

Local Climate Proof Fresh Groundwater Supply
adaptation water management strategy with national impact?

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 freshsalt.deltares.nl





Perry Esther Joost Pieter Marta

SWIM22: 19-22 June 2012

Outline

- Impressions of the bigger picture of fresh water resources
- My perspective
- Threats in fresh water resources
- What can we do about it?
- Changes for us SWIMers
- 10 Steps Procedure Climate Proof Fresh Water Supply

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Mission: Enabling Delta Life

Professional goal:
 Local Climate Proof Fresh Groundwater Supply

Personal goal:
 Working together with nice and interesting persons

Can we make a difference?


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Base idea

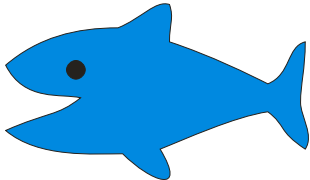
Many local solutions for fresh groundwater supply can have regional impact

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Starring

solution fresh groundwater supply




SWIM22 2012




Starring

Local solution fresh groundwater supply




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Starring

climate and global change




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climate and global change





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Local solution fresh groundwater supply

climate and global change

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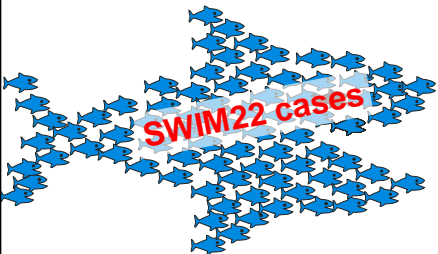

What should be the response?

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Many local solutions fresh groundwater supply

climate and global change

Many local solutions for fresh groundwater supply can have regional impact

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Key activities

- upscaling local cases to regional strategy
- assess economical feasibility
- increase impact: communicate our showcases
- working together



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Working together

Key-players of *Working together*:

- Universities
- Research institutes en Geological Surveys
- Consulting companies
- Water managers
- End users!

Universities <-> knowledge institutes <-> companies <-> end users

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Work together and learn from each other in the coastal zone

Areas in the world vulnerable to a rise in sea level
 ▲ Major river deltas of the world (J. M. Coleman, 1981)

www.delta-alliance.org

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Rol of SWIM community

A SWIM mission:

*To provide areas with fresh-salt issues
 enough and clean water
 in a sustainable way and at the right moment of time*

SWIM community

- - somewhat introvert, not yet enough impact
- + much experience and knowledge
- + young potentials

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Groundwater in the future

We have to cope which...:

- Development energy use/production (heat-cold)
- Groundwater extractions
- Land subsidence
- Climate change
- Development spatial land use
- Politics, Policy & Watermanagement

Direct anthropogenic influence on groundwater is more important than climate effect

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Global Change

1

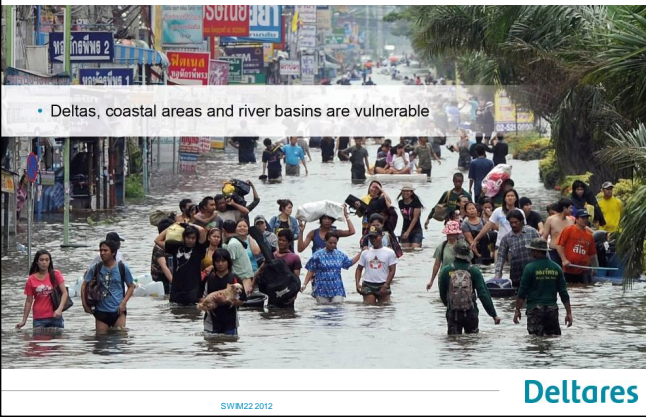
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Living in deltas, coastal areas and river basins

- Throughout the world, more and more people are settling in deltas, coastal areas and river

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Living in deltas, coastal areas and river basins

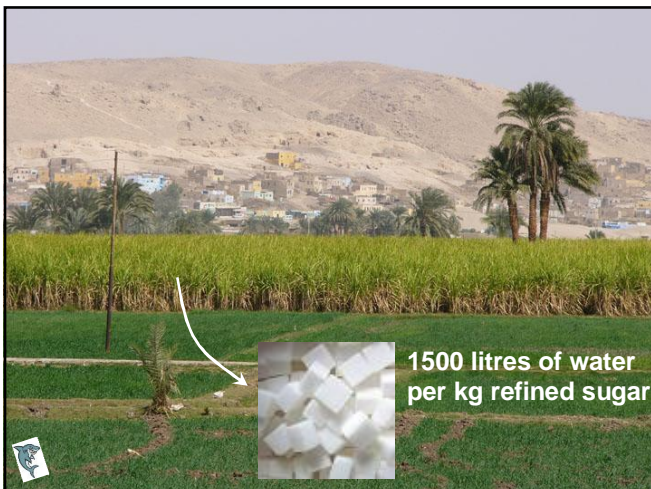



On water use...

I rest my case and say no more

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= 140 litres of water



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10 litres of water
for 1 sheet of A4-paper

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The water footprint of products

1 kg wheat	1 m ³ water
1 kg rice	3 m ³ water
1 kg milk	1 m ³ water
1 kg cheese	5 m ³ water
1 kg pork	5 m ³ water
1 kg beef	15 m ³ water

global averages






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Climate Change

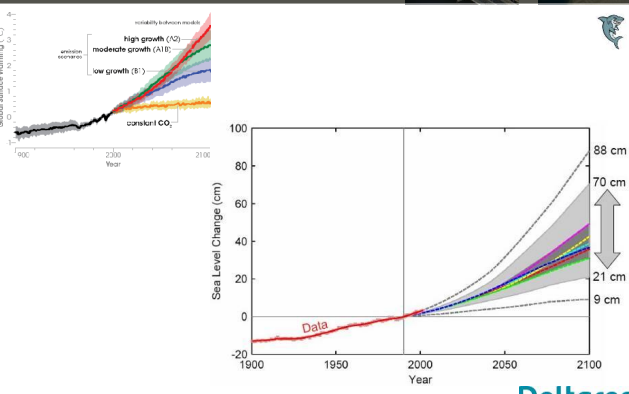
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Climate Change + sea level rise



IPCC 2001 Projections



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The Netherlands: low-lying lands

Sea level rise: +2 m

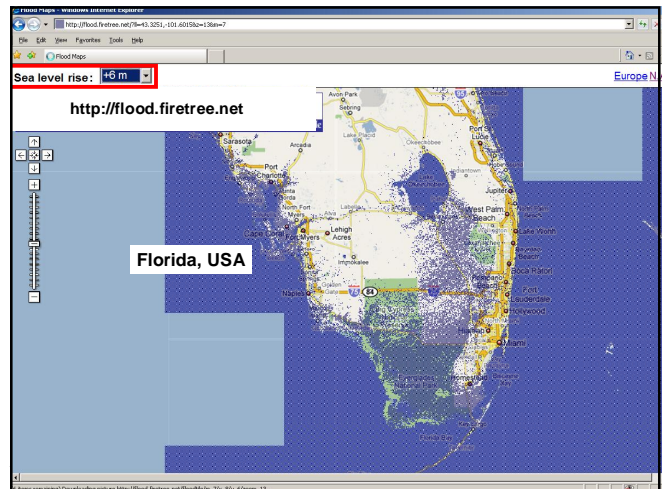
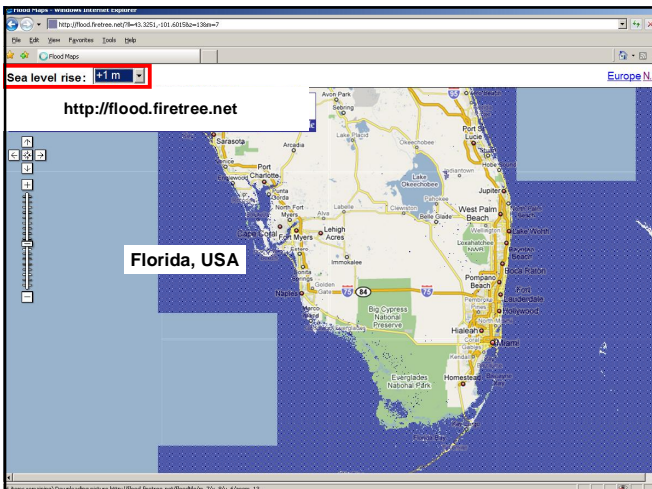
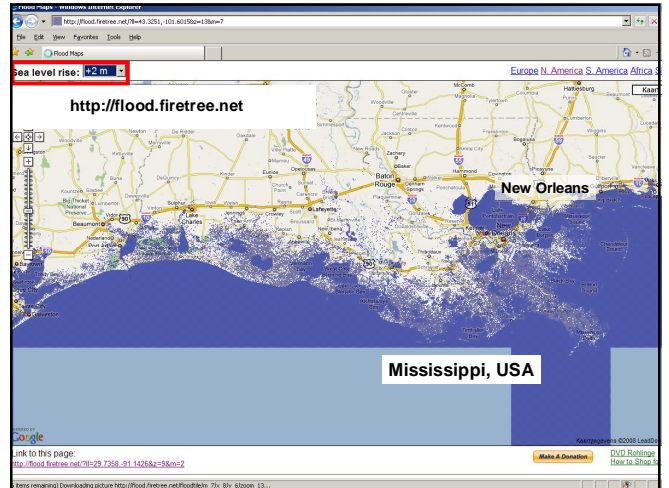
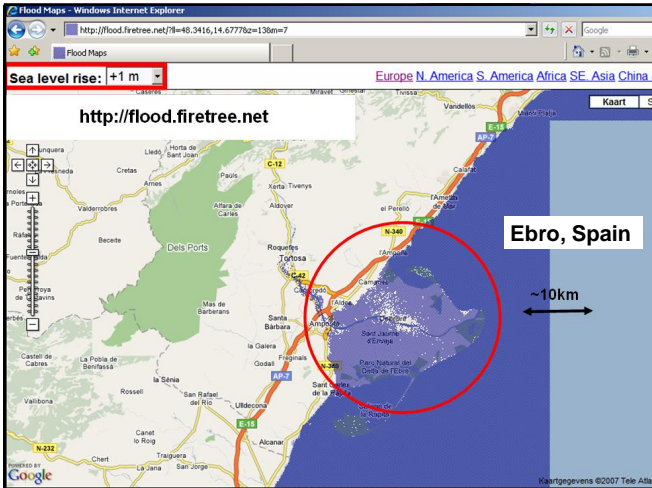
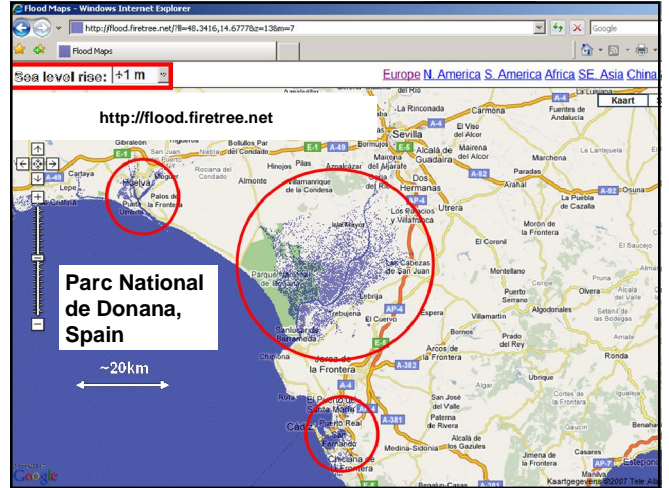
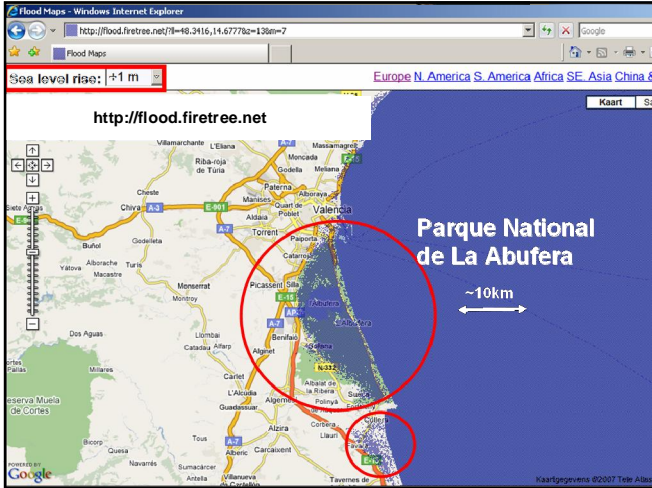
<http://flood.firetree.net>

