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Soil geochemistry as a major driver of carbon allocation, stocks and dynamics in vegetation and soils of African tropical forests

Sebastian Doetterl, EGU 2022; BG3.6

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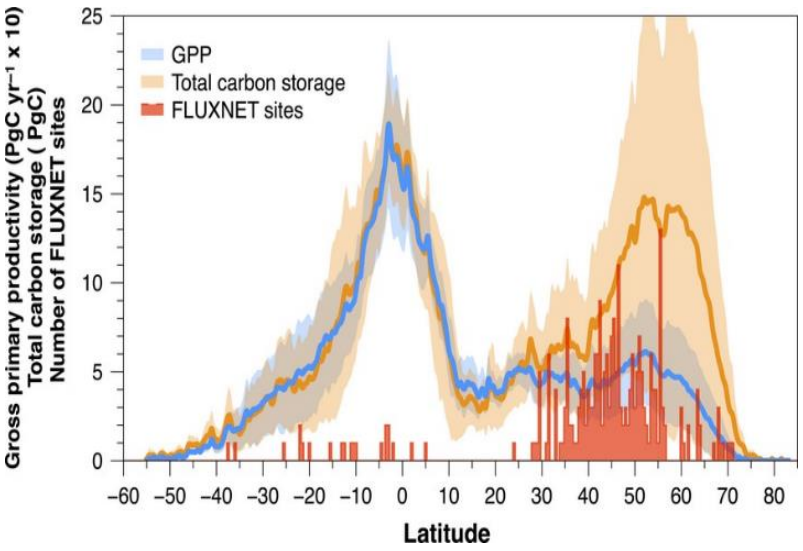
Geoclimatic controls on soil carbon stabilization



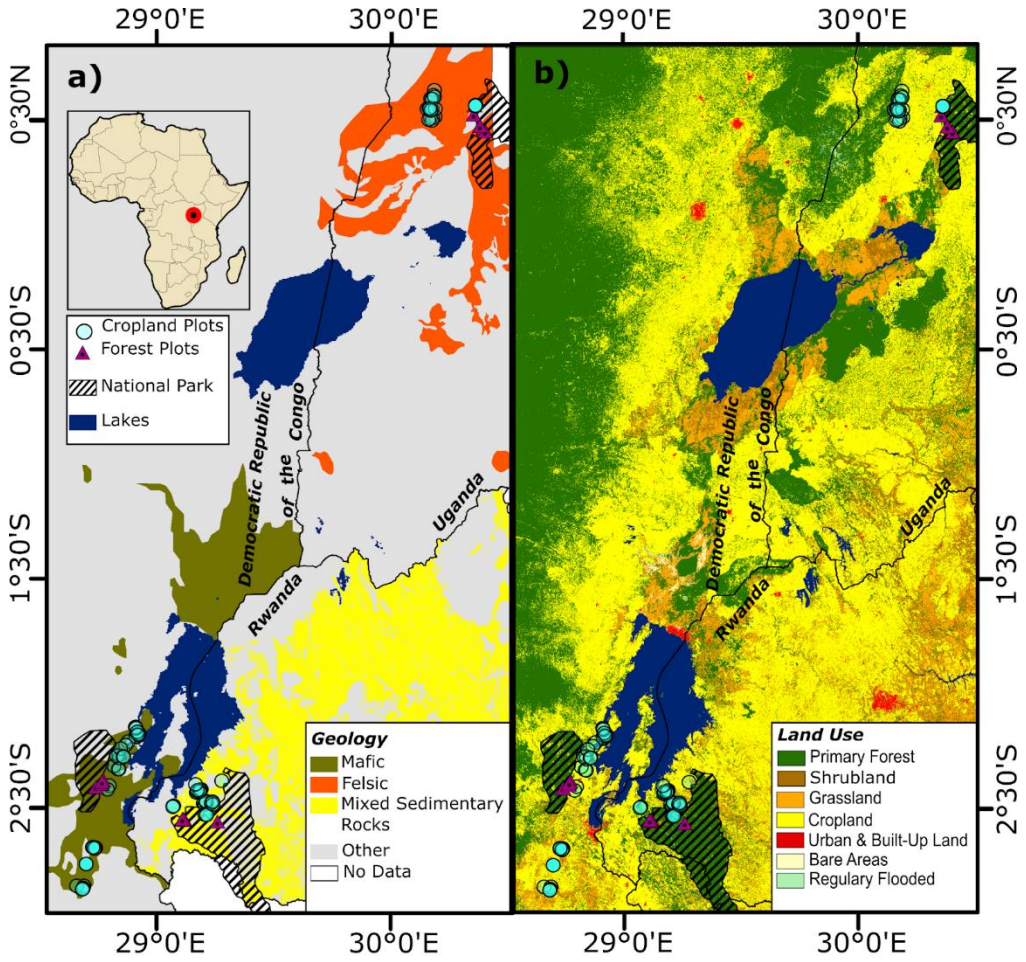
(Schimel et al. 2015)

