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## Climate change and fresh water for agriculture

*Sustainable technological solutions*

Jan Hofman, Raymond Creusen  
COP15, 11 december 2009

**KWR** Watercycle Research Institute



## Outline

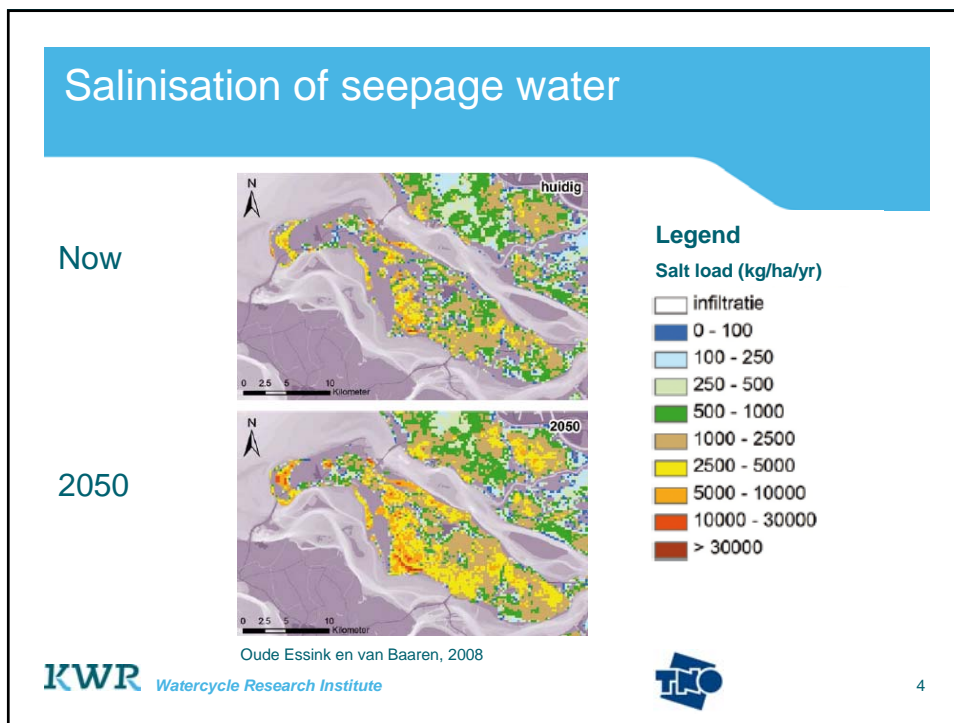
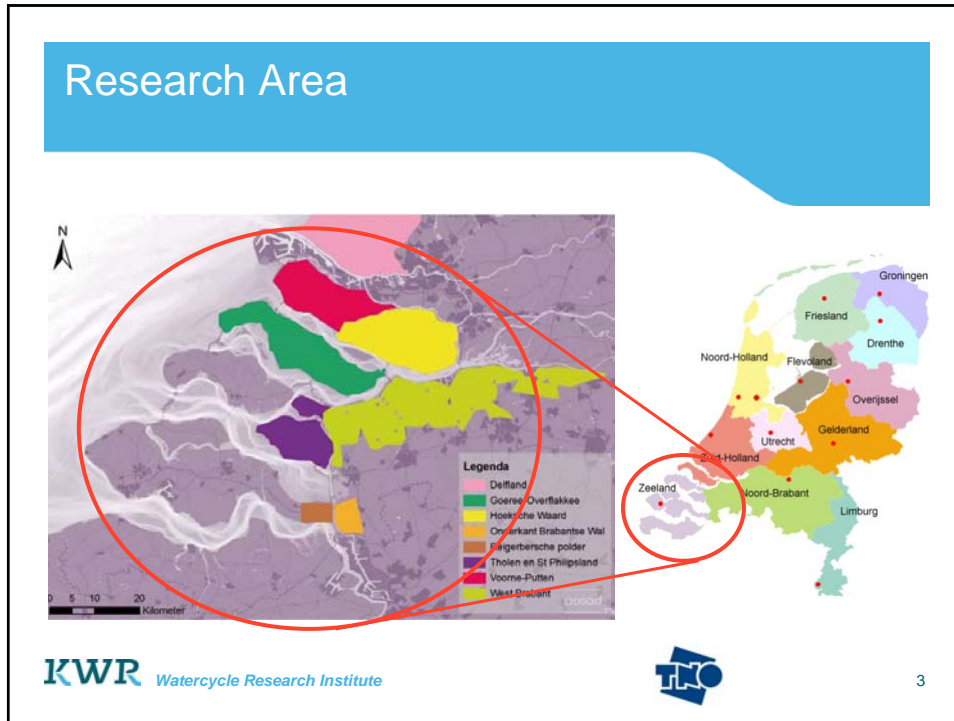
- Fresh water situation in The South-West Netherlands
- Options for climate adaptation
- Technological solutions
- Possible application in practical situations

