INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 06 Issue 05 May 2023

DOI: 10.47191/ijmra/v6-i5-24, Impact Factor: 7.022

Page No. 2029-2037

Fuelwood Consumption: Its Effects on Carbon Sequestration in the Derived Savannah Region of Cross River North, Nigeria

Ibol Philip

Faculty of Arts and Science, University of The Gambia.

ABSTRACT: Fuelwood harvesting accounts for about 40 percent of global removal of wood from forests and half of the World's population depend on it as their main source of energy. This study investigates the fuelwood consumption: Its effects on Carbon sequestration in the derived Savannah region of Cross River North, Nigeria. The study seeks to determine the type of fuelwood consumed and estimate carbon sequester. In order to achieve these objectives, primary data consisted of questionnaire, interviews, and field study while secondary data were obtained from Landsat, Nigeria Meteorological Agency (NIMET) Ogoja and the internet. Three hundred and ninety-one copies of questionnaires were returned out of three hundred and ninety-nine questionnaires administered. Regression, paired sample t test, percentages were used for analysis. Gmelina is the fuelwood tree used in the area with 54.7 percent due to its availability and accessibility. Fuelwood is an energy; income source; and it is affordable. Obanliku Local Government Area has the highest mean fuelwood consumption with 0.621795m^3 and the least is 0.476925m^3 in Yala Local Government Area. Carbon sequester in the study area is 20,394,418,025 tonnes. The regression model for the relationship between fuelwood consumption and carbon sequestration is expressed as: Fuelwood consumption = -4855725.118 + 17270584.078carbon sequester. As fuelwood consumption decreases, carbon sequestration increases. Fuelwood consumption needs to be reduced to increase carbon sequestration and alternative energy sources should be made affordable, available and at little or no price by the recommendations.

KEYWORDS: Afforestation, Carbon sequestration; Climate change; Energy; Fuelwood consumption; Fuelwood harvesting

I. INTRODUCTION

Fuelwood harvesting accounts for 40 percent of global removal of wood from forests and it is used by half of the world's population as the main source of energy. The firewood industry is estimated to be worth $390 million annually and thousands collect their wood from roadsides, stock routes, private property and reserves. During wood harvesting soil organic carbon is released and when it is burned as a source of energy, gasses are emitted. Gaston, Brown, Lorenzini and Singh (1998) explained that emissions from forest degradation due to harvesting wood for direct use as fuel or conversion to charcoal, constituted 57 percent of forest emissions in Africa. Burning fuelwood releases greenhouse gasses such as carbon dioxide (CO_2), methane (CH_4), Chlorofluorocarbon (CFCs) and nitrogen oxide (N_2O) which are said to be responsible for global warming or rising temperatures. The most effective greenhouse gas is CO_2 which arises from human activities such as fuelwood collection and invariably forest degradation constituting a major contributor to CO_2 emission, a GHG. The presence of greenhouse gasses (GHG) in the atmosphere causes global warming whereby the atmospheric temperature is high. If there is less CO_2 in the atmosphere, global temperature would drop to a suitable temperature for human adaptation. The concentration of CO_2 in the atmosphere is determined by continuous flow among the stores of carbon in the atmosphere, the ocean, biological systems and geological materials. One way of reducing carbon dioxide emissions will be to reduce our dependence on fossil fuels and use renewable resources like biomass (fuelwood consumption for energy) under Sustainable forest management.

Carbon sequestration can be defined as the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. Carbon sequestration helps in reducing carbon in the atmosphere, reduces Greenhouse gas effects and also, it reduces the temperature of a place.

Fuelwood is the most important wood item consumed in Nigeria and it accounts for about 95% of total wood consumed. Fuelwood experience in Nigeria can be classified into two stages namely: pre-colonial and colonial era (Ewah, 2014). During the pre-colonial era, fuelwood was products of nature from the rainforest and tree trunks and branches were dismantled and used as fuelwood. The colonial era had the introduction of commercial agriculture by Germans and British invasion in

Nigeria. This period involved clearing and logging of large areas for plantation agriculture. Northern Cross River State is a home for fuelwood energy and the environmental issues in the area are deforestation, drought, bush burning, poverty and indiscriminate use of agro-chemicals. It is not certain the types of fuelwood used in the area; the volume of fuelwood harvested in the area; and the amount of carbon sequestered. Majority of Nigerians, especially the poor facing energy crisis, depend on fuelwood and it has resulted in fuelwood shortage and shift from harvesting fuelwood in farms to community protected forests. This energy crisis has led to fuelwood harvesting and low carbon sequestration and if not checked and controlled will lead to increased global warming, hunger and poverty in the area. It is against these limitations that form the thrust of this paper. This paper is to determine the Fuelwood consumption and its effects on carbon sequestration in Derived Savannah Region of Cross River North, Nigeria. The specific objectives are to: examine the types of fuelwood harvested and the reasons for harvesting in the study area; examine the consumption rate of fuelwood in the area; and estimate the amount of carbon sequester in the study area.

