Exploiting the temperature dependence of electrical resistivity measurements to monitor infiltration.

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Three resistivity probes were installed to a depth of 2m below a seasonal infiltration pond on the central coast of California in December 2007. Each probe was instrumented with 35 electrodes and designed to monitor the change in bulk resistivity beneath the pond during infiltration. The pond was filled in January 2008 and resistivity measurements were made on each probe every hour for a period of 4 months. We observe diurnal fluctuations in the apparent resistivity signal due to the temperature dependence of in-situ resistivity. By processing the resistivity data, using a tight band pass filter, we can recover a time-depth section of pseudo-temperature data. We refer to these data as pseudo-temperature because they can be treated as a surrogate for temperature in terms of phase but not amplitude. The three filtered time series have a vertical resolution of approximately 8cm (electrode spacing), and a temporal resolution of 1hr. We used the pseudo-temperature data, along with measurements of pond stage (depth) over the entire experiment, to obtain estimates of 1D infiltration rates and hydraulic conductivity. From this analysis we clearly see a marked decrease in the pond infiltration rate throughout the 4 months of operation; this observation is consistent with pumping and pond stage records at the site. The observed variation in phase shift with depth suggests that the decrease in infiltration is due to clogging that is occurring in the top ~1m of the soil column. The use of the temperature dependence of measured resistivity is a promising field technique. The pseudo-temperature data, from the diurnal signal, can be acquired with no additional effort as part of a resistivity monitoring experiment. Future research will involve extending this approach to 2D and 3D tomography allowing us, in specific situations, to obtain spatially exhaustive estimates of near-surface infiltration rates.