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The environmental trail of the global charcoal supply chain

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Charcoal production in a forest in Tekirdag, Turkey.

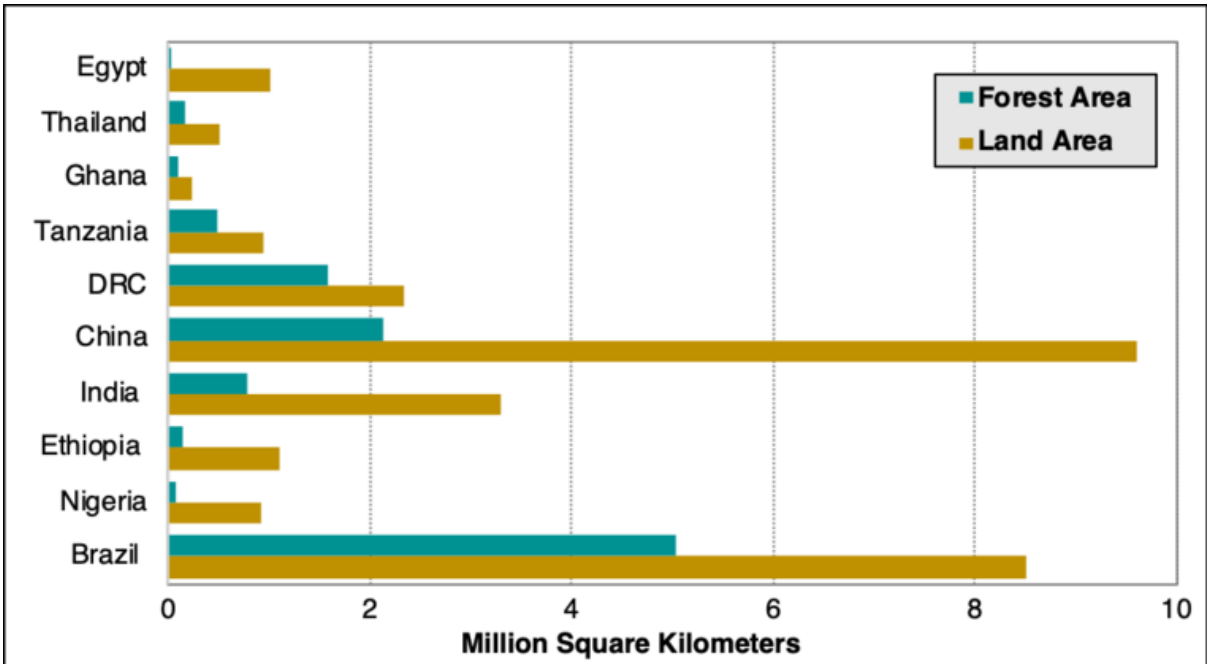
Decades after the invention of electricity and significant investments in its generation around the world, one would expect a consequential decline in the demand and usage of traditional sources of energy such as charcoal, which are directly obtained from forest resources.

However, our research shows that in some African economies, charcoal demand continues to surpass demand for electricity in cooking even where grid connections are prevalent. In some major cities, including Kampala, people still use charcoal as the default fuel for cooking, preferring to use electricity for overhead lighting, entertainment and light tasks such as ironing. Moreover, In Europe and North America, where charcoal demand is less conspicuous, this energy source is still remarkably relevant as an imported fuel for leisure activities, such as barbecues.

Over the past two decades, global charcoal production has increased from 37 million tons in 2000 to 51.2 million tons in 2017. Regrettably, some of the world's top charcoal producers, in particular Egypt, Ethiopia and Nigeria, do not have vast forest resources in relation to their total land area (see Figure 1 below). This supply chain is sustained in part by global demand for this fuel.

Why the higher rate of consumption? For one, consumers have limited information about the sources of raw materials and production practices. Secondly, there is limited awareness

of charcoal's side effects, such as the release of carbon monoxide and its direct link to high mortality, especially in sub-Saharan Africa, where indoor cooking is still rampant.



Why significant forest loss from charcoal production has persisted

As with many forest-based commodities, production of charcoal involves intensive tree felling upstream. What makes this supply chain unique is that pyrolysis, the high-temperature transformation of logs under low-oxygen conditions to produce charcoal, is mostly rudimentary, and in many sub-Saharan countries involves setting open fires in earth-mound kilns within forested regions, thereby increasing risks of wildfires.

