CRC 1253 CATCHMENTS AS REACTORS

CAMPOS

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Fate and Effects of Agricultural and Urban Organic Pollutants in a Small River Catchment

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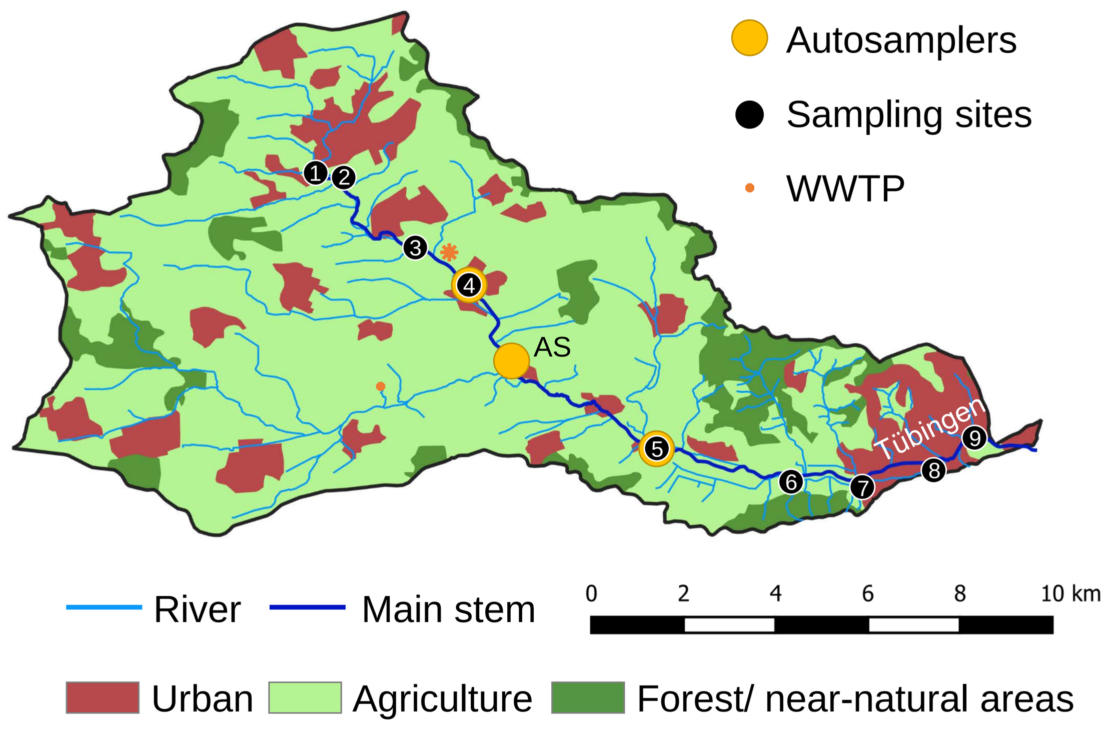
Background & Objectives

- **Water quality in rivers** affected by **pollutant emissions** from agricultural and urban areas under different weather and discharge conditions
- **Transformation processes** in the field not well understood
- Degradation kinetics in the field are not predictable based on literature and laboratory data
- **Objectives**: Identify
  - dominant **input sources** of organic pollutants
  - dominant **attenuation processes** and
  - their **driving factors**

  along the Ammer River (Tübingen, Germany)

