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SOILPAR, a software to estimate and validate soil hydrologic parameters.
SOILPAR, un logiciel pour estimer et valider les paramètres hydrologiques des sols.

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1. Introduction

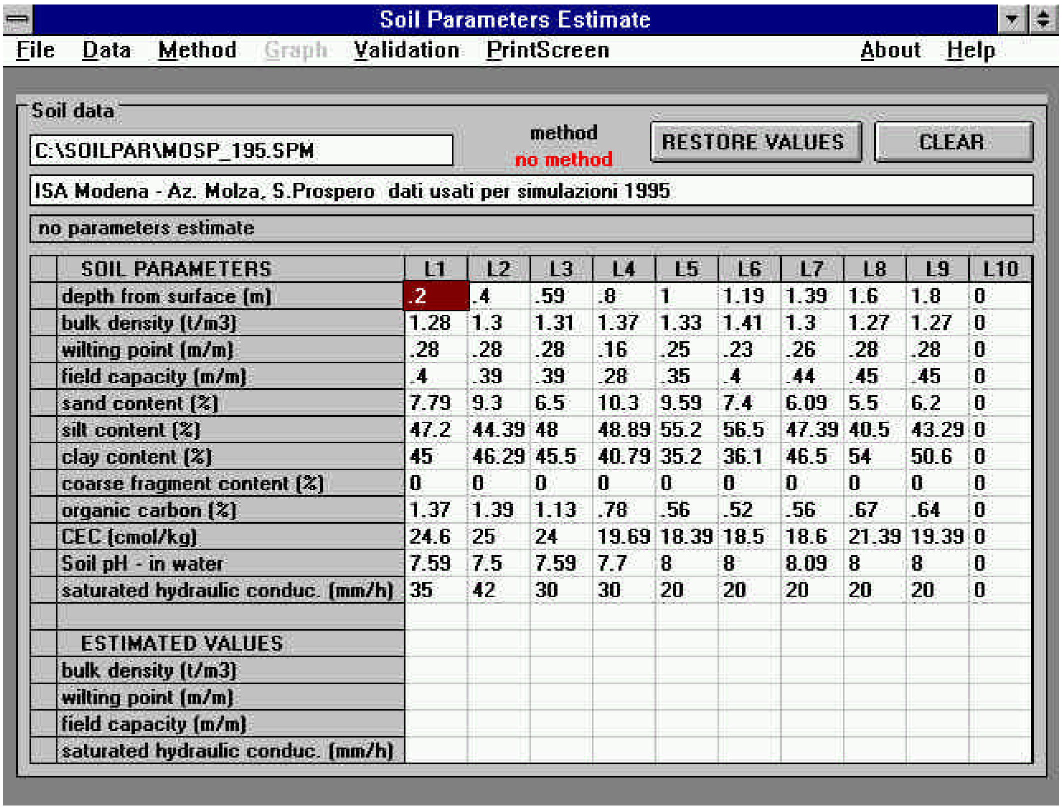
Mathematical models applied to biological systems are getting more and more important in terms of their possible use. Since they describe the main processes acting on the soil-plant systems as a consequence of climatic and management influences, these models allow to analyze *a priori* any possible scenario represented by different choices of technologic management under different environmental conditions. All models require some input parameters to describe the system, such as parameters concerning soils, crops and sites.

When referring to practical applications, i.e. when model simulations are not run within the context of well known conditions as those represented by research stations, many input parameters are not available. Among soil parameters, hydrologic characteristics are seldom available, and they represent very important inputs to run model simulations. Several methods for their estimation are reported in the literature, based on commonly available parameters which are determined in any routine analysis. These methods differ at least partially for the required inputs, and their output is represented by one or more hydrologic parameters. They are generally based on empirical relations among commonly available data, such as soil texture and measured values of hydrologic parameters. Since their basis is almost empirical, their validity may be limited to the data sets used to define the methods. Moreover, comparisons assessing the validity of the forecasts among different methods can seldom be performed , even when their use is widespread.

The software described in this paper allows the estimation of volumetric water content at field capacity (q_{FC}; $m^3\ m^{-3}$) and permanent wilting point (q_{PWP}; $m^3\ m^{-3}$), bulk density (r_b; $t\ m^{-3}$), and saturated hydraulic conductivity (*Ks*; $mm\ h^{-1}$).

