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Lumbering as a Factor of Deforestation in the Freshwater Swamp Forest in Delta State Nigeria

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ABSTRACT

Previous studies on lumbering and its impact on deforestation rely heavily on secondary data obtained through remote sensing and geographical information system. However, this study examined the impact of lumbering on spatial and temporal deforestation in the freshwater swamp forest in Delta state, Nigeria by actual ground based measurement of characteristics of timber trees and rate of exploitation over a year. Data for the study were collected by a careful demarcation and measurement of a plot measuring 500m by 500m, followed by identification and characterization of timber trees; namely, number, average height, average girth size, species diversity and spatial distribution pattern. The measurement of the variables understudy was carried out quarterly from June 2013 to June 2014. The pair-wise student t-test was used to analyse the data collected for the study. The result showed that lumbering is a factor in deforestation of the environment. There were significant dynamics in characteristics of timber trees ($t=1.664$, $df= 4$, $p<0.05$) for the period. The study recommends taking of inventory of timber trees to enable effective monitoring, establishment of mono-specie plantations for the purpose of producing timber, and forest management in order to develop a proper management of existing resource.

Keywords: Lumbering, Deforestation, Freshwater Swamp Forest, Primary Occupations, Delta State

INTRODUCTION

Lumbering which is the felling of trees for timber has been identified as one of the primary occupations that leads to deforestation of the environment (Igben, 2012). However, the deforestation effect of lumbering on the environment can be differentiated from that of other human activities such as farming, industrialization, mining and construction. These latter activities involve the total removal of the forest vegetation of the affected areas in contrast to the former which is selective and involves felling of mature timber trees only.

Though lumbering is a very old human activity which perhaps dates back to the colonial era in Nigeria, there has been a recent upsurge in tree harvesting for timber as a result of rising demand and this has led to over-harvesting and complete devastation of standing stock of indigenous hardwood species in Nigerian forests (Okpo, 1996). Processed timber provides raw materials for pulp and paper industry and for making of plywood and particulate, furniture making, construction of houses, fuel wood for domestic and industrial uses, and provision of employment, income and foreign exchange.

Lumbering in the study area is done manually using cutlasses, axes, hand and motorized saws. The timber trees are felled and cut into logs measuring between 5 - 10m. The logs are transported out of the forest by skidding on the ground and loading into lorries or trucks or by floating through hand-dug canals to nearby streams from where they are floated downstream through the numerous rivulets in the area. The process of hauling logs out of the forests usually involves the creation of paths through previously inaccessible forest area, thus destroying the vegetation. The major trees fell for timber in the area include *Chlorophora excelsa,* (Iroko or African teak) *Entandrophrogma cylindruim* (Sapele wood), *Tripochitan scleroxylon* (Obeche), *Khaya spp* (Mahogany), *Mitragyna ciciata* (Abura), *Lovoa trichilioides* (African walnut), *Terminalia supeaba* (Afara), *Piptadeniastrum africanum*, *Pentacenthra mycrophylla*, *Ceiba pentandra* and other hardwood species with straight trunks.

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There is a plethora of comments and studies on the impact of lumbering on deforestation of the environment (Cropper and Griffiths, 1994; Osei, 1997; Krisher 1997; Mgbang, 2001; Sands 2005; Putz *et al*., 2001; Adekunle *et al*., 2010; Ibimilua, 2012; Enaruvbe and Atafo, 2014). For instance, Mgbang (2001) classified the causes of deforestation to include direct and indirect causes. The direct causes are agricultural activities, fuel wood exploitation, commercial logging, bush burning, overgrazing and industrial development, while the indirect causes are population explosion and poverty, government or economic policy failures. Similarly, Cropper and Griffiths (1994) highlighted the harvesting of logs, and the gathering of fuel wood in addition to the desire to convert forest and woodland areas to pasture and cropland, and population pressures, as the main reasons for deforestation.