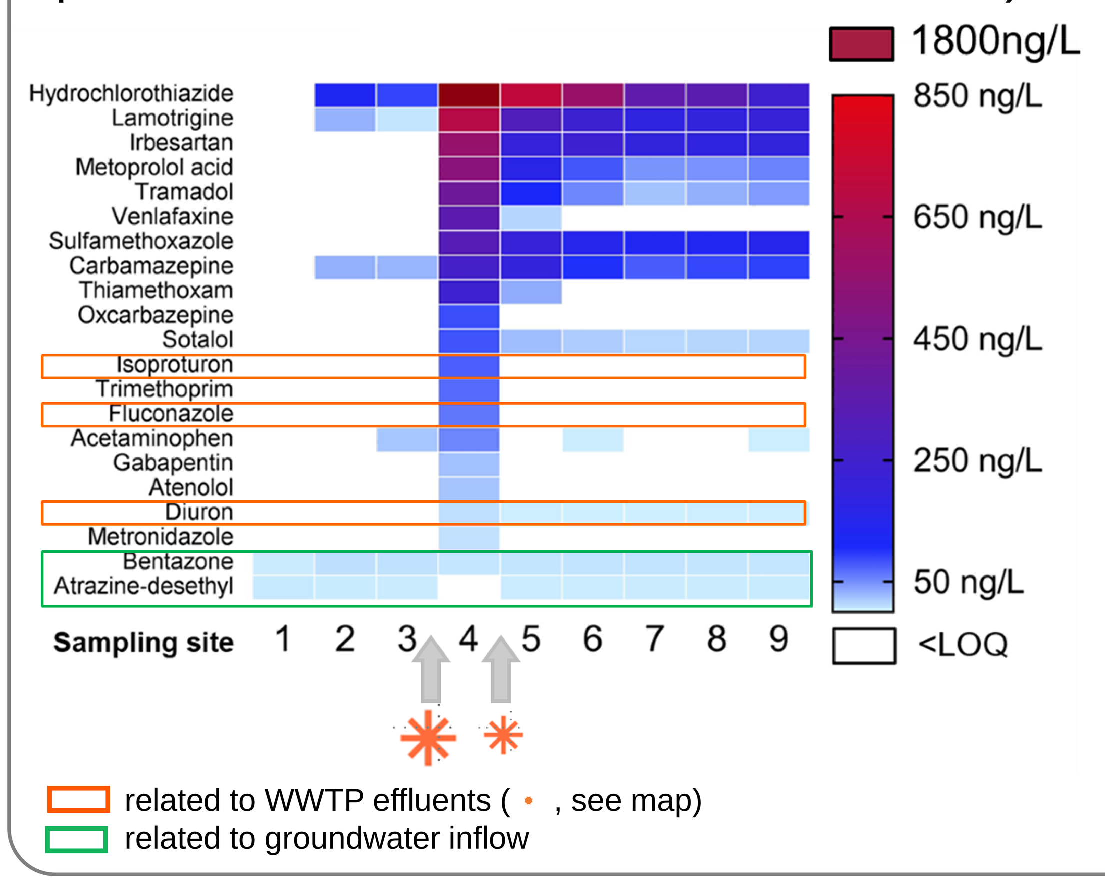


Approach

- **Study site**: Ammer River; tributary to the Neckar River; gauged (AS3) catchment: area 137 km^2, Ø discharge Q = 0.87 m^3 s^{-1}
- **Overall approach**: integration of field sampling with chemical & toxicity analysis and process-based modelling
- **Sampling** in 2017-2019: combination of autosamplers (at sites 4, 5 and AS), Lagrangian and grab sampling in the Ammer main stem, tributaries and headwaters
- **Chemical analysis**: target and non-target analysis
- **Toxicity analysis**: cell-based bioassays
- **Modelling**: mass balance and transport modelling

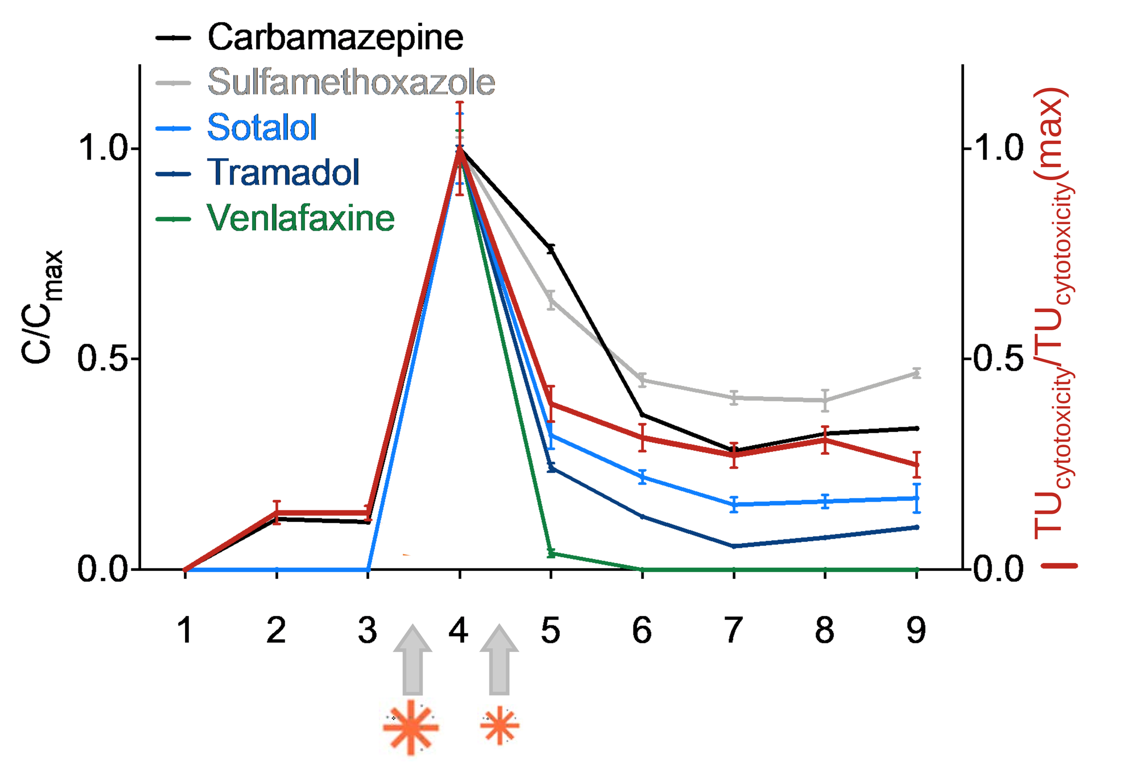
Chemical Inventory & Toxicological Pollutant Profile Along the River

