Object-oriented digital soil mapping for the support of Delineation of Areas with Natural Constraints

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Institute for Soil Sciences and Agricultural Chemistry
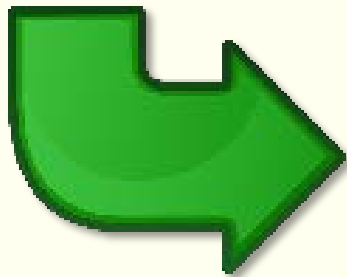Centre for Agricultural Research, Hungarian Academy of Sciences

INTRODUCTION

❏ Regional planning ➜ soil information demands

❏ Soil information systems and databases
- Primary and secondary soil properties
- Complex soil properties
- Unusual soil information

❖ Re-interpretation of soil information

❖ Integration of soil databases

❖ Applying digital soil mapping methods

AREAS WITH NATURAL CONSTRAINTS

Criteria	Threshold
CLIMATE	
CLIMATE AND SOIL	
S O I L	Limited soil drainage	Wet 80 cm > 6 months, or 40 cm > 11 months OR Poorly or very poorly drained OR Gleyic color pattern within 40 cm
	Unfavourable texture and stoniness	≥ 15% of topsoil volume is coarse material, rock outcrop, boulder
		Texture class in half or more (cumulatively) of the 100 cm soil surface is sand, loamy sand
		Topsoil texture class is heavy clay (≥ 60% clay)
		Organic soil (organic matter ≥ 30%) of at least 40 cm
		Topsoil contains 30% or more clay AND there are vertic properties within 100cm of the soil surface
	Shallow rooting depth	Rooting depth ≤ 30 cm
	Poor chemical properties	Salinity (electric conductivity) ≥ 4 dS/m in topsoil
		Sodicity ≥ 6 ESP in half or more of the 100 cm surface layer
		Soil acidity topsoil pH (H_2O) ≤ 5
TOPOGRAPHY	

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(left margin label: SOIL)

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SOIL

Soil information systems

DKSIS

☐ Digital Kreybig Soil Information System
- Polygon database: physical and chemical soil properties in classified form
- Profile database: physical and chemical soil properties on layer level (~250,000 points)

SIMS

☐ Hungarian Soil Information and Monitoring System
- Profile database: physical and chemical soil properties on layer level (1,234 points)

MARTHA

☐ Hungarian Detailed Soil Hydrophysical Database
- Profile database: physical and chemical soil properties on layer level (3,937 points)

SANDINESS

☐ Texture class in half or more (cumulatively) of the 100 cm soil surface is sand, loamy sand

Particle size classes in SIMS	
clay	<0.002 mm
silt	0.002–0.05 mm
sand	0.05–2.0 mm

SIMS

Log linear interpolation (Nemes et al. 1999)

Particle size classes by FAO	
clay	<0.002 mm
silt	0.002–0.063 mm
sand	0.063–2.0 mm

