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MODELLING GROUNDWATER FLOW AND SOLUTE TRANSPORT IN KARSTIC SYSTEMS: FROM DREAMS TO THE REALITY – HOW CAN MODELS HELP FOR GROUNDWATER VULNERABILITY ASSESSMENT ?

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Simulation (modelling) of groundwater flow and transport, using various numerical methods, and taking into account as far as possible the spatial variability of the hydrodynamic and hydrodispersive properties of karstic aquifers is certainly not an easy exercice. Many groups of models can be used. 'REV based models' with single, double, triple continuum approaches can be applied as well for solving flow problems (groundwater quantity) as for transport problems (groundwater quality), but many issues are still challenging: parameterisation and scale of application, calibration/validation issues, sensitivity, applicability. It is the same for 'discrete approaches', which require even more information for solving parameterisation and scale issues, for 'stochastic approaches', theoretically providing the uncertainty of your results in function of the uncertainty of your data, and even for 'fractals techniques' all these issues remain. 'Black-box models' are lighter to handle but are not anymore 'physically consistent'. The prediction results with such mathematical tools cannot be relied on when predictive computations are performed with aquifer stresses (i.e. recharge, pumping, boundary conditions) that will possibly lie out of the calibration range.

The choice of an adequate tool for analysing and simulating karst aquifer behaviour will depend strongly on the kind of problem to be solved: a steady-state flow problem will be considerably more simple to simulate than a transient transport problem with transient groundwater flow conditions. Unfortunately, in practice this last problem is in most cases more realistic than the former one. Another overwhelming factor is the scale of the study: local modelling simulations need more detailed data and probably a more discrete approach in the way of describing the spatial variability than in regional models.

Despite all these limitations, simplified physically consistent groundwater and transport models can help for groundwater vulnerability assessment. Numerical models are useful as tools for consistently interpreting, the results of field measurements and experiments. Calibration of numerical models using these measurements will allow to optimise the use of this information for validating (to some extent) the vulnerability assessment. They can be considered as useful intermediate tools between field measurements and vulnerability assessments. After calibration, one can perform sensitivity analysis to check how results can vary in different stressed scenarios ('what if' simulations) or to consider the uncertainty of the parameters used. Results of this analysis allow the validation of the assumptions in the adopted vulnerability assessment technique.