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Dynamics of Landuse Change: A Case Study of Warri and Environ, Delta State, Nigeria

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Abstract

Dynamics of landuse change was carried out in Warri and environ, Delta State, Nigeria to ascertain the level of changes in the land between the period 2000 and 2020. The imageries used include LANDSAT ETM of 2000 and NIGERSAT -1 of 2020. The various classes of landuse adopted are; cultivated area, bare surface, built-up area, natural vegetation and water bodies. The supervised method of landuse analysis was used in the extraction of the information from the imageries in ArcGis 9.3 environment. The results obtained showed that bare surface accounted for 0.72% in 2000 and increased to 1.91% in 2020, built up area occupy land cover of 2.63% in 2000 and by 2020, it increased to 3.55%, cultivated area covers 27.88% in 2000 and in 2020, it increased to 56.57%. Natural vegetation, which includes all forested area and grass land in was 57.34% in 2000 and decreased in 2020 to 25.43% and water bodies, which include all the surface water found in the study area such as ponds, streams, rivers, and marshes covered 9.43% in 2000 while in 2020, it increased to 12.53%. It can be concluded that despite the adverse effects of the changes on the environment, the study area can be seen as developing as there is increase in the built-up areas as this is reducing the vegetation of the study area, a deliberate attempt should be made to incorporate tree planting as part of the building policy in the study area.

Keywords: Landuse Dynamics, Remote Sensing, Spatio-temporal Change, Urbanization, GIS, Delta State.

Introduction

Our world is constantly changing and not all changes are profitable. Some changes have natural causes (volcanic eruption, earthquake and meteorite impact), while majority are caused by man in the quest to satisfy his needs through; construction, mining, lumbering, agricultural practices (arable and nomadic farming) etc. various developmental activities that man has engaged himself in over the years has brought about considerable unwholesome land use (environmental degradation) and an unplanned environment. This past events thus, set the present pattern which in turn determines the future. Since land is fundamental to all human activities, mans' concern about his environment has greatly increased overtime. land use, which is systematically linked through seasonal-temporal interactions, the land might be associated with a sequence of covers (Oyedele et al., 2023).

For decades now, man has been seeking a better way of controlling his immediate environment and as such this research has been initiated at analyzing and accessing the spatio-temporal changes of detection which methods must allow identifying a change within long term data sets and seasonal variation (Wang, et al., 2020). This study attempted the land use pattern in Lafia and its environs and its implication on the environment using remote sensing and Geographic Information System (GIS) techniques, within the period, 2000-2020.

Environmental planning dates back to when man began domesticating animals and propagating crops. With the advent of industrial revolution in the 18th century came an increase in world population due to improved health facilities which reduced death rate, thus giving way for increasing birth rate, and advancement in science and technology which enabled man to make machines which explore and exploit his immediate natural environment for the production of commodities which improves his livelihood. These factors lead to an increase in pressure of the environment, leading to environmental deterioration. This has necessitated the concept of environmental awareness (Obiahu et al., 2021). Land use Land cover (LULC) dynamics are widespread, accelerating, and significant processes majorly impelled by human actions and at the same time resulting to changes that impact human livelihood (Koko et al., 2022, Darem, et al., 2023; Tempa, et al., 2024).

Increase in world population, is necessitating expansion in land related activities which is resulting in considerable spatial changes with enormous consequences on the environment (Moisa et al., 2023). Therefore, the need for concern is great because our impact on developmental activities has made some of these areas undesirable, and this is increasing at an alarming rate (Patra et al., 2018 and Odiji, et al., 2024).

Environmental awareness brought about a new field of study known as environmental science, encompassing a wide branch of art and sciences focusing on proper environmental management. The effective management of the environment cannot be achieved in totality without the integration of Remote Sensing and Geographic Information System (GIS). Remote sensing as a technique involves data collection using photographs

from a distance without coming in contact with the object, while Geographical Information refers to any data, which relates to specific location on the earth surface. It includes data on natural resources, land use, utility distribution, urban structure, wastes disposal and pollutants (Telo da Gama, 2023). While Geographical Information System (GIS) refers to a system of software and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems (Hundy et al., 2021). Merging these two technologies has resulted in a great increase in information about man and his environment for many kinds of users. A lot of works on landuse/land cover have been carried out (Hussain et al., 2020; Lynch, et al., 2021; Younes et al., 2023; Higgins et al., 2023; Mashala et al., 2023; Swinnen, and Lanbin 2003; Basu and Das, 2021; Nath et al., 2021 and Arora et al, 2021), these works did not address the implications of the detected changes on the environment which this study has identified in assessing the spatio-temporal changes in landuse and its implication on the environment.

