

Inleiding Civiele Techniek

Waterbeheer

11 september 2012

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n.c.vandegiesen@tudelft.nl



Inleiding Civiele Techniek

Waterbeheer

- **Wat? Wie?**
- **Grote wateropgaves**
 - **Klimaat**
 - **Nederland**
 - **Ontwikkelingslanden**



1 Wat? Wie?



wolken / oceanen / ijs

1 Wat? Wie?



**Slechts een fractie kan
beheerd worden...**

wolken / oceanen / ijs

1 Wat? Wie?

Slechts een fractie kan beheerd worden...

	Waterlaag (m)	Percentage
Oceanen	2643	97%
IJs, gletschers	55	2.0%
Grondwater	16	0.59%
Grondwater-Antarctica	7	0.25%
Bodemvocht	0.12	0.0044%
Meren	0.25	0.0092%
Rivieren	0.0021	0.000077%
Atmosfeer	0.0255	0.00094%

Baumgartner&Reichel (in Brutsaert, 2005)

1 Wat? Wie?

Waterbeheer

- Oceanen ?
 - Ontzouten heel duur
 - 20 km³/j wereldwijd
 - Alleen in speciale gevallen



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1 Wat? Wie?

Waterbeheer

- Atmosfeer?
 - Cloud seeding



1 Wat? Wie?

Waterbeheer

- IJs?
- IJsbergen



1 Wat? Wie?

Waterbeheer >99%

- **Rivieren (& meren)**
- **Grondwater**
- **Bodemvocht**



1 Wat? Wie?



Faculteit

- **Afdeling Watermanagement**
 - **Sectie Gezondheidstechniek**
 - **Sectie Waterhuishouding**
 - **Leerstoel Hydrologie**
 - **Leerstoel Waterbeheer**

1 Wat? Wie?

<http://www.dispuutwatermanagement.nl/>



1 Wat? Wie?



1 Wat? Wie?

Waterbeheer:

- Maurits Ertsen
- Nick vd Giesen
- Eric Mostert
- Ronald v Nooyen
- Betty Rothfusz
- Frans vd Ven
- Peter-Jules van Overloop
- Olivier Hoes
- Gerrit Schoups
- Susan Steele

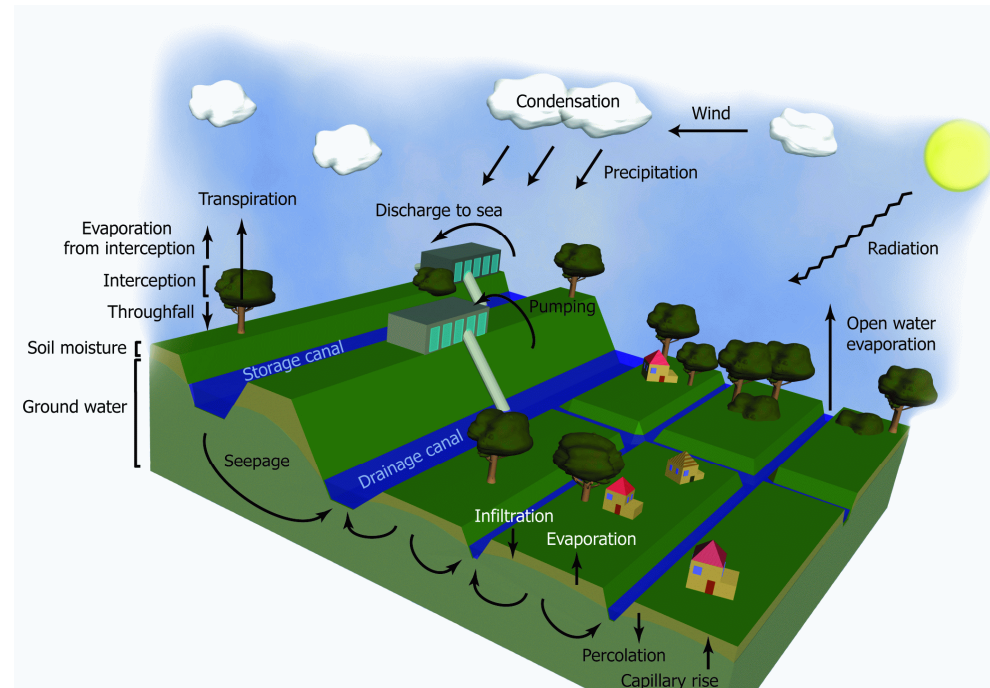


1 Wat? Wie?

Waterbeheer vakken BSc:

- Inleiding Watermanagement
- Waterbeheersing
- Projecten
- Challenging
- Minor

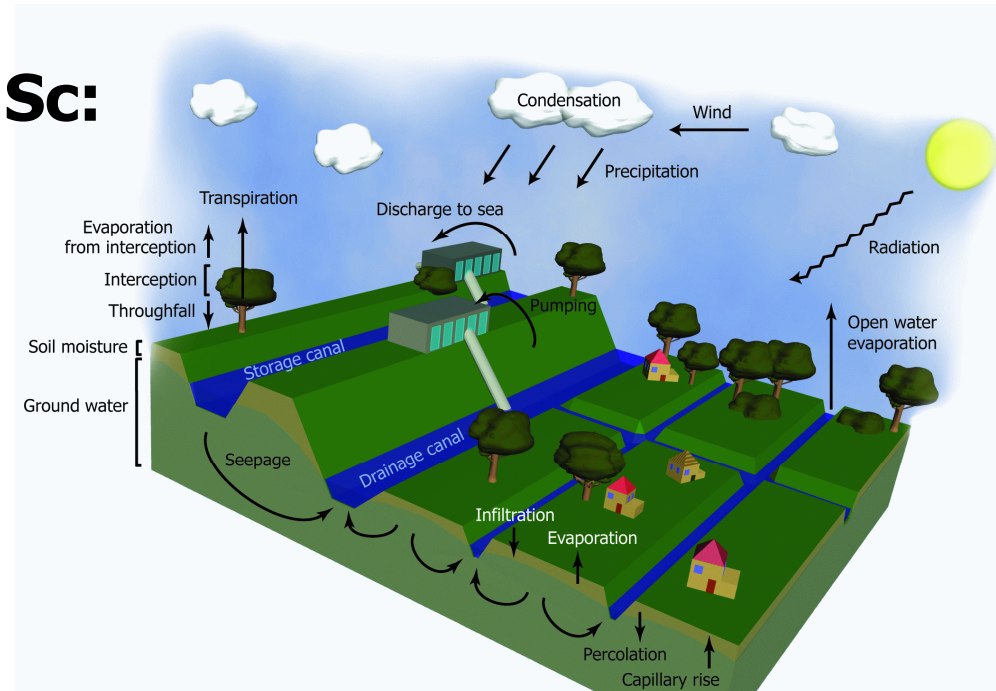
Dispuut



1 Wat? Wie?

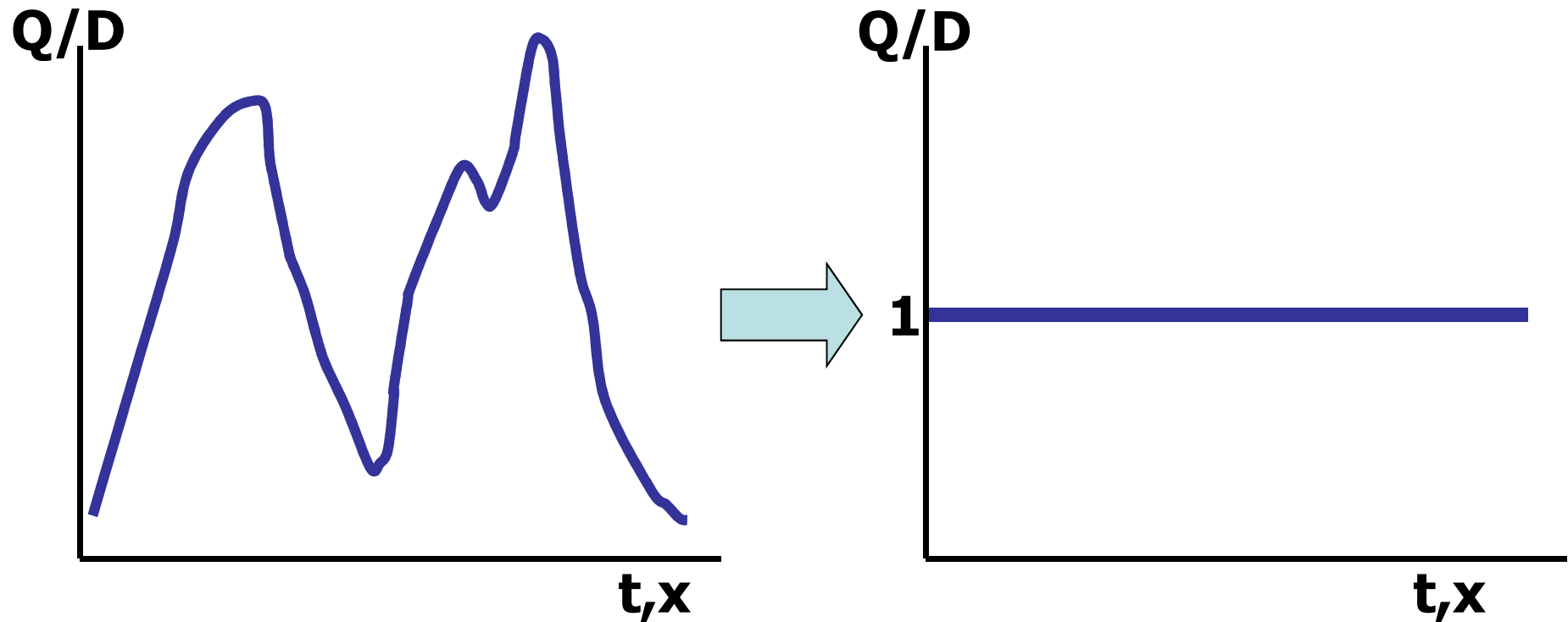
Waterbeheer vakken MSc:

- Polders
- Irrigatie
- Operationeel
- Integraal
- Water recht
- Stedelijk
- CT Ontwikkelingslanden
- Spatial tools



1 Wat? Wie?

Waterbeheer: Betere verdeling ruimte & tijd



2: Grote water opgaves

- **Klimaat**
- **Issues in Nederland/Europa**
- **Issues in ontwikkelingslanden**



2a: Wateropgave klimaat



Vakantie 2008

Is er iets aan de hand...?

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2a: Wateropgave klimaat

Klimaat

2012:
100 jaar droogte!



Is er iets aan de hand...?

2a: Wateropgave klimaat

Klimaat

Vakantie
2011
Nederland



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

[Publicaties](#) [Research](#) [Datacentrum](#) [Vacatures](#)

[Home](#) > [Nieuwsoverzicht](#)

Nieuws - Persbericht

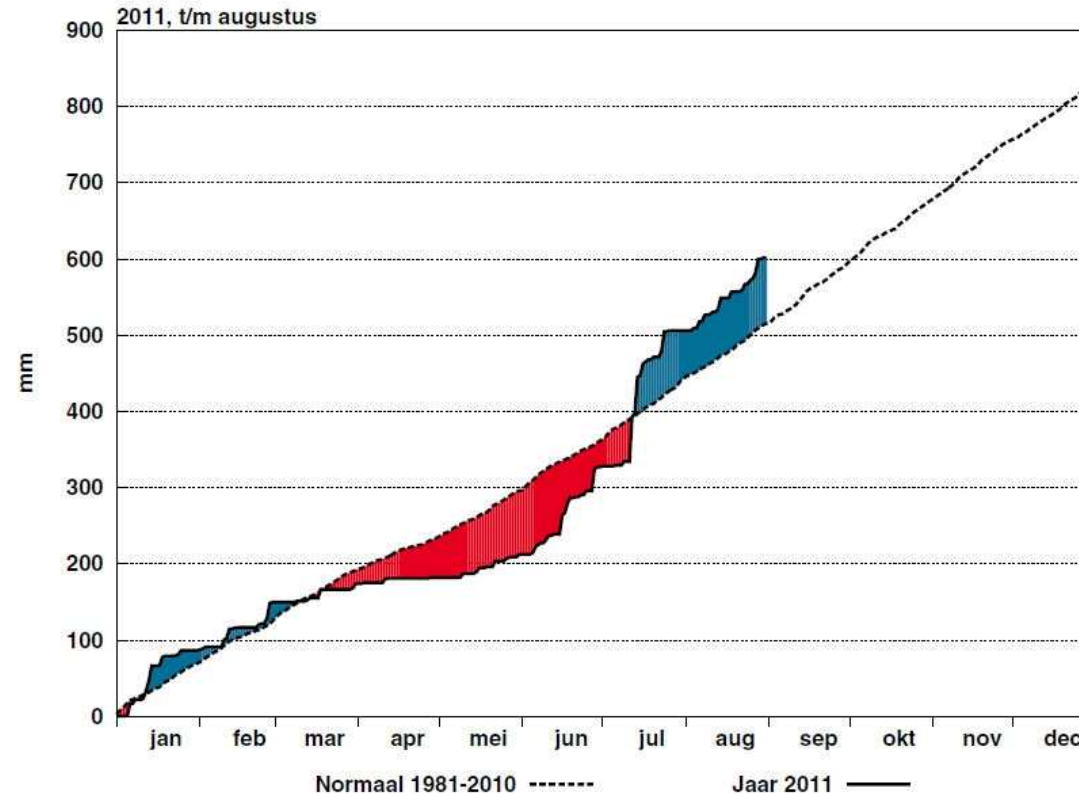
Natste zomer in zeker honderd jaar

6 september 2011 - Nederland beleefde dit jaar de natste zomer tenminste sinds het begin van de landelijke neerslagmetingen waarvan de meetreeks begint in 1906. Het KNMI berekende gemiddeld over het hele land omstreeks 350 mm tegen 225 mm normaal (gemiddeld over het tijdvak 1981-2010).

