Increasing Ecological Relevance of Chemical Risk Assessments Using Geospatial Approaches: Results From Two Case Studies

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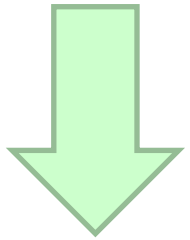
Also see companion posters:

4.05.08 PPP Case Study: Increasing the Ecological Relevance of Chemical Risk Assessments Using Geospatial Approaches

4.05.09 Surfactant Case Study: Increasing the Ecological Relevance of Chemical Risk Assessments Using Geospatial Approaches

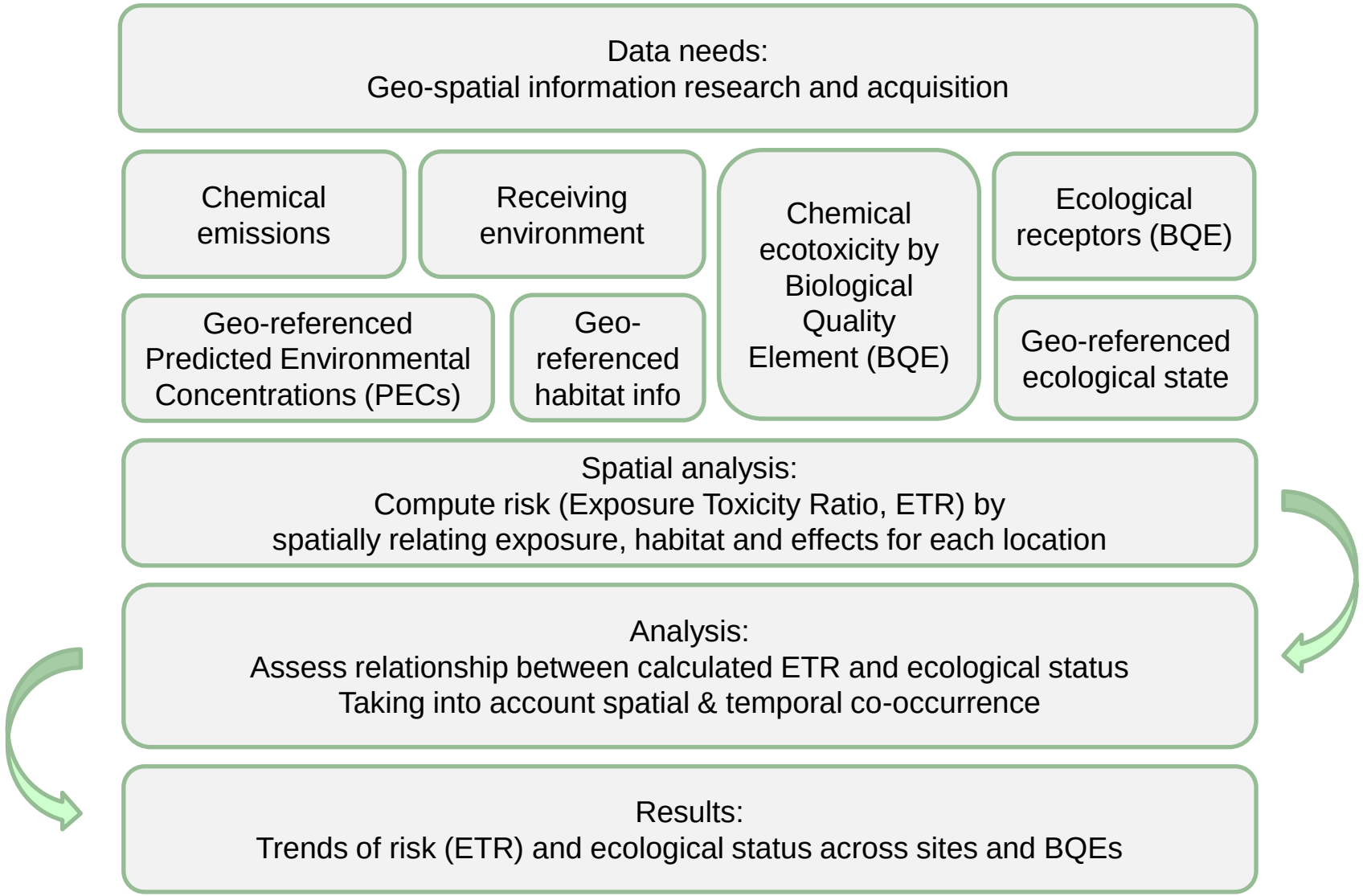
Environmental heterogeneity influences the risks of chemicals in landscapes & watersheds