During base flow, **WWTP** dominates spatial pattern of detected target pollutants (101 pesticides, pharmaceuticals and household chemicals) and the toxicological pollutant profile along main stem[1]



related to WWTP effluents (• , see map)

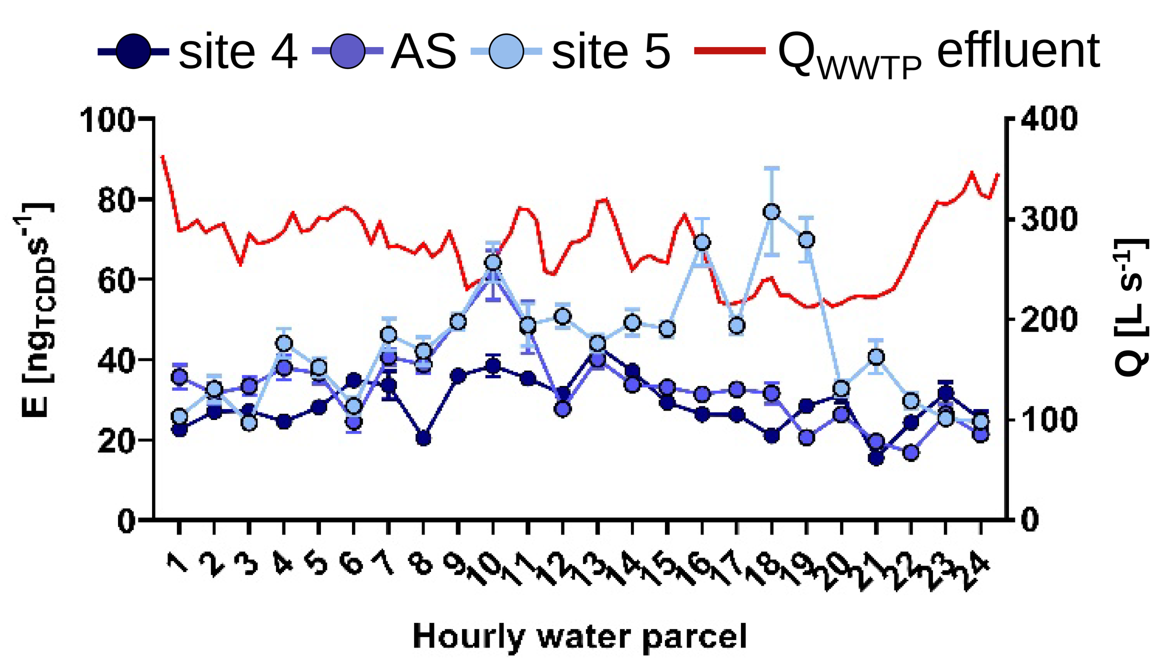
related to groundwater inflow



C/C_{max} – Normalized substance concentrations

$TU_{cytotoxicity}/TU_{cytotoxicity}(max)$ – Normalized cytotoxicity as toxic units (TU)

