

Assessing the potential impact of complex mixtures on water quality and aquatic ecosystems - What can we learn from SOLUTIONS?

Werner Brack and more than 100 scientists from 39 institutions

# Towards a non-toxic environment strategy



Living well, within the limits of our planet

7th Environment Action Programme



 The European Parliament and the Council shall adopt specific measures against pollution of water by individual pollutants or groups of pollutants presenting a significant risk to or via the aquatic environment, including such risks to waters used for the abstraction of drinking water. For those

#### Water Framework Directive



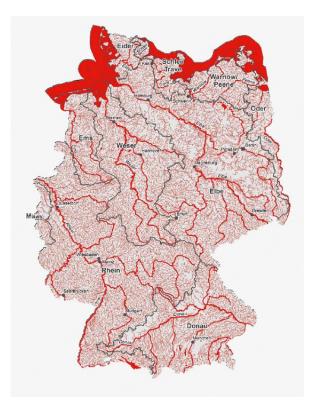
# Towards a non-toxic environment strategy

#### Chemical Status based on 45 Priority Substances

#### not appropriate

- ignores most of the chemicals
- ignores mixtures
- gives incentives for "bad" substitutions
- not solution-oriented, no differentiation

**Chemical Status Germany** 

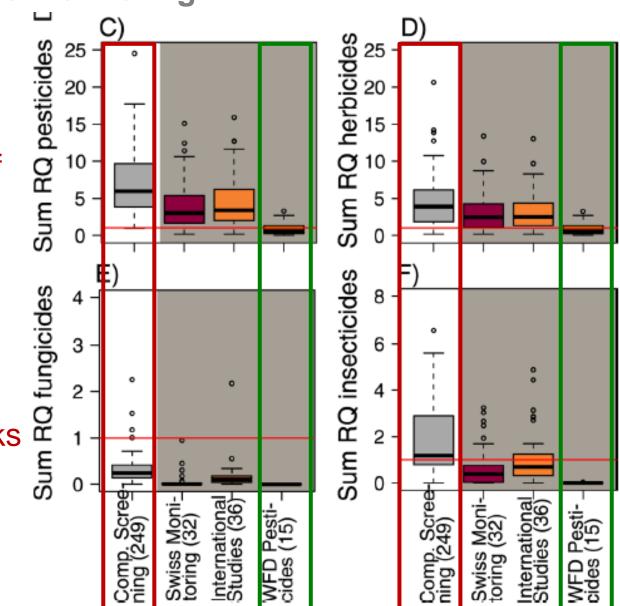




#### Example: Pesticide monitoring in Switzerland <sup>L</sup> C)

Strong underestimation of risks based on WFD PS only

PS-based abatement is **no solution** to reduce toxic risks



#### **Risk drivers for BQEs: Multi-Target Screening and TU evaluation**

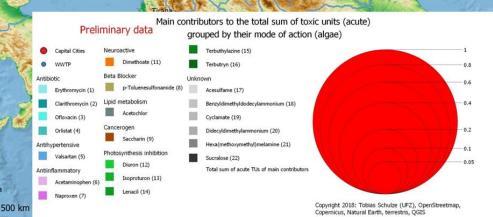
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## Chemical screening: hundreds of chemicals in one run

