SPATIO-TEMPORAL ANALYSIS OF LAND USE CHANGES TREND OF AKWA IBOM STATE, NIGERIA FROM 1986-2020 USING GEOSPATIAL TECHNIQUE

Akanimo Ezekiel Ekpo[1*], Louis Chukwuemeka Orakwe[1], Samuel Etim Inwang[2] and Chukwuemeka David Agbahia[2]

[1]Department of Agricultural & Bioresources Engineering, Faculty of Engineering, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
[2]Department of Geography, Faculty of Social Science, University of Uyo, Akwa Ibom State, Nigeria.
[*]Corresponding Author's Email: akanimoekpo@gmail.com

ABSTRACT
Land use change is a key component of research in environmental studies. "Land use" and "land cover" depict the information about the types of features existing on the Earth's surface and the physical individuality of Earth's surface. Land use/land cover has been known to affect the ecosystem of the environment. Therefore, there is a need to monitor the land use/land cover within the study area. An important tool in the management of land cover/land use is remote sensing. As such, remote sensing dataset was acquired for 17 years using the landsat imageries of Landsat Thematic Mapper (TM)/Enhanced Thematic Mapper Plus (ETM+)/Operational Land Imager (OLI) image data for 1986, 2003 and 2020 respectively. The downloaded imageries were processed and reclassified using the ERDAS IMAGINE. The land use/land cover identified within the study area was grouped into; water body, primary forest, secondary forest, swamp forest, cultivated land and built up/bare land. The Spatio-temporal analysis of the land use change the trend from 1986 to 2020 indicated that there is a continuous decrease in the water body, swamp forest and primary forest while secondary forest, cultivated land is experiencing a continuous increase. The data obtained in this research can serve as a guide to conservationists, policy makers and concerned groups and individuals for soil resource planning, management, conservation and distribution for sustainable soil resource utilization and sustainability. This work proves that remote sensing can be useful in land use/land cover mapping and has shown the variations across geologic formations of Akwa Ibom State of Nigeria.

KEYWORDS: Land use/Land cover, remote sensing, land degradation, GIS.

1. INTRODUCTION
Land use change is a key component of research in soil erosion, water resources, environmental changes and management globally (Turner *et al.,* 2007; Eyoh and Uboh, 2015; Karar *et al*., 2020). The modification of the earth's terrestrial surface by man is commonly known as land use/land covers (Hassan *et al*., 2016, Karar *et al*., 2020). However, man has explored and exploited his environment in search of resources for development and livelihood enhancement. The study of land use and land cover changes is one of the leading areas to understand the degree of interaction between man and his environment (Eyoh and Uboh, 2015). The terms "land use" and "land cover" are often used simultaneously to depict maps that afford information about the types of features existing on the Earth's surface. Land cover refers to the physical individuality of Earth's surface, which captures by vegetation, soil, water bodies and other physical features of the land (Karar *et al*., 2020). Land use refers to how land has been used by humans and their

habitat, usually for economic activities (Butenuth *et al.,* 2017; Dibs *et al.*, 2018). Land use and land cover changes play a major role in global environmental changes, as they significantly change the boundary relationship between the Earth and the atmosphere. Among the human activities carried out, land use and land cover changes affects the hydrological systems of the environment (Agrawal and Radhakrishna, 2007; Perumal and Bhaskara, 2010; Chimdessa *et al*., 2018). The use of remote sensing as a tool in the mapping of change detection of land use and land cover can be dated back to the 1970s (Coppock and Kirby, 1987). It has become an important tool in managing natural resources and observing environmental fluctuations (Karar *et al*., 2020). Remote sensing will help in change detection and analysis of land use and land cover and alteration for proper understanding of the environment and its possible impact. A change in the land cover tends to happen in an incremental manner, and as time goes on, these changes might be fast and unexpected because of human activities (Dibs *et al.,* 2018; Karar *et al*., 2020). The availability of landsat data allows an improved monitoring and assessment of large scale areas with land cover changes in areas of inaccessible land assessment (Kharazmi *et al.,* 2018). Remote sensing has been used to map deforested and urban expansion (Mansaray *et al*., 2016), monitoring of the shrinkage and shifting of wetland (Ghobadi *et al*., 2015) and climate change impact (Dangles *et al*., 2017). The specific aim of this research was to carry out an image generation/extraction of the spatial extent of the study area from three scenes of Landsat images; determine the land use and land classification (LULC) and analyze the spatiotemporal change trend of the LULC of Akwa Ibom state, Nigeria from 1986-2020 using remote sensing and GIS.

