Spatial prediction of soil texture in Region Centre (France) from summary data

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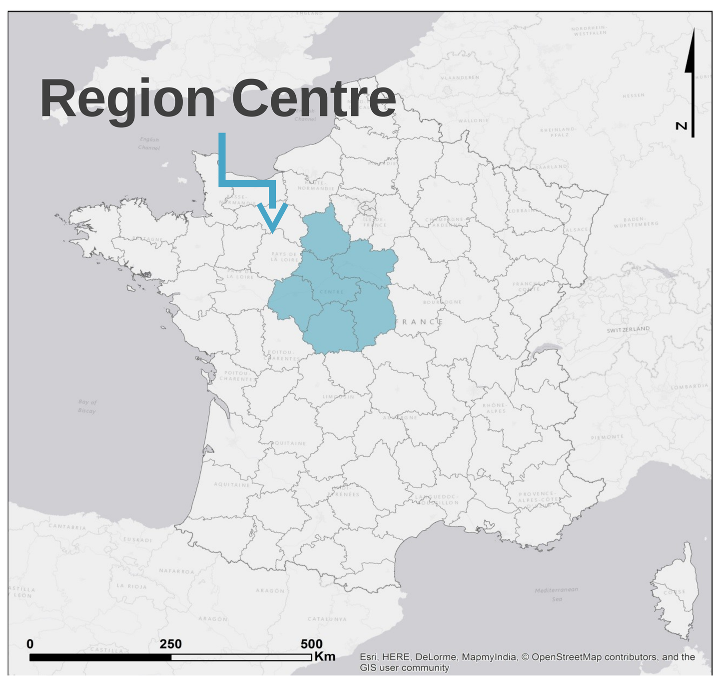
Mercedes Román Dobarco1, Nicolas Saby1, Tom G. Orton2, and Jean-Baptiste Paroissien1

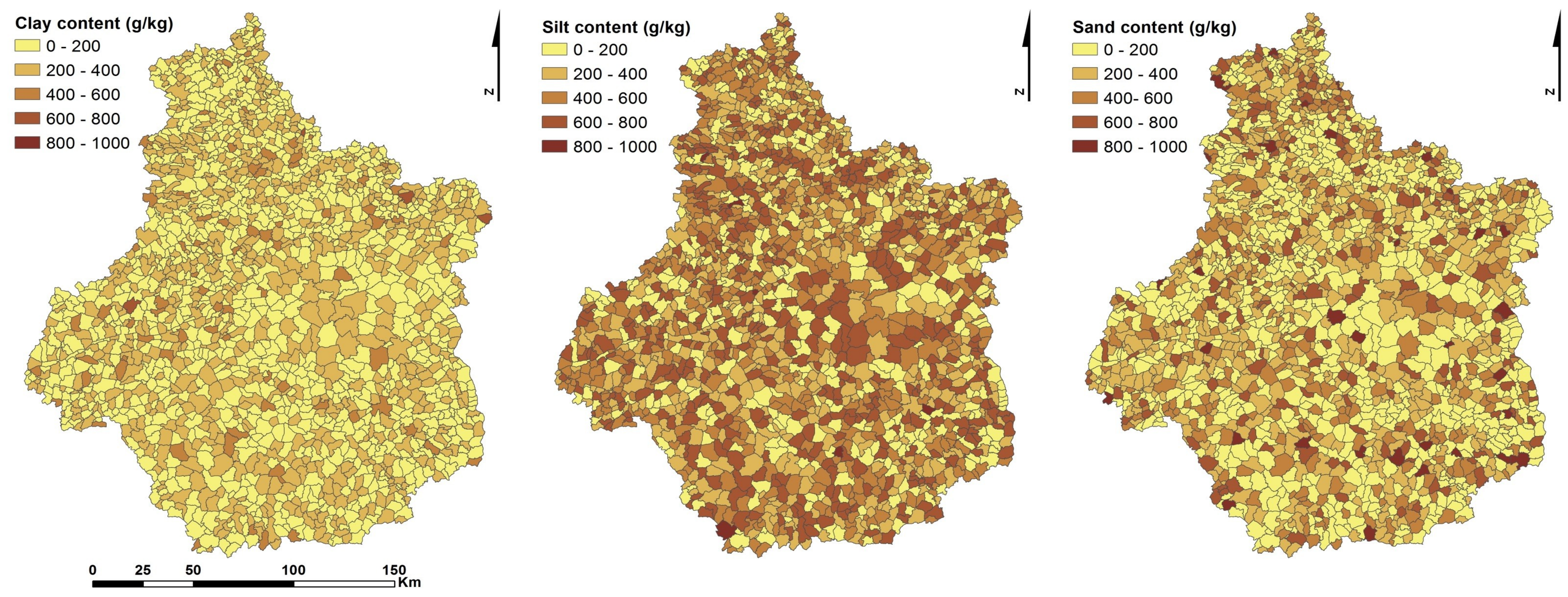
1. Institute National de la Recherche Agronomique, US InfoSol, France. 2. Faculty of Agriculture and Environment, University of Sydney, Australia