Ibimilua (2012) study on the causes of deforestation in Ekiti State of Nigeria indicated that 201 respondents representing 51.15 per cent interviewed in the study area are of the opinion that lumbering is the major cause of deforestation. Other causes identified are agriculture (15.01%), demand for wood and construction (11.20%)., clearing of forest for housing(7.63%), road construction(6.87%, bush burning (4.58%)), cattle rearing (1.27% and others(2.29%).), Furthermore, Krisher (1977) opined that the felling of trees for timber is an important cause of deforestation in the third world countries. In the process of timber harvesting, live trees with thick and straight trunks are felled and transported to commercial establishments elsewhere. By so doing, a large stretch of forest, which could have provided resources worth more to the people, is disrupted. In the same vein, Osei (1977) asserted that selective logging (lumbering) affects forest structure and species composition in many ways. It causes collateral damage to the forest floor and adjacent canopies even if it involves the removal of a few trees. Apart from creating gaps in previously well structured forests, it allows the invasion of foreign weeds. Localized logged area may generally support lower quality vegetation, in otherwise rich forested environment as a result of possible soil compaction and erosion; thus leading to severe forest destruction (Putz *et al*, 2001).

Still on lumbering vis-à-vis deforestation, Salami (2006) estimated the rate of deforestation in Nigeria at 1.36 per cent per annum, and that timber harvesting has remained a big business providing employment for people with its attendant forest destruction and deforestation right from the colonial era. Furthermore, Adekunle *et al* (2010) study on the rate of deforestation in a tropical rainforest in south western Nigeria between 2003 and 2005, based on data obtained from the Ondo State Department of Forestry, indicated an increasing rate of forest depletion as a result of lumbering. Similarly, Enaruvbe and Atafo (2014) examine the rate of deforestation in part of the Niger Delta Region between 1987 and 2013 using remote sensing data and geographical information system. The result of the study showed an increasing rate of deforestation. However, these previous studies relied heavily on secondary data and use of geographical information system and remote sensing techniques.

Following from the above, there is the need to estimate the actual number of trees felled for timber in a given ecosystem or geographical area over time using ground based measurement. In addition, data on trees harvested for timber are scarce as a result of non-monitoring. What is available in most cases are estimates based on satellite imageries as in Salami's (2006) study, which focused mainly on areal extent: hence, this study examines the spatial and temporal rate of tree felling for timber vis-a-vis deforestation in the freshwater swamp forest. Its specific objective is to determine the changes in the characteristics of the trees felled; namely, height, girth size, number, specie diversity and spatial distribution pattern, over a period of one calendar year. Data obtained for this study may form the basis for spatial and temporal estimation of trees harvested for timber in a given ecosystem. This study is predicated on the null hypothesis that lumbering does not have significant impact on deforestation in the study area.

Conceptual Framework

The study of lumbering vis-à-vis deforestation can be discussed within the broad framework of Population – Environment (P-E) interaction, which has been conceptualize via a number of models, e.g. Ehrlich and Holdren, 1990; Simon, 1982, 1998; Boserup, 1965, 1970; Davis, 1963; Harrison and Pearce, 2001and Clarke, 1995 . These models have tried to simplify the extremely complex link between the environment and population. Notwithstanding, their efforts at abstracting reality have met with many unresolved areas, as the relationship between population and the environment creates a new set of dynamics (Raven, 2001). The thrust of these models is that there is a sort of relationship

between population and degraded physical environment as a result of human exploitation of resources.

One of these models, which is adopted for this study is the Pressure – State – Response model proposed by Harrison and Pearce (2001). This model indicates that population pressure on the physical environment, which may be in form of a particular human activity (in this case lumbering) causing impact. The level of pressures lead to environmental degradation and depletion (deforestation), and the response to this state of affairs are scarcity, loss of amenities and hazards, which are in form of feedbacks. Filters, which include science, monitoring, political, legal, market and property system, set the overall conditions for the operations of other parameters. Lastly, the society reacts to these consequences of population pressure and physical environmental degradation in form of price shift, changes in behavior, culture and technology and resource management. Other reactions include policy measures, regulations, taxation subsidy and so on.

