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Evaluation of Charcoal Usage and Its Influence on Deforestation in Makurdi Metropolis Benue State, Nigeria

Obed Kohol Niambe[1*], Emmanuella Nguevese Gbaa[1], Ruth Seember Niambe[2], Gabriel Terkuma Ityowuhe[2]
Avalumun Emmanuel Kaa[3]

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ABSTRACT

Charcoal is the dark grey residue consisting of impure carbon obtained from vegetation substance and produced by pyrolysis, the heating of wood in the absence of oxygen. Charcoal is considered the major source of energy for the inhabitants of Makurdi metropolis. The study was conducted to assess the consumption of charcoal in Makurdi metropolis. Five council wards were selected purposively for data collection. The selected wards are noted for having large quantities of charcoal and consumers almost all year round. The wards selected are Agan, Fiidi, Wadata, Modern Market, and North Bank. From each council ward, 20 respondents were drawn using a random sampling technique. 100 respondents were selected and interviewed using a pre-tested checklist (questionnaire) to collect primary data. From the result, *Prosopis africana* was the highest used tree species for charcoal with 83.5% then *Vitellaria paradoxa* with 7.9%. Also, 88% of the respondents preferred charcoal for cooking in providing food for the family because of its affordability compared to other cooking energy sources. Therefore, it is inferred that charcoal has a positive impact on the lives of consumers since affordability is considered the main reason why the majority of households use charcoal. However, the continuous use of forest trees threatens the future of our forest estate and biodiversity leading to land degradation, endangering of species and enhancement of global warming. Therefore, Alternative energy sources should be encouraged for household fuel to ease the pressure on charcoal.

INTRODUCTION

Charcoal is reported to be a significant domestic product for decades and has extensive market acceptance (D. O. Ekhuemelo *et al*., 2019). Charcoal is found to be the primary urban fuel in most of Africa and around developed countries and is a major source of income (Jamala *et al*., 2013). (Zaku *et al*., 2013) claimed that developing countries' rural areas rely on biomass fuels such as wood fuel and charcoal for their energy consumption. Wood fuel as a source of energy function remarkably in household energy demands. As a result of growing economic difficulties in Nigeria, many people are finding it continuously hard to afford conventional fuels. At least 80% of the African population continues to depend on traditional biomass fuels, mainly charcoal and firewood for their energy needs. Though the precise quantity of charcoal produced and consumed is not easy to determine due to the informal nature of the products, about 24 million tonnes of charcoal have been estimated to have been consumed worldwide in 1992, with developing countries accounting for nearly all of this consumption (Babalola & Opii, 2012).

Energy supply is one of the basic needs of all human beings throughout the ages. What varies over time is the source from which energy is supplied and the system of supply. It is required for diverse purposes such as cooking, heating, transport, and industrial production. Fuel wood was probably the earliest source of energy ever used by human beings, and it has remained a dominant source of domestic energy, especially in developing countries, due to its affordability and social appropriateness of its use (Ortserga *et al*., 2019). Charcoal is a source of energy derived from burning wood materials like logs and twigs and is common among rural dwellers. The over-dependence on fuel-wood for energy is chiefly because of its relatively low prices and easy accessibility (Adebayo & Adeola, 2008). According to (Tee *et al*., 2009) Fuel wood is the major energy source for the inhabitants of Makurdi metropolis. It is utilized for a variety of purposes both domestic and industrial. There is a widening demand for fuel wood, with increasing pressure on the remaining forest trees. Charcoal is normally produced in rural areas and transported to urban areas for consumption (Tunde *et al*., 2013). Charcoal is the major source of energy for the inhabitants of Makurdi metropolis. It is utilized for a variety of purposes both domestic and industrial (Tee *et al*., 2009). According to Ekhuemelo *et al* (2019), charcoal production was regarded as one of the activities leading to uncontrolled clearing of forest cover in Nigeria, which is worsened by unlawful commercial logging. Nigeria has the world highest deforestation rate of primary forests according to revised deforestation figures. From the report, between 2000 and 2005 the country lost 55.7% of its primary forests which is defined as forests with no visible signs of past or present human activities. Logging, subsistence agriculture, and the collection of fuelwoods are cited as leading causes of forest clearing in the West African country(Gbiri & Adeoye, 2019).

[1] People's Friendship University of Russia Named After Patrice Lumumba, Moscow
[2] Joseph Sarwuan Tarka University, Makurdi
[3] Lakehead University Ontario, Canada
[*] Corresponding author's e-mail: 1032225329@rudn.ru

The objective of the study is to assess the consumption of charcoal consumption in Makurdi metropolis. The specific objectives of the study are to: Identify the socioeconomic characteristics of charcoal the tree species used for charcoal production, ascertain the price of charcoal, the quantity bought per month and the duration consumers use charcoal per month, ascertain the reasons for preferring charcoal to other cooking energy sources. There has been an increase in charcoal production, which is expected to increase with the rapidly growing population in the developing world. This situation is expected to remain unchanged for many decades to come. In particular, the demand for charcoal in most developing countries will continue to grow at high rates owing to the ever-increasing rural-urban migration.(Babalola & Opii, 2012).