Derived Savannah region of Cross River North is located in the North Eastern Niger Delta of Nigeria between longitude $8^0$17'E and $9^0$30E and latitude $6^0$15'0"N and $6^0$51'N. It is made up of 5 Local Government areas namely: Bekwarra, Obanliku, Obudu, Ogoja and Yala. Figure 1 shows the study area and the area is bounded in the north by Benue state, west by Ebonyi State, east by Republic of Cameroon and south by Boki and Ikom Local Government areas of Cross River state. The region has a population of approximately 789,774 from the 2006 census with landmass of approximately 4994km^2. The study area has a total of 50 wards and many languages. Region has hills and lowlands with its highest relief of about 1400m in Obudu and Obanliku areas which includes block of mountains with rock formations reaching altitudes of 1300 - 1400m in Obanliku and Obudu Local Government Areas. The soils differ in their physical-chemical characteristics. The soils vary from brown, dark brown to yellowish brown, brownish yellow to yellowish red and the texture varies from sandy loam to sandy clay to clay subsoils. The pH of the soil ranges from 5.0 and below with low Cation Exchange Capacity less than 10 meg/100g (Essoka and Essoka, 2014). The geology of the Derived Savannah region of Cross River North, Nigeria consists of the Obudu massif and the Cross River Plain (Ogoja Syncline). The area is made up of basic intrusions, cretaceous sediments and basement complex. There are many river formations taking their source from Obudu hills, Cross River Basin and other small hills. Oyi, Bemi and Okon rivers have tributaries from the Obanliku hills. The guinea savannah is dominated by the forest and the savannah. The savannah consists of semi- deciduous trees forming a continuous herbaceous stratum dominated by grasses. (Government of Cross River State, 2016). There are two types of Forests namely: community owned and Government protected forests. Some common tree species are: *Amphimaspeterocarpoides, Aubrevillea sp., Albizia zygia, Baionella toxisperma, Berlinia sp., Brachystegia sp., Chlorophora excela, Chrysophyllum albidum, Caryon preussii, Cola sp., Coula, Erythrophleum sp., Hylodendron gabunese, Irringia gabonensis, Lophira alata, Minmusops sp., Omphalocarpum sp. Pycnanthus angolensis, Secoglottis gabonensis, Scottellia coriacea, Uapaca sp.* (Afu, 2013). Cocoa, bushmango, mango, yams, kolanuts, coffee, wheat, cassava, groundnut, soyabeans, cotton, oil palm, rice, banana, plantain, cashew, castor, citrus, bush mango, pepper, cocoyam, water yam, banana, plantain, Chinese bamboo, cocoa, orange, aloe vera, bitter kola, oil palm, okro, African spinach, African eggplant, moringa, pineapple, tea, apple, grape, cocoyam, pumpkin, Greenleaf, waterleaf, melon, okra, pear, guava, Iroko, Mahogany, Obeche, *Daniellia orgae*, Almond, Gmelina, African Locust beans, Beneseed, Moringa, and Maize are found in the area. Fishing, livestock, cattle rearing for milk, honey breeding, butter and cheese. Wildlife in the area include: chimpanzee, birds, snakes, monkey, cattle, goats, sheep, pig, snail, squirrel, rats and rabbit (Afu, 2013). Others are: wild boar, mona monkey, yellow backed duiker, elephant, snail, red backed duiker, bush baby, kite, hawk, owl, deer, squirrel, cane mouse, shrew, grasscutter, monitor lizard, agama lizard, cobra, viper, parrot, crickets, soldier ant, sugar ants, earthworm, dragonfly, bush fowl, porcupine, skunk, warthog, civet, python and Cross River Gorilla.

II. METHODOLOGY

A. Types and Sources of data

Primary sources of data involved administration of questionnaires and interviews. Questionnaires were used to seek data for fuelwood consumption rate in the area and it had thirty questions and they were administered to adults above the age of eighteen. Using stratified sampling technique, two communities each were selected from the five local government areas. Respondents were further randomly selected to administer the questionnaires. The sample size was 399 using Taro Yamene (1967) and the distributed and returned questionnaires are shown on table i. Three hundred and ninety-one questionnaires were returned out of three hundred and ninety.

