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Soil detachment by overland flow on yellow soil in karst region of Southwest China

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Soil loss is serious problem in Karst region of Southwestern China and has resulted in soil resources degradation and rocky desertification. Owing to the rocky exposure on slope surface, fissures developed below soils and abundant bio-crusts on ground surface, the Karst region is rather different in erosion process from other geographic regions. Thus, it is much less suitable in Karst region to estimate soil loss using models derived on the base of data from other geographic regions, otherwise, great errors will be raised. So, it is urgent to develop a model for Karst region for improving soil loss assessment and soil conversation planning. However, better understanding of erosion mechanism and process are essential to develop a model. The aim of paper is to study detachment process of yellow soil which is dominated in Karst region of Southwest China.

Soil detachment is one of the processes involving in soil erosion by water. Generally, detachment rate (D_r) is adopted as an index to express soil susceptibility to surface flow and has been related to a lot of hydraulic parameters in previous studies, such as flow rate, slope gradient, mean velocity, shear stress, stream power, and unit stream power and so on. Unfortunately, the results are still argued depending on methods as disturbed soil samples were used to be scoured in laboratory and intact soil in the field was flowed directly. In attempts to reveal detachment mechanism and to establish models to predict soil detachment rate of yellow soil, two kinds of experiments were conducted: (1) Flume flowing on intact soil in the field with flow rates ranging from 0.2×10^{-3} m^{-3} s^{-1} to 0.5×10^{-3} m^{-3} and slope gradients varying from 8.8 % to 42.4 %. (2) Flume flowing on disturbed soil samples in laboratory with flow rates ranging from 0.5×10^{-3} m^{-3} s^{-1} to 2.5×10^{-3} m^{-3} and slope gradients varying from 8.8 % to 46.6 %.

Results showed that: 1) soil detachment rates of yellow soil were more close to natural conditions with small mean value of 0.0026 ± 0.0023 kg $m^{-2}s^{-1}$ for field experiments and the D_r from lab was more than 7 times greater than onsite observed values under the same flow rate condition. 2) The growth trend caused by flow rate increase on D_r was greater than slope gradient increase. Soil detachment rate increased linearly with flow rate and slope gradient increasing under lab conditions, and the influence of flow rate on soil detachment rate was greater at steeper slopes for field approach. Power function models were derived to depict the relationship between D_r and the two factors (R^2=0.91 for field and R^2=0.96 for lab). 3) $D_r$were better simulated by a power function of stream power (R^2=0.83 for field and R^2=0.89 for lab) than to functions of either shear stress or unit steam power. 4) Considering the accuracy, simplicity, and accessibility, the power function based on flow rate and slope gradient is recommended to predict soil detachment rate on yellow soil for both field and lab experiments. In conclusion, the results of our study would provide useful support for developing process-based soil erosion models for karst region of Southwest China.