Water Retention Properties of Soil in a Tropical Pre-Montane Transitional Forest

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Abstract H51-1367

Introduction

- Developing a water budget for a watershed at the Texas A&M Soltis Research Center, near San Isidro de Penas Blancas, Costa Rica, will facilitate understanding of the area's hydrologic cycle.
- Soil water storage represents a significant component of a water budget.
- The volume of water held in soil at 10 kilopascals (kPa) and between 10 and 1500 kPa provides an estimate of soil water storage and plant available water, respectively.

Objectives

- Quantify soil water storage and plant available water at three representative sites.
- Determine the variability of soil water storage and plant available water between each site and horizon.

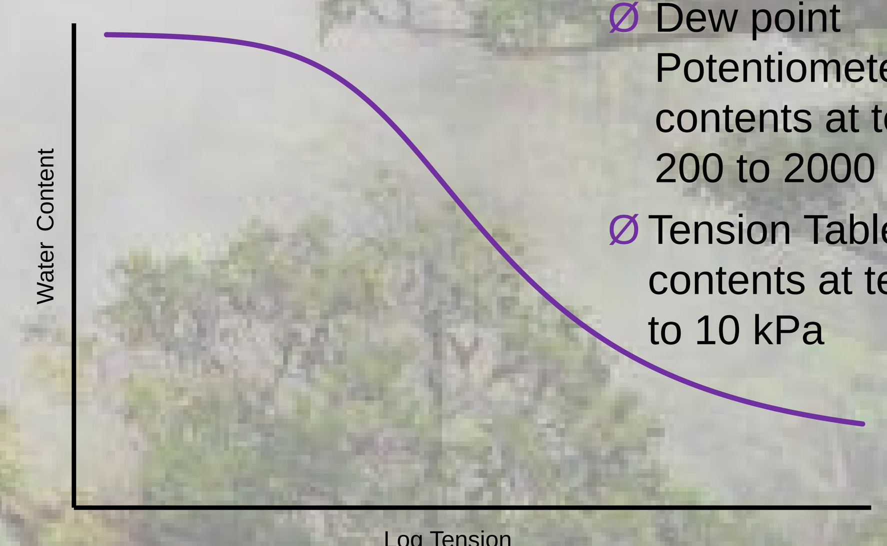
Research Site

- Three sites were selected to represent different slope classes and vertical distance from watershed stream

Site	Slope	Position	Depth to saprolite
1	25°	Middle (trail cut)	116 cm
2	45°	High (trail cut)	59 cm
3	32°	Low (dug pit)	65 cm

Measurements

1. Gravimetric water measurements (kg kg^{-1}) were converted to volumetric units (g cm^{-3}) using bulk density measurements from each soil horizon and site.
2. Soil water storage (in mm) is estimated as volumetric water content at 10 kPa (θ_{10kPa}) multiplied by soil depth (z) in mm
3. Soil plant available water (in mm) is estimated as $(\theta_{10kPa} - \theta_{1500kPa}) * z$



- Dew point Potentiometer: water contents at tensions 200 to 2000 kPa
- Tension Tables: water contents at tensions 0 to 10 kPa

Model

- The Van Genuchten (1980) model was used to generate complete soil moisture release curves.
- n and α parameters fit using least squares in Matlab.

$$\theta(\Psi) = \theta_r + \frac{\theta_s - \theta_r}{[1 + (\alpha\,|\Psi|)^n]^{1-1/n}}$$

θ(Ψ)	Water content as a function of tension
θ_r	Residual water content
θ_s	Saturated water content
α	Related to inverse of air entry potential
n	Measure of pore-size distribution

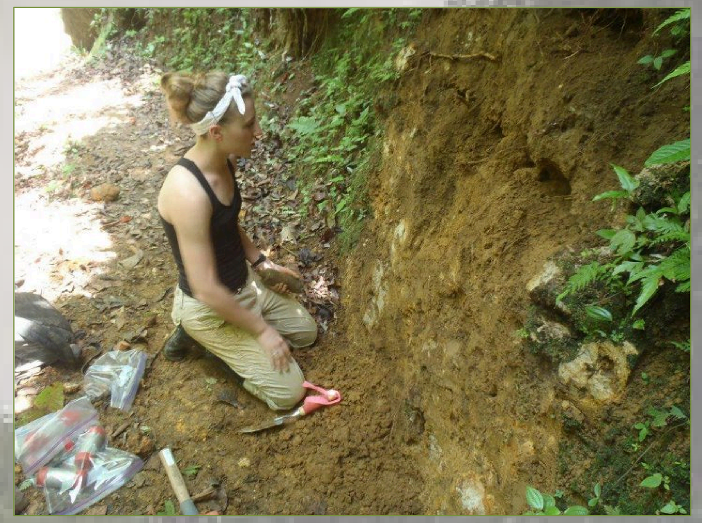
Results

Water Holding Properties

Site	Depth to saprolite	Storage mm H_2O	Plant-available water mm H_2O
1	1160	563	365
2	590	294	250
3	650	336	263