2. Software description

SOILPAR v 1.0 is presently available as 16 bit version, under Windows 3.X and Win 95. Version 2, at 32 bit, is under development, and will be improved at the level of user interface as well. The installation program creates a subdirectory where the program will run, and saves some *.DLL files in the subdirectory C:\WINDOS\SYSTEM. The current version is in English, while version 2 will allow the option of English or Italian.
After starting the software and selecting "*Data*" from the menu tool bar, the screen shown in Fig. 1 will appear. Parameters listed in the first 12 rows are different inputs from the user, and the file will be saved with the automatic filename extension SPM (Soil Parameters Measured).



SOIL PARAMETERS	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
depth from surface (m)	.2	.4	.59	.8	1	1.19	1.39	1.6	1.8	0
bulk density (t/m3)	1.28	1.3	1.31	1.37	1.33	1.41	1.3	1.27	1.27	0
wilting point (m/m)	.28	.28	.28	.16	.25	.23	.26	.28	.28	0
field capacity (m/m)	.4	.39	.39	.28	.35	.4	.44	.45	.45	0
sand content (%)	7.79	9.3	6.5	10.3	9.59	7.4	6.09	5.5	6.2	0
silt content (%)	47.2	44.39	48	48.89	55.2	56.5	47.39	40.5	43.29	0
clay content (%)	45	46.29	45.5	40.79	35.2	36.1	46.5	54	50.6	0
coarse fragment content (%)	0	0	0	0	0	0	0	0	0	0
organic carbon (%)	1.37	1.39	1.13	.78	.56	.52	.56	.67	.64	0
CEC (cmol/kg)	24.6	25	24	19.69	18.39	18.5	18.6	21.39	19.39	0
Soil pH - in water	7.59	7.5	7.59	7.7	8	8	8.09	8	8	0
saturated hydraulic conduc. (mm/h)	35	42	30	30	20	20	20	20	20	0
ESTIMATED VALUES										
bulk density (t/m3)										
wilting point (m/m)										
field capacity (m/m)										
saturated hydraulic conduc. (mm/h)										

Figure 1. *SOILPAR* screen after the selection of *Data* from the menu: a file has been opened.

Since soil profiles are commonly described as "horizons", or "soil layers" with different characteristics from the soil surface to the surveyed depth, the user can store a maximum of ten layers. Clicking the mouse on the left column, the user is given an explanation providing further information on the parameter name and measurement units.
Hydrologic parameters can be estimated according to different methods both when data have been inputted, or a file has been opened through the steps *File*fi *Open*. At present, the following methods are implemented: Baumer, Brakensiek-Rawls, British Soil Survey Subsoil, British Soil Survey Topsoil, Campbell, EPIC, Hutson, Jabro, Jaines, Manrique and Rawls. They evaluate different parameters and require different inputs, as shown in Table 1.

Table 1. Methods for parameters estimation, inputs required (I) and outputs resulting (O).

	Baum	B&R	B SS	B TS	Cam	EPIC	Hut	Jab	Jai	Man	Rawls
depth	I	I	I	I	I	I	I	I	I	I	I
r_b	O	I	I	I	I	I	I	I	I	I	O
q_{PWP}	O	O	O	O	O	O	O	-	-	O	O
q_{FC}	O	O	O	O	O	O	O	-	-	O	O
sand	I	I	I	I	I	I	I	I	I	I	I
silt	I	I	I	I	I	I	I	I	-	I	I
clay	I	I	I	I	I	I	I	I	-	I	I
coarse	-	-	-	-	-	-	-	-	-	-	-
org car	I	I	I	I	-	-	-	I	-	-	-
CEC	I	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-
Ks	-	-	-	-	O	-	-	O	O	-	-

