EMISSION INVENTORY FOR CHARCOAL PRODUCTION, USE AND TRUCK TRANSPORT IN AFRICA

[1]Alfred S. Bockarie* (asb608@student.bham.ac.uk), [1]E. A. Marais , [1]A. R. MacKenzie

[1]School of Geography, Earth and Environmental Sciences, University of Birmingham, UK.

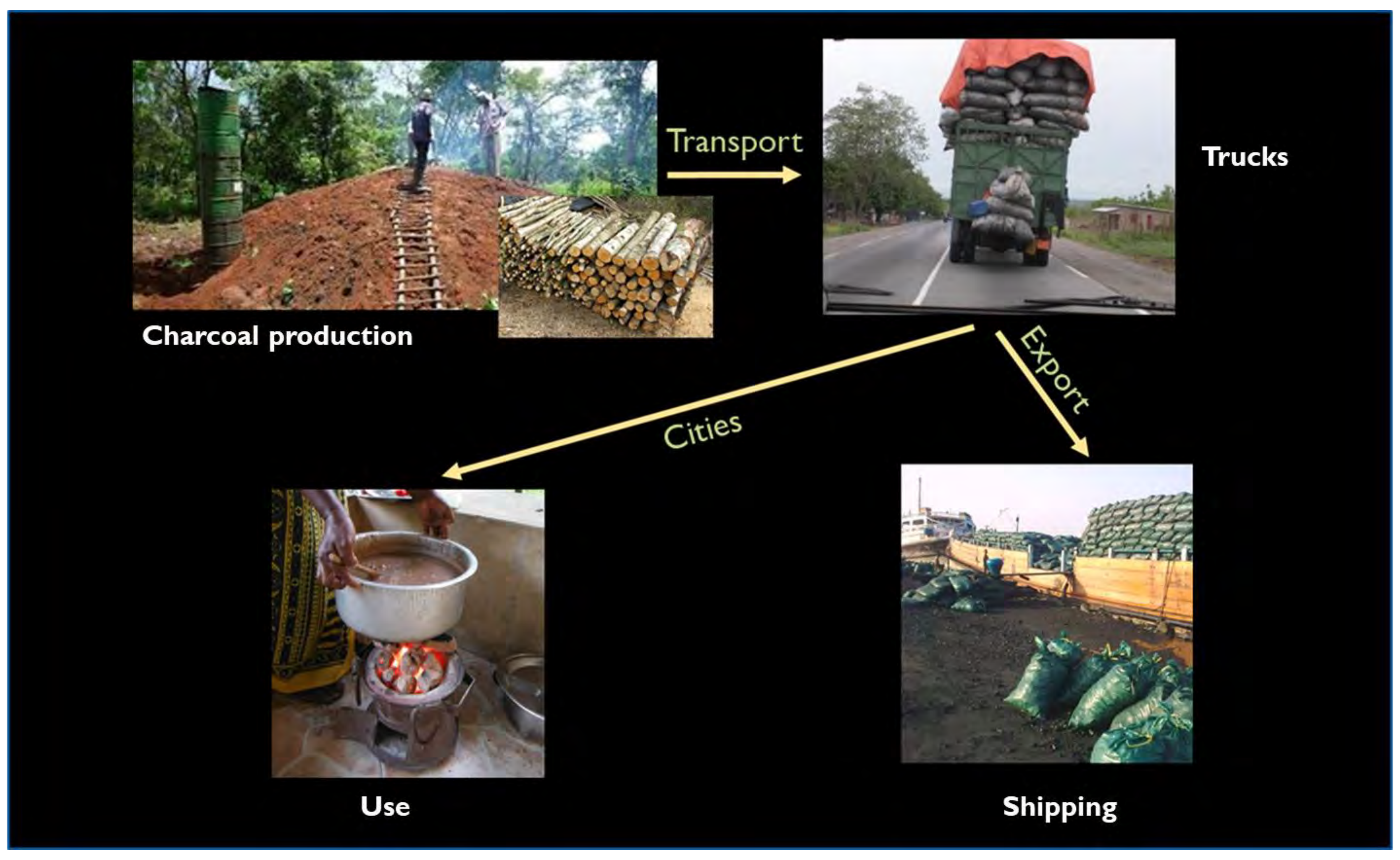
Introduction

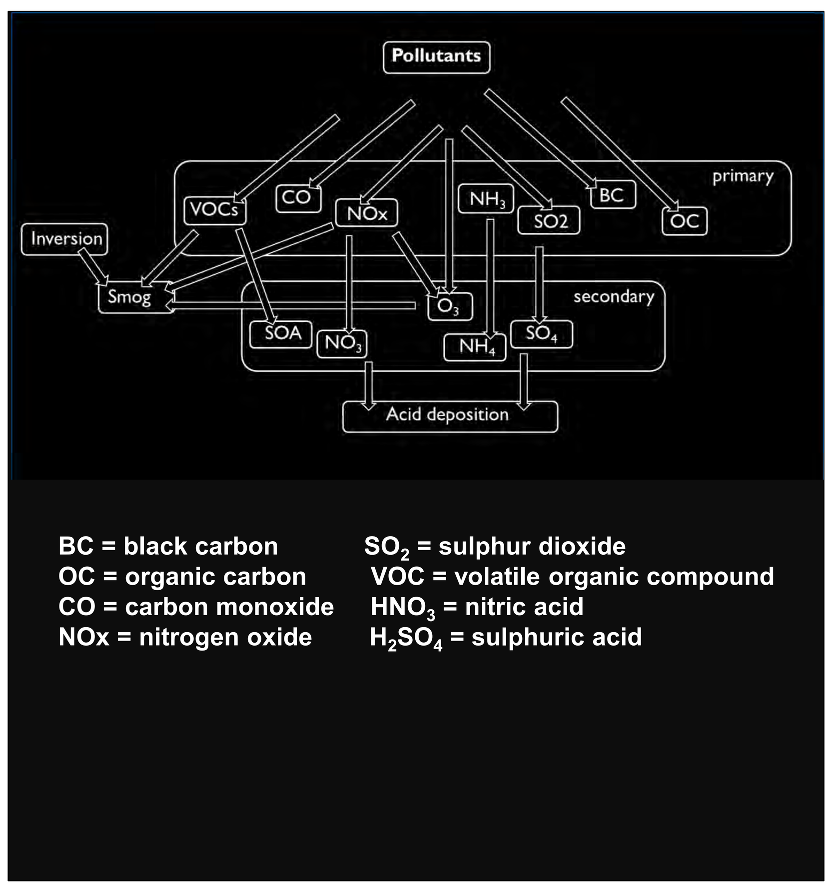
More than 75% of urban households in Africa use charcoal (Blackburn-Dwyer, 2016) and the demand for charcoal is growing at 6% per annum. Production, use and transport activities produce emissions of aerosols and trace gases (FAO, 2017) that impact human health and climate.

Marais and Wiedinmyer (2016) developed an inventory of emissions from diffuse and inefficient combustion sources (DICE-Africa) that included charcoal production and use. That study showed that charcoal is an often dominant and growing source of pollution in Africa.

Here we provide a substantial update on this work, utilizing more appropriate methods of mapping the location of charcoal production and use so that we can use this to estimate the impact of charcoal on air quality, climate, and forest cover.

Charcoal production, consumption, and transport in Africa and the impact on air pollution





Developing a Bottom-Up Emission Inventory

Emission = Activity X Emission Factor

- Activity linked to charcoal includes its production from fuelwood in rural areas, its transport to urban centres, and its domestic use in urban homes.
- The amount of charcoal produced and consumed for each country come from the United Nations Energy Statistics database.

