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Benchmarking the WaterGAP3 global hydrology model in reproducing streamflow characteristics

Stephanie Eisner and Martina Flörke
University of Kassel, Center for Environmental Systems Research, Kassel, Germany (eisner@usf.uni-kassel.de)

Global hydrological models are key tools to understand and assess the current state of global freshwater resources. They facilitate quantifying the degree of human interference on the natural hydrological regime and help to assess impacts of global and climate change on water resources. Large to global scale hydrologic simulation is, however, prone to large uncertainties which originate from spatially distributed input data (atmospheric forcing and land surface parameters) and, in particular, the (often) simplified physical process representation. Most large-scale modelling approaches are constrained by the implicit assumption that one single model structure is globally valid and the fact that the modeler lacks location-specific knowledge. In order to evaluate the quality of water availability estimates and to quantify the uncertainty associated with these estimates, it is thus essential to examine systematically where and why large scale hydrological models perform well or poor in reproducing observed streamflow characteristics.

This study presents an extensive benchmarking study of the WaterGAP3 (Water – Global Assessment and Prognosis) model to reproduce observed monthly stream characteristics on the basis of more than 2400 observed streamflow records globally. WaterGAP3 is a grid-based conceptual water balance model operating on a 5 arc minute global grid. The model is explicitly designed to account for human interference on the natural hydrologic regime through flow regulation and water abstractions.

Monthly simulated discharges for the period 1958–2010 are evaluated against observations based on three complementary performance metrics. Subsequently, model performance is assessed against a set of generic catchment descriptors supported by available global datasets which characterize climatic and physiographic conditions in the individual catchments as well as the degree of human alteration of the hydrologic regime. These relationships between catchment characteristics and model efficiencies help to detect inadequacies in model structure as well as in the underlying input data, thus set the stage for further model development.