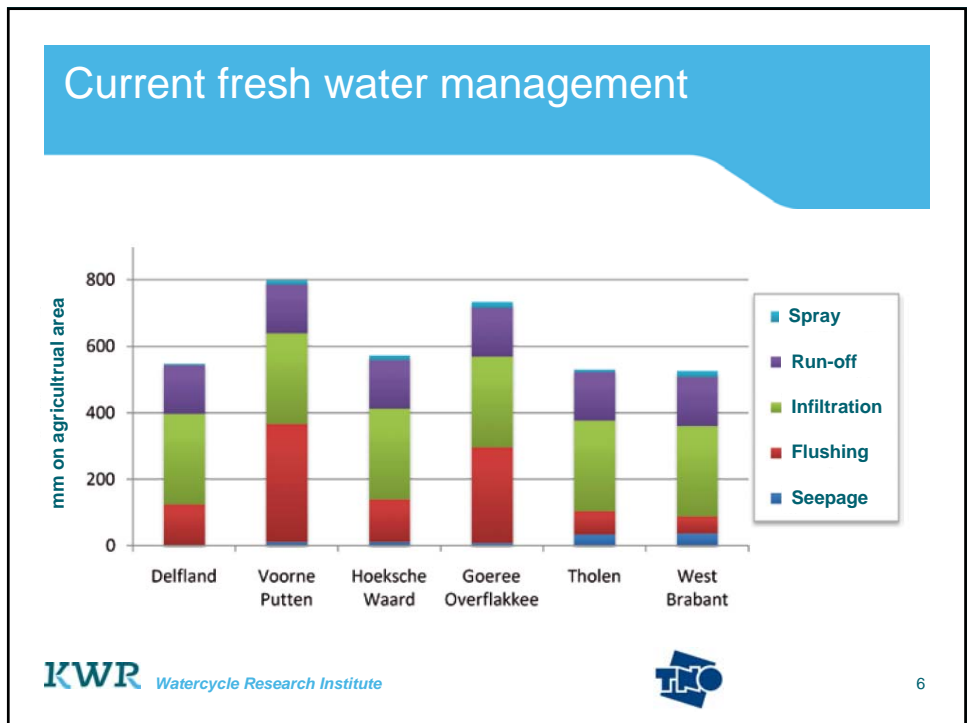
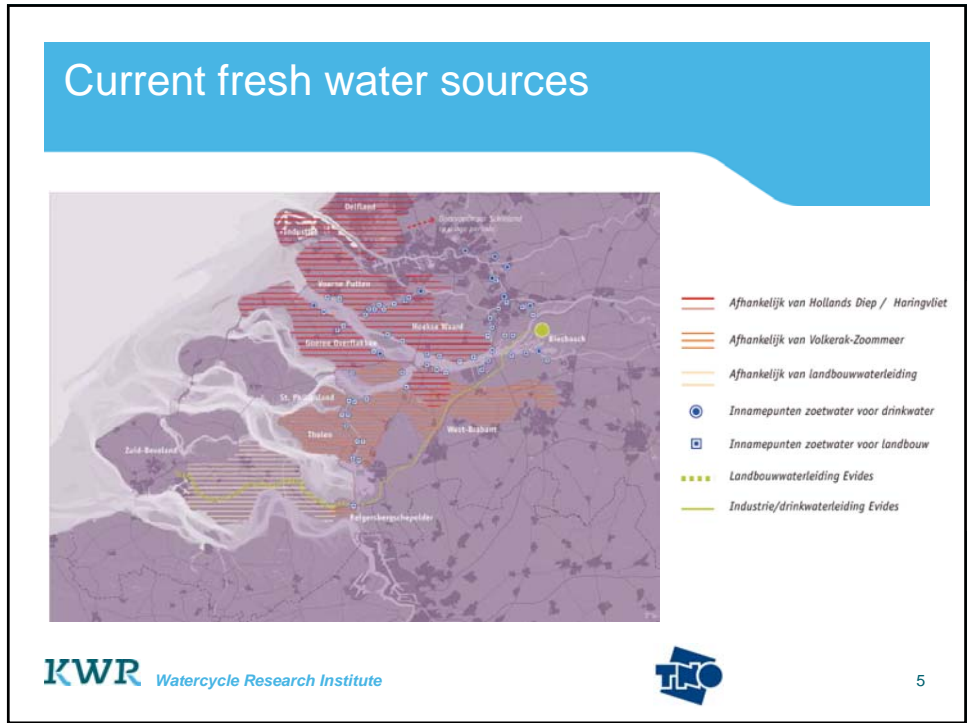
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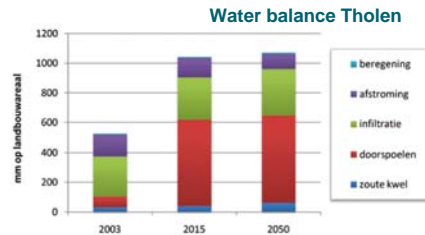