Materials and Method

Materials: The data used for this study were gotten from two sources which are primary and secondary.

The primary data include LANDSAT ETM of 15th November 2000 with a ground sampling distance of 30m, and NIGERSAT -1 of 17 October 2020 with a ground sampling distance of 32m, with sensors in 3 spectral bands (0.52 – 0.62μm), red (0.63 – 0.69μm) and near infrared (0.76 – 0.9μm) satellite imageries, obtained from the National Space Research and Development Agency (NASRDA) and the National Centre for Remote Sensing Jos, Nigeria respectively.

The secondary data in this study include information on vegetation, climate, soil, relief gotten from existing literatures and map of the study area which aided the effective analysis of the satellite imageries beside ground truthing that was carried out to verify some features in the imageries that were not visibly recognized.

Software and Hardware Used: AuctoCad Land Development Desktop 2i was used to georeference the images. EDARS Imagine 9.1, was used for the classification of the various land use land cover classes. While the hardware include 120G CPU 20 Inch VDU Screen

Method: The imageries were georeferenced using the Aucto Cad Land Development Desktop 2i. Auto-normalization of the images were done using Erdas Imagune 9.1 processing software which normalizes the images to the full dynamic range of the number system specified in the image file format. The normalization process produced iris regions, which have the same constant dimensions, for the images obtained from Land sat and Nigeria sat 1used for the study respectively making them have characteristic features at the same spatial location. The auto-normalization of the imageries was done before the classification of the landuses. Classification is the process of sorting pixels into a finite number of individual classes, or

categories of data based on their data file values. If a pixel satisfies a certain set of criteria, then the pixel is assigned to the class that corresponds to those criteria. There are two ways to classify pixels into different categories: supervised and unsupervised classification.
The supervised classification was adopted in this study. The supervised classification is more closely controlled by researcher who selects pixels that represent patterns you recognize or that you can identify with help from other sources. Knowledge of the data, the classes desired, and the algorithm to be used is determined before you begin selecting training samples. By identifying patterns in the imagery, the computer system was trained to identify pixels with similar characteristics that were used to generate the various land use categories used for analysis.

Quantitative Analysis: After categorisation of land use/land cover types and the determination of the area extent of each land cover for 2000 and 2020 respectively using the supervised classification method in an EDARS Imagine 9.1 software environment.

Results and Discussion

This section presents the discussion of the results of the analysis on Land use and land cover data of the study area. Five classes of relative distribution of land cover were identified in the study area and they include:

a. Bare surface
b. Built-up area
c. Cultivated area
d. Natural vegetation
e. Water bodies.

Analysis of Land use and Cover Distribution

This discussion is based on the various distribution of land use and land cover in the study area gotten from the analysis of remote sensing imageries of 2000 and 2020 of the study area.

Magnitude and rate of changes in Land use and cover between 2000 and 2020

Table 1 presents the total area of each land use and land cover in the study area and the calculated magnitude and percentage of change. The magnitude of change (C) for 2000 and 2020, is calculated by subtracting the area of each land use and land cover type for 2000 (A) from 2020 (B) that is (B – A). The percentage of change (E) is calculated by dividing the magnitude of change (C) of each land use/land cover class by the value of the base year (2000), then multiplying the result by one hundred.
The result of the analysis reveals that a lot of changes had occurred in land use and land study area within a period of 20 years (2000 and 2020). This also shows that percentage change in proportion of some land use and land cover classes has increased while others decreased. The discussion of the changes that occurred in the various classes is as follows:

Bare Surface: Table 1 shows that bare surface, which include rock outcrop, wasted land and sand deposit, accounted for 0.72% in 2000 and increased to 1.91% in 2020. The magnitude of change in bare surface area between 2000 and 2020 was 2.02km^2 with an annual change rate of 0.10km^2 and percentage change of 165.57%. This magnitude of change indicates an increase in bare surface from 2000 to 2020. However, this change is as a result of the fact that built up area and afforestation had taken over some portion of the built surfaces implying that the population of the study area had engaged in activities, which put wasted land into use.

Built up Area: Table 1 shows that built up area occupy land cover of 2.63% in 2000 and by 2020, it increased to 3.55%. The magnitude of change in built up area between 2000 and by 2020, shows an increase in land area from 4.45km^2 to 6.01km^2 with an annual change rate of 0.08km^2 and a percentage change of 35.06%. This change is attributed to increase in population, which brought about demand for shelter, commercial activities and basic amenities.