Secondary data used satellite images from Earthexplorer.usgs.gov. These images were used to derived Normalized Difference Vegetation Index (NDVI) and later to obtain pixel count, sum and area of the study area which was used to estimate carbon sequestration. Other secondary data were temperature and population of the area. Temperature data for the year 2017 was obtained from Nigeria Meteorological Centre, Ogoja and it was used with the processed satellite images to obtain carbon sequestration. Population of the study area was obtained from the National Population Commission 1991 census.

Satellite images from Landsat and Google earth maps were obtained for the transect areas and the study area. ArcGIS was used to estimate carbon loss from the study area by evaluating fuelwood removal in the forest for a period of ten years. Figure II shows the shape file of the Normalized Difference Vegetation Index (NDVI) for the Derived Savannah region of Cross River North, Nigeria. The choice for the sampling techniques is to allow for easy assessment or monitoring of the vegetation.

B. Techniques of data analysis

Data obtained was presented in tables, means and percentages. Tables were used for presenting results obtained from questionnaires and temperature data. Percentage was used to determine the type of fuelwood obtained in the study area and the reasons why people prefer a particular tree. Estimation of fuelwood consumption rate was determined using formula by ACR REDD modules which states,

$$\text{Mean consumption} = \frac{\text{Household total}}{\text{Number of people in the household}} \quad \text{..... eqn 1}$$

{Where household total is the sum of household size in the study area (found in question number five in questionnaire), number of people in the household comprises the total number of children and number of married, single, divorced and widowed in the study area}.

The choice of this formula for consumption of fuelwood is based on the fact that most research on fuelwood study has not given a clear formula on fuelwood consumption due to unavailability of data.

Carbon sequestration was estimated from Landsat images covering the Derived Savannah region of Cross River North, Nigeria which were downloaded between 21 to 30 December 2017 at 30m by 30m resolution from Earthexplorer.usgs.gov. Clearer skies (zero cloud) were reasons for obtaining these images during this period. Four images were downloaded and merged with ArcGIS to form a composite image which covered the study area. A composite image involves merging two or more images to become one image. Composite images were made from images downloaded since most images did not cover the study area. After downloading the landsat images, they were processed with ArcGIS which obtained Normalized Difference Vegetation Index (NDVI), biomass and carbon sequestration. It captured the number and sum of pixels and area. The sum of pixel value was used to obtain the carbon sequestration of the area. Biomass plays a major role in carbon sequestration. Tripathi et al, (2010) explained the steps for calculating carbon sequestration from remote sensing.

III. RESULTS AND DISCUSSION

A. Tree types harvested for Fuelwood

Table ii shows the tree types harvested for fuelwood in the Derived Savannah region of Cross River North, Nigeria. The trees harvested include: *Daniella ogea,* Obeche (*Triplochiton scleroxylon*), Mahogany (*Swietenia macrophylla*), Iroko (*Militia excelsa*), Almond (*Prunus dulcis*), Moringa (*Moringa oleifera*), Gmelina (*Gmelina arborea*), *Cola spp,* Bush mango (*Irvinga gabonensis*), *Velvet tarmarind*, African locust beans (*Parkia biglobosa*) and Tallow (*Triadica sebifera*). Two hundred and ninety respondents (54.7 per cent) agree that Gmelina is the commonly tree harvested for fuelwood, this is followed by Almond with 9.9 per cent, Iroko with 7.9 per cent, Mahogany with 6 per cent, Moringa with 5 percent, African locust beans with 3.9 per cent, *Daniellia ogea* has 1.6 per cent and Bush mango has 1.3 per cent, Cola specie with 0.8 per cent and lastly, Obeche with 0.5 per cent. Other trees harvested for fuelwood was 7.9 per cent. The breakdown of respondents from each local government on the fuelwood harvested is shown on table ii. In a study by Abdul-hadi (2009) the trees used for fuelwood are different from this study and there include: *prosopis Africana, Anogeissus leicarpus, Guiera senegalensis, Piliostigma reticulatum* and *Bauhinia rufescens.* Gmelina is the highest tree harvested for fuelwood with respondents of 75.4 percent. Gmelina is planted mostly for fuelwood since it has calorific value of 4800 kcal/kg and compared with other crops, it is more available than Iroko and Obeche with values of 20.20MJ/kg and 20.14MJ/kg. The availability of Gmelina in the area makes it highly used for fuelwood.

