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Swiss Federal Institute of Aquatic
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aquatic research

Combining chemical analysis, bioanalysis and risk assessment to prioritize risk driving substances in wastewater-impacted streams

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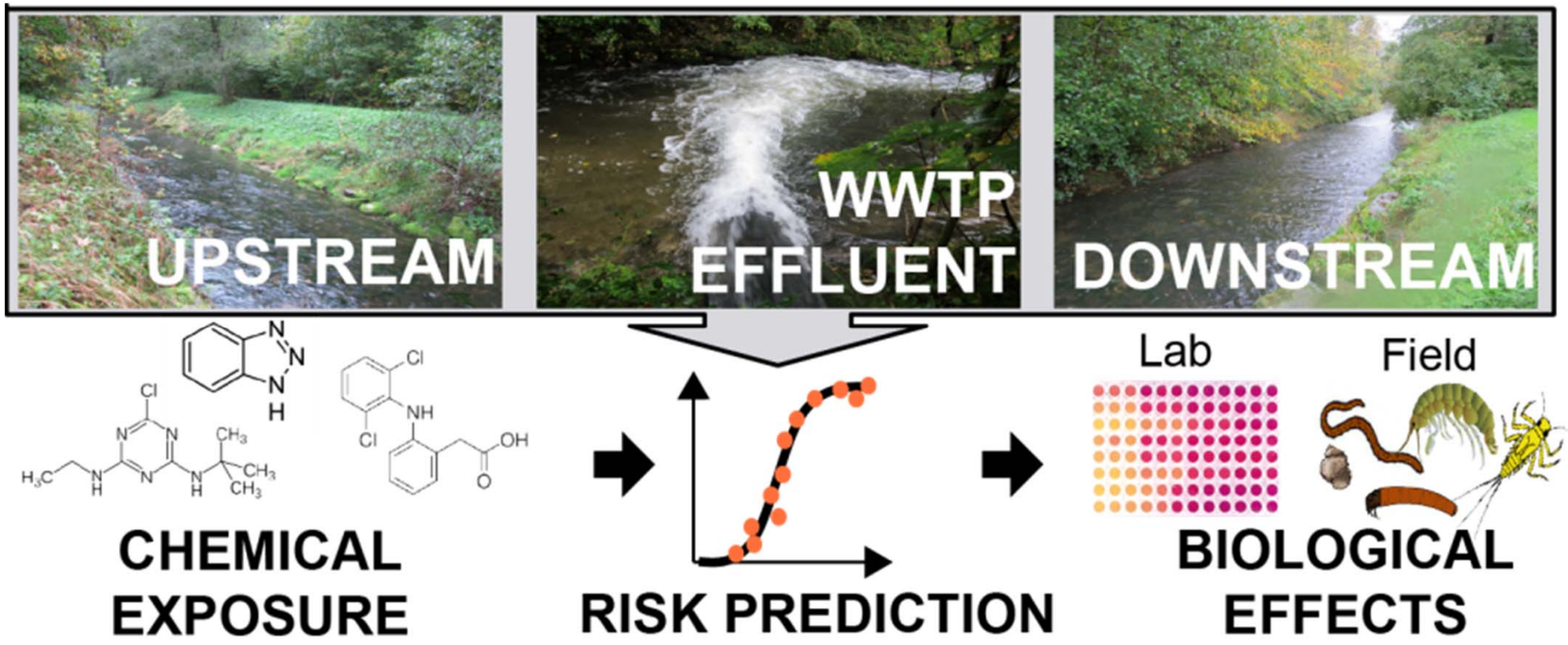
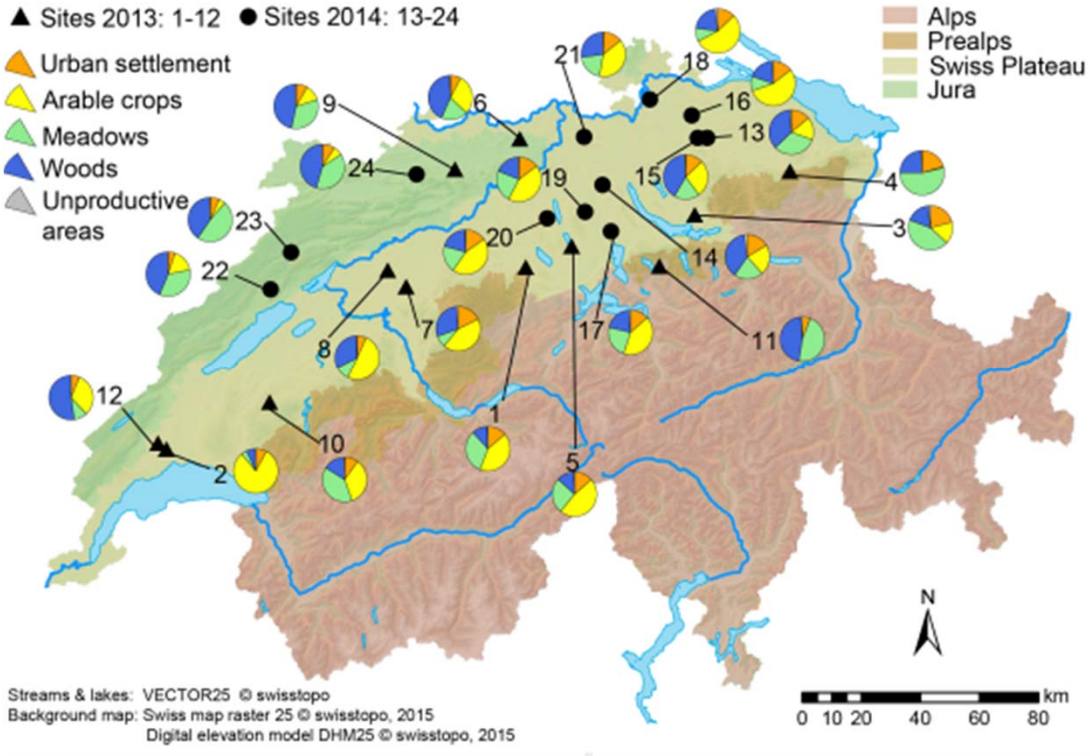
Norman Workshop
11./12.04.2017
Amsterdam

