Food and Agriculture Organization of the United Nations

GLOBAL SYMPOSIUM ON SOIL INFORMATION AND DATA

MEASURE
MONITOR
MANAGE

Space-time modelling of soil organic carbon stock change at multiple scales
- Case study from Hungary -

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Introduction

- Many national and international initiatives are interested in the spatial and temporal variation of SOC at various scales.

- We are often asked, e.g.,
  - How much SOC is stored in the topsoils?
  - How much SOC is stored on average in grasslands?
  - How SOC stock has changed for a given time period in arable lands? Was this change significant?

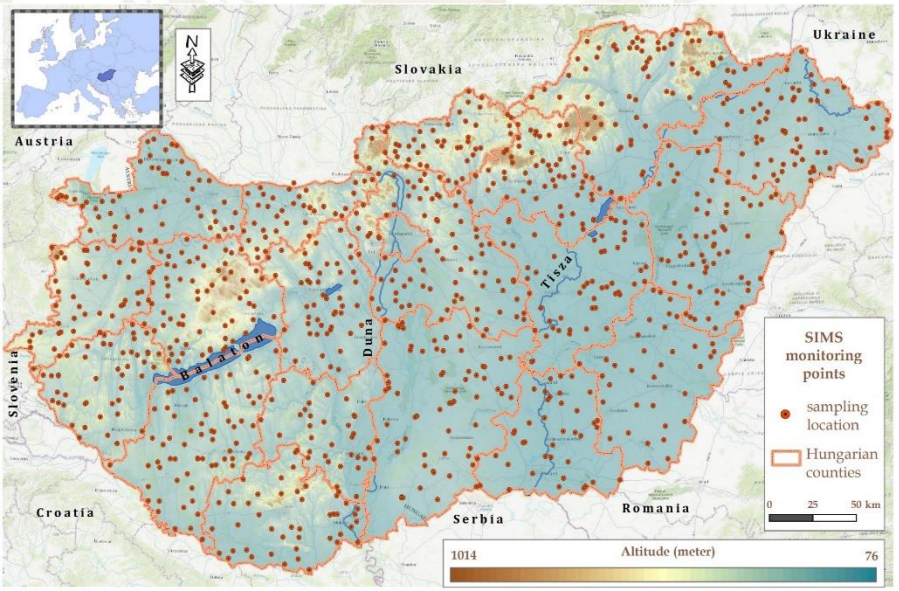
- We want to answer these questions to the best of our knowledge

