Wading through our water

Bridging Science to Practice

Kees van Leeuwen

Success stories in Environmental Research as Inspiration
MilieuChemTox Symposium April 6 2023

http://www.retired-environmental-scientists.nl/

Recent papers:

Van Straalen NM, Den Haan KH, Hermens JLM, Van Leeuwen CJ, Van de Meent D, Parsons JR, De Voogt WP, De Zwart D (2022) Risk assessment acknowledging variability in both exposure and effect. Environ Sci Technol 56(20):14223–14224

Dik van de Meent, Dick de Zwart, Jaap Struijs, Joop L. M. Hermens, Nico M. van Straalen, Klaas H. den Haan, John R. Parsons, Pim de Voogt and Kees van Leeuwen (2023). Expected Risk as basis for assessment of safe use of chemicals Environmental Sciences Europe (2023) 35:16

James W Bridges, Helmut Greim, Kees van Leeuwen, Rainer Stegmann Theo Vermeire, Klaas den Haan (2023). Is the EU chemicals strategy for sustainability a green deal? Regulatory Toxicology and Pharmacology Volume 139, March 2023, 105356

- **Dr. Jaap Struijs** (1949) -ex RIVM Bilthoven; Zeist NL
- **Dr.** Dick de Zwart (1950) – ex RIVM Bilthoven; Odijk NL
- **Prof. Dr. Ir.** Dik van de Meent (1950) – ex RIVM Bilthoven, Radboud University Nijmegen; Bilthoven NL
- **Dr.** Joop Hermens (1951) – ex IRAS, Utrecht University; Houten NL
- **Dr.** Klaas den Haan (1958) – ex SHELL; Hilvarenbeek NL
- **Prof. Dr.** Nico van Straalen (1951) – ex VU Amsterdam; Edam NL
- **Dr. John Parsons** (1952) – ex University of Amsterdam NL
- **Prof. Dr.** Pim de Voogt (1952) – ex University of Amsterdam NL
- **Prof. Dr.** Kees van Leeuwen (1955) – KWR Water Research Institute & University of Utrecht; Bilthoven NL

Contents

A) Point source pollution, incidents and accidents

B) Lekkerkerk and the (re)discovery of the soil

C) Fabric softeners

D) REACH

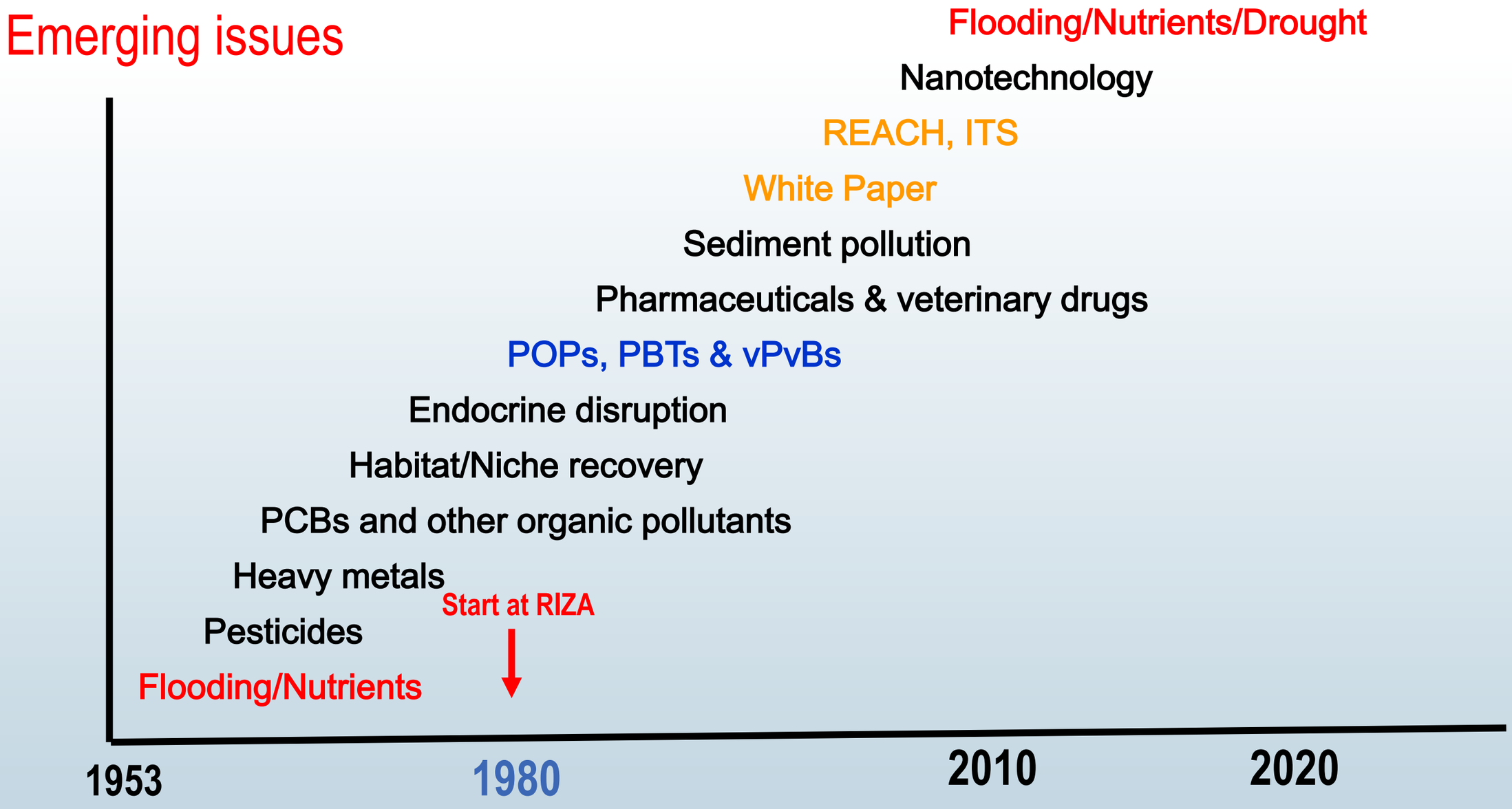
E) Monitoring, COVID, Drugs and Sewer Epidemiology

