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Groundwater modelling within the framework of integrated regional models in Germany, Uzbekistan and Benin

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The objective of the EU-Research project RIVERTWIN (www.rivertwin.org) is the development of integrated water and land use management tools in 'twinned' river basins. RIVERTWIN supports the goals of the EU Global Water Initiative (www.euwi.org), which proposes to apply the principles of the European Water Framework Directive (WFD) to other continents. This is achieved by adjusting, testing and implementing the integrated regional model MOSDEW for the strategic planning in river basins in Europe, Central Asia and West Africa. Three basins with areas between 13.000 and 40.000 km2 and with contrasting ecological, social and economic conditions were selected:

1. Neckar basin (Germany, Central Europe, temperate-humid);

2. Ouémé basin (Benin, West Africa, tropical-subhumid);

3. Chirchik basin (Uzbekistan, Central Asia, continental-semiarid).

The overall concept of Rivertwin is described in another contribution to this session (HS16) by Gaiser et al.

The task of the sub-project 'Groundwater' at the Institute of Hydraulic Engineering, Universitaet Stuttgart, is to develop the groundwater components in the Neckar and the Ouémé basin and to support the groundwater component development in the Chirchik basin. Groundwater as a resource plays an important role in each of the basins but neither the hydrogeological conditions nor the mode of groundwater use are similar.

In the Neckar catchment, quasi-horizontal fractured and carstic sedimentary aquifers with poor to medium groundwater extraction potential are present in the whole basin area. The groundwater quality is fairly good. In the Chirchik catchment, porous sedimentary aquifers exist only in the lower parts of the basin. High groundwater salinity and very low recharge rates limit the capacity of these resources. Groundwater overuse is one of the consequences. The Ouémé, finally, is split into two parts: a (larger) crystalline region in the North and a (smaller) sedimentary coastal area with mainly weakly consolidated porous aquifers. In the northern, crystalline parts groundwater is an important source of water supply in rural areas but limited to shallow, saprolithe aquifers and few fracture zones. Small yields and quality problems (mostly hygienic) make groundwater an unreliable resource, particularly during dry periods. In the South the big cities Cotonou and Portonovo rely on groundwater extraction. Here seawater intrusion induced artificially by over-pumping threatens the water supply system.

According to the principle idea of RIVERTWIN, the integrated model along with its individual model components should be transferable between the three river basins as much as possible. Following this idea, the development of the integrated model MOSDEW was started in the Neckar basin. Only 1.5 years later, the adaptation of the framework to the Benin and Uzbekistan basins was started in cooperation with the local partners. Most of the individual models contained in MOSDEW can be quite easily transferred. For the groundwater component this is problematic because of the different hydrogeological conditions and the data availability. The latter is is very limited in the two developing countries in comparison with Germany. In the Neckar catchment a three-dimensional groundwater flow model was applied using the MODFLOW finite difference approach. In the Neckar basin this approach is suitable for the whole area.In the other basins, conditions suitable for the application of a FD approach exist in parts of the basins only. Nevertheless MODFLOW is used to model groundwater flow in the Ouéme and Chirchik catchments as well. It is one of the scientific goals of the project to find out if the application of a three-dimensional flow model in complex areas with limited data availability has any advantages over the application of a merely conceptual hydrological approach. If such advantages cannot be found, it is possible to replace the groundwater component simply by the hydrological model which is part of MOSDEW: a (semi-)distributed HBV-model.

This contribution presents results of the Neckar catchment groundwater flow model and compares the model with the groundwater flow model of the southern Ouémé basin, which is currently being developed and soon to be completed. The groundwater model of the Ouémé basin is furthermore compared to the results of the hydrological model (HBV) of the Ouémé. The main focus of this contribution however is not on the presentation of numerical schemes but on some still unsolved questions in integrated

(ground)water resources management:

1. Which type of hydrological or groundwater model (conceptual, deterministic ...) is necessary to answer which type of questions and which type of model is suitable for which hydrogeological conditions?

2. What is the right balance between model complexity, data availability and complexity of the geological conditions, and finally:

3. How should groundwater related questions be analysed on the regional scale in different parts of the world anyway?