Gembloux Agro-Bio Tech
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Evaluation of soil structural changes through macroscopic and microscopic measurement

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Introduction

The heterogeneity of soil structure and pore size distribution are highly influenced by external factors like tillage systems and other agricultural management practices. However, changes in soil hydrodynamic behavior are not fully understood and are still under research. Also, researchers have explained the impact of tillage practices on soil hydraulic properties related to pore size distribution, connectivity and orientation but the characterization of these modifications and consequences remains a challenge. Furthermore, the relation between macroscopic measurements and microscopic investigation of the soil structure remains scarce. In this study, we focus on macropore distribution by two different methods regardless any effect of tillage systems

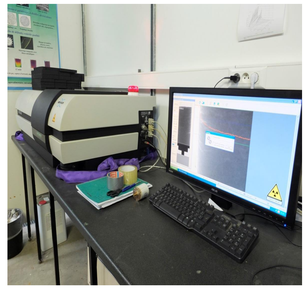
Methodology

X-ray microtomography (X-µCT) has been used in order to characterize changes in soil pore size distribution in various contexts and the method is able to link microtomography information to hydrodynamic measurement. In our study, X-µCT and evaporation method was combined to get pore size distribution near saturation

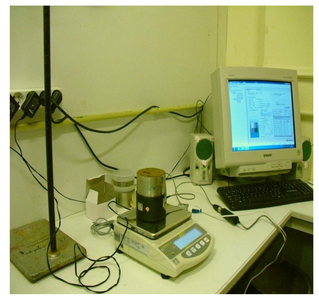
Soil sampling has been done in Gembloux, Belgium. Four different tillage systems has been considered (Winter plough, strip till, Reduced-till with residues and Reduced-till without residues)

3 undisturbed soil samples at **45-60 cm** (at this depth there is **barely any difference** among different tillage systems)

3 samples
2samples 3cm
1sample 5 cm



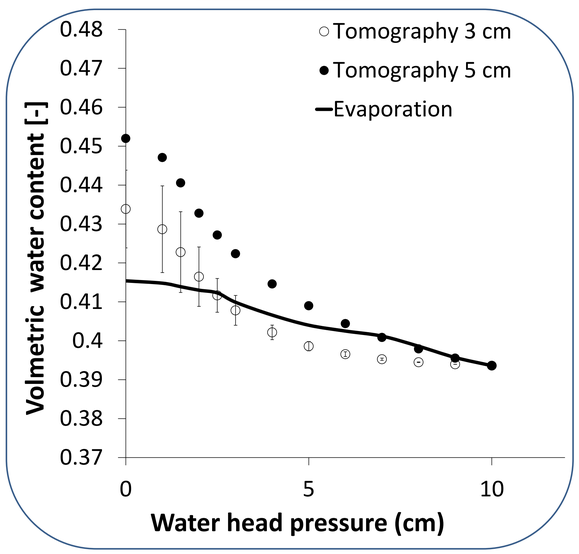
Skyscan-1172 high-resolution desktop micro-CT system (Skyscan, Kontich, Belgium)
Image pixel size of 27.27 µm
Rotation step was 0.3° over 180°
The cone beam source operates at 100 Kv
Al-Cu filter is used



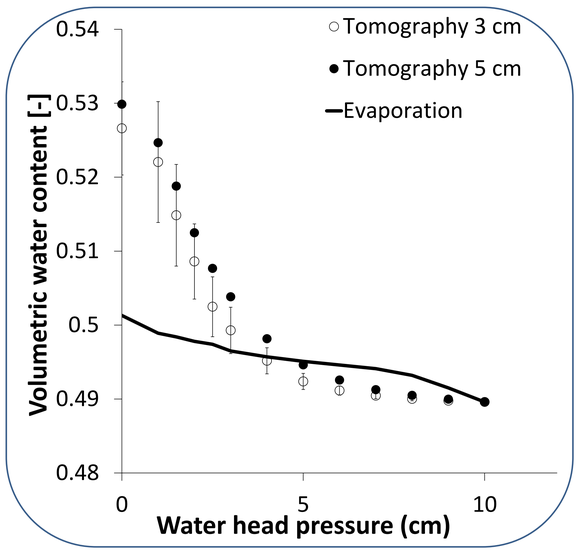
HYPROP© modular lab apparatus
Each tensiometer's range +20 hPa to -1200 hPa / -2500 hPa
Resolution 0.01 hPa
Accuracy 1.5 hPa (0 hPa to 800 hPa)

