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Modeling saltwater intrusion in highly heterogeneous coastal aquifers

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In this study, a 3D variable-density flow and solute transport model SEAWAT was used to examine the impact of macroscopic variation in a soil matrix on widening or narrowing the thickness of the saltwater-freshwater mixing zone. Located along the Eastern Mediterranean (Beirut), the pilot aquifer consists of karstified limestone of Cretaceous age overlain by Upper Tertiary and Quaternary unconsolidated deposits. The model used the advanced pilot-points parameterization coupled with PEST to characterize spatial heterogeneity. Historically simulated water levels were relied upon to reduce potential numerical instabilities induced by insensitive parameters in transient calibration. The latter demonstrated a high degree of heterogeneity in the middle parts of the aquifer and along western coastlines with specification of a high hydraulic conductivity and low storativity in fault networks. The response of the aquifer to seasonal stresses such as climate cycles, pumping rates and recharge rates was manifested as high fluctuations in potentiometric surface due to potential fast flow pathways along faults. The final distribution of saltwater intrusion supports two mechanisms 1) lateral encroachment of recent seawater into the western zone of the aquifer which is of most concern due to high horizontal hydraulic conductivity in the wave direction and 2) upconing in the northwest and southwest of the aquifer due to large vertical hydraulic conductivities that tend to exacerbate the vertical movement of salinity.

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