Accounting for Soil Organic Matter for Estimating Soil Hydraulic Properties

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Background

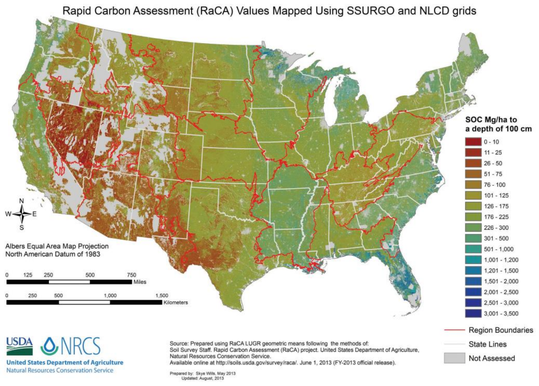

Figure 1. NRCS Rapid Carbon Assessment map.

New maps of soil organic matter (SOM) are being produced, one example is the rapid carbon assessment (RaCA) developed by the NRCS (Fig. 1). In addition to soil texture, SOM has shown a statistically significant effect in the pedotransfer functions (PTFs) for estimating soil hydraulic properties (Saxton et al., 2006); however, the practical value of adding SOM to PTFs is unclear.

Objectives

Our objectives are 1) to assess the functional improvements of incorporating SOM in the PTF estimations of permanent wilting point (PWP), field capacity (FC), porosity (θ_s), and saturated hydraulic conductivity (K_s), nationally and regionally, and 2) to identify an optimum SOM for an improved estimations of these hydraulic properties.

Methods

Dataset: 699 surface horizon samples from NRCS Soil Characterization Database within the Major Land Resource Areas of Texas

PTFs:
- Saxton et al. (2006) = National (from a USDA/NRCS National Characterization database)
- Texas Developed PTFs = Regional (from NRCS Soil Characterization Database)

Analysis:
1) Calculated PWP, FC, θ_s , and K_s with SOM and without SOM for all soil textures
2) Calculated PWP, FC, θ_s , and K_s with SOM and without SOM for 4 textural groups
3) Estimate PWP, FC, θ_s , and K_s by soil texture group and by increasing levels of SOM

- Statistics: with and without SOM estimates of hydraulic properties were compared using a paired t-test at $\alpha = 0.001$.

Results

- PWP, FC, and θ_s display a similar trend for the Regional (Fig. 2) and National PTFs.
- Porosity (θ_s) is significantly different when SOM is used in the PTFs.
- PWP and FC values are not significantly different when SOM varies.

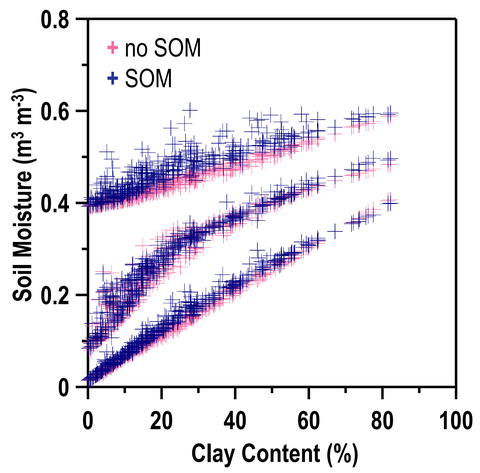

Figure 2. Results for all soil textures estimated with the Regional PTF.

