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# Forest Cover Change in Stubb's Creek Forest Reserve Akwa Ibom State, Nigeria

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## ABSTRACT

*Stubb's Creek Forest Reserve (SCFR) is the largest remaining forest in Akwa Ibom State. The reserve possesses fragile ecosystems with valuable fauna and flora species. Human activities have resulted to continued biodiversity degradation necessitating monitoring, protection and conservation. Forest cover change in SCFR was examined. Three sets of time-series satellite imageries were used to assess the trend in forest cover change in the study area. Integrated Land and Water Information System, and ARCGIS were used to analyse the imageries of 1993, 2003, 2013 and maps of the land cover were produced. Results indicated that between the period of 1993 and 2013, the overall forest cover change was 35.28 $km^2$ (55.56%) with annual rate of 1.76 $km^2$ (2.78%). Between 1993 and 2003, 21.07 $km^2$ (35.50%) of forest was lost at an annual rate of 2.107 $km^2$ (3.31%) and between 2003 and 2013 it declined to 14.21 $km^2$ (33.50%) with an annual rate of 1.42 $km^2$ (3.35%). This decline could be attributed to increased awareness on the importance of the forest reserve, shift in preferred source of energy, and concentration of infrastructural development. It was predicted that by 2033 the whole SCFR will be lost. This could bring about diverse disasters. Therefore, ecological restoration should be conducted. Human activities within the SCFR should be sustainable and environmentally friendly.*

**Keywords:** Forest reserve, Integrated Landsat, Land cover, Change Rate

## INTRODUCTION

Over the years, the incessant forest exploitation for agricultural development, fuelwood collection, sand excavation, mining, mineral exploitation, urbanization, uncontrolled harvesting and the lack of awareness of the importance of forest by the populace and population growth in rural area are complementary factors resulting in the continued shrinkage of Nigerian's forest estate (Boucher *et al.*, 2011). Like identified by Efiong (2011), in an assessment of the changing pattern of land use in the Calabar river catchment, the major drivers of forest loss range from large-scale conversion of forest to plantain plantations, to small-scale shifting cultivation. According to Osei *et al.* (2005), land under agricultural cultivation is increasing at an average rate of 554,657 hectares per annum, while land under high forest is diminishing at a rate of 105,865 hectares per annum. Drought, forest fires, overgrazing and flooding also add up to the severe loss of biodiversity and diminished forest productivity. Currently, Nigeria has lost more than 50% of its forest and less than 10% of the country is forested. Deforestation is estimated to be at a rate of 3.5% to 3.7% per annum (Akingbogun *et al.*, 2012; Federal Ministry of Environment, 2014).
The actual forest cover in Nigeria may not be known because most of these records, according to Akingbogun *et al.* (2012), only exists on paper, due to the present high annual rate of deforestation in the country. In Akwa Ibom State, the forest cover has also changed drastically, due to the high deforestation rate also. This is as a result of unsustainable farming practices which account for over 80% of the deforestation rates (Ndoho *et al.*, 2009). They opined that de-reservation as a result of farming, logging, fuelwood exploitation, bush burning, fuelwood gathering, environmental pollution and urban and industrial expansion among others are the pertinent causes of deforestation. Most of the forests of the state are located outside conservation/ protected areas thus, resulting in uncontrolled exploitation. The situation is not different at the SCFR, one of the reserves of Akwa Ibom State where indiscriminate land-use practices in the area have led to the destruction of a sizeable portion of the reserve (Amubode, 1992). The original area of the SCFR at the time it was gazetted was 310.80$km^2$ but presently, it has reduced greatly (Akpan-Ebe, 2005).

Coastal regions are vital biodiversity spots that are extremely utilized globally (Jacob *et al.*, 2015). These areas are known to possess fragile ecosystems with valuable fauna and flora species utilized for food, medicine, fuel, construction and other uses (Onojeghuo and Blackburn, 2011). In addition to providing valuable fauna and flora species, coastal areas are usually locations of rich mineral deposits such as crude oil, making them prone to degradation and fragmentation. The SCFR, located in the coastal region of Nigeria, called the Niger Delta, is the largest remaining area of intact forest, constituting mangrove forest, swamp forest, and lowland rainforest, in Akwa Ibom State (Udo *et al.*, 1997). The SCFR was originally gazetted to be 310.8 km$^2$ in 1930 but, the area has been exposed to oil exploration, population growth, infrastructural development, and other resulting in fast vegetation loss and biodiversity degradation (Akpan-Ebe, 2014). Presently, SCFR barely sustained a vegetation cover of about 48.22 km$^2$ therefore, creating a need for monitoring, protection and conservation of the area (Ndoho *et al.*, 2009).

