Prediction of the Soil Water Characteristic from Soil Particle Volume Fractions

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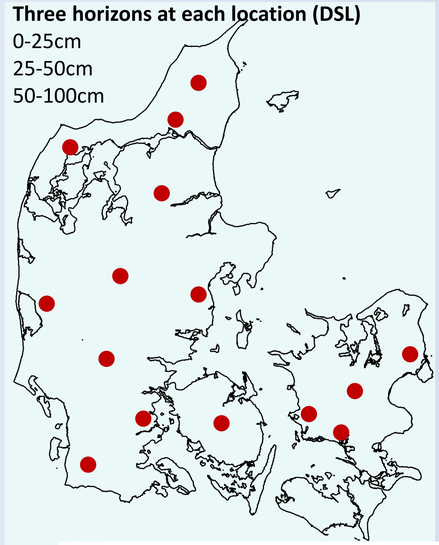
Introduction

- A quantitative description of the relationship between matric potential and soil water content, the soil water characteristic (SWC), is the basis for many soil-water related studies. However, measurement of the SWC over a wide range of matric potentials is both expensive and time-consuming.
- Therefore, several mechanistic models and pedotransfer functions providing a continuous description of the SWC have been proposed in the past.

Objective

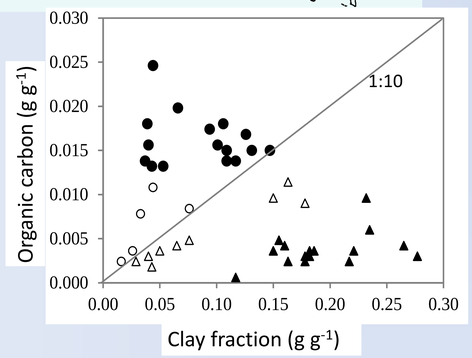
- To develop a robust predictive model for prediction of SWC as a function of easily measurable soil properties such as texture and bulk density.

Materials and Methods



Total 45 soil samples, three samples from each loction with one sample per horizon

Soil texture was determined with a combination of mechanical sieving and hydrometer measurements. Total organic carbon (OC) was determined with a LECO carbon analyzer (St. Joseph, Michigan) coupled with an infrared CO_2 detector.



Grouping of soils

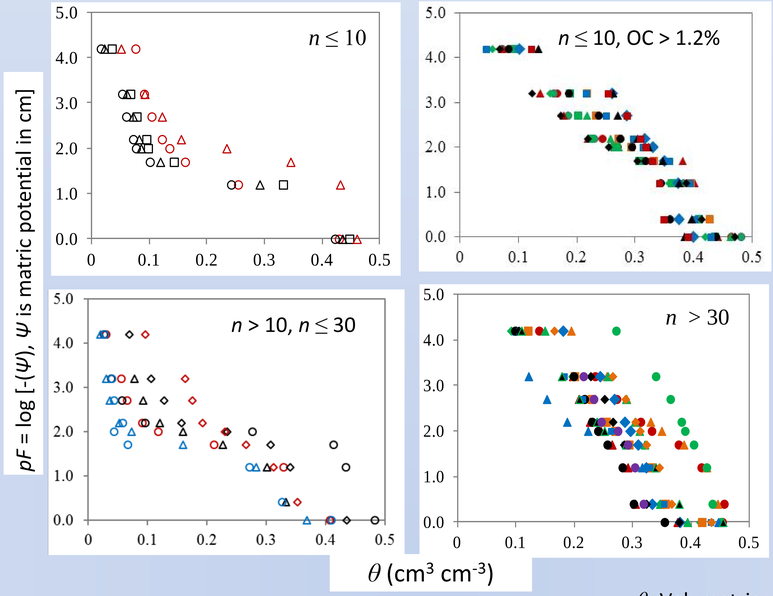
Dexter, *n* = Clay/OC

- ○ $n \leq 10$
- ● $n \leq 10$, OC > 1.2%
- △ $n > 10, n \leq 30$
- ▲ $n > 30$

Soil water characteristics were measured on undisturbed soil samples ($100cm^3$) using the hanging water column sandbox and pressure plate apparatus methods (Hansen, 1976).

