THE APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (GIS) FOR MONITORING DEFORESTATION IN SOUTH-WEST NIGERIA

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ABSTRACT

The forest vegetation of South-West Nigeria has been seriously undergoing deforestation in a rapid state. The region, with population of over 40 million, who engaged in cultivation of food crops and timber extraction for industrial uses have put the forest vegetation in the region under pressure. The need for monitoring forest vegetation changes therefore, becomes inevitable. Spot XS land use and vegetation cover map of and lansat MSS land use/vegetation map of 1995, a period of 17 years. Ilwis 3.1, Arcview 3.0 and Idrisi 32 were used for map capturing, digital mapping and image classification/analysis respectively. The study revealed that the forest vegetation which 3360.79Km^2 in 1978 has reduce to 2549.659km^2 in 1995. This means that 2367.67km^2 of the forest vegetation remains as forest vegetation in 1995, while 1190.36km^2 have changed to the land use types within the period. It was also revealed that forest vegetation was mainly due to urbanization, which results to settlement expansion, disturbed forest, grassland encroachment, reservoirs for the water sources and intensive agriculture. Enactment and operation of land use activities, control of indiscriminate bush burning and other protective measures were suggested for sustainable utilization of the forest vegetation.

Keywords: *Deforestation, Forest, Vegetation, GIS, Remote sensing*

INTRODUCTION

According to Jones (2000), deforestation refers to the removal of trees from locality. This removal may be either temporary or permanent leading to partial or complete eradication of trees; covert can be gradual or rapid and may occur through natural or human agencies, or a combination of both. Deforestation may take place to create new land for urban expansion or agricultural use to provide wood for fuel or construction, to allow the exploitation of mineral deposits, or to create reservoirs or build high ways. Deforestation has occurred since human population roamed the earth and was especially common in pre-modern slash-and-burn societies. Pickering and Owen (1997) report that in Europe, from the eleventh century, extensive deforestation took place as lands were cleared for use as fuel and settled agriculture, in 200 years the forest of central Europe were almost completely depleted. With the rise of colonial globalization, deforestation in the periphery began both to serve local needs and supply raw materials to the imperial heartlands. Pudis (1983) states that tropical deforestation like the South-West Nigeria can have severe consequences to the farming capability, which is the bases for development in the highly

populated developing countries. The main reason for this is that in Africa and Asia, majority of the areas have leach and weathered soil with low nutrients and clearing reduces the productivity drastically. It will not be easy to reverse the trend of deforestation in the short run, since the problem is linked to the satisfaction of a basis need. While the temperate zone forest are afflicted by industrial air pollution particularly from acid, the tropical forest are decreasing because deforestation is not compensated by reforestation.

The forest cover change in Nigeria between 1990-2000, Nigeria lost an average of 409,700 hectares of forest per year. The amount of an average annual deforestation rate of 2.38% per annum. In total between 1990-2005, Nigeria lost 35.7 of the forest cover or around 6.145,000 hectares. Nigeria lost -1.230, 000 hectares -1- of its primary forest cover during that time (Rhett, 2005). Deforestation rate of primary cover have decrease 79.1% since the close of the 1990's measuring the total of habitat conversion (defined as change in forest area minus net plantation expansion) for the 1990-2005 interval, Nigeria lost 39.2% of its forest and woodland habitat (Rhett, 2005). The developing countries together deforest 11.3 million hectares per year (Guppy, 1984) in countries like India, Haiti, Indonesia, Malaysia, Tanzania, and Brazil. The deforestation problem is severe such that over 250,000 hectares are converted to non forest land use each year (Wood, 1991). The aim of this study therefore is to access the deforestation of South West Nigeria between 1978 to 1995. The following objectives shall also be pursued.

- To demonstrate the application and potential of GIS techniques for trends, monitoring based on spatial remotely sensed data.
- To detect the deforestation of south west Nigeria between 1978 to 1995.
- To detect the land use and land cover changes of south west Nigeria.
- To assess and map the land use and land cover stability of the study area, that is, assessment of the areas which have not experience any changes within the period of this study.
- To map and assess the land use and land cover that have been lost and/or gained to other classes within the year of study.

