Spatial and temporal variability of the unsaturated zone characterised by geophysical and conventional methods

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Oslo Airport Gardermoen
4 km
2 km
4 km
Simulations of flow and transport based on random fields of the permeability.
Moreppen

GPR profiles

Ground Penetrating Radar
How do we characterise the spatial variability?

- Range
- Semivariance

Soil Physical data

Geophysical data

Geophysical images

Which data do we use?
Sampling points, soil physical data, vertical section
Semivariogram analysis
From soil physical data to inverted geophysical data

Semivariogram Angle: 0, Tolerance: 7
Variogram analysis of resistivity data in a horizontal plane
Variogram Model for horizontal data

Gaussian model
Nugget: 3.25
Range: 1.27
Sill: 7.78
Time changes in spatial structure

Gaussian model, omnidirectional

### Times and range changes

- **Range (m)**
  - 28.03
  - 5.04: Increase
  - 11.04: Decrease
  - 16.04
  - 19.04
  - 25.04: Decrease
  - 30.04

### Nugget and Sill (m^2)

- **Nugget**
  - 0.2
  - 0.4
  - 0.6
  - 0.8
  - 1

- **Sill**
  - 2.8
  - 3.0
  - 3.2
  - 3.4
  - 3.6
  - 3.8
  - 4

- **Total Sill**
  - 5
  - 7
  - 9
  - 11
  - 13
  - 15
  - 17
  - 19
  - 21
  - 23
  - 25
  - 27
  - 29
  - 31
  - 33
  - 35
  - 37
  - 39

### Dates and Changes in Spatial Structure

- **28.03**: Initial range and nugget.
- **5.04**: Increase in range and nugget.
- **11.04**: Decrease in range and nugget.
- **16.04**: Range and nugget stabilize.
- **19.04**: Slight increase in range and nugget.
- **25.04**: Decrease in range and nugget.
- **30.04**: Range and nugget remain consistent.
Semivariograms of resistivity and changes in resistivity show different behaviour.

Inverted resistivities (at 0.32 m)

Ratioed inverted resistivities (at 0.32 m)
Conclusions

- All methods give similar size of the range
- The semivariance may vary considerably with time, especially during snowmelt, but the range seems to remain fairly constant
- Geophysical methods may serve as a supplementary method for characterisation of spatial correlation structure
- Electrical methods offer great potential for characterising the dynamics of spatially variable processes