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Stochastic modelling of flow in an alluvial aquifer

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Ground water flow in the aquifer system of the Province of Cremona (Northern Italy) shows a double system of circulation. Shallow sediments host a phreatic aquifer characterised by high conductivities, great recharge fluxes due to rainfall and irrigation, exchanges with surface water (Adda, Po, Oglio and Serio rivers, springs at topographical depressions and at the terraces bordering the main river valleys). Deeper sediments host semiconfined aquifers whose geological structure is quite complex and not yet fully known; fluxes through these semiconfined aquifers are much smaller than fluxes through the phreatic aquifer and are driven by extraction of water for drinkable purposes only. A stationary equivalent single layer model and a transient quasi-3D model was developed and calibrated. Here we present the very first 3D modelling exercise, in order to evaluate the potentiality of some instruments of stochastic flow modelling. In particular, transition probabilities and Markov chain modelling (Carle and Fogg, 1997) have been applied to simulate the facies distribution from the water well lithological logs; the simulation is performed on a “fine” grid with 125 m spacing in the horizontal plane and 3.75 m in the vertical direction. Furthermore estimates of conductivities for the different facies are used to upscale conductivity with Simplified Renormalization (Renard, 1997) to a “coarse” grid with spacing of 500 m in the horizontal plane and from 15 to 60 m along the vertical direction. Tests with different equiprobable simulations of the facies distributions and different values of facies conductivities – in a Monte Carlo fashion – provide useful insights on the uncertainty of the model predictions and on the data required to obtain a thorough calibration of the flow model.