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Soil erosion by surface runoff at the landscape scale: Is event size important?

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Quantifying the relative importance of low intensity-high frequency and high intensity-low frequency erosion events in long-term erosion studies is challenging given the lack of long-term observations, especially at larger spatial scales. Information on statistical distributions of soil loss is important to optimize management practices and to simulate the future effects of erosion on soil properties. For example, conservation strategies have often been set up based on average erosion rates derived from plot studies, but these might be insufficient during extreme rainfall events. Furthermore, most long-term erosion models or erosion modules in soil simulation models use an average annual soil erosion rate, which is constant over time, the basic assumption therefore being uniformitarism. An inherent problem in long-term modelling is the frequent use of the USLE as a basis for erosion prediction, whereas the USLE was not designed to be used as a tool to estimate frequency distributions of soil loss but to average out variability.

Several long-term soil erosion assessments exist but it is clear that these studies do not provide a conclusive answer to the question whether the size of an event is important when assessing the long-term effects of soil erosion. This reflects, to some extent, the difficulties and uncertainties associated with evalating long-term soil erosion rates and measuring soil loss during infrequent extreme events. Continuous measurement series are usually based on small, standard erosion plots covering 5-10 years, sometimes up to 30 years. Due to the small scale, these studies do not include intensive soil loss due to rills and gullies or deposition. On the other hand, much of the temporal detail is lost when moving to larger scales. Detailed studies at the field- or catchment scale exist but they usually cover a limited time period or only provide an average erosion rate. It is therefore clear that the absence of reliable soil loss frequency distributions at the landscape scale hampers the predictive power of soil erosion models and the establishment of effective soil conservation management strategies.

The objective of this paper is to build and apply a continuous simulation model that represents the natural variability in climate, soil conditions, land use and other dynamic factors that cause erosion variability at the landscape scale. The role of event size on both rates and patterns of soil erosion will be evaluated by using measured long-term rainfall records for a period of 100 years. The results of these numerical experiments are presented and are discussed in relation to the role of event size and spatial/temporal scales.