2a: Wateropgave klimaat

Klimaat

Vakantie
2011
Nederland



2a: Wateropgave klimaat

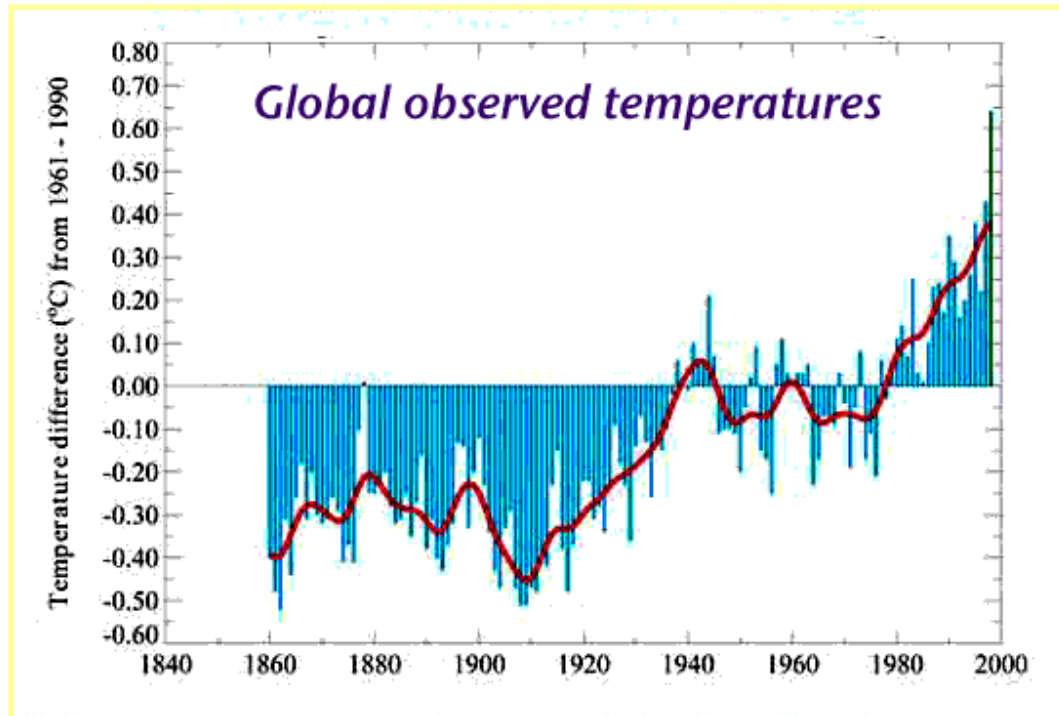
Klimaat

Vakantie
2013
Sardinie



2a: Wateropgave klimaat

Temperatuur



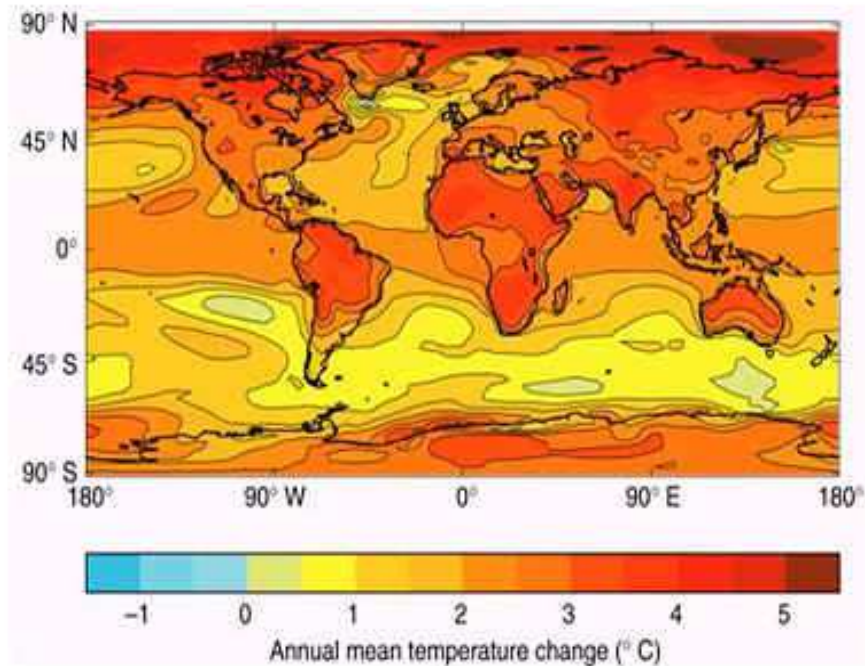
Er is iets aan de hand...!

2a: Wateropgave klimaat

Temperatuur

Vrij duidelijk

Projected Changes in Annual Temperatures for the 2050s

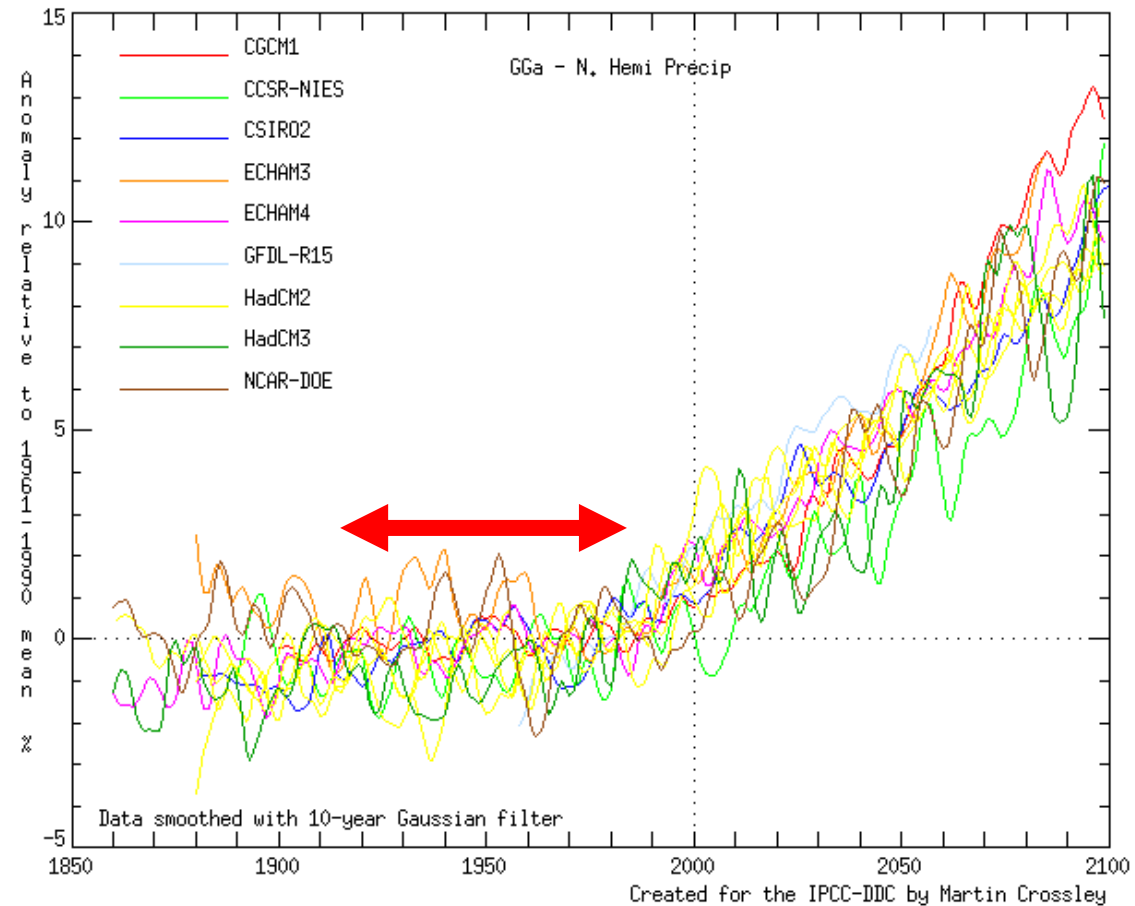


Projected change compared to the present, assuming $\sim 1\%/yr$ increase in equivalent CO_2

2a: Wateropgave klimaat

Klimaat

H₂O niet zo duidelijk...

