Use of high-resolution tidal data and highly-parameterized inversion for model calibration in managed coastal aquifers

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ABSTRACT

High-frequency water-level data for an 11-day period were used to calibrate a refined three-dimensional groundwater model of the coastal Biscayne aquifer in Florida, USA. The Biscayne aquifer in the study area is karstic and highly permeable and is intersected by a canal system managed to control flooding, provide recharge to municipal well fields, and control saltwater intrusion. The groundwater model was dynamically coupled to a hydrodynamic model of the canal system that uses a diffusive wave approximation of the Saint Venant equations and gate opening data for surface-water control structures in the study area. Initial model parameters and onshore external boundaries were derived from an existing model of the Biscayne aquifer. High-resolution tidal data were used to define water-levels in Biscayne Bay and at the downstream end of canals discharging to Biscayne Bay.

Aquifer water-level data exhibited periodic fluctuations caused by tides in Biscayne Bay, and were decomposed into the eight largest harmonic constituents present in the tidal data. A combination of raw water-level data and processed tidal efficiency data at specific frequencies were used with highly parameterized inversion methods to calibrate values of aquifer hydraulic diffusivity and canal leakance. The interference patterns produced by the tidal signal and its propagation through the canal system provide sufficient information to justify use of a highly parameterized calibration approach. Inclusion of the surface-water system in the model and use of surface-water data improved model calibration. This, in turn, provided important new insight regarding the complex interaction of the surface-water and groundwater systems to tidal forcing.

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