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Connecting the cycles: Impact of sediment, carbon and nutrient erosion on GHG emissions

N. J. Kuhn
Department of Environmental Sciences, University of Basel, Switzerland (nikolaus.kuhn@unibas.ch)

The role of agriculture in generating greenhouse gas (GHG) emissions through the use of fertilizers and fossil fuels is well documented. The negative impacts of soil erosion on agricultural land and its productivity have also been studied extensively. The lateral movement of soil through terrestrial ecosystems has also been recognized as a significant flux of C within the global C cycle. Soil erosion removes approximately 0.5 Gt of C/a from agricultural land. Much of this C is deposited in the landscape, effectively burying the organic matter from the atmosphere and taking it, at least for an unspecified time, out of the C exchange between soil and atmosphere. Such calculations raise the notion that soil erosion generates an unintentional benefit for climate, owing to the long-term burial of soil organic C. But limiting the assessment of the impact of soil erosion on climate change to organic C burial ignores, apart from economic and social damages, the coupling between biogeochemical cycles. For example, the eroded N has to be replaced, at least in part by artificial fertilizers, to maintain soil fertility. At this point the sediment, C and N cycles meet, because the production of fertilizer generates greenhouse gases. The production of one ton of fertilizer generates on the order of 850 kg of CO_2 (West and Marland, 2002). Applying this number to the 0.5 Gt C erosion estimate, the amount of N lost owing to erosion each year yields CO_2 emissions of 0.02–0.04 Pg/a. These emissions correspond to 15–30% of the organic C buried owing to soil erosion. In this presentation, the full complexity of biogeochemical cycling on agricultural land is explored and connections between cycles which require consideration for a full GHG emission balance of soil erosion on agricultural land are identified.