
# Decision making in times of water scarcity

## Risk-based methodology to support fresh water management


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## Word-wide problems due to water scarcity

### Examples of drought events in recent times:

- Po River delta in Italy, 2012
- Ebro River delta in Spain in 2005-2008 and 2012
- Amazon River delta in 2005 and 2010
- Sacramento-San Joaquim delta in California, USA in 1976, 1977, 1987-1994 and 2007-2009
- Yangtze river delta in China in 2006 and 2011

# Word-wide problems due to water scarcity

## Drought event in the Netherlands in 2003:

- Peat flood defence embankments: if they loose moisture, it results in decreases structure weight and a decreased water-damming ability
- Failure of peat flood defence in Wilnis






# Word-wide problems due to water scarcity

## Drought event in the Netherlands in 2011

**Water niet meer aan te slepen**
BN DeStem - 6 mei 2011

**Voorjaar uitzonderlijk droog – geen verandering in zicht**
NRC Handelsblad - 4 mei 2011

**Water boards take measures to cope with drought**
Brabants Dagblad 5 mei 2011

**Gemalen draaien op driedubbele capaciteit**
Brabants Dagblad - 5 mei 2011

**Sproeiverbod dreigt door droogte**
Telegraaf.nl - 4 mei 2011

**Drought still manageable: we will consider the situation of fluit growers**
Waterboard De Stichtse Rijnlanden – 2 mei 2011

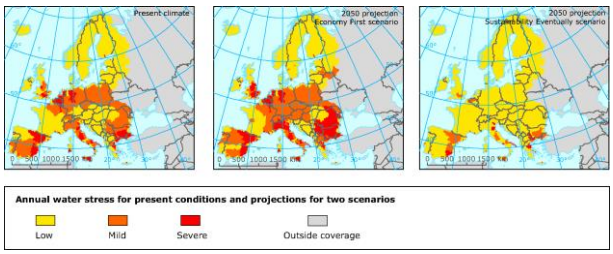
**Water boards take into account continuation of drought**
De Telegraaf – 28 april 2011

De Telegraaf - 28 april 2011

## Word-wide problems due to water scarcity

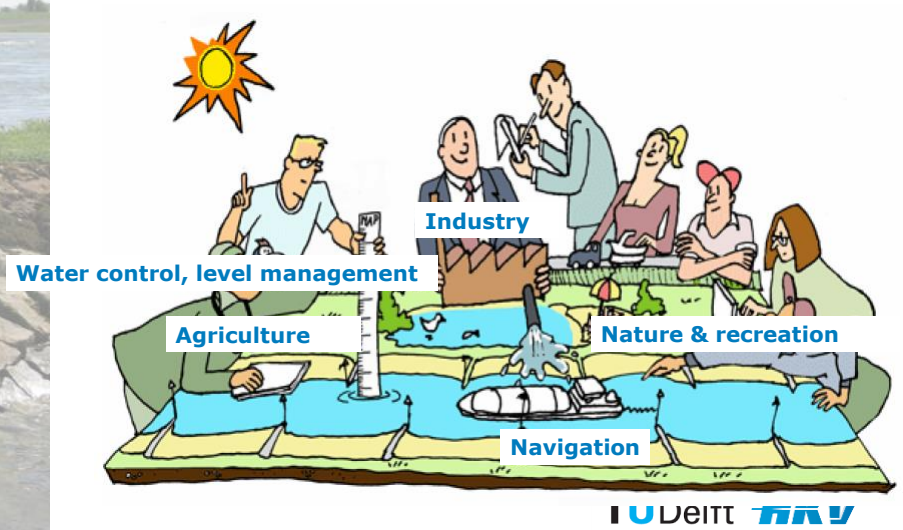
Delta societies more vulnerable to water deficits, due to

- future climate change
- socioeconomic developments



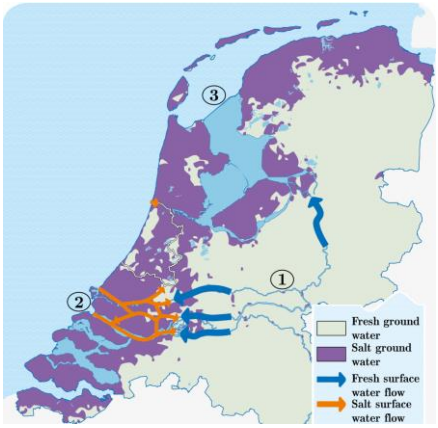

Annual water stress for present conditions and projections for two scenarios (source: EEA, 2012 )

## Fresh water management in the Netherlands



## Fresh water management in the Netherlands

- Fresh water supply:
  - main water system (river basin, IJssel lake)
  - regional water system (surface water, ground water)
  - end-user (private storage basins)

