Soil water-structure interaction in the tilled horizon as monitored in space and time by 2D Electrical Resistivity Tomography method

Maud Seger, Arlène Besson, Guillaume Giot, Bernard B. Nicoullaud, Isabelle I. Cousin

Soil water-structure interaction in the tilled horizon as monitored in space and time by 2D Electrical Resistivity Tomography method

Séger M.[1], Besson A.[1,2], Giot G.[1], Nicoullaud B.[1], Cousin I.[1]

[1] Soil Science unit, UR0272, INRA Centre d'Orléans, avenue de la Pomme de Pin, CS 40001, Ardon, 45075 Orléans cedex 2, France. maud.seger@orleans.inra.fr

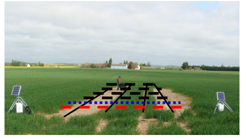
[2] UMR LISAH, INRA Montpellier, place Pierre VIALA, 34060 Montpellier, France

Introduction

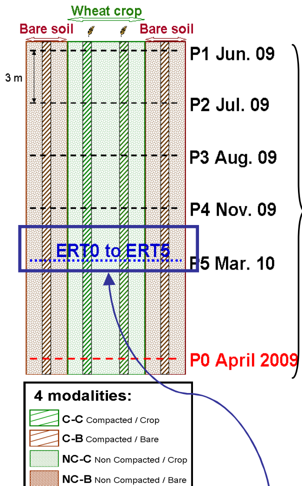
The soil water content changes in space and time as function of human, biological and climate activities. **The assessment of changes in soil water content, requires its precise space and time monitoring and then the use of non-invasive and exhaustive tools**, as geophysical methods. One of them, the Electrical Resistivity Tomography (ERT) is known to be very sensitive to the soil water content. But it is strongly influenced by the soil structure too (Besson et al., 2004; Séger et al., 2009). **The objective of this study was to analyse in space and time the soil water-structure interactions on resistivity measurements.** The study was conducted in field conditions.

Material and methods

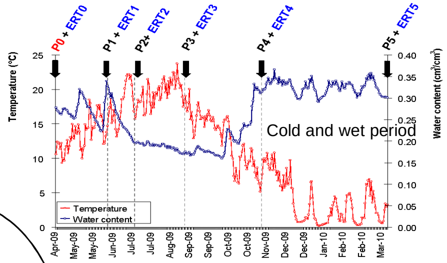
Experimental site



- Beauce Region (France)
- Typical Luvisol (WRB, 2006)
- **Creation of contrasted structural states:** 4 compacted bands by wheeling at field capacity
- **Creation of a large water content scale:** bare soil and cultivated soil
- Temporal and spatial monitoring of the soil water content and the soil structure



Soil water content and temperature



Soil sensors

During the whole period of the experiment in the 4 modalities, control of :

- **Soil temperature:** Thermistance probe
- **Soil water content (SWC):** TDR probes

In situ measurements

- **Temporal monitoring of the soil structure: soil pit dug (P0 to P5)**

→ Visual description (Manichon, 1982) with identification of the zones showing different degrees of compaction

→ Systematic soil cores sampling (see location on P1 profile) for measurements of bulk density in the 4 modalities

- **Temporal monitoring of the soil electrical resistivity at the same location (ERT0 to ERT5):**

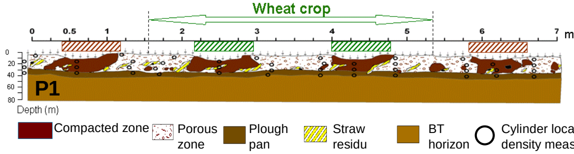
→ 72 electrodes, 0.1 m apart, Wenner array

→ Syscal Pro Resistivity meter (Iris Instrument, France)

→ Inversion: Res2DInv software (Geotomo, software), time-lapse inversion (reference = ERT0), temperature correction (Besson et al., 2009)