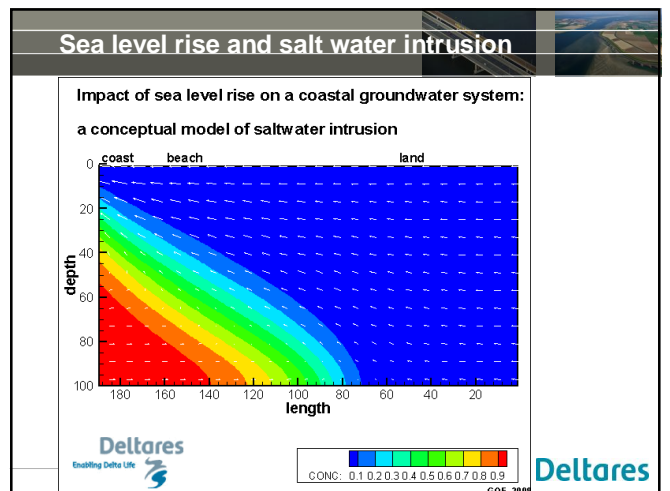
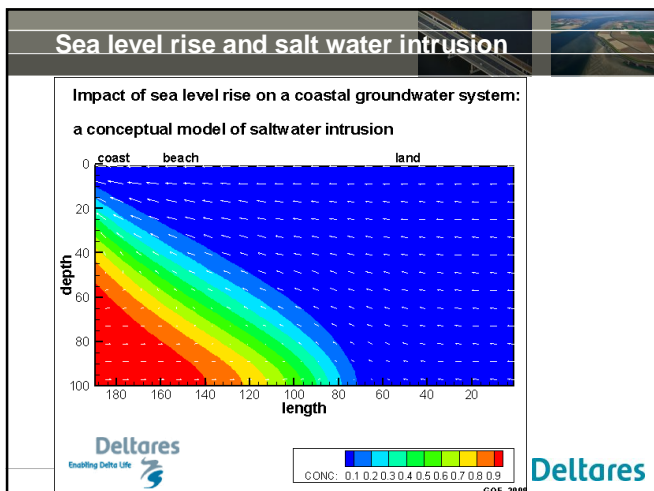
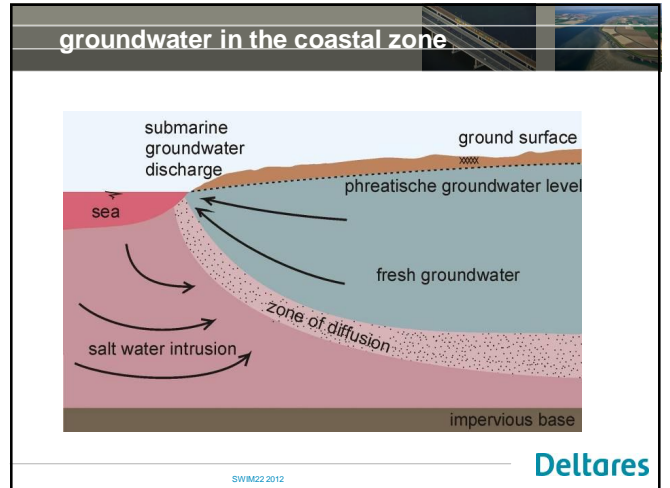
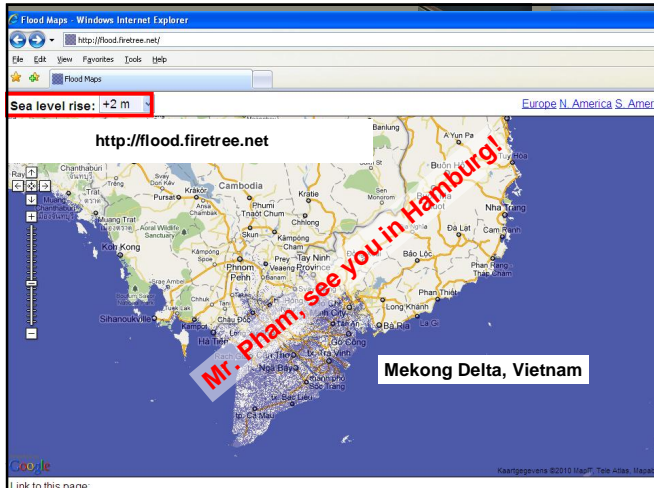
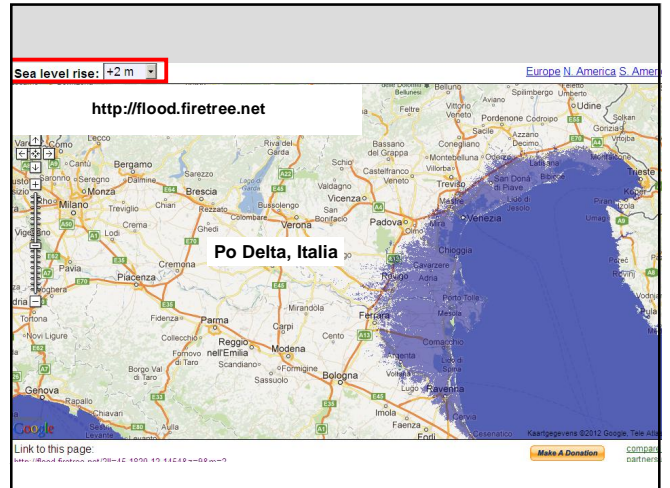
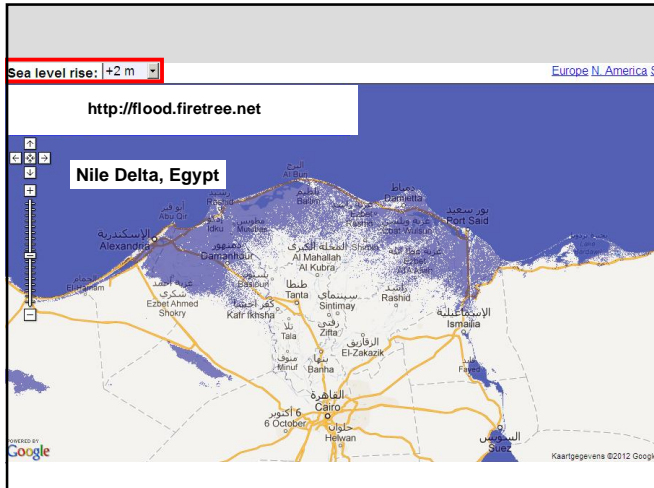
~50km

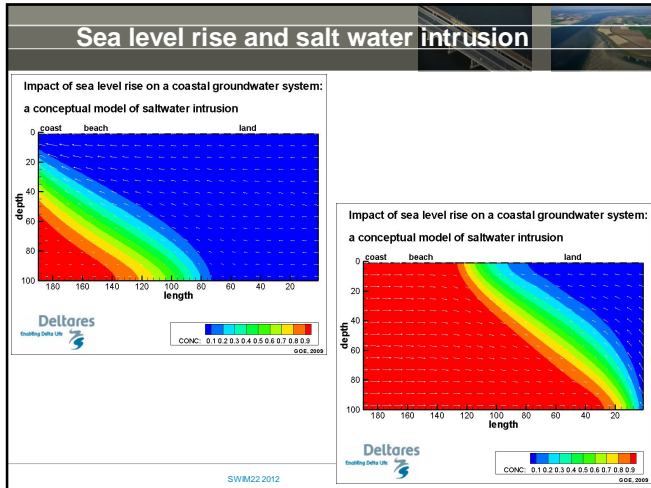
This is why there are so many Dutch in Brazil!



