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Multi-model ensemble predictions of changes in hydrological fluxes caused by a change in land use

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Ensemble model prediction is a well-established technique within atmospheric and climate sciences, but has only more recently been considered in hydrological research. The basic principle behind ensemble model prediction is the pooling of results of different model structures to reduce the overall predictive uncertainty. In this paper, we investigate the applicability of a multi-model ensemble to predict changes of hydrological fluxes induced by changes in land use. Forecasting the effects of land use on hydrological fluxes is highly uncertain due to the complex soil-vegetation-atmosphere interactions and the lack of observations for model verification. The latter fact is also true for predictions in ungauged basins (PUB). We argue that the use of an ensemble of models will result in a more rigorous estimate of change than can be developed through the application of any single model structure. In the framework of the LUCHEM Project "Assessing the Impact of Land Use Change on Hydrology by Ensemble Modelling" 10 different hydrological models (DHSVM, HBV, IHACRES, LASCAM, MIKE SHE, PRMS-MMS, SLURP, TOPLATS, SWAT, WASIM-ETH) were applied to the Dill catchment (693 km2), Germany. The ensemble model was first calibrated to the current land use distribution (baseline scenario) of the Dill catchment, and then applied to a set of land use scenarios. The land use scenarios have been developed by the agro-economic model ProLand and reflect the spatially differentiated effects of field size aggregation and allocation on land use distribution. We present the overall methodology of the LUCHEM project, including averaging procedures and overall outcomes for the baseline scenario and the land use scenarios using single models and different deterministic multi-model ensembles. In general, for simulations of the baseline scenarios, the simpler models outperformed the more complex

models. Despite relatively wide disparity in the individual model performance, most combinations of the 10 potential ensemble members resulted in improved overall simulation efficiencies. In addition, the direction of change in the hydrological fluxes for the different land use scenarios was predicted with a high degree of consistency. This, along with the success of the multi-model ensembles, suggests that we can predict with some confidence the direction and magnitude of potential streamflow changes associated with a change in land use in the Dill catchment.