László PÁSZTOR[1], Zsófia BAKACSI[2], Gábor SZATMÁRI[1], Piroska KASSAI[1], Brigitta SZABÓ[2], Mihály KOCSIS[1], Annamária LABORCZI[1], András BENŐ[1]

A comparative study of the Hungarian Soil Monitoring System and LUCAS Topsoil dataset and their countrywide spatial predictivity

Institute for Soil Sciences, Centre for Agricultural Research
[1] Department of Soil Mapping and Environmental Informatics,
[2] Department of Soil Physics and Water Management

Highlights

- Motivations
- Preprocessing data for the comparison studies
- Comparing representativity
- Map compilation (effect of change in auxiliary data)
- Comparing map products
- Take home message

Motivations

International/European

EJP SOIL
European Joint Programme

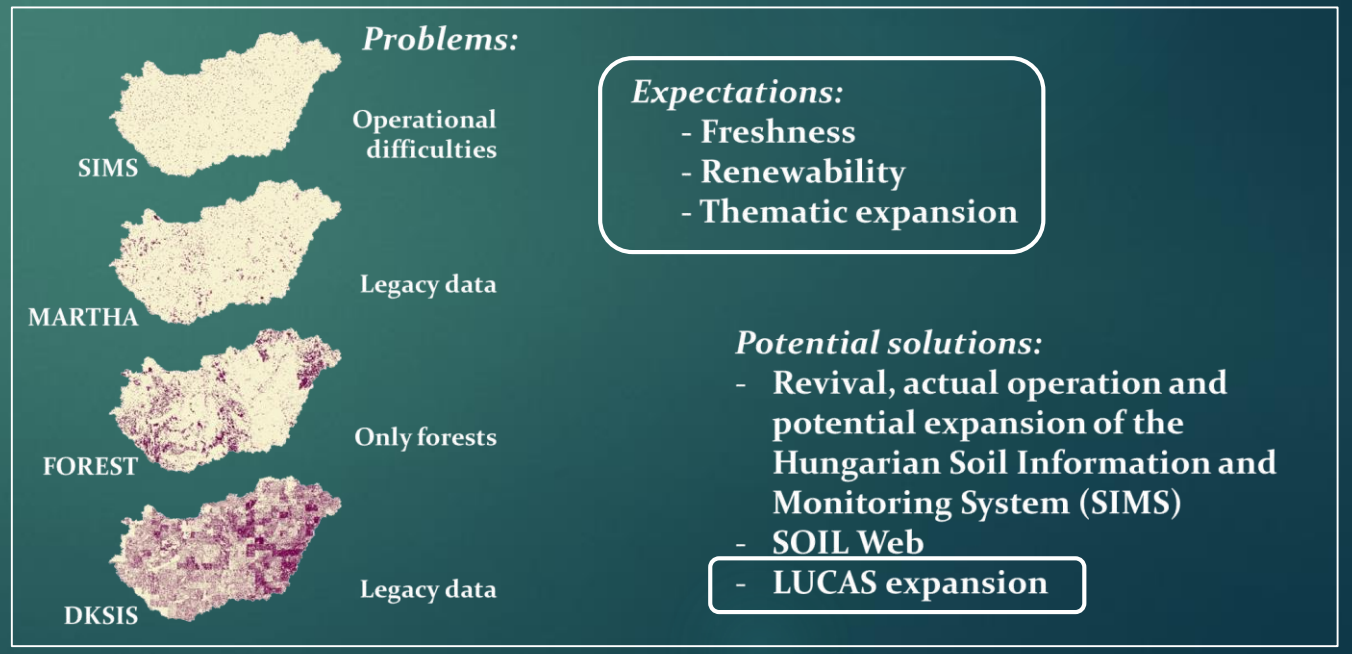
Understandable expectation on the production of „seamless" (i.e.: harmonized) maps to avoid border discrepancies and so-called Frankenstein-maps, which show inconsistencies along mapping regions (generally administrative borders).

National/Hungarian

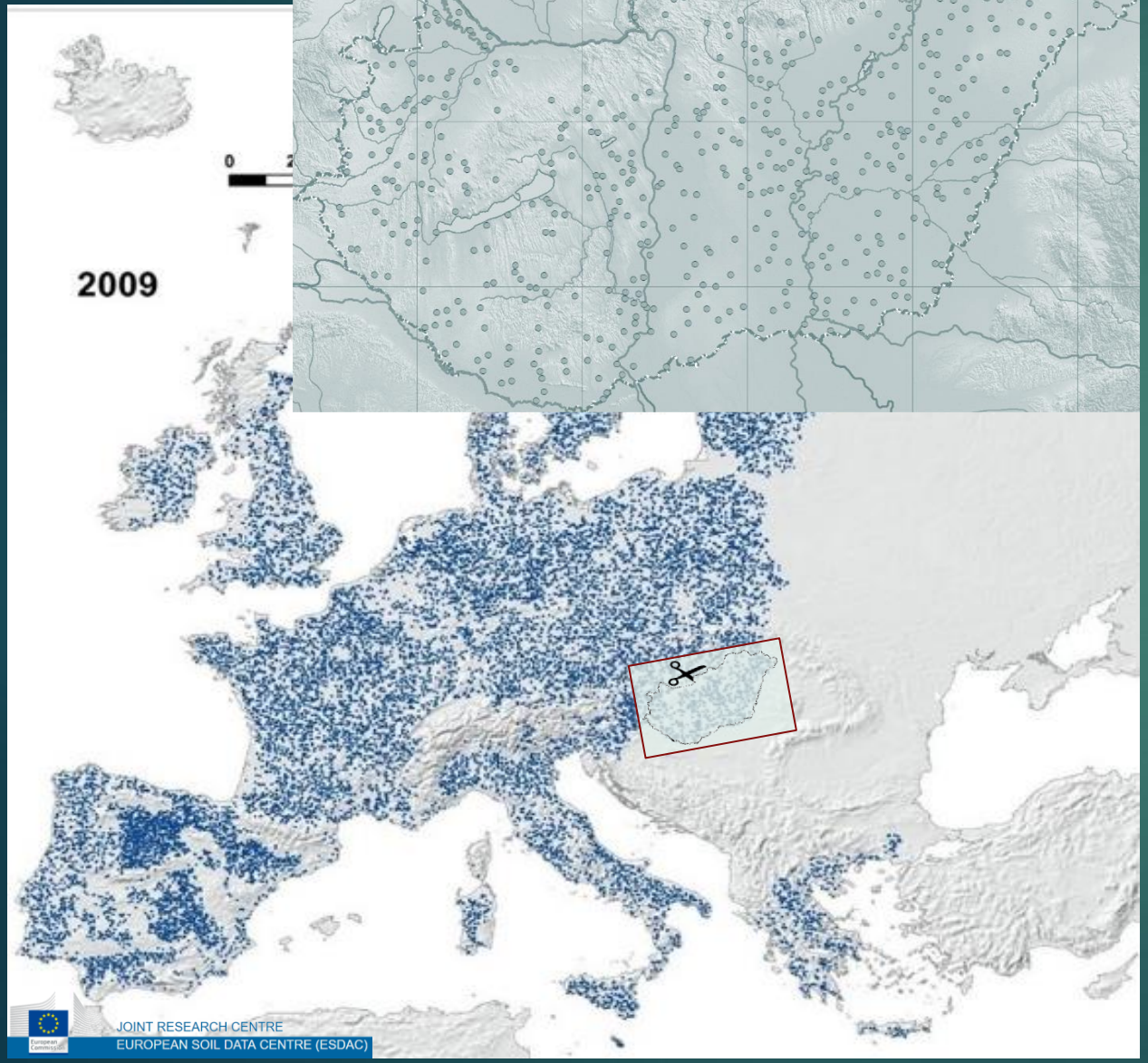
To make the renewed Hungarian Soil Spatial Data Infrastructure