- Old-growth African montane forest represent a significant amount of global terrestrial vegetation C stock and the global NPP (e.g. Cuni-Sanchez Nature 2021)
- The lack of field-based data limits our understanding of the drivers of NPP and C allocation
- Understanding the drivers of biomass productivity and C allocation strategies in old-growth tropical forests is key element to estimate their contribution to long-term climate change mitigation

Research questions

- What role does soil geochemistry play as a driver of NPP and C allocation in tropical montane forests?
- Can similarly developed forests show plasticity in their root:shoot C allocation depending on soil properties?
- Do soil carbon stocks relate to NPP and biomass C input in tropical soils?

Our hypothesis:
Geology matters also in old, weathered soils: Nutrient replenishment and soil C stabilization will vary with parent material geochemistry

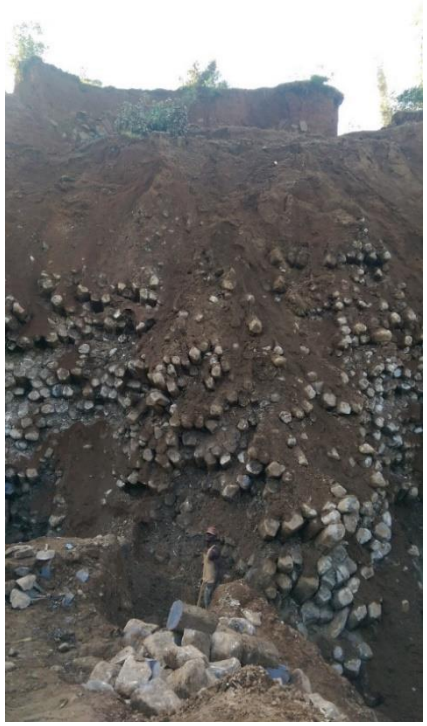


Doetterl et al. (2021)

- Study sites are located in the East African Rift Valley system across distinct soil parent material Mafic (most fertile) -> felsic -> mixed sedimentary rocks (least fertile)
- Plots in old growth forests were installed on along topographic gradients
- C compartments (NPP, C allocation and stocks) were assessed for wood, litter and root biomass as well as soil organic C monitored over two years, including forest inventories