- variation in release to receiving habitat
- variation in fate and behaviour within the receiving habitat
- variation in sensitivity of ecological receptors within the receiving habitat
- variation in the potential for ecological communities to recover from chemical impacts

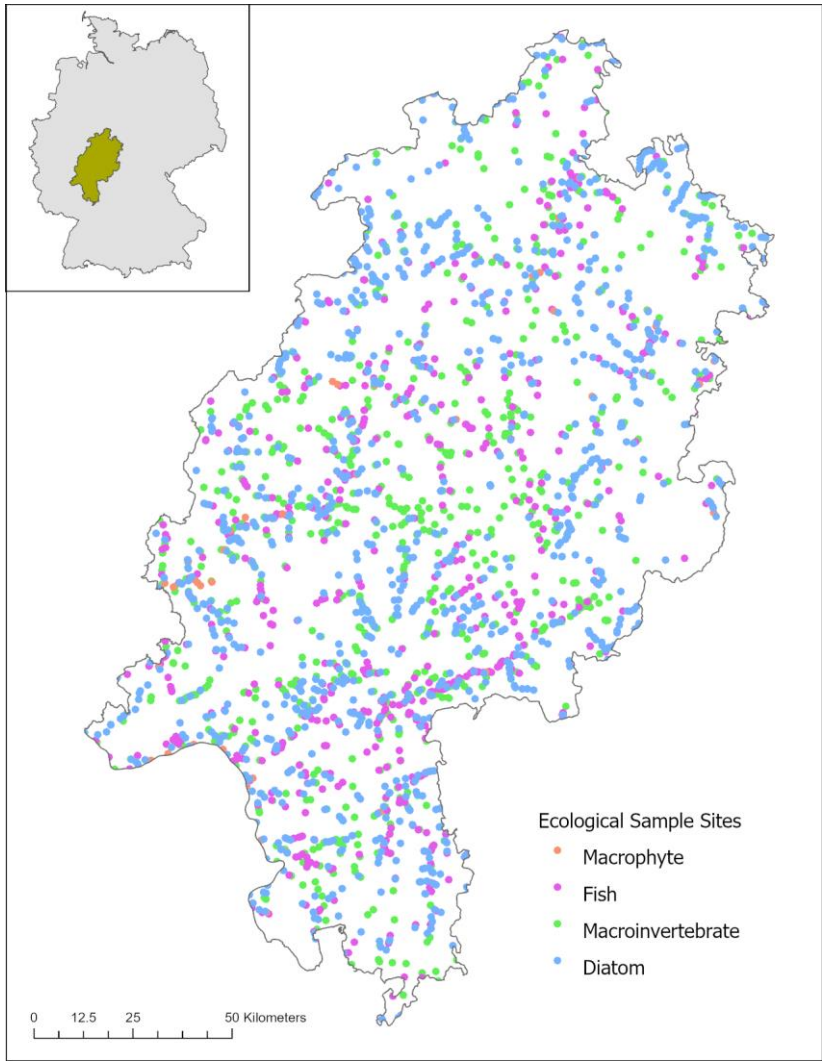


Consider in Ecological Risk Assessment (ERA) to inform good mitigation & conservation practices and to avoid loss of benefit from chemicals resulting from conservative ERA

