AIR QUALITY AND CLIMATE IMPACT OF CHARCOAL USE IN AFRICA

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5 SECONDS SUMMARY

- 208 Tg fuelwood burned to produce charcoal in 2014.
- Emissions of pollutants in 2014 are 15 Tg CO, 40 Gg BC, and 80 Gg OC.
- Charcoal production likely to double from 2014 to 2030 due to urbanization

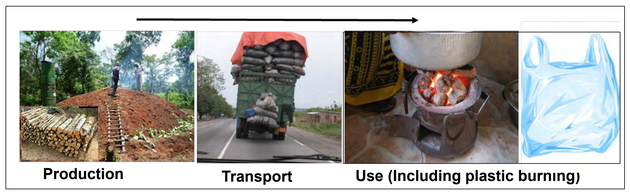
1. Introduction

Charcoal is a dominant source of energy in Africa, growing at 7% a^{-1} due to urbanization and population growth (Arnold *et al.*, 2006), low electricity access (Sawe, 2014) and unaffordable energy alternatives like kerosene or liquified petroleum gas (GIZ, 2014). Charcoal production, use (including plastic burning), and transport produce emissions of aerosols and trace gases (FAO, 2017) that impact air quality, human health and climate.

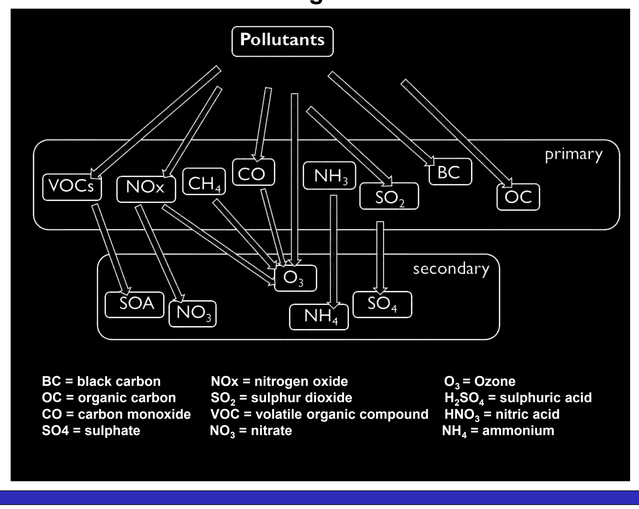
Marais and Wiedinmyer (2016) developed an inventory of emissions from diffuse and inefficient combustion sources for year 2013 that include charcoal production and use. Their study showed that charcoal is an often dominant and growing source of pollution in Africa.

Here, we develop an inventory to quantify emissions from charcoal production, use and truck transport in Africa for year 2014. We include our inventory in GEOS-Chem to determine the contribution of charcoal production, transport and use in Africa to local air quality and global climate.

1a. Charcoal production, consumption, and transport in Africa and the impact on air quality



1b. Pollutants emitted along the charcoal value chain



2. Developing a Bottom-Up Emission Inventory

- The charcoal supply chain includes production, transport from rural to urban centres, and use in cities and slums
- Amount of charcoal produced and consumed is from the United Nations Energy Statistics database.

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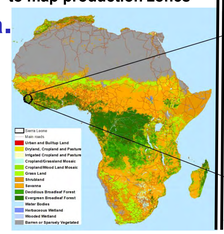
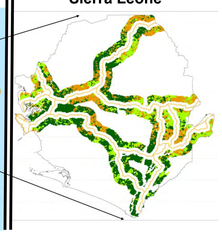
- Number of trucks is estimated assuming each truck transports 15.8 tonnes of charcoal.
- Plastic use to initiate combustion is estimated for slums only.
- Emission factors of pollutants for charcoal production and use are from Akagi et al. (2011) and that for trucks is from Zavala et al. (2017).

3. Mapping Charcoal Production, Use, and Transport

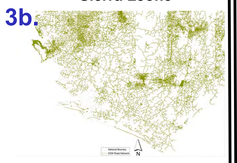
3a. Land cover and roads used to map production zones



