Tidal response method with simple decomposition techniques to determine hydraulic parameters of freshwater-lens aquifer

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ABSTRACT

Simple tidal response method was used to investigate hydraulic properties of a freshwater-lens aquifer. The employed tidal response method is characterized by consisting of groundwater-level observations for a specific length of time at paired two sites, near-shore and relatively inland, and two simple time-series decomposition techniques, nonrecursive digital filtering and discrete Fourier-transform calculations. The method used no surface-water (sea-level) data to reduce or offset errors derived from generally possible surface-water/groundwater boundary effects. The decomposition techniques were each recently optimized for extracting frequencies of known major tidal components. Digital high-pass filtering was used to separate tidal components of diurnal and shorter periods from longer-period components prior to the following isolation of tidal components. Basic formulas for Fourier transform were used to isolate major tidal components. Both decomposition techniques can be easily achieved only using built-in functions of spreadsheet software. The isolation of specific tidal signals helps reduce errors of a basic tidal response method that uses amplitude attenuation and phase lag of a simple sinusoidal wave of groundwater fluctuations. The tidal response method with simple decomposition techniques was applied to a freshwater-lens aquifer of a limestone island of Japan. The freshwater lens is the principal water resource for the island and investigations for its sustainable development are ongoing. The estimated hydraulic parameters agreed well with those previously estimated based on a pumping test conducted in the same island.

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