REFERENCE VALUES FOR SOIL STRUCTURAL DEGRADATION EVALUATION:
an approach using shrinkage analysis

ALICE JOHANNES (HES-SO, ETHZ)
PETER WEISSKOPF (AGROSCOPE)
RAINER SCHULIN (ETHZ)
PASCAL BOIVIN (HES-SO)

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ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

Administration fédérale admin.ch Agroscope

alice.johannes@hesge.ch EGU 2015

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A need for reference values

- Soil quality is threatened
- Soil protection regulation ← reference values
- For the moment, physical quality reference values are scarce. Soil structure in particular has none.
- Objective: Find reference values for soil structure quality

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Soil physical quality assessment

- Why aren't there any?

lack of general consensus → Not suitable for regulation

- Spatial variability
- Temporal variability
- Technical difficulties
- Expensive characterization

- What do we need?

- Robust
- Accurate
- Cost-efficient
- Of course… meaningful for soil structural quality assessment

→ Why is shrinkage analysis an opportunity?

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Soil shrinkage analysis

- Provides quantitative information on soil structure
  - Structural porosity
  - Plasma porosity
  - Hydrostructural stability
- Recent studies at field scale (Boivin et al 2004, 2006,2009; Schäffer et al. 2008, 2013; Goutal et al. 2012, 2013)
  - Accurate diagnosis of compaction or structural damage
  - Strongly determined linear relations between shrinkage analysis parameters and soil constituents (colloids)

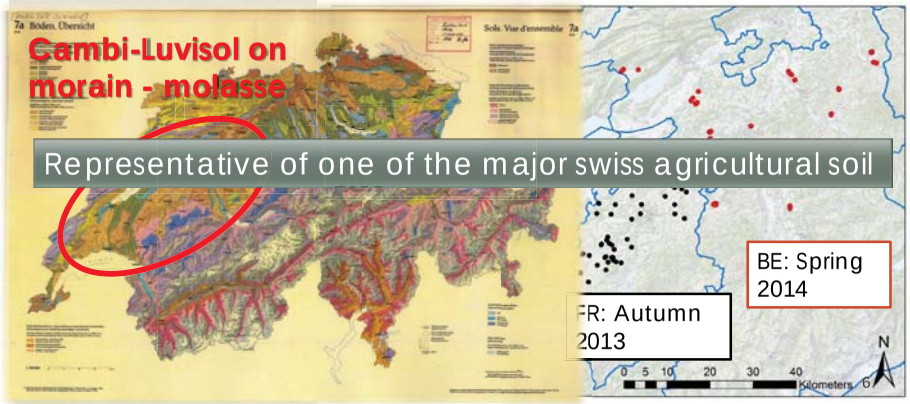
A major assumption of the project

If it is true that soil constituents predict soil structural properties at field scale… This should remain true and equally determined regardless of the geographical scale, provided that the colloidal constituents are of the same type.

→ At Swiss scale, the same soil order, on the same parent materials should exhibit unique relations between colloidal constituents (SOC and clay content in our case?) and structural properties

Sampling site: Swiss plateau

- 120 km across the Swiss plateau
- 174 undisturbed samples randomly collected
- From spring to autumn (2012 – 2014). Topsoil (5-10 cm)
- 3 different managements: No-till ; Conventional tillage ; Permanent pasture



Project strategy

- Step1: Sampling soils with non degraded structures for reference values
  - Excluded: wheel tracks, waterlogging, trampling, erosion, non degraded organic matter, blocky structures, etc.
  - VESS (visual evaluation of soil structure, Ball et al. 2007) scores ≤ 3

- Step 2: Sampling degraded soils

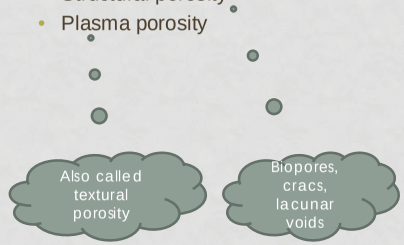
Analyses

- SOC
- Texture
- CEC + exch. Cations
- pH

- Air permeability
- Precompression stress

<u>Particularity:</u> analyses were performed on the same sample (minimize local variability)

- Shrinkage analysis
  - Volumes on the whole water content range
  - Hydro structural properties:
    - Hydro structural stability (slope)
    - Structural porosity
    - Plasma porosity

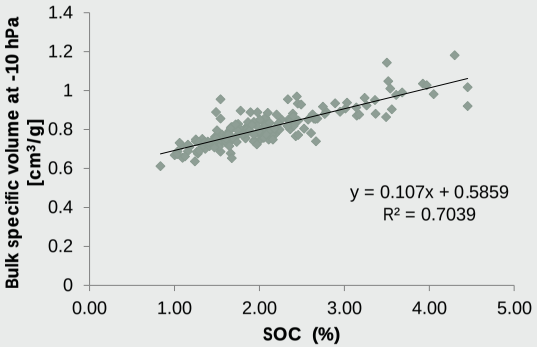


Results

Ex: Bulk specific volume at -10 hPa

Clay content range: 10-35%

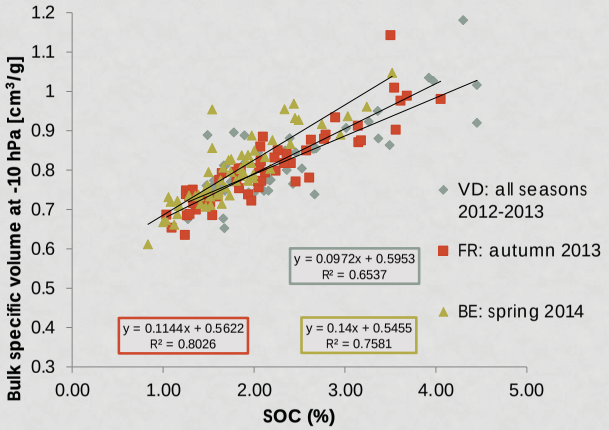
SOC could (in this case!) explain 70% of the variance