Remote Sensing technology have proven useful in acquiring information (spectral, spatial and temporal) about material objects, area, or phenomenon without having physical contact with the objects, or area, or phenomenon under investigation (Fabiyi, 2001). Data for land use and land cover assessment which has previously relied on in-situ field measurements, are now being obtained using the remote sensing technology. Data obtained through remote sensing at different spatial resolutions are analyzed to extract useful thematic information such as, land cover maps from the raw imagery. The geographical information system (GIS) as conceptualized in the literature is a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modelling, representation and display of geo-referenced data to solve problems regarding planning and management of resources (Danka and Klein, 2002). Given the capability to combine a variety of datasets in an infinite number of ways, GIS appear a useful tool for nearly every field of knowledge including forestry. Eludoyin and Oyebade (2011) reported that the combination of remote sensing technology and new data analysis techniques, with advances in remote sensing sciences and ecosystem modelling, enhanced the application in mapping, monitoring and management of forest resources. Within the frame of resource assessment, remote sensing found applications in activities such as tree inventory, delineation of spatial extent of forest cover, determination of vegetation indices, determination of vegetation type, determination of forest biophysical and biochemical properties, carbon sequestration and storage, clear cut mapping and deforestation, land cover and biomass mapping, and land use change (McKendry and Eastman, 1991; Eludoyin and Oyebade, 2011).

The objectives of the study were to assess forest cover change at the SCFR through the analysis of time series of satellite imageries, using the Geographic Information System and to examine the trend of forest cover at the Stubb's Creek Forest Reserve. Findings from the research have potentials to help determine the extent of ecological restoration and increased surveillance required for the area. Also, understanding the rate of deforestation in the reserve could improve managerial actions towards conservation of the area. It is necessary to quantify the forest resources in this study location for improved carbon accounting and climate change modelling. To have a full understanding of the changes in the forest cover, as well as, the trend in future forest modification in the SCFR for optimal management of the forest, a proper assessment of the estate is required. This will aid its delineation from non-forest and the calculation of the extent of forest cover (Boyd and Danson, 2005). Remote sensing and GIS offers a solution to these challenges.

## MATERIALS AND METHODS

### Study Area

This study was conducted in the Stubb's Creek Forest Reserve (SCFR), located in Akwa Ibom State, Southern Nigeria. The SCFR lies approximately at 04°32" - 04°49" N latitude and 08°00" - 09°10" E longitude (Figure 1) and covers an area of 310 km$^2$ (Ndoho *et al.*, 2009). The area is bounded in the south by the Atlantic Ocean and in the west by the Qua Iboe River, Mobil Producing Nigeria Unlimited (MPNU) installations and Ntak (Baker, 2003; Akpan-Ebe, 2005; Ndoho *et al.*, 2009). In the east, the SCFR is bounded by the Cross River Estuary, Okposso and Unyenge communities and in the north by Mbo Local Government Area (Baker, 2003; Akpan-Ebe, 2005; Ndoho *et al.*, 2009). The SCFR has a plain, gently undulating relief with long parallel depressions and low ridges that stretch inland from the shoreline and drainage consisting of three principal rivers with several creeks and streams; from which the name the Stubb Creek was derived (Akpan-Ebe, 2005). The soil is characterized by low acidity and low organic carbon content, poor electrical conductivity and low mineral ions and beach ridge that make up 95% of the soil physical properties. Hence the soil is almost sterile resulting in poor crop yield as seen in its traditional farmland (Ndoho *et al.*, 2009).

