Role of organic carbon in controlling the spatial variations of soil water content in varied fields

Jili Qu

Department of Environmental and Architectural College

Apr 27, 2017

Contents

Introduction

Many remote sensing data (eg. SMAP mission) about soil moisture from satellite have offered active cosmopolitan overlap (Entekhabi et al., 2010) at comparatively low distinguishability (9 km in the integrated active and passive retrieval).

The dense data about soil water content (SWC) in vast fields will help to improve in a great stride the forecasting in climate and weather, cropland planning and management and enhance our awareness of how hydrological development and terrestrial skin interplay(Entekhabi et al., 2010).

Introduction

Unremitting endeavors have been made to downscale the image data from the low resolution of satellite products in general (9×9 km) to field scale (0.5 km) according to the features of plant cover, soil texture, earth surface, relief feature and annual precipitation that impact the variation of SWC at the field scale (e.g. Zhu and Lin, 2011).

This initiative needs a huge quantity of spatial and temporal information that influence soil moisture variability at the field scale, including soil texture class, soil bulk density, land unevenness, and farming patterns.

Methods

Field site

Volumetric moisture

Core sample analysis

Statistical analysis

Field site

Fig.1. Location of the field tests in Chongming Island of Shanghai, China in relation to soil texture map. Data from Soil Landscape of Shanghai,1992

