



QUANTIFYING CHARCOAL CONSUMPTION IN OSUN STATE: IMPLICATIONS ON CLIMATE CHANGE

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ABSTRACT

This study investigated the implications of charcoal production and consumption in Osun State, Nigeria, particularly its impact on climate change and biodiversity. Data collection was done using a quantitative survey methodology and analysed using descriptive analysis. Four hundred (400) questionnaires were distributed across three senatorial districts in Osun State where three local government areas were randomly selected in each senatorial district and respondents' perceptions of charcoal's production and consumption on environmental impact were assessed. Findings revealed a significant reliance on charcoal, especially among lower-income households. Most respondents were self-employed, with an average household size of five. Educational levels varied, with many respondents holding tertiary qualifications, potentially influencing their awareness of environmental issues associated with charcoal use. The range between 50-75% respondents acknowledged the impacts of deforestation, yet economic constraints kept them reliant on charcoal but indicated a preference for regulatory measures rather than an outright ban. Hence, this study emphasizes and recommends the need for sustainable practices in charcoal production and calls for policies that help balance energy needs with forest conservation.

Keywords: Charcoal, Consumption, Deforestation, Environmental Impact, Climate, Change

INTRODUCTION

Globally, access to energy remains a basic human need to all household for either to cook and or for heating (Oyetunji *et al.*, 2020). The demand for energy to meet these domestic needs is becoming more impossible as factors such as geometric population increase, increase in the price of fossil fuel and low-income have made people resort to alternative source of fuel like firewood and charcoal (Olusola *et al.*, 2021).

The continuous clearing of forests and harvesting of fuelwood without deliberate reforestation has become a problem that bothers national planners not only in Nigeria but the world at large. In spite of the importance of the forest and its resources, the natural tropical high forest has continued to diminish rapidly in the African continent (Aliyu *et al.*, 2014) and the effects of deforestation on the environment and climate are imminent. In addition, there has been a consensus that deforestation is one of the major causes for climate change (Bennett, 2017). Till date, forest cover remains under pressure as a result of human activities especially in charcoal production as sources of energy for both domestic and industrial uses. Hence, this study looks into quantifying the current production and consumption rate of charcoal in the study area with a view to knowing and providing the necessary information on its implication on biodiversity conservation and its potential harms in combating climate change.





METHODOLOGY

Study Area

The study was carried out in Osun state. The state is situated in the tropical rain forest zone and located in the South-West geopolitical zone of Nigeria; occuping an area of land of about 14, 875km2. It covers an area of approximately 14,875km and lies between latitude 7° 300 0 N and longitude 4° 300 0 E. There are two seasons, the rainy season from April to October and the dry season from November to March. The state is covered by secondary forest and in the northern part, the derived Savannah mosaic predominates. Forest vegetation could be found along the river valleys and streams found across the State. Osun State comprises of 30 Local Government Areas (LGAs); geopolitically stratified into three Senatorial districts and each district consists of at least 8 (LGAs). The State has a population of about 3.5 million and the vegetation is characteristically that of rain forest and derived savannah with a mean annual rainfall that varies between 980mm and 2800mm and a temperature range of 27 -32°C.23.2°C and 31.9 °C, almost throughout the year. There is an annual mean radiation of 18.3 mm and an annual mean relative humidity of 59.1 %. Its annual mean evaporation is 4.4 mm while annual mean cloud coverage is 7 OCATS (NBS, 2012).

Sampling Procedure and Sample Size

This study employed the multi-stage sampling procedure through the use of questionnaire survey (Quantitative survey) for collection of primary data was collected. Four hundred (400) house-holds were sampled based on (Krejcie and Morgan 1970) sample size determination in both rural and urban areas of Osun State. Three (3) Local Government Areas of the State were randomly selected from three senatorial districts namely: (i) Osun central (ii) Osun east (iii)Osun west, followed by random selection of villages so as to provide information on consumption/utilization of charcoal. The primary sampling unit is the household units.

Method of Data collection and Analysis

Information on lists and human population (population census of 2006) of each LGAs were obtained from National population commission. Report from the population census in 2006, stated about 3,416,959 populations were censused in Osun State and the sum total population of local governments selected in the three senatorial district was 1,121, 284. Each Local Government that are randomly selected in three senatorial district and number of questionnaires administered are shown in table 1.

