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Abstract

This study examines determinants of forest resource use and its implications for environmental sustainability in Nigeria; using Kwara state as a case study. Specifically, the study examines awareness of climate change vis-a-vis forest resources use and factors affecting forest resources sustainability. For the study, one hundred and twenty households were selected across eight communities in ADP Zone C in Kwara state. Tools used to analysed data were the descriptive statistics and multinomial logit analyses. Study findings revealed that over half of the rural households have had basic primary education. Household perception of climate change indicators were indigenous and at low levels. Those mostly affected by climate change were children. However minimal losses due to climate change were perceived by the households while climate change forest related mitigation activities was mainly that of planting indigenous trees. Also, despite the fact that there is a high forest fuel resources usage by rural households in the study area, their likelihood of using non-forest fuels were found to dependent on their income, price of alternatives. Based on these findings, it is recommended that enlightenment and sensitization of all stakeholders on the reality of climate change, the promotion of sustainable agricultural practices and the provision of affordable and environmental friendly source of fuels should be pursued.

Key Words: **climate change, forest resources, a forestation, environmental sustainability**.

Introduction

The increasing size of the world population has led to a tremendous rise in the demand for living space, food and energy. About 90% of the total annual round wood products serve as fuel wood and 60% of this total is used for household consumption. This has therefore created a huge shortage in the supply of fuel wood that might be needed for other industrial and commercial purposes. This fuel wood supply and demand imbalance now constitutes a real threat to the energy and livelihood security of the rural communities as it has led to a series of serious environmental problem such as deforestation, soil erosion, grassland degradation, desertification and some other problems such as human being diseases and loss of time for education and recreation; and even farming (Nabinta et al., 2007), Specifically, the demand for energy often accompanied by unemployment, scarcity of land, over exploitation of forest resources, change in land use, pollution and lack of emphasis on forest conservation have been major contributory factors to forest deforestation in many developing countries (Adekunle, 2005).

Deforestation involves the conversion of forest to non-forest lands and they are recognized as the processes within the forest that could lead to a significant reduction in either the density or proportion of forest cover (Achard *et al.* 2002). Deforestation has grave consequences that include climate change, desert encroachment, soil erosion, sand dune formation, landslides, flooding and biodiversity loss (Salami, 1998: McNally *et al.*, 2002). Achard *et al*, (2002) estimated the mean annual deforestation in humid tropical forest of Africa to be as high as 0.85 ± 0.30 x 106 hectares. Okojie (1996) reported that the devastation and destruction of the environment could cause pollution, deep and extensive damage to the earth's crust, destruction of vegetation and wildlife and also continued increase in CO_2 emission into the atmosphere.

Another contributory factor to deforestation is bush burning. The practice is usually encouraged because of some of its merits. In addition to bush burning drudgery reduction influences, planted crops benefit from nutrients released from the dissolved ash. Crop yield and nutrients uptake of crops are also significantly enhanced by ash application (Ojeniyi and Adejobi, 2002, Owolabi et al, 2003). However, the beneficial effect of bush and residue burning is short-lived. Persistent burning and mechanized tillage accelerate desertification, loss of organic matter, degradation of soil physical, chemical and biological qualities, loss of soil productivity and crop yield, loss of biodiversity and rising atmospheric temperature Ojeniyi and Adejobi, 2002**).** Burning releases into the atmosphere carbon dioxide and monoxide which reduce the ozone layer and act as blanket to escape of ultraviolent rays from the atmosphere. These increases ambient temperatures, reduces rate of re-vegetation, increases water loss and ultimately the tendency for desertification.

In Nigeria, the exploitation of her forest resources has great implications for agricultural development and environmental sustainability. This is more so as forests contributes to the nation's agricultural gross domestic product (GDP) and provide many social, economic, and environmental benefits. It houses wildlife and provides humans with recreational opportunities, prevent soil erosion and flooding, help provide clean air and water and contain tremendous biodiversity. Forest litters and soil microbes together, constitute an important resource that makes forests fertile for arable farming in the tropics (Akachukwu, 2006). The ecotourism value of the forest is a potential source for revenue generation in the country if properly harnessed (Akachukwu, 2005). Equally with respect to environment sustainability, forest resources offer formidable defence against the hazards of global climate change by decreasing the amount of carbon dioxide in the atmosphere (Mastrandrea & Schneider, 2009).

