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TREND AND DETERMINANTS OF DEFORESTATION IN AKWA IBOM STATE

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ABSTRACT
The study examined deforestation rate, trend and perception of challenges facing it in Akwa Ibom State, Nigeriausing qualitative and quantitative approaches. The data were obtained using structured questionnaire, oral interviews and direct observation. Data collected were analyzed using descriptive and inferential statistics including remote sensing and least square regression. The results obtained indicates that within 1986 – 2016, the forest cover trend in Akwa Ibom State followed a downward trend with a trend line of y = 2991.5x + 6E+06 with a strong correlation (0.9997 or 99.97%) between the forest cover coverage and years. Also, between 1986 and 2016, the state lost a total of 86726.84ha of forest cover implying an annual loss of 2890.89ha. The regression analysis employed in the study showed a coefficient of multiple determination (R^2) of0.618with an F-Statistic of 2.77 ($p < 0.10$). Among the regressors included in the model showed that afforestation rate was significant at $p < 0.01$, while number of divisions and amount of money released for forestry development were significant at $p < 0.05$ respectively. However, regressors such as target revenue, and revenue generation were not significant ($p < 0.05$). The study concluded that the deforestation rate is high and modalities such as funding and increased afforestation should be encouraged to reduce the rate of deforestation in the state.

Keywords: *Deforestation rate, Remote sensing, Afforestation, Staff strength, Akwa Ibom State*

INTRODUCTION
Deforestation is defined as the removal of forest and other forms of vegetative cover from a site without its replacement (NEST, 1991). Available evidence confirms that the forest estate of Akwa Ibom State has suffered both deforestation and degradation over the years (Akpan-Ebe and Amankop, 2001). The state has accordingly lost parts of its rainforests like the OguItu, which has been completely deforested and now a wasteland. The Stubbs Creek Forest Reserve has seriously been degraded too, while sheet and gully erosion has devastated many parts of the state (Akpan-Ebe, 2015).

In the 1990s, the forest policy objective in Nigeria was aimed at increasing its area of forest estate from 10% to 25% of its total national land area and ensuring that the size does not diminish (Federal Environmental Protection Agency, 1990). That objective, however, failed to state the strategies that would be adopted to attain that goal. The 10% land area claimed to be under forest cover in the country was not evenly distributed among the component states such that while some states like Cross River attained about 30% forest cover, Akwa Ibom attained only 4% at its creation in 1987, and this has diminished by about 70% ever since (Akpan-Ebe and Amankop, 2001). Accordingly, Akpan-Ebe (2015) reported that as a result of increase in population and the growing demand for land by farmers, timber for

building construction, and expanding infrastructural development in the state, the three gazetted forest reserves in Akwa Ibom State with a land area of 318.57 km^2 have been degraded and as such do not show a true representation of a tropical rainforest. In terms of structure, physiognomy, composition and species abundance, the forest reserve has lost their value due to over-exploitation in the reserve. This has resulted in massive deforestation and degradation of land resources experienced in the State (Akpan-Ebe, 2015). Consequently, there is need to ascertain the trend of deforestation in the state since its creation and the factors affecting it.

MATERIALS AND METHODS

Study Area

The study was carried out in Akwa Ibom State, located in the southern part of Nigeria. It lies between latitudes $4^o32'$ and 5° 53' North and longitudes 7° 25' and 8° 25' East. It is located within the tropical rainforest zone with a landmass of 8,412km^2(AKSG, 1989). AkwaIbom State has a projected population of *5,671,223*persons for 2017 at a growth rate of 3.46% per year (NPC, 2007). The state has 31 Local Government Areas with three gazetted forest reserves namely; Stubbs Creek, Ogu Itu and Obot Ndom Forest Reserves and other protected forests in each local Government Area.

