Large-scale subsurface characterization using multi-configuration EMI and image classification.


Scientific Motivation
- Reliable information on soil characteristics is vital for hydrological modelling or for precision agriculture.
- At any scale, good results can be rarely achieved without relatively detailed and reliable soil information.
- The investigation of intermediate scales still presents challenges.

Study Area
We selected a square box of 1x1 km in Selhausen.
- 51 fields with 20 different owners and management (farm scale).
- Structures in the shallow subsurface affect crop development during water scarcity.
- Most detailed available soil maps are not capable of reproducing these patterns.

Electromagnetic Induction
An EMI device measures the apparent electrical conductivity (ECa).
- Measured ECa is related to water content, texture, temperature, use of fertilizers, etc.
- Modern instruments have multiple receivers allowing measurements with multiple depth of investigation.
- The instrument is put on a sled and dragged by an ATV at 5 km/h with 2.5 m spaced parallel lines.

Image classification
Used in remote sensing for land use classification of multispectral satellite images. Can be applied to EMI data?
- Larger coil separations result in an increased depth of investigation.
- Stack the ECa maps in a multiband image from the shallower to the deeper sensing.
- This multiband image can be analyzed with image classification techniques.
**Supervised classification**

- Iterative self organized (ISO) cluster followed by a maximum likelihood classification.
- An a priori interpretation is performed by the operator using the available geomorphological knowledge of the area.
- Define number and meaning of classes (training areas). Evaluate histograms and scatter plots to check the separation between classes.

**Soil sample analysis**

- Sampling campaign between January and February 2017 (5 consecutive days).
- Horizon and sub-horizon type and depth (max 2 m depth).

**Soil map and soil units of sub-area A**

- Each class has a typical soil profile.
- A T-test (P = 2.5 % in each tail) was performed on horizons depth and texture (clay, silt, sand, and gravel content) between profiles of the same sub-area.
- Typical profiles showed statistically significant differences in at least one of the horizons characteristics.

**Supervised classification soil map**

- A supervised classification is performed in every field.
- High-resolution soil map composed of 4 sub-areas divided in 18 classes.
- Soil map that qualitatively represents the patterns.
- Random selection of 100 ground truth locations.
Preliminary comparison with satellite derived LAI

- The four profiles of sub-area A are capable of representing meaningful patterns in satellite derived LAI (RapidEye) in Field F01 (2.8 ha).
- Results obtained with the AgroC agroecosystem model were similar to the satellite-derived LAI.

Conclusions

- The image classification of EMI data can define the horizontal geometry of homogeneous subsurface structures.
- Produce a high resolution soil map with 16 classes (subsurface structures).
- The typical soil profiles of each class carries information on horizons type, depth, texture and water content.
- A good knowledge of the geology of the study area is necessary to perform a proper supervised classification.

Submitted to Geoderma: Large-scale characterization of subsurface structures using multi-configuration EMI and image classification.


- The image classification of EMI data can define the horizontal geometry of homogeneous subsurface structures.
- Produce a high resolution soil map with 16 classes (subsurface structures).
- The typical soil profiles of each class carries information on horizons type, depth, texture and water content.
- A good knowledge of the geology of the study area is necessary to perform a proper supervised classification.

CONCLUSIONS

Agroecosystem model AgroC successfully simulated patterns in LAI for one sub-area (~33 ha).

Geophysics-based subsurface model successfully represents LAI patterns in sugar beet on a 2.8 ha test field.

Thank you for your attention.

Any question?

c.brogi@fz-juelich.de

11.04.2018

11.04.2018
SUPERVISED CLASSIFICATION SUB-AREA B

General decrease in ECa

Natural
Anthropogenic

06 Apr 2018

SUPERVISED CLASSIFICATION SUB-AREA C

General decrease in ECa

Natural
Anthropogenic

06 Apr 2018

SUPERVISED CLASSIFICATION SUB-AREA D

General decrease in ECa

Natural
Anthropogenic

06 Apr 2018