Numerical model of water flow and solute accumulation in vertisols using HYDRUS 2D/3D code

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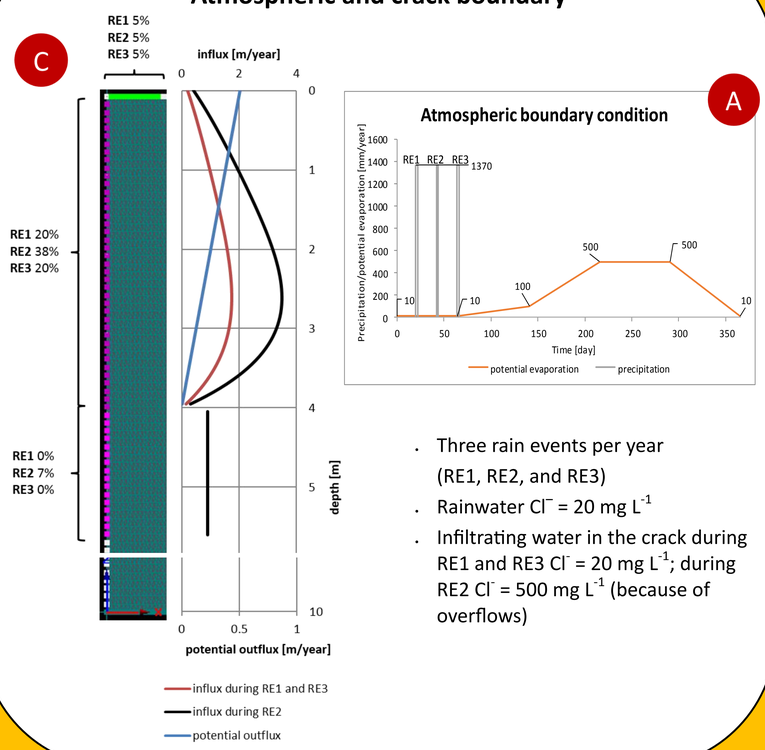
Introduction

Vertisols cover a hydrologicaly very significant area of semi-arid regions often through which water infiltrates to groundwater aquifers, therefore understanding of water flow and solute accumulation is very relevant to agricultural activity and water resources management. This poster presents a conceptual and 2D numerical model of water flow and chloride accumulation in cracked soil in coastal Israel at a site of a common dairy farm. The hydraulic model uses the well-known Richards' equation, the van Genuchten—Mulaem (1980) function for unsaturated hydraulic properties, and the convection-diffusion equation for solute transport. The conceptual model is based on the works of Baram et al. (2012a, 2012b, and 2013) .