LITERATURE REVIEW

Charcoal

Charcoal is the dark grey residue consisting of impure carbon obtained from vegetation substance, and is produced by slow pyrolysis; the heating of wood or other substances in the absence of oxygen. It is also described as a soft, brittle, lightweight, black, and porous material that resembles coal(Aderogba & Adeniyi, 2019). Charcoal burning is probably the oldest chemical process known to man. Commercial charcoal is found in either lump, briquette or extruded forms. The lump charcoal which is the commonest is made directly from hardwood material and usually produces far less ash than briquette. Briquettes are made by compressing charcoal, typically made from sawdust and other wood by-products. Extruded charcoal is made by extruding either raw ground wood or carbonized wood into logs without the use of a binder (Wim *et al.*, 2015).

Factors Influencing the Use of Charcoal by the Households

Studies have shown that charcoal is used for many domestic purposes (Kalu & Izekor, 2007); (Kambewa, 2007); (Babalola, 2011). About 76.7% of the sampled households used charcoal as energy for cooking food and 18.6% used it in ironing of cloth. Other uses of charcoal include roasting of meat (barbeque), maize, yam, plantain, cocoyam, and fish. rank on top of the main reasons for using charcoal by majority of the households was due to its cheaper cost (62.8%) when compare with other domestic energy sources. Other reasons for using charcoal were: ready availability (10.5%), prolong heat (15.1), and not turning pot black unlike firewood (9.3%). Affordability is therefore considered as the main reason why majority of the households use charcoal (Babalola & Opii, 2012).

Socio-economic Implications of Charcoal Production

In a study conducted by (Ajadi *et al.*, 2012) found out that charcoal enterprise is on part-time basis, undertaken as a coping strategy, and the forest is depleting due to uncontrolled and indiscriminate exploitation of mature and nearly-mature trees. On the other hand, (Kalu & Izekor, 2007) maintained that Charcoal enterprise is adopted to meet some socio-economic benefits and energy needs of the people. Therefore, its production would not stop because available alternatives are limited and expensive. In the year 2000, about 67,767,000 cubic metres (2.4 billion cubic feet) of round wood were produced, 85 % for fuel. In the same year, Nigeria's consumption of fuel wood and charcoal was the third highest in Africa (Obadimu *et al.*, 2023). About 70% of Nigerian population live in the rural areas and are directly or indirectly dependent on forest resources– especially wood – to meet both domestic and economic energy needs. The production of Charcoal is one of the activities leading to destruction of forest cover in Nigeria, a situation aggravated by illegal commercial logging. Also between 1990 and 2005, Nigeria lost 35.7% of its forest cover and only 12.2% of the country's land is currently forested while 350,000 hectares of land in the country are lost to desertification annually(Azare *et al.*, 2020).

Alternative Cooking Fuel to Charcoal Used by Households

It was discovered by (Kammen & Lew, 2005) that biomass users prefer charcoal over other biomass fuels such as wood, residues and dung. The alternative cooking fuels to charcoal used by the sampled household were kerosene and firewood. About 46.7% and 40.0% indicated that they sometimes and always respectively use firewood while 69.8% sometimes and 20.9% always use kerosene. On the contrary, 82.6% each and 51.2% of the respondents indicated that they do not use cooking gas and electricity respectively. Charcoal has a higher energy density than other biomass fuels and can be stored without fear of insect problems. It has excellent cooking properties: it burns evenly, for a long time, and can be easily extinguished and reheated. Even in developed countries, such as the US, charcoal is desired for the flavors which it imparts to grilled food (Babalola & Opii, 2012).

Charcoal Production and Consumption in Nigeria

Charcoal and Fuel wood are the most widely used energy sources in Nigeria, they are mostly used for household cooking (Tunde *et al.*, 2013). In terms of charcoal production, Nigeria ranks the highest in Africa and second in the world. There is a steady increase in annual production of charcoal in Nigeria yet Nigeria is not among the world's leading nations in the exporting of charcoal meaning that the nation consumes almost all that it produces. Indonesia, China and Poland led in exportation with 21.8%, 10.6% and 8.8% respectively; Nigeria is the 25th exporting nation with only 0.9% (James *et al.*, 2019). In Nigeria, there is no controlled supply of charcoal in urban areas, and this contributes to deforestation as an increase in population in these areas results to an increase in demand for charcoal. Also

due to the cost of transporting charcoal from the rural areas where it is produced to the urban areas where it is widely consumed there has been a steady increase in its price and this have inhibited the growth of small-scale traders who use wood, such as fish sellers, and has also affected household budgets. Furthermore, the use of wood presently surpasses the re-growth of forests and reforestation efforts have been very poor(James *et al.*, 2019)

The Choice of Charcoal among Nigerians

As reported, charcoal consumption is higher among individual and families that has low income with charcoal and fuel wood accounting for three-quarters of their total household energy expenditure (Kambewa, 2007). In weight, charcoal might be heavy or quite light depending on the weight of the dry wood of the various species used in its production. One of the reasons why several households prefer charcoal to firewood is the fact that transporting charcoal over a long distance is less expensive when compared to firewood and also when compared to firewood it doesn't require much storage space and it can't be easily deteriorated by insects or fungal attack (Faraji *et al.*, 2015).