Table 1: Magnitude and Percentage Change in Land use and Land cover Between 2000 and 2020

Classes	A	B	C	D	E
	2000 Area (km^2)	2020 Area (km^2)	Magnitude of change (B – A) km^2	Annual rate of change C/20 (km^2)	% change C/A x 100
Bare surface	1.22(0.72%)	3.24(1.91%)	2.02	0.10	165.57
Built up Area	4.45(2.63%)	6.01(3.55%)	1.56	0.08	35.06
Cultivated Area	47.18 (27.88%)	95.72(56.57%)	48.54	**2.43**	102.88
Natural Vegetation	100.41(59.34%)	24.04 (25.43%)	**-67.37**	-3.37	**67.10**
Water bodies	15.02(9.43%)	21.21(12.53%)	**6.19**	**0.31**	**41.21**
Total	169.22	169.22	**-9.06**	**-0.45**	**277.62**

Cultivated Area: Cultivated area covers 27.88% in 2000 and in 2020, it increased to 56.57% (Table 1). Between the period of 2000 to 2020, the magnitude of change had increased to 48.54km^2 with an increased annual change rate of 2.43km^2 and the percentage change of 102.88%. This implies that the major activities of the study area, is farming, and this increase in farming activities is due mostly to increase in population and the demand in agricultural produce both for commercial and subsistent purposes.

Natural Vegetation: Natural vegetation, which includes all forested area and grass land in 2000 decreased in 2020 to 25.43% (Table 1). This decrease in the size of natural vegetation is as a result of increased population, which brought about various human activities and urban expansion. The magnitude of change of natural vegetation between the periods of 2000 to 2020 was -67.37km^2 with an annual change rate of -3.37km^2 and a percentage change of 67.10%.

Water Bodies: Table 1 shows that water bodies, which include all the surface water found in the study area such as ponds, streams, rivers, marshes and lakes covered 9.43% in 2000 as a result of climate change, domestic and industrial water uses while in 2020, it increased to 12.53% owing to climate change. The magnitude of change between the periods of 2000 to 2020 of water bodies was 6.19km^2 with an annual change rate of 0.31km^2 and percentage change of 41.21%. this implies that between 2000 to 2020, water bodies experienced increase, this could be as a result perennial flooding experienced in the study area.

Implication of the Changes on the Environment

The results of the changes between 2000 and 2020 in the study area have some adverse effects on the environment which if not looked into critically by planners and environmentalist would degenerate into a state of urban decay. Increase in cultivated area at an annual rate of 2.55 km^2 between 2000 and 2020 is an indication of an increase in population that need to fend for themselves in the absence of white-collar jobs and have resorted to the fish farming. The major farming system practices in the study area as revealed by field observation is fish farming besides intensive continuous cropping as a result of land being competed for by other uses such as residential, commercial, institutional which are subsumed into built up area. The implication of the intensive continuous cropping on the environment is not only rendering the soil bare and exposed to soil erosion but also reducing the nutrient carrying capacity of the soil for agricultural sustainability.

The decrease experienced in natural vegetation at an annual rate of 3.37 km^2, is a pointer that the effects of global warming will be on the increase. The moderating effects of the vegetation on the environment would be greatly reduced exposing the environment to the scorching effects of the heat, which further enhances evapotranspiration reducing photosynthetic activities in plants leading to food shortage. The above observation in the study area is in line with (Patra, et al., 2018) who are of the view that vegetation canopy is an important land cover type that affects the development of the urban ecosystem and Mashala, et al., (2023) who concluded that urban trees play important roles in improving landscape aesthetics, reducing pollution and moderating the urban energy budget, water use, reducing storm runoff, and providing other amenities. Many problems facing management of the urban ecosystem are related to these factors. For example, urban heat island effects and increased storm runoff are related to vegetation cover. Air quality and water use are related to crown density and tree density because the total leaf surface area and leaf surface area per unit of land area controls both air pollutant removal and evapotranspiration rates (Higgins et al., 2023). To this end, with the reduction in the natural vegetation in the study area there is bound to be human discomfort as the air quality, energy exchange, hydrology and microclimate will be adversely affected. The increase in bare surface at an annual rate of 0.11 km^2 which is made up mainly of increase in the proportion of pavement area during the process of urbanization will strongly influence energy exchange, hydrology and microclimate in the study area and subsequent increase in global warming and its anticipated effects on the environment.

Conclusion

It can be concluded that despite the adverse effects of the changes on the environment, the study area can be seen as developing as there is increase in the built-up area as this is reducing the vegetation of the study area a deliberate attempt should be made to incorporate tree planting as part of the building policy in the study area and orchard gardening should be encouraged among farmers.

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