Title: Green-Ampt Infiltration and Redistribution Calculations for 1-D and Quasi 3-D (Point Source) Flow Domains

Leslie Gowdish, Rafael Muñoz-Carpena and Jason Icerman
Agricultural and Biological Engineering Department, University of Florida

Although unsaturated flow can best be described by Richards' equation, numerical solutions of Richards' equation are generally computationally intensive and require extensive soil property data. Therefore, simplified physically-based approaches have often been used. The purpose of this research was to develop and validate a physically-based approximate model for simulating infiltration and redistribution in 1-D and quasi 3-D flow domains. The first step was to improve an existing 1-D infiltration and redistribution model based on Green-Ampt assumptions, GAR, by increasing the number of redistributing wetting fronts and adding a correction factor, Γ (a function of redistribution number -N_R, redistribution time -T_R, and saturated hydraulic conductivity-K_s). A comparison of the modified (MGAR) and the original GAR models against a numerical solution of Richards' equation showed that MGAR predicts better the surface water content and is also able to predict well the average water content of a desired observation layer for a wide range of soils. The 3-D form of the Green-Ampt (3DGA) infiltration model was compared to several established point source models and published data and found to be a viable model for simulating 3-D (point-source) flow domains. A simplified equation for the water supply radius parameter, required by the 3DGA method, was developed based on Philip's point source radius equation. Testing of the proposed equation showed good results for a wide variety of soils. The 3DGA model was then extended based on the MGAR method to calculate the change in water content during the 3-D redistribution phase. Comparison with Richards' numerical solution (Hydrus 2D) showed the model to provide good point-source results for a wide variety of soils. The ability of these models to accurately simulate infiltration and redistribution for multistorm precipitation and irrigation time series is particularly important in Florida's sandy soils for potentially increasing water efficiency and decreasing nutrient leaching.

Keywords: 1-dimensional, 3-dimensional, Green-Ampt infiltration, redistribution, point source

Challenge: Population growth and land use change impacts to water resource sustainability

Issue: Water availability and allocation