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Quantitative assessment of key parameters in qualitative vulnerability methods applied in karst systems based on an integrated numerical modelling approach

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In the framework of a three-year PEER (USAID/NSF) funded project, flow in a Karst system in Lebanon (Assal) dominated by snow and semi arid conditions was simulated and successfully calibrated using an integrated numerical model (MIKE-She 2016) based on high resolution input data and detailed catchment characterization. Point source infiltration and fast flow pathways were simulated by a bypass function and a high conductive lens respectively.
The approach consisted of identifying all the factors used in qualitative vulnerability methods (COP, EPIK, PI, DRASTIC, GOD) applied in karst systems and to assess their influence on recharge signals in the different hydrological karst compartments (Atmosphere, Unsaturated zone and Saturated zone) based on the integrated numerical model.
These parameters are usually attributed different weights according to their estimated impact on Groundwater vulnerability. The aim of this work is to quantify the importance of each of these parameters and outline parameters that are not accounted for in standard methods, but that might play a role in the vulnerability of a system. The spatial distribution of the detailed evapotranspiration, infiltration, and recharge signals from atmosphere to unsaturated zone to saturated zone was compared and contrasted among different surface settings and under varying flow conditions (e.g., in varying slopes, land cover, precipitation intensity, and soil properties as well point source infiltration). Furthermore a sensitivity analysis of individual or coupled major parameters allows quantifying their impact on recharge and indirectly on vulnerability.
The preliminary analysis yields a new methodology that accounts for most of the factors influencing vulnerability while refining the weights attributed to each one of them, based on a quantitative approach.