

Welcome to Delft



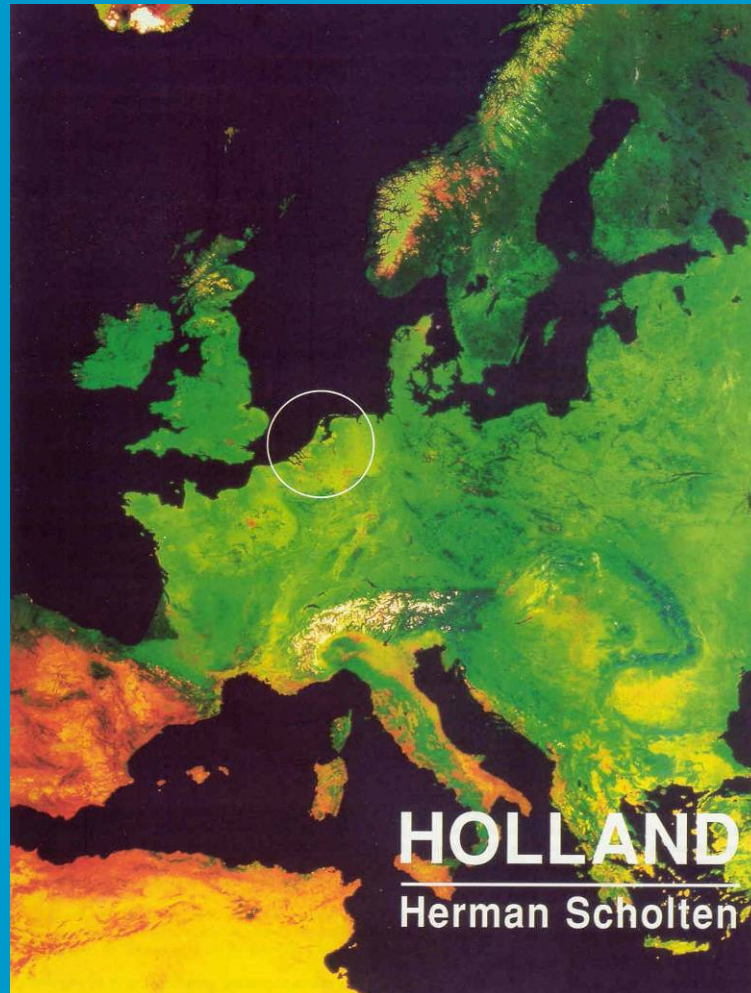
The faculty of Civil Engineering and Geosciences

Prof. ir. J.C. van Dijk

Outline

- Some facts about the Netherlands
- Drinking water in the Netherlands
- Drinking water and Delft
- Drinking water research themes

A small country...



but with great people !



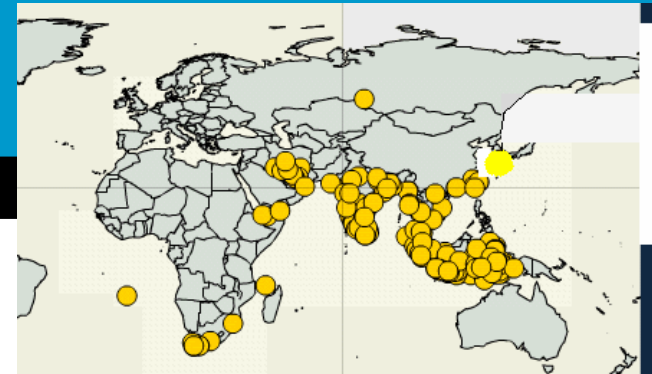
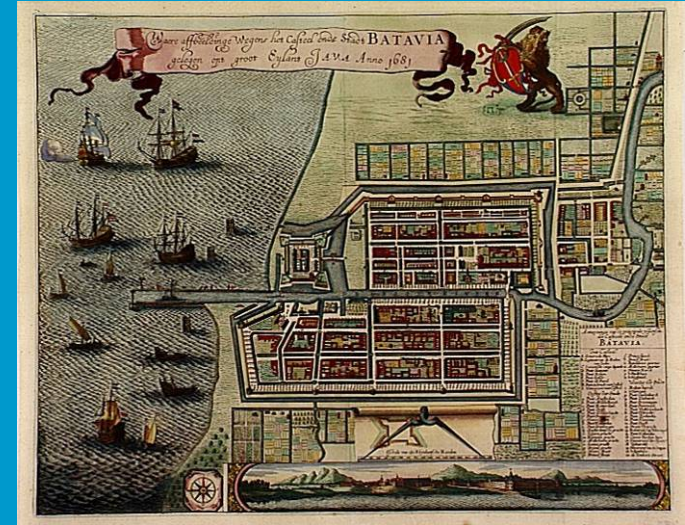
Wooden shoes and dikes and tulips and canals...



and a great football team...



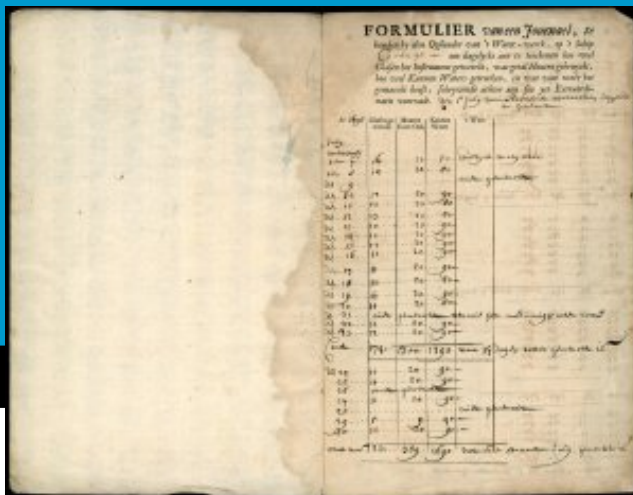
The Dutch Seaborne Empire



The first seawater desalination



- Discovery by Christiaan Nentwich 1690
- Applied widely by the VOC between 1691 till 1707
- Statistics by Johann Hudde showed succes (9% death rate instead of 13%)
- After the death of Hudde, the new administrators discontinued
- The English reinvented the wheel in 1785