2. MATERIALS AND METHODS

2.1 Study Area

The study area was Akwa Ibom state, Nigeria and it is located within the trigonometric boundaries of 4°32’ and 5°33’ north latitude and 7°25’ and 8°25’east longitude and a landmass of 7081km^2 as shown on Figure 1. The climate is divided into two seasons, wet season which starts from April to October and the dry season last from November to March. The annual total rainfall ranges from 1875 to 2500 mm with a mean annual temperature that varies between 21°c and 29°c and a relative humidity of 60% to 85% (Isaiah *et al*., 2020).

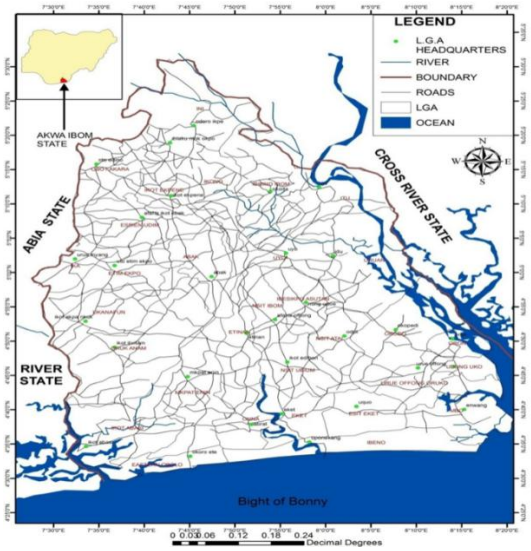

Figure 1: Map of the Study Area

2.2 Data

A 30 meters resolution dataset of remotely sensed satellite imagery of Landsat Thematic Mapper (TM)/Enhanced Thematic Mapper Plus (ETM+)/Operational Land Imager (OLI) image data acquired for 1986, 2003 and 2020 respectively from the United States Geological Surveys (USGS) was used for the land use/land cover classification and change trend analysis.

2.3 Image Processing and Data Preparation

The processing of the landsat images for change detection was carried out using ERDAS IMAGINE Software Version 15. Radiometric calibration and corrections were done during change detection to eliminate the image differences as a result of changing atmospheric conditions. A similar method has been employed by (Eyoh and Uboh, 2015; Essien and Cyrus, 2019; Karar *et al*., 2020).

3. RESULTS AND DISCUSSION

3.1 Land Use and Land Classification of Akwa Ibom State

Table 1 show the areas and percentages of the different land use and land classification identified within the study area from 1986, 2003 and 2020 in hectares.

Table 1: Table LULC Spatial Extent in 1986, 2003 and 2020

SN	Land Use Land Cover	1986 Area (Ha)	1986 Area %	2003 Area (Ha)	2003 Area %	2020 Area (Ha)	2020 Area %
1	Water Body	21951.38	3.1	25845.72	3.7	20269.35	2.9
2	Swamp Forest	143048.61	20.3	103812.59	14.7	77847.44	11.0
3	Primary Forest	168413.05	23.9	195272.75	27.7	95046.10	13.5
4	Secondary forest	180529.71	25.6	180059.25	25.5	212025.80	30.1
5	Cultivated land	141142.90	20	136425.30	19.4	159515.17	22.6
6	Builtup/Bare land	50149.71	7.1	63819.76	9.0	140531.51	19.9
	TOTAL	**705235.37**	**100**	**705235.37**	**100**	**705235.37**	**100**

Six categories of land use/land cover that were processed and applied to the region of study which include; water body, swamp forest, primary forest, secondary forest, cultivated land and bare land/built up. . The area covered by the water body in 2003 was 25845.72 ha and was higher than the areas in 1986 and 2020. The percentage of area covered by the swamp forest was 20.3% in 1986, while in 2003 and 2020 the percentage area coverage by swamp forest were 14.7% and 11%, respectively. The area covered by the primary forest was given as195272.75 ha and was higher than the areas in 1986 and 2020. Secondary forest occupied 30.1% of the total of the total land use and land cover which is greater than the areas occupied in 1986 (25.6%) and 2005 (25.5%). Cultivated land occupied 159515.17ha in 2020 which is higher than 1986 and 2003. In 2020, built up occupied 19.9% of the total land use and land cover which is greater than the area covered by built up for

1986 and 2003 covering 7.1%, occupied 9.0% respectively. The final classified land use and land cover map of the study area for 1986, 2003 and 2020 are shown in Figures 2, 3 and 4.

