AIR QUALITY AND HEALTH IMPACT OF THE CHARCOAL SUPPLY CHAIN IN AFRICA

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5-SECOND SUMMARY

- Charcoal production likely to double from 2014 to 2030 due to rapid urbanization
- $PM_{2.5}$ enhancement > 0.8 μg m^{-3} in East Africa.
- Population weighted $PM_{2.5}$ in Africa in 2014 is 0.8 μg m^{-3}
- Highest deaths from charcoal emissions in West Africa are in Nigeria (~2,460) and Ghana (~1,084)

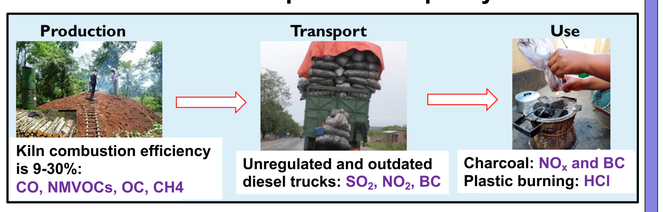
1. Introduction

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 air 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 premature mortality.

1a. The charcoal supply chain in Africa and the impact on air quality



2. Developing a Bottom-Up Emission Inventory

Amount of charcoal produced and used is from the United Nations Energy Statistics database.

UNdata A world of information

Number of trucks obtained assuming each truck transports 16 tonnes of charcoal.

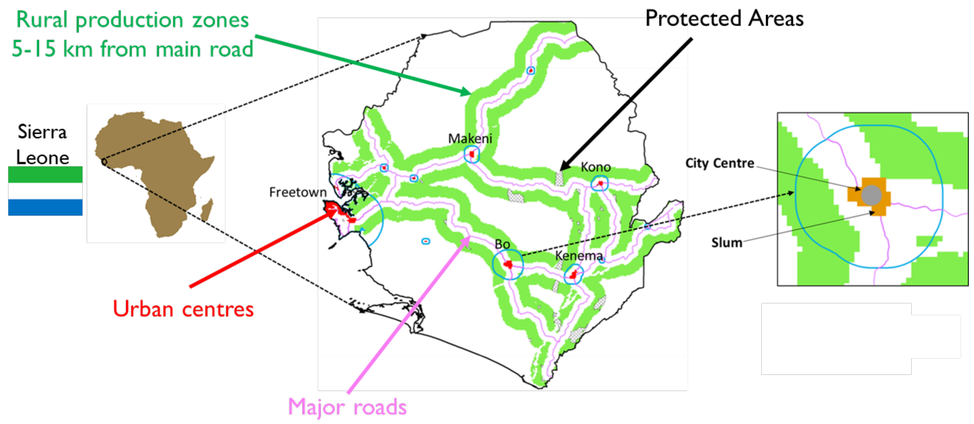
Our own estimate of plastic use in slums across Africa

Air pollutant emission factors from Akagi et al., (2011) and Pfotenhauer et al., (2019) for charcoal, Zavala et al. (2017) for trucks, and Jayarathne et al., (2018) for plastic.

References

Akagi, S. K. *et al.* (2011), doi:10.5194/acp-11-4039-2011.
Bird, J. *et al.* (2017), doi:10.1093/oxrep/grx036.
FAO. 2017. *The charcoal transition: greening the charcoal value chain to mitigate climate change and improve local livelihoods, by J. van Dam.*
GIZ (2014) *Multiple-household fuel use: a balanced choice between fuelwood, charcoal and LPG.* Eschborn, Germany.
Marais, E. A. and Wiedinmyer, C. (2016), doi:10.1021/acs.est.6b02602
UNDESA, P. D. (2017) 'World Population Prospects: The 2017 Revision, DVD Edition'.
Zavala, M. *et al.* (2017), doi:10.5194/acp-17-15293-2017

3. Mapping Charcoal Production, Use, and Transport



- **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.
- **Consumption locations:** urban centres. These are identified as zones in the OpenStreetMap residential road network that have line density ≥ 0.4 miles ha^{-1}.
- **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)