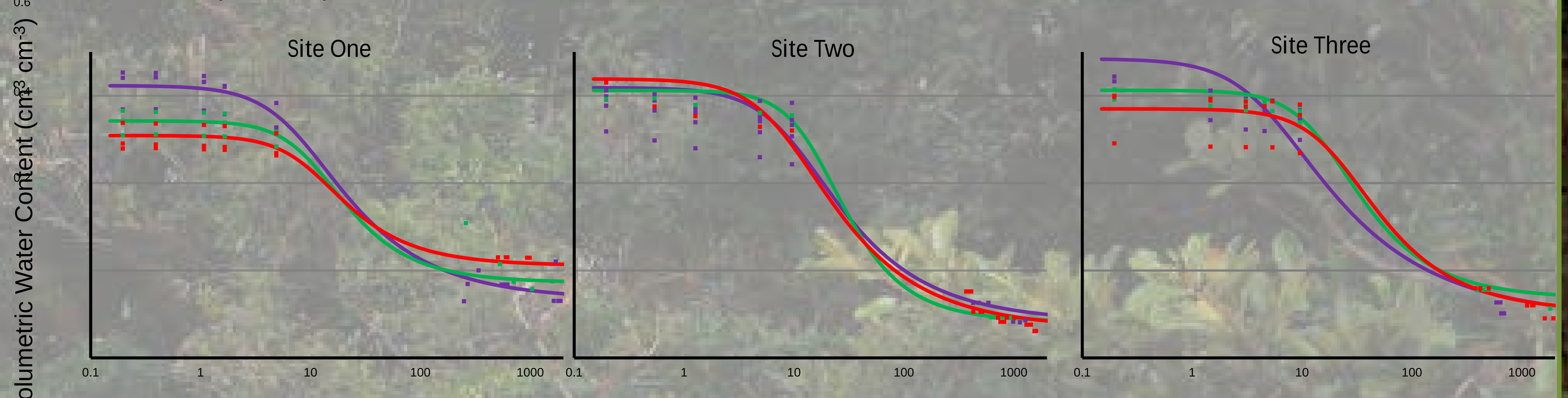
Soil Properties

Site	Horizon	Depth cm	Bulk Density g cm^{-3}	Color	η	α	θs cm^3 cm^{-3}	θr cm^3 cm^{-3}	RMSE
	A	0-35	0.623	Dark brown	1.65	0.13	0.62	0.13	0.03
1	Bw	50-66	0.542	Dark yellowish brown	1.94	0.09	0.54	0.17	0.03
	BC	80-116	0.509	Dark yellowish brown	1.89	0.10	0.51	0.21	0.04
	A	0-20	0.618	Dark brown	1.64	0.10	0.62	0.08	0.05
2	Bw	34-40	0.612	Dark yellowish brown	2.05	0.06	0.61	0.08	0.02
	B/Cr	54-59	0.638	Dark yellowish brown	1.64	0.12	0.64	0.07	0.03
	A	0-20	0.685	Dark brown	1.50	0.20	0.68	0.09	0.05
3	Bw	35-40	0.612	Dark yellowish brown	1.84	0.06	0.61	0.14	0.02
	B/Cr	63-65	0.570	Dark yellowish brown	1.75	0.05	0.57	0.10	0.04



Soil Water Content vs. Tension at three sites

- Horizon A
- Horizon Bw
- Horizon BC (site one) or B/Cr



Summary

- Differences in soil between sites:
  - Site one soil has lower bulk density and higher porosity
  - Site one soil holds less water at field capacity (10 kPa)
  - Preliminary particle size analysis indicates that site one is higher in clay-sized particles
- The Andic soils at the Soltis Center have lower bulk density than tropical Oxic soils.

Conclusions

- Delineations in slope and distance from the stream did not significantly control differences in soil properties, though soil on the shallowest slope had higher porosity.
- The water holding capacity of soils at the Soltis Center is determined by the properties of amorphous clays in Andic soils.
- More research in the tropics is needed to distinguish the water holding properties of Andic soils from those of Oxic soils.

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