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GRAPHIC USER INTERFACES FOR PEDOTRANSFER FUNCTIONS

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Pedotransfer functions (PTFs) can be established with a number of methods, yielding models that can range from very simple, such as univariate expressions or lookup tables to more complex multivariate expression (e.g., Cosby et al., 1984; Carsel and Parrish, 1988; Vereecken et al., 1989; Wösten et al., 1995). Until the mid-nineties even the more complex expressions for PTFs were simple enough to be published in printed journals. To get quick access to PTF estimates, all a user of such a PTFs had to do is to copy the expressions into a spreadsheet or to implement these into a computer code. More recently, increasingly sophisticated techniques have been used for PTF development, leading to models that cannot be easily published and/or implemented. Especially artificial neural network or related models come to mind here (e.g., Tamari et al., 1996; Pachepsky et al., 1996). These models generally have a "black-box" nature and often contain a large number of coefficients that are difficult to publish, especially when combined with the Bootstrap Method (e.g., Schaap et al., 1998). Direct implementation of such PTFs with some kind of user-interface is often the only way to make them useful for a wider audience. In addition, an attractive and useful user-interface can also open up the PTF to a wider audience. Several PTF implementations have emerged in recent years and in the following we will dicuss four codes that can be easily obtained through the world-wide-web.

1. SOIL WATER CHARACTERISTICS FROM TEXTURE

Soil Water Characteristics from Texture (SWCT) is part of the Soil Plant Atmosphere Water Field and Pond Hydrology (SPAW) package developed by K. E. Saxton (USDA/ARS) and is based on Saxton et al. (1986). The windows-based SPAW package is targeted at farmers and resource managers interested in water and nutrient budgeting in soil and ponds and is available at http://www.bsyse.wsu.edu/saxton/spaw/ SPAW uses SWCT to estimate soil hydraulic data such as wilting point, field capacity and available water content. The main window (Figure 1) allows the user to click on textural classes in the textural triangle. Estimated quantities at the top right hand side of the window ("Soil Characteristics") and plotted hydraulic characteristics at the bottom are updated immediately. A more fine-grained control of soil texture is possible through a horizontal and vertical slider bars, for clay and sand percentages, respectively. In addition, it is

