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## ANALYSIS OF LAND USE COVER CHANGE IN WESTERN NIGER DELTA: A PANACEA FOR AGRICULTURAL LAND REDUCTION

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### Abstract

This study was carried out using the 3S-Technology Approach involving geographic information system, remote sensing and global positioning system to ascertain the level of agricultural land reduction and cover change in Western Niger Delta. Landsat imageries of 1986 and 2008 acquired from National Space Research and Development Agency (NASRDA) were analysed, classified and interpreted. Related land cover types were merged to form the cover types of interest, namely, Agricultural lands, Built-up areas, Degraded areas and Water bodies. The findings revealed that Agricultural lands and Water bodies in the area reduced by 1103.29 hectares and 131.03 hectares respectively, while built-up and degraded areas increased by 134.46 hectares and 3299.15 hectares, respectively. However, the correlation result showed that there was an inverse perfect relationship between Agricultural Land and Degraded land, implying that as agricultural land is decreasing due to urbanization and infrastructural development, degraded area is increasing due to oil spills, effluent and saline discharge, land pollution/compaction by mud and dredged spoil; while there was a perfect positive relationship between Agricultural land and water bodies, as decrease in both cover types stems from the massive construction of canals and other infrastructural development made by Multinational oil companies due to oil exploration to facilitate transportation to gain access to the inland areas from the water bodies. There is no doubt that this had impacted on the livelihood of farmers, exacerbated poverty and food insecurity in the area, since farming and fishing are the major occupations in the area.

### Introduction

Land cover refers to the natural surface of the earth undisturbed by human activities, representing vegetation, natural or man-made features and every other visible evidence of Land use e.g. forest, cultivated/uncultivated land, settlements, etc (Njike *et al.*, 2011). It describes the total physical land features (water bodies, soil, vegetation, rocks and so on) covering a particular land surface (Saleh *et al.*, 2014). In other words, land-use is the various ways in which land is put to use depending on human needs. Land Use Cover Change (LUCC) is a very complicated process, affected by both natural and anthropogenic factors, although the former is generally dominant (Amissah-Arthur *et al.*, 2000; Haboudane *et al.*, 2002; Sujatha *et al.* 2000; Thiam 2003; Wessels *et al.*, 2004). Several researchers have linked land-use change to the overall global change processes (Selvaraj *et al.*, 2013). Land use and land cover change in Niger Delta region is increasing in recent time and generating widespread environmental problems that required being mapped (Boakye, 2008). Demand for land for agricultural purposes is increasing globally implying a limitation in land resources. This has necessitated a yearning for decisions leading to the most beneficial use of limited land resources. Evidence based decisions made for optimal benefits of land resources have considerable implications for conserving land resources for the future (Abah, 2013). Land use evaluation determines land use options which are important for land use planning. According to Van Diepen *et al* (1991), land use planning is the allocation of land to various categories of use. Rivereira and Maseda (2006) opined that the framework for land use planning and land evaluation should not be confined to assessing the physical characteristics alone but should consist of the analysis of physical suitability, economic viability, social consequences and potential environmental impacts. The Food and Agricultural Organization (FAO) framework allows for a multi-criteria evaluation and integration with spatial infrastructure, such as Geographical Information System (GIS) in mapping out land use (Abah, 2013). According to this author, the use of GIS in the management of agricultural resources is increasing rapidly due to improvement in space borne remote sensing satellites in terms of spatial, temporal and radiometric resolutions. Rosenberg (2012) argued that farming in the 20<sup>th</sup> century became highly technological in more developed nations with geographical technologies like Geographic Information System (GIS), Global Positioning System (GPS) and remote sensing, while less developed nations continued with practices which are similar to those developed after the first