Aims of the research

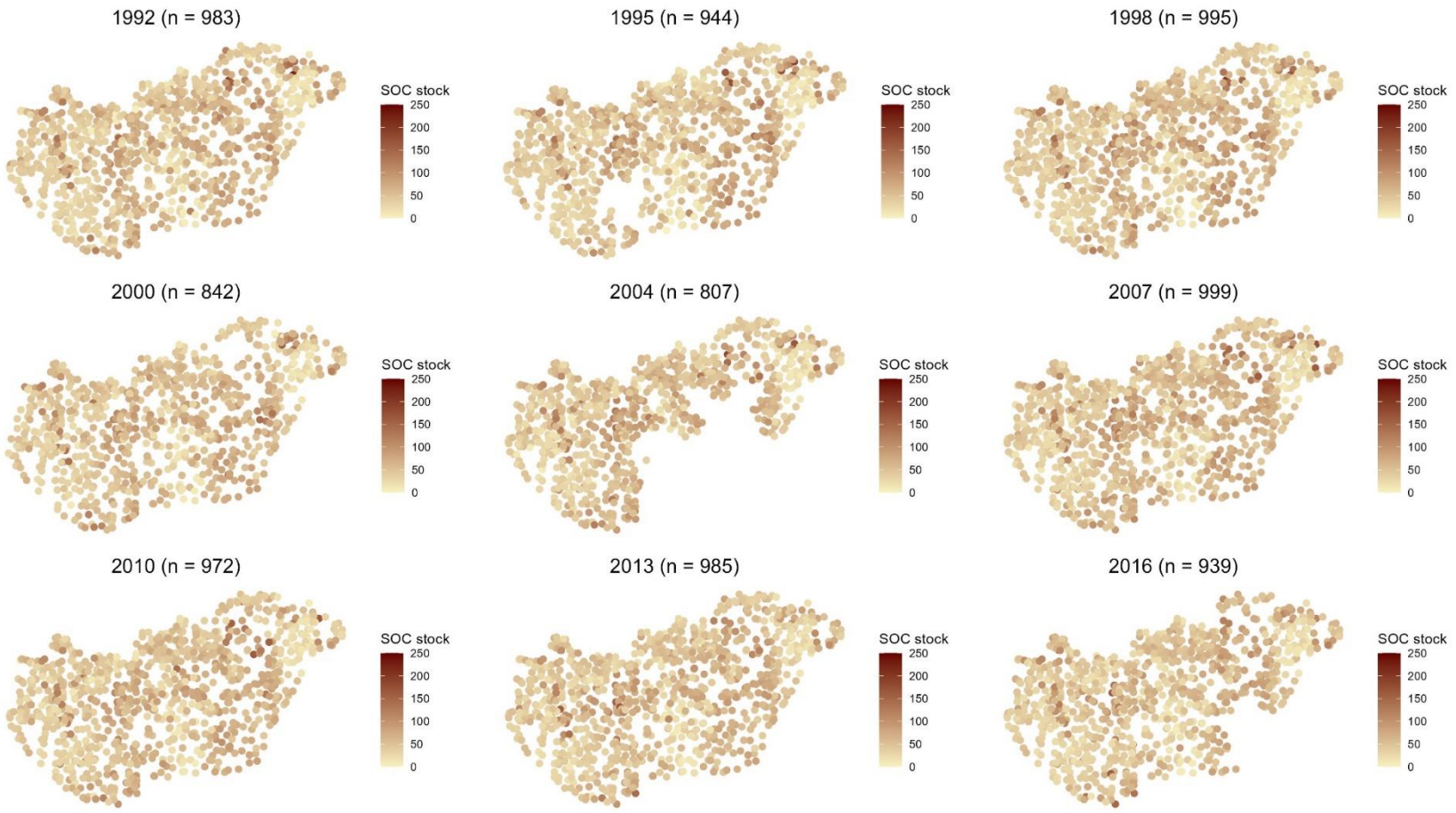
The objective of our study was

- **to predict the SOC stock for a 25-year long period (1992–2016) in Hungary at multiple aggregation levels**
- **to quantify the uncertainty associated with our predictions**
- **to identify and delimit areas with statistically significant SOC stock change**

Hungarian Soil Information and Monitoring System



Studied period
1992-2016



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Environmental covariates

Static in time:

- Parent material
- Topography and many of its derivatives (slope, aspect, etc.)

Dynamic in time (1992–2016):

- Climate (seasonal temperature, precipitation, etc.)
- Land use, land cover
- Satellite images (Landsat) and derived indicies (NDVI, etc.)

62 covariates in total

Some methodological challenges

Interdependency in space and time

- SOC stock data are interdependent not just in space but also in time and this should be taken into account