Bedrock and soil chemistry

Mafic



Kivu province
DRC

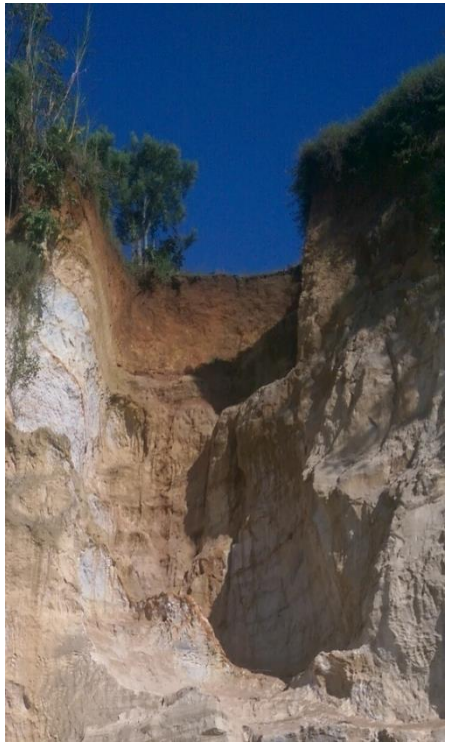
Basalt

Felsic

Kabarole District (S-W)
Uganda

Granite and Gneisses

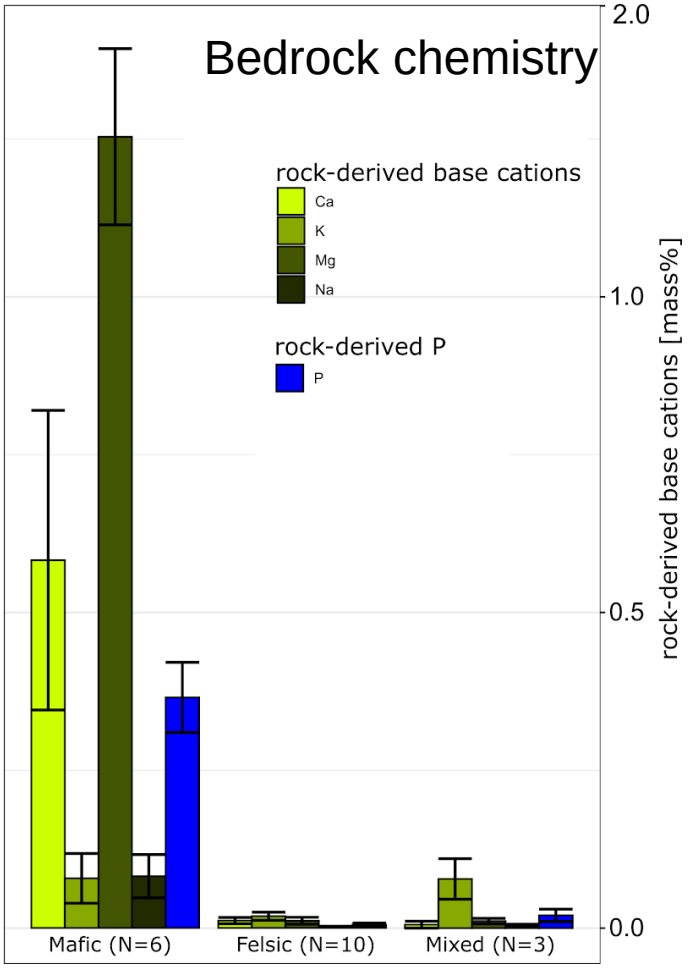
Mixed (sediments)

