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Assessment of Land Use Change using Remote Sensing and GIS Techniques in South Western Nigeria

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Land Use (LU) and change analysis have always been the contemporary challenge in sustainable environmental management. A study to assess changes between 1986 and 2003 was carried out using a topographical map and two satellite images which were digitally processed using ILWIS 3.2 software and exported to Arc GIS 9.2 for further processing and analysis. The processed images were subsequently classified using the maximum likelihood classification algorithm for LU/LC classes. This involved the generation of LU/LC statistics for Landsat TM 1986 and Landsat ETM+ 2003, in a manner suitable for change detection analysis. Seven LU/LC classes were identified, they are farmland, heavy forest, light forest, settlement, shrub, waterbody and wetland. The most dominant LU/LC trend in 1986 was forest which covered 6021 hectares (56.96%) while wetland constituted the least covering 19.71 hectares (0.19%). The reservoir flooded far beyond the dam site extending as far as the studied communities. This average rate of change in wetland by +60.84%, is a clear evidence that a vast area of farmland and forest area has been damaged. Factors identified affecting transmission and intensity of urinary schistosomiasis in the study communities are the LU/LC changes and its attendant effects on human in the study communities. This study provides a baseline data for sustainable environmental management and adaptability of GIS/RS techniques for identifying the observed changes due to human activities in the study area.

Keywords: land Use land Cover, Landsat TM 1986 and Landsat ETM+ 2003, sustainable environmental management and maximum likelihood classification algorithm

Introduction

Erinle/Owala Reservoir dam in the present study area was constructed in 1987 across Erinle/Owala Rivers to serve as a check/hold-up dam to Erinle Reservoir dam at Ede. A few years after damming the river, the reservoir flooded far beyond the dam site extending as far as to the studied communities. Schistosomiasis has become an unforeseen consequence of this damming**.** The dam construction is a function of water needs, which has brought about the recent increase in schistosomiasis transmission and other ecological impacts (Oladejo & Ofoezie, 2006; Oladejo, 2016; Adediji & Ajibade., 2008).

The fact that the reservoir flooded far beyond the dam site, extending as far as the study communities, showing a progressive increase in wetland, is evident the damage caused to vast area of farmland and forest. The major road and water pipes were also badly damaged thus increasing the flooded area and also creating a favourable condition for visiting the reservoir (Oladejo & Ofoezie, 2006; Oladejo, 2016). This without doubt suggests that a favourable environmental condition has been put in place thus enhancing ecosystem disturbance in the study area. This paper therefore seeks to investigate the LULC over a period of 17years in the south western Nigeria using remote sensing and GIS techniques and the associated factors with adverse ecological consequences on the people of the area.

Study Area

The study was carried out in communities around Erinle/Owalla reservoir in Osun State. These communities are Ilie, Oba-Oke, Oba-Ile in Olorunda Local Government Area (LGA), Eko-Ende in Ifelodun LGA and Ore in Odo-Otin LGA (Figures 1.). Erinle/Owalla reservoir was built at Igbokiti in 1987 to serve as check/hold-up dam to Erinle Dam at Ede. The Dam has a crest length of 677 m and a maximum height of 27 m at an elevation of 330 m. The reservoir has a total storage capacity of 94 million cubic metres (mcm) and a dead storage capacity of 1.5 mcm (Adewunmi *et al.*, 1993). The reservoir flooded areas are far beyond the dam site extending as far as Ilie, Oba-Oke, Oba-Ile, Eko-Ende and Ore.

The people in the five communities are predominantly peasant farmers and petty traders but fishing is gradually growing as a popular occupation due to the opportunities created by the reservior. According to National Population Commission (1991), the population of the five communities is approximately 20000 with 3% growth rate projection (Oladejo & Ofoezie, 2006; Oladejo, 2016).

