Geophysical Research Abstracts
Vol. 18, EGU2016-13556, 2016
EGU General Assembly 2016

Assessing impact of climate and land use change on water quality in two contrasting meso-scale catchments in Poland

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The Upper Narew (4280 km2) and the Barycz (5520 km2) are two Polish, meso-scale, lowland catchments, contrasting in terms of land use, water management and water quality. Semi-distributed process-based SWAT model was applied in both catchments for assessment of climate change impact on selected water quality parameters. The model setup was developed based on high-resolution inputs, e.g. 5 km gridded precipitation and temperature dataset and 30 m Landsat8-based land cover map. Multi-site calibration and validation against observed discharge, sediment loads and nutrients loads (nitrogen and phosphorus compounds) gave predominantly satisfactory goodness-of-fit measures which enabled further model use for scenario analysis. Impact of land use on water quality can be assessed by comparing nutrients loads and concentrations simulated for the current conditions between two contrasting catchments. Both specific loads and concentrations of major nitrogen and phosphorous forms were on average 80-100% higher in the Barycz than in the Upper Narew catchment. This is a result of more intensive agricultural practices taking place in the Barycz, unlike the Upper Narew where agriculture is mostly extensive. Large parts of the Barycz catchment have been designed as the Nitrates Vulnerable Zones and since 2007 there are legal restrictions concerning agricultural practices in these areas.
Nine GCM-RCM runs projected to the year 2100 for RCP 4.5 and 8.5 provided within the EURO-CORDEX experiment were first bias-corrected using quantile mapping method and then used as an ensemble of climate change scenarios in SWAT. Precipitation projections were largely consistent in showing an increasing precipitation trend, present particularly in winter and spring, in both catchments. This clearly affected the hydrological and biogeochemical cycle and resulted in higher projected water yield, increased erosion, and elevated nitrogen and phosphorus emission to water bodies.
The rate of change caused by climate is more visible in late future (2071-2100) than in the near future (2021-2050) and is more intensive for nitrogen than for phosphorus, which is related to its dominating transport pathway via baseflow, whose value is high in two lowland catchments. Yet, the magnitude of these climate-induced changes in nutrient emission is in most cases lower than the currently observed differences in nutrient loads between the Narew and the Barycz. Nevertheless, the results suggest that improving bad water quality in the Barycz catchment will be in the future hampered by the effect of climate change.
Acknowledgements. Support of the project CHASE-PL (Climate Change Impact for Selected Sectors in Poland) of the Polish-Norwegian Research Programme is gratefully acknowledged.