Results

Measured Soil-Water Characteristics



A_W-Model

$$\theta(pF) = A_w.\rho_b\left(\beta_1\frac{OM}{\rho_{OM}} + \beta_2\frac{CL}{\rho_{CL}} + \beta_3\frac{S}{\rho_S} + \beta_4\frac{FS}{\rho_{FS}} + \beta_5\frac{CS}{\rho_{CS}}\right)$$

$$A_w = A\,(5.4 - pF)$$

pF range	Constant *A*	Organic matter β_1	Clay β_2	Silt β_3	Fine Sand β_4	Coarse Sand β_5
> 3.0	0.85	1	1	0	0	0
3.0 ≤ & > 2.0	0.38	2.6	1	1	0	0
2.0 ≤ & > 1.5	0.17	2.6	1	1	1	0
≤ 1.5	0.12	2.6	1	1	1	1

θ -Volumetric water content
A_w-model parameter
ρ_b (g cm^{-3})- Dry bulk density
OM (g g^{-1}) - Organic matter
CL(g g^{-1}) - Clay fraction
S (g g^{-1})- Silt fraction
FS (g g^{-1})-Fine sand fraction
CS (g g^{-1})-Coarse sand fraction
ρ (g cm^{-3})-Particle density
β- Weighting factor
A-Slope of the relation between A_w and *pF* in different *pF* ranges

Model Development

d (μm) = $[3000/10^{pF}]$ ⟷ $d = 0.28D_{50}$

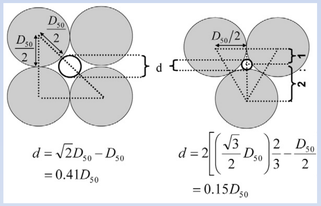
$0.28D_{50} = [3000/10^{pF}]$

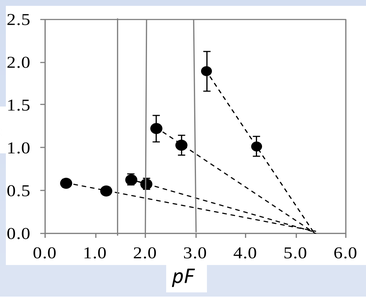
OM and Clay	Silt	Fine sand	Coarse sand
ISSS (mm) 0.002	0.02	0.20	2.0
pF value 3.0	2.0	1.5	0.0

$\theta\,(pF) = A_w$. Vol of soil particle fractions (pF)

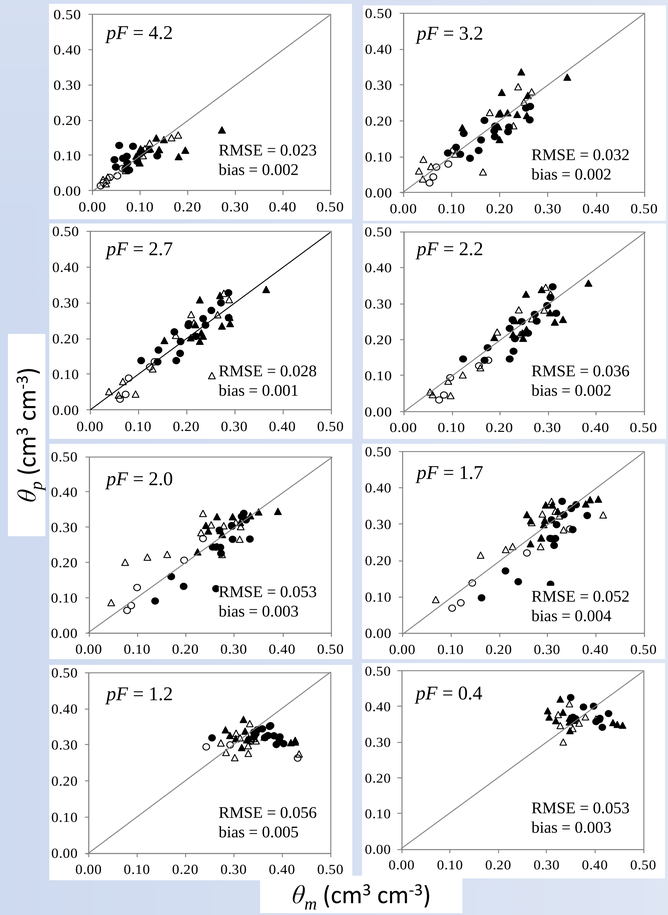
$A_w = \theta(pF)$ / Vol. of soil particle fractions(pF)

$A_w = A\,(5.4 - pF)$





Model Performance



Conclusions

The A_w-model was found to be quite robust, and it performed exceptionally well for all tested *pF* values ranging from 0.4 to 4.2 for different soil types.

For prediction of the continuous SWC, it is recommended to parameterize van Genuchten model based on the SWC data points predicted by the A_w-model.

Acknowledgements

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References

Naveed, M., P. Moldrup, M. Tuller, T.P.A Ferré, K. Kawamoto, T. Komatsu. 2012. Predictions of the Soil Water Characteristic from Soil Particle Volume Fractions**.** Soil Sci. Soc. Am. J. doi:10.2136/sssaj2012.0124

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