M. Sc. Thesis

A SPATIO-TEMPORAL ANALYSIS OF DEFORESTATION IN EPE AND ITS ENVIRONS (LAGOS, NIGERIA)

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Abstract: Wanton destruction of vegetal cover for some socio-economic reasons has become a common phenomenon in the tropical rainforest region of the world. In Africa, deforestation has been persistent over the years, and in the West-African sub-region and Nigeria in particular, it is a day-to-day practice. Deforestation is part of human activities on the earth surface considering the exploitation of endowed abundant natural resources; in particular, deforestation has become a big threat to Nigeria's environment. Because of the problems created by deforestation, the researcher tried to analyze the phenomenon in Epe Local Government Area of Lagos State, Nigeria. The study was carried out for the period between 1962 and 1994 using remote sensing technique. Aerial Photographs of 1962 and SPOT imagery of 1994 of the study area were used to map out land use/land cover of the two periods, after which the maps were overlaid to produce the change map. The maps were then digitized using geographical information systems (GIS) technology. The areal extent of each land use/land cover category was extrapolated through the system (GIS). The results show a lot of deforestation. For example, heavy forest lost to light forest, Agriculture, and open area under development. Light forests on the other hand lost to agriculture, palm forest and open area. etc.

INTRODUCTION

Deforestation is a major problem in many parts of the world, and the idea underlying the phenomenon can be a diminution of vegetal covers from thick forest to light forest, from heavy or light forest to open area under development. Also it can be from heavy or light forest to savannah or grassland and or from savannah to open or isolated land.

The main causes of deforestation are well known and many accounts have appeared, of which Palo's (1987) analysis indicates the complexities and interactions as pointed out by Evans, (1992).

These include clearance for agriculture, exploration for charcoal, firewood and other domestic uses, urban and industrial expansion, socio-political purposes, (sports, recreational centers and secretariats for example); timber logging; road construction; accidental or deliberate burning of forest and so on. Whenever conditions are sufficiently favourable the climax vegetation consists of forest. In some areas, notably in Savannah regions, forest clearance has led to an extension of grassland land where forest formerly occurred. Approximately, 42% of the total land area of the earth is potentially forest land, 24% potential grassland and 34% essentially desert (NASA. gov).

In the case of Nigeria and especially in Epe which lies to the South West of the country, the reasons attributed to the causes of forest damage and loss, include woods for furniture making, industrial used material like, gums, resins and oils for naval stores, taming, turpentine, distillates, essential oils, charcoal supplies as a reducing agent for steel making chemicals, polyvinyl chloride (PVC and dry cells).

Also deforestation in the area is due to the need for pulp wood that is used for the manufacturing of paper for newsprint as well as writing paper. In the case of provisions for materials in textile industry, woods for making poles for transmission lines in the energy industry and sand logs for timber, joinery-packing, etc; all make deforestation persistent in this area.

However, deforestation due to agriculture, building constructions and for domestic uses in the study area cannot be negligible. In this locality sticks and trees branches and woods from the forests are useful in agriculture for staking yam, and for making barns to store crops. The rural dwellers, particularly women damage forest for fuel woods. Construction of roads and other structures also account for forest damage in this part of Nigeria.

Lagos state, in the south-western Nigeria is characterized by high rainfall, high relative humidity and high temperature conditions. It is also characterized by typical mangrove forest in the South and rainforest in the North with luxuriant growth of trees and forest destruction are now characteristics of the state because of various economic reasons as earlier explained. With regards therefore to the menace of deforestation that is plaguing the state, this research is carried out to analyse the changes in forest conditions with particular reference to Epe area between 1962 and 1994, employing Remote Sensing Systems.

1.2 **DEFINITION OF BASIC PROBLEMS**

The forested landscape has been threatened by many activities for thousands of years; the tropical rainforest is however among the landscape that has been rapidly declining due to the interaction of man with the environment. In Nigeria and West Africa, deforestation is causing a noticeable problem to the environment and climate. In Lagos state and in Epe in particular, which is the area of study in this research, the rapid disappearance of vegetal cover is exposing the locality to serious environmental and climatic problems. It can be noticed that the abundance of heavy forests in Epe in the early 1960s have been drastically reduced to light forest or to some isolated areas. This is therefore causing some problems such as erosion and leaching because position of topsoil can now be taking over by sub-soils due to exposure of soils caused by deforestation. The exposure of the land to the effects of sun is another implication of deforestation on the environment and this will impact agricultural production because soil organisms that help in the increment of soil nutrient for the growth of crops would be adversely affected. Forests also serve ecological purposes, tropical forest in particular house two third of the world's living organisms (United Nations 1990), but the rapid decline of forests in Epe and its environs is now the beginning of the end of the organisms.