Dutch drinking water: principles and practices



Prof. ir. Hans van Dijk

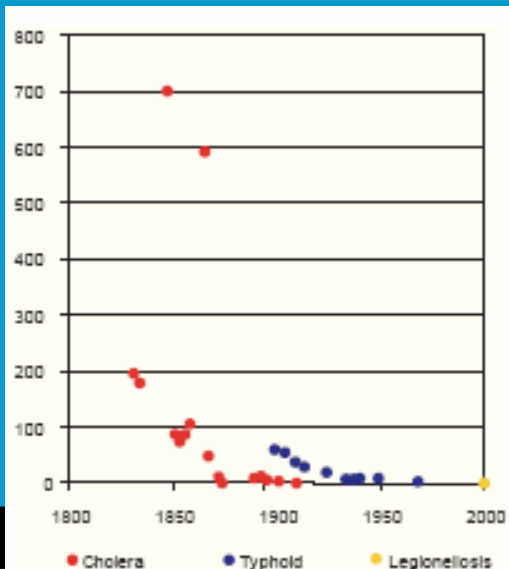
Drinking water in the Netherlands

- Total volume: $1.2 \times 10^9 \text{ m}^3/\text{jaar}$
- Sources
 - Groundwater: 2/3
 - Surface water: 1/3
- Treatment
 - Groundwater: aeration and sand filtration
 - Surface water: very extensive treatment
- Distribution
 - *no chlorine!*

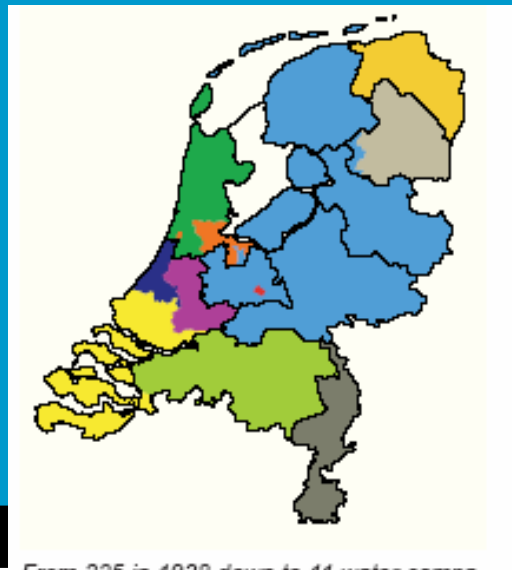


Principles and practices:1

1. Focus on public health...
2. Large publicly owned private companies...
3. With joined efforts for research and communication



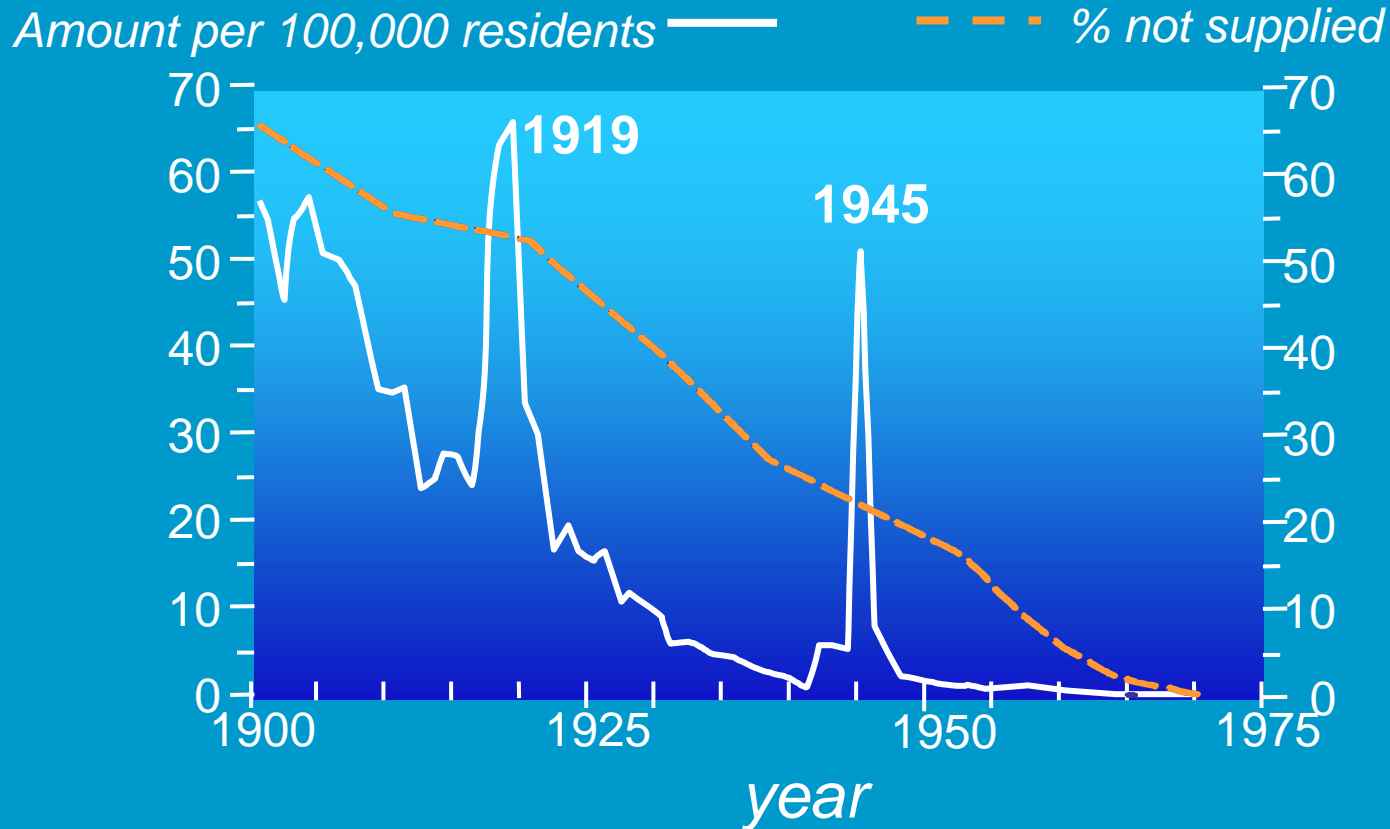
Mortality per 100,000 person in the Netherlands by drinking water related diseases (RIVM)



