Urban groundwater modeling scenarios to simulate a Bucharest City lake disturbance

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The urbanization impact on groundwater system becomes an important subject due to the continuous expansion of cities, climate change and water scarcity, and water quality degradation. In urban areas an important man-made disturbance on the water cycle is produced by: 1) the change of land use that reduces natural aquifer systems recharge from precipitation, 2) manmade sinks induced by groundwater abstraction, drains, subway tunnels, sewer systems, and others; 3) urban infrastructure elements acting like groundwater recharge sources, as for example the water supply network losses and leaky sewer systems. Besides, human activity affects the natural hydraulic connection between groundwater and surface water.

In the last decade a slow decrease of the water level has been observed in one of the Bucharest city lakes called “Lacul Circului”. However it has a man-made origin, the lake is naturally fed by the upper shallow aquifer of the Bucharest city. Several analysis scenarios have been studied in order to derive the real cause of this phenomenon. The urban aquifer system behavior, showing a strong relationship with the underground infrastructure changes since 2004, has been studied. These changes included the water supply network losses reduction of the area, the sewer network interaction, the barrier-effect produced by the existing subway tunnels, and potential temporary and permanent dewatering systems.

A pseudo-3D groundwater model, simulating the urban area groundwater behavior, has been set up by using MODFLOW software. The model has been developed on the basis of a previously developed 3D hydrogeological model assessing the groundwater flow for the entire Bucharest city. Complementary field investigations (borehole logs, electrical soundings and profiling, as well as groundwater leveling and pumping tests) have been conducted to better delineate the geology and to focus on the groundwater dynamics of the area. Together with the recorded history of diminishing the water supply system losses, dewatering systems information, existing interaction with the sewer network and subway tunnels and supposed contact with the other water surface elements, the field test results have been further used to build up the area groundwater model.

As before 2004 the lake water level showed a steady behavior, groundwater scenarios have been developed since, taking into account the infrastructure elements changes with time. Modeling results outlined a clear connection between the decrease of the lake water level and the existing permanent dewatering systems.