Forests absorb and reflect some percentage of ultraviolet radiation (about 10 - 20% reflection) from the sun reaching the earth surface, and since deforestation has set in, the area seems to be heated up. Also forests control winds from destroying lives and properties, but this area, due to high quest for development, can now suffer from windstorm because a lot of damages have been done to the tall trees within the locality.

Alongside the continuing demand for forest products, there is a huge burden placed upon forest and woodlands for fuel and as sites for shifting cultivation. More than 1500 million people in poor countries depend on wood for cooking and keeping warm. For example, fuel wood is now so scarce in the Gambia that gathering it takes 360 days per year per family (United Nations sources). Furthermore, air pollution is another problem caused by deforestation in the study area; this is because trees are cut down on a daily or regular basis for fuel wood. Thus, smoke released from the wood creates problems in the atmosphere which can even affect the Ozone layer. Bye and large, the activities of man within this locality in the area of deforestation is causing serious problems to humanity and this needs a solution.

1.3 AIM AND OBJECTIVES

This research is aimed at analyzing differences in forest cover in the study area between 1962 and 1994, using remote sensing technique, and in examining the extent of the deforestation in the area. Three objectives are outlined:

1) To demonstrate the use of remote sensing in determining land use which lead to deforestation in the study area.

- 2) To determine the magnitude and direction of change in the forest cover during the periods.
- 3) To evaluate some processes leading to the observed changes as it relates to possible change in climate.

1.4 SIGNIFICANCE OF THE STUDY

The availability of Remote Sensing imageries such as aerial photographs, land SATs (TM &MSS) and SPOT, e.t.c has done a great deal in carrying out scientific researches. It is pertinent to note that detection of deforestation from local scale to regional scale, using remote sensing systems is a welcome development in this technological era. Therefore the use of Remote Sensing technique in handling environmental issues like deforestation, erosion, drought and desertification, etc, is an acknowledged significance of this study. It is also significant to know that this study is stressing on the implications of deforestation on the environment, which can as well influence possible change in climate.

1.5 AREA OF THE STUDY

Epe is located on the latitude 6'31°N and longitude 4°E and lies north east of Lagos Metropolitan area. Its division comprises the former Agbona-Eredo, Epe and Ibeju Lekki district areas of old colony province having within it, the following settlement: Agbomola, Eredo, Ejrin, Itoikin, Naforija, Odomola and Akodo.

Epe is a riverine area and is located on a slightly elevated land which rises between about 30 and 60 metres above seal level. It is close to the shores of Lagos with the sheltered Lekki lagoons behind it. The climate is characterized by all year round precipitation and relatively high humidity and high temperature. Being characterized by numerous water bodies, the temperature of the area is also affected by the moderating influence of the water bodies. Precipitations occur in form of rain, and mean annual rainfall is about 400mm. The area experiences two seasons: the wet season between April and November and dry season between December and March temperature is generally high and mean annual maximum is about 30°C while the mean annual minimum temperature is about 23.8°C. The relative humidity is high throughout the year and ranges between 60% in January and over 80% in July, higher in the morning about (7 - 10 am) and lower in the afternoon about (1 - 4pm). Epe is located in the tropical sub-humid region that is within the freshwater swamp forest vegetation of Nigeria. The forest communities comprise the fresh water swamp along riverbanks and salt/fresh water swamps along the lagoon coast. Red mangrove and mangrove shrubs, silt-rooted trees with dense undergrowths and raffia palms are also seen in this vegetation zone. Slightly to north of Epe town is the lowland (tropical) rainforest that stretches to west of Ikeja through Ikorodu but has been modified by man (deforestation). Population size of the area by 1963 head count was 130390 while the 1988 projection was put at 273020 based on a 3% annual growth rate. 1991 census put the population at 101, 404, with male (49,802) and female (51, 662).