Results

Ex: Bulk specific volume at -10 hPa

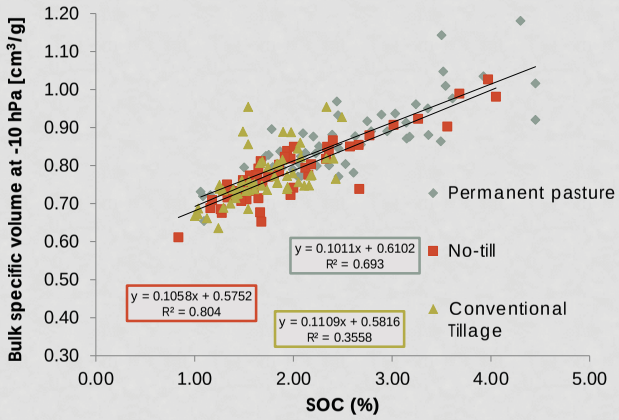
- Relation is independent of:
  - Geography
  - Season of sampling



Results

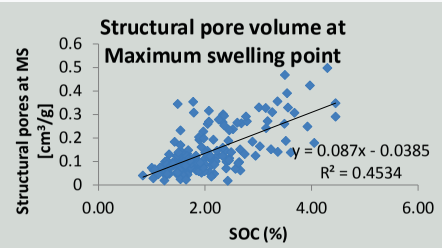
Ex: Bulk specific volume at -10 hPa

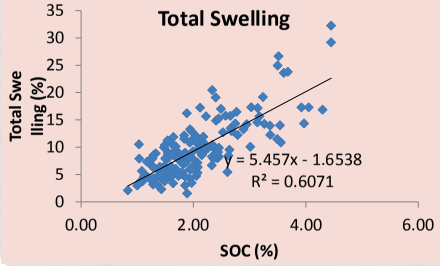
- As expected, land management does influence SOC, but…
- Relation is independent of land management!

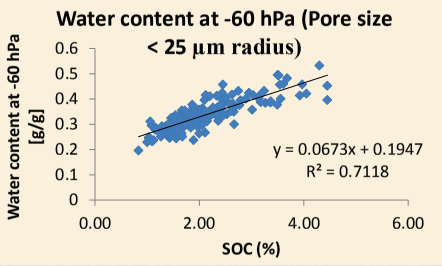


Results

- True for all the shrinkage parameters
- These are simple pedotransfer functions…
  - Validity not geographically limited
  - But by nature of the constituents (soil order)





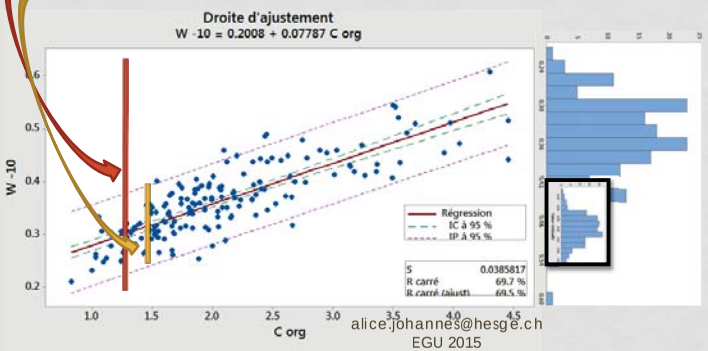


Reduced variability

This dramatically reduces the number of samples necessary to obtain a mean value!

Distribution of entire population

Distribution when SOC taken in account



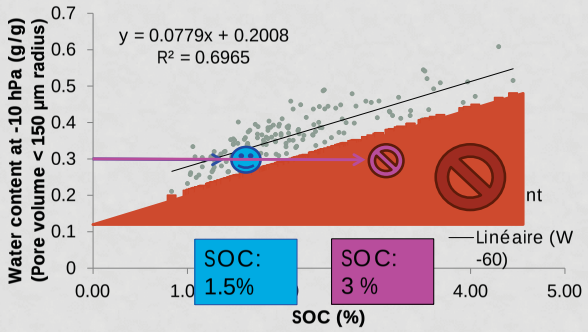
First conclusions

- We got what we need:
  - Robust (spatial & temporal variability, sampling conditions)
  - Accurate (small variance and standard errors)
  - Relevant for soil structural quality assessment

Further step

Comparing measured values to predicted values enables to distinguish degraded structure

Step 2: Comparison with structurally degraded soils



Conclusion: Establishing reference values for soil structure is feasible when using adequate precise parameters and taking in account soil colloidal constituents

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