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The possible regional impact of climate change on water quality: eco-hydrological modeling in the Jizera Basin (Czech Republic)

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The possible impact of climate change on water is well recognized and has been widely reported. Despite this recent progress, the research of impact of climate change on water quality has started only recently. Additionally, the consequences of climate change on water quality are important and are supposed to heavily influence the water resources management. In this sudy, the water quality modeling was done in order to evaluate the possible impact of climate change on water quality in selected mesoscale basin regarding nitrogen pollution and to assess the influence of atmospheric deposition on nitrogen pollution.
The research was done by using the eco-hydrological model SWIM (Soil and Water Integrated Model, http://www.pik-potsdam.de/research/research-domains/climate-impacts-and-vulnerabilities/models/swim), which simulates water and nutrient fluxes in soil and vegetation, as well as transport of water and nutrients to and within the river network. The modeling period was from 1981 until 2003.
The Jizera Basin, which is situated in NW Bohemia, Czech Republic, was selected as a study area. To setup the model of the Jizera Basin, the study area was characterized by several raster datasets: digital elevation model, soil map, land use map and subbasin map. Climate data, such as temperature, precipitation, solar radiation and air humidity, were interpolated to the 203 subbasin centroids by an inverse distance weighted method using data of 10 climate stations in and around the Jizera Basin.
The discharge at the outlet of the Jizera Basin was calibrated for the period 1981 – 1990. After the adjustments of snowmelt processes in SWIM model, the model reproduces discharge at the outlet quite satisfactorily. The Nash and Sutcliffe efficiency for whole calibration period is 0.78. The period 1991-1995 was used for validation of discharge. The Nash and Sutcliffe efficiency for whole validation period is 0.73.
After the calibration of the hydrological processes in the basin, water quality (nitrogen content and dynamics) modeling was carried out. The emissions from the point sources and agricultural diffusive sources were taken into account. After finding the best parameter combination for the calibration period, the model was tested for 11 year period from 1991 to 2001 that was later used as a reference period for modeling of climate change impact in the Jizera Basin. The seasonal dynamics of the measured nitrate nitrogen loads is simulated satisfactorily: the positive peaks in winter time and small amounts of nitrogen in summer time which is in agreement with observed data.
The influence of climate change on water quality in the Jizera basin was assessed by using regional climate change model. The outcomes are as follows: drier climate will cause lower loads but higher nitrate nitrogen concentrations in the Jizera Basin, whereas wetter climate will lead to reduced concentrations mainly due to increased discharge. The impact of possible increasing atmospheric deposition was also assessed. The outcomes of model considering atmospheric deposition show that atmospheric deposition significantly increases the nitrate nitrogen loads and concentrations.