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Land use change and agricultural soil cultivation as flood mitigation measures at the catchment scale

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Land use changes and agricultural soil cultivation are commonly considered as nature-based flood mitigation measures, but recent studies showed a large variability of possible flood reduction effects. Reasons for this discrepancy might cover differences in the catchment properties and flood event characteristics, parametrization and model (type) selection. The aim of this study is to identify which measures show a significant flood reduction potential depending on catchment and event characteristics to develop optimized solutions for mesoscale catchments. For this purpose, six land use and agricultural soil cultivation scenarios with multiple spatial extents were performed in eight catchments under consideration of seven flood events. The hydrological model WaSiM was used for the simulations. The generated flood events involve advective and convective precipitation characteristics and return periods from 5 to 1000 years. The scenarios include extensification of farming, conventional tillage and no-till soil cultivation, afforestation, ecological forest restructuring and unsealing of urban areas. The implementation was done by an adjustment of soil properties and vegetation distribution. The sizes of the investigation areas range from 32 to 1170 km^2 and therefore allow an efficiency analysis for different scales and catchment characteristics. In addition to the eight catchments, a comparison of multiple subcatchments as well as a raster-based analysis of the water balance components due to different scenarios are realized. Based on the simulations, the following results could be derived. Firstly, the peak reductions of the single scenarios are very diverse and show dependencies on the catchment and event characteristics. The largest reductions could be observed for the extreme scenarios of extensification of farming and afforestation in all catchments with maximum peak reductions of 34 % and 68 %, respectively. Secondly, large differences in the spatial distribution of possible peak reductions could be found. The peak reductions can be related to catchment characteristics as for example the change of the available water content or the leaf area index. The results show the importance of the spatial distribution of the analyzed land use changes and agricultural soil cultivation and their relation to catchment and event characteristics. They will be further used to evaluate the potentials and limits of nature-based solutions for supporting flood mitigation strategies.