



Renewal of national soil water management category system and legacy map by data mining methods, digital primary and hydrological soil property maps

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Grouping of soils based on their hydrological properties



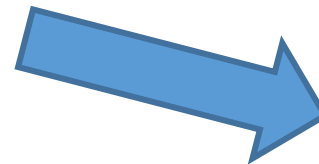
Hydrologic Soil Groups most often defined based on:

- Infiltration rate (or saturated hydraulic conductivity)
 - In case of no measured data → derived from: soil texture, bulk density, soil organic carbon content, type of clay minerals
- Depth to water table
- Depth to water impermeable layer

Expert based rules

Available method for Hungary:

- definition of soil water management categories (Várallyay et al. 1980) defined by **expert based rules** considering:
 - Water content at field capacity (FC)
 - Water content at wilting point (WP)
 - Plant available water content (AWC)
 - Saturated hydraulic conductivity (KS)
 - Infiltration rate (IR)



Aim of the research: to renew soil water management classification

- based on primary and hydraulic soil information and
- using data mining tools.

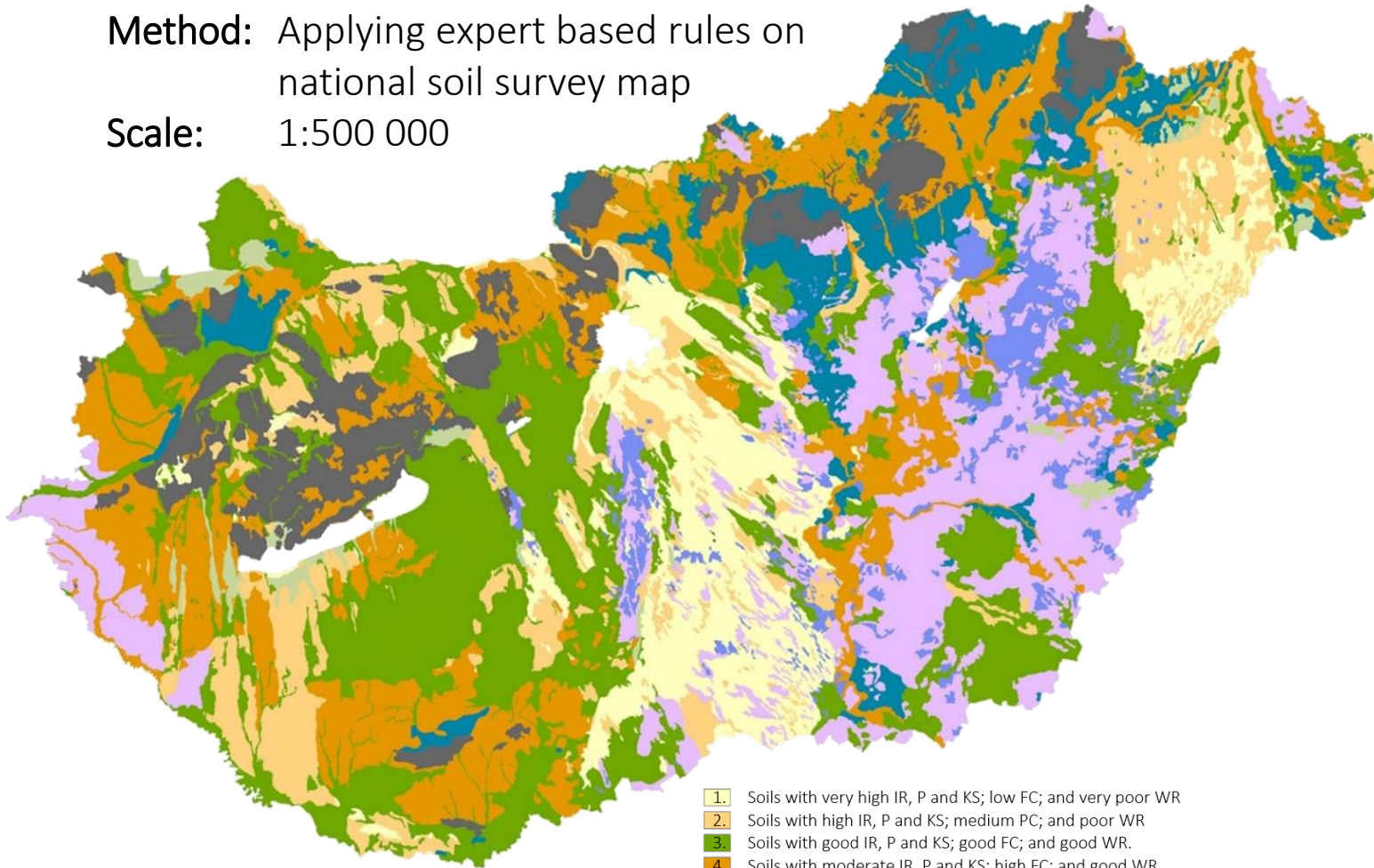
Map of soil water management categories – available

