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Analysis of the Effect of Global Warming on Forests of Southeastern Nigeria Using Remotely - Sensed Data

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PhD Dissertation Summary

1.0 Introduction

The forest cover of Southeastern Nigeria is being degraded and depleted (FGN, 2002, 2003 and Ezeala 2004) and it is suspected that the current rise in the mean annual surface temperature is contributing to this (Obioh, 2002). In this study, the role of global warming in the rapid depletion and loss of forest cover in the region as indicated by reduction in forest area over the years is investigated. The study examined the effect of global warming on the forest cover of Southeastern Nigeria, using remotely-sensed data.

2.0 Methodology

Satellite imageries of Southeastern Nigeria, namely, LANDSAT MSS of 12th December 1976, LANDSAT TM of 12th December 1986, and SPOT HRV XS of 12th December 1996, were obtained, for the three decades, from http://www.landcover.org and converted to mosaics before analysis. Data of relevant meteorological variables: surface air temperature, sunshine, rainfall, evaporation, wind speed, relative humidity, Cloud, and pressure at mean sea level were obtained from five synoptic stations, namely, Enugu, Owerri, Port Harcourt, Calabar, and Ogoja, in the study area. The imageries were used to compute the NDVI and to extract static forest impact/extent maps for the 1970s, 1980s and 1990s. The meteorological variables were applied to assess the degree of influence of rising trend of surface temperature on the forest cover as well as other variables, and to develop the weather-driven version of a regression model for the prediction and forecasting of the likely impact of global warming on the tropical forest cover of the area.

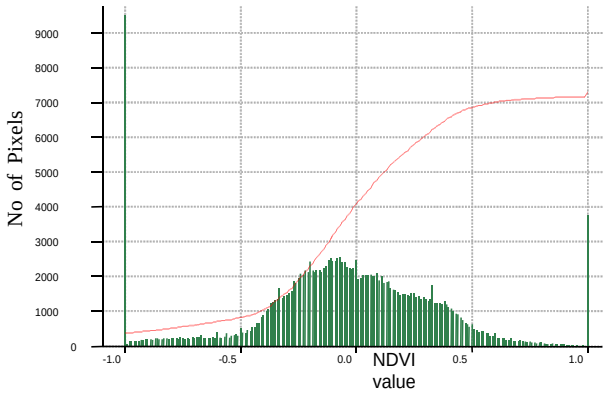

Figure 1: NDVI Histogram, 1970s.

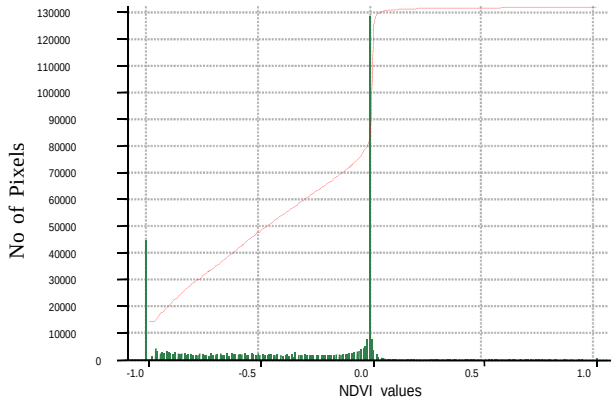

Figure 2: NDVI Histogram, 1980s.

Table 1: Decadal mean surface air temperature of the 5 synoptic stations in Southeastern Nigeria between 1970 and 2005 in °C.

Stations	Periods			
	1970-1979	1980-1989	1990-1999	2000-2005
Port Harcourt	25.7	26	26.2	31.6
Owerri	26.3	26.6	26.9	32.3
Enugu	26.7	27	27	31.5
Calabar	26	26.4	26	31.2
Ogoja	26.4	27.5	30.3	33.4