From 225 in 1938 down to 11 water companies in 2006, and still merging (TU Delft)



Safe water for public health..



Principles and practices: 2

1. Source protection
2. Safe groundwater when available...
3. Or artificial groundwater...
4. Or surface water with multiple barriers for micro-organisms, pollutants and nutrients...

- groundwater
- surface water
- Infiltration water
- bank groundwater



Source protection

Enforcing environmental protection laws in Europe
Early warning along Rhine and Meuse
Large reservoirs to overcome contamination waves

Reliable treatment

Self-purification in reservoirs
Double filtration systems
Absorption and oxidation processes
Safe water even during a failure

Multiple barriers in drinking water production from surface water



Three water reservoirs in Biesbosch National Park

| Source | Number of locations | Abstraction (million m ³) |
|---|---------------------|---------------------------------------|
| Groundwater (natural) | 182 | 709 |
| Artificial groundwater (riverbank filtration) | 12 | 61 |
| Artificial groundwater (dune infiltration) | 7 | 214 |
| Surface water (reservoirs) | 7 | 293 |
| Total | 218 | 1,277 |

Different sources for drinking water production in the Netherlands in 2004 (VEWIN/RIVM 2004)

Source protection

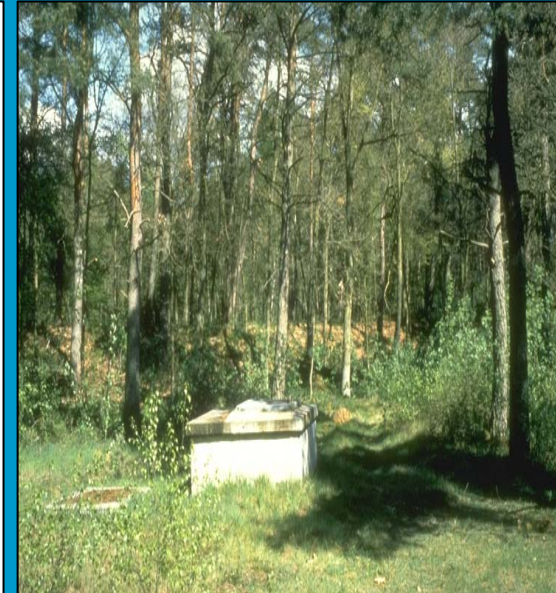


Waterbedrijven eisen verbod lozen bentazon

Van onze verslaggeefster
DEN HAAG — Er is onenigheid ontstaan tussen de waterleidingbedrijven en het kabinet over de aanpak van de omstreden chemische stof bentazon. Deze is aangetroffen in het drinkwater

consument dan 10 tot 20 cent meer voor een kubieke meter water betalen.

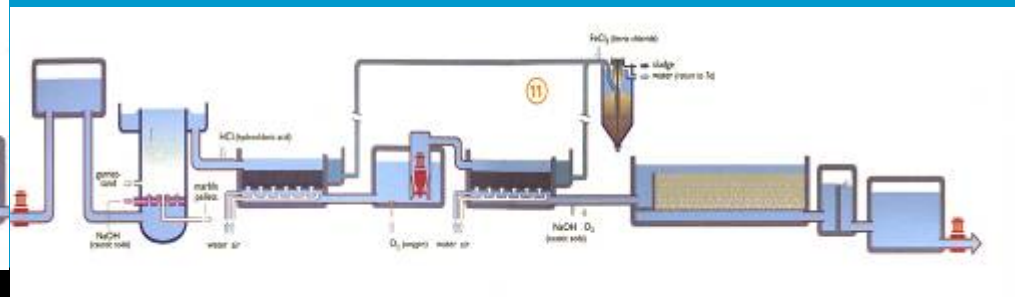
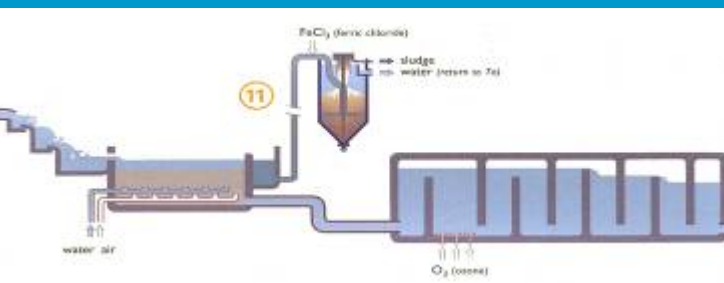
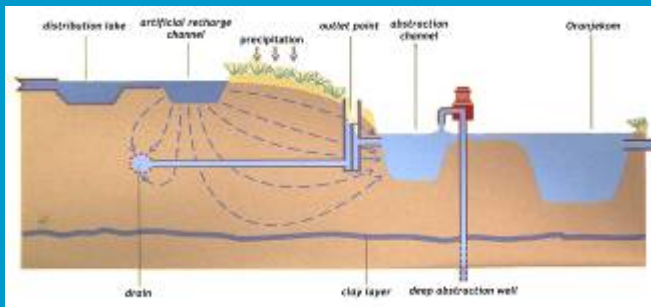
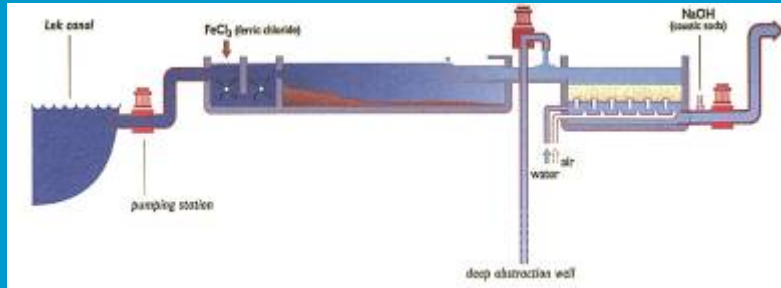
De wettelijke norm voor de aanwezigheid van pesticiden is 0,1 microgram per liter leidingwater. Die norm is door alle EG-landen onderschreven op grond van



