A solutions focused perspective on arising challenges of contaminants of emerging concern

Annemarie van Wezel & many collegues

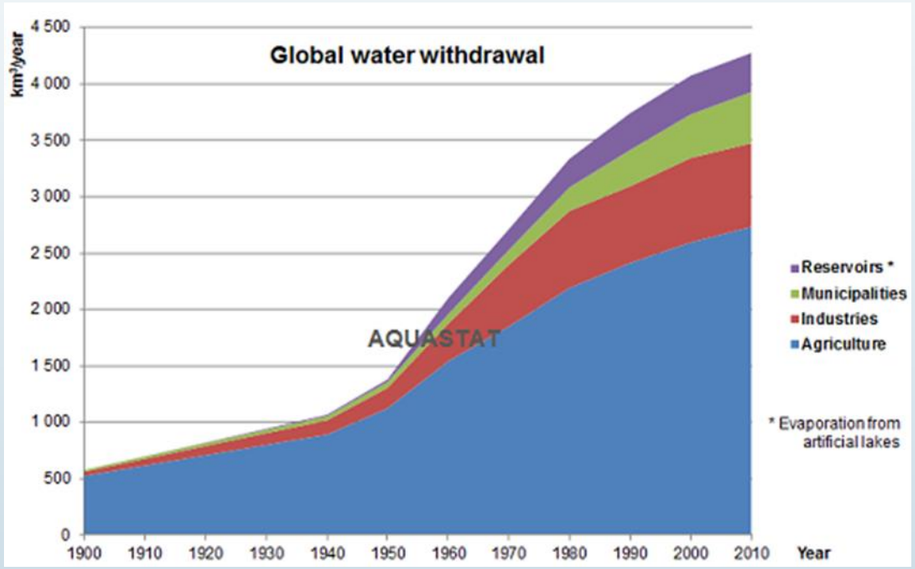
Chemicals: useful contributors to economic development

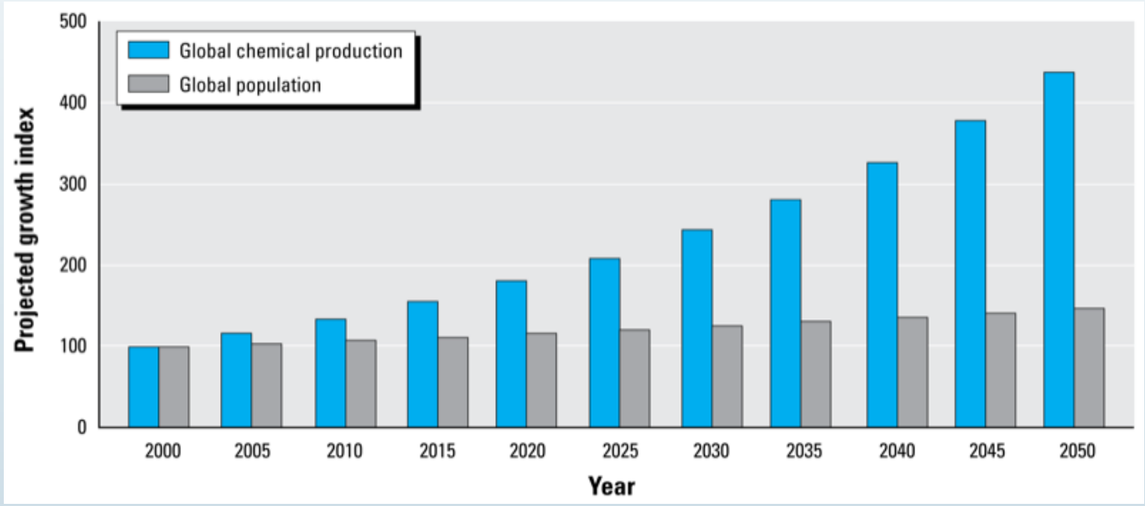
We use chemicals for beneficial purposes

