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Using hydrological modelling to account for uncertainty in the prediction of contributing areas for diffuse herbicide losses to surface waters

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Effective mitigation strategies to reduce diffuse water pollution from agriculture rely on an accurate understanding of the relevant loss processes and on the reliable delineation of the locations where they take place. In this project, we focus on diffuse herbicide losses from corn fields to surface waters. Field studies have shown that herbicide losses are strongly connected to catchment hydrology, and that losses are spatially limited to areas prone to fast flow processes like surface runoff or macropore flow to tile drains. We investigated the predictability of such critical source areas (CSA) by spatially distributed hydrological modelling based on readily available data. Exploring the potential and uncertainty of the usually limited available data is crucial for the subsequent practical implementation at larger scales. Our study area was a small agricultural catchment in Switzerland, where herbicide losses were monitored in previous field studies. Our analysis showed a good agreement between the spatial distribution of the predicted fast flow processes and the actually measured herbicide losses. We predicted saturation excess runoff mainly for Gleysol areas and found that the topographic location of those areas (in flat regions around the brook) affected the runoff formation more strongly than the soil hydraulic properties. Furthermore, our analysis revealed that the surface connectivity is of crucial importance for the spatial

loss dynamics. Small-scale topographic structures create internal sink areas where the runoff water ponds and reinfiltrates. Nevertheless those areas should not be neglected in the risk assessment because artificial drainage systems create a shortcut to the river system by preferential flow paths. The main challenge in the prediction of CSA is the data limitation, which leads to prediction uncertainties. The prediction of the spatial extension of CSA is for example very sensitive to the efficiency and the spatial extent of the drainage system or the storage capacity of the soil, which mainly depends on deep percolation. Quantifying these uncertainties by hydrological modelling provides insight into the underlying critical processes and data requirements. Thereto we test whether discharge data from the catchment helps to restrict the space of acceptable parameter values using a Bayesian inference approach.