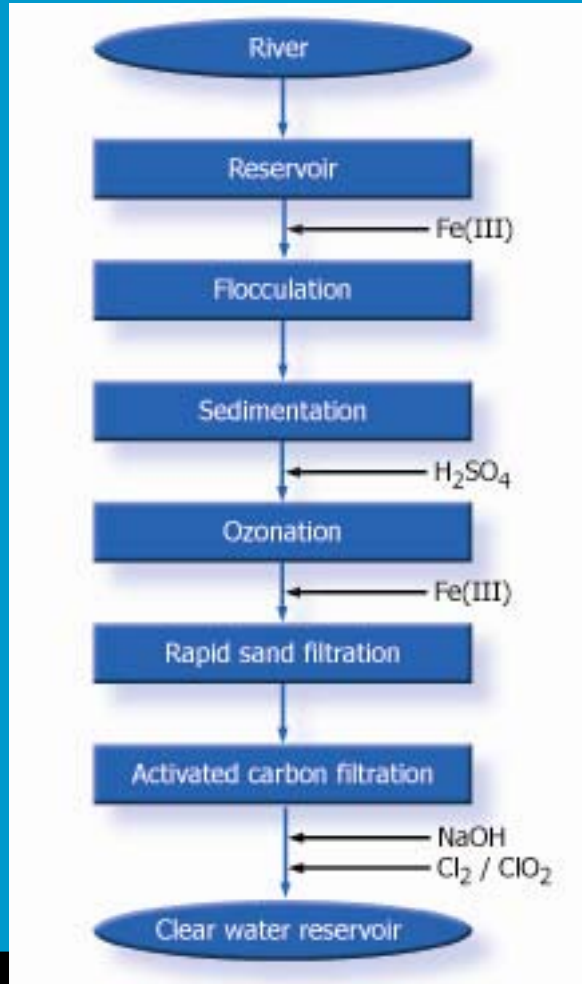
Groundwater



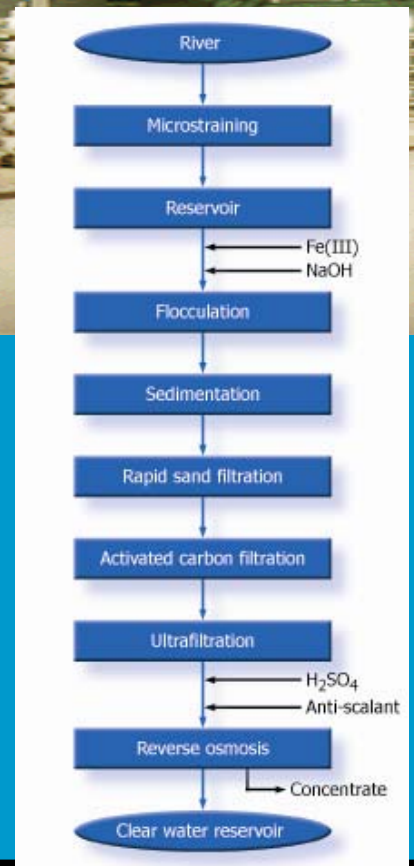
Artificial recharge



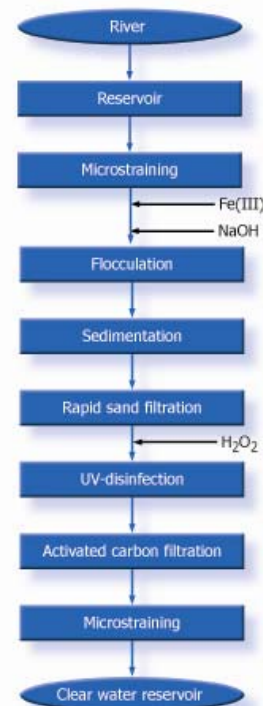
Multiple barriers...



Modern technology...