The application of the model to this study is seemingly apt as lumbering, a type of human activity, is increasing as a result of increased demand for wood, and subsequently increase in harvesting of timber trees, thus leading to deforestation and scarcity of timber trees. The rate of lumbering depends on science, monitoring, legal, market pressure and leads systems. Consequently, the prices of timber increases and policy measures are put in place to curb overexploitation. This model as applied to this study can be represented schematically as shown in Figure 1.

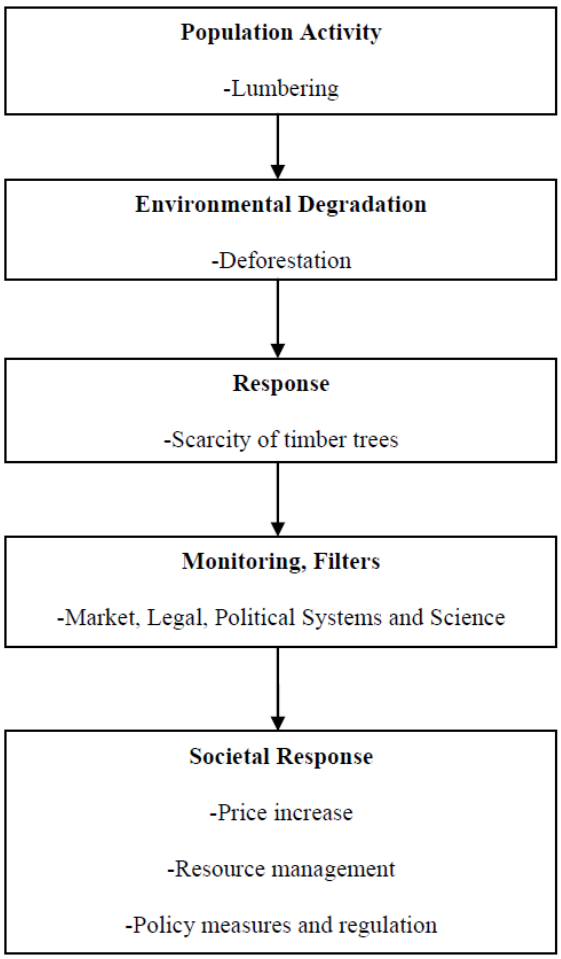

Figure1. *Schematic Representation of the Impact of Lumbering on Deforestation (Adapted from Harrison and Pearce (2001).*

MATERIALS AND METHODS

Study Area

Delta State is one of the thirty-six states in Nigeria. It is located in the southern part of the country roughly between Latitude 5°00' and 6°30'N and Longitude 5°00' and 6°45'E over an area of 22,159 sq km. The state is bordered in the north by Edo State, Ondo State to the northwest, Anambra State to the

east and Bayelsa State to the southeast. It is flanked by the Atlantic Ocean over a distance of 160 km in the south. The state has 25 political divisions referred to as Local Government Areas as depicted in Figure 2. The provisional population of the state in 2006 is 4, 098, 391 persons made up of 2, 074, 306 males and 2, 024, 085 females. Close to 25 per cent of the population live in towns and cities (NPC, 1991; 2006; Igben 2012). Consequently the state is mostly rural.

Delta State is generally a low-lying state, without remarkable hills, except for the Asaba Plateau, which spans Agbor and Asaba. Consequently, the state constitutes the landward extension of the Niger delta plain. Land elevation is generally below 30 meters above sea level and vast parts of the state are either flat or gently undulating, with the land elevation decreasing towards the Atlantic Ocean. The state has a deep coastal belt that is inter-laced with rivulets and streams, which form the Niger Delta. Most of these rivers are flat-floored, flooding adjoining areas during the wet season; thereby, giving rise to seasonal swamps. Perennial swamps characterize the immediate wet valley bottoms. The major rivulets and streams are in the western part; the big ones are Benin, Escravos, Warri, Ethiopia, Jamieson, Forcados and Ramos, while R. Niger is in the eastern flank.