Várallyay et al. 1980



Method: Applying expert based rules on national soil survey map

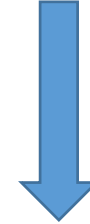
Scale: 1:500 000



1. Soils with very high IR, P and KS; low FC; and very poor WR
2. Soils with high IR, P and KS; medium PC; and poor WR
3. Soils with good IR, P and KS; good FC; and good WR.
4. Soils with moderate IR, P and KS; high FC; and good WR.
5. Soils with moderate IR, poor P and KS; high PC and high WR.
6. Soils with unfavourable water management: low IR, extremely high WR.
7. Soils with extremely unfavourable water management
8. Soils with good IR, P and HC; and very high FC.
9. Soils with extreme moisture regime due to shallow depth.

Soil hydraulic properties **assigned** to soil texture classes and soil types:

- infiltration rate (IR)
- permeability (P)
- hydraulic conductivity (KS)
- field capacity (FC)
- water retention (WR)



Soil hydraulic properties included in national soil hydraulic datasets and maps:

- water content at saturation (THS)
- water content at field capacity (FC)
- water content at wilting point (WP)
- plant available water capacity (AWC)
- saturated hydraulic conductivity (KS)

Unsupervised clustering of soil hydraulic properties



Input dataset for deriving clusters:

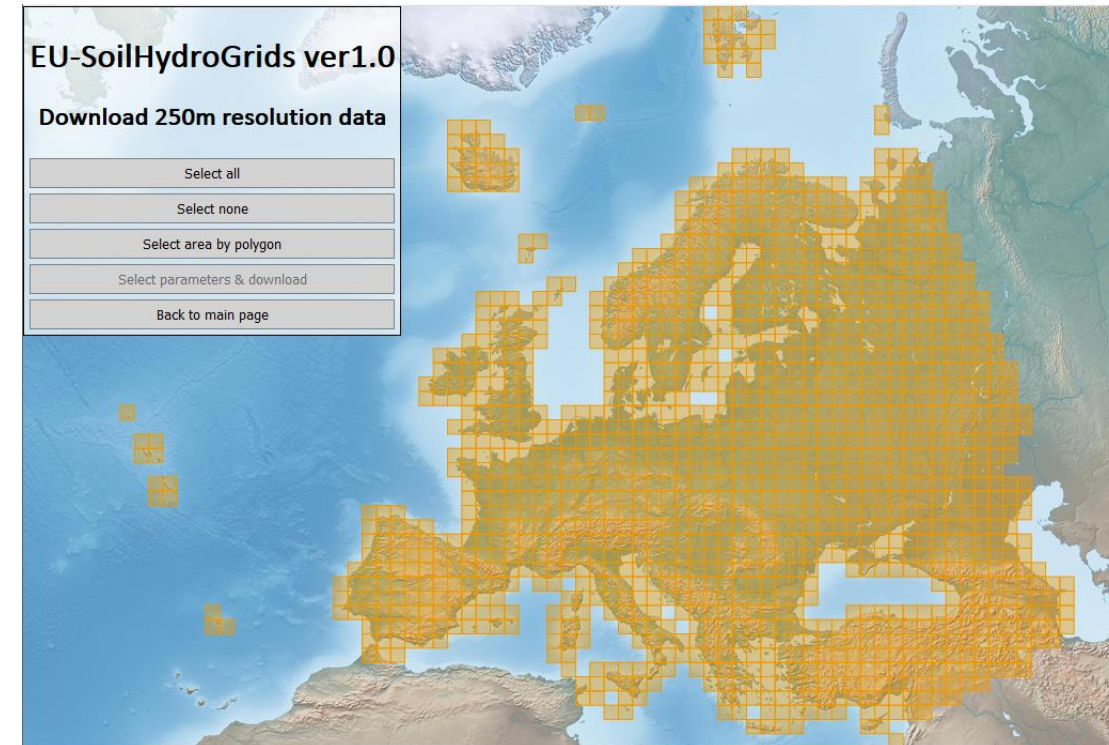
1. EU-SoilHydroGrids dataset for Hungary —→ **computed**
2. Hungarian Detailed Soil Hydrophysical Dataset (MARTHA) —→ **measured**