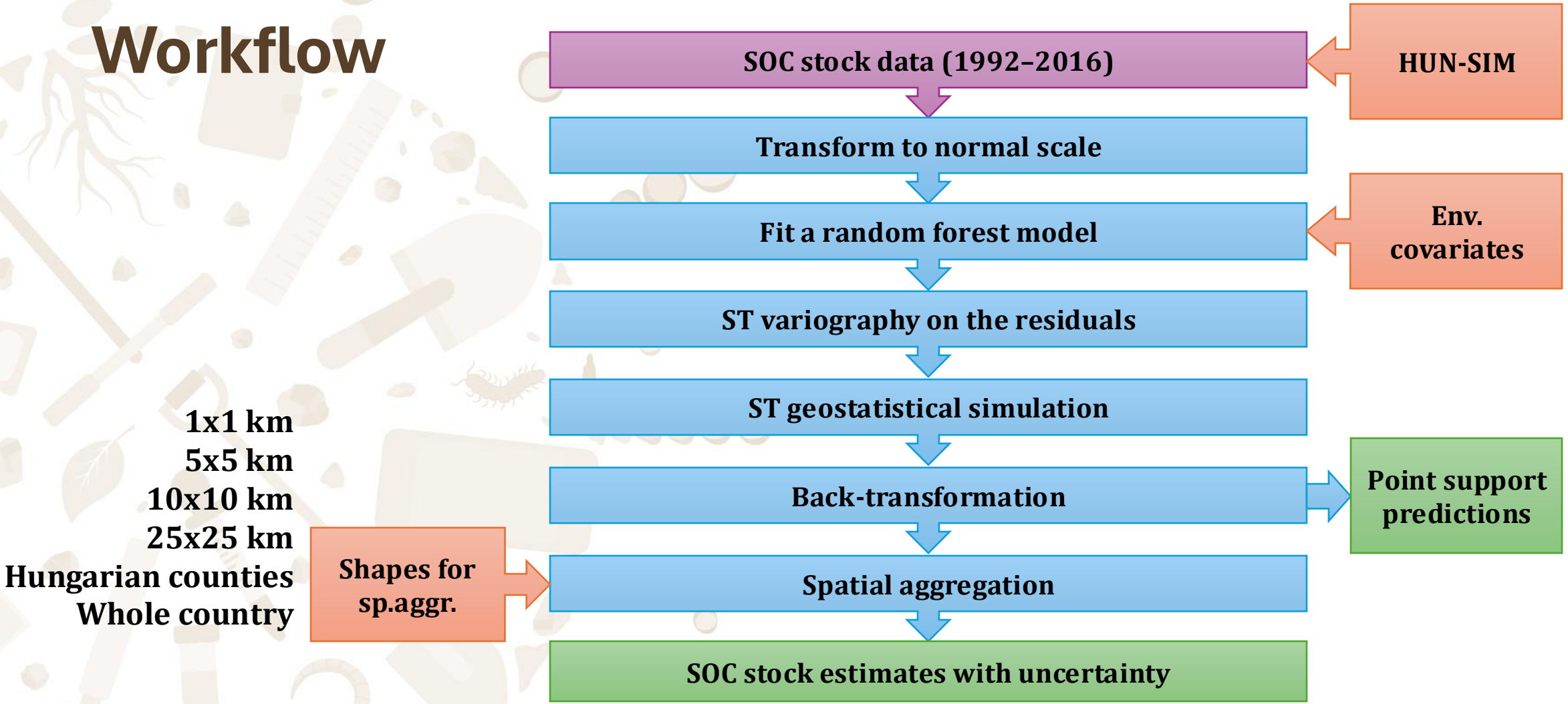
Space-time geostatistics

Lognormality and spatial aggregation

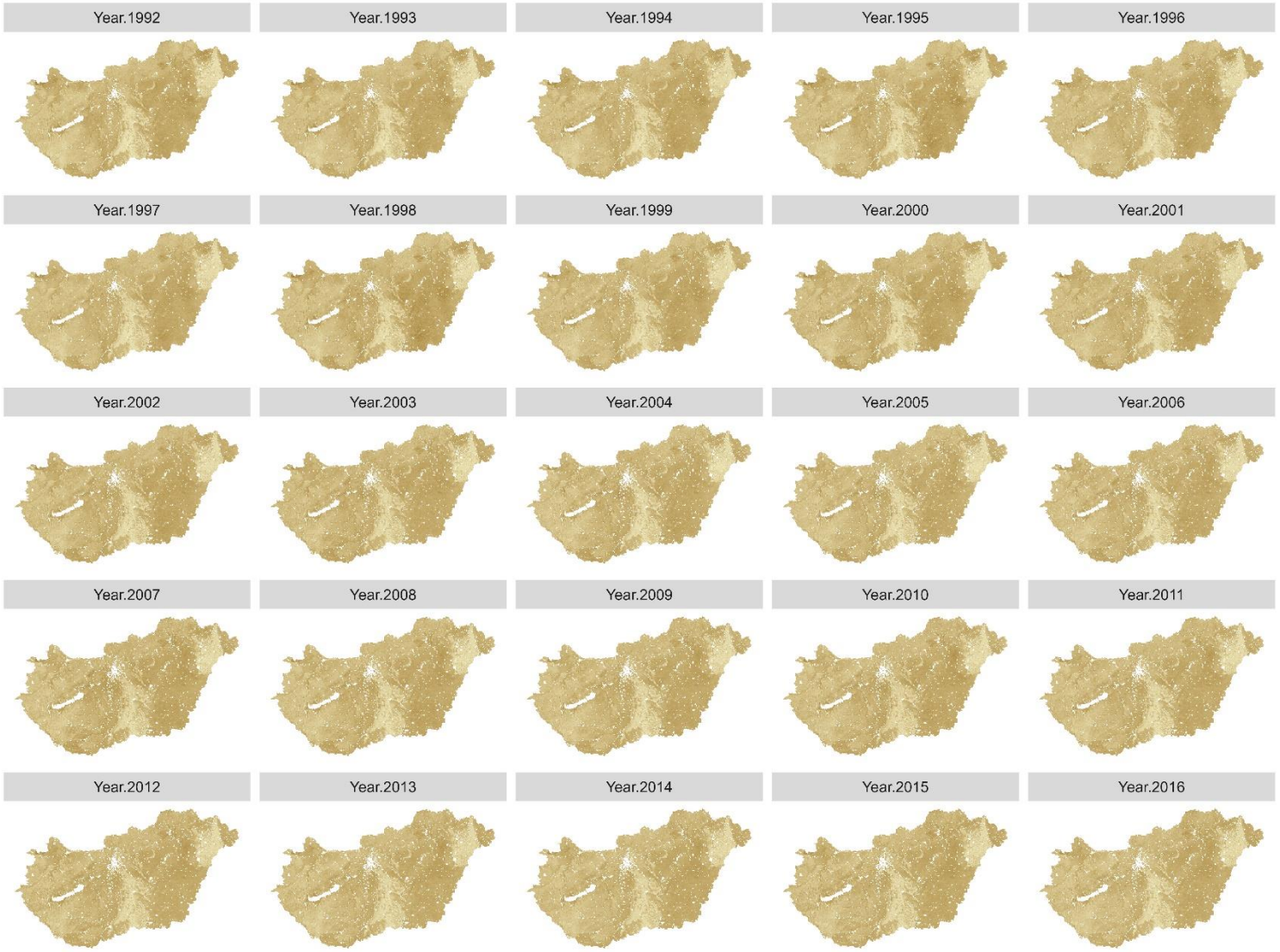
- SOC stock data are often positively skewed and this could pose difficulties

Geostatistical simulation

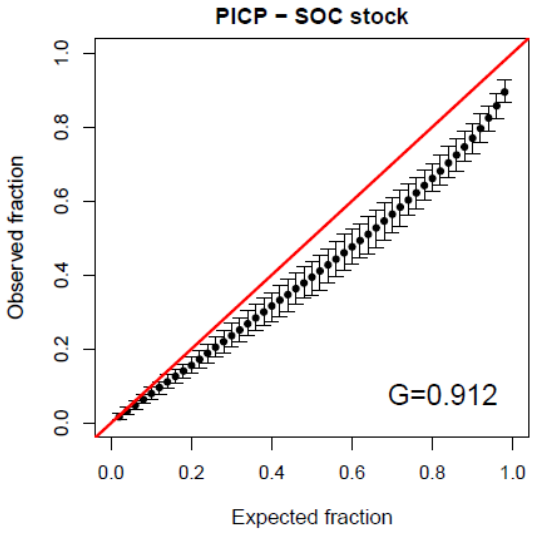
Workflow

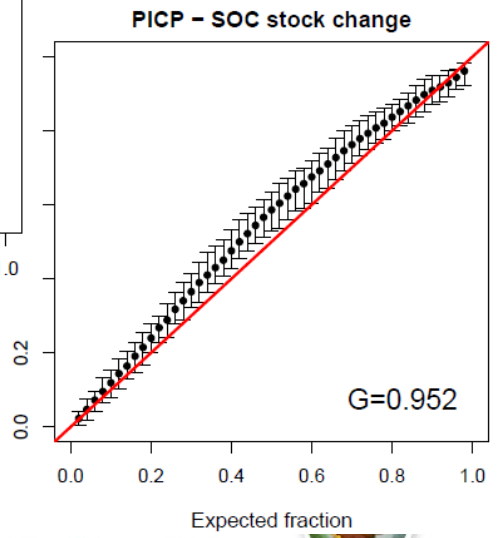

SOC stock data (1992–2016)
HUN-SIM
Transform to normal scale
Fit a random forest model
Env. covariates
ST variography on the residuals
ST geostatistical simulation
Back-transformation
Point support predictions
Spatial aggregation
Shapes for sp.aggr.
1x1 km
5x5 km
10x10 km
25x25 km
Hungarian counties
Whole country
SOC stock estimates with uncertainty