Fig. I: Map of the Study Area (Epe)

1.6 **RESEARCH METHODOLOGY AND DATA ANALYSIS**

1.6.0 Data Source

Data Type	Year	Scale	Code	Source	
Aerial photographs (Black and	1962	1:40,000	Run, 4-CN 89 (37-	Federal Surveys	
White)			39)	Department of	
			Run, 5 – CN 89, (2-3)	Lagos	
SPOT(X5)Imagery Base map	1994/1997	1:50,000	6 of 8 (A-0 1997)	GIS and Remote	
of Nigeria			Lagos state	sensing laboratory	
-			-	University of Lagos	
Topographic Map of	1962	1:100,00	281 SW	Federal Survey	
Nigeria(Lekki)				Departments Lagos	
Topographic Map of (Ijebu	1962	1:100,000	280 and 280 A	Federal Surveys	
Ode) Nigeria				Departments Lagos.	
Topographic Map of (Ijebu	1962	1:50,000	280 S E	Federal Surveys	
Ode) Nigeria				Departments Lagos	
Vegetation and land use map	1978	1:25,000	NB (31-7)	Federal Department	
of Nigeria				of Forestry Lagos	

The remotely sensed data for this research includes panchromatic black and white aerial photographs of the study area acquired from the Federal Surveys Department, Lagos. The photographs are of 1962 on the scale of 1:40,000 (S/S Ijebu Ode). Also used is spaced sheet compiled from 1:25, 000 map updated with SPOT X5 Imagery of 1994. This was produced from SPOT 3.2 (R.G.B) satellite Imagery map 68 – Lagos dated December 1994 at the scale of 1: 50, 000 produced by Geomatics International, Canada. The map was re-produced by the Laboratory for Cartography and Remote Sensing (LABCARS), University of Lagos. Other data used include, Topographical map of Nigeria, sheet 280 SE (Ijebu Ode) at scale of 1: 50, 000 scale, Topographical map of Nigeria (Lekki SW) sheet 281 at scale of 1: 100, 000 all produced by the Federal Surveys Department, Lagos 1962. Also used was the vegetation and land use map of Nigeria, sheet NB31-7 at 1:25,000 scale, printed by the Federal Department of Forestry, Lagos 1978 (Table i).

These maps were used for delimitation of the study area and the creation of base maps needed for the planimetric registration of the interpreted land use and land use cover categories from the aerial photographs.

The selection of remotely sensed data and supplemental information were based on their availability, costs and the study objectives.

Classification Scheme

Group	Primary classes	Code	Secondary classes
1	Settlement	01	All categories of structures
2	Water body	02	Lagoon
3	Sand bar	03	Sand beaches/sand beside lagoon
4	Vegetation	04.1	Palm forest
		04.2	Light forest
		04.3	Heavy forest
		04.4	Swamp forest
5	Agriculture	05.1	Cultivable land
6	Other	05.2	Open area under development

Table II: Land Use/Land Cover classification

By classification scheme, we mean segmentation of the image into a mosaic of parcels with each parcel assigned to a Land Use and Land Cover class. This classification is otherwise called "grouping of like categories of Land Use". Based, on some ideas of a classification scheme (e.g. Anderson 1977, Kyupper 1981 and Mchellan 1986), the data set for this analysis, especially the resolution and the scale of the imageries, and also the environmental complexity, only the major Land Use/Land Cover classification scheme is used for this study. The development of an appropriate classification scheme for the study was with a motive of categorizing the area into broad vegetation types on the remotely sensed data to be interpreted. The classification includes settlement, water body, sandbars, vegetation (forest categories) agriculture and others (Table ii)

1.6.1 **Description of Land Use/Land Cover categories and mapping unit**

This section described Land Use/Land Cover category as was applied to the satellite imagery used for the study. Baker, et al, (1979) said that mapping unit described each and every category used in making the map as they have been defined for a specific report and as they have been applied to a specific image. The settlement includes all categories of man-made structures as residents, institutions, commercial centres as well as industries and transport/utilities, though some categories could not be mapped out, due to the scale of mapping. Water body is described here to be the lagoon only; other rivers and creeks were not depicted in the study. The sand bar (the sand beaches) is the sand seen on the bank of the lagoon according to flow of water.

Forests involve all the vegetation covers, which are further sub-classified as palm. Light, heavy and swamp (mangrove) forests. Agriculture in its own category involves cultivated and cultivable lands while open land is an area, which is under development.

1.6.3 Creation of Base Map and Data Transfer

A 1: 50,000 topographical map of Ijebu-Ode SE 280 (sheet) and another topographical map of Lekki SW (sheet 281) at a scale of 1: 100, 000 were used together to map out the study area. The maps were produced in 1962 and the aerial photographs were of 1962 at a scale of 1: 40,000 which were as well interpreted to form a base map of the study area.

On the other hand, the base map produced from the 1994 SPOT imagery at the scale of 1: 50, 000 was introduced and enlarged to the scale of 1:40, 000 with the aid of grant projector. This was done to bring the two maps to the same scale for an overlay. The enlargement was necessary because of this scale; it was easy to transfer data from the overlay to the base map.