Global chemical production grows faster than population

So does water withdrawal by sectors using chemicals

→ Increasing chemical stress on our water systems





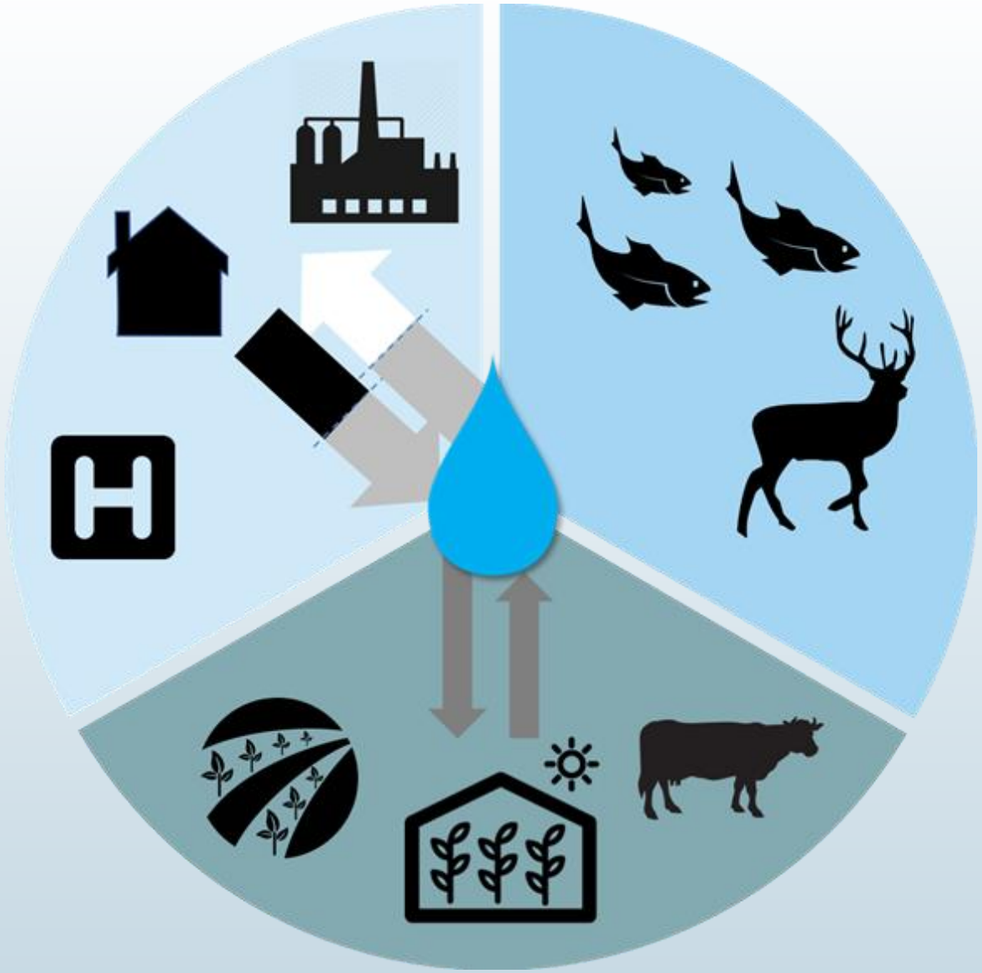
Wilson & Schwarzman 2009, FAO Aquastat

Functions of water…

Water flows…

and integrates urban and rural water withdrawals and returns

Sectors demand for sufficient water quality fit for purpose



Contaminants of emerging concern

Not commonly monitored

Indications of presence in environment

Likely toxic and persistent

Scarcity of information

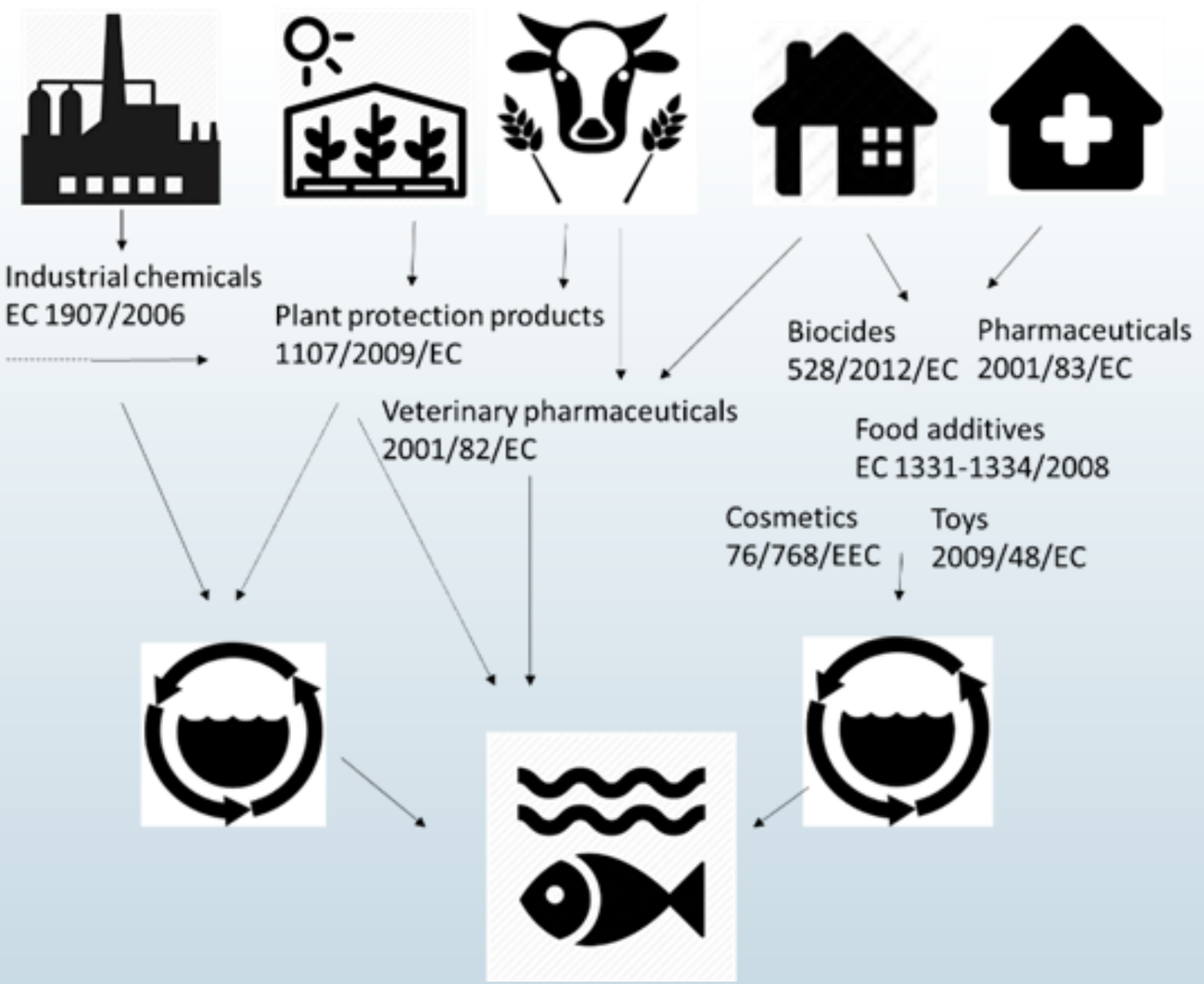
Potential to pose risks

No regulatory criteria or norms

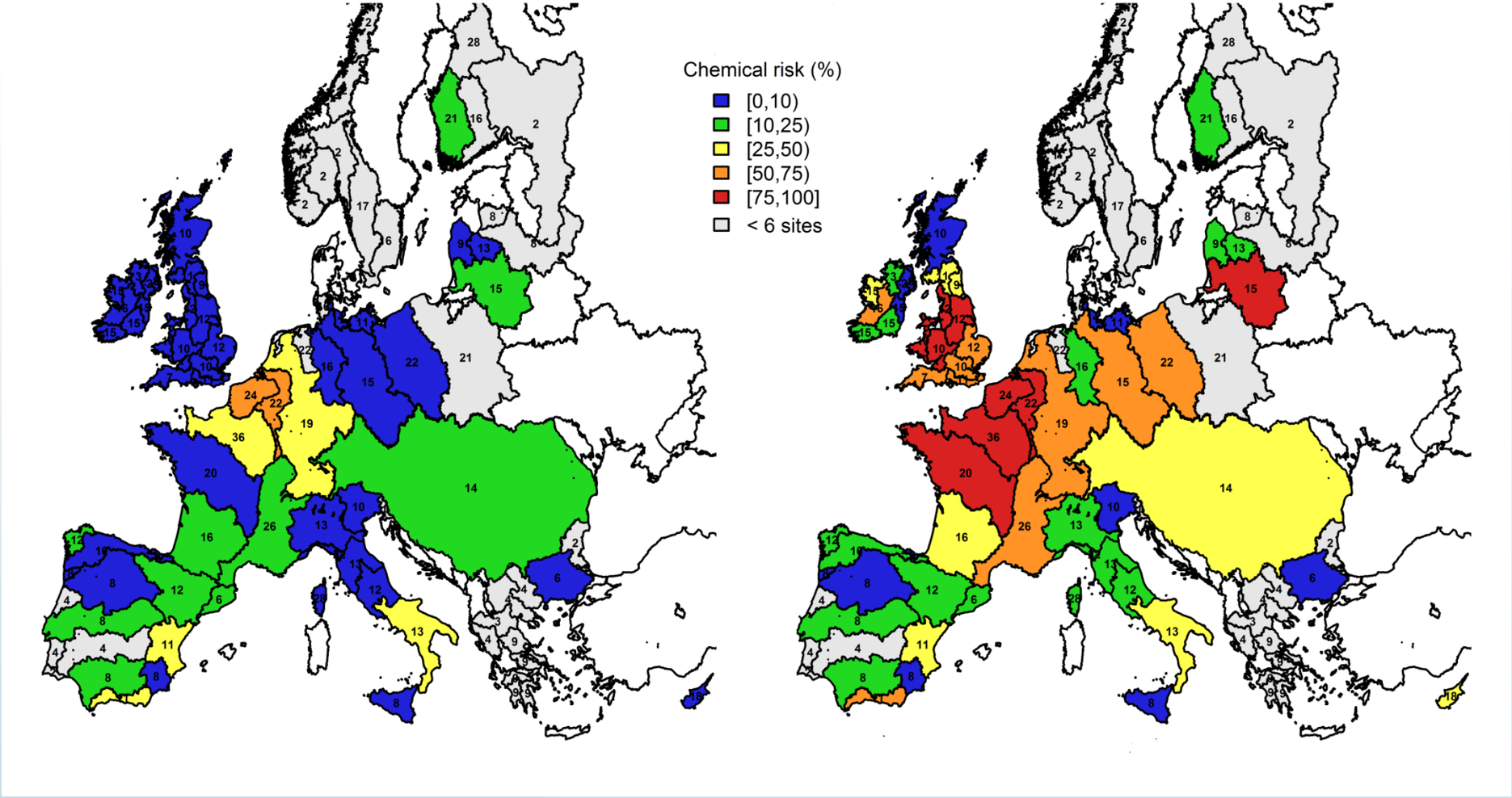
Sauve & Desoriers 2014