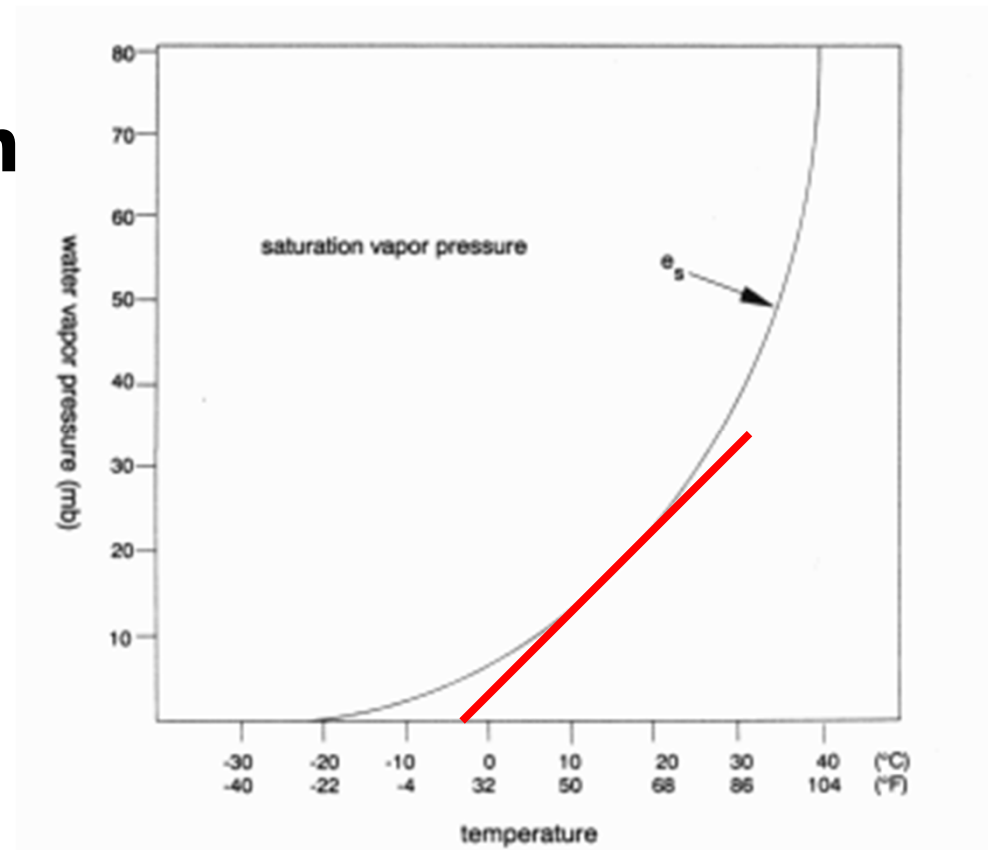


2a: Wateropgave klimaat

Klimaat

Clausius-Clapeyron

$$\frac{d \ln p}{dT} = \frac{\Delta H_{vap}}{RT^2}$$



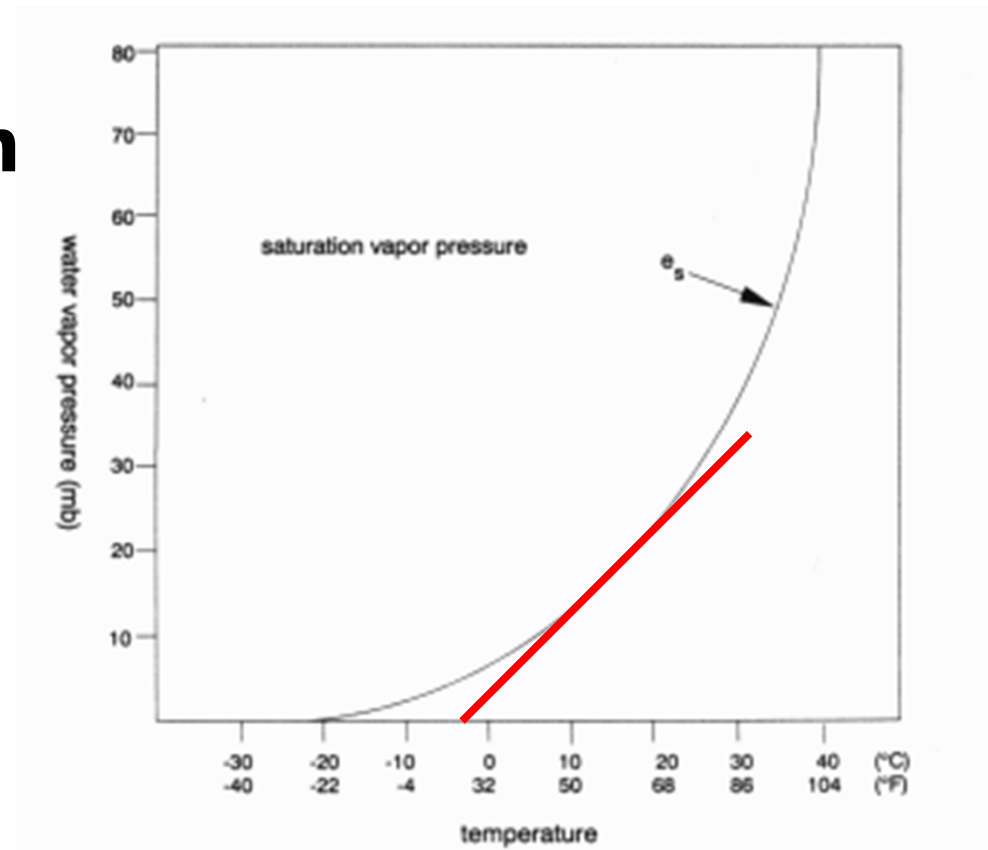
2a: Wateropgave klimaat

Klimaat

Clausius-Clapeyron

$$\frac{d \ln p}{dT} = \frac{\Delta H_{vap}}{RT^2}$$

$$+1^{\circ}\text{C} \Rightarrow +7\% \text{ H}_2\text{O}$$



2a: Wateropgave klimaat

Klimaat

Clausius-Clapeyron

$$+1^{\circ}\text{C} \Rightarrow +7\% \text{ H}_2\text{O}$$

Waarschijnlijk

$$+1^{\circ}\text{C} \Rightarrow +2\text{-}4\% \text{ H}_2\text{O}$$

Hydrologic cycle explains the evaporation paradox

The evaporation of water, measured using evaporation pans, has been decreasing in the past few decades over large areas with different climates. The common interpretation is that the trend is related to increasing cloudiness, and that it provides an indication of decreasing potential evaporation and a decreasing terrestrial evaporation component in the hydrologic cycle. Here we show that, although these studies are valuable, pan evaporation has not been used correctly as an indicator of climate change.

At first glance, reports of decreasing pan evaporation in European Russia, Siberia and the western and eastern United States¹, India² and Venezuela³ are paradoxical. They are hard to reconcile with well-substantiated increases in global precipitation and cloudiness⁴, which would normally require more surface evaporation as the only source of atmospheric water vapour, rather than less. They also run counter to predictions of increasing evaporation⁵, as one of the more

behaviour; indeed, for instance in the extreme case of a desert environment, E is zero, whereas E_{pa} is at its maximum. The idea of a complementary relationship between actual evaporation and apparent potential evaporation is not new⁷, and it has stimulated advances in the estimation of terrestrial evaporation⁸⁻¹⁰. In the case of a pan filled with water and placed in a region with less than adequate ground wetness to sustain E_0 , elimination of ΔH in the above yields $E = [(1 + b)E_0 - aE_{pa}]/b$.

Because a and b are of order one, this equation indicates how the observed¹⁻³ decreases in pan evaporation, E_{pa} , can be interpreted as evidence for increasing terrestrial evaporation, E , in those regions. This is consistent with data^{4,11} indicating an intensifying hydrologic cycle in large regions: increasing precipitation leads to increasing surface run-off and soil wetness, which in turn generates more evaporation, and so on.

W. Brutsaert*, M. B. Parlange†

*School of Civil and Environmental Engineering,
Cornell University,

Ithaca, New York 14853, USA

†Department of Geography and Environmental
Engineering, Johns Hopkins University,
Baltimore, Maryland 21218, USA

Nature 396 p 30

2a: Wateropgave klimaat

Klimaat

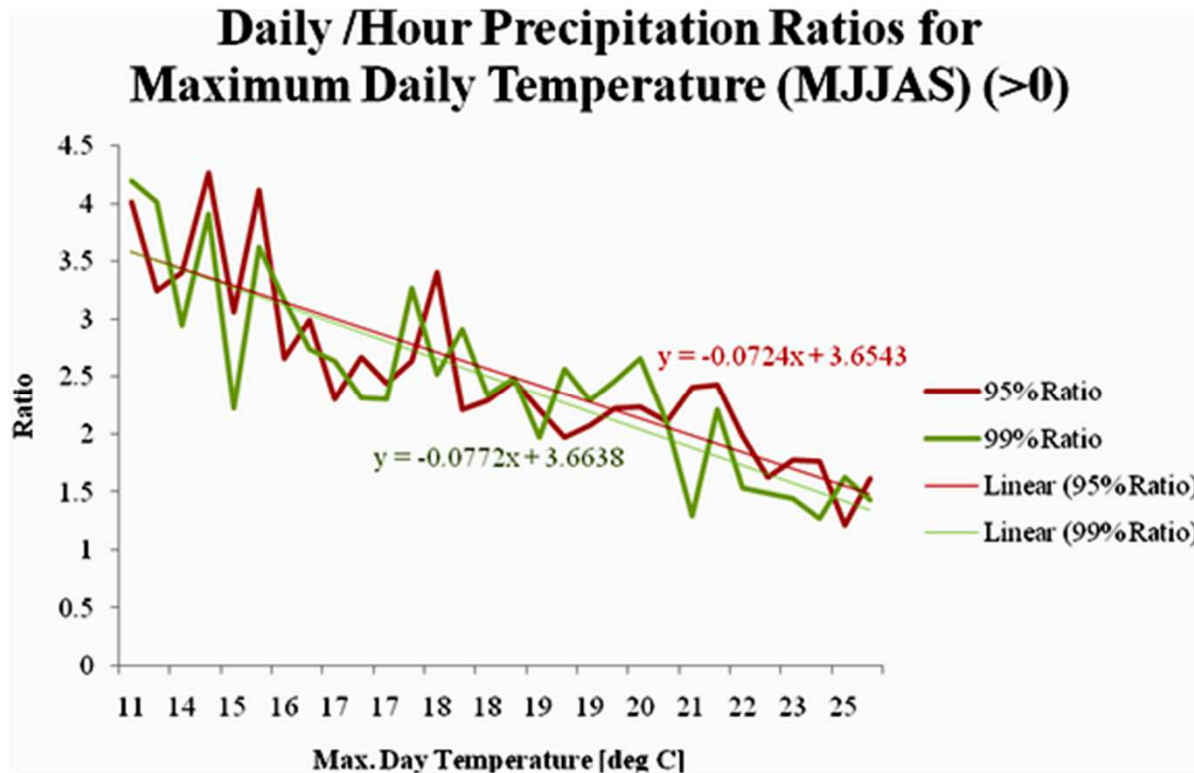
Clausius-Clapeyron

$$+1^{\circ}\text{C} \Rightarrow +7\% \text{ H}_2\text{O}$$

20% K^{-1} . The global average precipitation intensity increases by about 23% K^{-1} substantially greater than the increase of about 7% K^{-1} in atmospheric water-holding capacity estimated by the Clausius-Clapeyron equation. The

GRL, 5 September, 2009

2a: Wateropgave klimaat



Nina Romero
Climatic Change

2a: Wateropgave klimaat

Re-analysis ook waardeloos...