The transfer of the Land Use data from the interpreted overlays to the map was accomplished by using the Grant Projector. The transfer was relatively easy because the base map was originally made from the 1962 aerial photographs which was the one acquired for this project. The result of the transfer was the Land use/Land cover maps of the two time periods, i.e. 1962 and 1994.

1.6.4 DATA ANALYSIS

In generating the data, a lot of calculations were carried out. The produced maps on the transparent sheets (tracing papers) did not have co-ordinate points because grids were not shown on the maps. And the 1962 topographic map as well as the produced map of the 1994 SPOT imagery of the study area was not on the same projection. While the 1962 map was in Cartesian (Geographic co-ordinates), the 1994 map was in UTM, (Universal Transverse Mercado). So the transparent map was placed on the topographic map to trace the same features on both maps at different point co-ordinates to get the four geographic co-ordinates (latitudes and longitudes). The co-ordinates were then converted into UTM by getting the Northing and Easting of the study area through which total areal extent was calculated. Without the conversions, the total area cannot be calculated in the rectangular form as it appeared on the maps.

This conversion of geographic co-ordinates into UTM and the calculation of the area were done during the process of digitizing through Geo-informatics technology.

	GEOGRAPHIC CO-		UNIVERSAL TRANSVERSE MERCADO				
	ORDINATES						
S/N	LONGITUD	LATITUDE	EASTING	NORTHING			
	Е						
1	3 34'N	6 34'N	55967.79 ME	700512.50MN			
2	3 54'N	6 38'N	559754.82ME	705779.55MN			
3	3 59'N	6 38'N	565851.36ME	705802.09MN			
4	3 59'N	6 34'N	565887.21ME	700453.43MN			
		Total	Area = 34135944M.Sq.				
			= 3414 (ha)				

Table III. Boundary and Area covered by the study

1.7 **PRESENTATION OF RESULTS**

1.7.1 Land Use/Land Cover Situation of the Study Area in 1962

S/N	Code	Category	Area (M ²)	Area (Ha)	%
1	01	Settlement	4051263	405.1	12
2	02	Water body	2493144	249.3	7.0
3	03	Sand bar	114302	11.43	0.3
4	04.1	Palm forest	2603011	260.3	8.0
5	04.2	Light forest	3660569	366.1	11
6	04.3	Heavy forest	2500914	250.1	7.0
7	04.4	Swamp forest	5511222	551.1	16
8	05.1	Agriculture	13201519	1320.2	39
		Total	34135944	3414.00	100

Table IV: Areal Extent of each category from land use map of the area (1962).

From the table above, agriculture took the lead in areal extent by occupying 1320.0 ha representing 39% of the total area (3414ha). Swamp forest followed with 551.1ha, (16%), then settlement with 405.1 ha (12%),light forest including savannah with about 366.1ha, (11%), palm forest with about 260.3ha (8%), water body occupied 249.3ha (7%), heavy forest had an area of 250.1ha, (7%). The sand bar had the smallest area cover of only 11.43ha, about 0.3 %



Fig. II: Summary of Land Use/Land Cover categories in 1962



Fig. III: Land Use Map (1962)

1.7.2 Lar	d Use/Lan	d Covei	 situation 	of the s	tudy area	(1994)
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$1 a \beta \beta 1 a \beta 1 $	Table 1.4: Areal	extent of each	land use/ land	cover category	y of the area	(1994)
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S/N	Code	Category	Area (M ²)	Area (Ha)	%
1	01	Settlement	1615139	161.5	5
2	02	Water body	3572601	357.3	10
3	03	Sand bar	1110357	111.0	3
4	04.1	Palm forest	1014647	101.5	3
5	04.2	Light forest	1530208	1530.2	45
6	04.4	Swamp forest	901442	90.14	3
7	05.1	Agriculture	8097435	809.7	24
8	05.2	Open area	2522834	252.3	7
		Total	34136533	3414	100

The table shows that light forest occupied the largest portion of the total areas (3414.Ha) width about 1530ha (45%). Also Agriculture recorded a relatively high percentage of areal extent of about 80ha. (24%), while water bodies followed with 357ha (10%). Open areas under construction and settlement were recorded areas of about 252ha and 161ha respectively. Sand bar, swamp forest and palm forest showed about 3% each as they occupied areas of 110ha, 90.1ha and 101ha respectively (Fig iv & v)



Fig. IV: Land Use/Land Cover Categories in 1994



Fig. V: Land Use Map (1994)

1.7.3: Land Use/Land Cover characteristics (including land cover change) of the study area 1962-1914.