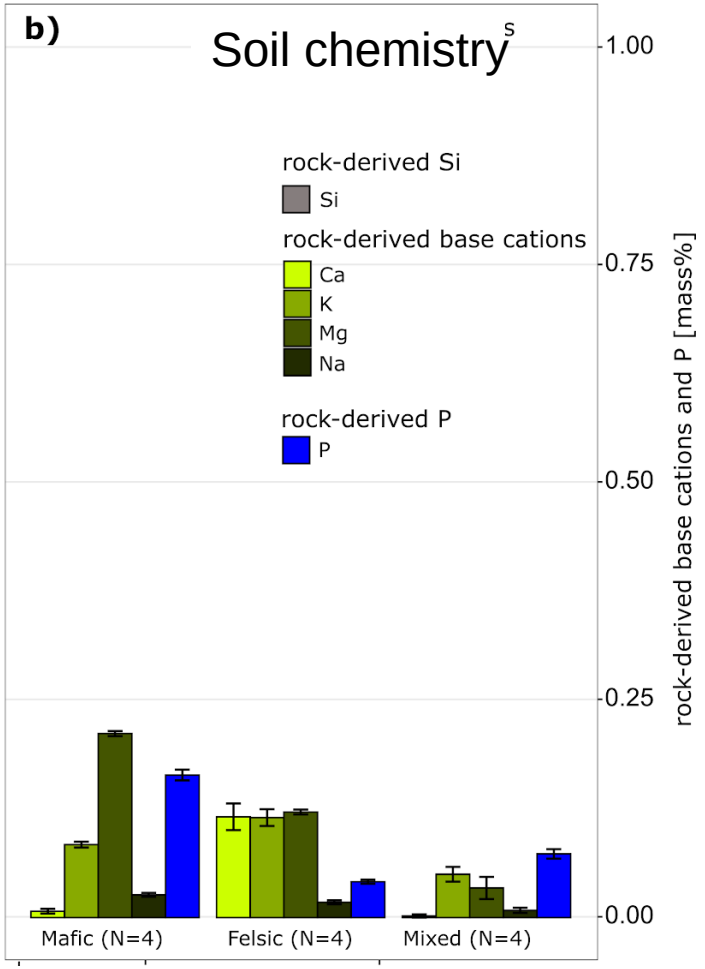


Western Province, Uganda
Rwanda

Siliciclastic schists

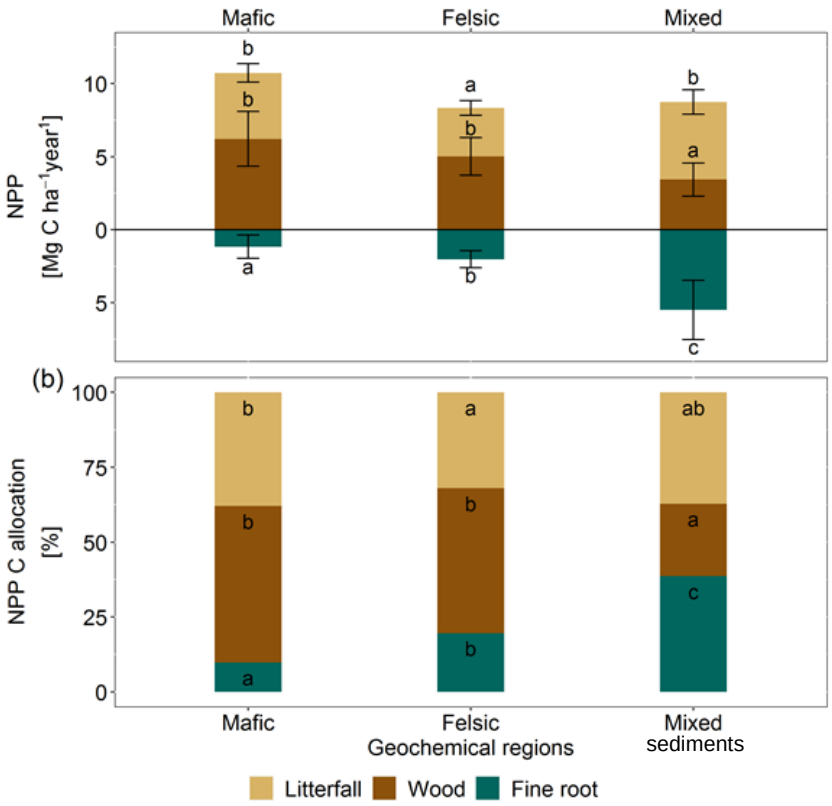
Bedrock and soil chemistry