Pathways to the aqueous environment

Sectors & their chemical uses



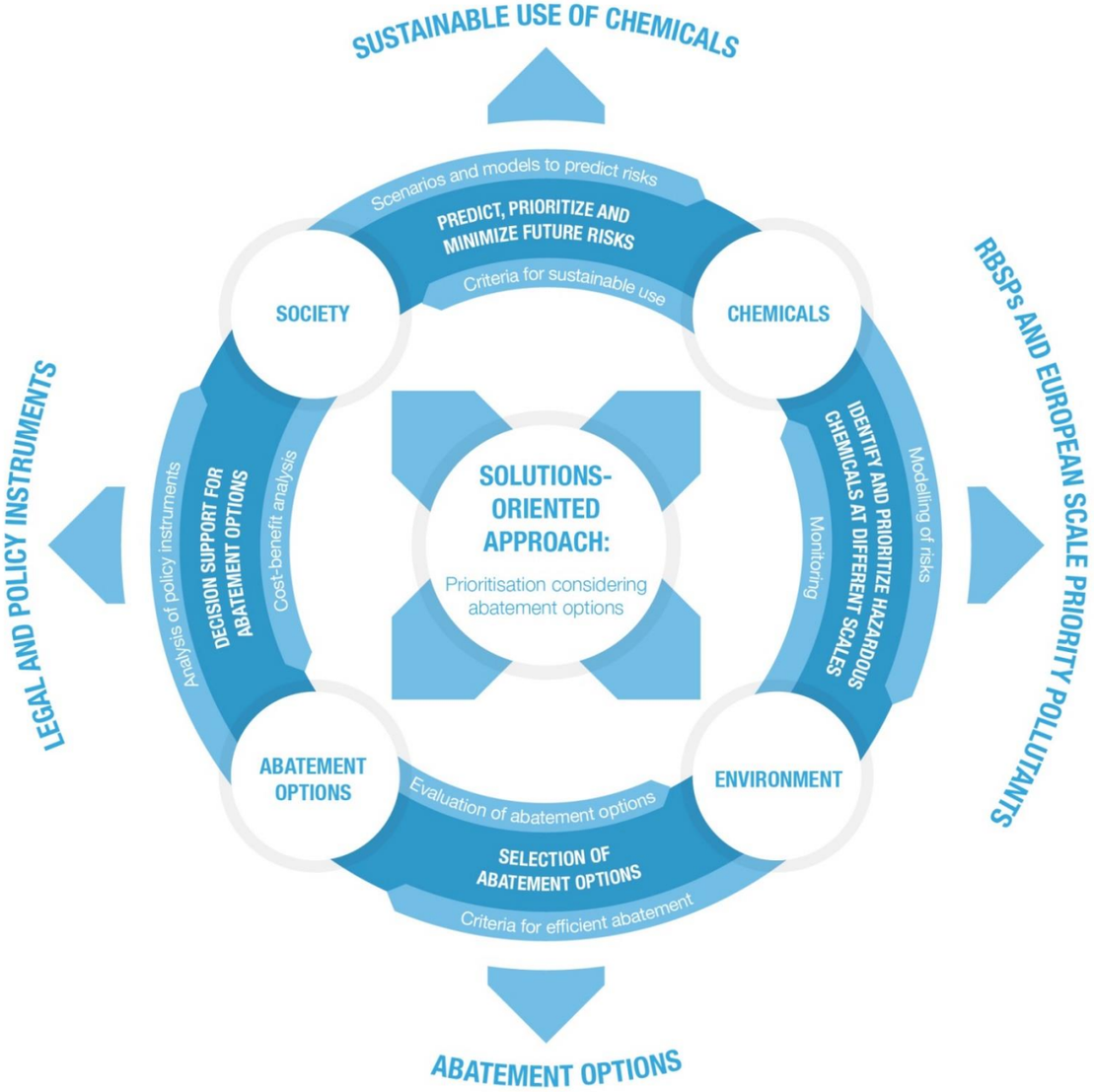
Acute and chronic risk at 14 and 42 % of the sites



Malaj et al 2014

solutions

- Conceptual framework for prioritisation, assessment and abatement of pollutants (eco and human health)
- Efficient tools for identification of substances and mixtures posing a risk (e.g. River Basin Specific Pollutants):
  - effect-based and analytical tools for early detection and identification
  - integrated models and databases for risk modelling exploiting data from chemical authorisation (e.g. REACH) and monitoring
- Demonstration in trans-European case studies (Danube, Rhine, Iberian Peninsula)

