Field Scale Variation in Water Dispersible Colloids from Aggregates and Intact Soil Samples: Method Comparison and Relevance for Leaching Risk Mapping

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Introduction

- Strongly sorbing environmental contaminants leach through the soil profile adsorbed to colloidal particle fractions of the soil (colloid-facilitated transport).
- The amount of water-dispersible colloids (WDC) is an indicator of soil structural stability and vulnerability.

Objectives

- Evaluate methods to determine the amount of WDC at different scales.
- Assess field-scale patterns in colloid-facilitated transport through the plough layer.
- Predict leached particle mass from measurable soil characteristics and multiple linear regression (MLR).

Methods

Sampling

Conventional arable field

No-till system for two years

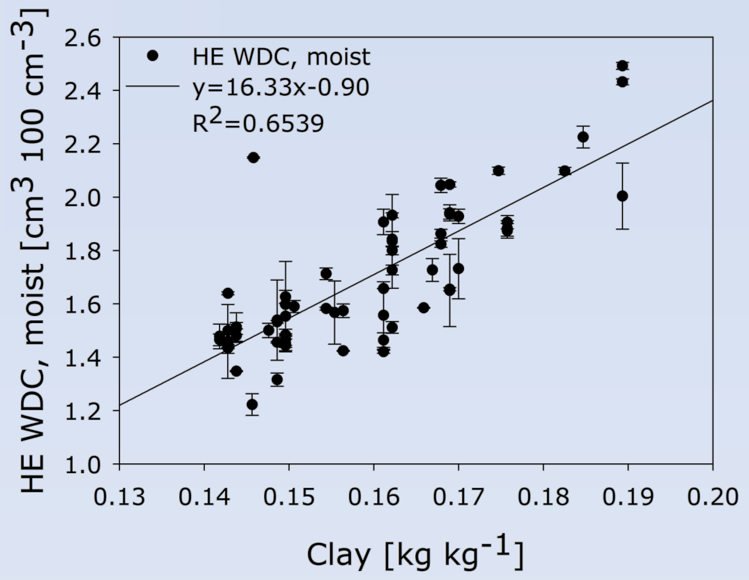
Loamy soil

15 x 15 m sampling grid

High energy (HE) WDC on moist ($\Psi = -100$ cm H_2O) 1-2 mm soil aggregates

Laser diffraction:

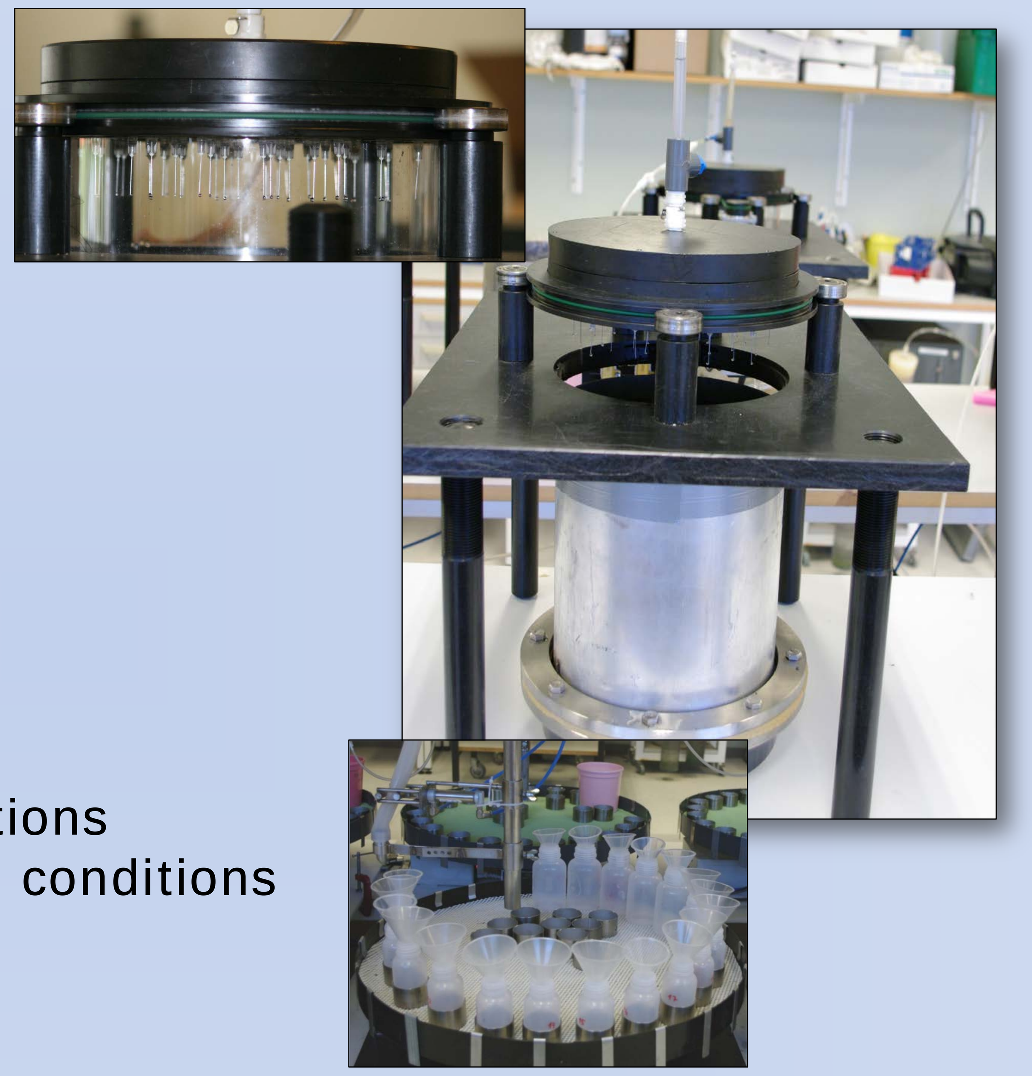
- Dispersion in rainwater solution (pH=7.82, EC=2.24 × 10^{-3} S m^{-1})
- One particle size distribution every minute for 15 min
- HE WDC ~ particles < 2 µm at reference time



Low energy (LE) WDC on 100 cm³ cylindrical, intact soil cores

Saturated hydraulic conductivity on 100 cm³ cores

Leaching experiments on 65 20x20 cm intact soil columns



Leaching setup:

10 mm h^{-1} for 6.5 hours
- Free drainage

Tritium tracer pulse:
10 min with 10 mm h^{-1}.

Effluent measurements:

Turbidity
Electric conductivity
pH
Total phosphorus
Total dissolved phosphorus

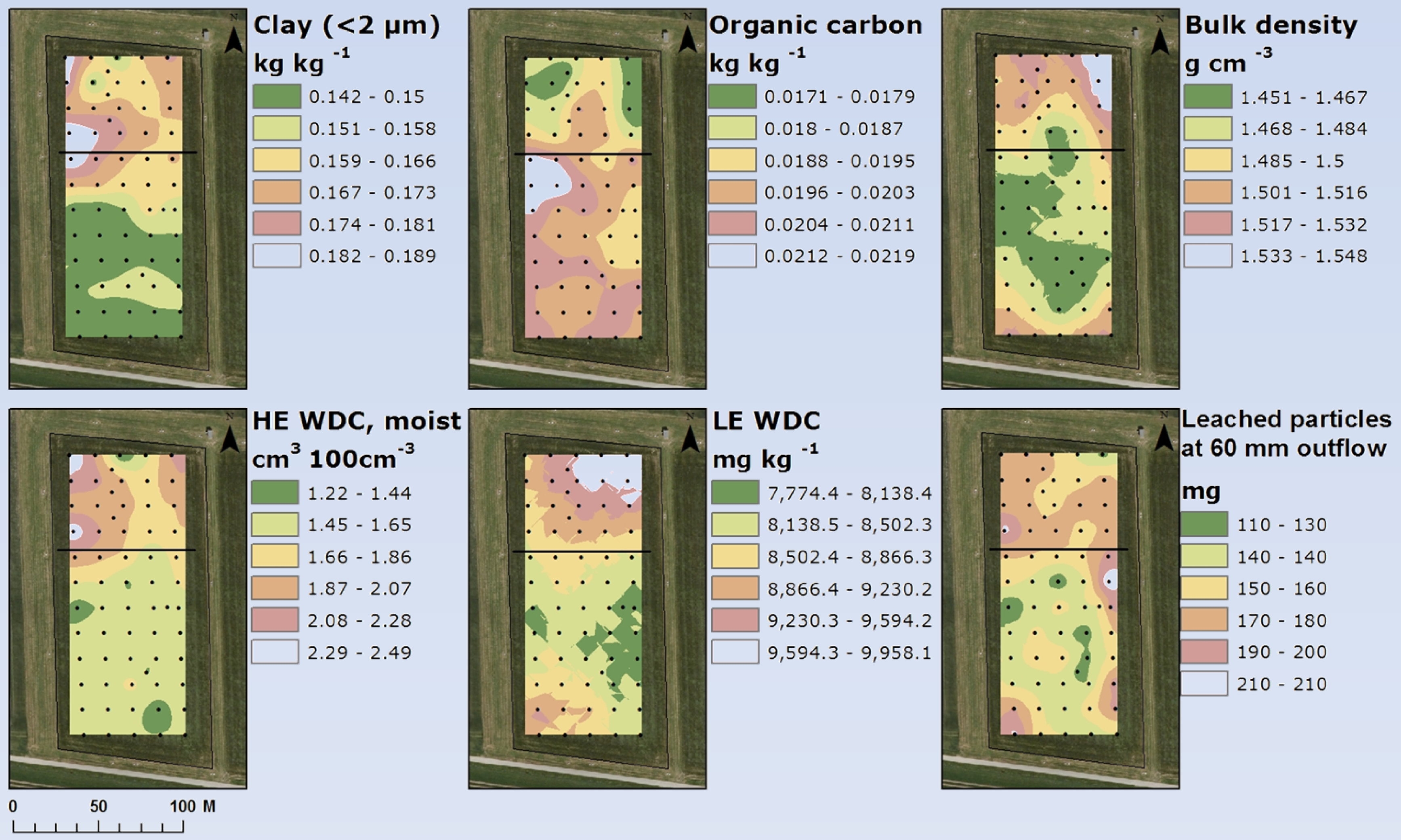
Additional measurements:

Air permeability at in-situ conditions
Air-connected porosity at in-situ conditions
Air permeability at -20 cm H_2O

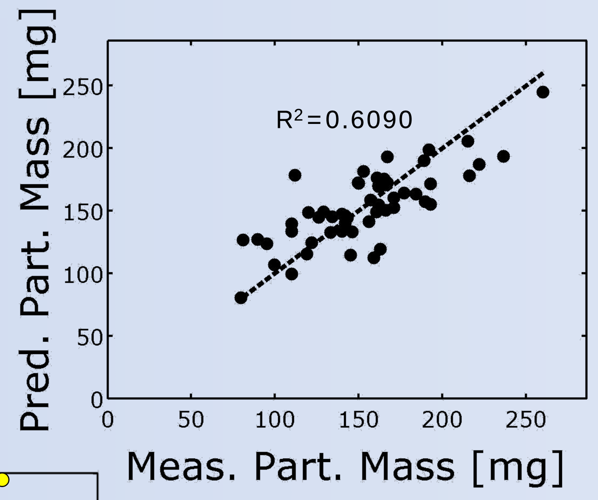
Bulk soil analysis

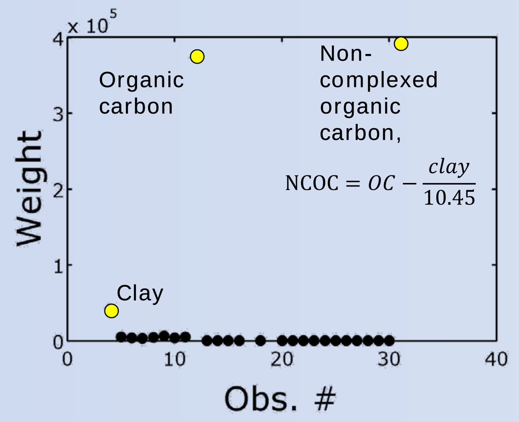
Texture, organic carbon, soil pH, electric conductivity, bulk density, oxalate-extractable iron, -aluminium and –phosphorus.

