Urban or Built-up Land* comprises Residential, Commercial and Services, Industrial, Communications and Utilities, Mixed Urban or Built-up Land, Other Urban or Built-up Land;

Forest Land comprise Deciduous Forest Land; Evergreen Forest Land; Mixed Forest Land; *Waterbody* comprise Rivers, Streams and Canals, Lakes, Reservoirs, Bays and Estuaries; *Wetland* comprise Forested Wetland; Non forested Wetland; *Barren Land* comprise Dry Salt Flats, Beaches, Sandy Areas Other than Beaches, Bare Exposed Rock; Strip Mines, Quarries, and Gravel Pits; Transitional Areas, Mixed Barren Land; *Rangeland* comprise Herbaceous Rangeland, Shrub and Brush Rangeland, Mixed Rangeland

The modification of Earth's terrestrial surface by human activities is commonly known as Land use/land cover change (LULCC) around the globe. Although modification of land by humans to obtain livelihoods and other essentials has been there for thousands of years, the extent, intensity and rate of LULCC are far greater now than were in the past. These changes are driving forces for local, regional and global level unprecedented changes in ecosystems and environmental processes (Hassan *et al*, 2016). For instance, in terms of urbanization, a large amount of agricultural / forestry land has been transformed into urban land, and mining activities / oil exploitation have occurred worldwide to meet the demands of people and can directly and obviously lead to the LUCC (Liping, 2018).

Land use and land cover changes occur constantly and at many scales, and can have specific and cumulative effects on air and water quality, watershed function, generation of waste, extent and quality of wildlife habitat, climate, and human health (United States Environmental Protection Agency, 2021). According to Mzuza *et al* (2018), land use and land cover changes have significant environmental consequences at local, regional, and global scales. These changes have intense implications at the regional and global scales for global loss of biodiversity, distresses in hydrological cycles, increase in soil erosion, and sediment loads. The United States Global Change Research Program (2018) further stated that changes in land cover continue to impact local- to global-scale weather and climate by altering the flow of energy, water, and greenhouse gases between the land and the atmosphere. Reforestation can foster localized cooling, while in urban areas, continued warming is expected to exacerbate urban heat island effects.

The study area, which is the most populous state in Nigeria and the African continent, having a projected population of 21 million in the year 2021 (Italoye, 2021), and one of the fastest growing cities in the world (Lees *et al*, 2015) is

experiencing a continuous built up land area, evident by sprawls in Local Government Areas (LGA's) situated next to Eastern and Western city limits in the study area, and beyond Northern limits, spilling into the LGAs in adjoining State (Pacetti *et al*, 2012). The increase in urban areas due to land reclamation is adding more pressure on the hydrological system in the area, as natural ecosystems like wetland and water body are being converted into built environment. Therefore, this study was carried out to assess the level of variation of the hydrological system due to the increase of human activities in terms of Land use/Land cover change.

The Study Area

The study area, Lagos state (Figure 1) is one of the thirty six states in Nigeria, which is a major African financial centre approximately lies within the latitudes and longitudes (6°42'N, 3°16'E), (6°41'N, 4°05'E), (6°23'N, 4°21'E), and (6°23'N, 2°42'E), with an area of 3449.4 square kilometres. It has the fourth-highest GDP in Africa and houses one of the largest and busiest seaports on the continent. It is one of the fastest growing cities in the world .