- temporally more acceptable and
- thematically broadened

(more details in the next presentation by Dr. Laborczi)

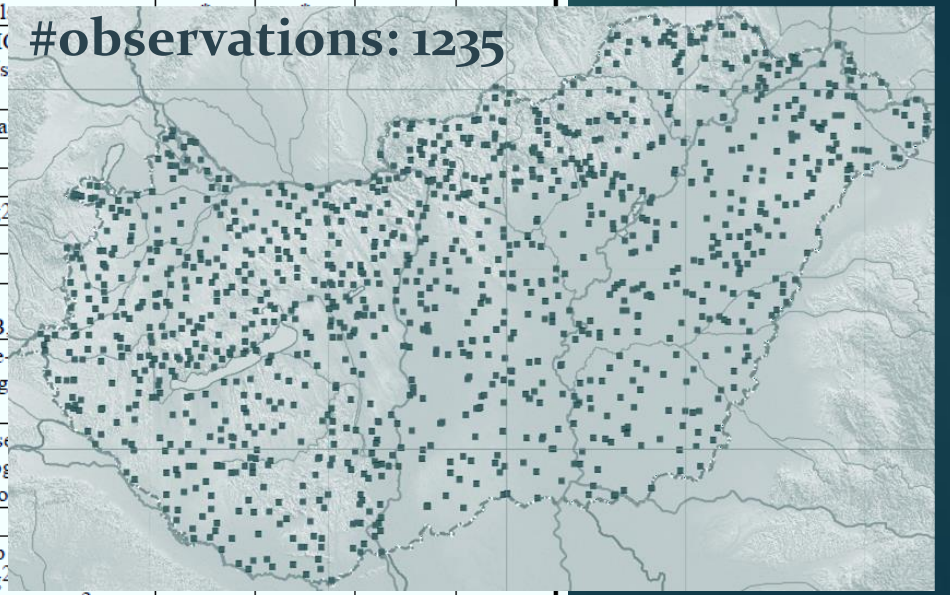


LUCAS Topsoil



Measured parameter	Baseline condition	Every year	3 years	6 years
Bulk density	*			
Particle size distribution	*			
Sticky point (KA)	*			
hygroscopy (hy2)	*			
Total water holding capacity (pFO)	*			
Field capacity(pF 2,5)	*			
Non available water (pF 4,2)	*			
Disporible water (pF 2,5-pF 4,2)	*			
CaCO3-content ha > 5 % ha 1-5 % ha < 1 %	* * *	 *	 * 	*
pH in distilled water if CaCO3 content > 1 % < 1 %	* *	 *	*	
pH in KCl if CaCO3 content > 1 % < 1 %	* *	 *	*	
Hydrolitic acidity	*	*		
Exchangeable acidity if no CaCO3 content	*	*		
Total salt content	*			*
Total salt content sodic/salic soil				
1:5 soil: water extract (CO_2^{3-} H(SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^{+},K^{+}) /s salt content				
Reaction with phenolphtalein (sa				
Organic matter content				
Cation exchange capacity				
Exchangable cations (Ca2+, Mg2				
Total N content				
Nitrate-nitrite content				
"available" nutrients (P,K,Ca,Mg,Cu,Zn,Mn,Na,Fe, B				
"toxic "(or potentially toxic) elements:(Al,As,B,Cd,Co,Cr,Cu,Hg Mo,Ni,Pb,Zn)				
Biological activity	Cellulos Dehidrog CO2-pro			
Natural radioactivity				
Chemical composition of the top groundwater (pH, EC, Ca^{2+},Mg- HCO_2^{3-}, Cl^{-}, SO_4^{2-}, NO_3^{-} NO_2^{-}, PO_4^{3-},)	*	*		