Like other states in Nigeria, Delta State has a tropical climate characterized by uniformly high rainfall and temperature throughout the year. The state experiences climate ranging from humid tropical in the south to sub-humid in the north. The state is marked by two distinct seasons: the dry season and the rainy seasons. The dry season occurs between November and April, while the main rainy season begins in April till October. There exists a brief dry spell in August commonly referred to as "August break". Therefore, two maxima of rainfall are recorded in the area.

The wet season is experienced when the area is under the influence of the tropical maritime air mass, the southwest wind. This air mass, which originates from the Atlantic Ocean, is moisture laden. The dry season starts in November and ends February. This season is experienced when the area is under the influence of the dust-laden tropical continental air mass, the northeast wind.

The average annual rainfall is high, about 266.5cm in the coastal areas and 190.5cm in the extreme north. Rainfall is heaviest in July in the southern part of the state where no month is completely rainless. January, which is the driest month in this part, is characterized by rainfall of up to 2.5cm of rain in most years (Aweto and Igben, 2013). The period from December to February is usually marked by relatively cool, dry and dusty weather called the 'harmattan'. The duration and severity of the harmattan vary from year to year and from the south to the northern part of the state.

Temperatures are generally high throughout the year, with a mean of between 24^0C (75.2^0F) and 27^0C (80.4^0F). There is no significant variation between day and night temperatures. There is, however, a slight seasonal variation averaging about 25^0C (82^0F) in the rainy season and 28^0C (82^0F) in the dry season. Relative humidity is normally over 90 per cent in the early morning, but falls to between 60 and 80 per cent in the afternoon (Udo, 1970)

Following from the above, the main occupations of the people are land intensive and dependent upon the different ecological zones. The state is made up of four ecological zones; namely, coastal barrier islands or ridges, mangrove swamp, freshwater swamp forest and lowland rainforest. These zones were classified by Ikporukpo (1996) into two; namely, the outer and inner delta. The outer delta compose muddy, sheltered creeks, deltas, brackish and a strong tidal waters characterized by mangrove (*Rhizophora racemosa*) as the most common plant. In this zone, the main occupations are fishing and trading. The inner delta is made up predominantly of swamp rain forest which is not as wet. The zone comprises wet lowland evergreen rainforests in the north and mangrove forests in the south. Associated with this zone are occupations such as farming, fishing, lumbering, hunting, trading and tapping of rubber trees and raffia palm. However, Igben *et al* (2014) divided the state into three ecological zones, namely, mangrove, freshwater swamp forest and the lowland rainforest. This division is based on the fact that the coastal barriers or ridges along the shore of the Atlantic Ocean is a transition zone containing little or no vegetation cover, Furthermore, the freshwater swamp forest has been identified as a major source of timber and forest products (Opute 2015).