agricultural revolution, thousand years ago. Several studies utilized the mapping capabilities of GIS and Remote sensing in studying agricultural systems. The '3S' technologies involve the integration of remote sensing, geographic information system (GIS), and global positioning system (GPS) in the detection of land use cover change. Remote sensing is the science (and art) of acquiring information about an object, without entering in contact with it, by sensing and recording reflected or emitted energy and processing, analysing, and applying that information (Patenaude, 2013), while a portable Global Positioning System (GPS) is employed to record the geo-positions of each sampling site (Xiao *et al.*, 2005). The GPS is used to establish the basic size of the plots subject to area conditions, and later transferred to Geographic Information System (GIS) and projected to the datum used for the satellite images (Almeida-Filho and Shimabukuro, 2002 and Jabbar *et al.*, 2006). GIS is a computer assisted system for the acquisition, storage, analysis and display of geographic data (Zubair, 2006). However, contemporary factors such as agricultural land change, farmland degradation etc., have not received adequate attention in land use studies in Nigeria. Current technology use computer assisted system to detect changes in those factors. Layers are extracted and manipulated from topographic, climatic, and soil maps, as well as satellite image (thematic Mapping (TM) and enhanced thematic mapping (ETM)) and field survey data, rates of conversion calculated and distribution patterns mapped with the aid of a GIS (Geographic Information System) (Jabbar and Zhou, 2013). Uchua *et al* (2012) mapped and analysed agricultural systems in the lower River Benue basin in Nigeria using GIS. The study acknowledged the recession of the lower River Benue which has led to some adverse ecological changes and decline of agricultural production in the face of rapid population growth in the area. Analysis of land use/cover change (LUCC) is an important research field across the globe, being supported as a core project within the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP) (Hui *et al.*, 2008). Research involving Land Use Cover Change (LUCC) is a basic precondition of regional LUCC monitoring, driving factor analysis and even LUCC prediction (Eiumnoh, 2001; Hoffman and Todd, 2000; Symeonakis and Drake, 2004; Taddese, 2001). Change detection being a process of identifying differences in the state of an object or phenomena by observing it at different times (Njike *et al.*, 2011).

Studies have shown that due to anthropogenic activities, the Earth's surface is being significantly altered and the presence on the Earth of man and his use of land has had a profound effect upon the natural environment (Briney, 2008). Since the early 1980s vast transformations have occurred in the land use and land cover patterns as evidenced by persistent expansion in cultivated land, decrease in natural woodland and grassland in the world (Miller, 1996 and Xiaomei and Ronqing, 1999). It can therefore be stated that the land use and land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. The situation is aggravated in recent times due to man's increasing intervention on the environment, hence, there remains few landscapes on the earth's surface that have not been significantly altered by human beings in some ways (Opeyemi, 2007).

In Nigeria, several studies focused on pure desert surface and gully erosion. As a result, no extensive attempts have so far been made to document the dynamics of agricultural land use and land cover, evaluate the status of agricultural land overtime and predict the possible changes that may occur in this status so that planners can have a basic tool for planning. The 3S-Technology provides a general extensive synoptic coverage of large areas and possesses powerful capabilities with evaluation techniques for change detection. It adopts satellite imagery which is suitable to study changes in agricultural land cover and help avoid the high costs for field surveying.

The broad objective of this study is to analyse land use cover change in Western Niger Delta: A panacea for agricultural land reduction. The specific objectives are to,

1. examine the land cover types that exist in the area,
2. determine the trend and incremental change in agricultural land cover in the area,
3. ascertain the relationships between agricultural land cover and other cover types in the area,
4. and make policy recommendations.

### Methodology

The study area (MahinTransgressive Coast in the Western Niger Delta of Nigeria ) lies approximately between latitudes 5°45' and 6°30' north of the Equator and longitudes 4°30' and 5°07' East of the Greenwich (Abbas, 2012). It covers an area of about 3,310km<sup>2</sup>, a mud coastline distance of 88km and an inland distance of 50km and 19km respectively at its farthest and closest stretches from the Atlantic coastline. The area covers principally communities in Ilaje and Ese-Odo local government areas of Ondo state. It also extends to small parts of Ikale (Okitipupa) and Irele local government areas in Ondo state (Ondo State Oil Producing Areas Development Commission (OSOPADEC), 2009).The MahinTransgressive

coast in the Western Niger Delta of Nigeria is associated with a high intensity of both oil mineral exploration and subsistence farming activities which is leading to changes in the pattern of land use/land cover of the area (Fasona, 2003).

