Does aggregation skew slope-scale SOC balances?

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1. Introduction

The effect of soil erosion on global carbon cycling, especially as source or sink of GHGs is subject to an intense debate. The controversy arises mostly from the lack of information on **the fate of eroded soil organic carbon (SOC) while moving from the site of erosion to the site of permanent deposition**.

Solving this controversy requires an improved understanding of the transport distance of eroded SOC, as this is principally related to the settling velocity of sediment fractions carrying 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.

2. Methods

A rainfall simulation was carried out on a silty loam. The eroded sediments were fractionated into six different classes according to their settling velocities (Figure 1). Based on these settling velocities, sediment was distinguished based on potential terrestrial deposition or transfer to watercourses.

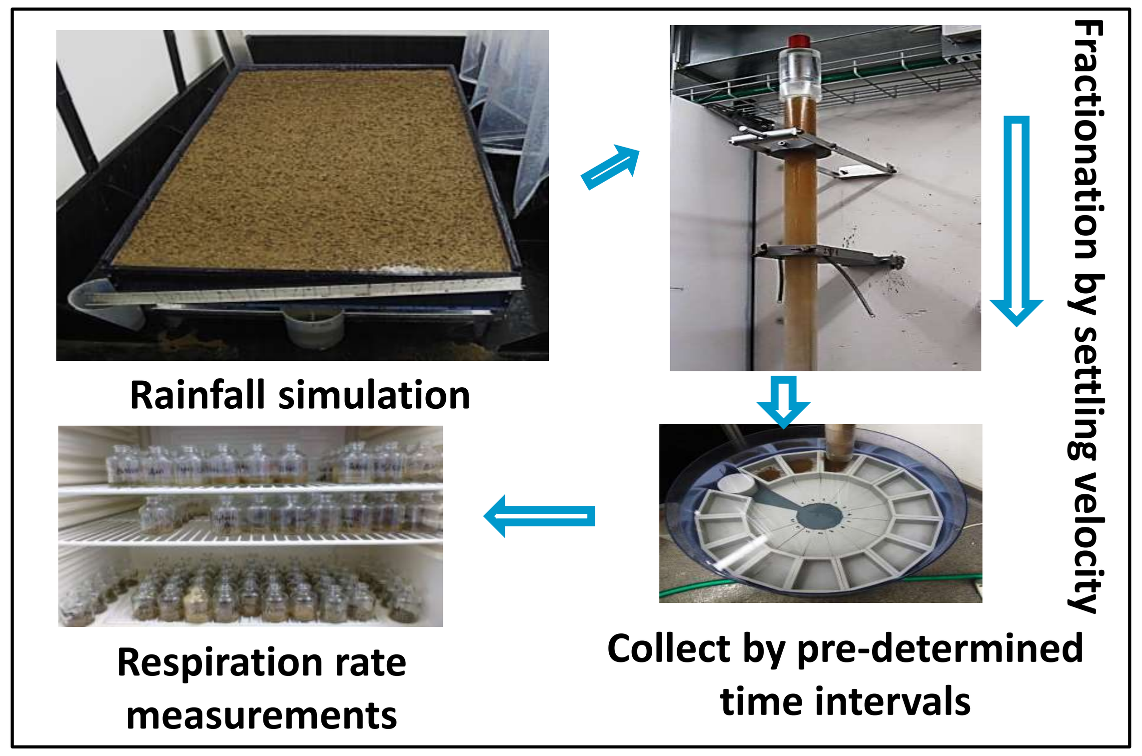

Figure 1. Experimental set-up

3. Results

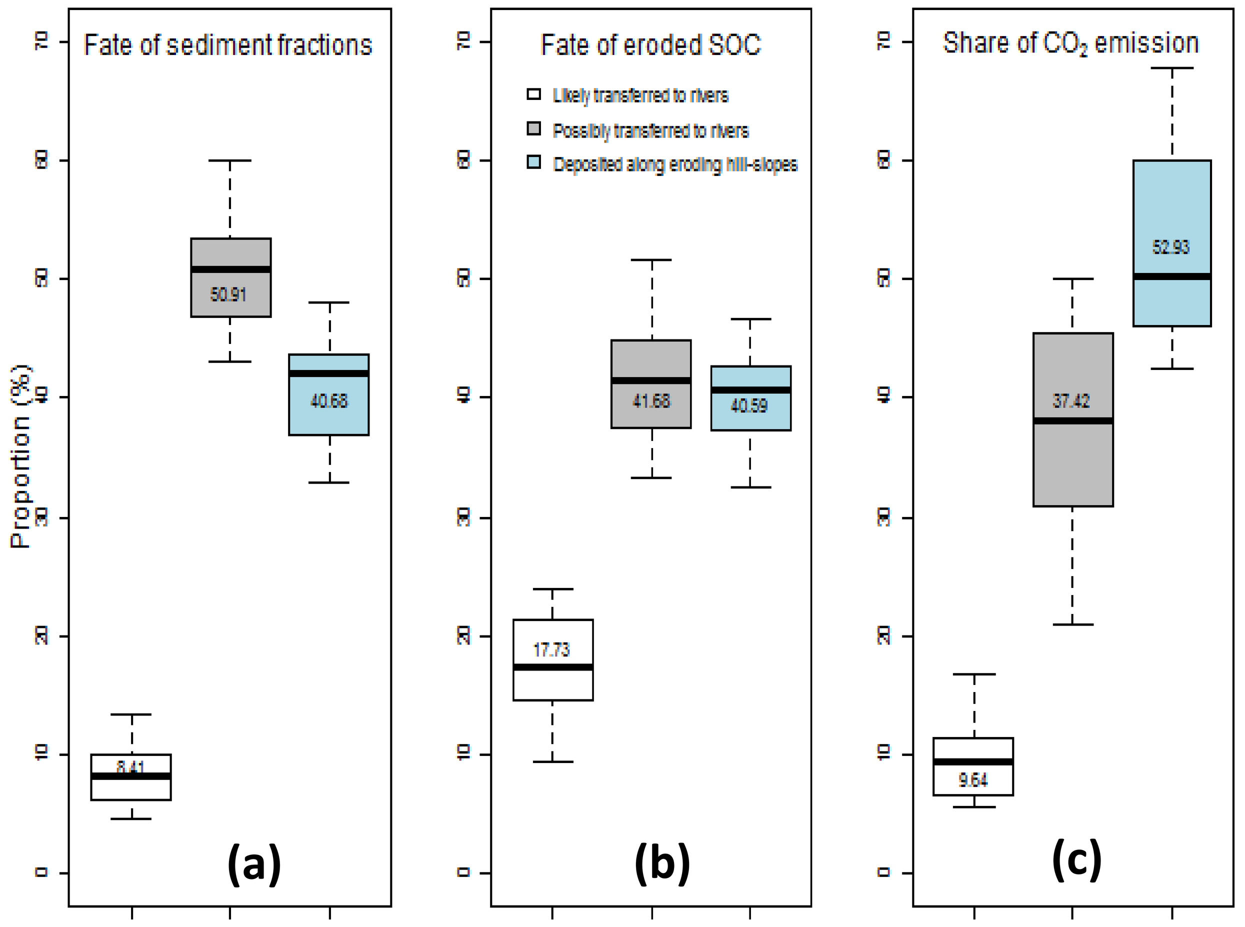

Figure 2. The likely fate of sediment fractions (a), eroded SOC (b), and potential share of CO_2 emission (c) by fractions that would have been likely transferred to rivers, possibly transferred to rivers, and deposited along eroding hill-slopes. The bar in box represents the median value, while numbers written in each box denote the average value. (N = 18)

<u>Distribution of sediment fractions</u>

About 41% of the eroded fractions would be re-deposited in the terrestrial system (Figure 2a). This is strongly contrasting with their mineral grain size distribution (10% terrestrial deposition).

<u>Likely fate of eroded SOC</u>

Aggregation also increased terrestrial SOC deposition by 31% compared to SOC associated with fast settling mineral grains (Figure 3a, b). If the SOC stocks on the SOC-enriched colluvial depositional site is applied to build the carbon balances (Figure 3a), the SOC loss from eroding site would be over-estimated, and vice versa.

<u>Accelerated SOC mineralization</u>

The landscape-deposited SOC generated 53% of the entire instantaneous respiration (Fig. 2c). This implies the immediately deposited SOC is more susceptible to mineralization than the mass of coarse sediment fractions and their SOC would predict.

