

An analytical solution for predicting transient horizontal infiltration in a porous formation

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A proper understanding of flow in the vadose zone is often essential for working out a successful hydraulic linkage between the surface and groundwater of a watershed. The flow in the vadose zone is now increasingly simulated by numerical means. This is understandable as the most commonly used governing equation (Richard's equation) for simulating flow in the unsaturated zone is of a non-linear nature.

Existing analytical solutions of the horizontal infiltration problem are mostly developed by resorting to some form of linearization of the Richard's equation, as it is not easy to obtain an analytical solution to the problem by considering the full non-linearized version of the Richard's equation.

In this study, an effort is made to develop a general solution to the problem by solving the non-linear one-dimensional Richard's equation for a few specific boundary conditions of the problem. The solution has the flexibility to tackle both constant as well as instantaneous source inputs and can also be extended to handle time dependent variable source inputs as well. As the proposed solution is of a general nature, it is hoped that the predictions of time dependent moisture distributions obtained from it for a variably saturated horizontal soil profile will be more realistic than those obtained from solutions developed with more simplified assumptions.

Further, the developed solution is also expected to provide a mathematical tool linking the hydraulics of surface and groundwater in areas where these zones are being interspaced by a vadose zone. Further, as the nature of the Richard's equation is similar to the diffuse contaminant movement equation, the developed solution with a little modification can also be used to simulate transient contaminant transport in a heterogeneous soil formation.