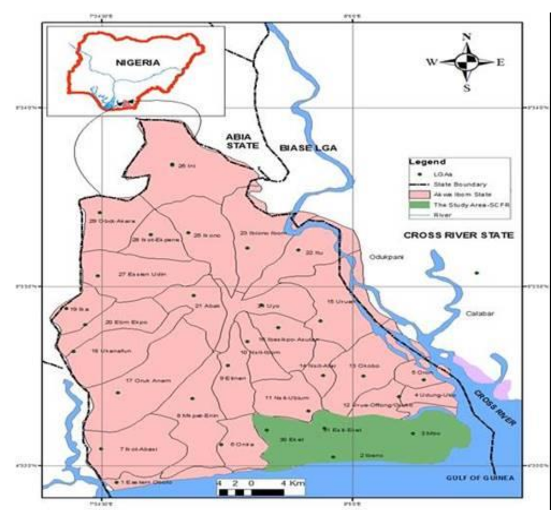


**Figure 1:** Map of Akwa Ibom State showing area covered by Stubb's Creek Forest Reserve.

The SCFR records heavy amount of rainfall in most months of the year, with a mean annual rainfall of more than 3,000 mm, mean annual temperature of between 26˚C and 30.5˚C and relative humidity varying from 60% to 95% with highest values recorded in July and the lowest in January (Werre, 2001 in: Jacob *et al.*, 2015). This heavy rainfall supports ever-green luxuriant vegetation throughout the year. The vegetation composed of marine estuaries and lowland rainforest species some of which appears in some areas as pure continuous belt, or indistinct colonies or as conglomeration of individual tree species (Akpan-Ebe, 2005). There are diverse species such as *Alchornea cordifolia, Anthocleista vogelii, Musanga cecropiodes* in the forest. There are also species like *Raphia hookeri, R. vinifera*, oil palm strips at the peat land or fresh water swamp area of the forest. The mangrove colonies, along the coastline and tidal waterways consist of *Rhizophora racemosa, R. harrisoni, R. mangel and Avicenia nitida* There is also rich lowland rainforest vegetation with wide range of economic tree species which include *Uapaca standii, Pachystek brevipes, Lophira alata, Ceiba pentandra, Strombosia postulata, Pcynanthus angolensis, Milicia excelsa, Hallea ciliata, Uapaca guinense, Symphonia globurifera, Parkia bicolor, Pausinystalia talbotii and Xylopia rubescens* (Amubode, 1992; Akpan-Ebe, 2005).

**Data Collection**

The SCFR was purposively selected for the study from the existing four (4) forest reserves in Akwa Ibom State based on the knowledge of the increasing rate of human activities in the area and the role this forest plays in controlling coastal flooding. Satellites images were obtained from Advanced Space Technology Application Laboratory, Uyo. The data was analysed at the GIS Laboratory, Department of Geography and Regional Planning, University of Calabar. Three sets (1993, 2003 and 2013) of satellite imageries were obtained; LANDSAT TM Imagery of 1993 and 2003 where downloaded from the Global Land Cover facility (GLCF) and ground truth imagery of 2013 (see Figures 2 to 4) was acquired from Google earth. Due to the challenges from cloud cover the images were multi-spectral.

**Method of Vegetation Change Detection**

Integrated land and Water Information System, GIS/ Remote sensing software for both vector and raster processing, were used for image enhancement and classification. ARCGIS version 9.3 was use for digitization and classification of areas. The three imageries were geo-referenced in ARCGIS environment for a common coordinate and pixel size. The coordinates of the area of study (SCFR) was then used to locate the area in the imageries. Unsupervised classification was used to group the area into four classes (Figures 5 to 7): Dense area/ less degraded area (areas of thick vegetation cover with deep shades of green coloration), Sparse/ degraded area (open areas with light/ faint shades of green), Bare soil (area of no vegetation cover) and Water body (area cover with water). The areas identified and classified were digitized in ARCGIS 9.3 to provide the land cover maps of the three periods using projected coordinate system. The area in square kilometre covered by each land cover were calculated using the numeric field of the attribute table in ARCGIS while annual and percentage changes were calculated between 1993 to 2013 using Area Differencing Approach. A common change value was calculated annually and using simple linear regression (Jacob *et al.*, 2015), this was used to project the extent of land cover changes to 2033 (20 years into the future).