#### Analytical techniques:

The study was carried out using the 3S-Technology Approach involving literature search for secondary information on land use and land cover change in the Western Niger Delta of Nigeria. Landsat imageries of 1986 and 2008 adapted from Abbas (2012), acquired from National Space Research and Development Agency (NASRDA), Abuja were used for the study. It has three spectral bands with spatial resolution of 32m on all the bands. The re-sampled Nigeriasat-1 image was interpreted to generate the static land use/ land cover data for 2008. The images were georeferenced to UTM-31 projection, WGS84 datum and corrected for geometric and radiometric errors from the source (as adapted from Abbas, 2012). The static land use cover distribution for each study year (Table 1) was then pooled, and land cover types of interest (Agriculture, Built-up Area, degraded areas and water bodies) collated. However, the average annual change in various land cover types was determined using the average annual change indices shown below (Rosenberg, 1997):

$$\mu = \left[ \frac{\frac{\varphi - \theta}{\theta}}{n - 1} \right] \times 100$$

and  $Constant = \mu \times \theta$

Where

$n$  = the number of years, first and final years inclusive (years)

$\mu$  = Average annual change (percent)

$\varphi$  = Data value at the end of a time period (Hectares)

$\theta$  = Data value at the beginning of a time period, baseline value (Hectares)

Moreover, the yearly incremental change in land cover types was estimated using the index below (Rosenberg, 1997):

$$Estimate_{(\gamma_i)} = \theta_i + Constant$$

Where

$\gamma_i$  = the estimate of the  $i^{th}$  new year (years)

$\theta_i$  = Data value at the beginning of  $i^{th}$  time period (Hectares).

To determine if the decrease in agricultural land cover was directly related to the increase in other land cover types, a correlation analysis was performed on the data, using the Statistical Package for Social Sciences (SPSS).

## **Results And Discussion**

### The Land Use/Land Cover Types and Annual Incremental Changes

The Figures 1 and 2 show the land use/land cover maps of Mahintransgressive coast in the Western Niger Delta of Nigeria for 1986 and 2008

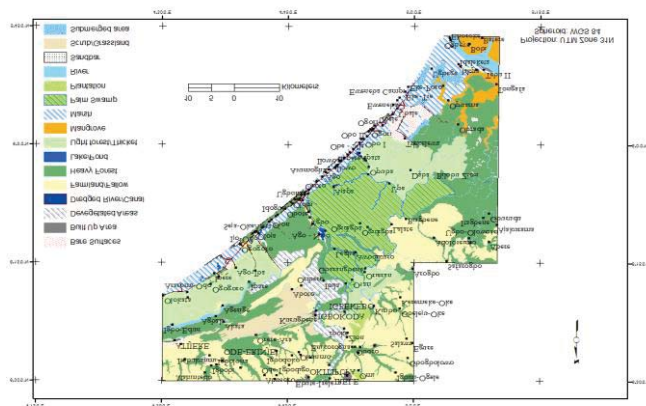
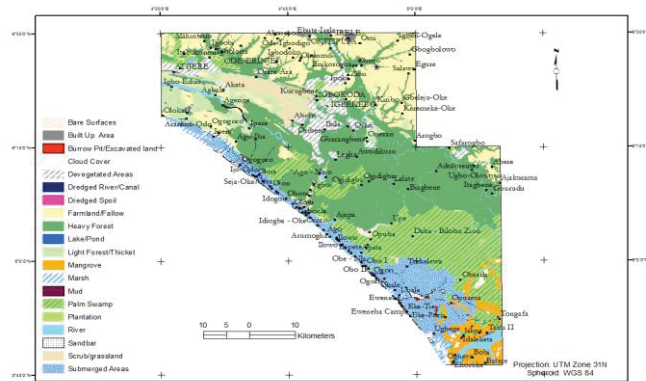


