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Assessment of vulnerability in karst aquifers using a quantitative integrated numerical model: catchment characterization and high resolution monitoring - Application to semi-arid regions- Lebanon.

Joanna Doummar, Michel Aoun, and Fouad Andari
American University of Beirut, P.O. box 11-0236, Riad El-Solh, Beirut 1107 2020, Lebanon (jd31@aub.edu.lb)

Karst aquifers are highly heterogeneous and characterized by a duality of recharge (concentrated; fast versus diffuse; slow) and a duality of flow which directly influences groundwater flow and spring responses. Given this heterogeneity in flow and infiltration, karst aquifers do not always obey standard hydraulic laws. Therefore the assessment of their vulnerability reveals to be challenging. Studies have shown that vulnerability of aquifers is highly governed by recharge to groundwater. On the other hand specific parameters appear to play a major role in the spatial and temporal distribution of infiltration on a karst system, thus greatly influencing the discharge rates observed at a karst spring, and consequently the vulnerability of a spring. This heterogeneity can only be depicted using an integrated numerical model to quantify recharge spatially and assess the spatial and temporal vulnerability of a catchment for contamination.
In the framework of a three-year PEER NSF/USAID funded project, the vulnerability of a karst catchment in Lebanon is assessed quantitatively using a numerical approach. The aim of the project is also to refine actual evapotranspiration rates and spatial recharge distribution in a semi arid environment. For this purpose, a monitoring network was installed since July 2014 on two different pilot karst catchment (drained by Qachqouch Spring and Assal Spring) to collect high resolution data to be used in an integrated catchment numerical model with MIKE SHE, DHI including climate, unsaturated zone, and saturated zone. Catchment characterization essential for the model included geological mapping and karst features (e.g., dolines) survey as they contribute to fast flow. Tracer experiments were performed under different flow conditions (snow melt and low flow) to delineate the catchment area, reveal groundwater velocities and response to snowmelt events. An assessment of spring response after precipitation events allowed the estimation of the fast infiltration component. A series of laboratory tests were performed to acquire physical values to be used as a benchmark for model parameterization, such as laboratory tests on soils for conductivity at saturation and grain size analysis. Time series used for input or calibration were collected and computed from continuous high resolution monitoring of climatic data, moisture variation in the soil, and discharge at the investigated spring. This similar model approach used on a catchment site in Germany is to be applied and validated on two pilot karst catchments in Lebanon governed by semi-arid climatic conditions.

References

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