Point support predictions



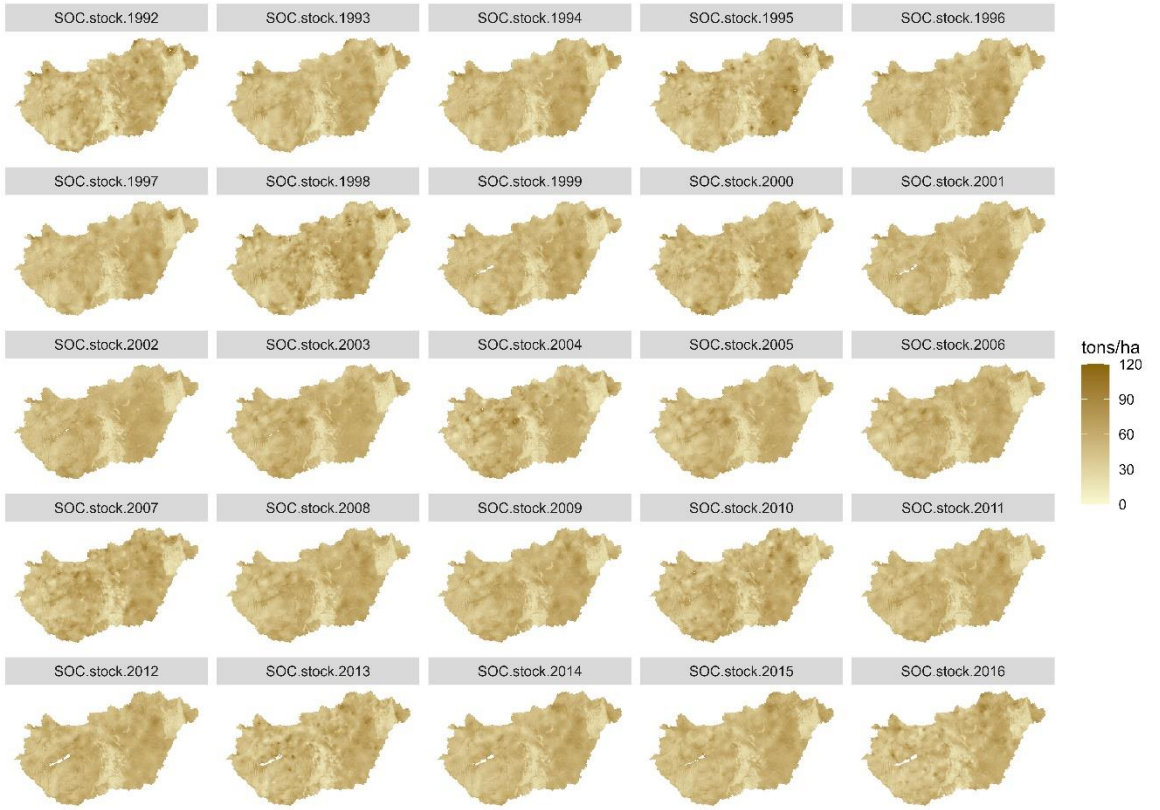
	ME [tons · ha^{-1}]	RMSE [tons · ha^{-1}]	MEC [-]
SOC stock	-0.89 (1.984)	19.35 (2.042)	0.32 (0.087)
SOC stock change	0.41 (1.742)	16.62 (2.112)	0.16 (0.067)

