EGU22-7091
https://doi.org/10.5194/egusphere-egu22-7091
EGU General Assembly 2022

Effects of charcoal production on carbon cycling in African tropical forests

Dabwiso Sakala and Maria J Santos
University of Zurich, Earth System Science, Geography, Switzerland (dabwiso.sakala@geo.uzh.ch)

The increasing demand for charcoal in Sub-Saharan Africa (SSA) is a growing threat to tropical ecosystems as more forest areas get cleared to meet the high energy needs. While the region's current socio-economic trends, such as increasing population, urbanisation and high poverty levels, will likely drive high charcoal demands into the future, current estimates indicate that charcoal production contributes up to 7% of total deforestation in tropical ecosystems every year, with carbon emissions corresponding to 71.2 million tonnes of CO_2 and 1.3 million tonnes of CH_4. Although forest management practices could enable sustainable production by using harvest cycles to allow forest regeneration, emissions from charcoal production may contribute to exacerbate global warming. A transition for other energy carriers in SSA has been called for, which may be a slow process as it depends on investments and cultural changes, thus projected demands for charcoal could severely impact the balance and timing of carbon fluxes and the overall carbon budget of tropical ecosystems. To better understand how charcoal production affects tropical ecosystems carbon dynamics, we parameterised a dynamic global vegetation model, LPJ-GUESS, to determine the magnitude and direction of carbon fluxes following charcoal production. We simulated 300 model years for two forest governance regimes, natural and managed forest, on 782 gridcells at 0.5° x 0.5° resolution covering the tropical rain forest of Africa. We allowed for tree harvesting for charcoal only in managed forests, where we vary the fraction of trees cut (10%, 20%, and 30%) and harvest rotation cycles (10, 20, and 30 years). We find that Net Ecosystem Exchange (NEE) under all charcoal production regimes cause tropical forests to transition from a net carbon sink (NEE natural = -0.024 ± 0.047 kg C/m^2 yr-1) to a net carbon source. We estimate NEE = 0.005 ± 0.432 kg C/m^2 yr-1 under the least intense management regime (10% forest cut every 30 years) and a mean NEE of 0.027 ± 0.630 kg C/m^2 yr-1 for the most intense regime (30% forest cut every 10 years). We further observe an initial and steep drop in vegetation carbon following the start of charcoal production for all management regimes, and this change quickly stabilises as tree harvest keeps vegetation under a new stable state that is lower than that of natural forests. Compared to our modelled natural forest, we find that all charcoal regimes lead to more than a 25% decline in vegetation carbon over time. We further examined carbon partitioning into pools of litter and soil and find consistent patterns of transition from sink to source. These findings suggest that while carbon dynamics vary in tropical systems depending on the intensity and frequency of charcoal production, even a management regime of 10% charcoal production every 30 years can result in forest carbon loss with amplified vegetation carbon losses in the order of 25%.