Geophysical Research Abstracts
Vol. 14, EGU2012-1051-1, 2012
EGU General Assembly 2012

Integrated runoff and water quality modeling by using a multi-objective calibration scheme

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Water quality models are increasingly used to investigate nutrient leaching processes and improve water resources management at catchment scale. Uncertainties exist in most water quality models due to data limitation and simplification of process descriptions. The objective of this study is to apply a multi-objective and multi-response calibration scheme for calibration and identification of a new integrated rainfall-runoff and water quality model at a meso scale catchment in Germany. The new HYPE model was used to simulate runoff and transport of nitrogen, phosphorus, DOC and conservative substances on daily time step. Nondominated sorting genetic algorithm II (NSGA-II) combined with various response simulations was used for parameters calibration.
From the first results of runoff and nutrient simulations (nitrogen and phosphorus), it is found that hydrographs and water balances as well as dynamics and mass balances of nitrate were simulated quite well at the three nested catchments. The average Nash-Sutcliffe Coefficients for calculations of water flow, nitrogen, and phosphorus are 0.75, 0.60, and 0.39. The calculated nutrient loads in the downstream lowland sub-basin are lower than in the upper-stream mountainous sub-basins, which is caused by decreasing precipitation and runoff along the slope. The nutrient loads in the catchment are mainly constrained by water flow rather than nutrient input amounts. The calculated average total nitrogen and phosphorus loads are 9.16 kg/ha/yr and 0.179 kg/ha/yr. The multi-objective and multi-response model evaluation scheme is effective for investigating internal water flow and nutrient processes and decreasing model prediction uncertainties.