Hydraulic analysis of two-dimensional subsurface water flow down a hillslope

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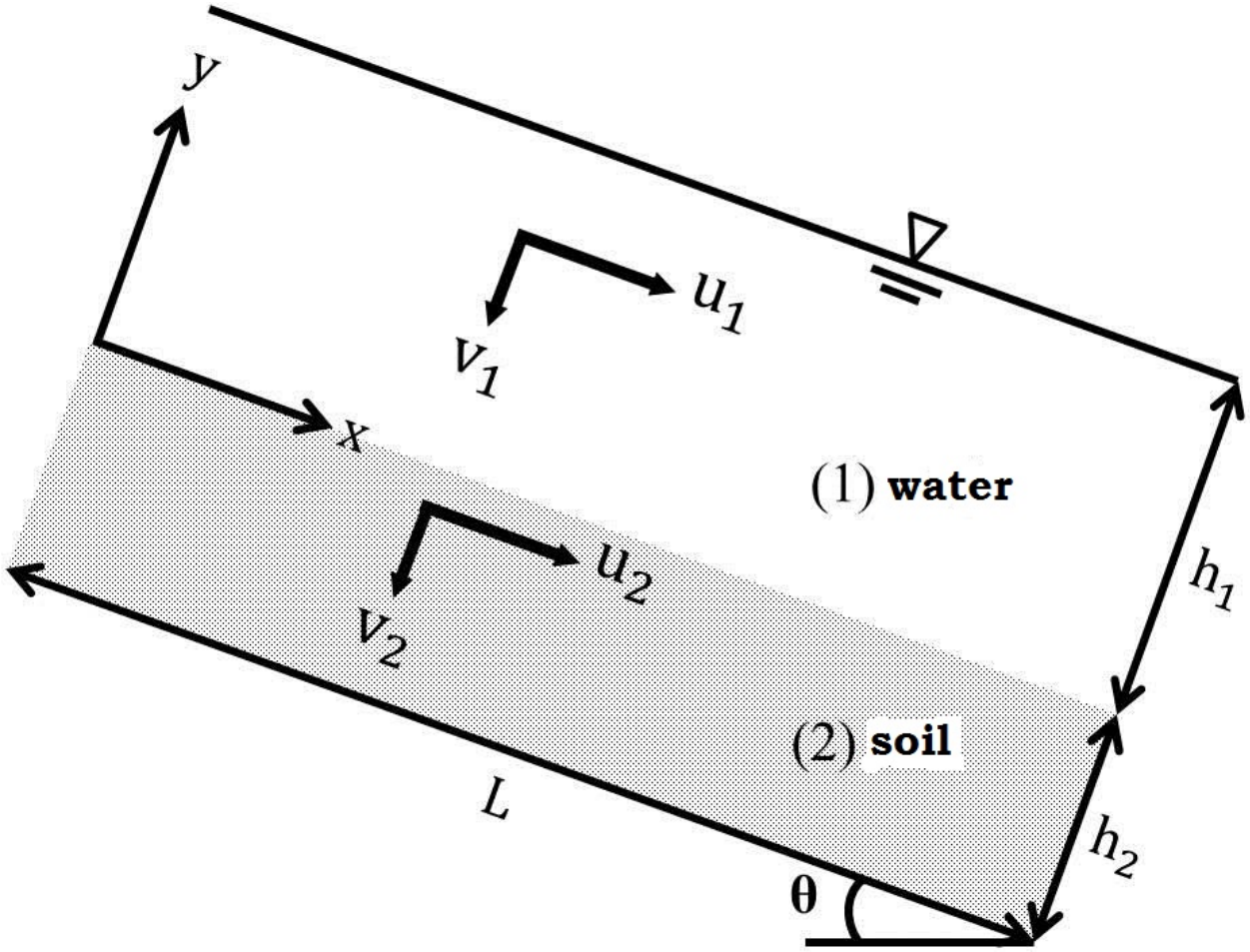
In this study, we are aimed at hydraulic analysis of a 2-D subsurface water flow down a slope. Different from the past, by additionally considering the vertical velocity and the inertia force in the momentum equation, we solve the equations in a new way. The flow field is divided into two regions (the water layer and soil layer). We derive horizontal, vertical velocity and physical quantities distribution both in the water and soil layers. In this article, the soil layer is regarded as an isotropic porous media so that the flow velocity on the ground surface is nonzero. For the momentum equations of the water and soil layer, we respectively adopt the Navier-Stokes equation and the Song's (1993) laminar model based on Biot's poroelastic theory. With the velocity type set by Desseaux (1999) and appropriate boundary conditions, we derive a couple of nonlinear ordinary differential equations which are solved by taking the Differential Transform Method (DTM) proposed by Arikoglu & Ozkol (2006). Finally, we derive the horizontal, vertical velocity and some other physical quantities distributions, and then compare the results with the relevant literature.

Keywords: porous media flow, subsurface flow, vertical velocity



Schematic diagram of the study