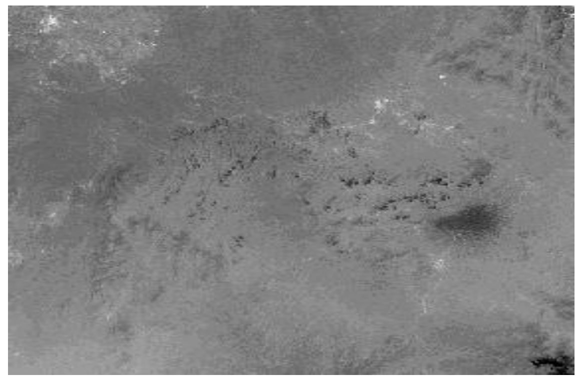

**Figure 1:** Landsat TM imagery of 1993 showing area covered by SCFR

**Figure 2:** Landsat TM imagery of 2003 showing area covered by SCFR.

The changes were estimated with the formula given as (eqn. 1):

$$\text{Change} = \frac{\text{Final Area} - \text{Initial Area}}{\text{Initial Area}} \text{ x } 100 \ldots (1)$$

The annual change was estimated with formula given as (eqn. 2):

$$\text{Annual change} = \frac{\text{Change in Area}}{\text{No of years}} \ldots\ldots\ldots (2)$$

Note: Positive values from this calculation will indicate an increase in area of land cover while negative values will indicate a decrease in area of the land cover (Jacob *et al.*, 2015).

