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Mechanisms of interrill soil erosion: Modelling the transfer and size distribution of eroded size fragments

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The size distribution of the soil controls both the quantity and the composition of eroded soil fragments. For example, the quick settling of coarse soil fragments during overland-flow transfer leads to a decrease of the exported sediment flux. The exported sediment are also subsequently enrich in fine fractions which have a high affinity for pollutants. The size distribution of the original soil is controlled by its structural characteristics, in particular its aggregate stability. The link between soil structure and water erosion is acknowledged but remains poorly described. The work presented here aims to investigate the relation between soil aggregate stability and the quality and the quantity of sediment delivery.

A set of laboratory experiments was carried on to describe the size characteristics of soil fragments produced by the different processes that occur during an interrill erosion event: breakdown, movement initiation by raindrops, splash transfer and overland-flow transport. Different soils, with various susceptibilities to erosion, were submitted to rainfall simulations in different experimental devices. The breakdown dynamic of soil aggregates was analysed and compared with a method of aggregate stability measurement. The effects of raindrop impact on movement initiation, splash transfer and overland-flow transport were studied by comparing the size distributions of the resulting soil fragments. Mass balance budgets were computed with the measured fluxes of eroded material.

The analysis of these results improved our understanding of the physical mechanisms that control the interrill erosion processes. Particularly, a preferential movement initiation and overland-flow transport of respectively the 20-1000 µm and the < 250 µm soil fragments were identified. This work showed also that the aggregate stability tests proposed by Le Bissonnais (1996) are able to simulate the breakdown of aggregates due to rainfall. A model for the prediction of sediments export by interrill erosion was designed from these data. The modelling approach includes aggregate stability measurements as inputs. This model is a first step towards the integration of soil structural dynamics in the physically-based modelling of water erosion.