Groundwater Modeling in Coastal Arid Regions Under the Influence of Marine Saltwater Intrusion

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The optimization of an aquifer's "safe yield", especially within agriculturally used regions, is one of the fundamental tasks for nowaday's groundwater management. Due to the limited water ressources in arid regions, conflict of interests arise that need to be evaluated using scenario analysis and multicriterial optimization approaches.

In the context of the government-financed research project „International Water Research Alliance Saxony" (IWAS), the groundwater quality for near-coastal, agriculturally used areas is investigated under the influence of marine saltwater intrusion. Within the near-coastal areas of the study region, i.e. the Batinah plains of Northern Oman, an increasing agricultural development could be observed during the recent decades. Simultaneously, a constant lowering of the groundwater table was registered, which is primarily due to the uncontrolled and unsupervised mining of the aquifers for the local agricultural irrigation. Intensively decreased groundwater levels, however, cause an inversion of the hydraulic gradient which is naturally aligned towards the coast. This, in turn,leads to an intrusion of marine saltwater flowing inland, endangering the productivity of farms near the coast.

Utilizing the modeling software package OpenGeoSys, which has been developed and constantly enhanced by the Department of Environmental Informatics at the Helmholtz Centre for Environmental Research Leipzig (UFZ; Kolditz et al., 2008), a three-dimensional, density-dependent model including groundwater flow and mass transport is currently being built up. The model, comprehending three selected coastal wadis of interest, shall be used to investigate different management scenarios. The main focus of the groundwater modelling are the optimization of well positions and pumping schemes as well as the coupling with a surface runoff model, which is also used for the determination of the groundwater recharge due to wadi runoff downstream of retention dams.

Based on the groundwater model, scenarios will be evaluated considering various target figures (i.e. agricultural water demand, drinking water supply, "beautification", tourism, industry etc.). Within these scenarios, marine saltwater encroachment should be minimized or saline groundwater should even be pushed back into the coastal direction, thus stabilizing the natural equilibrium between continental freshwater flux and seawater intrusion and ensuring a long-term, stable usage of the agricultural areas.

Literature

KOLDITZ O., DELFS J.-O., BÜRGER C.-M., BEINHORN M., PARK C.-H. (2008): Numerical analysis of coupled hydrosystems based on an object-oriented compartment approach. J. Hydroinformatics, 10(3): 227-244, DOI: 10.2166/hydro.2008.003.