# Scale-specific Prediction of (Top)Soil Organic Carbon Contents using Terrain Attributes and SCMaP Soil Reflectance Composites

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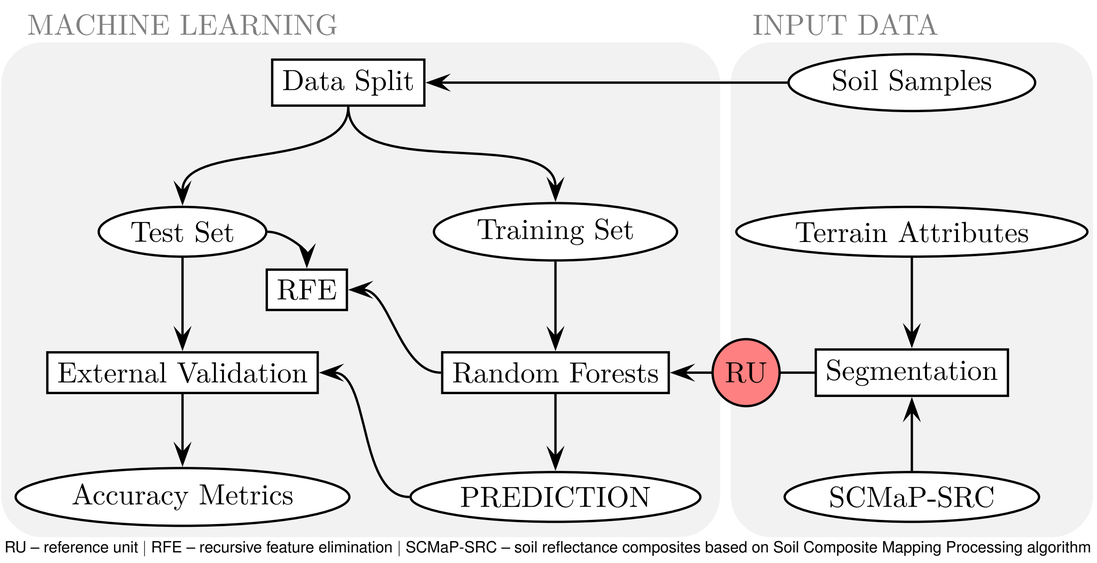
## 1 Background & Objective

- Soil properties are an expression of complex relationships between soil forming factors and landforms, which both are related to different scales.
- Scale dependencies of soil properties and positional inaccuracies of soil samples can be explained and considered by multi-hierarchical terrain attributes and soil-terrain objects generated by segmentation algorithms.
- The increasing availability of multi-temporal satellite imagery enables an expansion of the explanatory data space to better distinguish both spatial and temporal patterns of soil properties.

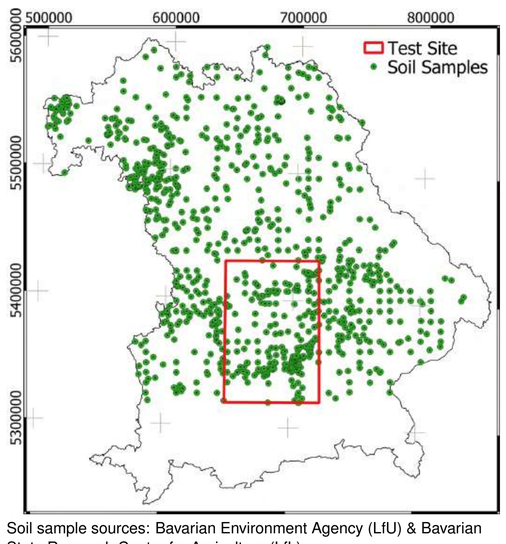
**Analysis of the relationships between soil samples, aggregation levels (L) of terrain attributes (TA) and satellite-based soil reflectance composites (SRC) with regard to their scale-specific predictive power using the example of soil organic matter (SOC).**

## 2 Methodology



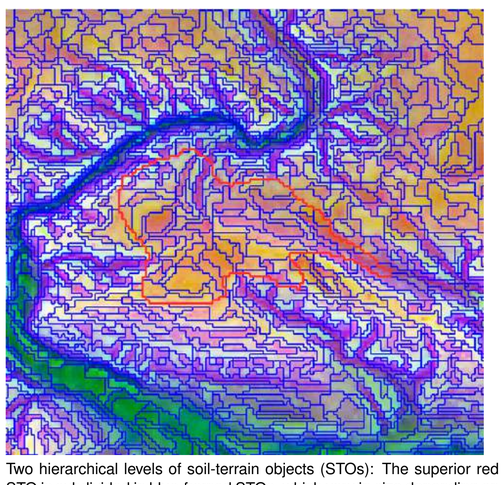

RU – reference unit | RFE – recursive feature elimination | SCMaP-SRC – soil reflectance composites based on Soil Composite Mapping Processing algorithm