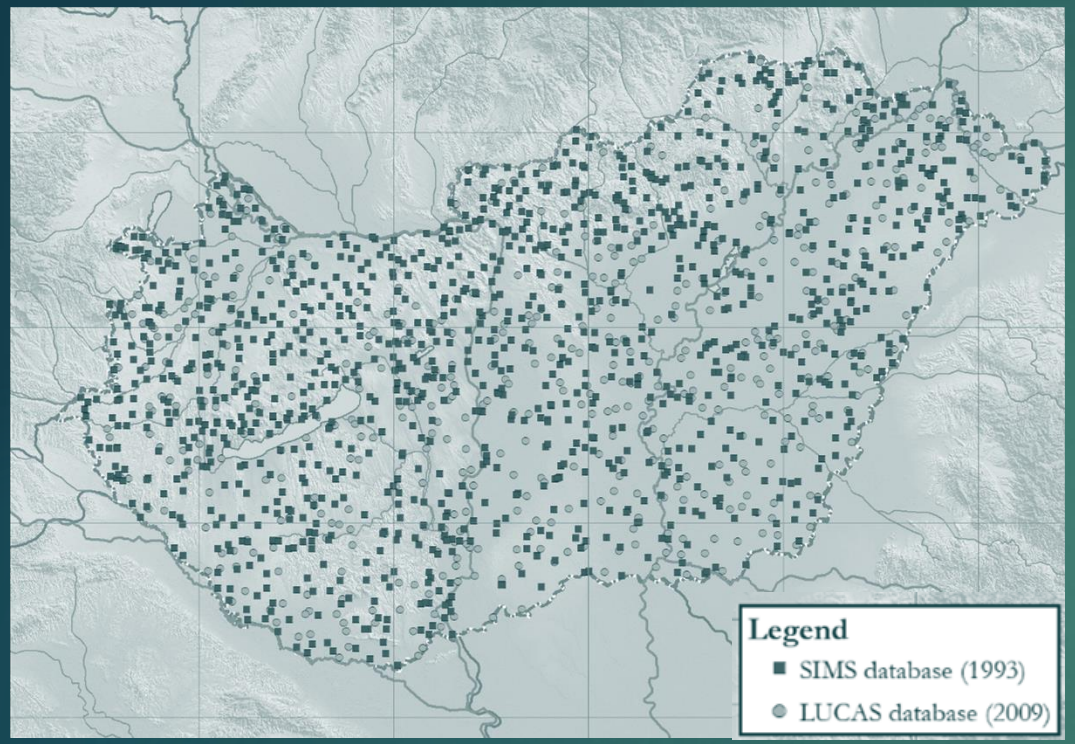
[1] every year in the top horizon 3 years lower horizons



Soil Information and Monitoring System (SIMS)

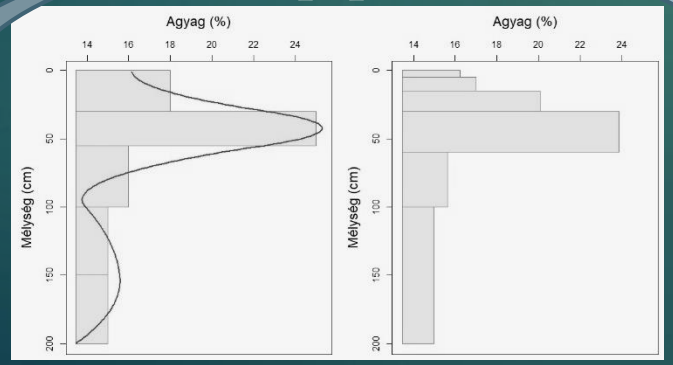
Operates since 1994

Preprocessing data for the comparison studies



mpspline

SIMS
- Genetic layers
- 0-30/30-60/ 60-90



LUCAS
0-20 cm

LUCAS Topsoil

Soil Information and Monitoring System

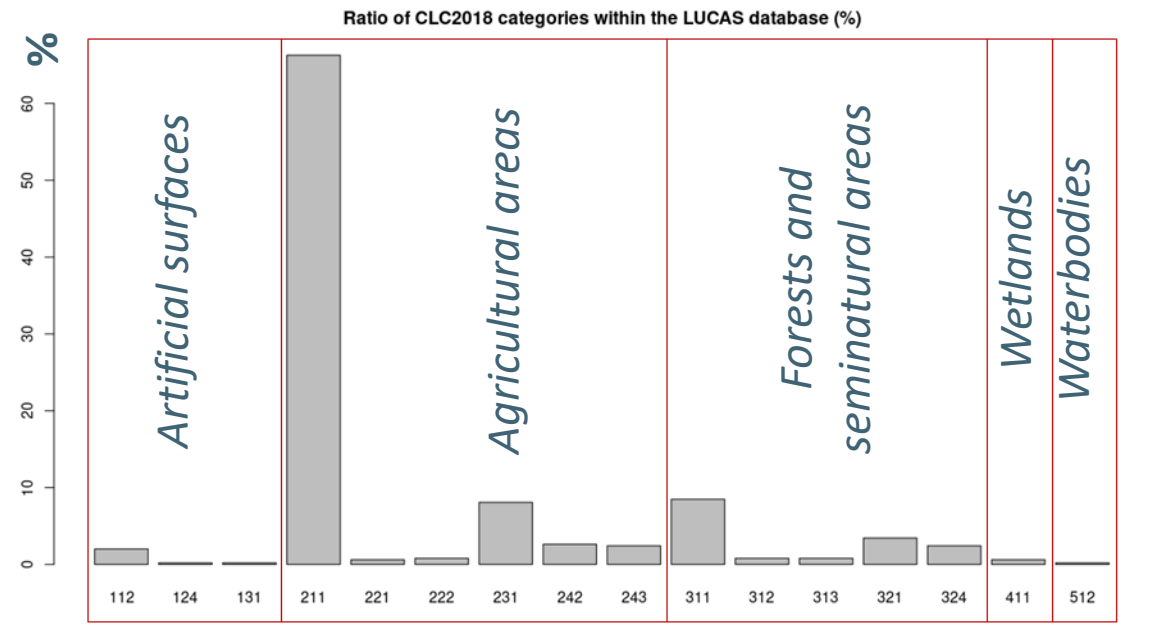
PTFs

Soil Property	LUCAS		SIMS	
	measurement method	unit	measurement method	unit
Particle size distribution (sand, silt, clay)	Sieving and sedimentation method (FAO/WRB) ISO 11277. 1998	%	Pipette method based on the Stokes-law (USDA) MSZ-08-0205-1978	%
Organic carbon content	Dry combustion ISO 10694:1995	g/kg	"Székely"-method (wet combustion) using 1:2 mixture of $K_2Cr_2O_7$ and H_2SO_4 MSZ-08-0210:1977	%
Carbonate content	Volumetric method ISO 10693:1995	g/kg	Scheibler-method MSZ-08-0206/2-1978	%
pH(H_2O)	Glass electrode in a 1:5 (V/V) suspension of soil in H_2O ISO 10390. 1994	-	Glass electrode in a1:2,5 (V/V) suspension of soil in H_2O MSZ-08-0206/2-1978	-
pH($CaCl_2$)	Glass electrode in a 1:5 (V/V) suspension of soil in $CaCl_2$ ISO 10390. 1994	-	Glass electrode in a1:2,5 (V/V) suspension of soil in KCl MSZ-08-0206/2-1978	-