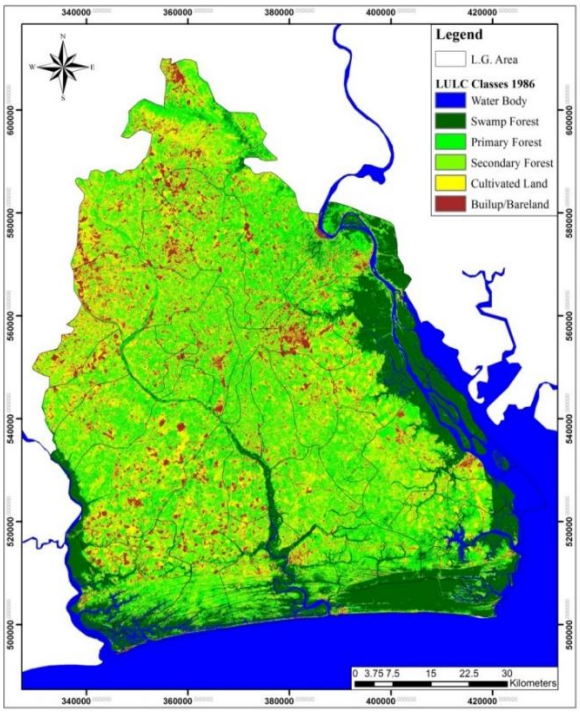

Figure 2: LULC Map of 1986 for Akwa Ibom

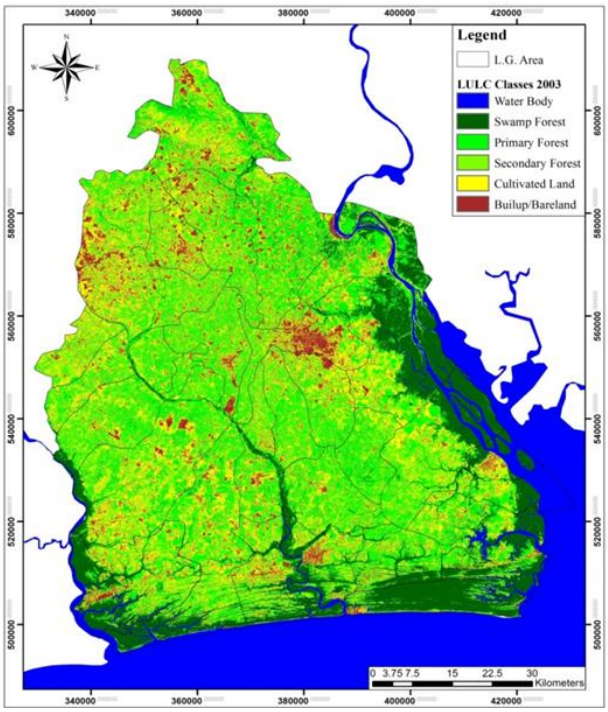

Figure 3: LULC Map of 2003 for Akwa Ibom

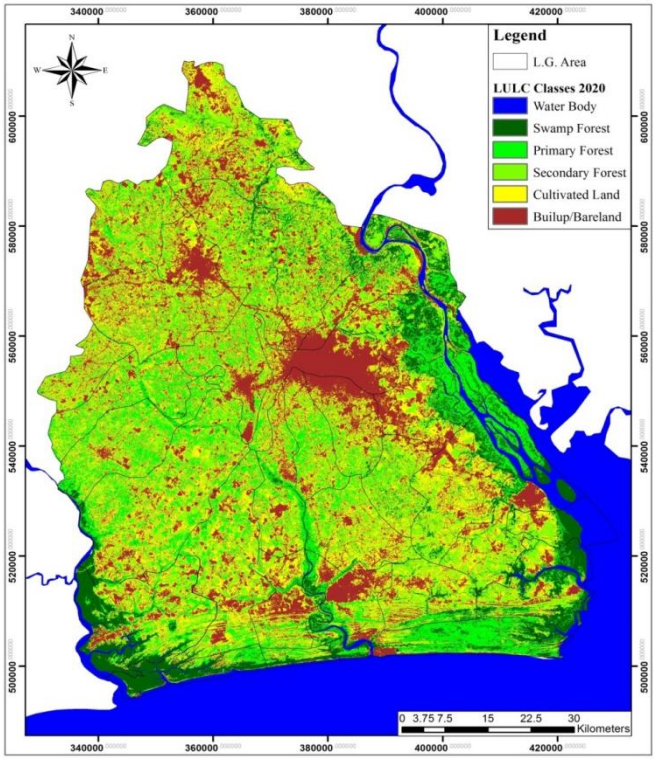

Figure 4: LULC Map of 2020 for Akwa Ibom

3.2 Trend of Land Use/Land Cover Change in the Study Area

The trend of land use and land cover changes within the study area in 1986 and 2020 is given as presented in Table 2. Considering 1986 and 2003, water body had an increase of 3894.34 ha, swamp forest had a decrease of 39236.02ha in 2003, primary forest had an increase of 26859.7ha, secondary forest had an increase of 470.46 ha, cultivated land had a decrease of 4717.6ha and built up/bare land had an increase of 13670.05ha. From 2003 and 2020, water body had a decrease of 5576.37 ha, swamp forest had a decrease of 19068.43ha, primary forest had an increase of 7793.95ha, secondary forest had an increase of 23089.87 ha, cultivated land had an increase of 76711.75 ha and built up/bare land had an increase of 5951.3ha.

Table 2: Trend of Land Use/Land Cover Change in the Study Area

SN	Land Use Land Cover	Area Change 1986	Area Change 2003	Area Change 2020	Area Change 1986-2003 (Ha)	Area Change 2003-2020 (Ha)
1	Water Body	21951.38	25845.72	20269.35	3894.34	-5576.37
2	Swamp Forest	143048.61	103812.59	77847.44	-39236.02	-25965.15
3	Primary Forest	168413.05	195272.75	95046.10	26859.7	-100226.65
4	Secondary Forest	180529.71	180059.25	212025.80	-470.46	31966.55
5	Cultivated Land	141142.90	136425.30	159515.17	-4717.6	23089.87
6	Builtup/Bare land	50149.71	63819.76	140531.51	13670.05	76711.75

From the results obtained, there was a land use and land cover changes within the study area. The total area covered by the study area is given as 705235.37ha. The increase in the water body in (1986 and 2003) was a result of the preservation of the primary forest which had helped in the reduction of soil erosion, siltation of the water body and increased the hydrological cycle (Chimdessa *et al*, 2018). Development of the study area has led to an increase in population and increase in land value (Essien and Cyrus, 2019). The influx of people to the study area is a result of the strategic location of the town and state capital serene environment and peaceful coexistence of the people and economic