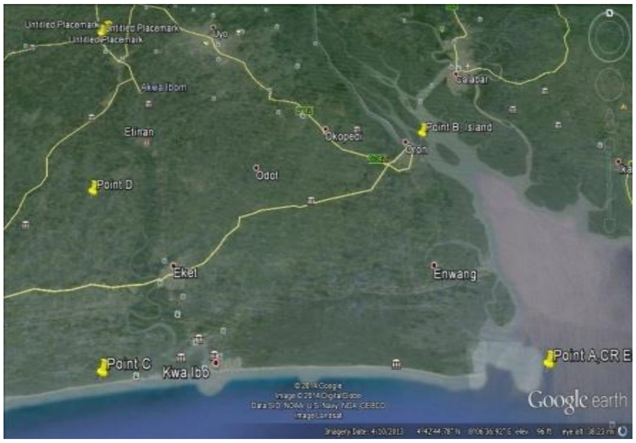


**Figure 4:** Google earth satellite imagery of 2013 showing area covered by SCFR

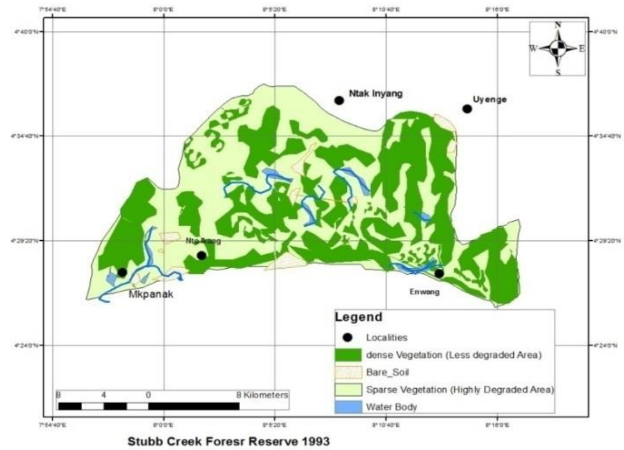


**Figure 5:** Land Cover Map of the study area as of 1993

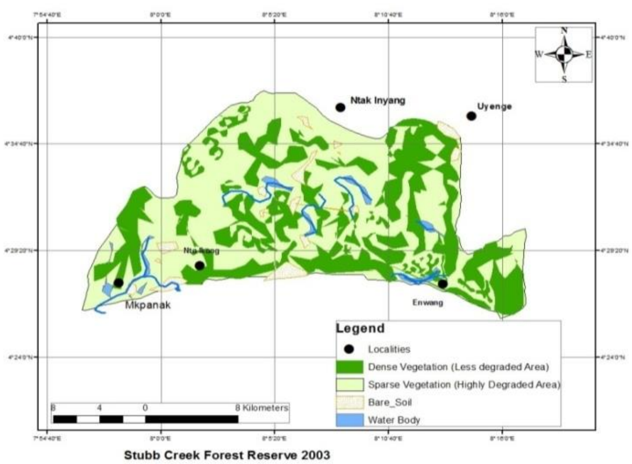


**Figure 6:** Land Cover Map of the study area as of 2003

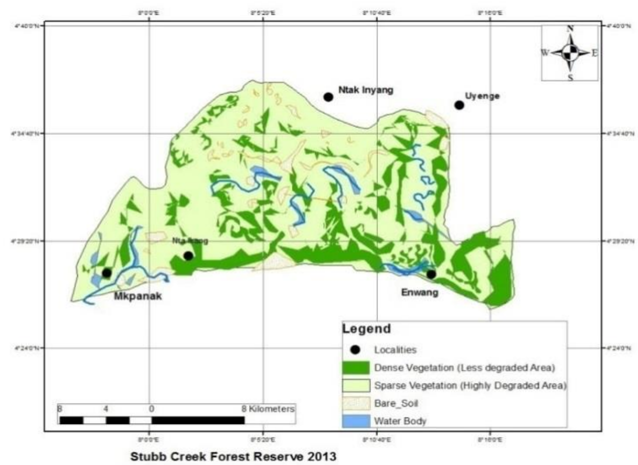


**Figure 7:** Land Cover Map of the study area as of 2013

## RESULTS AND DISCUSSION

In this study, some interesting results were found and presented in Tables 1 to 4 and Figures 8 to 10 below. As shown in table 1, the dense area apparently accounted for 43.45% of the study area as of 1993, while the sparsely covered area accounted for 55.26%, the bare soil accounted for 0.61% of land cover and water body accounted for 0.68%. By 2003, the dense area was reduced to 29.04% of the total area, while the degraded area increased to 68.77%, the bare soil increased to 1.57% and the water body was slightly reduced to 0.65% of the area. The dense area further reduced to 19.32% in 2013 while degraded area increased to 77.40%, bare soil to 2.57% and water increased to 0.75% of the study area. Tables 2 to 4 show the result of the vegetation changes with positive values indicating increase in area of land cover while the negative values indicating decrease in area of the land cover. Dense area decreased by 33.18% with change rate of 3.31% per annum in 2003. This decreased further by 33.50% with change rate of 3.35% per annum 2013. Between 1993 and 2013, there was an overall decrease of 55.56% in the dense vegetation area at a rate of 2.78% per annum.

Degraded area increased by 24.40% at a change rate of 2.44% per annum (table 2), further increased by 12.60% at a change rate of 1.26% per annum (table 3) and increased by 12.60% at a change rate of 1.26% per annum (table 4) between 1993 and 2003, 2003 and 2013 and 1993 and 2013 in that order. Bare soil showed increased of 158.43% at change rate of 15.84% per annum, increased further by 63% at 6.30% change rate per annum and increased by 321.25% at 16.07% change rate per annum between 1993 and 2003, 2003 and 2013 and 1993 and 2013 respectively. Finally, between 1993 and 2003, 2003 and 2013 and 1993 and 2013 the Water body decreased by 5% at annual change rate of 0.50%, then increased by 15.80% with annual change rate of 1.58% and further increased by 10.00% at change rate of 0.50%/annum.

**Table 1:** Land Cover Status of the study area for 1993, 2003 and 2013

| Year | 1993 | | 2003 | | 2013 | |
|---|---|---|---|---|---|---|
| Land Classes | Area ($Km^2$) | Percentage Cover | Area ($Km^2$) | Percentage Cover | Area ($Km^2$) | Percentage Cover |
| Dense | 63.50 | 43.45 | 42.43 | 29.04 | 28.22 | 19.32 |
| Sparse/ Degraded | 80.76 | 55.26 | 100.47 | 68.77 | 113.08 | 77.40 |
| Bare Soil | 0.89 | 0.61 | 2.30 | 1.57 | 3.75 | 2.57 |
| Water | 1.00 | 0.68 | 0.95 | 0.65 | 1.10 | 0.75 |
| Total | 146.15 | 100.00 | 146.15 | 100.00 | 146.15 | 100.00 |

**Table 2:** Rate of land Cover changes between 1993 and 2003 in the study area

| Land Cover Classes | 1993 ($Km^2$) | 2003 ($Km^2$) | Change in area ($Km^2$) | Percentage Change | Annual Rate of Change | Annual % change |
|---|---|---|---|---|---|---|
| Dense | 63.50 | 42.43 | -21.07 | -33.18 | -2.11 | -3.32 |
| Sparse/Degraded | 80.76 | 100.47 | 19.71 | 24.41 | 1.97 | 2.44 |
| Bare soil | 0.89 | 2.30 | 1.41 | 158.43 | 0.14 | 15.84 |
| Water | 1.00 | 0.95 | -0.05 | -5.00 | -0.01 | -0.50 |
| Total | 146.15 | 146.15 | | | | |