Analysis Overview



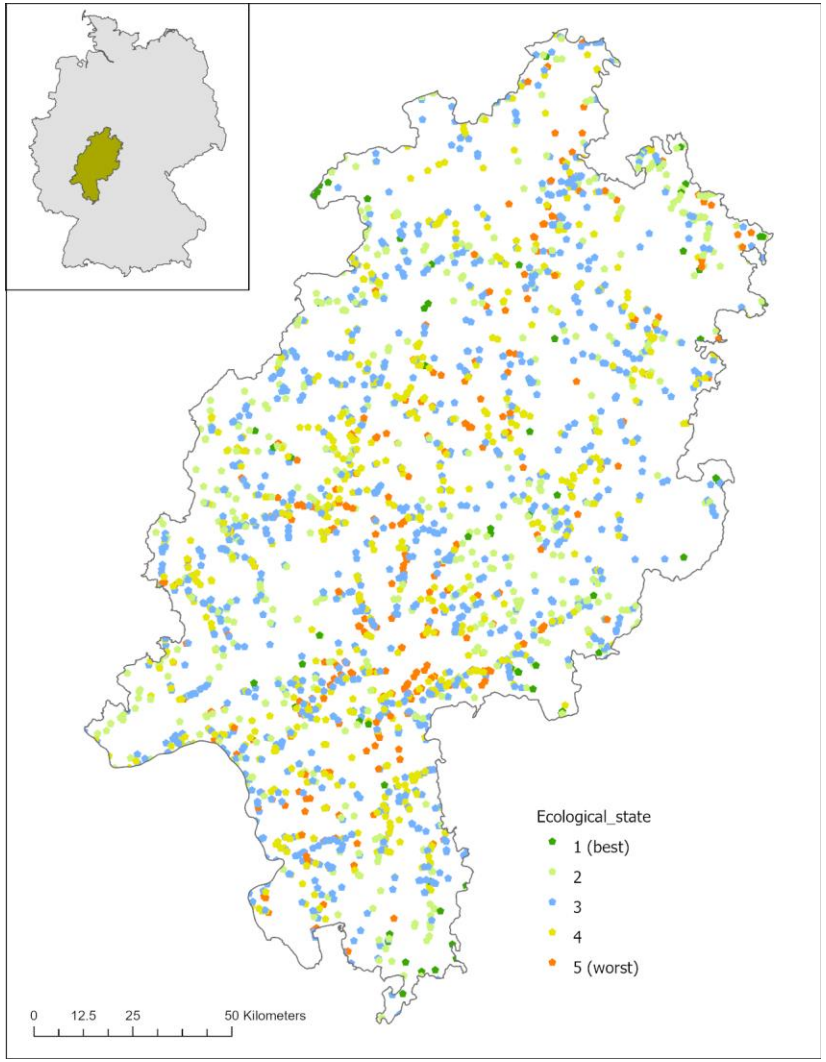
Study location



Hessen, Germany

Availability of high quality and comprehensive WFD ecological monitoring data (Representation based on data from the Hessian State Office for Nature Conservation, Environment and Geology, Wiesbaden)

Location of 3970 sample sites in Hessen showing four Biological Quality Elements (BQEs) fish, macroinvertebrates, diatoms, and macrophytes



Sample sites showing ecological state from best (1) to worst (5)

