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# Soils as sediment: does aggregation skew slope scale SOC balances?

Yaxian Hu, Wolfgang Fister, and Nikolaus Kuhn
Basel University, Basel, Switzerland (yaxian.hu@unibas.ch)

The net effect of soil erosion as a source or sink of $CO_2$ in global carbon cycling has been the subject of a heated debate. On one hand, erosion exposes the previously encapsulated soil organic carbon (SOC), which may accelerate the mineralization of eroded SOC. On the other hand, deposition limits the decomposition of SOC upon burial, while incorporation of biomass at eroding sites replaces the lost SOC. So far, effects of erosion on $CO_2$ emissions have largely been assessed by comparing SOC stocks at eroding and depositional sites. The underlying assumption for this approach is a non-selective transport of eroded SOC across a landscape. However, several recent publications showed both an at least temporary on-site enrichment of SOC in sediment as well as a preferential deposition of sediment particles with SOC concentrations that differed from the soil SOC. As a consequence, balances between eroding and depositional sites may over- or underestimate mineralization of eroded SOC during transport.

Two Luvisols, from the villages of Möhlin and Movelier in northwest Switzerland, were used in this study. They have different mineral grain size distribution, organic carbon concentration and aggregate stability. Based on the concept of Equivalent Quartz Size (EQS), the eroded sediments were fractionated by a settling tube apparatus into six different size classes, according to their settling velocities and likely transport distances. According to the model developed by Starr et al., 2000, the likely transport distances of six EQS classes were grouped into three likely fates: deposited across landscapes, possibly transferred into rivers, and likely transferred into rivers. Respiration rates of the fractionated sediments were measured by gas chromatograph for 50 days.

Our results show that 1) due to aggregation, 60% of the Möhlin eroded fractions and 82% of the Movelier fractions would be re-deposited in the terrestrial system, which strongly contrasts with their grain size distribution; 2) 63% of eroded SOC for the Möhlin soil and 83% for the Movelier soil would be re-deposited in the terrestrial system rather than transferred into the aquatic system. This is much greater than the high concentration of SOC in grain size fraction <32 $\mu$m would suggest; 3) the SOC re-deposited in the terrestrial system is more likely to be mineralized than the SOC in fine particles which would be transferred into the aquatic system. Our observations indicate that 1) aggregation reduces the likely transport distances of eroded SOC, and thus decreases the likelihood of eroded SOC to be transferred from eroding hill-slopes to the aquatic system; 2) the re-deposited SOC in the terrestrial system is more likely to be mineralized than the SOC in fine particles that could be transferred into the aquatic system. These findings highlight a potentially higher contribution of erosion to atmospheric $CO_2$ than anticipated by estimating source for sink transfer without considering the effects of aggregation.