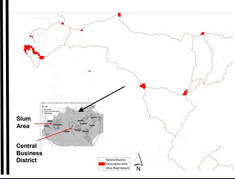
Production locations in Sierra Leone



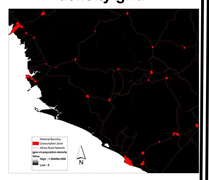
3b. OSM road network in Sierra Leone



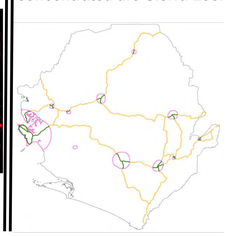
Consumption locations in Sierra Leone



3c. OSM roads + population density grid



Zones where trucks are most concentrated are Sierra Leone cities



Additional details of the mapping approach

- **Production locations:** areas 5-15 km from primary roads (Campbell, 1996). We use vegetation distribution and protected areas to isolate location where charcoal production is feasible and most likely to occur. (3a)
- **Consumption locations:** urban centres. These are identified as zones in the OpenStreetMap residential road network that have line density threshold with cell size value = 0.001 m and radius = 0.025 m (3b)
- **Truck routes:** primary roads from OpenStreetMap. The radius around the urban centre where charcoal trucks are concentrated is proportional to population size (2 km for cities with < 1000 inhabitants; 50 km for (cities with > 2 million people) (3c)

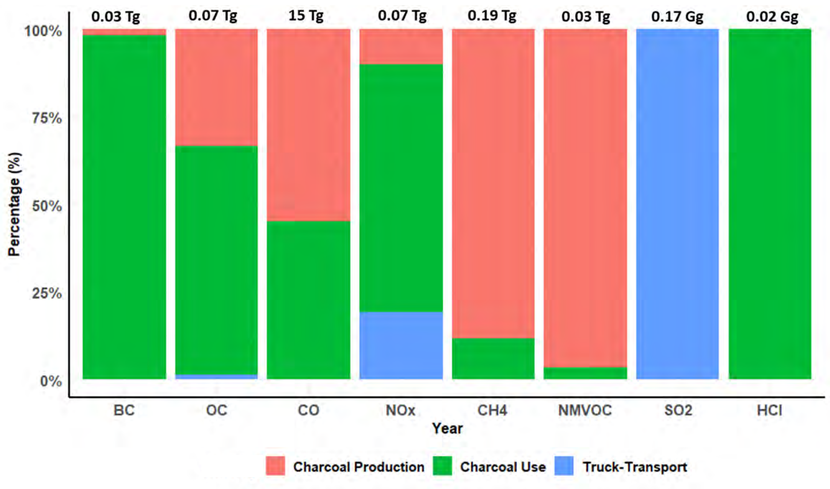
4. Impact Analysis

GEOS-Chem

We embed our inventory in the global GEOS-Chem model to estimate the impact of the charcoal supply chain on surface concentrations of fine particles ($PM_{2.5}$) and ozone and global tropospheric concentrations of short-lived climate forcers (aerosols and ozone)

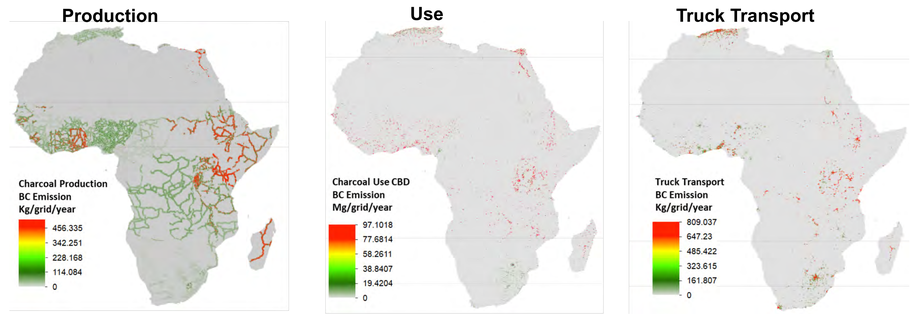
5. Charcoal Emissions of Dominant Air Pollutants

5a. Contribution of activities to pollutant emissions



5b. Spatial distribution of pollutants from charcoal production, use and transport

Black carbon (BC) emissions



In Africa, the dominant source of air pollution is open burning of agricultural residue and savanna fires. We estimate that 208 Tg of fuelwood was used to produce charcoal in 2014 (24% of biomass consumed from open fires). Emissions from charcoal are highest in East and West Africa where the majority of charcoal is produced (and consumed). Total annual air pollutant emissions are BC (41 Gg), OC (78 Gg), CO (15 Tg), NOx (78 Gg), CH_4 (1.8 Tg), SO_2 (0.2 Gg), NMVOC (6.9 Tg) and HCl (0.02 Gg) for 2014. Urbanisation is a strong predictor of trends in charcoal emissions. It is estimated that urban population will increase from 2014 to 2030 by 77 % (UNDESA, 2017). This will almost double the amount of charcoal produced in 2014 and likewise emissions.

6. Ongoing Work

- Include my charcoal emission inventory in GEOS-Chem to estimate the impact on air quality and climate forcing of aerosols and short-lived forcers
- Sample Earth observations of leaf area indices over locations of intense charcoal production to identify whether charcoal production contributes to forest degradation in Africa

References

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