Results

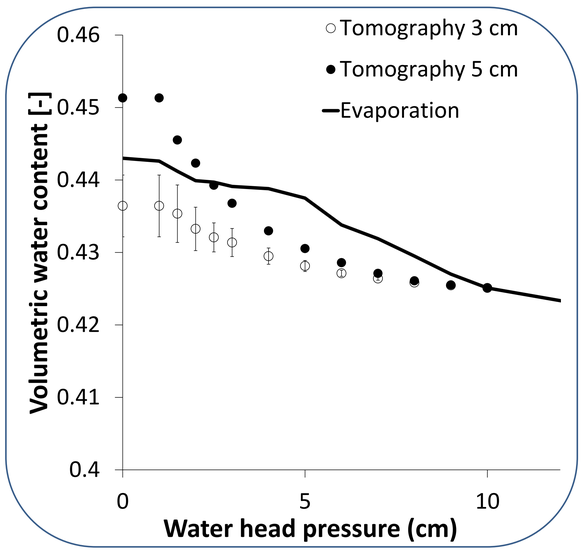
Winter plough



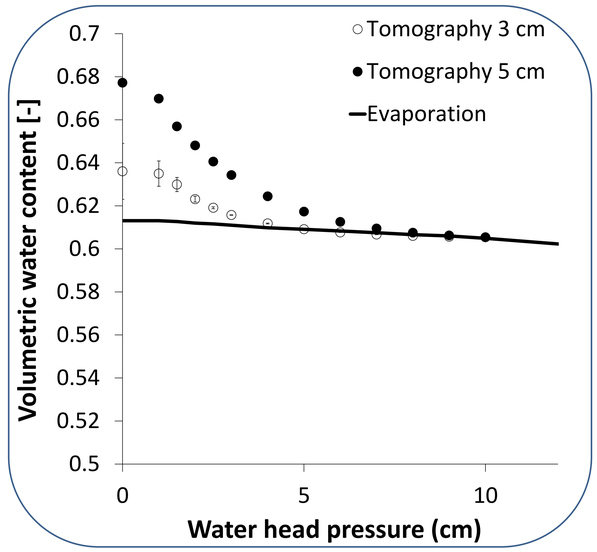
Strip tillage



Reduced tillage without residues



Reduced tillage with residues



Conclusion

- ✓ The extented pF curve obtained from microtomography shows **different dimension of macropore** at saturation compared to observed by evaporation method
- ✓ The pF curve from evaporation measurement remains almost flat, while microtomography gives more **variation**
- ✓ The microtomography provides the **actual size of macropore** (of course depending on accurate image analysis) no matter it is filled with water or empty but evaporation measurement count that pore only when it is empty
- ✓ But there is **NO** statistical significant difference on volumetric water content between microtomography and evaporation measurement
- ✓ We can conclude that X-ray microtomography and evaporation method (Hyprop©) can be coupled together to gather data on pore size distribution and connectivity within the soil matrix **near saturation**

Reference
E. Beckers, E. Plougonven, N. Gigot, A. Léonard, C. Roisin, Y. Brostaux, and A. Degré. 2014. Coupling X-ray microtomography and macroscopic soil measurements: a method to enhance near-saturation functions? Hydrol. Earth Syst. Sci., 18, 1805–1817.

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