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Threats

1+1>2!

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So: what can we do?

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in the Netherlands...

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Delta Program and National Water Plan

Two main goals for water management of our national government:

- To protect The Netherlands from flooding
- To make Fresh Water Supply Climate Change Resilient

Assessing the effects of:

- Changing water management (e.g. dike higher water level)
- Droughts
- Land subsidence
- Sea level rise
- Changing precipitation pattern
- Coming from agriculture (pesticides and pesticide leaching, etc.)
- Adapting to climate change strategies

Took into account the Delta Program and Netherlands Hydrological modeling Instrument

To implement Delta Program (2015-2050): >1.0 billion euro per year

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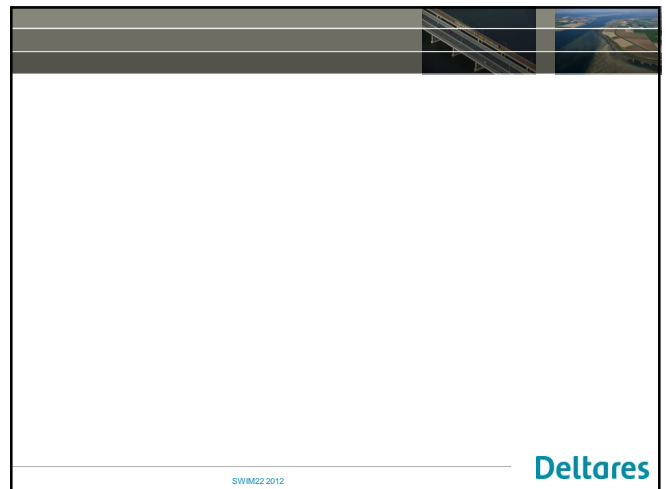
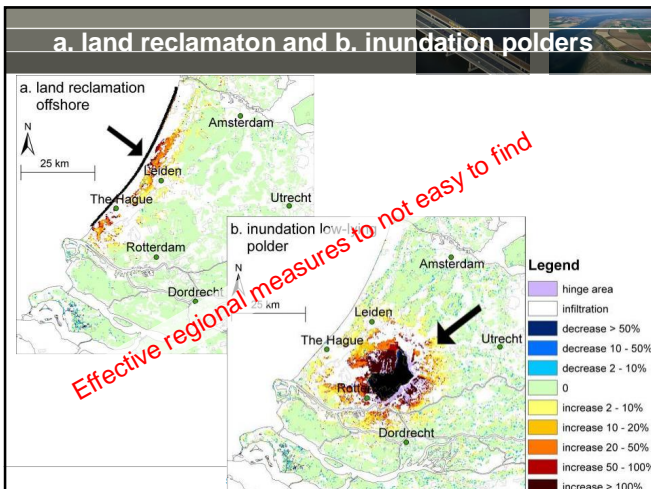
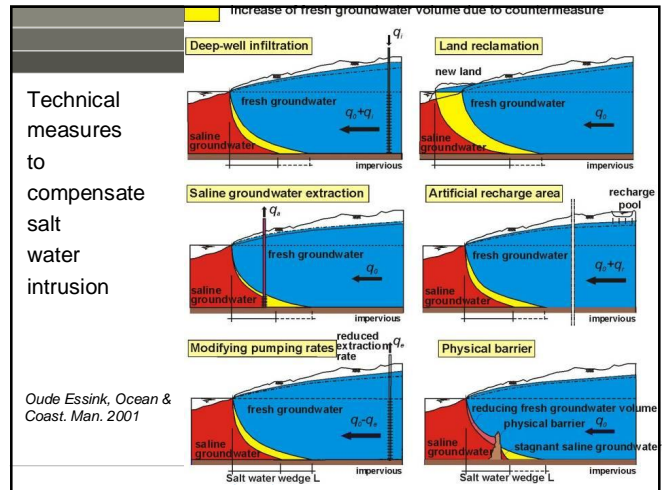
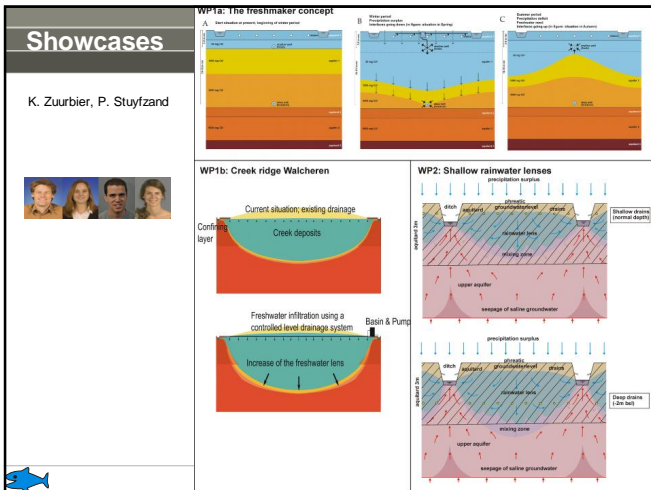
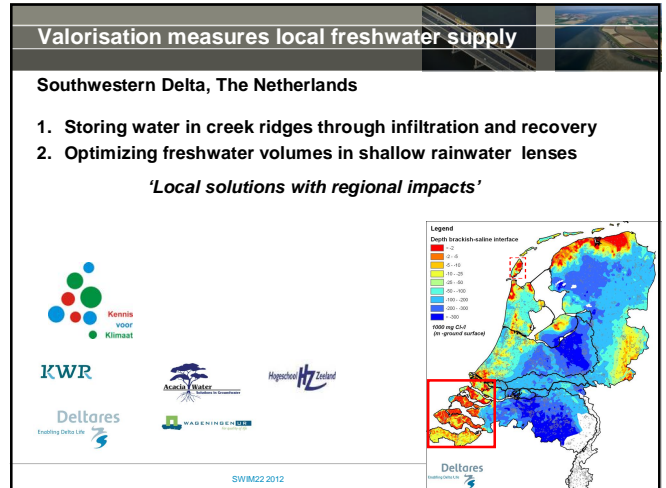
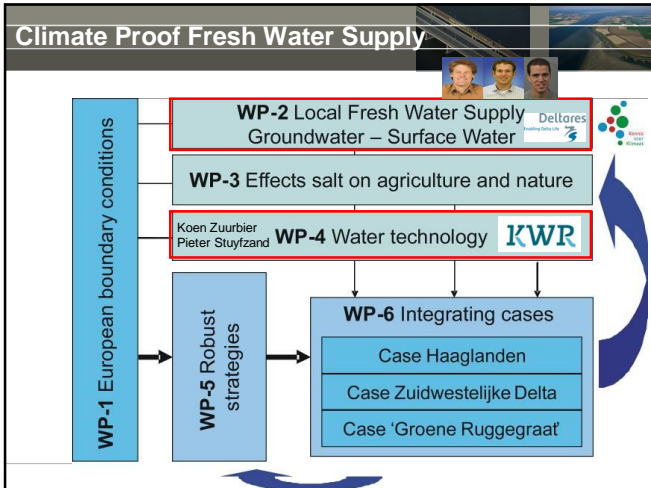
Solutions – Technology responses

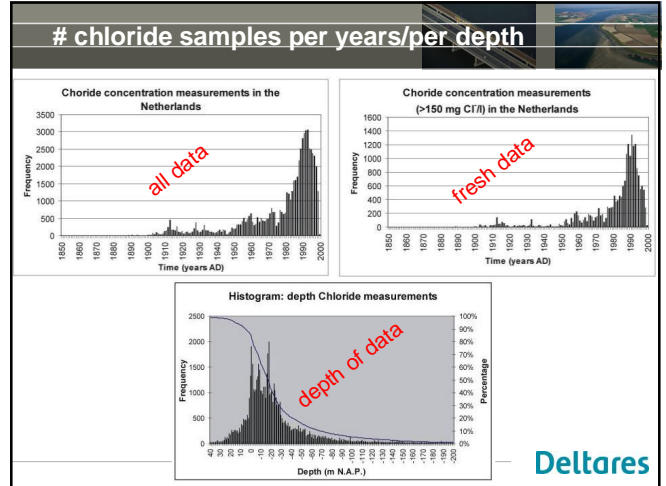
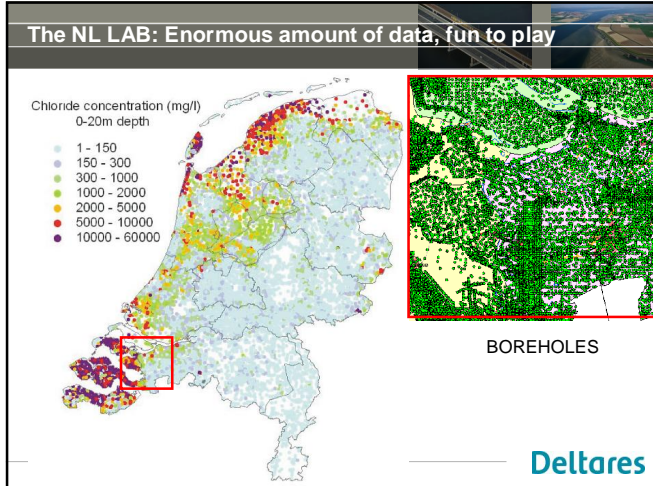
Delta Technology
Water system, water demand & supply, interaction fresh-salt, models, smart-sensors,

Water Technology
Desalination, brine disposal problems, ASR, use of sewage water, brine disposal subsurface

Agro Technology
Salt-resistant crops, drainage innovations

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10 Steps Climate Proof Fresh Water Supply

1. Learn from the past

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Want to get an idea about the effects of large extractions in your coastal area?