- risks and
- prioritisation of mixtures
- candidate toxicity drivers

# **Example:** Screening of WWTP effluents in the Danube basin



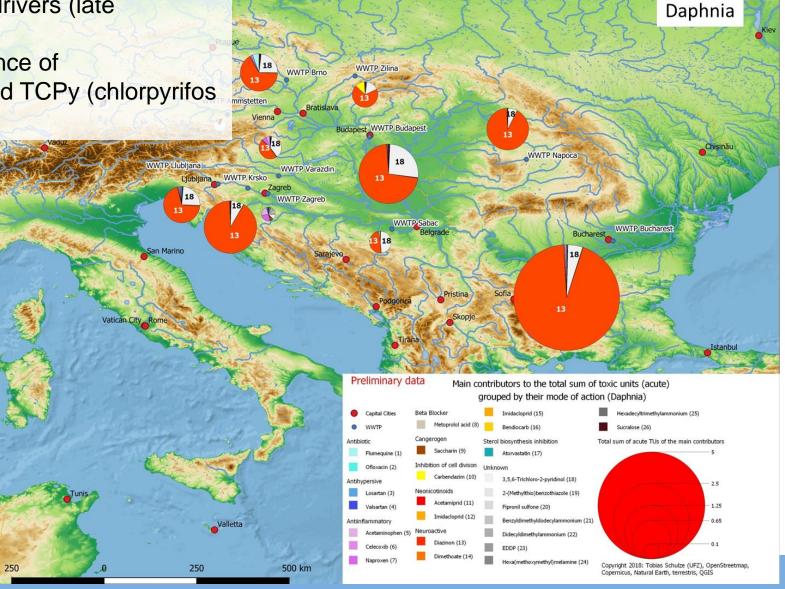


#### **Risk drivers for BQEs: Multi-Target Screening and TU evaluation**

TU-based drivers (late summer): Warsaw Algae pharmaceuticals and herbicides 22/ 6 16 Prague 2 22 WWTP Zilina WWTP Brno 12 WWTP Augsburg 16 WWTP Ammstetten 14 Budapest WWTP Budapest 12 Vaduz Bern WWTP Krsko WWTP Napoca WWTP Llubljana WWTP Varazdin Zagreb WWTP Zagreb 3 20 elgrade WWTP Sabac Bucharest WWTP Bucharest 18 6 Sarajevo 20 Monaco 6 12 Pristina Sofia Vatican City Main contributors to the total sum of toxic units (acute) Preliminary data grouped by their mode of action (algae) Neuroactive Terbuthylazine (15) Capital Cities Dimethoate (11) WWTE Terbutryn (16) 0.8 Beta Blocker Antibioti Unknown 0.6 p-Toluenesulfonamide (8) Erythromycin (1) Acesulfame (17) Lipid metabolism 0.4 Clarithromycin (2) Benzyldimethyldodecylammonium (18) Acetochlo Ofloxacin (3) Cyclamate (19) Cancerogen 0.2 Orlistat (4) Didecyldimethylammonium (20) Saccharin (9 Hexa(methoxymethyl)melamine (21) Antihypertensive 0.1 Photosynthesis inhibitio Valsartan (5) Sucralose (22) 0.05 Diuron (12) Total sum of acute TUs of main contributors Antiinflammator Isoproturon (13) Acetaminopher Valletta Lenacil (14) Naproxen (7) Copyright 2018: Tobias Schulze (UFZ), OpenStreetmap, 250 250 500 km Copernicus, Natural Earth, terrestris, QGIS

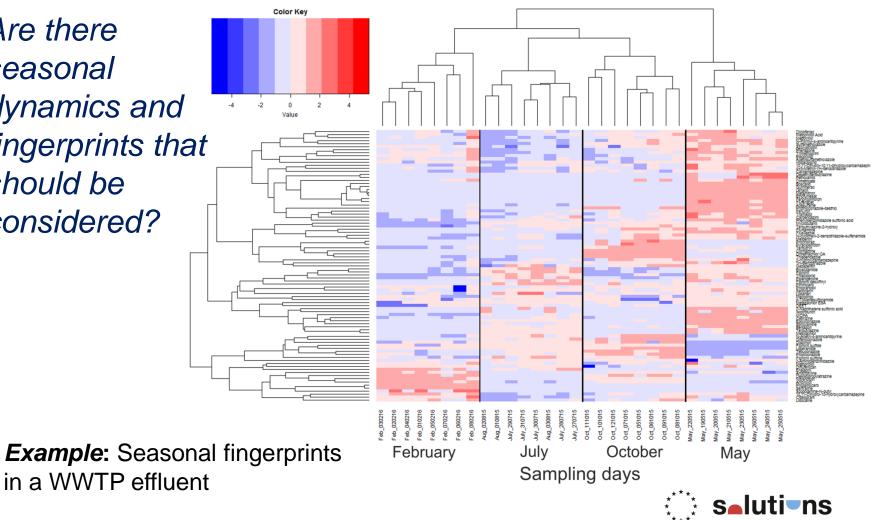
#### **Risk drivers for BQEs: Multi-Target** Screening and TU evaluation

**TU-based** drivers (late summer): Predominance of diazinon and TCPy (chlorpyrifos metabolite)



#### **Monitoring of complex contamination**

Are there seasonal dynamics and fingerprints that should be considered?

