Predicting the Soil Water Characteristic from Near Saturated to Hyper-Dry based on Volumetric Soil Size Fractions

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Introduction

- Knowledge of the soil water characteristic (SWC) is needed in many soil water related studies.
- Existing proxy SWC-models works within specific soil texture classifications.
- Until recently has the hyper-dry part of the SWC been difficult to measure accurately and the hyper-dry region is therefore excluded in SWC-models.

Objectives

- To develop an easy applicable model to estimate the full SWC based on easy to measure soil data (eg. texture, organic carbon, and bulk density).
- The prediction needs to be applicable for all soil texture classifications from coarse to fine textured soils.
- The model should be simple and easy to use.

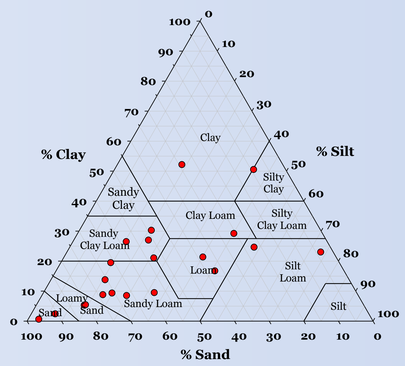
Methods

Soils

21 Arizonian reference source soils

Textures from coarse sand to clay

Organic carbon from 0-4%



Bulk Soil Analysis

Texture, organic carbon, particle density

Soil-Moisture Measurements

Tempe cells

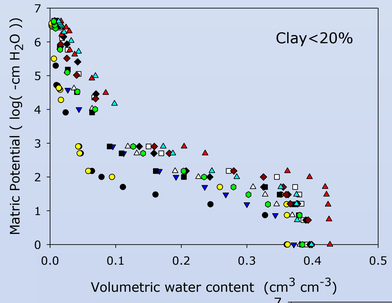
WP4-T Dewpoint Potentiameter

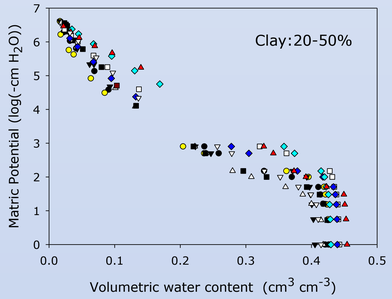
$$\psi = \frac{RT\rho_w}{M_w}\ln\left(\frac{e}{e_0}\right)$$

$$RH(\%) = \frac{e}{e_0}$$

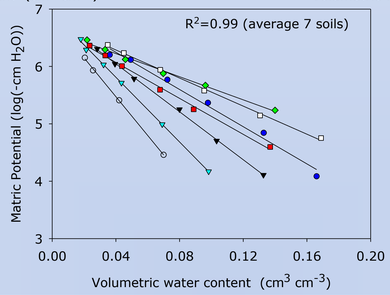
Results of Measurements

Soil water characteristics





Zero water content is found close to pF=6.9 for all soils. pF=log(-matric potential in cm H_20)



All soils have linearity with respect to pF at the dry-region.

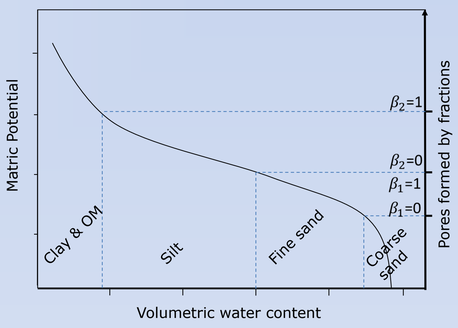
Model Development

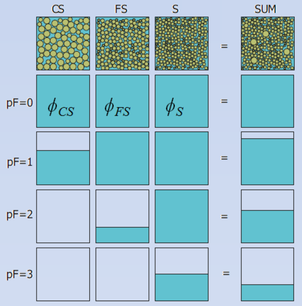
Prediction of the SWC – Wet-region

Capillarity is controlling

Volumetric texture fractions
→ Pore size fractions

$$\theta = \phi(1 - (V_{CS} + \beta_1 \cdot V_{FS} + \beta_2 \cdot V_S) \cdot \alpha)$$

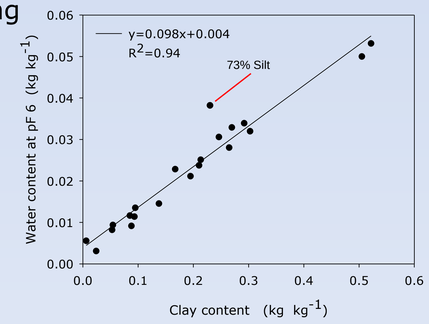




Prediction of the SWC – Dry-region

Adsorption is controlling

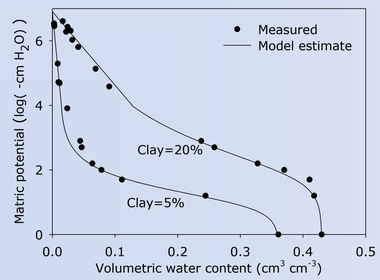
Specific surface area
→Highly related to clay content

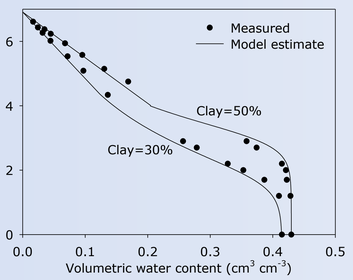


pF 6 corresponds to 48% RH.

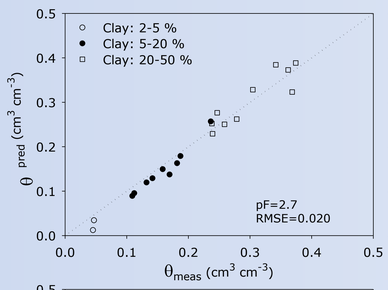
Model Performance

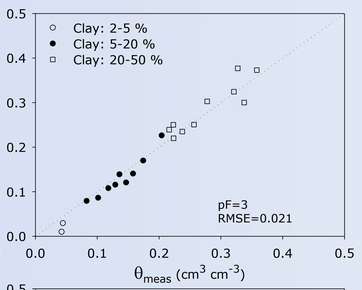
Soil water characteristic curves

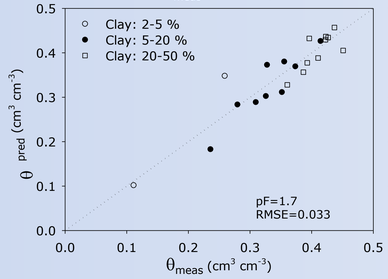


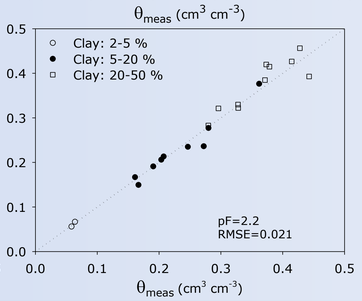


Measured vs. estimated water content









Conclusions

- This study presents a simple two-region model to estimate the full SWC from near saturation to dry.
- Volumetric particle size fractions were found to describe the soil water characteristic very accurately for a wide range of textural soil classes.
- Clay was found to be highly correlated with the hyper-dry water content and can be used as a parameter to estimate the hyper-dry water contents in the range from pF4.2 to pF6.9

Perspectives

- Test and evaluate the concept on undisturbed samples.

Acknowledgements

Soil Infrastructure, Interfaces, and Translocation Processes in Inner Space (Soil-it-is) project from the Danish Research Council for Technology and Production Sciences.

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