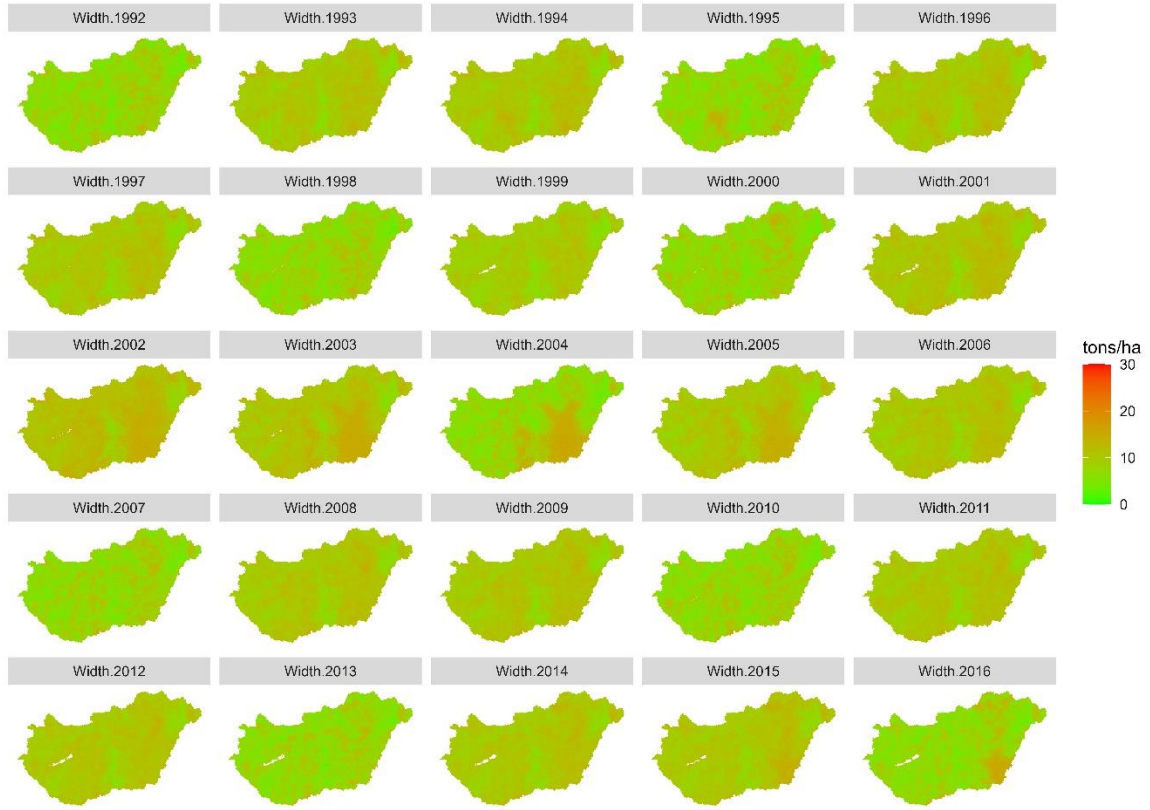




Predictions at larger supports

1x1 km | 10x10 km | Hungarian counties | Hungary





Prediction **Uncertainty**

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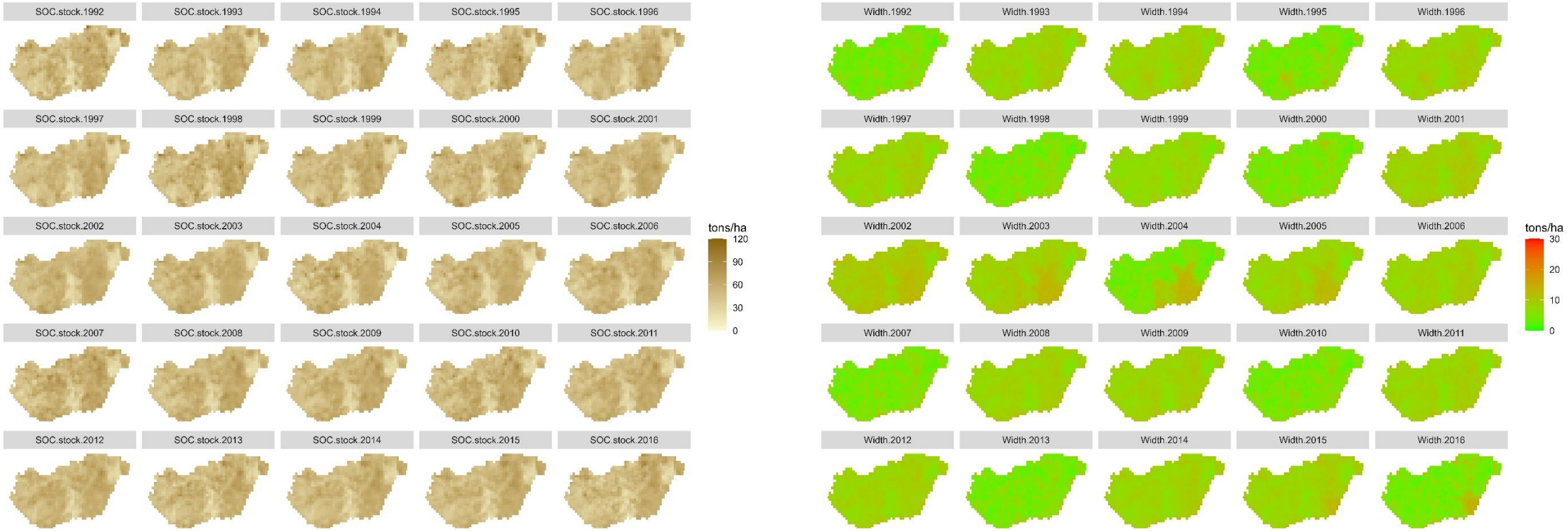
Larger supports

