Introduction

Aquifer sensitivity analysis, groundwater resource planning, and understanding climate-change impacts all require reliable approaches for estimating water flux in the unsaturated zone. This research seeks to answer the following questions related to quantifying water flux in various zones of glacial materials in the Midwestern United States:

- What is the optimal approach to efficiently determine unsaturated-zone saturated hydraulic conductivity?
- What numerical models are most appropriate for estimating 1-D fluxes and groundwater recharge below the rooting zone? This approach is addressed initially using objective model simulations with measured and fixed parameters applied to a soil water balance model and HYDRUS-1D.

Water flux/recharge modeling approach

Model time domains and boundary conditions

- Water-year simulations were run using daily time steps and input data for 2011/12 and 2012/13.
- Groundwater recharge season simulations were conducted between November and February for each water year.
- Daily time steps were used.
- Measured soil moisture data were used to establish initial conditions.
- General depth-to-groundwater measurements or estimates were used to establish the bottom of the modeled soil profile.

MODEL 1: Soil water balance model (Kendy et al., 2003)

- Infiltration and evapotranspiration are treated as separable, non-sequential processes.
- Hydraulic conductivity and solute gradient are used to represent vertical flux of water at the base of each soil layer.
- Transpiration and evaporation of potential evapotranspiration are calculated based on leaf canopy stage (i.e., LAI).
- Actual evapotranspiration (AET) is calculated based on soil layer moisture content relative to wilting point.

MODEL 2: HYDRUS-1D (Simunek et al., 2013)

- Automatically solves Richards' equation for unsaturated flow.
- Inflow equation includes sink term to account for water uptake by roots (inputs are LAI and root depth).
- Rates of PET that is allocated to evaporation is determined based on a specified reference coefficient.
- Hydraulic parameters can be specified by user or estimated using the R sponsen pedotransfer function model (Schapp et al., 2001).

Estimating LAI for turfgrass and prairie vegetation

Because each model requires daily LAI input data, we chose to estimate leaf canopy development stages for 1.5m by 2.5m sites with prairie vegetation. (Table 1: Annual variation in root depth was calculated using the estimated LAI and maximum depths listed in Table 1).

Discussion/Conclusions

The advantages of field permeability values that they provide a bulk conductivity estimate and can theoretically model components of secondary permeability without using a dual-porosity approach. However, the gamble estimates were less than Rosetta values in some cases (Table 2), and this could be because experiments were conducted during the late summer when antecedent conditions were dry.

References