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The analysis of the karst spring discharge as a reliable methodology to understand karst aquifer hydrodynamics under Mediterranean climate. Application to a large karst aquifer in Portugal.

Isabel Paiva and Lúcio Cunha
University of Coimbra, Geography and Tourism, Coimbra, Portugal (isabelrp@ci.uc.pt)

Karst aquifers are extremely complex and heterogeneous media. The importance of their water resources in Mediterranean areas and their high vulnerability require a deep knowledge of the groundwater circulation and storage behavior which is usually an enormous challenge. Karst spring flow represents the natural output of the karst aquifers and its analysis is a valuable method to understand the aquifers' hydrodynamics. This study deals with the complex process of hydrological transformation of recharge into discharge inside the aquifer. With no boreholes, sinkholes and points of direct measuring, the methodology is based on the analysis of the response of the main outlet of the karst aquifer. Time series analysis and recession curve analysis are applied to daily time series of rainfall as input and spring discharge as the output during 7 hydrological years (from 2009/10 to 2015/2016). The variations on temperature and electrical conductivity of spring water are considered on the short-term analysis (hourly data). Therefore, the present analysis consists on an integrated investigation that represents the first quantitative approach to understand the hydrogeological functioning of a large and non-well-known karst aquifer and improve the knowledge about its internal structure (degree of karstification, groundwater flow path network, storage capacity). The case study is the Sicó-Degracias karst aquifer at the central western region of Portugal, which is relatively unknown from hydrological and speleological perspective. The interpretation of the discharge of the main spring of the karst aquifer (considered as a black box) shows an important component of quick flow after heavy rainfall events and a very slow empty during the recession period. This bimodal behavior demonstrates the significant spatial complexity and heterogeneity of the karst aquifer with the presence of a conduit-dominated flow throughout a developed and connected conduit network system. The dominance of baseflow underlines the large storage capacity of the aquifer. The results demonstrate an important component of delayed flow as well. The results provide further insights for water resources management in karst regions and future hydrogeological processes modelling under uncertainties of climate change in Mediterranean region. Furthermore, the quantitative information extracted from this study proves that the analysis of hydrographs and chemographs remains a simple, valuable and reliable tool in the karst hydrology especially where only few data are available.