C=clay
I=silt
L=loam
S=sand
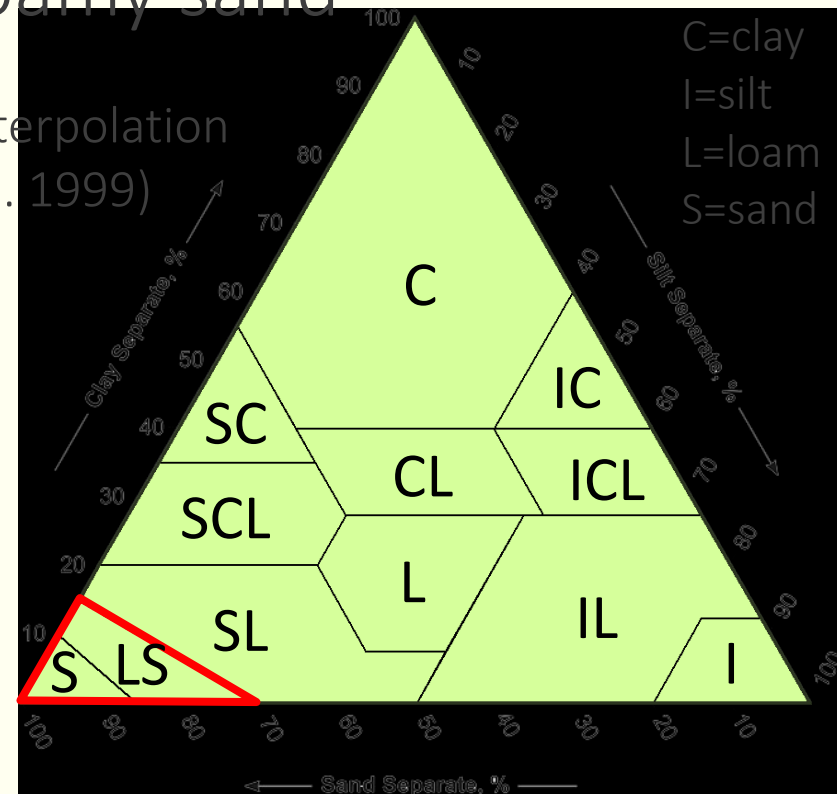
VERTIC PROPERTIES

❑Vertic properties:
- Wedge-shaped aggregates
- Slickensides
- Cracks, that open and close periodically

❑No direct measurements, just field observations

DKSIS Notes of the profile descriptions

⮕ binary parameter

SALINITY

❑ Based on electric conductivity

❑ EC ≥ 4 dS/m in subsoil

❑ No direct measurements in Hungarian databases

estimation
(Filep and Wafi 1993)

MARTHA **+** DKSIS

$$EC_e = \left(\dfrac{TSC}{SP}\right) \times 0.797$$

EC_e= electric conductivity; TSC= total salt content [%]; SP= saturation percentage [%]

AUXILIARY DATA

Topography: EU-DEM, derivatives (slope, aspect, TWI, MBI...)

Climate: temperature, precipitation, evaporation, ET

Satellite: spring and autumn R,NIR,NDVI CORINE Land Cover (1:50,000)

Geological map (1:100,000)