MATERIALS AND METHOD

According to Iloeje (1999), South West Nigeria is the part of the country which lies south and west of Niger valley. It can be sub-divided into two sub geographical region. The plateau of Yoruba land and lower Niger and the western coastal lowlands. It lies between latitude 70` and 80`N of the equator and 30` and 40`E of the Greenwich meridian. This plateau of the Yoruba land coincides roughly with the out crops of the basement complex rocks and includes much of Oyo and Ogun States and southern part of the Kwara State. Its personality is based on a high degree of urbanization found no where else in tropical Africa. The region contains most of the towns in western Nigeria with populations of over 4 million and it is continuing to rise. The land is inhabited by the Yoruba people. It is one of the most densely populated areas in the country. The density of this area lies between 115 and 125 per km^2 in the south east of the region. Cultivation of food crops, timber industry and the local trade. Roads and rail ways, built to evacuate the coco, brought amenities and more settlers to them. As a result, towns as Ibadan, Ogbomosho and Abeokuta increased

in size at the expense of the eclipsed cities in the north like Oyo, Shaki and Iseyin while, the lower Niger and western coastal lowland, this region lies south of the plateau of land. It covers the greater part of Bendel State, rural areas of Lagos State and the southern part of Ondo and Ogun States. The uniformity of sedimentary cover similarly of low relief, high temperatures, high humidity and dense vegetation cover are bases of the region, unity and geographical personality. The western sector of the region is inhabited by the Yoruba people. The Urhobo, Ishekiri and western Igbo people live in the eastern part and the population is fairly evenly spread. Densities lie between 55 and 115 per square kilometer, but in the vicinity of Lagos these figure are exceeded. The economy of this may be added fishing and farming. The tree crops are kola, oil palm and rubber.

Three GIS packages: Ilwis Academic 3.0, which was used for transforming Coordinates and Georeferencing, ARCVIEW GIS 3.0 for digitizing map and IDIRISI 32 for maps overlay and analysis as well as a Dell desktop with high RAM, HP scanner, and a color Hp printer as well as other complementary non-GIS packages like Corel-Draw 11 were used. The land use vegetation map of southwest for 1973 and 1995 were scanned, using Corel-Draw 11 and then exported to Ilwis environment through Tagged image file format (Tiff) for geo-referencing and transforming coordinates. Geo-referencing a map is very vital because it makes the maps to have the same rows, columns, pixel numbers and other reference parameters. If a map is not well geo-referenced, it cannot be overlaid. The two maps of 1978 and 1995 were georeferenced. The latitude and longitude coordinates of the four corners of the study area, that is 40.00" and 3016" were transformed to Universal Transverse Mercato (UTM) through the transform module of Ilwis 3.0, to create georeference corner. The transformation of "X" and "Y" values are 529409.265 and 779193.015 respectively, and maximum "X" and "Y" values are 610459.265 and 829093.015 respectively. On each map, four points were selected which were used as tie points. The referenced maps were then resample, using map to map registration of both maps each of the resample maps were imported into Arcview, where they were then digitized. All the area features such as Forest Plantation were digitized as polygon, line features such as road were digitized as line.

RESULTS AND DISCUSSION

Table 2, shows that forest vegetation which covered 3560.79km^2 representing 88.25% of the study area in 1978, have decreased to 2549.659km^2 representing 63.13% in 1995 which means 1011.131km^2 of the forest area have been lost within the seventeen years interval. Agricultural trees which existed in 1978 were no more there in 1995 as a result of deforestation. Disturbed forest which covers 511.92km^2 representing 5.02% had increase to 580.14km^2 representing 14.40% in 1995. Grassland which did not exist in 1978 had covered 459.82km^2 representing 12.30% in 1995. Reservoir did not exist in 1978 had covered 2.65km^2 representing 0.07% in 1995.

