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Change detection analysis in Yenagoa due to urbanization using remote sensing and geographic information systems

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Abstract

The change detection analysis has been investigated between 1990, 2015 and 2020 using Remote Sensing and Geographical Information Systems in Yenagoa, Bayelsa State of Nigeria. With the aid of ArcGIS and Erdas Imagine software to classify the environment, using the supervise classification method in categories of water bodies, built-up areas, bare land, and vegetation, it was revealed that the area covered by water bodies was 11% of the total area in 1990, decreased to 9% in 2015, and further reduced to 4% in 2020. The built-up area was 4 % of the total area of Yenagoa in 1990. It increased to 17% in 2015 and further increased to 23 % in 2020. Bare land covered 20% of Yenagoa in 1990. This area increased to 27 % in 2015 and further increased to 35 % in 2020. Yenagoa vegetation covered about 65 percent of the area in 1990. This was reduced to 47% in 2015 and was further reduced to 35% in 2020. Yenagoa water bodies and vegetation are being depleted in an unsustainable manner that will lead to environmental challenges in the near future if proper planning mechanisms are not put in place.

Keywords: GIS; Remote Sensing; Landuse; Landcover; Change Detection

1. Introduction

Land cover is the total physical features both natural and artificial in an area covering the surface of the land, this includes water bodies, vegetation, rocks, soil and settlements [1 – 4]. Land use emphasizes man's activities directly related to the use of land for economic activities [5 – 6]. Both land use and land cover changes are as a result of an interaction between natural and anthropogenic processes driven by man's activities [7 – 8]. Analyzing land use dynamics is essential in understanding various ecological and developmental consequences of land use change over a space of time [9 – 11]. Land use/cover change detection involves the identification of major processes of change necessary for proper planning and management of environmental resources to forestall adverse effects on the weather, climate, biodiversity and health of the inhabitants of the environment [9], [12]. The process involves applying multi-temporal time series remote sensing dataset to quantitatively analyze and identify salient spatial and temporal changes in land cover [13].

Due to urbanization there has been a gradual increase in the population of Yenagoa, this has led to a steady increase in built-up areas and a decrease in the water bodies in the area as the availability of land has reduced and there has been need to reclaim land by sand-filling water bodies in some areas to put up structures, also the vegetation has drastically reduced over the years affecting agricultural activities which has been a bane of the locals over time. This study investigates how urbanization has impacted the natural environment and would aid relevant authorities in planning for the future of Yenagoa. Areas for activities like recreation, waste management, marketing and agriculture must be taken into consideration in planning as the area develops to checkmate total dependence of external goods to the populace and also for the general well-being of the teeming populace.

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2. Material and methods

2.1. Study area

The study area is Yenagoa the capital city of Bayelsa State located in the Southern part of Nigeria (Fig. 1), it has area of 410.61 km^2 and an estimated population of 352,285 at the 2006 [14]. This area lies within longitudes 006^0 17'30" and 006^0 21'30" East of the prime meridian and Latitudes 04^0 55'0" and 04^0 7'30" North. The study area falls within the Niger Delta sedimentary. The area is generally low lying with an average elevation of 10 m asl, and falls within the rain forest vegetation of Southern Nigeria. Yenagoa is accessible by a network of major and minor roads and is drained by creeks and tributaries linked to the River Niger amongst them are the Epie and Tailor Creeks and the River Nun which all empty into the Atlantic Ocean.