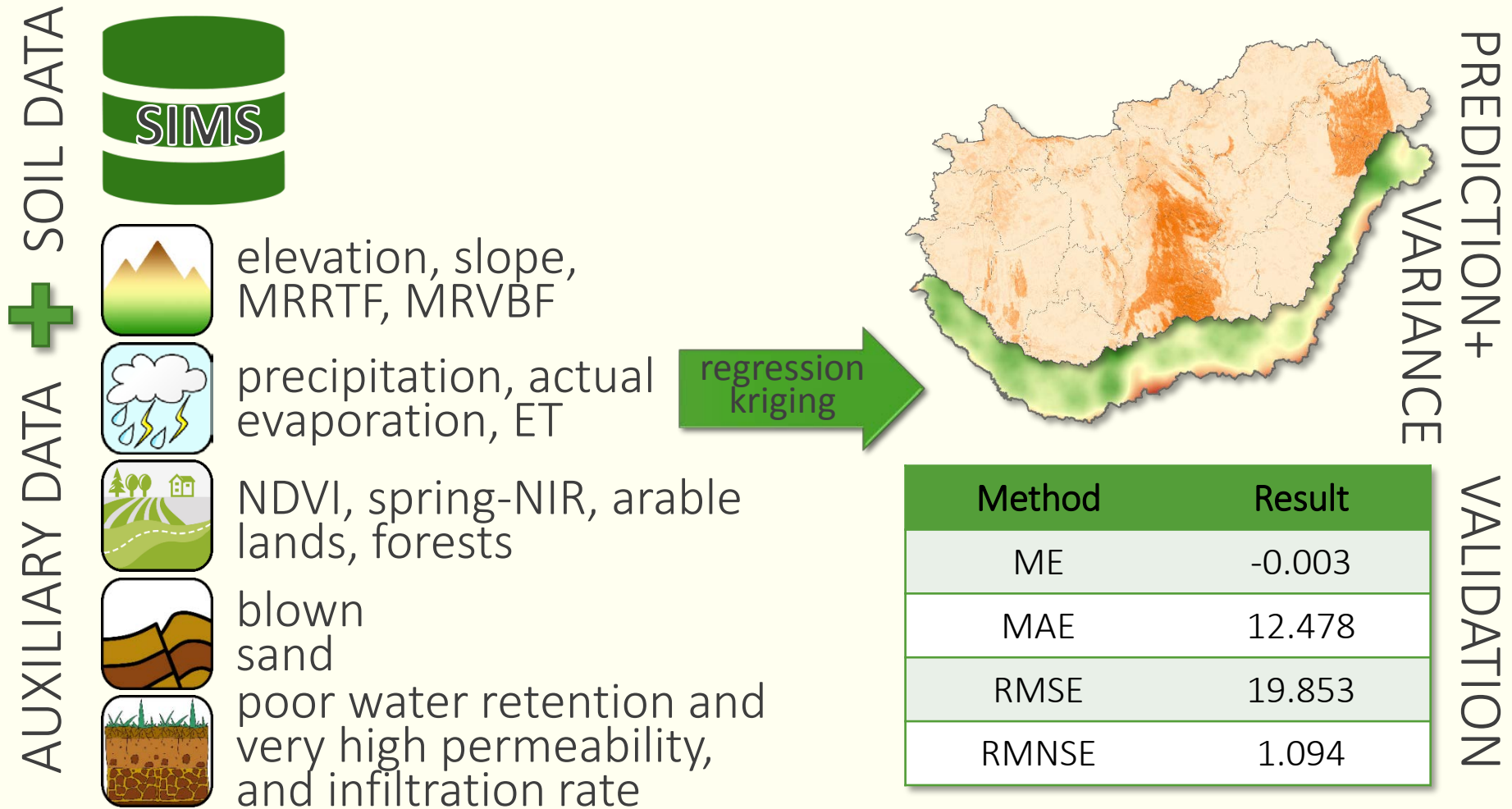DKSIS: soil physics and chemistry maps Genetic soil type map (100 m)
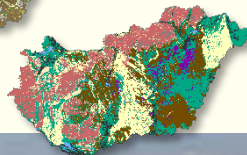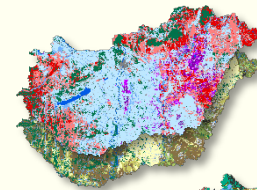