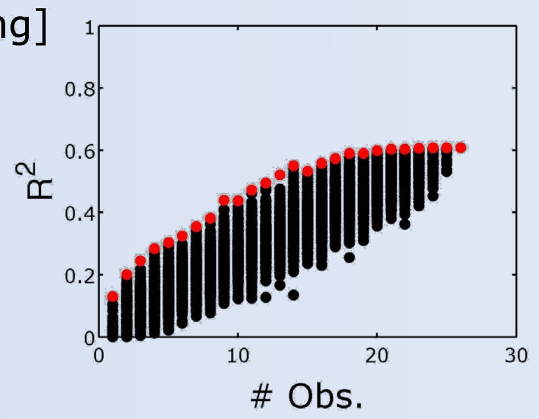
Results



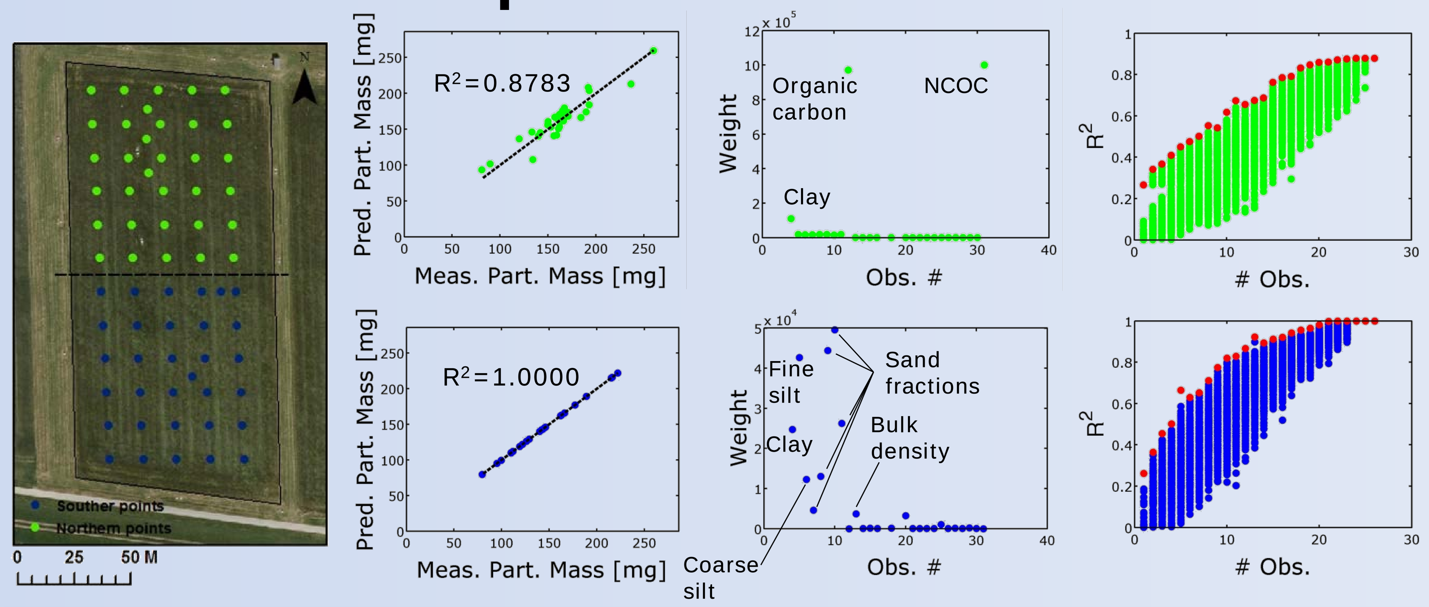
Multiple linear regression predicting total leached particle mass at 60 mm outflow







North-South separation of data



Conclusions

- Clay is a main driver for dispersibility on aggregate level.
- Particle leaching from 20x20 cm undisturbed soil columns can be explained by textural and structural parameters. The three most import factors are clay, organic carbon and non-complexed organic carbon.
- Complexity increases towards a larger sample. volume and scale.
- Prediction of particle leaching and mobilization is improved when separating this field in two parts based on characteristic soil properties.

Perspectives

- Simple near-surface screening of the soil using e.g. near-infrared reflectance spectroscopy could be used to point out high-risk areas vulnerable to leaching.

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