boom of the state (Essien and Cyrus, 2019; Eyoh and Ubom, 2015). This has led to an increase in built up/bare land within the study area. Population growth has led to an increase in the cultivated Land and secondary forest, while there is a reduction of the secondary forest, primary forest and swamp forest (Essien and Cyrus, 2019). The LULC shows the pattern of land usages and land classes within the study area which will help in understanding the pattern for conservation purposes. The land use and land classification (LULC) shows that most of the land within the study area will be subjected to soil erosion due to the pattern of land use and high rainfall experienced within the study area. Swamp forests are

being destroyed and have led to their reduction. There was an increase in secondary forest which was affected by the previous land use pattern. Cultivated lands and built up/bare land were exposed to soil erosion. Therefore, the land use changes signify that these changes within the study area have significant effects on the study area through the land use and land cover which affects the cover factor of the soil loss empirical model (USLE and RUSLE). Fertility decimation and the need to increase the cultivation to meet up with the food demand have influenced the increase in cultivated lands. Swamp forest and primary forest has been explored for the cultivation of crops while population growth has influenced the builtup/barelands changes within the study area. This study is relevant in land management erosion study. Designing and implementation of policies can be carried out based on this research for the preservation of the ecology.

4. CONCLUSION

Remote sensing was used to observe variations, modify, analyze and display the data from the satellite imageries. Change detection shows that there is a progressive increase in built up/bare land over the years, swamp forest and primary forest are being destroyed and converted into the secondary forest and cultivated lands which have affected the watershed and have led to a drastic reduction in the water bodies across the study area. Therefore, the land use/land cover information provided an insight into the land use pattern, which could aid in land use planning, distribution and management for sustainable soil resource management.

