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Using settling velocity to assess movement and fate of soil organic carbon after erosion

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Soil erosion affects soil organic carbon (SOC) dynamics by redistributing SOC within watersheds, including terrestrial and aquatic environments and thus the greenhouse gas release into the atmosphere. But the movement and fate of SOC after erosion is poorly understood. Most SOC is moved in aggregates of varying size, shape and density. Aggregation therefore affects the transport distance of the eroded SOC and the distribution of deposited SOC between eroding site and a water body. Large aggregates are likely to be deposited immediately after detachment, while smaller ones move on, either further downslope of even to rivers and lakes. Determining the aggregate properties relevant for transport distance (size, shape and density) and their SOC content and quality of organic matter is difficult. Settling velocity integrates these properties into one measurement which also offers the opportunity of fractionating the organic matter according to its likely transport distance in a small watershed.

In this study, a settling tube (2 m long) was used to measure the settling velocity distribution of sediment generated during a rainfall event. Two soils of different texture (silt loam vs. sand) were exposed to rainfall intensity of 40 mm h-1 for 3 hours. After collection, the fresh sediment was immediately transferred into the settling tube. Based on the settling velocities the eroded sediment was classified into different groups: > 0.05, 0.05-0.017, 0.017-0.003, 0.003-0.001 and < 0.001 m/s (according to Stokes' Law). Weight and size distribution, and SOC content within each group were measured. Our results show that: 1) most sediment (> 80%) were of sizes > 63 μm and settled down within 10 min, carrying most SOC (> 85%); 2) fine particles (< 20 μm) with high SOC concentration settled more slowly (longer than 90 min) and contained only a small amount of total SOC (due to small amount of fine particles). In conclusion, most of the SOC would have been deposited and re-distributed across the landscape along with the larger sized fragments (> 63 μm). These larger fragments/aggregates would be subject to further erosion or mineralization while small particles which are highly enriched in SOC would have been transferred into water bodies and would cause changes in aquatic system. The results are somewhat surprising because they infer that the enrichment of SOC associated with the clay fraction in soils does not translate directly into an enrichment of SOC in suspended sediment. They indicate, however, that an understanding of the SOC distribution in eroded soil particles, their settling velocity and change during transport is required to assess SOC movement between eroding sites and water bodies.