Housewives prefer charcoal because its fire is very gentle, effective, and easy to manage and does not to be inspected regularly unlike the wood fire which demands constant attention to prevent it from burning out. It is predominantly produced and sold locally and unlike other means of energy such as cooking gas, kerosene and electricity, charcoal is affordable and readily available and does not require any organised distribution network before the end user can access it (Anang *et al.*, 2011). More so, charcoal stoves are produced locally and very affordable compared to electric stove, cooking gas cylinder and kerosene stoves which are costlier. Unlike firewood it is a cleaner and a healthier fuel as it gives away little smoke (and hazardous gases) when burning. Despite all its benefits, the processes involved in its production results in deforestation and global warming thereby immensely contributing to environmental depletion (Anang *et al.*, 2011); (Kammen & Lew, 2005).

Charcoal Production and its Impact on Nigerian Forest

In Nigeria charcoal is mainly produced in the rural areas especially areas close to forests, thereafter, transported to the urban regions. The production is at a sub-industrial level, and it has an adverse effect on the environment locally and globally. It is indicated that from 1990 to 2005, 35.7% of Nigeria's forest cover was lost and approximately 12% of the country's land is presently forested while 350,000 hectares of land is being lost yearly to desertification. The rate of fuel wood and charcoal consumption in Nigeria ranks highest in Africa and this resulted in land degradation threatens biodiversity and accelerate climate change(Azare *et al.*, 2020). The reduction of forest cover also reduces the existing capacity to disintegrate carbon and release the already fixed carbon as many African nations have had over three quarter of their forest cover depleted and lost to inordinate harvest of trees. Charcoal production is very prominent in Benue, Kogi and Niger States of Nigeria where there are guinea belts that support its production. Forests are decimated; economic trees meant for fruit production are felled for charcoal production and farmlands have been used excessively without considering its future implications on the environment. Charcoal business as well as other ventures relating to renewable energy sources is an important part of rural economy, basically because domestic energy consumption is a very important aspect of the economies of most developing Africa nations. However, there is a limit to the usage of other forms of renewable energy sources because of inadequate technological development (Kalu & Izekor, 2007). To earn more living among rural poor, charcoal production has been considered a lucrative business, prompted by free access to forest resources, until such forest area is being depleted. The major shift in the use of household energy particularly with charcoal, led to the intervention of 'Abacha Coal Pot', over the years which became widely accepted and used (Ekhuemelo *et al.*, 2017)

Problems Associated with Charcoal Production and Utilisation

Charcoal production in Nigeria results in different forms of problems some of which are environmental pollution arising from smoke, deforestation because of tree harvest and erosion which exposes the soil to direct sunshine, it also leads to reduction in the soil fertility and health problems to people around the production site (Ajadi *et al.*, 2012). Due to the steady increase in the demand for charcoal because of different industrial revolutions and urbanization, production of charcoal has been largely carried out with an unsustainable approach (James *et al.*, 2019).

MATERIALS AND METHODS

Area of Study

This study was carried out in Makurdi Local Government Area (LGA) of Benue State. Apart from its status as the Headquarters of Makurdi LGA, Makurdi town also doubles as the state capital. The local government area is situated between latitude 6o 22' and7o 56' to the North and longitude 7o37' and 9o5' East and has a total area of 325km2 (Tee *et al.*, 2009). In 2006, the population of the inhabitants was estimated to be 297,398 people comprising of 157,295 males and 140,103 females. The LGA is made up of 11 council wards. The primary occupations of the traditional inhabitants of Makurdi LGA were fishing and farming, and the settlers' civil servants and traders (Babalola, 2019).

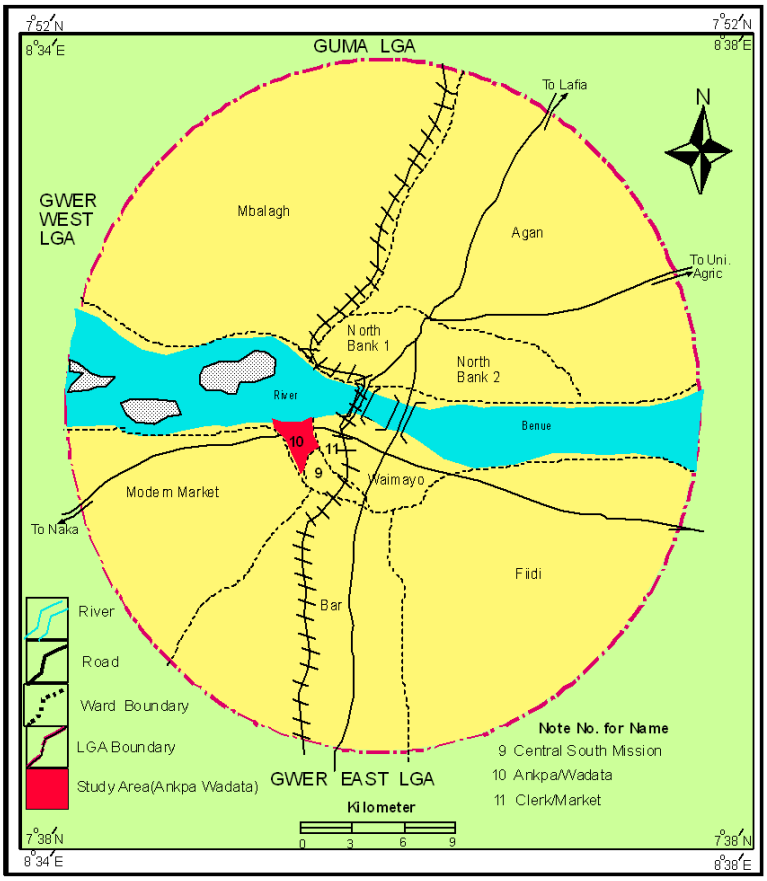

Figure 1: Location of the study area on Map of Makurdi Local Government Area
(Songu et al., 2015)

