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Drivers of spatial and temporal variability of soil erosion within catchments- results from long-term field observations in Southern Germany

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Over the last decades a major focus in erosion research was to improve erosion prediction with process-based, spatially distributed models and to enhance evaluation techniques of these multi-parameter models. This contrasts with the fact that model input as well as validation data are often not representing their spatio-temporal variability. Hence, spatially distributed models are often only validated against catchments sediment and water output.

In this study an extensive 8-yr data set from 14 small agricultural, partly nested catchments (0.8-16.8 ha) located within a research farm in Southern Germany was used to address: (i) the accuracy and spatio-temporal variability of input data (rainfall and soil cover) required for most erosion models, and (ii) to elucidate typical patterns of erosion and deposition within and in-between the small catchments. This work is based on continuous monitoring of rainfall distribution, land management and cover, runoff and sediment delivery and additionally on rainfall simulations and runoff experiments within the catchments.

A high variability in model input parameters commonly not taken into account for small-scale modelling was observed. For example, 37% of all erosive rainfall events during the summer months showed a spatial trend with a median gradient in 30-min intensity of 8 mm/km/h and a maximum of 27 mm/km/h. Also cover varied considerably during individual storms even within small, single fields, e.g. on partly harvested potato fields. Due to effective soil conservation at the test site (visually detectable) erosion occurred only during rare events but under unfavourable conditions (e.g., large rains on freshly harvested potato fields) large losses were possible. Any heterogeneity

during these large events will only be levelled out over long periods due to the rareness of large events. Additional within-catchment variability is caused by any retention structures like field borders, grassed surfaces (e.g., bufferstrips or grassed waterways) or ponds.

The extensive data set exemplifies that event based (spatial) prediction of soil erosion on a catchment scale has to take the spatio-temporal variability of dominant input parameters like rain or cover into account, either by explicit or by lumped modelling. Explicit modelling is highly demanding in terms of data availability and model complexity while lumped modelling is hindered by the non-linearity of erosion processes, which does not allow using averages alone. For both approaches the effects of heterogeneities and different structures within a catchment have to be understood. This calls for long-term catchment data combined with detailed experiments to evaluate the combined and individual effects of field layout, field management, local soil conservation measures and so on.