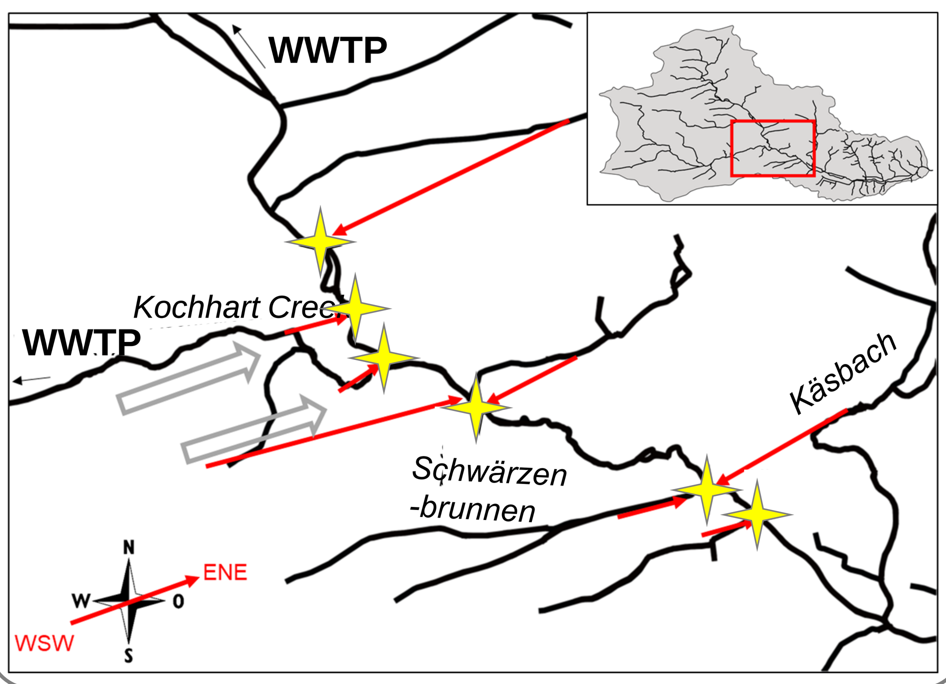
Temporal effect variability does not follow WWTP discharge and masks spatial patterns[2]



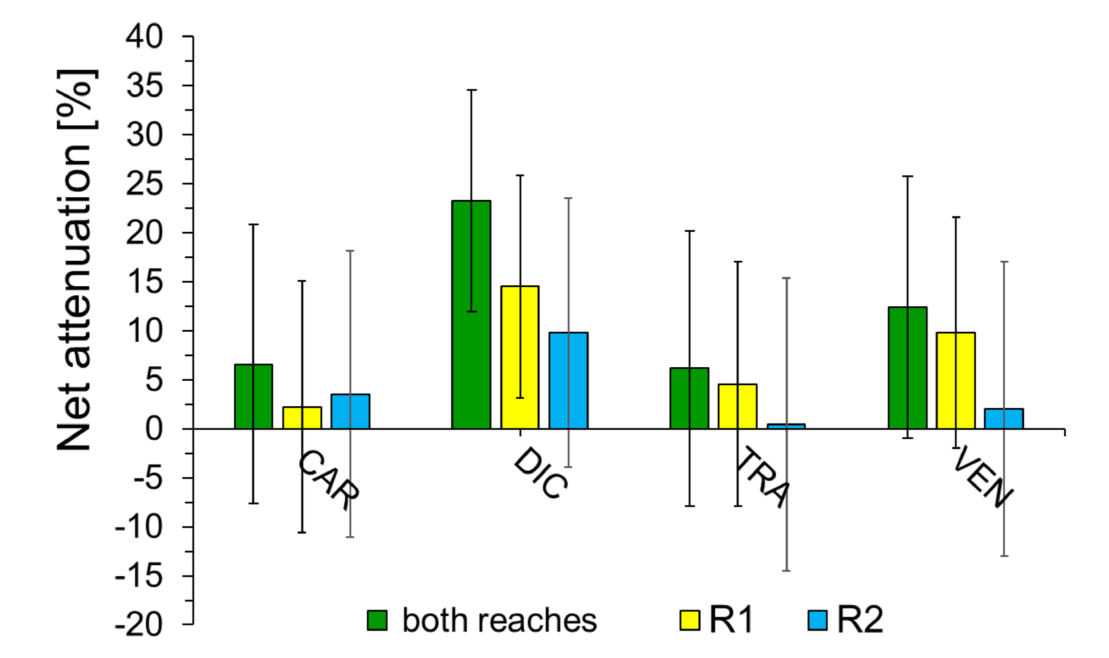
E – Effect fluxes measured by bioassay AhR-CALUX: **E = TCDD-EQ · Q**;
Q – Discharge WWTP; TCDD-EQ – Equivalent conc. reference compound