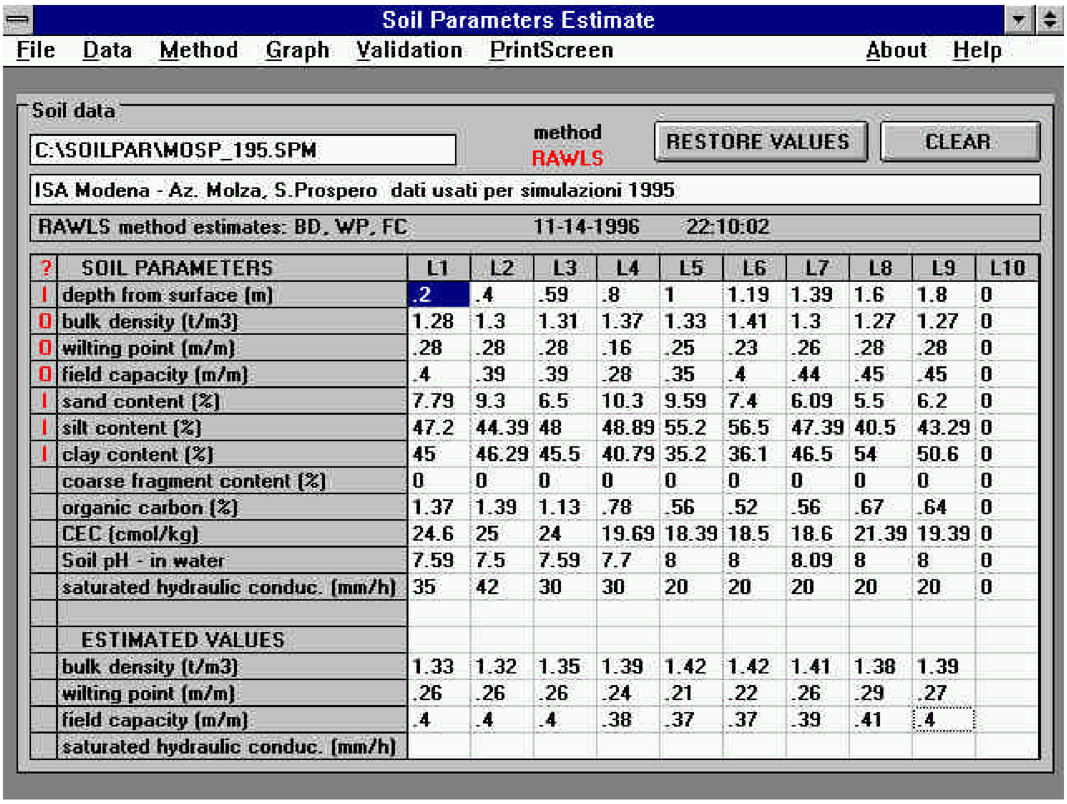


Figure 2. Parameters estimation according to one of the available methods (Rawls).

The file description, in the row above the grid of data, identifies: the estimation method used (instead of “no method”), the parameters estimated, and the date of estimation. When the file is saved (*File*fi *Save*), it takes the same name and the filename extension is set automatically to SPE (Soil Parameters Estimated).

Parameters estimation allows two further operations: The first saves both measured and estimated values in a general validation file (*File*fi *Save validation*); the use of this file, one for each method, will be described when the validation procedures of the model are described. The second operation can be made through the Graph function of the menu tool bar: it gives a graphical comparison of the values of measured and estimated data of the considered data set. The graphs of the estimated parameters are shown for each method. Figure 3 contains the graph of q_{FC} and q_{PWP}, and of the corresponding available water (PAW) calculated by the Rawls method. Note that the graph on the left shows estimated vs. measured values of field capacity and wilting point, while the graph on the right shows the pattern of PAW in the soil profile. Because of the importance of the simulation of the soil water balance, the total PAW for each layer as well as the total profile is reported in the table above the graphs. The user is allowed to make estimates from the same data with different methods, and/or to use the same method for different data sets. It is recommended to save the estimation– in the general validation file (*File*fi *Save validation*) every time, which will contain an increasing representative collection of different soils. The software gives an automatic warning message to prevent undesired repetition of any previously saved data. In fact, at least five pairs of points can be saved for each method in the validation file (generally many more). The validation can be made using either all the data in the validation file or according to the classification based on the triangle of textures, as shown in Figure 4.

