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

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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

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

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

Soil water-structure interaction on electrical resistivity

- Temporal monitoring of the soil electrical resistivity at the same location (ERT0 to ERT5): 72 electrodes, 0.1 m apart, Wenner array
- Systcal Pro Resistivity meter (Iris Instrument, France)
- Inversion: Res2DInv software (Geotomo, software), time-lapse inversion (reference = ERT0), temperature correction (Besson et al., 2009)

Bibliography

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.

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.

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