Soil hydraulic properties considered for the clustering:

- Water content at saturation (THS)
- Water content at field capacity (FC)
- Water content at wilting point (WP)
- Plant available water capacity (AWC)
- Saturated hydraulic conductivity (KS)

Method:

- K-means clustering
- For MARTHA dataset: analysis on splined soil hydraulic data (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)



EU-SoilHydroGrids

→ <https://eusoilhydrogrids.rissac.hu/250.php>

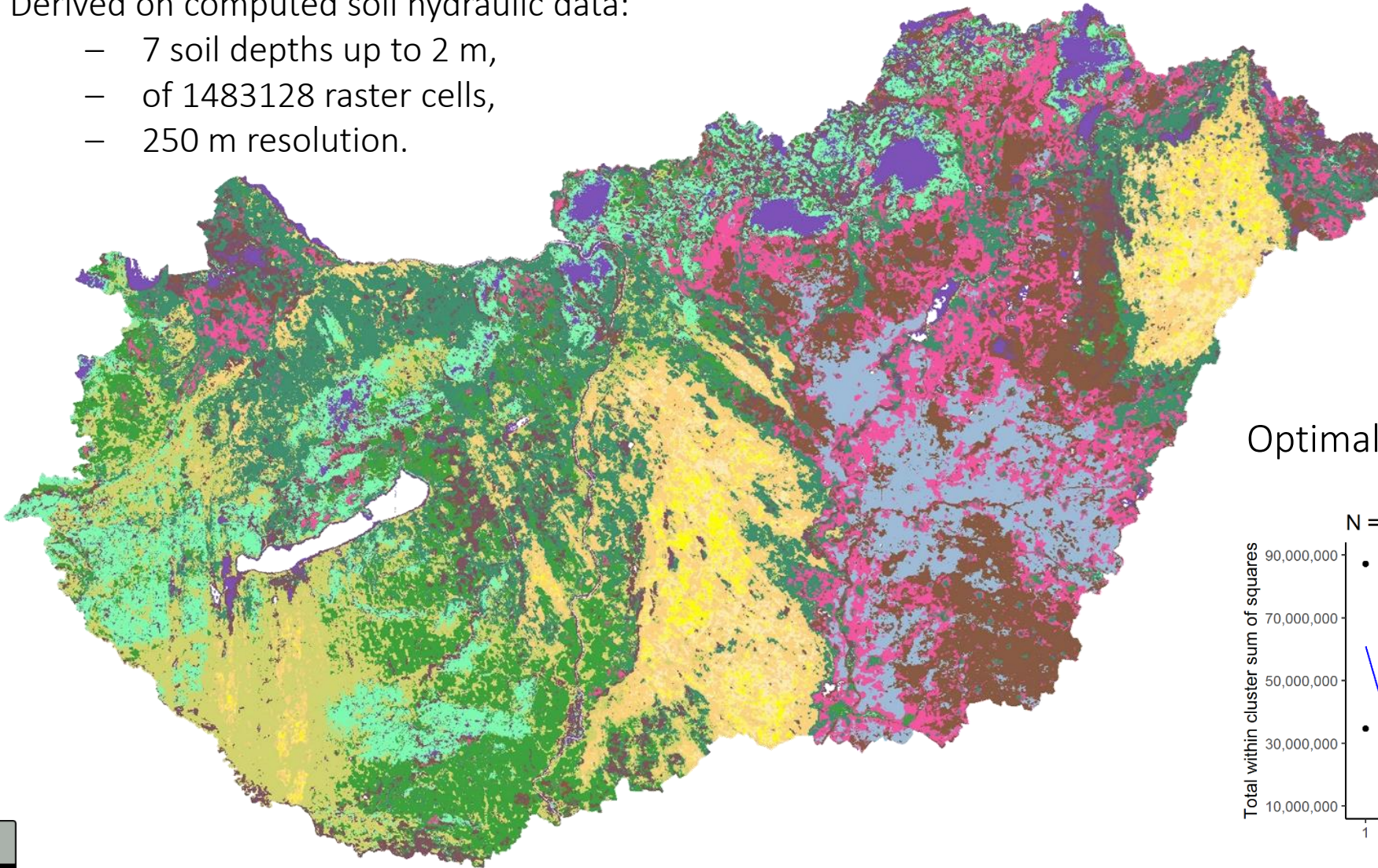
→ <https://esdac.jrc.ec.europa.eu/content/3d-soil-hydraulic-database-europe-1-km-and-250-m-resolution>