Table iii shows the uses of fuelwood in the study area. Results showed that 75.4% respondents used fuelwood for energy and 18.9% respondents as income source. This agrees with Xia (2015) findings that over half of all fuelwood produced in the world is used for energy but disagrees with a local study in Akwa Ibom State by Esin and Mba (2009) that 50 percent of fuelwood harvested are sold and it is a source of income. The breakdown of uses of fuelwood in the five Local Government Areas are shown on table iii.

B. Reasons for choice of tree types harvested

Affordability, availability, accessibility, storage and the belief that food tastes better with fuelwood and can be used for cooking for a large population are the reasons for the choice of trees harvested for fuelwood. Table iv showed that 39.6 percent respondents agreed that fuelwood is available, 26.9 percent agree that fuelwood is accessible and 15.6 per cent agree that fuelwood is affordable. 13.8 percent of respondents agreed that fuelwood can be stored for a long time and other reasons for the choice of fuelwood tree are: it can be used for cooking for a large population, improvement in food quality and quantity and the price is low as compared with fuelwood alternatives. These reasons differ from Brazil where Arnold, Persson and Shepherd (2003) explained that fuelwood was harvested due to industries rather than residential needs and these have resulted in depletion of their forests.

C. Fuelwood consumption rate

Fuelwood consumption rate was obtained through mean fuelwood consumption. Mean fuelwood consumption is obtained from the household total divided by the number of people in the household. Household total was obtained from the sum of married people and children in the household. The average household size for the study is 4.9 people. The mean consumption rate of fuelwood is derived from the ACR REDD modules expressed in equation one which is household total divided by number of people in the household. Table v shows the mean consumption of fuelwood for Obanliku, Obudu, Bekwarra, Ogoja and Yala Local Government Areas are 0.621795m^3year^{-1}, 0.530233 m^3year^{-1}, 0.619632m^3year^{-1}, 0.497508 m^3year^{-1} and 0.476923 m^3year^{-1} respectively. Obanliku Local Government Area has the highest consumption rate with 0.621795m^3 while the least is Yala Local Government Area with 0.476925 m^3year^{-1}. The average mean consumption of fuelwood is 0.518018 m^3year^{-1} which is high. The consumption of fuelwood in the study area is high since the mean fuelwood consumption rate ranges from 0.476923 m^3year^{-1} to 0.621795 m^3year^{-1}. It shows that the study area has a high fuelwood consumption rate. Obanliku Local Government Area has the highest mean fuelwood consumption with 0.621795 m^3year^{-1}. This means the area has the highest number of people staying in a small household size that depends on fuelwood. Since it is a rural area, the people would depend more on fuelwood usage than any other energy sources. It is more forested than other areas. The mean of daily fuelwood consumption per capita was 3.2kg (1168 kg/person/year) which is comparatively higher than that for this study. In Brazil and India, it is 961 and 744 kg/person/year respectively (Ullah & Masakazu, 2017).

Fuelwood consumption rate of Myanmar is 0.3m^3year^{-1} which differs from that of the Derived Savannah region of Cross River North, Nigeria with 0.5 m^3year^{-1}. Comparing the two rates of fuelwood consumption from both studies, the household size in Myanmar ranged from 1 to 11 members and the averaged household size is 4.6 people. The household size in this study area ranges from 2 to 11 members with an average household size of 4.9 people. Fuelwood consumption rate is higher in the Derived Savannah region of Cross River North, Nigeria than in Myanmar due to the average household size.

D. Estimation of Carbon Sequestration

The composite Landsat image was loaded in ArcGIS software and band 3 and 4 were used to produce normalized difference vegetation index (NDVI). Raster calculator in the software was used with the values of Photo-synthetically Active Radiation (PAR) and Light Use Efficiency factor (LUE) which produced the pixel values for the area. The summation of pixel values for the entire scene which is equal to the carbon sequester for the entire scene is shown on table vi. ArcGIS was used to produce the table and the table showed the pixel values for the study area and count is the number of pixels in a particular area.

The carbon sequestered in the study area is 20,394,418,025 tonnes. (approximately 20,394, 418kiloTonnes). Yala Local Government Area has the highest carbon sequester with 10.719, 683,208tonnes while Ogoja has the least carbon sequester with 484,453,829 tonnes.

Testing of hypotheses

H_0: Fuelwood consumption has no significant influence on Carbon Sequestration in the Derived Savannah region of Cross River North, Nigeria.