Forest vegetation change: magnitude, annual rate of change and proportion of change: The magnitude of change is the difference between the areas of each land use changes between the study years which is derived by subtracting the area covered in the present

year from the previous year. The percentage change is the change of each class to the overall change. It is derived by dividing the magnitude of change by 100. The Annual rate of change is calculated by dividing the percentage of each class by 100 and multiplied by the number of the study years that is seventeen years. On table 3, all the land use classes except forest vegetation and reservoir increase in their spatial coverage. Forest vegetation had 1011.131km^2 of magnitude of change, which is 1011.131km^2 of the total forest vegetation area in 1978 which had changed to other land use classes in 1995. Among the 1978 existing land use classes, forest vegetation had the highest percentage change of 55.95% between 1978 and 1995. Most importantly, the table revealed that forest vegetation is the only land use class that recorded negative changes of -9.51%. If the situation is unchecked, one will wonder what the situation of the forest would be after 50 years.

Land use vegetation changes Nature: From this study, three main information were generated from the nature of forest vegetation changes; areas of forest vegetation with no change, areas of forest vegetation that gained from other classes and areas of forest vegetation that lost to other classes. The nature of the forest vegetation of the area within the study years is as illustrated on matrix table 4. On the table 4, all the figures along the diagonal that were bold are the areas with no change throughout the study period of seventeen years. All the figures along the rows, except those in the diagonals represent the areas that were lost to other classes. While the figures along the columns except those in diagonal represent areas that gained from other classes. For example, forest had the total land area of 3560.79km^2 in 1978, it lost 171.02km^2, 29.32km^2, 511.92km^2, 11.50km^2, 47.20km^2 and 2.65km^2 to settlement, teak plantation, disturbed forest, forest plantation, grassland, and reservoir respectively. However, forest vegetation had gained 61.77km^2, 33.36km^2, 75.78km^2 and 0.24 from settlement, teak plantation, disturbed forest, and agricultural tree respectively.

Forest vegetation area that has changed to other land use types: This section deals with the forest vegetation which has changed to other land use types between 1978 and 1995. The image calculator of the Idrisi 32 software was used for this purpose using the logical "expression" option and the "And" to find the areas as shown in fig 1. The forest vegetation areas that have been lost to other land use type between 1978 and 1995 were calculated to be 1190.36km^2 representing 33.2% of the total forest vegetation area in 1995 while 2367.76km^2 of the forest vegetation have remain static. The black areas on the map represent the forest vegetations areas that have not changed, green represent forest vegetation areas that is static.

Table 1: Description of data and material obtained for the study.

Data type	Data	Scale	Identification	Acquisition/Source
Vegetation and Land use	1978	1:250000	S/West Nig.	Forestry Monitoring and Evaluation Unit
Vegetation and Land use	1995	1:250000	S/West Nig.	(FORMECU) Abuja.

Table 2: Land use vegetation cover changes between 1978 and 1995

Land use vegetation cover		1978		1995	
		Area (km²)	Area (%)	Area (km²)	Area (%)
1	Settlement	171.46	4.25	287.511	7.13
2	Teak plantation	29.32	2.42	108.14	2.67
3	Disturbed forest	511.92	5.02	580.14	14.40
4	Forest 3560.79	88.25	2549.	659	63.13
5	Forest plantation	_	_	11.50	0.29
6	Agricultural tree	3.03	0.08	_	_
7	Grass land	_	_	495.82	12.30
8	Reservoir	_	_	2.65	0.07
	Total	**4035.49**	**100.02**	**4035.49**	**99.99**