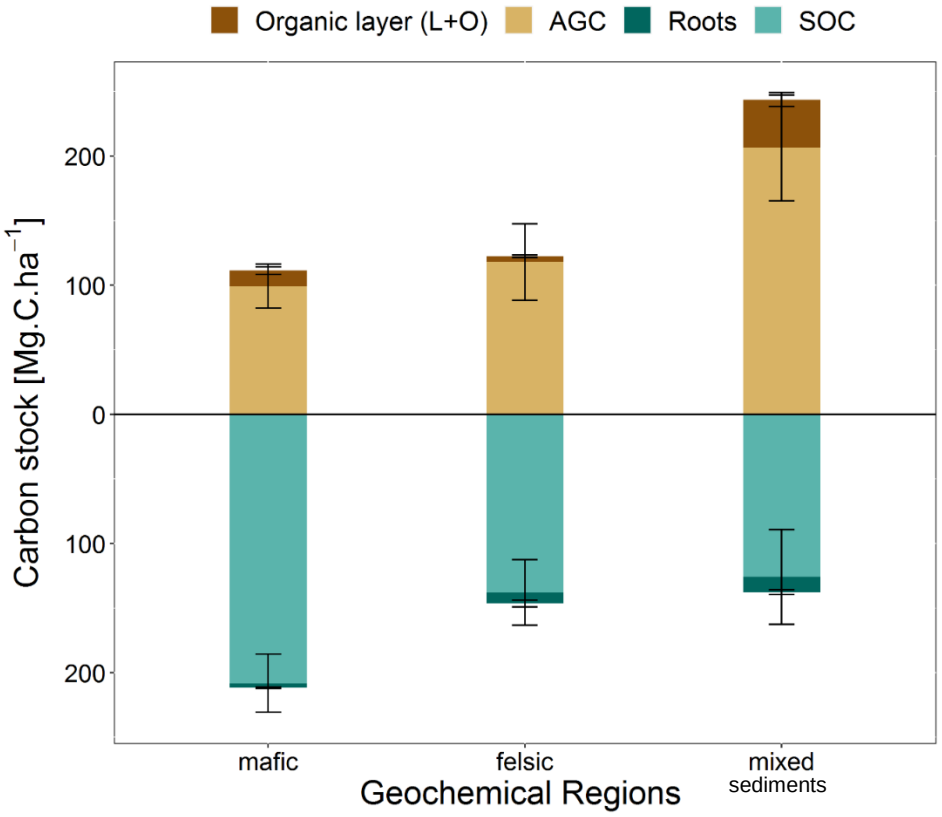




Doetterl et al. (2021)

Plant NPP, C stocks and C allocation strategies in African Tropical Forests across geochemical regions