1. Unsupervised clustering of EU-SoilHydroGrids for Hungary

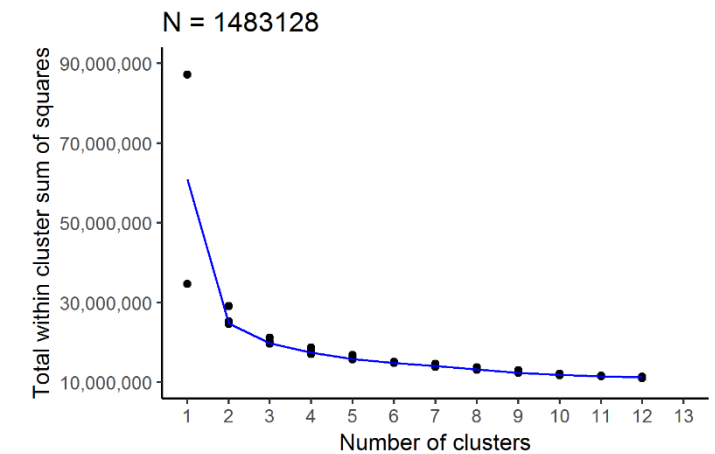


Derived on computed soil hydraulic data:

- 7 soil depths up to 2 m,
- of 1483128 raster cells,
- 250 m resolution.