REFERENCES

Agrawal, N. K. and Radhakrishna, M. 2007. Multispectral image classification: a supervised neural computation approach based on rough–fuzzy membership function and weak fuzzy similarity relation. *International Journal of Remote Sensing* 28(20): 4597-4608, DOI: 10.1080/01431160701244898

Butenuth, M., Gösseln, G. V. and Tiedge, M. 2007. Integration of heterogeneous geospatial data in a federated database. *Journal of Photogrammetry and Remote Sensing* 62(5): 32.

Chimdessa, K., Quraishi, S., Kebede, A. and Alamirew, T. 2018. "Effect of land use land cover and climate change on river flow and soil loss in Didessa River Basin, South West Blue Nile, Ethiopia." *Hydrology* 6(1): 2. https://doi.org/10.3390/hydrology6010002

Coppock, J. T. and Kirby, R. P. 1987. Review of Approaches and Sources for Monitoring Changes in Land Cover, Scottish Development Office, Victoria Quay, Edinburgh EH6 6QQ

Dangles, O., Rabatel, A., Kraemer, M., Zeballos, G., Soruco, A., Jacobsen, D., Anthelme, F. 2017. Ecosystem Sentinels for Climate Change? Evidence of Wetland Cover Changes over the last 30 years in the Tropical Andes. *PLoS ONE* 12(5):e0175814. https://doi.org/10.1371/journal.pone.0175814

Dibs, H. S., Al-Hedny, and Abed Karkoosh, H. S. 2018. Extracting detailed buildings 3D model with using high resolution satellite imagery by remote sensing and GIS analysis; Al-Qasim Green University a Case Study. *International Journal of Civil Engineering and Technology* 9 (7): 1097– 1108.

Essien, E. and Cyrus, S. 2019. Detection of urban development in Uyo (Nigeria) using remote sensing. *Land* 8(6):102. https://doi.org/10.3390/land8060102

Eyoh, A and Ubom, O. 2015. Spatio-temporal analysis of land use/land cover change trend of Akwa Ibom State, Nigeria from 1986-2016 using remote sensing and GIS. *International Journal of Science and Research (IJSR)* 5(10):1805-1810.

Ghobadi, Y., Pradhan, B., Shafri, H. Z., Bin Ahmad, N. and Kabiri, K. 2015. Spatio-temporal remotely sensed data for analysis of the shrinkage and shifting in the Al Hawizeh wetland. *Environ Monit Assess*. 187(1):41-56. doi: 10.1007/s10661-014-4156-0.

Hassan, Z., Shabbier, R., Ahmad, S. S., Malik, A. H., Aziz, N., Butt, A. and Erum, S. 2016. Dynamics of land use and landc over change (LULCC) using geospatial techniques: A case study of Islamabad Pakistan. *SpringerPlus* 5(1):812. Doi: 10.1186/s40064-016-2414-z

Isaiah, A. I., Yamusa, A. M. and Odunze, A. C. 2020. Impact of climate change on rainfall distribution on cassava yield in coastal and upland areas of Akwa Ibom State, Nigeria. *Journal of Experimental Agriculture International*, *42*(5):44-53. https://doi.org/10.9734/jeai/2020/v42i530517

Karar, H. F., Hussein, S. and Hayder, D. 2020. Spatial-temporal analysis of land use and land cover change detection using remote sensing and GIS techniques. *IOP Conference Series: Material Science Engineering* 671(1) 012046 DOI: 10.1088/1757-899X/671/1/012046

Kharazmi, R., Tavili, A., Rahdari, M. R., Chaban, L., Panidi, E., Rodrigo-Comino, J. 2018. Monitoring and assessment of seasonal land cover changes using remote sensing: a 30-year (1987-2016) case study of Hamoun Wetland, Iran. *Environmental Monitoring and Assessment* 190(6):356. doi: 10.1007/s10661-018-6726-z.

Mansaray, L. R., Huang, J., Kamara, A. A. 2016. Mapping deforestation and urban expansion in Freetown, Sierra Leone, from pre- to post-war economic recovery. *Environmental Monitoring and Assessment* 188(8):470. doi: 10.1007/s10661-016-5469-y.

Perumal, K. and Bhaskara, R. (2010). Supervised classification performance of multispectral images. *Journal of Computing* 2(2):124–129.

Turner, L., Lambin, F. and Reenberg, A. 2007**.** The emergence of land change science for global environmental change and sustainability. *Procedure of Nationa*l *Academi*a of *Science. USA*, 104: 20666–20671.