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Predicting temporal development of discharge and nitrate in relation to dynamic changes of spatial crop distribution in three land use scenario runs with a catchment model

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In the past years, relevant changes in the use of agricultural areas were observed in German catchments. To achieve good ecological conditions in river basins as demanded by the European Water Framework Directive, the implications of land use change on water quantity and especially water quality needs to be quantified. Therefore, recent data of agricultural crops are prepared for the catchment scale. Based on this, simulations of future land use scenarios are carried out with a hydrological catchment model to analyse the linkage between dynamic changes of land use and modeled discharge and nutrients.

Spatial and temporal variations of changes within agricultural areas lead to a dynamic change of pressures on the ecological status of rivers. While static land use distributions assume constant conditions for agricultural areas for the whole simulation period, dynamic changes of agricultural areas and their spatial patterns consider the varying land use conditions within the scenario simulation.

In our study, a dynamic modeling of spatial distributions for agricultural crops and its impacts on discharge and nitrate is presented at the catchment scale. The area proportions of the crops are estimated in a data-based statistical approach and are implemented into the eco-hydrological model SWAT for recent and future conditions

To obtain an accurate reproduction of the water cycle, the SWAT model is calibrated for discharge and nitrate time series for recent conditions. Three land use change scenarios are developed for the study catchment focusing on a dominance of food production, energy crops and on a best ecological practise. According to the scenarios, the spatial crop distribution is updated dynamically for each year, while non-agricultural land use types remain constant.

The SWAT model provides satisfying results for discharge and nitrate. The evaluation of the three land use change scenarios for the period from 2021 to 2030 shows low differences in discharge, while nitrate loads increase in the food scenario and decrease in the energy and best practise scenario. The analysis of the dynamic update illustrates an increase in the changes in nitrate loads between the scenarios within the modeling period. Due to the increasing differences in nitrate loads, this study shows that the dynamic modeling of land use change is recommendable to assess the temporal development of impacts within land use change scenarios.