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Evaluation of sediment transport capacity formulae implemented in PSEM_2D (Plot Soil Erosion Model) using the soil erodibility data from the WEPP database

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PSEM_2D is a physically-based model of soil erosion at the plot scale. The model handles with microtopography. Infiltration is computed using a Green and Ampt model and overland flow using the depth-averaged two-dimensional unsteady flow equations (Saint-Venant equations). The model is able to reproduce concentrated overland flow on natural slopes under complex rainfall events. Soil erosion calculation is based on the equation of mass conservation of sediment. The erosion processes involved are rainfall and overland flow detachment of previously uneroded soil, rainfall redetachment and overland flow entrainment from a layer of loose sediment, and deposition. The model uses a single representative particle size for both the matrix soil and the eroded fragments. The model does not distinguish explicitly between rills and interrill areas. The same processes are involved all over the plot. Microtopography and hydraulic conditions emphasize either the effects of rainfall or those of overland flow. This study aims at testing different approaches encountered in recent erosion models to calculate transport capacity as it is widely supposed that estimation of transport capacity is of major importance when predicting soil losses. Different versions of PSEM_2D are developed. In a first version transport capacity is calculated using the shear stress approach as proposed in WEPP. Another version is developed where transport capacity is estimated using the unit stream power approach as found in KINEROS. A last version close to the Rose-Hairsine model is developed using the stream power approach and a continuous rate of deposition instead of the first order detachment-transport coupling model as used in the two first versions. This study presents a comparison of these approaches implemented in PSEM_2D against the soil erodibility data from WEPP cropland soil field erodibility experiments in 1987 and 1988.