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Sensitivity analysis of an integrated numerical flow model output to key parameters used in common qualitative vulnerability assessment methods

Joanna Doummar and Assaad H. Kassem
American University of Beirut, Geology, Beirut, Lebanon (jd31@aub.edu.lb)

Qualitative vulnerability assessment methods applied in karst aquifers rely on key factors in the hydrological compartments usually assigned different weights according to their estimated impact on groundwater vulnerability. Based on an integrated numerical groundwater model on a snow-governed karst catchment area (Assal Spring- Lebanon), the aim of this work is to quantify the importance of the most influential parameters on recharge and spring discharge and outline potential parameters that are not accounted for in standard methods, when in fact they do play a role in the intrinsic vulnerability of a system. The assessment of the model sensitivity and the ranking of parameters are conducted using an automatic calibration tool for local sensitivity analysis in addition to a variance-based local sensitivity assessment of model output time series (recharge and discharge) for two consecutive years (2016-2017) to various model parameters. The impact of each parameter was normalized to estimate standardized weights for each of the process based key-controlling parameters. Parameters to which model was sensitive were factors related to soil, 2) fast infiltration (bypass function) typical of karst aquifers, 3) climatic parameters (melting temperature and degree day coefficient) and 4) aquifer hydraulic properties that play a major role in groundwater vulnerability inducing a temporal effect and varied recession. Other less important parameters play different roles according to different assigned weights proportional to their ranking. Additionally, the effect of slope/geomorphology (e.g., dolines) was further investigated. In general, this study shows that the weighting coefficients assigned to key vulnerability factors in the qualitative assessment methods can be reevaluated based on this process-based approach.