

Interactive
Comment

Interactive comment on “Aggregates reduce transport distance of soil organic carbon: are our balances correct?” by Y. Hu and N. J. Kuhn

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Dear Referee:

Thank you very much for your time and comments. Your suggestions are appreciated and helpful to improve the manuscript. Below are our replies to the individual questions.

(1) The soil preparation in the flume may represent in a best case one field situation, while many others can be expected in the field (depending e.g. on soil moisture, tillage operations, temp., earth worm activity ...). Hence, a transfer of results to similar soil seemed to be impossible.

Answer: We understand your concerns in terms of extrapolating data from a single soil type under certain simulated rainfalls to global scales. As stated in our manuscript, the

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potentially significant deposition of eroded SOC within the terrestrial system inferred from this study aims at illustrating the risk of overestimating the erosion-induced CO₂ sink strength, rather than quantitatively determining the significance of such biased estimation. Similar concerns have also been raised by several other referees on the way the risk was calculated in this paper. However, Referee 9 also acknowledges that the estimation in this study is put in a proper perspective. Therefore, we would prefer to still draw attention to the comparison in the paper, but without too specific numbers to justify the uncertainty. In order to accurately deliver our statement, the relevant section will be changed in the revised manuscript:

A 15.5% SOC enrichment of sediment re-deposited in the terrestrial system would imply a corresponding reduction in lateral SOC transfer between eroding and all colluvial depositional sites. The percentage of such enrichment corresponds to the proportion of eroded SOC estimated to be deposited in permanent sinks (e.g., 0.12 Pg yr⁻¹ by van Oost et al. 2007). While the effects of aggregation on SOC redistribution and subsequent fate cannot be assessed based on one experiment, most sediment is transported in form of aggregates (Walling, 1988; Walling and Webb, 1990). Ignoring the effect of aggregation on erosion and redistribution of SOC, therefore, bears the risk of overestimating the erosion-induced carbon sink effect. As a consequence, the behavior of aggregated sediment requires a reconsideration of existing approaches. Further study of different soil types, their aggregation and aggregate breakdown while moving through landscapes of varying topography during rainfall events of different intensity, frequency and duration, is required to assess the relevance of aggregation for SOC movement and fate identified in this study.

(2) The transport mechanisms in the flume only partly address all processes involved when transporting soil from erosional sites into water bodies (e.g. aggregate breakdown during prolonged transport with water).

Answer: We agree with your concerns that further breakdown of aggregates into fine particles during transport process can potentially increase the transport distance of

eroded SOC and thus increase the likelihood of eroded SOC to be transferred into rivers. However, previous research has pointed out that sediment delivery ratios are up to 90% smaller than soil erosion rates even in catchments with soils of fine texture where all soil particles should move as suspended load (Walling, 1983; Beuselinck et al., 1999b, 1999c; Parsons et al., 2006). This demonstrates that most of the eroded sediments are re-deposited during transport processes (Beuselinck et al., 2000). There could be two possible explanations: 1) sediment is not eroded and transported by mineral particles, but in form of aggregates (Beuselinck et al., 1999c). Aggregates do not move that far as individual mineral particles, due to the accelerated settling velocity of aggregates by the greater masses and larger sizes. 2) Runoff is not always continuous, but of certain transport capacity. So, preferential deposition occurs along the transport pathway, once aggregates are out of the transport capacity of runoff.

In addition, we assume that the aggregate size distribution during prolonged transport processes would not significantly change. The proportional composition of the six EQS classes in each sediment collection interval did not significantly differ over rainfall time (ANOVA, single factor, $P > 0.05$, $n=18$). Experiments from other colleague (Xiao et al., in preparation) also show that increasing raindrop impact to aggregates, within a certain extent, does not reduce aggregate size distribution much more. In future study, more simulation as well as field experiments will be carried out to investigate the effects of various transport processes (such as slope length, slope gradients, field barriers) onto the mechanism of aggregate breakdown and aggregate specific SOC distribution.

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