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Investigation of the effect of groundwater flow in a complex hydraulic situation

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Groundwater flow systems are the subsurface elements of the hydrologic cycle, thus they have an important effect on surface water bodies and surface water-groundwater interaction processes. Moreover, groundwater flow systems are not simple, different driving forces govern and form different regimes with different behaviour. Their effects on surface systems differs, respectively. Based on this consideration, the characterization of the subsurface flow regimes and their operating mechanisms are crucial for the understanding of hydrological problems and situations at the surface.

The Great Hungarian Plain can be handled as a natural laboratory, where several geological mechanisms act as groundwater driving forces. As a result, two main flow regimes, a gravity-driven, unconfined, and a confined, overpressured system could be separated (Tóth and Almási, 2001). The recharge and water budget of the systems, their spatial distribution, and their surface discharge features influence the possibilities of water withdrawal from them, their effect on the surface water bodies, vegetation, soil mechanisms and salinization etc.
Numerical modelling with COMSOL Multiphysics was carried out for the Duna-Tisza Interfluve area of the Great Hungarian Plain, to characterize the two main flow regimes at three different scales. The aim of the study was to understand the flow distribution and their surface discharge character in quantitative way. The simulation was based on the understanding of the systems' operation from preproduction hydraulic head and pressure data analysis by Mádl-Szőnyi and Tóth (2009). These data could serve as basis for the validation of the model. The results were interpreted and discussed focusing on the flow systems' possible influence on the surface salinization, lake water – groundwater interactions, inland water problems, land-use planning.

It could be revealed that overpressured system is concentrated in the deep basin and the overpressure maintains usually below basin-wide aquitard layers. However, it has dissipated in some places along conductive faults and permeable zones. Therefore production of this system is restricted and economically not feasible. In addition to that, the elevated dissolved solid content of the system can have large effect on salinization processes on the surface in case of discharge situation, in spite it transports only negligible amount of water to the surface. The gravity-driven systems are in continuous connection with the surface, they are recharged from the precipitation. It is a renewable system from water production point of view (Mádl-Szőnyi and Simon, 2016).

The location of the recharge and discharge areas of the interplaying flow systems influence quantitatively the surface water processes and phenomena: droughts, surface inland water problem, floods.

References

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