Moreover, there is limited tracking and documentation of the amount of vegetation withdrawn because trees are cut sporadically on private land, and material inputs are not measured.

Whereas many supply chains are embarking on the noble and worthwhile challenge of forest preservation to reduce the impact of forest loss caused by the demand for paper packaging for their products, for example through certifications and forest protection easements on private land, such practices are unfortunately not commonly applied in the charcoal supply chain, for various reasons:
First, we found that many producers of charcoal in sub-Saharan Africa are nomadic, because the process does not require sophisticated stationary infrastructure (Figure 2). Producers turn trees into charcoal near the place where the trees grew and then move on to search for new vegetation.

Because producers do not necessarily have legal ownership of the land where tree felling and production occur, they feel a limited obligation to plant new trees or preserve forests, as this duty normally falls on landowners. Landowners might permit charcoal burning in order to repurpose land for commercial agriculture or as entrepreneurs that maintain sole ownership of the charcoal for downstream trade.

Charcoal production site in the forested region of the Nwoya district in Uganda, East Africa.

Secondly, the charcoal supply chain is mostly informal, with limited documentation or tracking of raw materials and inventory. This means consumers are not informed about the nature and source of the charcoal they purchase in final markets.

According to the World Wildlife Fund (WWF), there are significant gaps in knowledge about the precise origin of trees that supply charcoal in the international market place, although some WWF findings indicate that "barbecue fuel" in Germany is sourced from Poland, Nigeria and other tropical rainforests.

Logging and production may be illegal where trees are sourced, and yet, in the informal marketplace, barcoding for this product is nonexistent to support raw-material and product tracking for sustainability efforts.

More innovation is needed at the cooking level (opportunities for cleaner and low-cost cooking)

Charcoal production is inherently problematic because pyrolysis releases dangerous gases, including methane, carbon dioxide and carbon monoxide, thereby affecting air quality around the rudimentary earth-mound kilns.

Moreover, the significant loss of vegetation at production sites also means fewer trees are left to capture and sequester carbon dioxide from the atmosphere. With high randomness in producers' skill and tree varieties used to make charcoal, poor pyrolysis is common, leading to substandard wood waste abandoned at the sites and low quality of charcoal, especially when logs have high sap content.

The side effects of poor-quality charcoal are more distinct on the consumption side. Charcoal used extensively for cooking produces fumes and smoke (Figure 3), causing users discomfort through eye irritation and coughing, and creating risks through inhalation of loose dust (particulate matter) and the lethal carbon monoxide. Charcoal in the presence of modern alternatives

Charcoal's unyielding presence as a commodity in local and international markets mostly can be attributed to affordability when compared to modern alternatives, such as electricity and gas. We found that a typical sack of charcoal (71-94 inches tall) costs between $17-23 in African urban centers such as Kampala; and this amount can last up to a month.

Cooking with biomass and basic materials in Kikumbi, Mityana District, Uganda.

By contrast, the local electricity tariff for domestic use is $0.068 per kilowatt-hour, and the total cost of cooking tends to be higher depending on food types and length of time it takes to prepare food.

The overall usage rate for both energy alternatives, which determines final cost to consumers, usually depends on variables such as family size and the amount of time spent cooking, which is sometimes determined by the type of food.
Nonetheless, costs incurred in cooking depend on various situations, and consumers' fuel choices also can be determined by the amount of disposable income. In other cases, charcoal is favorably linked to the taste of food, compared to the more convenient alternatives, which means that consumers that can afford to pay for electricity in these economies still opt to use charcoal.

Conclusion

Addressing the fundamental issue of forest degradation in tropical regions, as well as developing strategies for universal access to electricity, especially in sub-Saharan Africa, requires a strong fact-based understanding of charcoal — both as an energy source and as a commodity that aggressively competes with modern electricity.

Energy investment strategies and technological innovation also should be focused on alternatives for safer cooking. Such developments would reduce the devastating health impacts, especially in economies that still heavily rely on charcoal fuel. Consumer education about the side effects of charcoal to human health and related supply chain issues, such as origin of trees and risks of deforestation, is also needed.

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