



## Turnover of eroded soil organic carbon after deposition in terrestrial and aquatic environments

Frédérique Kirkels (1), Erik Cammeraat (1), Karsten Kalbitz (2), Kristof van Oost (3), Ruth Ellerbrock (4), Stéphane Follain (5), Lucia Fuchslueger (6), Horst Gerke (4), Goswin Heckrath (7), Ingrid Kögel-Knabner (8), Nikolaus Kuhn (9), Emiel van Loon (10), John Quinton (11), Andreas Richter (6), Sébastien Salvador-Blanes (12), Michael Sommer (4), and Markus Steffens (8)

(1) University of Amsterdam, Earth Surface Science, Institute for Biodiversity and Ecosystem Dynamics, Amsterdam, Netherlands (frederiquekirkels@gmail.com), (2) Dresden University of Technology, Institute of Soil Science and Site Ecology, Dresden, Germany, (3) Université catholique de Louvain, Earth and Life Institute, Louvain-la-neuve, Belgium, (4) Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Soil Landscape Research, Müncheberg, Germany, (5) Montpellier SupAgro, UMR LISAH, Montpellier, France, (6) Department of Microbiology and Ecosystem Science, Terrestrial Ecosystem Research, University of Vienna, Austria, (7) Aarhus University, Department of Agroecology, Aarhus, Denmark, (8) Technische Universität München, Lehrstuhl für Bodenkunde, Department for Ecology and Ecosystem Management, Freising, Germany, (9) University of Basel, Physical Geography and Environmental Change, Basel, Switzerland, (10) University of Amsterdam, IBED, Computational Geo-Ecology, Amsterdam, The Netherlands, (11) Lancaster University, Lancaster Environment Centre, Lancaster, United Kingdom, (12) University of Tours, GéHCO, Tours, France.

The fate of eroded soil organic carbon (SOC) after deposition is a large uncertainty in assessing the impact of soil erosion on C budgets. Globally, large amounts of SOC are transported by erosion and a substantial part is transferred into adjacent inland waters, linking terrestrial and aquatic C cycling. However, the net effect on C fluxes between soils, inland waters and atmosphere remains uncertain. In this study, we determined SOC turnover in terrestrial and aquatic environments and identified its major controls.

A European gradient of agricultural sites was sampled, spanning a wide range soil properties (e.g. texture, aggregation, etc.), SOC quantity and quality. In a 16-week incubation experiment, SOC turnover was determined for conditions reflecting downslope soils or inland waters. Moreover, we studied the impact of labile C inputs ('priming') on SOC stability using  $^{13}\text{C}$  labeled cellulose. Physical and chemical soil properties and SOC molecular composition were assessed as potential controls on C turnover. SOC deposition in aquatic environments resulted in up to 3.5 times higher C turnover than deposition on downslope soils. Labile C inputs enlarged total  $\text{CO}_2$  emissions, with the largest increase for aquatic conditions. Solid-state  $^{13}\text{C}$  NMR and FT-IR spectroscopy showed broad similarities in SOC molecular composition. Soil and SOC properties could not (yet) fully explain variation in SOC turnover between the sites. However, temporal trends in  $\text{CO}_2$  emissions clearly differed between downslope soils and inland waters. We established a quantitative model, based on the ten sites of the European gradient, that is capable to describe  $\text{CO}_2$  emissions for SOC deposited on soils and in inland waters and upon different levels of labile C inputs. Our findings indicate that deposition conditions (soils vs. inland waters) play a crucial role in determining C turnover. Erosion measures preventing deposition in aquatic environments could therefore be an important carbon saving strategy. We envisage that these quantitative results can be used to parameterize biogeochemical models and contribute to better estimates of the impact of soil erosion on C budgets and reduce uncertainties in the link between terrestrial and aquatic C cycling.