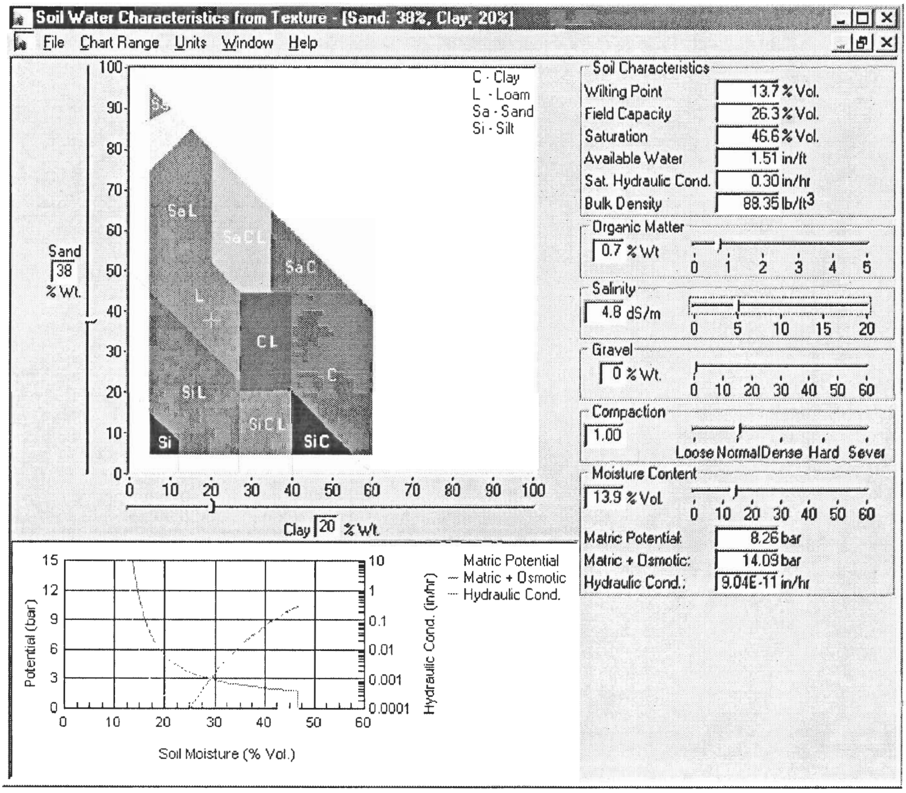

Figure 1. The main window of SWCT, see text for explanation.

possible to input, organic matter content, gravel content, salinity and soil compaction through slider bars at the right hand side of the screen. A separate retention curve is plotted for non-zero salinities to account for salinity-induced osmotic potentials. The resulting graph provides an effective retention characteristic as experienced by vegetation. The program allows for the export of graphical and numerical results and includes a help-system that explains the background of the program.

2. SOILPAR

SOILPAR was developed by M Donatelli and M. Acutis at the Research Institute for Industrial Crops (ISCI), Bolongna, Italy. The program, and its update, can be downloaded from http://www.sipeaa.it/ASP/ASP2/SOILPAR.asp. The program implements various published point (ten) and parametric PTFs (four) and provides a wide range of output data (Figure 2). Required input data and estimated output data depend on the model used and include soil texture, organic carbon, soil pH, and cation exchange capacity. The window depicted in Figure 2 consists of an input area (top) and output area. The “tabs” at the

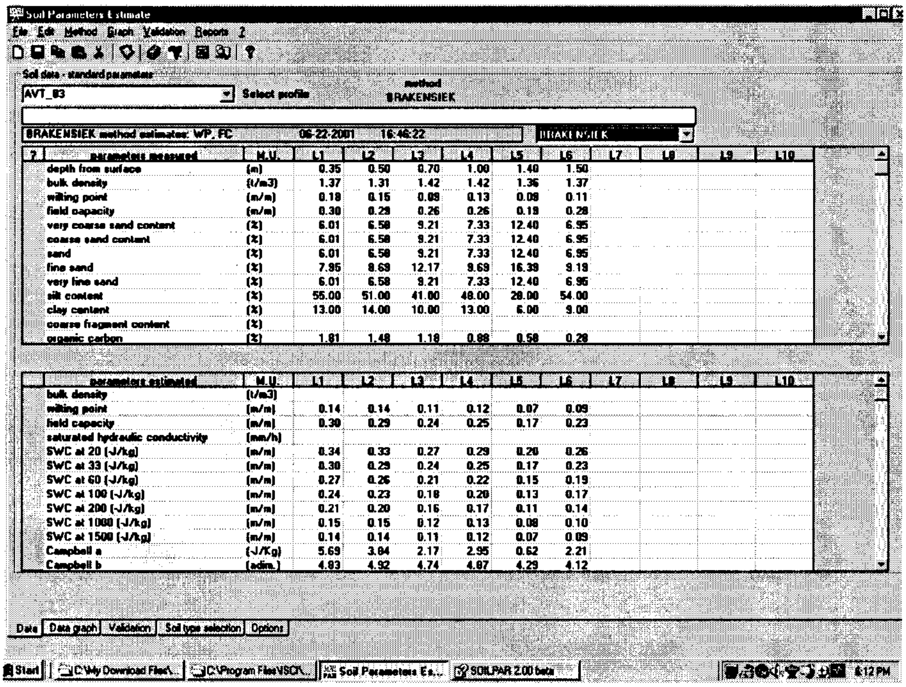

Figure 2. The main window of SOILPAR.

bottom of the window provide access to various other program functions including plotting and validation routines, and a utility to convert various systems textural data. The program also allows fitting retention data to four types of retention equations. Soil data are stored in as geo-referenced soil database and various input and output data formats are supported (such as EXCEL and ArcView/ArcInfo). The program is well documented through a "help" system that describes the prgram background, data organization and possible operations on the data.