The climate of the study area is described as humid tropical environment (Orimoogunje, 2005. Oladejo & Ofoezie, 2006; Oladejo 2016), where the temperature is high throughout the year with no marked seasonal variations. The mean annual temperature is 27ºC. It is characterized by high humidity and substantial rainfall. The mean annual rainfall ranges from 1200mm to 1450mm, the pattern of rainfall is characterized by the double maxima regime, the two periods of maxima rainfall being June/ July and September/ October. There are two seasons in the region, namely the wet and dry seasons. The wet season last from March to October and dry season lasts from November to February. These climatic conditions are basically influenced and controlled by two major air masses namely the tropical maritime (mT) and the tropical continental (cT). Tropical rain forest dominates over other vegetation types in the study area. The soil is largely humus ferruginous which supports the cultivation of tree and arable crops such as cocoa, rubber, nuts and palm trees, citrus, cola, maize, vegetables, cassava, and yam. (Oladejo and Ofoezie, 2006, Oladejo 2016).

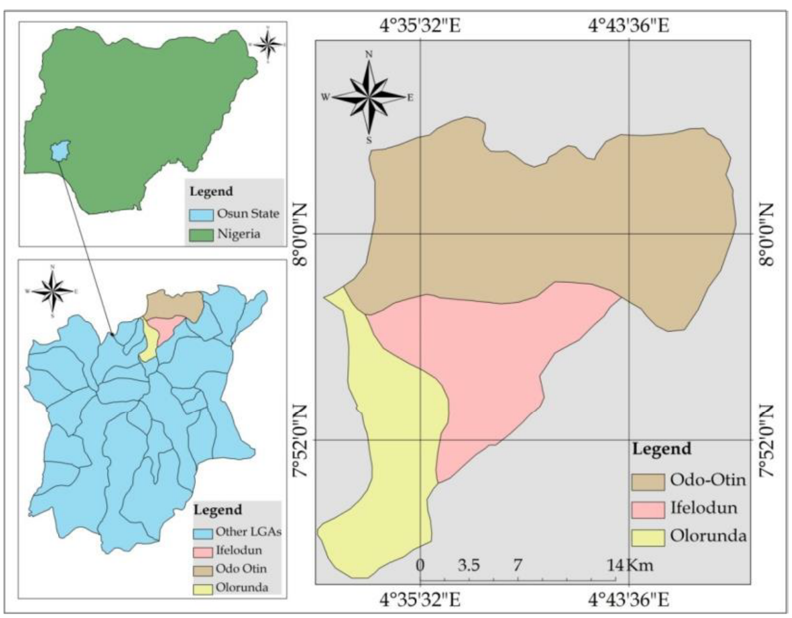


Figure 1: Map of Osun state showing the three LGAs where studies were conducted

Materials and Methods

Data sources

The multidate satellite images of the study area were accessed through Global Land Cover Facilities (GLCF) courtesy of the Regional Centre for Mapping of Resources for Development (RCMRD), Nairobi, Kenya. They are Landsat TM 1986 and ETM+ 2003, the data sets were located on the satellite path 190 and row 55. The selection of the images in the same season was to minimize the influence of seasonal variations in the result. (Table 1)

Image processing

This study made use of multidate satellite images and geospatial modelling techniques to analyse LU/LC change in the five communities around Erinle/Owalla Reservoir Dam. This involved the generation of LU/LC statistics for Landsat TM 1986 and 2003 in a manner suitable for change detection analysis. The study also involved an initial reconnaissance survey of the study area, which was carried out in June, 2008. The study area was georeferenced to its true ground position and some crucial information about the physical and cultural features in the study area were gathered, which assisted in developing an appropriate LULC classification scheme. The GPS and topographical maps of the study area were used during the reconnaissance survey.

Following the above, coupled with the fact that multidate data was employed for the research, an accuracy assessment was performed on the images using confusion matrix operation to identify the nature of the classification errors (errors of omission or exclusion; errors of commission or exclusion or inclusion) as well as their quantities.

The LU/LC analysis was done using Arc GIS10, ENVI 4.7 and ERDAS IMAGINE software and subsequently classified using maximum likelihood classification algorithm. Change detection pattern of LULC was calculated as described by Salami (2006a). Change in LULC=LULC2-LULC1 Where LULC2 represents current areal extent of a particular land use/land cover type. LULC1 represents previous areal extent of a particular land use/land cover type. Change LULC represents land use/land cover change. Average Rate of Change [ARC] = Average Rate of Change in LULC/T. T represents total number of years.

