EGU2020-2021
https://doi.org/10.5194/egusphere-egu2020-2021
EGU General Assembly 2020

Identification of an appropriate method for assessing large-scale and long-term recharge in Mediterranean karst aquifers

Irina Engelhardt[1], Sandra Banusch[1], Paul Hepach[1], Márk Somogyvári[1], Gerd Wessolek[2], Tomy-Minh Truong[1], Edoardo Bucchignani[3], Christopher Conrad[4], Yakov Livshitz[5], and Martin Sauter[6]
[1]Department of Hydrogeology, TU Berlin, Berlin, Germany (irina.engelhardt@tu-berlin.de)
[2]Department of Soil Protection, TU Berlin, Berlin, Germany (gerd.wessolek@tu-berlin.de)
[3]CIRA Meteo System and Instrumentation, Caserta, Italy (E.Bucchignani@cira.it)
[4]Department of Geoecology, University Halle-Wittenberg, Halle, Germany (christopher.conrad@geo.uni-halle)
[5]Department of Hydrogeology, Israel Water Authority, Jerusalem, Israel (YakovL20@water.gov.il)
[6]Department of Applied Geology, Georg-August-University Göttingen, Göttingen, Germany (msauter1@gwdg.de)

Groundwater recharge is an important variable for sustainable groundwater resources management in regions affected by water scarcity. The specifics of the Mediterranean require adapted techniques to also account for climate change implying a higher frequency of extreme events. Appropriate techniques are highly relevant for recharge with low rates. We compare three methods for the Western Mountain Aquifer, a karst in Israel: soil moisture budget calculations at basin scale, empirical functions, and machine learning algorithms. Resulting recharge are compared with measured spring discharge.

Neural networks have the advantage of not requiring much knowledge about physical processes or hydrogeological and hydrological conditions, nor about model parameters. This data-driven machine learning algorithms learn the non-linear relationship between precipitation events and spring water discharge given a sufficient amount of training data is available. After training, the neural network could be used as a nonlinear function to model recharge of any predicted precipitation time series. However, this approach does not allow for any quantitative analysis of external forcing, such as land use, or internal parameter, such as soil characteristics, nor does it account for any expected future change in precipitation pattern.

Hydro-pedotransfer functions (HPTF) are based on empirical relationships between precipitation and recharge. HPTFs account for potential evapotranspiration, annual precipitation, land cover, and a critical water supply (a threshold when actual evapotranspiration depends only on atmospheric conditions). Resulting percolation rates consider i) vegetation types, ii) precipitation during the vegetation growth period, iii) runoff, iv) plant available soil water, and v) capillary rise. The application of HPTF to a karst aquifer has the advantage that only limited input data are required. However, our results indicate that HPTFs are not able to capture the rapid recharge component observed in karst systems and thus underestimate recharge.

The **Soil Water Assessment Tool (SWAT)** employs a hydrological and soil moisture budget

calculations. Objective functions are actual evapotranspiration and surface runoff. Evapotranspiration is obtained from MODIS remote sensing data. Calibration of actual evapotranspiration is especially challenging for summer periods due to the impact of vegetation and irrigation. However, the most relevant parameter determining daily recharge rates are water loss by surface-runoff and surface water storage in wadi beds generating episodic recharge.

Impact of shifts in climate is considered by climate projections obtained with the RCM COSMO-CLM at resolution of 3 km, under the IPCC RCP4.5 scenario, nested into the MENA-CORDEX domain. However, we believe that changes in land use from natural vegetation (trees, grass-, and shrublands) to rain-fed agricultural area could possibly shift the water budget from deficit to surplus conditions (recharge dominated). During the period 1992 to 2015 natural vegetation decreased by 8% and urban areas increased by up to 6%, while (rain-fed) agricultural areas remained almost constant. We investigate if land use changes might have (a much) larger impact on percolation rates than the predicted climate change effect. Thus, in future recharge may be controlled and enhanced in regions with water scarcity by better management of land use employing an optimized combination between precipitation, irrigation, and crop type.