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Selective nature and inherent variability of interrill erosion across prolonged rainfall simulation

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Sediment of interrill erosion has been generally recognized to be selectively enriched with soil organic carbon (SOC) and fine fractions (clay/silt-sized particles or aggregates) in comparison to source area soil. Limited kinetic energy and lack of concentrated runoff are the dominant factors causing selective detachment and transportation. Although enrichment ratios of SOC (ERsoc) in eroded sediment were generally reported > 1, the values varied widely. Causal factors to variation, such as initial soil properties, rainfall properties and experimental conditions, have been extensively discussed. But less attention was directed to the potential influence of prolonged rainfall time onto the temporal pattern of ERsoc. Conservation of mass dictates that ERsoc must be balanced by a decline in the source material which should also lead to a reduced or even negative ERsoc in sediment over time. Besides, the stabilizing effects of structural crust on reducing erosional variation, and the unavoidable variations of erosional response induced by the inherent complexity of interrill erosion, have scarcely been integrated. Moreover, during a prolonged rainfall event surface roughness evolves and affects the movement of eroded aggregates and mineral particles.

In this study, two silt loams from Möhlin, Switzerland, organically (OS) and conventionally farmed (CS), were exposed to simulated rainfall of 30 mm h-1 for up to 6 hours. Round donut-flumes with a confined eroding area (1845 cm2) and limited transporting distance (20 cm) were used. Sediments, runoff and subsurface flow were collected in intervals of 30 min. Loose aggregates left on the eroded soil surface, crusts and the soil underneath the crusts were collected after the experiment. All the samples were analyzed for total organic carbon (TOC) content, and texture. Laser scanning of soil surface was applied before and after the rainfall event. The whole experiment was repeated for 10 times.

Results from this study showed that: 1) ERsoc in eroded sediment increased at first, then reached steady state and declined afterwards, corresponding well with the formation and completion of structural crust and conservation of mass; 2) the effect of structural crust on stabilizing the surface condition and reducing variation of erosional response was more apparent once steady state discharge was achieved ; and 3) both texture and TOC content in crusts and soil underneath the crusts were comparable to parent soil, explaining the decline in ERsoc.

In conclusion, the experiment showed that crusting and conservation of mass lead to a decline and even negative enrichment of organic matter in interrill sediment over time. Enrichment of organic matter should therefore be reported only in conjunction with information about the stage of crust development observed during an erosion event.