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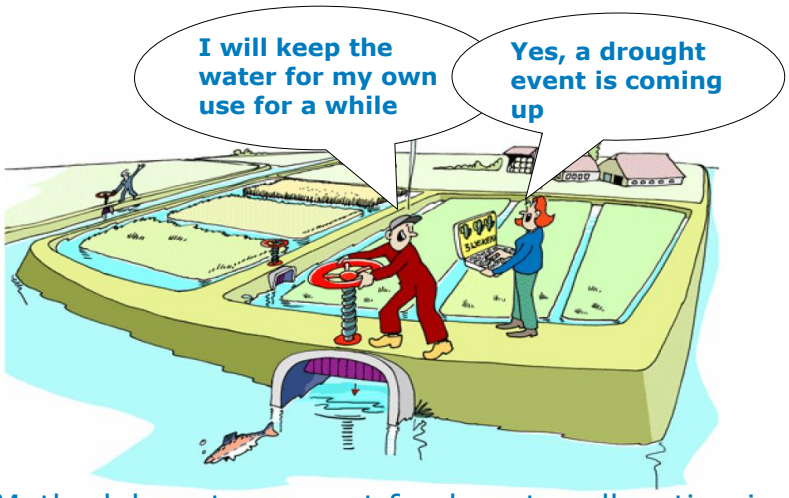
## Fresh water management in the Netherlands




Methodology to support fresh water allocation is needed

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## Fresh water management in the Netherlands

| Category 1<br>*Safety and the prevention of irreversible damage* | Category 2<br>*Public facilities* | Category 3<br>*Small-scale first-rate utilization* | Category 4<br>*Remaining interests; (both economical and environmental reflexion)* |
|---|---|---|---|
| 1 Stability of flood defenses | 1 Drinking water provision | * Temporarily irrigation of capital intensive cults | * Navigation<br>* Agriculture |
| 2 Settlement and subsidence (of peat and upland moor)<br>3 Nature (committed to the soil characteristics) | 2 Energy provision | * Process water | * Nature (as long as no irreversible damage occurs)<br>* Industry<br>* Water leisure pursuits<br>* Lake fishing |

A ranking scheme for fresh water allocation

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## Fresh water management in the Netherlands

- Prearranged ranking system: a water hierarchy scheme)
- Risks (in terms of probability x consequences) that would ensue due to drought are not well considered
- Degree end-users suffer from drought, depend on
  - Location of deficit
  - Point of time of deficit
  - Size and duration of deficit
  - Sensitivity of the end-user for deficits
  - Degree mitigation measures are possible
- Drought risk implies a temporal fluctuation!

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## Fresh water management in the Netherlands

- Measures to cope with water scarcity
  - Main water system scale
    - Optimizing distribution of fresh water flows over Rhine branches
    - Reducing salt water intrusion in main system
  - Regional scale
    - Water storage in regional water systems
  - Local scale
    - Private storage basins, surface and underground storage



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## Fresh water management in the Netherlands


Measures proposed in Deltaplan for fresh water


## Fresh water management in the Netherlands

- Question:
- Do measures compensate drought-damage in a cost-efficient way?
- How to deal with uncertainty?
  - in water supply (river discharge, salt water intrusion, water storage in soil and surface)
  - in water need of various end-users/sectors (time (seasonal period), location, duration,
- How to deal with its consequences and resulting risks?

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## Risk-based methodology to support

- Approach considers risks: probability of drought related event and their possible consequences
- Meant to:
  1. evaluate the impact of climate variability and socioeconomic developments on drought-related risks,
  2. assess the cost-efficiency of measures to try to prevent water scarcity and mitigate drought damage, and in the end
  3. develop strategies to better deal with drought-related risks

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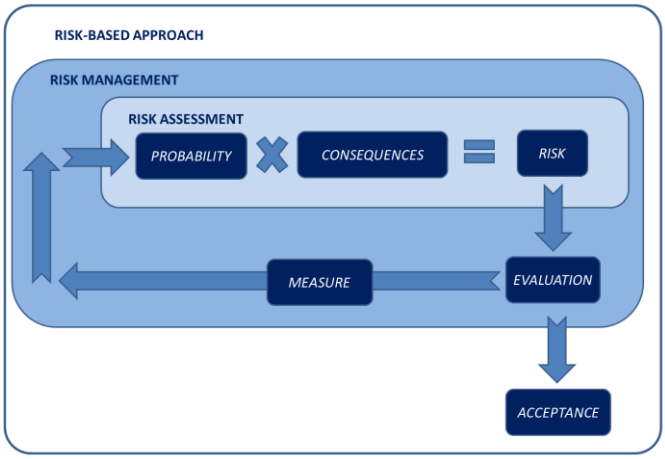
## Risk-based methodology to support

