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An analytical model for tide-induced groundwater head fluctuation in two-dimensional coastal leaky aquifer systems

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This paper presents an analytical model for describing tidal responses in a two-dimensional leaky confined aquifer system bounded by oceanic and estuarine boundaries. This aquifer system has an unconfined aquifer on the top, a confined aquifer at the bottom, and an aquitard between them. Consider that both the unconfined and confined aquifers, interacting with each other through leakage, have dynamic responses to the tidal fluctuations. Assume that the aquitard storage is negligible and the leakage is linearly proportional to the head difference of the unconfined aquifer and confined aquifer. The solution of the model is developed based on the perturbation method, separation of variables, and Green's function method. The solutions of Li et al. (2002, Tide-induced groundwater level fluctuation in coastal aquifers bounded by L-shaped coastlines, Water Resources Research, 38(3), 6-1$\sim$8) and Tang and Jiao (2001, A two-dimensional analytical solution for groundwater flow in a leaky confined aquifer system near open tidal water, Hydrol. Process., 15, 573-585) can be shown to be the special cases of the present solution when the water table in the unconfined aquifer assumes constant. Based on this solution, the groundwater head distribution, the dynamic effect of water table fluctuation, and the influence of leakage on the behavior of the groundwater level fluctuations in the two-dimensional leaky aquifer system can be clearly explored.