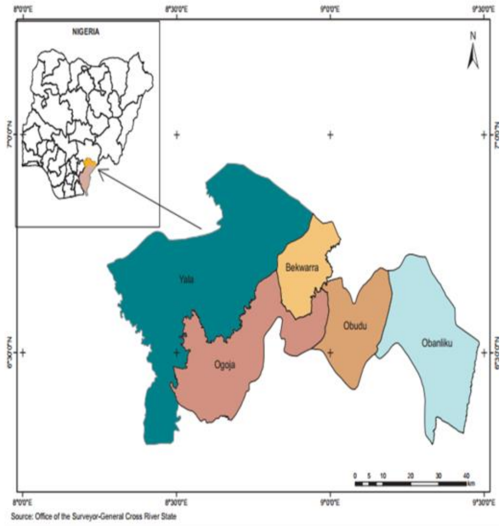
H_1: Fuelwood consumption has significant influence on Carbon Sequestration in the Derived Savannah region of Cross River North, Nigeria.

Questionnaire was used for fuelwood consumption data in table v and Landsat data was used for carbon sequestration data in table 7. Using Statistical Package for Social Sciences (SPSS), linear multiple regression between fuelwood consumption rate and carbon sequestration for the Derived Savannah region of Cross River North, Nigeria was obtained. The average mean consumption of fuelwood is 0.518018 while the carbon sequestered in the study area is 20,394,418,025 tonnes (approximately 20,394, 418kiloTonnes). Yala Local Government Area has the highest carbon sequester with 10.719, 683,208tonnes while Ogoja has the least carbon sequester with 484,453,829 tonnes. Hypothesis 1 states that there is no significant relationship between fuelwood consumption and Carbon sequestration in the Derived Savannah region of Cross River North, Nigeria. The regression between fuelwood consumption and carbon sequestration is Fuelwood consumption = -4855725.118 + 16260584.078carbon sequester

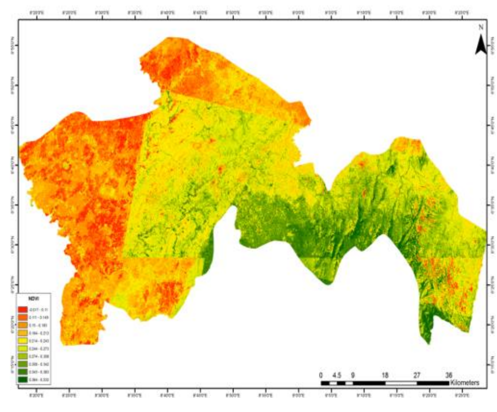
as indicated by the slope of regression with 16260584.07792 which shows that for every additional unit, carbon sequestration increases by 16260584.078KiloTonnes. The coefficient of determination, r^2 is 0.76 which means that 76 % of the variance in carbon sequestration is due to fuelwood consumption while the remaining 24% is due to individual variation which might be explained by other factors. The p-value is greater than 0.05 and so null hypothesis is accepted. This is because as fuelwood consumption decreases carbon sequestration increases therefore, changes in fuelwood consumption has great effect on carbon sequester in the communities of the Derived Savannah region of Cross River North, Nigeria. Fuelwood harvesters and users remove trees meant for capturing and storing carbon and also pollute the carbon sequestration potential decreases since air during usage.

Trees in forests act as sinks of Co_2 from the atmosphere and store carbon in their biomass. IPCC (2007) stated that 1.6 billion tons of $C0_2$ is released into the atmosphere in a year due to deforestation and degradation. Fuelwood cutting causes degradation and burning the fuelwood releases enormous amounts of $C0_2$ into the atmosphere and plays a major role in the greenhouse effect. This agrees with the fact by scientists that the largest loss of carbon from fuelwood and other biomass and soils occurs when land use changes from tropical forest to permanent agriculture. During this conversion, trees harvested are used as timber fuelwood and other uses. FAO (2015) observed that fuelwood and other wood energy accounts for 7 percent of total global carbon emissions in the world in 2010 and 85 percent of $C0_2$ emitted in the world is from fuelwood. The emission of $C0_2$ reduces carbon sequestration in forest trees.