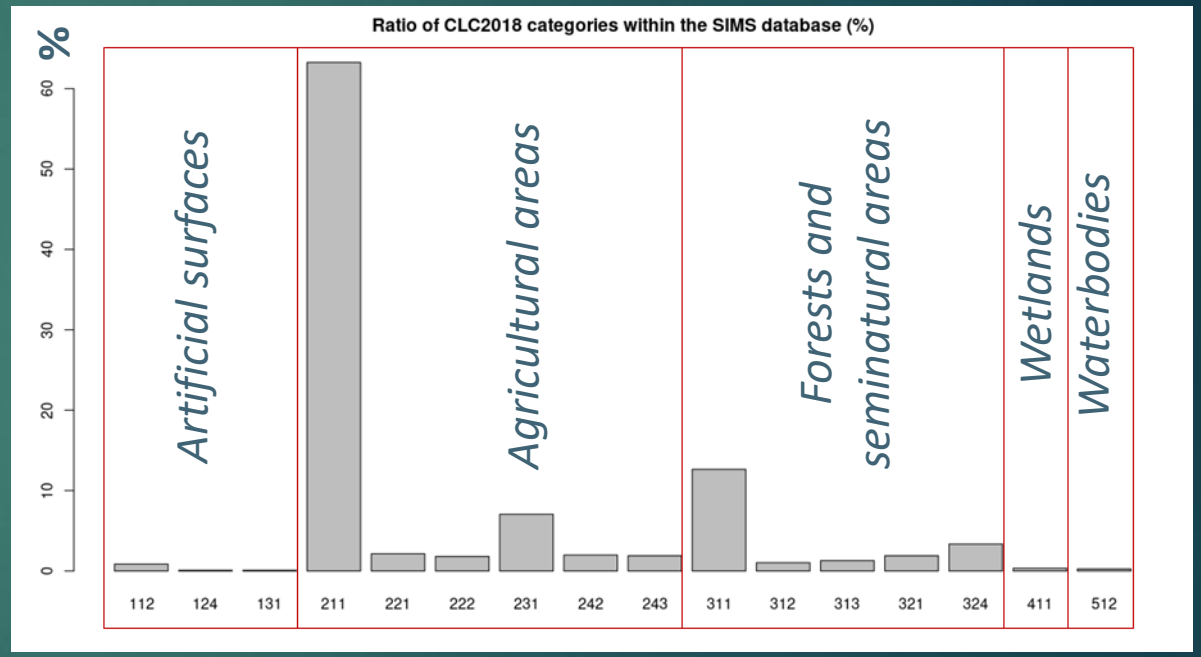
Comparing representativity

Sampling various landcover types
according to CLC2018

LUCAS Topsoil



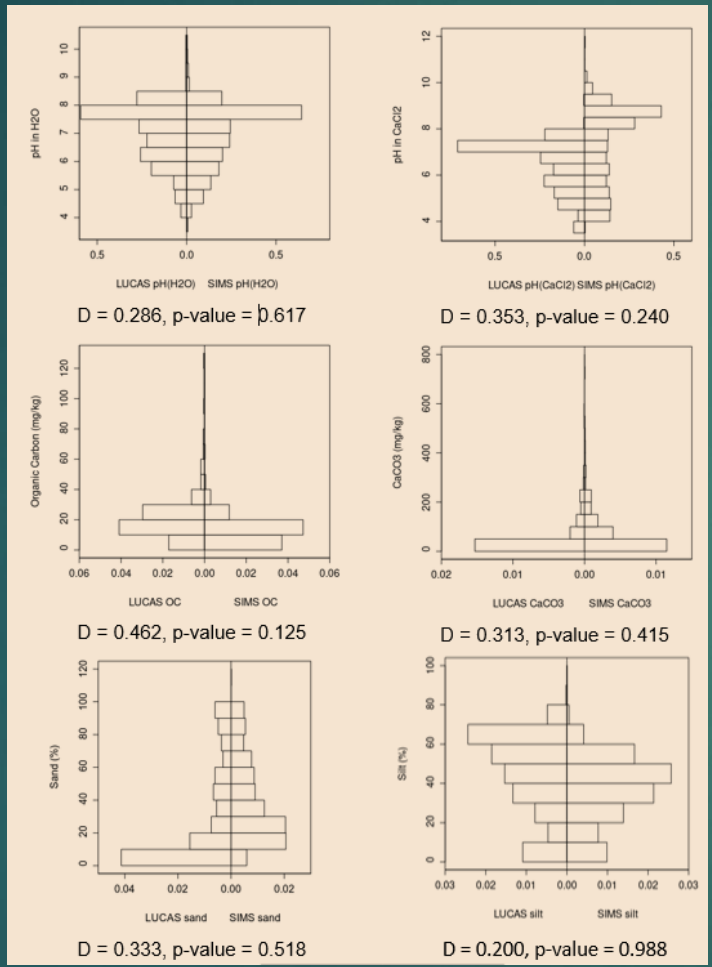
Soil Information and Monitoring System

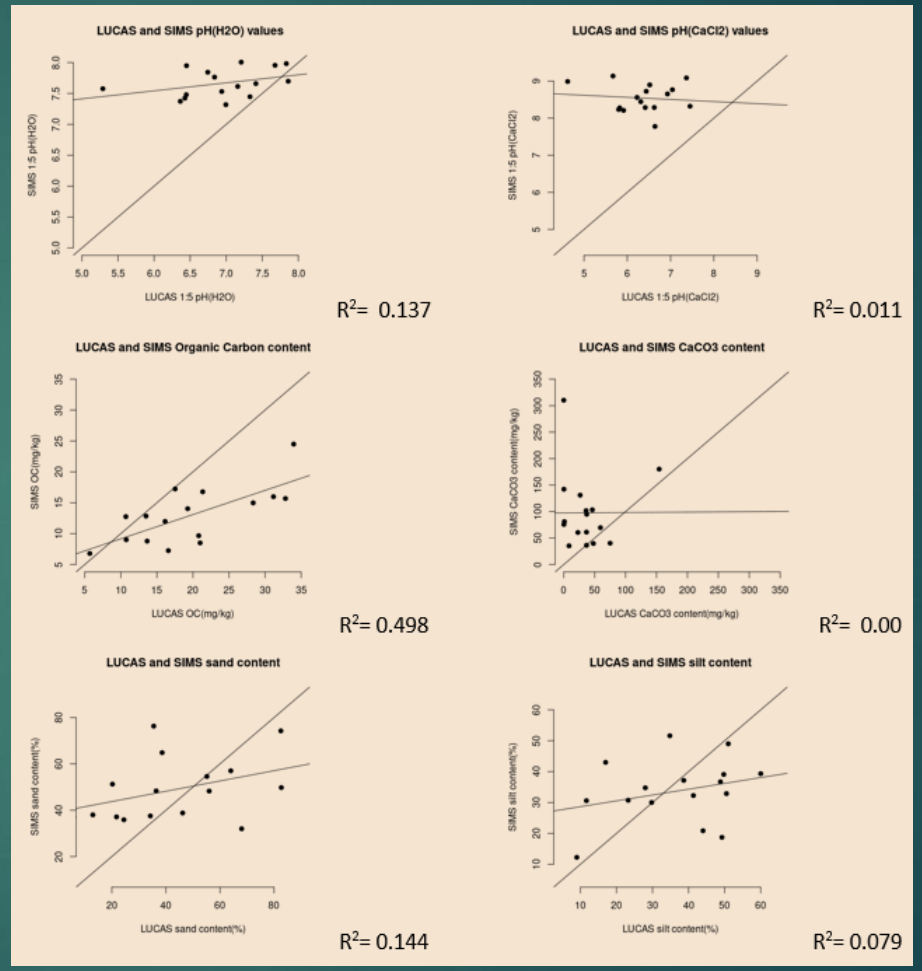


The two datasets represent the different CLC2018 categories in almost the same ratio, despite having different spatial distributions and sample sizes.

Comparing representativity

Back-to-back histograms and results of the Kolmogorov-Smirnov test for the comparison of LUCAS and SIMS for pH(H2O), pH(CaCl2), SOC, $CaCO_3$ and sand, silt content.





Scatterplot of LUCAS vs. SIMS for pH(H2O), pH(CaCl2), SOC, $CaCO_3$, sand, silt content data aggregated by CORINE land cover categories at Level 3.

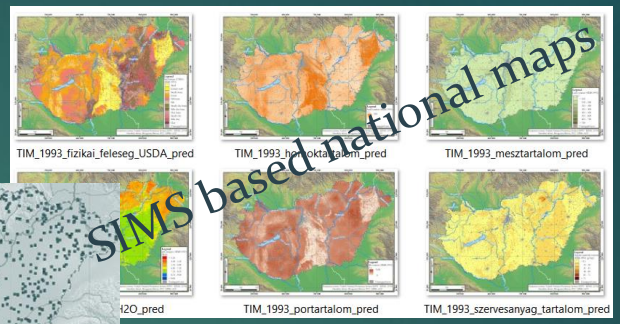
KS test: SIMS and LUCAS seem to represents the same population for each soil property at a significance level of 0.05

No relationship between LUCAS and SIMS in case of pH(CaCl2), $CaCO_3$, silt and clay content. For pH(H2O), SOC and sand content there is a weak linear relationship

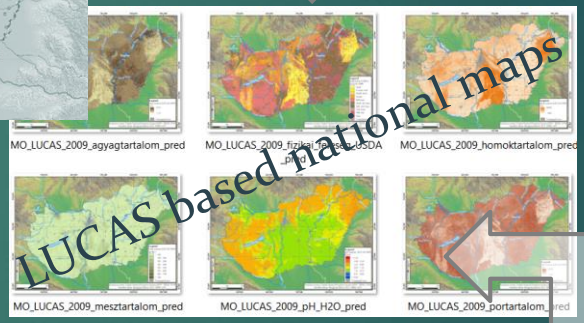
Map compilation (effect of change in auxiliary data)

SORPAN factor	Name	Resolution	Type