**Table 3:** Rate of land Cover changes between 2003 and 2013 in the study area

| Land cover Classes | 2003 ($km^2$) | 2013 ($km^2$) | Change in area ($km^2$) | Percentage Change | Annual Rate of Change ($km^2$) | Annual % change |
|---|---|---|---|---|---|---|
| Dense | 42.43 | 28.22 | -14.21 | -33.50 | -1.42 | -3.35 |
| Sparse/Degraded | 100.47 | 113.08 | 12.61 | 12.60 | 1.26 | 1.26 |
| Bare Soil | 2.30 | 3.75 | 1.45 | 63.00 | 0.15 | 6.30 |
| Water | 0.95 | 1.10 | 0.15 | 15.80 | 0.02 | 1.58 |
| Total | 146.15 | 146.15 | | | | |

**Table 4:** Rate of land Cover changes between 1993 and 2013 in the study area

| Land Cover Classes | 1993 ($km^2$) | 2013 ($km^2$) | Change in area ($km^2$) | Percentage Change | Annual Rate of change ($km^2$) | Annual % change |
|---|---|---|---|---|---|---|
| Dense | 63.50 | 28.22 | -35.28 | -55.56 | -1.76 | -2.78 |
| Sparse/Degraded | 80.76 | 113.08 | 32.32 | 40.02 | 1.62 | 2.00 |
| Bare soil | 0.89 | 3.75 | 2.86 | 321.35 | 0.14 | 16.07 |
| Water | 1.00 | 1.10 | 0.10 | 10.00 | 0.01 | 0.50 |
| Total | 146.15 | 146.15 | | | | |

SCFR was first gazetted to be 310.80km$^2$ in 1930 to serve as a barrier against coastal tidal waves but its vegetation is fast disappearing (Akpan-Ebe, 2014). Presently, it sustains a vegetation of about 48.22km$^2$ due to indiscriminate land use, resulting in the destruction of a sizeable area of the reserve (Ndoho *et al.*, 2009). Ndoho *et al.* (2009) and Akpan-Ebe (2014) reported that between 1941 and 1998 a total of 460.085 hectares of SCFR was de-reserved for the purpose of farming, office building, oil production industries and tank farm expansion with the beneficiaries being individual, Mbo community, Seawell company, Mobil producing, Mkparak community and Inua Eyet Ikot. While forest cover loss for the remaining periods were attributed to farming, sand mining and oil exploitation and exploration (Amubode, 1992; Akpan-Ebe, 2005). Boucher