IV. FIGURES AND TABLES



I. Map of Derived Savannah Region of Cross River North, Nigeria



II. NDVI for Derived Savannah Region of Cross River North

Table i. Distribution of questionnaires and names of research assistants

Local Government Area	Communities	Distribution of questionnaires	Questionnaires returned
Obanliku	Bendi II Busi	20 21	19 21
Obudu	Ukpe/Ubang Ipong	37 21	37 21
Bekwarra	Inyanya Afrike	25 18	24 18
Yala	Okpoma Yache/Ijegu	21 22	20 22
Ogoja	Ibil UFP, Igoli	18 196	18 191
Total		399	391

Table ii. Trees harvested for fuelwood

Fuelwood trees	Count and Percentage	Obanliku	Obudu	Bekwarra	Ogoja	Yala	Total
Daniellia ogea	Count	3	0	0	2	1	6
	% within Fuelwood trees	50.0%	0.0%	0.0%	33.3%	16.7%	100.0%
	% within LGA	7.5%	0.0%	0.0%	1.0%	2.9%	1.6%
	% of Total	0.8%	0.0%	0.0%	0.5%	0.3%	1.6%
Obeche	Count	0	0	2	0	0	2
	% within Fuelwood trees	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	% within LGA	0.0%	0.0%	5.0%	0.0%	0.0%	0.5%
	% of Total	0.0%	0.0%	0.5%	0.0%	0.0%	0.5%
Mahogany	Count	3	4	3	13	0	23
	% within Fuelwood trees	13.0%	17.4%	13.0%	56.5%	0.0%	100.0%
	% within LGA	7.5%	6.9%	7.5%	6.2%	0.0%	6.0%
	% of Total	0.8%	1.0%	0.8%	3.4%	0.0%	6. 0%
Iroko	Count	12	0	1	17	0	30
	% within Fuelwood trees	40.0%	0.0%	3.3%	56.7%	0.0%	100.0%
	% within LGA	30.0%	0.0%	2.5%	8.1%	0.0%	7.9%
	% of Total	3.1%	0.0%	0.3%	4.5%	0.0%	7.9%
Almond	Count	4	2	1	26	5	38
	% within Fuelwood trees	10.5%	5.3%	2.6%	68.4%	13.2%	100.0%
	% within LGA	10.0%	3.4%	2.5%	12.4%	14.3%	9.9%
	% of Total	1.0%	0.5%	0.3%	6.8%	1.3%	9.9%
Moringa	Count	1	0	6	11	1	19
	% within Fuelwood trees	5.3%	0.0%	31.6%	57.9%	5.3%	100.0%
	% within LGA	2.5%	0.0%	15.0%	5.3%	2.9%	5.0%
	% of Total	0.3%	0.0%	1.6%	2.9%	0.3%	5.0%
Gmelina	Count	16	39	16	112	26	209
	% within Fuelwood trees	7.7%	18.7%	7.7%	53.6%	12.4%	100.0%
	% within LGA	40.0%	67.2%	40.0%	53.6%	74.3%	54.7%
	% of Total	4.2%	10.2%	4.2%	29.3%	6.8%	54.7%
Cola spp	Count	0	0	1	1	1	3
	% within Fuelwood trees	0.0%	0.0%	33.3%	33.3%	33.3%	100.0%
	% within LGA	0.0%	0.0%	2.5%	0.5%	2.9%	0.8%
	% of Total	0.0%	0.0%	0.3%	0.3%	0.3%	0.8%

Bush mango	Count	0	0	2	3	0	5
	% within Fuelwood trees	0.0%	0.0%	40.0%	60.0%	0.0%	100.0%
	% within LGA	0.0%	0.0%	5.0%	1.4%	0.0%	1.3%
	% of Total	0.0%	0.0%	0.5%	0.8%	0.0%	1.3%
African locust beans	Count	0	7	2	5	1	15
	% within Fuelwood trees	0.0%	46.7%	13.3%	33.3%	6.7%	100.0%
	% within LGA	0.0%	12.1%	5.0%	2.4%	2.9%	3.9%
	% of Total	0.0%	1.8%	0.5%	1.3%	0.3%	3.9%
Others	Count	1	6	5	18	0	30
	% within Fuelwood trees	3.3%	20.0%	16.7%	60.0%	0.0%	100.0%
	% within LGA	2.5%	10.3%	12.5%	8.6%	0.0%	7.9%
	% of Total	0.3%	1.6%	1.3%	4.7%	0.0%	7.9%
Anyone available	Count	0	0	1	1	0	2
	% within Fuelwood trees	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
	% within LGA	0.0%	0.0%	2.5%	0.5%	0.0%	0.5%
	% of Total	0.0%	0.0%	0.3%	0.3%	0.0%	0.5%
Total	Count	40	58	40	209	35	382
	% within Fuelwood trees	10.5%	15.2%	10.5%	54.7%	9.2%	100.0%
	% within LGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	10.5%	15.2%	10.5%	54.7%	9.2%	100.0%

