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Simulating land use changes in the Upper Narew catchment using the RegCM model

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Catchment hydrology is influenced by climate forcing in the form of precipitation, temperature, evapotranspiration and human interactions such as land use and water management practices. The difficulty in separating different causes of change in a hydrological regime results from the complexity of interactions between those three factors and catchment responses and the uncertainty and scarcity of available observations. This paper describes an application of a regional climate model to simulate the variability in precipitation, temperature, evaporation and discharge under different land use parameterizations, using the Upper Narew catchment (north-east Poland) as a case study.

We use RegCM3 model, developed at the International Centre for Theoretical Physics, Trieste, Italy. The model's dynamic core is based on the hydrostatic version of the NCAR/PSU Mesoscale Model version 5 (primitive equations, hydrostatic, compressible, sigma-vertical coordinate). The physical input includes radiation transfer, large-scale and convective precipitation, Planetary Boundary Layer, biosphere. The RegCM3 model has options to interface with a variety of re-analyses and GCM boundary conditions, and can thus be used for scenario assessments.

The variability of hydrological conditions in response to regional climate model projections is modeled using an integrated Data Based Mechanistic (DBM) rainfall-flow/flow-routing model of the Upper River Narew catchment. The modelling tool developed is formulated in the MATLAB-SIMULINK language. The basic system structure includes rainfall-flow and flow routing modules, based on a Stochastic Transfer Function (STF) approach combined with a nonlinear transformation of rainfall into effective rainfall.

We analyse the signal resulting from modified land use in a given region. 10 month-long runs have been performed from February to November for the period of 1991-2000 based on the NCEP re-analyses. The land use data have been taken from the GLCC dataset and the Corine Land Cover programme (http://dataservice.eea.europa.eu/, GIOS, Poland). Simulations taking into account land use modifications in the catchment are compared with the reference simulations under no change in land use in the region.

In the second part of the paper we discuss the application of the RegCM3 model in two climate change scenarios (SRES A2 and B1).

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