Soil Climate	Soil type map of Hungary	100 m	Categorical
	Long-term mean annual evapotranspiration	100 m	Continuous
	Long-term mean annual evaporation	100 m	Continuous
	Long-term mean annual [illegible]	100 m	Continuous
	[illegible]	[illegible]	[illegible]
Relief	Altitude	100m	Continuous
	Slope	100 m	Continuous
	Surface area	100 m	Continuous
	Profile curvature	100 m	Continuous
	Total curvature	100 m	Continuous
	Topographic wetness index (TWI)	100 m	Continuous
	Topographic ruggedness index (TRI)	100 m	Continuous
	Topographic position index (TPI)	100 m	Continuous
	Multiscale TPI	100 m	Continuous
	SAGA wetness index	100 m	Continuous
	LS factor	100 m	Continuous
	Multi-resolution index of valley bottom flatness (MRVBF)	100 m	Continuous
	Multi-resolution ridge top flatness (MRRTF)	100m	Continuous
	Vertical distance to channel network (VDCN)	100 m	Continuous
	Horizontal distance to channel network (HDCN)	100 m	Continuous
	Channel network base level	100 m	Continuous
	Diurnal anisotropic heating	100 m	Continuous
	Mass balance index (MBI)	100 m	Continuous
	Stream power index (SPI)	100m	Continuous
Land Cover	CORINE LC 1990	100 m	Categorical
	CORINE LC 2000	100 m	Categorical
	CORINE LC 2012	100 m	Categorical
Parent Material	Geological map of Hungary	100 m	Categorical

