Soil properties mapping at the field scale from DC landscape survey sensor

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Vienna | Austria | 03 – 08 April 2011

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Introduction

Soils are complex media whose properties can have a strong spatial variability. At the field scale when usual practises of characterization, as soil sampling, give only a rough idea on the real in-field variability, non destructive geophysical methods can overcome this difficulty from high density of measurements. These methods are also time-efficient. However data interpretation in term of soil properties is not straightforward. This requires a processing workflow developed here, from a DC dataset.

DC landscape survey sensor

Direct Current (DC) method enables to measure electrical resistivity (ER, ohm m) of soils. Its basic principle relies on an electrical current at low signal frequency generating into soil by electrodes.

- ✓dGPS sytem
- ✓Resistivity meter
- ✓Control in real time

- High spatial resolution
- Small acquisition time
- 3 apparent soil layers
- Non destructive
- Useable for ploughed soils…

One electrode (contact improved) **V-shape system** (noise restricted)

A technique adapted for field prospecting is the **MultiContinuous Electrical Profiling (MuCEP)**. It is a mobile soil electrical resistivity mapping system which comprises a multi-probe system towed by a cross-country vehicle. It cover a large area in few time and measure field resistivity at high resolution. (ARP patented, Geocarta society, Paris, France)

Processing workflow

Geophysical measurements (resistivity: ER)
- Raw ER at three apparent depths
- 52000 data/ plot of 5 ha
- Median smoothing and filtering

Soil sampling
- Local soil cores (n=30)
- Local soil properties (n=30)

Ancillary dataset
- Soil layering-soil depth measured locally
- Local Vertical Electrical Sounding (VES 1D)

Inverse modelling process
- **1D inversion** (QWinv1DN, Tabbagh, 2004)

→ Two ER layers
- o Initial ER values given by 1D sounding
- o Layering depth fixed

Calibration
- **Statistical analysis** (PCA, standard regression)

→ Transfer function developpement:
ER=f(soil properties)

Mapping process
- **Spatial interpolation** of soil properties from ER by transfer function inversion

Validation
- Analysis of estimated properties versus measured properties

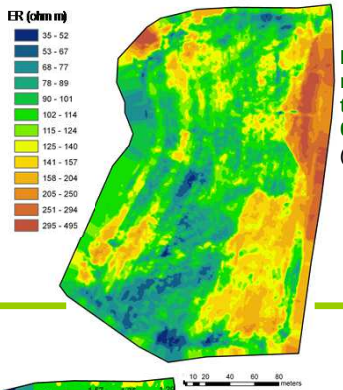
→ RMSE calculation

Iterations

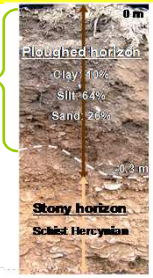
An exemple of a soil property mapping from DC

(soil bulk density map)

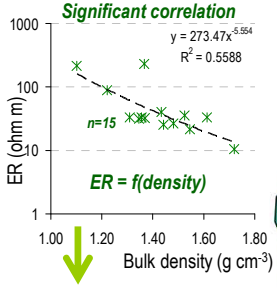
Field: 5 ha area Luxembourg site



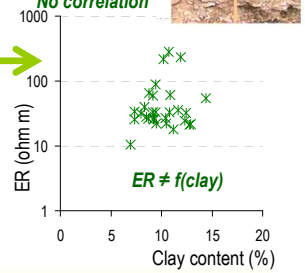
Electrical resistivity map of the first soil layer 0-0.3 m depth *(after 1D inversion)*



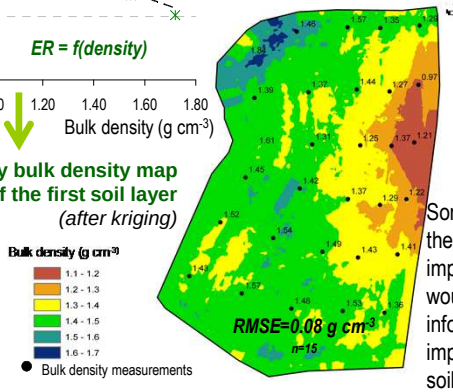
Significant correlation



No correlation



Dry bulk density map of the first soil layer *(after kriging)*



Conclusion

Some soil properties, as bulk density, can be estimated at the field scale at high resolution from DC method and after implementing the general processing workflow. This last still would gain by being combined to additional geophysical information. The result of this data fusion in workflow might improve considerably estimations in space of many others soil properties (as clay content).

*This work was part of **DIGISOIL project** and financed by the European Commission under the 7th Framework Programme for Research and Technological Development, Area "Environment", Activity 6.3 "Environmental Technologies".*