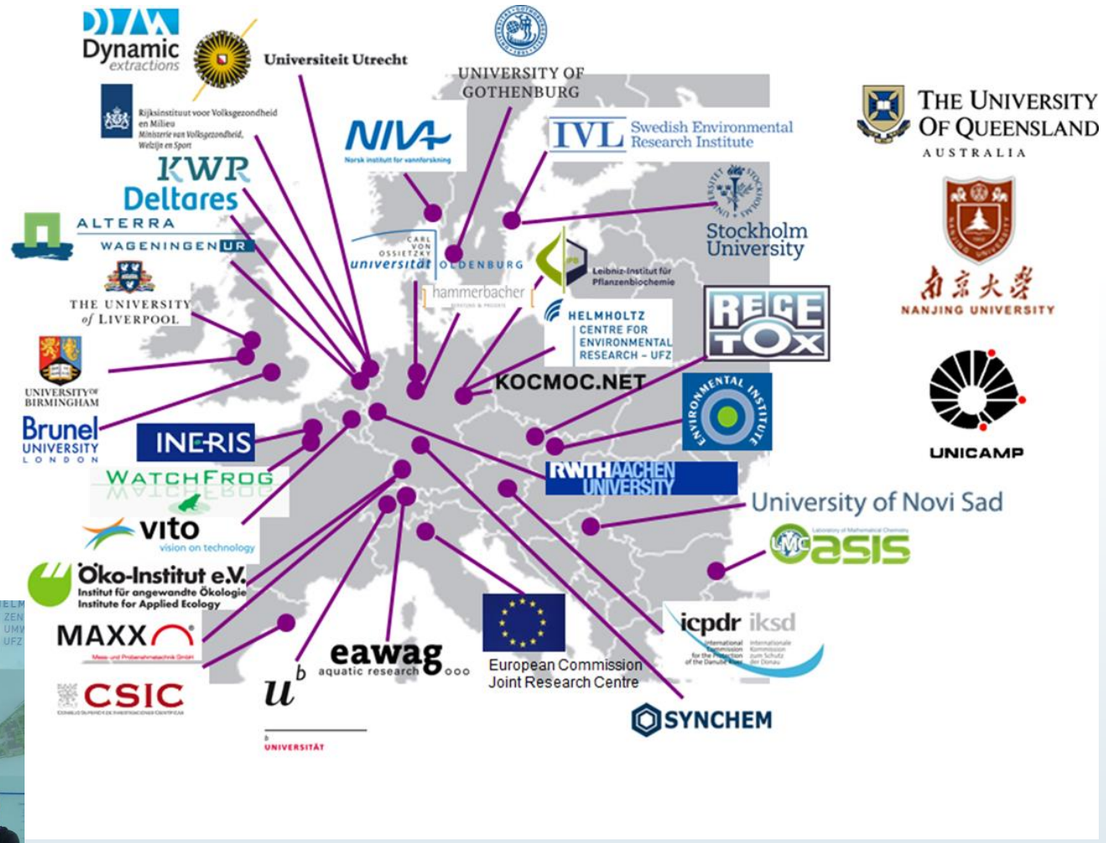


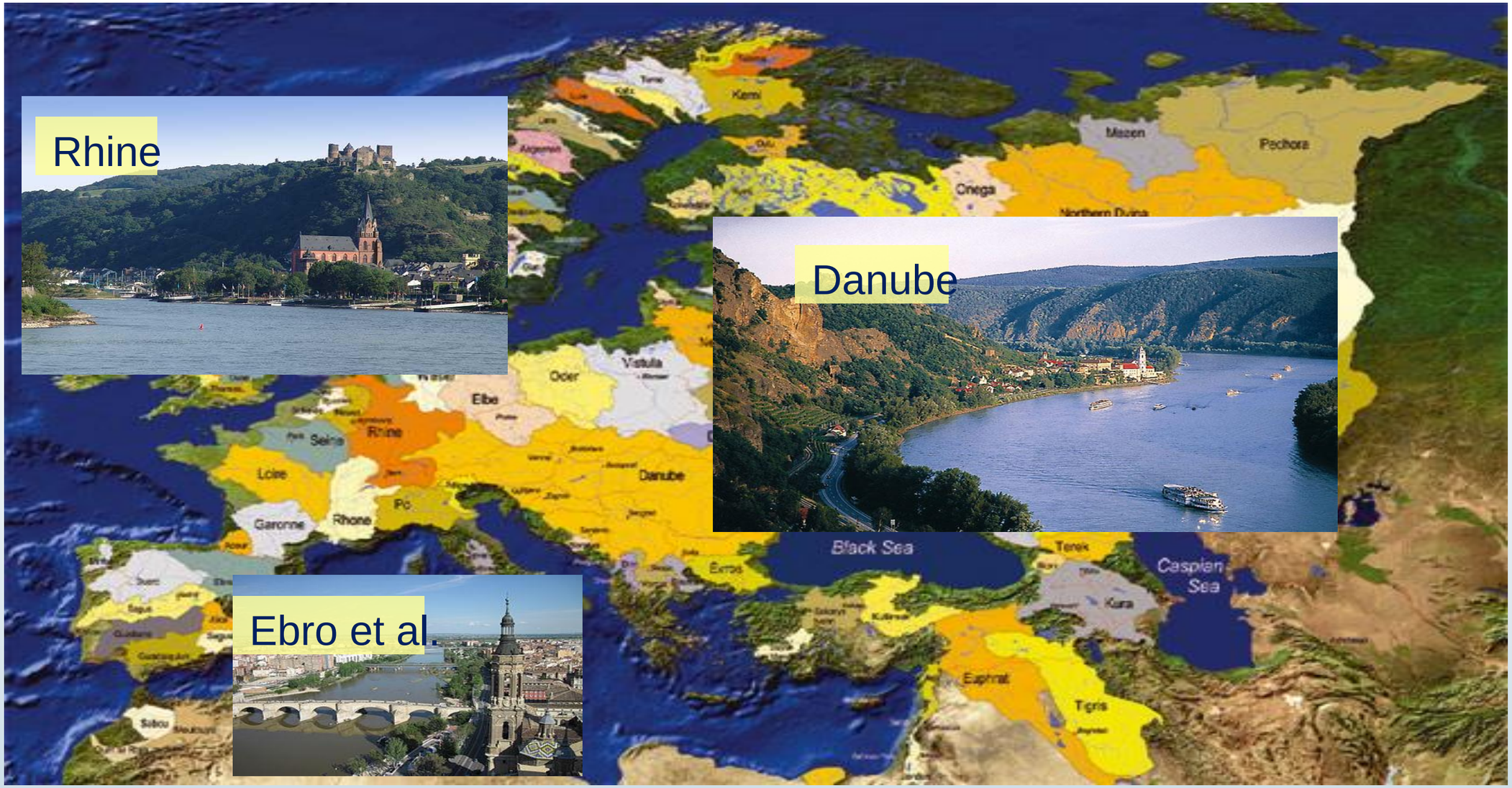
39 partners

12 mio Euro

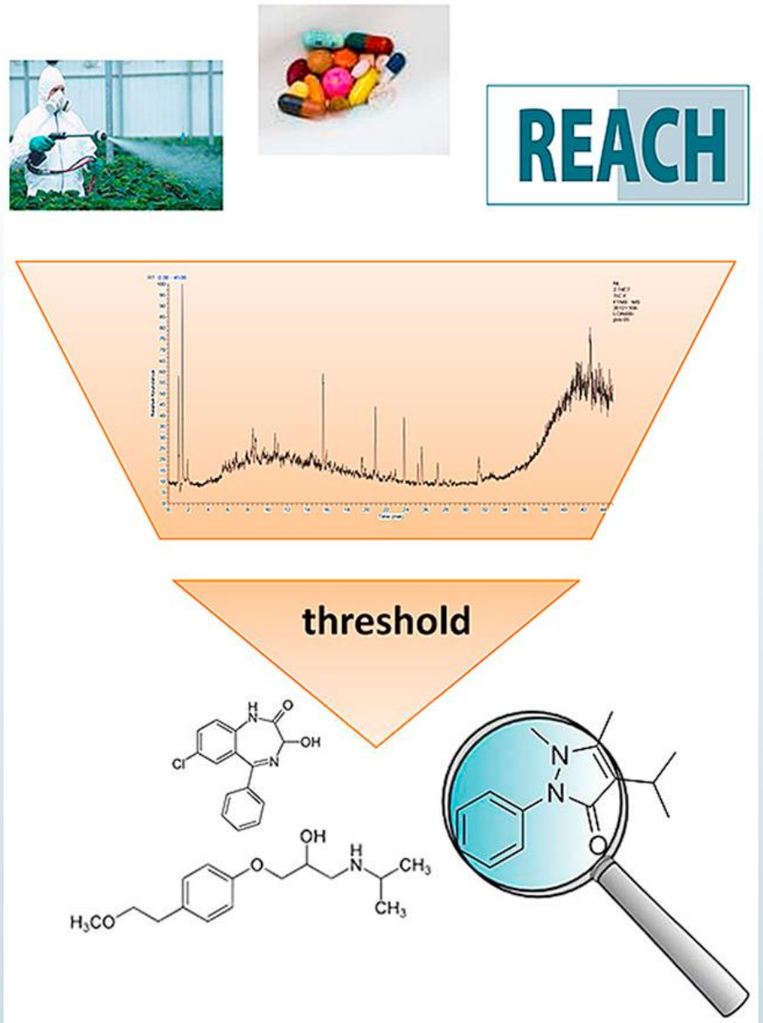
1/10/2013 – 1/10/2018

UFZ coordinates




Rhine
Danube
Ebro et al.
Mezen
Pechora
Onega
Kemi
Vistula
Oder
Elbe
Seine
Rhine
Loire
Danube
Po
Garonne
Rhone
Black Sea
Tenek
Caspian Sea
Kura
Euphrat
Tigris

All these chemicals…→suspect screening and prioritization



Composition of suspect list.

