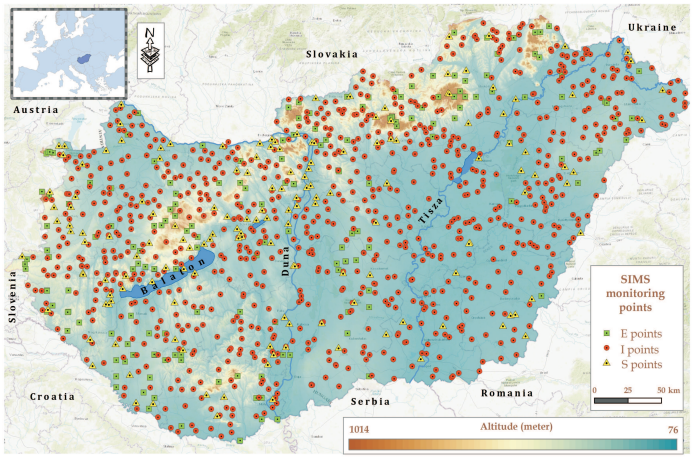
Organic carbon saturation pattern in the topsoils of Hungary and the potential to increase

Gábor Szatmári [1], László Pásztor [1], Zoltán Szalai [2,3], Gergely Jakab [2,3,4]

(1) Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research, Budapest, Hungary,
(2) Geographical Institute, Research Centre for Astronomy and Earth Sciences, Budapest, Hungary,
(3) Department of Environmental and Landscape Geography, Eötvös Loránd University, Budapest, Hungary,
(4) Institute of Geography and Geoinformatics, University of Miskolc, Miskolc, Hungary
jakab.gergely@csfk.org

Introduction

Due to intensive cultivation and the increasing environmental pressure, soils have lost most organic carbon (OC) stocks. Shifts in land use and cultivation practices can reload a considerable amount of the lost OC stock. This process may decrease the atmospheric carbon concentration on a global scale without further energy demand. Increasing OC concentration in the soil also improves fertility, hydrological conditions and leads to improved crop production. Organic matter entering the soil may be stabilized or decomposed depending on the current climatic, biological, and mineral conditions.



Soil profiles of the Hungarian Soil Information and Monitoring System (SIMS) (n=1,236) of which 183 are under forest and considered as SOC saturated

Factors	Covariates	Unit
Soil	Calcium carbonate content	[wt. %]
	pH	[-]
	Clay content	[wt. %]
	Silt content	[wt. %]
	Sand content	[wt. %]
	Actual SOC content*	[wt. %]
Topography	Elevation	[m]
	Slope	[%]
	Profile curvature	
	Total curvature	
	Topographic position index	
	Topographic roughness index	
	Surface area	
	MRVBF	
	MRRTF	
	LS factor	
	Topographic wetness index	
	SAGA wetness index	
	Vertical distance to CN	
	Horizontal distance to CN	
	CN base level	
	Diurnal anisotropic heating	
	Mass balance index	
	Stream power index	
Climate	Mean annual precipitation	[mm]
	Mean annual temperature	[C]
	Mean annual evapotranspiration	[mm]
	Mean annual evaporation	[mm]