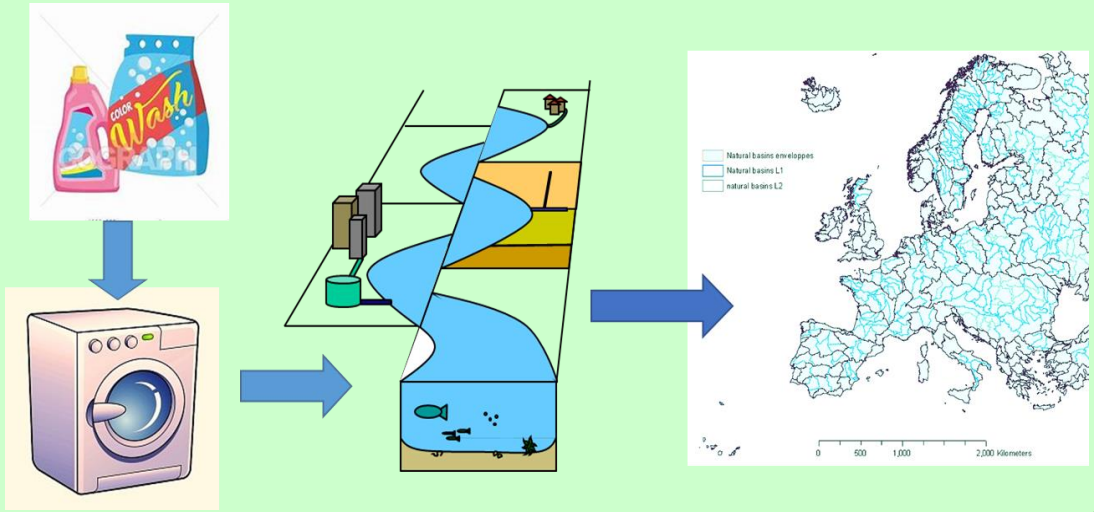
Case studies

- Two separate usage and emission profiles
- Focus on methodology

- Simplified & conservative risk assessments

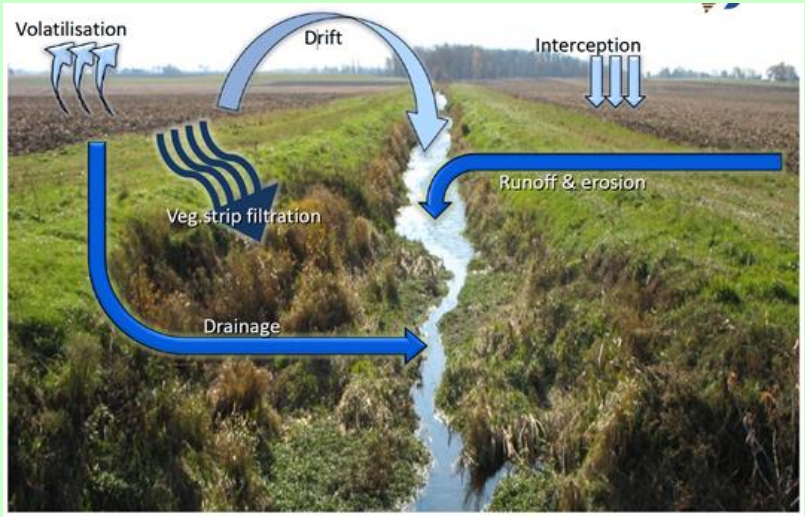
Anionic surfactant

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

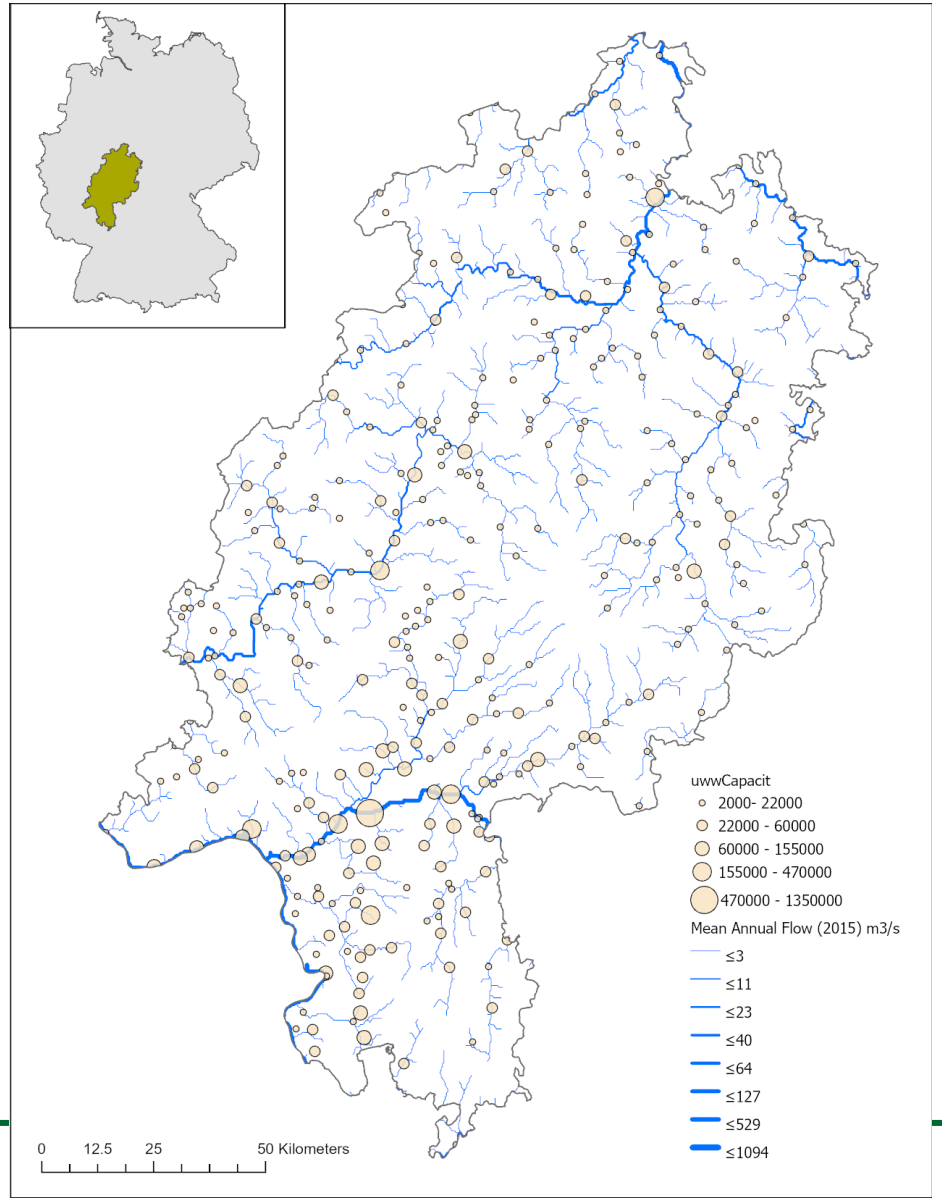


Plant Protection Products (PPP)

- Insecticide, herbicide, fungicide
- Runoff, erosion, drift



Surfactant PEC estimation



- Per capita surfactant and water usage
  - Commercial product survey and ingredient inclusion assumptions
- WWTP locations and population
  - EEA Waterbase-UWWTD
- River location and flow
  - HydroSHEDS and FLO1K

$$\mathbf{PEC} = \underbrace{\frac{\boldsymbol{Mass} \times \boldsymbol{Population}}{\boldsymbol{WaterUse} \times \boldsymbol{Population}}}_{\text{Influent concentration}} \times \underbrace{(1 - \boldsymbol{Removal})}_{\text{Effluent concentration}} / \underbrace{\boldsymbol{Dilution\_Factor}}_{\text{Environmental concentration}}$$

