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LARGE-SCALE WATER RESOURCES MANAGEMENT WITHIN THE FRAMEWORK OF GLOWA-DANUBE - PART A: THE GROUNDWATER MODEL

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The interdisciplinary research co-operation Glowa-Danube aims at the development of innovative techniques, scenarios and strategies to investigate the impacts of Global Change on the hydrological cycle within the catchment area of the Upper Danube Basin (Gauge Passau). Both the influence of natural changes in the ecosystem, such as climate change, and changes in human behavior, such as changes in land use or water consumption, are considered. A globally applicable decision support tool "DANUBIA" that comprises 15 individual disciplinary models will be developed. The models are connected with each other via customized interfaces that facilitate network-based parallel calculations. The strictly object-oriented DANUBIA architecture was developed using the graphical notation tool UML (Unified Modeling Language) and has been implemented in Java code. The Institute of Hydraulic Engineering of the Universitaet Stuttgart contributes two models to DANUBIA: A groundwater flow and transport model and a water supply model. The latter is dealt with in a second contribution to this conference. This paper focuses on the groundwater model.

The catchment basin of the Upper Danube covers an area of approximately 77.000 km2. The elevation difference from the highest peaks of the Alps to the lowest flatlands in the Danube valley is more than 3.000 m. In addition to the Alps, several lower mountain ranges such as the Black Forest, the Swabian and Franconian Alb and the Bavarian Forest are located respectively in the Northeast, North and Northwest of the basin. The climatic conditions, geomorphology, geology and land use show a

wide range of different characteristics. The size and heterogeneity of the area make it extremely difficult to represent the natural conditions in a numerical model. Both data availability and accessibility add to the difficulties that one encounters in the approach to simulate groundwater flow and contaminant transport in this area.

The groundwater flow model of the catchment developed by the research group uses a finite difference approach (MODFLOW). A transport model (nitrogen) will be added in a second stage (MT3D). A three-dimensional conceptual hydrogeological model consisting of four layers was developed. Only aquifers with basin-wide occurrence are considered. Aquifers on the local scale cannot be included in the model due to insufficient data availability, the model grid resolution (1km2) used and various limitations arising from the MODFLOW-approach. The cell size of 1 km is compulsory for all models in DANUBIA in order to facilitate 1:1 parameter exchange.

The concept of DANUBIA is based on the parallel execution of strictly independent disciplinary models. At each time step, the required parameters are exchanged. On the "physical side" the groundwater model has interfaces to a soil water and a surface water model which provide important parameters that are used as model boundary conditions. The soil water model calculates the groundwater recharge as the infiltration through a layered soil zone. The surface water model calculates the heads in the rivers, which are used to determine flow from the aquifers to the rivers and vice versa. The main aim of the groundwater model is to assess and forecast quantity and quality of the groundwater resources together with the other physically based models under conditions of global change. On the "socio-economic side", the groundwater model exchanges data with the so-called "Actors" component, a group of models concerned with the human impact on the water cycle. The amount of groundwater extraction for drinking water purposes is a boundary condition of the groundwater model calculated by the Actors models. The feedback between demand and supply invokes the need for complex optimization algorithms.