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Upscaling of a process based erosion model using systematic hillslope and parameter variations

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The variation rates of sediment transport to receiving waters in space and time according to the nature of erosion and deposition processes can be determined using process based numerical models. However, these models are often unsuitable for practical application as they require a large set of input parameters which are usually not available on the basin scale. The objective of this research is, therefore, to derive a basin scale methodology based on easily available input parameters for predicting erosion using the process based model CATFLOW-SED for the simulation of water and sediment transport and detailed process studies in a loess region. To this end we followed a threefold approach: a) development of an effective process model for erosion and derivation of the related parameters based on the process studies; b) generation of a database of erosion events by means of process based simulations and systematic variation of input parameters; c) derivation of the main influence factors on the erosion and deposition process of loess soils.

CATFLOW-SED is a model for hillslopes and small catchments based on Richards Equation and the Saint-Venant-Equation to simulate soil water dynamics and overland flow / river flow, including an effective approach for preferential flow and a detailed SVAT model. Soil erosion is modeled using an optimized detachment approach for loess soils, the transport capacity equation of ENGELUND & HANSEN (1967) and the sinking velocity of grain size fractions to account for the deposition process.

The underlying field studies consist of 60 irrigation experiments carried out in the Weiherbach catchment located in a loess region of Southwest Germany. CATFLOW-SED was validated for the database of the Weiherbach catchment at various scales (plot scale, hillslope scale, catchment scale) showing a good agreement between predicted and observed sediment loads. Following these results a sensitivity analysis on virtual hillslopes was performed based on the systematic variation of hillslope geometry, rainfall intensity, erosion resistance, soil parameters, soil moisture, vegetation cover and type and surface preparation. A factor / multivariate statistical analysis is carried out to evaluate the results and to derive the main influence factors and their magnitude on the erosion process. As this methodology is only based on simple shape-, texture- and vegetation parameters as well as nominal scaled information about surface preparation, it may be easily implemented into a GIS based model and regionalized to larger basins in loess regions.