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Charcoal production: A promoter of deforestation in Nigeria

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ABSTRACT

Charcoal production in Nigeria is a growing source of concern for government and forestry institutions because of its perceived impact on the environment. The agreed impact is deforestation, i.e., the clearance of indiscriminate cutting of forest trees. Forest degradation associated with charcoal production is difficult to monitor and overlooked and under-represented in forest cover change and carbon emission estimates. Emissions of greenhouse gases as a consequence of deforestation from charcoal production in tropical ecosystems in 2009 are estimated at 71.2 million t for carbon dioxide and 1.3 million t for methane. Trees used for charcoal production are *Vitellaria paradoxa*, *Ficus sur*, *Tectona grandis*, *Khaya ivorensis*, *Bombax buonopozense*, just to mention a few. This review aims to further discredit the act of indiscriminate forest tree falling for charcoal production which have proofed by various works as a promoter of deforestation.

Keywords: Deforestation, Charcoal production, Forest degradation, greenhouse gases, Tree plant, *Vitellaria paradoxa*, *Ficus sur*, *Tectona grandis*, *Khaya ivorensis*, *Bombax buonopozense*

1. INTRODUCTION

Charcoal is a fuel produced by carbonization of biomass. Although investment in charcoal production from forest plantations is increasing in tropical regions, mostly, biomass for charcoal production is obtained from natural forests in which natural regeneration is the main source of forest recovery. Charcoal is a key source of energy in African urban centers, where 80% percent of the population uses it as the main source of energy for cooking (Zulu and Richardson, 2013). Population projections show an unprecedented increase in the urban

population in African cities, increasing from 30% in 2000 to reach 60% by year 2050 (Boko *et al.*, 2007; Montgomery, 2008, UN-HABITAT, 2010). The energy needs of the growing urban population will pose an increasing pressure on forest resources of rural areas (Barnes *et al.*, 2004; Arnold *et al.*, 2006; Grimm *et al.*, 2008).

In many Sub-Saharan Africa, there is low energy consumption among household and in many other developing countries and this makes them too dependent upon wood fuels for their energy requirements (Arnold and Persson, 2005). The growing demand for charcoal in these countries has resulted in localized deforestation in vulnerable areas. The problem of fuel in Nigeria is becoming unbearable, resulting in constant deforestation to meet domestic needs.

Deforestation and forest degradation are the principal causes of forest cover change and account for a large proportion of global carbon emissions (Achard *et al.*, 2007; van der Werf *et al.*, 2009). Deforestation, defined as the long-term or permanent conversion of land from forest use to other non-forest uses (GOFCEGOLD, 2009), represents an abrupt and rapid change in land cover. Population projections show an unprecedented increase in the urban population in African cities, increasing from 30% in 2000 to reach 60% by year 2050 (Boko *et al.*, 2007; Montgomery, 2008; UN-HABITAT, 2010).

The energy needs of the growing urban population will pose an increasing pressure on forest resources of rural areas (Barnes *et al.*, 2004; Arnold *et al.*, 2006; Grimm *et al.*, 2008). The charcoal sector in Africa is weakened by a lack of reliable information, because a very small fraction of charcoal produced is assessed and recorded.

Therefore, the actual magnitude of use and impacts on forest degradation or rural livelihoods has been a subject of debate (Zulu, 2013). The attempt to capture the impact of charcoal production on deforestation in Africa has been addressed by many scholars (Chidumaya and Gumbo, 2013). In Tanzania, charcoal production accounted for 30,000 ha per year of degraded closed woodland in 2005 and 2006 (Abdallah and Monela, 2007; Schafsma *et al.*, 2012). In Malawi, about 15,000 ha of forest have been cut down yearly due to charcoal production (Kambewa *et al.*, 2007).

This paper reviews traditional charcoal production methods and assesses this process from a deforestation view point. We base the paper on a literature review; it seeks to provide a broader perspective of the concerns surrounding charcoal production in Nigeria.

2. IMPACT OF CHARCOAL PRODUCTION ON DEFORESTATION

Deforestation is the clearing up of forest areas and converting them to other purposes, like Agriculture, Urbanization and wood-fuel which includes charcoal production. This charcoal production contributes to deforestation for the main source of charcoal production are trees and to produce charcoal trees must be cut down.