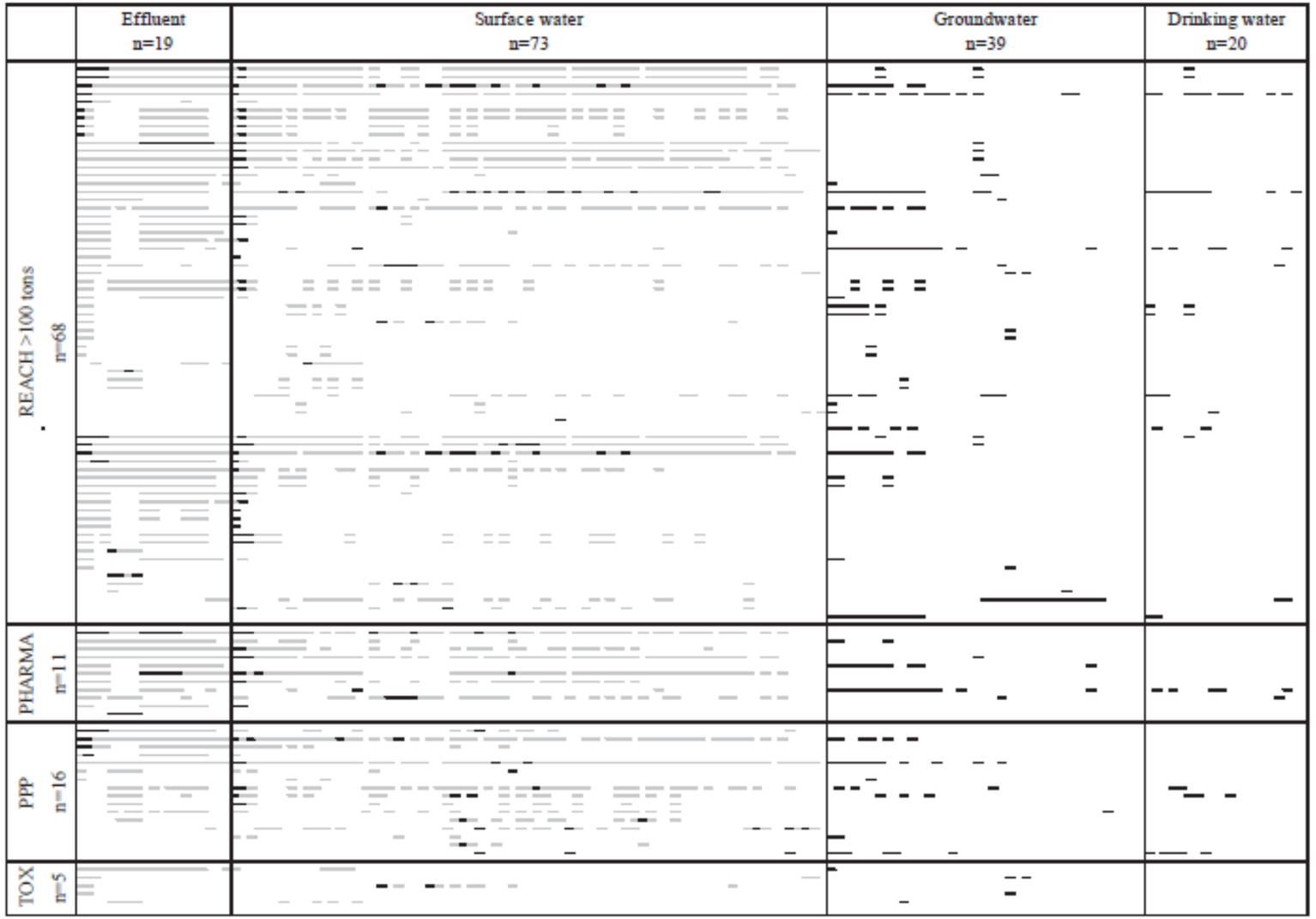
Suspects	Number of chemicals
Authorized chemicals	
REACH Registration list >1000 tons	2198
REACH Registration list 100−1000 tons	1922
REACH SVHC	68
CMR	181
Pesticides/Biocides	364
Human and veterinary pharmaceuticals	211
Chemicals in EU water quality regulation	
Drinking water directive	15
Priority substances directive	37
Potentially relevant chemicals	
Drinking water relevant chemicals IAWR/RIWA	81
Ecosystem relevant chemicals NORMAN	623

Sjerps et al 2016

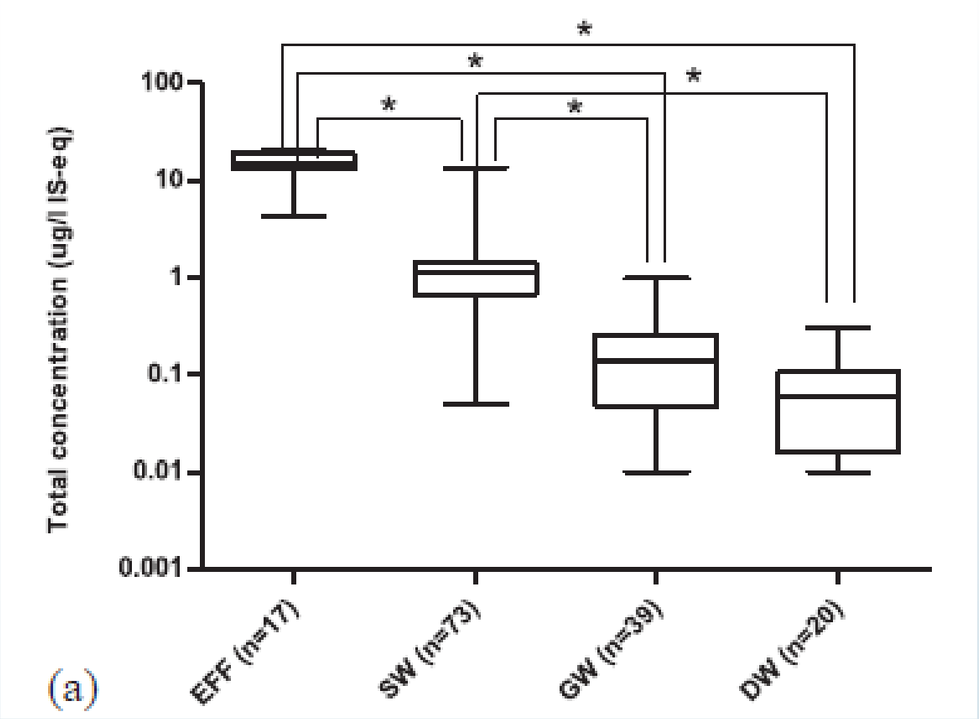
Fingerprinting water samples

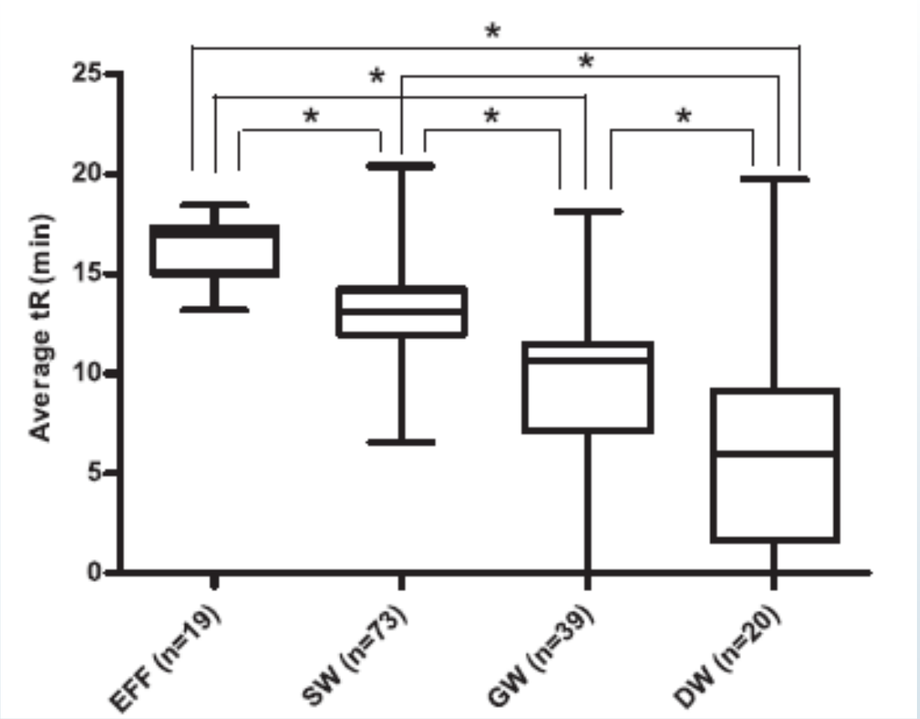
Water type	Combined modes	
	Masses	Suspects
Effluent >1 µg/L	29	43
Surface water >0.1 µg/L	62	86
Ground water >0.01 µg/L	47	66
Drinking water >0.01 µg/L	28	50
All > threshold	113	174

One prioritized suspects regulated,
20% mentioned on lists of potentially relevant chemicals
→ complementy to target-based methods