The forest resource is therefore an important renewable natural resource which is closely related to man's daily life. It is also a crucial factor in maintaining ecosystem balance.

In the light of the foregoing this study examined forest resource use and its implication for environmental sustainability in Nigeria, using Kwara state as a case study. Specifically, this study;

- Examined respondents' awareness of the effect of climate change vis-à-vis their forest resources, land, and vegetation, and,
- assessed factors that influence forest resources use in the study area

Study Area and Data

The study was conducted in Kwara State, Nigeria. Kwara State is located in the North-Central geographical zone of Nigeria within latitudes 7^0 $45^{!}$ N and $9^0 30^{!}$N and longitudes $2^0 30^{!}$E and 6^0 $25^{!}$E. It covers a total land area of about 36,825 square kilometers and shares boundary with Ondo, Oyo, Osun, Niger and Kogi States in Nigeria and an international border with the republic of Benin along its north-western part. Because of the state's location between the Northern and Southern parts of Nigeria, it is referred to as the gateway state.

The state has two main climatic seasons: the dry and wet seasons. The wet season falls between April-October while the dry season runs between November-March of each year. The annual rainfall range from 1000-1500mm, while maximum average temperature ranges between 30^0C and 35^0C. The state's vegetation which hitherto consisted ofa mix of savannah to its north and thick forest in its southern parts is now mainly wooded Guinea savannah, which is well suited for the cultivation of a wide variety of staples like Yam, Cassava, Maize, Cowpea, Fruits and Vegetables. Rice and sugarcane are significant cash crops. (NCRI,1984,1997; Kwara State Ministry of Information, 2002; Encyclopedia Britannica, 2003).

Kwara state is classified by the Kwara State Agricultural Development Project into four Zones A, B, C and D, based on agronomic and climatic characteristics of the state area. For the study, Zone C was purposively selected because of its relative forest resources endowment. The sampling procedure comprised therefore comprised two stages. The first stage was the random sample selection of eight communities across Zone C, while the second stage involved the random selection of 15 households per community. In all, a total of one hundred and twenty households were selected as study respondents. Questionnaires were used to solicit responses from respondents. However, the questionnaire approach to collecting information was augmented with interview and participatory rural appraisal survey approach. This was to ensure detail information collection and to validate the information collected.

Data Analysis

To achieve the stated specific objectives of the study, the descriptive and multinomial logit analysis were the tools employed for data analysis. Descriptive statistical analysis employed were the percentage, frequency distribution, mean, mode and standard deviation. These tools were used to analyse socio- economic characteristics of respondents and forest resources use vis-a-vis climate change.

Multinomial logit model

The multinomial logit model as used in Fakayode, et al, (2010) was used to assess why households in the study area prefer to use any of the following fuel options

i) agricultural/forest resource (wood, sawdust and coal) fuels only

ii) agricultural resources fuels augmented with non-agricultural resources/ alternatives fuels like kerosene, electric stoves and;

iii) non-agricultural resources/ alternative fuels only option.

The multinomial logit model was chosen based on pretested questionnaire survey results that revealed that household use of agricultural resources and non-agricultural resources fuels (dependent variable) was found to be a categorical variable which can take three (3) categories or levels: agricultural/forest resource (wood, sawdust and coal) fuels only, agricultural resources/alternative fuels augmented with non-agricultural resources fuels and non-agricultural resources/alternative fuels as indicated earlier

These categories were assigned numbers; 0 for households who only use of agricultural resources as fuel, 1 for households who used agricultural resources fuels augmented with non-agricultural resources/alternative fuels and 2 for households who used only non-agricultural resources/alternative fuels as sources of energy. The multinomial logit model was therefore used to identify the variables that make households belong to each categories of 0, 1 and 2.