Volumetric moisture

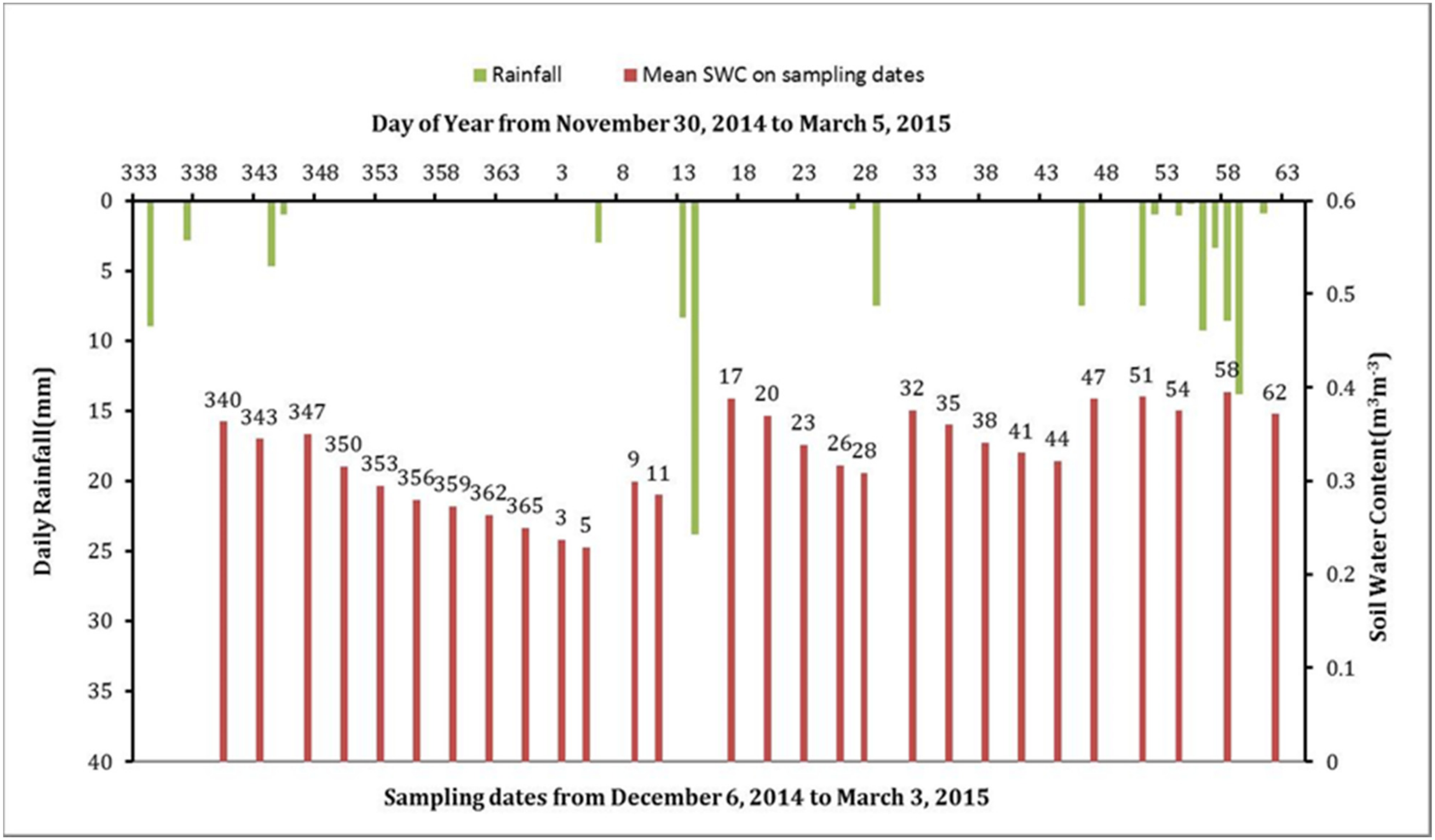