Results and Discussion

Land Use /Land Cover Studies (1986-2003)

Table 2 shows the LU/LC description of LU/LC classes identified in the study communities. The most dominant LULC trend in 1986 was forestlands which covered 6021.hectares (56.96%) while wetland, cropland, grassland, settlement and other lands covered 19.7, 3833.34, 53.35, 107.30 and 54.81 hectares respectively (Table 3) wetlands constituted the least 19.8 hectares (0.198%). In 2003, the dominant LULC was cropland with 3943.80 hectares (34.38%), followed by wetland 1054.0 hectares (9.19 %) and settlement with 210.96 hectares (1.84%) (Table 3). There is significant change occurrence in all the land use classes with wetland having highest, increased from 19.71 hectares to +1034.29 hectares (Table 3).

Table 1: Satellite Data Sources and Characteristics

Data	Type	Date	Source	Scale/ Number
Topographical Map (Ilesha SW Sheets 279)	Analog	1964	Federal Survey, Lagos	1:100000
Landsat TM	Digital	Jan, 1986	Regional Centre Mapping of Resources for Development, Nairobi, Kenya.	30 m
Landsat ETM+	Digital	Feb,2003	Regional Centre Mapping of Resources for Development, Nairobi, Kenya.	30 m

LULC results showed that farmland, heavy forest and light forest were declining, thus making the habitat more favourable for the breeding of intermediate host snails for the transmission of schistosomiasis in the study communities.

The environmental changes that took place between 1986 and 2003, as they are shown by the satellite images used in this study, made it possible to quantify the present effect of LULC. Land use change detection allows for the identification of major processes of change and, by inference, the characterization of land use dynamics. The reason for such consequence is as a result of over-dependence on primary resources with direct effect on biodiversity; land use and land cover dynamics, terrestrial ecosystem and climate (atmospheric composition, vegetation, temperature changes and occurrence of extreme climatic events (Salami, 2006a; Ademiluyi *et al*., 2008 Simoonga *et al*., 2008

Table 2: Comparison of areas and rates of change of the six L U L C between 1986 and 2003

LU/LC Types	1986 LU LC **Areal Extent**		2003 LU LC **Areal Extent**		Change between 1986 and 2003	Av. rate of change
	Ha	%	Ha	%	Ha	ha/yr
Wetlands	19.71	.019	1054.0	9.19	+1034.29	+60.84
Forestland	6021	56.96	5351.10	46.65	-669.9	-39.40
Cropland	3833.34	36.30	3943.80	34.38	+110.45	+6.49
Grasslands	533.35	5.10	708	6.17	+174.65	+10.27
Settlements	107.30	1.91	210.96	1.83	+103.66	+6.09
Otherlands	54.81	0.52	201.78	1.76	+146.97	+8.65
Class Total	10569.51	100	11469.67	100		

Table 3: Temporal Variation of Wetland coverage between 1986 and 2009

Year	Coverage Area (hectares)	Change per interval year	Av. rate of Change/ interval year	% Change per year
1986	19.7	-	-	-
2003	1054.1	- 81.0	-4 .8	7.6