The probability that the ith household belongs to the jth resources fuels group reduces to:

$$\mathbf{P_{ij}} = \frac{e^{\beta j X i}}{\sum_{k=j} e^{\beta j X i}} \qquad (1)$$

Accordingly, the model makes the choice of probabilities on individual characteristics of agents. Following Maddala, (1990), the basic model is written as:

$$\mathbf{P_{ij}} = \frac{e^{\beta j X i}}{\sum_{k=0} e^{\beta j X i}} \qquad (2)$$

Where *i*= 1, 2, ----- *n* variables; *k*= 0, 1, ---*j* groups and *j* is vector of parameters that relates *Xjs* to the probability of being in group j where there are *j+1* groups. For this study, the *Xi* variables range from X_1–X_4, where X_1= Income of household of household head in naira ₦, $X_{2=}$ Household size, X_3=Educational status of household head, X_4= age of household head in years, X_5= price of kerosene in ₦/liter and X_6= price of charcoal/per kilogram**.**

Normalization of the Model

As a rule, the summation of the probability for the three categorical groups in our model must equal to unity. This calls for a normalization of the equation model. The common rule is to set one of the parameters vectors equal to zero (Kimhi, 1994). Hence, for k number of choices only v–1 distinct parameters is identified and estimated. Based on equation (2), the probability of being in the reference group: the agricultural/forest resources fuels group with parameter vectors equal zero is

$$\mathbf{P_{io}} = \frac{1}{1+\sum_{k=j} \mathbf{e^{\beta jXi}}} . \qquad (3)$$

Similarly, the probability of being in each of the other j group is

$$\mathbf{P_{ij}} = \frac{1}{1+\sum_{k=j} \mathbf{e^{\beta jXi}}} . \qquad (4)$$

Dividing equation (3) by (4) gives

$$\frac{\mathbf{P_{ij}}}{P_{io}} = \mathbf{e^{\beta jXi}} \qquad (5)$$

This denotes the relative probability of each group to the probability of the reference group. Hence, the estimated coefficients for each group reflect the effect of Xi's on the likelihood of the household belonging to that alternative group relative to the reference group. The logarithm of the odd ratio in the equation to base e gives the estimating equation.

$$\ln \left(\frac{P_{ij}}{P_{i0}} \right) = \beta jXi \qquad (6)$$

Following Hill (1983), the coefficients of the group can be given using the formula

$$\beta_v = - [\beta_1 + \beta_2 + \text{----- } v\text{-}1] \qquad (7)$$

Issues: Coefficients, their Signs and Interpretations

i. A positive coefficient indicates that the variable is associated with a higher probability of being in the group choice under consideration relative to the reference group. This implies that the probability of the individual selecting the particular group is greater than the probability of choosing the reference group.
ii. A negative coefficient means that the probability of the household choosing the particular group is smaller than the probability of being in the reference group.
iii. Estimates not significantly different from zero indicate that, the particular regressor (X_i) does not affect the resources fuels use nor the probability of the state to which it applies relative to the reference group .

Results and Discussion

The analysis results of socio-economic characteristics of the rural dwellers are shown in Table 1. The Table shows that about half (45.0%) of the respondents have had no form of formal education, while over half of them (55.5%) have had basic primary education. Most of them (75.3%) were practicing farmers, few were hunters and lumbering men, fishermen and traders. Most of them (95.5%) do not belong to any farming association.

As regards respondents' knowledge of climate change, few of them (34.8%) were aware of climate change indicators like rising temperatures. Other climate change indicators including increased rain, hailstorm, erratic rainfall, early on-set of rains,delayed on-set of rains and frequent drought were also reported by respondents (Table 2). This implies that climate change is already affecting the study area. It therefore requires urgent mitigation. The study also revealed that the population affected by climate change were mostly children below the age of 15 years and the elderly people (Table 3). It was however revealed that most households (41.62%) did nothing to remedy climate change in the study area (Table 4) implying that the study area stands to experience future devastating climate change if urgent actions/mitigation are not encouraged..