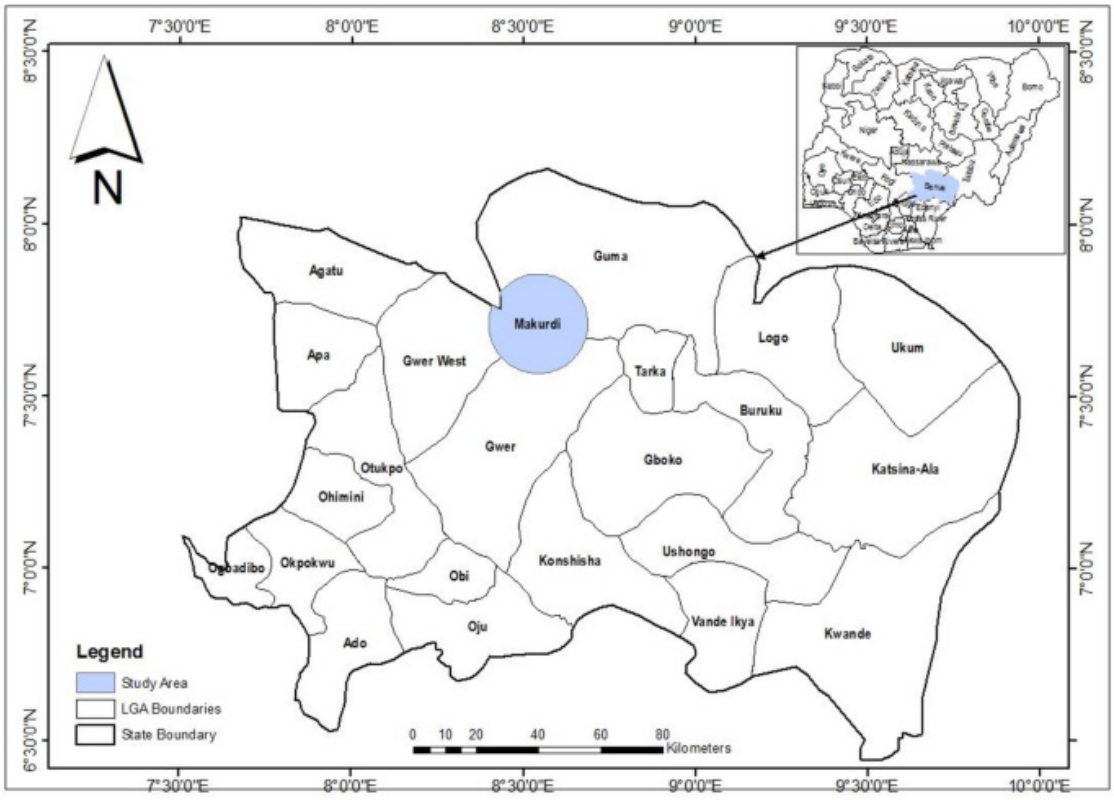

Figure 2: Map of Benue State showing Makurdi Local Government Area
(Adzande, 2023)

Vegetation and Climate

The climate of Makurdi has two distinct seasons which are wet and dry seasons. The wet season lasts for seven months, starting from April and ends in October. Temperature ranges are generally very high during the day, particularly in March and April. Along the river valleys, there is high temperature plus high relative humidity. Makurdi the state capital records average maximum and minimum daily temperature of 350C and 290C at dry season and 320C and 240C at rainy season respectively. Benue state lies in the Southern Guinea Savanna. Persistent clearing of vegetation has led to the development of re-growth vegetation at various levels of serial development, but more important park lands with grasses deal for animal grazing during their early growth. The grasses however grow very tall, coarse and tough on maturity. The scattered trees are mainly those of locust bean, shear butter, mango, silk cotton, African iron, cashew, oil palm, Daniellia oliveri and Gmelina arborea, amongst others (Tee *et al.*, 2009).

Data Collection

Five council wards were selected purposively for data collection. The selected wards are noted for having large quantities of charcoal and consumers almost all year round. The wards selected are Agan, Fiidi, Wadata, Modern market and North-Bank. From each of these council wards, 20 respondents were drawn applying a random sampling technique. A total of 100 respondents were selected and interviewed using a pre-tested checklist (questionnaire) to collect primary data. Simple descriptive statistics was used in analyses of the variables studied using statistics analysis software. Frequencies and percentages were used to analyze charcoal utilization.

