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Hydrological and hydraulic results of an integrated modelling approach in a mesoscale Chinese catchment

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Catchment properties, in-stream processes and their effects on aquatic organisms are closely linked. For the assessment of key driving forces, pressures on an ecosystem, the habitat state and the effect of climate or land use changes on a habitat, DPSI (Driver-Pressure-State-Impact) approaches are used. The aim of our DFG-/NSFC project is the development of an integrated modelling approach to depict the impact of environmental changes on aquatic ecosystems in the Changjiang catchment of the Poyang lake area in China.

We create a dynamic DPSI-system, integrating the models SWAT (catchment processes), HEC-RAS (in-stream processes) and BIOMOD (biological responses). The ecohydrological model SWAT simulates the water and nutrient balances of the entire catchment. The SWAT results as discharge and sediment are transferred to the hydraulic model HEC-RAS. HEC-RAS calculates in-stream parameters as flow velocity, water depths, shear stress, etc. for cross sections at selected river sections. Afterwards, both models transfer their results to the species distribution model BIOMOD, which calculates the habitat functions and occurrence probabilities for each selected species (benthic macroinvertebrates).

The developed concept, the procedure of the field campaigns and the first steps and results of the ecohydrological and hydraulic modeling are presented. Catchment discharge time series of the SWAT model were used as boundary conditions to the hydraulic modelling. The HEC-RAS models were set up for ten river sections with a length of about 300 meters each. The calibration of the HEC-RAS stream flow models was carried out towards the elevation differences between adjacent cross-sections, rather than roughness values. In a sensitivity analysis this approach proved to yield very good calibration results. Among other parameters, the stream flow variables water depth, flow velocity, shear stress and stream power were calculated and analysed. The HEC-RAS model results showed that model instabilities occurred on single days on some river sections in the unsteady flow analysis. However, a validation attempt of the stream flow model towards high water marks yielded promising results. A cluster analysis to group river sections with similar flow and sediment conditions provides an interesting linking point to stream communities, e.g. the relation between species richness or abundances and habitat conditions between river sections.