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Coupled hydrologic process modelling in the Upper Danube using the integrated expert system DANUBIA

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An assessment of Global Change impacts on the availability of water and the sustainability of water resources management activities is one, maybe the key issue in modern hydrological science. However, solitary sciences approaches, with their inevitably unilateral perspective, usually encounter severe difficulties to develop methods for sustainable water resource management under globally changing boundary conditions for which a transdisciplinary integration of expertise is required. The principle objective of the GLOWA-Danube project is to support these ambitious goals by identifying, examining and developing new techniques of coupled distributed modelling for the integration of natural and socio-economic sciences in the Upper Danube watershed (77.000 km^2), by means of the Global Change decision support tool DANUBIA. The study outlines the GLOWA-Danube approach of network-based, object-oriented model coupling to communicate data and model parameters, which is exemplarily illustrated for the integration of hydrological, hydrogeological and hydraulic process models. This coupling segment of DANUBIA comprises a physically based SVAT scheme (PROMET), a finite element groundwater model (MODFLOW) and a river hydraulics model (DAFLOW), which are fully integrated in a distributed Java-based modelling environment, representing the objects Landsurface, Groundwater and Rivernetwork of the DANUBIA system They comprise the capabilities of interdependent physically based expert models for energy exchange at various surface types, plant growth, snow cover dynamics, soil water movement and runoff formation, saturated zone transport, in/exfiltration and retention and translation processes in river runoff. While the concept and the implementation of the coupling approach are described, including the interface definition and the data and parameter exchange, this work primarily focusses on the validation procedure and the difficulties of regionalization for different temporal and spatial scales. Due to the heterogeneity of physical environmental conditions in the Upper Danube, special adaptations had to be developed in the coupling process, especially for the alpine and cristalline parts of the watershed. While field measurements to verify the model results are usually sparse, the qualitative and quantitative performance of the model system has been tested and validated over several 5-year model time frames, using a multi-response validation strategy. First results indicate that the integrated expert system is capable to satisfactory image the hydrologic processes in the Upper Danube watershed. The concluding perspectives for applying the system under global change conditions are discussed.