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Estimation of rainfall-driven soil erosion from different rainfall intensities, exposed areas and initial soil conditions

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The factors influencing the rain-splash soil erosion include rainfall characteristics, area exposed to raindrops and soil properties. Understanding of these factors and of their interactions is crucial for better predictions of soil erosion yields. To this end, laboratory flume experiments were conducted varying the precipitation rate, the fraction of exposed soil area and initial soil conditions. The discharge rate and concentrations of individual size classes were measured at the flume outlet. These data were used to investigate the dependence of soil sediment yield on the precipitation rate, area exposed and soil initial conditions. In particular, we examined the role of these factors on predicting experimental results based on a prototype experiment. Results revealed that estimates of the concentrations of individual size classes, taking the area-based approach into account, reproduce satisfactorily the measured data at steady state. It was also found that, under carefully controlled conditions, this proportionality (to area of exposed soil) holds for the entire erosive event. These findings, in terms of sediment concentrations of individual size classes, generalized previous results for the total sediment concentration. At short times, most sediment size classes have an early concentration peak, which was found not to be proportional to the area exposed and effective rainfall rate. Rather, short time behaviour is mainly controlled by the soil antecedent conditions, such as surface roughness, bulk density and soil moisture. For predictions based on precipitation rate, results showed that erosion rates based on a prototype were within a factor two of measured rates. Overall, the results indicate that, for a given soil, experimental data based on a given rainfall rate can be used as a crude estimator of the steady rate of erosion for a different rainfall rate.