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Greenhouse gas emissions and N turnover along an altitudinal gradient at Mt. Kilimanjaro, Tanzania.

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Worldwide climate and land-use change force alterations in various ecosystem properties and functions such as diversity and activity of soil microbial communities which are responsible for biogeochemical processes like soil nitrogen (N) turnover and associated greenhouse gas (GHG) exchange. Tropical deforestation is highest in Africa and despite the importance of those ecosystems to global climate and biogeochemical cycles, data for greenhouse gas exchange is still rare (Serca et al., 1994, Werner et al., 2007) and no study regarding N turnover processes has been published yet. For that reason, we focused on seven different land-use types extending along an altitudinal gradient (950 – 3880m) at Mt. Kilimanjaro, East Africa, covering (semi-) natural savanna, two montane forests and one afro alpine ecosystem, an extensive agroforest (homegarden) and an intensively managed coffee plantation. On all ecosystems we measured CO_2, CH_4 and N_2O fluxes and gross rates of ammonification, nitrification, N immobilization, and dissimilatory nitrate reduction to ammonium (DNRA). GHG results reveal pronounced N_2O fluxes depending mainly on soil moisture and to a lesser extent on soil temperature. Emissions are highest during the rainy seasons while lowest at dry season conditions. The largest N_2O emissions are recognizable at Ocotea forest, most likely due to the generally higher SOC/ totN and wetter conditions favoring formation and emission of N_2O via denitrification. Soils of the studied ecosystems were a sink of atmospheric CH§$_4$. Uptake rates were highest at Lower montane forest. CO_2 fluxes were less pronounced across the different sites with highest fluxes at the Lower montane forest. N gross rates showed a substantial variability between the different ecosystems, which was more pronounced than seasonal variations at a given site. Highest turnover rates occur during the transition period from dry to wet season. N turnover rates were highest at the montane Ocotea forest and decrease with increasing land-use intensity and SOC/ totN. N retention and characteristics of soil nutrient status (available N and organic C) revealed a clustering of faster but tighter N cycling in the (semi-) natural savanna and Ocotea forest in contrast to the more open N cycle in managed systems of homegarden and coffee plantation. The disturbed (logging) lower montane forest was in between these two groups. Our conclusion is that both GHG and N turnover rates follow seasonal patterns. CO_2 and CH_4 do not differ greatly between the different ecosystems. In contrast, N_2O emissions and N gross rates show an increase with altitude as far as to the wettest Ocotea site and a subsequent decrease with ascending elevation.

References:

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