Number of questionnaires administered as samples was done according to Krejecie and Morgan, (1970) on population on statistics determination said "Any population that is above 1million, the sample population should be 400. This was validated using: "Slovin's formular"

 $n = N/(1 + N(e^2))$ (1)

Where n= sample size+++

N= Total population=3,416,959

e= Margin of error (0.05)

n=3,416,959/1+3,416,959(0.05)

3,416,959/1+8542.39(0.05x0.05)

3416959/8543.39= 399.99 which is estimated to 400 samples





Total of all the selected senatorial district gives 1,121,284.

Data collected was subjected to descriptive statistical analysis such as mean frequency, mean and percentages was used to arrange and describe the socio-economic characteristics of the respondents.

Sen. Districts in Osun	LGA	Villages sampled	Sample size	
Osun Central	Boripe	Iragbiji, Iree, Ada	50	
	Irepodun	Ilobu, Erin, Olorunsogo	43	
	Osogbo	Aiyetoro, Alekuwodo,	68	
		Kolabalogun		
Osun East	Atakunmosa West	Iperindo, Ipole, Araromi	27	
	Obokun	Otan Ile, Ilase, Ikinyinwa	42	
	Ilesa West	Ilesa, Itakogun, Ayeso	38	
Osun West	Ede North	Ede, Kajola, Araromi	30	
	Ejigbo	Ejigbo, Ife Odan,	47	
		Isundunrin		
Total	Iwo	Iwo, Sekona, Olubusan	55	

Table 1: Sample Size and Sampling Techniques

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Socio-economic characteristics from this study area revealed a significant proportion (40.0%) of respondents were from Osun Central, followed by those from Osun West (33.3%) and few (26.8%) were from Osun East (Figure 1).



Figure 1: Distribution of the Respondents according to their Senatorial District (n=400) Source: Researcher's Field survey, 2022

Result on Table 2, showed the distribution of the respondents age, across the three senatorial districts. The respondents had a mean age of 44 ± 13.05 . About 28.0% of the respondents fell within the age group of 40 to 49years, followed by age group 30 and 39 years (20%); 50 to 59 (20%). This is in accordance with the study of Adebayo *et al.*, (2019) on charcoal consumption where the age range of the respondents was also at the highest within the range of 40-49 years in Oyo state. The age groups (30-39,40-49 &50-59) with high frequencies from this study depicted and fell within the economically productive age group according to WHO, (2024).





I able	2. DISUID	ution of Respondents based on Age				
Age		Frequency	Percentage			
<20		1	0.3			
20-29		53	13.3			
30-39		96	24			
40-49		112	28			
50-59		80	20			
60-69		40	10			
70-79		18	4.5			
a	D' 11	2022				

Cable 2: Distribution of Respondents based on Age

Source: Field survey, 2022

The different levels of respondents' education in relation to charcoal consumption was accessed (Table 3). From this study, result revealed that 40.3% of the respondents had tertiary level of education (NCE), followed by secondary (30.5%) and primary education (21.5) while a little proportion (7.8%) had no form of education. This result also showed that the respondents' level of education and probably their monthly income could have influenced the informed decision in using charcoal in place of firewood and other sources of energy. Similar result was reported by Muazu *et al.*, 2022 on a study of charcoal consumption at Kaduna state, Nigeria where 40.3% of the respondents had high level of education, exhibiting better understanding in terms of environmental pollution, lesser smoke and thermal efficiency in the utilization of charcoal. This also corroborated the findings of Lay *et al.*, (2013).

Table 3: Distribution of Respondents based on Educational L
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Education	Frequency	Percentage
No education	31	7.8
Primary	86	21.5
Secondary	122	30.5
Tertiary	161	40.3
a p	1	

Source: Researcher's Field survey, 2022

The result in Table 4 presented the different ranges of income based on the responses given by respondents. The findings of this study revealed that on a monthly basis,30.8% of the respondents realizes income below N216,000, 28.2% of the respondents realizes between N216,000 and N315,000monthly. Furthermore, about 22.5% of the respondents realizes between N316,000 and N415,000 monthly, while 18.5% of the respondents realizes above N416,000. It also established that the lower the income range, the higher the number of people and the more charcoal is consumed. The above result also correlated with the findings of Muazu *et al.*, (2022) who reported that higher income earners consume less of charcoal.