About 31% of the world land surface is covered by forest, while in Nigeria it falls from 16.6% in 1996 to 7.7% in 2015. According to Food and Agricultural Organization of United Nations as of 2005, Nigeria has the highest deforestation rate in the world at 12.2% equivalent of 11,089,000 hectares had been deforested between (2000 to 2005). The link between charcoal production and deforestation have been demonstrated by several studies since the early 90s, and this linkage is due to fact that deforestation frequently occurs in the areas with intense charcoal production (Mwampamba *et al.*, 2013).

The common reason is that deforestation was always a result of agricultural expansion and logging. The need for new agricultural lands causes more damage than the charcoal production itself. Charcoal production is considered as merely a by-product of the deforestation process [French, 1986; Combes *et al.*, 2009]. Michael Daley, associate professor of environmental science at Lasell College in Newton, Massachusetts, the number one major problem caused by deforestation is the impact on the global carbon cycle, when these trees are being cut down, those carbon they supposed to absorb as food through photosynthesis process will be trapped in the atmosphere and this contributes to the increases on carbon dioxide accumulated in the atmosphere. Moreover, there are more emission also created when felled trees release the carbon they had been storing and rot or burn on the forest floor, so not only that these trees act as carbon dioxide mitigation but cutting them down also increases carbon dioxide emission through carbon cycle process. Forests make up about 30% of total land cover and are of incredible value to the life on earth, they are carbon bank and play very important role in climate control, climate mitigation and effects of global warming, also act as watershed and with many raw materials that human depends on joined with the bio-diversities they contain. Trees lower temperature through transpiration of water and shading of surface and also reduce heat sink while carbon dioxide makes trees healthier, which in turn serve as climate change mitigation which are major cause of global warming.

In almost all countries where charcoal is produced, there have been reports highlighting concern about deforestation and forest degradation that accompanies the production process (Hofstad *et al.*, 2009). Forest degradation refers to less obvious changes in the woody canopy cover while deforestation is the more or less complete loss of forest cover that is often associated with forest clearance (Grainger, 1999). Degradation therefore represents the temporary or permanent reduction in the density, structure, species composition or productivity of vegetation cover. The most predominant species used for charcoal production in Nigeria are Teak and Shea tree, as shown in **Table 1**; the local communities do not use Eucalyptus spp. for charcoal production, in the areas where the preferred trees are scarce, several fruit trees are used to produce charcoal. Therefore, it is recommended that Eucalyptus could be an alternative tree for afforestation plans to curb deforestation.

Table 1. Tree name and species used for Charcoal production in Nigeria

Tree name	Species	Family
Shea Tree	<i>Vitellaria paradoxa</i>	Sapotaceae
Bush Fig Tree	<i>Ficus sur</i>	Moraceae
Kapok Tree	<i>Bombax buonopozense</i>	Bombacaceae
Mahogany	<i>Khaya ivorensis</i>	Meliaceae
Teak	<i>Tectona grandis</i>	Verbenaceae

Source: Fieldwork 2019.

3. GREENHOUSE GASES EMISSION AS BYPRODUCT OF DEFORESTATION: THE ROLE OF CHARCOAL

Charcoal from most earth-based kilns is produced in an oxygen-poor environment that results in the formation of products of incomplete combustion, such as methane. Charcoal production therefore affects global warming through the production and emission of greenhouse gases, such as carbon dioxide (CO₂) and methane (CH₄). Although carbon monoxide is one of the products of incomplete combustion during charcoal making, it is not listed as a greenhouse gas by the IPCC as it is considered being short-lived in the atmosphere (IPCC, 2007). Kammen and Lew (2005) have shown that emissions during charcoal production have a greater global warming contribution than emissions from charcoal burning. The emission factors for charcoal production have been calculated in a number of studies (Adam, 2009; Akagi *et al.*, 2010; Pennise *et al.*, 2001; Smith *et al.*, 1999; Ward *et al.*, 1999). To calculate emission quantities from charcoal production in tropical ecosystems, we used FAO estimates of wood-charcoal production in 2009 available at www.fao.org/faostat. The values represented in **Table 2** are the values of carbon emissions in Nigeria between 1960 and 2014. Charcoal-based energy demand has been identified as a mechanism of forest cover change in Africa (Hosonuma *et al.*, 2012; Siteo *et al.*, 2016). The emissions associated with this mechanism represent a key component of the large CO₂ emissions and emission uncertainties at the continental level (Ciais *et al.*, 2011).

