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A two-dimensional analytical model for groundwater flow in a leaky aquifer extending finite distance under the estuary

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In recent years, cities and industries in the vicinity of the estuarine region have developed rapidly, resulting in a sharp increase in the population concerned. The increasing demand for human activities, agriculture irrigation, and aquaculture relies on massive pumping of water in estuarine area. Since the 1950s, numerous studies have focused on the effects of tidal fluctuations on groundwater flow in the estuarine area. Tide-induced head fluctuation in a two-dimensional estuarine aquifer system is complicated and rather important in dealing with many groundwater management or remediation problems. The conceptual model of the aquifer system considered is multi-layered with estuarine bank and the leaky aquifer extend finite distance under the estuary. The solution of the model describing the groundwater head distribution in such an estuarine aquifer system and subject to the tidal fluctuation effects from estuarine river is developed based on the method of separation of variables along with river boundary. The solutions by Sun (Sun H. A two-dimensional analytical solution of groundwater response to tidal loading in an estuary, Water Resour. Res. 1997; 33:1429-35) as well as Tang and Jiao (Tang Z. and J. J. Jiao, A two-dimensional analytical solution for groundwater flow in a leaky confined aquifer system near open tidal water, Hydrological Processes, 2001; 15: 573–585) can be shown to be special cases of the present solution. On the basis of the analytical solution, the groundwater head distribution in response to estuarine boundary is examined and the influences of leakage, hydraulic parameters, and loading effect on the groundwater head fluctuation due to tide are investigated and discussed.

KEYWORDS: analytical model, estuarine river, groundwater fluctuation, leaky aquifer.