AGU-SEG Hydrogeophysics Workshop

The effect of initial water distribution and spatial resolution on the interpretation of ERT monitoring of water infiltration

POSTER T-19
ABSTRACT #204228

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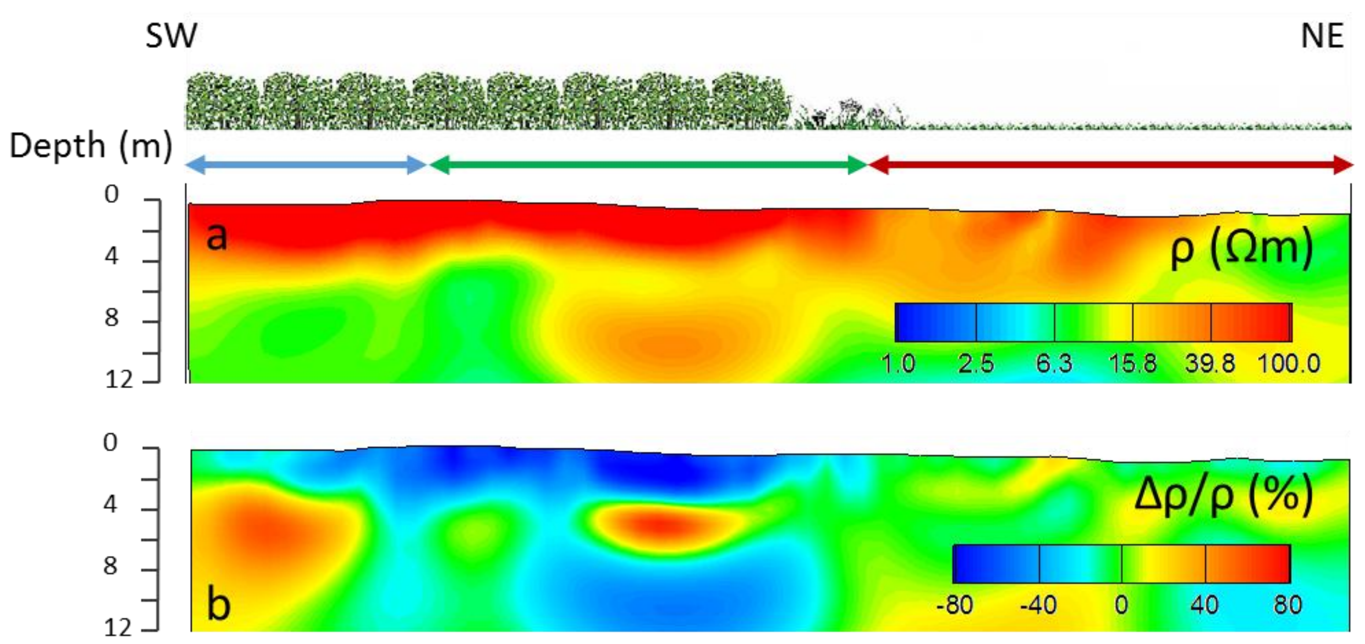
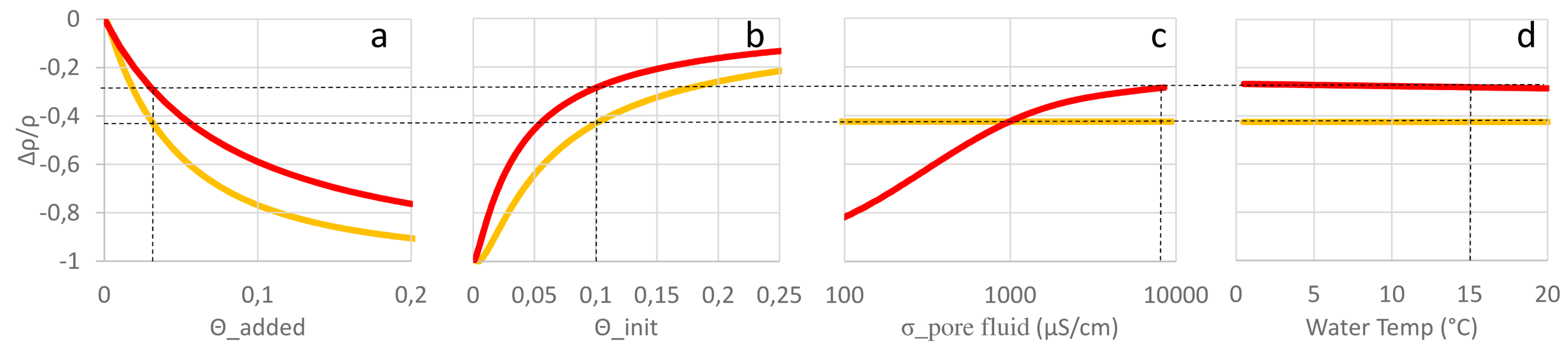
1. Context of the study

A better understanding of the water balance of a landfill is crucial for its management, as the waste water content is the main factor influencing the biodegradation process of organic waste. In order to investigate the ability of long electrical resistivity tomography (ERT) profiles to detect zones of high infiltration in a landfill cover layer, low resolution time lapse data were acquired during a rainfall event. Working at low resolution allows to cover large field areas but with the drawback of limiting quantitative interpretation.