RESULTS AND DISCUSSION

Socioeconomic Characteristics

The results in figure 3 shows that the respondents in Fiidi Council Ward had 23% which is the highest percentage of charcoal usage as a source of fuel and Agan Council Ward had the lowest charcoal usage of 17%. The result

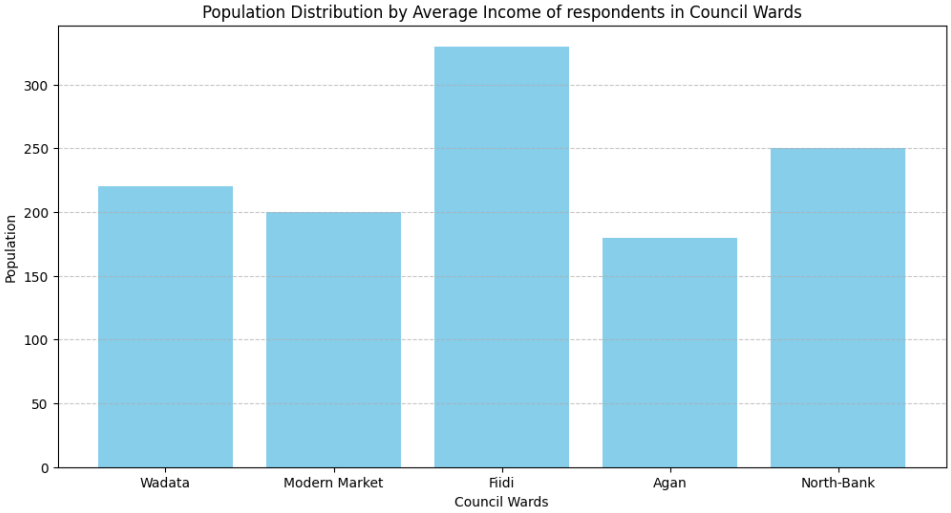

Figure 3: Population distribution by average income of respondents in council wards in Makurdi
Source: Field survey

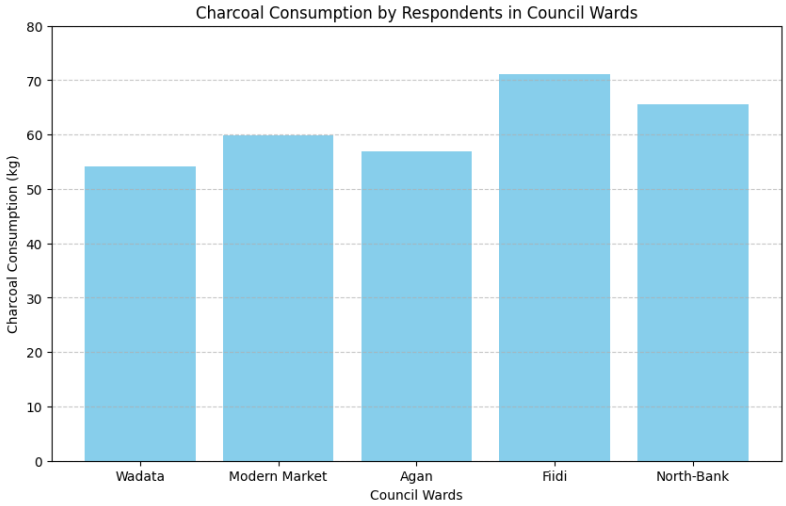

Figure 4: Average charcoal consumption by respondents in study areas in Makurdi
Source: Field survey

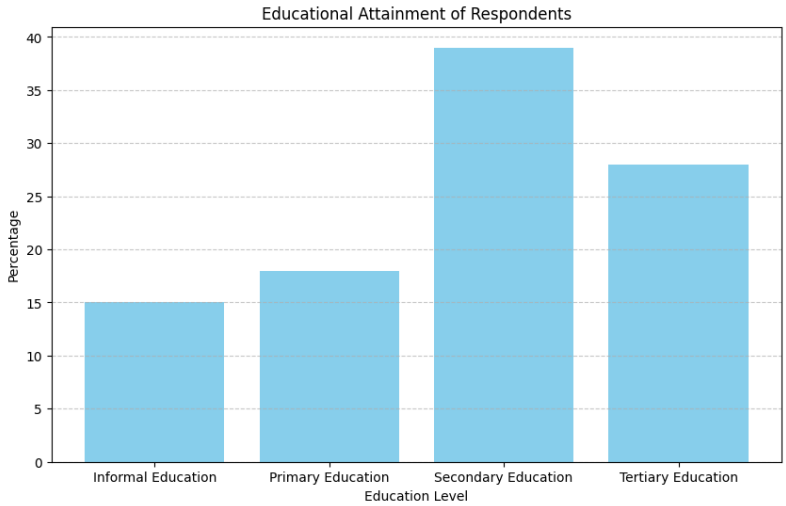

Figure 5: Average charcoal consumption by respondents in study areas in Makurdi
Source: Field survey

(Figure 2) shows that Fiidi council ward has the 71% being the highest and Wadata having the lowest of 54%. However, there is an even distribution charcoal consumption across the council wards. The economic activities undertaken in the household is a very strong factor that affects household charcoal use. The amount spent in buying charcoal may affects the family financially in one way of the other. Figure 5 shows that 39 percent attained secondary education whereas only 15 percent have no formal education. This implies that a greater number of the head of respondent are well learned and enlightened. It also important because the educational status determines the level at which the respondent is informed. This variable is closely related to social status, income, household size, eating habit, and type of food consumed. All these can trigger fuel switching to charcoal, as well as the quality of charcoal that is needed in the household (Ogwuche, 2012).