UV for disinfection at Andijk (PWN 2005)



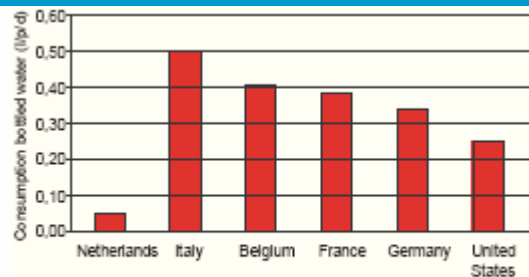
Principles and practices: 3

1. High quality water without chlorine...
2. And with a low hardness...
3. So the customers drink water from the tap



| Public health | The environment | Comfort | Economics |
|---|---|---|---|
| Less lead, copper and zinc No risky home filters | Less phosphate Less household waste water Less metals in waste sludge | Better soap while showering Better taste Better appearance (tea) Less scaling in hot water | Savings on washing powder Savings on home-filters Savings on scaling Overall lower costs |

The benefits of soft drinking water are recognized in the Dutch drinking water regulations



Consumption of bottled water (Bottled water reporter 2005/ VEWIN 2006)



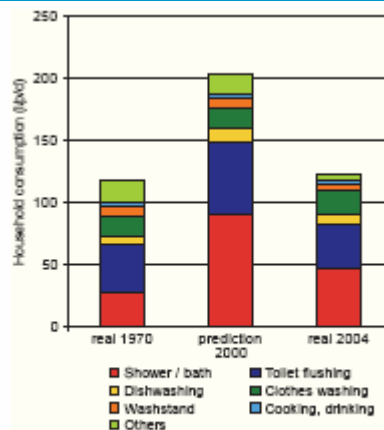
Principles and practices: 4

1. No leakage...
2. Reliable systems...
3. Stimulate water saving...

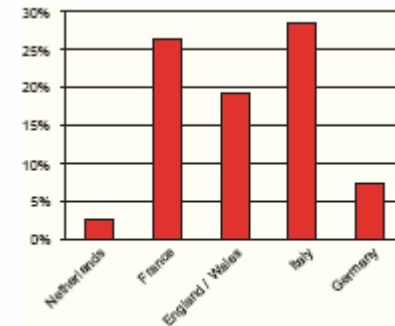


■ substandard supply
■ normal supply

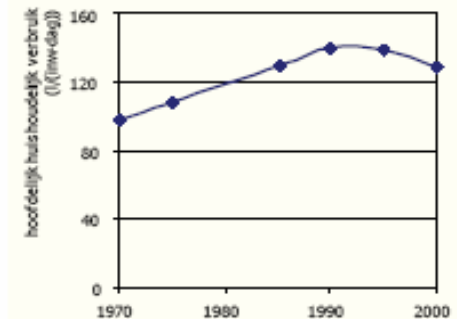
Drinking water supply with 99,99329% uptime (TU Delft 2005)



Water saving in households (Vakantie cursus 1973, VEWIN 2004)



Lowest leakage in the world (DGW 2006, VEWIN 2004).



Figuur 8 - Ontwikkeling hoofdelijk verbruik in huishoudens (l/(inw-d))

The miracle from the tap

High quality water supply

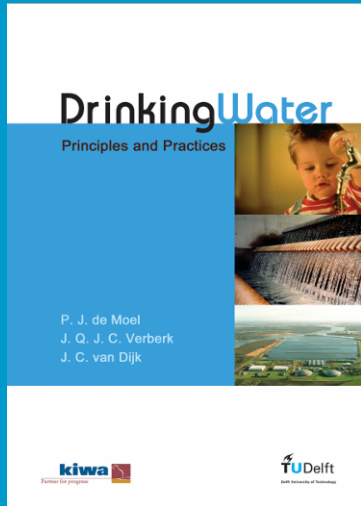
- No waterborne diseases
- No chlorine
- No pesticides
- No hard water
- No corrosion and metals
- No leakage
- No need for home filters
- No need for bottled water
- No wasting of water



Drinking water and Delft



The 1st lecture (1937)