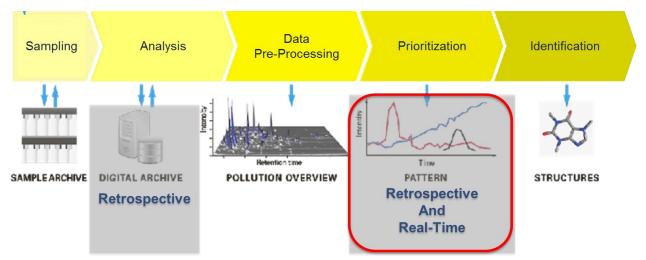


Compounds

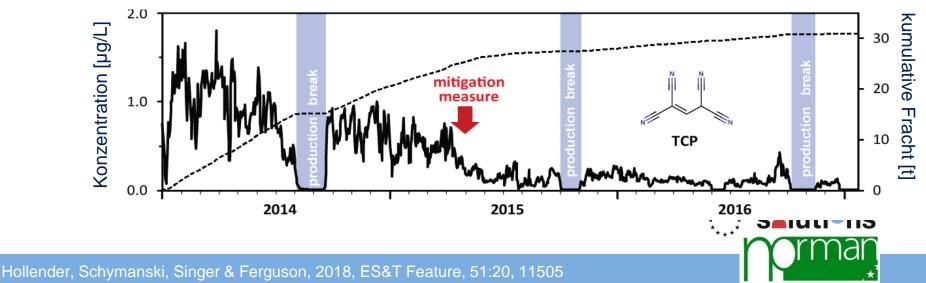
### **Chemical: Non-Target Screening**

#### Non-Target Screening

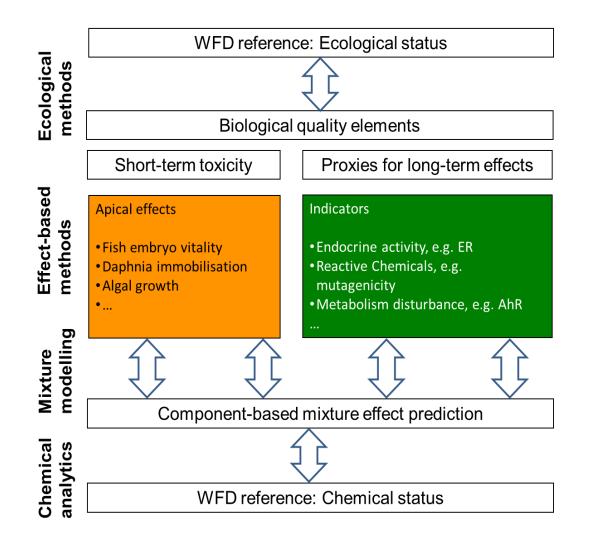
- Discovery and management of new compounds
- Ubiquitous and site-specific compounds
- Source-related patterns



#### **Example:** Tetracarbonitril-1-propene in the River Rhine



#### **Effect-based: Recommended test battery**



Effect-based monitoring:

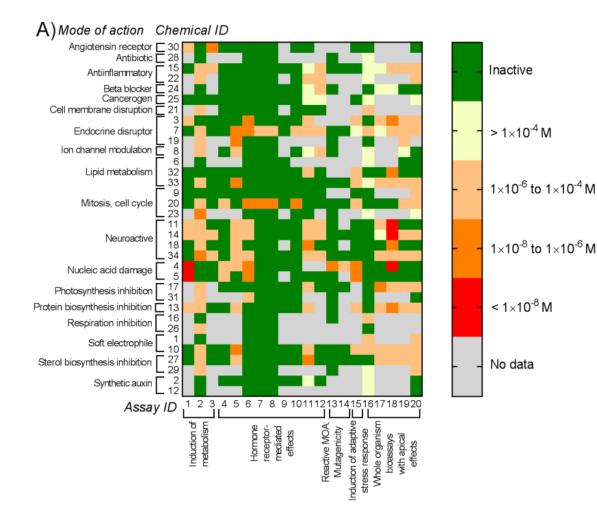
- modular
- in vitro + in vivo
- bridges chemistry and ecology
- addresses mixtures and all compounds (incl. substitutes) with similar effects





