Determining land use change pattern in southern Nigeria: a comparative study

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Abstract. The use of land for different purposes makes it an essential commodity. The fact that it is fixed in supply constitute a problem to land usage. This paper presents a land use change pattern analysis in the three geopolitical zones of southern Nigeria as a prerequisite towards the development of adequate human health monitoring model for the study area. The land area of Ebonyi Edo and Ondo states were used for the study. Time series of multitemporal landsat satellite imageries of four different epochs from 2000, 2005, 2010 and 2016 that were obtained from the United State Geological Survey was used for the analysis. The results indicate that there is substantial change of land use from 2000 to 2016 for the built-up land, forestland, farmland and mixed land in the study area. On the other hand, water body and rock outcrop land show less significant land use change. Other types of land decreases as the built-up land increases. The findings suggest that animals such as rat, monkey and rabbit that have their homes in the forest and farmland would be displaced, and might be tempted to dwell among men, which implies that humanity in the Southern Nigeria might become susceptible to diseases.

1. Introduction

Land as a resource is fixed in supply with variable demand. Briassoulis [1] defined land as the foundation of the resources required for human activities as well as a platform on which the activities are performed. The use of land and its resources by mankind gives rise to "land use" which differs with the purposes it serves, whether for production of food, provision of housing, leisure, mining and handling of materials including the bio-physical features of land itself. The need of mankind, coupled with ecological features and processes are the two major forces that influence land use [2]. Changes in the employments of land happening at different spatial levels and inside various eras are the material articulations (among others) of natural and human flow and their cooperation which are intervened by land. Land usage is portrayed by the courses of action, exercises and data sources individuals attempt in a specific land cover to produce, change or support it [3].

Changes in land cover and land usage are among the most critical human prompted changes that have effect on the working of the earth framework [4, 5]. Land cover and land utilize change influence biodiversity, climate change and an Earth-wide temperature boost [6,7], and in addition the vulnerability of homes and people to ecological, money related or socio-political changes. [8-10].

For the results at nearby and provincial levels, the spatial examples of land usage change are consequently as applicable as the total volume of progress. Hence, investigation of Land Use/Land
Cover (LULC) change is basic for social financial and provincial advancement and natural change [11-14]. As indicated by Mirkatouli et al. [11], advancement of urban locale must be overseen in such a way, to the point that addresses open issues and advantages present and future inhabitants of urban communities and its encompassing zones. It requires usage of particular devices and procedures, for example, remote detecting. Remote detecting as a noteworthy wellspring of information, is utilized as a part of the investigation of zones with urban or synthetic qualities, scenes and common habitats [15-18].

Remote detecting innovation offers high spatial determination and is a profitable instrument for the observing, analysis, spatial and zoning of characteristic assets, particularly in land utilize mapping [19]. Remote detecting advanced pictures give refreshed data and complete perspectives and utilize distinctive parts of the electromagnetic range to record qualities of the territory under examination [20, 21]. The redundant land spreads, speed and assortment of information composes are of extraordinary esteem [22]. In a blend of GIS strategies, for example, the different land usage models, it gives a gadget to observing spatial improvement to build comprehension of current patterns of advancement. It can be utilized to gauge improvement of a city and to actualize vital control measures. Understanding the extent of land usage and its progressions after some time are fundamental for arranging and improvement of control measures.

Owoeye and Ibitoye [23] utilized the remote sensing technique to detect land use change in Akure metropolis of Nigeria in order to provide data that can advise policy formulation towards the physical planning of the metropolis. They collected the research data in 2014 from a study area that has a target population of 476,159 with a land area of 125,212 hectares through Aerial Imagery Overlay (AIO) with the help of Geographical Information System (GIS), Remote Sensing (RS), and personal observations. The post-classification comparison analysis of satellite imageries of the study area acquired at three decade intervals from 1985 to 2014 was conducted. The results indicate adverse effect on the pattern of land uses in the city because of unplanned growth expansion.

Lambin et al. [4] researched reasons for land usage and land cover change in urban areas as a manual for encouraging the understanding expected to evaluate and build up the future part of land-utilize and land cover change in the working of the Earth System. The discoveries demonstrate that tropical deforestation, rangeland adjustments, farming strengthening, urbanization, and globalization are the significant reasons for arrive utilize and arrive cover change in numerous urban communities of the world.