Charcoal Usage for Household Cooking

Results in Table 6 indicate that 88% of respondents use charcoal for household cooking while just 12% of the respondents useable 6 indicate that 88% of respondents use charcoal for household cooking while just 12% of the respondents use other sources of fuel for house household cooking. From Figure 6, all 5 sampled council wards in the Makurdi metropolis use charcoal as the main household cooking energy. This study work agrees with the work of (D. O. Ekhuemelo *et al.*, 2019), which reveals charcoal as a source of energy for cooking in Makurdi and Guma Local Government Area as well as a source of income for dwellers to meet family needs such as feeding, paying school fees and other needs. This finding agreed with (Tunde *et al.*, 2013) who reported that charcoal production had important aspect of the positive impact on the lives of the consumers since it improves their wellbeing and hence reduce their poverty situation.

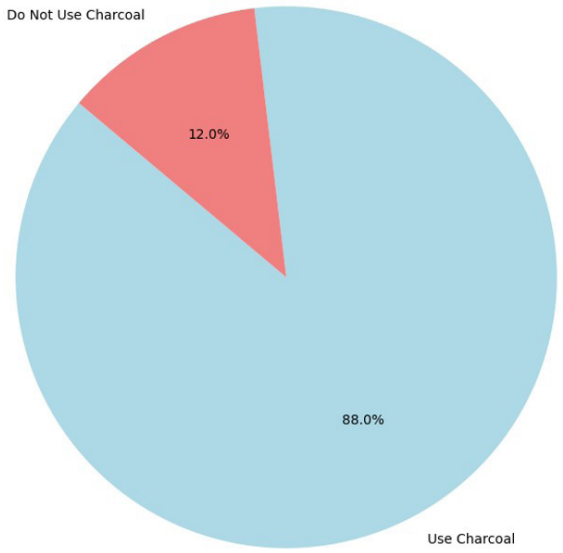

Figure 6: Charcoal usage by respondents for daily household cooking

Tree Species used for Charcoal Production

The results in the table 1 and figure 7 below indicates that *Prosopis africana* is the frequently used tree species with the frequency of 83.5 percent and Khaya Senegalensis is the least used tree species with frequency of 0.8% This also shows the tree species used for charcoal production in Makurdi metropolis. *Prosopis africana* is the highest used with 83.5% then *Vitellaria paradoxa* with 7.9%.

The use of *Prosopis africana* for charcoal production also agrees with the work of (D. O. Ekhuemelo *et al.*, 2019) on the massive exploitation of the tree species (Prosopis africana). This finding also agrees with (Adeniji *et al.*, 2015) and (D. Ekhuemelo *et al.*, 2017) who in their respective studies found *Prosopis africana* to be most preferred in charcoal production. *Prosopis africana* is a multipurpose tree and is currently threatened and need to be conserved.

Table 1: Tree species used for Charcoal production by respondents

Tree species	**%**
Prosopis Africana	83.5
Vitellaria paradoxa	7.9
Parkia biglobosa	4.7
Daniella oliveri	1.6
Burkia Africana	1.6
Khaya senegalensis	0.8
Total	**100**

Field survey

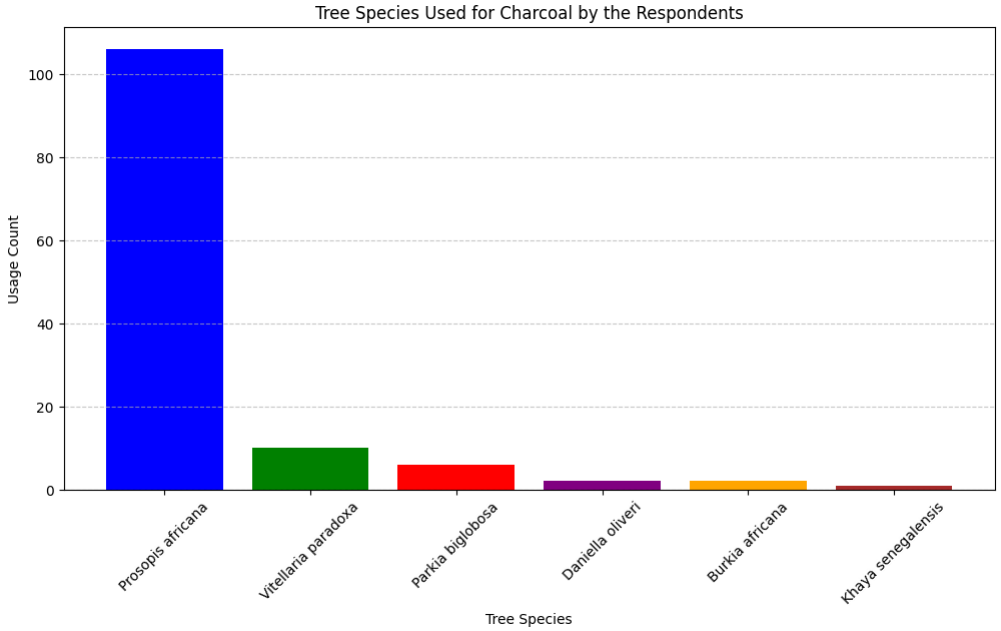

Figure 7: Tree species used for charcoal production by respondents
Source: Field survey

Reasons for Preference of Charcoal to Other Cooking Energy Sources

Figure 8 below indicates that affordability of charcoal is the main reason why respondents prefer charcoal to other cooking energy sources. The results showed that 88% of respondent in Makurdi prefer charcoal for cooking in providing food for the family because of its low price compared to other cooking energy source (Figure 8) The data showed that higher percentage of people in Makurdi metropolis prefer using charcoal to other household energy sources. This agrees with the work of (Izekor & Amiandamhen, 2017), (Kambewa, 2007) and (Babalola, 2011) which in their research also showed that 76.7% of households used charcoal as energy for cooking food and rank on top of their main reasons for using charcoal by majority of the households was due to its cheaper cost (62.8%) when compare with other domestic energy sources. Therefore, Affordability is considered as the main reason why majority of the households use charcoal.