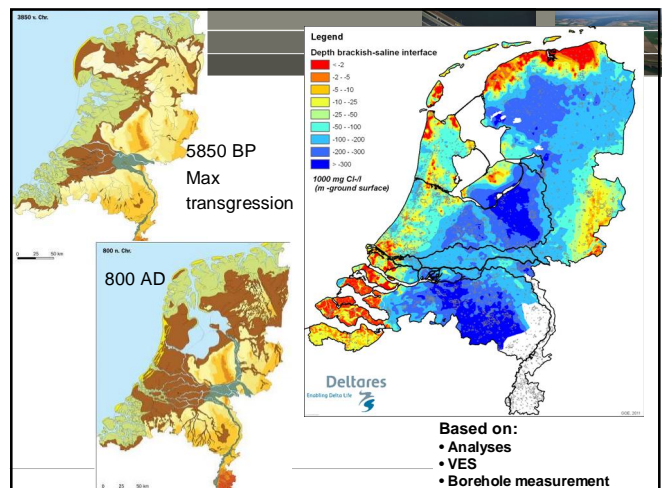
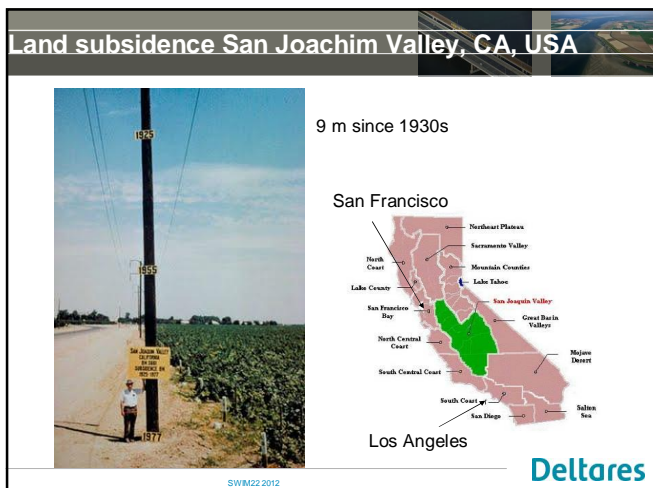
Evaluate past water management in Spanish and USA aquifers

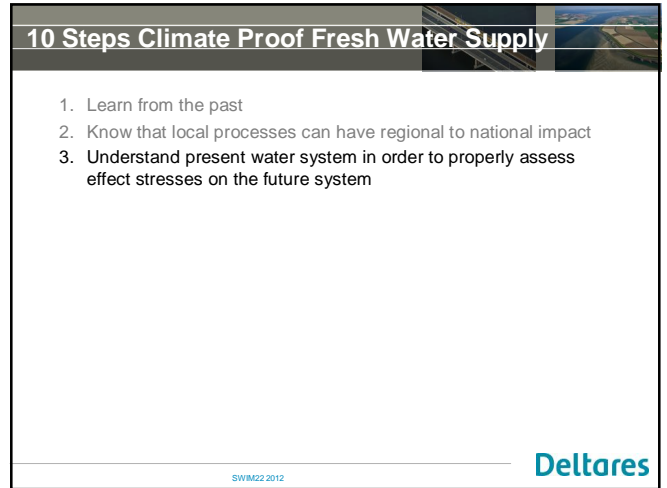
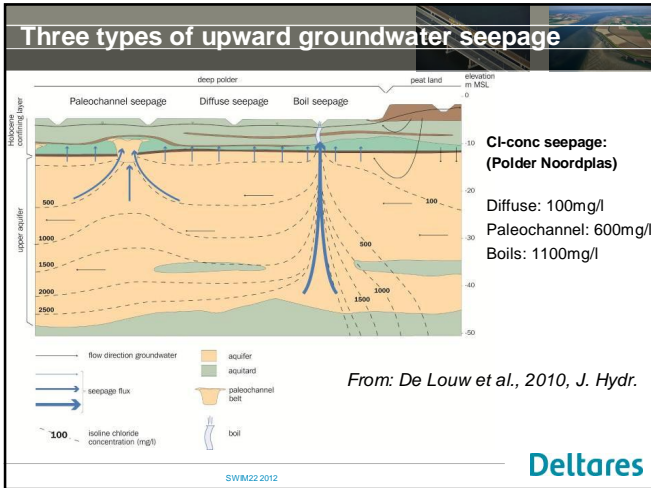
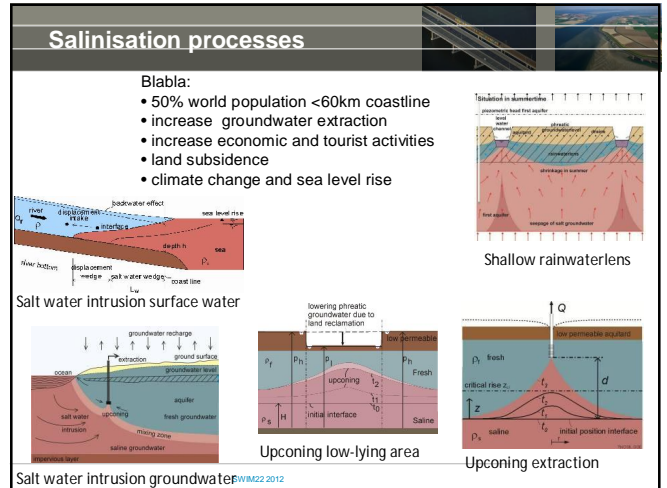
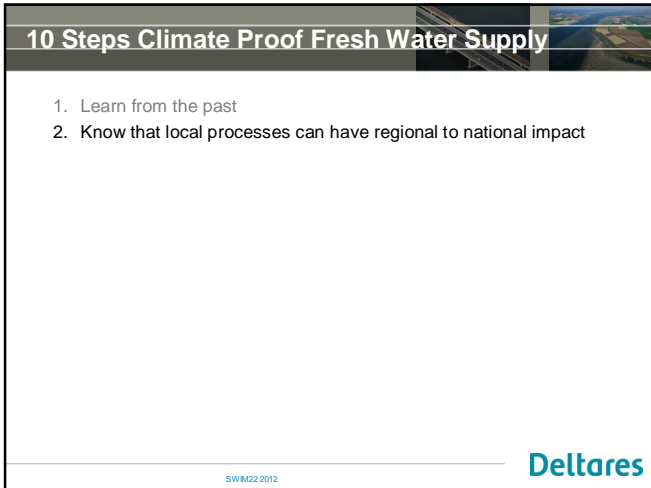
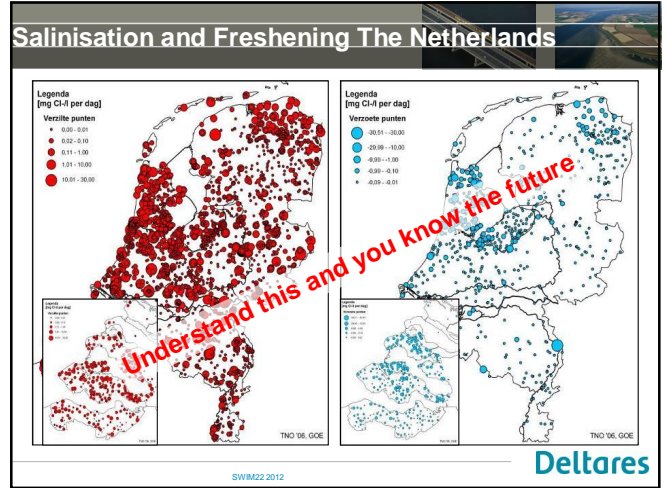
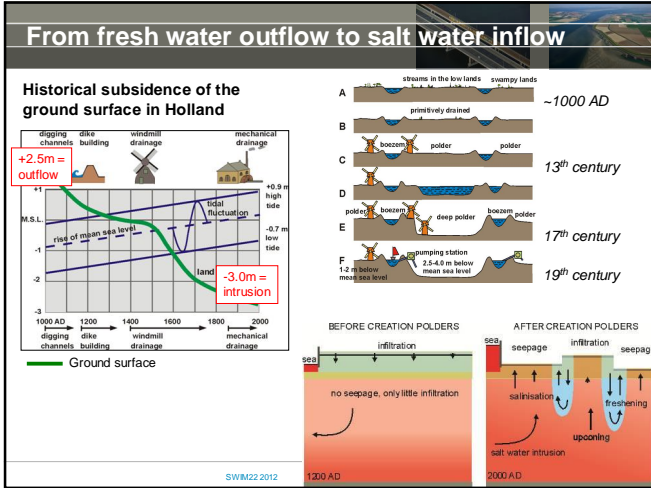
Want to get an idea about the effects of climate change in your delta?

