CRITICAL SHEAR STRESS AND RILL SEDIMENT TRANSPORT CAPACITY OF PALOUSE SOIL

Abstract

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Rill erosion and subsequent sediment delivery to streams are one of the main environmental issues in the inland Pacific Northwest. The peculiarities of the rill erosion process in this region and its complexity make necessary the advancing in the understanding and mathematical representation of this phenomenon. This research focused on certain characteristics of rill erosion including critical shear stress and the sediment transport capacity concept. Additionally, a rill erosion model based on energy relations was developed.

Flume experiments on undisturbed Palouse soil allowed determining an average critical shear stress of 1.4 Pa in unfrozen soil and 1.21 Pa in thawing soil. The soil bulk density was found the most consistently variable related to critical shear stress in the unfrozen soil, while in the thawing soil the most important variable was the soil water content. The results confirmed that soil cohesion is diminished when the freeze-thaw process occurs.

A rill erosion and delivery model based on energy relations and field-observed rill data was developed. The model estimates the amount of sediment transported in a rill

section at a certain time, the sediment transport concentration and/or the rate of sediment transport per unit width of the rill section. The model integrated the energy equation to a modified power expression developed by Bagnold and a newly turbulence-related equation to determine the energy losses due to transport of sediments in rills and then the amount of sediment involved. The model is potentially compatible to GIS application.

The applicability of the sediment transport capacity to rill erosion was questioned based on the field experimental data. The results showed that transport capacity occurred only in 3.2 % of 468 measured rill points, while net deposition rate was found in 7.7 % of the cases. Therefore, the flow conditions are not always the limiting factor for transport of sediments as is usually assumed in soil erosion models, but the soil resistance is also a major factor. Four of the most recently-proposed and three of the most used equations for sediment transport capacity were compared to the measured data. All the equations differed largely in their estimations for sediment transport capacity. The results revealed that the understanding and mathematical representation of the sediment transport capacity in rill erosion is still far from complete.