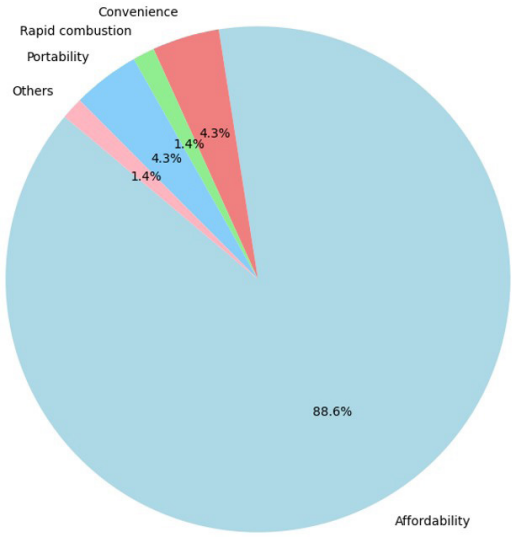

Figure 8: Reasons for preference of charcoal by respondents

CONCLUSION

There has been a drastic increase in the utilization of charcoal as a source of energy for cooking in Makurdi metropolis due to the incessant rise in price of alternative sources of energy, thereby making charcoal the best affordable alternative for the populace. The populace prefers charcoal made from *Prosopis africana* trees. However, this directly impact on forest tree species from which charcoal is produced. Thus, continuous use of forest trees poses a threat to the future of our forest estate and biodiversity. The higher the supply of charcoal to this increasing demand in the metropolis entails increasing level of deforestation leading to land degradation, endangering of species and enhancement of global warming.

Sequel to the findings that has been made in this study, the following recommendations are therefore proposed

- Alternative sources of energy should be encourage for household fuel to ease the pressure on charcoal
- Stakeholders should intervene in the incessant rise in price of other household sources of energy such as kerosene, natural liquid gas, electricity to prevent extreme environmental occurrences.
- Sustainable approaches such as planting of more trees should be implored if charcoal production increases.

REFERENCES

Adebayo, O. O., & Adeola, R. G. (2008). Sources and Uses of Agricultural Credit by Small Scale Farmers in Surulere Local Government Area of Oyo State. *The Anthropologist, 10*(4), 313–314. https://doi.org/10.1080/09720073.2008.11891069

Adeniji, O. A., Zaccheaus, O. S., Ojo, B. S., & Adedeji, A. S. (2015). Charcoal Production and Producers' Tree Species Preference in Borgu Local Government Area of Niger State, Nigeria. *Journal of Energy Technologies and Policy, 5*(11). https://core.ac.uk/download/pdf/234668142.pdf

Aderogba, K. A., & Adeniyi, K. A. (2019). Charcoal Production and Energy Resources in Western Nigeria: Issues and Challenges for Sustainable Development. *Savanna Journal of Basic and Applied Sciences, 1*(1)), 111–120. http://www.sjbas.com.ng

Adzande, P. (2023). Socio-spatial structure of urban communities and the distribution of crime in Makurdi, Nigeria. Security Journal. https://doi.org/10.1057/s41284-023-00397-y

Ajadi, K. O., Alabi, F. M., & Adebisi, J. A. (2012). Subsistence Living and Global Climate Change: Implications of Biocharcoal Production for Farmers in Rural Areas of Nigeria. *Ethiopian Journal of Environmental Studies and Management, 5*(1), Article 1. https://doi.org/10.4314/ejesm.v5i1.8

Anang, B. T., Akuriba, M. A., & Alerigesane, A. A. (2011). Charcoal production in Gushegu District, Northern Region, Ghana: Lessons for sustainable forest management. *International Journal of Environmental Sciences, 1*(7). https://shorturl.at/jnQ01

Azare, I. M., Abdullahi, M. S., Adebayo, A. A., Dantata, I. J., & Duala, T. (2020). Deforestation, desert encroachment, climate change and agricultural production in the Sudano-Sahelian Region of Nigeria. *Journal of Applied Sciences and Environmental Management, 24*(1), Article 1. https://doi.org/10.4314/jasem.v24i1.18

Babalola, F. (2011). Domestic Energy Carriers and Consumption Pattern: implications of Biomass Energy on Household Welfare in Rural and Urban Households. *Mediterranean Journal of Biofuels and Bioenergy, 1*.

Babalola, F., & Opii, E. (2012). Factors influencing consumption of charcoal as household energy in Benue State, Nigeria. *International Journal of Organic Agriculture Research and Development, 6,* 68–81.