Further enquiry revealed that respondents incurred minimal annual losses due to climate change effects. Over half of the households acknowledged losses of between ₦6000-₦10,000 while the remaining households acknowledge below ₦6000. Only a handful of them acknowledged greater than ₦10,000 worth of losses (Table 5).

Table 1: Respondent's Socio-economic Characteristics

Characteristics	Frequency	Percentage
Gender		
Male	104	86.7
Female	16	13.3
Total	120	100
Marital Status		
Married	78	65.0
Single	29	24.2
Divorced	2	1.7
Widow	4	3.3
Widower	7	5.8
Total	120	100
Educational Qualification		
No formal education	54	45.0
Primary education	36	30.0
Secondary education	29	24.2
Tertiary education	1	0.8
Total	120	100
Occupation		
Farming	73	75.3
Hunter	10	10.3
Lumberman	2	2.1
Fisherman	11	11.3
Other(trading)	1	1.0
Total	120	100
Farming association		
Member of Assoc.	5	4.5
Non-member	105	95.5
Total	110	100

Source: Field Survey, 2011

Table 2: Respondents' Perception of Climate Change Indicators

Knowledge	Frequency	Percentage
More frequent drought	3	1.4
Delayed on-set of rainfall	13	6.3
Earlier on-set of rainfall	44	21.5
Erratic rainfall pattern	1	0.49
Hailstorm	1	0.49

Too much rain	36	17.6
Less rain	35	17.1
High temperature	71	34.8

Source: Field Survey, 2011

Table 3: Age group mostly affected by climate change

Categories	**Frequency**	**Percentage**
Children(below 15yrs)	118	50
Women	-	-
Men	-	-
The elderly	118	50
All	-	-

Source: Field Survey, 2011

Table 4: Respondents' action taken on climate change

Action Taken	**Frequency**	**Percentage**
Did nothing	92	41.62
Started growing a new crop	6	2.17
Adopted drought tolerant	29	13.12
Moved focus from crops to livestock	19	8.59
Started using new land management practices	73	33.03
Other	2	0.90

Source: Field Survey, 2011

Table 5: Respondents annual loss in Naira to the effects of climate change

Losses In Naira	**Frequency**	**Percentage**
1000-5000	48	42.47
6000-10,000	57	50.44
11,000-15,000	8	7.08
Total	113	100

Source: Field Survey, 2011

Factors influencing Farm Households use of Forest Resources Fuels

Tables 6 and 7 show factors that explain households disposition to the use of the forest resources fuel including firewood, coal and the non-forest resources fuels comprising electricity and kerosene based on multinomial logit estimates results. For the determinants of forest resources fuel use augmented with non-agricultural resources/alternative fuels, the income variable of the households was implied as a significant variable (significant at 5 per

cent level; P≤0.05) that influenced households use of forest resources fuel augmented with non-agricultural resources/alternative fuels. The implication is that households that are poor tend to be disposed to the use of forest resources fuels like firewood and coal for cooking and other related uses while those that were better-off tend to augmented with non-agricultural resources/alternative fuels. In the case of determinants of households use of use of non-forest resources fuels including kerosene and electricity only, it was shown that the prices of kerosene and coal are implied as significant variables (significant at 5 per cent level; P≤0.05) (Table 7). The implication of this is that these factors explain why households can decide to use kerosene and electricity energy sources for the cooking and other related uses only. Thus the prices of these alternative sources if at reasonably low rates can help deter household use of forest resources fuels like firewood, coal and saw dust for cooking purposes.

Table 6: Multinomial Logit Estimate for the Determinants of Agricultural Resource Uses augmented with non-agricultural resources/alternative fuels

	Coeff.	**Std. Err.**	**z**	**P>|z|**	**95% Conf**	**(Interval)**
Income (X_1)	***-.0000195***	***7.39e-06***	***-2.63***	***0.008****	***-.0000339***	***-4.97e-06***
Hhsize ***(X_2)***	-.0774549	.0571034	-1.36	0.175	-.1893756	.0344658
Edu status ***(X_3***	-.2376613	.4158417	-0.57	0.568	-1.052696	.5773734
Age ***(X_4)***	.0248202	.0348797	0.71	0.477	-.0435428	.0931831
Price of kerosene***(X_5)***	-.0952698	.1310793	-0.73	0.467	-.3521806	.1616409
Price of charcoal ***(X_6)***	0.0083158	.0035039	2.37	0.018	.0014483	.0151833
cons	7.227175	17.52204	0.41	0.680	-27.11539	41.56974

