



UNIVERSITY
OF AMSTERDAM



13-02-2020 Zwolle MEDUWA

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Monitoring and Modelling Micro- contaminants in the urban water cycle

SOURCE ← STP → ENVIRONMENT

Thomas ter Laak

kwr

Bridging Science to Practice



contents

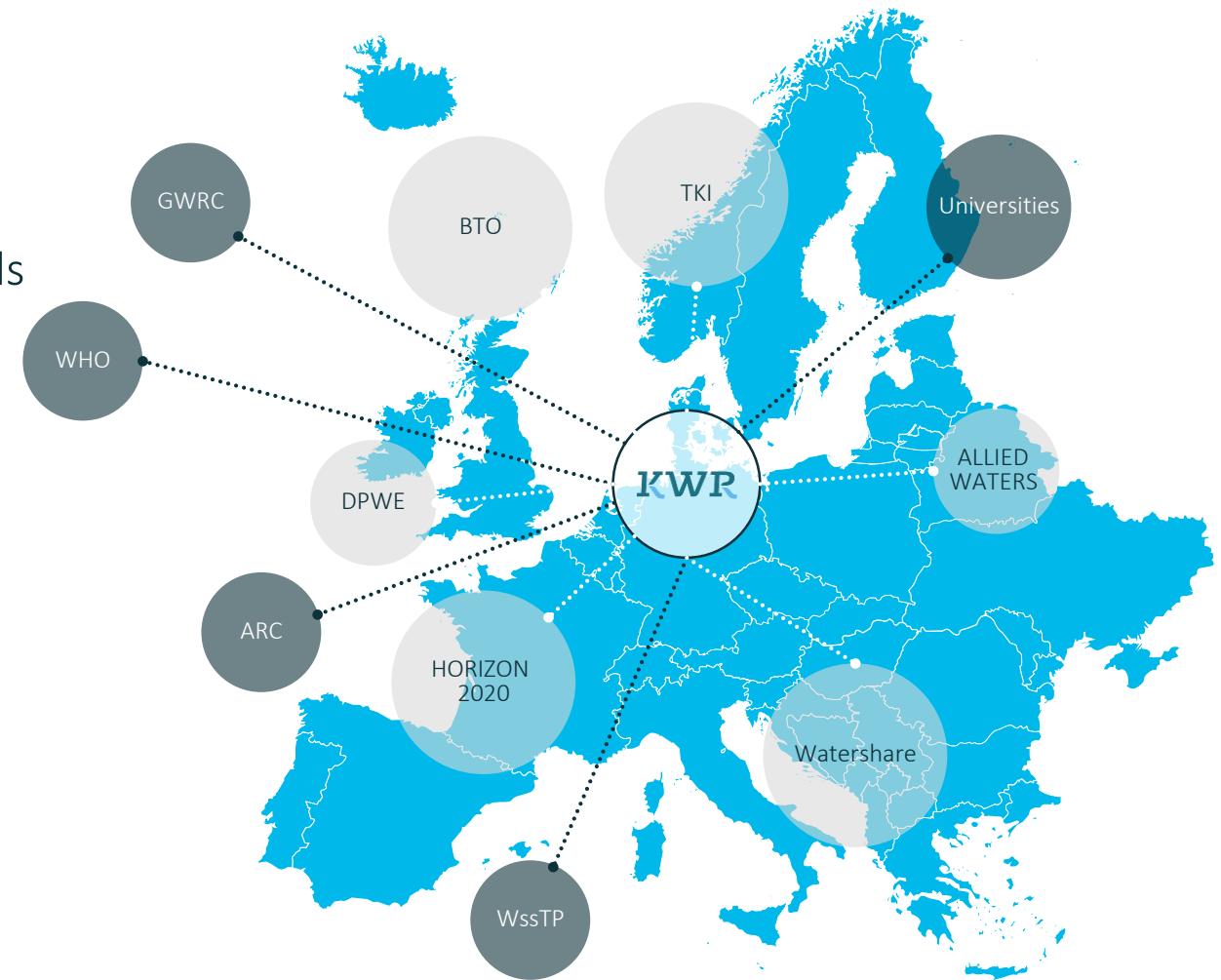
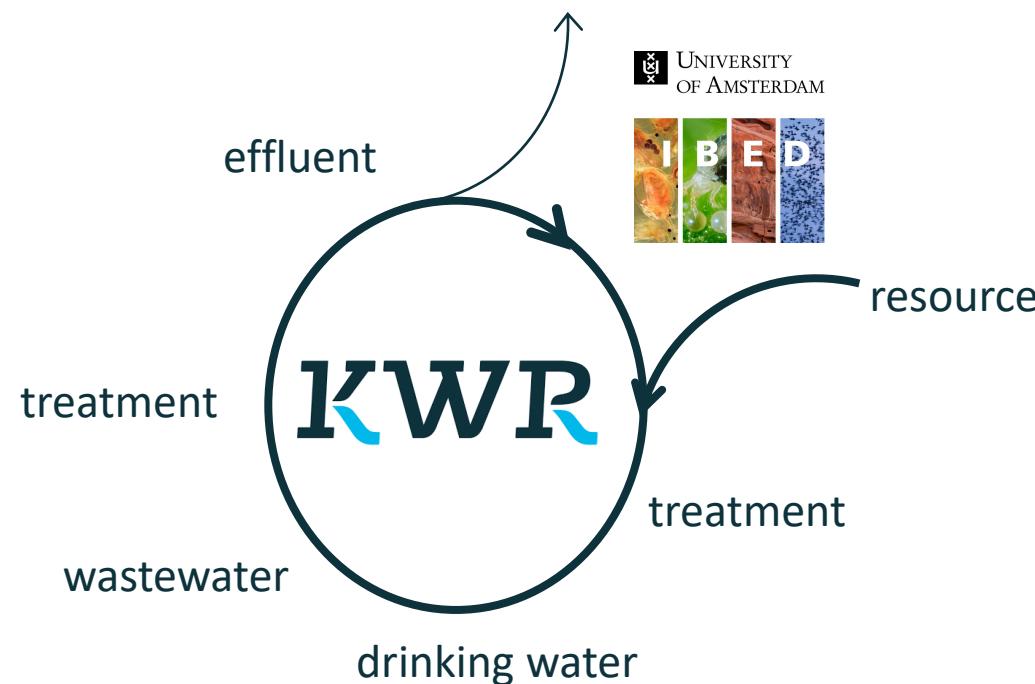
- KWR/UvA
- Micro-contaminants; SOURCE \leftarrow STP \rightarrow ENVIRONMENT
- Prognoses of environmental concentrations (impact of climate change)
- ABR – open discussion



About KWR (& IBED)