3. ROSETTA

Rosetta is a windows-based program that implements artificial neural network results published by Schaap et al. (1998), Schaap and Leij (1998), and Schaap and Leij (2000) and is available from http://www.ussl.ars.usda.gov/models/rosetta/rosetta.HTM. The program implements five PTFs in a so-called hierarchical approach (H1, see also Schaap et al., 2001). This approach was chosen to maximize the accuracy of the PTF estimates given a particular data availability. All models in Rosetta estimate saturated hydraulic conductivity, and van Genuchten (1980) retention and unsaturated hydraulic conductivity parameters. Through use of the Bootstrap Method, Rosetta is also able to estimate the uncertainty of the estimated hydraulic parameters.

Rosetta uses a database to store its input and output data. In general the user creates a new database or opens an existing one, after which Rosetta's main window is accesses as shown in Figure 3. This window contains three main area's. The "Input Data" box on the left contains information about the current record in the database (shown is record 1 out of a total of 564). Under these entry boxes the textural distribution, bulk density and water retention at 33 and 1500 kPa are shown (data that are not available are shown as −9.9). Entry boxes become gray or white, depending on the type of model selected in the bottom area. Estimates and associated uncertainties appear in the "Output Data" area on the right and are made by clicking the single or double exclamation marks in the tool bar, for estimation for the current or all records, respectively. Other toolbar and menu options serve to edit or navigate through the database, or to import data from or into the database. The database is compatible with MS-ACCESS™ software.

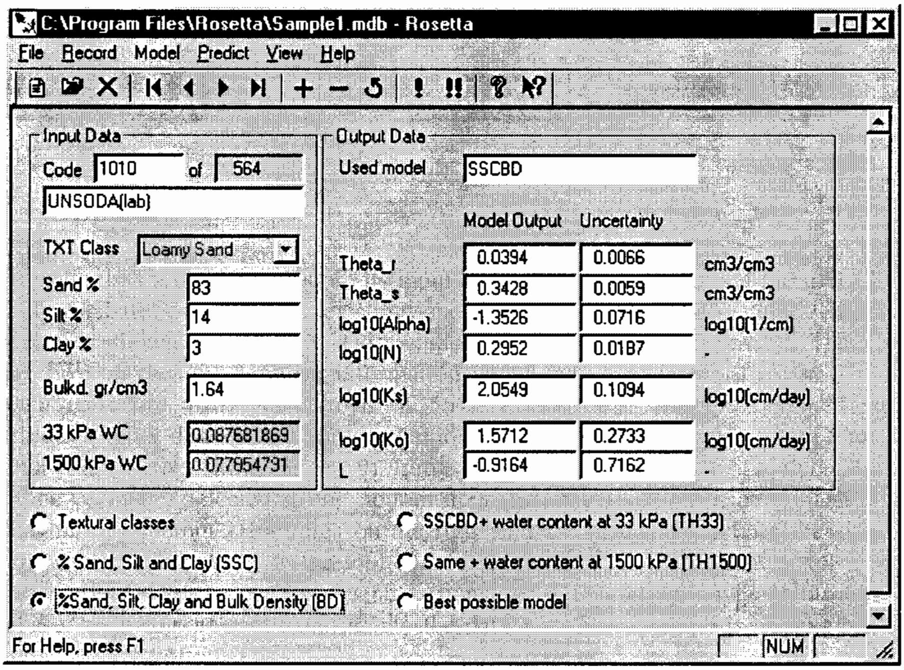

Figure 3. The main window of Rosetta.

A simplified version of Rosetta (Rosetta-Lite) is available as plugin for external software for the computation of water retention and saturated hydraulic conductivity parameters. This plugin is currently included in the Hydrus-1D and Hydrus 2-D software, but can be easily implemented in other types of software. Rosetta-Lite comes with a user-interface that is similar to the one depicted in Figure 4 but without data-base support.

