Estimation of Coastal Aquifer Properties Using Multiple-Frequency Ocean Tides

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Determination of the hydraulic properties of coastal aquifer systems has important implications that cover a number of research topics, such as seawater intrusion, submarine groundwater discharge, migration of contaminants, assessment of water resources, and geotechnical engineering. Although many theoretical solutions have been developed over recent decades, most of them assume that an aquifer system extends inland and subjected a single-frequency tidal fluctuation on coastline boundary. In addition, only one hydraulic parameter, i.e., the hydraulic diffusivity, a ratio of transmissivity to storage coefficient, of an aquifer can be obtained in most cases.

Considering more realistic conditions, the solution of groundwater response in a leaky confined coastal aquifer to dual frequency tidal fluctuations has been developed as an example. The solutions for a perfectly confined aquifer and single-frequency tidal fluctuations can be considered as special cases of the newly developed, generalized solution. The transport of ocean tides through a leaky confined aquifer depends on both the hydraulic diffusivity of the aquifer and leakage of semi-impermeable aquitard overlapped on it. Ocean tides could only transport to a limited distance towards inland if the hydraulic diffusivity is low and/or the leakage is large. Cautions should be excised that both earth tides and changes in local atmospheric pressure may induce similar tidal fluctuations in hydraulic head within an inland monitoring well. Both the hydraulic diffusivity and leakage can be identified from the monitored, time-depended fluctuations of hydraulic head detected with reliable accuracies. By incorporating the use of aquifer thickness that can be determined independently from observation of core materials during drilling of a monitoring well, both the transmissivity and storage coefficient of a perfectly confined aquifer or a confined aquifer with small leakage can be simultaneously estimated. The findings obtained from this study may provide a better understanding of using ocean tides for determining the hydraulic properties of coastal aquifer systems and a practical example for examining the applicability and/or limitations of the tidal method.

Keywords: Coastal Aquifer , Hydraulic properties, Tidal method, Mutiple-frequency