F) Conclusions and challenges ahead

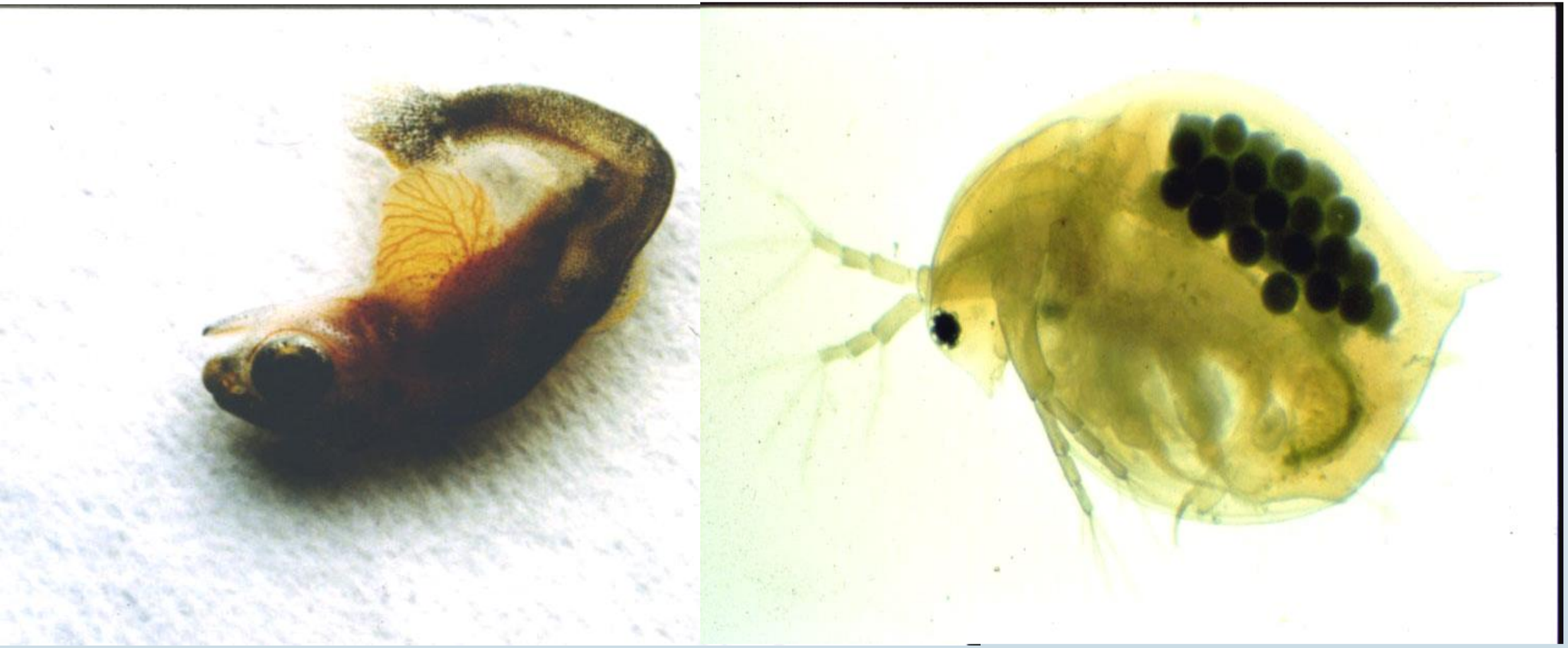

~1955
Soest, De Eem nabij de groote Melm


https://www.youtube.com/watch?v=Jd7kjVwjQbA

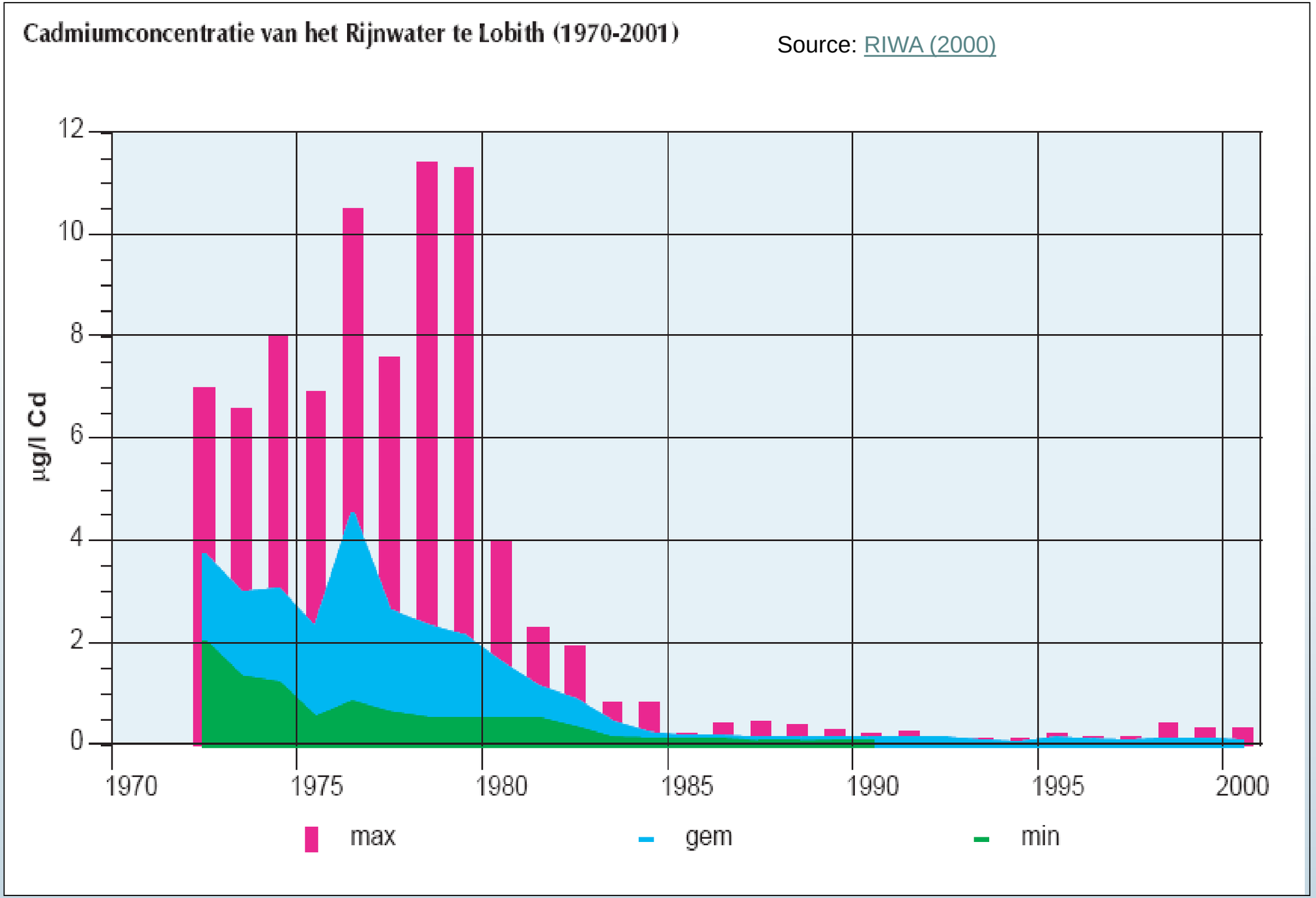
Developments in water management



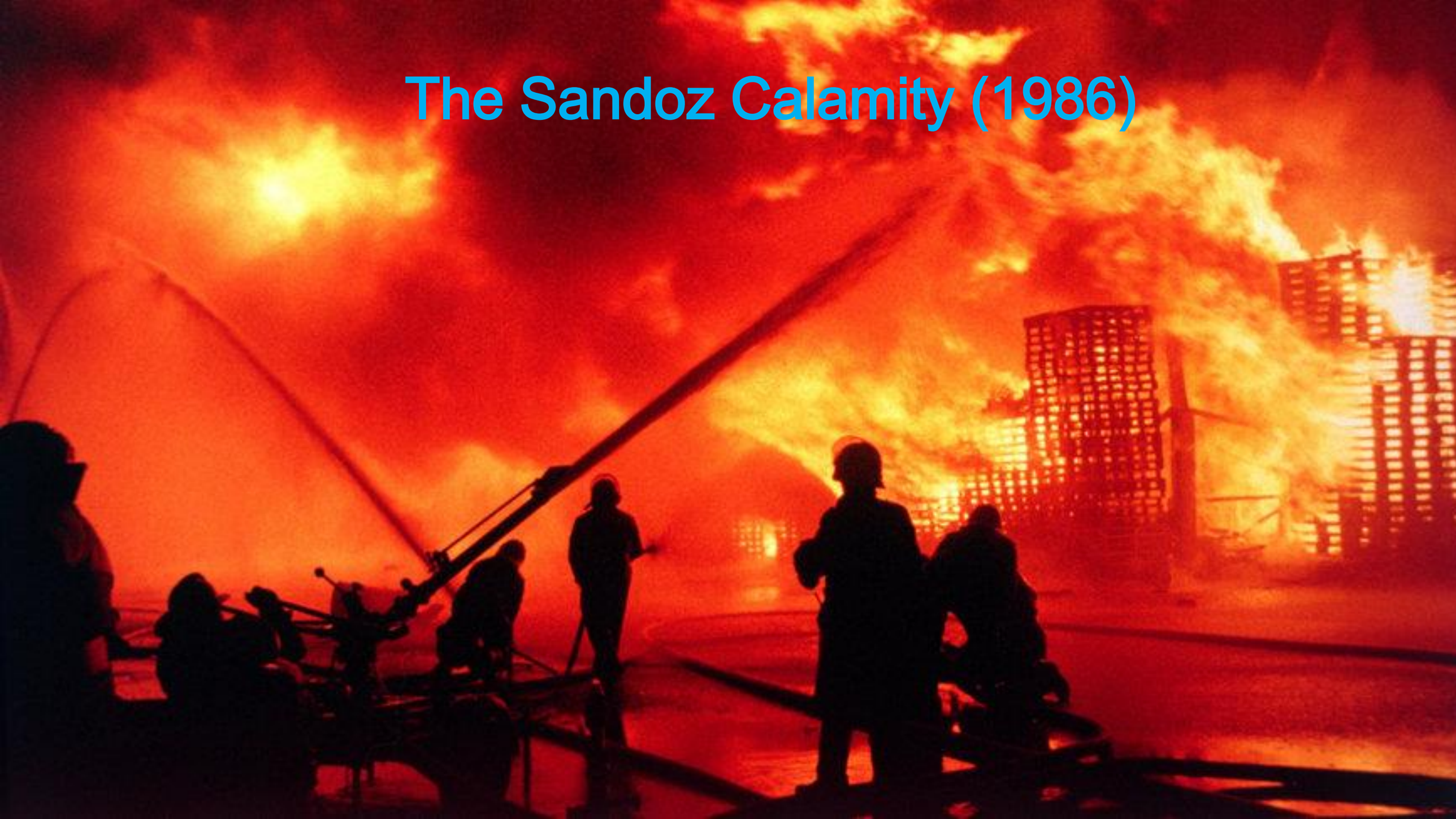
A) Point source pollution, incidents and accidents



Source: Van Leeuwen, 1986


Cadmiumconcentratie van het Rijnwater te Lobith (1970-2001)
Source: RIWA (2000)
µg/l Cd
12
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
max
gem
min

The Sandoz Calamity (1986)



Massive fish kills in Rhine in Southern Germany (1986)

Political Symbol: Return of Salmon into the river Rhine

Van Urk et al., 1993

Conclusions Rhine calamity

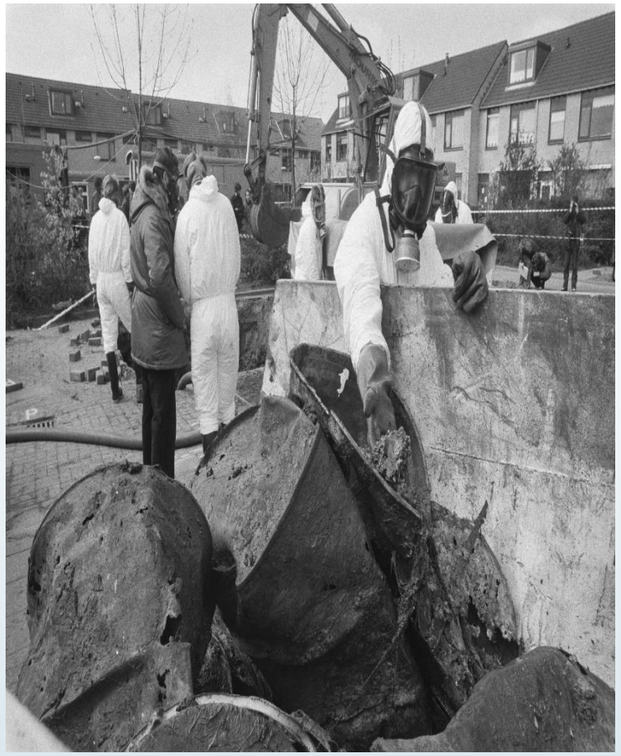
- Teamwork
- Empowerment
- Multidisciplinary science and clear scope (IRC)
- Good communication with all media!
- Symbol: Salmon back into the river Rhine
- Minister Kroes turned an accident into a great success, i.e., ecology and river basin management were introduced on the political agenda of IRC

Scientific Developments (1975-1985)

- Analytical Chemistry
- Method development (Ecotox)
- International Standardization (NNI, ISO, OECD)
- Application (Point source pollution; WVO; IRC)

Thea Adema (TNO), Wilbert Slooff (RID), Hans Canton (RIVM) & Hans Könemann (UU)

B) Lekkerkerk (1980) and the (re)discovery of the soil



Op 1 januari 1987 is, tegelijkertijd met de inwerkingtreding van de Wet Bodembescherming (Wbb), de Technische Commissie Bodembescherming (TCB) ingesteld door de toenmalige minister van VROM, Ed Nijpels. Twee jaar eerder, vooruitlopend op de inwerkingtreding van de Wbb, was reeds door minister Pieter Winsemius een voorlopige TCB ingesteld. De TCB adviseert de ministers van vooral VROM en LNV over het milieubeleid voor de bodem.

Bodeminterventiewaarden

Joop Vegter, Joke van Wensum, Carl Denneman, Herman Eijsackers, Nico van Straalen, Kees van Gestel & Wim Ma

Stimuleringsprogramma Bodemecotoxicologie en (V)TCB

C) Fabric softeners (~1990)

- DTDMAC, 1989 (VROM/RIVM/RIZA)
- “Expert Panel on Detergents and Environment”
- Toxic and persistent (similar to bactericides)
- Highly adsorptive (sediment / suspended matter)
- Research articles in H2O (1989) and Chemosphere (1992)
- Questions in parliament / TV interviews (VARA)

- Ban or voluntary agreement? (economic impact was substantial!)

- Carla Roghair et al., 1992
- Ton de Nijs & Jody de Greef, 1992
- Kees van Leeuwen et al., 1992

Wasverzachters; zacht, ook voor het milieu?

Samenvatting

De wasverzachters die in dit artikel worden besproken zijn kationische oppervlakte-actieve stoffen. Het verbruik van deze stoffen in Nederland wordt geschat op tweeduizend ton actieve stof per jaar. Deze stoffen worden geloosd op het oppervlaktewater, breken daarin langzaam af en blijken bovendien zeer giftig voor waterorganismen. De geen-nadelige-effect concentratie voor ecosystemen wordt, conform het advies van de Gezondheidsraad inzake de ecotoxicologische risico-beoordeling van stoffen, geschat op 16 μg/l. Dit zijn ook de concentraties die in oppervlaktewater berekend, respectievelijk gemeten worden. De conclusie is dan ook, dat alleen al deze stoffen het Nederlandse oppervlaktewater kritisch belasten. In verband met de grote verbruiksomvang en mede in het licht van de beleidsintentie ecologisch inpasbaar te handelen c.q. te 'zorgen voor morgen', wordt geconcludeerd dat het beter is te kiezen voor een minder zachte was.

Inleiding

In een recent uitgebrachte literatuur-analyse van de Overleggroep Deskundigen Wasmiddelen-Milieu worden milieu-aspecten van kationische oppervlakte-actieve stoffen (kat-OAS) beschreven.
Het initiatief tot het vormen van deze overleggroep is voortgekomen uit informeel overleg tussen het ministerie van VROM, de wasmiddelen-industrie en betrokkenen bij het wetenschappelijk

KEES VAN LEEUWEN
Directie Stoffen en Risicobeheersing
DGM
Ministerie VROM

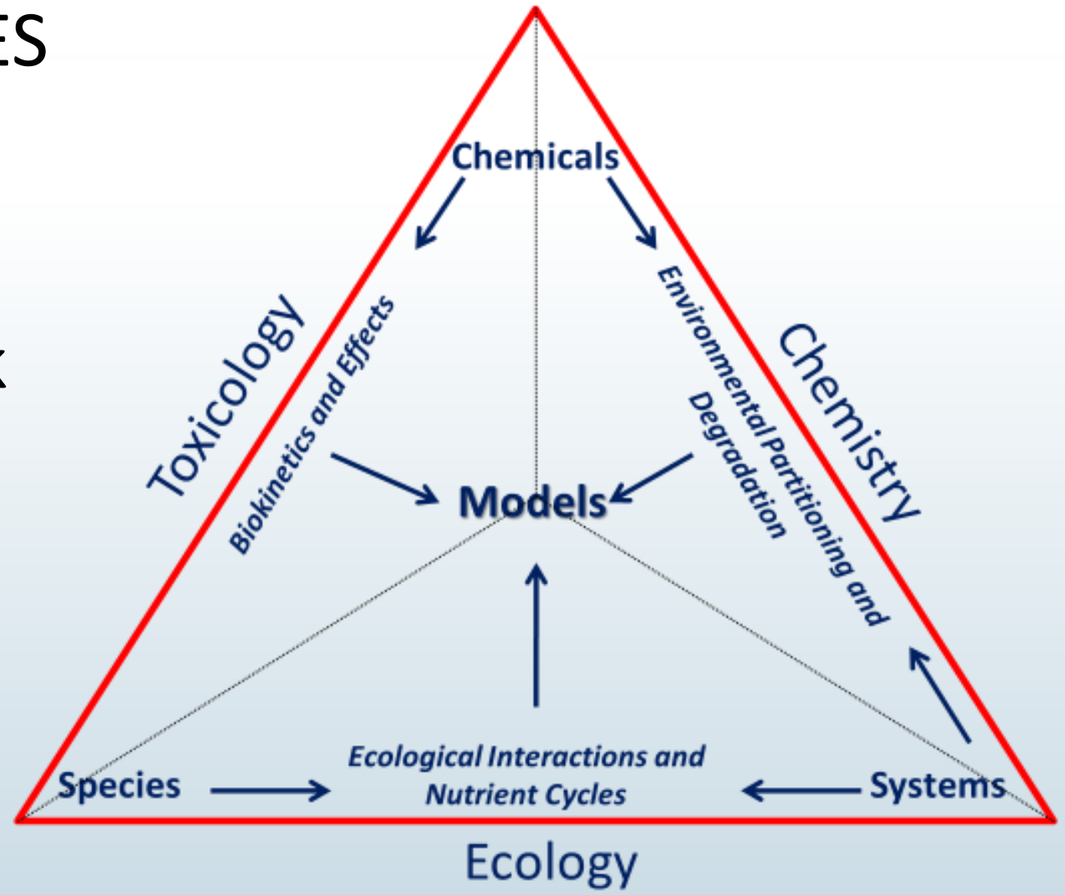
onderzoek. De leden van dit overleg

oplossing in water onttrokken. In een rwzi blijft circa 90% van de stoffen achter in het (actieve) slib. In proeven in het laboratorium breken de stoffen redelijk goed af; het blijkt echter dat de snelheid

Ook ontbreken gegevens over de concentraties van deze stoffen in Nederlandse oppervlaktewateren.
Uit modelberekeningen volgt echter dat de concentratie in oppervlaktewater na