Table iii. Uses of fuelwood

			LGA					
Uses of Fuelwood			*Obanliku*	*Obudu*	*Bekwarra*	*Ogoja*	*Yala*	**Total**
Uses of fuelwood	Energy	Count	14	37	30	184	30	295
		% within Uses of fuelwood	4.7%	12.5%	10.2%	62.4%	10.2%	100.0%
		% within LGA	35.0%	63.8%	71.4%	88.0%	71.4%	75.4%
		% of Total	3.6%	9.5%	7.7%	47.1%	7.7%	75.4%
	Income	Count	24	21	12	6	11	74
		% within Uses of fuelwood	32.4%	28.4%	16.2%	8.1%	14.9%	100.0%
		% within LGA	60.0%	36.2%	28.6%	2.9%	26.2%	18.9%
		% of Total	6.1%	5.4%	3.1%	1.5%	2.8%	18.9%
	Heating homes	Count	2	0	0	13	1	16
		% within Uses of fuelwood	12.5%	0.0%	0.0%	81.3%	6.3%	100.0%
		% within LGA	5.0%	0.0%	0.0%	6.2%	2.4%	4.1%
		% of Total	0.5%	0.0%	0.0%	3.3%	0.3%	4.1%
	Other uses	Count	0	0	0	6	0	6
		% within Uses of fuelwood	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
		% within LGA	0.0%	0.0%	0.0%	2.9%	0.0%	1.5%
		% of Total	0.0%	0.0%	0.0%	1.5%	0.0%	1.5%
Total		Count	40	58	42	209	42	391
		% within Uses of fuelwood	10.2%	14.8%	10.7%	53.5%	10.7%	100.0%
		% within LGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	10.2%	14.8%	10.7%	53.5%	10.7%	100.0%

Table iv Reasons why the trees types harvested are preferred for fuelwood usage

Reasons for using tree for Fuelwood			LGA: *Obanliku*	*Obudu*	*Bekwarra*	*Ogoja*	*Yala*	**Total**
Reason using tree for fuelwwod	*Accessible*	Count	10	9	2	74	10	105
		% within Reason using tree	9.5%	8.6%	1.9%	70.5%	9.5%	100.0%
		% within LGA	25.0%	15.5%	4.8%	35.4%	23.8%	26.9%
		% of Total	2.6%	2.3%	0.5%	18.9%	2.6%	26.9%
	Available	Count	10	38	32	62	13	155
		% within Reason using tree	6.5%	24.5%	20.6%	40.0%	8.4%	100.0%
		% within LGA	25.0%	65.5%	76.2%	29.7%	31.0%	39.6%
		% of Total	2.6%	9.7%	8.2%	15.9%	3.3%	39.6%
	Affordable	Count	0	11	8	29	13	61
		% within Reason using tree	0.0%	18.0%	13.1%	47.5%	21.3%	100.0%
		% within LGA	0.0%	19.0%	19.0%	13.9%	31.0%	15.6%
		% of Total	0.0%	2.8%	2.0%	7.4%	3.3%	15.6%
	Can be stored for a long time	Count	20	0	0	28	6	54
		% within Reason using tree	37.0%	0.0%	0.0%	51.9%	11.1%	100.0%
		% within LGA	50.0%	0.0%	0.0%	13.4%	14.3%	13.8%
		% of Total	5.1%	0.0%	0.0%	7.2%	1.5%	13.8%
	Others	Count	0	0	0	16	0	16
		% within Reason using tree	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
		% within LGA	0.0%	0.0%	0.0%	7.7%	0.0%	4.1%
		% of Total	0.0%	0.0%	0.0%	4.1%	0.0%	4.1%
Total		Count	40	58	42	209	42	391
		% within Reason using tree	10.2%	14.8%	10.7%	53.5%	10.7%	100.0%
		% within LGA	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	10.2%	14.8%	10.7%	53.5%	10.7%	100.0%

Table v. Consumption of fuelwood

Household size	**Local Government Area**					
	Obanliku	Obudu	Bekwarra	Ogoja	Yala	*Total*
Household size	97	114	101	599	124	1035
Number of people in the household	156	215	163	1204	260	1998
Mean consumption of fuelwood ($m^3 year^{-1}$)	0.621795	0.530233	0.619632	0.497508	0.476923	0.518018