Table 4: Distribution of Respondents based on Income

Income (N)	Frequency	Percentage				
Below 216, 000	123	30.8				
216,00-315,000	113	28.2				
316,000-415,000	90	22.5				
Above 41 6,000	74	18.5				
С <u>Г'11</u>	2022					

Source: Field survey, 2022

The result in Table 5 further indicated that more than half (56.3%) of the respondents were married, 12.0% were divorced, 11.0% are separated, 10.8% are widow and few (10%)





were single. Muazu *et al.*, (2022) and Sowunmi *et al.*, (2018) also reported similar results in their studies where they had majority of their respondents who consumes charcoal were married in Kaduna State Nigeria, South Africa and Oyo state Nigeria; respectively. It shows that the more respondents that are married, the more dependence on the use of charcoal.

Table 5: Distribution of Responde	nts based on Marital Status
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Marital status	Frequency	Percentage	
Married	225	56.3	
Single	40	10	
Separated	44	11	
Divorced	48	12	
Widowed	43	10.8	
<u>с</u> г' 11	2022		

Source: Field survey, 2022

The result in Table 6 revealed that a significant proportion (46.8%) of the respondents were self-employed, 23.3% had formal occupation, 17.0% had causal occupation and 13.0% of them were unemployed. The occupational status obtained in this study showed that lesser people were formally employed and consequently, the others who were unemployed, self and casually employed rely more on a readily available and affordable source of fuel. This is also in line with the study of Adeniji *et al.*, 2022 where majority of their respondents (71%) were self-employed in Niger State, Nigeria.

Table 6: Distribution of Respondents based Occupational Status

Occupation	Frequency	Percentage			
Self-employed	187	46.8			
Causal	68	17			
Formal	93	23.3			
Unemployed	52	13			
Source Field survey 2022					

Source: Field survey, 2022

The findings in Table 7 revealed that the respondents had an average household size of 5persons. Majority (61.5%) of the respondents had between 4 and 6 persons in their household, 20.3% had over 6 persons and 18.3% had less than 4 persons. This result also implies that household size determines the consumption rate of charcoal. This also corresponds with the report of Sowunmi *et al.*, (2018) who observed in his study that majority of their respondents had a household size that is less than 6.

Table 7: Distribution of respondents based on Household size

Household size	Frequency	Percentage	
1- 3members	73	18.3	
4-6 members	246	61.5	
7-10members	81	20.3	
0 11	2022		

Source: Field survey, 2022

Consumption and Utilization of Charcoal

The result in Table 8 presented the distribution of the respondents according to their consumption and utilization of charcoal. About 31.3% of the respondents indicated that they use charcoal twice a week, 26.8% of the respondents revealed that they use it every day of the week, 23.0% of the respondents did not use it at all and few (19.0%), use it three times a





week. In the same vein, 32.2% of the respondents use charcoal in their household two weeks in a month, 26.3% of the respondents use it all through the month, 18.3% of the respondents indicated that they use it about three weeks in a month and 23.3% identified that they did not use it at all. The frequency of usage when compared to that of non-use of charcoal in this study area, is an indication that there will be more pressure on forest estate for harvesting of wood fuel tree species.

A significant proportion (31.0%) of the respondents rate their utilization at 50%, 27.0% rated their utilization at 100%, 19.3% rated it at 20% and few (22.8%) of the respondents rated their utilization at 0% indicating that they did not use it at all. On the average, Osun west consume more of charcoal(64.20kg) than Osun central (59.56kg) and Osun east (52.36kg) on a monthly basis. When asked if charcoal was a good replacement for cooking gas, more than half (52.0%) of the respondents disagreed while 48.0% agreed that it is a good replacement. This led to further findings that some combines the use of charcoal with other sources of fuel like kerosene, firewood and other biofuel. Result obtained implies the dependence on charcoal as a suitable alternative source of fuel. About 36.0% of the respondents indicated that charcoal demand is high during rainy season, 32.0% indicated more demand to be during dry season and about 32.0% of the respondents was not sure of time of high demand. The study established the link of higher demand and use of charcoal during rainy season than the dry season as it is seen as a cheaper source of fuel for cooking and warming up during the cold season.