Further Scientific Developments

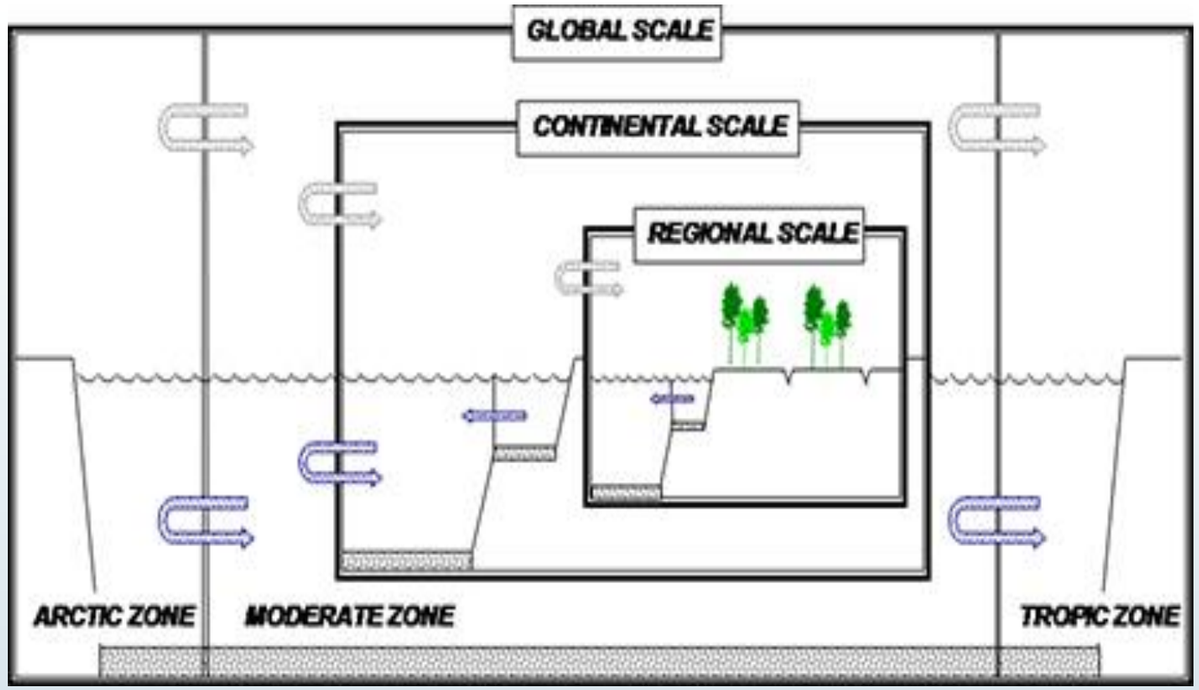
- SimpleBox/SimpleTreat, USES, EUSES
- QSARs and Mixture Toxicity
- Extrapolation methods → SSD Book
- Classification & Labelling
- Risk assessment

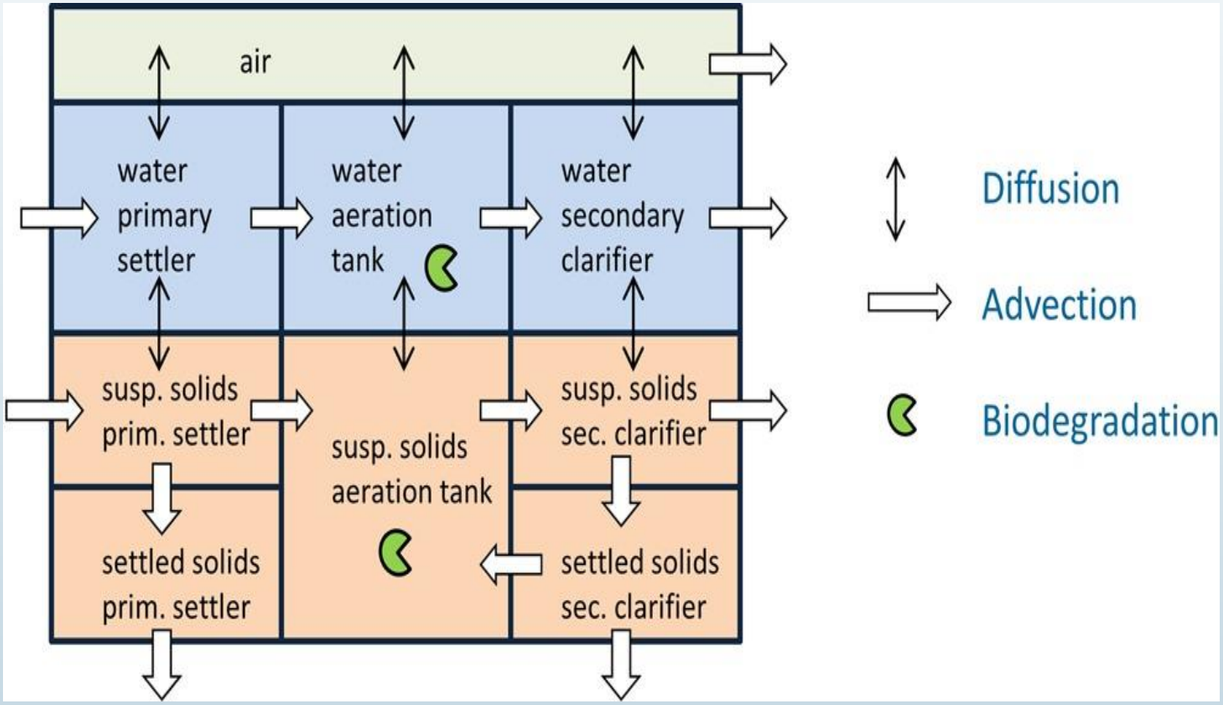


Redrawn from Figure 7.1 of van Leeuwen and Vermeire (2007)

Simplebox and Simpletreat

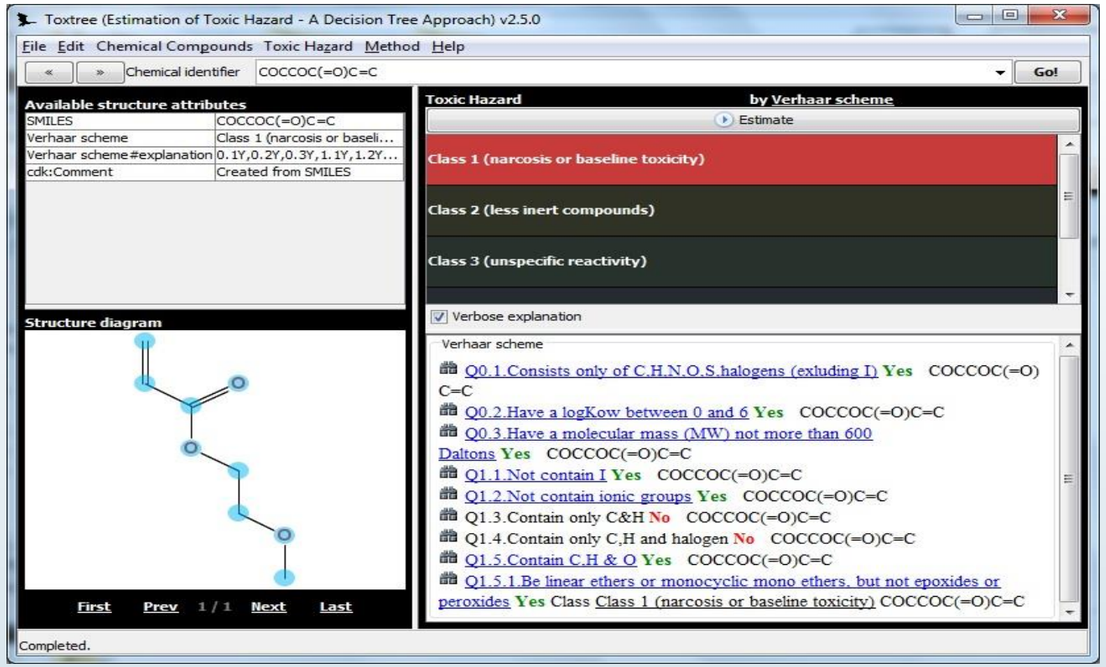
(Dik vd Meent, Jaap Struijs)





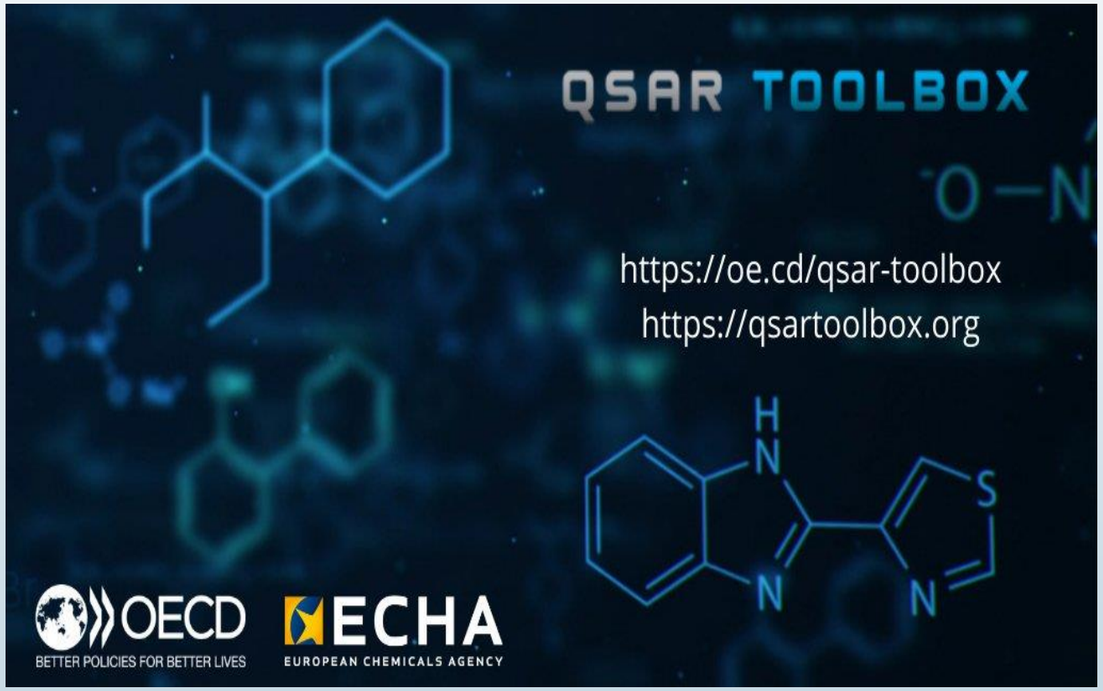
QSARs and Mixture Toxicity

(Hans Kőnemann, Joop Hermens, John Deneer, Henk Verhaar et al.)



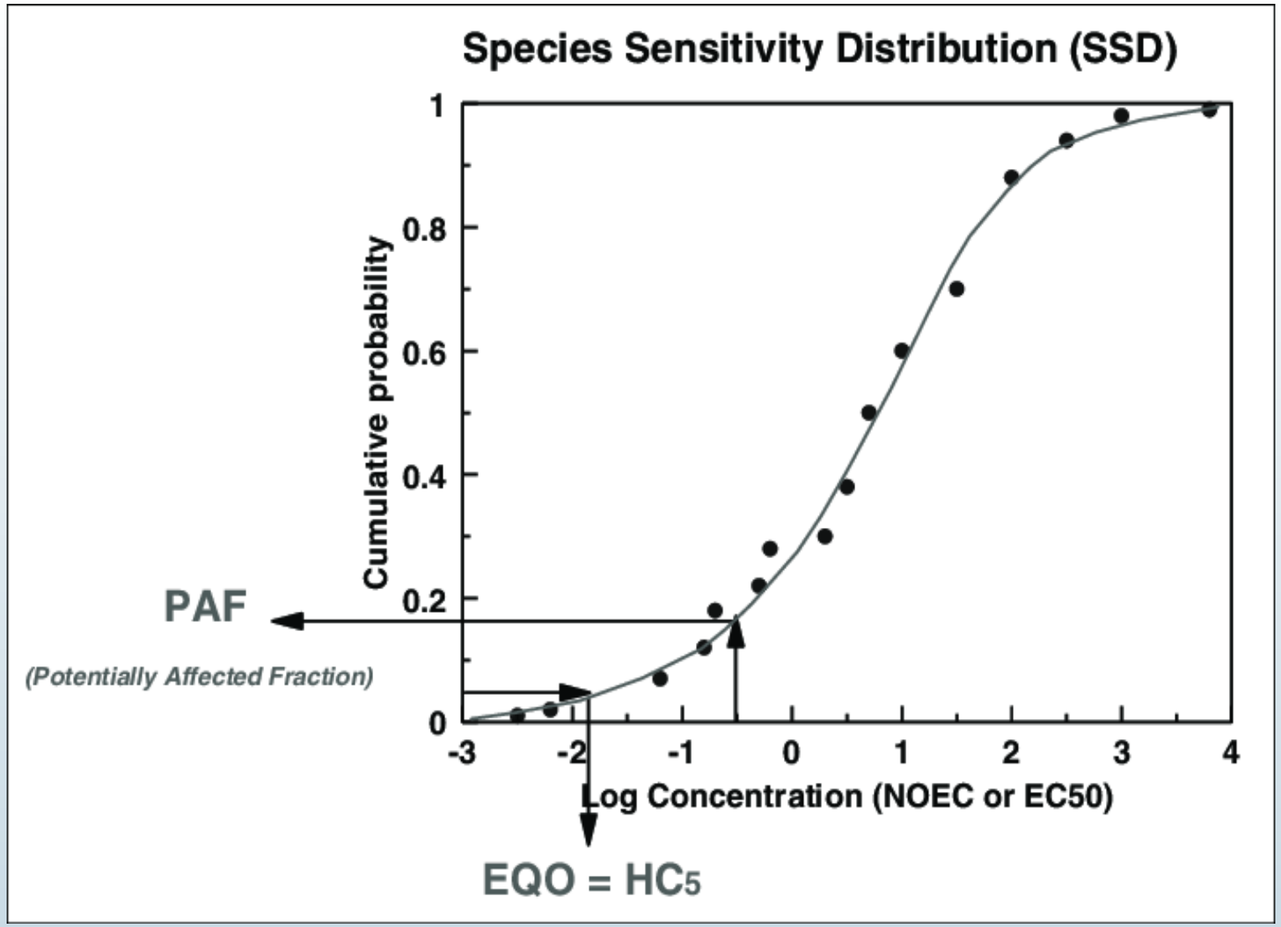
Könemann, H. (1981) Quantitative Structure-Activity Relationships in Fish Toxicity Studies. Part 1: Relationship for 50 Industrial Pollutants. Toxicology, 19: 209-221

