Vulnerability to salinization of thin fresh water lenses for different climatic and hydraulic conditions

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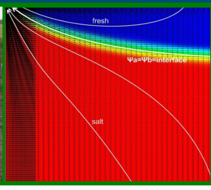
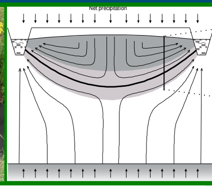
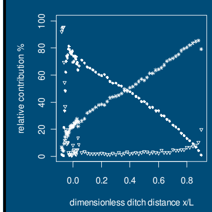
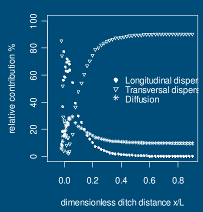



Fresh water lenses on saline water in deltas

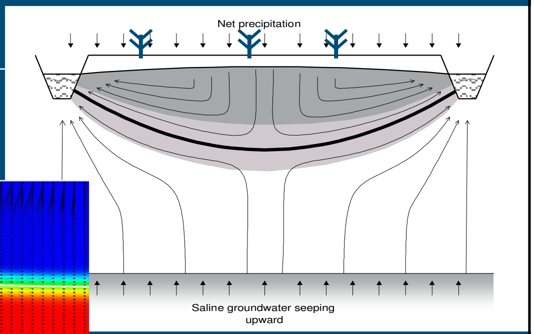
- Fieldwork and monitoring of real-life lenses
  - What is actually happening out there?

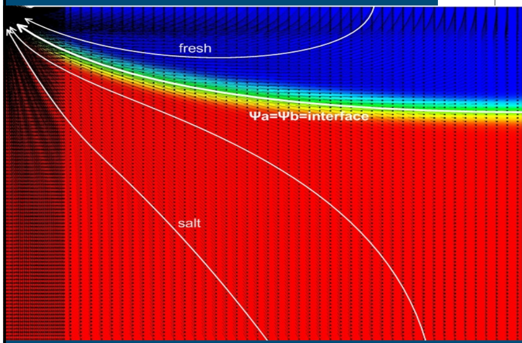




- Numerical modeling of lenses
  - What mechanisms play a role? What is (theoretically) happening?

Schematization





Numerical Model

- SUTRA: saturated/unsaturated density dependent groundwater model

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Steady state lens analysis

- Size of lens and transition zone under certain conditions
- Dimension analysis to group parameters together logically
- Sensitivity test on the resulting Dimensionless Groups

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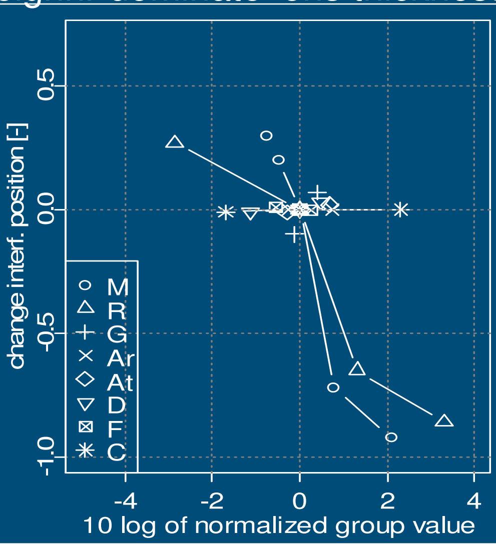
Mass flux ratio and Rayleighnr dominate lens thickness

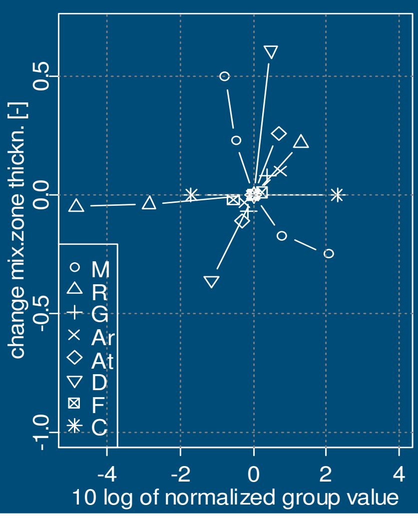
- Mass flux ratio M: Seepage/Precipitation, incl. density difference
- Rayleigh number R: Density induced flux/precipitation



Mixing-groups and mass flux ratio dominate trans. zone thickness

- Diffusion coefficient D
- Mass flux ratio M
- Transverse dispersivity A_t

- Geometry G, Longitudinal dispersivity A_r, and the ditch resistance C are of minor importance



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Seasonal variation and climate change