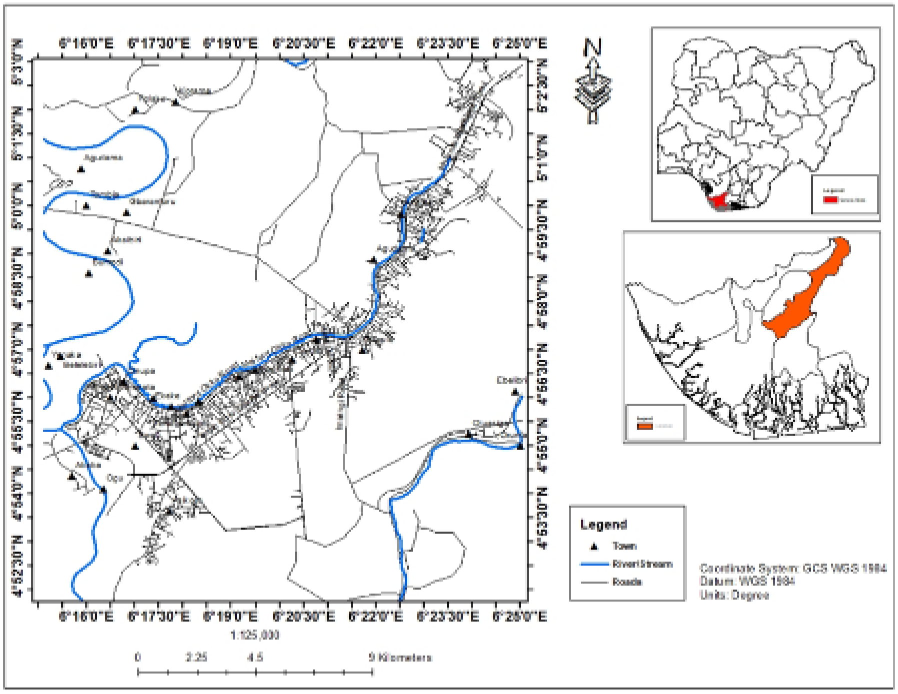

Figure 1 Map of study area

2.2. Material and Method

Table 1 List of Satellite Data used

Satellite Data	Date	Spatial Resolution (m)	Source
Landsat 5	28/02/1990 Path: 189, Row: 57	30	[15]
Landsat 8	26/12/2015 Path: 189, Row: 56	30	[15]
Landsat 8	06/01/2020 Path: 189, Row: 56	30	[15]
Google Earth Imagery	06/02/2020	3m	[16]

Data used for the study are Landsat 5 (1990), Landsat 8 (2015) and Landsat (2018) images downloaded from https://landsate usgs.gov. Satellite images were downloaded from Google Earth for 1990, 2015 and 2020 with the aid of Universal Map Downloader (Table. 1). Spatial locations of communities in Yenagoa were acquired by the use of Garmin72 Global Positioning System (GPS). An administrative map for the area under study where political boundaries and roads exist was digitized. Several techniques are employed for change detection analysis, the Post Classification method employed for this study (Fig. 2). This approach involves rectification of the classified images independently followed by generation of thematic maps for the area under study. A comparison of corresponding labels is then carried out to identify the areas where change has occurred. If the classification result is properly coded for time T1, T2 and T3 change maps which show a complete matrix of change can easily be obtained. Using this method, series data from at least two dates are separately classified, thereby minimizing the challenges of normalizing data for sensor and atmospheric differences. ArcGIS 10.6 is used for processing landuse/landcover by defining of training sites, extraction of signatures from the image then classification is done. Finally, Maximum Likelihood Classification (MLC) methods were applied to analyze for change detection analysis to study the changes in terms of urbanization.

Limitation

Cloud cover in the Niger Delta region couldn't allow good access to Landsat 7 and 8 for 1995 to 2010 and also sentinel 2 data too also have problem with cloud cover.

