Typical Applications
Using VADOSE/W, you can analyze 2D flux boundary problems such as:

- Design and performance monitoring of single or multi-layered soil covers over mine and municipal waste facilities
- Development of climate controlled pore-water pressure distributions on natural or man-made slopes for use in stability analyses
- Determining infiltration, evaporation and transpiration rates resulting from agriculture, irrigation projects, or natural systems
- Predicting oxygen or radon gas diffusion and decay through the vadose zone
- plus many more!

Environmental impact on soil conditions
Understanding unsaturated soil mechanics is now critical for geotechnical engineers performing slope stability analyses, designing soil covers for mine or municipal waste facilities, or determining the effect of agricultural or irrigation projects on groundwater flow. Environmental conditions at the ground surface, such as precipitation, evaporation and transpiration, have been increasingly recognized as having a significant impact on soil behaviour in the unsaturated or vadose zone. In fact, “unsaturated soil mechanics may have more to do with the ground surface moisture flux conditions than it has to do with the thickness of the unsaturated soil zone” (D.G. Fredlund, Geotechnical News, Dec. 2001). So how can you determine the impact of environmental conditions on the unsaturated zone? VADOSE/W provides a solution to this problem.

Comprehensive and Powerful
VADOSE/W is a finite element CAD software product for analyzing flow from the environment, across the ground surface, through the unsaturated vadose zone and into the local groundwater regime. Its comprehensive formulation allows you to analyze both simple and complex problems, from a simple analysis of ground infiltration due to rainfall, to a sophisticated model considering snow melt and root transpiration as well as surface evaporation, runoff, ponding, and gas diffusion. VADOSE/W can be applied to the analysis and design of geotechnical, mining, hydrogeological, agricultural, and civil engineering projects.
Formulation

Computing the surface flux boundary
The key to modeling the vadose zone is predicting an accurate surface flux boundary. VADOSE/W computes this surface flux boundary by coupling ground heat, mass and vapor flow with actual climate data.

Critical to the formulation of VADOSE/W is its ability to predict actual evaporation as a function of the soil pore-water pressure and temperature, rather than simply using soil water content, drying time, or empirical user-defined relationships.

Actual and Potential Evaporation
Actual Evaporation (AE) is only equal to Potential Evaporation (PE) when the soil is saturated. If the soil at the ground surface is not saturated, the AE rate can be much less than the PE rate. Wilson (1990, 1994) showed that the only way AE can be predicted correctly for all soil types and climatic conditions is to base the calculation on both the negative pore-water pressures and temperatures in the ground. Wilson modified the Penman (1948) method to make the actual evaporation rate dependent on the relative humidity of the soil and the air. The relative humidity in the soil can only be known if the soil temperature and water pressure are known and solved for simultaneously. To solve this complex set of equations, it is necessary to include vapor flow in the soil. VADOSE/W meets all these requirements, and is fully coupled in two dimensions.


Gas Transport
VADOSE/W is formulated to analyze transient 2-dimensional oxygen or radon gas diffusion, dissolution and decay in response to changing heat and moisture conditions in the ground. The gas transport analysis is carried out simultaneously with the coupled heat and mass transfer solution. This feature can be used to determine gas concentrations and mass flows into or out of the ground in response to pre-set or user input concentration boundary conditions.

Features
- Generate soil cover meshes based on cover thickness and soil type data.
- Model complex soil cover stratigraphy, including pinch-out layers.
- Use adaptive time stepping during the solve process to help with convergence and the diurnal nature of climate boundary data.
- Estimate soil properties based on grain size data or other input soil functions.
- Use a scalable global climate database or enter site specific climate data.
- Specify net solar radiation or potential evaporation as your climate data, or let VADOSE/W estimate the energy component.
- Import and export DXF™, WMF, EMF, or bitmap graphics.
- plus many more!

Easy to Use
A complete modeling solution
Beginning an analysis is as simple as defining the geometry by drawing regions and lines that identify soil layers, or by importing a DXF™ file, and adding a soil cover at the surface. Then graphically apply boundary conditions and specify material properties.

Material properties can be estimated from easily measured parameters like grain-size, saturated conductivity, saturated water content, and the air-entry value, or imported from the included databases. Boundary conditions can be fully coupled to the climate, as a function of time, or as specific values for temperature, head, pressure, total or unit water flux, or a potential seepage surface.

Define initial conditions for the analysis by drawing an initial water table and nodal temperatures, or by using computed results from a previously solved analysis.

Scale data automatically in order to conduct sensitivity studies or to create data suited to your specific site.

Integrated with Other Applications
Use VADOSE/W pore-water pressures in SLOPE/W
Using finite element computed pore-water pressures in SLOPE/W makes it possible to model the effects of evaporative flux on stability. For example, you can analyze changes in stability as the pore-water pressure changes over time due to the evaporative flux process. Also use VADOSE/W data in CTRAN/W contaminant transport analysis.
Comprehensive Results

Viewing the Results
VADOSE/W offers many tools for viewing results. Generate contours or x-y plots of any computed parameter for any time steps. Velocity vectors show flow direction and rate. Transient conditions can be shown as the changing water table position over time. Graph any parameter versus time or distance. Interactively query computed values by clicking on any node, Gauss region, or flux section. Then prepare the results for your report by adding labels, axes, and pictures, or export the results into other applications such as Microsoft® Excel® for further analysis.

Computed Parameters
When VADOSE/W analyzes an evaporative flux problem, it computes data regarding:
- Precipitation and infiltration
- Snow accumulation and melt
- Plant transpiration
- Ground freezing and thawing
- Potential and actual evaporation
- Surface seepage, runoff and ponding
- Groundwater recharge

Specific computed parameters include:
- Temperature
- Total Head
- Pressure
- Pressure Head
- Boundary Flux
- Liquid Velocity
- Vapor Velocity
- Ice Content
- Water Content
- Vapor Pressure
- Conductivity

Soil surface results data includes (for each time interval, or cumulative since Day 1):
- Precipitation
- Net Radiation
- Potential Evaporation
- Actual Evaporation
- Runoff
- Infiltration
- Snow Depth
- Actual Transpiration

Water Balance data includes cumulative:
- Precipitation
- Runoff
- Boundary Fluxes
- Evaporation
- Storage
- Water Balance
- Plant Transpiration

Cover layer interface results data includes:
- Volume of liquid flow
- Volume of vapor flow
- Total gas mass across layer
- Total volume across layer

Infiltration and ponding resulting from high rainfall event
Water content profiles across capillary break during a 365 day simulation in a shallow sloped cover

Comparison of down slope and up slope cumulative surface infiltration on a shallow sloped cover

Site-measured net solar radiation data can be imported if available; otherwise, VADOSE/W uses other climate data to predict similar values for net solar radiation.

Join a growing network

By acquiring GEO-SLOPE software, you are joining a group located in more than 100 countries, including practicing engineers, university professors, regulators, researchers and students. You can be assured that we will support and continue to enhance the software’s engineering capabilities, making it even more powerful and easy to use.

Get help when you need it

When you need assistance with your model, we have helpful services available. Attend one of our workshops, or communicate directly with our experienced numerical modeling professionals. We’ll help you to create better models and to gain confidence in your results.

Try out VADOSE/W now!

Experience VADOSE/W for yourself today! Download the free evaluation software from our web site at www.geo-slope.com/downloads.