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Saturated and Unsaturated Flow due to Tidal Fluctuation and Rainfall in a Coastal Aquifer

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The prediction of groundwater level fluctuations due to tidal waves propagation and localized recharge in coastal aquifers is important for the development and management of water resources in coastal areas. Most of the past models for the recharge problem consider either saturated flow or unsaturated flow in the aquifers. However, it is expected that the recharge sources infiltrating from the ground surface have significant impact on the hydraulic heads in saturated and unsaturated zones of an unconfined aquifer in reality. The objective of this study is to derive a closed-form analytical expression for predicting tidal responses in a coastal aquifer system with considering rainfall recharge as well as coupled saturated and unsaturated flow. The model is composed of a linearized Richards equation for unsaturated flow coupled with the saturated groundwater flow equation. The top boundary at the ground surface is represented by the flux condition with a source term denoting the recharge in the coastal aquifer system. The solution of the model is developed in Cartesian coordinates based on the methods of Laplace transform and double-integral transform. On the basis of the analytical solution, the groundwater head fluctuations induced by the joint effect of rainfall and oceanic tides is examined in saturated and unsaturated zones of the aquifer. In addition, the influences of the unsaturated flow on the water table movement are also investigated and discussed.

Key words: analytical solution, unsaturated flow, coastal aquifer.