Table 2. Nigeria carbon Emission from 1960-2014

Year	Carbon dioxide emission (kt)
2014	96,280.0
2010	91,517.3
2005	106,068.0
2000	76,057.2
1995	35,841.3
1990	39,196.6
1985	69,893.0
1980	68,154.9
1975	47,396.0
1970	21,540.0
1965	11,763.7
1960	3,406.6

Source : Worldbank

4. POPULATION GROWTH AND ECONOMIC GROWTH: MAJOR FACTORS LIMITING CHARCOAL FUEL TRENDS

The key factors that affect the outlook of demand and supply include the current state of forest resources and their uses are population and income. Each of these factors affects both, demand and supply of wood. It should be recognized that these factors differ in their effects on demand for fuelwood and demand for round wood, although factors such as population growth and economic growth are important for both. The demand for industrial roundwood is derived from the demand for forest products. Therefore, an understanding of the dynamics of the supply and demand process of these markets can be brought to operation in understanding future developments for this component of wood demand and supply. This situation is contrary to the fuelwood demand structure and the process of supply is quite different from those four industrial products. Three billion people depend on wood to meet basic energy needs and much of the production of fuelwood is based on gathering from forests and scattered trees by individual households which promote forest degradation.

Population growth has historically been a major factor influencing wood consumption, and it is not likely that the close relationship between population growth and growth in consumption will change significantly in the foreseeable future. The world population increased from 2.4 billion people in 1950 to 5.5 billion people in the mid-1990s. The world population grew at a rate of 2.0% per year in the early 1970s and is currently increasing at a rate of 1.7% per year.

On a *per capita* basis, world consumption of timber, both fuelwood and industrial roundwood, declined slightly over the past four decades to 0.6 m³ per person from 0.7 m³ per person (Brooks *et al.*, 1996). There has been changes in patterns of consumption (among developing and developed countries) and in the composition between fuelwood and industrial round wood, and among industrial products), but the net result has been little change in global per capita consumption.

Economic growth also have a particular impact on the demand for fuelwood, because the marginal propensity to increase consumption of commercial energy in developing countries is very high and the highest among the poorest countries with currently high dependence on wood and biomass. The strong preference for convenience, efficiency and cleanliness in cooking and heating fuel may be expected to lead to the substitution of commercial fuels as income rises. Energy is of particular importance in the context of wood demand as it constitutes both, a basic need for human civilization and an essential component in economic activity and development.

As already noted, charcoal production contributes to deforestation through the growing demand for wood biomass energy (Defries *et al.*, 2010) as well as through fragmentation of habitats and forest degradation at the local level (Nellemann and Corcoran, 2010). Over the years, charcoal production has contributed to the loss of resilience in tropical forest ecosystems (Thompson *et al.*, 2009).

Further, the value of total forest removals is increasingly being questioned while values of the contribution of employment and services have been further marginalized (FAO, 2010b). Also affected are market based mechanisms for the promotion of the forest sector e.g., eco-tourism, sale of certified forest products, payments for environment services (Crowe and Ten Kate, 2010).

Charcoal making has been viewed as a leakage under REDD+ mechanisms, thereby affecting any co-benefits that may be realized from such schemes (UNFCCC, 2010).



Fig. 1. Processes of charcoal production by traditional earth kiln. Upper images (II) show the process of log piling into clamp, and the lower left image (III) shows covering of the clamp with dung and soil lumps, while the lower right image (V) shows the harvesting of charcoal and packaging it into bags. The steps number (I, IV) is not represented in this figure.

Recommendations

- Since it could be difficult to completely eradicate tree felling for charcoal production due to the given the prevailing poverty rate in Nigeria, government should enforce tree planting policies to encourage afforestation.
- Public enlightenment and awareness should be carried out to educate the general public on the importance of agro-forestry. Forest and environmental conservation should be embarked upon by all tiers of government.
- Government should monitor tree cutters so as to ensure that not just single species of tree is being cut down. This will help to prevent the extinction of such endangered species

- Forestry research organizations should be funded for more sustainable research into the reduction of growth years of indigenous trees for a faster regeneration.
- Mechanisms for methane capture should be developed and adopted so as to collect the emissions during charcoal production process. This gas can be used to generate energy while protecting the environment from pollution and global warming.
- The charcoal producers through their associations should embark on a vast tree planting project and reduce dependence on natural forest degradation to protect the forest regions.

5. CONCLUSION

Due to a high demand for cleaner energy, the demand for charcoal has extended from national to international market. This has further increased the dangers of deforestation in the country. It has been established that Charcoal production is a driver of deforestation around the world; hence to curb this disaster, prohibition of charcoal production from unauthorized felling of trees must be enforced.

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