Optimal number of clusters: 12

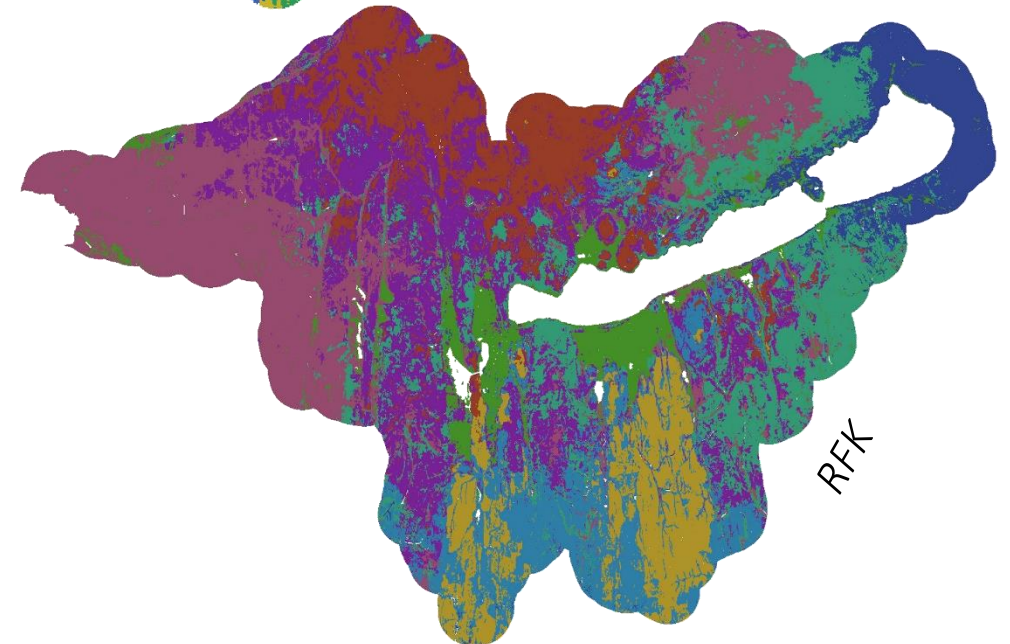
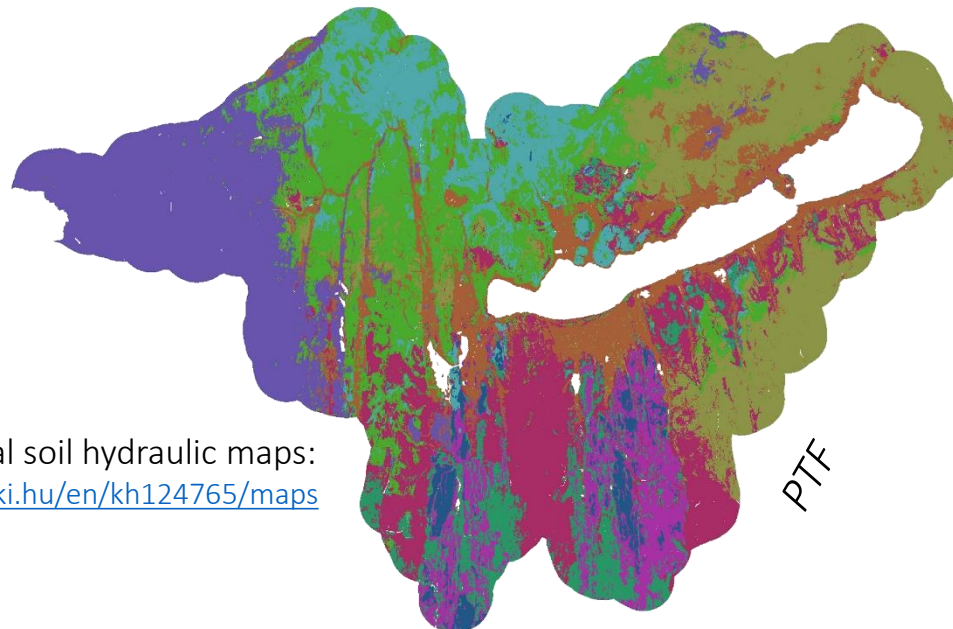
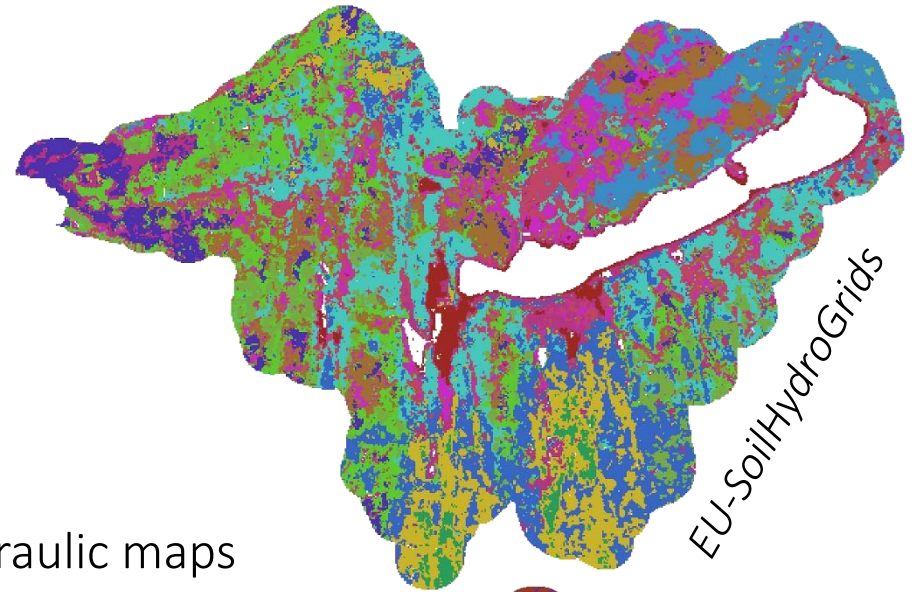


1. Unsupervised clustering on a study site – importance of local data



Unsupervised clustering on Balaton catchment using computed soil hydraulic dataset:

- a) open access EU-SoilHydroGrids dataset
- b) local, significantly more accurate data:
 - pedotransfer function based maps (PTF) and
 - random forest and kriging (RFK) based soil hydraulic maps



Availability of local soil hydraulic maps:
<https://www.mta-taki.hu/en/kh124765/maps>

2. Unsupervised clustering of the Hungarian Detailed Soil Hydrophysical Database



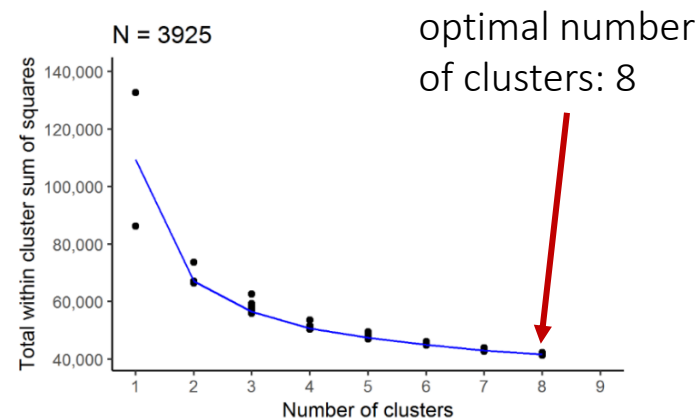
Splined values to 0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm:

