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Method Article

# Soil pedostructure-based method for calculating the soil-water holding properties

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A B S T R A C T

Soil aggregates structure (pedostructure) plays a pivotal role in regulating water and nutrient circulation, and consequently defines soil health, productivity, and water use efficiency. However, the soil aggregates structure is not currently considered in the quantification of soil-water holding properties. The authors applied a thermodynamic and soil structure-based approach to quantify soil-water holding properties. The paper provides a methodology, based on pedostructure concept, to quantify field capacity (FC), permanent wilting point (PWP), and available water (AW). The validity of the developed method was tested through application to two types of soil: a loamy fine sand soil and a silt loam soil. The calculated values for FC, PWP, and AW were compared with the FAO recommended values of FC, PWP and AW. For the loamy fine sand, the calculated values were: FC = 0.208 $m^3/m^3$, PWP = 0.068 $m^3/m^3$, and AW = 0.140 $m^3/m^3$ all of which fall within the recommended values of FAO for such a soil type. Similarly, the calculated values for the silt loam were: FC = 0.283 $m^3/m^3$, PWP = 0.184 $m^3/m^3$, and AW = 0.071 $m^3/m^3$ all were in agreement with the FAO recommended ranges for such a soil type.

- A thermodynamic, structure-based approach for soil water holding properties.
- Unique solutions for quantifying both field capacity and permanent wilting point.



A R T I C L E I N F O
*Method name:* Pedostructure method for calculating the field capacity, Permanent wilting point, Available water
*Keywords:* Soil aggregates structure, Thermodynamic, Field capacity, Permanent wilting point, Available water
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## Specifications Table

| | |
|---|---|
| Subject area | *Agricultural and Biological Sciences* |
| More specific subject area | *Soil-Water Holding Properties* |
| Method name | *Pedostructure Method for Calculating the Field Capacity, Permanent Wilting Point, and Available Water* |
| Name and reference of original method | *New method.* |
| Resource availability | https://wefnexus.tamu.edu/hydrostructural-pedology/ |

## Method details

This work introduces a new methodology for calculating the field capacity (FC), Permanent Wilting Point (PWP), and available (AW), using the soil aggregates structure (pedostructure) instead of soil texture. The Pedostructure approach was developed from the pedological description of the level of soil aggregates organization in which the primary particles (minerals "sand, silt, clay" and natural organic matter) assemble to form "primary" peds. These primary peds then aggregate to form the pedostructure (soil aggregates structure) as described by Braudeau et al. [1]. Pedostructure can be practically taken using a standard soil core (Fig. 1a) to represent the unique soil organization of the horizon from which it was taken. Each soil type has a unique pedostructure whose hydro-structural properties (pore systems and potential energies of surface charges on the primary peds) can be described using various hydrostructural parameters [2]. These parameters are extracted from the continuously and simultaneously measured data points of the water retention curve (WRC: the curve of soil water content vs. soil suction) and soil shrinkage curve (ShC: the relationship between the soil water content and the soil volume) produced by the TypoSoil™ device (Fig. 2a).

According to the thermodynamic formulation of the WRC and the ShC [2], one should recognize that there are two pore regions within a pedostructure (Fig. 2b):

1 **Micro-pore region,** representing the pore volume and structure *inside* the primary peds. Its water content is called micro-water content ($W_{mi}$). The following characteristic points of micro-pore

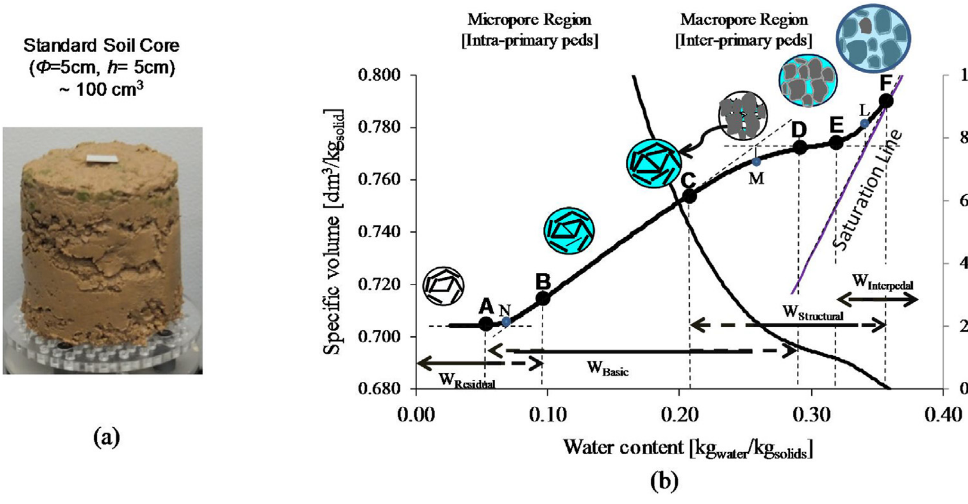


**Fig. 1.** Pedostructure concept: (a) a standard soil core to represent the pedostructure of a soil horizon, (b) delineating the two water types of a pedostructure by soil shrinkage curve (ShC) and water retention curve. On the ShC, points (A, N, B, C, M, D, E, L, and F) are the characteristic points of the water pools of the different shrinkage phases: interpedal, structural, basic and residual.