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EVALUATION OF PEDOTRANSFER FUNCTIONS FOR PREDICTING SOIL WATER RETENTION IN PORTUGUESE SOILS

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INTRODUCTION

Estimates of soil water retention characteristics using pedotransfer functions (PTFs) are useful in many studies, such as hydrological modelling and soil mapping. Also reliable information about soil hydraulic properties like water retention characteristic and conductivity functions often constitutes an essential precondition to adequately apply protection and remediation techniques to soil related problems in forest ecology.

The determination of the parameters for these functions can be obtained from direct laboratory and field measurements. However, these measurements are time consuming which makes it costly to characterize an extensive area of a land. As an alternative, the existing databases of measured soil hydraulic data may be used to obtained hydraulic parameters by fitting the water retention functions or to develop PTFs from easily measured properties, such as texture, bulk density and soil organic matter content. Pedotransfer functions (PTFs) are being applied worldwide in global climate modelling exercises, regardless of their textural and regional validity. The objective was to evaluate four published PTFs (Rawls – Brakensiek, Vereecken, Mayr – Jarvis e Campbell) to estimate the parameters of soil water retention functions for Portuguese soils.

METHODS

Two different soil data sets (Agroconsultores & Coba, 1991; Agroconsultores & Geometral, 1995) from North of Portugal (231 horizons), consisting of a full description of soil properties and soil water retention characteristics, were used in this study.

Soil water retention function parameters were estimated for Campbell, Brooks – Corey, van Genuchten and Hutson – Cass functions by fitting to soil water content-pressure data, using an algorithm based on the simplex method adapted to use constraints on parameters values to avoid physical inconsistencies, and by application of a PTF for each function. The PTFs were evaluated by comparison of predicted and measured water contents at field capacity ($\theta_{-33\ kPa}$) and permanent wilting point ($\theta_{-1500\ kPa}$).

Pedo-transfer functions used to estimate the parameters of the Brooks & Corey (h_d, λ, θ_r), van Genuchten (θ_r, n, α), Huston – Cass (a e b) and Campbell (a e b) were, respectively, the "*Rawls & Brakensiek (1999)*", "*Vereecken et. al (1989)*", "*Mayr – Jarvis (1999)*" and Campbell (1985).

Table 1. Information of 231 soil samples

	N	Average	SD	Max	Min
Sand (%)	231	51.90	14.40	91.70	14.30
Silt (%)	231	35.10	10.60	67.40	7.30
Clay(%)	231	13.00	6.50	45.00	0.01
Organic carbon(%)	231	2.17	2.00	9.30	0.01
Bulk density (Mg m^{-3})	231	1.17	0.18	1.56	0.57
$\theta_{-33\ kPa}$ (m^{-3} m^{-3})	231	0.23	0.09	0.57	0.02
$\theta_{-1500\ kPa}$ (m^{-3} m^{-3})	231	0.10	0.05	0.26	0.01