Ekhuemelo, D. O., Agbidye, F. S., Anyam, J. V., Ekhuemelo, C., & Igoli, J. O. (2019). Antifungal Activity of Compounds obtained from Sawdust and Stem Bark of Sasswood Tree (Erythrophleum suaveolens) on Wood Rot Fungi. *Journal of Applied Sciences and Environmental Management, 23*(9), Article 9. https://doi.org/10.4314/jasem.v23i9.13

Ekhuemelo, D., Tsembe, J., & Amonum, J. (2017). Investigation of Charcoal Production in Gwer West and Gwer East Local Government Areas of Benue State, Nigeria. *Asian Journal of Environment & Ecology, 3*(1), 1–13. https://doi.org/10.9734/AJEE/2017/34362

Faraji, N., Msalilwa, U., Mbwambo, L., & Balama, C. (2015). Assessment of household charcoal consumption in urban areas: The case of Dar es Salaam City, Tanzania. *Tanzania Journal of Forestry and Nature Conservation, 84*(2), Article 2. https://www.ajol.info/index.php/tjfnc/article/view/140809

Gbiri, I. A., & Adeoye, N. O. (2019). Analysis of Pattern and Extent of Deforestation in Akure Forest Reserve, Ondo State, Nigeria. *Journal of Environmental Geography, 12*(1–2), Article 1–2. https://doi.org/10.2478/jengeo-2019-0001

Izekor, D., & Amiandamhen, S. (2017). Utilization of fuelwood as household energy among residents of Benin metropolis, Edo State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment, 13*(2), 174–178. https://urn.kb.se/resolve?urn=urn:nbn:se:lnu:diva-81160

Jamala, G. Y., Shehu, H. E., Yidau, J. J., & Joel, L. (2013). Factors Influencing Adoption of Agro-Forestry among Smallholder Farmers in Toungo, Southeastern, Adamawa State, Nigeria. *IOSR Journal Of Environmental Science, Toxicology And Food Technology, 6*(6), 66–72. https://doi.org/10.9790/2402-0666672

James, R., Egbewole, Z., Adeagbo, A., & Blessing, O. (2019). Effect of Indiscriminate Charcoal Production on Nigeria Forest Estate. *International Journal of Environmental Protection and Policy, 7,* 134–139. https://doi.org/10.11648/j.ijepp.20190706.12

Kalu, C., & Izekor, D. N. (2007). Charcoal Enterprise

in Benin City, Edo State, Nigeria. *Journal of Applied Sciences and Environmental Management, 11*(3), Article 3. https://doi.org/10.4314/jasem.v11i3.55104

Kambewa, P. (2007). Charcoal--the Reality: A Study of Charcoal Consumption, Trade, and Production in Malawi. IIED.

Kammen, D., & Lew, D. (2005). Review of Technologies for the Production and Use of Charcoal. Renewable and Appropriate Energy Laboratory Report, Energy and Resources Group & Goldman School of Public Policy.

Obadimu, O. O., Azeez, F. A., Bolaji-Olutunji, K. A., & Awe, F. (2023). An Investigation Into The Socio-Demographic determinants of charcoal production in oyo state and the need for its discontinuation. *Journal of Agribusiness and Rural Development, 70*(4), Article 4. https://doi.org/10.17306/J.JARD.2023.01658

Ogwuche, J. (2012). Access to physical capital as a panacea to urban poverty reduction: A case study of Otukpo urban area of Benue state, Nigeria. *Global Advanced Research Journal of Social Science (GARJSS), 1*(4), 077-082,. http://garj.org/garjss/index.htm

Ortserga, D. S., Dam, D. P., Kile, T. I., Ujoh, F., & Gyuse, T. T. (2019). Intensification Of Arable Agricultural Land Use As A Response To Changing Agro-Ecological Context In The Benue Basin, Nigeria. *Advances in Social Sciences Research Journal, 6*(2). https://doi.org/10.14738/assrj.62.5906

Songu, G. A., Oyatayo, K. T., & Iorkua, S. A. (2015). Impact of Gully Erosion Stream Sedimentation in Demepke Drainage Basin. *American Journal of Water Resources, 3*(4), Article 4. https://doi.org/10.12691/ajwr-3-4-1

Tee, N. T., Ancha P. U, & Asue, J. (2009, July 7). Evaluation of fuelwood consumption and implications on the environment: Case study of Makurdi area in Benue state, Nigeria [Www.biosciences.elewa.org]. ISSN 1997–5902. https://m.elewa.org/JABS/2009/19/2.pdf

Tunde, A. M., Adeleke, E. A., & Adeniyi, E. E. (2013). Impact of Charcoal Production on the Sustainable Development of Asa Local Government Area, Kwara State, Nigeria. *African Research Review, 7*(2), Article 2. https://doi.org/10.4314/afrrev.v7i2.1

Wim, V. S., Sascha, K., & Wolfang, P. (Eds.). (2015). Biomass Power for the World—Google Books (Vol. 6). Taylor & Francis. https://shorturl.at/bfn27

Zaku, S. G., Kabir, A., Tukur, A. A., & Jimento, I. G. (2013). Wood fuel consumption in Nigeria and the energy ladder: A review of fuel wood use in Kaduna State. *Journal of Petroleum Technology and Alternative Fuels, 4*(5), 85-89, https://doi.org/10.5897/JPTAF 12.023