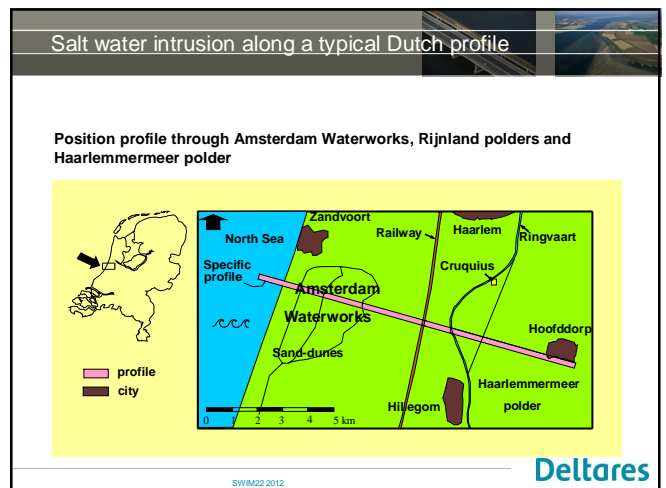
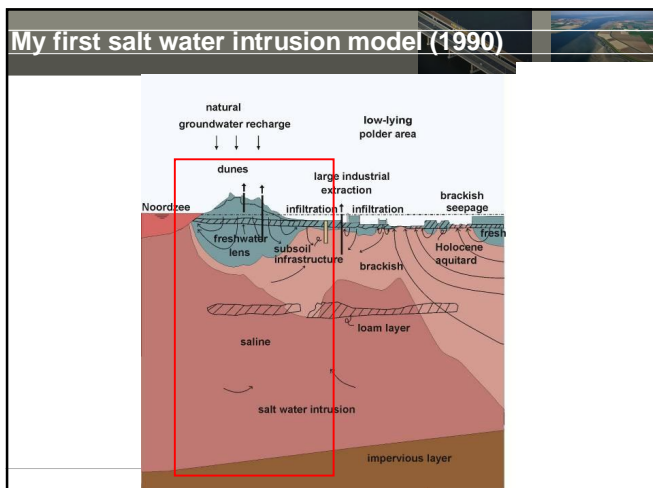
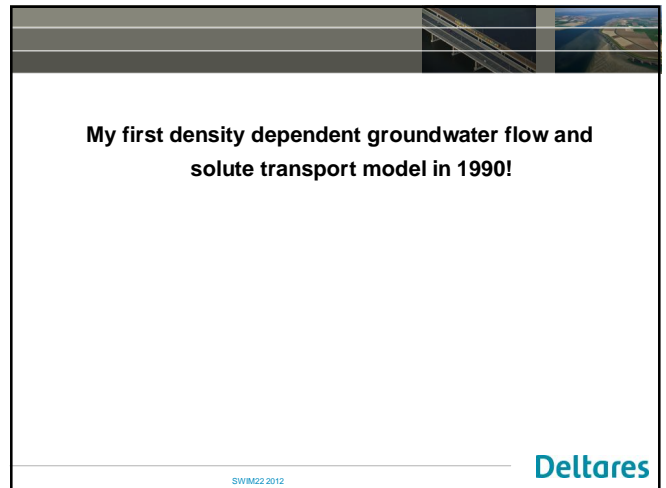
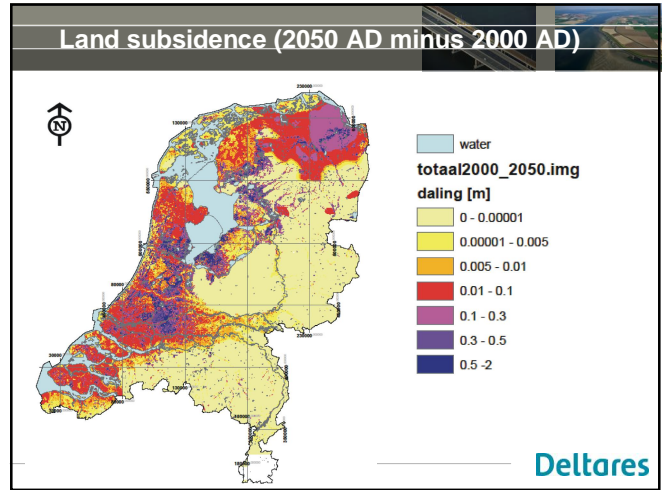
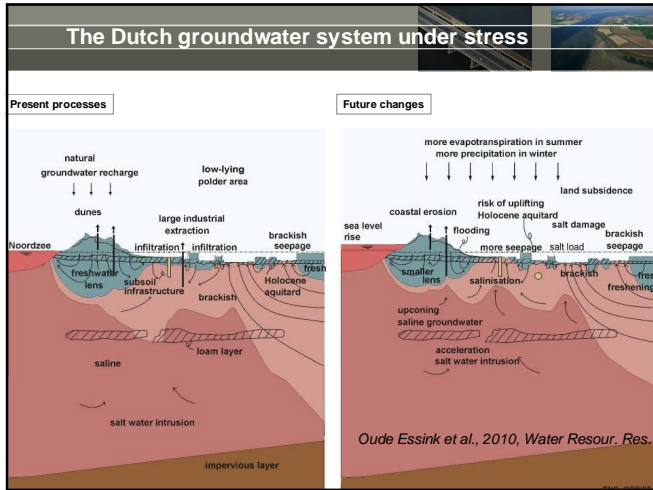
Evaluate past water management in the Dutch delta

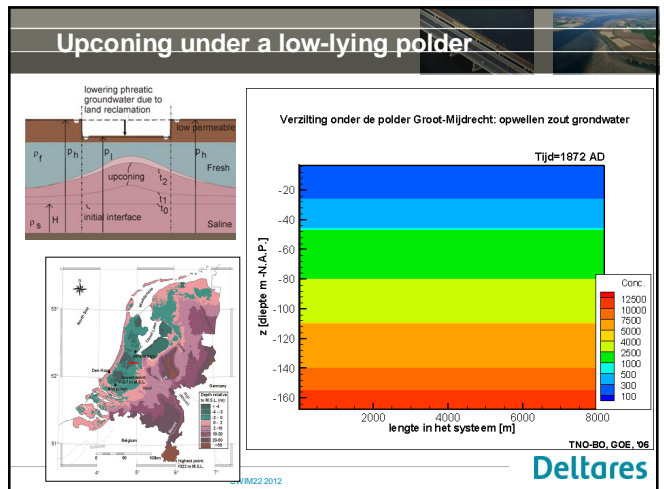
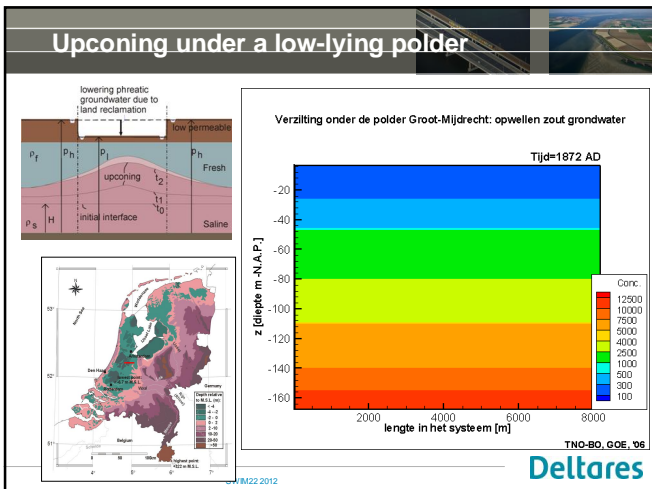
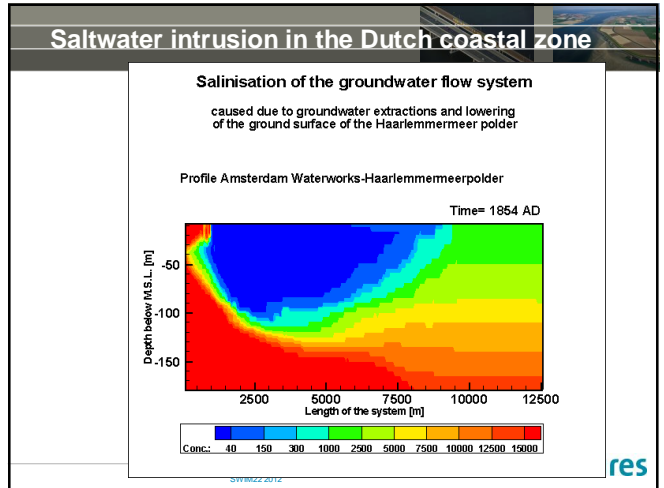
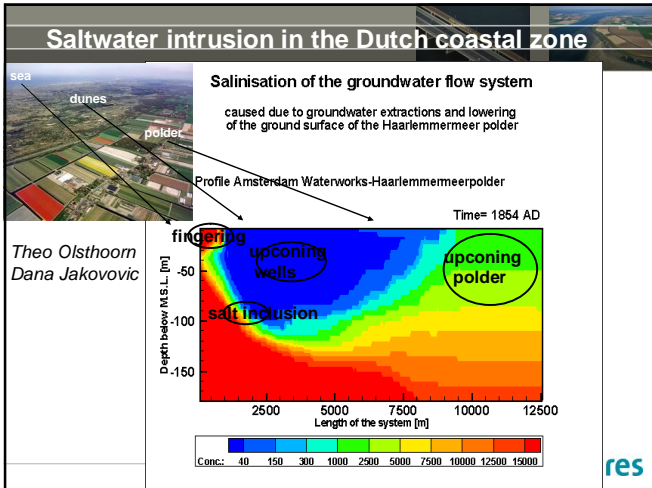
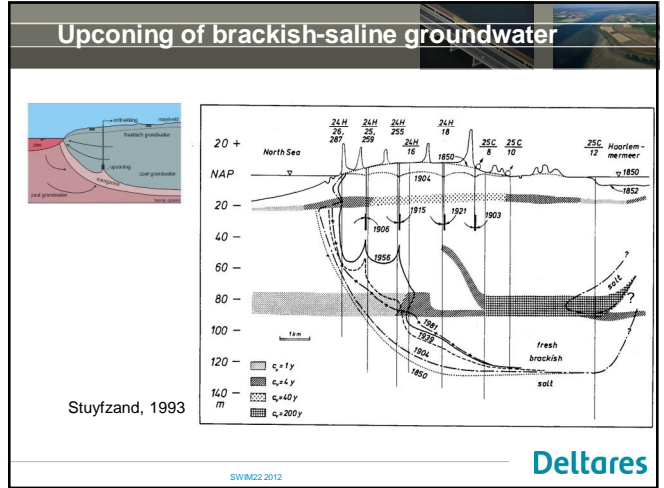
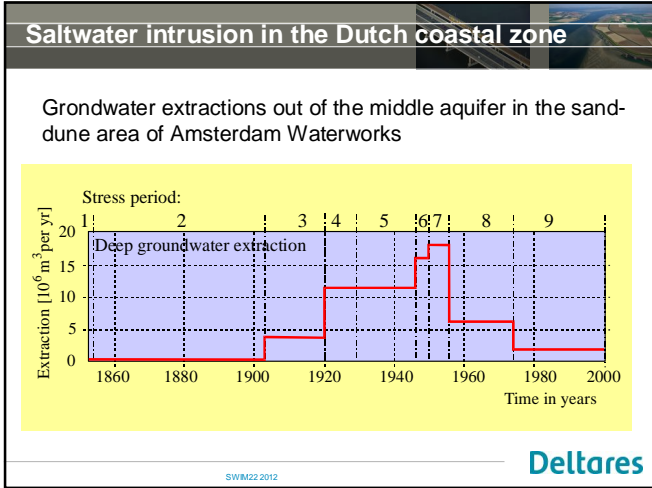
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10 Steps Climate Proof Fresh Water Supply