Integrating Hydrology and Substance Reactivity

Combining tracer experiments and model-based data analysis to derive location (✦) and amount of groundwater exfiltration into the Ammer River[3]



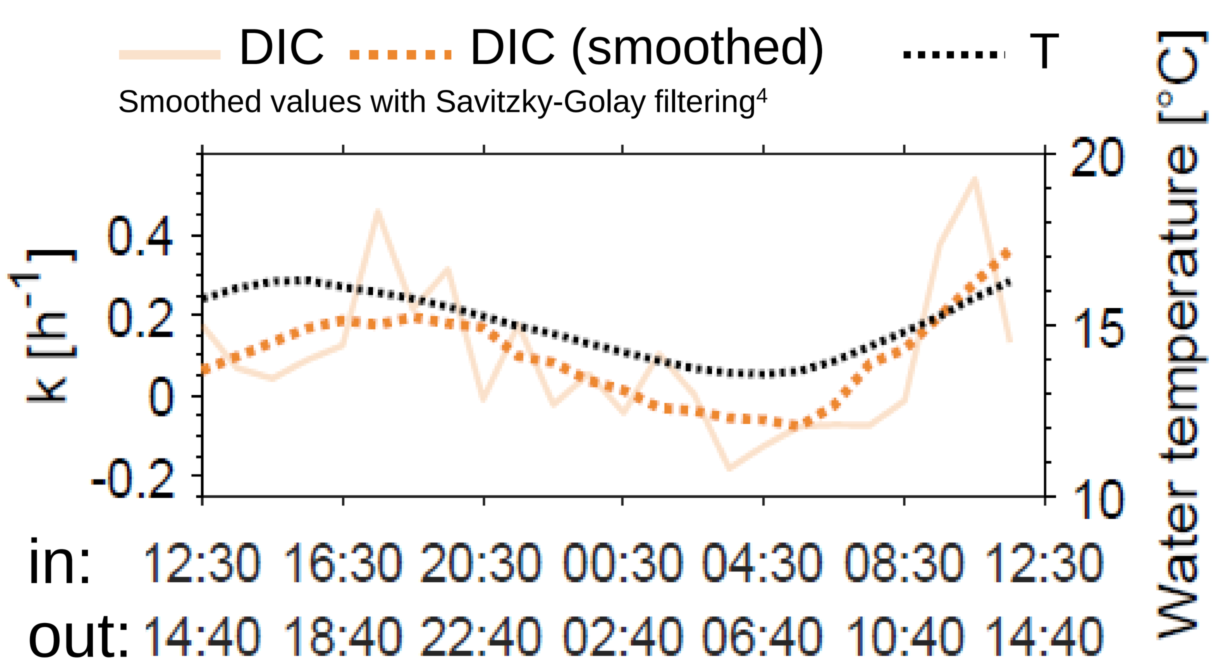
Net attenuation of micropollutants along the investigated Ammer reaches is generally small, and correlates with irradiation (and thus water temperature) for photodegradable compounds[2]



River reaches R1: site 4 – AS; R2: AS – site 5

CAR – Carbamazepine, DIC – Diclofenac, TRA – Tramadol, VEN – Venlafaxine

Error bars – Monte-Carlo-Simulation on measurement errors with 10000 shots[4]