- Steady state not to be expected; quantification of lens response to weather/climate change relevant
- We are finally interested in damage occurring to crops or natural vegetation
- This is work-in-progress!!
  - SWAP (1D) to include crop-parameters
  - Relate back to lens using SUTRA (to be done)

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Link to sensitivity analysis

- Inter-seasonal variations
- Sea level rise
- Climate change
  - Rayleigh number and Mass flux ratio may both change
  - Where/when should “critical” situations be expected (not limited to Dutch situations)

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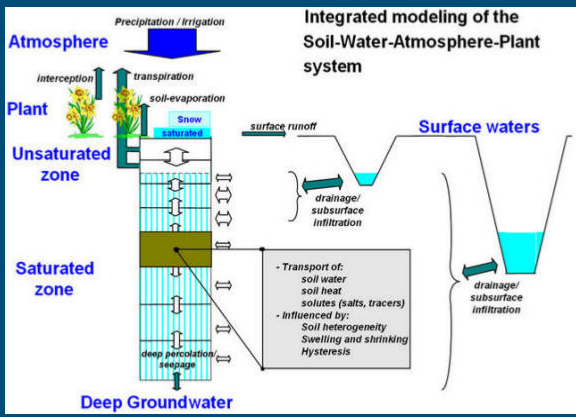
SWAP Soil-Water-Atmosphere-Plant

- Parameters:
  - Climate: Nl, It
  - Soil: Clay, Loam, Sand
  - Groundwater: level and salinity
  - Plants: Root parameters, water demand, salinity tolerance
  - Total 3888 combinations

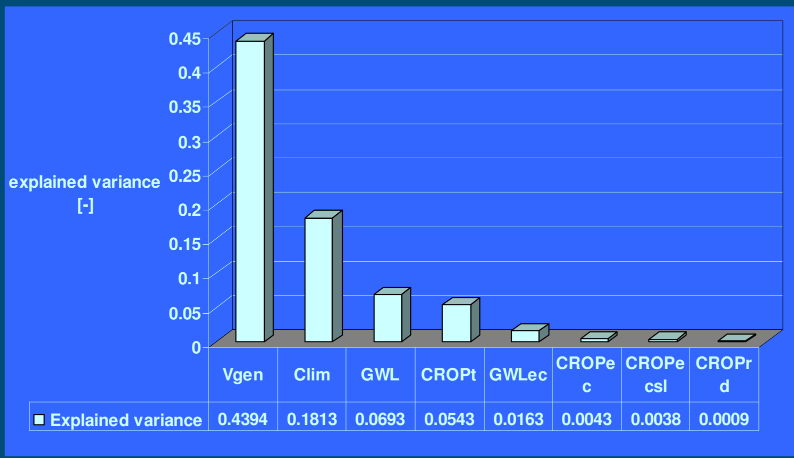


Analysis of simulation outcomes

- Response variable: Crop damage
  - Defined as a decrease in plant transpiration compared to the potential transpiration
  - Caused by oxygen stress, drought stress and salinity
- Regression and ANOVA used to
  - Define the most important variables
  - Differentiate between wet and dry conditions
- Attention: we do NOT irrigate in these simulations.
  - Saline water only comes from below

Crop parameters minor compared to soil & climate

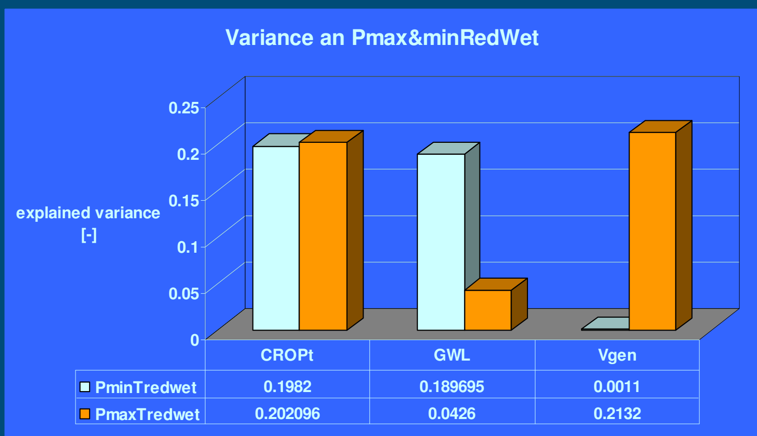
- Variance analysis on all runs, averaged over 26 years



	Vgen	Clim	GWL	CROPt	GWLec	CROPec	CROPecsl	CROPrd
Explained variance	0.4394	0.1813	0.0693	0.0543	0.0163	0.0043	0.0038	0.0009