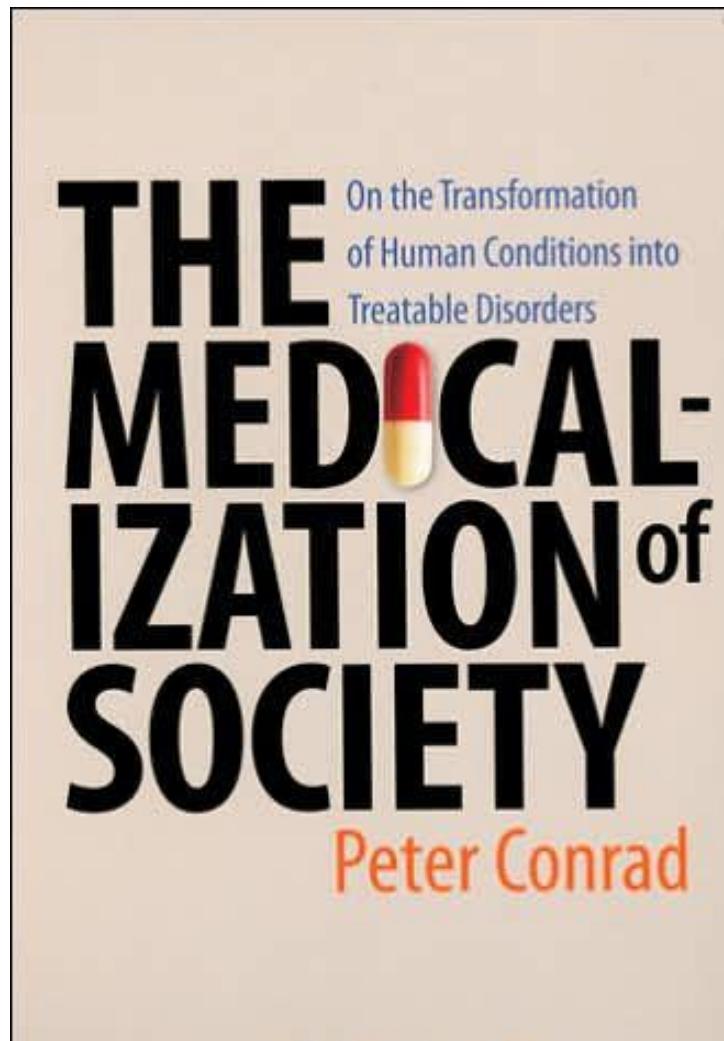
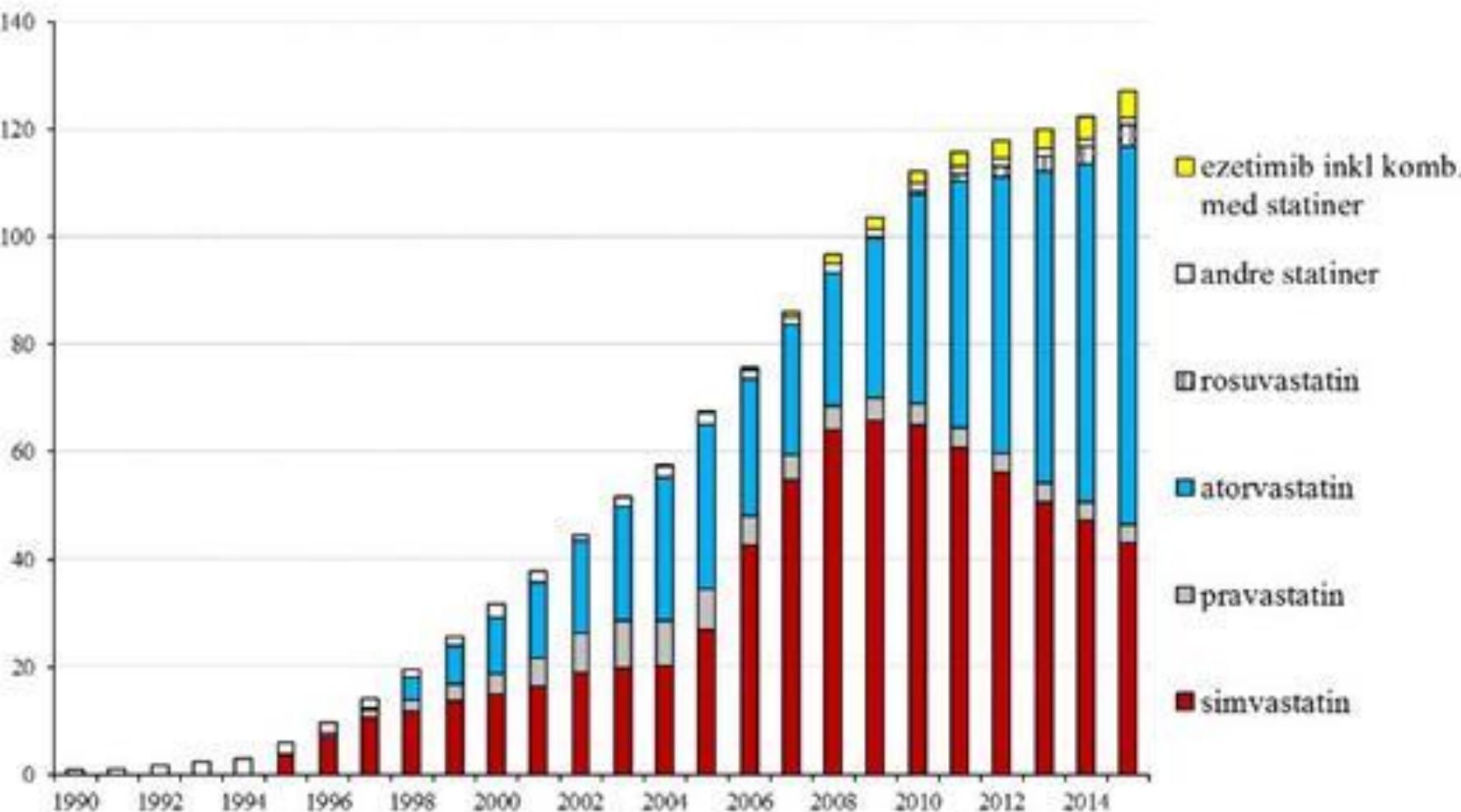
Research Institute of the Dutch drinking water sector;
~180 employees

Evolution from national drinking water research towards
international research in the water cycle



Measuring pharmaceutical emissions

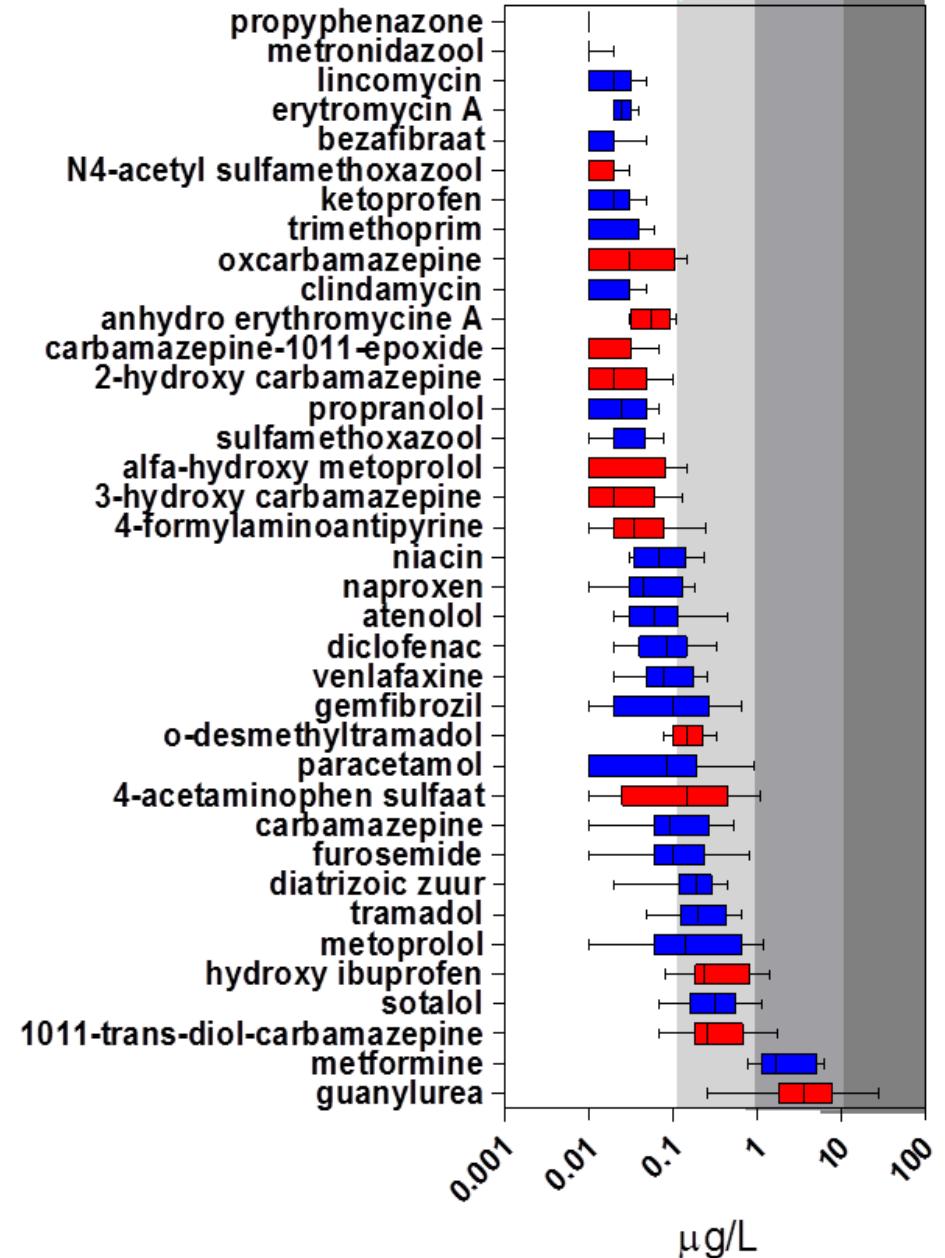
SOURCE ←STP→ ENVIRONMENT



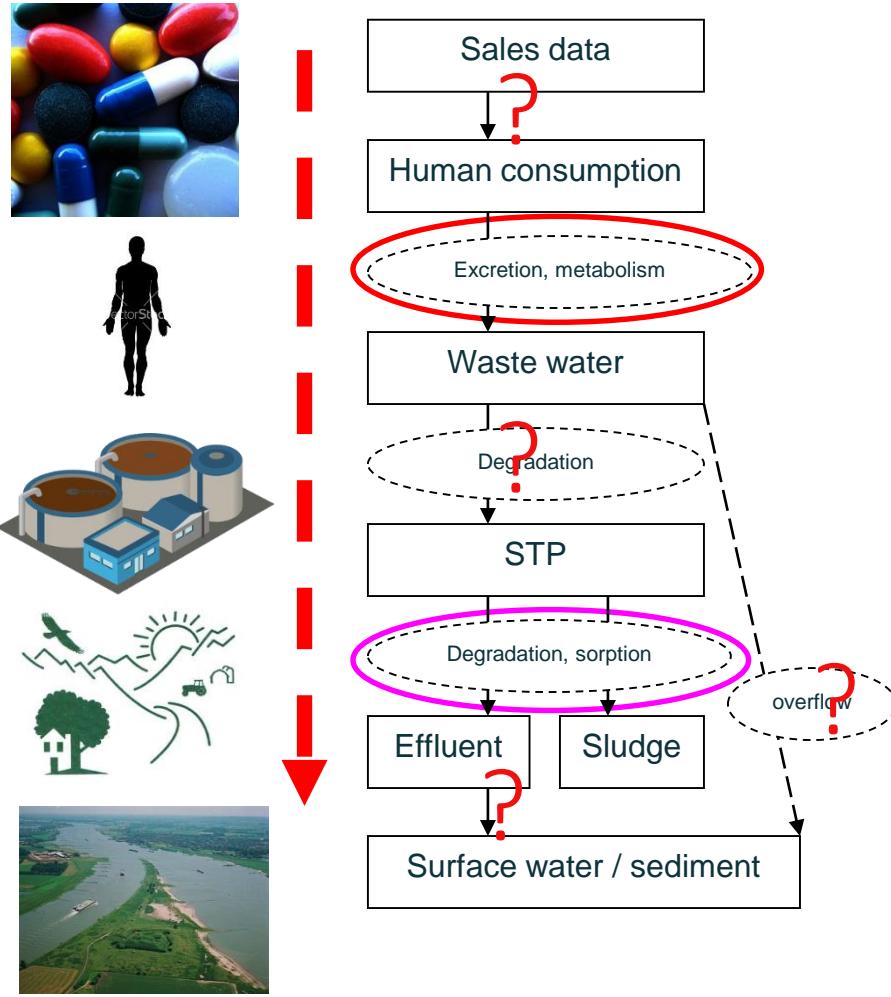
Measuring pharmaceuticals

23 pharmaceuticals and 13 TPs observed

1. Guanyl urea (50 %)
2. Metformine (21 %)
3. 10-11 trans diol carbamazepine (4%)
4. Hydroxy ibuprofen (4%)
5. Sotalol (3%)
6. Metoprolol (2%)
7. Tramadol (2%)
8. Diatrizoic acid (2%)
9. Furosemide (1%)
10. Carbamazepine (1%)
11. Other (10%)