Verhaar, H.J.M., C.J. Van Leeuwen and J.L.M. Hermens (1992). Classifying environmental pollutants. I. Structure-activity relationships for prediction of aquatic toxicity. Chemosphere 25, 471-491



Extrapolation methods

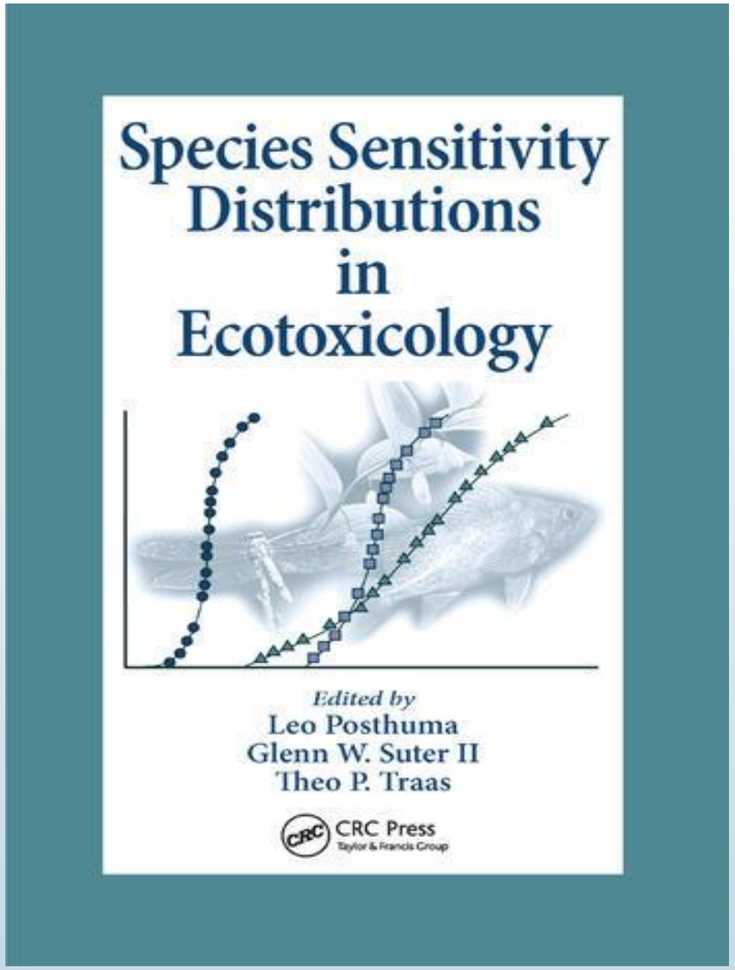
(Bas Kooyman, Nico van Straalen, Tom Aldenberg & Health Council)



Glenn Suter called this:
the Dutch Deluge

Health Council of the Netherlands. 1989. Assessing the risk of toxic chemicals for ecosystems. Report 1988/28E. The Hague, The Netherlands. 173 pp.

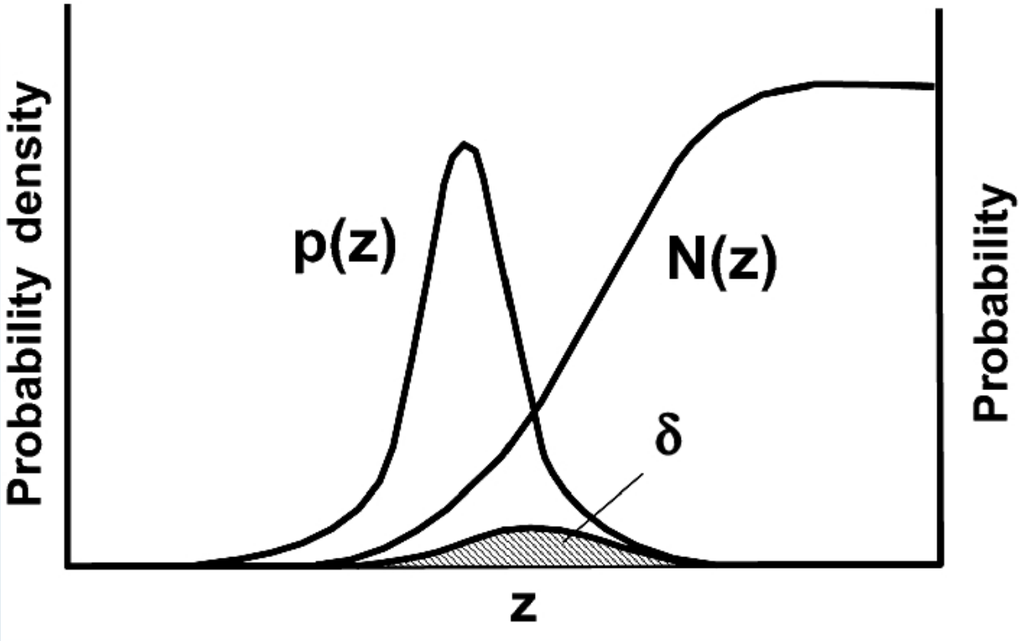
Species Sensitivity Distributions in Ecotoxicology (Leo Posthuma, Glenn Suter, Theo Traas, 2002)



Species sensitivity distributions for use in environmental protection, assessment, and management of aquatic ecosystems for 12 386 chemicals Leo Posthuma, Jos van Gils, Michiel C. Zijp, Dik van de Meent, Dick de Zwart (2019)

"We quantified the chronic and acute mixture toxic pressure of mixture exposures for >22 000 water bodies in Europe for 1760 chemicals for which we had both exposure and hazard data. The results show the likelihood of mixture exposures exceeding a negligible effect level and increasing species loss."

Van de Meent et al., 2023: Expected Risk as basis for Assessment of Safe use of Chemicals



The expected risk of a chemical, denoted δ, is defined as the probability that *PEC* is greater than *NEC*, where both *PEC* and *NEC* are random variables: $\delta = \text{Prob}(PEC > NEC)$. Figure from Van Straalen [27]

The ecotoxicological risk (delta) is equal to the probability that PEC is greater than PNEC. We can determine the size of that probability in two ways:

1) by taking a large number of water samples from a "system" and by measuring how often it occurs that the measured concentration of a substance exceeds its critical effect concentration, and

2) by calculation: thanks to Nico van Straalen and Tom Aldenberg, we can simply calculate HOW BIG the ecotoxicological risk of a substance is. For most substances, this risk is negligible (<10-6). Substances can easily be prioritized on the basis of the size of this risk.

Principles for risk assessment

Detailed procedures for risk assessment are given in the Technical Guidance Documents (TGD):

- man
- environment
- QSARs
- emission scenario documents

2nd edition of the Technical Guidance Document (TGD) on Risk Assessment of Chemical Substances following European Regulations and Directives

Freely available from ECB web page

http://ecb.jrc.it/tgdoc

Medical & Science

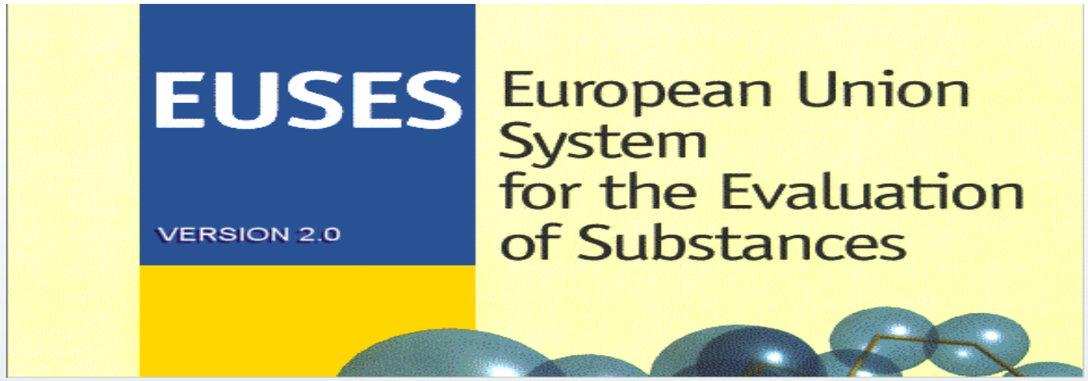
USES

means

Uniform System for the Evaluation of Substances

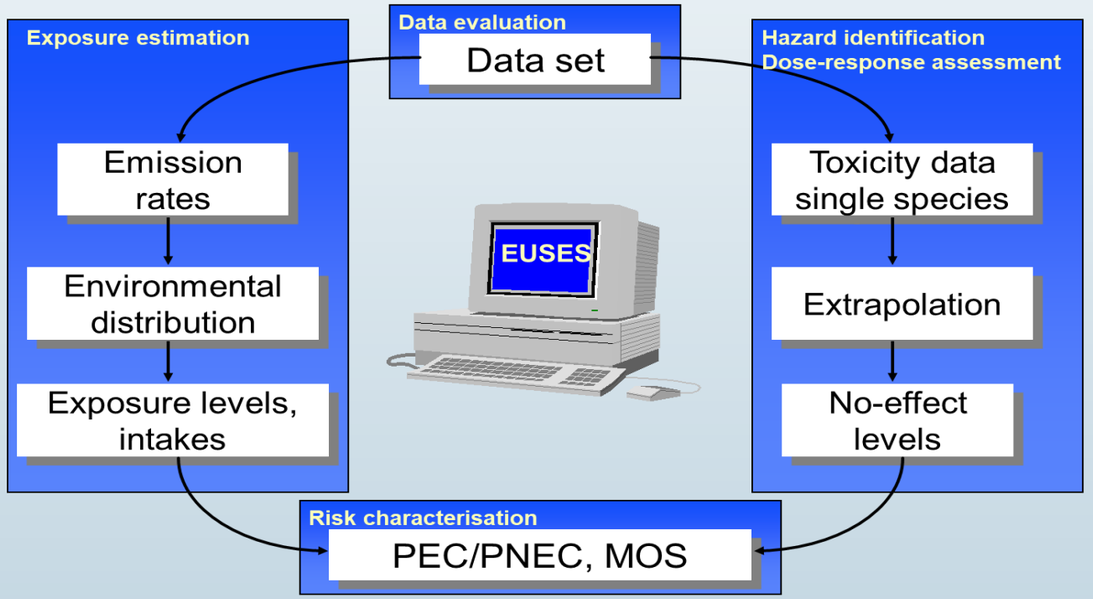
by acronymsandslang.com

USES became EUSES



RIVM:

- Jan Linders
- Matthieu Rikken
- Paul van der Poel
- Tjalling jager
- Theo Traas
- Theo Vermeire



Classification Criteria Dangerous for the Environment
Annex III of 67/548/EEC (1991)

Changes in the perception of health and environmental risks and their solutions

1970	2000
Sectoral (air or surface water)	Multiple media (including soil, sediment and groundwater)
Localized	Diffuse pollution
Human health and well-being	Ecosystem health, production and goods
Local/regional	National/international/global
Limited economic damage	Great economic damage
End of pipe solutions	Integral approaches

Van Leeuwen and Vermeire, 2007

Societal Changes

From	To
Representative Democracy	Participative Democracy
Government	Governance
Bottom Line	Corporate Social Responsibility
Growth	Sustainability
Top Down	Bottom Up
Decisiveness	Consensus

D) REACH (1996-2006)

Hazard information

Exposure information

Safe use?