Concentrations decrease in watercycle, polarity increases



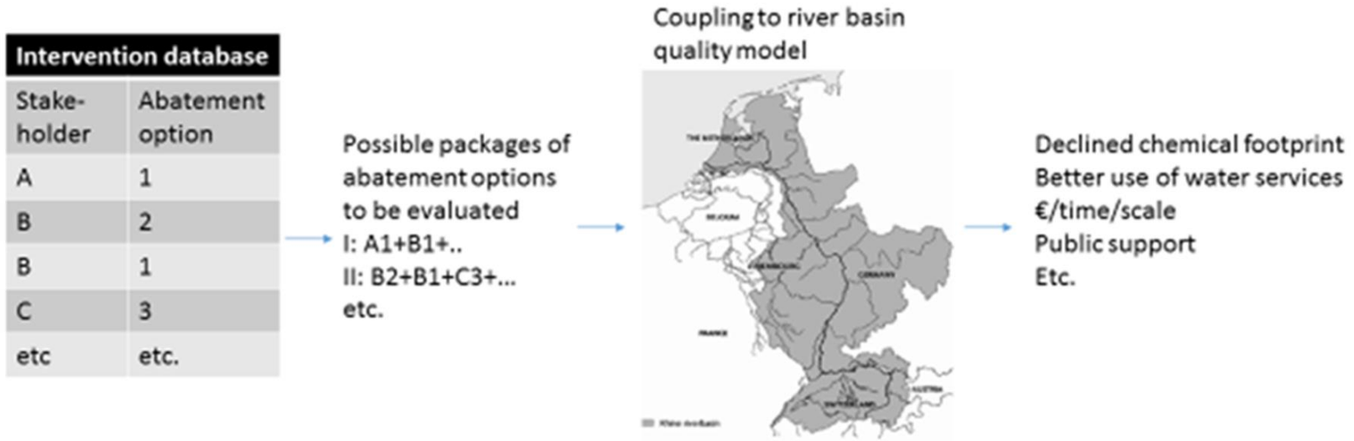


Stakeholder in the water sector more aware on their presence

→ a strong drive for measures to reduce exposures and effects.

Solutions-focused risk assessment

- Insight in the effects of sets of abatement options throughout the chemical's life cycle, in various sectors and at various places in the water system
- Environmental improvement expressed as decreased concentrations, improved ecological quality or water system services.



Improvement of water quality

a) decreased concentrations
b) diminished adverse effects on environmental and human health
c) better possibilities to obtain water system services

Zijp et al 2014

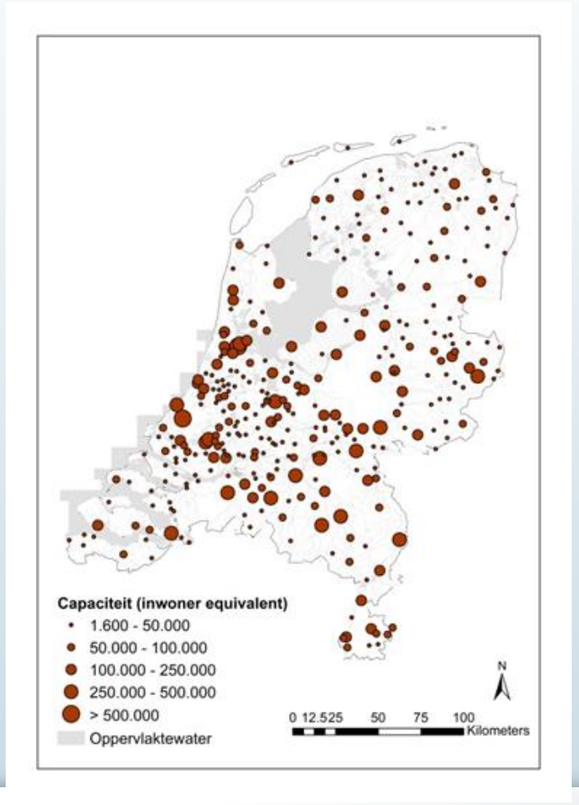
Where to place interventions?

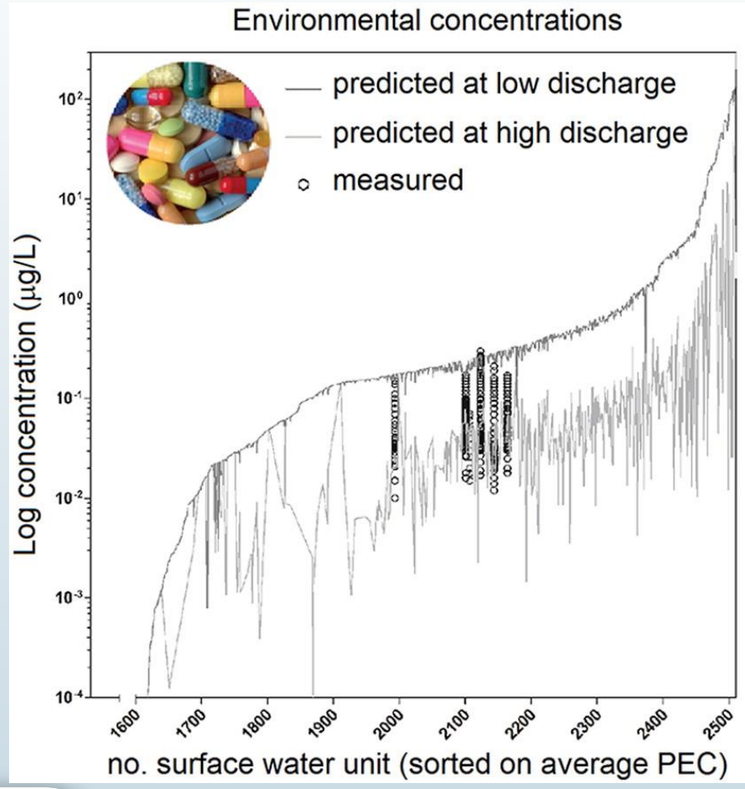
Dutch surface water bodies modelled for 345 STPs and 9 rivers

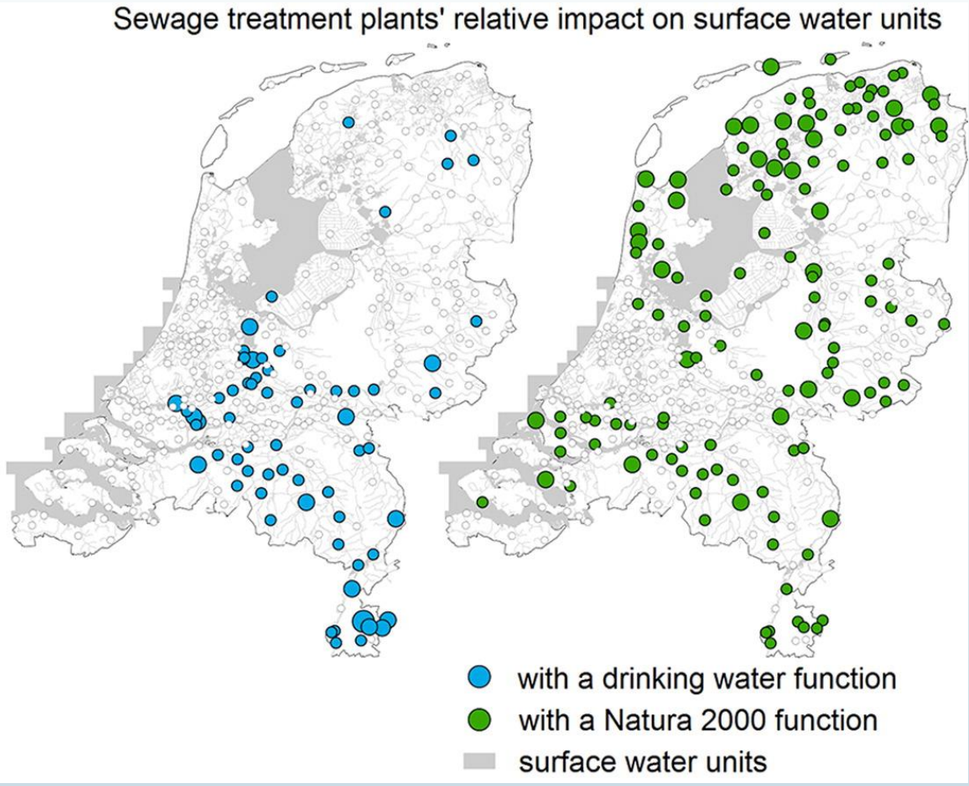
Two pharmaceuticals, two extreme climate conditions

