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Soil organic carbon erosion from two silty loam soils – a laboratory rainfall experiment

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The development of enrichment or depletion of soil organic carbon in sediment, in relation to the eroding soil, is one of the key-questions for understanding the influence of soil erosion on the global carbon cycle. The gap of knowledge has been filled considerably over the last years in terms of budgeting organic carbon fluxes and estimation of erosion rates. However, on the process level many questions are still not well understood. One issue is the understanding of the detachment and transport behavior of organic carbon (spatially and in time) in dependence on rainfall characteristics and soil properties (e.g. soil texture, aggregate stability). For improving the quality of prediction of sediment transport models it is necessary to know which soil fractions experience an enrichment in organic carbon content and how this situation changes over time. The objective of this laboratory rainfall experiment was therefore to evaluate the development and transfer of organic carbon content in soil and sediment depending on soil treatment (conventional vs. organic), soil roughness, crust development, grain size, density, and time. Furthermore, the study aimed at describing the "natural variability" of enrichment and depletion of organic carbon content in different size fractions for identical soil samples.

Soil from an organic and conventionally farmed land near Basel, Switzerland, was exposed to a 6h rainfall with mean intensity of 31 mmh-1. The experiment was repeated 10 times with same conditions. For each test two round flumes (diameter of 0.5m) were used. The slope of the soil surface was 10% and soil texture was silty loam. Runoff rate, infiltration rate, sediment detachment rate and rainfall intensity were recorded during the 6 hours experiment. Texture, density, and organic carbon content was analyzed separately for intervals of 30min from sediment, loose aggregates on the surface, crusts, and soil underneath the crusts. In addition, soil surface roughness measurements by means of a point laser scanner were accomplished before rainfall, after pre-wetting (for 1h, 24hs prior simulation), and after rainfall application.

The results show that runoff developed earlier on conventionally farmed soil than on organic soil. Accordingly, the sediment detachment rate from conventional soil (6 g h-1) was higher than from organic soil (3.97 g h-1). Highest quantity of organic carbon was transported in size class 32-63μm. A slight difference in organic carbon content in sediment, crusts, soil underneath and original soil could be observed. In conclusion, the aggregates of the organic farmed soil proved to be more resistant to rainfall and therefore experienced less soil and carbon erosion.