Akwa Ibom State has common borders with Cross River State to the East, Abia State to the North, Rivers State to the West, and the Atlantic Ocean to the South (Akwa Ibom Agricultural Development Programme (AKADEP, 2006). The climate of the state is characterized by two seasons – rainy or wet season, which lasts for about 8 months (mid-March – November) and the dry season (December – early-March). The total annual average rainfall is about 2500mm (Ekanem, 2010). Temperatures are uniformly high throughout the year with slight variation between 26^oC and 28^oC. High range of relative humidity (75% - 95.6%) is common across the length and breadth of the State (AKSG, 1986).

Sampling and Data Collection

All the 31 Forestry Divisions in Akwa Ibom State, in addition to the Forestry Headquarter, were considered for revenue and forest resources exploitation data. This was to ensure that all the revenue from forest resource exploitation data was captured for the state covering the period under review (1996 – 2015). The instruments used for data collection in the study included questionnaire, personal interviews, personal observation and documentary reviews. A set of questionnaire involving questions on revenue generation, forest resources exploitation, amount expended, staff strength and afforestation rate were given to each Forestry Divisions and the Headquarter.

Also, thematic Mapper imageries for three epochs (1986, 2001 and 2016) were obtained from the United State Geological Surveys (USGS) with a resolution of 28.5m. These datasets were all acquired in the dry season in order to minimize seasonality variations (Jacob *et al.*, 2015), and were radiometrically and geometrically corrected to allow for direct image-to-image comparison.

Data Analysis

i. Landuse/Land cover changes

The satellite images were classified using the unsupervised ISODATA (Iterative Self Organizing Data Analysis) classification technique as described by Ball and Hall (1965) and Jacob *et al*. (2015). These procedures were performed using the ISODATA classifier algorithm in ERDAS Imagine 2014™* software. Using independent training and testing data, a total of five broad classes were delineated to show primary forest, bush fallow, farm land, built-up/bare land and water bodies. The classified satellite images were also confirmed that they were within tolerance level. The training and validation ground truth data were obtained from Google Earth, high resolution satellite imageries,

historic aerial photographs, global positioning system (GPS) ground data and manual interpretation of the satellite imageries used in the study. The process of change detection analysis was performed using the Land Cover Modeler of IDRISI 17.0 Selva Edition. The three-time intervals that were investigated in this study were 1986 to 2001, 2001 to 2015 and 1986 to 2015 respectively. The resulting Areas (in hectares) of land cover types were calculated for each of the study years. The comparisons of the land cover statistics would assist in identifying the change in hectares/Percentage, trend and rate of change. The Percentage change to determine the trend of change were calculated by dividing observed change by sum of changes and multiplied by 100.

Trend = Observed change/sum of change * 100 - - - Eqn. 1

ii. Regression and Correlation Analysis

Least square regression was used to calculate the trend in deforestation in the study area. It was also used to measure the amount of variability of the dependent variable that could be explained by the independent variables. The explicit form of the equations as used by Nelson (2015) is given as:

a. OLS regression model

$$y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \dots\dots\dots + b_7X$$ - Eqn.2

Where,

y= Yearly deforestation rate

a = constant; b_i, where i =1, 2...7 were the regression coefficients of X_i variable.

X_1 = Yearly staff strength (Numbers);

X_2 = Yearly number of divisions/beats (Numbers);

X_3 = Yearly target revenue (₦);

X_4= Yearly amount released for forestry development (₦);

X_5 = Yearly afforestation rate (ha);

X_6= Yearly timber exploitation rate (Numbers);

μ = factors that were not adequately accounted for but contributed to total revenue.

The *a priori* expectations of the changes in variables X_1 to X_7 on output (revenue) are indicated in Table 1.

