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Predicting soil erosion in loess areas using a physically based erosion model

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Sediment associated transfer of nutrients and contaminants from agricultural land is a serious threat to surface waters. 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 physically based numerical models.

The objective of this research is to investigate the spatial pattern of erosion and deposition processes for several landuse scenarios using the physically based hydrological model CATFLOW and detailed process studies in a small rural German Loess catchment.

CATFLOW is based on the Richards Equation to simulate soil water dynamics and the Saint-Venant-Equation for modeling overland flow / river flow including an effective approach for preferential flow and a detailed SVAT model. The erosion process is modeled using shear stress, the momentum balance of precipitation and a semi-empirical erosion resistance for predicting soil detachment. The underlying process studies consist of 60 irrigation experiments which were used to derive the related parameter sets and a method for extrapolation to the catchment area. The modeling results were validated using measured data on the plot, hillslope and basin scale. For a good agreement of measured and simulated runoff at the catchment outlet the observed sediment load could be well predicted by the erosion submodel for different landuse patterns during the investigation period.

Based on these results various landuse scenarios were modeled. For all scenarios the percentage of the different landuse categories was hold constant to its given present value whereas the spatial pattern was changed. Comparing the sediment load of the

largest observed runoff event for the given landuse pattern to the best case scenario a reduction of 40 % was achieved. For the worst case scenario an increase of 25 % was modeled. So under comparable conditions the rearrangement of the landuse pattern may vary the sediment load at the catchment outlet by the factor 0.6 – 1.3 showing an efficient way to minimize soil erosion.