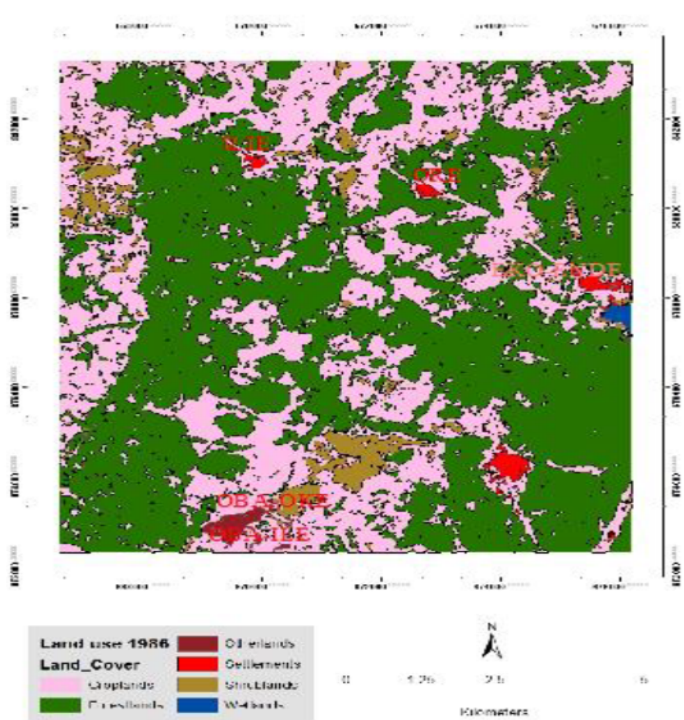


Figure 2: Land Use/ Land Cover Map of the Study Area based on LandsatTM1986.

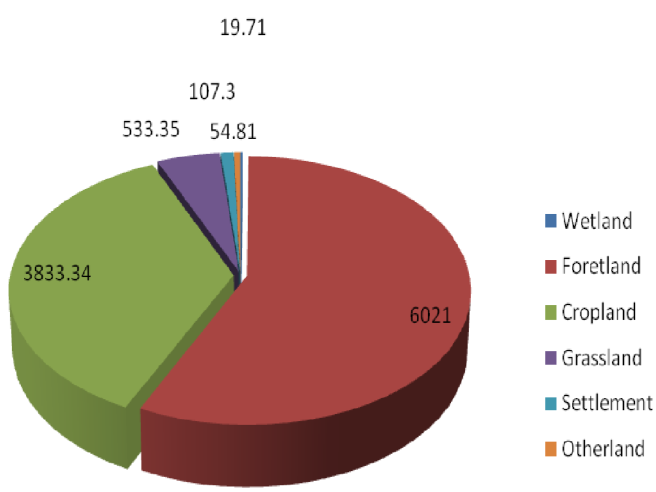


Figure 3: Land Use/ Land Cover Area Extent based on Landsat TM 1986

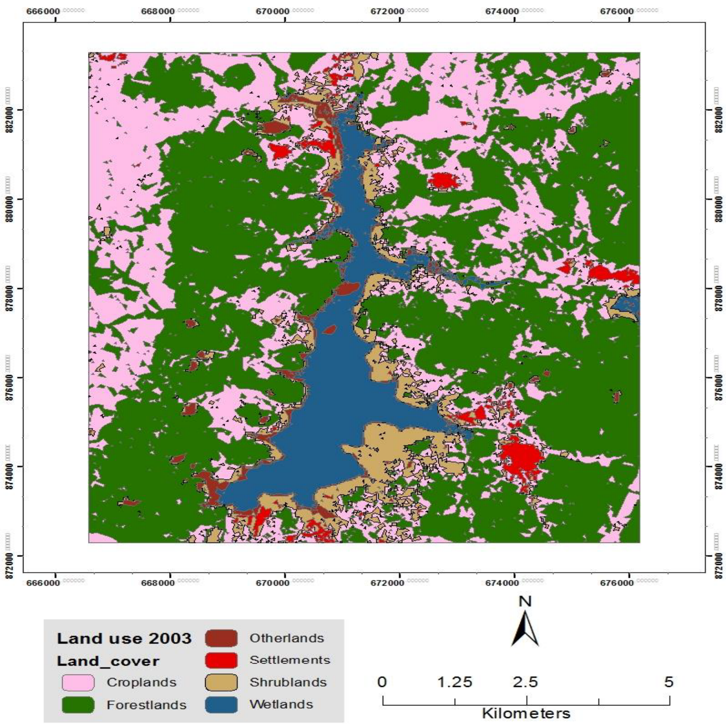
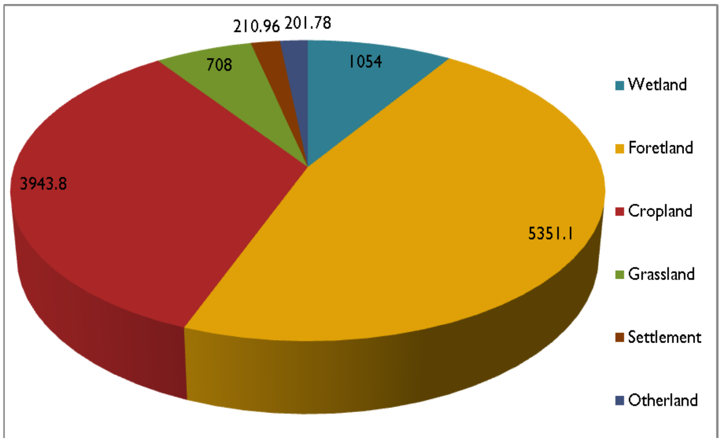


