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Software to model soil water retention curves (SWRC, version 2.00)

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ABSTRACT: A software for the adjustment of soil water retention curves (SWRC) is presented, using twelve models found in the literature.

Key words: soil matric potential, soil water content, retention

Programa computacional para modelagem de curvas de retenção de água no solo (SWRC, versão 2.00)

RESUMO: Um programa computacional é apresentado para o ajuste de curvas de retenção de água (SWRC), utilizando doze modelos encontrados na literatura.

Palavras-chave: potencial mátrico, umidade do solo, retenção

INTRODUCTION

The SWRC software was developed with the objective of estimating the empirical parameters of the soil-water retention curve, for different models, using the least-squares method and the general iterative method of Newton-Raphson. The software permits the following options: (i) estimation of initial values by anamorphosis and

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manual procedures, (ii) estimation of Van Genuchten's (1980) parameter m for two different conditions: independent and dependent, with the dependent case having the restrictions described by Mualem's ($m=1-1/n$) model or Burdine's ($m=1-2/n$) model (Van Genuchten, 1980), and (iii) the estimation of residual and saturated soil water content by (a) a fixed value procedure (measured or any value fixed by the user), (b) by regression (with and without restriction), or (c) by an extrapolation method (Jong van Lier & Dourado-Neto, 1993). This software can be useful for routine analysis of soil water retention data.

MATERIAL AND METHODS

The SWRC software, version 2.00, was developed in VISUAL BASIC 6.0 for the Windows environment (IBM or compatible) with twelve models for soil-water retention curves (TABLES 1 and 2). The input file format is ASCII, the first column referring to the matric potential, and the following columns referring to soil water content. The output permits an approximated r^2 -value, as an indication of the explained variance by the fitted model, the residual sum of squares to compare different models, and the analysis of variance for nonlinear regression. The F-test (Campbell, 1974) is used to verify the fitting of the selected model.

TABLE 1 - Models for soil water retention curves (matric potencial $\Psi = |\Psi_m|$ as dependent variable and soil water content θ as independent variable) available in the SWRC software (version 2.00).

Author	Model	Restriction	equation used in the SWRC software
Exponential	$\psi = \alpha e^{-\beta\theta}$	$\beta > 0$ and $0 < \psi < \alpha$	$\theta = -\frac{1}{\beta} \ln\left(\frac{\psi}{\alpha}\right)$
Power	$\psi = \alpha\theta^{-\beta}$	$\psi > 0$	$\theta = \left(\frac{\psi}{\alpha}\right)^{-\frac{1}{\beta}}$
Visser (1966)	$\psi = \frac{\alpha(f - \theta)^\beta}{\theta^w}$	$f = \theta_s$	$\psi = \frac{\alpha(f - \theta)^\beta}{\theta^w}$
Farrel and Larson (1972)	$\psi = \psi_{crit} e^{\alpha\left(1 - \frac{\theta - \theta_r}{\theta_s - \theta_r}\right)}$	$\psi < \psi_{crit}$ $\psi \geq \psi_{crit}$	$\theta = \theta_s$ $\theta = \theta_r + (\theta_s - \theta_r) \left[1 - \frac{1}{\alpha} \ln\left(\frac{\psi}{\psi_{crit}}\right)\right]$
Simmons et al. (1979)	$\psi = \alpha \left[e^{\beta(\theta - \phi)} - 1 \right]$	$\beta < 0$	$\theta = \phi + \frac{1}{\beta} \ln\left(\frac{\psi}{\alpha} + 1\right)$
Libardi et al. (1979)	$\psi = \alpha \left[e^{\beta(\theta - \theta_s)} - 1 \right]$	$\beta < 0$	$\theta = \theta_s + \frac{1}{\beta} \ln\left(\frac{\psi}{\alpha} + 1\right)$
Campbell (1974)	$\psi = \psi_e \left(\frac{\theta_s - \theta}{\theta} \right)^\lambda$	$\psi < \psi_e$	$\theta = \theta_s$

TABLE 2 - Models for soil water retention curves (soil water content θ as dependent variable and matric potential $\Psi = |\Psi_m|$ as independent variable) available in the SWRC software (version 2.00).

Author	restriction	Model
Gardner (1958)	$\psi \geq 0$	$\theta = \theta_r + (\theta_s - \theta_r) e^{\frac{\gamma \psi}{2}} \left(1 + \frac{\gamma \psi}{2}\right)^{\frac{2}{m+2}}$
Brooks and Corey (1964)	$0 \leq \psi < \frac{1}{\alpha}$	$\theta = \theta_s$
	$\psi \geq \frac{1}{\alpha}$	$\theta = \theta_r + \frac{\theta_s - \theta_r}{(\alpha \psi)^{\lambda}}$
Rogowski (1971)	$0 \leq \psi < \psi_e$	$\theta = \theta_e$
	$\psi \geq \psi_e$	$\theta = \theta_e + \frac{\theta_{15} - \theta_e}{\ln(\psi_{15} - \psi_e + 1)} \ln(\psi - \psi_e + 1)$
Van Genuchten (1980)	$\psi \geq 0$	$\theta = \theta_r + \frac{\theta_s - \theta_r}{\left[1 + (\alpha \psi)^n\right]^m}$
Driessen (1986)	$\psi \geq 1$	$\theta = \theta_s \psi^{-\gamma \cdot \ln(\psi)}$

Estimated values of empirical parameters for each model, and graphs of the soil-water retention curve, relative hydraulic conductivity, water capacity and relative soil-water diffusivity are outputs of the SWRC software.

There are two different options to compute all empirical parameters: (i) anamorphosis procedure, and (ii) iterative method of Newton-Raphson.

RESULT

The result is the SWRC software, available through contact with the first author: dourado@carpa.ciagri.usp.br.

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