## 3 Test site/Soil samples



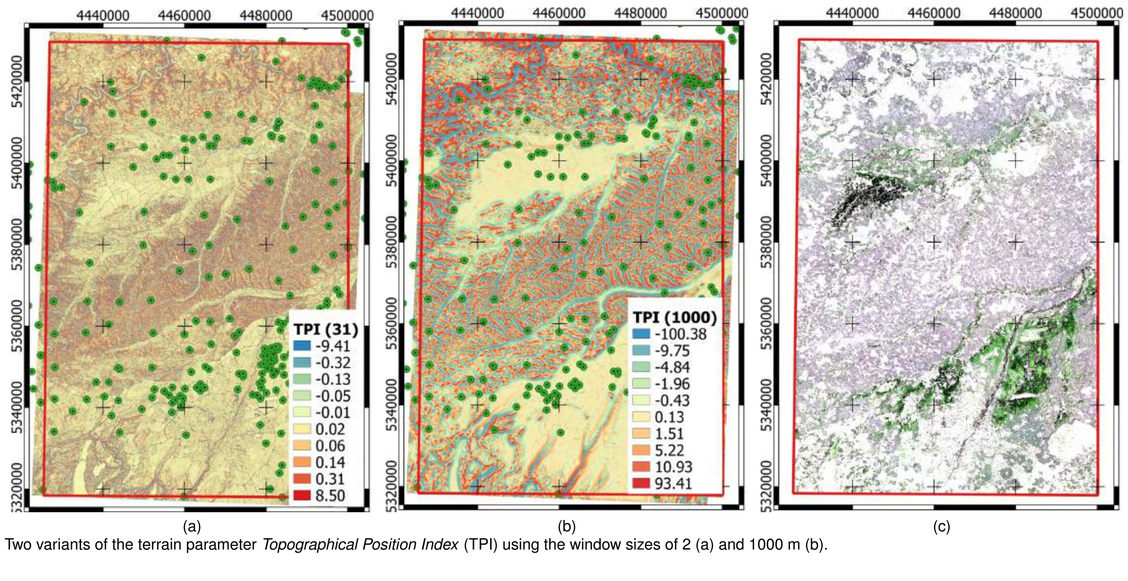

Soil sample sources: Bavarian Environment Agency (LfU) & Bavarian State Research Center for Agriculture (LfL)

## 4 Soil-terrain objects



Two hierarchical levels of soil-terrain objects (STOs): The superior red STO is subdivided in blue-framed STOs, which vary in size depending on their terrain position and corresponding STOs' heterogeneity. In rather flat areas (floodplain = green, plateau = orange), the STO sizes are bigger than in steeper areas (magenta and blue).

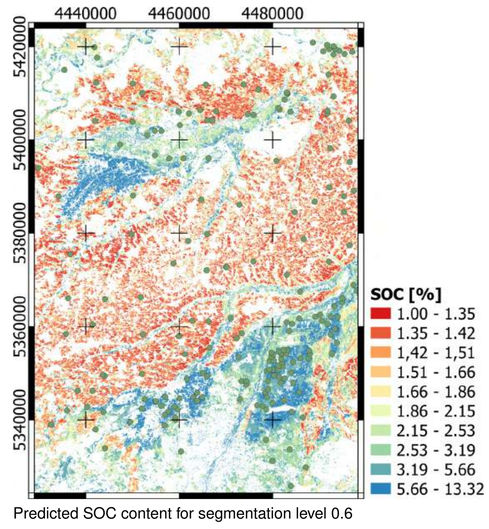
## 5 Explanatory variables



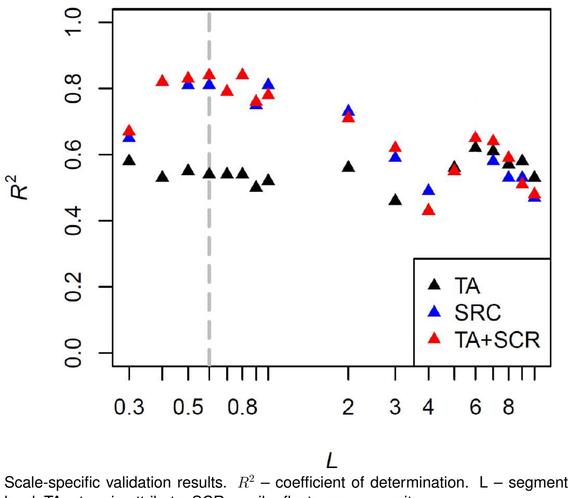

(a) (b) (c)

Two variants of the terrain parameter *Topographical Position Index* (TPI) using the window sizes of 2 (a) and 1000 m (b).

## 6 SOC content prediction and validation results




Predicted SOC content for segmentation level 0.6




Scale-specific validation results. $R^2$ – coefficient of determination. L – segmentation level, TA – terrain attribute, SCR – soil reflectance composite

## 7 Conclusion and Outlook

- We could identify scale-specific dependencies between the representativeness of the soil samples and the explanatory power of the variables used.
- Compared to terrain attributes, parameters based on multi-temporal soil reflectance composites are characterized by a higher explanatory power at fine scales.
- The explanatory power of terrain attributes is generally smaller but more balanced across scale levels.

### References

Möller, M., Zepp, S., Wiesmeier, M., Gerighausen, H., Heiden, U., 2022. Scale-Specific Prediction of Topsoil Organic Carbon Contents Using Terrain Attributes and SCMaP Soil Reflectance Composites. Remote Sensing 14, 2295. https://doi.org/10.3390/rs14102295
Zepp, S., Heiden, U., Bachmann, M., Möller, M., Wiesmeier, M., van Wesemael, B., 2023. Optimized Bare Soil Compositing for Soil Organic Carbon Prediction of Topsoil Croplands in Bavaria using Landsat. ISPRS Journal of Photogrammetry and Remote Sensing 202, 287-302, https://doi.org/10.1016/j.isprsjprs.2023.06.003.

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