solutions

Overview


UPSTREAM
WWTP
EFFLUENT
DOWNSTREAM
Lab
Field
CHEMICAL
EXPOSURE
RISK PREDICTION
BIOLOGICAL
EFFECTS

Study design



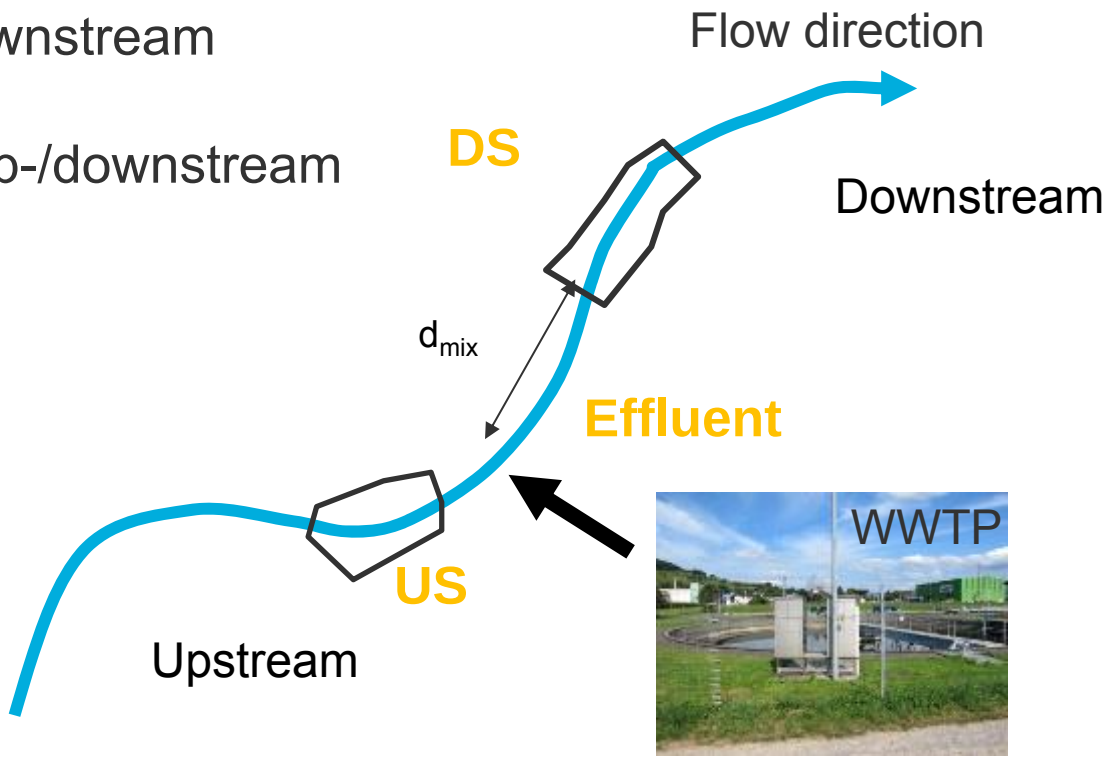
- 24 WWTP
- Grab sampling, at 8 timepoints, over all seasons
- Collection of macroinvertebrates

www.ecoimpact.ch

Study design

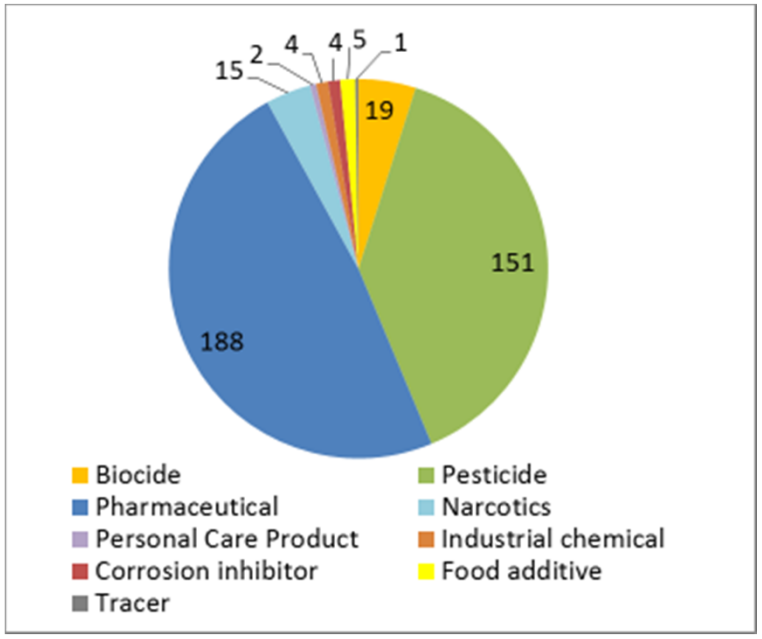
Criteria:

- o no WWTP upstream
- o >20% wastewater downstream
- o Similar morphology up-/downstream
- o Low-flow conditions



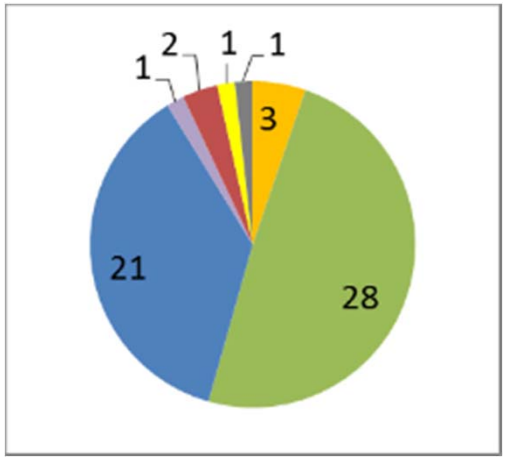
Chemical analysis

Extended target screening (n=389)



→2/3 detected (257 substances)

Selected mixture (n=57)



Selection criteria:

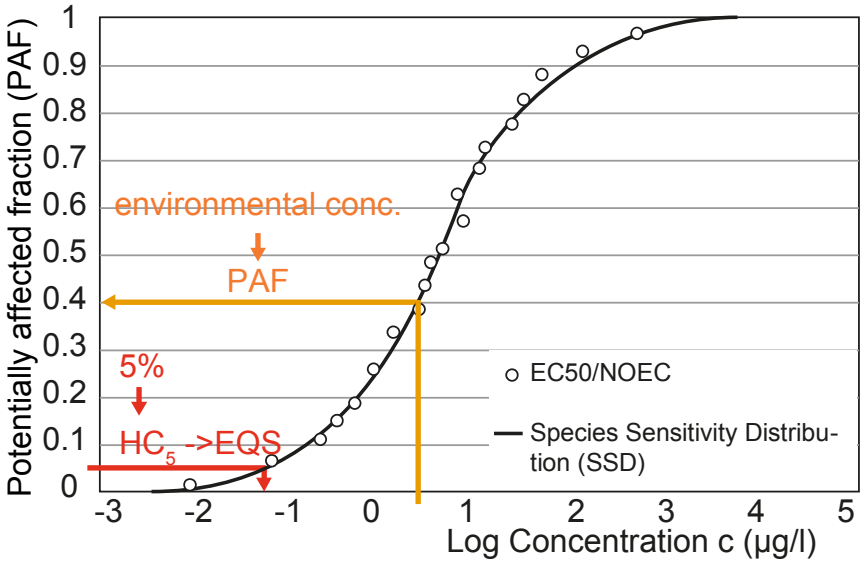
- Detection frequency
- High concentrations
- Different substance types
- Toxic substances
- Specific TMoA

TMoA: toxic mode of action

Risk assessment approach

msPAF – **m**ulti-**s**ubstance **P**otentially **A**ffected **F**raction

- Mixed-model:
  - Concentration addition
  - Response addition
- Acute data preferred:
  - More data
  - better correlation with observed effects in the field
- msPAF > 5% → effects expected

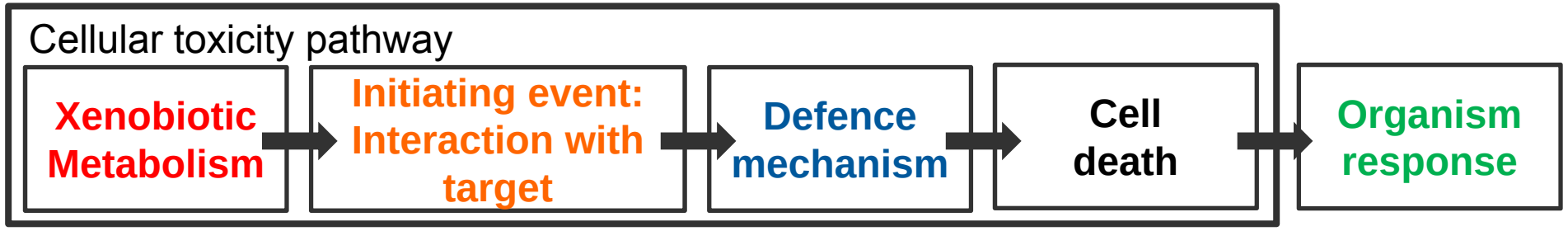


Adapted from Posthuma, Suter and Traas, 2002.

