

Time lapse imaging of water content with geoelectrical methods: on the interest of working with absolute water content data

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The electrical resistivity tomography is a suitable method to estimate the water content of a waste material and detect changes in water content. Various ERT profiles, both static data and time-lapse, were acquired on a landfill during the Minerve project.

In the literature, the relative change of resistivity ($\Delta\rho/\rho$) is generally computed. For saline or heat tracer tests in the saturated zone, the $\Delta\rho/\rho$ can be easily translated into pore water conductivity or underground temperature changes (provided that the initial salinity or temperature condition is homogeneous over the ERT panel extension).

For water content changes in the vadose zone resulting from an infiltration event or injection experiment, many authors also work with the $\Delta\rho/\rho$ or relative changes of water content $\Delta\theta/\theta$ (linked to the change of resistivity through one single parameter: the Archie's law exponent "m"). This parameter is not influenced by the underground temperature and pore fluid conductivity (ρ_w) condition but is influenced by the initial water content distribution. Therefore, you never know if the loss of $\Delta\theta/\theta$ signal is representative of the limit of the infiltration front or more humid initial condition.

Another approach for the understanding of the infiltration process is the assessment of the absolute change of water content ($\Delta\theta$). This requires the direct computation of the water content of the waste from the resistivity data. For that purpose, we used petrophysical laws calibrated with laboratory experiments and our knowledge of the in situ temperature and pore fluid conductivity parameters. Then, we investigated water content changes in the waste material after a rainfall event ($\Delta\theta = \Delta\theta/\theta * \theta$). This new observation is really representative of the quantity of water infiltrated in the waste material. However, the uncertainty in the pore fluid conductivity value may influence the computed water changes ($\Delta\theta = k * m \sqrt{(\rho_w)}$; where "m" is the Archie's law exponent).

Using these two complementary approaches, we analyzed the effect of a major rainfall (20-30 mm in 2 hours) that occurred on the test site, characterized by a vegetated and relatively dry zone and a devegetated and humid zone. We intended to prove that most of the information contained in the $\Delta\theta/\theta$ distribution is the initial water content distribution in the ground. Water addition in dry zones resulting in large relative changes. The computation of the $\Delta\theta$ is necessary to demonstrate preferential infiltration through the capping in a restricted zone of the vegetated area.