Crown Prince Willem-Alexander during a guest lecture at TU Delft



Celebrating the completion of design course



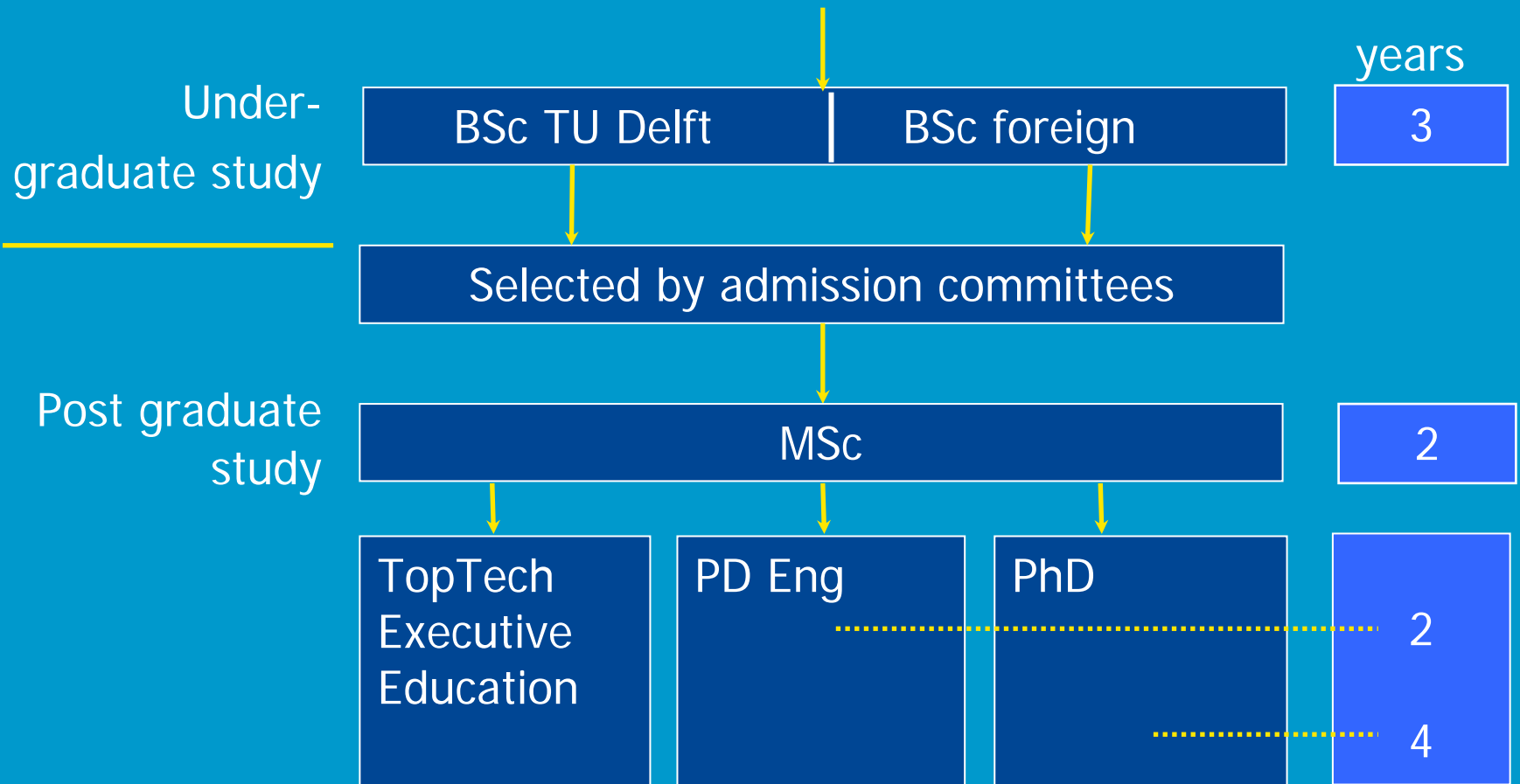
PhD graduation of Jasper Verberk (2005)

About TU Delft

- Founded in 1842
- Eight faculties
- 14 BSc programmes
- 38 MSc programmes
- 13,000 students
- Academic staff of 2,100 (including 200 professors)
- 85 PhD dissertations annually
- 4,000+ annual publications in scientific journals