Table vi. Carbon Sequester in the study Area

LGA	**Count**	**Area (m^2)**	**Sum (kg/m^2)**	**Carbon Sequester (Tonnes)**
Yala	223466	2011197600	4171220.147369	10,719,683,208
Bekwarra	383580	345222000	928777.30242	1,840,033,260
Ogoja	100991	908919000	2440931.870865	484,453,827
Obudu	540410	48636900	1640139.162618	2,592,346,770
Obanliku	987680	4640619600	11920023.816741	20,374,418,025
Total	2236127	4640619600	11920023.816741	20,374,418,025

V. CONCLUSIONS

Cross River Northern senatorial district is a transition zone comprising savannah and montane forest/grassland. The area has forests which have been degraded. Gmelina is most highly used for fuelwood consumption in the area 547 percent of the people used Gmelina while the least is Obeche. The study reveals that the reasons for usability are energy source, low or no price and availability. This implies that Gmelina is available and affordable in the study area. The mean consumption of fuelwood is 0.518018. The mean consumption of fuel wood in Obanliku, Obudu, Bekwarra, Ogoja and Yala Local Government Area are 0.621795, 0.530233, 0.616932, 0.497508 and 0.476925 respectively. This implies that the area experienced heavy consumption.

Carbon sequestration potential using remote sensing for the study area is 20,394,418, 025 Tonnes. Yala Local Government Area has the highest carbon sequester in the study area with 10,719, 683,208T and the least is Ogoja Local Government Area with 484,453,827T. Data on fuelwood consumption and carbon sequester in the Derived Savannah region of Cross River North, Nigeria showed that significant increases in fuelwood consumption may result in low carbon sequestration.

ACKNOWLEDGMENT

I acknowledge my late father, Noble (Chief) Philip M. A. Ibol and other members of my family who are: Nimi, Jessie, Alvin, Philippa, Julie, Emma, Eddie and Roseline (Mummy) for their prayers and support. I acknowledge Prof. Pauline Essoka, Dr. Raphael Offiong and Dr. Moses Abua for their contributions, advice, and guidance.

REFERENCES

1) Gaston, G. Brown, S. Lorenzini, M. and Singh, K. D. 1998 State and change in carbon pools in the forests of tropical Africa. John Wiley and sons.
2) Ewah, J. O. 2014 Exploitation of Carbon Energy and the Integrity of Protected Rainforest Areas in Nigeria. International Journal of Humanities and Social Science. Vol. 4 No. 6 (1)
3) Essoka, A. N. and Essoka, P. A. 2014 Characterization and Classification and Classification of Obudu Mountains Steep Hill Soils. Nigerian Journal of Soil Science. Vol. 24 (1).
4) Government of Cross River State Nigeria. 2016 Draft Environmental Impact Assessment (EIA) Report. Of the proposed Calabar-Ikom-Katsina Ala Superhighway Project. Cross River State.
5) Afu, S. 2013 Contributions of Organic Matter Components, Clay and Silt fraction to the Cation Exchange Capacity (CEC) of Soils of different LandUse History in Northern Cross River State. (Doctoral dissertation, University of Nigeria, Nsukka).
6) Tripathi, S. Soni, S. K. Maurya, A. K. and Soni, P. K. 2010 Calculating carbon sequestration using remote sensing and GIS. [Internet]. http:www.geospatialworld.net
7) Abdul-hadi, A. D. 2009 Impact of fuelwood consumption on vegetation cove in Zaria and its environs, Kaduna State, Nigeria. (Doctoral dissertation, Ahmadu Bello University, Zaria, Nigeria).
8) Xia, Z. 2015 Woodfuel Data in FAO Statistics. International Renewable Energy Agency. Abu Dhabi, UAE. (28 – 30 Apr).
9) Arnold, M. Kohlin, G. Persson, R. and Shepherd, G. 2003 Fuelwood Revisited: What has changed in the last Decade. CIFOR Occasional Paper No. 39. Center for International Forest Research.
10) Ullah, S. M. A. and Masakazu, T. 2017 Fuelwood Consumption and its Impact on forests in the Teknaf Peninsula on the Southern Coast of Bangladesh. American Journal of Environmental Science. 13(3)225-232. DOI:10.3844/ajessp.2017.225.232.
11) Intergovernmental Panel on Climate Change. 2007 Climate Change 2007: Impacts, Adaptation and vulnerability. IPCC.
12) Food and Agriculture Organization. 2015 FAOSTAT database. Food and Agriculture Organization of United Nations. Italy.
13) Taro, Y. 1967 Statistics: An Introductory Analysis. 2 Edition. New York. Harper and Row.