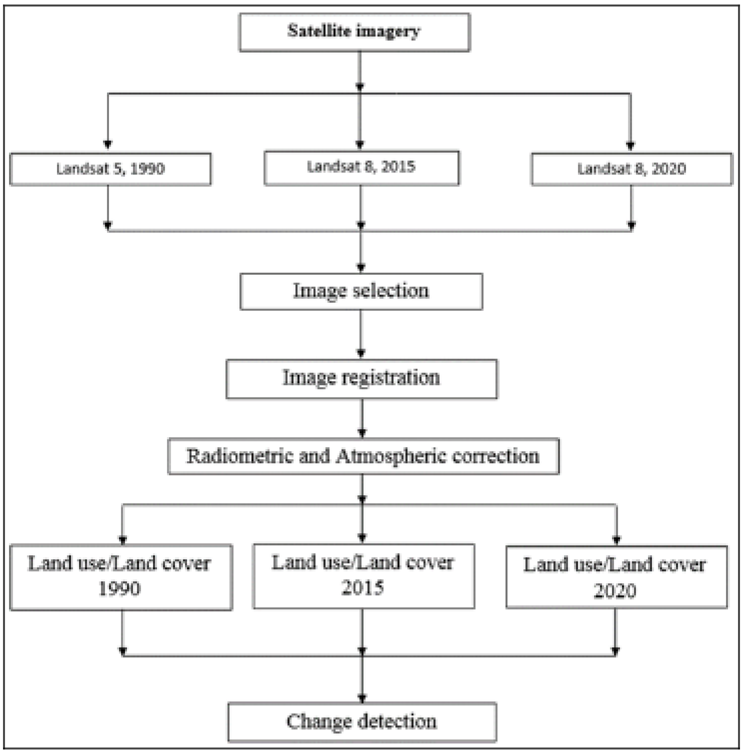

Figure 2 Change detection analysis flowchart

3. Results and discussion

The landuse/landcover map generated from the integration of remote sensed data with thematic features from landuse/landcover models using satellite imagery for 1990, 2015, and 2020 is presented (Fig. 3). The satellite imagery was processed and classified using a supervised classification scheme by assessing land use/land cover pattern and categorized into four classes namely: Water bodies, Vegetation, Bare land and Built-up areas based on area covered and percentage (Table 2, 3 & Fig. 4 - 9).

Results of the analysis showed that in 1990 Water Bodies covered an area of 44.5 km^2 which represented 11 % of the study area, Built-up areas covered 16.96 km^2 accounting for 4 % of the area under study, Bare land covered an area of 82.28 km^2 a representation of 20 % of the total study area and Vegetation covered 266.87 km^2 of the area under study which represented 65 % of the total area under study. 25 years later in 2015, Water Bodies had been reduced to 36.64 km^2 representing 9 % of the study area, Built up areas increased to 70.81 km^2 accounting for 17 % of the area under study, Bare land had been increased to 109.59 km^2 representing 27 % of the study area and Vegetation reduced to 193.56 km^2 accounting for 47 % of the total study area. In 2020, human interference on the natural environment had further reduced the area under study covered by Water bodies to 16.07 km^2 representing just 4 % of the study area, Built-up areas increased to 93.30 km^2 accounting for 23 % of the area under study, Bare land increased to 144. 44 km^2 representing 35 % of the study area and Vegetation further reduced to 156. 80 km^2 a representation of 38 % of the study area.