- Comparison with EQS using risk quotients (RQ)

→Comparison with effects observed in the field (SPEAR index)

Bioanalysis



- Activation of aryl hydrocarbon receptor (AhR)

Specific MOA

- Activation of estrogen receptor (ER)
- Activation of androgen receptor (AR)
- Photosynthesis inhibition (PSII)
- Acetylcholinesterase (AChE) inhibition

Reactive MOA

- Mutagenicity

Adaptive stress responses

- Oxidative stress response (Nrf2)
- Genotoxicity (p53)
- Inflammation (NF-κB)

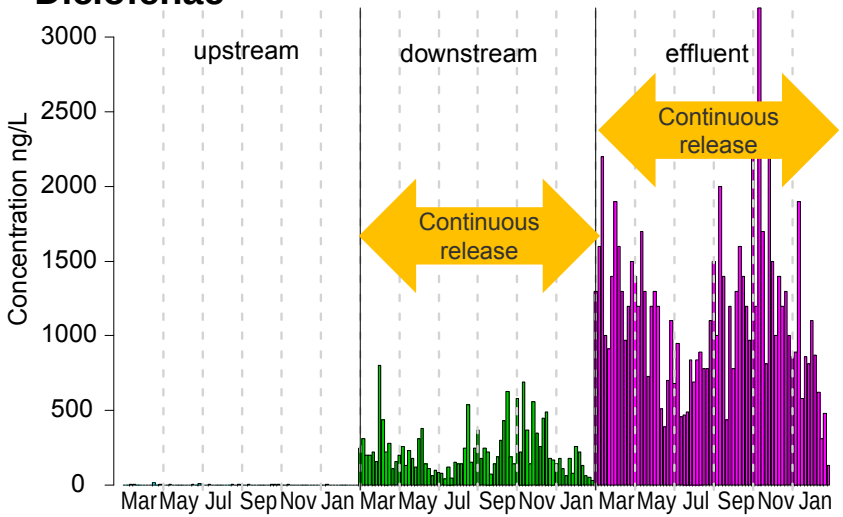
- Cell viability

- Fish embryo toxicity (FET)
- ER-regulated cyp19a1b (brain aromatase)

