SOFTWARE REVIEW

HYDRUS
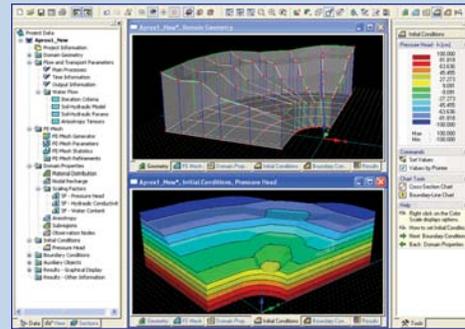
John E. McCray – *Colorado School of Mines. Software Review courtesy of International Ground Water Modeling Center and Colorado School of Mines.*

The HYDRUS-2D/3D software package is a major upgrade and extension of the HYDRUS-2D/MESHGEN-2D software package originally developed and released by the U.S. Salinity Laboratory, PC-Progress and the International Ground Water Modeling Center. The new version, released under the name HYDRUS, is a Microsoft Windows-based modeling environment for analysis of water flow, solute, and heat transport in variably saturated porous media.

For flow, the code solves the mixed form of the Richards' equation, with many functions for simulating hydraulic conductivity versus water content (or pressure head) relationships, including hysteresis. It allows root water uptake with compensation and spatial root distribution functions, and includes new soil hydraulic property models. The new code allows for dynamic, system-dependent boundary conditions such as switching among pressure heads, seepage face, zero flux, or atmospheric boundaries, depending on the position of the water level.

For solute transport, the code solves the advection-dispersion equation, but with many processes not usually included in unsaturated zone codes. For example, in addition to the typical linear partitioning between soil, water, and gas phases, the code also simulates the following processes: non-linear and non-equilibrium partitioning between phases; diffusion in the gas phase; zero- and first-order degradation kinetics, including decay chains (such as for nitrates and radionuclides); advective flow in a dual-porosity system allowing for preferential flow in fractures or macropores while storing water and dissolved chemicals in the matrix; transport of viruses, colloids, and bacteria using an attachment/detachment model; filtration theory; blocking functions; and flowing

Review of **HYDRUS-2D/3D**

Ease of Use:	⫲⫲⫲⫲
GUI:	⫲⫲⫲⫲⫲
Output/Plotting:	⫲⫲⫲⫲
Documentation:	⫲⫲
Speed:	⫲⫲⫲
OVERALL RATING:	⫲⫲⫲⫲

Application
Vadose zone flow and transport

Best Features
New GUI

Worst Feature
No optimization in 3D

Rating System:
Excellent ⫲⫲⫲⫲⫲
Poor ⫲

igwmc International Ground Water Modeling Center
Colorado School of Mines

particles in two-dimensional applications. HYDRUS also includes a new constructed wetland module, only in 2-D.

HYDRUS still allows optimization in 1-D and 2-D; unfortunately, it is not provided for 3-D applications. Another useful new feature is better print management, allowing the user to print at regular time intervals or after a constant number of time steps.
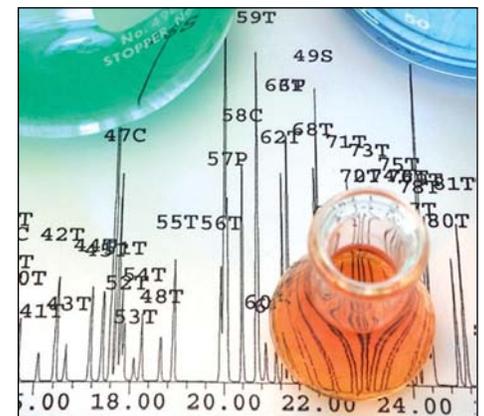
The GUI is much improved with many new user-friendly functions, such as drag-and-drop, context-sensitive pop-up menus after clicking on objects, selection and editing of multiple objects in the same dialog window, and allowing multiple projects and views to be opened at the same time in the HYDRUS main window. One of the best new features is that time-varying and cumulative fluxes can be calculated and displayed across internal meshlines.

The only negatives associated with the program are that the user's guide could be more complete. Not all features are explained well enough for a modeler without previous HYDRUS experience to easily follow. However, the online discussion forum is very helpful; it can be found at *www.pc-progress.cz/_Forum/default.asp*.

Pricing varies depending on the level purchased. Single-computer licenses are $1,500 for HYDRUS that can handle applications for simple (hexahedral) geometries, and $1,800 for HYDRUS

standard for 3-D geometries comprising flexible 2-D geometries and layers for the third dimension. A professional version that will allow application of general, flexible 3-D geometries is expected in summer 2007.

The original, public-domain version of HYDRUS-1D is included in the HYDRUS package and may still be downloaded for free from the IGWMC web site at www.mines.edu/igwmc/software/igwmcsoft/hydrus1d. htm. HYDRUS may be purchased by visiting typhoon.mines.edu/software/igwmcsoft/hydrus3d.htm.