Soil crack dynamics as driver for preferential flow in clay-rich soils

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Material & Methods

Three plots (0.7 x 0.7 m) were installed on a corn field with a silty clay texture.

Period: 7 July - September 21st

Measurements:
- Crack occurrence on the soil surface
- Time lapse photography (1 photo/hour)
- Crack depth: anisotropy of apparent electrical resistivity (AARo) - 3 cm depth resolution
- Soil water content: 3 depths (5, 10, 20 cm)
- Meteorological forcing: rainfall (mm/day), shortwave radiation, air temperature

Image Processing

Crack Surface Area (m²/m²)
One image per week for all three plots were manually digitized.

Additionally, digital image processing was used to classify cracks during specific events. This was based on the Python code of Beck et al. (2018) which includes:
- Contrast enhancement (bit greyscale)
- Threshold filtering
- Morphological opening
- Size filtering

Crack Surface Density (m/m²)
Image J/ij: Analyze Skeleton tool

Wetting 1

Crack Surface Area

1h

5.2
16.9

1.6 %
4.0 m²/m²

Mean area
mean density

Wetting 2

Crack Surface Area

1h

4.6
15.7

0.5%
1.7 m²/m²

Mean area
mean density

Wetting 1: 21-26 July - 4 rainfall events (41 mm)
Drying: 3-17 Aug - only minor rainfall
Wetting 2: 28 Aug - 1 rainfall event (9.7 mm)

Mean temporal dynamics

Three major phases:
- Wetting 1: 21-26 July - 4 rainfall events (41 mm)
- Drying: 3-17 Aug - only minor rainfall
- Wetting 2: 28 Aug - 1 rainfall event (9.7 mm)

Conclusion

- Large surface crack area does not lead to higher amounts of preferential flow.
- Surface crack area and density decreases rapidly during a rain event (hour).
- For following events a higher topsoil water content favors subsurface initiation of preferential flow unless cracks are closed at the surface.
- High amounts of rain are necessary for closing a soil crack in the subsurface.