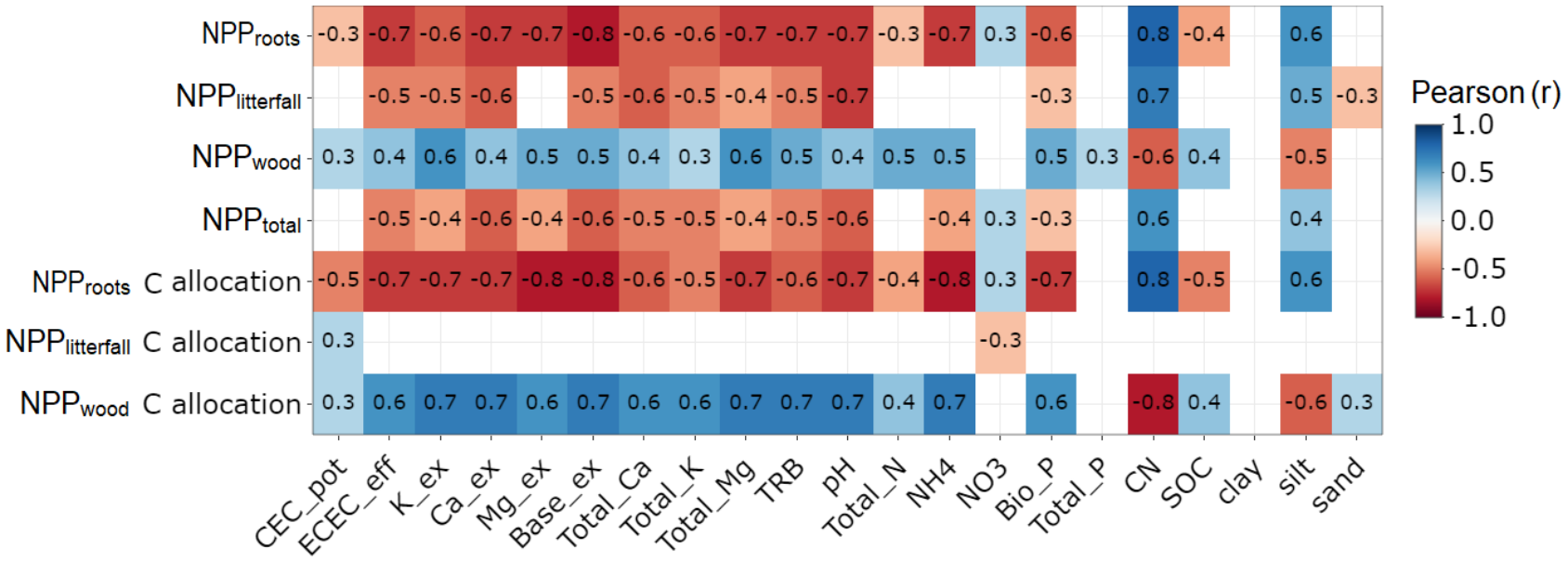


High — Soil fertility — Low

High — Soil C mineral stabilization — Low

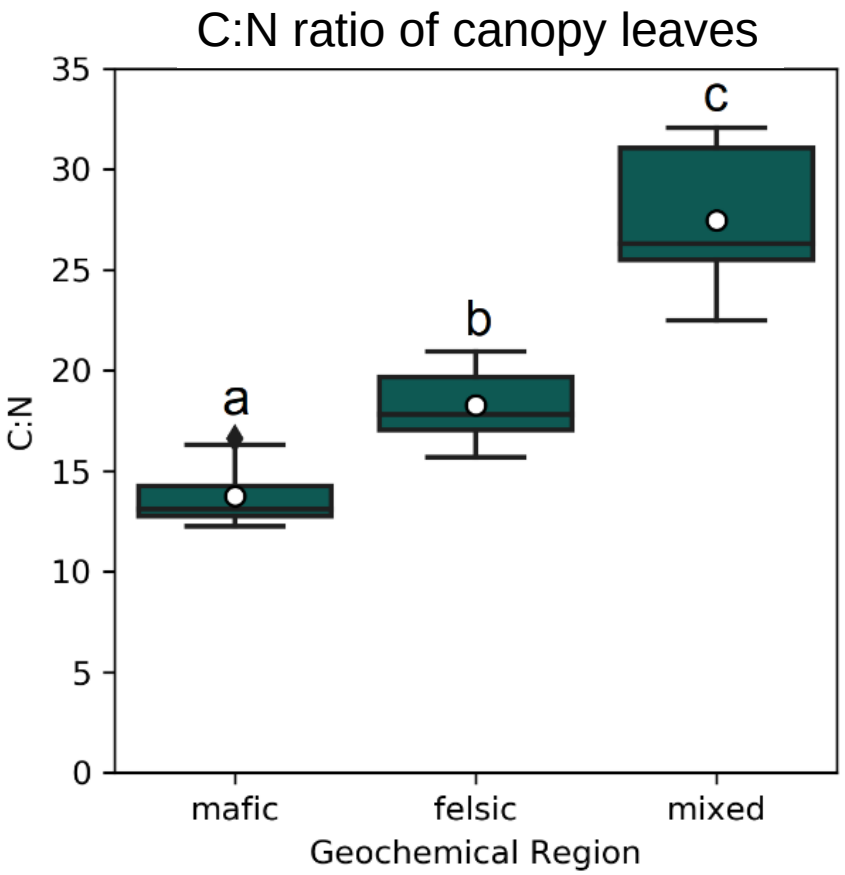
Bukombe et al. (in review)

