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Interactions between raindrop impact and shallow interrill flow under wind-driven rain (WDR)

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Raindrops impacting shallow interrill flow create hydraulic friction in overland flow, and the roughness caused by raindrops against the shallow flow is generally explained by the Darcy-Weisbach friction coefficient, which is calculated as a function of rainfall intensity along with bed roughness. However, this effect is not studied sufficiently for the impact cases of wind-riven raindrops, in which a vector field establishes at the impact-flow boundary in a way that differently directed lateral jets (shear stress) of raindrop splashes with respect to the downward flows might occur and partition of normal and lateral stresses on flow might change depending upon the magnitude of winds. Consequently, together with compressive normal stresses of the bursts of raindrops, their along-surface lateral jets would determine the transport capacity of the overland shallow flow. The wind-driven rainfall experiments (WDR) were therefore conducted in the WDR simulator facility of the International Center for Eremology (ICE), Ghent University, Belgium by an experimental setup to work with different raindrop impact velocity vectors (RIVV). Synchronized wind and rain simulations with wind velocities of 6, 10 and 14 ms-1 were applied to a test surface placed on windward (Ww) and leeward (Lw) slopes of 7, 15 and 20%. The interrill delivery rates (Di) were measured, and based on interrill erosion mechanics, which is principally described by an interaction of rainfall and flow parameters, the Di values were modeled by kinetic energy fluxes of both rain and flow. In calculation of both parameters, different values of RIVV were taken into consideration. The results showed that vectorally introducing normal and along-surface effects of raindrop impacts on flow hydraulics and its transport capacity significantly improved the prediction ability of the model for Di under WDR.

Key words: interrill erosion, wind-driven rain, raindrop impact velocity vector, flow kinetic energy flux