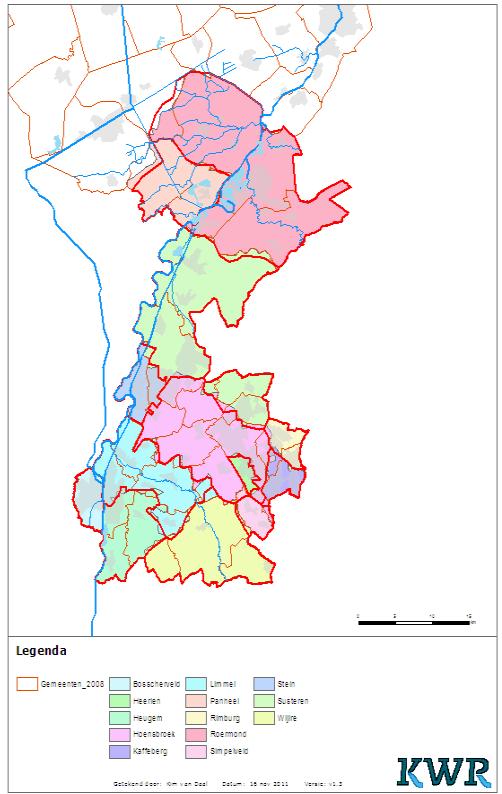
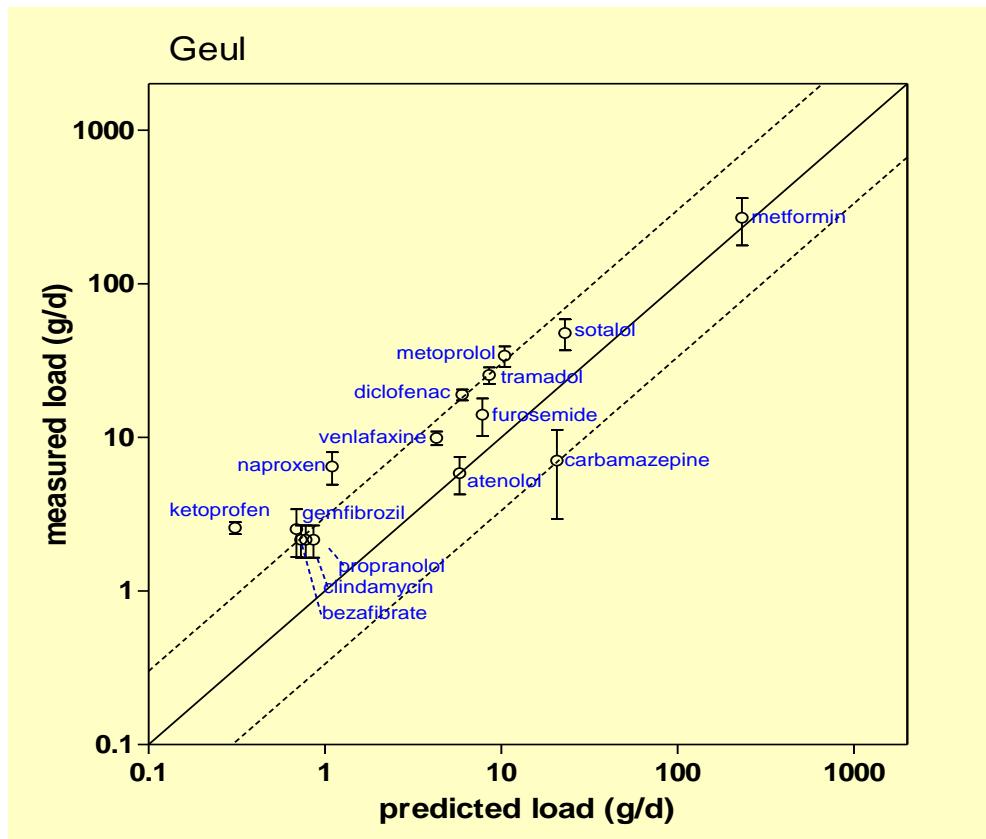
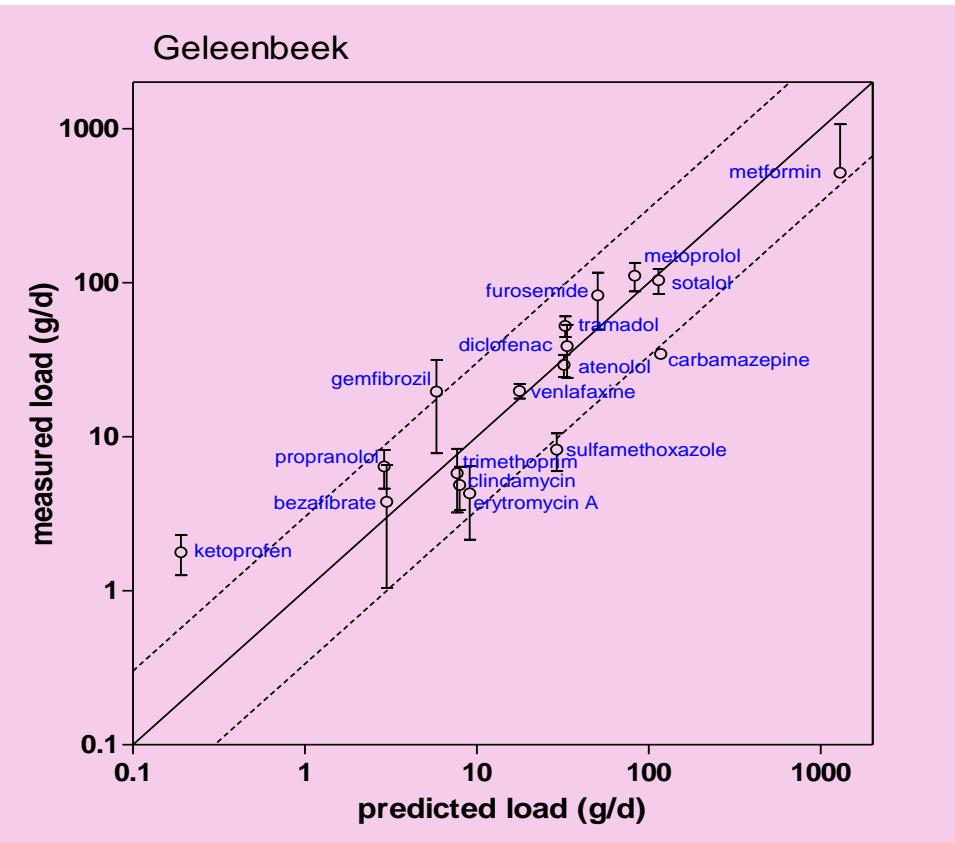