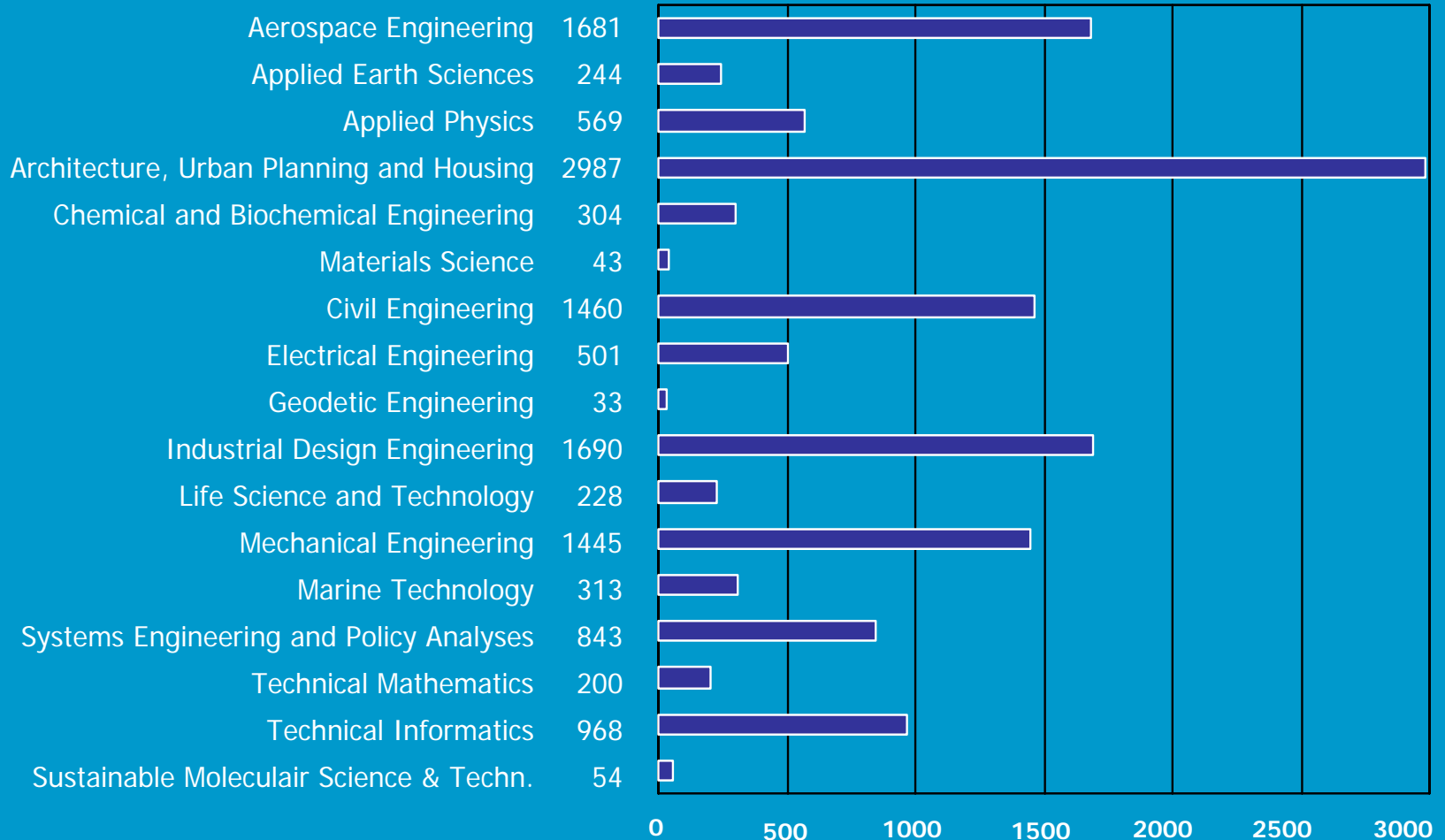


Education system



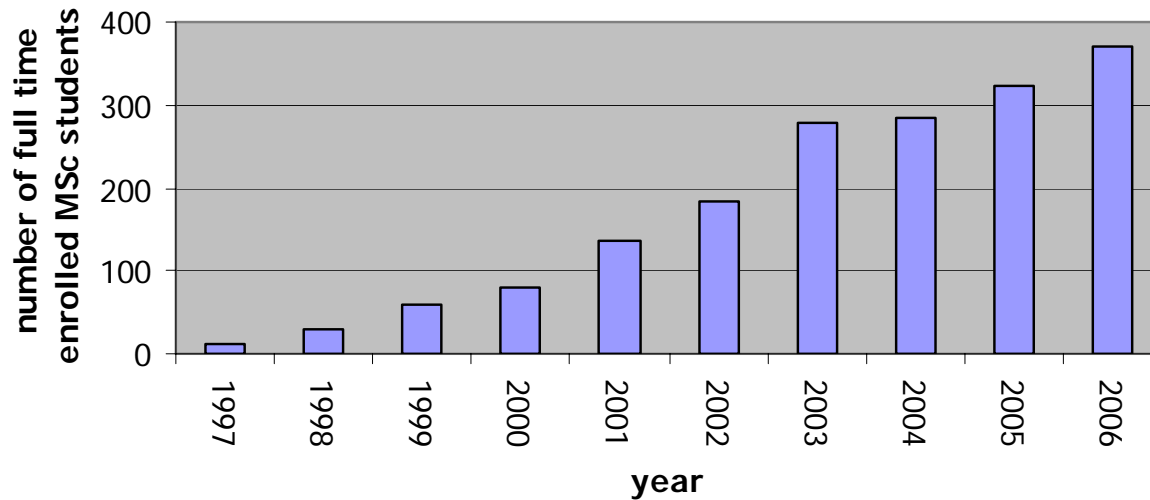
Disciplines

Total number of students: 13.563 (2005, excluding PhD students)



International MSc's at TU Delft

Enrolled MSc students 1997-2006 (international)



Drinking water education

- All students do their Masters
- 2 courses in BSc
- 3 courses in MSc
 - Course on theory and experiments (36 hours of lectures, 5 days of experiments)
 - Course on design (2 weeks)
 - Course on distribution systems
 - Research thesis at water company
- Similar programme for wastewater and sewerage systems



Erasmus Mundus International MSc

75th MSc graduate in drinking water (1991-2006)

Gert-Jan Schers (1991)



Qing Wang (2006)

Graduates with prof. ir. J.C. van Dijk:

| | | | |
|------------------------------|---|-------------------------------------|--------------------------------|
| 1991 Gertjan Schers | 1995 Jan Leen van der Vlies | 1997 Steven Oterdoom | 2002 Remco Keijser |
| 1992 Robert Willemse | 1995 Gert-Jan Schoterman | 1997 Martin de Koning | 2002 Angela Puts |
| 1992 Idsart Dijkstra | 1995 Marieke van Winkelen | 1997 Michiel Riemersma | 2002 Martijn Kramer |
| 1993 Carel Aeyels Averink | 1995 Mireille Beumer | 1997 Jonneke Klomp | 2002 Guy Heijnen |
| 1993 Jan Timmer | 1995 Marc Eikens | 1998 Siebe van der Zel | 2002 Sawan Raktoe ² |
| 1993 Georgina Martinez Ortiz | 1995 Edgardo Valeriano | 1998 Bonne Hijlkema | 2004 Michiel van der Meulen |
| 1993 Jenne van der Velde | 1995 Peter Tienhooven | 1998 Alex van der Helm ³ | 2004 Christiaan Kivit |
| 1993 Peter Wessels | 1996 Marc Brieskorn | 1999 Jeroen Krijgsman | 2005 Maarten Lut |
| 1994 Nico Versteeg | 1996 Jasper Verberk | 1999 Bram Martijn | 2005 Menno van Leenen |
| 1994 Ellen van Duikeren | 1996 Maarten Keuten | 1999 Johan Boel | 2005 Jan-Hendrik Vos |
| 1994 Roel Bronda | 1996 Piet-Hein Spaans | 1999 René van der Aa ^{1,2} | 2005 Anke Grefte ¹ |
| 1994 Patrick van der Wens | 1996 Ernst-Jan Hageman | 2000 Johannes Vijlbrief | 2005 Sharleen Alberga |
| 1995 Petra Holzhaus | 1996 Martijn Nijse | 2000 Ignaz Worm ³ | 2005 Leo Meijer |
| 1995 David Visscher | 1996 Francois v. Ekkendonk ¹ | 2000 Anton van Rosmalen | 2006 David de Ridder |
| 1995 Ronald van den Berg | 1996 Marij Hendriks | 2000 Jan Post ² | 2006 Qing Wang |
| 1995 Hella van de Maarel | 1996 Joukje Keuning | 2001 Sian Gwan Tan | |
| 1995 Orjan van Drongelen | 1996 Erik Schwencke | 2001 Maaike Glastra | |
| 1995 Martijn Bakker | 1996 Eelco Trietsch | 2001 Pepijn Koenders | |
| 1995 Patrick Smeets | 1997 Jan-Dik Verdel | 2002 Colette de Roo | |
| 1995 Bas van Efferen | 1997 Weren de Vet | 2002 Michel Bretveld | |

¹ Graduation with honours (cum laude)
² Gijss Oskam Award for best young researcher
³ Faculty Award for best graduation



Celebrating the completion of design course



First Chinese MSc graduates on drinking water



Qing Wang
 Doctoral candidate in Drinking Water Technology
 Researcher in the Department of Water Engineering



On the 18th of July, the first two Chinese students in the drinking water technology MSc program graduated from TU Delft. They are Qing Wang and Sheng Li. Both students are currently working as researchers in the Department of Water Engineering.