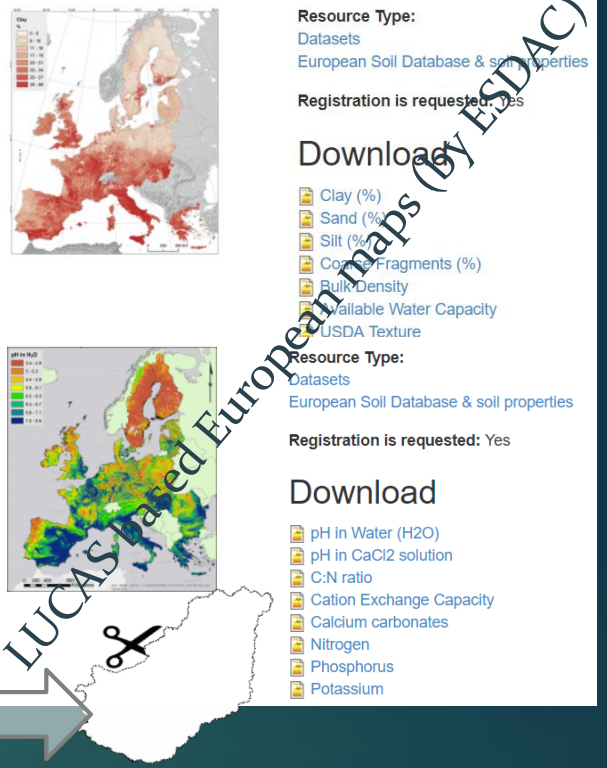
Random Forest



SIMS based national maps



LUCAS based national maps

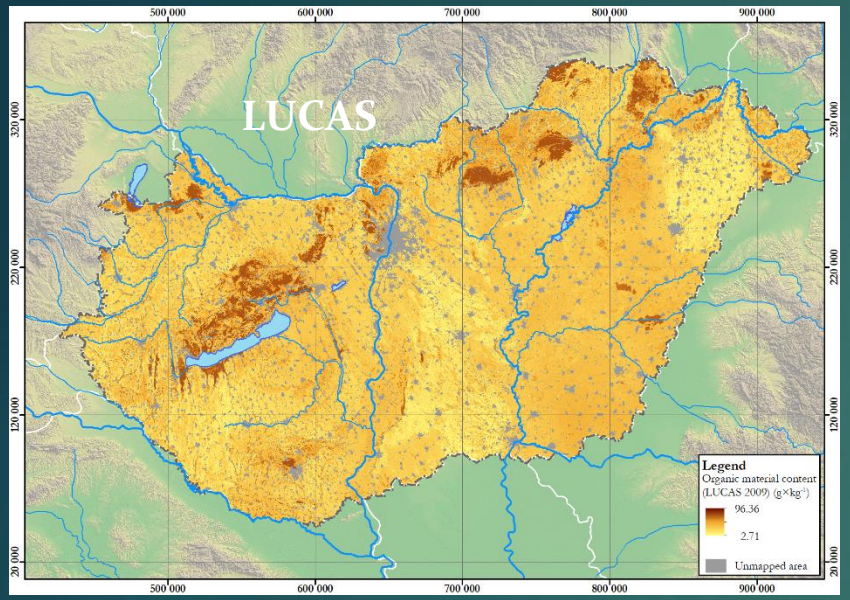


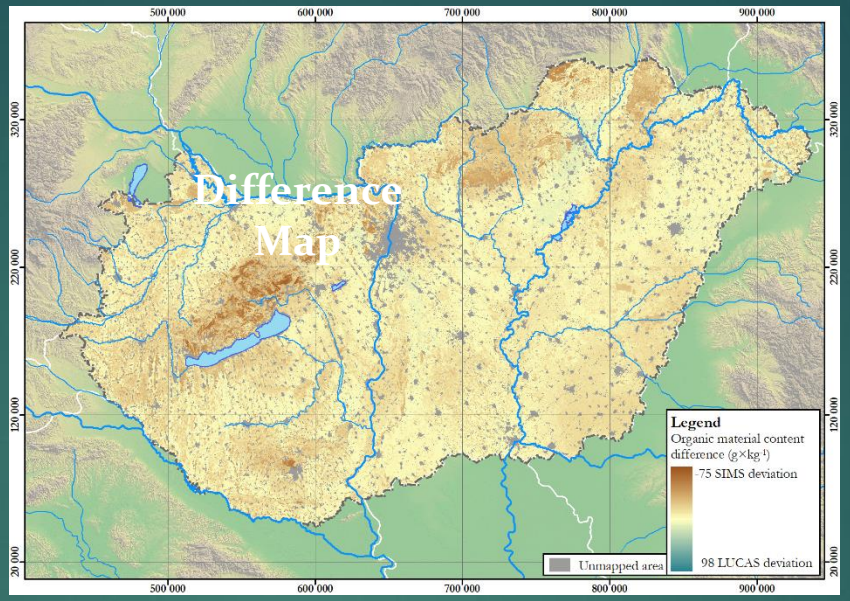
LUCAS based European maps (by ESDAC)