2. Factors influencing electrical resistivity relative changes

In this contribution, we used synthetic case studies to investigate the interpretation of ERT data of a field infiltration phenomenon. The first one is a simple humid sand volume in which fresh and cold water is added. This simple case served to illustrate the effects of several state variables and parameters (the added water quantity, the initial soil water content, the initial pore fluid resistivity and the initial soil temperature) on the resistivity changes. The analysis of relative changes, as commonly used in literature, is not adequate when the background water content is highly heterogeneous. In such a case, relative changes reflect both the initial water content distribution and the observed changes.

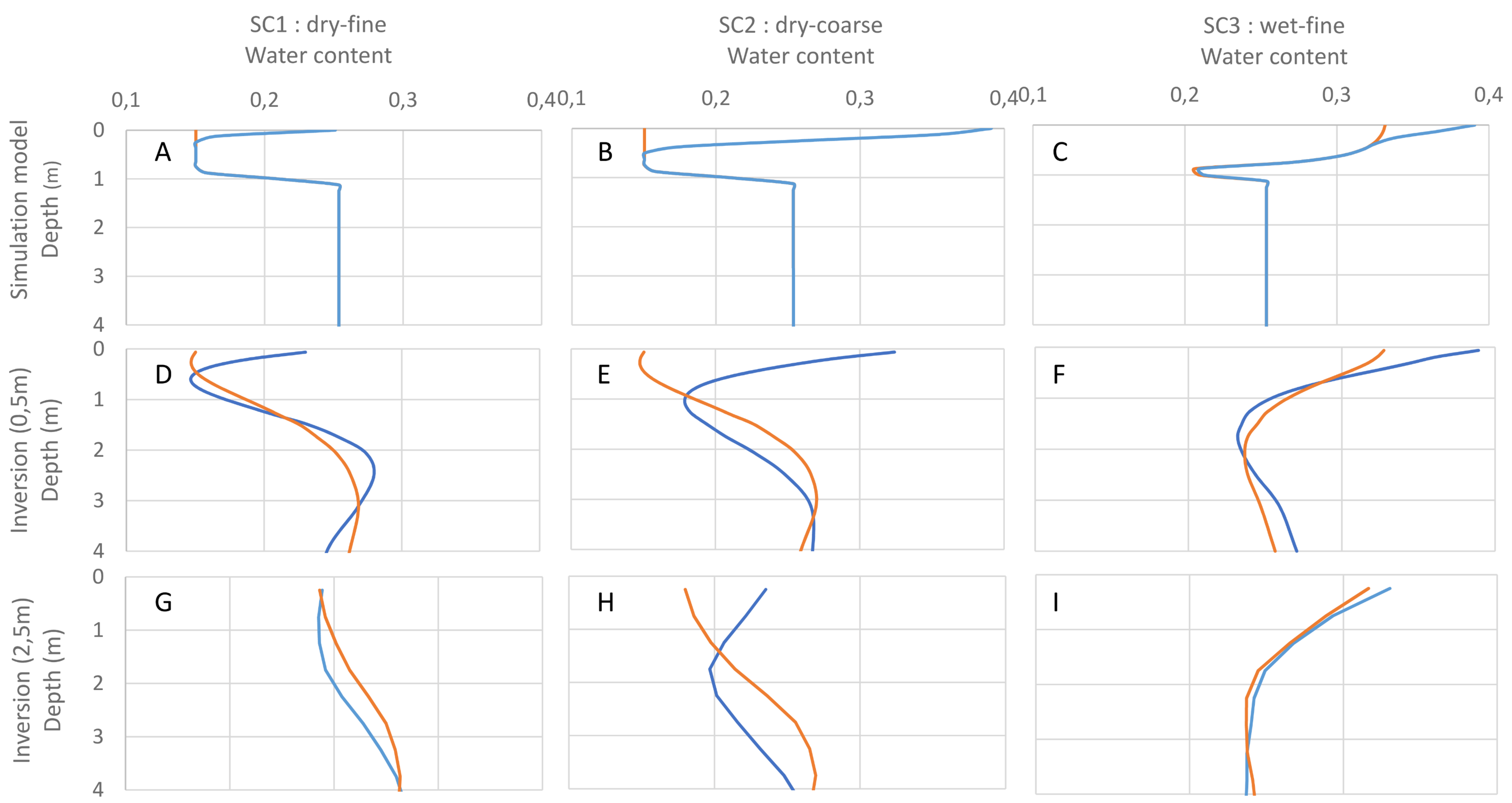


Dilution is considered for the red curves, and neglected for the yellow curves.