Oxygen stress dominated by crop, gwl and soiltype

- Variance analysis on a very wet and a very dry year

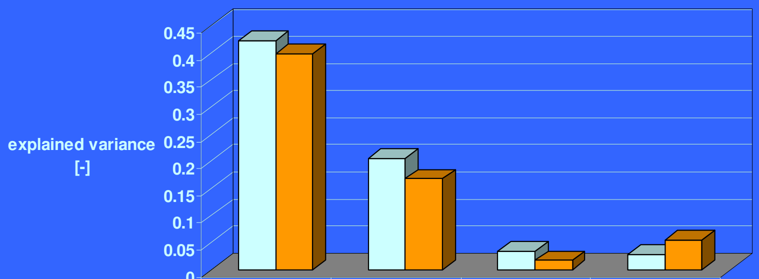


	CROPt	GWL	Vgen
PminTredwet	0.1982	0.189695	0.0011
PmaxTredwet	0.202096	0.0426	0.2132

Drought stress dominated by soil type

- Variance analysis on a very wet and a very dry year

Variance an Pmax&minRedDry



	Vgen	Clim	GWL	CROPt
PminTreddry	0.4227	0.2056	0.0344	0.0287
PmaxTreddry	0.3994	0.168	0.0176	0.0556

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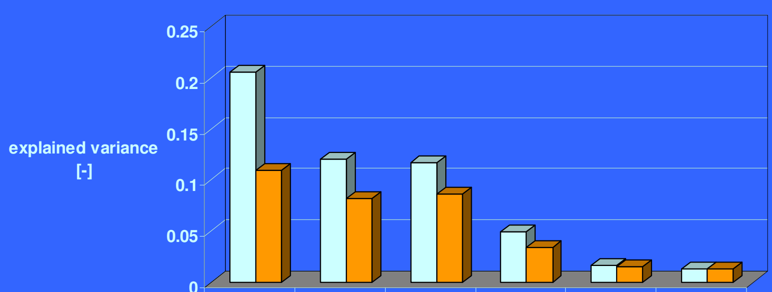
Salinity stress dominated by climate, gwl and soiltype

- Variance analysis on a very wet and a very dry year

Variance an Pmax&minRedSol



	Clim	GWL	Vgen	GWLec	CROPt	CROPec
PminTredsol	0.2056	0.1203	0.1171	0.0491	0.0163	0.0136
PmaxTredsol	0.1095	0.0822	0.0861	0.0335	0.0159	0.0134

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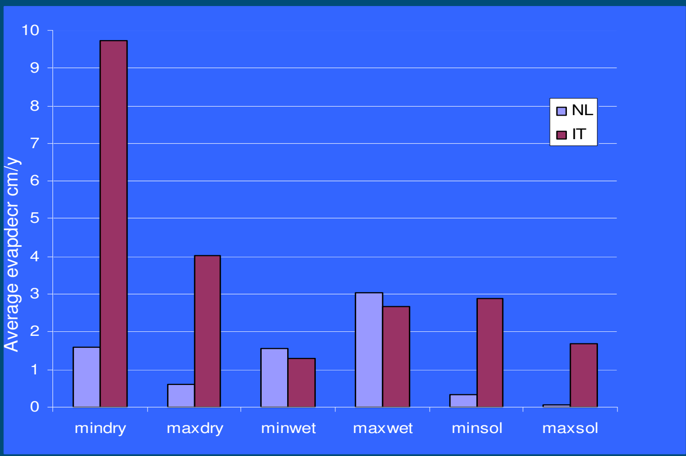
Mediterranean vulnerable for drought and salinity damage



Some preliminary conclusions

- Sensitivity to oxygen and salinity stress seems to increase strongly when the climate gets warmer… to be quantified
- The relation between soil type and crop damage appears to be strong for all kinds of damage. This needs to be elaborated

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Thank You!

Questions? Comments? Suggestions?

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Dimensionless groups steady state

Position

- Raleigh nr. $\frac{\kappa_{zz}\Delta\rho g}{\mu P}$
- Recharge ratio $\frac{\rho_s S}{\rho_0 P}$

Others

- Anisotropy factor $\frac{\kappa_{zz}}{\kappa_{xx}}$
- Geometrical ratio $-\frac{H}{L}$
- Ditch resistance $\frac{\mu L}{\rho_0 g c}$

Thickness

- Transverse Dispersivity $\frac{\alpha_t}{L}$
- Dispersivity difference $\frac{\alpha_l - \alpha_t}{L}$
- Diffusivity $\frac{D_m}{\tau L v_r}$

See Eeman et al., subm.

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Slide 18

S1 deze slide is alleen om voor evt., vragen achter de hand te hebben.
Eeman; 27/09/2010