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The fate of organic carbon in colluvial soils in a subtropical agricultural catchment (Arvorezinha, Brazil)

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One of the main reasons as to why soil erosion is considered to be a carbon sink for the atmosphere is that eroded carbon is often redeposited and buried in depositional environments. However, the quantification of the magnitude of this effect is still uncertain because the residence time of soil organic carbon in depositional environments is ill defined. The latter is especially true for tropical and subtropical areas as field data for these climatic zones are largely lacking. This is an important hiatus as ca. 40% of the total global arable land is located in the (sub-)tropics [1].

We collected samples from four depositional and one stable agricultural profile in a small agricultural catchment in Arvorezinha (Brazil) where deforestation started ca. 90 yrs ago. δ13C depth profiles allowed to identify the bottom of the original A-horizon: this is because δ13C values of the buried forest soils are significantly heavier than those of the colluvial deposits. The results show that soil organic carbon contents systematically decrease with depth below the actual plough layer. This is due to the fact that a significant fraction of the organic carbon that was originally deposited is removed by mineralization from these soils over decadal time scales. As the time of deforestation is known, age-depth curves could be established. Combining this information with SOC measurements allowed for a first estimate of carbon preservation rates and showed that after 70 years ca. 25% of the deposited organic carbon is released to the atmosphere: results were very consistent across profiles. In temperate environments, the time necessary for this fraction of the deposited carbon to be mineralized is somewhat longer, i.e. 100 years [2]. This suggests that soil organic carbon may be decomposed faster in sub-tropical environments in comparison to temperate environments. This is not unexpected, given the fact that average soil temperatures are higher and soils are, in this climate, relatively moist during most of the year.

The effect of soil redistribution on carbon dynamics has, until now, mainly taken place in temperate areas, leaving (sub)tropical areas largely understudied. Our study shows that it is important to extend available field information to other climatic zones: while the processes occurring here may be similar, the impact on carbon cycling may be different because process rates are affected by climate. Global extrapolations based on temperate field zone data only may overestimate the soil erosion sink term, as they may overestimate carbon burial efficiency.

References

[1] Ramankutty et al. 2008, Global Biogeochemical Cycles 22; [2] Wang et al. 2014, Biogeosciences (11)