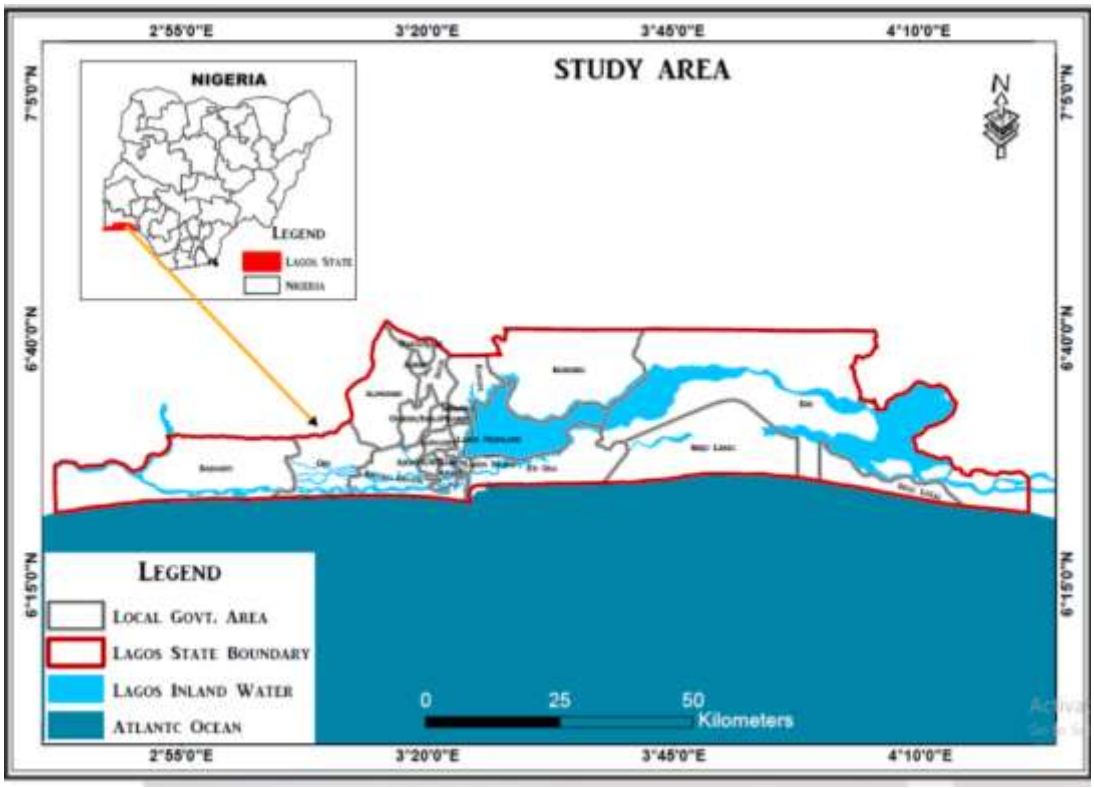

Figure 1: Map of the study area

The wet season starts in April and ends in October, while the dry season starts in November and ends in March. The highest wet month is June with precipitation total 315.5 millimetre or 12.42 inches, while the highest dry month is January with precipitation total 13.2 millimetre or 0.52 inches. Located near the equator, It has only a slight seasonal temperature variation, with mean high temperatures ranging from 28.3 to 32.9 °C (82.9 to 91.2 °F). It shares the seasons of the Southern Hemisphere, with highest temperatures in March with a daily range from 32.9°C to 22 °C (91.2 to 75.4 °F), and least hot temperatures in August ranging from 28.3 to 21.8 °C (82.9 to 71.2 °F). (Italoye, 2021, Lees *et al*, 2015)

Materials and Methods

The data acquired for the research are shown in Table 1.

Table 1: Data description

Data	LANDSAT (OLI/TIRS)	LANDSAT (TM)	Worldview 3 image	Administrative map	Ground Coord.
Source	USGS	USGS	Google Earth	OSGOF	Field Survey
Year	2020, 2013	2000	2020		2021
Resolution	32m	32m	1.24m		

[Key: USGS= United State Geological Survey; OSGOF =Office of the Surveyor General Of the Federation]

The Landsat data were processed to ameliorate geometric and rediometric anomalies and converted into LULC by extracting three needed bands 5,4,3 from the Landsat images and combining them using the image analysis tool in ArcGIS 10.5 software environment to form a composite image which were interpreted to distinguish the different LULC classes. To increase the resolution of the composite image for good quality interpretation high-resolution panchromatic band 15m resolution and lower resolution band 30m resolution multispectral imagery were integrated to create a single high-resolution colour image. The boundary in shape file (in .shp format) of the study area was used in sub-setting the enhanced image into the study area. Maximum likelihood

method of supervised image classification algorithm was used for classify the LULC types in the study area into Built Environment, Bare Land, Forest, Shrub, Water Body, Wetland and Grassland and the LULC maps were generated for each of the study years. Post classification processes was carried out by calculating the area of coverage of all the land cover types using the "Field Calculator Tool" on ArcGIS software. The ground coordinates and coordinates of LULC classes obtained from a higher resolution (Worldview image 3) image was compared with the classified image and accuracy assessment parameters were calculated.

Results And Discussion

The dynamics of Land Use/Land Cover (LULC) of Lagos State was assessed between the years 2000 and 2020. The maps of the LULC (Bare land, built environment, forest, shrub, water body, wetland, and grass land) types present in Lagos of 2000, 2013 and 2020 are shown in Figure 2 to 4.

Pattern of the Land use/Landcover

The pattern of the land use/Land cover for each of the study year were analysed as follows:

Year 2000

Figure 2 showed the Land use and land cover (LULC) of Lagos State in the year 2000. In the year 2000, it was observed that built environment was dominant from the North-Western areas to the South-West of Lagos, which consists Local Government Areas (LGA's) including Ifako/Ijaye, Agege, Ikeja, Alimosho, Mushin, Oshodi/Isolo, Mushin, Shomolu, Surulere, Lagos Mainland, Ojo, Ajeromi/Ifelodun, Amuwo-OdofinApapa, Lagos Island, and Eti-Osa. Vegetation (Forest and Shrub) were dominant Ikorodu, Epe, Ibeju-Lekki and Epe LGA's. Grass land was dominant in Badagry, Ojo, Amuwo Odofin, Ibeju Lekki and Epe. Wetland. Wetland was present in every areas of Lagos State, and its most dominant in LGA's which are Badagry, Ojo, Amuwo Odofin, Kosofe, Ikorodu, Eti Osa and Epe in the year 2000. Water Body in Lagos State such as; Five Cowrie Creek, Commodore Channel, Lagos Lagoon etc. cut across all the areas of Lagos State, which are mostly dominant from the central of Lagos State, which are surrounded by LGA's which are; Kosofe, Shomolu,

Lagos Mainland, and Ajeromu/Ifelodun to the Eastern areas of Lagos State (Ibeju Lekki and Epe LGA's).