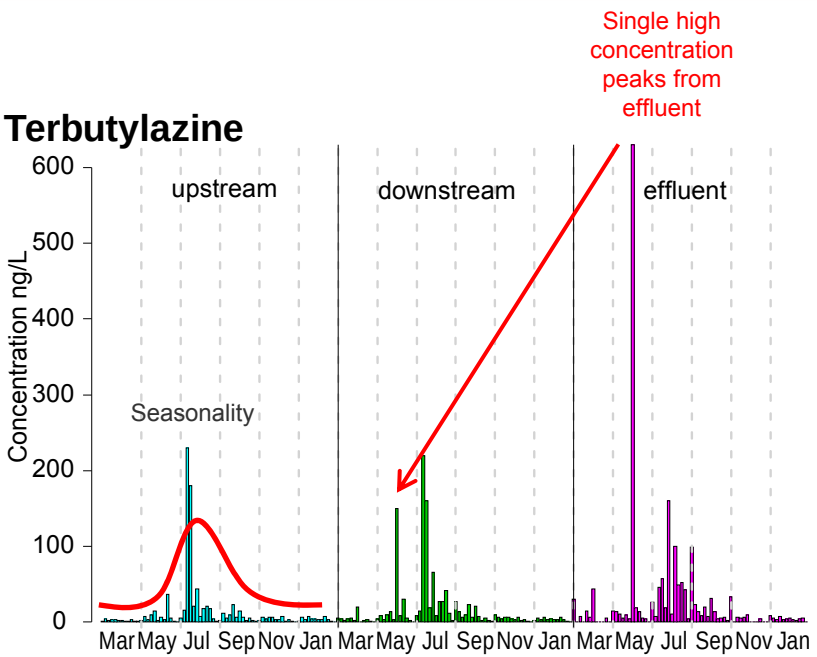
Neale et al. 2016, STOTEN

Concentration patterns

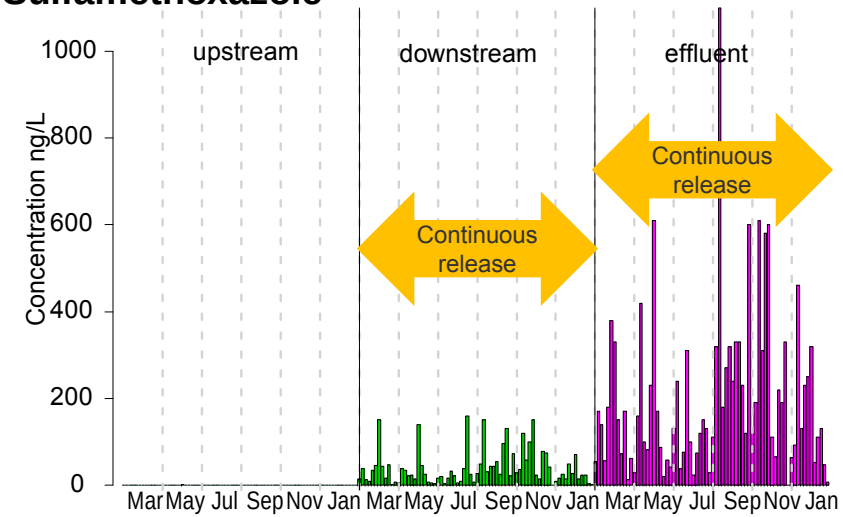
Diclofenac



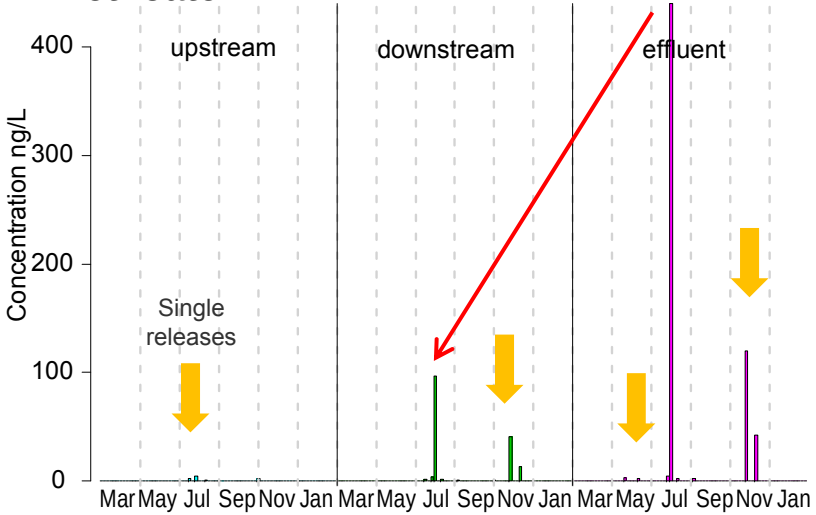
Terbutylazine



Sulfamethoxazole