Table 3: The magnitudes and proportion of change

LUV	1978(km²)	1995(km²)	MoC	PoC	ARC	Remark
Settlement	171.46	287.511	116.051	9.19	(+)1.56	Increase
Teak plantation	29.32	108.14	98.82	5.47	(+)0.93	Increase
Disturbed forest	511.92	580.14	68.22	3.78	(+)0.64	Increase
Forest	3560.79	2549.69	1011.131	55.95	(-)9.51	Decrease
Forest plantation	_	11.50	11.50	63.6	(+)1.08	Increase
Grassland	• _	495.82	495.82	27.44	(+)4.66	Increase
Reservoir	_	2.65	2.65	1.47	(+)0.25	Increase
Agricultural tree Disappeared	3.03	_	3.03	1.68	(+)0.29	
Total	**4035.49**	**4035.49**	**1807.222**	**111.34**	**18.92**	

LUV = Land use vegetation; MoC = Magnitude of change; PoC = Percentage of change; ARC = Annual rate of change

Table 4: The nature of the forest vegetation of the area within the study years is illustrated in matrix

1978	1995	Set [10]	TP [20]	DF [30]	F [40]	FP [50]	GL [60]	Res [70]	Total
Set.	[1]	11	21	31	41	51	61	63	**171.26**
		104.81		4.68	61.77				
T P	[2]	12	22	32	42	52	62	72	**126.37**
			46.03	8.32	33.36		38.66		
DF	[3]	13	23	33	43	53	63	73	**163.68**
		0..59	32.86	**54.45**	75.78				
F	[4]	14	24	34	44	45	64	74	**3549.37**
		179.02	29.32	511.92	**2367.76**	11.50	447.20	2.65	
AT	**[5]**	15	25	35	45	55	65	75	**3.01**
		2.77			0.24				
Total		**287.19**	**108.21**	**579.37**	**2538.91**	**11.50**	**485.86**	**2.65**	**4013.69**

Set = Settlement TP = Teak plantation DF = Disturbed forest; F = Forest; FP = Forest plantation; GL = Grassland Res = Reservoir; AT = Agricultural tree

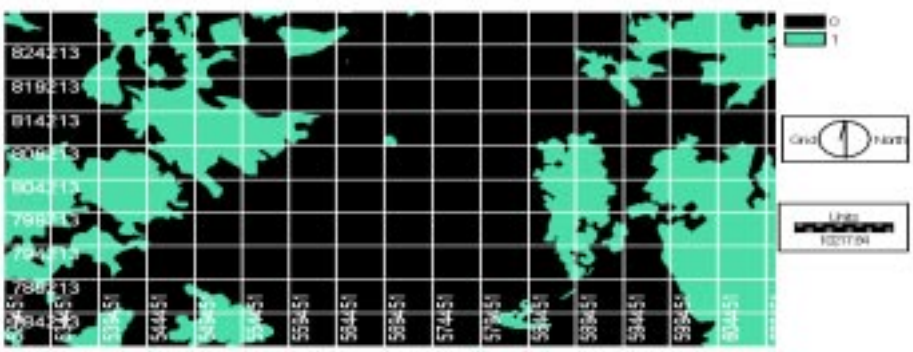

Fig. 1: Static and Change Map For 1978/1995 by overlay

CONCLUSION AND RECOMMENDATIONS

Deforestation which happens to be a serious cause of environmental hazard such as drought lost synthetic beauty of environment. These study demonstrated the effective use of remote sensing and GIS technique in the assessment of vast lost of forest vegetation in the south western Nigeria as a result of man's activities such as urban expansion, fuel wood cutting trees for industrial activities (lumbering) as a result of population increase which has put much pressure on the forest vegetation. Immediate protection measure such as afforestation, and other regulation which are existing but not effective should seriously engage in their activities so that the forest vegetation in south west Nigeria can be protected for safety while conducive environmental condition will be attained. Remote Sensing and GIS are techniques recommended to individuals, organizations, legislatures and governments for environmental monitoring and formation of land use policy for future development. There is the urgent need for afforestation by the Ministry of Agriculture and Environment as well as private individuals and organizations to replace the lost trees in their regions. There is the need to pursue alternative sources of energy in place of fuel wood as most trees were cut for fuel wood.

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