1x1 km | 10x10 km | Hungarian counties | Hungary

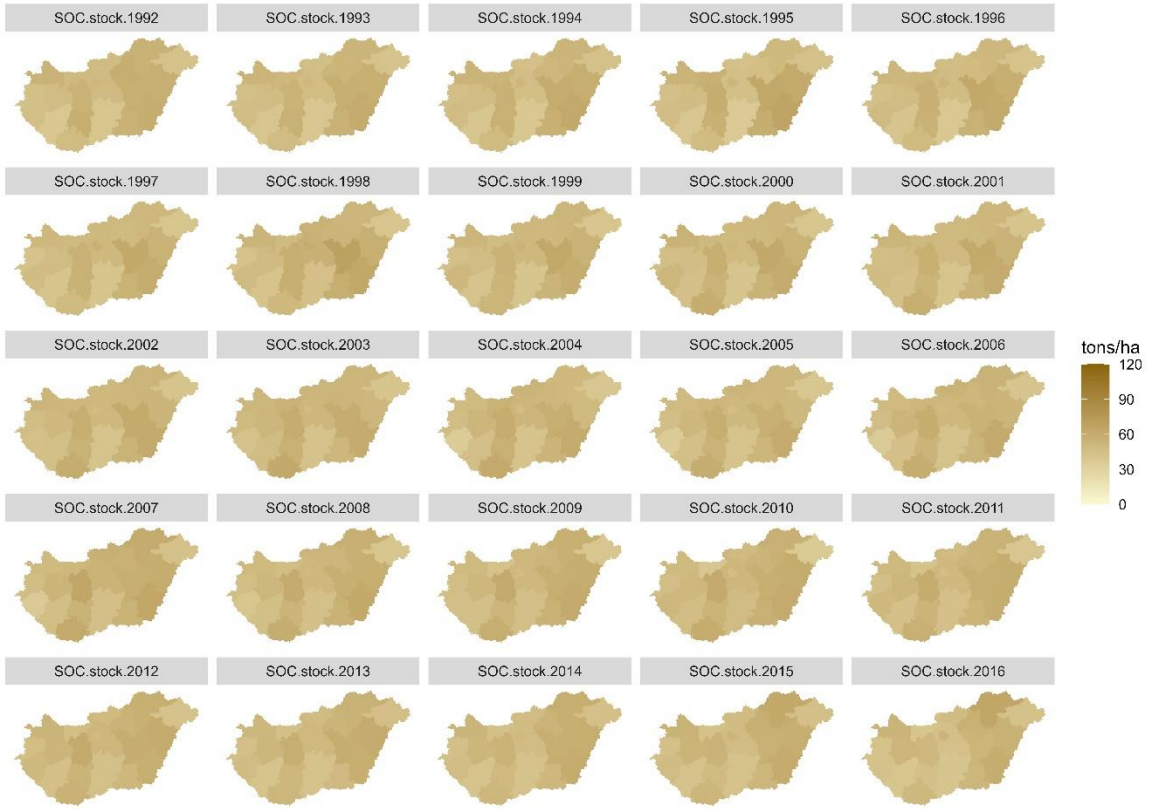


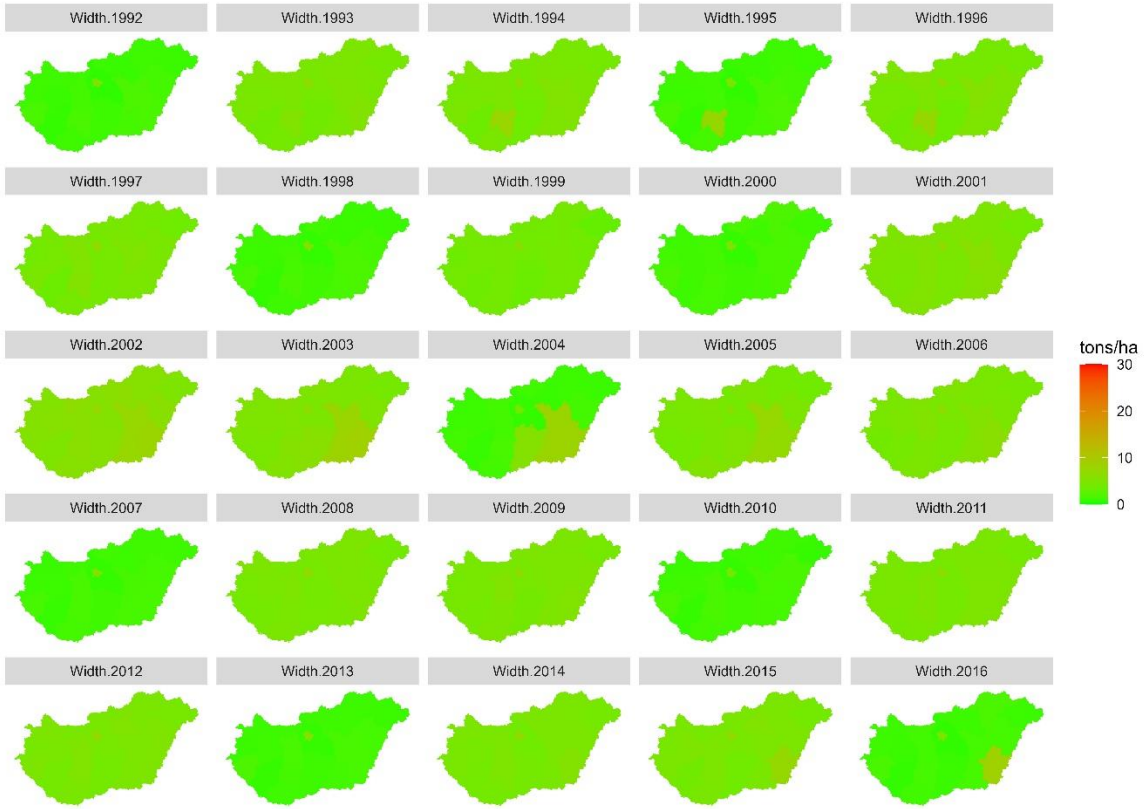
Prediction **Uncertainty**

GLOBAL SOIL PARTNERSHIP

Larger supports

1x1 km 10x10 km **Hungarian counties** Hungary





Prediction **Uncertainty**

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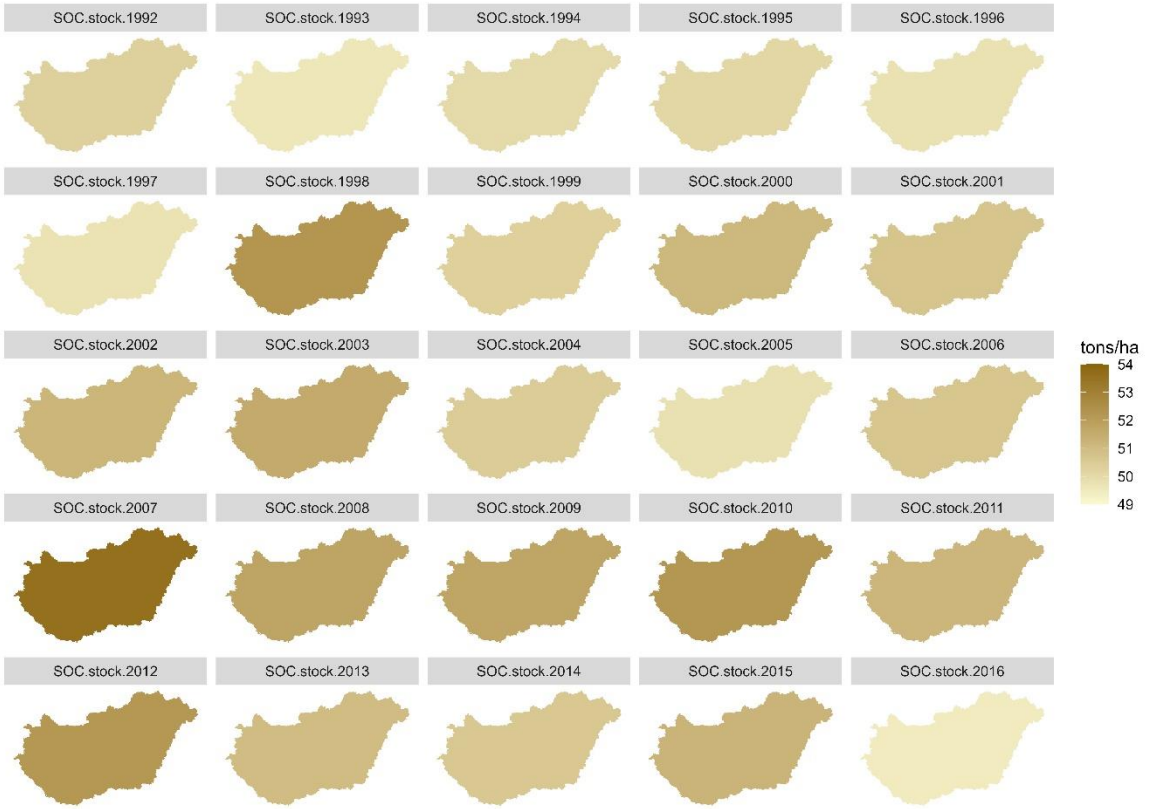