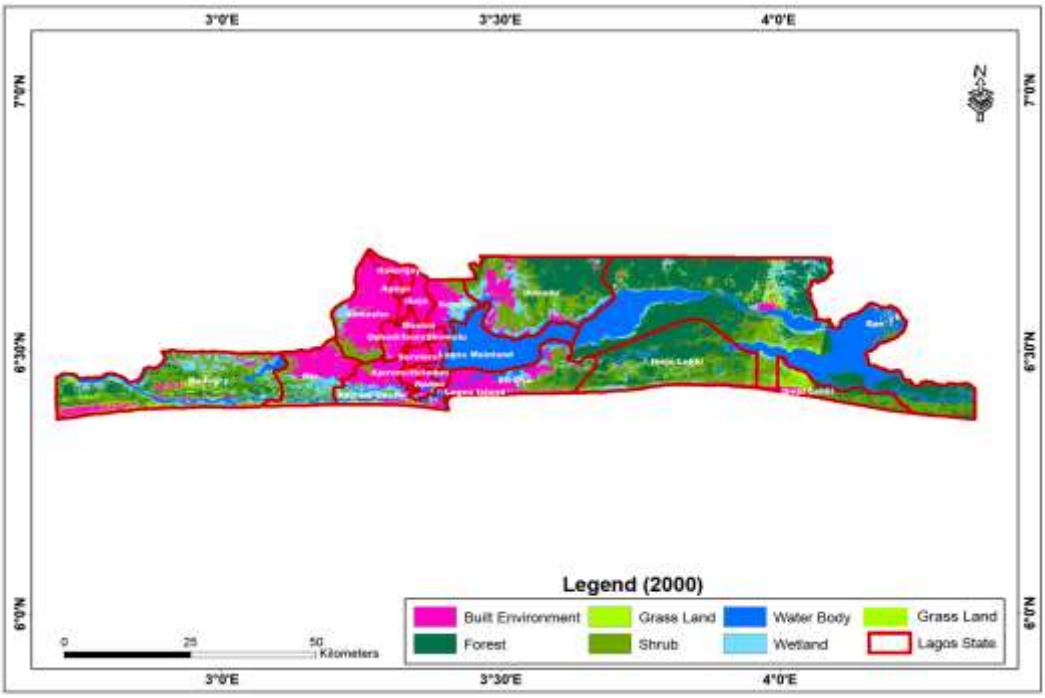

Figure 2: Map showing the Land use and Land cover of Lagos State in the year 2000

Year 2013

Figure 3, showed the land use/land cover (LULC) map of Lagos State in the year 2013. In the year 2013, it was observed that built environment was also dominant from the North-Western areas to the South-West of Lagos, which consists Local Government Areas (LGA's) including Ifako/Ijaye, Agege, Ikeja, Alimosho, Mushin, Oshodi/Isolo, Mushin, Shomolu, Surulere, Lagos Mainland, Ojo, Ajeromi/Ifelodun, Amuwo-OdofinApapa, Lagos Island, and Eti-Osa. Vegetation (Forest and Shrub) were dominant Ikorodu, Epe, Ibeju-Lekki and Epe LGA's. It was observed that built environment was increasing in Ikorodu and Ibeju-Lekki. Grass land was observed to be increasing in Badagry, Ikorodu, Eti Osa and Ibeju Lekki areas of Lagos State. Wetland was also present in every areas of Lagos State, and its most dominant in LGA's which are Ibeju Lekki, Epe and Ojo LGA's in the year 2013. Water Body in Lagos State such as; Five Cowrie Creek, Commodore Channel, Lagos Lagoon etc. cut across all the areas

of Lagos State, which are mostly dominant from the central of Lagos State, which are surrounded by LGA's which are; Kosofe, Shomolu, Lagos Mainland, and Ajeromu/Ifelodun to the Eastern areas of Lagos State (Ibeju Lekki and Epe LGA's).

