Aggregates reduce transport distance of soil organic carbon: are our balances correct?

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The effect of soil erosion on global carbon cycling, especially as a source or sink for greenhouse gases, has been the subject of intense debate. The controversy arises mostly from the lack of information on the fate of eroded soil organic carbon (SOC) whilst in-transit from the site of erosion to the site of longer-term deposition. Solving this controversy requires an improved understanding of the transport distance of eroded SOC, which is principally related to the settling velocity of sediment fractions that carry the eroded SOC. Although settling velocity has already been included in some erosion models, it is often based on mineral particle size distribution. For aggregated soils, settling velocities are affected by their actual aggregate size rather than by mineral particle size distribution. Aggregate stability is, in turn, strongly influenced by SOC. In order to identify the effect of aggregation of source soil on the transport distance of eroded SOC, and its susceptibility to mineralization after transport and temporary deposition, a rainfall simulation was carried out on a silty loam. Both the eroded sediments and undisturbed soils were fractionated into six different size classes using a settling tube apparatus according to their settling velocities: >250, 125 to 250, 63 to 125, 32 to 63, 20 to 32 and <20 mu m. Weight, SOC content and instantaneous respiration rates were measured for each of the six class fractions. Our results indicate that (1) 41% of the eroded SOC was transported with coarse aggregates that would be likely re-deposited down eroding hillslopes, rather than with fine particles likely transferred to water courses; (2) erosion was prone to accelerate the mineralization of eroded SOC, and thus might contribute more CO2 to the atmosphere than current estimates which often ignore potential effects of aggregation; (3) preferential deposition of SOC-rich coarse aggregates potentially causes an increase of SOC remaining in the colluvial system and a reduction of SOC flux to the alluvial or aquatic system. These findings identify a potential error of overestimating net erosion-induced carbon sink effects, and thus add an additional factor to consider when improving our current understanding of SOC erosion and deposition on hillslopes.
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