Half of source water used for drinking water production influenced by STPs

→ **Fraction of STPs causes majority of impact**





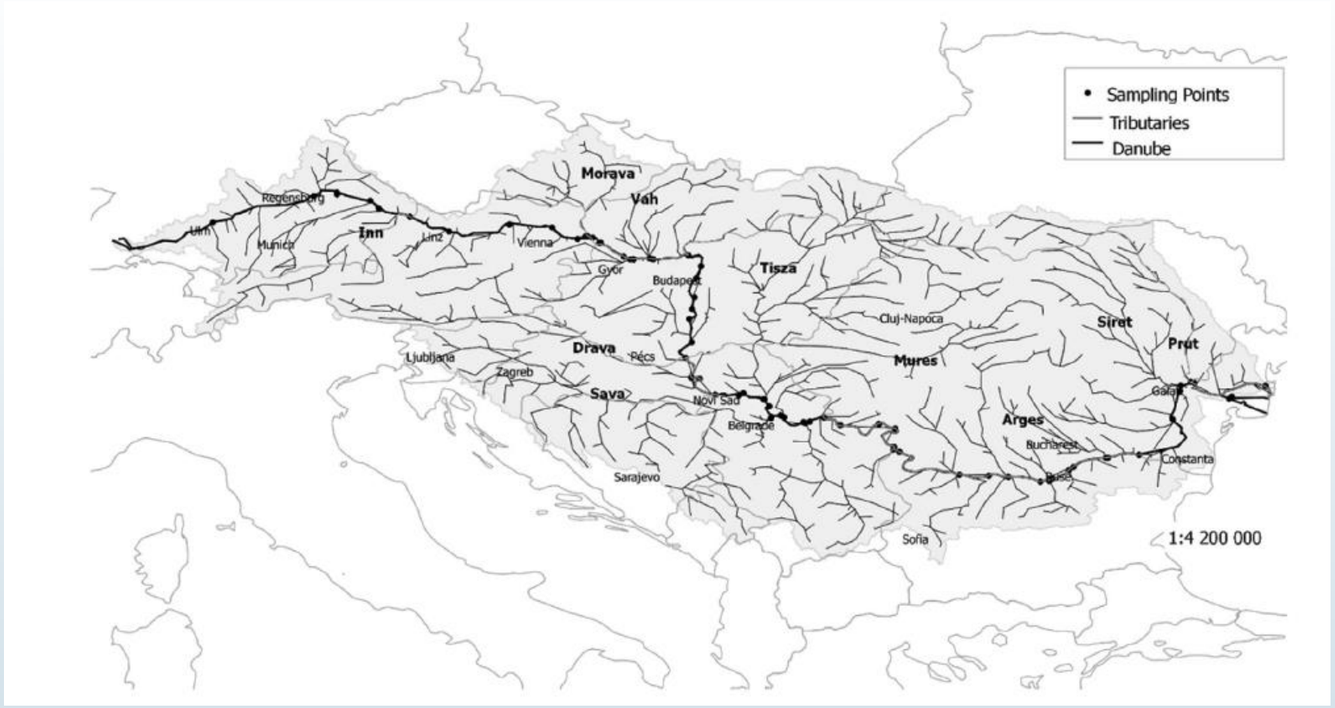


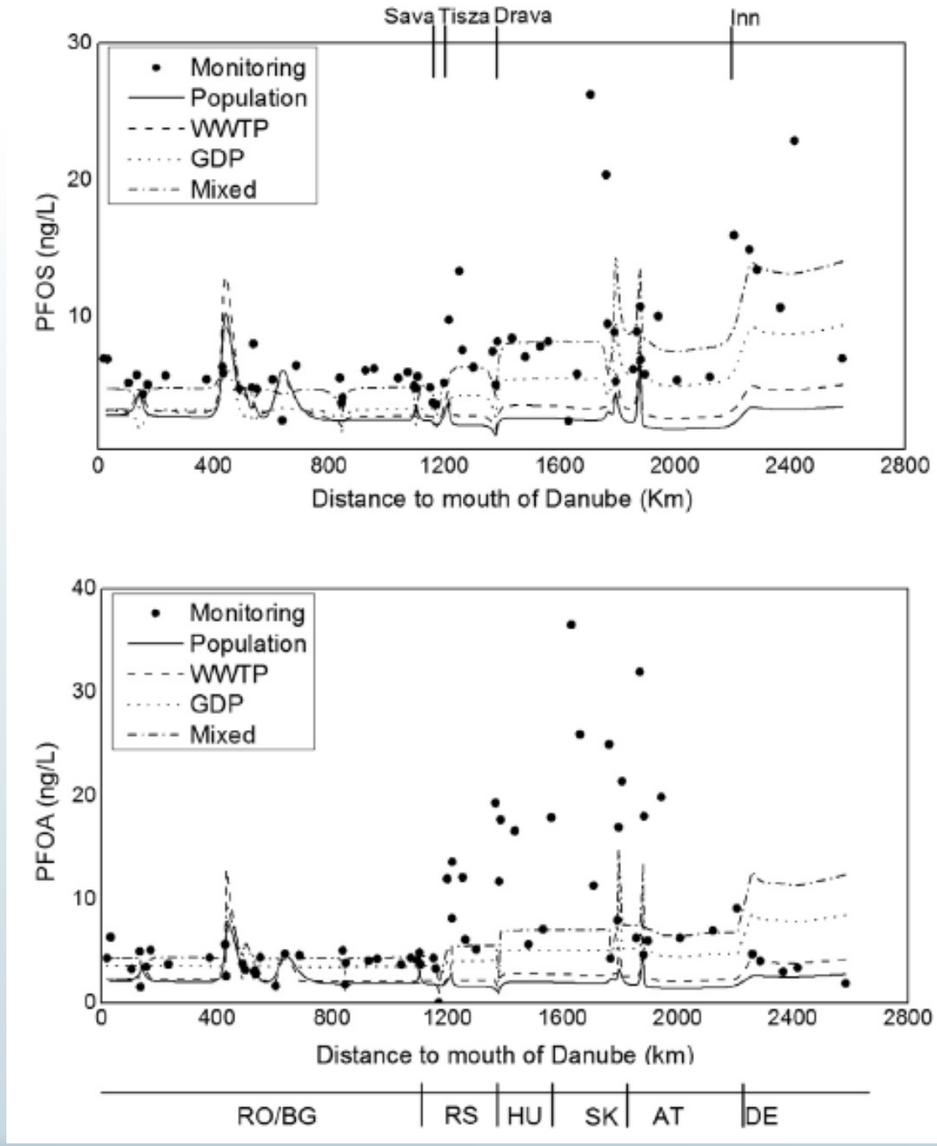
Coppens et al 2015

To be continued at larger scale

STREAM-EU; Spatially and Temporally Resolved Exposure Assessment Model

for European basins

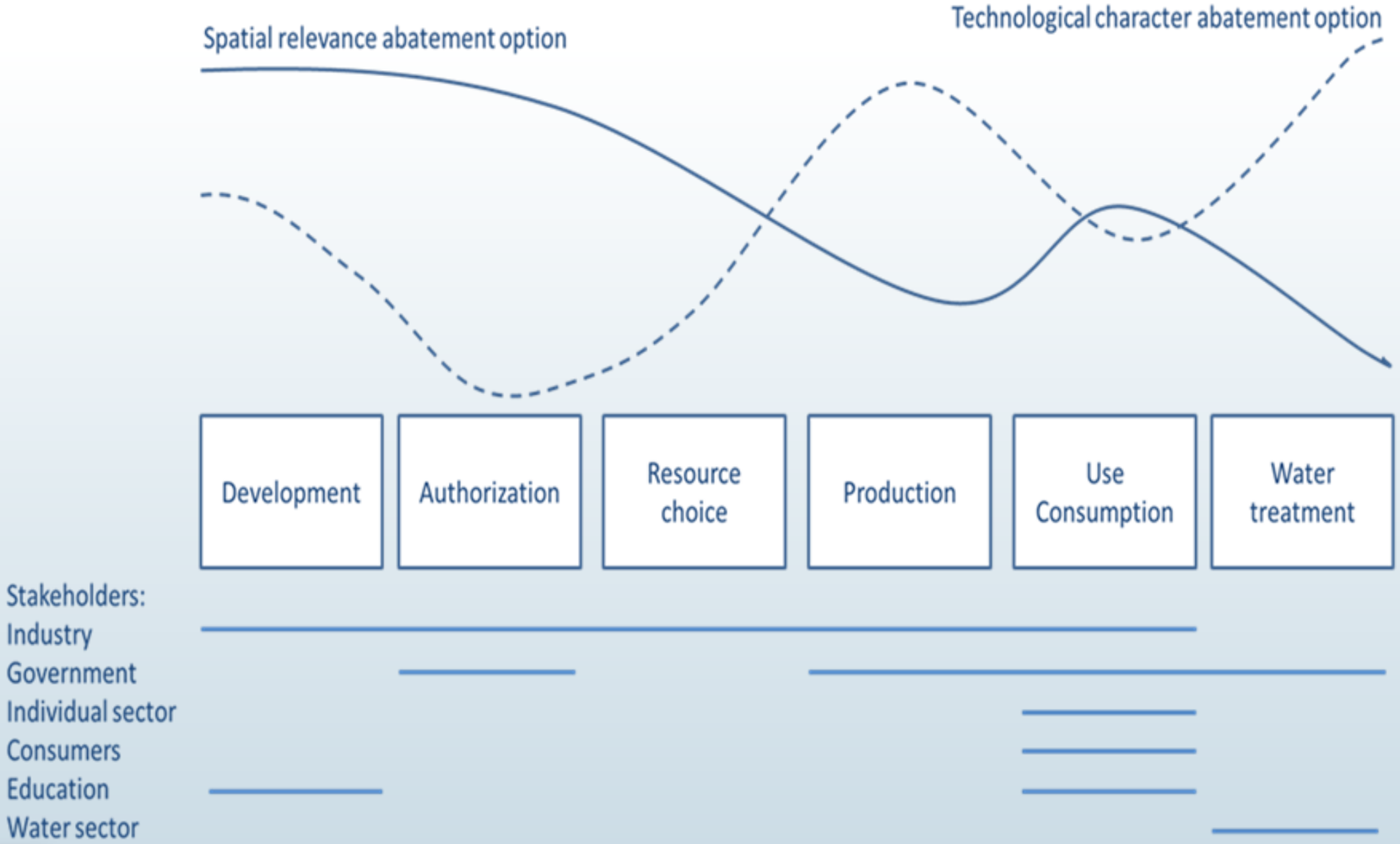




Lindim et al 2015

Efficient abatement combines options in various stages of life cycle, using both preventive and curative options

- Early in the life cycle, non-technological options relevant on large scales
- Technological options differentiated to specific uses later in the life cycle, relevant at regional scale
- Sectors involved could benefit by cross-sectoral learning
- → Intervention database



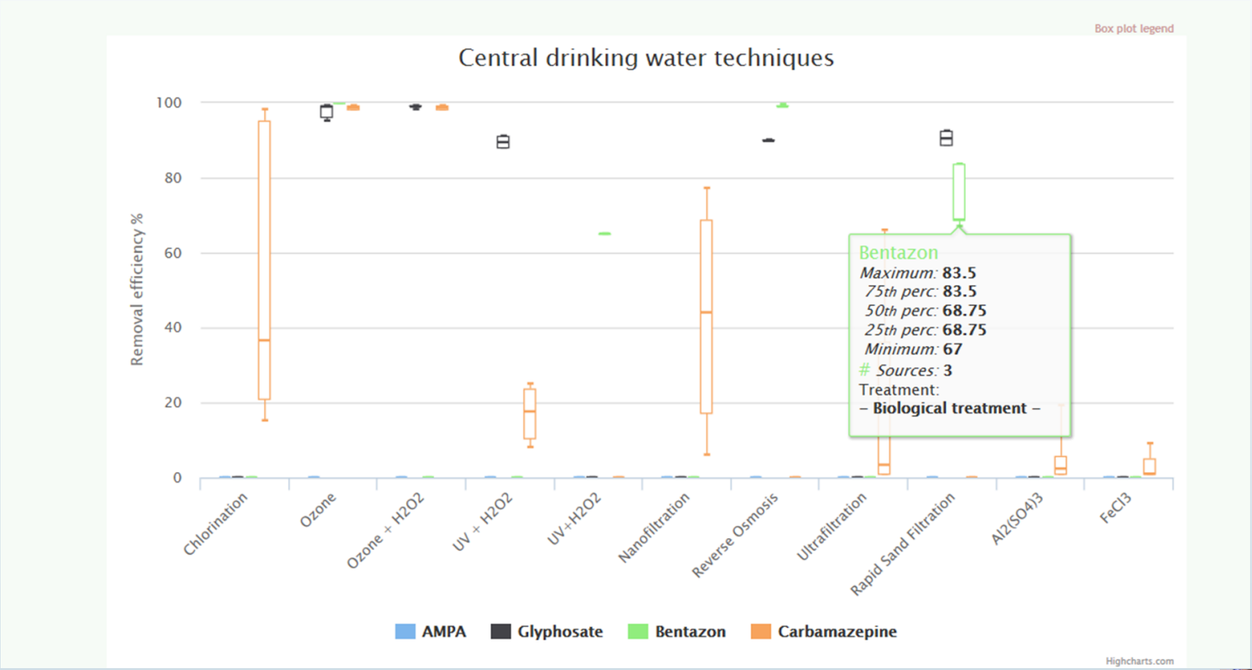
Database with removal efficiencies

Including 91 emerging substances, mainly drinking water treatment techniques

Activated carbon, oxidation, membranes, conventional WWTP;

Ranges of efficiency of techniques used full scale, related to substance characteristics, water matrix or process conditions

Sorption	GAC	10 to >95%	High removal for hydrophobic chemicals
Biodegradation	Sand filtration	<20 to >90%	Higher removal for biodegradable chemicals, e.g. negatively charged and hydrophobic
Oxidation	UV (+H2O2), ozone	5 to >99%	Higher removal for reactive chemicals
Size exclusion	NF, RO membrane	generally >85%	Lower removal for small hydrophilic compounds, or fouled membranes.



Fisher et al in prep

RBF sites (so far) considered

- Worst-case simplified analytical approach gives first indication for which substances and where attenuation capacity during RBF may be insufficient