1. Learn from the past
2. Know that local processes can have regional to national impact
3. Understand present water system in order to properly assess effect stresses on the future system
4. Try to implement old but good ideas in our new setting

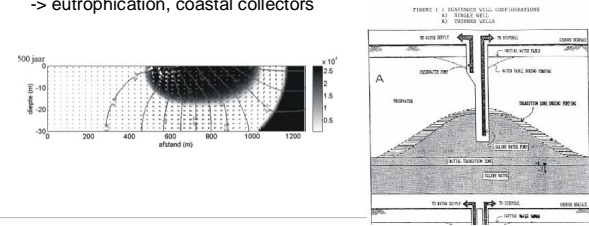
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Try to implement old ideas/concepts in our new setting

Airborne EM: Fitterman, Sengpiel&Meiser 1970-1980s
 -> AEM + modelling (Cliwat 2008-2012)

Scavenger wells: BGS 1960s (e.g. SWIM12)
 -> ASR+desalination+optimisation (KWR, Watemet, Haskoning)

Submarine groundwater discharge: Lebbe early 1980s
 -> eutrophication, coastal collectors



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4. Try to implement old but good ideas in our new setting
5. Know that many small local solutions can have regional impact

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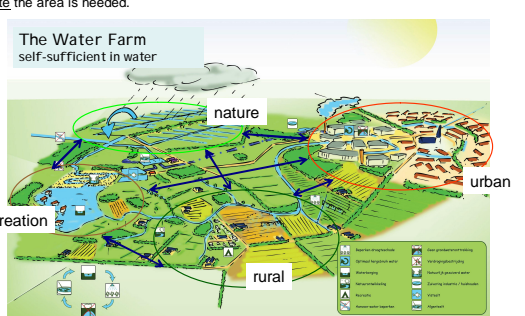
Combining all projects

- The Water Farm
- Climate Proof Areas
- CliWat
- Valorisation measures fresh groundwater supply
- The Creek Back
- The Sand Engine

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'The Water Farm': Local pilot fresh water supply:

Aim of 'The Water Farm':
 An cooperation of farmers, other landowners, local authority, water board and area residents in order to manage the water (receive, store, use, process, deliver) such that no fresh water from outside the area is needed.

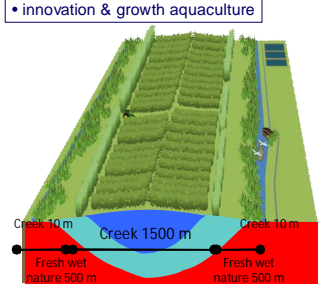
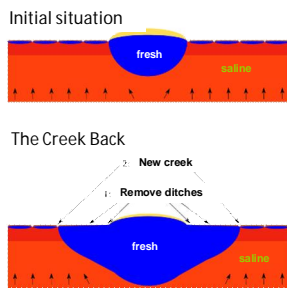


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The Creek Back: measure for local freshwater supply

Goal The Creek Back:

- climate proof fresh water supply
- vital agricultural sector
- robust nature
- innovation & growth aquaculture

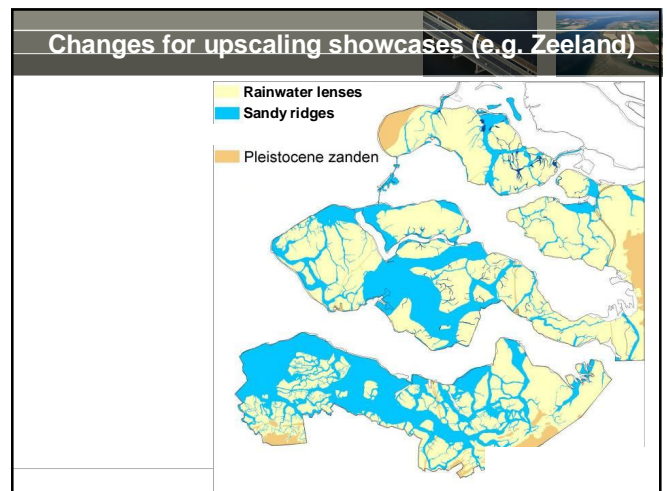
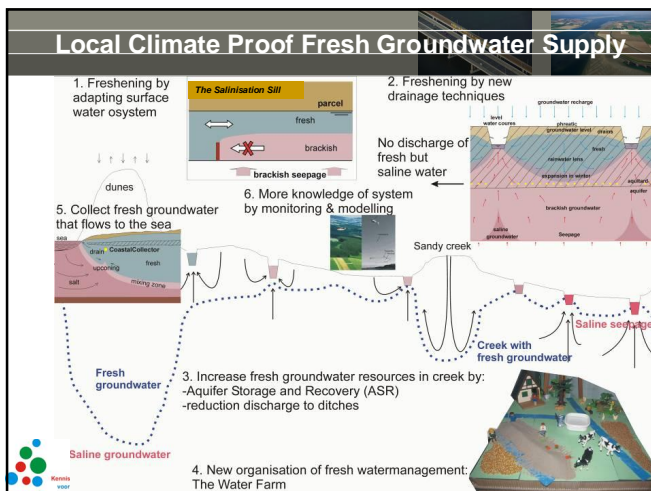
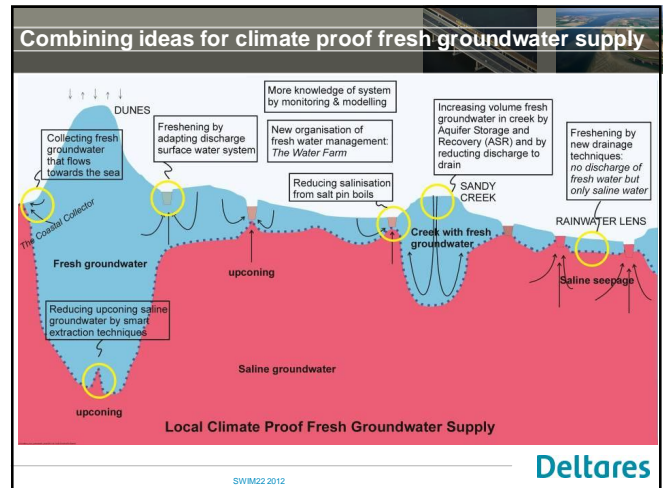
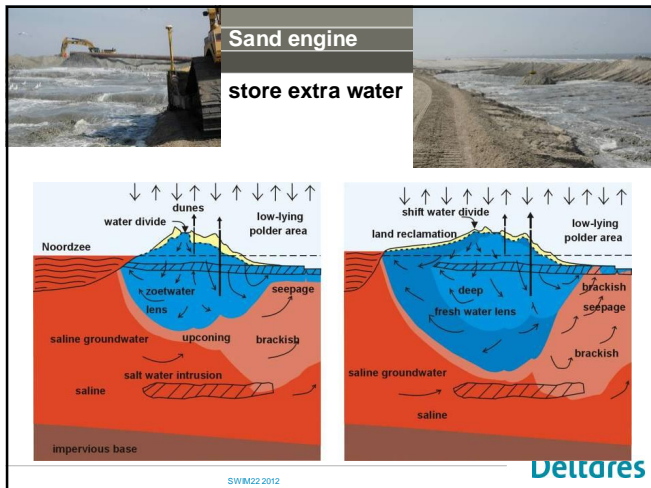
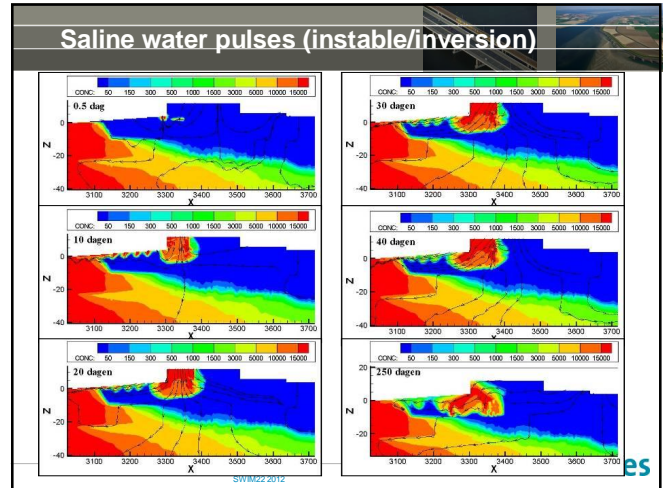