Table 1: The *a priori* expectations of the changes in variables affecting deforestation rate in Akwa Ibom State, Nigeria

Determinant	Variable	Input	Output	Explanations of the relationship
Yearly staff strength (Numbers)	X_1	+	-	Increase in number of staff in a division would decrease deforestation rate.
Yearly number of divisions/beats (Numbers)	X_2	+	-	More number of divisions/beats would result in decreased rate of deforestation.
Yearly target revenue (₦)	X_3	+	+	Increase in annual target revenue would increase deforestation rate for the year.
Yearly amount released (₦)	X_4	+	-	Amount released for forestry development would decrease deforestation rate
Yearly afforestation rate (ha)	X_5	+	-	Yearly increase in afforestation rate would reduce annual deforestation rate.
Yearly timber exploitation rate	X_6	+	+	Yearly increase in timber exploitation rate would increase annual deforestation rate.

+ = increase in input/output; - = decrease in input/output

RESULTS AND DISCUSSION

i. Forest cover trend and deforestation rate in Akwa Ibom State

The forests cover area trend of the study year is presented in figure 1. The results indicated that the forest cover before the state was created in 1987 was 201070.13ha. In 2001, the forest cover area was 155017.42ha, while in 2016, the forest cover coverage 114343.29ha. The result indicts that within 1986 – 2016, the forest cover trend in Akwa Ibom State followed a downward or decreasing trend with a trend line of y = 2991.5x + 6E+06 and there was a strong correlation (0.9997 or 99.97%) between the forest cover coverage and year. This implied the deforestation rate almost followed a straight line pattern or decreased constantly over the study period. The result indicates that between1986 and 2001, the result indicates that 46052.71ha of forest cover was lost implying a mean deforestation rate of 30170.18ha per annum. Also, between 2001 and 2016, a total of 68290.58ha of forest cover was lost implying an annual deforestation rate of 4552.71ha. However, between 1986 and 2016, the state lost a total of 86726.84ha of forest cover implying an annual loss of 2890.89ha.The decreasing trend of forest cover in the study area could be attributed to high pressure due to population growth resulting in the over-exploitation and forest degradation. This agreed with the observation by Ekpo (2001), Baker (2003), Ndoho *et al.* (2009) and Jacob *et al.* (2015) and that the state forest reserves had suffered from mismanagement, while other forest estates had been reduced to farmlands.

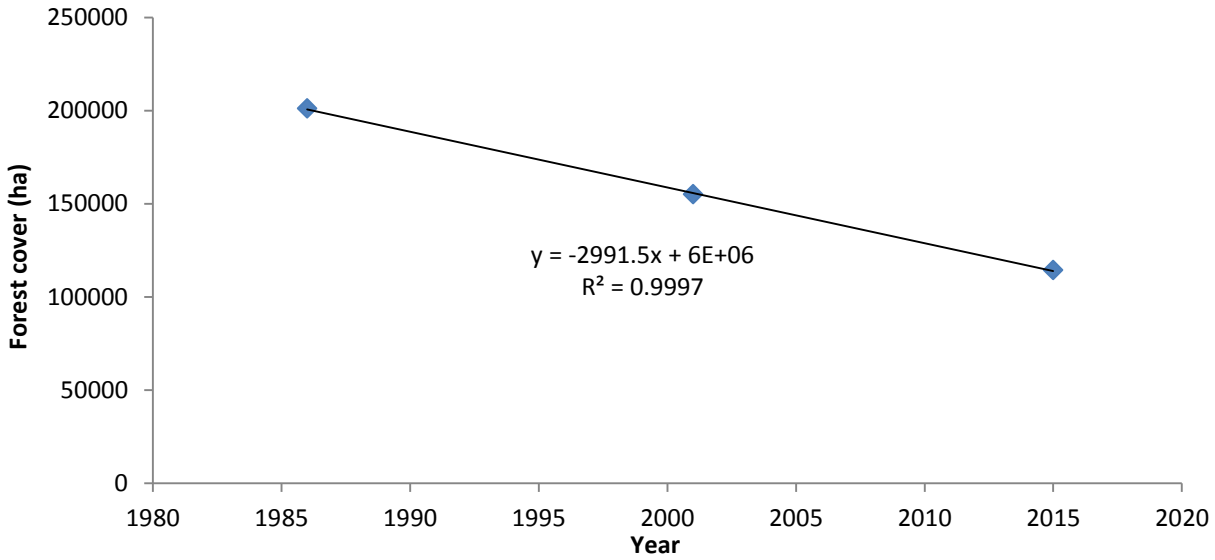

Figure 1: Deforestation trend in AkwaIbom State (1986 – 2016)