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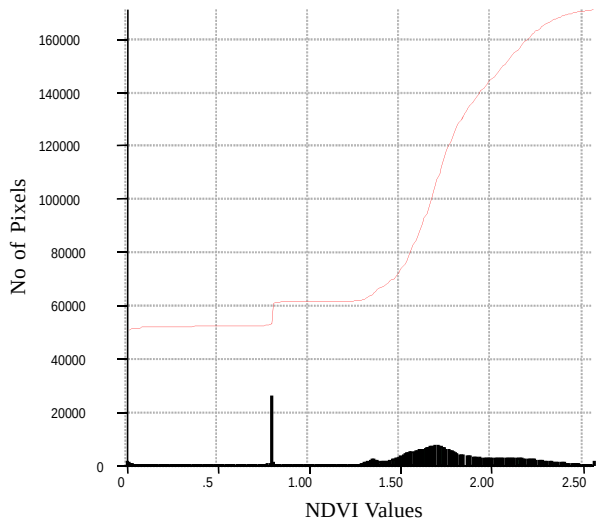

Figure 3: NDVI Histogram, 1990s.

3.0 Principal Results of the Study

The results presented in Figures 1 – 3 showed that there is decline of forest cover quality and health as a result of rising trend in surface air temperature between year 1970 and year 2000 (see Table 1).

Apparently this has caused significant shifts, reduction and degradation of forest cover over the years. By overlaying the 1970s forest impact map on that of the 1980s, it was revealed that the disturbed, undisturbed and riparian forests were depleted. The total area under the forest cover went down from 11, 705.64 km^2 in the 1970s to 9, 516.21 km^2 in the 1990s. This amounted to decrease of 34.68% in the 1970s to 28.19% in the 1990s with annual decrease of 3.4% between 1970 and 1980 and 2.5% between 1990 and 1999 (see Tables 2 and 3). The NDVI revealed apparent stress and negative trend of the forest cover beginning from the 1970s to the 1990s. This implies that the forest cover of the 1970s was healthier and better than the 1980s and the forest cover of the 1990s was not as good as in the previous decades. The index for the 1970s clustered between - 0.5 and 0.5, involving large amount of pixels. This implies that the forest cover contains high biomass and vegetal quality.

Table 2: Forest cover in Southeastern Nigeria between 1970 and 2000 computed from satellite imageries in km^2.

Forest Type	Years		
	1970s	1980s	1990s
Undisturbed forest	7,177.33	7,258.08	6,432.04
Disturbed forest	3,620.68	4,049.23	2,628.99
Riparian forest	911.63	1,223.17	455.18
Total forest land cover	11,705.64	12,530.48	9,516.21

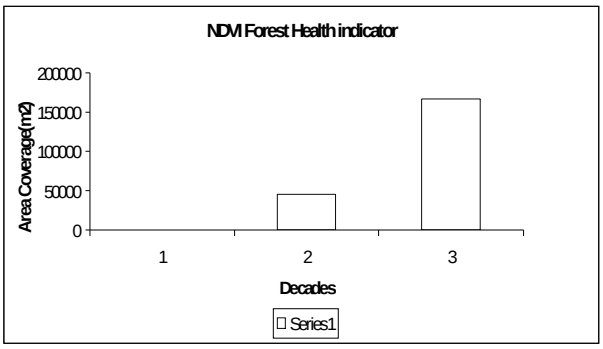

Figure 4: NDVI Forest Health Indicator for the 3 Decades.

The values for the 1980s thinned out, spreading between -1.0 and 0.0 with low amount of pixels. This showed stress and imminent degradation and deforestation of the forest cover caused by loss in vegetal quality and biomass. For the 1990s the NDVI was skewed and clustered heavily around the 0.0 value on the scale, implying that no measurable forest cover was detected by the satellite imageries. Further forest health assessment showed reduction in vegetal vigour (lowered index values) as shown in Figures 4 - 6.