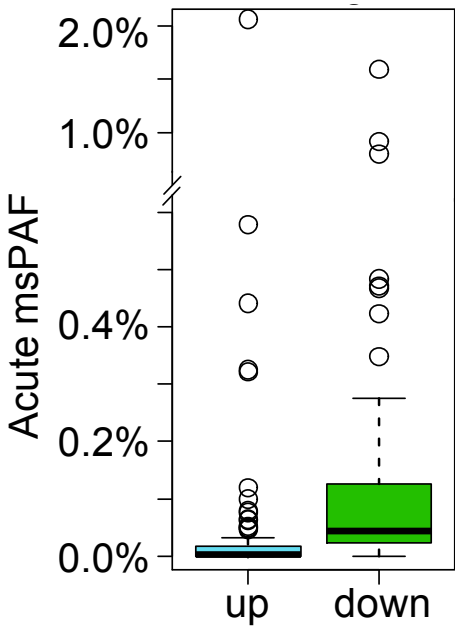


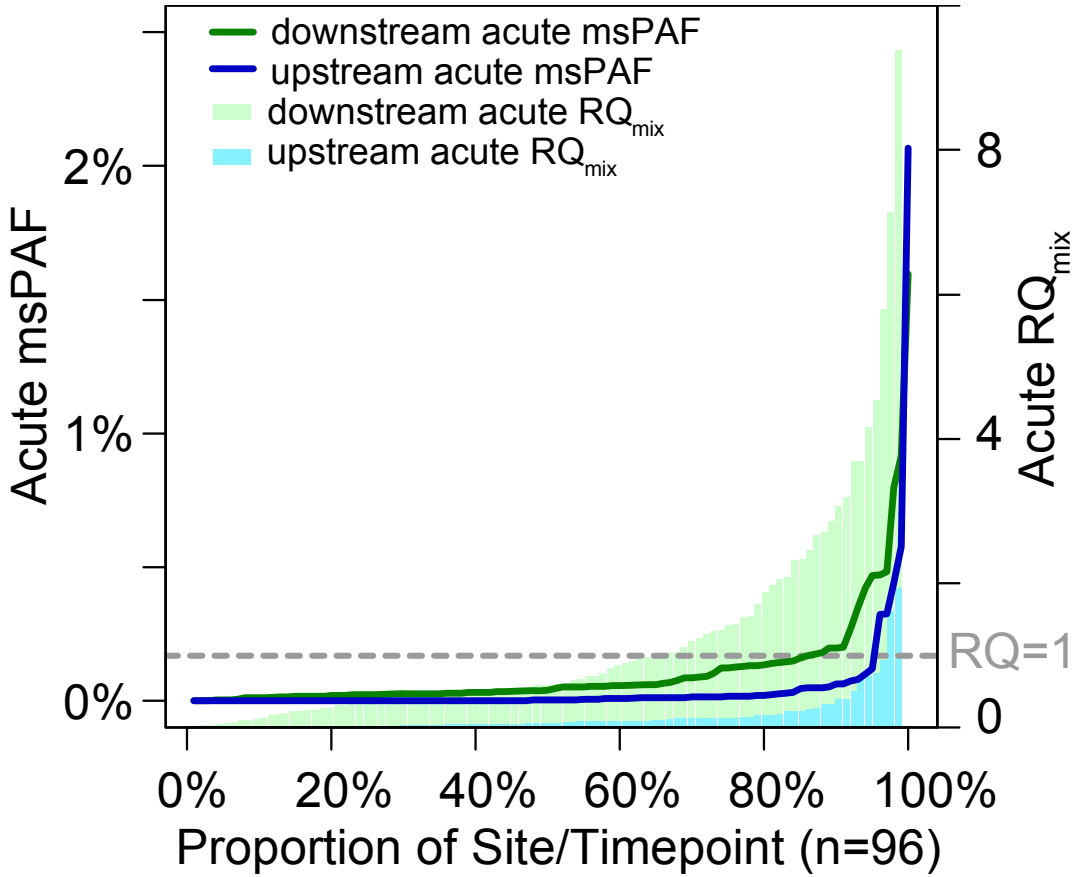
Dimethoate



Munz et al. 2017, Wat Res

Toxic pressure

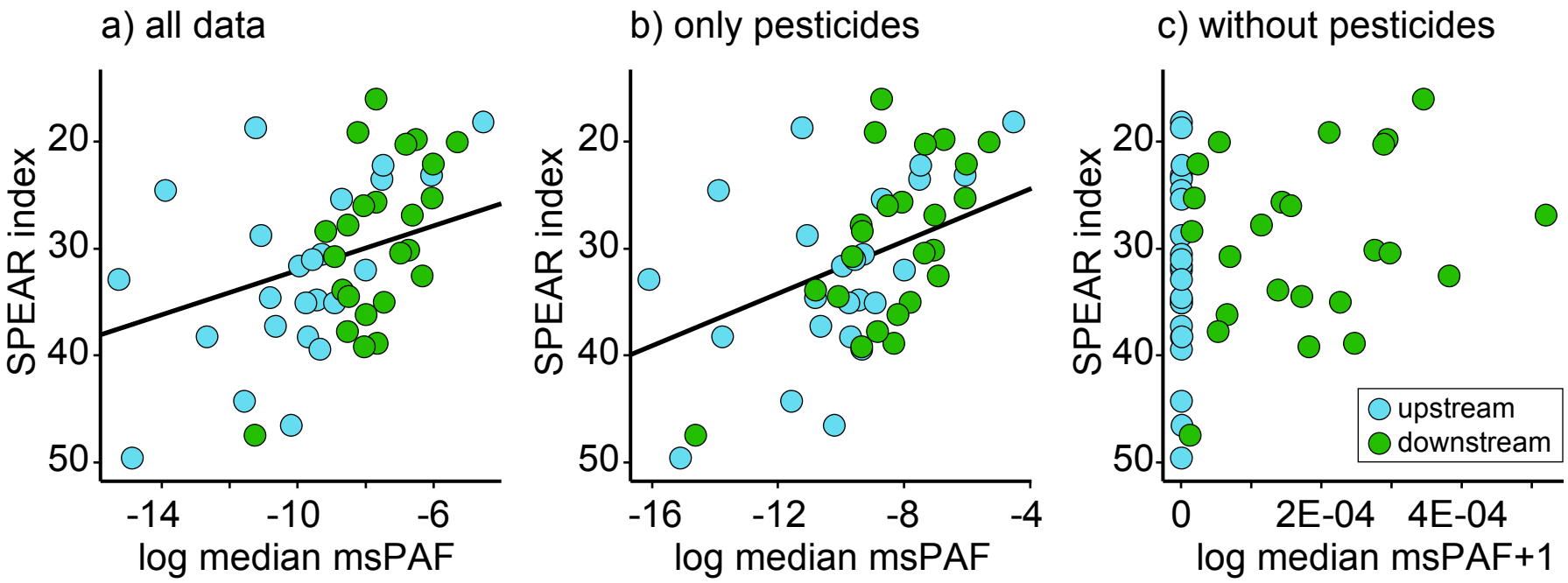




Munz et al. 2017, Wat Res