Variables	Frequency	Percentage
Frequency of charcoal usage/week	requency	Tercentage
Every day of the week	107	26.8
Twice a week	107	20.8
Three times a week	76	10.0
Not at all	70 02	19.0
Not at all	92	25.0
Frequency of charcoal usage/month	105	26.2
Every day (all through the month)	105	26.3
About two weeks in a month	129	32.3
About three weeks in a month	73	18.3
Not at all	93	23.3
Rate of utilization of charcoal		
100%	108	27.0
50%	124	31.0
20%	77	19.3
0%	91	22.8
Quantity of charcoal consumed	Mean	SD
Osun central	59.56	54.280
Osun east	52.36	53.925
Osun west	64.20	59.840
Is charcoal a good replacement for cooking gas		
Yes	192	48.0
No	208	52.0
Season in which demand for charcoal is high		
Dry season	128	32.0
Rainy season	144	36.0
I don't know	128	32.0
G F: 11 20020		

Table 8: Distribution of the Respondents according to their Consumption and Utilization of Charcoal (n=400)

Source: Field survey, 2022





Impact of Charcoal Production and Consumption on Climate Change

The growing demand for charcoal and its production has resulted in deforestation which involves felling of trees and this has led to disruption of essential ecological services that help to mitigate climate change (Adebayo *et al.*, 2019). It is evident in this study as presented in Table 9 that charcoal production as perceived by the respondents, have impact on climate change; as 48.5% of the respondents agreed that it does while a considerable number (28.6%) of the respondents however disagreed with such postulate.

In addition, 38.3% of the respondents were not sure if charcoal production has impact on rainfall pattern and 32.3% of the respondents were of the opinion that it does not affect, only few (29.5%) stated otherwise. This indicated how knowledgeable they are about the importance of trees to the environment which suggests creating more awareness and enlightenment.

Table 9:	Distribution	of the	Respondents	according	to th	e Perceived	Impact	of	Charcoal
Productio	n and Consur	nption (on Climate Cl	nange(n=40	0)				

Variables	Frequency	Percentage				
Charcoal production strongly affect climate change						
Strongly agree	98	24.5				
Agree	96	24.0				
Neutral	92	23.0				
Disagree	71	17.8				
Strongly disagree	43	10.8				
Charcoal production affects rainfall						
Yes	118	29.5				
No	129	32.3				
Maybe	153	38.3				

Source: Field survey, 2022

Impact of Charcoal Production on Deforestation and Conservation

According to the report of Ekpo and Emeodilichi, (2020), charcoal industry if unsustainably managed may lead to deforestation and environmental degradation; thus disrupting the rich biodiversity ecosystem. Result presented in Table 10 show the distribution of the respondents according to the perceived impact of charcoal production and consumption on deforestation and conservation. The Table revealed that 45.5% of the respondents estimated 50% forest loss, 32.3% estimated 75% losses and 22.3% estimated the loss to be around 25%. The responses obtained from this study imply that the production and use of charcoal have great devastating impact on the forest if there are no deliberate actions to conserve the forest and re-afforest felled sites; as 59.3% of the respondents in summation, agreed that charcoal production leads to deforestation. This also corroborated the report of FAO (2005) on the annual rate of Forest cover lost in Nigeria between 1999 and 2005.

However, 54% of the respondents in summation disagreed with stopping charcoal production while 34.3% agreed with halting charcoal production. It can be inferred from the responses that despite the perceived impact on the forest, the production and use of charcoal is a suitable and alternative source of energy the respondents rely on, and a source of income.





Table 10: Distribution of the Respondents according to the Perceived Impact of Charcoal Production and Consumption on Deforestation and Conservation (n=400)

Variables	Frequency	Percentage
Estimate of forest loses extent associated with		
charcoal production		
25%	89	22.3
50%	182	45.5
75%	129	32.3
Charcoal production leads to deforestation		
Strongly agree	100	25.0
Agree	137	34.3
Neutral	73	18.3
Disagree	65	16.3
Strongly disagree	25	6.3
Charcoal production should be stopped		
Strongly agree	58	14.5
Agree	79	19.8
Neutral	47	11.8
Disagree	90	22.5
Strongly disagree	126	31.5