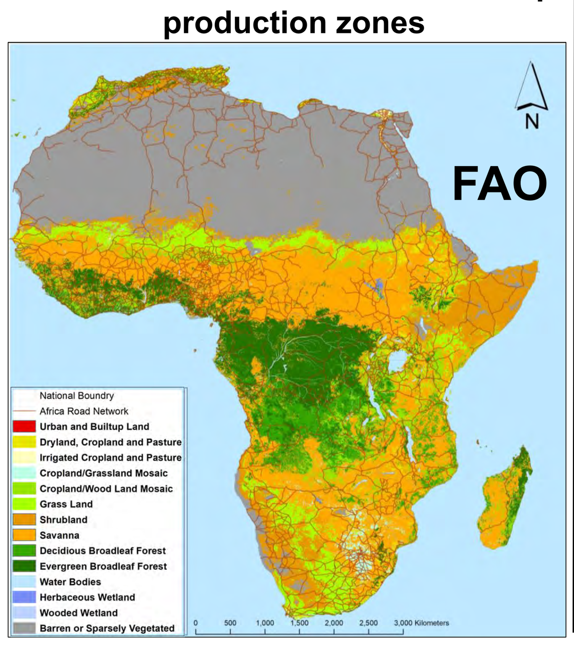
UNdata
A world of information

- We estimate the number of trucks needed to transport charcoal by assuming that on average, a truck carries 15.8 tonnes of charcoal to a city.
- Emission factors of pollutants from charcoal production and use are already in the literature (Akagi et al., 2011) and we use values for inefficient and outdated vehicles measured in Mexico (Zavala *et al.*, 2017).

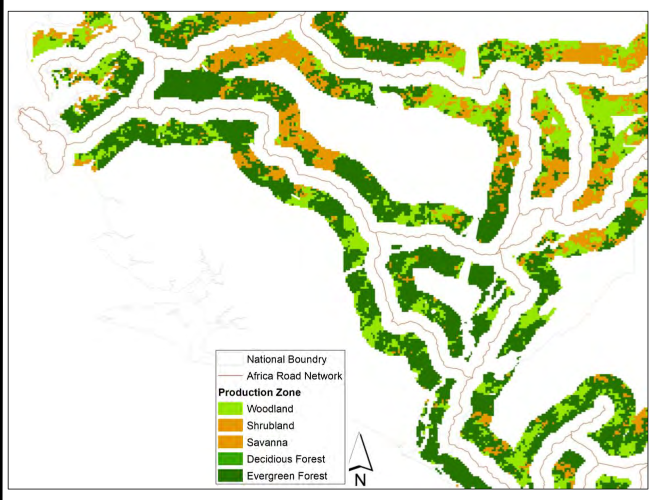
Method of Mapping Charcoal Activities (Production, Use, Transport)