- Water content at saturation (THS)
- Water content at field capacity (FC)
- Water content at wilting point (WP)
- Plant available water capacity (AWC)
- Saturated hydraulic conductivity (KS)

Descriptive statistics of the splined soil hydraulic properties.

Soil hydraulic property	Number of samples	Mean	SD	Median	Minimum	Maximum	Range
Water content at saturation (cm ³ cm ⁻³)	20368	0.470	0.062	0.469	0.259	0.911	0.651
Water content at field capacity (cm ³ cm ⁻³)	19913	0.319	0.077	0.323	0.100	0.676	0.576
Water content at wilting point (cm ³ cm ⁻³)	20430	0.169	0.076	0.165	0.000	0.499	0.499
Available water capacity (cm ³ cm ⁻³)	20217	0.145	0.055	0.145	0.000	0.620	0.620
Saturated hydraulic conductivity (log ₁₀ (cm day ⁻¹))	4917	1.02	1.02	0.92	-3.00	3.96	6.96

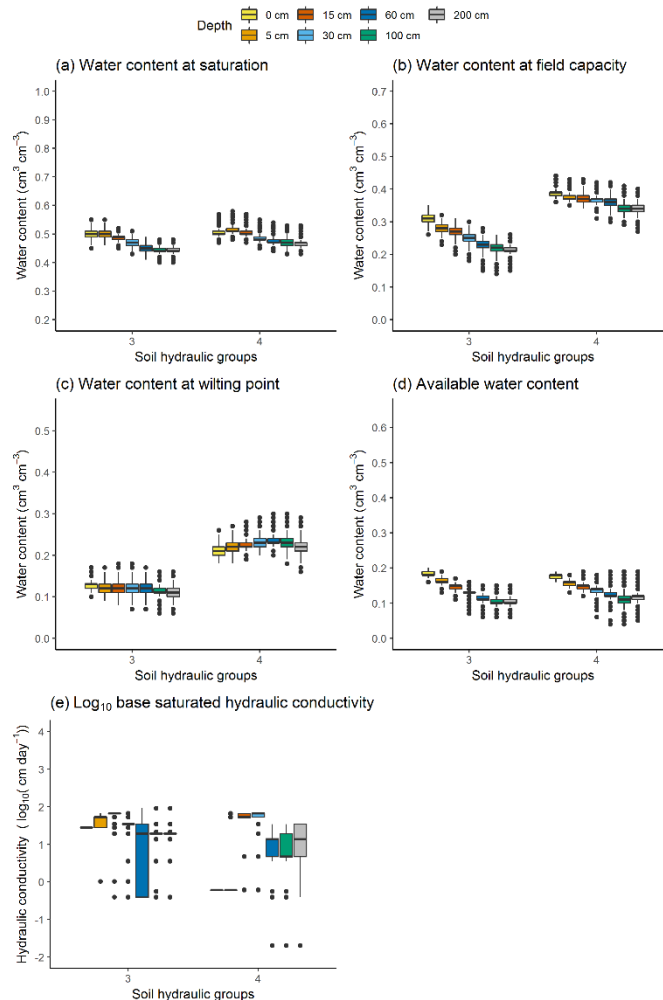
K-means clustering:



