Geophysical Research Abstracts
Vol. 20, EGU2018-6872, 2018
EGU General Assembly 2018

Analysis on spatial variability of soil erosion parameters – Experiments with a JET erosion test

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Soil erosion through precipitation and surface flow from agricultural areas is a main cause of soil degradation in Europe. To estimate the magnitude of erosion processes and evaluate appropriate protection measures, erosion processes are represented in computer models. Although a wide variety of models exists, their common basic principal is to compare the erosive effect of precipitation and surface flow with a defined erosion resistance of the surface. In physically based modelling the linear excess shear stress equation is a common approach, which defines the erosion resistance through the soil parameters critical shear stress and erodibility. However, in general these parameters can be gained only on a coarse scale and empirically by pedotransfer functions, which are usually specific for a certain model or concept. Yet, these parameters are very sensitive and vary in time and space with a value range over several orders of magnitude. Additionally, it is well known, that erosion resistance is depending on a variety of soil properties that pedotransfer functions do not account for. An alternative to quantify the erosion resistance of the soil surface are measuring devices. In the context of erosion of cohesive soils through surface flow the JET erosion test (JET) by G.J. Hanson seems to give reasonable results in situ as well as in laboratory. A soil sample is exposed to a precisely defined shear stress and the resulting scour in the sample measured.

The Chair of Engineering Hydrology and Water Management (ihwb) of Technische Universität Darmstadt (Germany) uses a self-designed JET device to evaluate measured erodibility as an input for erosion modelling. The research focuses on the variability of erosion resistance properties, their influence on erosion processes and appropriate parametrization in modelling. The JET is designed as a laboratory device to test soil samples with shear stress between 1 Pa and 30 Pa. Different hydraulic operating conditions can be realized through a pump and a height adjustable stand module. A curve was developed that correlates the height of the stand module with the shear stress. Testing of standardized samples showed that resulting erosion parameters are independent of the applied shear stress. Thus, the device is applicable to a wide variety of samples and soil types. The design and functionality of the device as well as testing procedure and solving algorithms are presented. A study on spatial variability of soil properties on steep plots in the German low mountain range area is conducted in the hydrological research basin of the ihwb. Spatial variable properties (e.g. the soil structure) as well as temporal variable properties (e.g. soil moisture and bulk density) are connected to the erosion resistance. Both have great influence on the scour process and the resulting erosion parameters which can be seen in disturbed and undisturbed field samples as well as in comparing model samples. The influence of sampling techniques, particularly the difference between disturbed and undisturbed soil samples, is also accounted for.