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Testing the validity of different synthetic scenarios for flow and transport simulation in karst systems using a real case study application.

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Climate change and pollution are posing additional unprecedented threats to existing water resources, especially to water supply from karst aquifers in Mediterranean and semi-arid regions. A numerical model considering the most important key hydraulic parameters can forecast the impact of any given input on model quality and quantity output. In this work, we propose to model flow and transport using Comsol multiphysics in a synthetic model and to apply it to a simplified real case study (Jeita spring in Lebanon supplying water to 1.5 million inhabitants). The model geometry consists of a 5300 m long variably saturated horizontal conduit portrayed as 1) 2-D continuum and/or 2) a channel draining a porous equivalent matrix (400 m thick). Flow is simulated using the Richards Equation in both saturated and unsaturated medium. Recharge is applied vertically as both diffuse and point source in a shaft linked to the conduit. Percentages of fast infiltration rates are obtained from the analysis of event time series recorded at the spring (electrical conductivity and discharge). Flow rates at the outlet are used for transient model calibration. Mean velocities, dispersivities, and phreatic conduit diameters obtained from tracer experiments under various flow periods are used for transport validation in the channel. The aim is to test the validity of a functional simplified flow model on a complex real case and to identify based on a sensitivity analysis the key parameters that allow an optimal calibration of such a model.