Modeling emissions of human pharmaceuticals

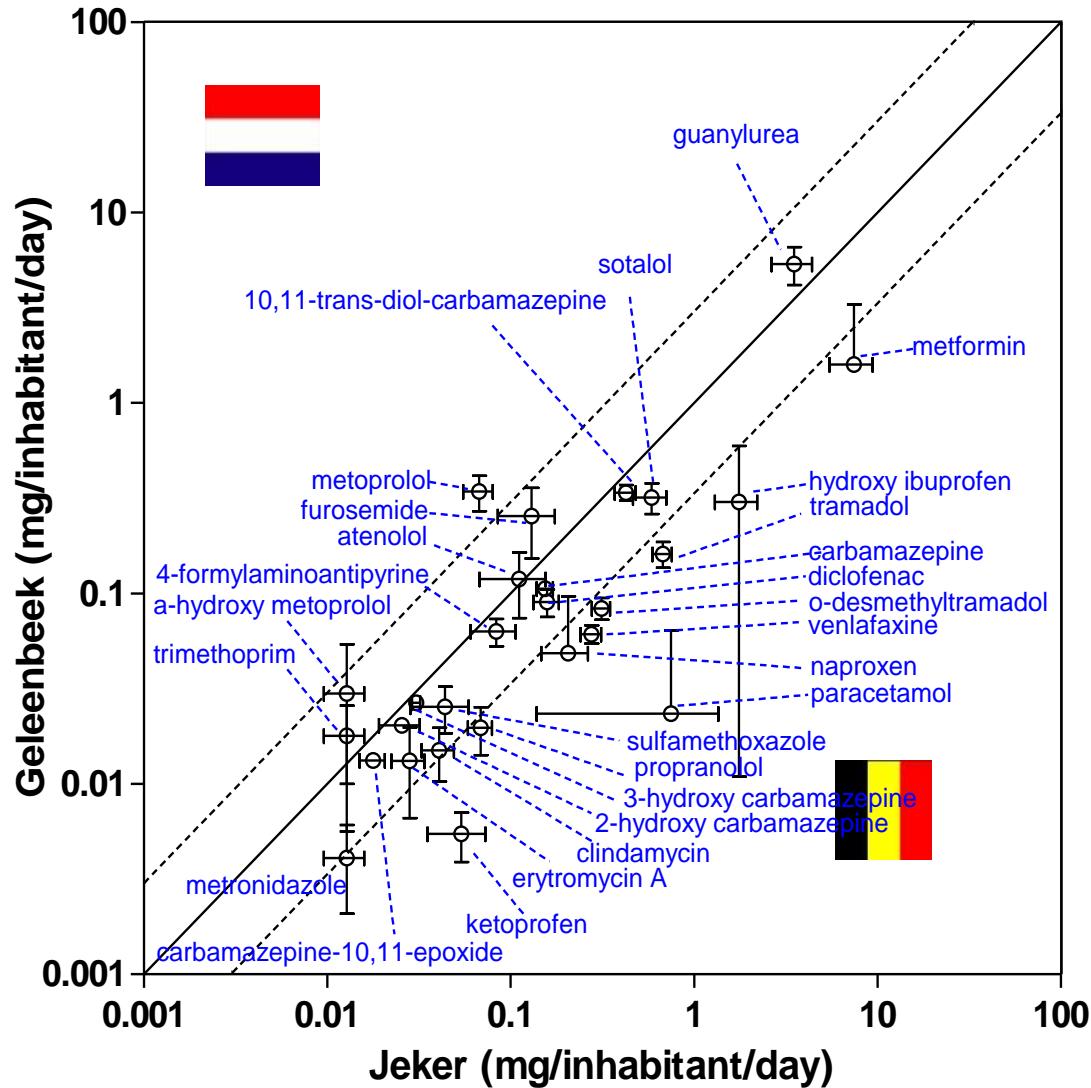
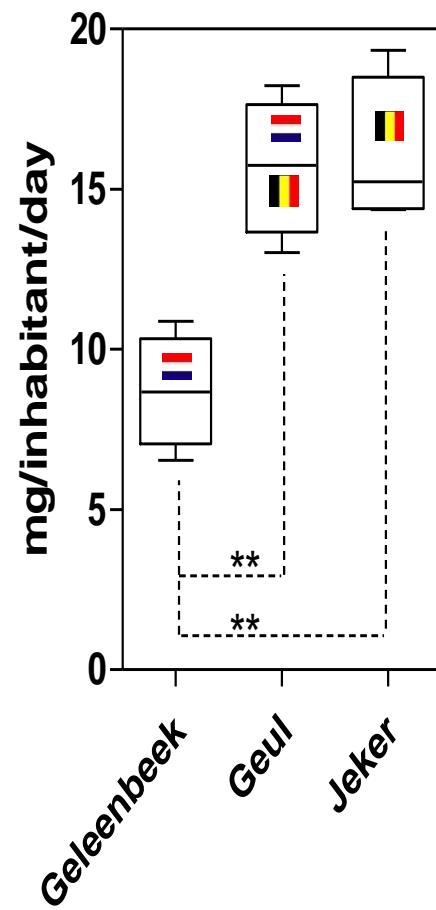


$$Load_{SW} = Consumed \cdot f_{Excr} \cdot f_{WWTP}$$

Actual vs. predicted loads



BE vs. NL (regional differences)

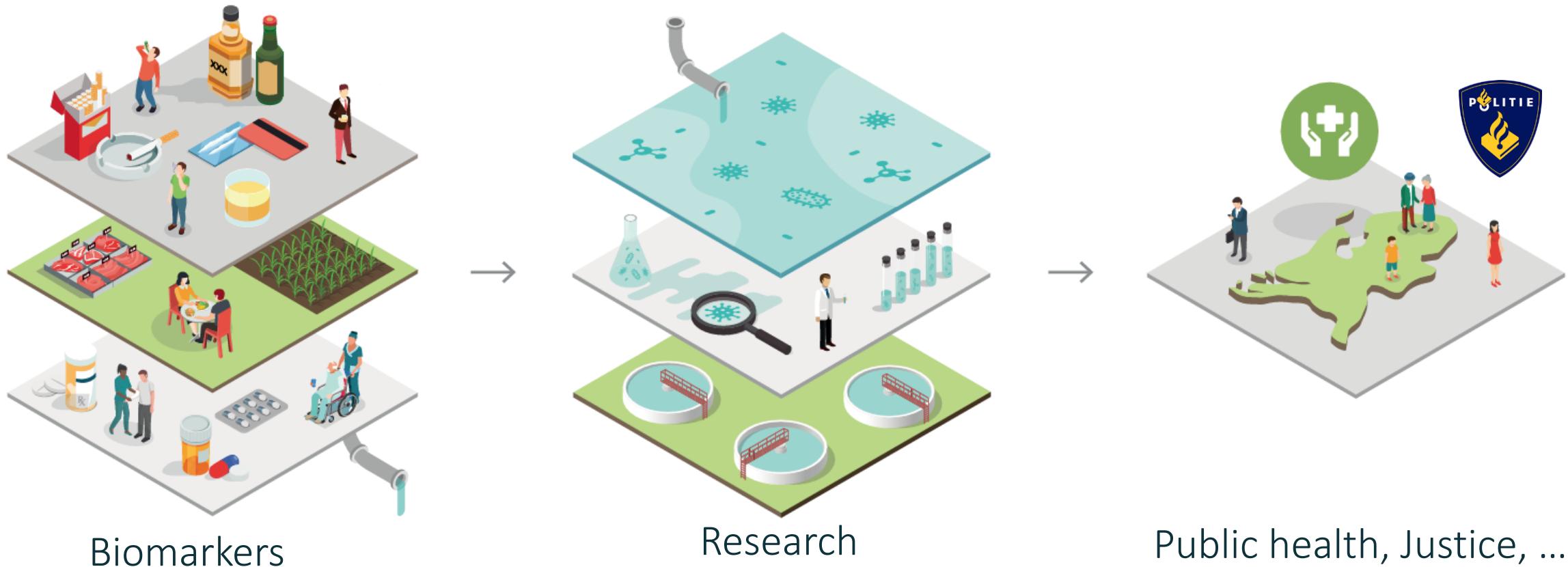


From emission to source characterization

SOURCE \leftarrow STP \rightarrow ENVIRONMENT

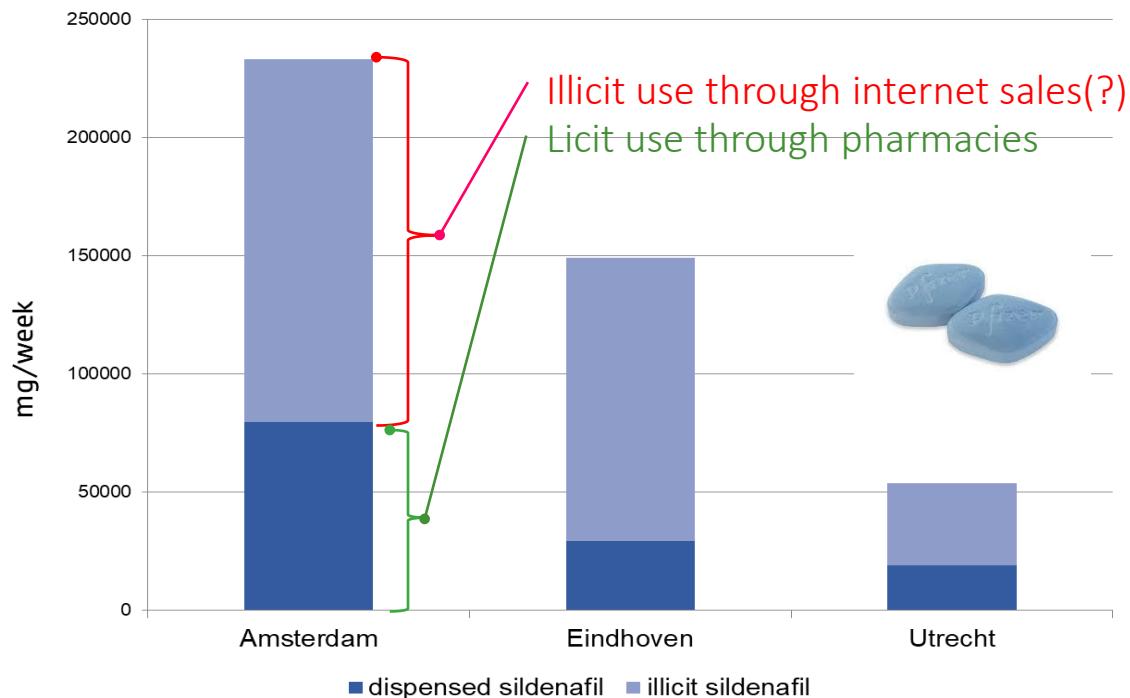
SOCIETY - SOURCE \leftarrow STP \rightarrow ENVIRONMENT