Introduction and Objective

Soil texture is a key controlling factor of important soil functions like water and nutrient holding capacity, retention of pollutants, drainage, soil biodiversity, and C cycling. High resolution soil texture maps enhance our understanding of the spatial distribution of soil properties and provide valuable information for crop management and environmental protection.

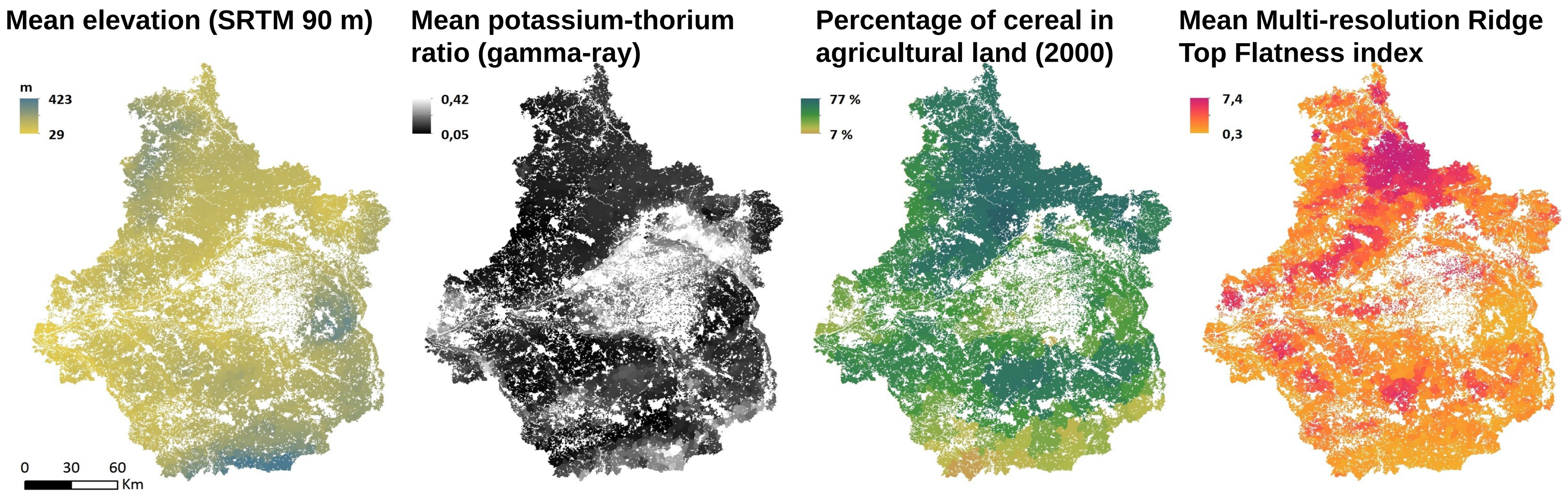


- The French soil-test database (BDAT) is populated with soil analysis requested by farmers interested in improving soil properties.
- **Unknown location** of farms.
- Soil texture data are available aggregated by municipality (but valuable information!).
- The objective is to predict soil texture of agricultural topsoils in the Region Centre (France) in point support **from areal data** combining regression models and area-to-point kriging.

