Ph.D. Dissertation Defense for Nathan Haws

Monday, Oct 27 at 8am in CIVL 3153

ABSTRACT

Haws, Nathan W. Ph.D., Purdue University, December, 2003. Integrated Flow and Transport Processes in Subsurface-Drained Agricultural Fields. Major Professor: P. Suresh Rao.

Describing water and solute movement in subsurface-drained agricultural fields is challenging due, in part, to an array of macropore networks that infuse the soil matrix. Using the hypothesis that subsurface-drained fields integrate the effects of spatial heterogeneity, effective parameters are calibrated for a flow and transport model (HYDRUS-2D) from drain outflow data. Though some success was achieved using a dual-porosity representation, the effective parameter simulations fail to predict the rapid flux response of solutes at the field-scale. In order to better understand this rapid flux response, the internal transport processes of subsurface-drained fields were then studied in batch, column, and field systems. Batch-scale diffusion studies indicate that inter-aggregate fissures act as preferential conduits for solute diffusion into the soil matrix. Column-scale experiments further confirm the importance of inter-aggregate diffusion, and give evidence of two preferential flow networks whose relative dominance of the transport response depends on the soil saturation. A multi-solute field-scale experiment conducted on two replicate field-plots, dramatically illustrates the spatial extent of these preferential flow networks with the simultaneous arrival of reactive and non-reactive solutes applied 5 meters from the drain. However, the inter-aggregate diffusion processes trap most of the solute in immobile regions near the soil surface. Finally, numerical experiments indicate the spatial variability of the macropore network at the field-scale leads to a greater state of non-equilibrium transport than might be predicted assuming a homogeneous media and using surface-measures values.