Wastewater Based Epidemiology (WBE) (measuring consumption/prevalence)

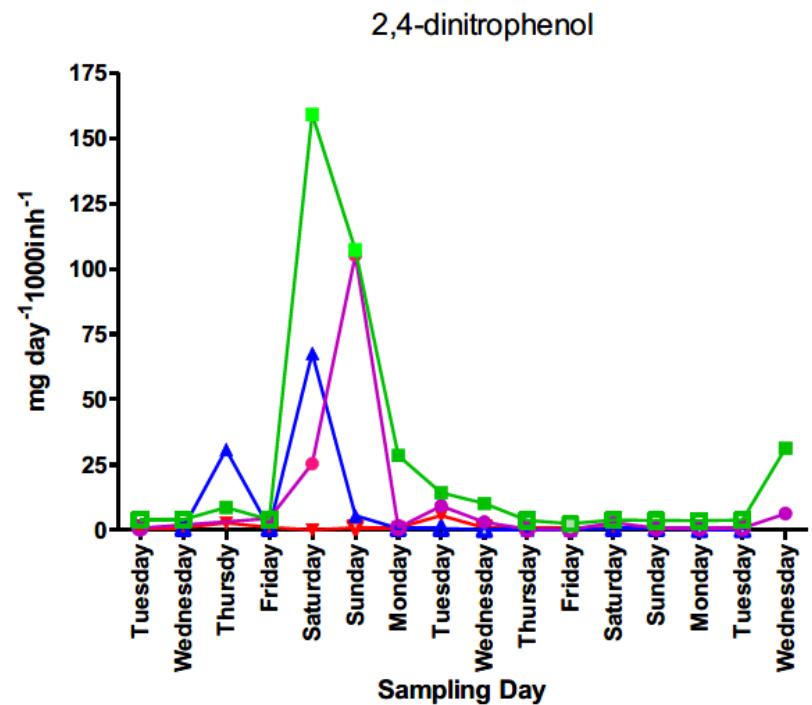


Example 1 WBE

Performance enhancing substances



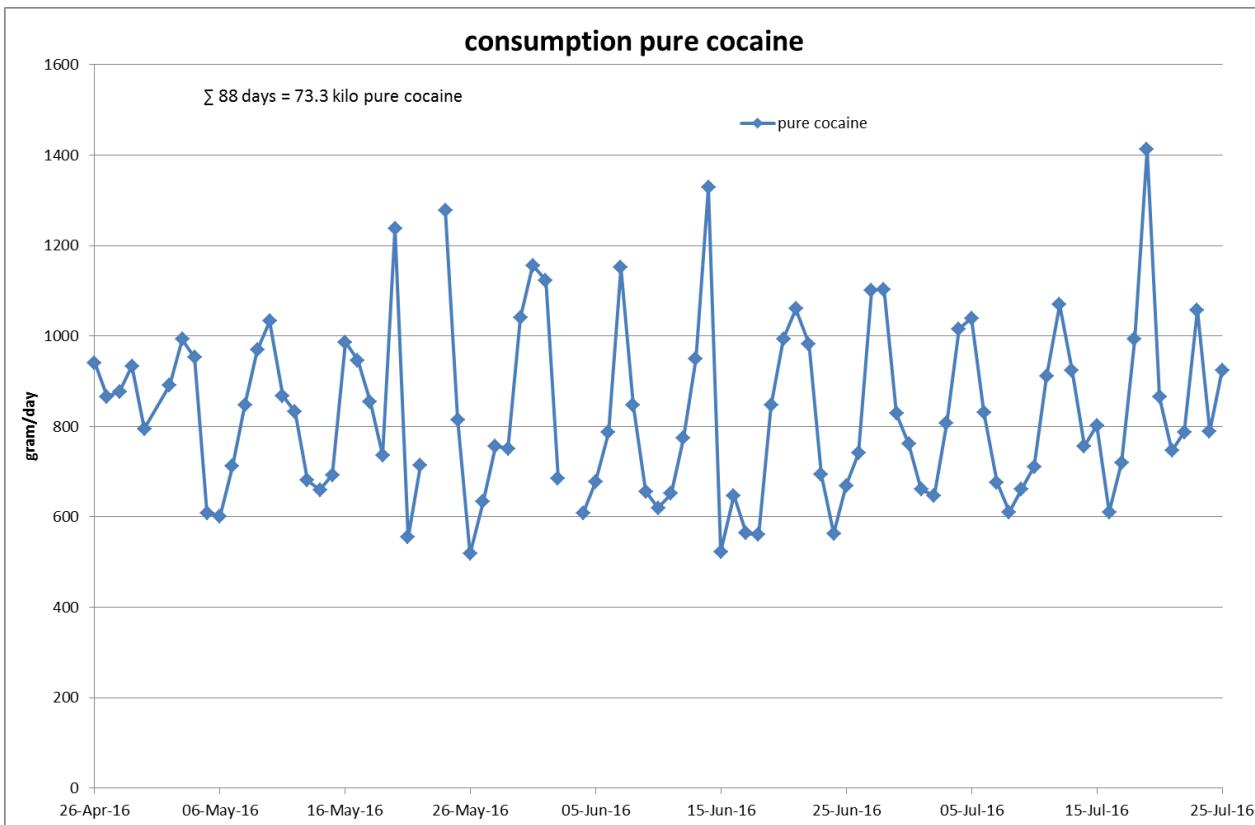
"Success of rogue online pharmacies: Sewage study of sildenafil in the Netherlands." BMJ (Online) 349.





Example 2 WBE

Illicit drugs



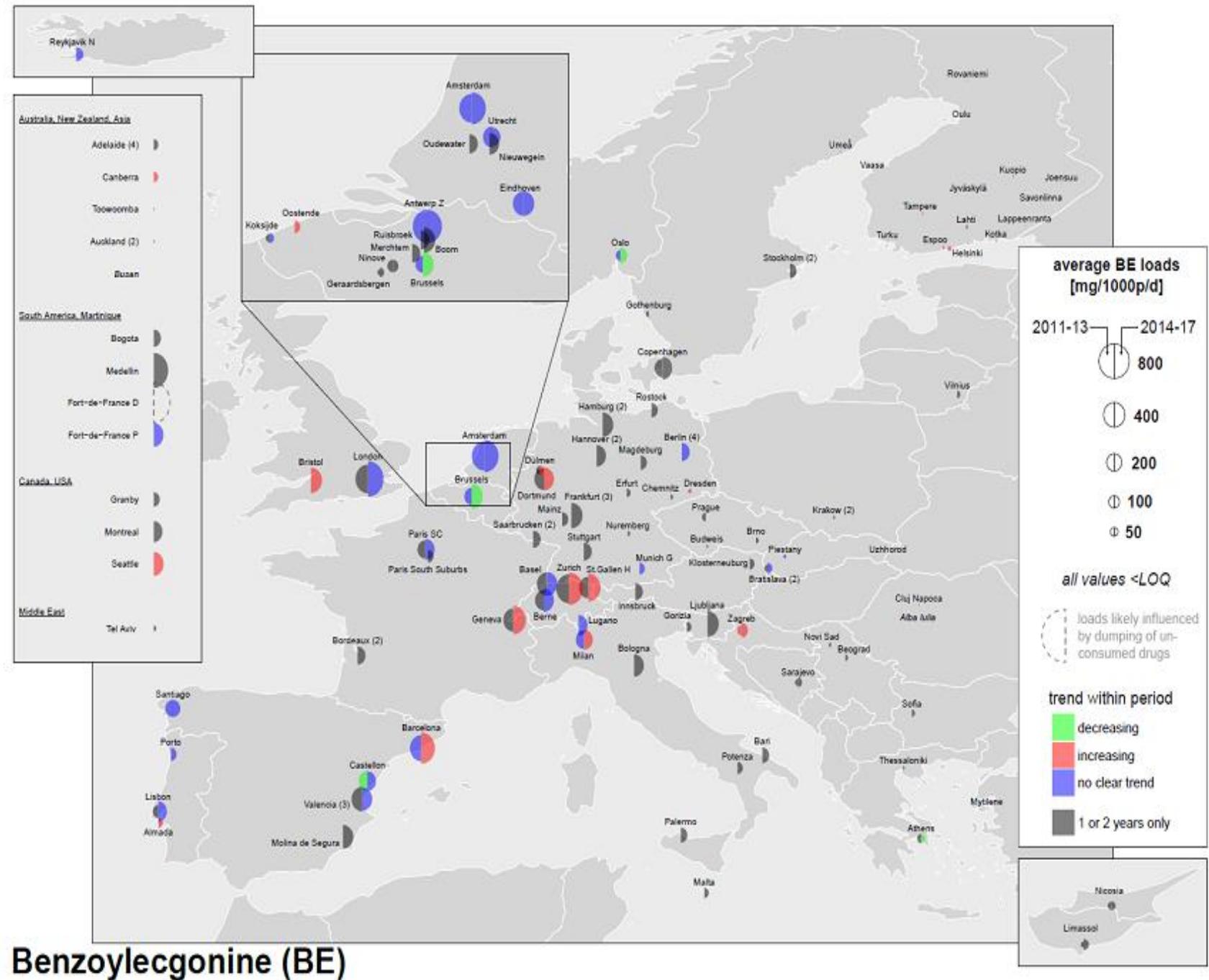
temporal trends of a city:
understanding consumption volume, market size on
regional scale, use patterns