Tour de EU

Priority list

Draft RAR

Agreed RAR

Agreed risk reduction strategy

Implementation of EU measures

1-? y

SETAC BRIGHTON 2000 CONFERENCE JdB, BH, KvL

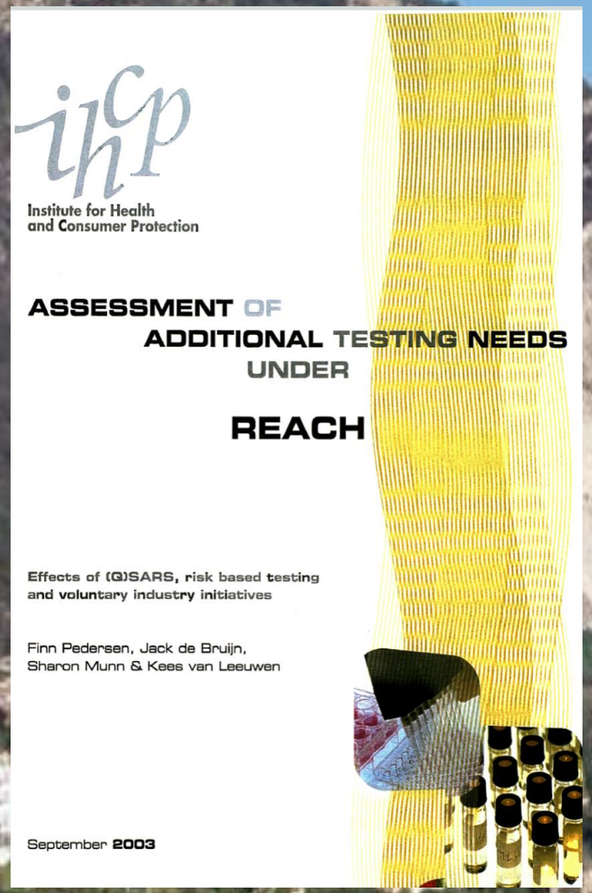
REACH HISTORY AND CONTEXT

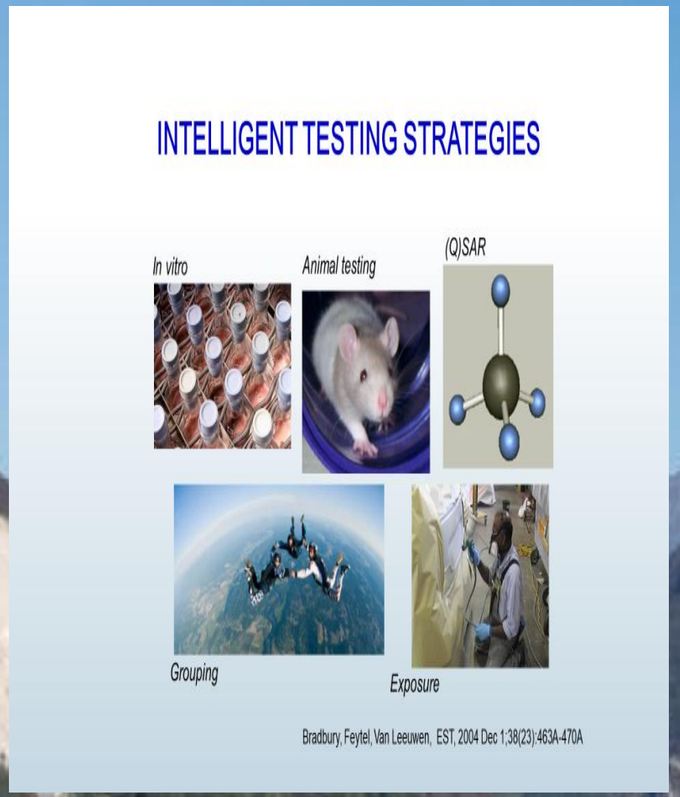
1. 1996	Van Leeuwen et al., *Environ Toxicol Pharmacol* 2:243-299 (1996)
2. 1997	Minutes Competent Authorities meetings (The Hague, the Netherlands)
3. 1998	Council of Environment Ministers (Chester, UK)
4. 2001	White Paper published
5. Summer 03	Internet consultation
6. 29/10/2003	Proposal adopted by Commission
7. 17/11/2005	Parliament Opinion in First Reading
8. 26/06/2006	Council Common Position adopted
9. 13/12/2006	Parliament Opinion in Second Reading
10.18/12/2006	Regulation adopted

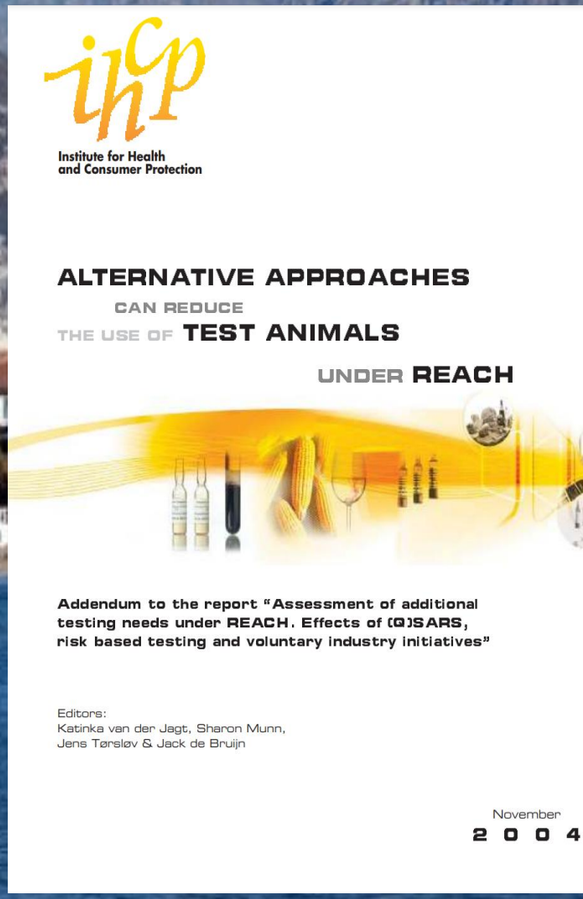
Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC; See van Leeuwen and Vermeire, 2007

REACH – Discussion points

1) Economic aspects: High costs of REACH impacting Europe (Letter of Blair, Schröder and Chirac; 2003)
2) Animal welfare: REACH will lead to a significant increase in animal testing (2005)
3) Workability and effects on Small and Medium Entreprises (SMEs)

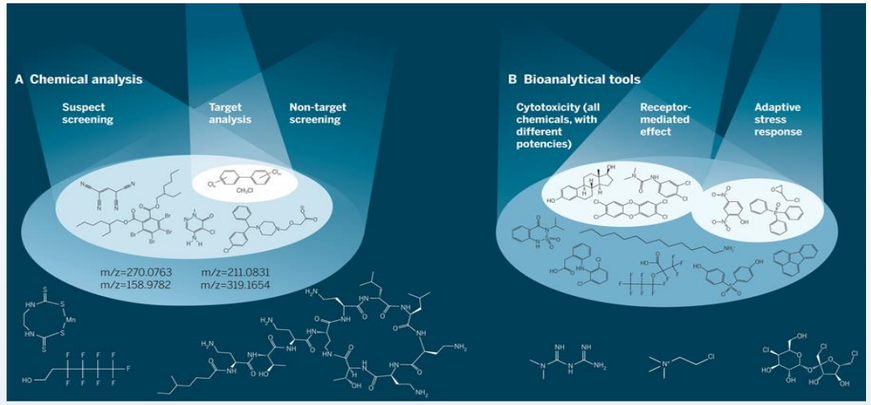

Institute for Health
and Consumer Protection
ASSESSMENT OF
ADDITIONAL TESTING NEEDS
UNDER
REACH
Effects of (Q)SARS, risk based testing
and voluntary industry initiatives
Finn Pedersen, Jack de Bruijn,
Sharon Munn & Kees van Leeuwen
September 2003

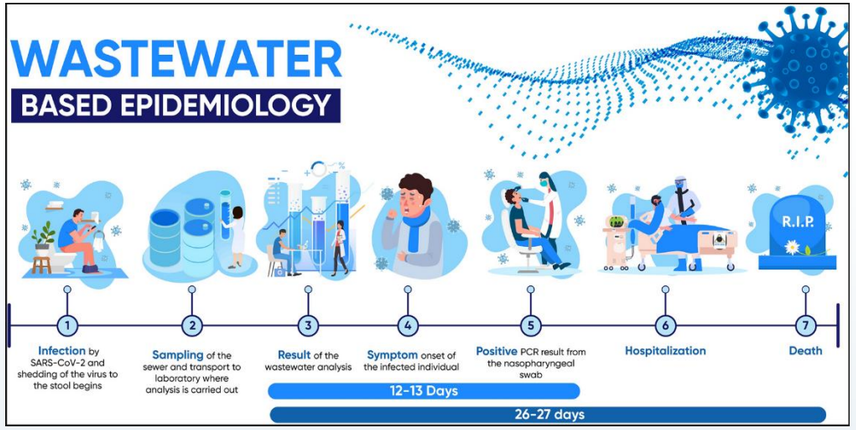

INTELLIGENT TESTING STRATEGIES
In vitro
Animal testing
(Q)SAR
Grouping
Exposure
Bradbury, Feytel, Van Leeuwen, EST, 2004 Dec 1;38(23):463A-470A


Institute for Health
and Consumer Protection
ALTERNATIVE APPROACHES
CAN REDUCE
THE USE OF TEST ANIMALS
UNDER REACH
Addendum to the report "Assessment of additional
testing needs under REACH. Effects of (Q)SARS,
risk based testing and voluntary industry initiatives"
Editors:
Katinka van der Jagt, Sharon Munn,
Jens Tørsløv & Jack de Bruijn
November
2004

E) Monitoring, COVID, Drugs and Sewer Epidemiology

Gert-Jan Medema, Annemarie van Wezel, Pim de Voogt, Joop Hermens, Thomas ter Laak





Tracking complex mixtures of chemicals in our changing environment, Beater I. Escher,[1,2,*] Heather M. Stapleton,[3] and Emma L. Schymanski4,

Science. 2020 Jan 24; 367(6476): 388–392.

Presence of SARS-CoronaCOVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands Gertjan Medema*, Leo Heijnen, Goffe Elsinga, Ronald Italiaander, and Anke Brouwer. Environ. Sci. Technol. Lett. 2020, 7, 7,

Time-Integrative Passive sampling combined with TOxicity Profiling (TIPTOP): an effect-based strategy for cost-effective chemical water quality assessment. Hamers, T.; Legradi, J.; Zwart, N.; Smedes, F.; de Weert, J.; van den Brandhof, E.J.; van de Meent, D.; de Zwart, D. Environmental Toxicology and Pharmacology 2018, 64, 48-59.

F) Conclusions (science-policy interface)

1. Timely delivery of high quality products
2. Communicate clearly
3. Think in terms of interests
4. Loyalty and integrity
5. Remain open to change, but not at the expense of your own integrity
6. Legislation is only as strong as its implementation and enforcement
7. And remember: never waste a good crisis

E = Q x A

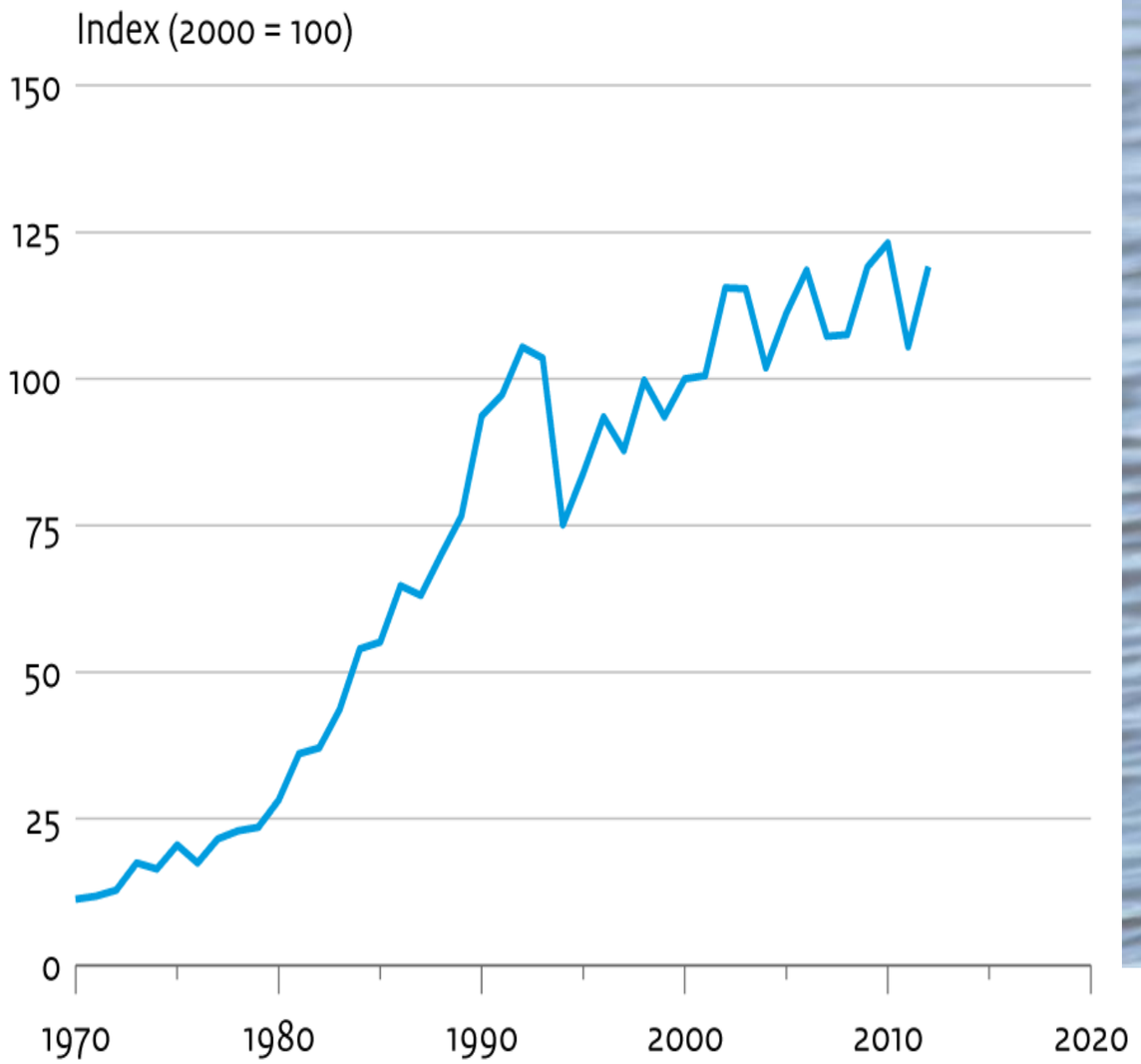
Effectiveness = Quality X Acceptance

COURSES

PAO, POT, EUSES, Risk Assessment, SETAC Ecotoxicology, REACH

Successes (Heavy metals,PBTs & WWT)

