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(Inclined)Rainfall simulation to assess the stream power of runoff and sediment transport

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Numerous experiments have been carried out on laboratory and on field plot scales in order to assess the different sub processes and factors involved with soil erosion. For this assumptions are made that experimentally obtained equations and/or relationships can be used to simulate the complex erosion process at the hill slope and/or (micro) watershed level.

Erosion occurs when the erosive forces, represented by the momentum flux of the raindrop impact and the momentum flux of the overland flow, exceed the cohesive forces between the soil particles and the downward component of the turbulent overland flow.

Given the fundamental principle that rainfall erosion occurs when the acting forces (raindrop impact and runoff) exceed the cohesion of the soil particles and the fact that different soil types erode at different rates, many authors searched for threshold driven detachment and transport equations. The most determining parameters in the equations are: the critical momentum flux , the mean runoff velocity, the unit stream power or the critical shear strength. However, the parameters as critical momentum flux and critical shear strength are difficult to measure and good relationships with the measured soil physical properties are lacking. And because discharges are easily measured at stream outlets, it is better to apply relationships using the discharge instead of the velocity parameter.

For the erosion process in rills and gullies, a simple but very accurate transport function using the stream power Ω concept can be used: Ω = mg S q, where ρ is the density of the water (g/cm^3), g the gravitational constant (cm/s^2), S the slope (m/m) and q the discharge per unit width (cm^2/s). Moreover, under wind-driven rains, the energy fluxes of both flow (Ωflow = ρgq$_u$S) and raindrop splash (Ωdrop=ρgI$_{wd}$d$_{50}$), with I$_{wd}$the intensity of wind-driven rain and d$_{50}$ the median raindrop diameter, are to be considered

Sediment transport models are presented based on laboratory field rainfall simulations for the sheet erosion process in which the sediment is delivered towards rills in an agricultural field. A comparison is made between the sediment transport processes under interrill erosion, typically observed during small scale laboratory simulations and the complex sediment transport processes occurring during field rainfall simulations. Finally a comparison is made with measurements of runoff and erosion events caused by natural rainfall occurring on a hillslope.

Key words: stream power, runoff, unit discharge, sediment transport, rainfall simulation, laboratory, field.