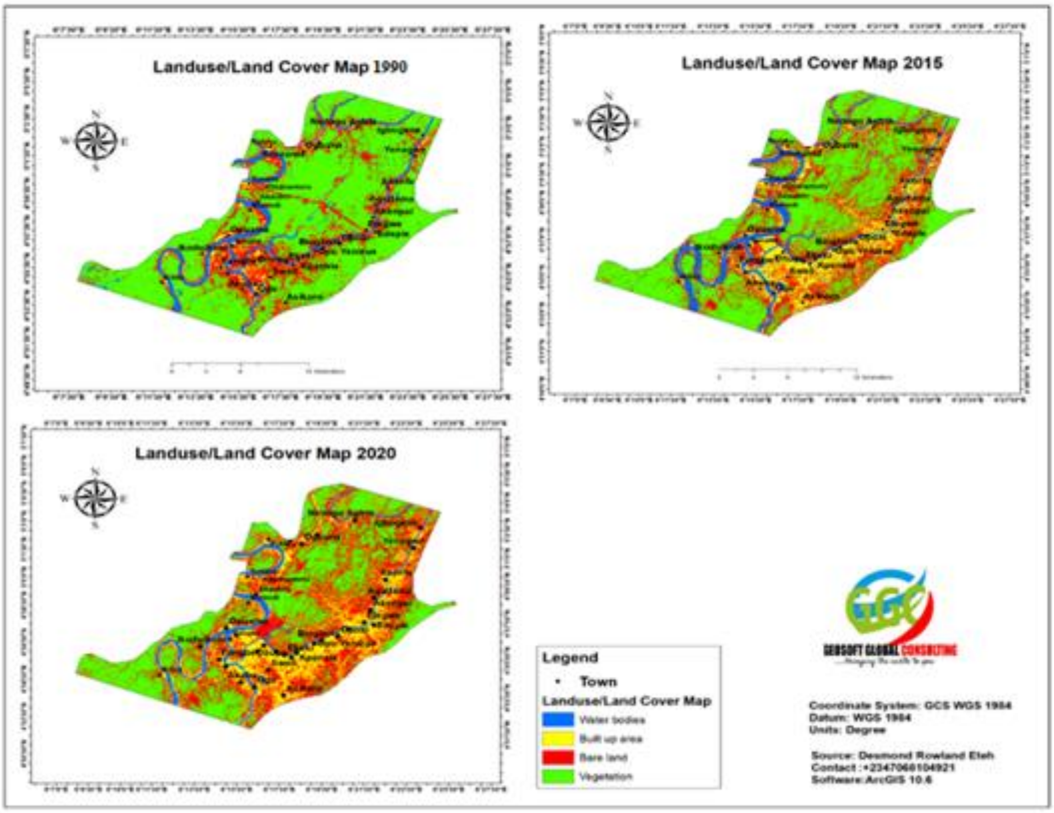

Figure 3 Change Detection map of the Study Area

Table 2 Statistics of landuse/landcover for 1990, 2015 and 2020 in study area

Classification	LU/LC 1990 km²	LU/LC 2015 km²	LU/LC 2020 km²
Water bodies	44.50	36.64	16.07
Built up area	16.96	70.81	93.30
Bare land	82.28	109.59	144.44
Vegetation	266.87	193.56	156.80
Total area	410.61	410.61	410.61

Table 3 Percentage Analysis of landuse/landcover for 1990, 2015 and 2020 in study area

Classification	LU/LC 1990 %	LU/LC 2015 %	LU/LC 2020 %
Water bodies	11`	9	4
Built up area	4	17	23
Bare land	20	27	35
Vegetation	65	47	38