Example 2 WBE

Illicit drugs

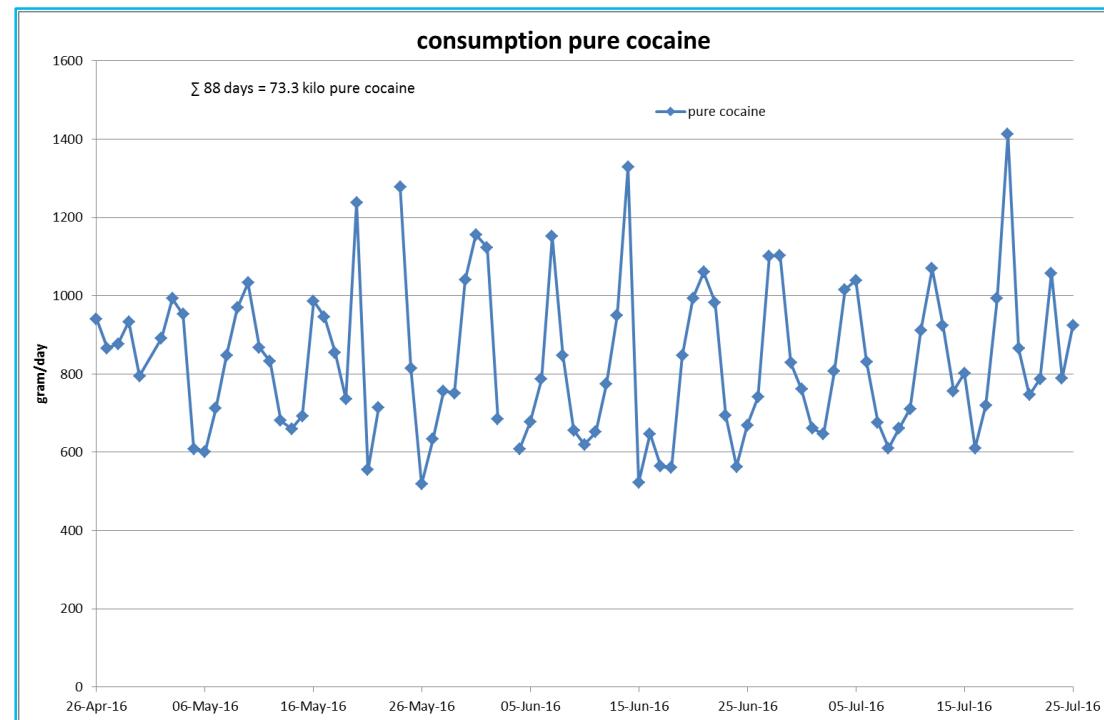
Spatial and temporal trends; understanding consumption volume, market size

(SCORE for EMCDDA drug report)



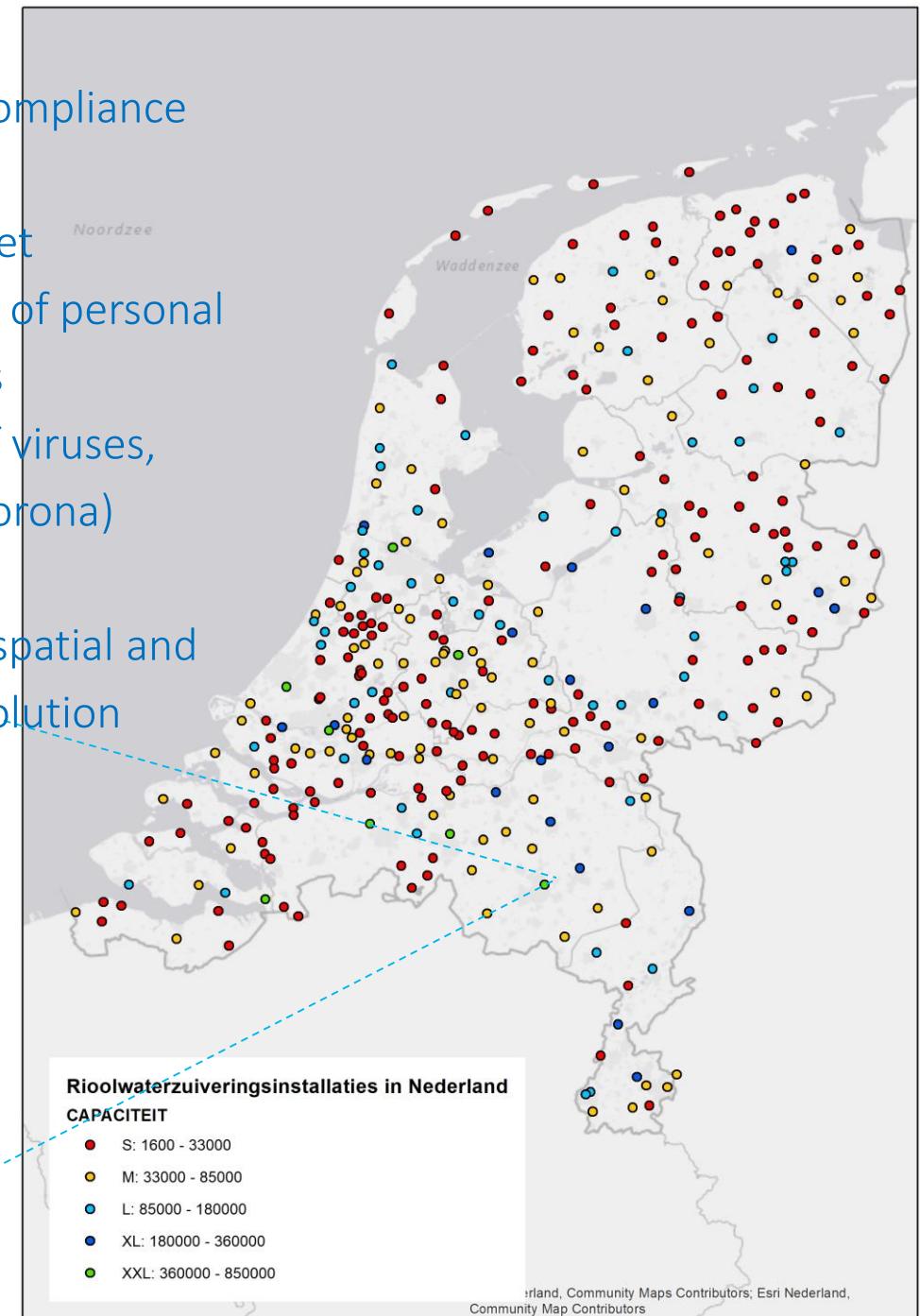
FUTURE (!)

- Sampling all 323 WWTP
- Plethora of health related parameters possible!



Illicit Drugs,
medication compliance
Stress levels
Population diet
Consumption of personal
care products
Prevalence of viruses,
pathogens (corona)

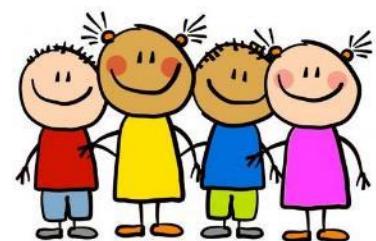
All with high spatial and
temporal resolution





Example 3

Health indicators (australia)



negative correlation
with age



Picture © Phil Choi QAEHS Australia



negative correlation
with SES

positive correlation
with SES



KEY

- Diet & sweeteners (Orange circle)
- Recreational drugs (Blue circle)
- Nonrecreational drugs (Black circle)