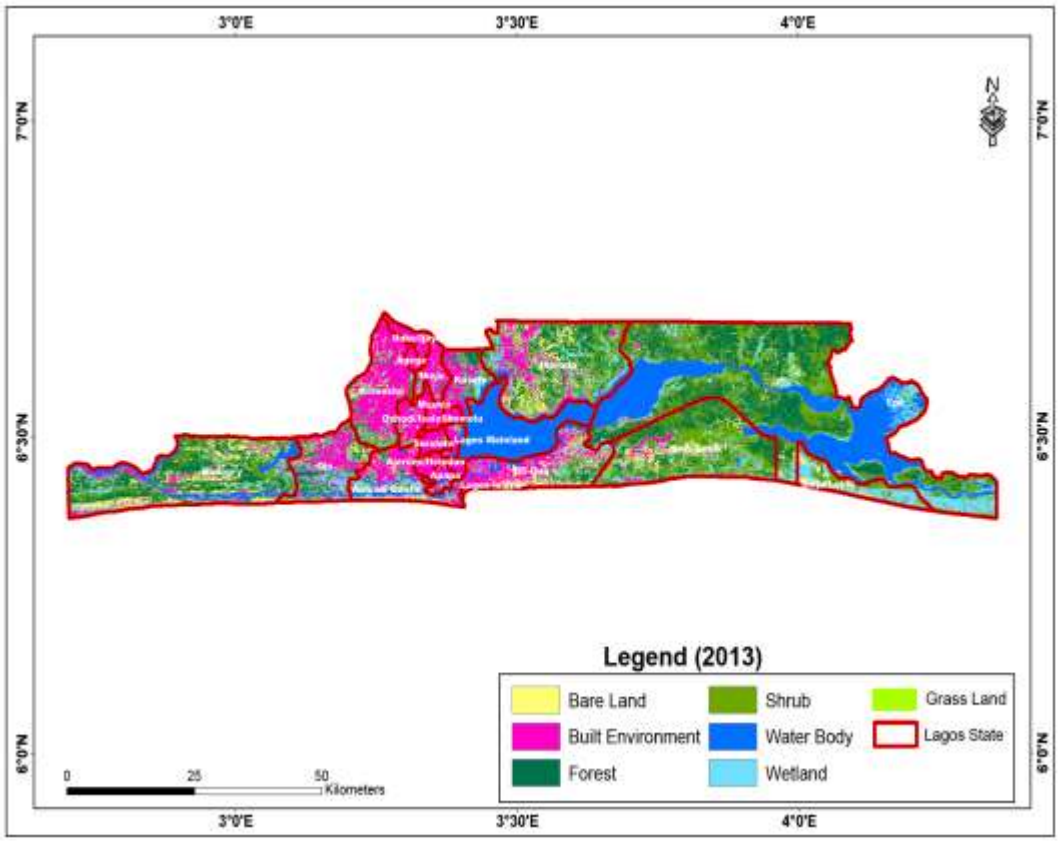

Figure 3: Map showing the Land use and Land cover of Lagos State in the year 2013

Year 2020

Figure 4, showed the land use/land cover (LULC) map of Lagos State in the year 2020, In the year 2020, it was observed that built environment was also dominant at it was in the year 2000 and 2013, from the North-Western areas to the South-West of Lagos, which consists Local Government Areas (LGA's) including Ifako/Ijaye, Agege, Ikeja, Alimosho, Mushin, Oshodi/Isolo, Mushin, Shomolu, Surulere, Lagos Mainland, Ojo, Ajeromi/Ifelodun, Amuwo-OdofinApapa, Lagos Island, and Eti-Osa. Vegetation (Forest and Shrub) were

dominant Ikorodu, Epe, Ibeju-Lekki and Epe LGA's. It was observed that built environment was had increased massively in Ikorodu, Eti-Osa, Ibeju Lekki and Epe. Bareland and Grass land were in Badagry.

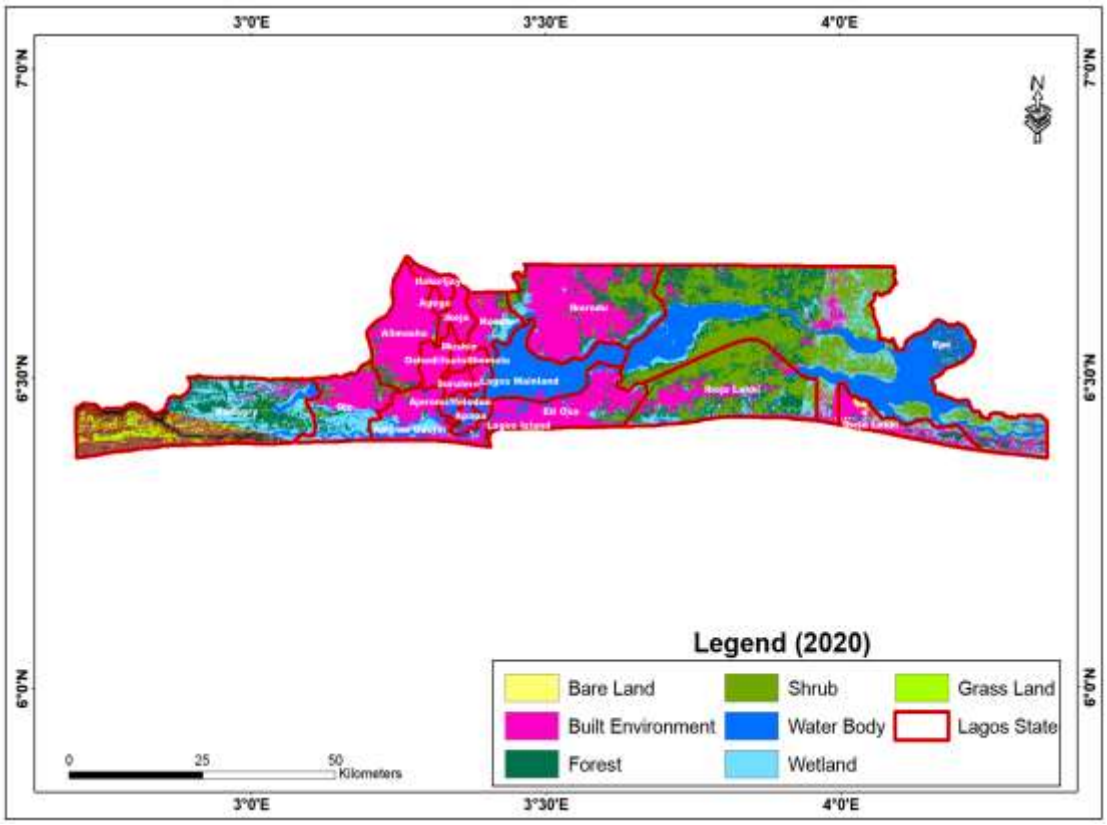

Figure 4: Map showing the Land use and Land cover of Lagos State in the year 2020

Wetland was concentrated in the Western areas of Lagos, in which Badagry, Ojo and Amuwo Odofin were located. Wetland was also prominent in Kosofe, Ikorodu, Ibeju Lekki and Epe areas of Lagos State. Water Body in Lagos State such as; Five Cowrie Creek, Commodore Channel, Lagos Lagoon etc. cut across all the areas of Lagos State, which are mostly dominant from the central of Lagos State, which are surrounded by LGA's which are; Kosofe, Shomolu, Lagos Mainland, and Ajeromu/Ifelodun to the Eastern areas of Lagos State (Ibeju Lekki and Epe LGA's).