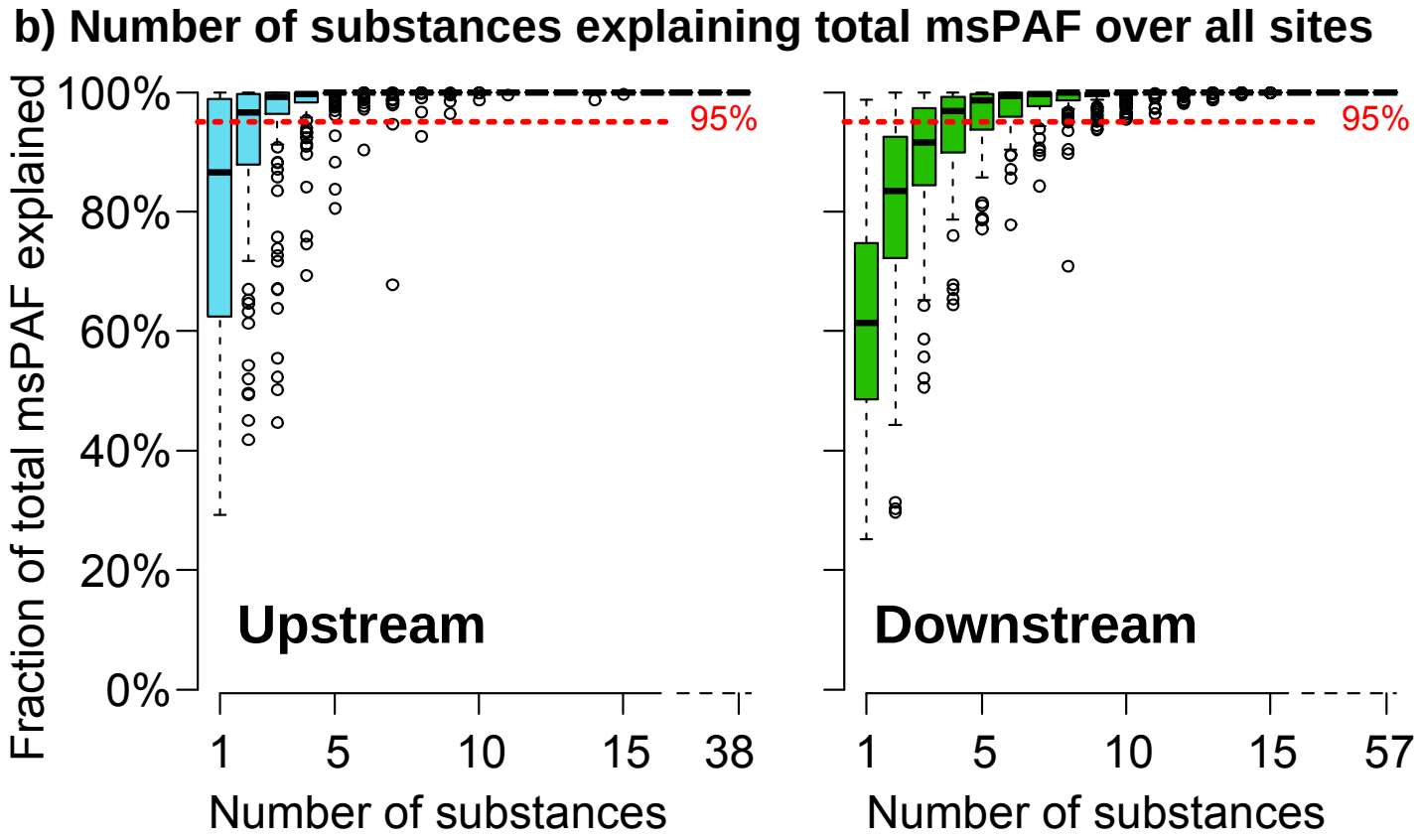
Biological field data (SPEAR index)

…correlates with predicted toxic pressure



Munz et al. 2017, Wat Res

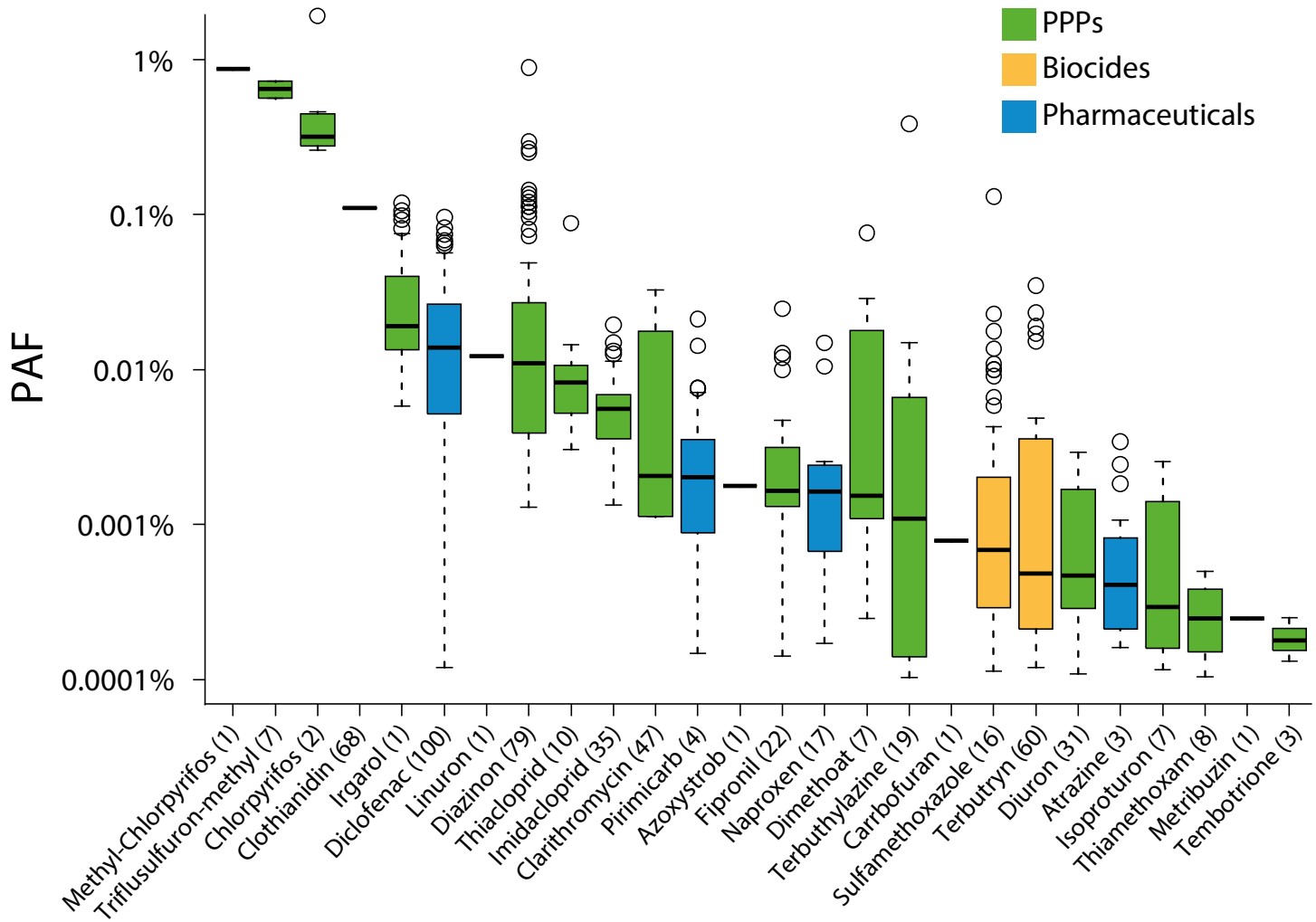
Only a few substances drive overall risk