The hydrological cycle in three state-of-the-art reanalyses:

intercomparison and performance analysis

CHRISTOF LORENZ¹ * AND HARALD KUNSTMANN^{1,2}

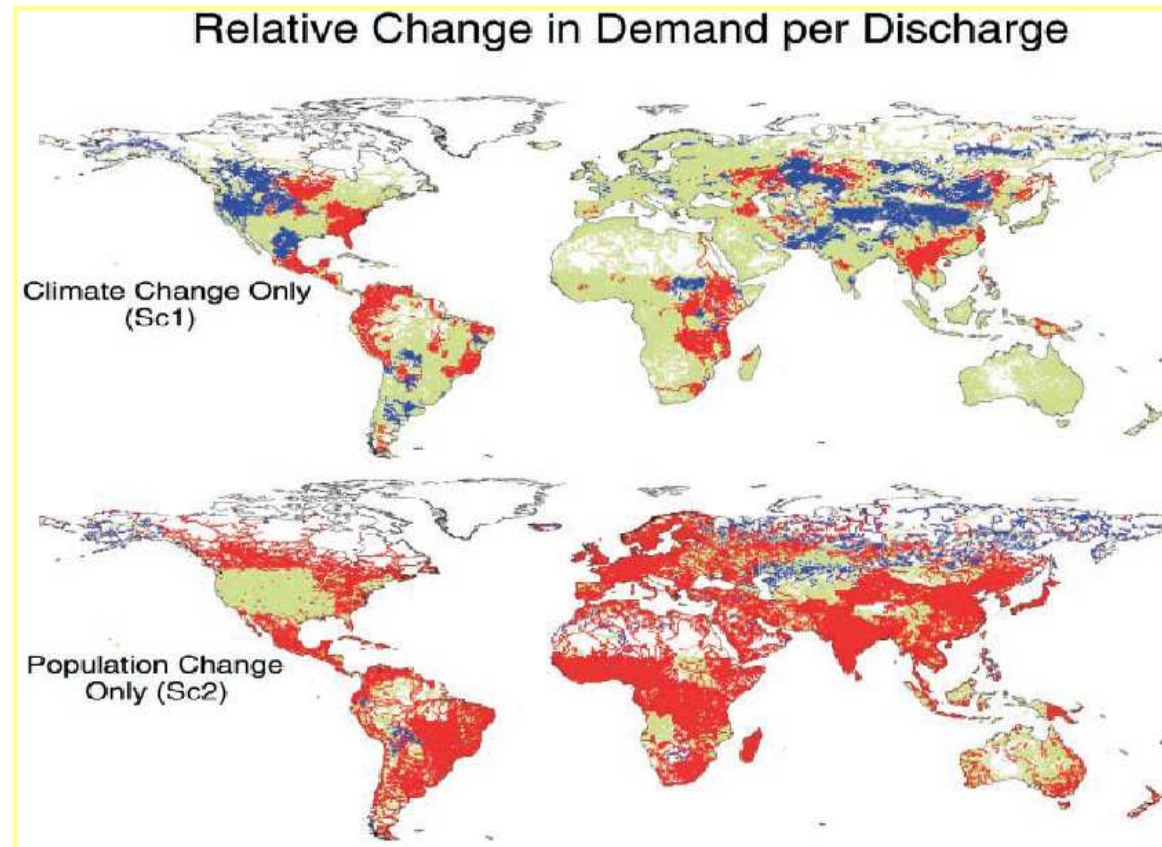
1 Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research,

Garmisch-Partenkirchen, Germany

2 Augsburg University, Institute of Geography,

2a: Wateropgave klimaat

Eerste orde processen

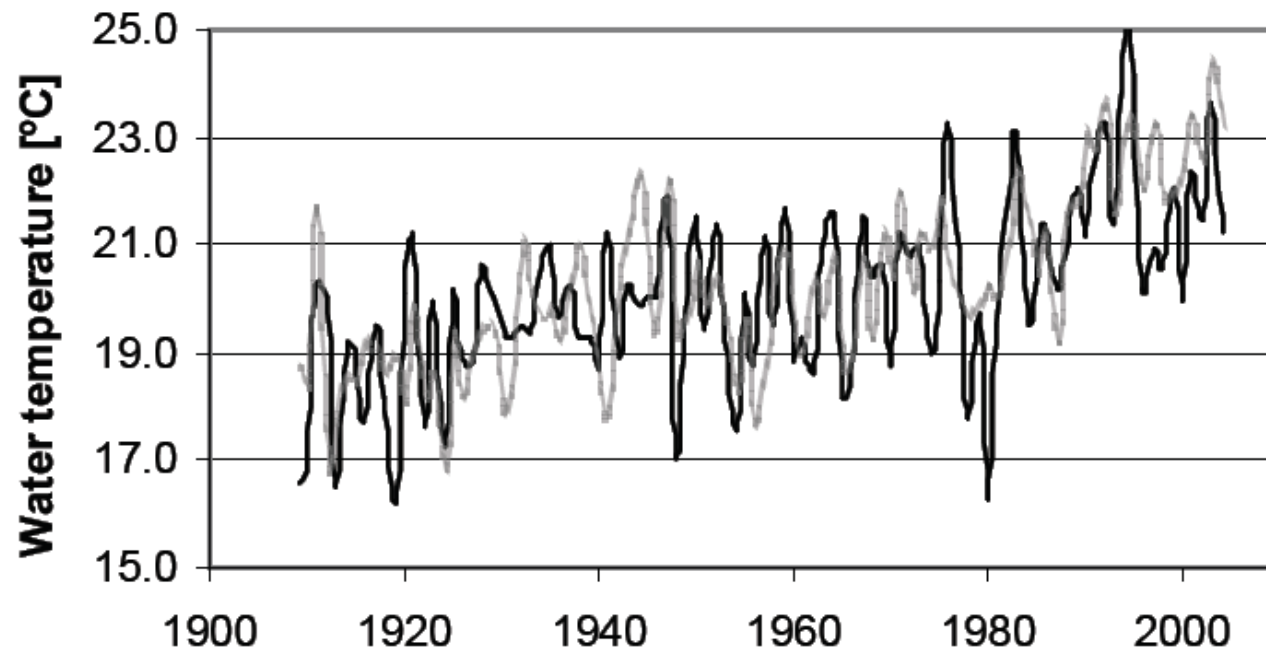


Vorosmarty et al,
Science 289, July 2000

2a: Wateropgave klimaat

Eerste orde processen

Rhine water temperature July and August: 1909-2004



Martine Rutten

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Waterbeheer

2a: Wateropgave klimaat

Wat kunnen we zeggen:

- **Er is iets aan de hand...**
- **Lokale impact / extremen**
- **Gezond verstand is nooit weg**
- **Robuust ontwerpen: IJsselmeer**