Area of coverage of land use/land cover (LULC) of Lagos State from 2000 to 2020.

The spatial extent of the land use/land cover (LULC) types in Lagos state from 1990 to 2000 were calculated and analyzed, in order to assess the Spatio temporal changes of each LULC type in the study area as shown in Table 2.

Year 2000

From Table 2, it was observed that in the year 2000, bare land covered 106.4 Sq.km (2.9%) out of the entire study area (3632.5 Sq.km), built environment covered 688.4 Sq.km (18.9%), forest had the highest coverage with an area of 847.1 Sq.km (23.3%), shrub had an area of 655.3 Sq.km (18.0%), water body covered 812.6 Sq.km (22.4%), wetland covered 460.4 Sq.km (12.7%), and grass land covered 62.4 Sq.km (17.2%) of the total area (Figure 5).

Table 2: Area of Coverage of LULC of Lagos State from 2000 to 2020

Name	2000 (km^2)	%Δ	2013 (km^2)	%Δ	2020 (km^2)	%Δ
Bare Land	106.4	2.9	103.1	2.8	86.1	2.4
Built Environment	688.4	18.9	80	22.1	1082.5	29.8
Forest	847.1	23.3	608.5	16.8	531.1	17
Shrub	655.3	18.0	803.4	22.1	701.9	19.3
Water Body	812.6	22.4	791.0	21.8	773.5	21.3
Wetland	460.4	12.7	440.7	12.1	397.7	10.9
Grass Land	62.4	17.2	81.3	2.2	59.8	1.6
TOTAL	**3632.5**	**100.0**	**3632.5**	**100.0**	**3632.5**	**100.0**

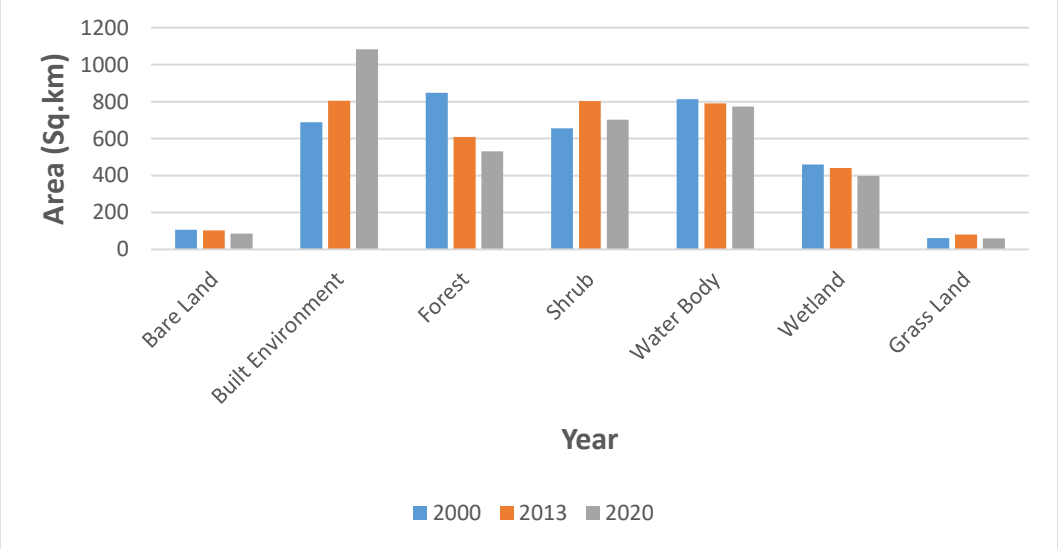

Figure 5: Area of coverage of LULC types in Lagos State

Year 2013

In the year 2013, bare land covered 103.1 Sq.km (2.8%) out of the entire study area (3632.5 Sq.km), built environment covered 80 Sq.km (22.1%), forest had the highest coverage with an area of 608.5 Sq.km (16.8%), shrub had an area of 803.4 Sq.km (22.1%), water body covered 791.0 Sq.km (21.8%), wetland covered 440.7 Sq.km (12.1%), and grass land covered 81.3 Sq.km (2.2%) of the total area (Figure 5).

Year 2020

In the year 2020, bare land covered 86.1 Sq.km (2.4%) out of the entire study area (3632.5 Sq.km), built environment covered 1082.5 Sq.km (29.8%), forest had the highest coverage with an area of 531.1 Sq.km (17%), shrub had an area of 701.9 Sq.km (19.3%), water body covered 773.5 Sq.km (21.3%), wetland covered 397.7 Sq.km (10.9%), and grass land covered 59.8 Sq.km (1.6%) of the total area (Figure 5).

Trend of of land use/land cover (LULC) of Lagos State from 2000 to 2020.

The trend of coverage of each LULC type was also analysed, in order to further assess their changes from 2000 to 2020. The coverage of bare land in the study area was 106.4 Sq.km in the year 2000, but declined to 103.1 Sq.km in the year 2013 and further decreased to 86.1 Sq.km in the year 2020.