Du et al. [24] utilized three land use maps of 2000, 2005 and 2008 got from the server farm for assets and natural sciences Chinese institute to show the investigation of the spatial example of land use change and its main thrust in Jiangsu territory of China. The discoveries demonstrate that there was a significant variation in land use that was portrayed by an unremitting substitution of cropland and vegetation regions with developed terrains.

It is pertinent to argue that land use change pattern influences the health status of any given society. A good understanding of land use change pattern is required for effective human health monitoring model. Land use change pattern in southern Nigerian cities has not received enough research attention. This paper presents a comparative analysis of land use change pattern in the three geopolitical zones of southern Nigeria as a prerequisite towards the development of adequate human health monitoring model for the study area.

2. Methodology

2.1. The Study Area

The study area covers Ebonyi state, Edo state and Ondo state in Nigeria. Ebonyi state lies between latitude 6º 15’N and 6º 20’N of the equator and longitude 8º 05’E and 8º 10’E of the meridian in the eastern part of southern Nigeria. Edo state lies between latitude 5º 44’N and 7º 34’N of the equator and longitude 6º 04’E and 6º 43’E of the meridian in the southern part of southern Nigeria. Ondo state lies between latitudes 5º 45’N and 7º 52’N of the equator and longitudes 4º 20’E and 6º 05’E of the
meridian in western part of southern Nigeria [25-27]. Figure 1 shows the study area within the map of Nigeria.

![Figure 1. Map of Nigeria showing the study area (https://en.wikipedia.org/wiki/Nigeria)](image)

The climate of the study area is generally tropical in nature with vegetation spanning from the tropical rainforest in the southern part to derived Guinea savannah in the northern part [25-27]. The region is predominantly an agrarian economy relying on rain-fed agriculture. In any case, some portion of the investigation territory, particularly Edo and Ondo states are among the oil creating state, which fills in as primary wellspring of income to the Federal Government of Nigeria. In particular term, the atmosphere of Edo state is the tropical mainland with exchanging wet and dry periods of differing length [27]; the seasons relate to the times of strength of the wet tropical mainland air masses.

Much the same as Edo, the tropical atmosphere of Ebonyi state, is extensively of two seasons, which are the blustry season amongst April and October and dry season amongst November and March. The temperature goes between 21 °C to 29 °C and dampness is moderately high during the time [26]. The annual rainfall is 2,000 mm with luxuriant vegetation that has high forest zone (rainforest). On the other hand, the climate of Ondo state, like other states in the western part of southern Nigeria, is that of tropical rainforest type [25], with distinct wet and dry seasons and an annual rainfall of 2,000 mm. Western part of southern Nigeria has a mean monthly temperature of 27 °C and a mean relative humidity of over 75 % [25].

2.2. Data Source
Time series of multitemporal landsat satellite imageries of four different epochs from 2000, 2005, 2010 and 2016 were obtained from the United State Geological Survey (USGS) online archive (Global Visualization Viewer) via [http://glovis.usgs.gov/](http://glovis.usgs.gov/). Enhanced Thematic Mapper (ETM+) of year 2000, 2005 and 2010 with spatial resolution of 30 m as well as Operational Land Imager (OLI) of year 2016 that has a panchromatic band (band8) of 14.25 m were used for data acquisition. The satellite imageries of the study areas for the study durations are shown in Figures 2 to 5. Eight primary levels of land use types, namely: bare surface, farmland, forest, built-up area, mixed-land use, water body, rock outcrop, and unclassified land use type were considered in the study.
Figure 2. Land use land cover map for year 2000

Figure 3. Land use land cover map for year 2005

Figure 4. Land use land cover map for year 2010
2.3. Data Processing Stage
The radiometric and geometric corrections of the satellite image have been carried out by the USGS. The grey level stretching, which is an image enhancement technique was conducted to improve visual appearance of the image. Land use change analysis and cross-tabulation analysis for land use transition was done using the ERDAS and IDRISI Selva software.