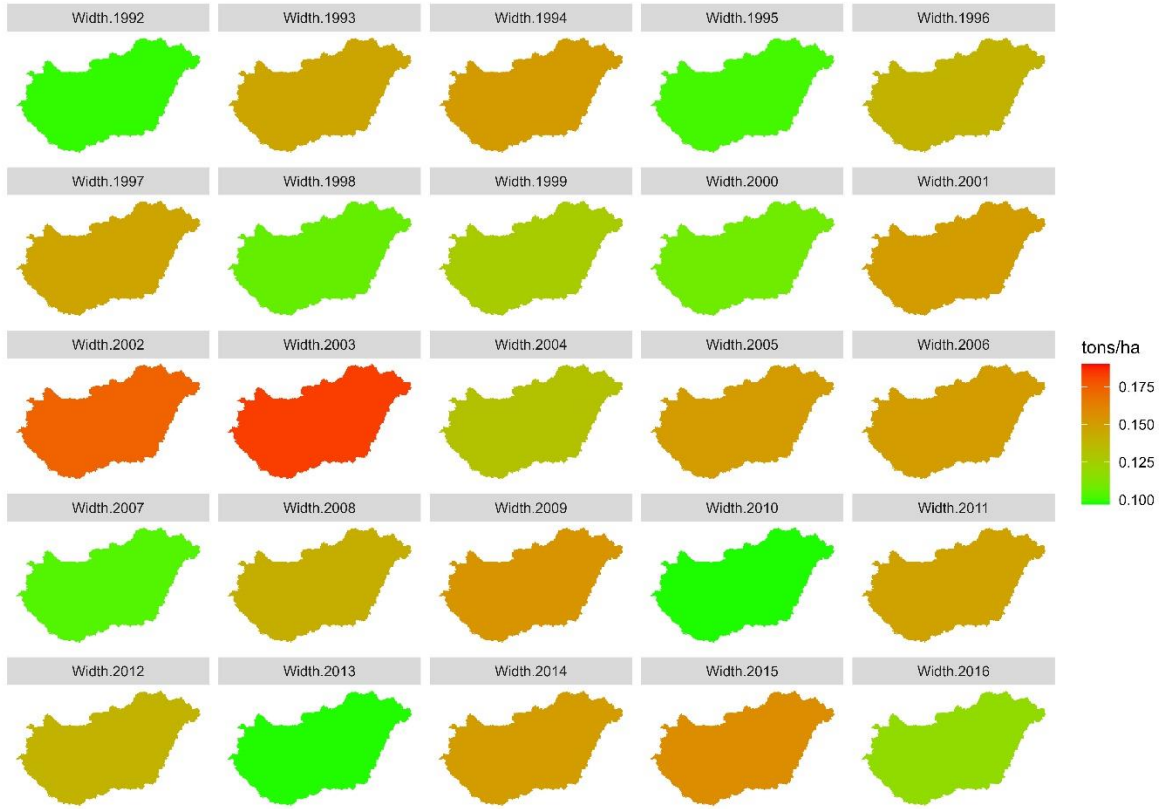
Larger supports

1x1 km **10x10 km** **Hungarian counties** **Hungary**





Prediction **Uncertainty**

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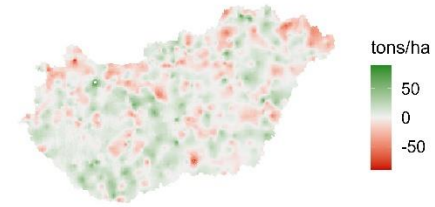
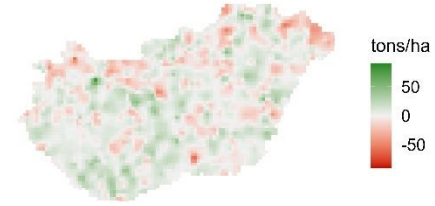
SOC stock change (1992-2010)