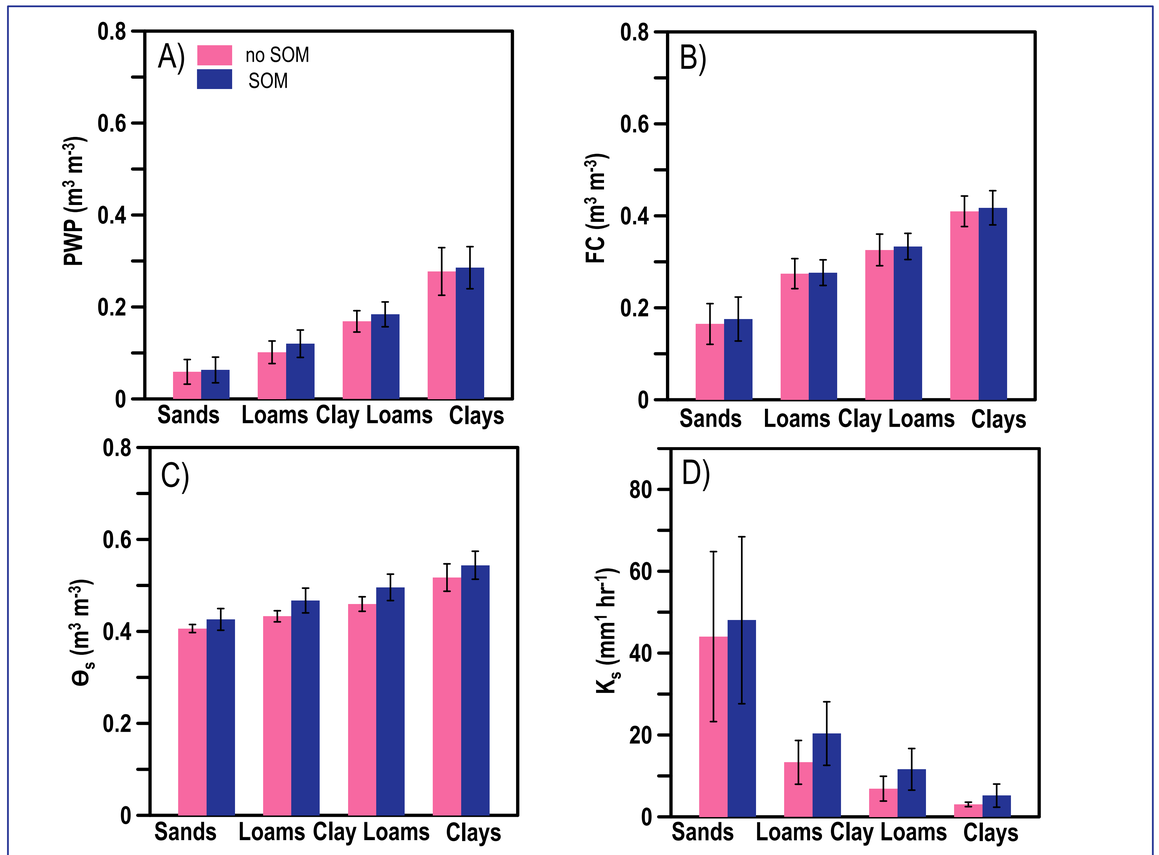

Figure 3. Results of Regional PTFs for PWP , FC , θ_s , and K_s by textural groups with and without SOM.

- After allowing SOM to vary, PWP and FC do not have significantly differences; however, θ_s & K_s significantly increased for all texture groups (Fig. 3).
- The numerical increases were very small and may not be practically important.

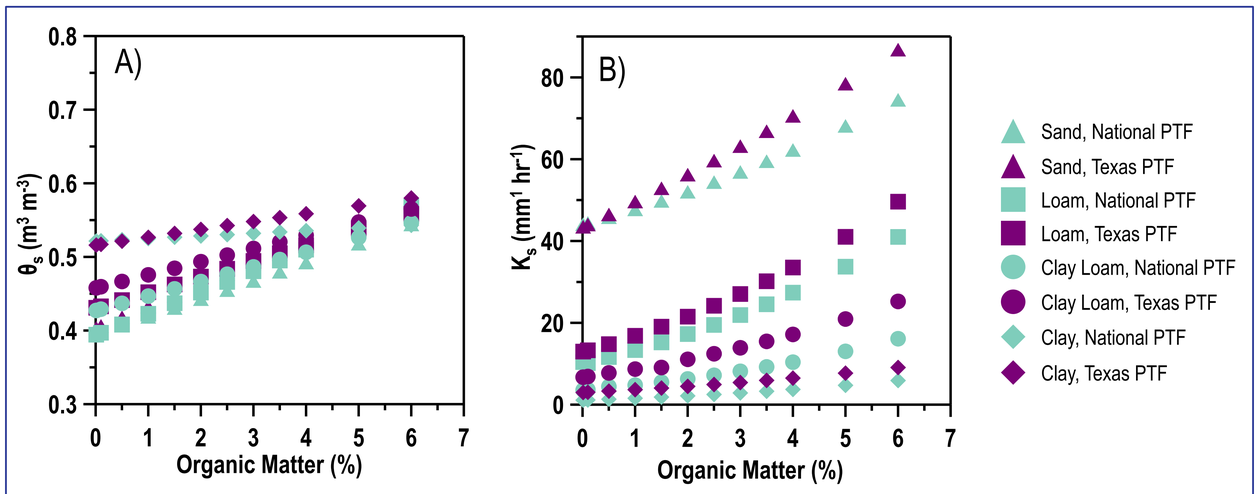

Figure 4. θ_s and K_s estimated by varying SOM by 0.5% for both PTFs (Regional and National)

- θ_s increases with SOM up to 4% (Fig. 4A), above that the improvement is minimal to none.
- Using the Regional PTFs yields a higher prediction of K_s than using National PTFs; however, both functions need at least 0.5 to 1.0% SOM to see the effect on the K_s (Fig. 4B).

Summary

The significant change in θ_s and K_s, but not PWP or FC, by incorporating SOM in the PTFs indicates that SOM could have altered the characteristics of macropores. However, these changes are surprisingly small for all soil hydraulic parameters. If SOM truly changes soil hydraulic properties significantly, PTFs built from NRCS databases are not capturing that change very well.

References

- Morgan, C. L., & Kishne, A. (2013). Revised Soil Parameters for meteorological Modeling. College Station: Texas Commission on Environmental Quality.
- Saxton, K. E., & Rawls, W. J. (2006). Soil Water Characteristic Estimates by Texture and Organic Matter for Hydrologic Solutions. *Soil Science Society of America*, 1569-1578