## Options for climate adaptation

### *Resist*

Adaptation measures that maintain the current situation



### *Bend*

Effects of climate change are allowed; salinisation is accepted



## Example Goerree-Overflakkee

Salt sensible crops: Max 150 mg/l chloride

- Flower Bulbs 730 ha
- Chicory 300 ha

Crop rotation (cycle 3-6 years)

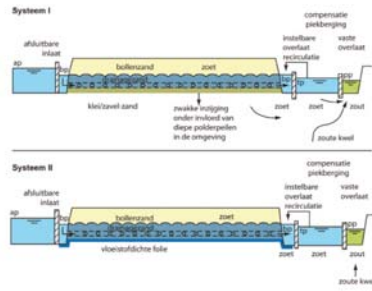
Spray irrigation:  
1.8 - 5.4 million m<sup>3</sup>/crop

How to improve water efficiency?

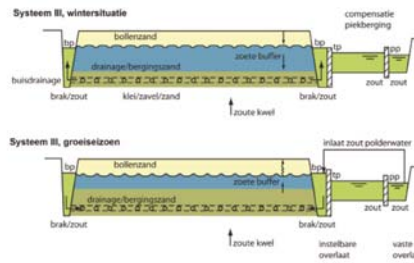


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## Efficient water use



Local storage in the crop fields  
But: crop rotation



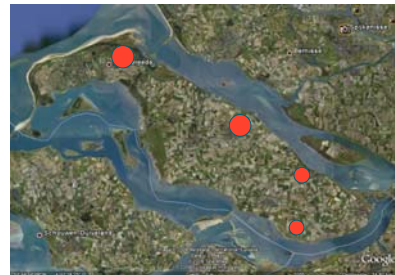
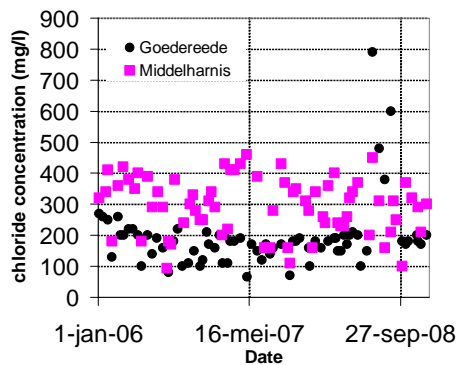
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## Sewage water reuse

