Sensor data fusion for topsoil mapping

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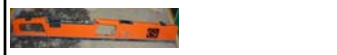
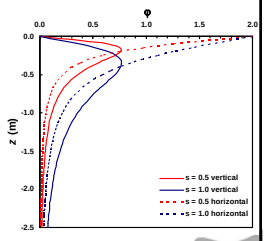
Aim

Evaluate and compare the ability of different combinations of proximal data to predict topsoil clay content

The sensors – EM38 Mk2 2

Geonics Ltd., Canada





Dual-depth bulk electrical conductivity (ECa)

The sensors – The Mole

The Soil Company, The Netherlands

Proximal sensor for Gamma (γ) radiation

Radioactivity (Bq kg^{-1}) can be determined for

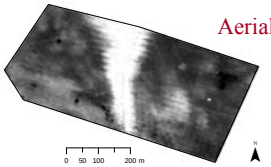
Thorium (^{232}Th),
Potassium (^{40}K),
Uranium (^{238}U)
Cesium (^{137}Cs)


Photo: Van Egmond et al., 2008

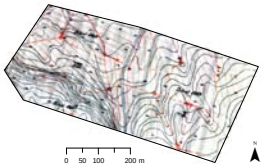
Depth response 0.2-0.3 m

Van Egmond, F. M., Loonstra, E.H. & Limburg, J., 2008. Gamma-ray sensor for topsoil mapping: the Mole. 1st Workshop in High-resulotion digital soil sensing and mapping (HRDSS), 5-8 feb, 2008, Sydney, Australien. Workshop Program and Papers, Volume II, 10 p.

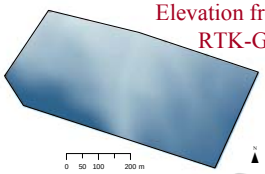
Ancillary data



Aerial photo

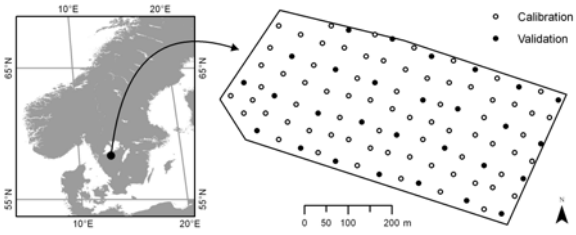


Drainage map



Elevation from RTK-GPS

Reference data



Contents of clay and soil organic matter (SOM) from soil samples

Hypotheses

1) ECa measurements from multiple occasions would perform better than one ECa measurement alone.
2) ECa measurements with multiple measurement depths would perform better than one single-depth ECa measurement.
3) Using the ECa and the γ radiation sensor together would improve predictions compared to using one sensor alone.
4) Introducing information on spatial variation patterns by adding relevant ancillary data would improve the predictions of either sensor.

Methods

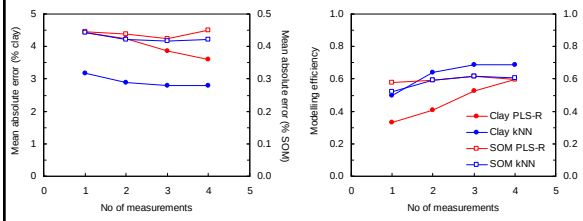
- Calculate all types of independent data to a common grid ($10 \times 10 m^2$)
- Extract data from soil sampling locations
- Calibrations (70 sample cells)
- Validation (28 remaining sample cells)
- Prediction (all grid cells)

Study design

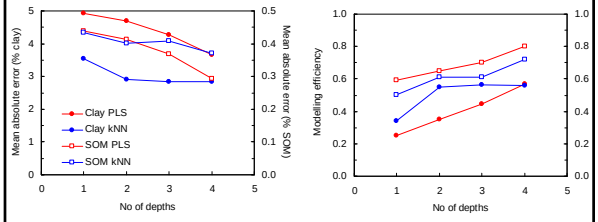
(calibrations made)

2 dependent variables
(Contents of clay and soil organic matter, SOM)
×
26 sets of independent data
×
2 prediction methods
(Partial least squares regression, PLS-R,
and k-Nearest Neighbour, kNN)

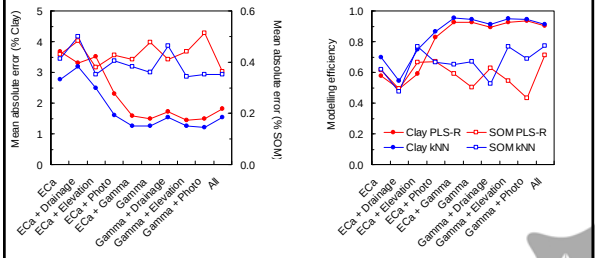
Results only ECa



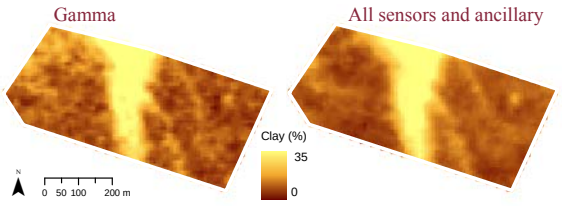
Results only ECa



Results Data Fusion



Results



Summary

If you have an ECa sensor, you could probably improve your predictions of topsoil clay content by:

- increasing the number of measurement depths
- increasing the number of measurement occasions
- add radiance data from aerial photo or gamma radiation data or both
- use kNN instead of PLS-R

If you have a gamma radiation sensor, you could probably predict topsoil clay content rather accurately from one sensor measurement alone.