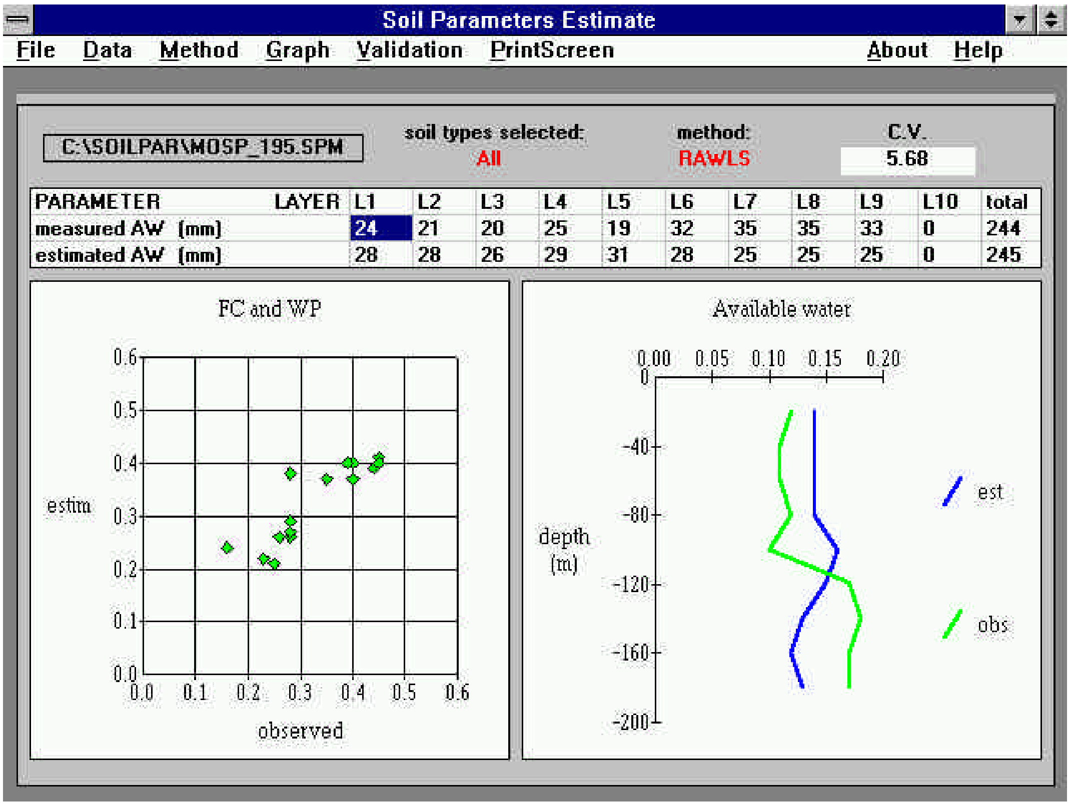


Figure 3. Graphs for the evaluation of the estimates made with a method (e.g. Rawls).

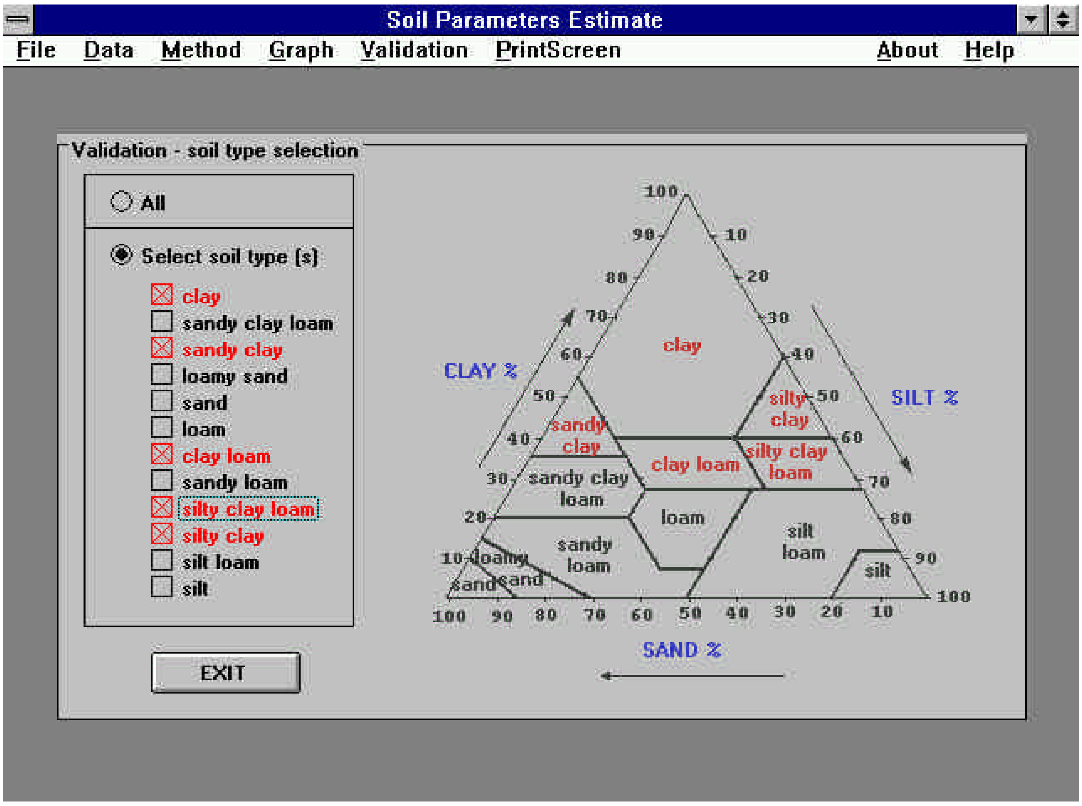


Figure 4. Soil type selection for the validation based .on the soil texture.