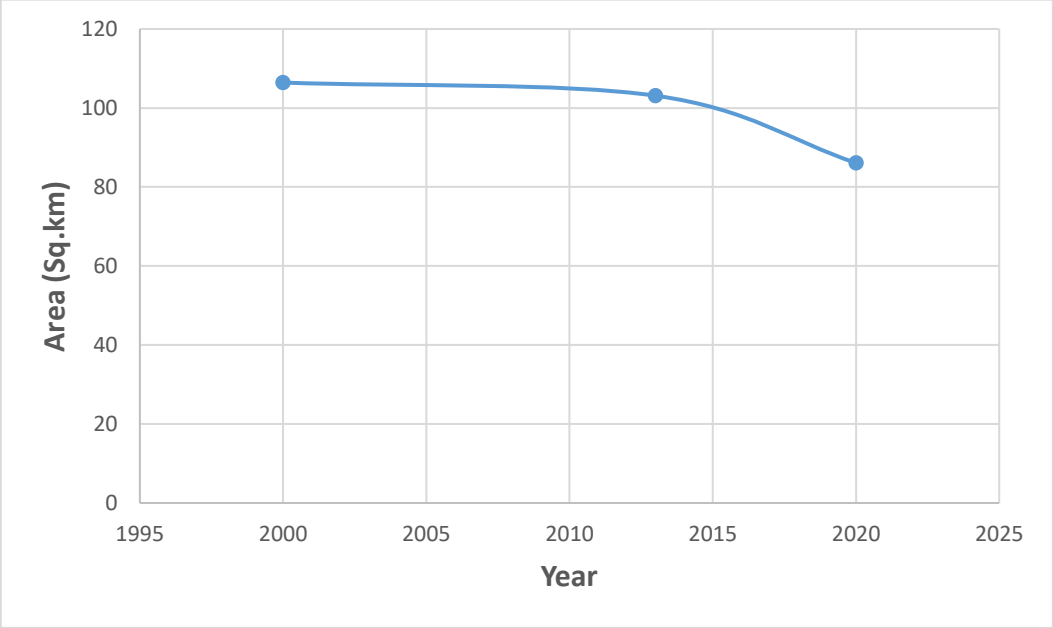

Figure 7: The trend of bare land from 2000 to 2020

Built environment, which indicates urban development experienced increase from 1990 to 2020, as the area of coverage was 688.4 Sq.km in the year 2000, and it increased to 80 Sq.km in the year 2013 and further increased to 1082.5 Sq.km in the year 2020 (Figure 7).

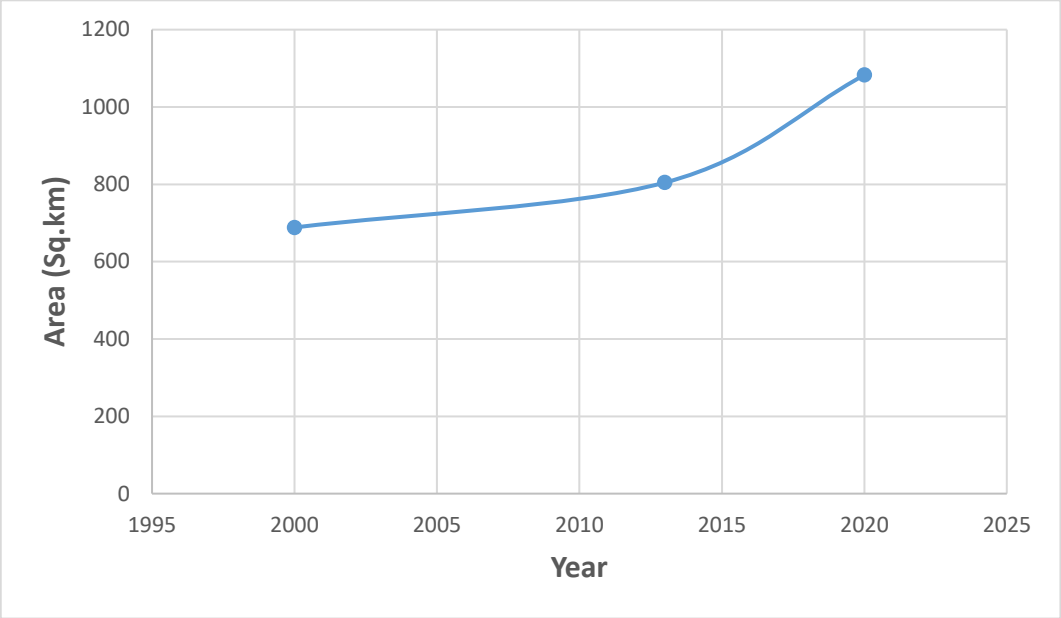

Figure 7: The trend of built environment from 2000 to 2020

Forest cover experienced decrease over the study years. In the year 2000, forest cover was 847.1 Sq.km and declined to 608.5 Sq.km in the year 2013, and further decreased to 531.1 Sq.km (Figure 8).