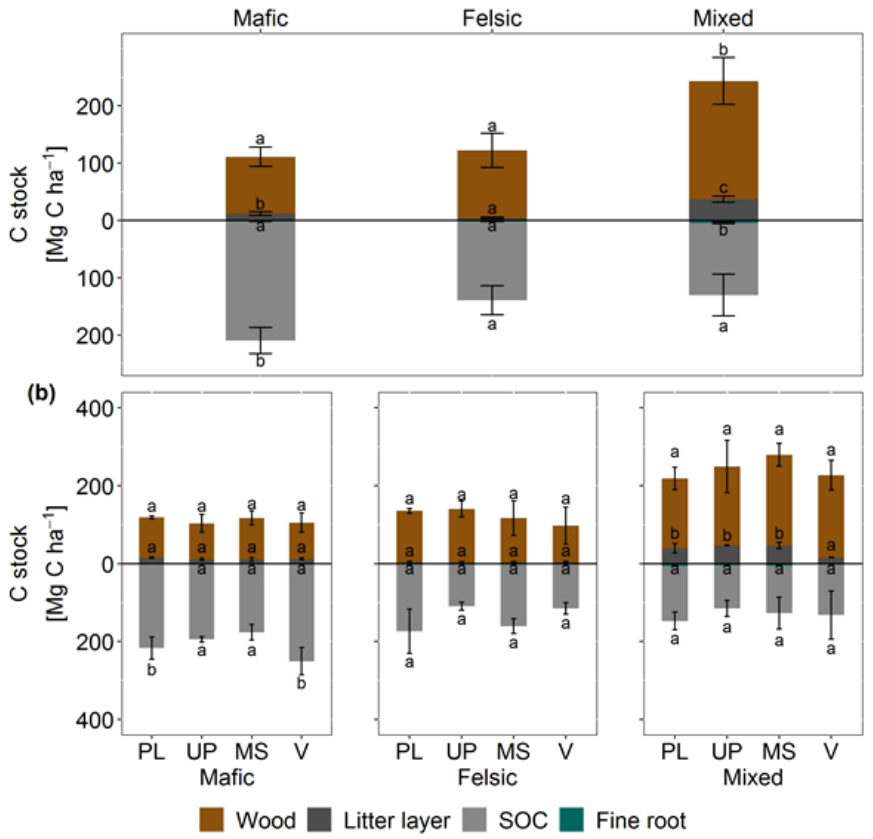
Soil biogeochemisty and NPP



- NPP wood, and wood C allocation increased with exchangeable base cations, available-N and P
- NPP roots, and roots C allocation decreased with exchangeable base cations and total reserve base available-N and P
- NPP litter has no strong soil controls

CN ratios and C stocks across geochemical regions and topography





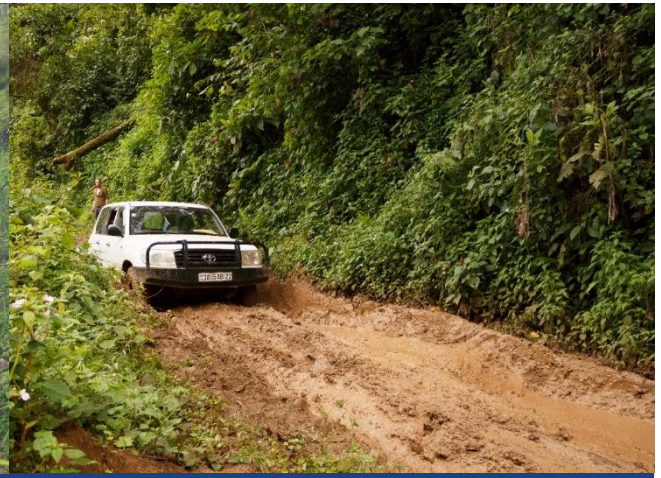
Bukombe et al. (in review)

Conclusions

- NPP compartments (wood & fine roots) strongly relate to soil biogeochemistry in tropical montane forests.
- Topography had no effect on NPP, C allocation or C stocks in intact tropical forest landscapes
- SOC stocks were not related to plant biomass C input or stocks, suggesting that these tropical soils have exceeded their maximum potential to stabilize C despite high input -> **Mineralogy controlled C stocks through stabilization more than plant C input.**
- Many millennia of soil weathering under tropical conditions did not abolish the control of soil geochemical properties inherited from parent material

Acknowledgements

Special thanks to:



Thank you for listening!

Emmy Noether-Programm
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