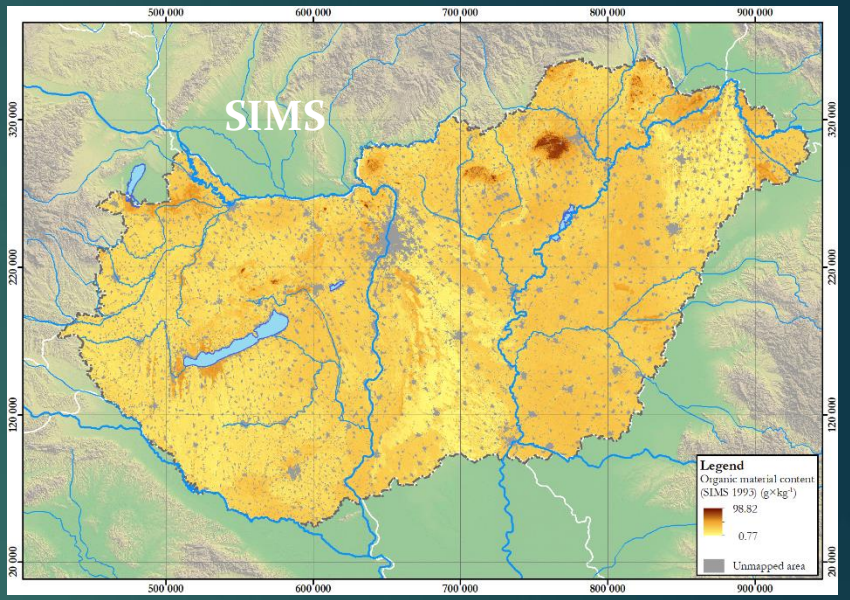
Evaluation indicators	Sand content	Silt content	Clay content	Organic carbon content	pH (H_2O)	$CaCO_3$ content
LUCAS based European maps (by ESDAC) validated by SIMS						
Average absolute difference	24.98	20.94	16.44	11.93	0.68	58.94
RMSE	21.68	15.93	10.51	17.24	0.86	100.10
LUCAS based national maps (by TAKI) validated by SIMS						
Average absolute difference	16.77	13.29	7.75	9.07	0.68	58.99
RMSE	21.82	16.64	10.00	12.11	0.84	98.58