Figure 4: Land Use/ Land Cover Map of the Study Area based on Landsat ETM 2003



LU/LC classes (Ha^2)

Figure 5: Land Use/ Land Cover Area Extent for Landsat ETM 2003

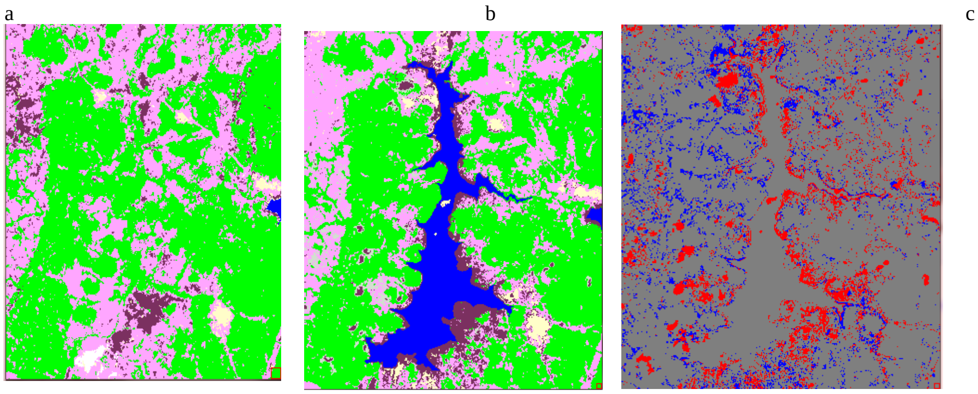


Figure 6 Image difference of the Change detection between 1986 and 2003

The resultant effect of LU/LC classes conducted in the study area indicated that the dam construction resulted in flooding and the resultant effect on the increase in wetland led to bio-richness thus creating ecological conditions which led to unprecedented environmental and ecological implications. The ecological implication resulting from LU/LC showed that there was flooding, biodiversity richness, biodiversity loss, destruction of farmlands, reduction of settlement area extent and sedimentation in the study communities.

LU/LC changes with the environmental changes and social disruption resulting from the construction and operation of large dams and the associated infrastructure developments such as irrigation schemes can have significant adverse health outcomes for local populations and downstream communities (Ofoezie, 2002, Oladejo & Ofoezie 2006; Adediji & Ajibade, 2008).

Conclusions

This study reaffirms clear evidence of the link between LU/LC, the more interesting aspects of recent modelling studies concerns the role of non-climatic factors (LU/LC) i.e. human impacts in determining associated impacts, especially at local scales (Zhou, 2001; Berke, 2004; Brooker, 2006). The trend and extent of urban change is likely to continue with the rapid development of infrastructure due to increasing population. There has been a progressive increase of wetland in the study communities between 1986 and 2003 The results of this study will enhance the understanding of the causes and consequences of land use and land cover change and change. Furthermore, it will serve as an addition to the growing body of knowledge and information in the effort aimed at policy making towards sustainable biodiversity management in Nigeria.

This study has demonstrated that the recent advancements in remote sensing and GIS technologies provide powerful tools for mapping and detecting changes in LU/LC risk models as function of ecological impact matrix models. This trend has serious implications for human health and overall outcome of control programmes in the study communities and the state at large. In order to alleviate the dramatic land use/landcover change and adverse environmental impacts of water needs and dam construction, there is need for proper mitigating measures, which will enhance the principle of sustainable development, the current growth pattern needs to be managed through effective land use/landcover planning and management. This would be useful to protect the ecology of the area and further reduce environmental degradation in the form of flooding, soil erosion and water stress.

