EGU21-6777, updated on 24 Oct 2021
https://doi.org/10.5194/egusphere-egu21-6777
EGU General Assembly 2021

Influences of land use changes on the dynamics of water quantity and quality in the German lowland catchment of the Stör

Chaogui Lei[1], Paul Wagner[2], and Nicola Fohrer[3]
[1]Kiel University, Institute for Natural Resource Conservation, Department of Hydrology and Water Resources Management, Kiel, Germany (cglei@hydrology.uni-kiel.de)
[2]Kiel University, Institute for Natural Resource Conservation, Department of Hydrology and Water Resources Management, Kiel, Germany (pwagner@hydrology.uni-kiel.de)
[3]Kiel University, Institute for Natural Resource Conservation, Department of Hydrology and Water Resources Management, Kiel, Germany (nfohrer@hydrology.uni-kiel.de)

Understanding the impacts of land use changes (LUCC) on the dynamics of water quantity and quality is necessary to identify suitable mitigation measures that are needed for sustainable watershed management. Lowland catchments are characterized by a strong interaction of streamflow and near-surface groundwater that intensifies the risk of nutrient pollution. In this study, a hydrologic model (Soil and Water Assessment Tool, SWAT) and partial least squares regression (PLSR) were used to quantify the impacts of different land use types on the variations in actual evapotranspiration (ET), surface runoff (SQ), base flow (BF), and water yield (WYLD) as well as on sediment (SED), total phosphorus (TP), and total nitrogen (TN). To this end, the model was calibrated and validated with daily streamflow data (30 years) and daily sediment and nutrient data from measurement campaigns (3 years in total). Three model runs over thirty years were performed using the different land use maps of 1987, 2010, and 2019, respectively. Land use changes between those years were used to explain the modelled changes in water quantity and quality on the subbasin scale applying PLSR. SWAT achieved a good performance for streamflow (calibration: NSE=0.8, PBIAS=5.5%; validation: NSE=0.78, PBIAS=5.1%) and for TN (calibration: NSE=0.65, PBIAS= -11.3%; validation: NSE=0.87, PBIAS=2.7%) and an acceptable performance for sediment and TP (calibration: NSE=0.49-0.53, PBIAS=25.8% -29.7%; validation: 0.51-0.7, PBIAS= -23.9% - -8.7%) in Stör catchment. The variations in ET, SQ, BF, WYLD, SED, TP, and TN could be explained to an extent of 67%-88% by changes in the area, shape, dominance, and aggregation of individual land use types. They were largely correlated with the major LUCC in the study area i.e. a decrease of arable land, and a respective increase of pasture and settlement. The change in the percentage of arable land affected the dynamics of SED, TP, TN and BF, indicated by a Variable Influence on Projection (VIP) > 1.2 and largest absolute regression coefficients (RCs: 0.45-0.72 for SED, TP, TN; -0.84 for BF). The change in pasture area affected ET, SED, TP, and TN, as indicated by VIPs >1. The change in settlement percentage had VIP up to 1.62 for SQ and was positively and significantly influenced it (RC: 1.28). PLSR helped to identify the key contributions from individual land use changes on water quantity and quality dynamics. These provide a quantitative basis for targeting most influential land use changes to mitigate impacts on water quality in the future.