Figure 1: Land use-land cover map for 1986

Source: Global Land Cover Facility (GLCF), [www.glcg.umiacs.umd.edu](http://www.glcg.umiacs.umd.edu)



The Figures 1 and 2 show the various land cover types in the area, as classified. Related land cover types were merged to form the cover types of interest, namely, Agricultural lands, Built-up areas, Degraded areas and Water bodies, as shown in the Table 1:

The analysis of annual and incremental change in land cover types carried out (shown in Table 2) showed that Agricultural lands and water bodies in the area reduced by 1103.29 hectares and 131.03 hectares respectively, while built-up land area increased by 134.46 hectares annually. This is as a result of the massive construction, development and urbanization going on in the area, and since agriculture is the major occupation of the dwellers in the area, the pressure put on agricultural land and water bodies by the urbanization process puts food production increasingly at risk, as well threatens food security, exacerbates poverty level and results in loss of livelihood of those that depend on these agricultural lands. However, it was found that degraded areas increased by 3299.15 hectares. This emanates from the mud and dredged spoil exposed during canalization of lands and dredging of streams, which form a compaction on the top soil and prevent the growth of vegetation. Moreover, this increase in degraded area results from saline water inflow, oil spills and permanent inundation resulting from oil exploration activities in the area.

#### Relationships Between other land Uses and Agricultural Lands

The correlation analysis was used to determine if there was an inverse relationship between the decrease in Agricultural land cover areas and the increase in Built-up and Degraded land cover areas, and the corresponding decrease in water bodies. The result of the SPSS calculation showed that there was an inverse perfect relationship between Agricultural Land and Degraded land, while there was a perfect positive relationship between Agricultural land and water bodies as shown in the table 3.

The negative correlation produced by the results showed that for each unit of decrease in one land cover type, the other land cover type would increase by the same amount.

## Conclusion and Recommendations

The 3S-Technology Approach detects agricultural land use cover changes and predicts annual changes in the land cover types. The study concluded that Agricultural lands and Water bodies in the Western Niger -Delta reduced by 1103.29 hectares and 131.03 hectares respectively, while built-up and degraded areas increased by 134.46 hectares and 3299.15 hectares, respectively. However, as confirmed by the correlation result, it was concluded that this reduction in agricultural land cover was directly related to the increase in other land cover types. The reduction in agricultural areas and water bodies underlines the dangerous trend, such as food insecurity, poverty and general livelihood reduction that the pressure posed by anthropogenic factors has in converting land cover from agricultural uses to other uses. It is believed that if intensive bioremediation and agricultural land/water body reclamation are carried out, the degraded agricultural lands will be restored. This will not only better the lives of the farmers in the area, but will balance the ecosystem and restore its life support services.

