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Analysis of different treatments schemes of ERT dataset in view of monitoring the structure of a soil tilled layer in space and in time

Maud Seger, Arlene Besson, Guy Richard, Bernard Nicoullaud, Guillaume Giot, and Isabelle Cousin

INRA, UR0272 Science du Sol, Centre de recherche d'Orléans, 2163 avenue de la Pomme de Pin, CS 40001 Ardon, F-45075 ORLEANS Cedex 2, France (maud.seger@orleans.inra.fr)

Geoelectric experiments have been performed for an increasing number of applications in archaeology, hydrogeology, agriculture as well as soil science in the past decade. These geophysical methods are non destructive, rapid and exhaustive. One of them, the Electrical Resistivity Tomography (ERT) gains information on subsurface resistivity structures by injecting electrical current into the soil and measuring electrical potentials at different locations from pre-installed multielectrodes lines. 2D and 3D images of the electrical resistivity of the soil can be then realized. Since the measuring process does not provide the desired information directly, a reconstruction process leading on inversion techniques for imaging the spatial distribution of resistivity is required. It consists to solve in an iterative procedure the inverse resistivity problem that is non-linear, generally ill-posed with non-unique solutions with respect to data errors, incomplete and finite numbers of measurements.

Gathering both measuring and reconstruction processes, the ERT method is largely used in soil science to monitor properties of the studied media in time and in space. For instance, ERT enables to image water and solute infiltrations in soils and the root water uptake, to identify soil layering and soil structural features as compacted clods in the soil tilled layers without any soil disturbance. Indeed resistivity measurements are sensible enough to the variability of several soil properties as water content, salinity, soil texture or bulk density. However measurements are often realized in soil wet conditions. Indeed, in dry conditions, the bad electrical contact between the electrodes and the soil, and the numerous voids in the near surface created by soil cracking and biological activity restrict the electrical conduction. As a consequence, the raw dataset is often noisy and the reconstruction process, sensible to noise, becomes hazardous. It results in estimating a set of resistivity models often unrealistic.

This point was particularly problematic in a studied case that we have conducted in field: it concerned the space and time monitoring of the soil structure by ERT measurements. The time monitoring was conducting during the entire period of growing, so ERT measurements were realized in wet as well as in dry conditions. In addition to that, we used an original experimental design of 72 electrodes spaced 10 cm apart, which was very sensitive to small heterogeneities in the near surface of the soil.

The objective of the study was then to test different schemes of data treatments in view of obtaining the best model of electrical resistivity that correspond to the monitoring in space and time of the structural changes of a loamy tilled layer.
These schemes gathered filtering strategies of raw data and various iterative least-square inversions options using Marquardt's method or smoothest inversion implemented in Res2Dinv software (Loke and Barker, 1999). They were comforted by an analysis of sensibility matrix. The time lapse method was also compared to independent inversion method. The resistivity values were converted at a given reference temperature. We discussed then the reliability, the quality and inconsistencies of resistivity models by comparison to the real structure features described on soil pits dug in the field after each ERT measurements.

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