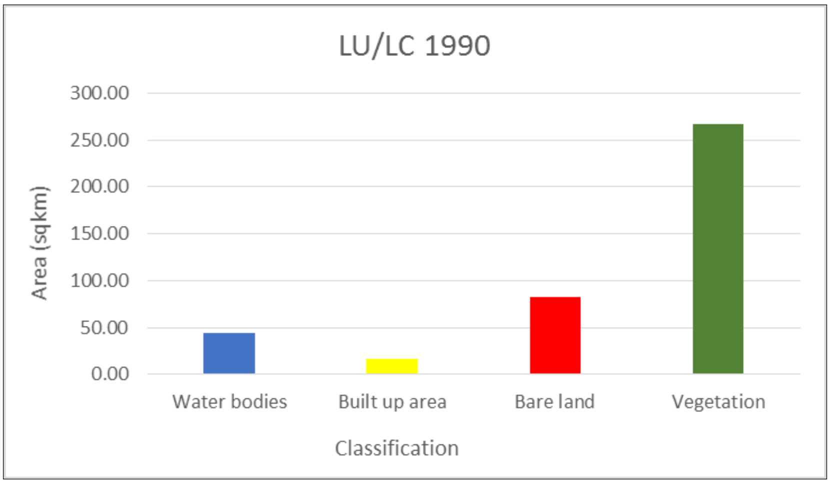

Figure 4 Landuse/Landcover classes for 1990

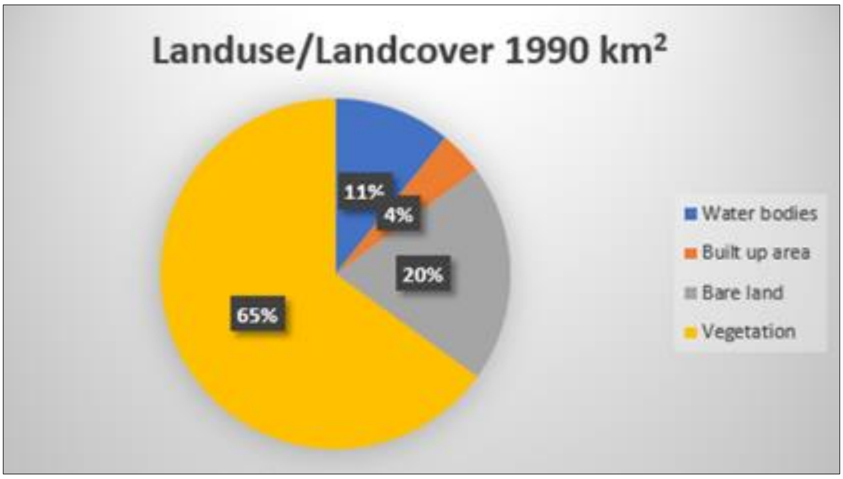

Figure 5 Landuse/Landcover percentage classification for 1990

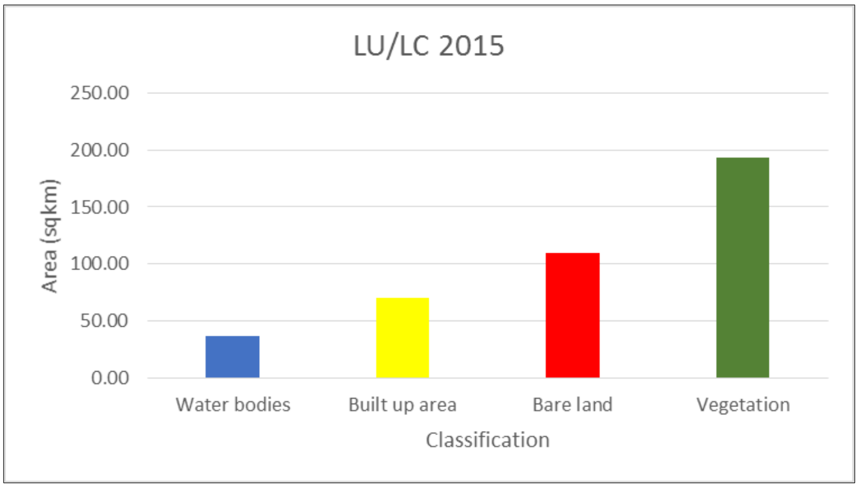

Figure 6 Landuse/Landcover classes for 2015

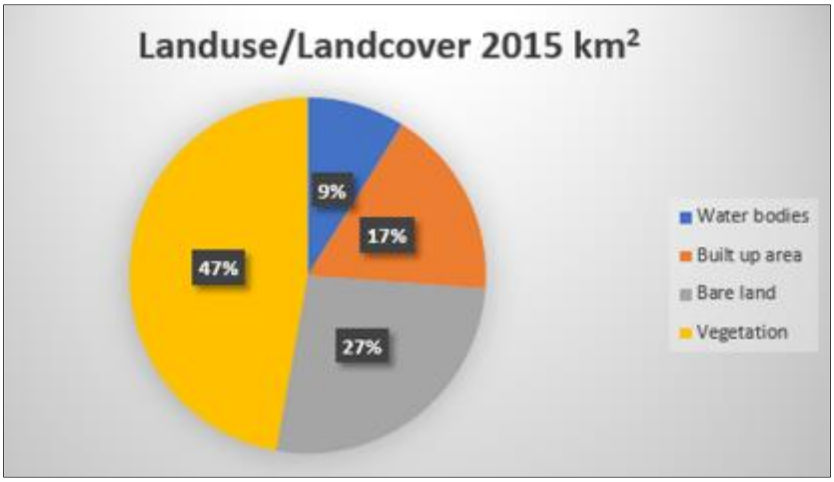

Figure 7 Landuse/Landcover percentage classification for 2015

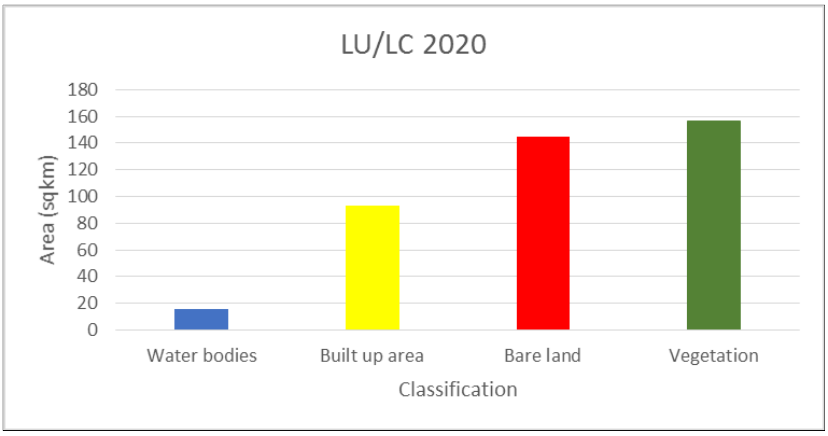

Figure 8 Landuse/Landcover classes for 2020

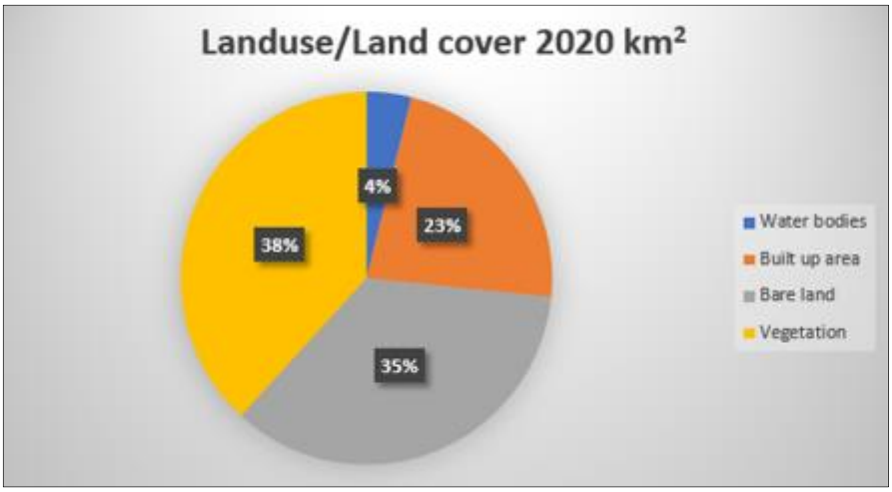

Figure 9 Landuse/Landcover percentage classification for 2020

From the results presented, one would observe that there is a drastic reduction in Water bodies from 1990 to 2020. This reduction can be attributed to land reclamation for construction of Built-up areas as the population of Yenagoa increased due to urbanization. Naturally occurring creeks and ponds have been sand-filled in a bid to reclaim land and in some cases causing blockage of natural drains in the area, this has led to incessant flooding in the area during the wet season. Surface water bodies also serve as a primary source of groundwater recharge, a reduction in surface water bodies can also be linked to the draw-down of the water table across the study area. If Yenagoa had not been located within the rain forest vegetation, future projections from this study would have meant acute water shortages for the teeming populace in the no distant future.