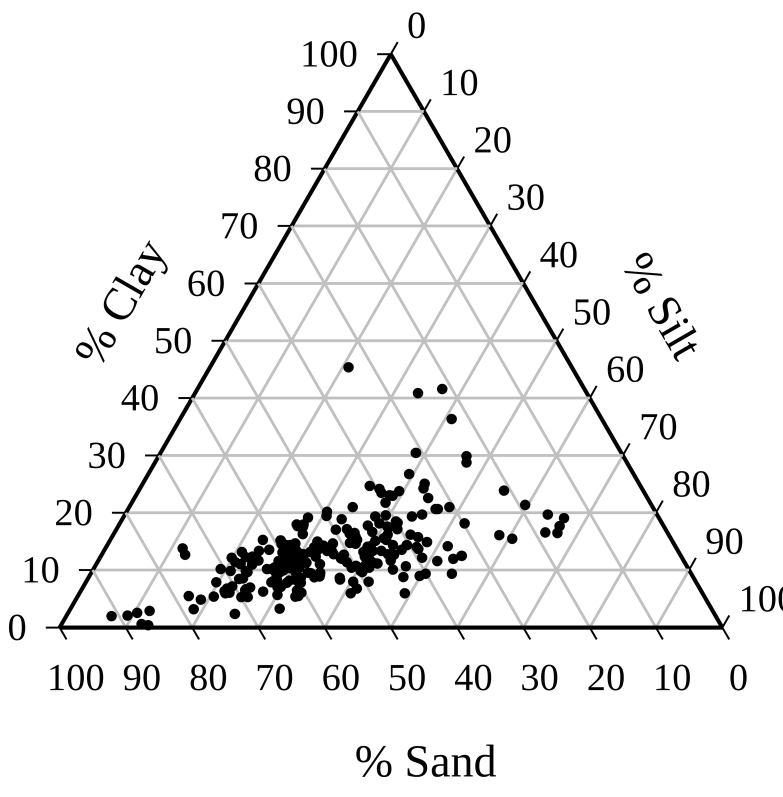

Fig. 1. Textural distribution of dataset

RESULTS

A Table 2 shows regression statistics for predicted versus observed water content at field capacity ($\theta_{-33\ kPa}$) and permanent wilting point ($\theta_{-1500\ kPa}$) and Fig. 3 the predicted versus observed plots in relation to the 1:1 line. The results show a good performance of the PTFs.

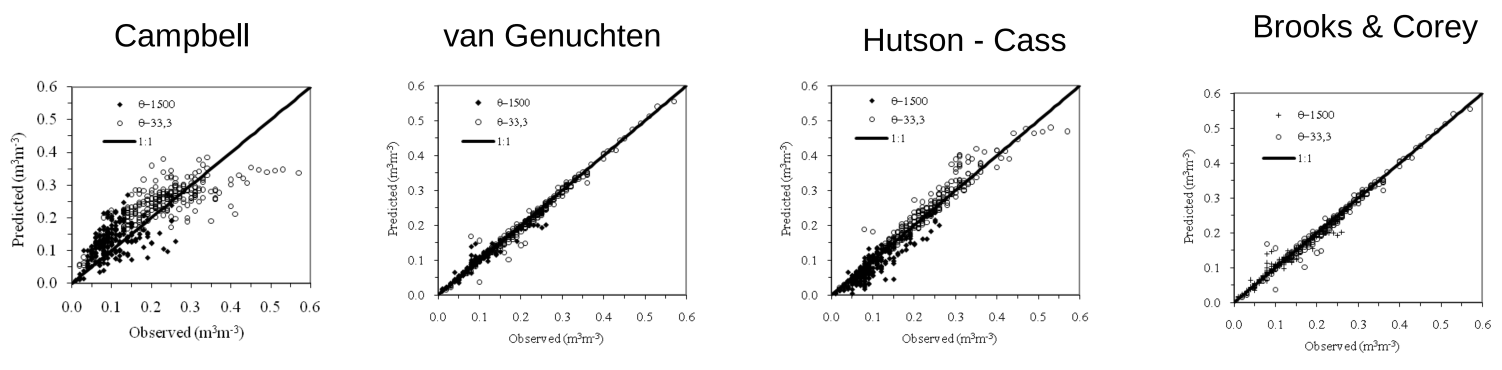

Fig. 3 Predicted *versus* observed plots of water content at field capaciity ($\theta_{-33\ kPa}$) and permanent wilting point ($\theta_{-1500\ kPa}$) in relation to the 1:1 line.

Table 1. Regression statistics for predicted versus observed water content, where x_o and x_p are the means and σ_p and σ_o are the standard deviations for predicted and observed water content from *N* samples. The variables *a* and *b* are the intercept and slope of the regression line, *RMSE* is the root mean square error, and *EM* is the mean error.

Water retention function (PTF)		N	x_o	x_p	σ_o	σ_p	*b*	*a*	EM	RMSE
van Genuchten (Vereecken)	$\theta_{-33\ kPa}$	231	0.233	0.285	0.092	0.148	1.169	0.012	-0.014	0.115
	$\theta_{-1500\ kPa}$	231	0.098	0.150	0.048	0.096	1.190	0.030	-0.051	0.094
Hutson – Cass (Mayr - Jarvis)	$\theta_{-33\ kPa}$	231	0.233	0.375	0.092	0.072	-0.448	0.480	-0.142	0.200
	$\theta_{-1500\ kPa}$	231	0.098	0.018	0.048	0.011	-0.019	0.020	0.080	0.095
Brooks – Corey (Rawls - Brakensiek)	$\theta_{-33\ kPa}$	231	0.233	0.207	0.092	0.050	0.413	0.011	0.027	0.069
	$\theta_{-1500\ kPa}$	231	0.098	0.102	0.048	0.030	0.349	0.067	-0.003	0.040
Campbell (Campbell)	$\theta_{-33\ kPa}$	231	0.233	0,250	0.092	0.059	0.470	0.140	-0.016	0.065
	$\theta_{-1500\ kPa}$	231	0.098	0.124	0.048	0.049	0.570	0.070	-0.025	0.053

CONCLUSION

The Brooks – Corey function with parameters predicted by Rawls – Brakensiek PTF showed the best results for predicting water content .

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