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Landscape deposition of Carbon after rill erosion

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Conventionally, sediment generated by rill erosion is considered to have identical properties to the soil it is derived from because of the non-selective nature of rill erosion. However, this assumption is not valid once the rill sediment is transported through an agricultural landscape. Here a differentiation of sediment may occur due to cyclic rilling or changes in topography and flow obstruction, e.g. at field borders. In undisturbed rill systems, a regular pattern of erosion and deposition evolves due to the cyclic nature of energy expenditure on erosion and transport. Deposition of sediment is not uniform, but affects large particles first. Similar differentiation of sediment also occurs when rills are obstructed at the edges of fields or when slope angles are declining. Organic C content of sediment varies with grain size. Therefore, deposition of rill sediment leads to a differentiation of C content of both the deposited sediment and the sediment that is transported further downslope.

In this study, soil and rill sediment organic C-data collected in March 2008 after the storm "Emma" near the town of Oberkail (50°02′[U+F020]N, 6°43′[U+F020]E) in the Eifel region of Germany are presented. To ensure that spatially averaged values of organic C content were achieved, sampling of soil and rill sediment was conducted along bodies of sediment deposition and the rills which had delivered the deposited sediment. A pairwise comparison of source area soil and corresponding rill sediment confirmed that the soil had a significantly higher organic C content than the sediment. Consequently, the sediment that remained in suspension had a higher organic C content than the sediment deposited at rill mouths and field edges. Such differentiation of sediment along its pathway through a geomorphic system highlights a critical issue for estimating the organic C balance along slopes. "Balance" is based on the assumption that sediment moved from a source to a sink does not change in quality. Our data indicate that the differentiation of rill sediment causes an enrichment of organic C in the sediment with distance from the source area. The degree of C enrichment depends on the nature of the landscape system the sediment is moving through, i.e. whether it is hydraulically "rough" or "smooth" surface. Assuming constant C contents of sediment moved by rill erosion throughout a watershed may therefore lead to an underestimation of organic C exports from slopes to rivers or an overestimation of slope C erosion, depending on whether erosion rates are based on the C content of soil or alluvial deposits. Geomorphologic research should therefore focus on developing a good understanding of hillslope-channel coupling not only for sediment, but also organic C.