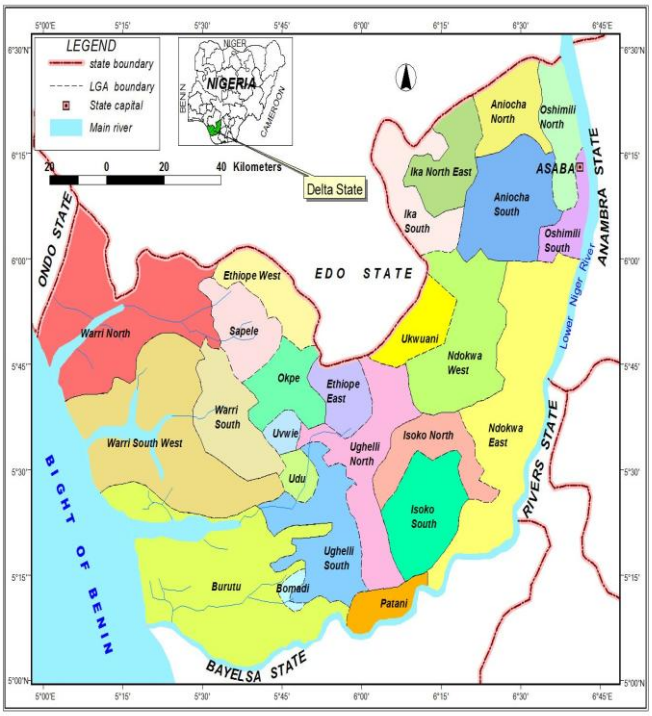

Figure2. *Map of Delta State showing Local Government Areas*

Research Design

The research design employed in this study is descriptive in nature. This type of research, according to Organdie *et al* (2006) is used to find the meaning and obtain understanding of the present conditions through a careful study and methodical observation of a particular event in the real world. Data utilized in this type of research may be collected by observation and measurement, which has to do with active utilization of all senses.

In line with this type of research design, data used for this study were obtained mostly from the primary source through direct ground measurement of variables, such as, number, average height, average girth size, species diversity and spatial distribution pattern of timber trees. This was however, complemented by oral interview with workers in the lumbering business. Data were also obtained from secondary sources.

Sampling Procedure

The study involved a purposive sampling of a freshwater swamp forest where lumbering activities are going on. This was done in order to examine the impact of the activity in relation to deforestation. Therefore a recognizance survey of the area was undertaken to ascertain the number and characteristics of fellable timber trees, because of the heterogeneity of the forest. The timbers were identified with the assistance of workers in the lumbering business.

In the study area, a careful demarcation and measurement of a plot measuring 500m by 500m was done in a thick freshwater swamp forest between Ayama and Epama villages in Aladja, Udu Local Government Area of Delta State. The plot chosen is located between Latitude 5.489^{o}N and Longitude.5.758^{o}E, with an altitude of 5.5m above sea level. The timber trees were identified and their characteristics namely, number, average height, average girth size, species diversity and spatial distribution pattern recorded. The species of timber trees and their number were counted manually. The girth size was measured using a tape at breast height. This was done in line with the Nature Conservation Practice Note of June 2006, by the U.S Agriculture, Fisheries and Conservation Department. The heights of trees were measured by determining the angle of elevation using a theodolite from a known distance and their heights worked out by plane geometrical calculations. The spatial distribution pattern of the tree was determined by the use of the Nearest Neighbor Statistics (R_n), which defines the ratio of the mean distance (D_o) in the area under investigation. Mathematically, the Nearest Neighbor Statistics (R_n) is calculated by the following formula:

$R_n=2D_o\sqrt{n}/A$ (1)

Where R_n is Nearest Neighbor Statistics, D_o is mean distance, n is number of trees, and A is area under investigation (Silk, 1979; Ayeni, 2006).

The statistics provides an index R_n which values ranges from 0, indicating a distribution that is clustering, through 1, indicating a distribution that is completely random, to 2.15, which implies a distribution that is regular. In measuring this variable, the nearest neighbor of the identified timber trees was measured using a tape. The distances were then used to compute the statistic. The measurement of all the variables understudy was carried out on quarterly bases from June 2013 to June 2014. Thus data were collected on the variables in June 2013, October 2013, February 2014 and June 2014.

Data Analysis

The data were obtained over the period of study were collated and compacted into manageable size and analyzed using the Statistical Package for Social Science (SPSS). The spatio-temporal dynamics or changes in characteristics of the trees in the first and fourth quarters on a case-by-case basis were tested for significance using the pair-wise Student t-test.. The test provides an index t to represent the relationship between individual pairs of observation rather than the difference between the means of each group (Bamgboye *et a*l, 2006). This index is compared to values in prepared tables or graphs from which the degree of significance can be assessed. Thus, the hypothesis posited for the study was tested using this test.