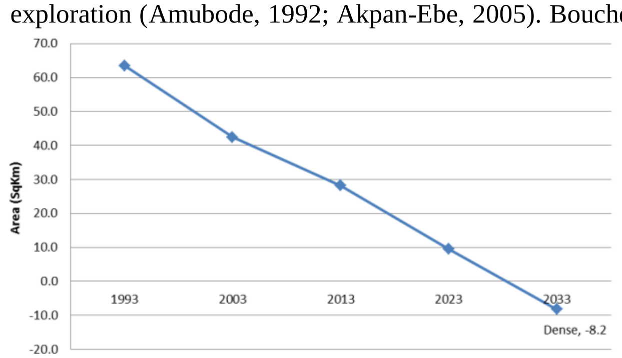


**Figure 8:** Projection of Less Degraded/Dense area in the study area

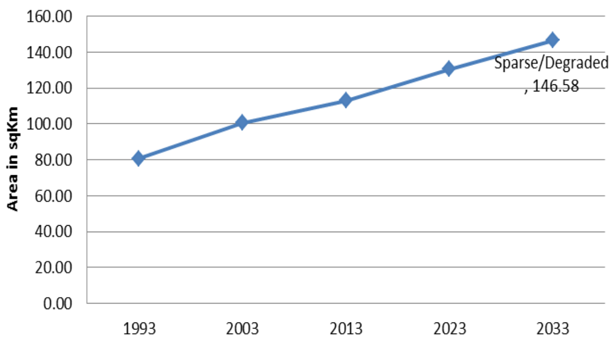


**Figure 9:** Projection of Sparse/ Degraded area in the study area.

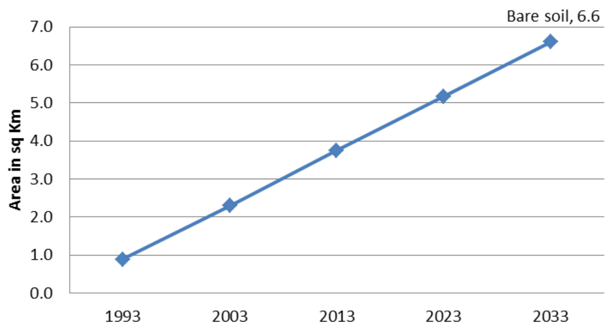


**Figure 10:** Projection of Bare Soil in the study area.

*et al*. (2011) pointed out the underlying causes of deforestation to include the ever-increasing demand for food, fuel, and forest products not just as a result of growing population but also due to higher incomes and changing patterns of consumption among the majority of the population.

**Projected land cover change in Stubb's Creek Forest Reserve for 2033**

From Tables 1 to 4 and Figures 8 to 10, the dense area which represents forest cover, decreased from 63.50km$^2$ in 1993 to 28.22km$^2$ in 2013 thus, there is significant change in forest cover in the study area. Furthermore, if the prevalent factors causing vegetation change are not controlled, from the projection in Figures 8, 9 and 10, by 2033, the dense area will be completely lost and the vegetation in SCFR will be totally degraded. Amubode (1992) projected that the indiscriminate land-use activities in the SCFR due to traditional use for cultivation of staple food crops, massive illegal timber exploitation and use as terminal to an oil company residing in the area, will result to the destruction of a sizeable portion of the reserve.

## CONCLUSION

Presented in this study, is the forest cover change of the SCFR between 1993 and 2013. Between 1993 and 2003 21.07 km$^2$ (35.50%) was lost at an annual rate of 2.107 km$^2$ (3.31%) and between 2003 and 2013 it declined to 14.21 km$^2$ (33.50%) with an annual rate of 1.42 km$^2$ (3.35%) thus, summing up to 35.28 km$^2$ (55.56%) of the forest area lost within the time period. The loss of forest cover in the study area is quite significant and could lead to increased flooding and related disasters in communities within the SCFR catchment area as well as loss of lives and properties; if something is not done urgently to remedy the situation. Therefore, the degraded forest reserve should be restored through appropriate silvicultural systems such as replanting of the degraded area, sustainable planning and management of the remaining reserve area. The State Government should provide alternative livelihood options to the local people apart from the extraction of forest products. In addition, the local people should be enlightened on the need for forest conservation. The oil companies should embrace environmentally friendly ways of oil exploration and exploitation in the area. It is necessary to monitor the activities of the local people living within the reserve and that of the oil company operating within the forest reserve; so that they can keep to environmental standard.

## REFERENCES

Akingbogun, A. A., Kosoko, O. S. and Aborisade, D. K. 2012. Remote Sensing and GIS Application for Forest Reserve Degradation Prediction and Monitoring. *First FIG Young Surveyors Conference "Knowing to create the Future"*. Rome, Italy. 4-5 May, 2012. 27pp. Available at http://www.fig.net/pub/fig2012/papers/ss03b/ss03B_akingbogun_kosoko_et_ al_6208.pdf. Retrieved on 3/11/2014. 27pp.

Akpan-Ebe, I. N. 2005. *Gap-phase Dynamics and Natural Regeneration in the Stubb's Creek Forest Reserve of Akwa Ibom State*, Nigeria. Unpublished Ph.D. Thesis University of Ibadan, Ibadan. 221pp.

Akpan-Ebe, I. N. 2014. Reforesting the Tropical Rainforest in South-Eastern Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 10(4), 128-134.

Amubode, F. O. 1992. Biology and Socio-Economic Survey of Stubb's Creek Forest Reserve, Akwa Ibom State. A study report prepared for Nigeria Conservation Foundation, 88pp.

Baker, I. R. 2003. *Report on a Survey of Stubbs Creek Forest Reserve*. Centre for Education Research and Conservation of Primate and Nature (CERCOPAN), Calabar, Cross River State, Nigeria, 22pp.

