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Hydraulic parameters in eroding rills and their influence on detachment processes

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In many experiments as well in laboratory as in field experiments the correlations between the detachment rate and different hydraulic parameters are calculated. The used parameters are water depth, runoff, shear stress, unit length shear force, stream power, Reynolds- and Froude number. The investigations show even contradictory results. In most soil erosion models like the WEPP model, the shear stress is used to predict soil detachment rates. But in none of the WEPP datasets, the shear stress showed the best correlation to the detachment rate.
In this poster we present the results of several rill experiments in Andalusia from 2008 and 2009. With the used method, it is possible to measure the needed factors to calculate the mentioned parameters. Water depth is measured by an ultrasonic sensor, the runoff values are calculated by combining flow velocity and flow diameter. The parameters wetted perimeter, flow diameter and hydraulic radius can be calculated from the measured rill cross sections and the measured water levels. In the sample density values, needed for calculation of shear stress, unit length shear force and stream power, the sediment concentration and the grain density are are considered. The viscosity of the samples was measured with a rheometer.
The result of this measurements shows, that there is a very high linear correlation (R^2 = 0.92) between sediment concentration and the dynamic viscosity. The viscosity seems to be an important factor but it is only used in the Reynolds-number-equation, in other equations it is neglected. But the viscosity value increases with increasing sediment concentration and hence the influence also increases and the in multiclications negiligible viscosity value of 1 only counts for clear water. The correlations between shear stress, unit length shear force and stream power at the x-axis and the detachment rate at the ordinate show, that there is not one fixed parameter that always displays the best correlation to the detachment rate. The best hit does not change from one experiment to another, it changes from one measuring point to another. Different processes in rill erosion are responsible for the changing correlations. In some cases no one of the parameters shows an acceptable correlation to the soil detachment, because these factors describe fluvial processes. Our experiments show, that not the fluvial processes cause the main sediment procduction in the rills, but bank failure or knickpoint and headcut retreat and these processes are more gravitative than fluvial. Another sediment producing process is the abrupt spill over of plunge pools, a process not realy fluvial and not realy gravitativ. In some experiments, the highest sediment concentrations were measured at the slowly flowing waterfront that only transports the loose material. But all these processes are not considered in soil erosion models. Hence, hydraulic parameters alone are not sufficient to predict detachment rates. They cover the fluvial incising in the rill's bottom, but the main sediment sources are not considered satisying in its equations.