3. Investigation of the ERT low resolution issue

The second case study consists in an unsaturated water flow model combined with ERT data simulation and inversion to understand how the information derived from inverted resistivity data set might differ from the reference infiltration model and how the lack of spatial resolution (inherent to the ERT method), added to the originally heterogeneous water content, pore fluid conductivity and temperature distribution (as described at frame 2.) actually hinder quantitative and qualitative analysis of resistivity changes.

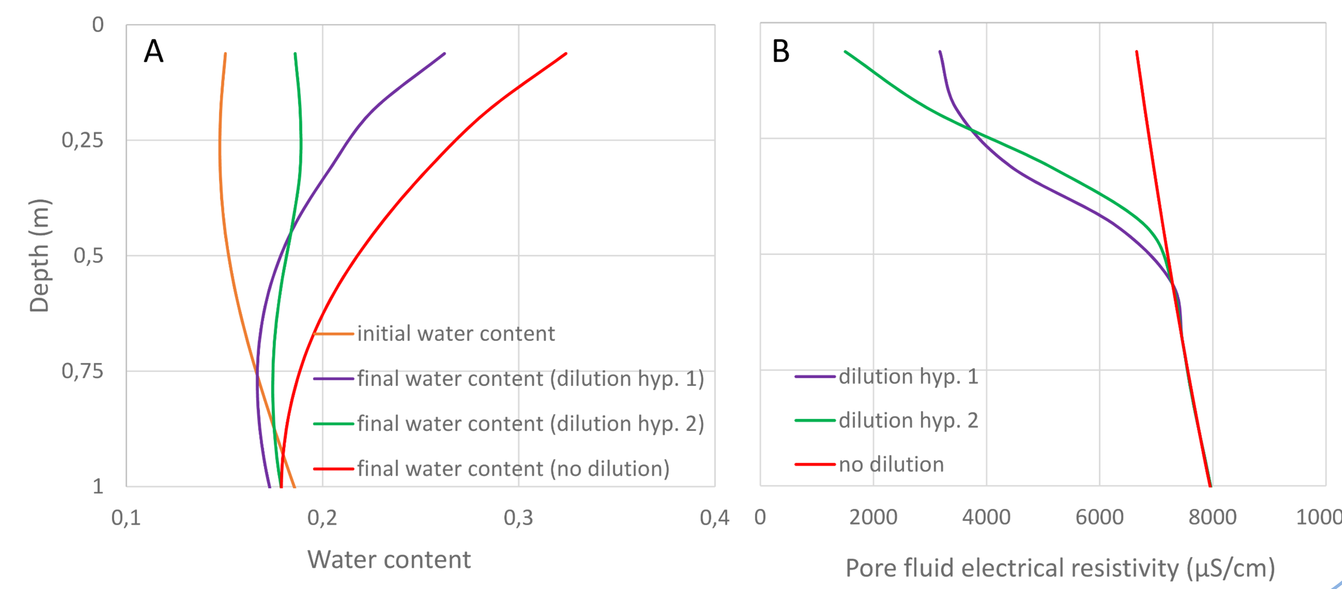
Due to the lack of spatial resolution, the regularized inversion process yields a smoothed distribution of resistivity changes that fail to detect small infiltration zones and yields an overestimation of the infiltration depth and an underestimation of the infiltrated volume in large infiltration areas. The computation of absolute water content changes better reflects the infiltration pattern, but requires spatially distributed temperature and pore fluid conductivity input data.



4. Dilution of pore water during infiltration

Given the contrast between the initial pore fluid resistivity (1-10 Ω.m) and the infiltrated water resistivity (estimated to 10 Ω.m), the salinity dilution effect is not negligible. We conducted three simulations with the same infiltrated quantity of water, but distinct hypotheses for the dilution effect (see final pore fluid profiles is figure b).

Thereafter, ERT data are simulated (with the 0.5m electrode spacing). Inverted resistivity data are converted into water content while considering a 7200 µS/cm pore fluid conductivity (1.39 Ω.m resistivity). By doing this, the dilution effect is simulated in the model, but neglected in the interpretation (figure a). The dilution effect, if not considered, leads to an underestimation (half the simulated volume) of the infiltrated volume.



5. Conclusion et perspectives

The initial water content strongly influences the observed changes. A special care is needed for water infiltration or recirculation observation in the vadose zone. The computation of the absolute water changes helps in determining the actual changes.

The choice of the electrode spacing offers a necessary compromise between the investigation scale (and geophysical survey cost) and the spatial resolution of the ERT images. The 2.5 m electrode spacing leads to smoothed resistivity distribution values that fails to quantify the observed changes. However, the detection of preferential infiltration zones could contribute to a better landfill water balance management and landfill gas emission regulation.

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