Significance cutoff: $R = |0.5|$

KWR





modeling

SOURCE ←STP→ ENVIRONMENT

Society - SOURCE ←STP→ ENVIRONMENT

SOURCE ←STP→ ENVIRONMENT

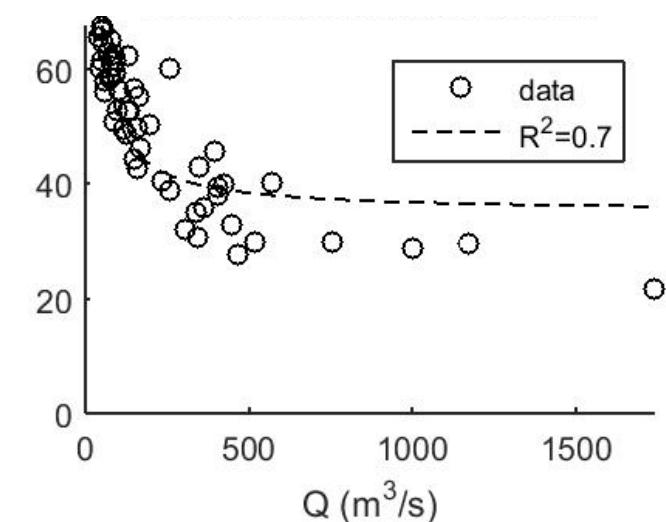
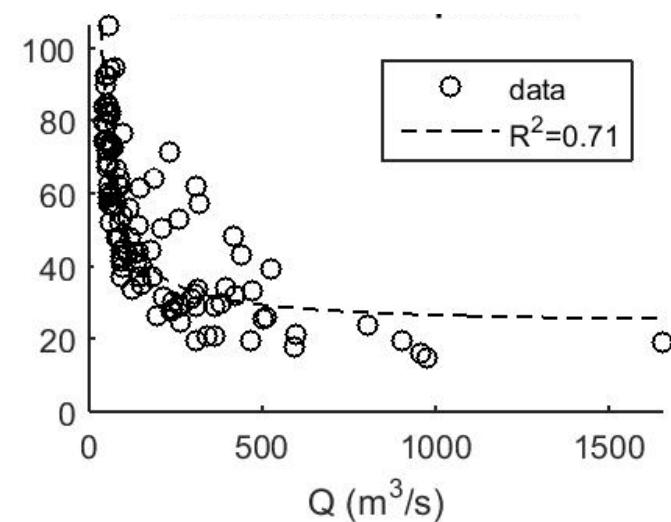
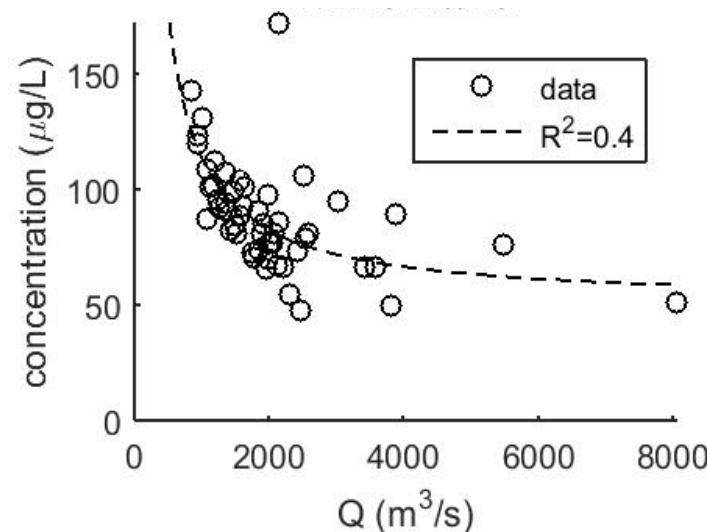
Prognoses of future environmental concentrations

Projections of Rhine and Meuse

SOURCE ←STP→ ENVIRONMENT

Prognoses of concentrations:

1. Flow-concentration relationships (Q-C)
2. Flow scenario's 2050 (KNMI, 2006)
3. Emissieprognoses

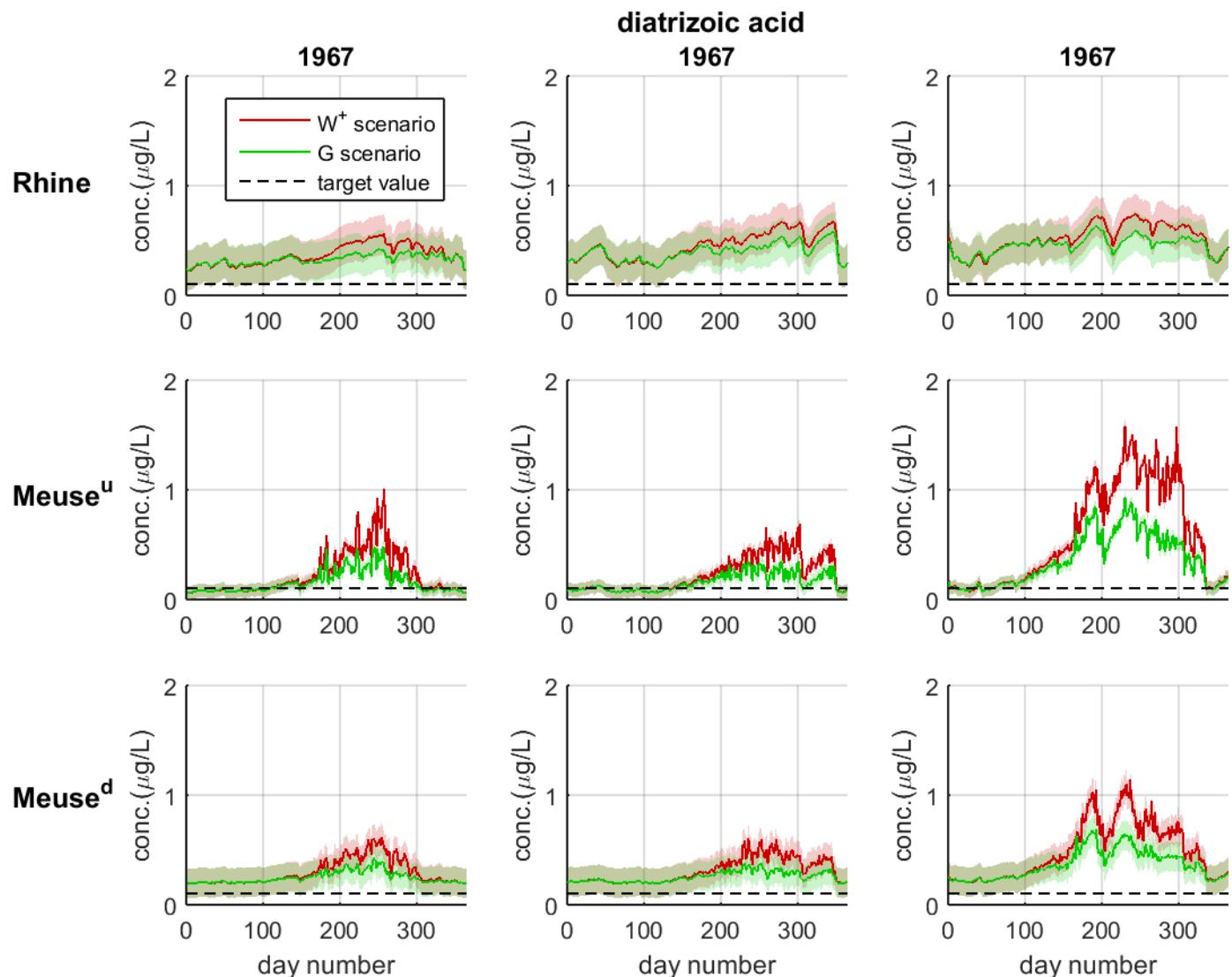


Prognoses of future environmental concentrations

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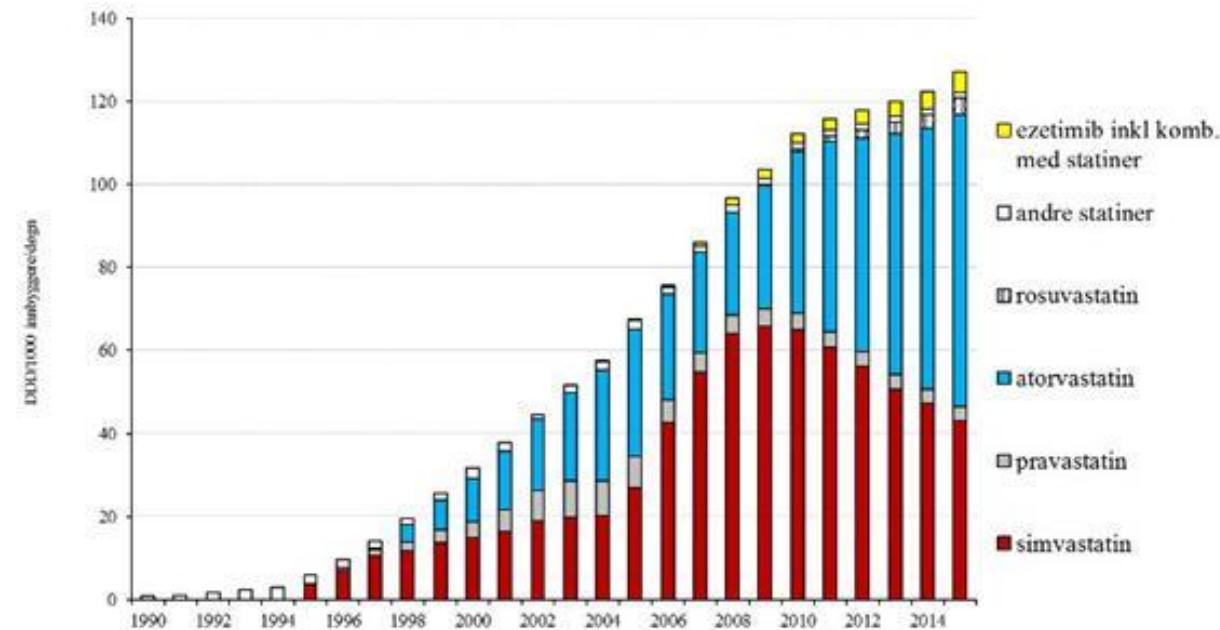


Prognoses of future environmental concentrations

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Prognoses of concentrations:

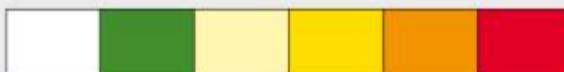
1. Flow-concentration relationships (Q-C)
2. Flow scenario's 2050 (KNMI, 2006)
3. Emissieprognoses (trends, predictions, scenarios, expert judgement)



van der Aa NGFM et al. 2011. *Water Science and Technology*:825-832.

