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An example of inverse delineation of basin boundaries based on water budgeting in highly karstified terrains

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Globally, karst aquifers are one of the most significant sources of drinking water. Although characterized by variable regimes, karst groundwater has excellent natural quality. The main prerequisite for successful utilization and management of karst groundwater is the proper evaluation and characterization of a karst hydrogeological system. It is very important to define the hydrogeological parameters of a system, its boundaries, and the amount of groundwater that could be sustainably used. Delineation of the catchment area is one of the most complicated tasks in karst aquifer characterization, but it is necessary when it comes to the definition of sanitary protection zones. Due to high seasonal fluctuation of groundwater tables, it is very common in a highly karstified area to discover reorientation of the groundwater flow and the changes of the basin's boundaries. The catchment area of a karst aquifer usually consists of an autogenic and an allogenic part of the recharge area, where the former is consistently very difficult to identify.

This article discusses a case of inverse definition of karst spring catchment boundaries based on water budget and systematic measurements of spring discharge and precipitation. The studied area covers the karst spring Vučkovo vrelo, located in the vicinity of the city of Sjenica in SW Serbia. The catchment area at the karstic Pešter Plateau consists of Triassic limestone and dolomites (autogenic recharge), which are in some areas partly covered by Jurassic ophiolites and Miocene sediments. The karst spring discharge rate has been monitored since 2016, while precipitation data has been collected since 1950s. On average, at this spring, the karst aquifer annually drains a total water amount of 7.9 x 106 m^3, while the sum of the annual rainfall in an average hydrological year for the concerned period is 850 l/m2. Some water budget components are approximated by necessity, or values have been used by analogy. Such is the case with effective infiltration (Ief), which is estimated to be 55% of the rainfall on average. This value resulted from calculated evapotranspiration of 35%, based on Turc's equation, with an estimated runoff of 10%. At the Vučkovo vrelo spring, this approach resulted in the catchment size of approximately 15 km2, which, in the field has been found to indeed correspond to the suggested the sanitary zone no. 3 (the zone of observation according to the national legislation). Considering that karst spring is of ascending type, with a very stable discharge in the course of a hydrologic year, it is assumed that boundaries of its catchment area are not changing considerably throughout the year. Nevertheless, continuous monitoring of karst spring discharge and precipitation would provide a basis for more precise delineation of the catchment area as an iterative process.