Aalscholver



Bron: NEM (SOVON, CBS)

CBS/dec13
www.clo.nl/nl105812

Success of REACH

1. Reversal of the burden of proof (no data, no market)

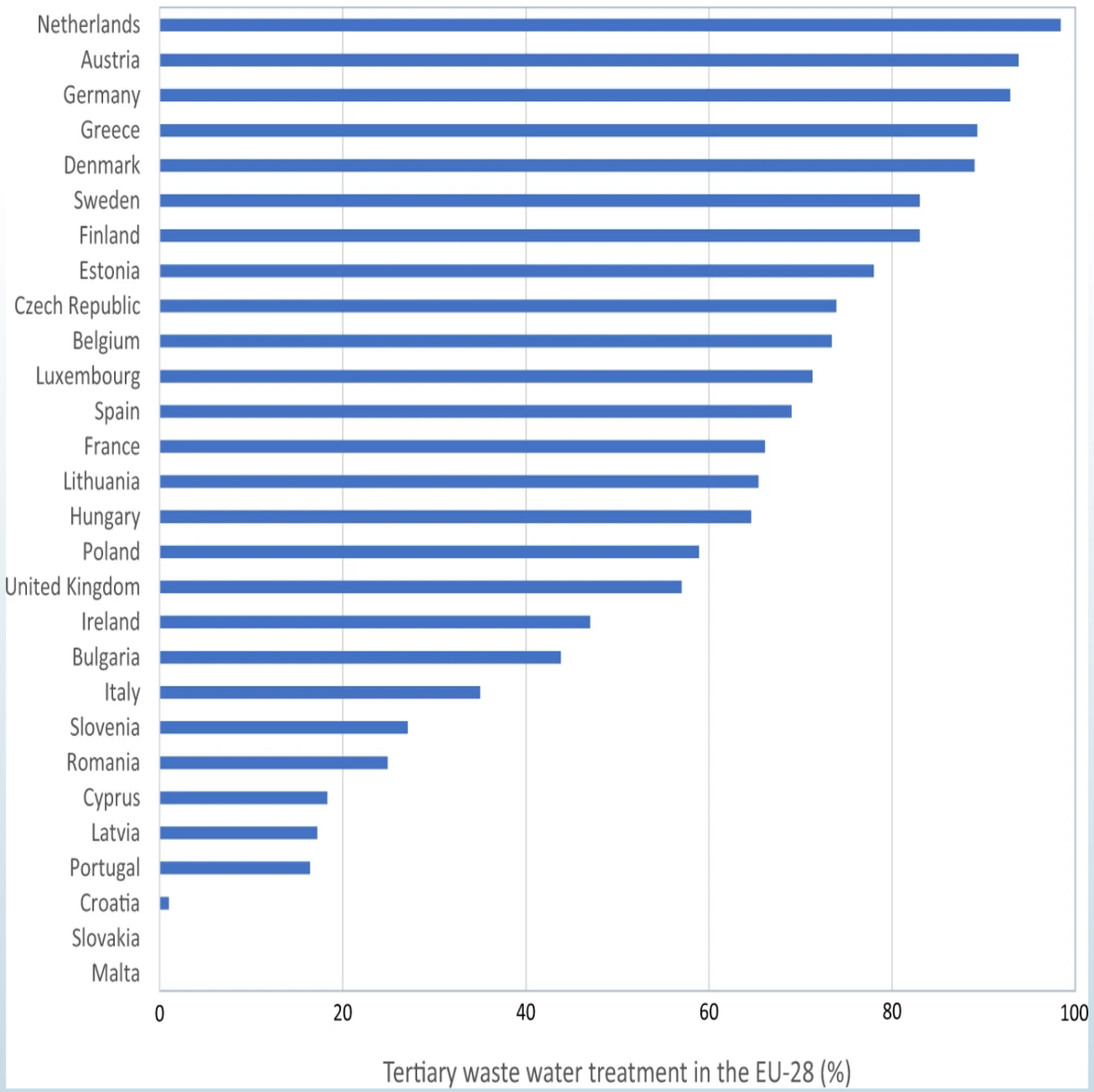
2. Focus on exposure and exposure scenarios

3. Substantial acceleration of the risk assessment and risk management process, i.e., in more than 100,000 registrations of more than 22,000 chemicals to date (ECHA, 2022; 100x faster than before REACH).

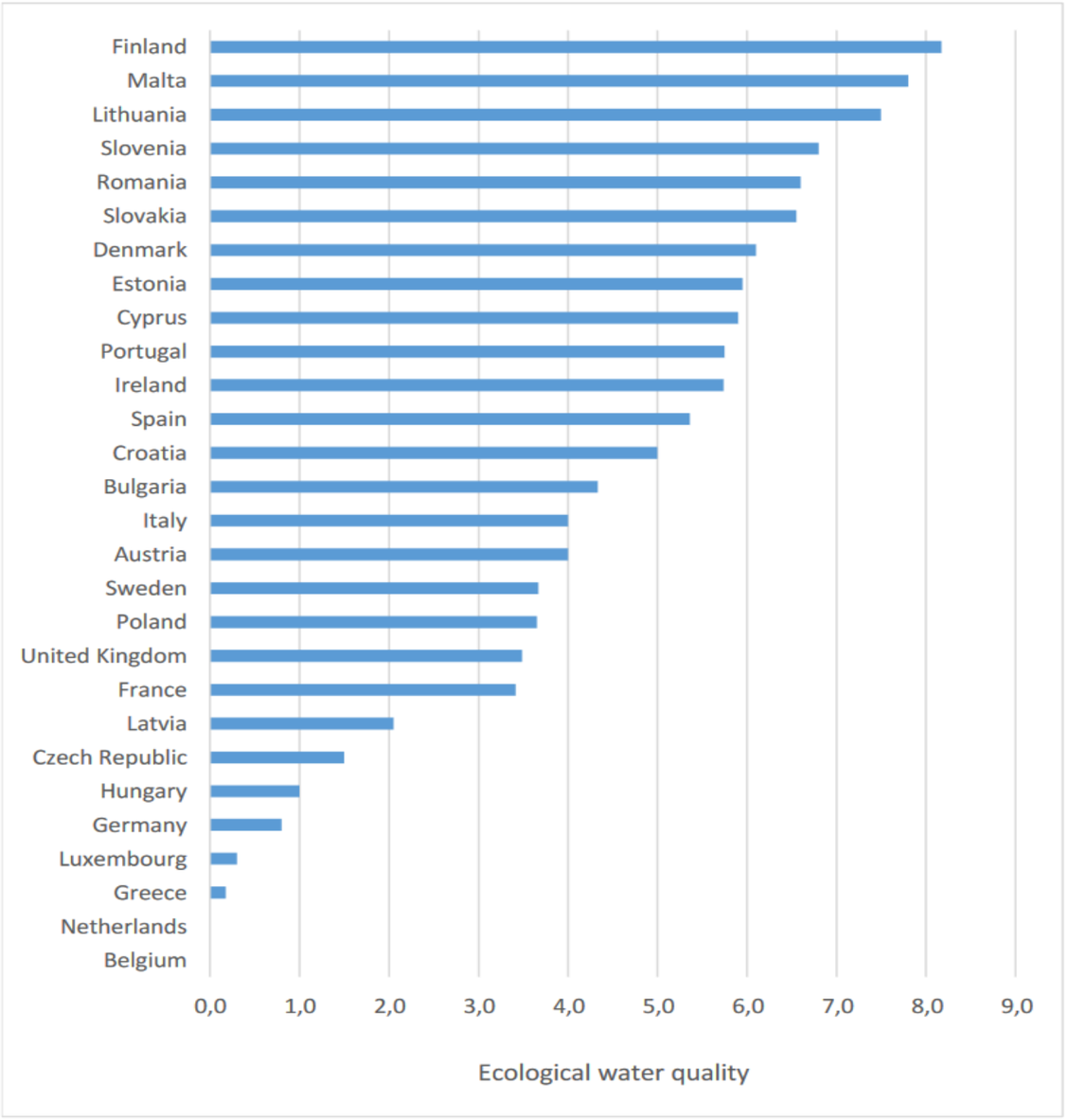
4. Major international policy impact

5. Barile et al. (2021) conclude that due to the existing system of chemicals regulation in the EU, the current level of protection of its population as a whole, including sensitive sub-populations, against chemical risk is among the highest in the world.

Comparison of tertiary wastewater treatment (%) among the EU-28

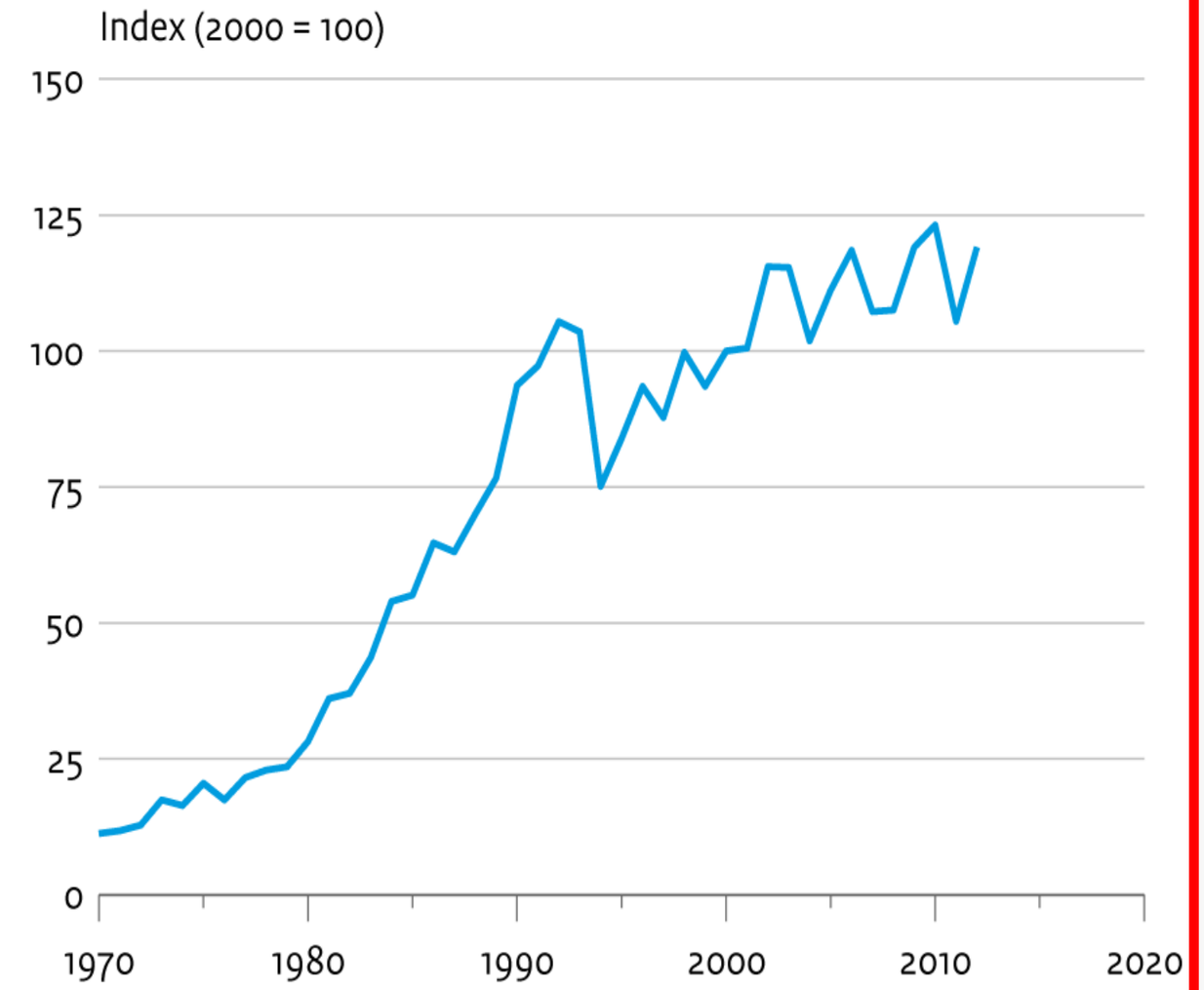


6. Ecological water quality



Essex et al. (2020). **Proposal for a National Blueprint Framework to Monitor Progress on Water-Related Sustainable Development Goals in Europe**