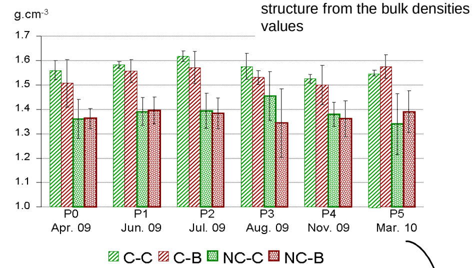
Results

Temporal changes in soil structure



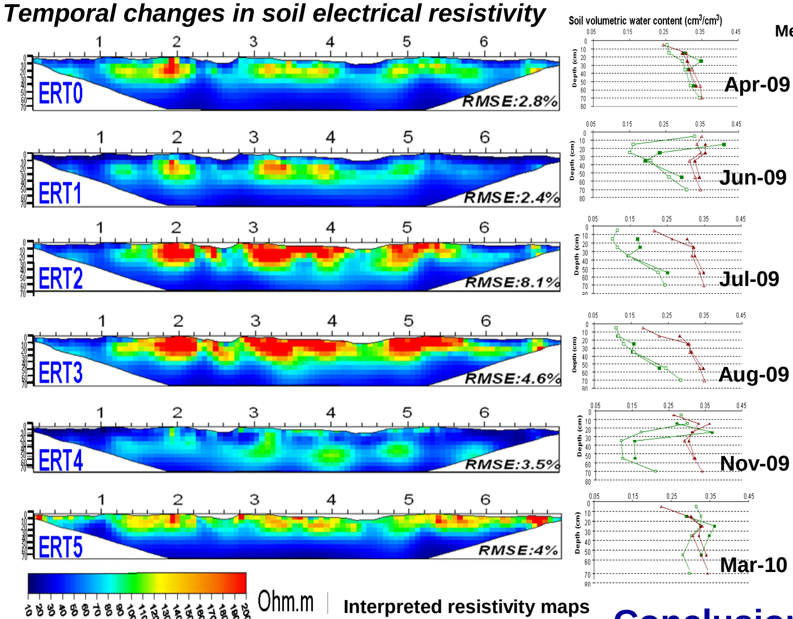
Analysis of the bulk density values

Difficulties to analyse temporal changes in soil structure from the bulk densities values

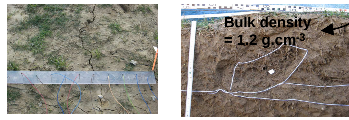


Mean bulk density in the cultivated layer (0-30 cm)

Temporal changes in soil electrical resistivity

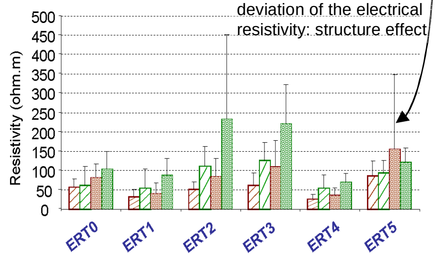


Interpreted resistivity maps

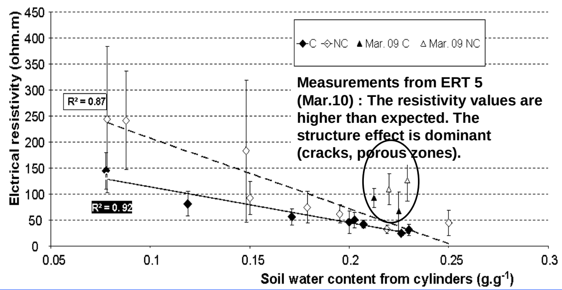


Desagregation of the soil structure observed at the soil surface and on the vertical pit of March 2010

High mean and standard deviation of the electrical resistivity: structure effect



Soil water-structure interaction on electrical resistivity



Conclusion

This study showed that a linear relationship between the electrical resistivity and the soil water content can be shown for a given soil structure. The effect of soil structure on electrical resistivity is clearly demonstrated: the electrical resistivity values are smaller when the soil is compacted. For values of water content up to 0.15 g.g[-1] the effect of soil structure is not visible except in March: the electrical resistivity was higher as expected, probably because of the formation of porous zones and cracks as described on the soil morphological profile.

Bibliography

Besson, A., Cousin, I., Samouëlian, A., Boizard, H., Richard, G., 2004. Structural heterogeneity of the soil tilled layer as characterized by 2D electrical resistivity surveying. Soil & Tillage Research, 79, 239-249.

Besson A., Cousin I., Dorigny A., Dabas M., King D., 2008. The temperature correction for the electrical measurements in undisturbed soil samples: analysis of the existing conversion models and proposal of a new model. Soil Science. 173, 10.

Manichon, H., 1982. Influence des systèmes de culture sur le profil cultural : élaboration d'une méthode de diagnostic basée sur l'observation morphologique. Thèse Docteur-Ingénieur INA P-G.

Séger M., Cousin I., Frison A., Boizard H., Richard G., 2009. Characterisation of the structural heterogeneity of the soil tilled layer by using in situ 2D and 3D electrical resistivity measurements. Soil & Tillage research, 103, 387-398.

European Geosciences Union General Assembly 2011

Vienna | Austria | 03 – 08 April 2011

The DIGISOIL project (FP7-ENV-2007-1 N°211523) is financed by the European Commission under the 7th Framework Programme for Research and Technological Development, Area "Environment", Activity 6.3 "Environmental Technologies".

UR SOLS Unité de Recherche de Science du Sol d'Orléans