RESULTS AND DISCUSSION

Table 1 below presents the characteristics of the timber trees in the study area on a quarterly basis for the period under study.

Table1. *Characteristics of Timber Trees between June 2013 and June 2014*

S/N	Characteristics of Timber Trees	1st Quarter, June 2013	2nd Quarter, October 2013	3rd Quarter, February 2013	4th Quarter, June 2014
1.	Number	23	21	16	4
2.	Average height (m)	25.5	24.8	20.3	16.7
3.	Average girth size (m)	2.1	1.8	1.6	1.4
4.	Species diversity	3	3	2	1
5.	Distribution Pattern	0.63	0.49	0.35	1.03

Source: *Fieldwork, 2013 and 2014*

The Table reveals that the characteristics of the timber trees in the study, namely, number, average height, average girth size, species diversity and spatial distribution pattern. It shows that in the first quarter that is in June 2013, the number of timber trees identified in the study plot was 23 of three (3) different species with an average height of 25.5m. The average girth size of these trees was 2.1m and a spatial distribution pattern of 0.63, which is near clustering. In the second quarter, October 2013, the number of timber trees decreased to 21, with an average height of 24.8m and an average girth size of 1.8m. Though species diversity remained at three (3), the distribution pattern was 0.49 and near clustering. However, in the third and fourth quarters, average number of timber trees decreased from 16 to 4. Average tree height and girth size also decreased from 20.3m to 16.7m and 1.6m to 1.4m respectively, within the same period. Species diversity also decreased from 2 (two) in third quarter to 1 (one) in the fourth quarter. Similarly, the distribution pattern changed from 0.35 to 1.03 in the third and fourth quarters respectively.

The sharp changes in the third and fourth quarters may be attributed to the season of the year. Lumbering activities are higher during the dry season when the paths created by lumberjacks are passable, because of the terrain of the area, which is mostly swampy. During this period, logs are easily tied into rafters in preparation for floating downstream. The implications of all these activities have far reaching effect on deforestation. Furthermore, the spatio-temporal characteristics of timber trees the study area in the first and fourth quarters was tested for significance change using the pair wise Student t-test. The result showed a t-test value of 1.664, which is significant at 0.05 level of confidence, as depicted in Table 2. Consequently, lumbering has significant effect on deforestation.

Table2. *Paired Samples Test*

		Paired Differences					t	Df	Sig.(2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	First Quarter (June 2013) and Third Quarter (June 2014)	6.02000	8.09148	3.61862	-4.02690	16.06690	1.664	4	.172

CONCLUSION AND RECOMMENDATION

The study reveals that lumbering is a significant factor of deforestation in the area under investigation. This was manifested in the spatial and temporal changes in the variables considered in the study. The variables are number, height, girth size, species diversity and the distribution pattern of timber trees over a period of one year. Trees that are felled for timber constitute the natural biodiversity of the area and are therefore critical in the ecological balance of the freshwater swamp forest zone. Consequently, selective felling of timber trees is unarguably a measure factor in the deforestation.

Following from the above, the study recommends that an inventory of timber trees should be taken on a spatio-temporal basis to enable effective monitoring of indiscriminate tree felling. This would enhance the determination of the rate of timber exploitation and promote sustainable use of forest resources. In addition, the establishment of mono-specie plantations for the purpose of producing timber should be encouraged. Lastly, the government and relevant agencies should embark on reforestation programme in already depleted areas and promote planting of trees and forest management in order to develop a proper management of existing resources.

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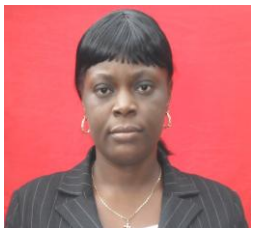

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