~ Prognoses of exceeding thresholds (SW&DW)

Percentage dagen met normoverschrijding per jaar



geen data 0% >0-10% 10-25% 25-50% >50%

Klimaatscenario's

HK G W+ G TB W+ TB

gemiddeld jaar

droog jaar

zeer droog jaar

Prognose ruwwater

Overschrijding ERM-streefwaarde voor oppervlaktewater als bron van drinkwater (Europees Rivierwatermemorandum, 2013): 1 ug/L voor AMPA, acesulfaam-K, EDTA en MTBE en 0,1 ug/L voor alle overige stoffen

Prognose reinwater

Overschrijding ERM-streefwaarde na verwijdering stof afhankelijk van huidige locatiespecifieke zuiveringsrendement

Toelichting klimaatscenario's

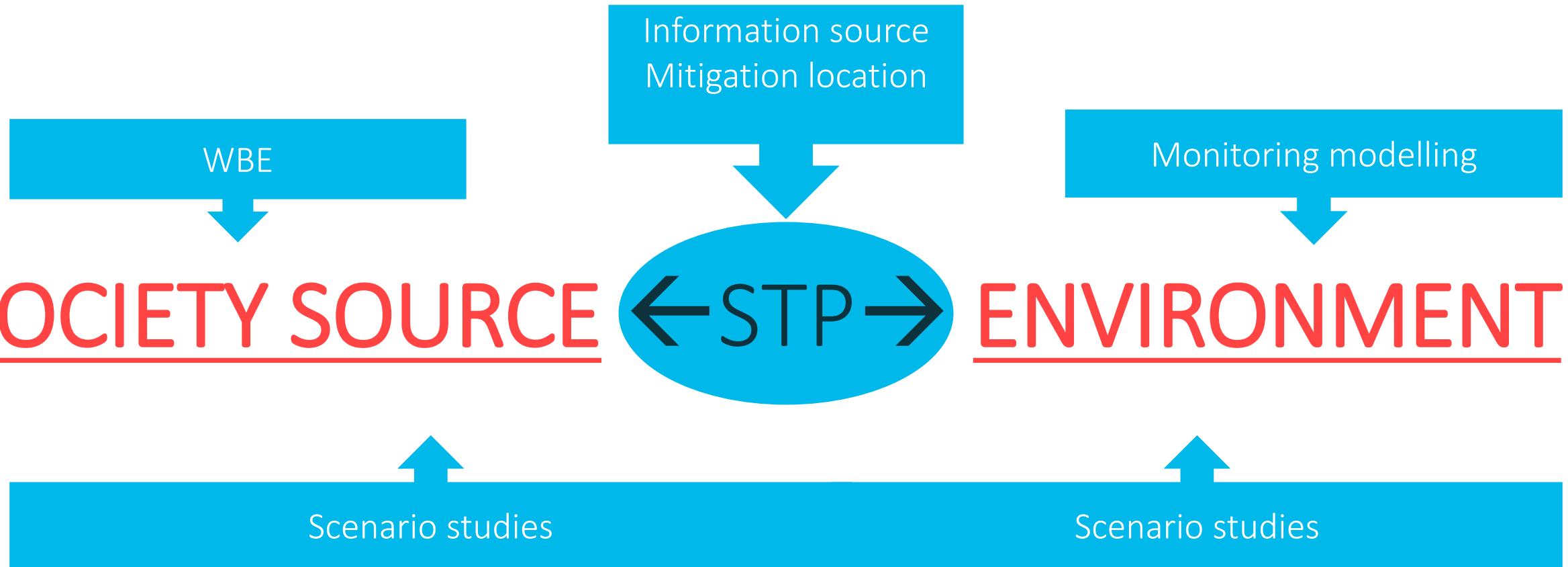
- HK Huidig Klimaat
- G G scenario: gematigde klimaatverandering (KNMI, 2006)
- W+ W+ scenario: snelle klimaatverandering (KNMI, 2006)
- TB Verwachte toekomstige stofbelasting

Prognoses

Exceeding thresholds
(SW&DW)



Recapture: covering the water cycle





Antibiotics, antimicrobial resistance (AMR)

Relevant: WHO -> global health threat

Antibiotics, antimicrobial resistance (AMR)

Relevant: WHO -> global health treat

AMR Risk: Hospitals, veterinary practice (short cycle)

- Consumption of antimicrobials
- Patient - patient transfer



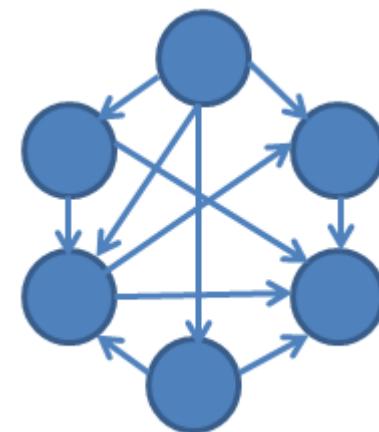
Antibiotics, antimicrobial resistance (AMR)

Relevant: WHO -> global health treat

Urban water cycle: Antibiotics, AMR, genes, bacteria, gene transfer, covers the full water cycle, STP as central source of information (long cycle)

- Consumption of antimicrobials
- Environmental monitoring antimicrobials
- Measuring effects of antimicrobials (bioassays)
- Measuring resistant microorganisms / genes
- Relating prevalence to risks

} Environmental domain



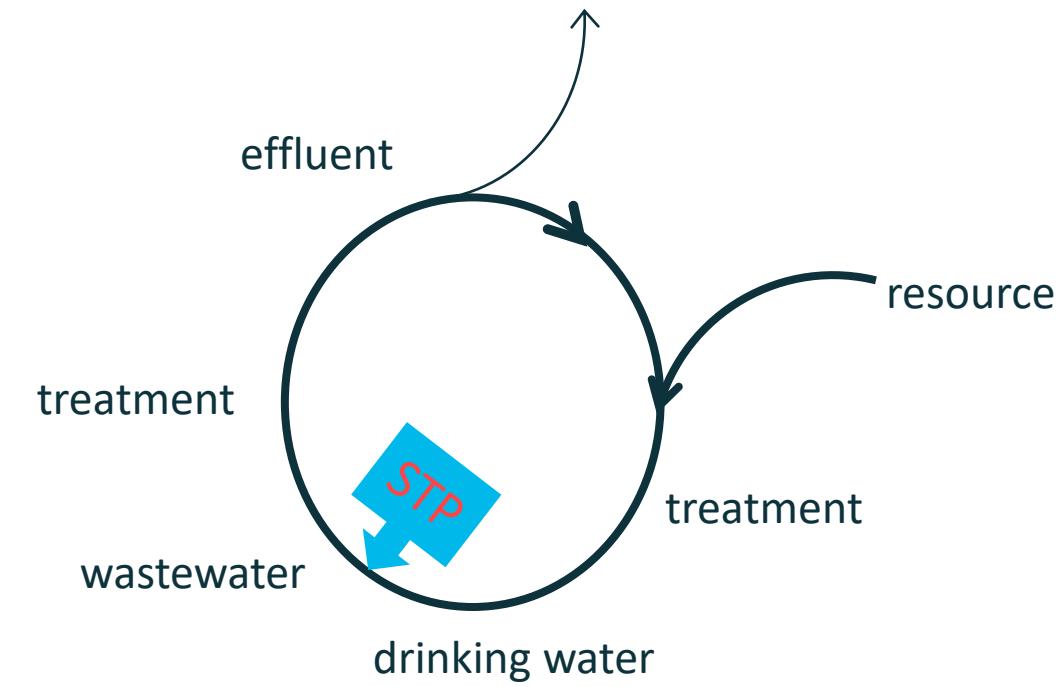
Antibiotics, antimicrobial resistance (AMR)

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Urban water cycle: Antibiotics, AMR, genes, bacteria, gene transfer, covers the full water cycle, STP as central source of information (long cycle)

SOCIETY SOURCE ←STP→ ENVIRONMENT

Multidisciplinary: Pharmacology, medical sciences, veterinary sciences, environmental chemistry, microbiology, epidemiology, hydrology, modelling, data science,etc



Dialogue / Discussion

Wastewater is an under-used source of information, develop and use diagnostic tools

- Can you think of some examples from your own field?





Dialogue / Discussion

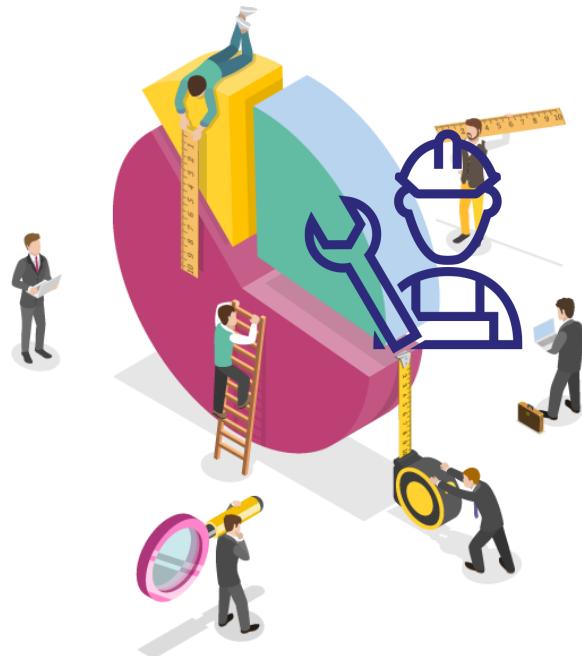
Wastewater might help diagnostics, but mitigation measures reduce emissions, we should act!





Dialogue / Discussion

Considering the topic AMR, diagnostics guide measures to optimize impact!



Dialogue

Development of diagnostic tools (for AMR) makes us loose precious time, better safe than sorry





Dialogue / Discussion

Diagnostics to mitigation is not always an easy road. Regulation is often required as catalyst

What are the requirements for regulation?



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Many others..