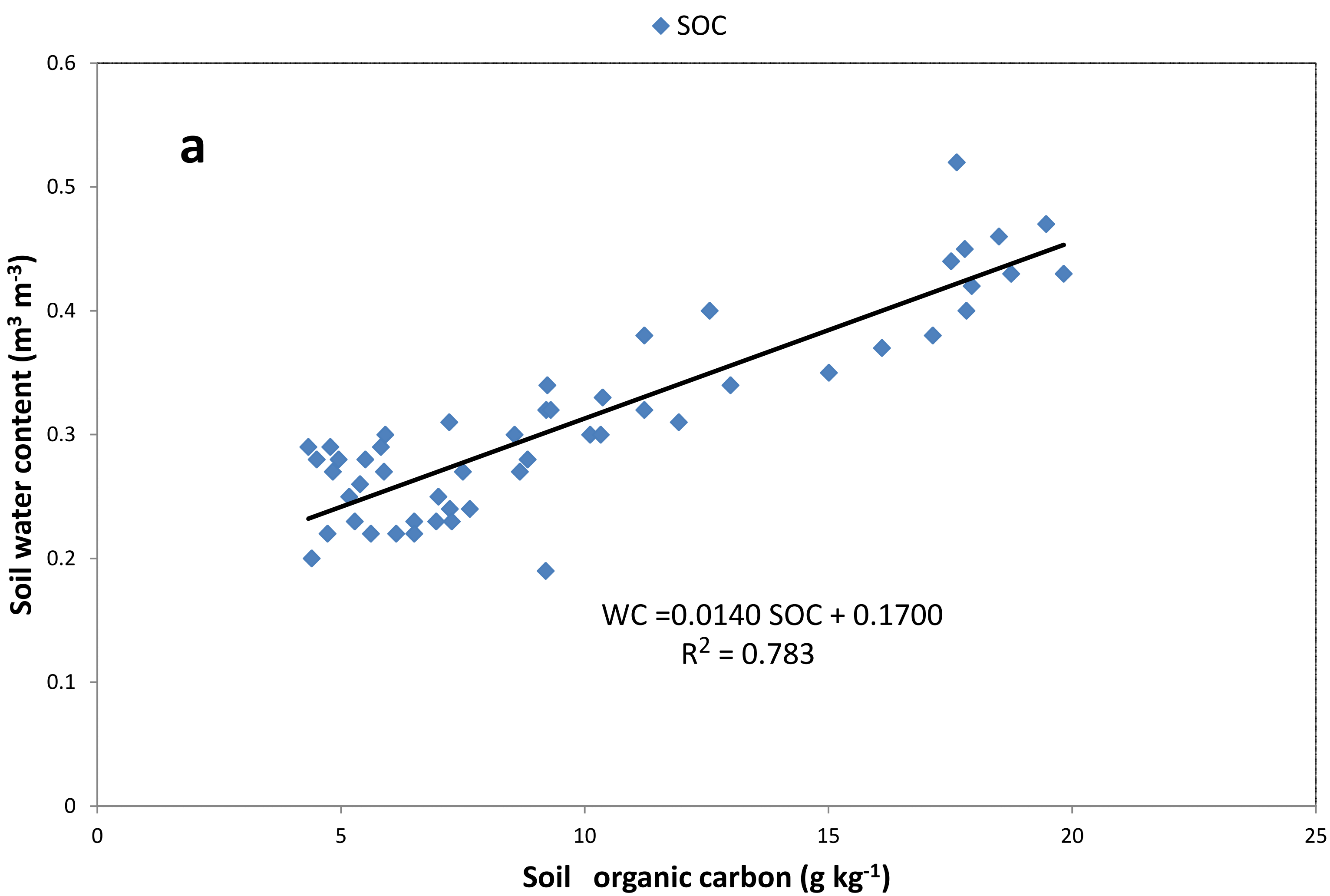
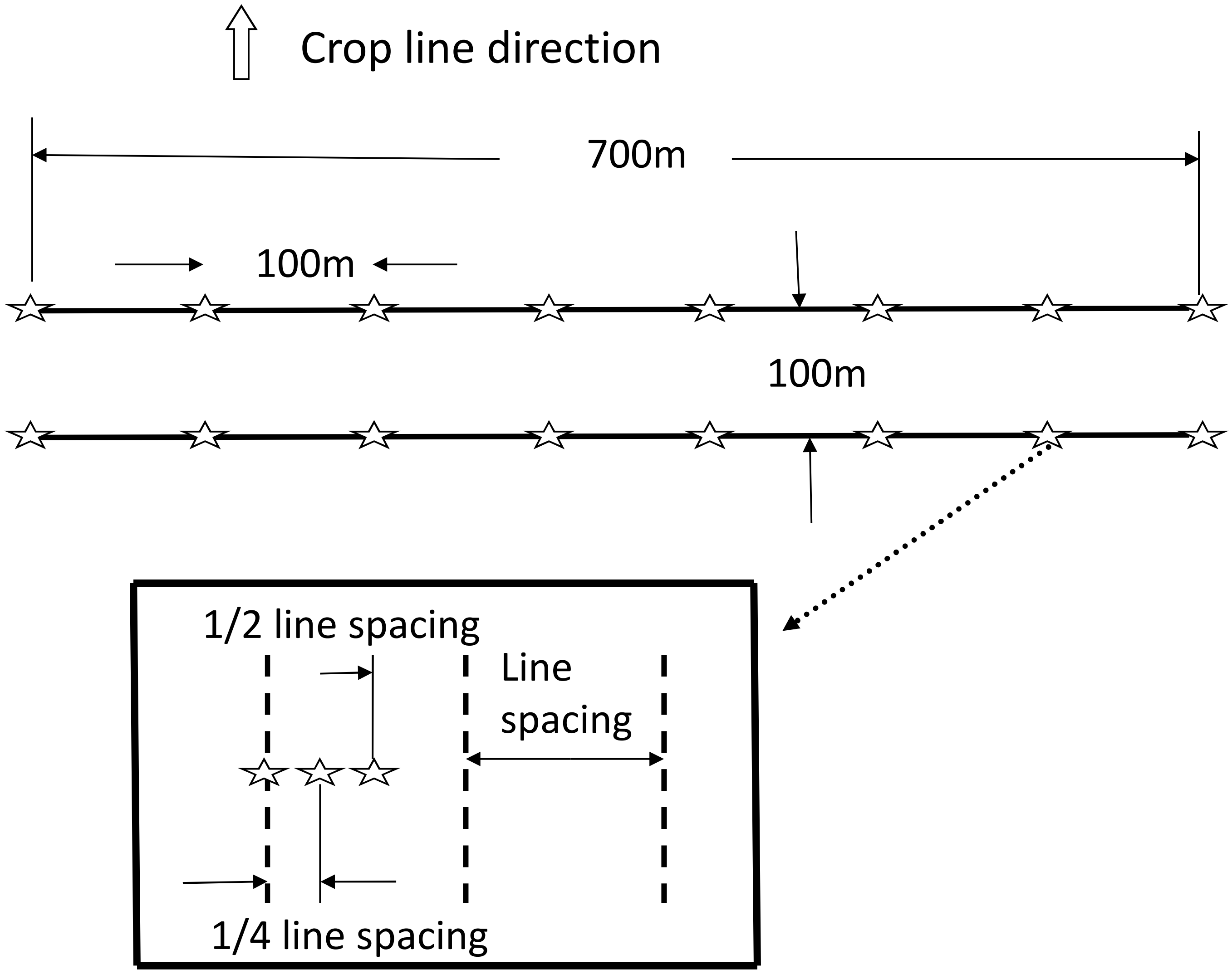