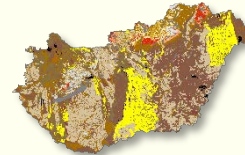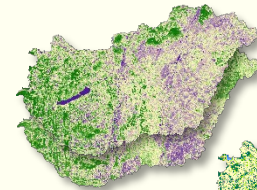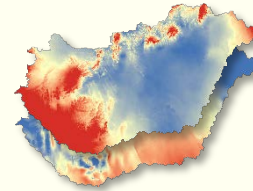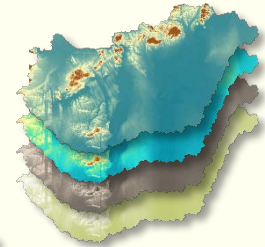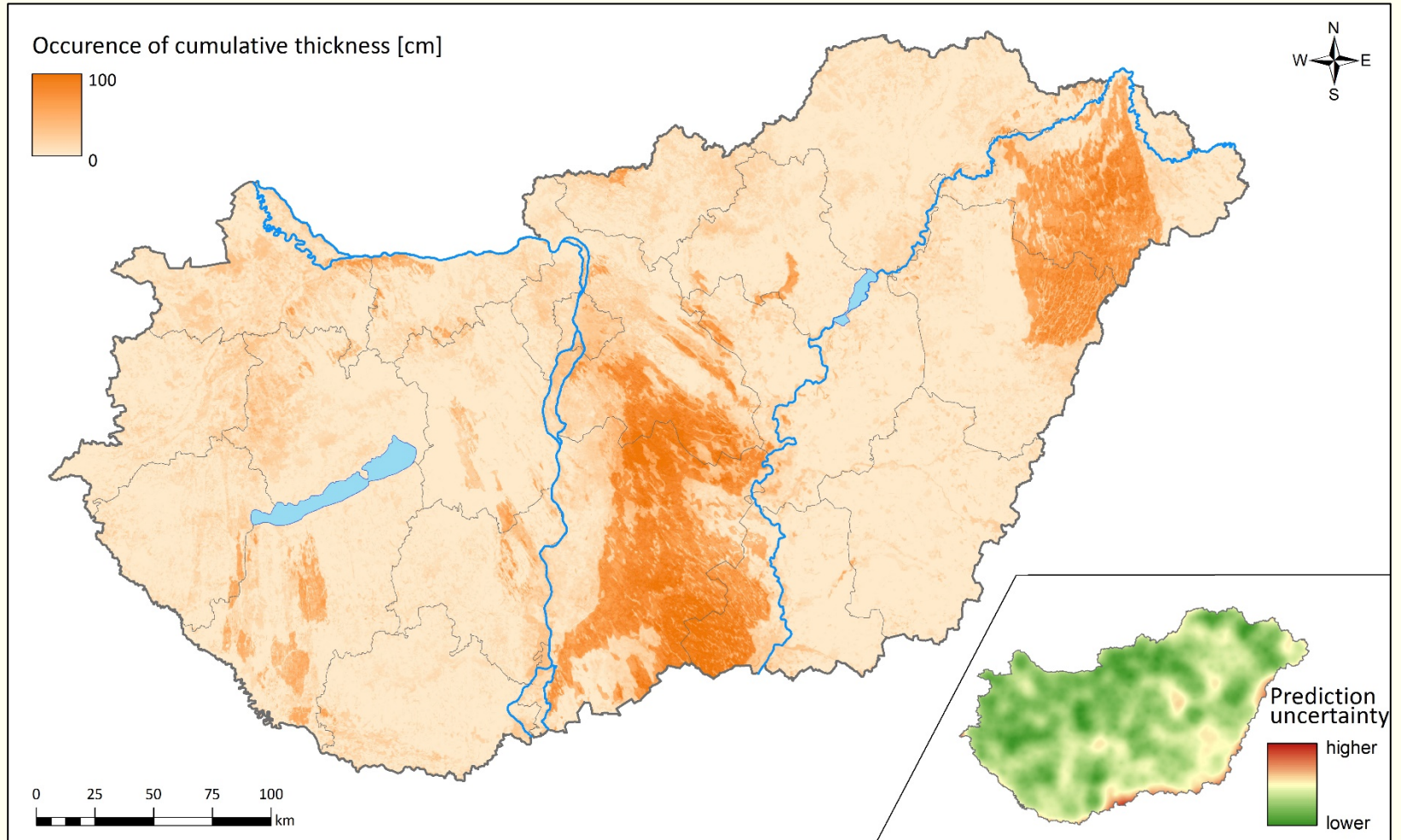
Spatial inference