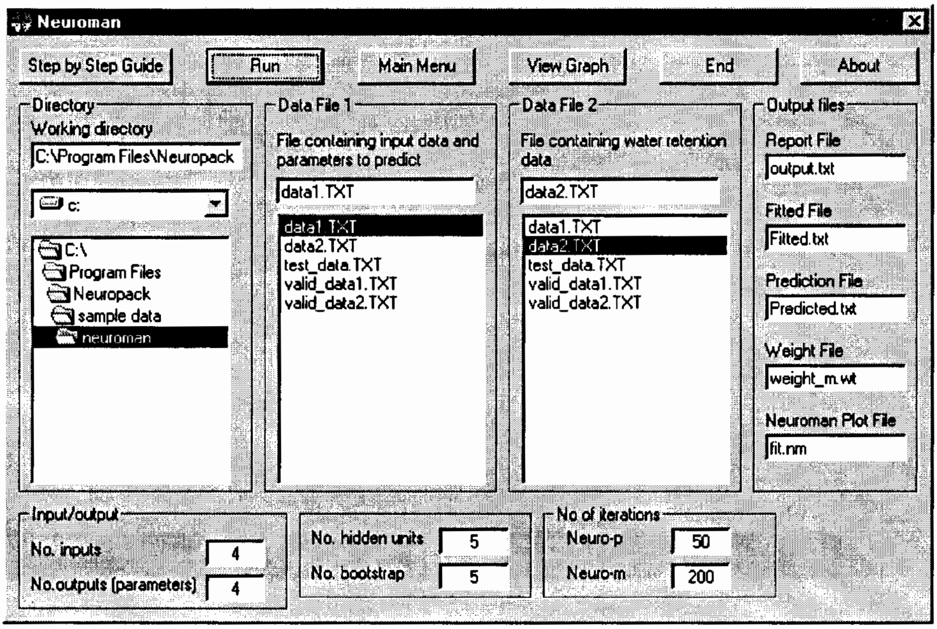

Figure 4. The main window of NeuroMan.

4. NEUROPACK

Minasny and McBratney (2002) developed the Neuropack software package (http://www.usyd.edu.au/su/agric/acpa/neuropack/neuropack.htm). This package differs from the previously discussed software in that it is primarily intended to develop PTFs using neural network-based techniques using data that is supplied by the user. Except from some sample data, no previously calibrated PTF is shipped with Neuropack. The Neuropack package comes with a complete technical guide and users manual. The technical guide describes the scientific background of both programs and includes a ANN primer, an explanation of the Bootstrap Method, and a description of optimization and error-criteria. The users guide provides a detailed description of the various program options. A small drawback of Neuropack is that it can only work with 100 data points, a full version is available from Dr. B. Minasny upon request.

The package consists of two separate programs, NeuroPath and NeuroMan. NeuroPath is somewhat simpler than Neuroman and can be used to develop ANN and Bootstrap Method-based PTFs that estimate water retention points in a cycle of calibration, validation and prediction. A similar but more elaborate structure is used for NeuroMan. This program can be used to develop parametric-PTFs, again based on a combination of ANNs and the Bootstrap Method. Neuroman uses a two-step approach outlined in Minasny and McBratney (2002) for establishing parametric PTFs by defining the objective function in terms of water contents (see also Section 1 of Chapter 3).

Figure 4 shows the main optimization window of NeuroMan; other windows in NeuroMan and NeuroPath are similar in setup. Essentially, NeuroMan requires a working folder (leftmost box "Directory"), a data file with basic input data (e.g., texture, bulk density) and fitted retention parameters (second box from left, "Data File 1"), and a data file with measured retention points ("Data File 2"). The rightmost box ("Output files") lists the various output files generated by Neuroman (coefficients, plotting files, etc). The bottom of the window contains six entry boxes to list the number of input and output parameters, or to control the neural network topology, the number of bootstrap replicas (see Section 3 of Chapter 3), and the number of optimization steps in the two-step optimization. The top of the window contains buttons for a step-by-step specification of the necessary data files, running the optimization, to get back to an introductory menu, to view graphs, as well as to end the program or to get more background information.

