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Experimental validation of basic model assumptions

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In process based soil erosion models different processes are described in numerical equations. The basic of these equations is in many cases a hydraulic parameter which is linked to an erosion parameter. The most used hydraulic parameter is the shear stress from which is assumed that it shows a linear correlation to erosion parameters like detachment rate, detachment capacity or sediment concentration. From shear stress, different other hydraulic parameters like unit length shear force or different variations of stream power can be calculated. The used erosion and hydraulic parameters change between different research groups.
Another model assumption is that transport rates can not exceed transport capacities. If the transport rate / transport capacity relationship exceeds a value of 1, sedimentation processes decrease the rate until capacity is reached again.
We tested in rill erosion field experiments in the Bardenas Reales in Ebro-Basin (North-Spain) and in different test sites in Andalusia (South Spain) the following assumptions:
1) Is the relationship transport rate vs. transport capacity always lower than 1?
2) Is there a linear correlation between different hydraulic parameters and soil erosion parameters?
3) Do the same hydraulic parameters generated in different experiments also cause the same erosion parameters?
The results show clearly that the basic model assumptions can not be confirmed in field experiments. The question is why it is not possible to comprehend the model assumptions. We suppose that our measurements are correct, so the reasons must be searched in other areas.
In literature investigation, it strikes that different research groups use totally different equations to calculate shear stress values. So it seems not to be clear how shear stress is physically defined.
The basis of the shear stress equations is the Navier-Stokes equations. But for the general, 3-dimensional case, existence- uniqueness- and regularity statements are not proven yet. Another reason is the high spatial and temporal variability of several different erosion processes which occur in (rill-) erosion. It can be distinguished between hydraulic erosion, mass wasting processes on rill sidewalls, gullying, piping, the transport of loose material and spill over of plunge pools. All these different processes shall be described by one hydraulic parameter. This hydraulic parameter only describes a small part of the different erosion processes, most of these processes are not accounted for in the used model equations and concepts.
We suggest therefore a modelling approach which considers the erosion processes in a comprehensive way. This could be e.g. a stochastic representation of the processes, as it has been proposed by numerous researchers, but not found yet an effective entry into soil erosion modelling.