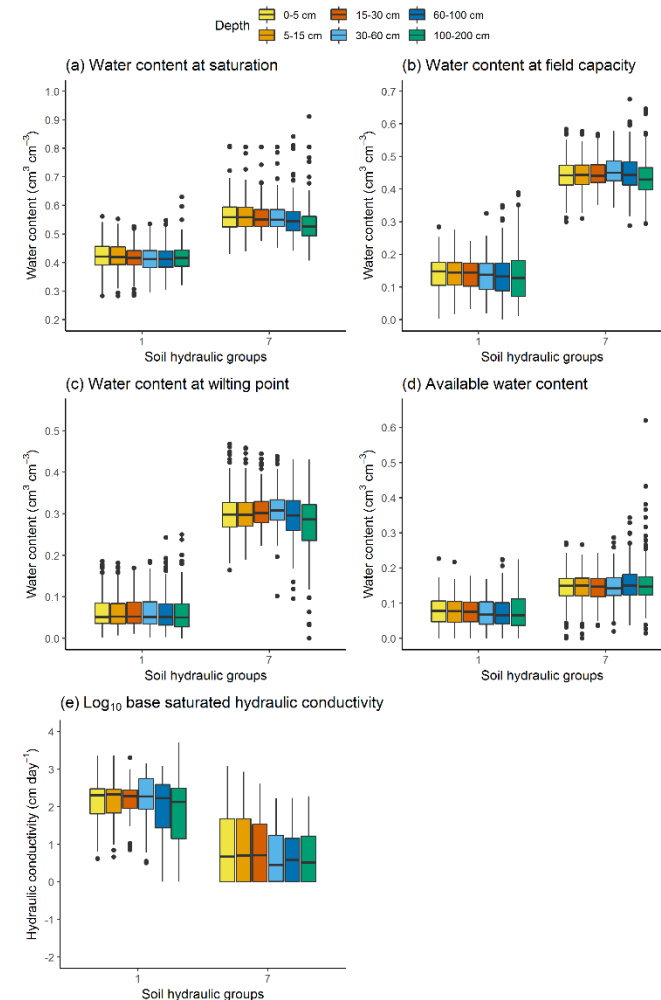
Unsupervised clustering – comparison of clusters based on computed vs. measured values



Selected clusters from the analysis of the
EU-SoilHydroGrids dataset (computed values)



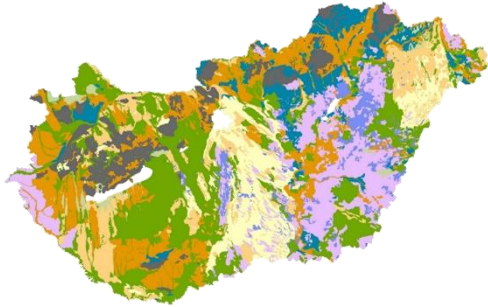
Selected clusters from the analysis of the
MARTHA dataset (measured values)



Supervised clustering of EU-SoilHydroGrids for Hungary

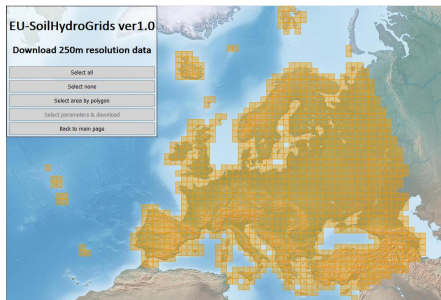


Map of soil water management categories – Várallyay et al. (1980)



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a) EU-SoilHydroGrids dataset

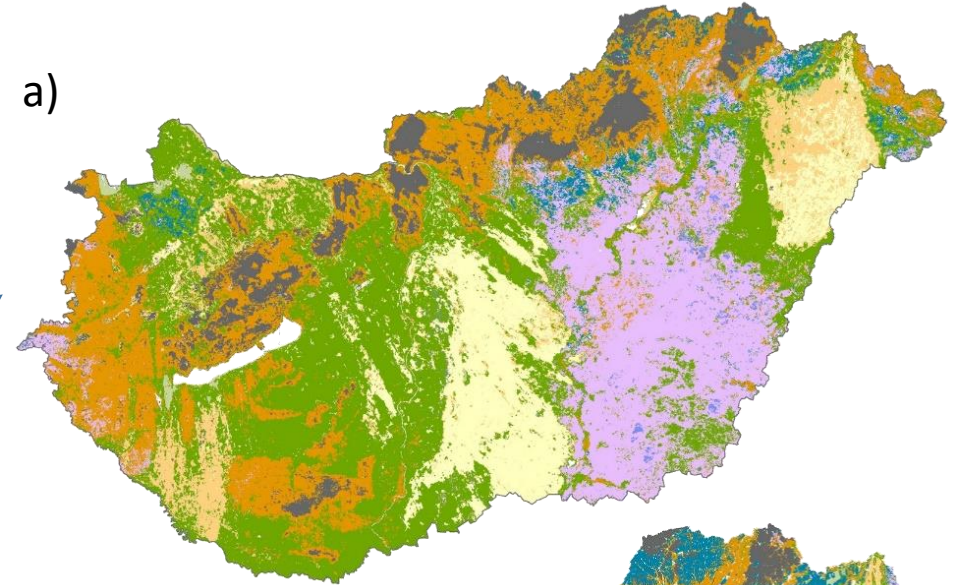


b) National soil property maps: organic carbon content, particle size distribution, ...
<http://dosoremi.hu/>

