Fluctuation of groundwater level in a sloping unconfined aquifer due to time varying recharge

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When a water-permeable slope is recharged by rainfall, the variation of the groundwater level is usually observed by setting up observation wells. However, the point observations are not sufficient to represent the vast domain of an aquifer and are constrained by the high cost of instrumentation and excavated wells. Therefore, the development of mathematical models for groundwater simulations can help us to understand the change of groundwater level more easily.
This study considers the variation of the groundwater level in a sloping aquifer with an impervious bottom. We divided the aquifer into two areas with and without rainfall recharge, and then use the nonlinear Boussinesq equation with a source term derived from the law of mass conservation. Analytical solutions to the nonlinear equation was acquired by the perturbation method for a finite region and a semi-infinite domain. After the transformation of variables, the general integral transformation method was used. The groundwater level varying with time under different factors (such as the dip angle of impervious bed, hydraulic conductivity, storage coefficient and different recharge rates) was discussed.
The present results were compared with the observed data from an observation well, and the difference in between was discussed. It is expected that the research results can better understand the physical mechanism of groundwater level change, and help to manage the groundwater.

Keywords: nonlinear Boussinesq equation, perturbation method, general integral transform method (GITM)

