Characterization of soil physical and hydraulic properties of TexMensonet monitoring sites

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INTRODUCTION

- The TexMesonet is a statewide environmental monitoring network (Figure 1) designed for continuous measurement of atmospheric variables, soil moisture, and soil temperature.
- The goal of the network is to provide data to support applications such as precision agriculture, flood forecasting, and wildfire mitigation.
- However, the soil moisture data collected by the TexMesonet have yet to be used for these applications because the soil physical and hydraulic properties of the sites are unknown.
- The objective of this project is to quantify the soil physical and hydraulic properties for sites in the TexMesonet which are managed by the Texas Water Development Board.

The specific objectives are to:

1. *Characterize the soil physical properties including soil texture, bulk density, saturated hydraulic conductivity, and water contents at field capacity and permanent wilting point.*
2. *Estimate the site- and depth-specific van Genuchten (1980) soil parameters: saturated water content (θ_s) and residual volumetric water content (θ_r) , α, n, m and hydraulic conductivity function.*

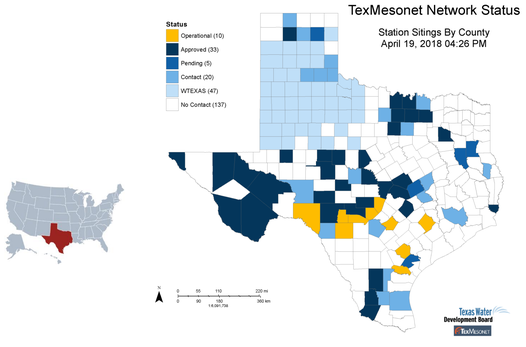

Figure 1: Current and future counties with TexMesonet monitoring sites.

MATERIALS AND METHOD

- There are currently 84 TexMesonet sites across the state which are managed by the Texas Water Development Board.
- Two soil cores per site (5.1-cm diameter × 5.0-cm height) will be collected using a Giddings probe at depths of 5, 10, 20, and 50 cm.

Figure 2: TexMesonet site in Colorado County.

Table 1. Field parameters with their corresponding methods

Parameter	Methods
Bulk density	Core method
Particle size	Hydrometer method (Gavlak et al. 1994)
Soil moisture content	Pressure cell method (Dane and Hopmans,2002)
Saturated hydraulic conductivity	Permeameter

- Site-specific soil hydraulic properties will be estimated using the van Genuchten model (Eq. 1) to predict the relationship between volumetric water content and matric potential:

$$\frac{\theta - \theta_r}{\theta_s - \theta_r} = [1 + (-\alpha\Psi_m)^n]^{-m} \quad (1)$$

$where\ \ m = 1 - \frac{1}{n}.$

Ψ_m is the matric potential (kPa), θ is the volumetric water content (cm^3cm^{-3})
, θ_r is the residual water content (cm^3cm^{-3}), θ_s is the saturated volumetric water content, $\alpha, n, and\ m\ are\ \ parameters$.

MATERIALS AND METHODS (CONT.)

- The hydraulic conductivity function is given by:

$$K(S_e) = K_0 S_e^L \left\{1 - \left[1 - S_e^{\frac{n}{n-1}}\right]^{1-\frac{1}{n}}\right\}^2 \quad (2)$$

K_0 (cm/day) is a fitted matching point at saturation, L (-) is an empirical parameter, S_e (-) is the effective saturation.

EXPECTED RESULTS

The expected outcomes of this study are:

1. The development of a state-wide soil physical and hydraulic property database for TexMesonet sites.
2. To develop soil moisture maps to make data more accessible to users and stakeholders.

IMPACT OF THE STUDY

The database that will be generated can be applied in order to:

- ❑ Develop soil moisture–based drought indices.
- ❑ Improve wildfire prediction.
- ❑ Estimate potential groundwater recharge.
- ❑ Validate soil moisture data from remote sensing.
- ❑ Plan of irrigation and drainage schemes.
- ❑ Relate forage and crop yield to soil moisture.

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