Munz et al. 2017, Wat Res

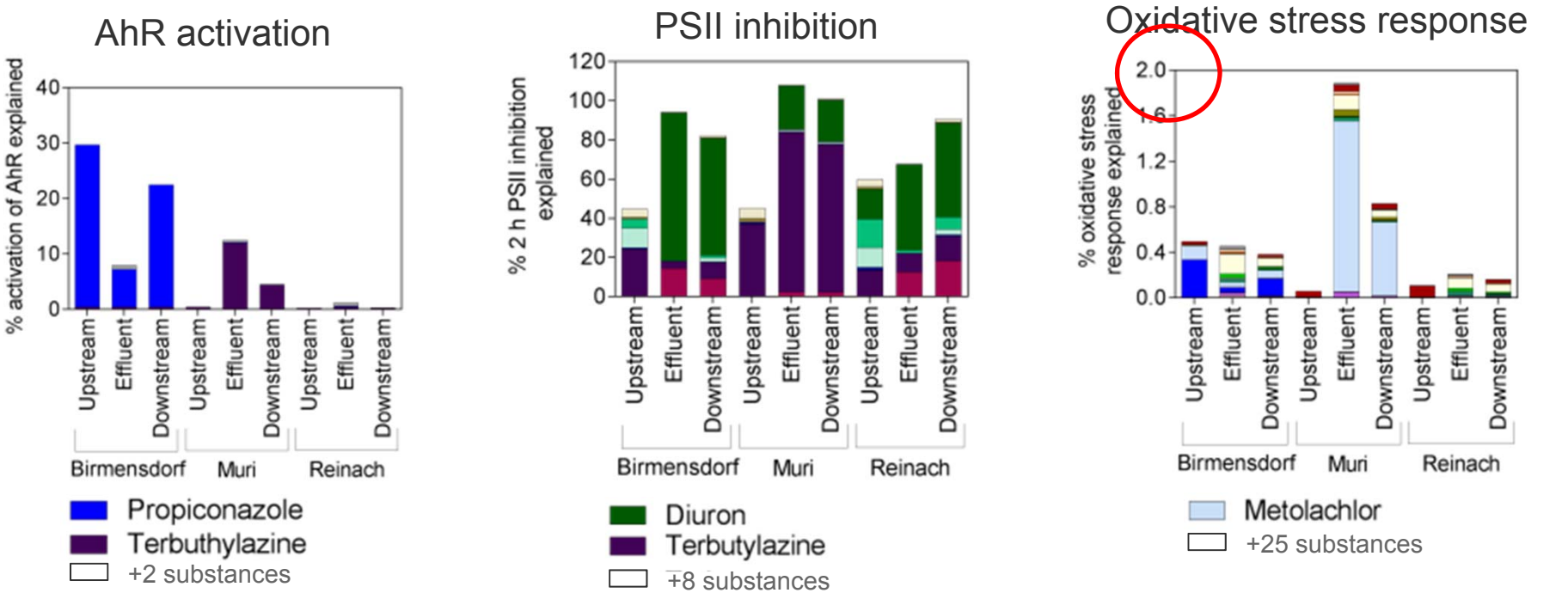
Substances with impact on toxic pressure

…are mainly pesticides



Mixture toxicity modelling

Underlines relevance of single substances…



Neale et al. 2016, STOTEN

…but overall only a small fraction of effect explained

→ (joint) effect of **many unknown** substances.

Conclusions

- Pesticides are main drivers of toxic pressure in wastewater-impacted streams during low-flow conditions
- A few substances responsible for risk predicted
- Combination of chemical analysis and bioanalysis valuable complimentary approach to monitor the micropollutant burden
- Lack of effect data critical for mixture toxicity modelling and risk assessment
  - Limited interpretation possible on relevance of pharmaceuticals

Acknowledgments

- SOLUTIONS partners conducting bioanalyses
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