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Vulnerability assessment of groundwater-dependent ecosystems based on integrated groundwater flow modell construction

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Groundwater-dependent ecosystems (GDEs) are highly influenced by the amount of groundwater, seasonal variation of precipitation and consequent water table fluctuation and also the anthropogenic activities. They can be regarded as natural surface manifestations of the flowing groundwater. The preservation of environment and biodiversity of these GDEs is an important issue worldwide, however, the water management policy and action plan could not be constructed in absense of proper hydrogeological knowledge. The concept of gravity-driven regional groundwater flow could aid the understanding of flow pattern and interpretation of environmental processes and conditions.

Unless the required well data are available, the geological–hydrogeological numerical model of the study area cannot be constructed based only on borehole information. In this case, spatially continuous geophysical data can support groundwater flow model building: systematically combined geophysical methods can provide model input. Integration of lithostratigraphic, electrostratigraphic and hydrostratigraphic information could aid groundwater flow model construction: hydrostratigraphic units and their hydraulic behaviour, boundaries and geometry can be obtained. Groundwater-related natural manifestations, such as GDEs, can be explained with the help of the revealed flow pattern and field mapping of features.

Integrated groundwater flow model construction for assessing the vulnerability of GDEs was presented via the case study of the geologically complex area of Tihany Peninsula, Hungary, with the aims of understanding the background and occurrence of groundwater-related environmental phenomena, surface water–groundwater interaction, and revealing the potential effect of anthropogenic activity and climate change. In spite of its important and protected status, fluid flow model of the area, which could support water management and natural protection policy, had not been constructed previously.

The 3D groundwater flow model, which was based on the scarce geologic information and the electromagnetic geophysical results, could answer the subsurface hydraulic connection between GDEs. Moreover, the gravity-driven regional groundwater flow concept could help to interpret the hydraulically nested flow systems (local and intermediate). Validation of numerical simulation by natural surface conditions and phenomena was performed. Consequently, the position of wetlands, their vegetation type, discharge features and induced landslides were explained as environmental imprints of groundwater.

Anthropogenic activities and climate change have great impact on groundwater. Since the GDEs are fed by local flow systems, the impact of climate change and anthropogenic activities could be notable, therefore the highly vulnerable wetlands have to be in focus of water management and natural conservation policy.