Between 1970 and 1979 the extent of distressed vegetation was 0.3m^2 (0.0%), while between 1980

Table 3: Change in forest cover between 1970 and 2000

	% increase/decrease		% increase/decrease		% Increase/Decrease	
Forest Type	1970 – 1979	Yearly	1980 – 1989	Yearly	1990 – 1999	Yearly
Undisturbed forest	34.38 %	3.4 %	34.79 %	3.4 %	30.83 %	3.0 %
Disturbed forest	35.16 %	3.5 %	39.31 %	3.9 %	25.53 %	2.5 %
Riparian forest	35.20 %	3.5 %	47.23 %	4.7 %	17.57 %	1.7 %

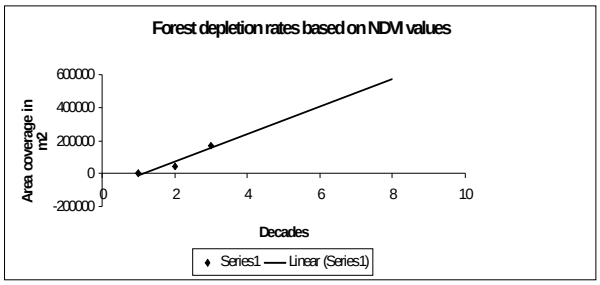

Figure 5: Forest Depletion Rates Based on NDVI Values.

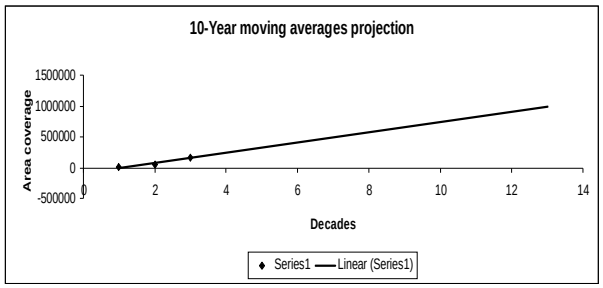

Figure 6: Ten – Year Moving Averages Projection

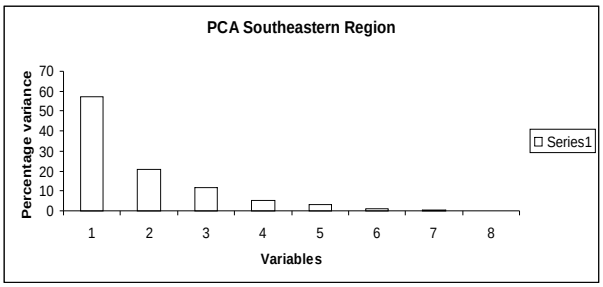

Figure 7: PCA bar graphs for the Southeastern Region.

and 1989 about 44,755m^2 *(*21.2%*)* lost vegetal vigour and was distressed. Between 1990 and 1999 about 166,388m^2 *(*78.8%*)* lost vigour, and showed poor health and deforestation. The extent of forest cover loss in the future was projected from the 10-year moving averages. The regional regression analysis showed significant values as R^2 = 97% *(*i.e., 97% of the variation in y is explained by the regression model*)*, adjusted R^2 = 96% and F = 102.446, likewise variables 1, 2, 4, 6, and 8 which implies that the variables contribute to the variation in the forest cover in the region.*(*where R^2 , i.e. multiple coefficient of determination , measures how well the model fits the data and F measures the degree of contribution of the variables used in the model*)* The Principal Components Results *(*PCA*)* results further showed that in Southeastern Nigeria, temperature exerts 57.2% influence on the forest vegetal cover, while sunshine contributes 20.8% and rainfall 11.7% while evaporation and wind speed contribute 5.2% and 3.4%, respectively *(*see Figure 7*)*. Thus, temperature, sunshine and rainfall exert over 89.7% influence on the forest cover. A weather-driven version of regression model was developed, using only meteorological variables, to predict the impact of global warming on the forests in the region.

A chi square test of significance was carried out to further establish association between meteorological variables and forests in the study area. Given that $0.0001<p<0.05$ the H_o is rejected, and it is concluded that there is significant degree of association between temperature and forest cover depletion in Southeastern Nigeria.

4.0 Recommendations

The results showed that sustainable forests management in Southeastern Nigeria is possible only if, the apparent vast disappearance and other adverse effects of, the current global warming are considered in forest programmes. The result also underscores the imperativeness of regular monitoring and repeated inventorying of the forest ecosystem using remote sensing and GIS techniques amidst climate shifts in Nigeria in the future.

References

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