Regression analysis and predictors of deforestation rate in Akwa Ibom State, Nigeria

As shown in Table 2, the coefficient of multiple determination (R^2) value was 0.618. This indicates that all the regressors included in the model explained about 61.80% of the variations in deforestation rate in the study area. The F-Statistic of 2.77 was significant at ($p < 0.10$) and indicated that the regressors included in the model had a positive impact on yearly deforestation rate in the studied area. Afforestation rate was significant at $p < 0.01$, while number of divisions and amount of money released for forestry development were significant at $p < 0.05$ respectively (Table 2). However, target

revenue, staff strength, timber exploitation and revenue generation were not significant ($p < 0.05$).

Number of division was positive (61.18), significant ($p < 0.05$) and not in conformity with *a priori* expectation that increase in funds released for forestry development would lead to a corresponding decrease in deforestation rate. This could be attributed to the fact that each division is usually given a revenue target to meet which sometimes are not realistic, and in order to meet this target, more trees would be exploited to generate revenue, thus resulting in deforestation. . This corroborated with the observations by FAO (1997), FAO (2001), FAO (2003), Ezebilo (2004), Agbogisi and Ofuoku (2009), Udo *et al*. (2009), Akinsoji (2013) and Sule (2013) observation that a unit increase in the input (target revenue) would eventually result in an increase in revenue output of the forest divisions.

Afforestation rate coefficient (-139.22, $p < 0.01$) was in conformity with *a priori* expectation for the study, thus implying that an increase in afforestation rate in the state would reduce deforestation rate in the state. A vigorous afforestation exercise in the state would imply that more forest areas would be established either naturally or artificially. This is in accordance Akpan-Ebe (2006; 2015) observation that the yearly rate of reforestation in the state was not equally distributed, hence the high deforestation rate in the state.

The coefficient for amount of money released for forestry development (X_4) was negative (-58096.67), significant ($p < 0.05$) and in conformity with *a priori* expectation that increase in funds released for forestry development would lead to a corresponding decrease in deforestation rate. According to Akpan-Ebe (2015), adequate funding of forestry operations such as land preparation, nursery operations, plantation establishment and maintenance is an important factor to consider in sustainable forest management. Therefore, increased funding will translate to sustainable management of the forest estate *vis-à-vis* continued revenue to the state government. However, the variables that were not significant did not imply that they do not have any effect on the deforestation rate in the state, rather their effects varied even though not significant.

Table 2: Regression analysis and predictors of deforestation rates in AkwaIbom State

Variables	*Coefficients*	*Standard Error*	*P-value*
Intercept	4172493.13	2323969.86	*
Target revenue	-134.08	594.38	NS
Staff strength	-1842988.31	1102947.15	NS
Division	61.18	26.22	**
Afforestation rate	-139.22	67.70	*
Amount released	-58096.67	22700.66	**
Timber exploitation	-44827.55	92628.85	NS
Revenue generation	-5053.48	162862.31	NS

$R^2 = 0.618$, Adjusted $R^2 = 0.395$, ***, ** and * represent 1%, 5% and 10% significance levels respectively

CONCLUSION AND RECOMMENDATIONS

The study showed that within 1986 – 2016, the state lost a total of 86726.84ha of forest cover implying an annual loss of 2890.89ha. This followed a downward trend with a strong correlation (r = 99.97%) between the forest cover coverage and years. Also, afforestation rate, number of divisions and amount of money released for forestry development weremajor determinants that affected deforestation rate in the study area. The study recommends that urgent measures such as funding and increased afforestation should be undertaken to ensure sustainable landuse practices in the state especially

checking forest cover decrease as these features are socially, economically and environmentally important, in the development of the state.

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