Geophysical Research Abstracts
Vol. 19, EGU2017-5990, 2017
EGU General Assembly 2017

Relationships between slope erosion processes and aggregate stability of Ultisols from subtropical China during rainstorms

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Soil aggregates, being a key soil structural unit, influence several soil physical properties such as water infiltration, runoff and erosion. The relationship between soil aggregate stability and interrill and rill erodibility is unclear but critical to process-based erosion prediction models. One obvious reason is that it is hard to distinguish between interrill and rill-eroded sediment during the erosion process. This study was designed to partition interrill and rill erosion rates and relates them to the aggregate stability of Ultisols in subtropical China. Six kinds of rare earth element (REE) were applied as tracers mixed with two cultivated soils derived from the Quaternary red clay soil and the shale soil at six slope positions. Soil aggregate stability was determined by the Le Bissonnais (LB)-method. Simulated rainfall with three intensities (60, 90 and 120 mm/h) were applied to a soil plot (2.25 m long, 0.5 m wide, 0.2 m deep) at three slope gradients (10°, 20° and 30°) with duration of 30 min after runoff initiation. The results indicated that interrill and rill erosion increased with increasing rainfall intensity and slope gradient for both types of soil. Rill and interrill erosion rates of the shale soil were much higher than those of the Quaternary red clay soil. Rill erosion contribution enhanced with increasing rainfall intensity and slope gradient for both soils. Percentage of the downslope area erosion to total erosion was the largest, followed by the mid-slope area and then upslope area. Equations using an aggregate stability index As to replace the erodibility factor of interrill and rill erosion in the Water Erosion Prediction Project (WEPP) model were constructed after analyzing the relationships between estimated and measured rill and interrill erosion data. It was shown that these equations based on the stability index, As, have the potential to improve methods for assessing interrill and rill erosion erodibility synchronously for the subtropical Ultisols by using REE tracing method.