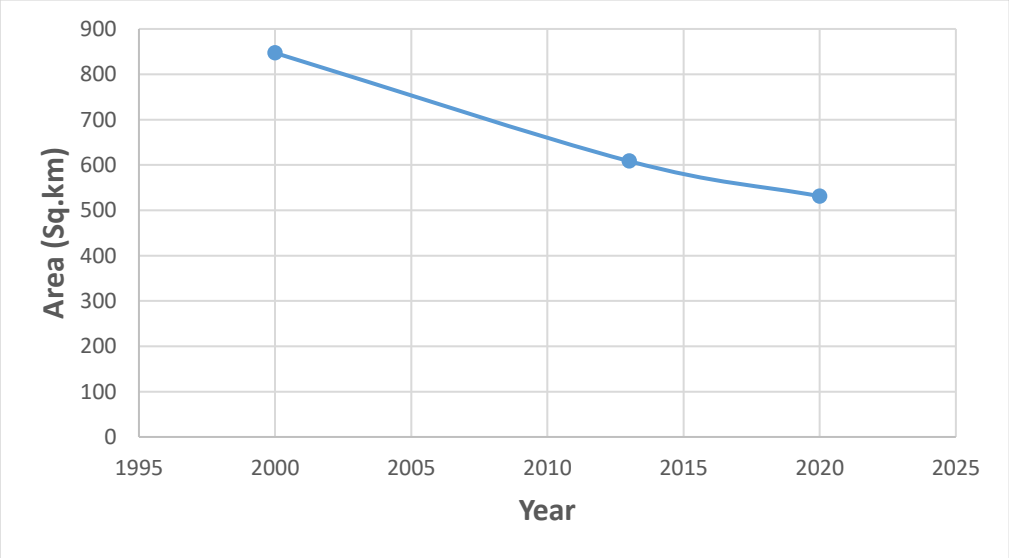

Figure 8: The trend of forest landcover from 2000 to 2020

Shrub cover experienced increase between years 2000 and 2013, as it increased from 655.3 Sq.km to 803.4 Sq.km, but experienced decrease to 701.9 Sq.km in the 2020 (Figure 9).

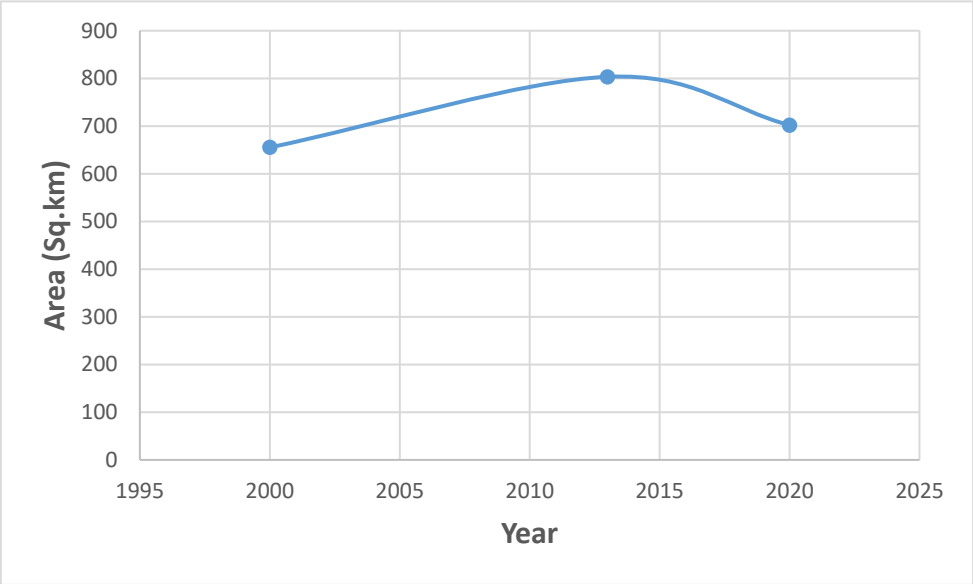

Figure 9: The trend of shrub landcover from 2000 to 2020

Water body experienced decrease over the study years. In the year 2000, water body was 812.6 Sq.km and declined to 791.0 Sq.km in the year 2013, and further decreased to 773.5 Sq.km (Figure 10).

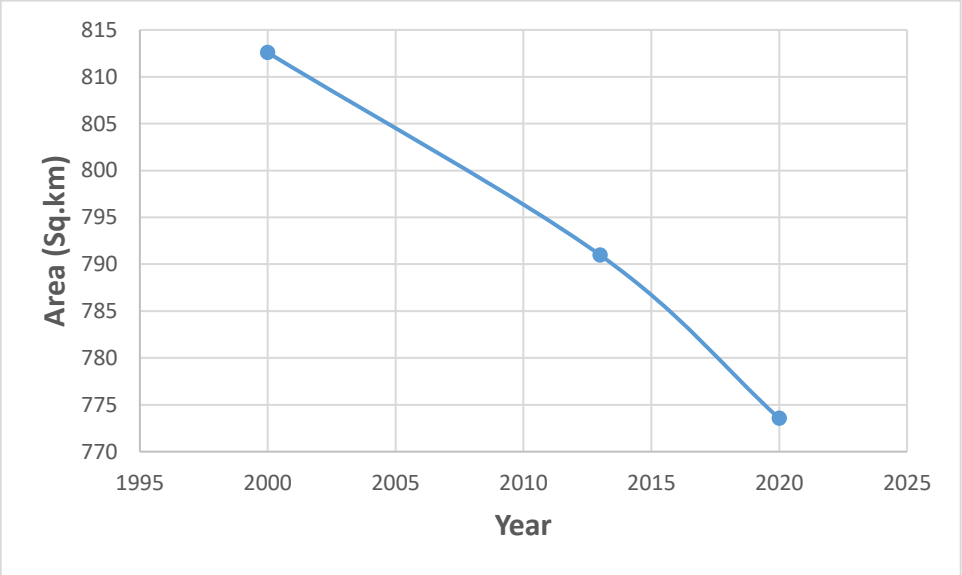

Figure 10: The trend of water body from 2000 to 2020

Wetland also experienced decrease over the study years. In the year 2000, wetland was 460.4 Sq.km and declined to 440.7 Sq.km in the year 2013, and further decreased to 397.7 Sq.km (Figure 20).