Source: Field survey, 2022

Perception on Charcoal Production

In relation to issues as regard the implications of charcoal production, the level of respondents' awareness and views on control of resources obtained from the forest were also assessed. The result on Table 11 showed that about 32.3% of the respondents agreed that charcoal production should be made legal, seconded by a hand full (30.0%) who strongly agreed on this statement. Although, 37.5% of the respondents agreed that charcoal production should be controlled, in addition to the 23.8percent who strongly agreed there is a need for control. Secondly, on the issue of material sources, findings show that about 30.3% of the respondents, were undecisive of whether materials used in charcoal production were fetched from government reserves area. While in summation, 45.8% disagreed that the materials are not fetched from government reserves area. In the same vein, above one third (36.0%) strongly agreed that the materials used in charcoal production are fetched from anywhere and 26.8% were indecisive on the location. While a larger proportion (45.5%) of the respondents strongly agreed that charcoal production relies heavily on presence of forest. This seconded by a handful (39.3%) who agreed on the same statement.

The results from the above postulates established that charcoal production relies on the forest areas and there is need for control of harvesting wood material and legal control of production so as to reduce the effects caused by the activity. This also corresponds to the findings of Olori, (2009), which indicated that production of Charcoal is one of the activities leading to destruction of forest cover in Nigeria, a situation aggravated by illegal commercial loggings, bringing about felling of both mature and nearly-mature trees in almost all the areas involved in the business (Wikipedia Encyclopedia, 2005). Mitchell, (2009) also maintained that deforestation is a problem, and the need for the business world to wake up, to mitigating the effect of global climatic change.





Table 11: Distribution of the Respondents according to their Perception on Charcoal Production (n=400)

Variables	SA	Α	Ν	D	SD
Charcoal production should be	120(30.0)	129(32.3)	76(19.0)	39(9.8)	36(9.0)
made legal					
Charcoal production should be	95(23.8)	150(37.5)	83(20.8)	34(8.5)	38(9.5)
controlled					
The materials used in charcoal	30(7.5)	66(16.5)	121(30.3)	102(25.5)	81(20.3)
production are fetched from					
government reserve areas					
The materials used in charcoal	144(36.0)	98(24.5)	107(26.8)	32(8.0)	19(4.8)
production are fetched from					
anywhere					
Charcoal production relies heavily	182(45.5)	157(39.3)	38(9.5)	15(3.8)	8(2.0)
on presence of forest					
C					

Source: Field survey, 2022

SA-Strongly Agree, A-Agree, N-Neutral, D-Disagree, SD-Strongly Disagree

Drivers of Charcoal

The above chart (Fig. 5) was the result on different driving forces behind the use of charcoal. Findings from the study showed that highest number of respondents indicated *poverty* as the major reason for using charcoal in the three senatorial districts. The second major reason was the cheapness when compared to other sources of energy and lastly, the prolonged heat produced from charcoal. This study corroborated with the findings of FAO, (2003) that made it known that there is easy shift from the use of petroleum products to the use of fuelwood because of the available prices of these fossil fuels are beyond the reach of ordinary people in Nigeria. The increase use of fuelwood amidst others have been identified as a cause of forest depletion (Agarwala *et al*, 2016).



Major reasons for using charcoal as major domestic energy source

Figure 2: Major reasons for using charcoal as a major domestic energy source





CONCLUSION AND RECOMMENDATION

Findings from this study revealed that there is high rate of charcoal consumption in the study area which has led into forest trees exploitation and loss (Deforestation), as the major driving force of the respondents is low-income level (Poverty). It was realized that charcoal production and utilization have an effect on deforestation and conservation, rating this to around 50-75% impact although, the respondents want the Government to regulate charcoal production.

The use of charcoal fuel especially for cooking was observed to be highest among households in Osun west senatorial district. It was also realized that demand for charcoal is higher during the rainy season than the dry season implicating that climatic seasonality is a factor that has significant effect on forest products especially charcoal.

The study also revealed that there is significant relationship between charcoal consumption and socio-demography characteristics of the respondents; that is, increase in age range and increase in household size result in an increase in consumption of charcoal. However, it was identified that if there is an improved standard of living for these respondents, they will switch to other sources of fuel other than charcoal.

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