2b: Wateropgave Nederland

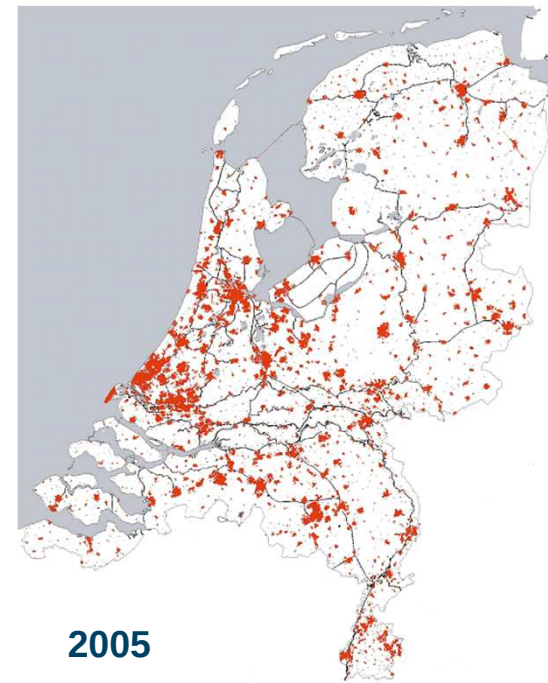
Stedelijk waterbeheer



1900



1970



2005

2b: Wateropgave Nederland

Stedelijk waterbeheer

- **Betere nieuwbouw**
- **Grondwater beheer**
- **Buitendijks bouwen**

2b: Wateropgave Nederland

Stedelijk waterbeheer

- **Betere nieuwbouw**



Rutger de Graaf

2b: Wateropgave Nederland

Stedelijk waterbeheer

- **Grondwater beheer**



Lucas vd Winkel
Tijs Opperman
Toine Vergroessen

2b: Wateropgave Nederland

Stedelijk waterbeheer

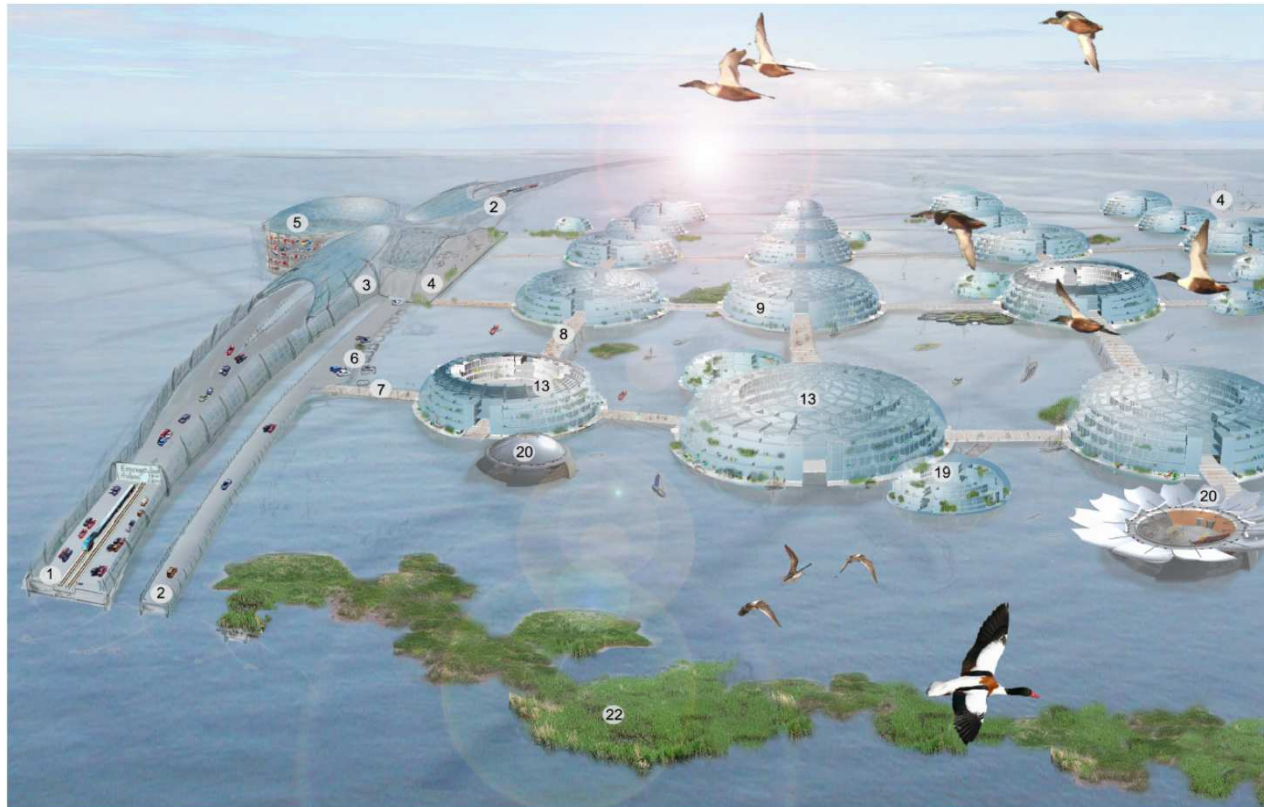
- **Buitendijks bouwen**

Bart v Genugten
Michiel Wolthuis



2b: Wateropgave Nederland

Stedelijk waterbeheer



DeltaSync

Rutger de Graaf

2b: Wateropgave Nederland

Stedelijk waterbeheer



DeltaSync

Rutger de Graaf

2c: Wateropgave ontwikkelingslanden

Issues

- **Millenium goals**
- **Kleinschalige investeringen**

2c: Wateropgave ontwikkelingslanden

Millenium goals

- Goal 1 Eradicate extreme poverty and hunger
- Goal 2 Achieve universal primary education
- Goal 3 Promote gender equality and empower women
- Goal 4 Reduce child mortality
- Goal 5 Improve maternal health
- Goal 6 Combat HIV/AIDS, malaria, and other diseases
- Goal 7 Ensure environmental sustainability
- Goal 8 Develop a global partnership for development

2c: Wateropgave ontwikkelingslanden

Millenium goals, World Bank

The World Commission on Water has estimated that investments in water infrastructure in developing countries need to increase from about \$75 billion to \$180 billion a year over the next 25 years

2c: Wateropgave ontwikkelingslanden

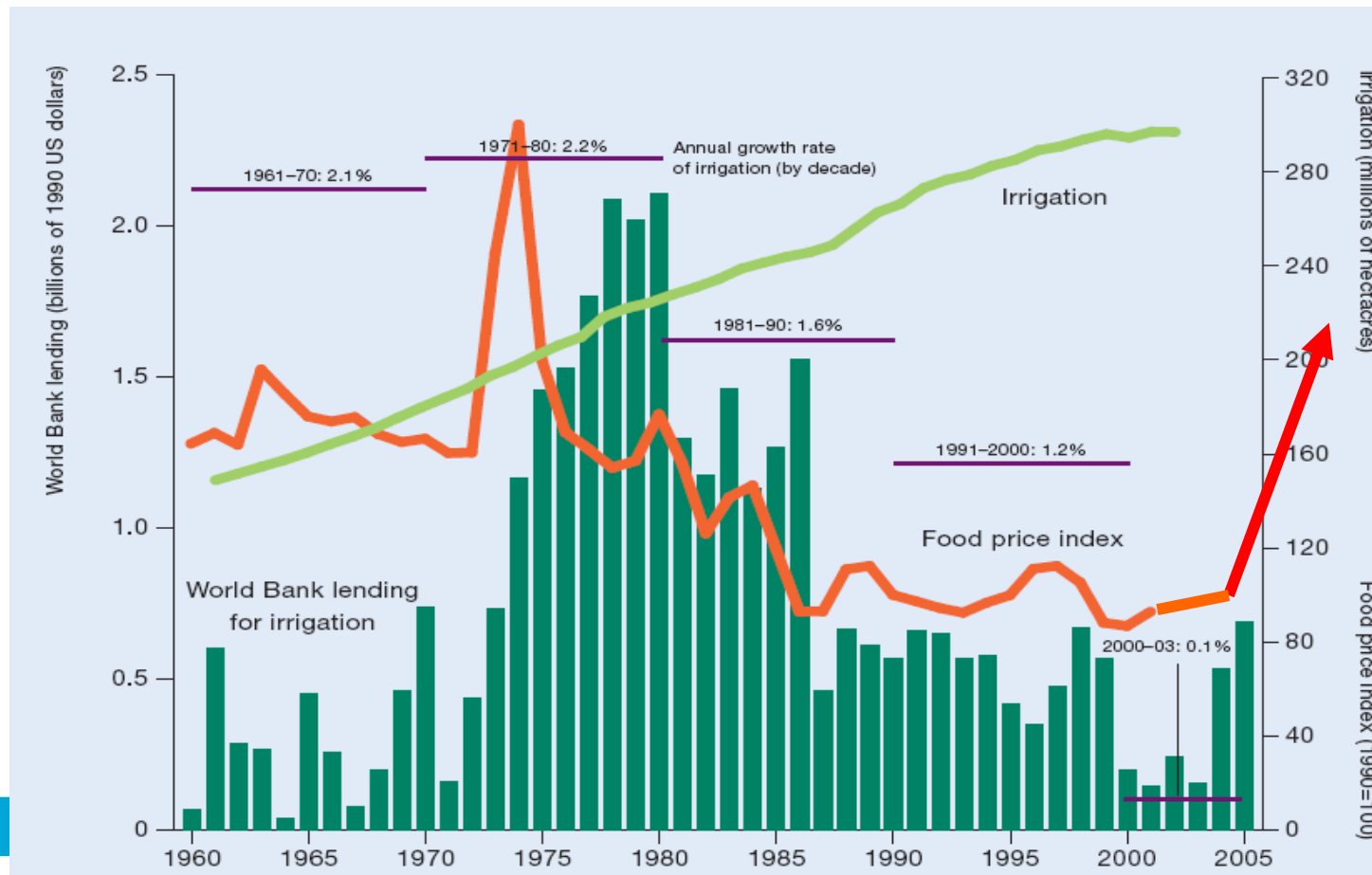
Millenium goals, voedsel

800-2800 m³ pp / jaar (geen tekort)