Source: Field Survey, 2011

Table 7: Multinomial Logit Estimate for Determinant of Non- Agricultural Resources/alternative fuels use

	Coef.	**Std. Err.**	**z**	**P>|z|**	**95% Conf**	**(Interval)**
Income ***(X_1)***	-.0000109	.0000109	-0.99	0.321	-.0000323	.0000106
Hhsize ***(X_2)***	-.0319328	.0932836	-0.34	0.732	-.2147654	.1508997
Edustatus ***(X_3)***	-.2303955	.7738216	-0.30	0.766	-1.747058	1.286267
Age ***(X_4)***	.0212717	.064153	0.33	0.740	-.104466	.1470093
Price of Kerosene(X_5)	***2.479426***	***.0880913***	***28.15***	***0.000***	***2.30677***	***2.652082***
Price of charcoal(X_6)	***.0239049***	***.0124598***	***1.92***	***0.055***	***-.0005159***	***.0483257***
cons	-382.9619	.	.	.	.	.

Source: Field Survey, 2011

Forest Sustainability Practices of Households

Also investigated during the study were forest sustainability practices by households in the study area. Table 8 shows that tree planting activities was the most practiced activity. Further enquiry however revealed that on average, households left about 2 hectares of their farmland holdings to fallow over about 5 years period (Table 9). This has implications for forestation strategies in the study area. Government of the day could therefore liaise with community leaders and farmers on ways of meaningful forestation activities in the area.

Table 8: Respondents Prevalent Sustainable Forest Practices

Practices	**Frequency**	**Percentage**
Plant tress	67	54.9
Crop rotation	24	19.6
Bush fallow	16	13.1
A forestation	16	13.1
total	122	100

Source: Field Survey, 2011

Table 9: Area allowed fallowing by Respondents

Area	**Frequency**	**Percentage**
1-2	12	100
3-4	-	-
>4	-	-
Total	12	100

Source: Field survey 2011

Conclusion and Recommendations

From this study which investigates forest resources use and sustainability practices by the masses rural people in Nigeria, it is revealed that over half of the rural households have had basic primary education. Those mostly affected by climate change in these areas were mostly children. However minimal losses due to climate change were experienced by households while climate change forest related mitigation activities was mainly that of indigenous Tree

planting. Also, the study reveals that despite the fact that there is a high forest fuel resources usage amongst rural households, their likelihood to patronise and using non-forest/alternative fuels is dependent on household income, price of kerosene and price of charcoal.

Based on the study findings therefore, the following recommendations were made;

From the study majority of the respondents though without formal education, were only coerce to deplete forest resources for cooking and other uses, only because of the low income, poverty status. A hungry man they say is an angry man. There is therefore the need to generate activities that could better household income in the study area, as these will reduce their dependence on forest resources for cooking and other resources. Also the prices of alternatives fuels like kerosene and electricity if subsidized could help alleviate the worth of people's incomes that would in turn empower them use these alternative fuels.

To reverse the trend of desertification that is prevailing in the northern states of the country, state governments resorted to annual tree planting campaigns and between 1989 and 1999. However, one thing still remains clear, without a strong, radical and aggressive a forestation campaign by the federal government and more importantly the Northern States governments through their various agencies, the problem of climate change stemming from the unsustainable use of our forest resources will continue to stark at our faces. In this wise, there is an urgent need to raise people's awareness as to the gains of green environments. In this wise, education and sensitization of all stakeholders through careful dissemination of information on the negative consequences of environmental degradation need be urgently initiated by government and other environment stake holders. Also spreading the knowledge that the atmosphere is our collective asset is long over due. Specialized knowledge should also be availed the masses, to communicate the devastating effects of embarking on unsustainable agricultural practises.

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