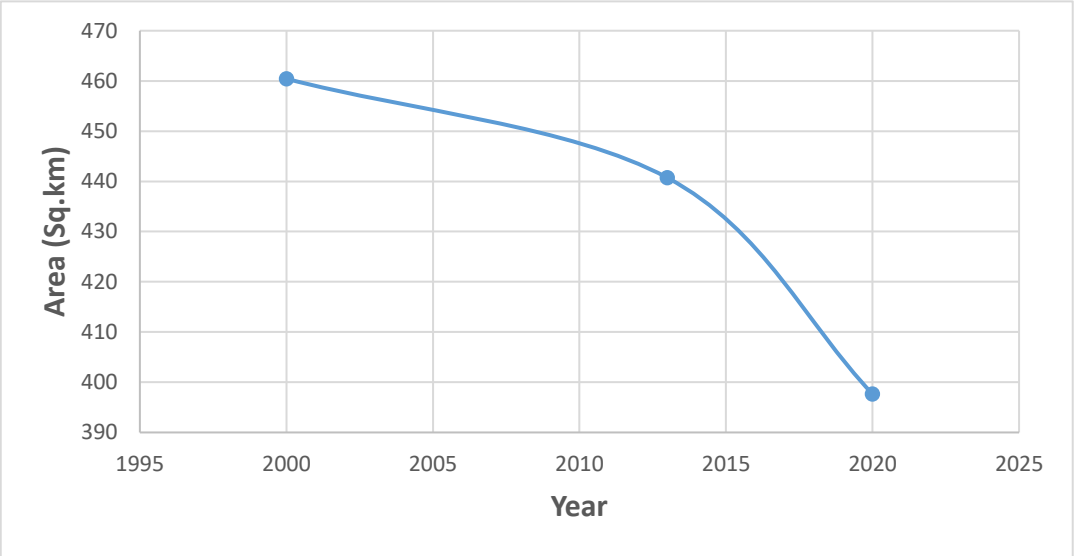

Figure 20: The trend of wetland from 2000 to 2020

Grass land experienced increase between years 2000 and 2013, as it increased from 62.4 Sq.km to 81.3 Sq.km, but experienced decrease to 59.8 Sq.km in the 2020 (Figure 21).

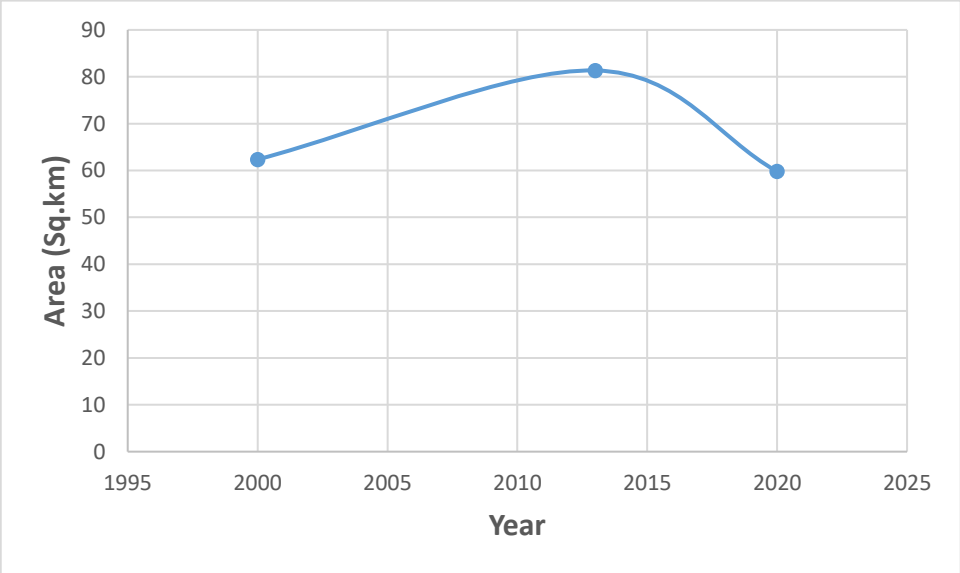

Figure 21: The trend of grass land from 2000 to 2020

From the trend analyses, it was observed that built environment experienced a continuous increase in spatial extent from year 2000 to 2020, which signified a continuous development and urban expansion in Lagos State.

Conclusion

The research have revealed that there are significant effects of changes in land use/land cover in the study area. From the analysis of the land use/land cover types present in the study area, it was observed that only built environment experienced a continuous increase in spatial extent during the study years 2000,2013,2020. This signified that there was a continuous development and urban expansion in agreement with Ogunlade (2020a, 2020b); Ogunlade (2021); Ogunlade *et al*., (2021, 2021b). The increase in built environment and the decline in the natural land cover classes (Forest, shrub, grass land, wetland, bare land) and also the increase in rainfall in the study area has lead to increase in surface runoff which had led to water overflow (flood)in agreement with Watson *et al.*, (2014) while the increase in potential evapo-transpiration according to Imeson (2004) is dependent on increase in water body and forest, and also decrease in built environment.

Recommendation

Based on the results obtained and conclusion drawn in this research, it is hereby recommended that this research findings be adopted to improve water drainage system in the study area since rainfall is increasing and will continue to increase, which will also be causing increase in the surface runoff, to lead also to water overflow in the study area.

Further research to assess the effect on land use and land cover changes with more hydrological components such as condensation, infiltration, groundwater base flow, sublimation, and interception etc. are recommended.

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