• drinkwater	1
• koken etc.	5
• wassen etc.	10
• toilet	20
• industrie	200
• vegetarisch dieet	500
• vlees (extra)	500-1000
• biofuel 1000 liter	1000

2c: Wateropgave ontwikkelingslanden

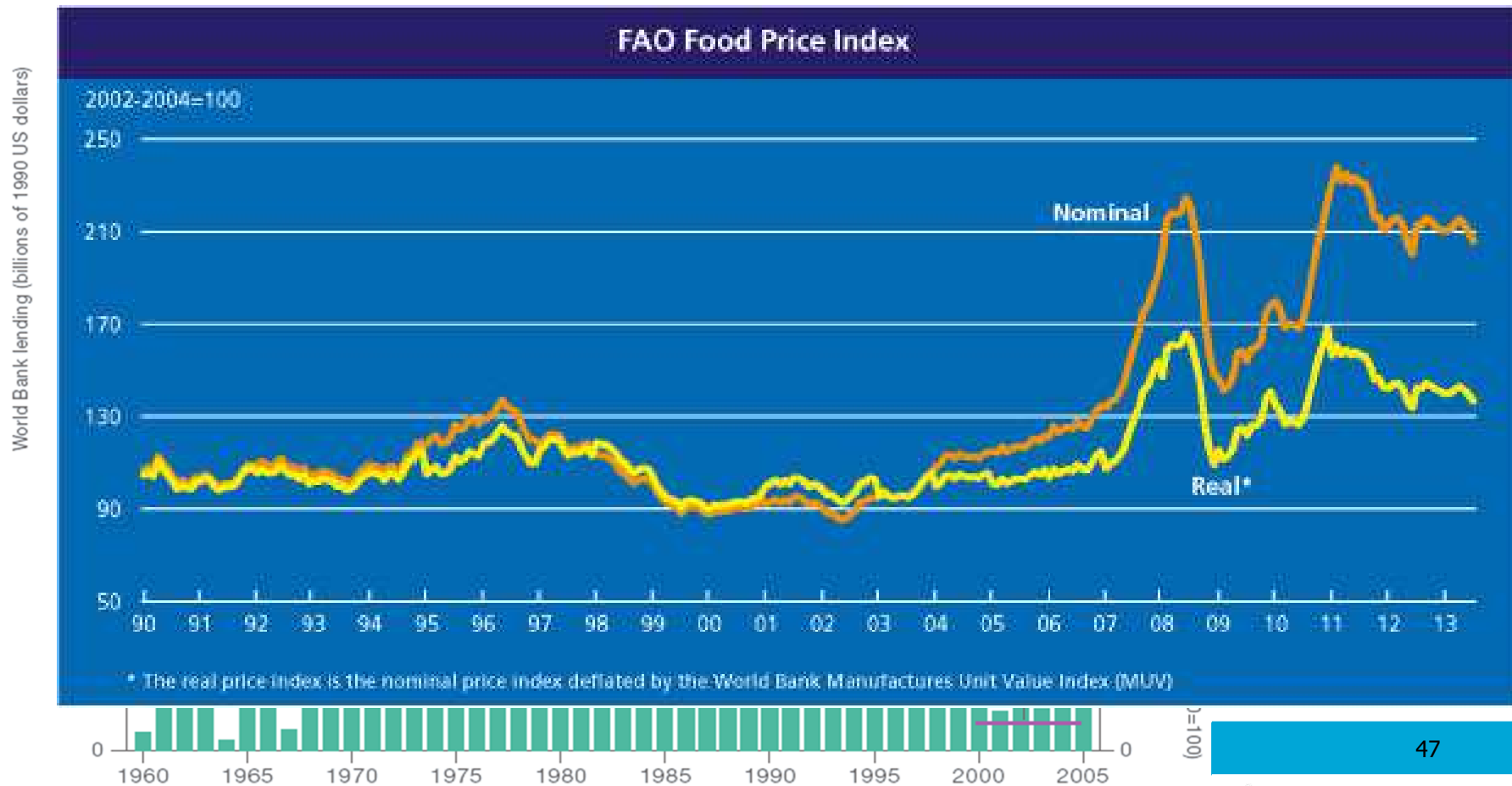
Voedsel



Jippe
Hoogeveen

2c: Wateropgave ontwikkelingslanden

Voedsel



Waterbeheer

2c: Wateropgave ontwikkelingslanden

Voedsel

- **Kleinschalige investeringen**



Tono, Ghana
70-er jaren
\$45,000 / ha

2c: Wateropgave ontwikkelingslanden

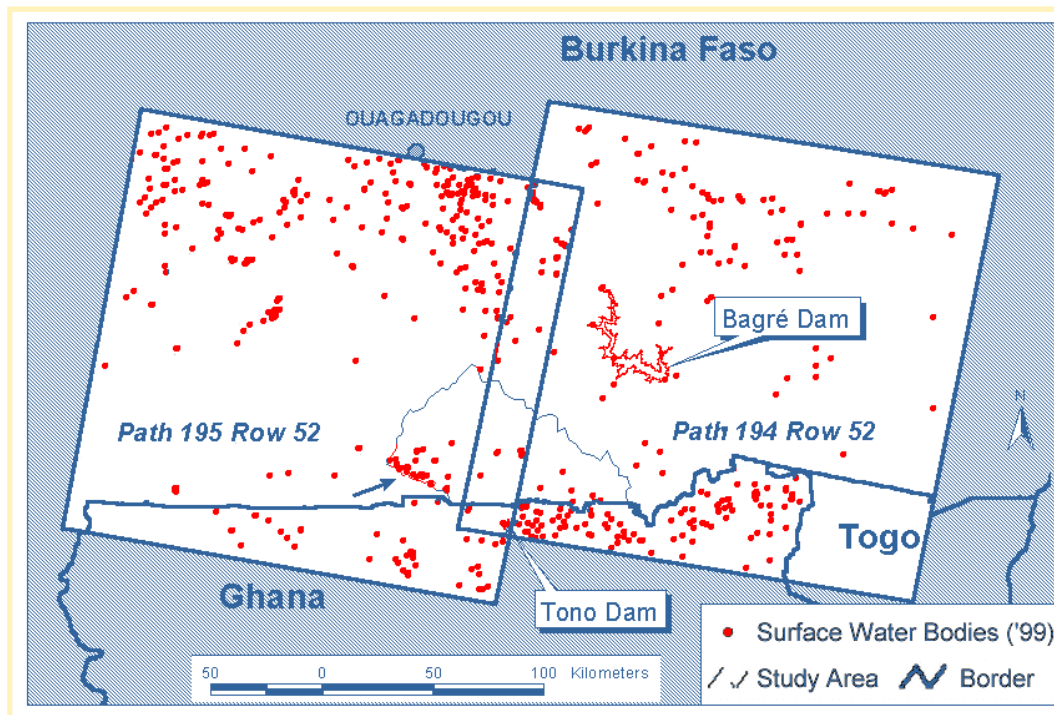
Voedsel

- **Kleinschalige investeringen**



2c: Wateropgave ontwikkelingslanden

Kleinschalige investeringen



	1984	1999
#	302	710
ha	4134	31200

2c: Wateropgave ontwikkelingslanden

Kleinschalige investeringen, hoe:

- **Institutioneel?**
- **Financiering?**
- **Technisch?**
- **Opschalen impact?**

2c: Wateropgave ontwikkelingslanden

Kleinschalige investeringen

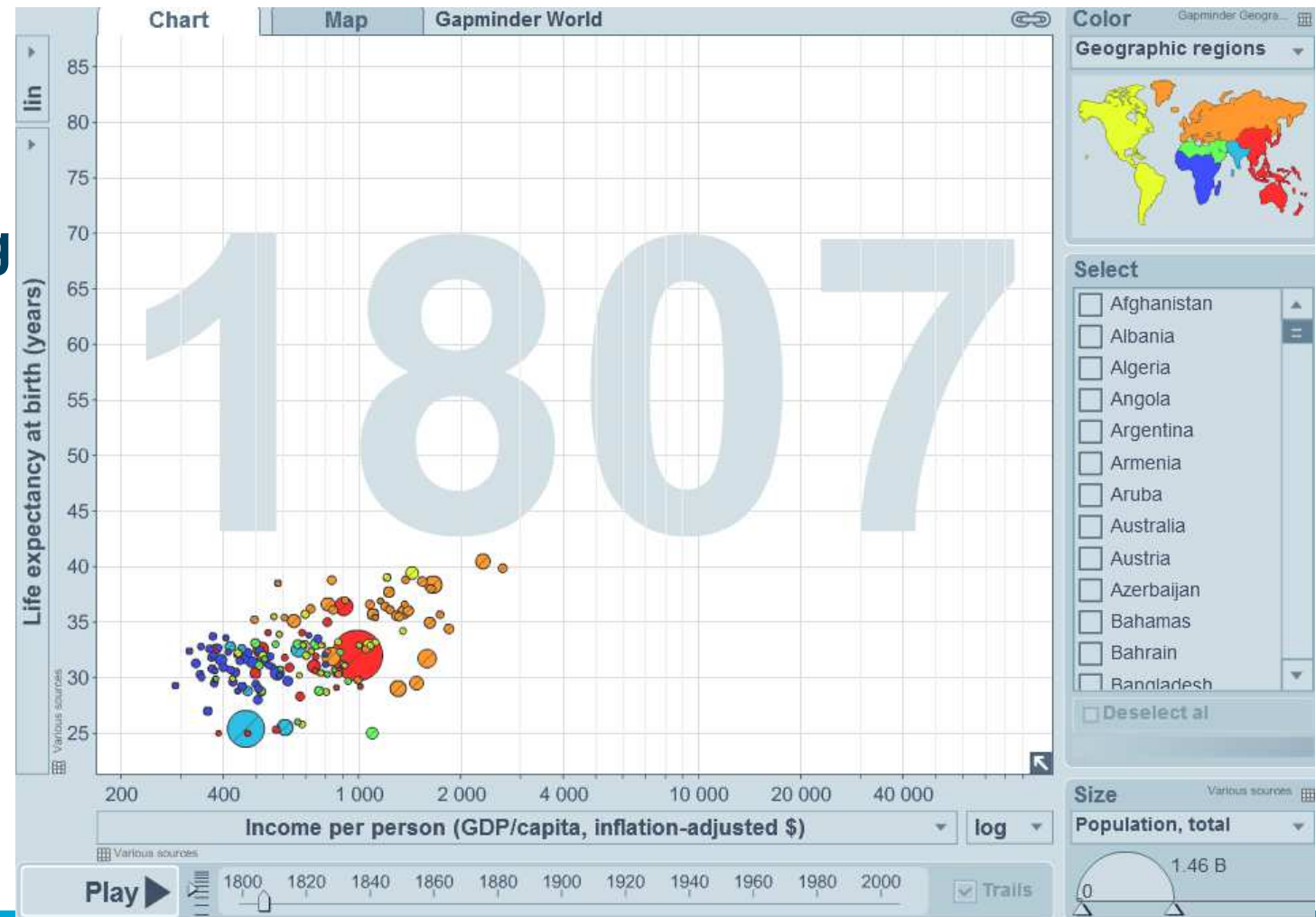
<http://www.smallreservoirs.org>



2: Grote water opgaves

CT

gapminder.org



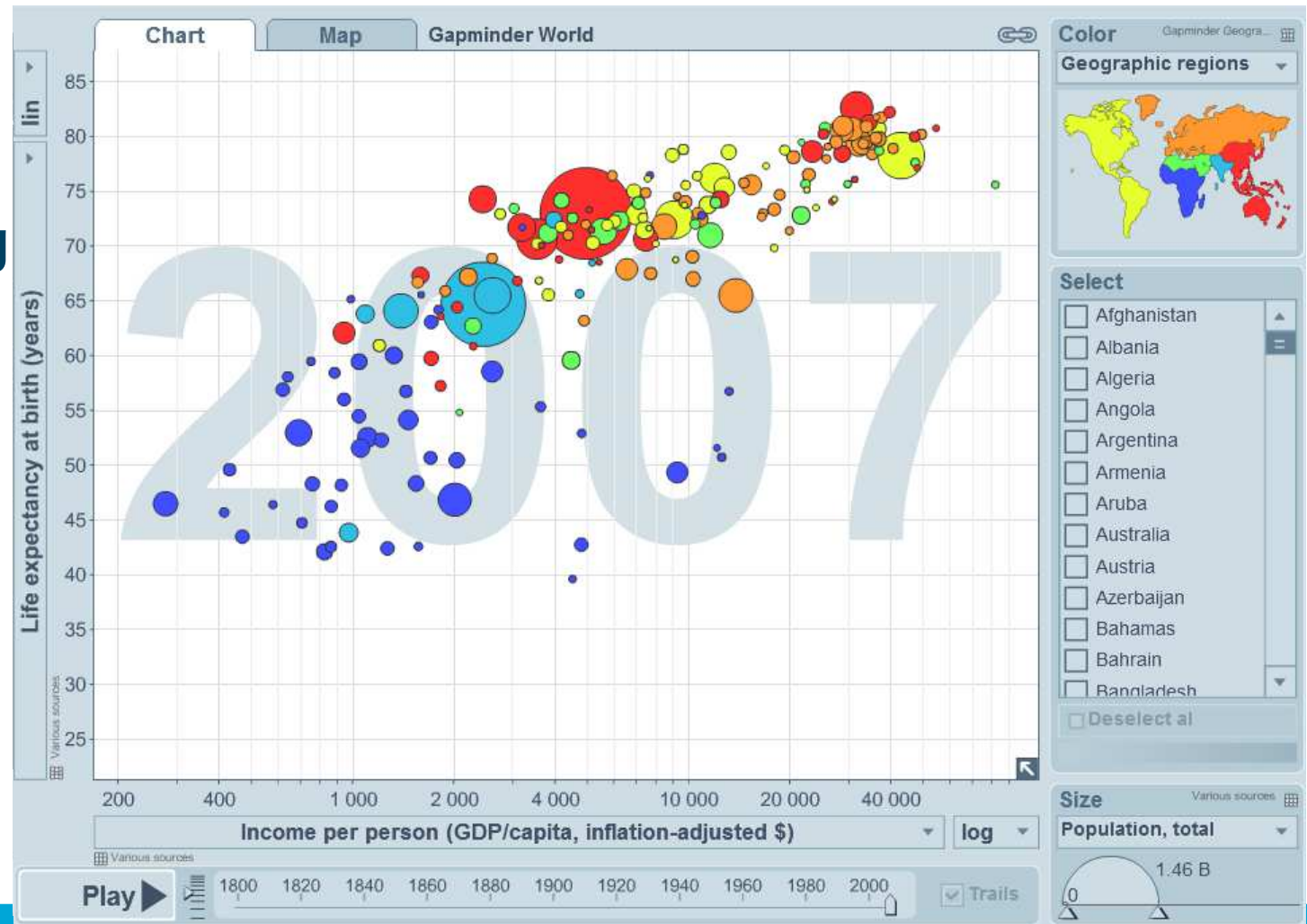
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Waterbeheer

2: Grote water opgaves

CT

gapminder.org



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Waterbeheer

2d: Wateropgave globaal

www.eWaterCycle.org



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2d: Wateropgave globaal



Rens Hasman
Pradeep Rathore
Alwin Commandeur

Waterbeheer

www.wrm.tudelft.nl

nick@citg.tudelft.nl



Dank voor uw aandacht