- Biggest challenge remains uncertainty regarding field scale degradation rate constants, which often show strong deviations between experiments/sites
- Hardly any well data at this stage available to verify outcome
- To be continued for more sites…

Site information used:

- Concentrations in river
- RBF share
- Subsurface residence times
- Hydochemical conditions

IDPS - Integrated Data Portal for SOLUTIONS

Project info ▶
IDPS info ▶
IDPS contacts ▶
Participant databases ▶

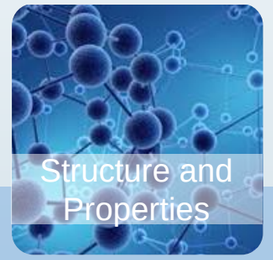
Search for chemical

by CAS

by name

by INChIKey

Select for module



Open the selected link

Information on the link

Links

RiBaTox

IPCheM

IDPS – Emission and Abatement

SOLUTIONS & JPI

Search for: Diclofenac

- [x] Emission
- [ ] Use
- [ ] Abatement
- [ ] SE indicators

Freeze the selected area (click and color change) to recall the same selection in the other modules or in a new chemical search

Go to the results page

Contact details of the dataset

Visualise the metadata

Select databases

solutions-focused perspective

- Research on chemical water quality is focused mainly on problem and risk analysis.
- Prioritization of mitigation options, throughout the chemical's life cycle, in various sectors and at various places in the water system, might trigger effective and innovative approaches.
- Solution-focused assessments connect the perspectives of the water cycle and the chemical life cycle, and can be supported by a mitigation database.
- Studies on mitigation allow a common perspective, coherent implementation of cost-effective mitigation options, and stimulate cross-sectoral learning.