## References

- Abah, R. C (2013) Importance of Agricultural Land Use Evaluation in Nigeria: A Review of Literature. *Agricultural Journal* 8 (5): 262-275
- Abbas, I. I (2012). An Assessment of Land Use/Land Cover Changes in a Section of Niger Delta, Nigeria. *Frontiers in Science* 2(6): 137-143
- Almeida-Filho, R and Shimabukuro, Y.E (2002). Digital processing of a Landsat-TM time series for mapping and monitoring degraded areas caused by independent gold miners, Roraima State, Brazilian Amazon *Remote Sens Environ* 79:42–50.
- Amissah-Arthur A, Mougenot, B and Loireau, M (2000) Assessing farmland dynamics and land degradation on Sahelian landscapes using remotely sensed and socioeconomic data . *Int J GeogrInfSci* 14:583–599
- Boakye, E. *et al.*, (2008) Landsat Images for Assessment of the Impact of Land Use and Land Cover Changes on the Barekese Catchment in Ghana: *European Journal of Scientific Research*. Vol. 22 No. 2, pp. 269 – 278.
- Briney, A. (2008) GIS An overview. An Overview of Geographical Information Systems.  
<http://geography.about.com/od/geographyinter/a/gisoverview.htm02052014>.
- Eiumnoh, A (2001) Tools for identification, assessment, and monitoring of land degradation. In: Bridges EM, Hannam ID, Oldeman LR, Penning de Vries FWT, Scherr SJ, Sombatpanit S . (eds) Response to land degradation. *Science, Enfield*, pp 249–260
- Fasona M J (2003) Coastal Flooding Risk and Community Adaptive Strategies in the Western Niger Delta, *Journal of Environment and Behavior*, Vol. 1 pp 56
- Haboudane, D, Bonn, F and Royer, A (2002) Land degradation and erosion risk mapping by fusion of spectrally based information and digital geomorphometric attributes. *Int J Remote Sens* 23:3795–3820
- Hoffman M.T and Todd S (2000) A national review of land degradation in South Africa: the influence of biophysical and socio-economic factors. *J S Afr Stud* 26:743–758
- Hui, W, Xiaolei, Z and Changgui W (2008). Ecoenvironmental degradation in the northeastern margin of the Qinghai–Tibetan Plateau and comprehensive ecological protection planning. *Environ Geol* 55:1135–1147
- Jabbar, T and Zhou, J (2013) Environmental degradation assessment in arid areas: a case study from Basra Province, southern Iraq. *Environ Earth Sci*: 70:2203–2214



- Jabbar, M.T, Shi, Z, Wang, T and Cai C (2006) Vegetation change prediction with geo-information techniques in the three gorges area of China. *Pedosphere* 16:457–467
- Miller, G. T. (1996), *Living in the Environment. Principles, Connections and Solutions.* Wardsworth. U.K.
- Njike, C, Igbokwe, J.I & Orisakwe, K. U (2011) “Analysis of Landuse and Landcover Changes of Aba Urban Using Medium Resolution Satellite Imageries”. FIG Working Week 2011 Bridging the Gap between Cultures Marrakech, Morocco, May 18-22.
- Ondo State Oil Producing Areas Development Commission (OSOPADEC) (2009): *A Compendium of the Commission's Formation and Activities, Ondo State Oil Producing Area Development Commission*, Integrity Press Ltd, Akure.
- Opeyemi, Z. A (2007). ”Change Detection in Landuse and landcover using Remote Sensing and GIS: A Case Study of Ilorin and its Environs in Kwara State”. Unpublished Msc Thesis, Dept. Geography, University of Ibadan, Nigeria.
- Patenaude, G (2013) “Introduction to Remote Sensing”.  
[http://www.forestry.gov.uk/pdf/Introduction\\_toRemote\\_Sensing.pdf/\\$FILE/Introduction\\_to\\_Remote\\_Sensing.pdf23072014](http://www.forestry.gov.uk/pdf/Introduction_toRemote_Sensing.pdf/$FILE/Introduction_to_Remote_Sensing.pdf23072014)
- Riviera, I.S and Masada, R. C (2006) A review of Rural Land Use Planning Models. *Environ. Plann. Des.*, 33:165-185.
- Rosenberg, M (2012) Geography of Agriculture:  
<http://geography.about.com/od/urban.economicgeography/a/aggeography.htm20092014>
- Rosenberg, D (1997) *Trend Analysis And Interpretation Division of Science, Education, and Analysis: Key Concepts And Methods For Maternal And Child Health Professionals* Maternal and Child Health Bureau, HRSA, PHS, DHHS, Parklawn Building 5600 Fishers Lane Rockville, Maryland 20857. Contract No. 240-94-0047
- Saleh, Y.; Badr, A. M ; El Banna, F and Shahata, A (2014) Agricultural Land-Use Change And Disappearance of Farmlands in Kaduna Metropolis-Nigeria. *Science World Journal Vol 9 (No 1)*
- Selvaraj, M., Kangabam, R., D. Kumar, P. & Govindaraju, P. (2013). Assessment of Land Use Land Cover Class Conversions within the Forest Ecosystem through Remote Sensing and GIS Technology. *International Journal of Recent Scientific Research* (4)5: 560- 562.
- Sujatha G, Dwivedi RS, & Sreenivas K (2000) Mapping and monitoring of degraded lands in part of Jaunpur district of Uttar Pradesh using temporal space borne multispectral data. *Int J Remote Sens* 21:519–531
- Symeonakis, E & Drake N (2004) Monitoring desertification and land degradation over sub-Saharan Africa. *Int J Remote Sens* 25:573–592
- Taddese, G (2001) Land degradation: a challenge to Ethiopia. *Environ Manag* 27:815–824
- Thiam A.K (2003) The causes and spatial pattern of land degradation risk in southern Mauritania using multitemporal AVHRR-NDVI imagery and field data. *J Land Degrad Dev* 14:133–142
- Uchua, k A; Olowolafe, E. A and Nduke, G E (2012) Mapping and analysis of Agricultural systems using GIS in the lower river Benue basin Nigeria. Proceedings of the International Conference on Tropical and Subtropical Agricultural and Natural resource management, September 19-21.
- Van Diepen, CA; Van Keulen, H; Wolf, J and Berkhourt, J A A (1991) Land Evaluation: From Intuition to Quantification In: Advances in Social, Stewart, B.A (ed), *Springer, vol.15*, New York. Pp139-204.