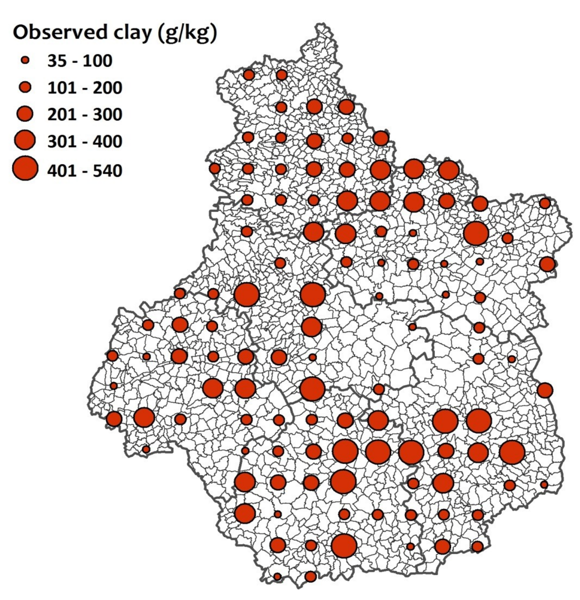


Methods

- 25 environmental covariates calculated within the agricultural land by municipality: continuous variables (mean value), categorical variables (dominant class).



- Additive-log-ratio transformation of soil texture data (alr-transform).
- Individual texture observations (n=25548) and average covariate values were used to fit multiple linear regression models (MLR), cubist models, and boosted regression trees models (BRT) for sand-alr and clay-alr.
- Independent validation of back-transformed predictions with data from 104 sites from the systematic soil quality monitoring network



References

Orton, T.G., Saby, N.P.A., Arrouays, D., Walter, C., Lemercier, B., Schvartz, C., Lark, R.M., 2012. Spatial prediction of soil organic carbon from data on large and variable spatial supports. I. Inventory and mapping. Environmetrics 23(2), 129-147.

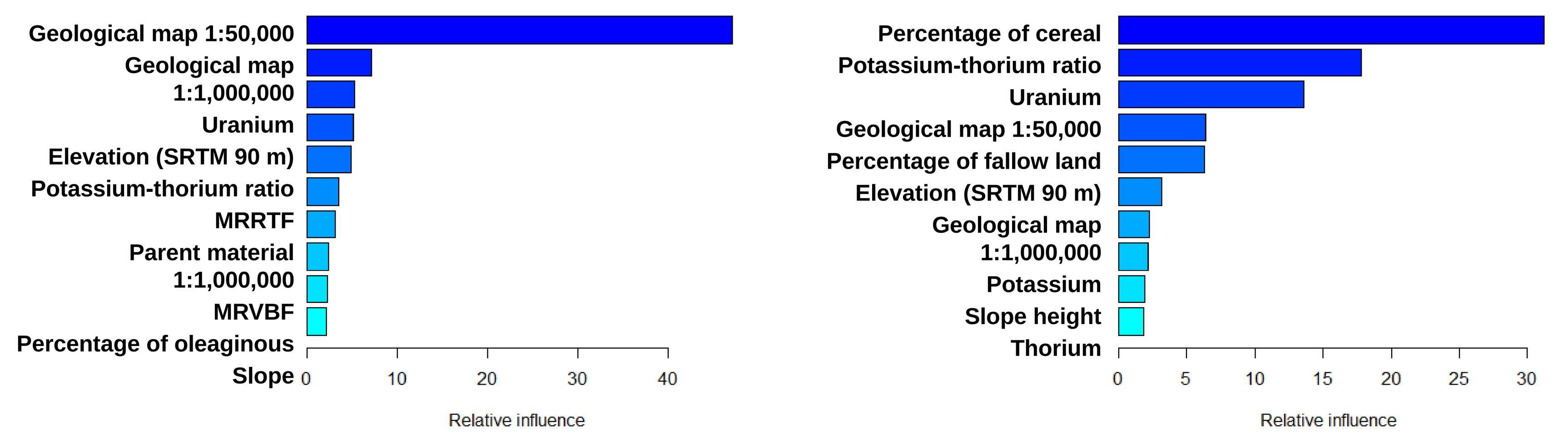
Orton, T.G., Saby, N.P.A., Arrouays, D., Walter, C., Lemercier, B., Schvartz, C., Lark, R.M., 2012. Spatial prediction of soil organic carbon from data on large and variable spatial supports. II. Mapping temporal change. Environmetrics 23(2), 148-161.