Neale et al. 2017. Water Res. 123:734

#### **Effect-based: Validated test battery**



#### Validation for

- individual compounds with different MoAs
- designed mixtures thereof
- complex environmental mixtures



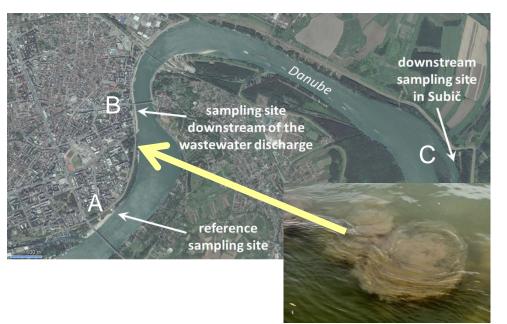
Neale et al. 2017. Water Res. 123:734

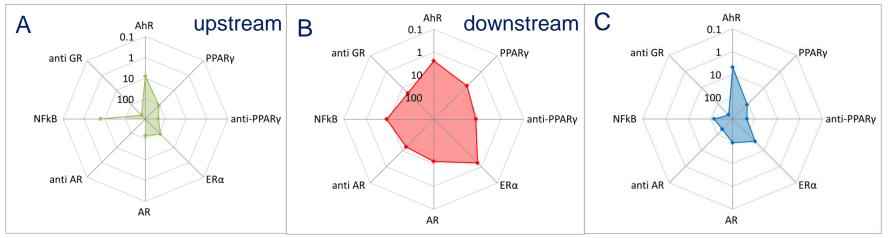
#### **Effect-based: Validated test battery**

#### Validation in case studies

Discrimination of more from less contaminated sites? Consistent effect profiles?