There is need to put the necessary mitigating measures in place by carrying out an Environmental Impact Assessment before and after a dam is constructed for sustainable LU/LC pattern, less pollution towards sustainable growth.

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References
Adeoye, N.O. (2007). Deforestation and Land Use Dynamics: In Ijesa-Ekiti Region of Southwestern Nigeria. PhD Thesis, University of Ibadan

Adebola1, O A., Adegboyega.1, S.A., Olajuyigbe, A.E, & Oladejo, S.O (2015). Modelling of land Use and land cover change in Ibadan north-west local government area (LGA), Nigeria using Satellite imageries and GIS techniques. *Journal of Sustainable Development in Africa* **17**(7), 1520-1529

Adediji, A & Ajibade, L.T (2008). Change detection of major dams in Osun State, Nigeria using Remote sensing (RS) and GIS techniques. *Journal of Geography and Regional Planning*, 1(6), 110-115.

Adewumi (1993). Schistosomiasis and Intestinal parasites in rural villages in Southwest NigeriaAn indication for expanded Programme in Nigeria. *Tropical Parasitology* 44, 174-180.

Ademiluyi I. A., Okunade A.S. and Akanni C.O. (2008) An appraisal of land use and landcover Mapping in Nigeria. *African Journal of Agricultural Research*,3 (9), 581-586

Berke, O. (2004). Exploratory disease mapping: Kriging the spatial risk function from regional count data. *International Journal of Health Geographics, 10.1186/1476-072x-3-18*

Brookers S, Hay SI & Bundy D. A. P. (2002). Tools from ecology: useful for evaluating Infection risk models. *Trends in Parasitology*, 18, 70–74.

Brookers S, Hay S. I., & Bundy D. A. P. (2007). Tools from ecology: useful for evaluating infection risk models? *Trends in Parasitology*, 18, 70–74.

Brookers S, Clements A. C. A., & Bundy D. A. P. (2006). Global epidemiology, ecology and control of soil-transmitted helminth infections. *Advances in Parasitology*, 62, 221–261.

Brookers S, Hay SI, Issae W, Hall A, & Kihamia C. M. (2001). Predicting the distribution of urinary schistosomiasis in Tanzania using satellite sensor data. *Tropical Medicine and International Health*, 6, 998–1007.

Oladejo S.O. (2016). *Schistosoma haematobium* distribution pattern associated with environmental variablels selected communities from, Osun State, Nigeria. PhD Thesis. University of Ibadan, Ibadan.

Oladejo S.O. & Ofoezie, I.E. (2006). Unabated schistosomiasis in Erinle river dam, Osun State Nigeria: evidence of neglect of environmental effects of developments. *Journal of tropical Medicine and International Health*, 11, 6

Raso G., Vounatsou P., Singer B.H., N'Goran E.K., Tanner M., & Utzinger J. (2006). An integrated approach for risk profiling and spatial prediction of *Schistosoma mansoni*–hookworm coinfection. *Proc. Natl. Acad. Sci.* USA.; 103: 6934–6939. Report No. 31. IDRC

Salami, A.T. (2006a). "A Potientials of Nigeriasat-1 for Sustainable Forest Monitoring in Africa: A case Study from Nigeria", A paper presented at DFG Research Group 510 on 'Ecological and cultural change in West and Central Africa,' Goethe Institute Yaounde, Cameroon. March 5-7,

Simoonga C, Kazembe LN, Kristensen TK, Olsen A, Appleton CC, & Mubita P. (2008). The epidemiology and small-scale spatial heterogeneity of urinary schistosomiasis in Lusaka province, Zambia. *Geospatial Health*, 3, 57–67

Stow, D. A., & Chen, D. M., (2002). Sensitivity of multitemporal NOAA

AVHRR data of an urbanizing region to land-use/land-cover change and misregistration. *Remote Sensing of Environment*, 80, 297–307.

Zhou XN, Malone JB, Kristensen TK, & Bergquist N.R. (2001). Application of geographic information systems and remote sensing to schistosomiasis control in China. *Acta Trop,* 79, 97–106.