Boucher, D. H., Elias, P., Lininger, K., May-Tobin, C., Roquemae, S., and Saxon, E. 2011. *The root of the problem: What's driving deforestation today*? Union of Concerned Scientists. Available at http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/UCS_RootoftheProblem_DriversofDeforestation_FullReport.pdf. Retrieved on 1/04/2015. 126pp.

Boyd, D. S. and Danson, F. M. 2005. Satellite Remote Sensing of Forest Resources: Three Decades of

Research Development. *Progress in Physical geography*, 29(1), 1-26.

Danka, F. S. and Klein, C. 2002. Using GIS to Predict Potential Wildlife Habitat: A Case Study of Muskoxen in Northern Alaska. *International Journal of Remote Sensing*, 23(21), 4611-4632.

Efiong, J. 2011. Changing Pattern of Land Use in the Calabar River Catchment, South-eastern Nigeria. *Journal of Sustainable Development*, 4 (1), 92-102.

Eludoyin, O. S. and Oyebade, B. A. 2011. Remote Sensing and Forest Resources Management. In: Aiyeloja, A. A. and Ijeomah, H. M. (eds.) *Books of Reading in Forestry, Wildlife Management and Fisheries*, Topbase Nigeria Limited, Lagos, Nigeria. Pp. 272-315.

Fabiyi, O. 2001. *Geographic Information Systems, Techniques and Methods.* Published by Research Supports Services, Ibadan, Nigeria. Pp. 1-147.

Federal Ministry of Environment 2014. *Federal Republic of Nigeria: REDD$^+$ Readiness Preparation Proposal (R-PP)*. For consideration by Forest Carbon Partnership Facility (FCPF) & The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries(UN-REDD). Available at http://www.forestcarbonpartnership.org/sites/fcp/files/2014/july/Nigeria%20REDD%20R-PP_FINAL.%207%20Jun%202014.pdf. Retrieved on 22/8/2014. 171pp.

Jacob, D. E., Nelson, I. U., Okoh, K. S. and Tom, A. A. 2015. Trend in Land Use/ Cover Changes in Stubbs Creek Forest, Akwa Ibom State, Nigeria. *International Journal for Research in Business, Management and Accounting*, 1(1), 123-130.

McKendry, J. E. and Eastman, J. R. 1991. *Applications of GIS in Forestry: A Review*. Available at http://www.nrac.wvu.edu/classes/for326/GISInForestryReviewPaper.pdf. Retrieved on 3/11/2014.

Ndoho, J. T., Umoren, V. E. AndAdu, E. 2009. Spatial Analysis of Illegal Resource Extraction. In: Stubbs Creek Forest Reserve. In: AkwaIbom State. *Nigerian Journal of Agriculture, Food and Environment*, 5(2-4), 72-78.

Onojeghuo, A. O. and Blackburn, G. A. 2011. Forest transition in an ecologically important region: Patterns and causes for landscape dynamics in the Niger Delta. *Ecological Indicators*, 11, 1437-1446

Osei, A., Merem, E, C. and Twumasi, Y. A. 2006. Use of Remote Sensing Data to Detect Environmental Degradation in the Coastal Region of Southern Nigeria. In: *Proceedings of the ISPRS Commission VII Mid-term Symposium "Remote Sensing: From Pixels to Processes".* Enschede, Netherlands.

Udo, E. O., Olajide, O. and Umotong, S. E. 1997. *Conservation of Nigerian Mosaic Coastal Vegetation: AkwaIbom State Stubbs Creek Forest Reserve in Perspective*. In: *Environment and Resource Development*. Oduwaiye, E. A., Obiaga, P. C. And Abu, J. E. (eds.) Proceedings of the 25th Annual Conference of the Forestry Association of Nigeria held in Ibadan, Oyo State, Nigeria, 22nd-26th September 1997 Pp. 35-43.

Werre, J. L. R. 2001. Cross-Niger transition forests (AT0106). Report to the World Wildlife Fund (WWF). In: Jacob, D. E., Nelson, I. U., Okoh, K. S. and Tom, A. A. 2015. Trend in Land Use/ Cover Changes in Stubbs Creek Forest, Akwa Ibom State, Nigeria. *International Journal for Research in Business, Management and Accounting*, 1(1), 123-130.

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