Fig. 2. Rainfall (mm) (green bars) from 6 December 2014 to 3 march 2015 and soil water content (m3 m-3) (red bars) averaged over all 52 fields at each sampling time.

SOC versus SWC



Volumetric moisture



Core sample analysis

$$\mathrm{SWC} = \mathrm{Gravimetric\ SWC} \times \mathrm{SBD}$$

$$\mathrm{SOC} = \frac{\dfrac{\text{mass loss after ignition (g)}}{\text{dry mass before ignition}}}{1.8} \times 100\%$$

Statistical analysis

- Evaluate the normality of soil parameters with the examination of plot of residuals of regression equations.

- Arcsine transform %Sand and %Clay.

- Apply Pearson correlation coefficient to investigate the correlation between indexes of soil physical behavior and SWC.

- Evaluate the relationship between SWC and other physical behavior indexes with multiple linear regression method.

- $AIC = \left[N * Ln\left(SSE\right)\right] + (2 * p)$

Results and Discussion

Table 1
Pearson correlation coefficients between soil physical variables and average soil water content (SWC) over all sampling times and fields. All values are significant at $p<0.01$

	Average SWC	%Sand	%Clay	SOC	SBD
Average SWC (m^3m^{-3})	1.00				
Sand (%)	-0.84	1.00			
Clay (%)	0.80	-0.78	1.00		
Organic carbon ($g\cdot kg^{-1}$)	0.89	-0.77	0.78	1.00	
Soil bulk density	-0.75	0.60	-0.76	-0.69	1.00

Table 2
Summary of optimum model combination with 2 or 3 variables of sand, clay, SOC and SBD from linear regression to SWC in wet, drying and dry soil wetness conditions. The sum of squares (SS) and R2 are shown for each model, along with the AIC value and VIF. The partial least squares regression coefficients are given along with the significance of the individual variables in the regression at p = 0.05(*), 0.01(**) and 0.001(***) or not significant (ns). The models are sorted within wetness group by AIC, with the optimum model in bold script. A high VIF that disqualifies a model is also in bold script.

Model predictors		Model				Partial least squares regression coefficients			
		R^2	SS	AIC	VIF	Sand	Clay	OC	BD
Wet	AS rOC	0.82	0.371	-346.66	3.1	0.471***		0.003ns	
	Sand OC	0.81	0.364	-339.61	5.6	0.037***		0.007*	
	Sand Clay OC	0.83	0.392	-323.67	11.0	0.013*	0.000ns	0.009*	
	Sand BD	0.73	0.332	-290.63	5.2	0.085***			0.002ns
	Sand Clay	0.79	0.366	-326.68	17.6	0.039***	0.000ns		
Drying	AS rOC	0.77	0.302	-321.65	3.1	0.422***		0.004ns	
	Sand OC	0.79	0.313	-318.88	5.8	0.038***		0.013*	
	Sand Clay OC	0.79	0.321	-313.28	11.2	0.017*	0.004ns	0.015*	
	Sand BD	0.67	0.303	-273.67	5.4	0.038**			0.000ns
	Sand Clay	0.71	0.297	-301.12	18.4	0.077**	0.001ns		
Dry	AS rOC	0.64	0.113	-329.23	3.3	0.170**		0.013*	
	Sand OC	0.63	0.146	-324.85	5.1	0.003ns		0.004ns	
	Sand Clay OC	0.65	0.135	-322.29	12.6	0.002ns	0.003ns	0.011*	
	Sand BD	0.53	0.113	-285.91	5.8	0.014*			0.002ns
	Sand Clay	0.52	0.118	-314.58	19.3	0.019*	0.004ns		

Results and Discussion

Table 3
Comparison of single variable models (sand, clay, SOC, SMD) in wet, drying and dry wetness categories. Models are sorted by AIC within wetness category. The model R2 and sum of squares (SS) is also shown. All model regressions are significant at p<0.01.

		Single model comparison		
		R^2	Model SS	AIC
Wet	Sand	0.71	0.30	-311.72
	SOC	0.84	0.36	-347.76
	Clay	0.68	0.34	-326.68
	SBD	0.62	0.27	-300.11
Dring	Sand	0.69	0.29	-294.23
	SOC	0.80	0.34	-340.08
	Clay	0.65	0.28	-313.55
	SBD	0.57	0.18	-288.64
Dry	Sand	0.67	0.24	-304.75
	SOC	0.76	0.26	-345.29
	Clay	0.63	0.17	-324.47
	SBD	0.63	0.15	-301.81

Conclusion

Soil organic carbon has a key effect on water content in any wetness condition;

Only soil organic carbon has a significant effect on soil moisture in dry condition;

Sand content has the second significant influence on soil moisture.

Conclusion

The water content of soil is best interpreted by the assembly of field texture and organic carbon over the spectrum of humidness.

Field organic carbon is a key component to predict the variation of soil moisture and could be applied to catch a larger percentage of variation than is generally correlated with indices like bulk density of soil.

In view of relatively reliable relationship between soil water content and soil organic carbon, refined study on methods for predicting organic carbon in soil would sustain and enrich the better understanding of dimensional variation of soil moisture from low resolution.

Thank you !