CN - channel network

Environmental variables used for pedotransfer construction

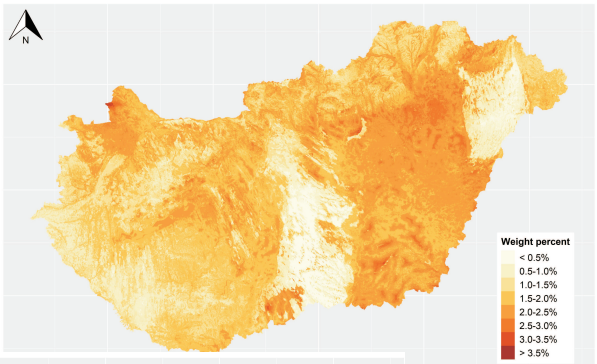
Methodology

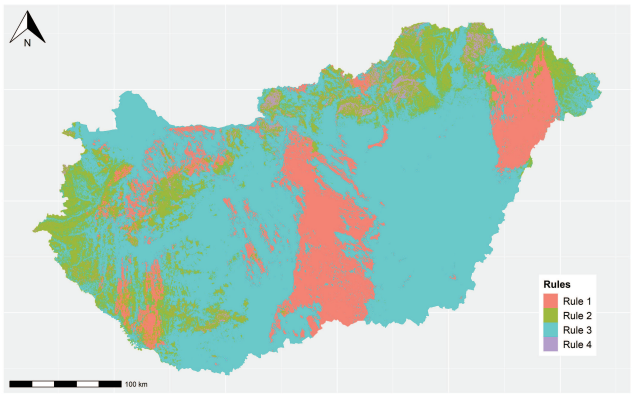
On those sites where the organic matter input is unlimited (e.g., forests), the current OC concentration equals the saturation value and can be interpreted as the result of the local environmental, soil, and climatic conditions. Forest sites of the Hungarian Soil Information and Monitoring System were used as reference sites. Using the Cubist data mining method, the measured saturation value of a forest site is empirically referred to the investigated variables values. Applying this relationship for spatial predictions a high resolution county wide organic carbon saturation map was compiled.

Results

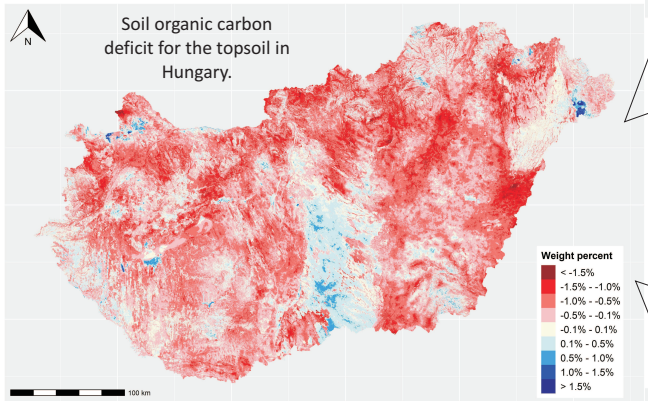
Results are in line with the theoretical approaches underlying the role of soil texture in organic carbon saturation. Comparing the potential saturation map to the current OC values sites with various increasing potentials (>80% of the country) were identified. Moreover, site specific special environmental conditions those most suitable for additional soil OC storage in the topsoil were also detected. Results indicated the highest soil OC deficit under soils of middle or even high OC concentration.
However, oversaturated parts are also detected, mainly under extremely hydromorphic conditions or regarding Arenosols. Thus, to improve prediction efficiency and describe limitations further analyses are needed.

Map of saturated soil organic carbon content for the topsoil predicted by the fine-tuned cubist-based pedotransfer function.





Soil organic carbon deficit for the topsoil in Hungary.



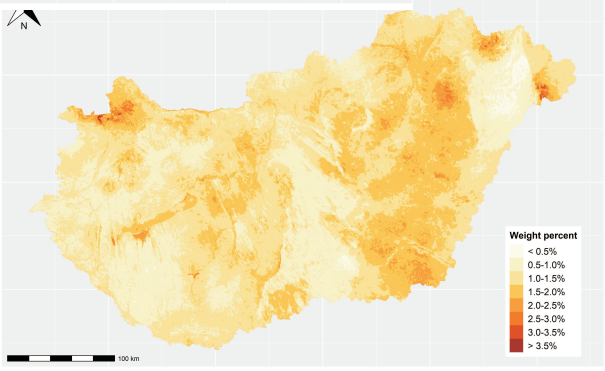
Altogether four rules were constructed with various spatial relevance to predict theoretical SOC saturation values

Rules	Conditions	Specific multivariate linear regression models
1	IF *Sand* > 61.69	THEN SOC_{sat} = 0.58804 + 0.113 *Clay* 0.0008 *Sand* 0.02 *Temperature* + + 0.01 *pH*
2	IF *pH* d 6.24 ***and*** *Sand* d 61.69 ***and*** *Slope* d 13.96	THEN SOC_{sat} = 7.6349 0.0087 *Evaporation* + 0.022 *LS factor* + + 0.0004 *Altitude* 0.0013 *Sand* 0.03 *Temperature* + 0.02 *pH*
3	IF *pH* > 6.24 ***and*** *Sand* d 61.69	THEN SOC_{sat} = 31.6689 0.0217 *Evapotranspiration* 0.8 *pH* 0.139 *Slope*
4	IF *pH* d 6.24 ***and*** *Sand* d 61.69 ***and*** *Slope* > 13.96	THEN SOC_{sat} = 0.7695 + 0.0966 *Sand* + 0.27 *Topographic position index*

Technics to increase SOC content of crop fields

tillage intensity mitigation
cover crops and buffer strips application
leaving plant residuals on the surface

Map of actual soil organic carbon content of the topsoil in Hungary



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