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A combined methodology of vulnerability mapping and groundwater flow models for the management of karstic aquifers

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The present study examines the application of a distributed flow model to a typical Mediterranean karstic aquifer and the importance of the input information. The site of interest is located at the eastern part of Crete and extends to an area of 167 km^2 mainly of coverless limestone. The geological and climatic conditions of the area are representative of the Mediterranean karst. Also, the information on geological and hydrological characteristics is limited, which is also very common for these systems. The developed model is a combination of the Equivalent Porous Continuum with Discrete Fractures (EPC-DF) modeling approach and the GIS-based vulnerability mapping method PaPRIKa. The EPC-DF method is commonly used for the simulation of systems characterized by dual porosity. In the present study the karstic system is represented by a porous aquifer which also has a principal drainage axe. The model is developed using the finite element code FEFLOW (WASY) which allows for the integration of discrete features such as channels in a porous matrix. The PaPRIKa method is a multi-criteria cartographic method for the evaluation of intrinsic vulnerability of karstic systems, which considers four criteria: the existence of a Protection cover (P map), the lithological properties of the Reservoir (R map), the duality of Infiltration (I map) and the degree of Karstification (Ka map). It spatially describes both structural and functioning characteristics of the karst, providing a simple and realistic conceptual scheme. In the developed model the distribution of the parameters follows the cartographic limits provided by i) the P and I maps for the assignment of recharge, and ii) the R and Ka maps for the assignment of the hydraulic parameters of the saturated zone. The obtained simulated results of groundwater levels are in a good agreement with the selected field measurements. The overall aim of the present study is the development of a flexible tool for the management of water resources in karstic terrains based on groundwater flow modeling. A groundwater flow model of distributed parameters allows for the realistic representation of the hydrological and structural characteristics of karst and is applicable to scenarios exhibiting spatial variability, such as land use modifications and artificial recharge plans.