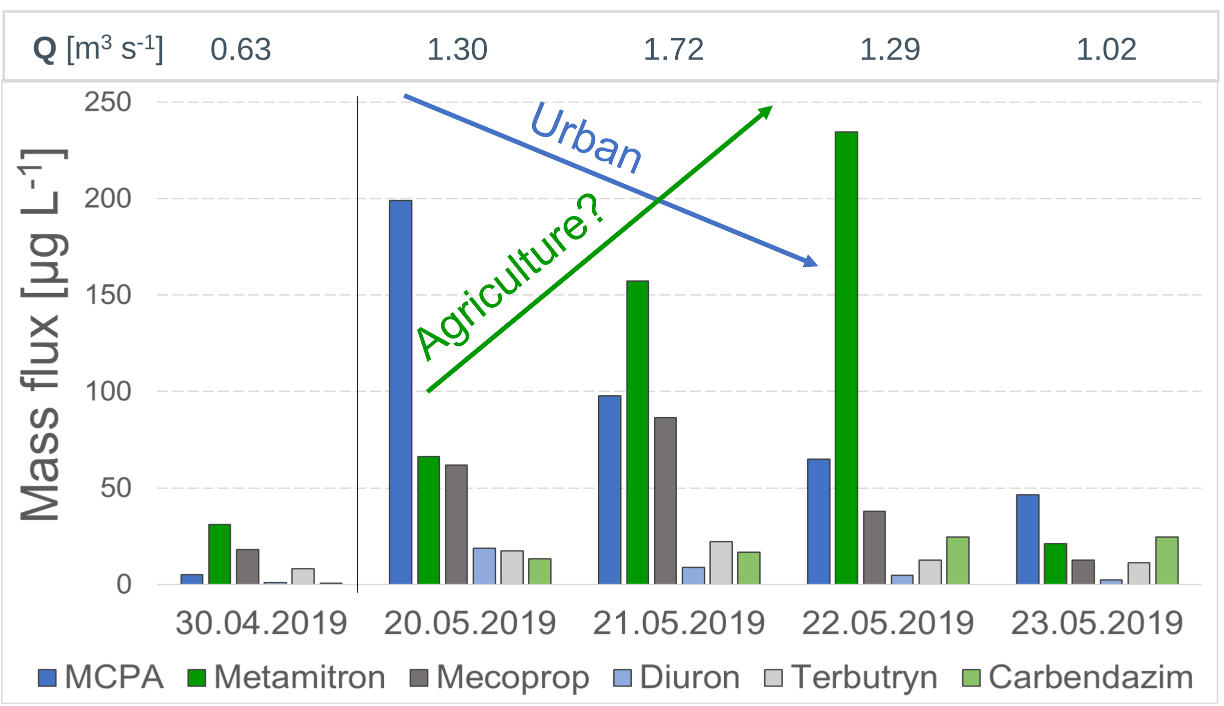


k – Attenuation rate constant k derived from measurements of 24h water parcels

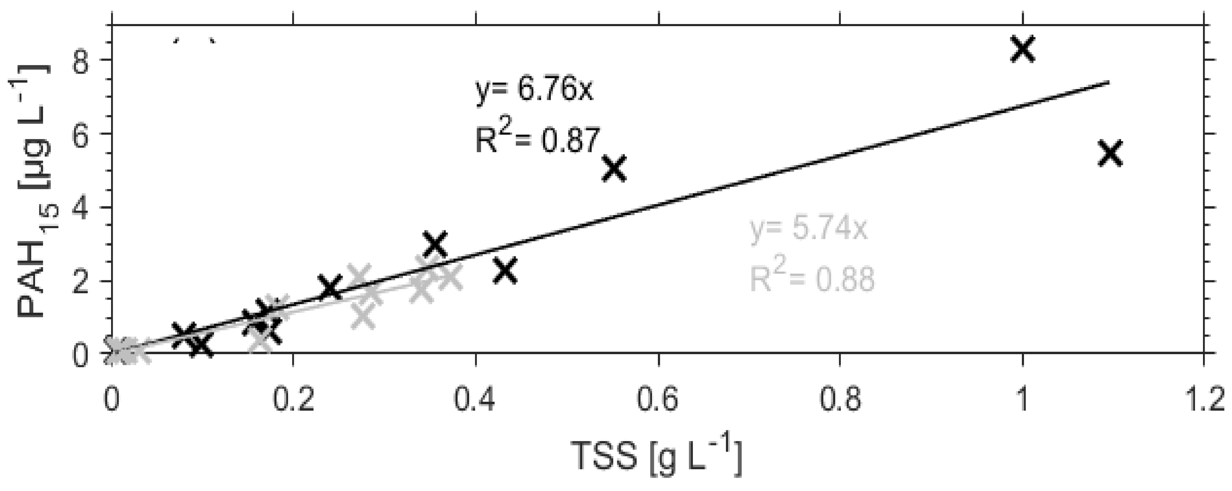
DIC – Diclofenac; Correlation between k and temperature: $r^2 = 0.89$, $p < 0.05$

Rain Events Mobilize Pollutants from Different Sources

Mobilization of pesticides during a rain event depends on sources and flow pathways (data at gauge site 5)



Hydrophobic pollutant concentrations governed by mobilized particles (rain event July 2019)[5]



PAH_{15} – Sum of polycyclic aromatic hydrocarbon concentrations

TSS – Total suspended solids

X – Upstream of the WWTP (site 3); X – Gauging station (site 5)

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References

[1]Müller et al. (2018) Environ. Sci. Europe. 30(1):20

[2]Müller et al. (subm. 2020) Environ. Toxicol. Chem.

[3]Glaser et al. (subm. 2020) Hydrological Processes

[4]Glaser et al. (revised 2020) Sci. Total Environ.

[5]Glaser et al. (in prep.)

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