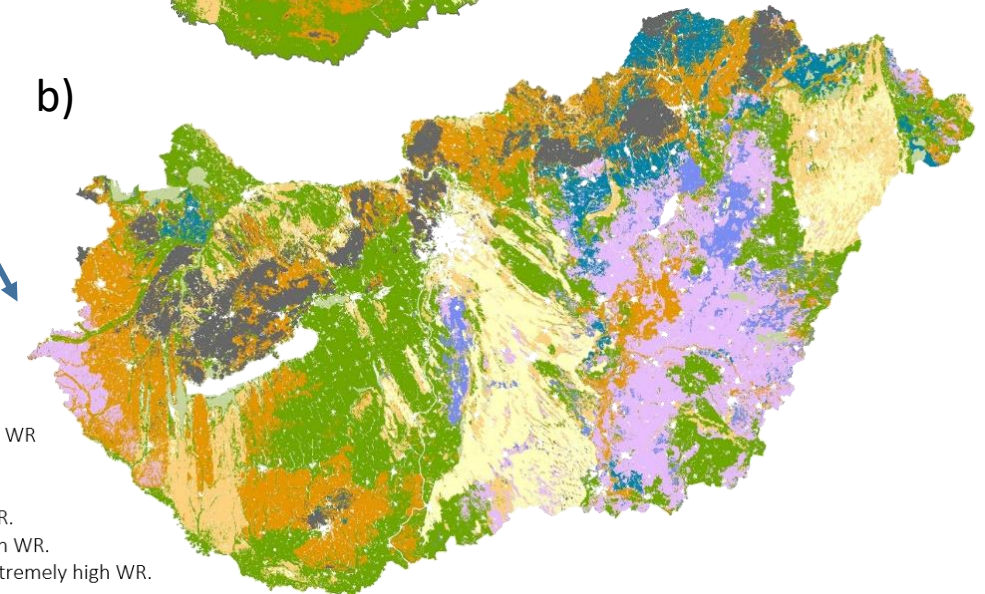
Random forest analysis:

- on several random sampling realization
- selecting most probable class

a)



b)



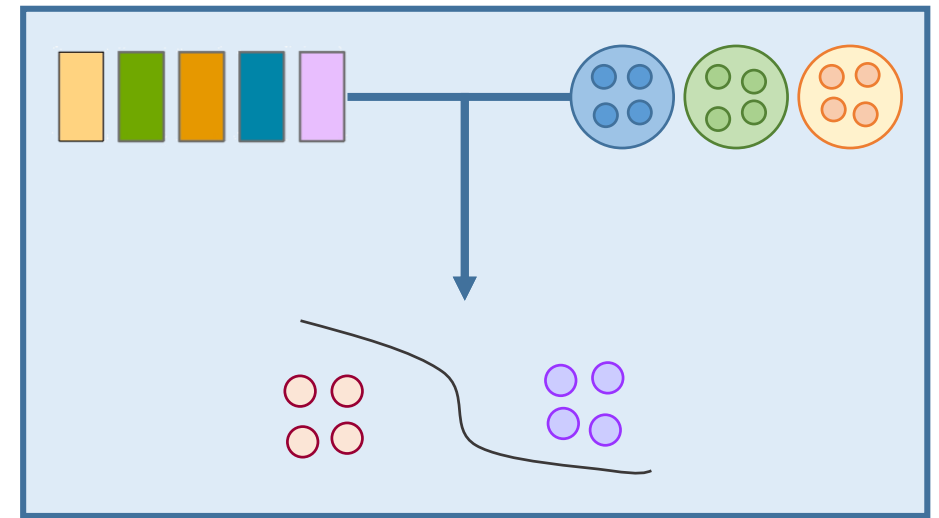
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Conclusions and outlook

The renewal of the category system of soil water management types could be based on measured soil hydraulic properties.

For distinguishing soils with extreme soil moisture regime unsupervised classification method could be combined with expert based rules.

Soil classes derived by the unsupervised clustering needs to be analysed from soil hydrological point of view.



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Thank you for your attention!