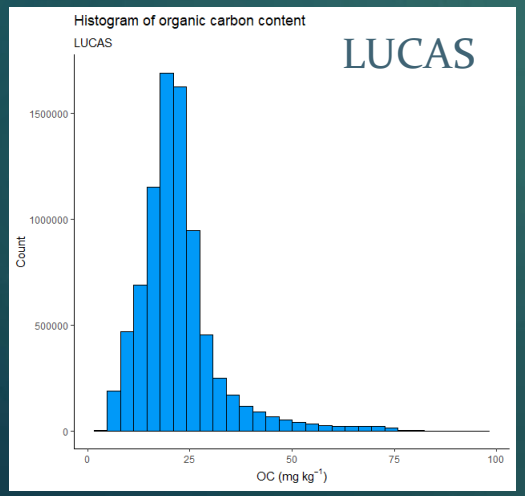
Comparing map products

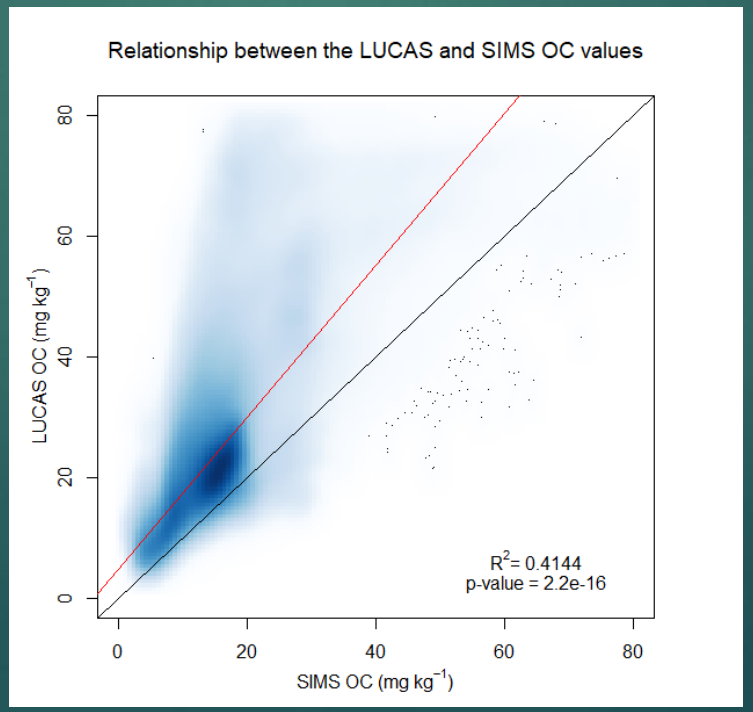
Example: *Soil Organic Matter Content*

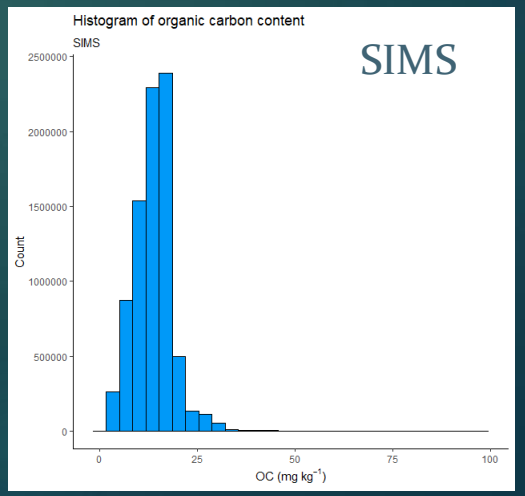




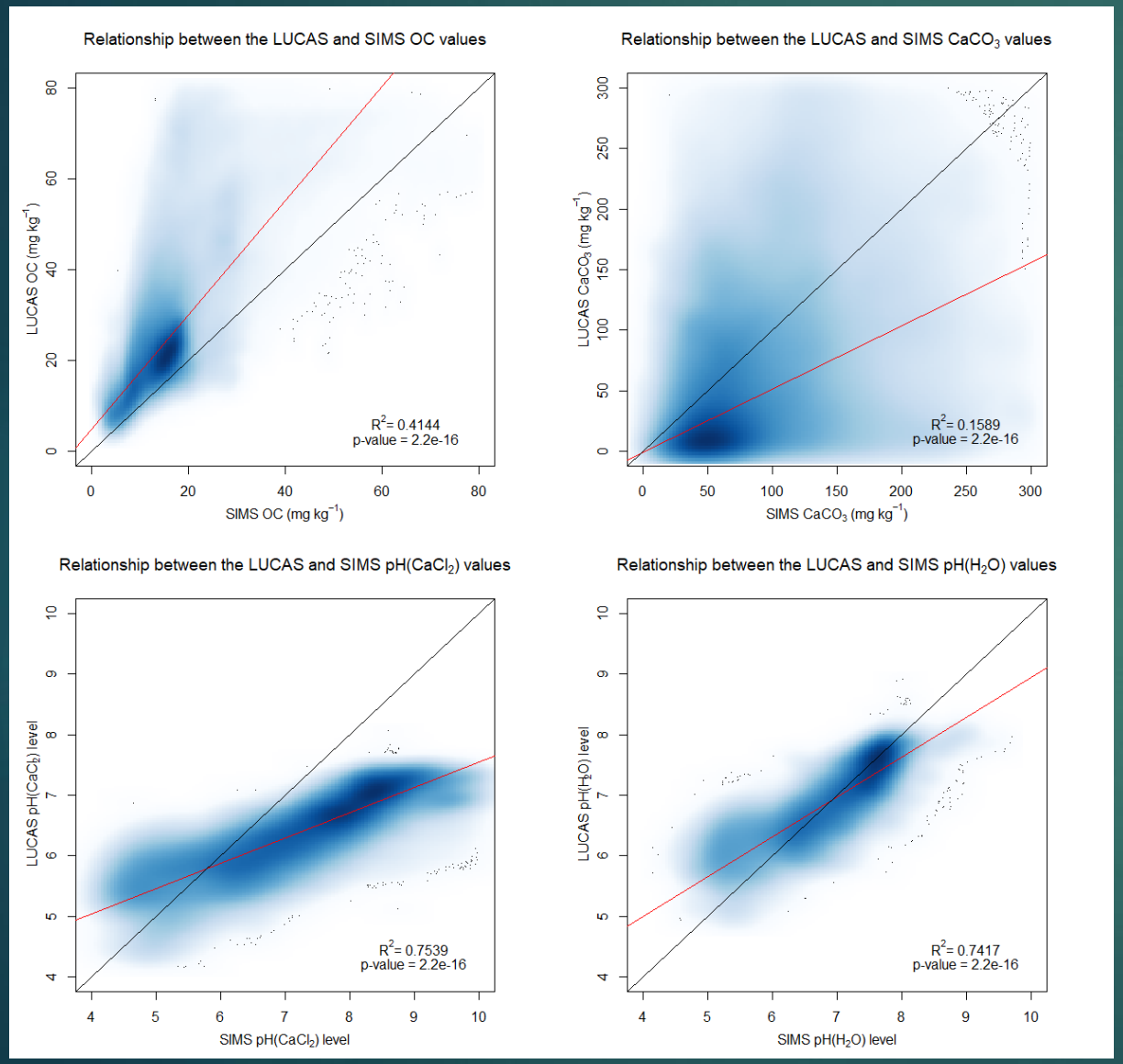


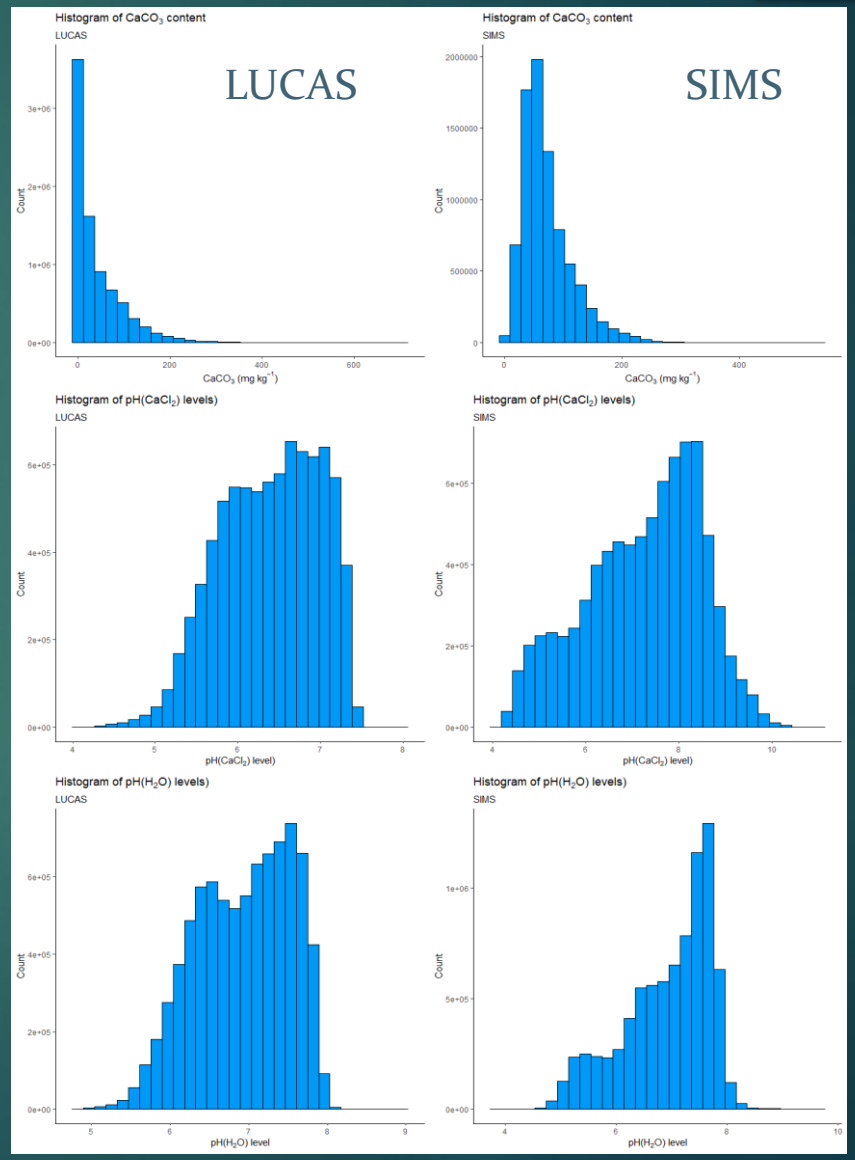






Comparing map products





$CaCO_3$

pH($CaCl_2$)

pH(H_2O)

Take home message

- Digital soil maps based on different observation datasets will definitely differ
- Decision on the reliability and applicability of DSM products should be based on careful consideration of the actually used observation and ancillary data together with the applied DSM method
- Initiative and hesitation on joint application of national and continental datasets

THANK YOU FOR YOUR KIND ATTENTION

International Decade of Soils 2015-2024