Erosion-induced exposure of SOC to mineralization in aggregated sediment

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 3720518
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Year 2016
Title Erosion-induced exposure of SOC to mineralization in aggregated sediment
Journal CATENA
Volume 137
Pages / **Article-Number** 517-525

During slope-scale erosion events, re-distribution of eroded soil and the associated soil organic carbon (SOC) is not always uniform, but very often affected by preferential transport and deposition. Under given flow conditions, the site of SOC deposition depends on the transport distances of sediment particles containing the SOC. Very often, soil and SOC erosion risk are assessed by applying mineral particle specific SOC distributions to erosion models. However, soil is not always eroded as individual mineral particles, but mostly in a form of aggregates. Aggregates are likely to increase settling velocities of individual mineral particles, which may considerably reduce the transport distance of sediment fractions and the associated SOC, skewing SOC redistribution and its subsequent fate. Yet, little is known about the potential effects of aggregation on the movement and fate of eroded SOC. To assess the effect of preferential deposition, a simulated rainfall was applied to two soils in this study, with the Movelier silty clay having greater SOC content and aggregate stability than the Möhlin silty loam. The eroded sediments of the two soils were fractionated by a settling tube apparatus according to their potential transport distances. The CO2 emissions of the fractionated and incubated sediments were then measured for 50 days enabling the assessment of the bioactivity of eroded SOC for weeks after deposition. Our results show that: 1) the re-deposition of eroded SOC into terrestrial systems increased by 64% if considering the actual aggregate specific rather than the mineral particle specific SOC distribution. 2) The CO2 emission rates differed across settling fractions, with the most pronounced rates in the finest fractions from the Möhlin silty loam sediment and in the medium-size fractions from the Movelier silty clay sediment. 3) Over 50-day incubation, the CO2 emissions from the Möhlin silty loam sediment was 114% greater than that from the non-eroded Möhlin soil, whereas CO2 emissions were roughly equivalent for the Movelier sediment and non-eroded Movelier silty clay. These data demonstrate that erosion and preferential deposition of SOC-enriched aggregates can enhance terrestrial SOC deposition. This can further result in greater CO2 efflux than commonly applied mineral particle size specific SOC distribution would suggest. The different performances of deposition and CO2 emissions between the two soils also suggest that these effects can vary with soil type. Our observations certainly illustrate that sediment aggregation requires further investigation to assess the redistribution and subsequent fate of eroded SOC appropriately.

Publisher Elsevier
ISSN/ISBN 0341-8162 ; 1872-6887
edoc-URL http://edoc.unibas.ch/53305/
Full Text on edoc No;
Digital Object Identifier DOI 10.1016/j.catena.2015.10.024
ISI-Number 000367635800050

Document type (ISI) Article