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Where does the drinking water come from? – Interrelationship between surface water and groundwater in a carbonate area, Hungary

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Naturally discharging springs have provided high-quality water as a local drinking water resource in the Bakony–Balaton Highland area (Central Hungary, Europe) for centuries. On the other hand, the Balaton Highland – Lake Balaton region is a popular tourist destination with an outstanding ecological value of the Lake Balaton and the surrounding wetlands. For the proper and sustainable water management, we need to gain a better understanding of the groundwater flow systems of the Bakony–Balaton Highland–Lake Balaton region, hydraulic connection between the subareas of it, quantity and areal distribution of groundwater recharge, subsurface flow paths through the mainly carbonate formations and also the exploitable amount of groundwater which, meets the human and ecological needs, as well.

Therefore, the main aim of the study was to disclose the natural hydrogeological processes in the Bakony–Balaton Highland–Lake Balaton region, applying the modern theory of basin hydraulics, considering the special behaviour of carbonate systems. Hydraulic and hydrochemical connection between surface water and groundwater, as well as among Bakony, Balaton Highland and Lake Balaton were examined. Water management-related issues were also discussed regarding drinking water resources, sustainable water use and geothermal potential.

Based on the performed data analysis, surface water recharged to the groundwater in the highest areas of Bakony, while in the Southern Bakony and Balaton Highland the creeks discharged the groundwater according to the fluid potential distribution. The hydrochemical composition of groundwater was primarily determined by the carbonate aquifers: $Ca2+$, $Mg2+$ and HCO_3- ions were dominant even in the siliciclastic cover. All of the water samples had the similar TDS value of 500–1000 mg/l regardless the areal and vertical position and also the type of sample, i.e. well or spring. Subsurface temperature field reflected the advective heat transport caused by the groundwater flow. The recharging cold water could infiltrate down to –3 000 m asl, hot water (>30 °C) could be found only in deeper parts of the basin, except the 3 near-surface heat accumulation under the area of Little Hungarian Plain, under the boundary of Bakony and Balaton Highland and under the basin of Lake Balaton.

In conclusion, there is a strong interrelationship between the surface water and groundwater in the study area, these waters form a single and interconnected resource. Therefore, any use of groundwater would affect the surface water and vice versa. For sustainable water management, reconsideration of water bodies delineation used by water directorates (Water Framework Directive) on the basis of revealed groundwater flow directions and hydraulic connections in the study area is proposed. These results can be crucial in the planning of artificial/managed recharge due to climatic changes to maintain water resources for human and ecological use.

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