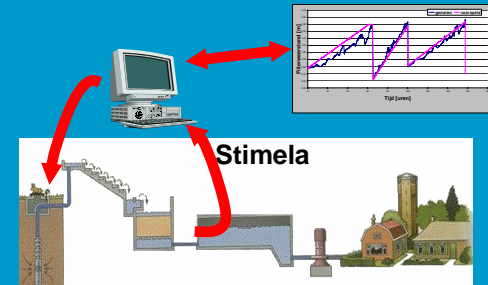
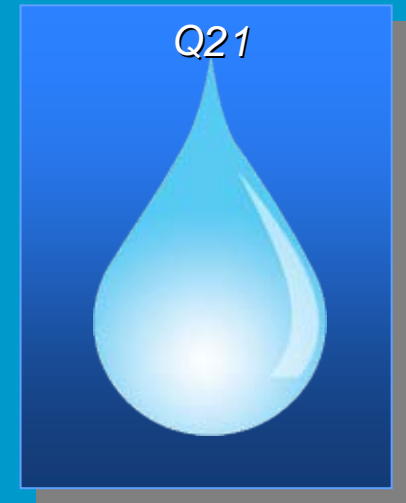
Sheng Li
 Doctoral candidate in Drinking Water Technology
 Researcher in the Department of Water Engineering



Sheng Li received his Master of Science degree in Drinking Water Technology from TU Delft. He is currently working as a researcher in the Department of Water Engineering.

Research themes

- Unwanted organic micropollutants
 - Biological stability/*Legionella*
 - Water quality in the distribution system
-
- Modelling
 - New technologies and tools



Micropollutants

What is the effectiveness of our treatment barriers to deal with unwanted polar organic micropollutants and how can we improve on this?



Unwanted micropollutants in drinking water

(maximum concentration occasionally found in the Netherlands)

| | Individual compounds | Concentration |
|-----------------|-----------------------|---------------|
| EDC | Oestron | 5 ng/l |
| | Bisphenol A | < 10 µg/l |
| | Phtalates | 3 µg/l |
| | Alkylphenoethoxylates | 2 µg/l |
| Pharmaceuticals | Ibuprofen | 20 ng/l |
| | Sulfamethoxazole | 40 ng/l |
| | Carbamazapine | 90 ng/l |
| | Iopamidol | 70 ng/l |
| | Clofibric acid | 30 ng/l |
| Others | Amidotrizoic acid | 80 ng/l |
| | NDMA | 2 ng/l |
| | MTBE | 3 µg/l |

Dirces (Dutch Innovation and Research Consortium on Emerging Substances)

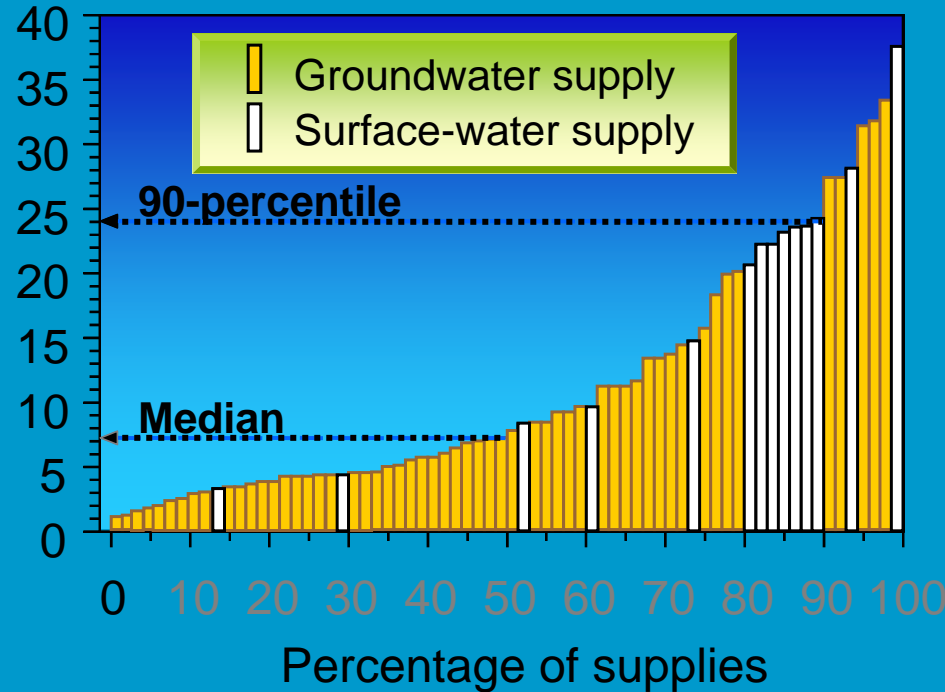


Biological stability/*Legionella*

Is it possible to prevent the growth of *Legionella* in water installations by improving the biological stability of the drinking water and the piping materials?



Percentage of installations with *Legionella*



Water quality in the distribution network