Classification		Area	Area	%	%	Change	%	
		(Ha)	(Ha)			in Area		
S/N	Code	Category	1962	1994	1962	1994	Gain-loss	Difference
1	01	Settlement	405.1	161.5	12	5	-243.6	-7
2	02	Water body	249.3	357.3	7	10	84.55	3
3	03	Sand bar	11.43	111.0	3	3	92.28	2.7
4	04.1	Palm forest	260.3	101.5	8	3	-91.7	-5
5	04.2	Light forest	366.1	1530.2	11	45	1079.87	34
6	04.3	Heavy forest	250.1	-	7	-	-250	-100
7	04.4	Swamp forest	551.1	90.14	16	3	-374.8	-13
8	05.1	Agriculture	1320.2	809.7	39	24	-373	-15
9	05.2	Open area	-	252.3	-	7	252	100
		Total			100	100		

 Table 1.5: Changes in land use/land cover categories of the Study Area (1962 – 1994)

Table 1.5 shows the Land Use/Land Cover change characteristics (1962 – 1994) and it can be noted that settlement recorded a serious decrease in areal extent as at 1994. From (405 Ha) in 1962 to (161.5 Ha) in 1994 giving a negative value of about -7%. Water body increased from 249 (ha) to 357 (ha) which is about 3% gain. Sand bar increased by about 2.7%. Palm forest lost by about 5%. Light forest recorded the greatest increase during the period by 34%. Heavy forest lost its areal extent completely in 1994. From 250 (Ha) in 1962 to zero Ha in 1994. The forest was completely lost in 32 years and its place was taken over in 1994 by other Land Use/Land Cover categories such as light forest, sand bar and open area under construction. Swamp forest declined by about -13%. Agriculture reduced considerably in 1994 by about -15%, which shows that people in this study area might have left agriculture for other secondary and commercial activities.

Finally, open area under construction recorded an areal extent of about 252 ha, (7%) in 1994. This land use category was not present in the 1962 imagery. It then means that some categories of Land Use/ Land Cover have been cleared and left open for other unidentified uses. This portion was derived from the heavy forests, which in 1962 was in the south west

and extreme north-west of the study area. Thus, heavy forest lost 53% (133.8Ha) to the open area and light forest lost 20% (50.5Ha). Swamp forest also lost about 16% (40.4Ha) to open area while agriculture lost about 11% (22.7Ha) of its portion to the area.



Fig VI: Land Use/Land Cover change characteristics of the Study Area (1962-1994)



Fig. VII: Land Use change map of the Study Area (1962-1994)

1.8 **DISCUSSION/CONCLUSION**

The total areal extent of all vegetation categories in 1962 was bout 1427516m² with all the four categories present (palm forest, light forest, heavy forest and swamp forest), but heavy

forest disappeared completely by 1994. This explains that deforestation had really taken lace in this area within periods of study in relation to the aim of this research. The fact that heavy forests in 1962 lost some portions to light forest proves that a lot of forest clearing took place in the area between 1962 and 1994. This is with respect to diminution of heavy to light forests, on the other hand the taken over of some portion of the heavy forest by swam forest in 1994 was possible due to the lagoon encroachment, i.e. over flow of water into the area made some parts to be swampy. Interestingly, all the vegetation types put together in 1994 was 1723.3ha, as against 1427.6 ha, recorded in 1962. This shows an increase of about 296.2ha or about 21% increase, however, vegetation lost was observed in different forms as well as the gain. For example, palm forest declined from 260ha, in 1962 to 102 ha, in 1994, while light forest increased by 63.2 ha. Heavy forest on the other hand had lost some portions to other forms in 1994 (e.g. light and swamp forests), and swamp forest also declined from 551.1ha in 1962 to 90.14ha, in 1994.

In conclusion, it can be observed that Land Use change occurred at a high magnitude within the time periods. This is with respect to changes in the forest cover, such as a complete change from heavy forests in 1962 to other Land Use categories in 1994. The fact that heavy forest in 1962 disappeared within 32 years signifies a high magnitude of deforestation in the study area. And prior to the results of the study a serious change in vegetation cover was detected and however the process that led to huge lost of heavy forest in the area are no doubt the clearing of vegetation for exploitation for charcoal, firewood and other domestic uses, timber logging, accidental burning of forest and deliberate burning of forest for hunting. Also grazing of livestock and cutting trees for industrial use, furniture making and wood works, and fishing are other human activities that have caused the changes.

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