Production zones in rural areas

Land cover and roads used to map production zones

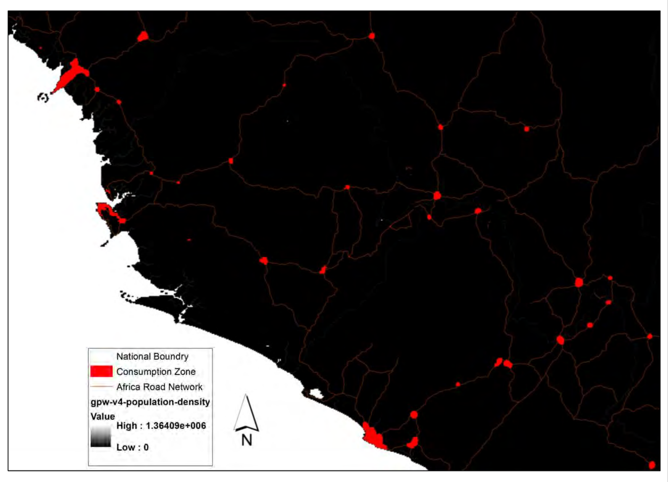


Production locations in Sierra Leone

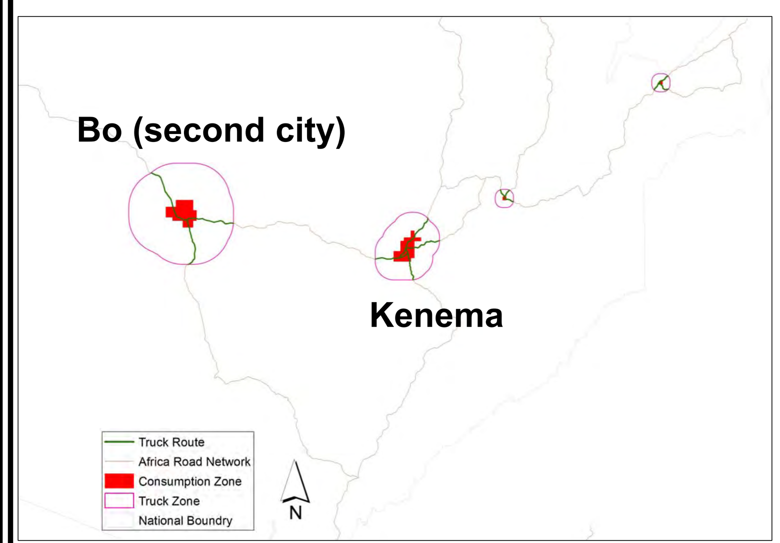


Location (highest density) of trucks around urban centres

Population density in Sierra Leone

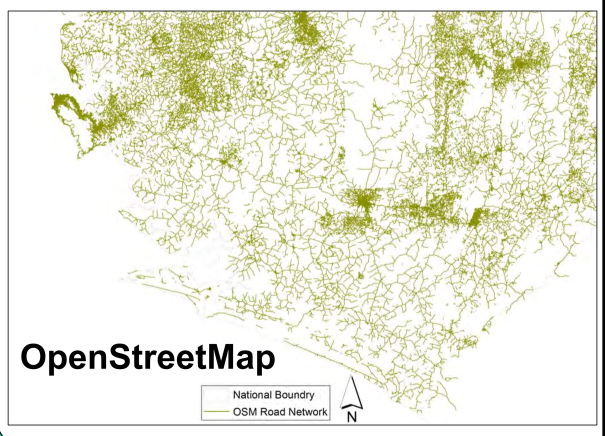


Zones where trucks are most concentrated are Sierra Leone cities

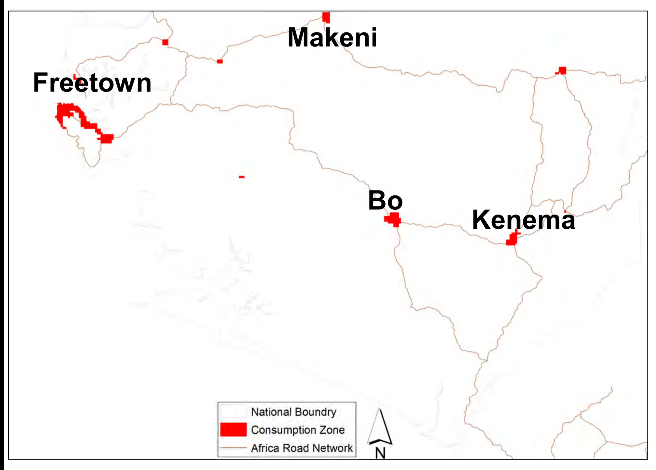


Charcoal consumption in urban centres

Road network in Sierra Leone



Consumption zones in Sierra Leone



Additional details of the mapping approach

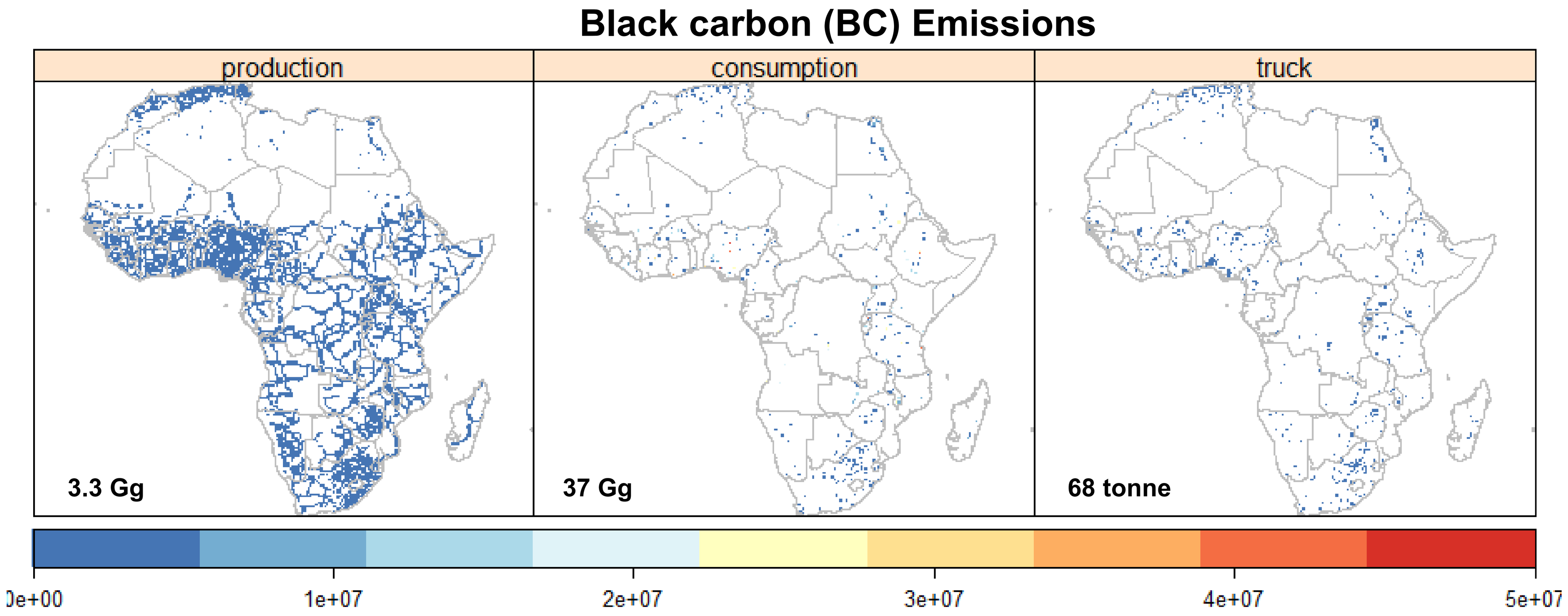
- **Production locations:** areas 5-15 km from primary roads (Campbell, 1996). We use vegetation distribution and protected areas to isolate location where charcoal production is feasible and most likely to occur.
- **Consumption locations:** urban centres. These are identified as zones in the OpenStreetMap residential road network that have line density threshold with cell size value = 0.001 m and radius = 0.025 m
- **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)

Charcoal Emissions of Dominant Air Pollutants

Contribution of activities to pollutant emissions

Spatial distribution of pollutants from charcoal production, use and transport

Black carbon (BC) Emissions



Unit = gram x grid^{-1}

Emissions are gridded to a 0.1^{0} x 0.1^{0} grid (~10 km x 10 km)

In Africa, the dominant source of air pollution is open burning of agricultural residue and savanna fires.

We estimate that 250 Tg of fuelwood was used to produce charcoal in 2014 (6% 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 40 Gg BC, 47 Tg CO, 0.10 Tg NO_x, and 0.17 Tg OC for 2014.

Urbanization is a strong predictor for trends in charcoal emissions. It is estimated that urban population will increase by 40% from 2014 to 2030 (UNDESA, 2017) resulting in emissions of 0.06 Tg BC, 69 Tg CO, 0.15 Tg NO_x, 0.25 Tg OC in 2030.

Future work

- Use a chemical transport model to estimate the impact of charcoal production on air quality and climate
- Sample Earth observations of leaf area index over charcoal production zones to identify whether charcoal production is contributing to deforestation in Africa

References

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