❑Principal component analysis

❑Regression kriging

❑Validation: Leave-One-Out Cross Validation
- Mean error (ME)
- Mean absolute error (MAE)
- Root mean square error (RMSE)
- Root mean normalized square error (RMNSE)

COMPILATION OF THE MAP OF SANDINESS

SOIL DATA

AUXILIARY DATA

SIMS

elevation, slope, MRRTF, MRVBF

precipitation, actual evaporation, ET

NDVI, spring-NIR, arable lands, forests

blown sand

poor water retention and very high permeability, and infiltration rate

regression kriging

PREDICTION+ VARIANCE

VALIDATION

Method	Result
ME	-0.003
MAE	12.478
RMSE	19.853
RMNSE	1.094

COMPILATION OF THE MAP OF SANDINESS

COMPILATION OF THE MAP OF VERTIC PROPERTIES

SOIL DATA

DKSIS

+ AUXILIARY DATA

NDVI, NIR, RED

aspect, TWI, SAGA wetness index, MRRTF, MRVBF, diurnal anisotropic heating

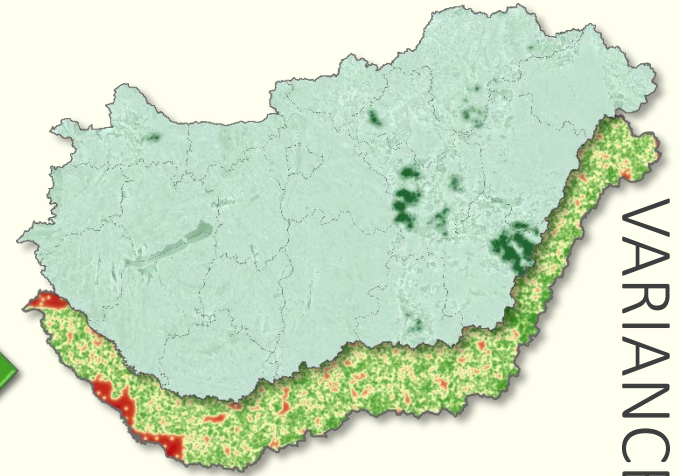temperature, precipitation, actual evaporation, ET

good and high water retention, saline soils, peaty soils
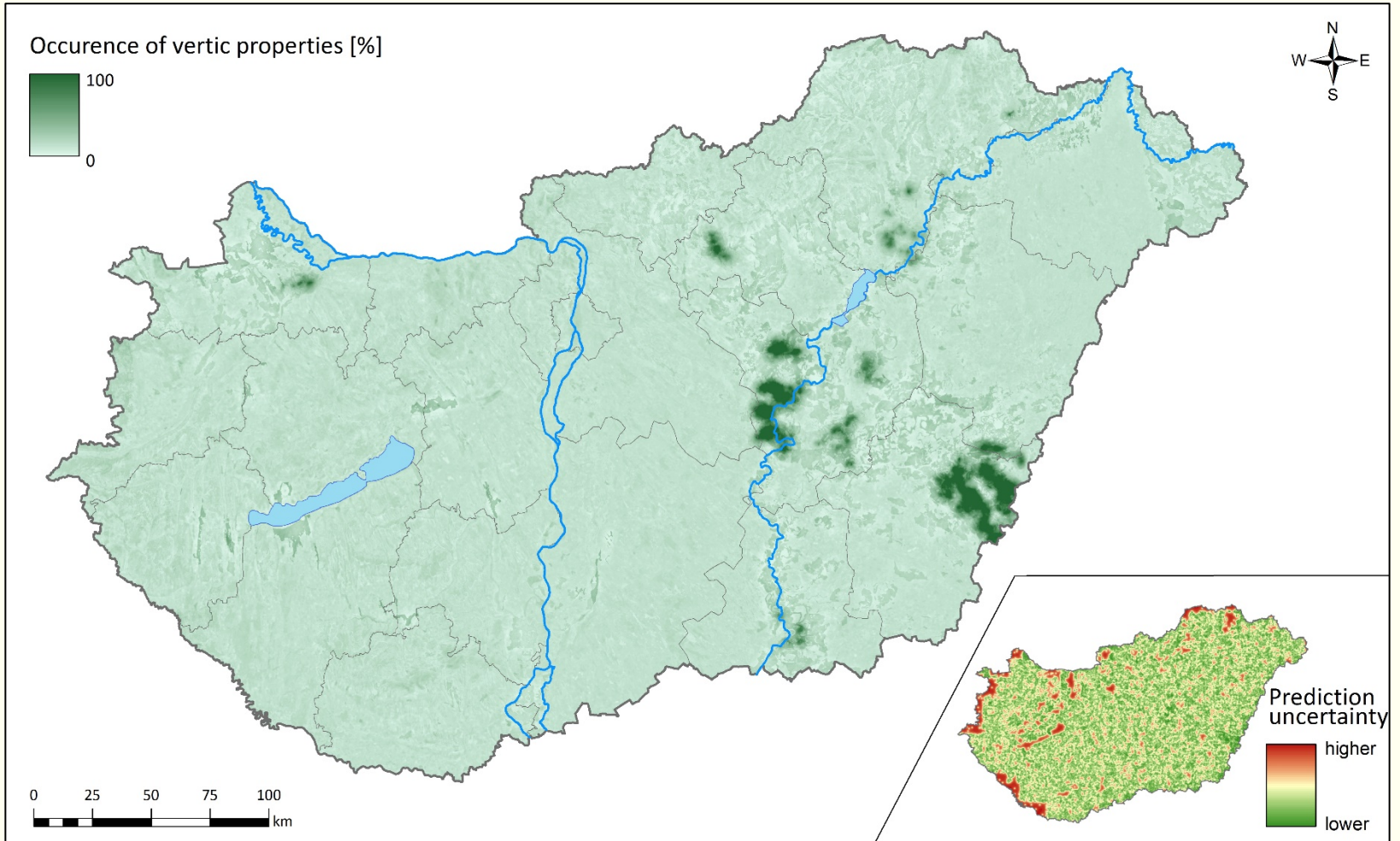
regression kriging