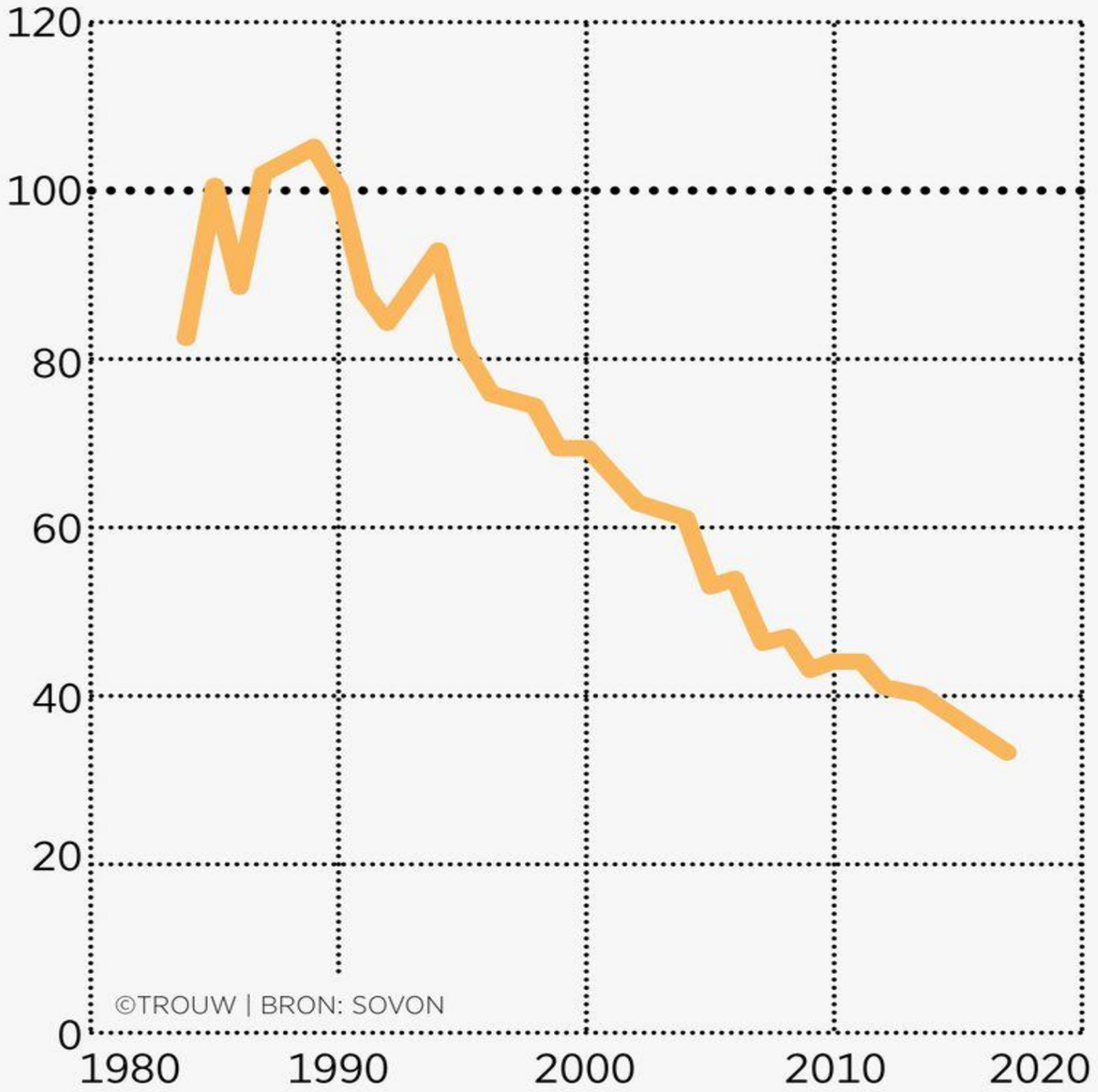
Aalscholver



Bron: NEM (SOVON, CBS)

Broedpopulatie grutto

Index t.o.v. 1990

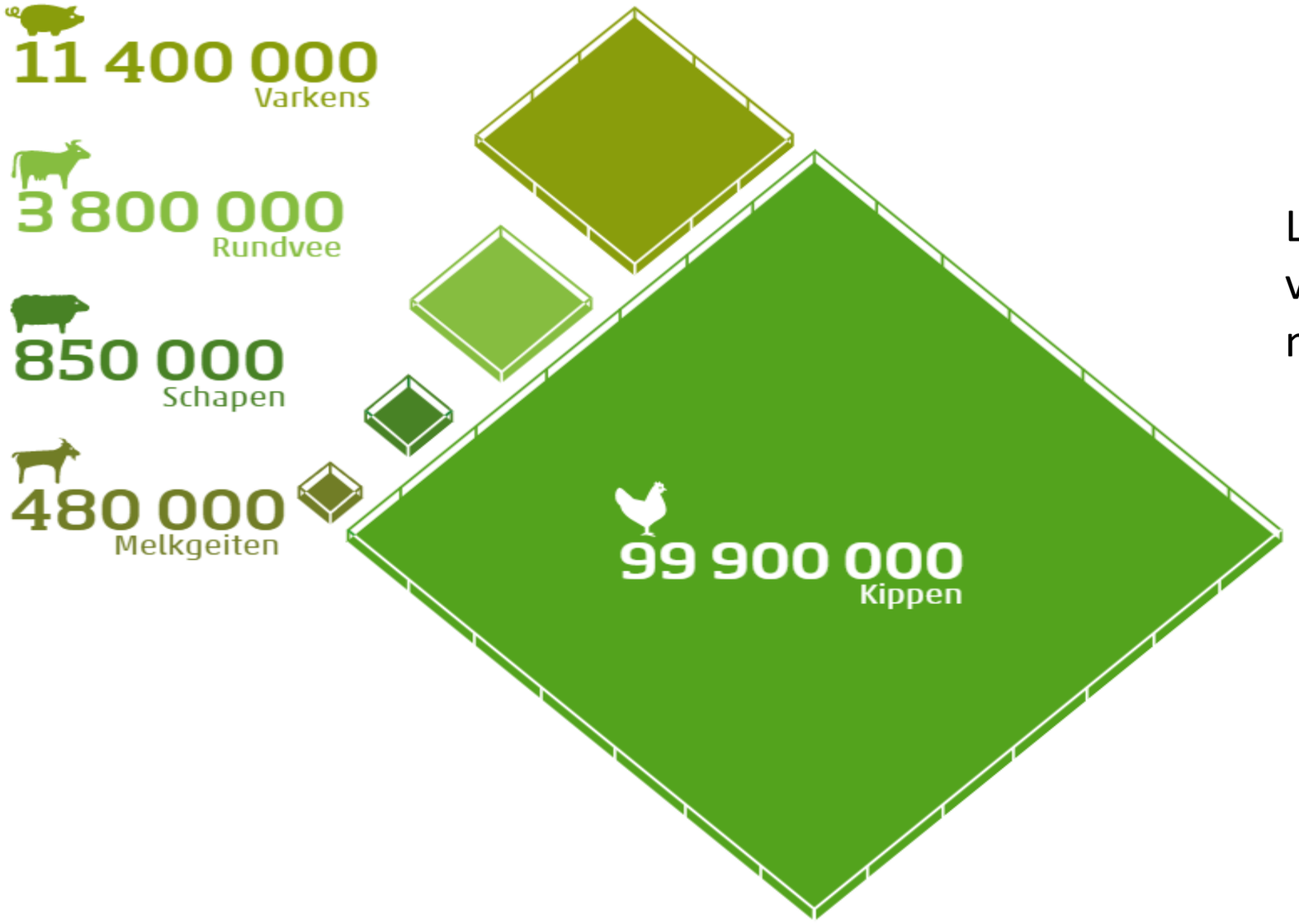


Complete failure: agro-industry emissions

- **Nutrients** 60% N from agriculture
- **Pesticides** (5000 tonnes/y)
- **Biocides** (annual use not available)
- **Veterinary drugs** (500 tonnes/y)
- **Feed additives/antibiotics**
  in animal nutrition (11.5 million tonnes/y)

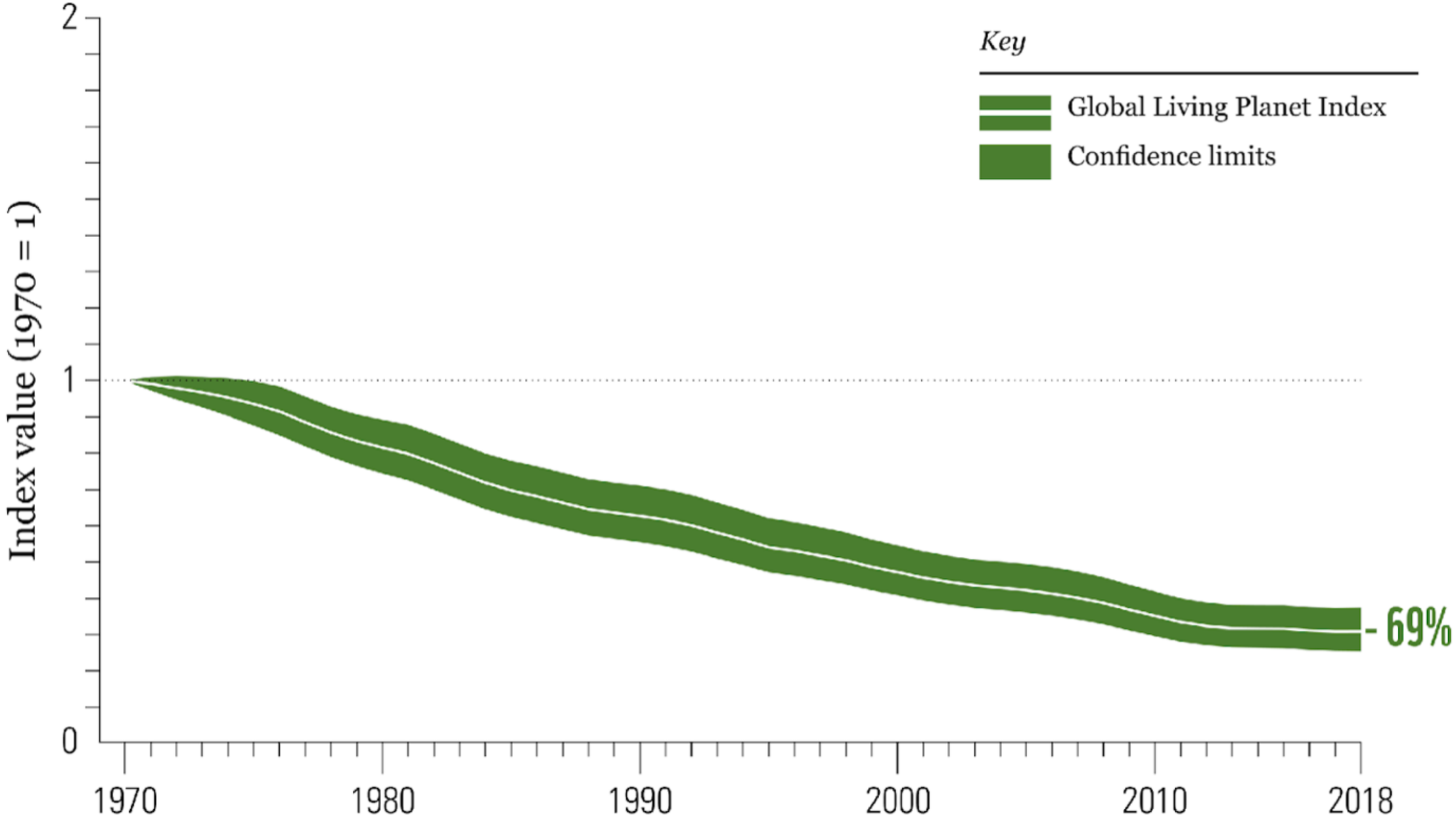
- 300,000 km of Dutch ditches = open sewers
- Land resembles green asphalt
- Great loss of biodiversity

Hoeveel landbouwdieren telt ons land?



