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Variable density flow and geochemical processes to assess salinization problems in the Rhodope aquifer, Greece

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In this study, a variable density flow and contaminant transport model for the Rhodope coastal aquifer, located in Northern Greece and covering an area of approximately 180 km^2, has been developed using the FEFLOW model. In addition to that, geochemical processes in conjunction with field data have been investigated with the aim of the PHREEQC model to identify other groundwater salinisation sources than seawater. Based on available hydrogeological data for the area, two main aquifer layers can be identified; a shallow semi-confined aquifer layer with an average thickness of 35 m and of limited hydrogeological potential and, an underlain thicker one (50–100 m) which is confined and hosts the regional groundwater reserves. Between these two aquifer layers, a semi-impermeable layer with an average thickness of 10 m is considered.

The variable density flow model in FEFLOW environment has been set up using geological and hydrological information for the study area and assuming that only seawater intrusion affects groundwater quality. The domain area consists of 3 geological layers and 4 computational slices and is discretised by a finite element mesh of 2,008 nodes and 2,781 triangular prism elements. The finite element mesh is denser close to the computational area where a high variation of the dependent variables (i.e. hydraulic head, concentration of total dissolved solids) is expected.

The boundary conditions for the flow problem and the contaminant transport problem were well defined and a sufficient calibration both for the steady-state and the transient-state flow problem was achieved. However, in many parts of the study area the model results were not conformed with field data. This issue was substantially improved by the incorporation of geochemical processes as instructed by geochemical modelling with PHREEQC and included in the variable density flow model with appropriate boundary conditions in the semi-impermeable layer of the groundwater system.

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