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Soil erosion and effluent particle size distribution under different initial conditions and rock fragment coverage

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It is well known that the presence of rock fragments on the soil surface and the soil's initial characteristics (moisture content, surface roughness, bulk density, etc.) are key factors influencing soil erosion dynamics and sediment delivery. In addition, the interaction of these factors increases the complexity of soil erosion patterns and makes predictions more difficult. The aim of this study was (i) to investigate the effect of soil initial conditions and rock fragment coverage on soil erosion yields and effluent particle size distribution and (ii) to evaluate to what extent the rock fragment coverage controls this relationship. Three laboratory flume experiments with constant precipitation rate of 74 mm/h on a loamy soil parcel with a 2% slope were performed. Experiments with duration of 2 h were conducted using the 6-m $\times$ 2-m EPFL erosion flume. During each experiment two conditions were considered, a bare soil and a rock fragment-protected (with 40% coverage) soil. The initial soil surface state was varied between the three experiments, from a freshly re-ploughed and almost dry condition to a compacted soil with a well-developed shield layer and high moisture content. Experiments were designed so that rain splash was the primary driver of soil erosion.

Results showed that the amount of eroded mass was highly controlled by the initial soil conditions and whether the steady-state equilibrium was un-, partially- or fully- developed during the previous event. Additionally, results revealed that sediment yields and particle size composition in the initial part of an erosion event are more sensitive to the erosion history than the long-time behaviour. This latter appears to be mainly controlled by rainfall intensity. If steady-state was achieved for a previous event, then the next event consistently produced concentrations for each size class that peaked rapidly, and then declined gradually to steady-state equilibrium. If steady state was not obtained, then different and more complex behaviour was observed in the next event, with large differences found between fine, medium and coarse size classes. The presence of rock fragments on the topsoil reduced the time needed to reach steady state compared with the bare soil. This was attributed to the reduction of rain splash erosion caused by the rapid development of the overland flow, as a result of rock fragments reducing the flow cross-sectional area.