# Surfactant case study: Increasing the ecological relevance of chemical risk assessments using geospatial approaches

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## BACKGROUND

**Environmental heterogeneity influences the risks of chemicals in landscapes**

- Current chemical risk assessment frameworks do not directly address the landscape-scale heterogeneity of exposure and ecological receptors
- In order to achieve high levels of protection, generic frameworks assume that reasonably worst-case chemical exposure concentrations co-occur in space and time with species assemblages that are most sensitive to the chemical's toxicity
- At locations in the environment where these metrics do not co-occur, mitigation and conservation practices might be deployed where they are not needed and conventional risk assessment may be over-protective
- An ECETOC Task Force was established to assess the utility of geo-referenced chemical exposure and ecological data for making prospective ecological risk assessment over large spatial scales

**Overview of Task Force approach**

Data needs:
Geo-spatial information research and acquisition

Chemical emissions | Receiving environment | Chemical ecotoxicity by Biological Quality Element (BQE) | Ecological receptors (BQE)

Geo-referenced Predicted Environmental Concentrations (PECs) | Geo-referenced habitat info | Geo-referenced ecological state

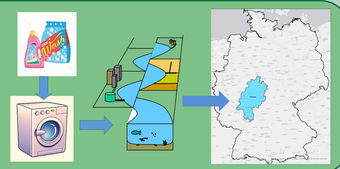
Spatial analysis:
Compute risk (Exposure Toxicity Ratio, ETR) by spatially relating exposure, habitat and effects for each location

Analysis:
Assess relationship between calculated ETR and ecological status
Taking into account spatial & temporal co-occurrence

Results:
Trends of risk (ETR) and ecological status across sites and BQEs

**Anionic Surfactant Case Study**

Continuous, widespread emission to surface waters via wastewater treatment plant (WWTP)

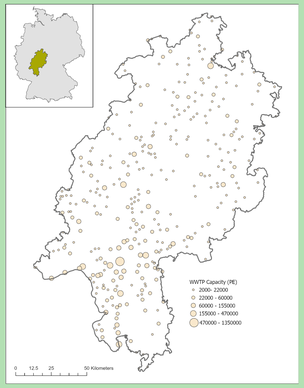


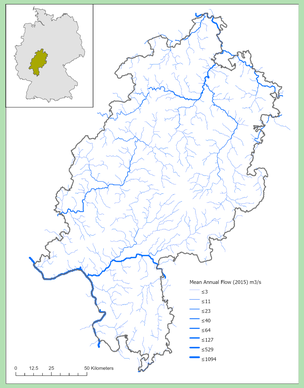
## METHODS

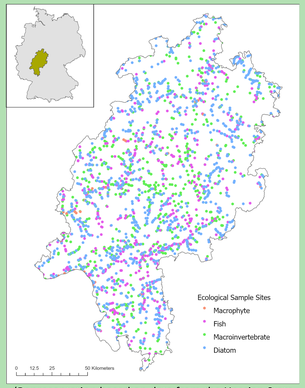
**Surfactant Emission**
Per capita ingredient usage
Water use (Eurostat 2017)
WWTP location (EEA 2017)

**Aquatic Environment**
River location (Lehner 2018)
River flow (Barbarossa 2018)

**Ecological Receptors**
Biological Quality Elements
Ecological Status
3970 locations in Hessen




(Representation based on data from the Hessian State Office for Nature Conservation, Environment and Geology, Wiesbaden)

### Spatial Processing

- WWTPs linked to closest river segment
- Ecological monitoring sites linked to river segments
- Monitoring sites assigned to upstream WWTP (if present)

### Predicted Environmental Concentrations

$$\mathrm{PEC} = \frac{Mass \times Population}{WaterUse \times Population} \times (1 - Removal)/Dilution\_Factor$$

Influent concentration
Effluent concentration
Environmental concentration

### Exposure Toxicity Ratio (ETR)

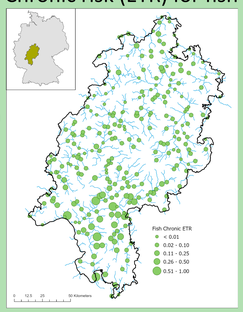
$$\frac{\text{Annual mean PEC}}{\text{Acute EC50}_{\text{fish or } \textit{Daphnia (HERA 2013)}}}$$

$$\frac{\text{Annual mean PEC}}{\text{Chronic NOEC}_{\text{fish; } \textit{Daphnia}\text{; algae; } \textit{Lemna (HERA 2013)}}}$$

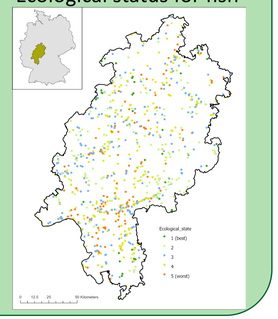
### Analysis of ETR and Ecological Status

- Spatially relate river ETR with Ecological Status for each Biological Quality Element

Chronic risk (ETR) for fish

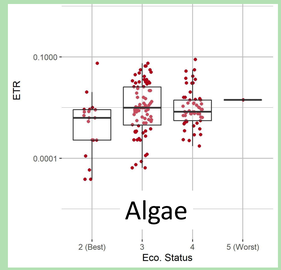


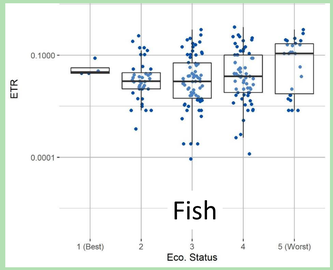

Ecological status for fish

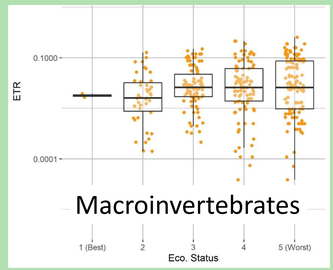


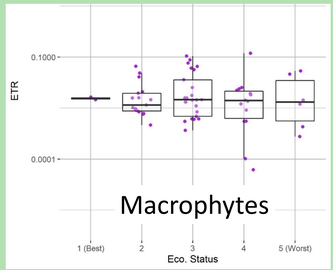

## RESULTS

Chronic Risk and Ecological Status by Biological Quality Element (BQE)




Thanks to Inka Marie Willms (BASF) for results visualization

- Fish have higher ETR values due to higher sensitivity to surfactant
- No relationship between chronic ETR and ecological status for any BQE – indicates that surfactant not driving ecological status
- Evaluated chronic risk based on constant emissions from WWTP
- All eco monitoring locations had acute ETR < 0.1

## CONCLUSIONS

- Demonstrated capability for feasible geo-spatial analysis of the relationships between ecological status and chemical risk
- Remediation or conservation measures can be informed to identify locations where species assemblages may be at relatively higher risk
- Framing of landscape-scale risk assessment requires clear statement of the question to be addressed and must consider data handling, required resolution, and methods for integrating data layers
- Few ecological data sets are sufficiently comprehensive, consistent and extensive for use in EU-wide chemical risk assessment

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Also see poster 4.05.08 for the PPP Case Study

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