3. Results and Discussion

3.1. Land Use Change
The landscape composition of Edo state for 2000 and 2016 is shown in Figure 6. It shows that the unclassified land is the most dominant land use type occupying 53.38 % and 49.47 % of the total land area in 2000 and 2016. Forestland and mixed land are the second and third major land use type in 2000 with 13.99 % and 13.28 %. The built-up land is the fourth major land use type in 2000 with 6.69 %. Conversely, the built-up land becomes the second major land use type in 2016 with 16.74 %, followed by the mixed land and forestland with 11.37 % and 8.59 %. The rock outcrop land is the least land use type with 1.96 % in 2016.

Figure 6. Land use change in Edo state from 2000 to 2016

Figure 7 shows the landscape composition of Ebonyi state for 2000 and 2016. It indicates that the unclassified land is the most dominant land use type occupying 54.55 % and 46.42 % of the total land
area in 2000 and 2016. Rock outcrop and mixed land are the second and third major land use type in 2000 with 10.39 % and 9.50 %. The built-up land is the fourth major land use type in 2000 with 8.87 %. Conversely, the built-up land becomes the second major land use type in 2016 with 17.94 %, followed by the rock outcrop and farm land with 10.41 % and 7.51 %. The water body is the least land use type with 1.10 % throughout the study duration.

![Figure 7. Land use change in Ebonyi state from 2000 to 2016](image)

The landscape composition of Ondo state for 2000 and 2016 is presented in Figure 8. It shows that the unclassified land is the most dominant land use type occupying 79.21 % and 78.30 % of the total land area in 2000 and 2016. Forestland and bare surface are the second and third major land use type in 2000 with 12.38 % and 2.06 %. The rock outcrop land is the fourth major land use type in 2000 with 1.84 %. Conversely, the farm land becomes the second major land use type in 2016 with 6.92 %, followed by the forestland and built-up land with 6.37 % and 3.08 %. The mixed land is the least land use type with 0.62 % in 2016.

![Figure 8. Land use change in Ondo state from 2000 to 2016](image)

There is substantial change of land use from 2000 to 2016 for the built-up land, forestland, farm land and mixed land in the three study areas. On the other hand, water body and rock outcrop land show less significant land use change.

3.2. Comparative Study of Land Use Change

The trend of usage of land types in three states of Southern Nigeria is presented in Figure 9. It shows that the built-up land has the most vivid trend on the positive direction from 2000 to 2016 in the three
states. There is a steeper gradient in the built-up land change from 2000 to 2005 relative to the other years in Edo state, while built-up land in Ebonyi and Ondo states has a gradual steady increase from 2000 to 2016.

There was an increase of farmland in Edo state from 2000 to 2005, and decreases afterwards. It increases slowly from 2000 to 2016 in Ebonyi and Ondo states; however, the increase is not prominent relative to the built-up land. Figure 9d indicates that other types of land decreases as the built-up land increases. The finding suggest that animals such as rat, monkey and rabbit that have their homes in the forest and farmland would be displaced, and might be tempted to dwell among men. The implication is that humanity in the three states would become susceptible to diseases. The finding is in accordance with not just the attestation of [24] that land utilize change of a place impacts the monetary improvement of a place, yet additionally influences the soundness of people that stays in the land.

**Figure 9.** Trend of usage of land type (a) in Edo, (b) in Ebonyi, (c) in Ondo, (d) built-up land vs other land types
4. Conclusion
This paper presents the land use change analysis of Edo, Ebonyi and Ondo states in the Southern Nigeria. Time series of multitemporal landsat satellite imageries of four different epochs from 2000, 2005, 2010 and 2016 that were obtained from the United State Geological Survey was used for the analysis. The bare surface, farmland, forest, built-up area, mixed-land use, water body, rock outcrop, and unclassified land were the types of land used in the analysis. The radiometric and geometric corrections of the satellite image have been carried out by the USGS. The grey level stretching, which is an image enhancement technique was conducted to improve visual appearance of the image. Land use change analysis and cross-tabulation analysis for land use transition was done using the ERDAS and IDRISI Selva software. The results of the land use change pattern analysis indicate that there is substantial change of land use from 2000 to 2016 for the built-up land, forestland, farmland and mixed land in the three study areas. On the other hand, water body and rock outcrop land show less significant land use change. Other types of land decreases as the built-up land increases. The finding suggest that animals such as rat, monkey and rabbit that have their homes in the forest and farmland would be displaced, and might be tempted to dwell among men. The implication is that humanity in the three states would become susceptible to diseases.

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