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Surface runoff and sediment delivery affected by patchiness of agricultural landscapes and spatio-temporal patterns of rainfall

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Planning of integrated management in small agricultural catchments usually follows a two-step approach. In the first step the erosion potential of the different types of surfaces (e.g., land uses, soils) is determined either within the catchment itself or outside the catchment (e.g., literature data). In a second step these erosion potentials are combined by modelling to yield the integral response of the catchment under study. This approach ignores two important aspects: First it ignores the effects of patchiness and conductivity between the landscape elements and second, it ignores the spatio-temporal variation of rainfall events.
In this study we try to address both aspects: (i) We use measured rainfall data with a high spatio-temporal resolution (13 tipping-bucket rain gauges were operated on a 1.4 km^2 test site in southern Germany for four years); and (ii) we simulate surface runoff and sediment delivery with the dynamic multi-class sediment transport model (MCST) especially developed to account for varying erosion conditions along the flow path, e.g. due to linear structures between fields. To isolate effects of patchiness and hydraulic connectivity we apply the model in a synthetic catchment varying only the number of fields and the number and location of linear structures between these fields.
Our results indicate that for a realistic determination of the effects of patchiness on surface runoff and especially sediment transport within agricultural catchments it is essential to use high resolution spatio-temporal patterns of rainfall for modelling. In case of our test site the largest measured rainfall gradient during a highly erosive rainfall event was 15.7 mm/km. Compared to an assumed homogeneous rainfall this kind of gradient rain produced a significantly different runoff and sediment delivery response for different degrees of patchiness and hydraulic connectivity.
In general, our results indicate that the effects of patchiness and hydraulic connectivity on surface runoff and sediment delivery can only be fully addressed if the small scale rainfall patterns are also taken into account.