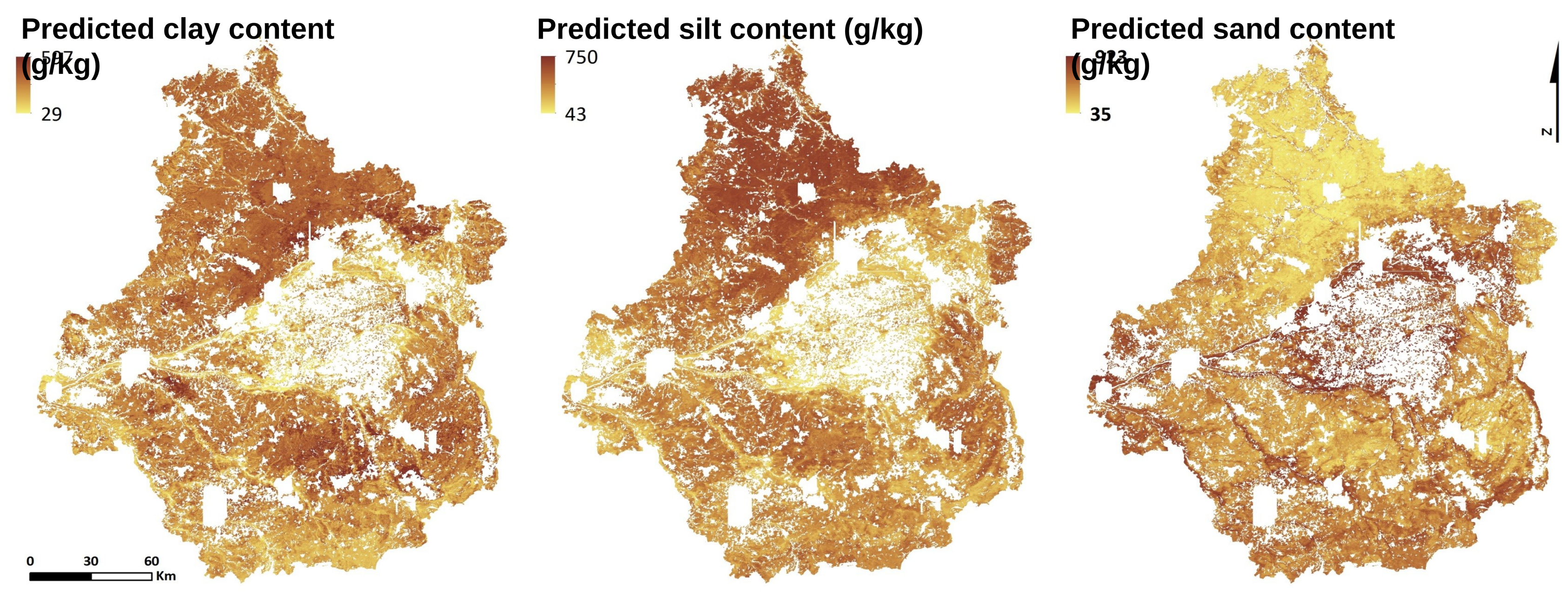
Preliminary Results

- Only BRT models provided better predictions than average BDAT data by municipality.

Model	Particle size fraction	RMSE	R2	Bias
BDAT reference	**Clay**	**96.93**	**0.32**	**-8.57**
BDAT reference	**Sand**	**153.73**	**0.59**	**-2.72**
BDAT reference	**Silt**	**123.02**	**0.64**	**10.45**
MLR	Clay	88.98	0.40	-4.92
MLR	Sand	168.73	0.51	-38.3
MLR	Silt	132.81	0.59	43.21
Cubist	Clay	100.97	0.23	-11.33
Cubist	Sand	167.1	0.52	-19.06
Cubist	Silt	126.06	0.63	30.39
BRT	**Clay**	**81.58**	**0.50**	**-20.02**
BRT	**Sand**	**125.19**	**0.73**	**-4.65**
BRT	**Silt**	**99.96**	**0.77**	**24.67**

Variable influence for clay-alr BRT model and sand-alr model





Future work

- Soil texture model predictions will be used as auxiliary variables for area-to-point kriging following the method developed by Orton et al. (2012).
  - Area-to-point kriging considers the average value, the number of observations, and the sample variance by municipality, assessing the **uncertainty** areal means.
  - Predictions are **mass-preserving** (average of the point predictions within a municipality equals the average measured value).
  - Point predictions are calculated with a linear mixed model, in which BRT predictions are included as a fixed effect, including indirectly the relationships among covariates and soil texture.
- Prediction for sand-alr and clay-alr will be calculated by cokriging using a linear model of coregionalization.
- Covariance parameters are estimated with residual maximum likelihood, and spatial predictions by empirical best linear unbiased predictor.
- The results will inform on whether the later and statistically more-challenging approach improves significantly texture predictions.

INRA Centre de recherche d'Orléans
2163 Avenue de la Pomme de Pin
45075 Orleans CEDEX 2
France
http://www.val-de-loire.inra.fr/