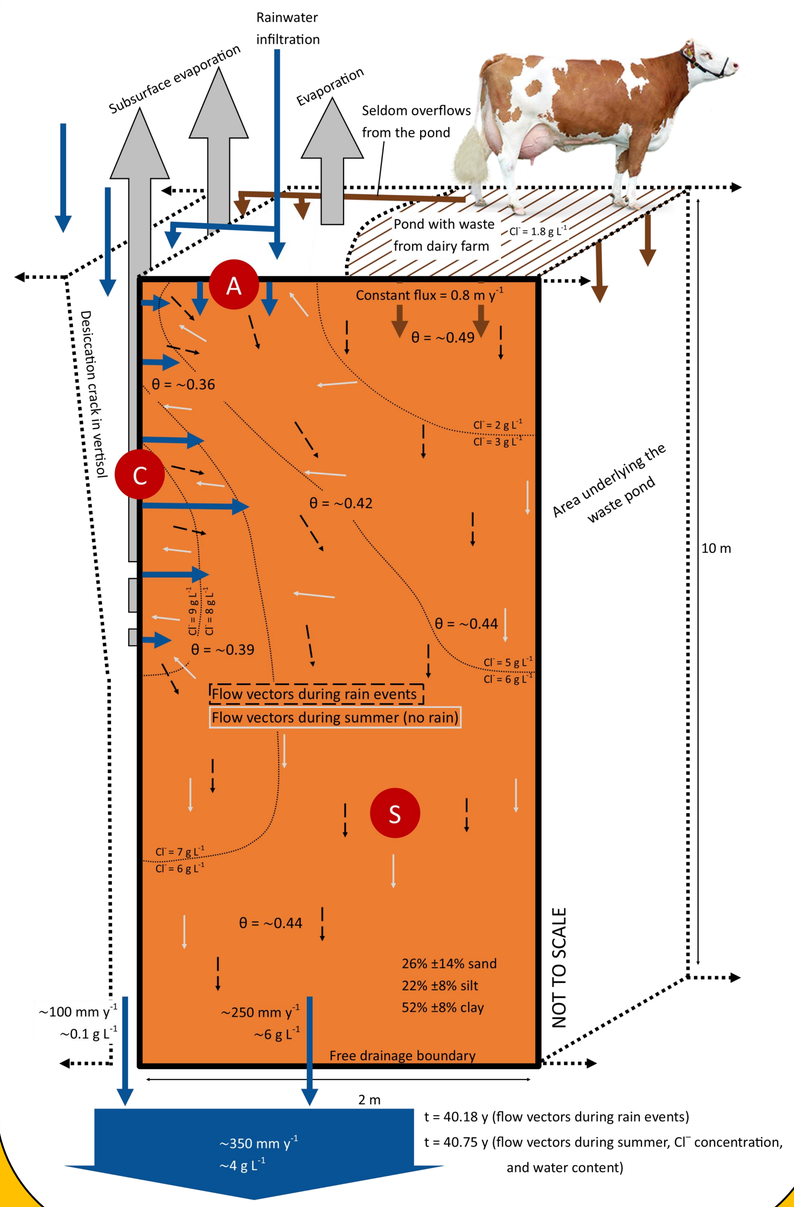
Atmospheric and crack boundary



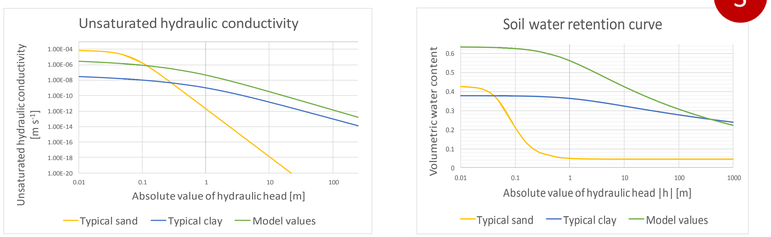
- Three rain events per year (RE1, RE2, and RE3)
- Rainwater Cl^- = 20 mg L^{-1}
- Infiltrating water in the crack during RE1 and RE3 Cl^- = 20 mg L^{-1}; during RE2 Cl^- = 500 mg L^{-1} (because of overflows)

Conceptual model

(with results of numerical model)



Material



Calibration process

Simulations were conducted using several modeling approaches with an ultimate goal of fitting the simulation results to the controlling variables measured in the field: temporal variation in water content, soil salinity (Cl^-) and water salinity leaving the domain based on salinity of the aquifer beneath the site. The development of the model was engineered in several steps; all computed as forward solutions by trial-and-error approach. The main fitting parameters were: parameter *a* and *n* in the soil water retention curve and saturated hydraulic conductivity. The amount of infiltrated water (within a reasonable range), the infiltration function in the crack and the actual evaporation from the crack were also used as secondary fitting parameters.

Important results

- Desiccation cracks play a crucial role in hydrology of vertisols:
  - >90% of rainwater infiltrates through the cracks
  - Cracks responsible for >70% of total evaporation
  - Rapid infiltration of rainwater beneath the model domain
  - Infiltration through cracks increases with depth, up to 3 m (C)

References

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van Genuchten, M. T., 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Sci. Soc. Am. J.,* pp. 892-898.