De Deltares
 Enabling Delta Life

The Sand Engine: Changes of storage

2D model profile

- Ter Heijde peninsula: 128 hectares (256 football fields)
- Protection against rising sea levels and space for nature



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4. Try to implement old but good ideas in our new setting
5. Monitoring

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Monitoring & data assimilation & numerical modelling complex (fresh-brackish-saline) water systems

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5. Monitoring
6. Modelling

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Different model cell sizes to consider several phenomena

Sub-local: fingering, salty sand boils
Sri Lanka (Tsunami 2004), Zandmotor
cell size=1cm-1m

Local: rainwater lenses, heat-cold
Tholen, Schouwen-Duiveland
cell size=5-25m

Regional:
Zeeland, Gujarat/India, Philippines
cell size=100m

National: salt load
Zuid-Holland, NHI
cell size=250m-1km

Goal:
To take largest cell size possible to accurately model relevant salinisation processes

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Numerical modelling of salt water intrusion

Characteristics:

- variable-density groundwater
- fresh, brackish and saline
- 3D, non-steady
- coupled solute transport
- heat transport

Assess combined effects:

- past land subsidence polders
- sea level rise
- changing recharge pattern
- land subsidence
- changing extraction rates
- adaption measures

Software (MODFLOW family):
SEAWAT, MOCDENS3D, MT3DMS parallel

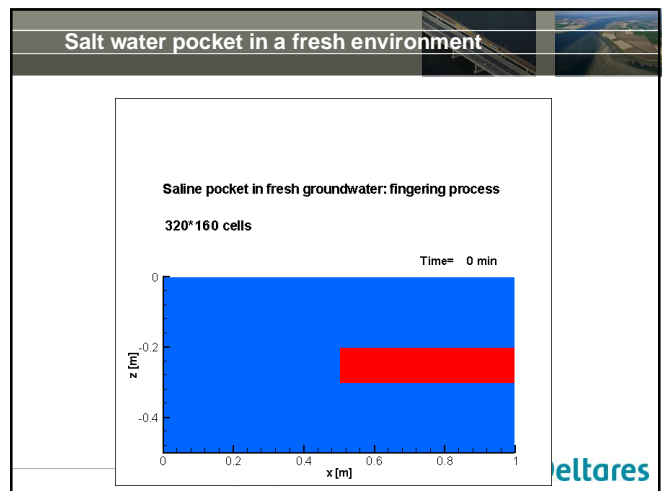
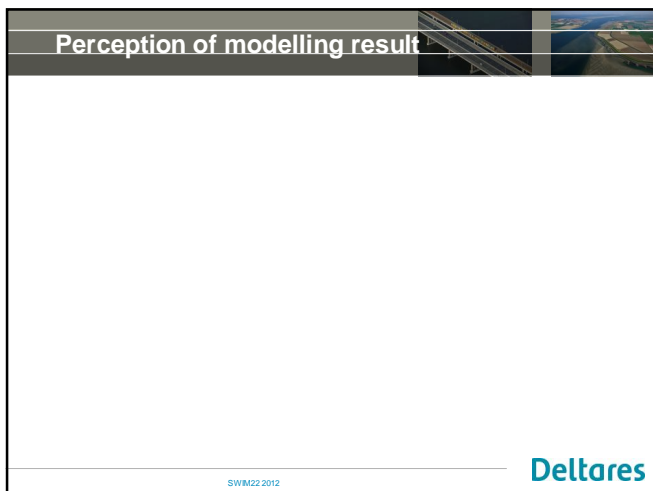
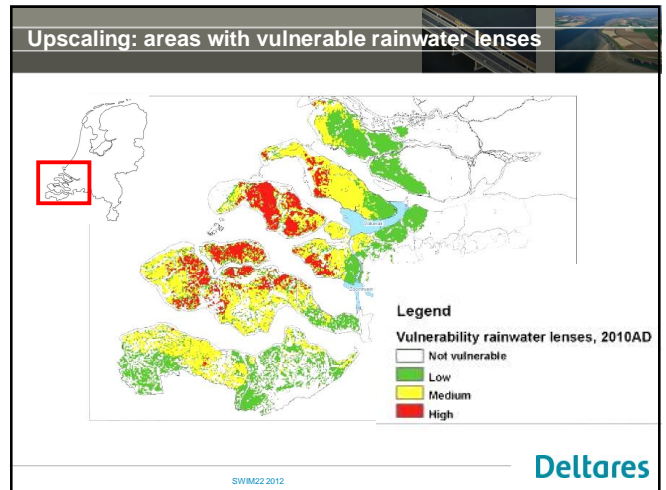
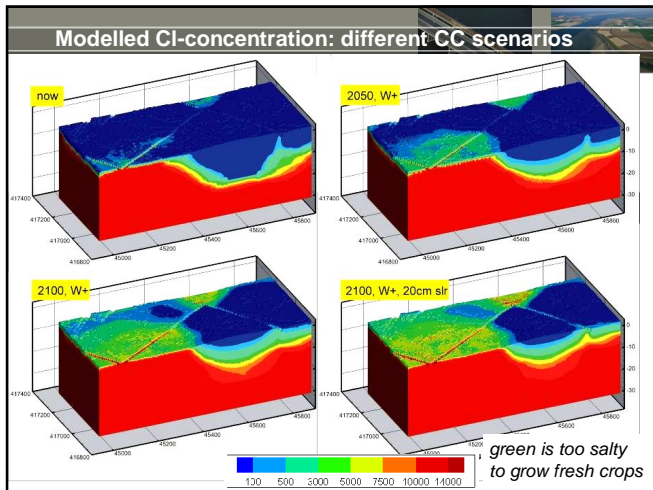
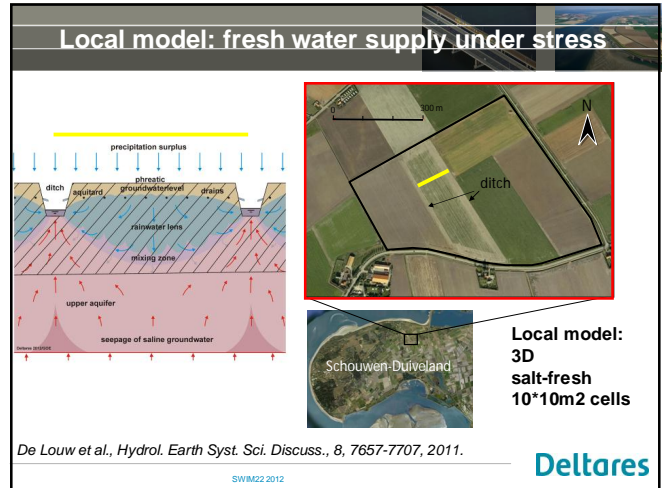
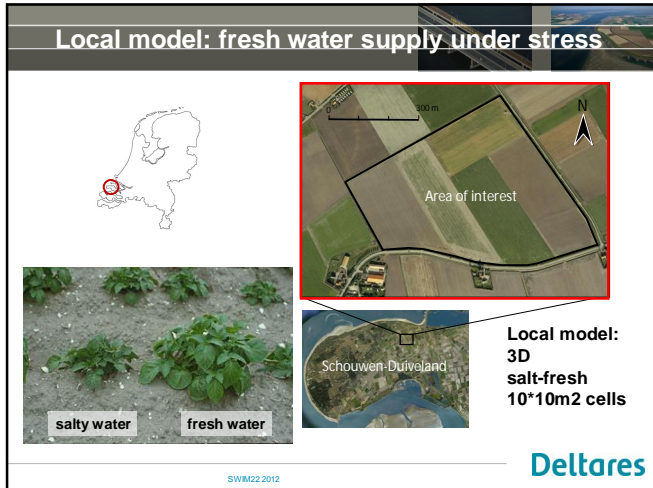
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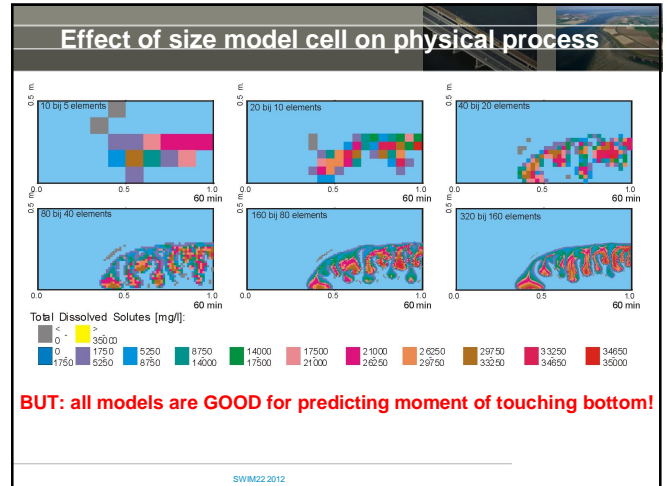
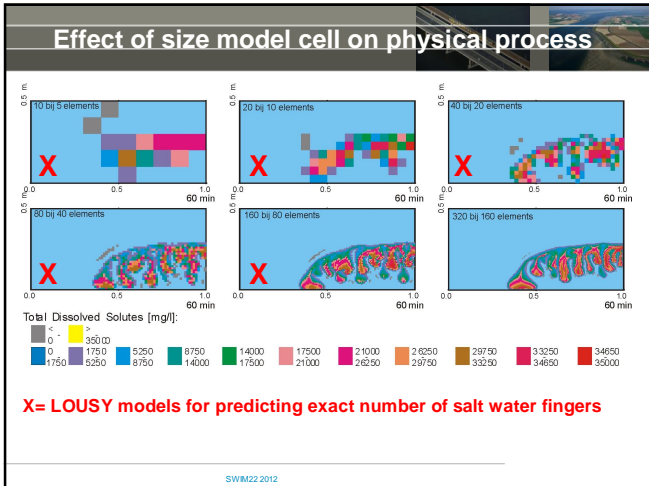
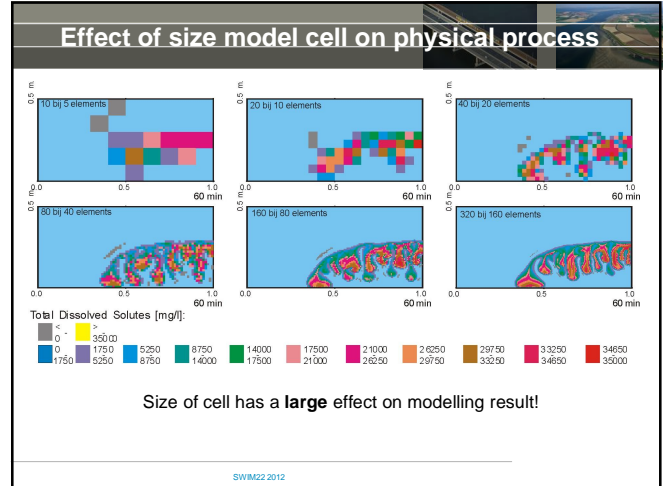
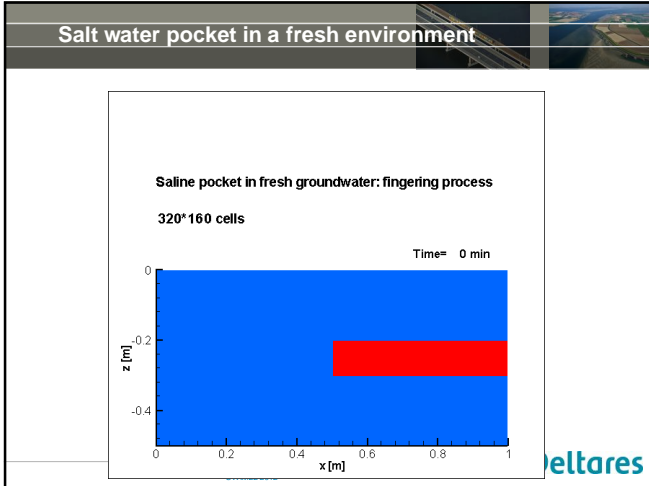
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Salinisation and freshening of groundwater system

