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Soil carbon redistribution by water erosion at the catchment level in an intensively cultivated area: characteristics, budgets and implications

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Large uncertainties still exist on both the rates of soil organic carbon (SOC) mobilization by erosion as well as the fate of eroded C. Using a range of techniques we characterized soil carbon redistribution during water erosion in small agricultural catchments in Belgian Loess Belt. We used rainfall simulation, field surveys as well as flux monitoring to quantify C mobilization and C fluxes at various scales. Laboratory analysis such as grain size analysis as well as C, N and13C determination were used to investigate the relationships between sediment and C mobilization as well as the characteristics of eroded C. Results from rainfall simulations indicated a high selectivity during interrill erosion processes with the mobilized sediments having on average a clay enrichment ratio of 1.36 times and a carbon enrichment ratio of 2.47 times. Selectivity was also observed in depositional processes: sediment deposits were more depleted in carbon and finer fractions compared to the source soil. Selectivity was much more pronounced in winter than in summer, which is related to the degree of aggregation of the transported/deposited sediment. The selectivity of erosion and depositional processes resulted in a significant carbon enrichment of the exported sediment: enrichment ratios varied both with the season and with the intensity of the event. The uncertainties on catchment-wide erosion and deposition rates precluded the closure of the sediment-carbon budgets. However, both the magnitude and variation of the catchment-level carbon enrichment ratio was as expected from our understanding of carbon mobilization and deposition within the catchment, suggesting that most of the mobilized carbon was not mineralized but either re-deposited within the catchment or exported with the runoff. Similarly, comparison of the elemental and isotopic signatures between exported sediments and source soil implied no significant mineralization during sediment transport processes. Overall, enrichment ratios were higher for carbon than for exported sediment with the degree of selectivity depending on event intensity. This selectivity needs to be accounted for when catchment-wide carbon budgets are established.