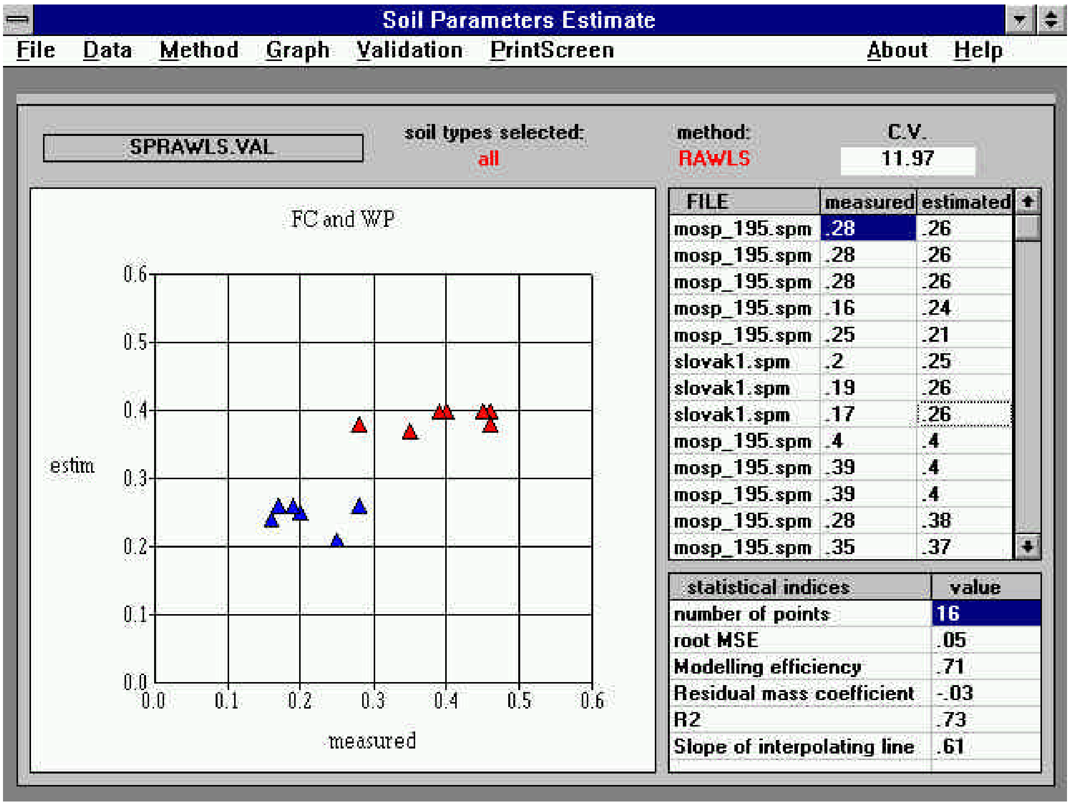


Figure 5. Graphs and statistical indexes related to the validation.

The validation is made through the menu *Validation*fi *method*fi *PAW/FC-PWP/BD*. The corresponding screen is shown in Figure 5. The numeric indexes calculated during the validation are based on the differences between estimated and measured data. They include: **number of points**; root MSE; **modelling efficiency**, which can assume values ≤1, where 1 is the optimum value, and figures <0 show that the mean of measured data is a better estimation than that attained with the method in exam; **residual mass coefficient**, whose optimum value is equal to 0, shows if the method overestimates (<0) or underestimates (>0); **R^2**, shows the fit of the regression of estimated values vs. measured values, with an optimum value equal to 1; **slope of interpolating line**, with an optimum value equal to 1. The indexes root MSE, modelling efficiency and residual mass coefficient are calculated according to Loague and Green (1991).
A previous version of the program allowed assessment of the forecasting ability of the methods, using a set of 248 experimental data (Donatelli *et al*., 1996). This paper is available in the help of the model. Other methods are currently being implemented. They are intended to allow users to estimate hydrologic parameters, to compare the procedures they commonly use with others, and to allow a better choice of the methods once the comparison between evaluated methods vs. measured data has been done.

3. Conclusions

The described software allows estimation of parameters which are required to run simulation models; and, at the same time, to evaluate different options for the estimation of parameters themselves. This gives users of simulation models a more accurate and possibly standardized choice of the methodologies for parameters estimation when necessary.

4. References

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Mots clés: Fonctions de pédotransfert, modèles de simulation, paramètres hydrologiques, logiciel