- Wessels KJ, Prince SD, Frost PE & van Zyl D (2004). Assessing the effects of human induced land degradation in the former homelands of northern South Africa with a 1 km AVHRR NDVI time- series. *Remote Sens Environ* 91:47–67
- Xiao, J., Shen, Y., Ryutaro, T & Bayaer, W (2005) Detection of land desertification and topsoil grain size using remote sensing. *IEEE* 7803-9050
- Xiaomei, Y. & Ronqing, L.Q. Y. (1999), Change Detection Based on Remote Sensing Information Model and its Application to Coastal Line of Yellow River Delta – Earth Observation Center, NASDA, China
- Zubair, A. O (2006) Change detection in land use and land cover using remote sensing data and GIS: A case study of Ilorin and its environs in Kwara State:  
[http://geospatialworld.net/uploads/thesis/opecyemizubair\\_thesisdoc.doc16062014](http://geospatialworld.net/uploads/thesis/opecyemizubair_thesisdoc.doc16062014)

Table 1: Land use/land cover Statistics for 1986 and 2008

Primary Class	Area (Ha) 2008	Percent 2008	Area (Ha) 1986	Percent 1986	
Agricultural Lands	57043.44	17.24	81,315.57	24.6	
Built-Up Areas	7934.11	2.39		1.5	4,976.13
Degraded Lands	94202.48	28.46		6.6	21633.74
Water bodies	11432.03	3.36	14,314.68	3.5	

Source: Adapted from Abbas (2012)

Table 2: Annual and incremental change in land Cover types

Classes	Annual Change (Ha) 1986-2008
Agricultural Lands	-1103.29
Built-up area	134.46
Degraded Land	3299.15
Water Bodies	-131.03

Source: Computed from the Adapted panel data



Table 3: Correlation values for the land cover types.

		<b>Correlations</b>			
		Agric_land	Built_up	Degraded_land	Water_Body
Agric-land	Pearson Correlation	1	-1.000**	-1.000**	1.000**
	Sig. (2-tailed)		.000	.000	.000
	N	23	23	23	23
Built-up	Pearson Correlation	-1.000**	1	1.000**	-1.000**
	Sig. (2-tailed)	.000		.000	.000
	N	23	23	23	23
Degraded-land	Pearson Correlation	-1.000**	1.000**	1	-1.000**
	Sig. (2-tailed)	.000	.000		.000
	N	23	23	23	23
Water-Body	Pearson Correlation	1.000**	-1.000**	-1.000**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	23	3	23	3

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Source: Computed from data collected