Example: Novi Sad/River Danube







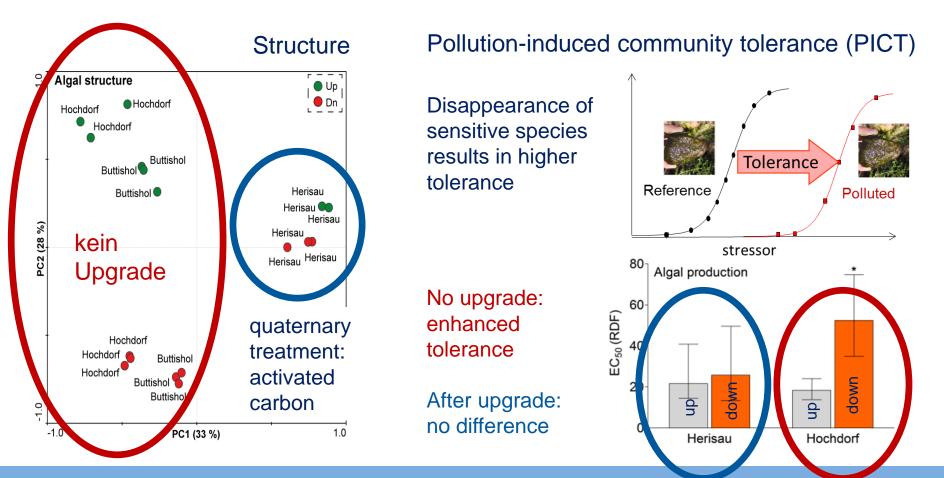


König et al., 2017. Environ. Pollut. 220:1220

#### **Ecological monitioring tools**

Success control of abatement measures

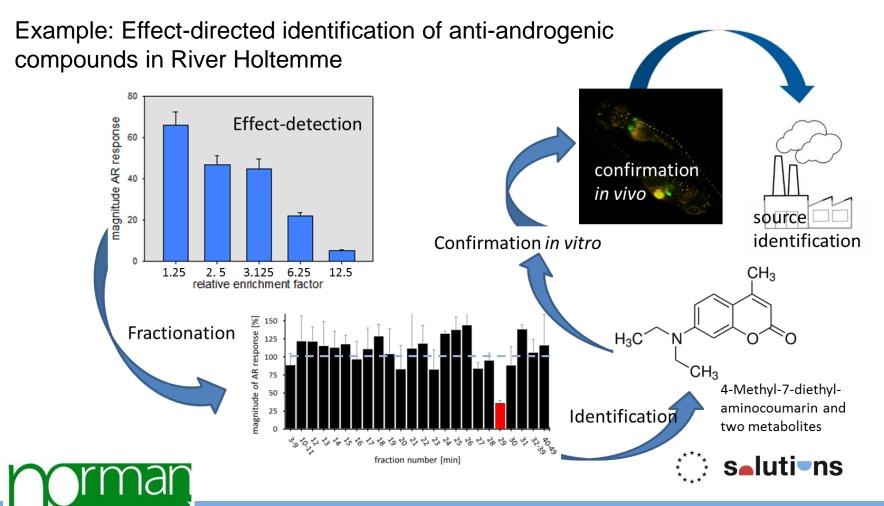
Example: Upgrade of WWTPs in Switzerland - Impact on biofilms:



#### **Integrated tools: Driver identification**

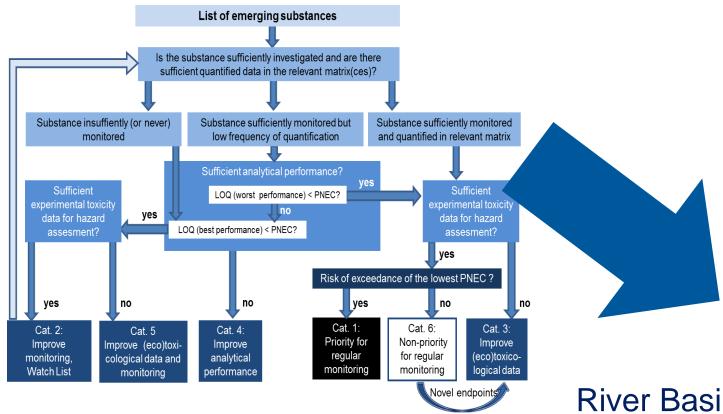
If effect-based monitoring gives an alarm: How to identify causes?

### **Effect-directed analysis (EDA)**



Muschket et al., 2018 ES&T 52:288

#### **Prioritisation for legal purposes**



#### River Basin Specific Pollutants Danube





#### **Challenge: Compound prioritisation**

concentrations

#### objectives

assessment:

TU, msPAF.

**PEC/PNEC** 

effect data

chemicals considered (available information, accessible with analytical methods etc.) distribution, MEC95, maximum median, average etc.

measured predicy

whole water vs. dissolved direct injection/ SPE/ passive sampling distribution (SSD), PEC95, minimum (per organism group)

measured

predicted

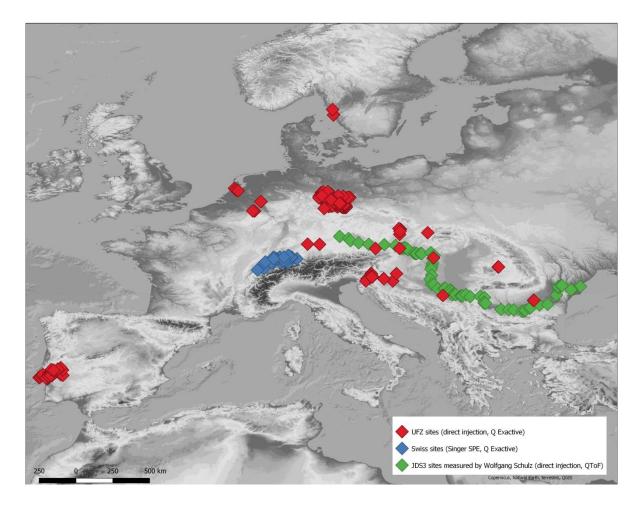
acute, chronic, specific endpoints, human toxicity, secondary poisoning

#### prioritization

salutians

# Solution: Evaluation of rich SOLUTIONS datasets recorded with harmonized/comparable method

- EDA-EMERGE
- JDS3
- Swiss dataset
- UFZ dataset Elbe catchment
- UFZ agricultural streams, event-based
- NORMAN WWTP effluents + receiving waters
- Watchlist sites







More Information: http://www.solutions-project.eu/