Urbanization of the area has driven the need for accessible land for construction, thus, the surrounding vegetation has undergone drastic deforestation within the period of study (1990 to 2020) to make room or create Bare land for this purpose. An increase in Bare land and built-up area on one hand has resulted in a decrease in Vegetation and water body of the area in Table 2

Factors that affect LULC changes Road construction

- Road construction
- Building of structures
- Industry
- Human begins

4. Conclusion

The evaluation of change detection analysis for land use/land cover and its environmental implication has been investigated between 1990, 2015 and 2020 using Remote Sensing and Geographical Information System in Yenagoa, Bayelsa State of Nigeria. Using a classification scheme of Water bodies, Built-up areas, Bare land and Vegetation, result revealed that area covered by Water bodies was 11 % in 1990, decreased to 9 % in 2015 and further reduced to 4 % in 2020. Built-up area was 4 % of the total area of Yenagoa in 1990, it increased to 17 % in 2015 and further increased to 23 % in 2020, Bare Land covered 20 % of Yenagoa in 1990, this area increased to 27 % in 2015 and further increased to 35 % in 2020 and the Vegetation of Yenagoa covered 65 % of the area in 1990, this reduced to 47 % in 2015 and was further reduced to 35 % in 2020. The rate at which the Water bodies and Vegetation are being depleted in the area is not sustainable and could lead to environmental challenges in the near future if proper planning mechanisms are not put in place. Issues of waste management, water pollution and flooding should also be expected in the foreseeable future.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

[1] Campbel JB. Introduction to Remote Sensing. Guilford Press. 1996, Pp. 55 – 74.

[2] Abbas II. An assessment of Landuse/Landcover changes in a section of the Niger Delta, Nigeria. Frontiers in Science. 2012, 2(6): 137 – 143.

[3] Saleh Y, Badr AM, El Banna F, Shahata A. Agricultural landuse change and disappearance of farmlands in Kaduna Metropolis, Nigeria. Science World Journal. 2014, 9(1): 25 – 35.

[4] Emenyonu CA, Orebiyi JS, Eze CC, Odii MA, Onyemauwa CS, Eririogu IH. Analysis of landuse cover change in Western Niger Delta: A panacea for agricultural land reduction. Nigerian Journal of Agricultural Economics.2015, 5(1): 92 – 99.

[5] Anderson JR, Hardy EE, Roach JT, Witmer RE. 1976. A landuse and landcover classification system for use with remotely sensed data. Geological Survey Professional paper 964.

[6] Abdukadir A. Remote Sensing and Land Degradation. Nigerian Journal of Remote Sensing.1993, 1(1): 65 – 72.

[7] Thiam AK. The causes and spatial pattern of land degradation risk in Southern Mauritania using multi-temporal AVHRR-NDVI imagery and field data. Journal of Land Degradation and Development.2003, 14: 133 – 142.

[8] Wessels KJ, Prince SD, Frost PE, Van-Zyl D. Assessing the effects of human induced land degradation in the former homelands of Northern South Africa with 1Km AVHRR-NDVI time series data. Remote Sensing and Environment.2004, 91: 47 – 67.

[9] Ademiluyi IA, Okude AS, Akanni CO. An appraisal of landuse and landcover mapping in Nigeria. African Journal of Agricultural Research.2008, 3(9): 581 – 586.

[10] Matiko M, Mtalo IF, Mwanuzi F. Landuse and landcover changes in Kihansi River catchment and its impact on river flow. Department of Water Resources Engineering Report. 2012, Pp. 22.

[11] Dami A, Odihi JO, Ayuba HK. Assessment of landuse and landcover change in Kwale, Ndokwa East LGA, Delta State. Global Journal of Human Social Science.2014, 14(6): 16 – 24.

[12] Eludoyin OS, Obafemi AA, Hardy T. Effects of urbanization changes on landuse in Yenagoa Metropolis, Bayelsa State. International Journal of Development and Sustainability.2017, 6(8): 728 – 745.

[13] Idowu IA. An assessment of land use/landcover changes in a section of the Niger Delta, Nigeria.2012, 2(6): 137 – 143.

[14] National Population Commission on the 2006 Census, 2007. Population and Development Review, vol. 33, pp. 206–210. Available: https://www.citypopulation.de/php/nigeria-admin.php?adm2id=NGA006008https://earthexplorer.usgs.gov/http://www.google.com/earth/