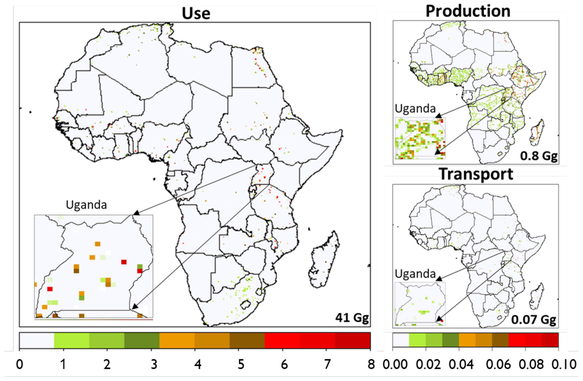
4. Impact Analysis

GEOS Chem

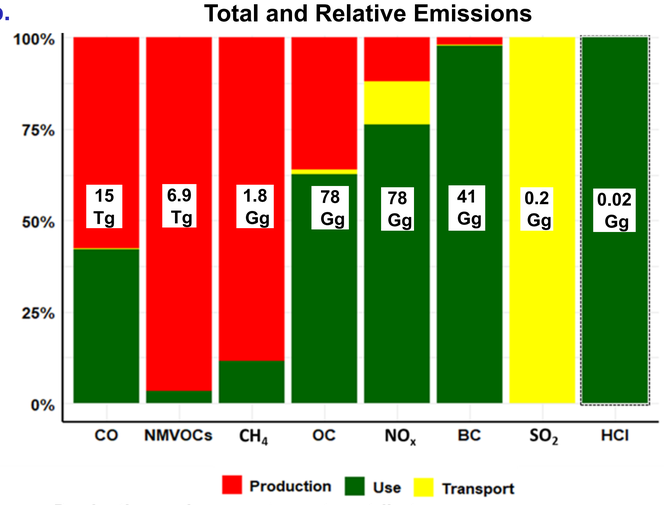
We embed our inventory in GEOS-Chem model and run at coarse resolution (2^0 x2.5^0) to estimate the air quality impact and at fine resolution (0.25^0 x 0.3125^0) with updated emission factors to estimate premature mortality over West and East Africa.

5. Charcoal Activities and Pollutants Emissions

5a. Black carbon emissions at 0.1° x 0.1° [tonnes per year]



5b. Total and Relative Emissions

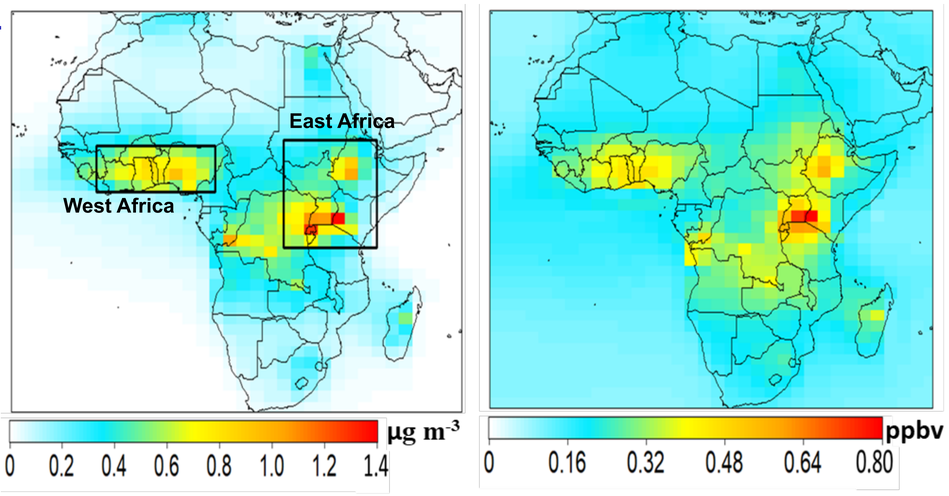


Production and use are largest contributors

Emission factors are a large source of uncertainty

6. Air Quality and Health Impacts

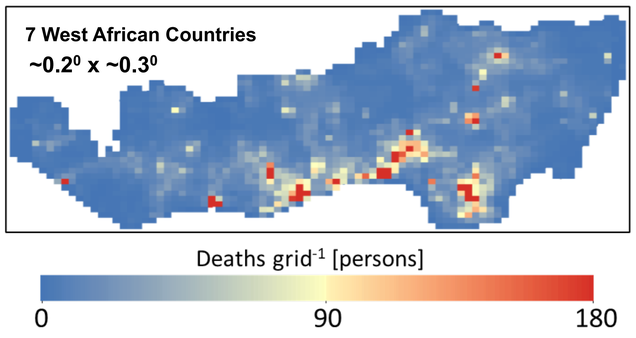
6a.



Largest enhancements are in urban centres in East and West Africa, and in Kinshasa, DRC

- $PM_{2.5}$ enhancement > 0.8 μg m^{-3} in East Africa may have serious health implications
- Surface ozone increase is small (at most 0.8 ppbv)

6b. Mortality from Charcoal Emissions in West Africa in 2014



Peak $PM_{2.5}$ is 2 μg m^{-3}, this is double the peak $PM_{2.5}$ at coarse resolution.

Highest deaths are in Nigeria (~2,460), and Ghana (~1,084)

Total deaths will double in 2030