

Future Scenarios for Environmental Flows in a Large Semi-Natural River Basin in Poland: A Case Study with the SWAT Model

Published by the American Society of Agricultural and Biological Engineers, St. Joseph, Michigan www.asabe.org
Citation: 21st Century Watershed Technology: Improving Water Quality and the Environment Conference Proceedings, May 27-June 1, 2012, Bari, Italy 12-13865.

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Keywords: Environmental flows, Narew, climate change, land use change, scenario, SWAT

Environmental flows, the quantity of water required to maintain a river ecosystem in its desired state, are of particular importance in areas of high natural values. In NE Poland, the Narew River Basin (NRB) occupying ca. 28,000 km² is a good example of a water region with many rivers in near-pristine conditions. The general aim of this study is the impact assessment of a multiple set of scenarios describing changes of global (i.e. climate, atmospheric CO₂) and regional (land use, agriculture development and agricultural water management) scale driving forces, on environmental water requirements of selected river-dependent biota. To this end, a semi-distributed physically-based hydrological model (SWAT) was applied. SWAT was calibrated and validated in the NRB using daily flow data from 27 gauging stations for the baseline period 1989-2008. The model performance evaluated by various goodness-of-fit measures was in general satisfactory, with significantly better results for gauges with larger upstream areas. Global change was represented in the model by projections from selected GCMs associated with the GHG emission scenario SRES-A2. Regional change was represented in SWAT based on a complex scenario development framework carried out within the SCENES project. Environmental flow impact indicators (EFIs) were designed to quantify each of the designed building blocks of the flow regime: (1) providing minimum in-stream (hydrobiological) flow; (2) providing spawning and nursery habitat for pike; (3) maintaining four types of floodplain vegetation communities in good health. The results suggest that the impacts on environmental flows triggered by climate and atmospheric CO₂ change exceed the impacts caused by regional change in land use, agricultural development and agricultural water management in the NRB.