Effluent: 6 million m<sup>3</sup> per year  
approx. 65,000 PE



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## Energy and Nutrient reuse

### Wastewater: potential energy source

- 18 W/PE from COD
- Goerree-Overflakkee: 0.6-1.0 MW

### Nutrient recovery for local fertilisation

- P-fertilisation flower bulbs
  - 730 ha; 20-35 kg P/ha
- P-demand: 14,600 – 25,600 kg P per year
- Potentially available from wastewater: 42,000 kg P/year

## Sewage water reuse *Conclusion*

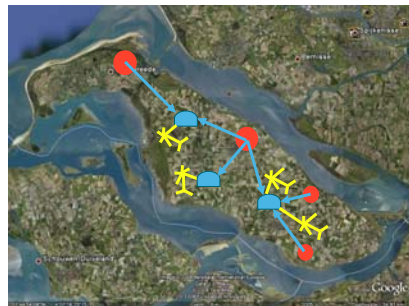
Quantity: good match; but storage required

Quality: partial desalination required (50% split treatment)  
or: sewers maintenance ?

Questions: disinfection; organic micropollutants, heavy metals; nutrients ?

## Treated sewage water distribution

- Centralised treatment
- Decentralised storage facilities
- Local distribution from storage tanks
- Infrastructure needs to be constructed



## Direct surface water desalination

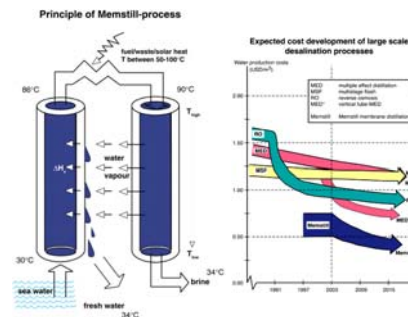
Mobile units, traveling with crops

Water source: brackish water from local water system

Desal options:

- Reverse osmosis
- Memstill

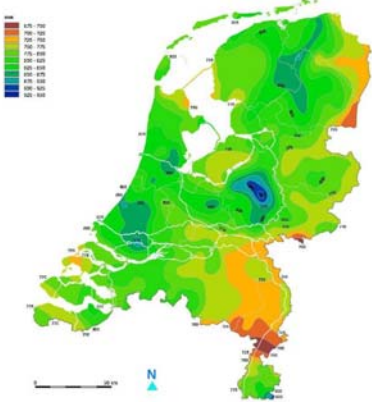
Concentrate disposal?  
Sustainable energy supply?





## Other sources

- Rainwater harvesting / storage  
Average 750 mm/y  
800 ha => 6 Mm<sup>3</sup>
- Import via aquaduct



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## Sewage water reuse Cost estimate for 6 Mm<sup>3</sup>/y

Option	Investment	Operation <sup>1</sup>
Reuse effluent; storage tanks+distrib.	6Mm <sup>3</sup> storage: 780M€ 100 km mains: 200M€	WWTP 0.50 €/m <sup>3</sup> Infra: 14 €/m <sup>3</sup>
Reuse effluent; ASR+distrib.	ASR: 10M€ 150 km mains: 300M€	WWTP 0.50 €/m <sup>3</sup> Infra: 3 €/m <sup>3</sup>
Containerized Desalination	0.5-1.0 M€ per unit	0.50-2.00 €/m <sup>3</sup>
Aquaduct	200 km mains: 400M€	5.60 €/m <sup>3</sup>

<sup>1</sup> Annuity: 30 Year, 6% – Energy €0,10/kWh – Maint. 1% Investment

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## Cost - Benefit

### Crop yields

- Cichory: 6 M€ per year
- Flower bulbs: 36.5 M€ per year

### Fresh water

- WWTP+Storage+Infra: 81 M€ per year
- **WWTP+ASR+Infra: 17 M€ per year**
- **Local Desalination: 12 M€ per year**
- Aquaduct: 34 M€ per year

## Our vision on the future *Conclusion*

**Local desalination**

**- Or -**

**Reuse Effluent+ASR**  
*Option P-recycling and Energy  
production from wastewater*