4. Implications

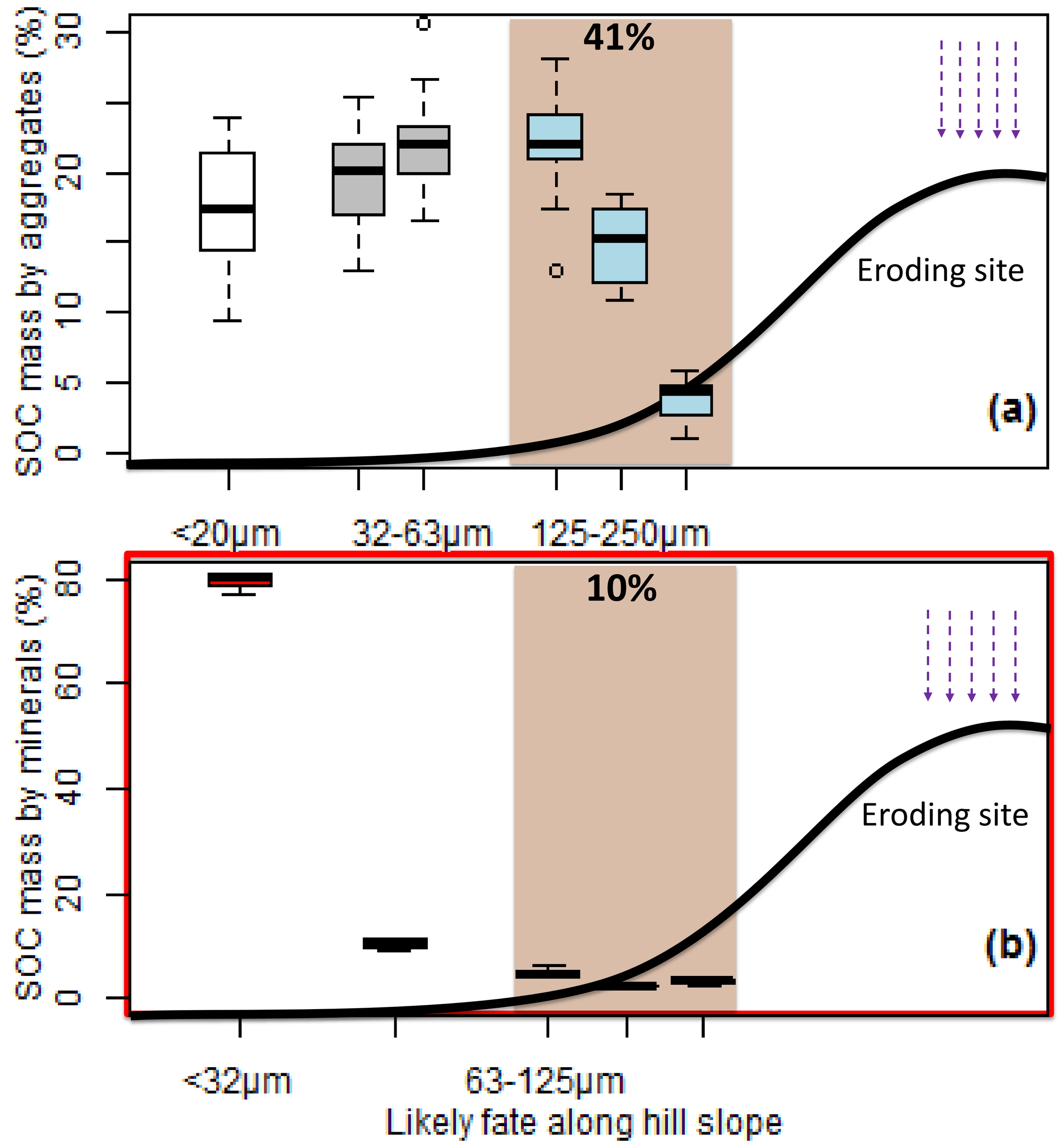

Figure 3. The likely fate of eroded soil organic carbon (SOC) along hill slopes predicted by aggregate size distribution (a), and by mineral particle size distribution (b). The shaded area marks the colluvial depositional site.

5. Conclusions

Aggregation of source soil, and thus that of sediment, considerably reduces the transport distance of eroded SOC, and hence skews its re-deposition towards the terrestrial system.

Carbon balances built only on either SOC stocks from sites of erosion or colluvial deposition may not adequately consider the potential effect of aggregation on SOC re-distribution and subsequent fate in the terrestrial system.

<u>**Yaxian Hu's publications:**</u>

Hu, Y., Fister, W., Rüegg, H. R., Kinnell, P. I. A. and Kuhn, N. J.: The use of Equivalent Quartz Size and settling tube apparatus to fractionate soil aggregates by settling velocity, Geomorphol. Tech. Online Ed. Br. Soc. Geomorphol., Section 1.1.1, 2013.

Hu, Y., Fister, W. and Kuhn, N. J.: Temporal variation of SOC enrichment from interrill erosion over prolonged rainfall simulations, Agriculture, 3(4), 726–740, 2013.

Hu, Y., and Kuhn, N. J.: Aggregates reduce transport distance of soil organic carbon: are our balances correct? Biogeosciences (accepted).

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