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## Risk-based methodology to support

- Risk assessment:
  1. probability of drought-related hazard events in the presence of current and possible future climate changes,
  2. impact of these events on water supply/availability,
  3. water demand of end users,
  4. resulting water shortage
  5. consequences for the various end-users, yielding
  6. a so-called risk profile (trans-sectoral and cross-regional)

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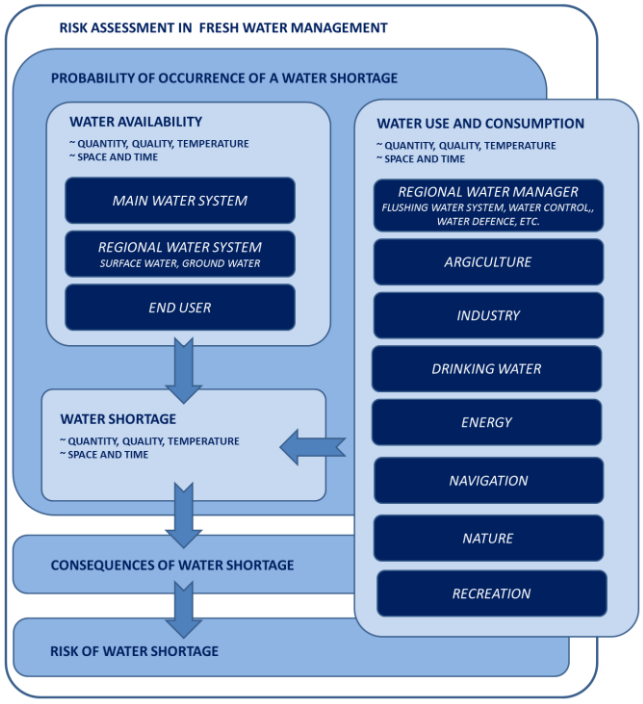
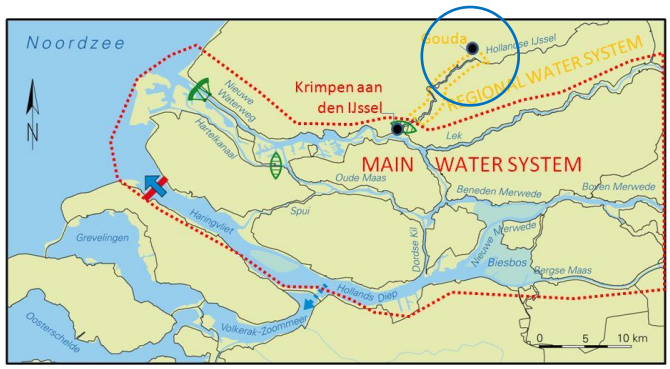



## Risk-based methodology to support

- Case study Gouda

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## Risk-based methodology to support

- Salinity Risk at intake Gouda for agriculture sector
  - Probability of the exceedance duration for Chloride concentration (250 mg/l)
  - Its consequences/damage for agriculture
  - Its resulting risk



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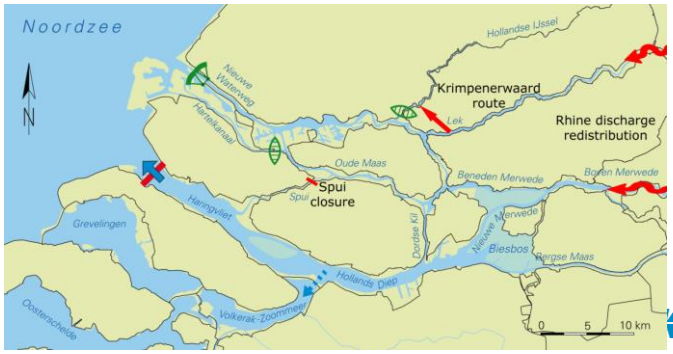
## Risk-based methodology to support

- Impact four measures
  - Closure Spui
  - Extra Intake from Lek river (Krimpenerwaard route)
  - Redistribution of Rhine discharge (10% extra over Lek)
  - Redistribution of Rhine discharge (25% extra over Lek)



## Risk-based methodology to support

- Impact four measures

| Measure | Present value of salinity risk [$10^6$ €] | Investment cost |
|---|---|---|
| Closure Spui | 45 | 17 |
| Extra intake from Lek river (Krimpenerwaard route) | 651 | 250 |
| Redistribution of Rhine discharge (10% extra over Lek) | 281 | 250 |
| Redistribution of Rhine discharge (25% extra over Lek) | 801 | 100 |
| Reference situation | 2.361 | - |

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## Risk-based methodology to support

- Objective for future
  - application of the methodology to the Netherlands
  - developing and evaluating drought-related risk management strategies to better cope with droughts

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