Nederland in cijfers 2021

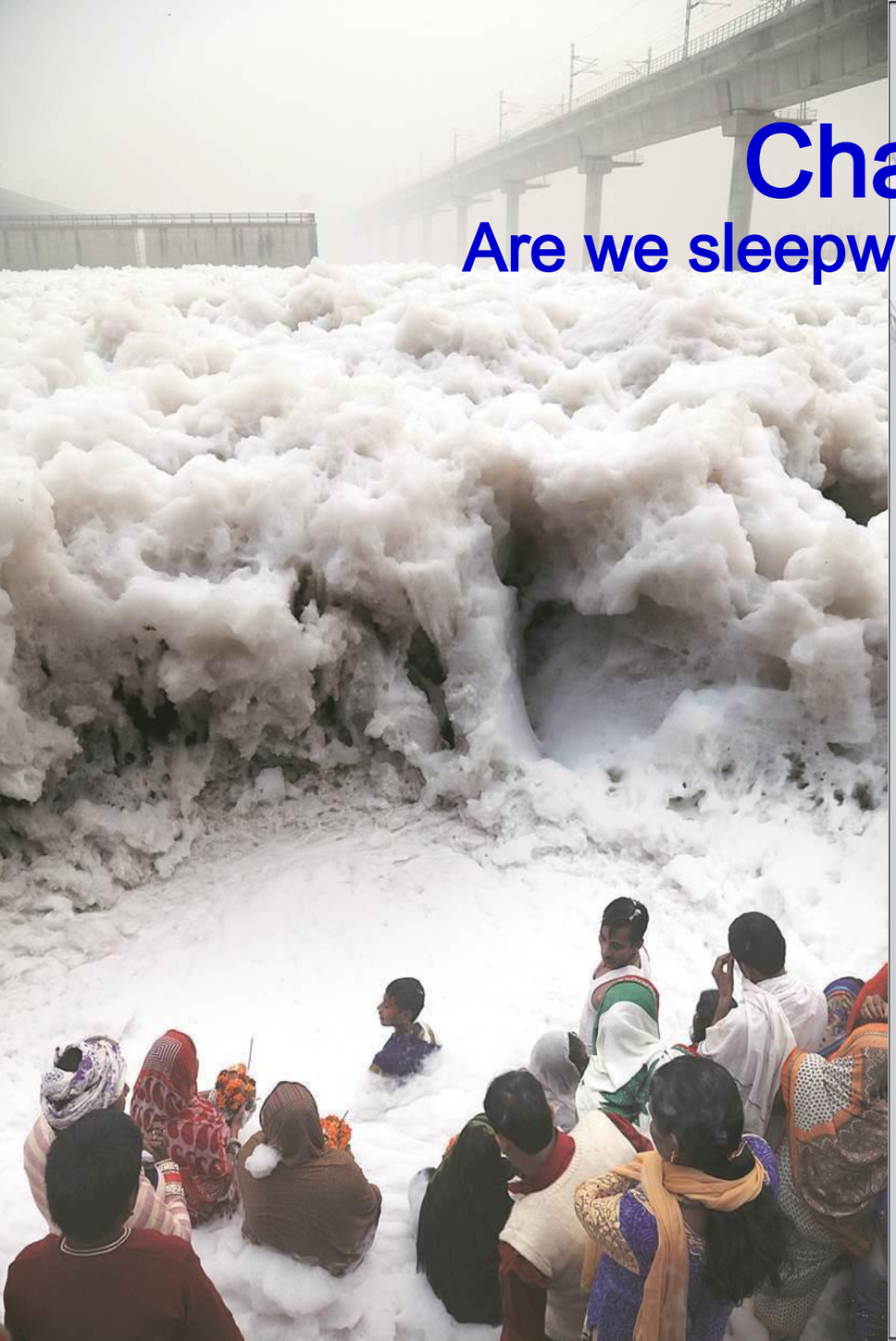
Landbouwexport in 2021 voor het eerst boven de 100 miljard euro

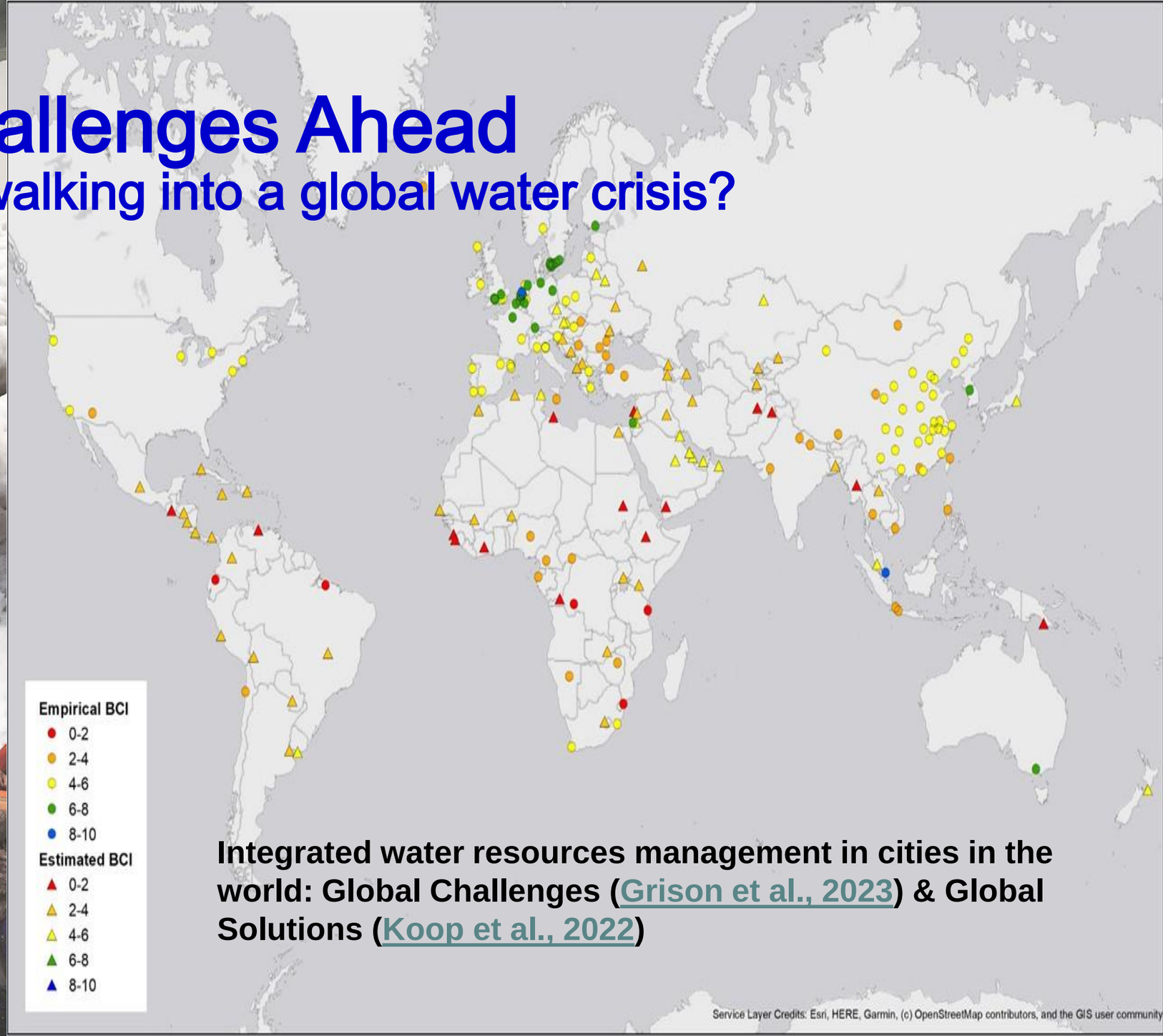


Source: https://stats.livingplanetindex.org/lpi

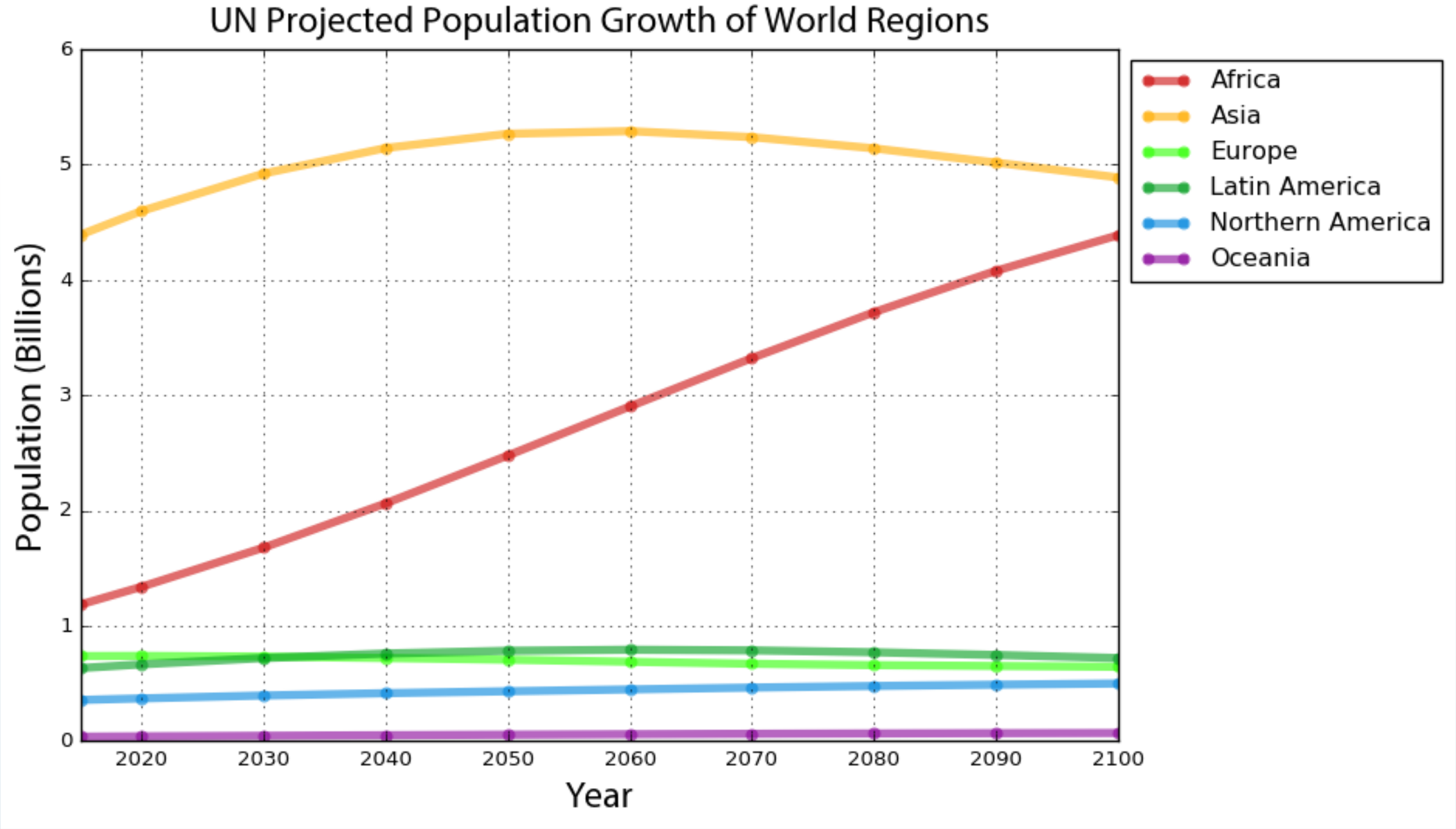
Challenges Ahead

Are we sleepwalking into a global water crisis?





Integrated water resources management in cities in the world: Global Challenges (Grison et al., 2023) & Global Solutions (Koop et al., 2022)


UN Projected Population Growth of World Regions
Population (Billions)
Year
0
1
2
3
4
5
6
2020
2030
2040
2050
2060
2070
2080
2090
2100
Africa
Asia
Europe
Latin America
Northern America
Oceania


ipcc

GENERATION TIMES OF SOME 'SPECIES'

Species	Generation time
Bacteria	≈ 0.1 d
Algae (*Chlorella sp.*)	≈ 1 d
Waterfleas (*Daphnia sp.*)	≈ 10 d
Snails (*Lymnaea sp.*)	≈ 100 d
Rats	≈ 1 y
Politicians	≈ 5 y
Man	≈ 25 y
Cities	>100 y

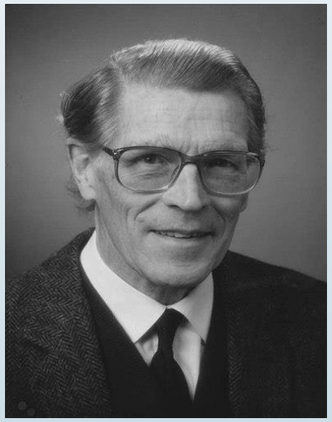
Modified after Van Leeuwen en Vermeire (2007)

Matthew 7:15-20: You Will Know Them by Their Fruits

Prof. Leendert Ginjaar (Photo 1977)

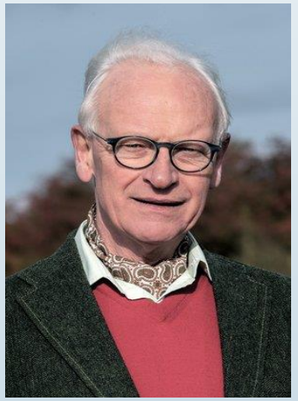
Ginjaar, oud minister, vz. College van Bestuur van de Rijksuniversiteit Utrecht, deeltijd-hoogleraar voor milieu-gezondheidkunde aan de Rijksuniversiteit Limburg, vz. Gezondheidsraad. Hij behartigde binnen dit adviesorgaan van de regering de domeinen milieu & leefomgeving en was voorzitter vd. postdoctorale opleiding toxicologie.

postgraduate education in Toxicology



Prof. Herman Van Genderen

Prof Jan Koeman



Prof Willem Seinen