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Combining time-lapse electrical resistivity, suction cup and tensiometer measurements to monitor snowmelt and solute transport at Oslo airport, Gardermoen

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Geophysical methods provide indirect measurements of subsurface properties over larger volumes than traditional techniques, and are potentially cost-efficient. However, the usefulness of any individual set of geophysical measurements (akin to a snapshot at one point in time) is severely limited by the problem of non-uniqueness or ambiguity when used to study contaminated sites, where the attendant processes vary in space and time. To make progress on soil contamination assessment and site characterization there is a strong need to integrate quasi field-scale, extensively instrumented tools, with non-invasive (geophysical) methods.

The impact of annual infiltration of large quantities of de-icing chemicals at Oslo airport, Gardermoen, represents common challenge for all airports with winter frost. It is also similar to the challenge posed by de-icing salt application along roads. To improve risk assessment, monitoring, and treatment strategies for natural attenuation, we require a better understanding on the resistivity effects from infiltrating snowmelt and contaminant movement to the methods suitable for monitoring resistivity changes over time at contaminated sites.

Electrical and electromagnetic methods are widely applied for soil mapping and detecting of contaminated plumes. Time-lapse measurements have become a common method to characterize changes in water saturation and solute transport in the unsaturated zone (French and Binley, 2004; French et al. 2002). The non-uniqueness of the interpretation techniques can be reduced by constraining the inversion through the addition of independent measurements along the same profile. Such measurements include soil physical properties, soil suction, contaminant concentration and temperatures.

At the research field station at Gardermoen, a degradable de-icing chemical and an inactive tracer were added to the snow cover prior to snowmelt. In order to link geophysical measurements to solute transport processes in the unsaturated zone, time-lapse cross borehole resistivity measurements were conducted at the same time as soil water samples were extracted at multiple depths with suction cups. Measurements of soil temperature, and tension were also carried out during the monitoring period. We present a selection of results from the snowmelt experiments and combination of measurement techniques and illustrate the potential strength of geophysics for mapping snowmelt and solute transport.