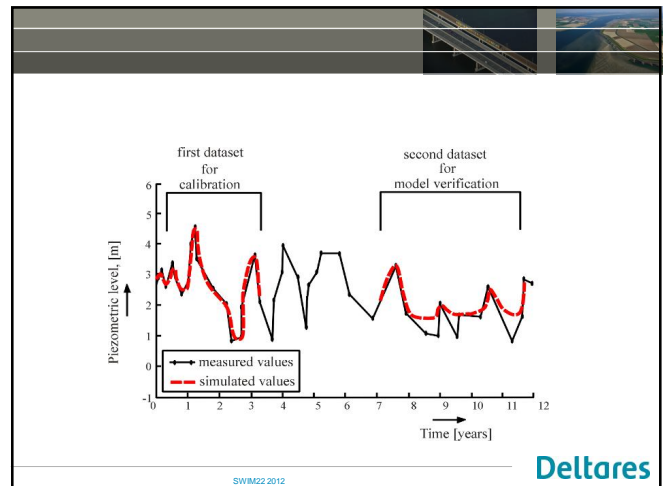
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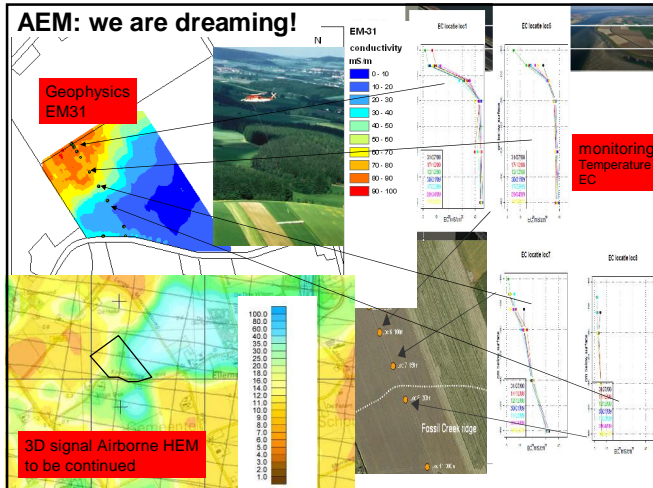
Source: NHI 250*250m² Source: model Zeeland 100*100m²





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 6. Modelling
 7. Never trust a perfect fit, but keep on dreaming to get one
- Deltares
- SWM22.2012

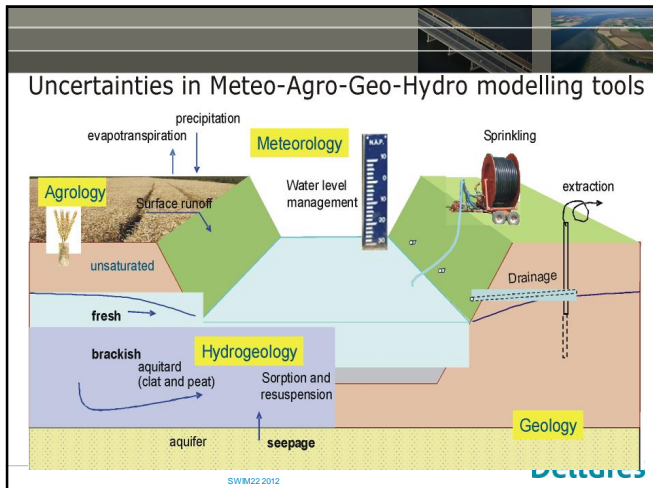




10 Steps Climate Proof Fresh Water Supply

1. Learn from the past
2. Know that local processes can have regional to national impact
3. Understand present water system in order to properly assess effect stresses on the future system
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8. Consider and communicate uncertainties

Deltares



Geological uncertainties

5 individual simulations

In total 50 simulations, equal certain

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Deltares

Public awareness of the effects of climate change in NL

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Sense of Urgency farmers: agriculture and climate change



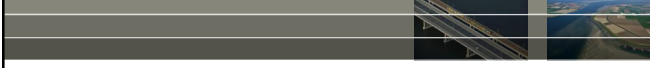
Mr. Van den Hoek:
"Spring starts earlier: sowing earlier means increased production!"

"Land subsidence is a threat: my house is sinking and the roots of the crops are losing space"

Mr. Van der Velde:
"In recent years more noticeable extremes: wetter, colder and drier."
"We have little experience with measures against drought."

Mr. Rentmeester:
"Climate change is uncertain, hence not relevant for the management of my farm."

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Some next steps in LCPFGWS

1. Upsaling potential: from showcase to region
2. Parallelisation codes (SEAWAT -> PHT3D)
3. Implement uncertainties Meteo-Agro-Geo-Hydro modelling tools
4. Modelling & data assimilation & monitoring (e.g. Airborne EM)

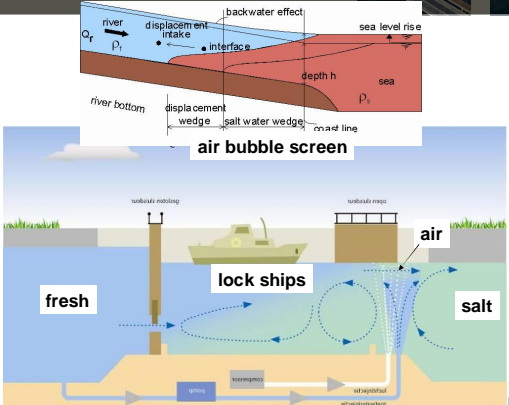
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Wake-up call for us SWIMers!


- Major fresh-salt issues are facing us, worldwide
- It is just started
- We can make a difference
- Work together in getting better solutions!
- Let us reorganize:
 - Addressing our key issues (applied and science issues)
 - Link with cross sciences:
 - > Agronomy
 - > Surface water-groundwater interaction
 - > Ecology
 - > Economic feasibility

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Example: measure to stop salinisation surface water



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9. Communicate and cooperate with (local) stakeholders, like farmers, water boards and provinces. Make them tell your story!
10. Always join next SWIM and thank the organizers for doing this great but ungrateful job!

Thank you!

SWIM22 2012

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