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The Impact of Charcoal Production for Energy on Tropical Rainforest Resources in Nigeria

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## Motivation



### Sub Saharan Africa (SSA)

- prime world region where gaps need to be closed on the pathways to 2030 SDGs.
- over 90% of households in rural areas and over 50% of households in urban areas rely on charcoal and firewood for household energy (IEA, 2006, 2014)
- population in SSA is expected to double by 2050 (UN, 2015).
- Nigeria (pop. 200M<sub>2020</sub>, 3<sup>rd</sup>populous/world, charcoal producer & exporter)

## Nigeria

- To produce charcoal in Nigeria, tropical forest wood as feedstock is required (Chidumayo & Gumbo, 2012).
- Charcoal production is linked to deforestation and forest degradation according to FAO (2005) and several studies according to Hofstad et al., 2009.
- Nigeria has lost almost half of its tropical forest in the period 1990-2015 (FAO, 2016) with highest deforestation rate during the period 1990-2010 (FAO, 2010).



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## Problem



## Deforestation or Forest Degradation?

- trade-off between charcoal production & ecosystem services
- production, use and export of charcoal, is expected to affect tropical savannah and woodlands
- tropical savannahs and woodlands: one-third of all primary terrestrial production (Ribeiro et al., 2013); among the most endangered ecosystems (MacFarlane et al., 2015)
- deforestation = land use change: no forest
- forest degradation = less invasive, eco-services decrease

### Nigeria

- charcoal feedstock = tropical forest wood
- has lost almost half of the forest area in the period 1990-2015 (FAO, 2016)
- wood-to-charcoal conversion rates differ by production techniques
- projected population growth and economic growth by 2030, may increase charcoal demand

# To what extent charcoal production causes deforestation and/or forest degradation?



## Method



## Conceptual model

impact	indicator	Curro
Deforestation	Land use change (change of forest lands into non- forest lands)	Curre
Forest degradation	Fragmentation	Cha
	Forest canopy coverage	
	Biodiversity	
	Productivity	
	Soil fertility	
		Econo





## Deforestation



### Reported open data & literature

Possible link between charcoal production and **deforestation**.

Open data on:

- charcoal production quantities per year in Nigeria
- charcoal-to-wood conversion rate in Nigeria
- forest area per year in Nigeria
- average amount of biomass above the ground in Nigeria

## Contribution of charcoal production to deforestation in Nigeria:

 $\textit{Contribution to deforestation} = \frac{\textit{CP x CR}}{\textit{B x (Fyear (x - 1) - Fyear (x))}}$ 

With:

СР	= charcoal production (tonnes = Mg)
CR	= charcoal-to-wood-conversion rate
В	= above ground mass biomass (Mg/hectare)
F	= forest area (hectare)

**Projected charcoal production** for domestic use (household energy) by

Open data on:

- charcoal production quantities per year in Nigeria
- export quantities
- population Nigeria
- projected population by 2030

Contribution of population growth to charcoal production (household energy) in Nigeria:

Contribution =  $(AR * P_{2030}) * 1,04$ 

#### With:

AR	=av. ratio = [domestic charcoal use (Mg, 1990-2015)/
	population (1990-2015)
P <sub>2030</sub>	= projected population by 2030
1,04	= assumed export percentage based on latest 5 years



## Results





### Deforestation

- Since 1990, charcoal production has been contributing an increasing percentage to total deforestation
- Same trend after **sensitivity analysis** 
  - on charcoal-to-wood conversion rate
    - production technology: surface earth mound kiln/pit kiln (55%=5.1; 65%=4.8; 85%=4.2)
  - on aboveground biomass
    - 184 Mg/ha (capacity for **forest restoration**, FAO); 350 Mg/ha (Nigeria nat.data); 532 Mg/ha capacity

- Sensitivity analysis
  - If aboveground biomass is 350-532 Mg/ha, production technology is of less influence

## 2030 projection

- 'business as usual' =>21% deforestation by charcoal production
- 'less biomass' scenario =>19%

#### Fig. Calculated deforestation by charcoal production in Nigeria (dark green), 1990-2015; (total deforestation = 100%); at 4.5 charcoal-to wood conversion rate & at 450 Mg/ha aboveground biomass for tropical rainforest (both calculated from lit.)



Fig. Sensitivity analysis of Calc. deforestation by charcoal production in **Nigeria** to above ground biomass & prod.technology; tot.deforestation=100%



## Deforestation or Forest Degradation?



## Wood feedstock harvesting for charcoal => Forest degradation => Degradation

Harvesting wood from rainforest to produce charcoal does not necessarily lead to deforestation. This can be **forest degradation due to fragmentation**. At a certain point, forest degradation turns into **deforestation**. From sensitivity analyses deforestation by charcoal production is linked to rainforest loss (beyond 2010).

### Reported open data (1990-2015) on Nigeria => helps for a first analysis of the problem

For better understanding regarding **trade-offs** between charcoal production & ecosystem services, use of **satellite time series of land use change** and accurate data regarding **charcoal production & export (BBQ)** is needed

Nexus approach might be of help in a spatio-temporal analysis of the indicators on forest degradation.

### **Future studies?**

- How regeneration of forests and planting of forests mitigates the effects of charcoal production?
- Validation through established/new SDG indicators like Land Degradation Neutrality SDG15.3 (Keesstra et al, 2018)

## Contact

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