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Process based modelling of soil organic carbon redistribution on landscape scale

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Recent studies have pointed out the great importance of erosion processes in global carbon cycling. Continuous erosion leads to a massive loss of top soils including the loss of organic carbon accumulated over long time in the soil humus fraction. Lal (2003) estimates that 20% of the organic carbon eroded with top soils is emitted into atmosphere, due to aggregate breakdown and carbon mineralization during transport by surface runoff. Furthermore soil erosion causes a progressive decrease of natural soil fertility, since cation exchange capacity is associated with organic colloids. As a consequence the ability of soils to accumulate organic carbon is reduced proportionately to the drop in soil productivity. The colluvial organic carbon might be protected from further degradation depending on the depth of the colluvial cover and local decomposing conditions. Some colluvial sites can act as long-term sinks for organic carbon. The erosional transport of organic carbon may have an effect on the global carbon budget, however, it is uncertain, whether erosion is a sink or a source for carbon in the atmosphere. Another part of eroded soils and organic carbon will enter surface water bodies and might be transported over long distances. These sediments might be deposited in the riparian zones of river networks. Erosional losses of organic carbon will not pass over into atmosphere for the most part. But soil erosion limits substantially the potential of soils to sequester atmospheric CO_2 by generating humus.

The present study refers to lateral carbon flux modelling on landscape scale using the process based EROSION 3D soil loss simulation model, using existing parameter values.

The selective nature of soil erosion results in a preferentially transport of fine particles while less carbonic larger particles remain on site. Consequently organic carbon is enriched in the eroded sediment compared to the origin soil. For this reason it is essential that EROSION 3D provides the grain size distribution (clay, silt and sand) of the transported sediment.

A test slope is modeled covering certain land use and soil management scenarios referring to different rainfall events. Results allow first insights on carbon loss and depletion on sediment delivery areas as well as carbon gains and enrichments on deposition areas on landscape scale.

Lal, R. (2003). Soil erosion and the global carbon budget. Environment International vol. 29: 437-450.