After running the optimization, a graph like Figure 4a appears, showing how well measured and estimated water contents match for the entire calibration data set; the root mean square error (RMSE, Section 2 of Chapter 3) is also given. Individual retention characteristics can be inspected (Figure 5), showing the originally measured data, the mean curve, as well as the 95% confidence interval as derived with the Bootstrap Method. Pertinent numerical data for this characteristic are also listed in this graph.

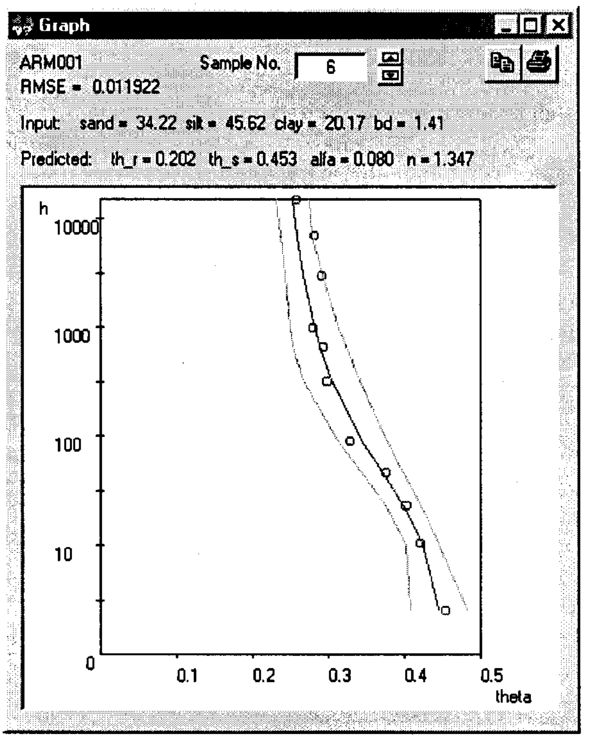

Figure 5. NeuroMan results for one particular soil sample. Circles represent measured data points, the estimate with the 95% interval is shown as lines.

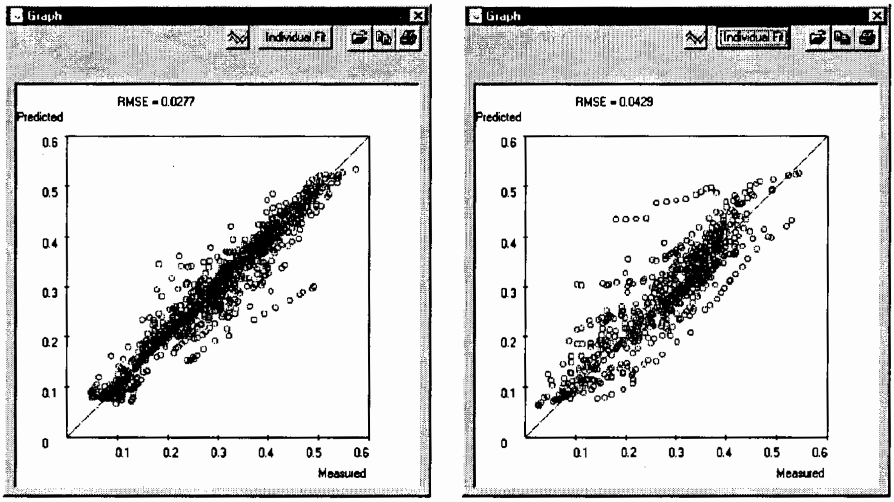

Figure 6. Calibration (left) and validation results (right) for the sample data set in NeuroMan.

Calibrated models can be tested with a validation step, using a window that is similar to that in Figure 6a. Figure 6b shows a scattergram that indicates that the model does not perform as well on the validation dataset as for the calibration dataset (Figure 6a). Other program options include making estimates and the printing and saving of results.

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