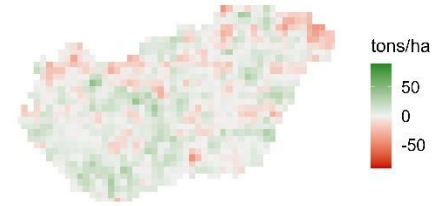
Support: 1x1 km



Support: 5x5 km



Support: 10x10 km

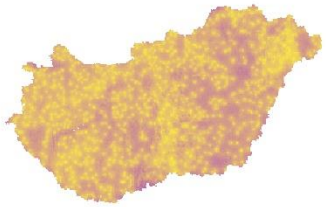


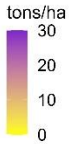
Support: Hungarian counties

Support: Hungary

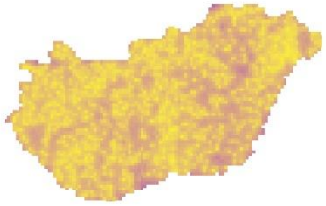
Width of the 90% prediction interval

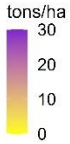
Support: 1x1 km



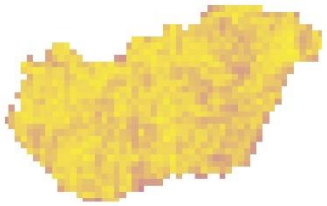


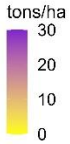
Support: 5x5 km



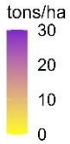


Support: 10x10 km

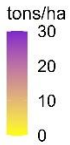




Support: Hungarian counties

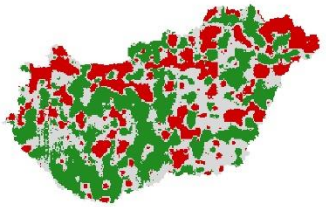


Support: Hungary

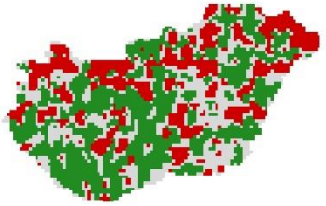


Significant change (1992-2010)

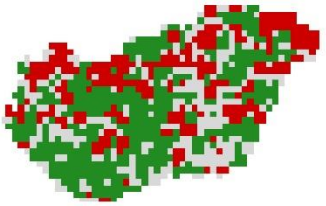
Support: 1x1 km



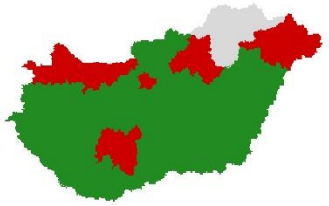
Support: 5x5 km



Support: 10x10 km

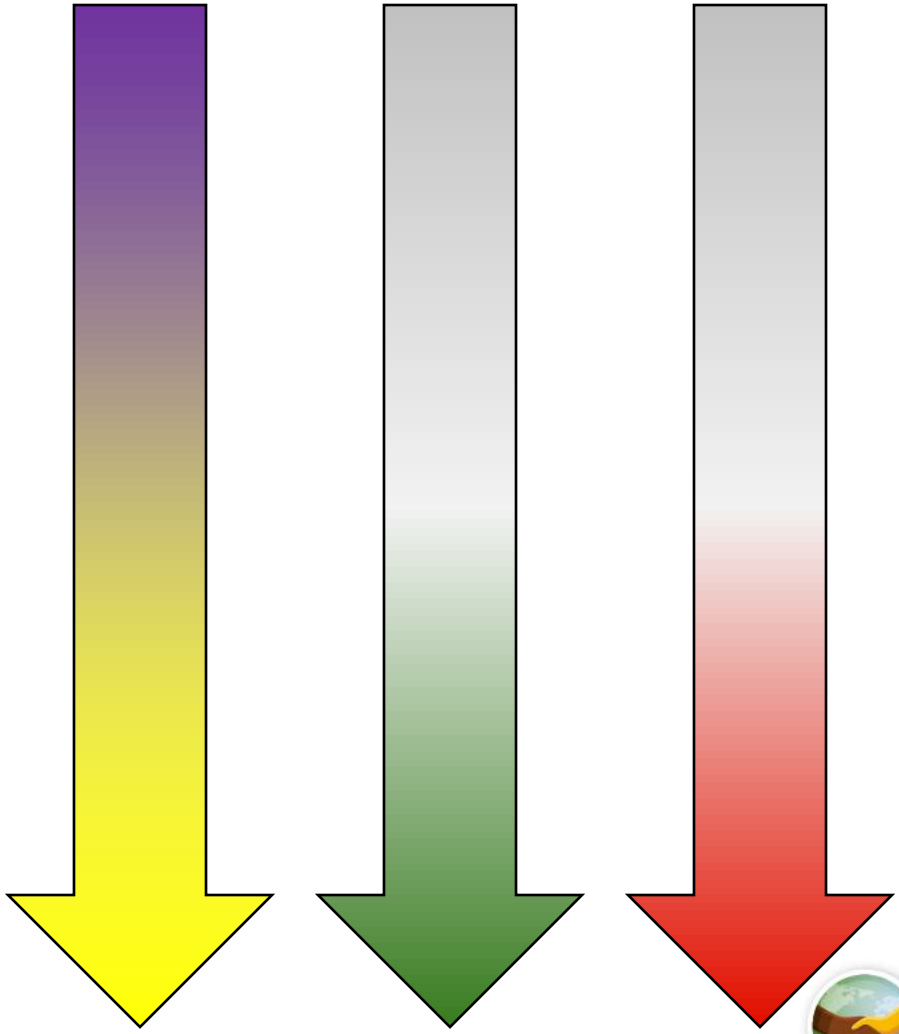


Support: Hungarian counties



Support: Hungary

SOC stock change (1992-2010)



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Summary

- Methodology for modelling SOC stock in space and time at multiple scales using a combination of machine learning and space-time geostatistics

- Geostatistics offers an efficient way to do spatial aggregation and quantify the prediction uncertainty associated with it

- Aggregation decreases prediction uncertainty and supports detection of statistically significant SOC stock change

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THANK YOU

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