Large-extent digital soil mapping approaches for total soil depth

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General information

Total soil depth (SD_t) plays a key role in supporting various ecosystem services and properties, including plant growth, water availability and carbon stocks. Therefore, predictive mapping of SD_t has been included as one of the deliverables within the GlobalSoilMap (GSM) project. In this work SD_t was predicted for France using 2 different methods 1) Data mining, including a bias correction + kriging of residuals (DM) and 2) Multi-Resolution Kriging for large datasets (MrK).

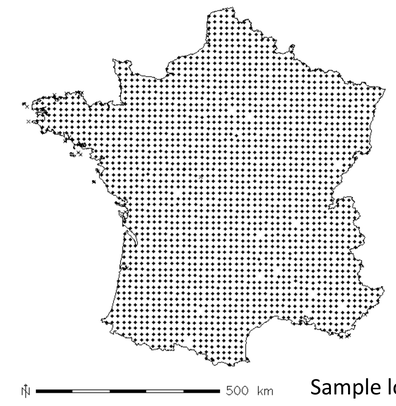
Methods

	Deterministic trend	Interpolation residuals	Prediction uncertainty
DM + Kriging of residuals	Data mining (R package GBM) Bias correction	Ordinary kriging	Calculation of prediction intervals by ordinary kriging of error
Multi – resolution kriging	Linear regression model	Multi-resolution kriging using spatial basis function for estimating the covariance matrix	Calculation of confidence intervals by Gaussian simulation of the kriging model

Data

Soil samples

The SD_t was determined for 2116 sites, originating from the French Soil Monitoring network (RMQS). This dataset encompasses a broad spectrum of climatic, soil and agricultural parameters and covers the entire metropolitan France, based on a regular, 16km x 16km grid. Soil depth ranged from 0 to 300 cm, with a mean value of 102 cm.



Sample locations

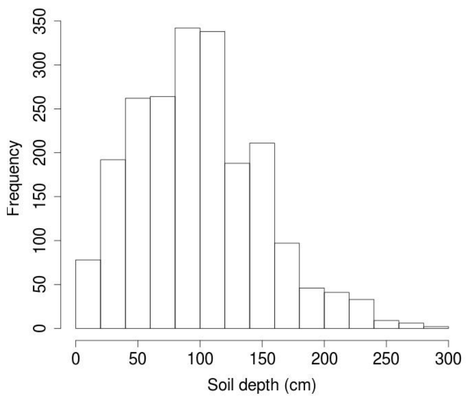
Environmental data

Topography
Elevation
Slope
Aspect
CTI
Roughness
Exposition
Curvature
Scale position

Vegetation
Land use
Forest type

Climate
Precipitation
Temperature
Climate type

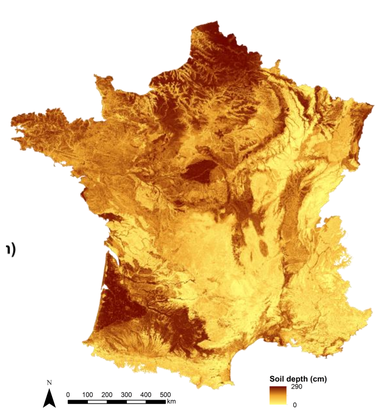
Soil/Geology
Parent material
Bare rock areas
Soil waterlogging indices



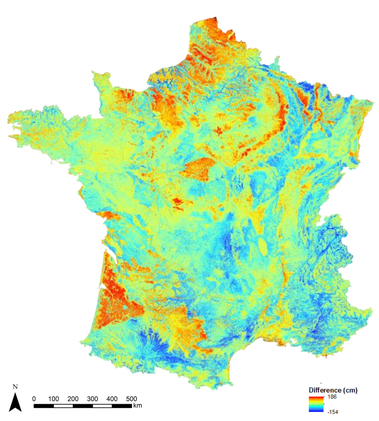
Results

Predicted soil depth

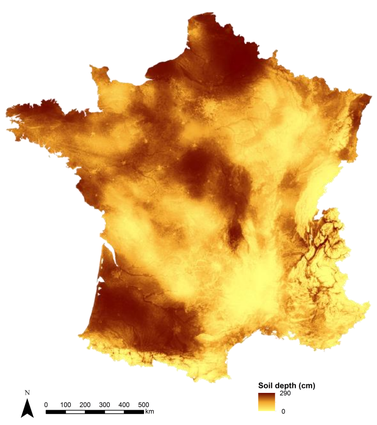
Data mining



Difference



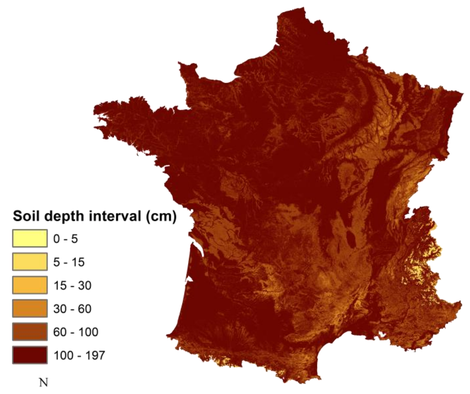
MrK



	Min	Q1	Mean	Median	Q3	Max	sd
Data Mining	0	66	99	97	125	288	45
MrK	4	78	95	96	112	193	25

Spatial uncertainties

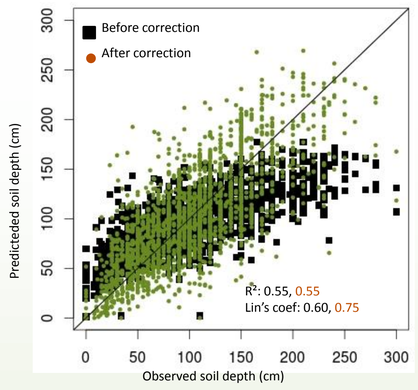
Data mining: prediction interval



MrK: confidence interval

	Min	Q1	Mean	Median	Q3	Max	sd
Data Mining	0	97	111	113	127	197	25
MrK	13	35	38	38	42	72	6

Bias correction



Empirical adjustment (bias correction)of the distribution of variables using quantile mapping"

2 steps correction method:
- 1) Identifying the distribution parameters of a population (RMQS data)
- 2) Apply these parameters to the predictive data to correct its distribution

	Min	Q1	Mean	Median	Q3	Max	sd
Observed	0	60	102	100	130	300	52
Before	1	79	96	97	113	178	27
After	0	68	102	98	130	269	49

Major findings

Data mining

Predictive map of soil depth
Consistent spatial pattern
Good prediction of the mean values

- Prediction of extremes values
- (bias correction)

Prediction interval

Implementation
- Deterministic trend: flexible model choice, flexible for large datasets, high resolution
- Estimation of uncertainties: no direct of and not flexible for large datasets

Outlook
- Promising prediction of soil depth class instead

MrK

Predictive map of soil depth
Consistent spatial pattern
Good prediction of the mean values

- No extremes values

Different meaning, direct comparison not possible

Confidence interval

Implementation
- Deterministic trend: limited to a linear model
- Straight forward modelling approach
- Flexible in delivering spatial explicit uncertainty measures

Outlook
- Potential for modelling beyond the country level, at high resolution