PREDICTION+VARIANCE

VALIDATION

Fulfilled criterion	predicted	
observed	Yes (1)	No (0)
Yes (1)	34.8	1.8
No (0)	1.2	62.2

COMPILATION OF THE MAP OF VERTIC PROPERTIES

COMPILATION OF THE MAP OF SALINITY

SOIL DATA — MARTHA, DKSIS

+ AUXILIARY DATA

SAGA wetness index, MRRTF, MRVBF

precipitation, actual evaporation

autumn-NDVI, grasslands, sparse vegetation

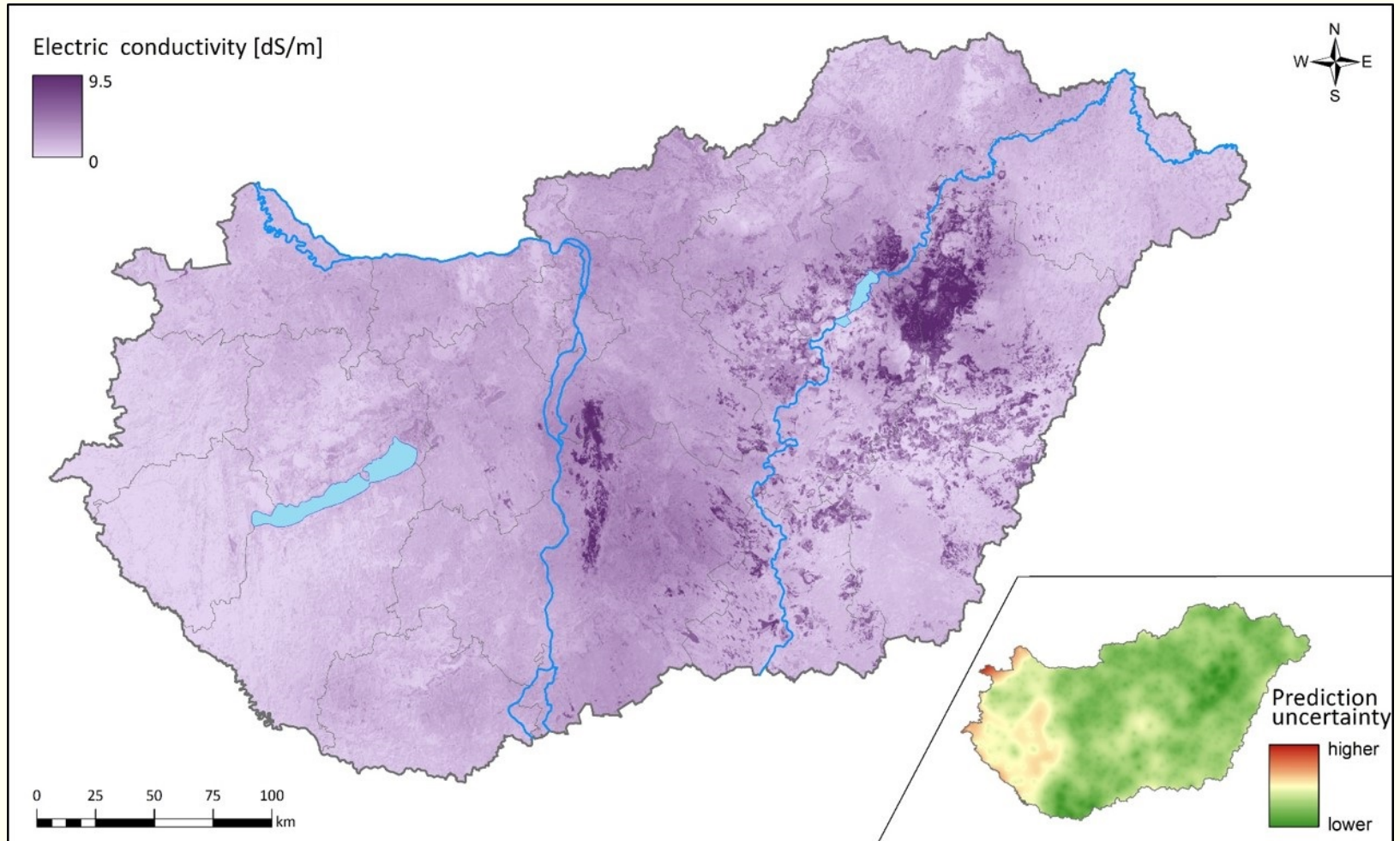saline soils, neutral and calcic soils

regression kriging

PREDICTION+ VARIANCE
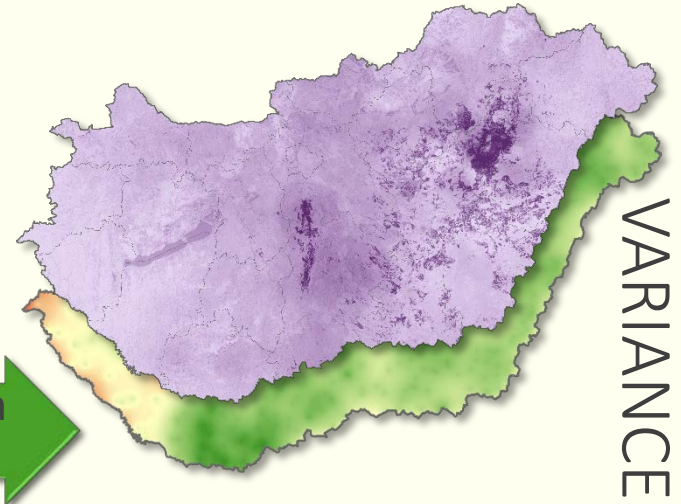
VALIDATION

| method	result
ME	0.010
MAE	0.850
RMSE	1.430
RMNSE	0.935

COMPILATION OF THE MAP OF SALINITY

Conclusion
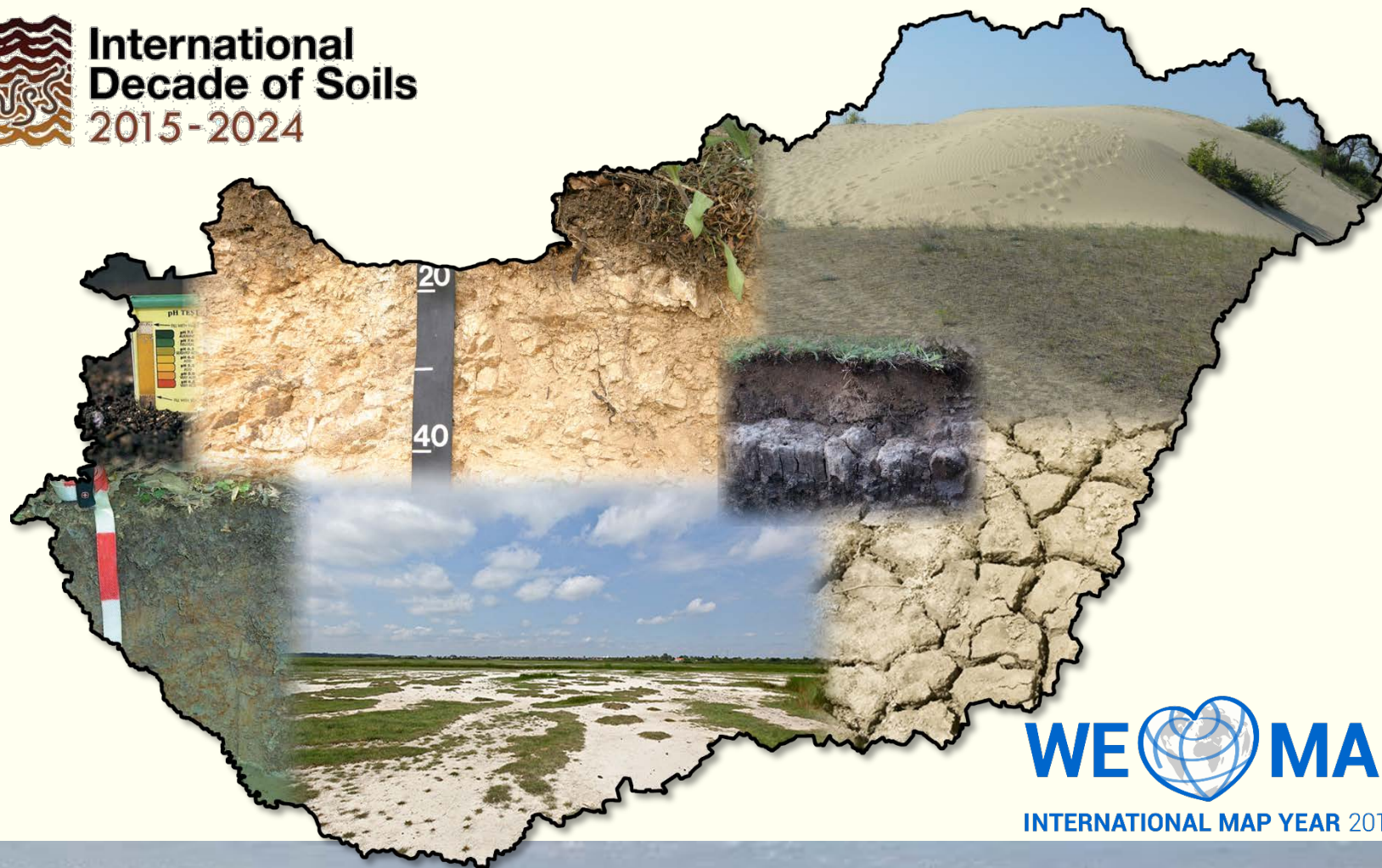
❑Reliable and nationwide maps were produced on specific soil features, which were not mapped formerly

❑The compiled new maps can satisfy the need of designation of Areas with Natural Constraints

❑Our approach can be also applied by other tasks of regional planning

THANK YOU FOR YOUR KIND ATTENTION!
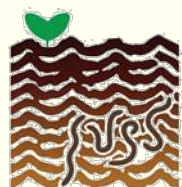
International Decade of Soils
2015-2024

WE ♥ MAPS
INTERNATIONAL MAP YEAR 2015–2016