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Statistical techniques applied on multiparameter daily time series to groundwater recharge assessment in a calderic aquifer: Roccamonfina Volcano, Italy.

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The analysis of hydrogeological time series, is a widespread useful tool to support the aquifer characterization, although the distribution of the monitoring points often is not able to describe the complexity of the studied aquifer. In these cases, the combined analysis of different parameters collected over the time, such as groundwater levels, river stages, rainfall and temperature, can get a deeper insight into the conceptual model definition, especially where the monitored hydrological and hydrogeological features interact.
The studied area corresponds to the non-active Roccamonfina Volcano caldera (southern Italy). Previous researches identified a productive aquifer (around 300 L/s) in the deposits of the last stage of the volcano activity. Therefore, lateral no flow boundaries correspond to the calderic rim which mostly appears intact. The southeastern portion of the calderic rim was involved in the sectoral volcano collapse which corresponds to the aquifer discharge area. The main recharge area of the aquifer corresponds to the outcrop of two domes characterized by high permeability due to the strong fractured cooling pattern. The infiltrated water laterally drains through the pumice layers toward the Savone delle Ferriere gaining stream. The formation of calderic lakes between the calderic pumices depositions allowed the distinction of a multilayer aquifer levels separated by clay lacustrine deposits.
Here, a monitoring of the major hydrological and hydrogeological features was implemented. Groundwater level and temperature in three wells, tapping the different aquifer layers, river stage and surface-water temperature in the Savone delle Ferriere stream have been measured on a daily basis. In addition, daily thermo-pluviometric data were acquired from the Campania Region weather station, located in the recharge area.
A statistical approach based on the cross-correlation (Chiaudani et al. 2017), among the monitored rainfall, groundwater levels and temperature, has been applied to point out the response time of each aquifer layer. In this way, it has been possible to estimate the time delay of the different aquifer layer response, in terms of piezometric level and temperature variation in the monitored wells, to the local rainfall pattern. In addition, the Water-Table Fluctuation (WTF) method (Healy and Cook, 2002) has been applied to the piezometric level time series to estimate the recharge, which considers the specific storage coefficient of the aquifer, the difference between maximum and the minimum hydraulic head values of each peak extrapolated from the regression curve, and the time that elapses during the peak decrease.
First results show that the different aquifer layers respond to the daily rainfall within 13 days and that the estimated recharge is about 20% with respect to the local precipitation.

References

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