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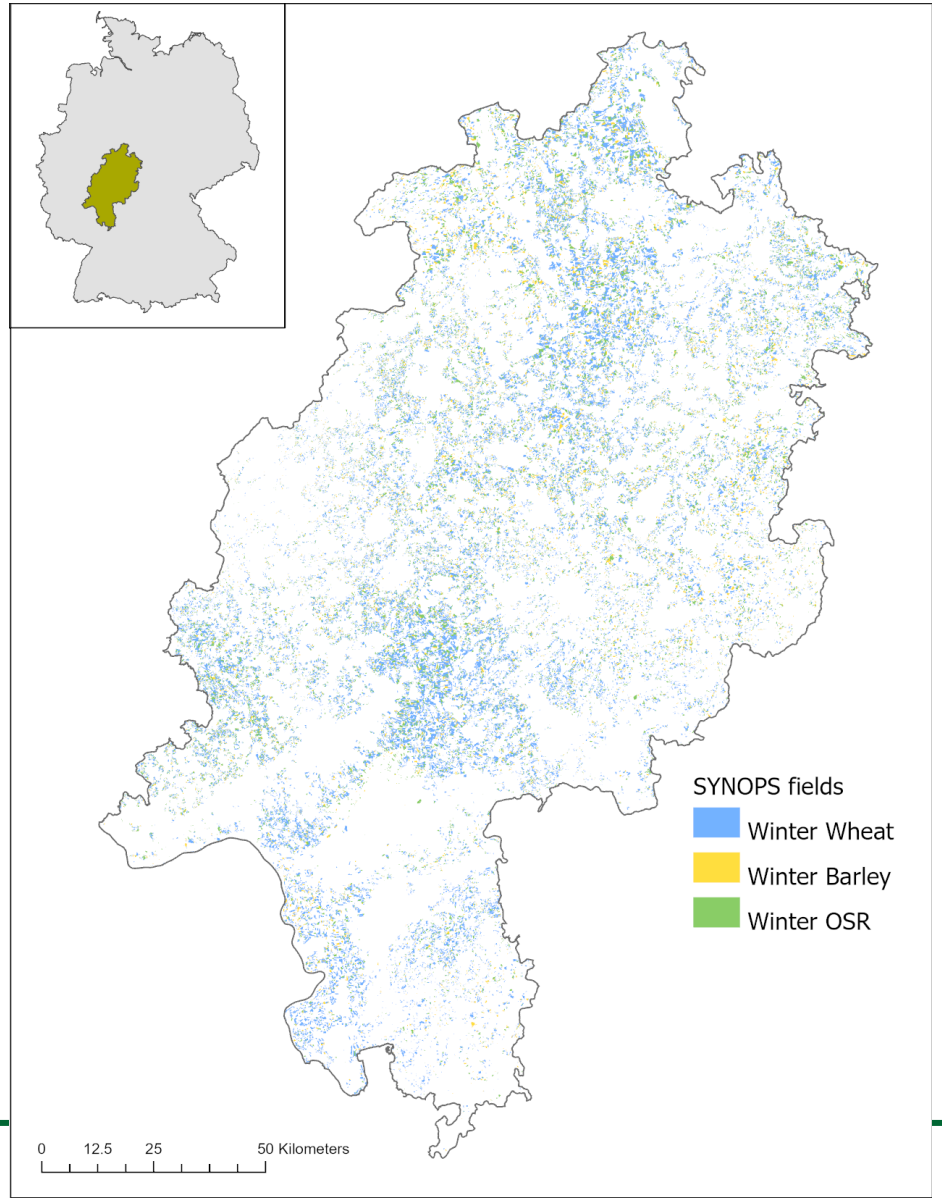
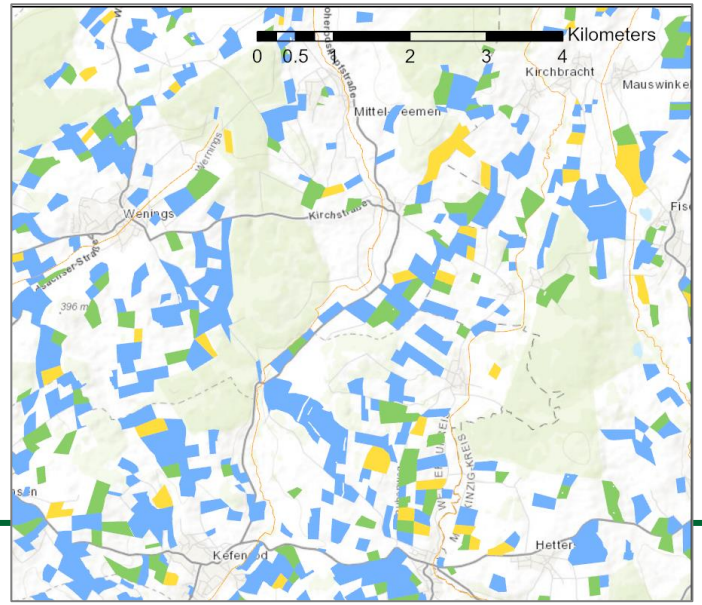
Plant Protection Product PEC estimation



- Insecticide, herbicide, and fungicide
- Modeled using SYNOPS (Julius Kühn-Insititut)
- Crops: winter wheat, w. barley and w. OSR
  - 81,822 cropped fields
- Field level PPP applications
  - 134,183 applications (1 year)
- Surface water PECs
  - Regulatory PPP models daily timestep
  - Label setback distances as appropriate

Number of PPPs per field	% of fields
One	42%
Two	52%
Three	6%



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Exposure:Toxicity Ratio (ETR)

- Estimate acute and chronic risk to macroinvertebrates, fish, macrophytes, and diatoms
- Compare estimated environmental concentrations to ecotoxicity data
  - Surfactant - Human and environmental risk assessment on ingredients of household cleaning products
  - PPP - European Food Safety Authority (EFSA) peer reviewed reports

Surfactant

Annual mean PEC
Acute EC50 fish or *Daphnia*

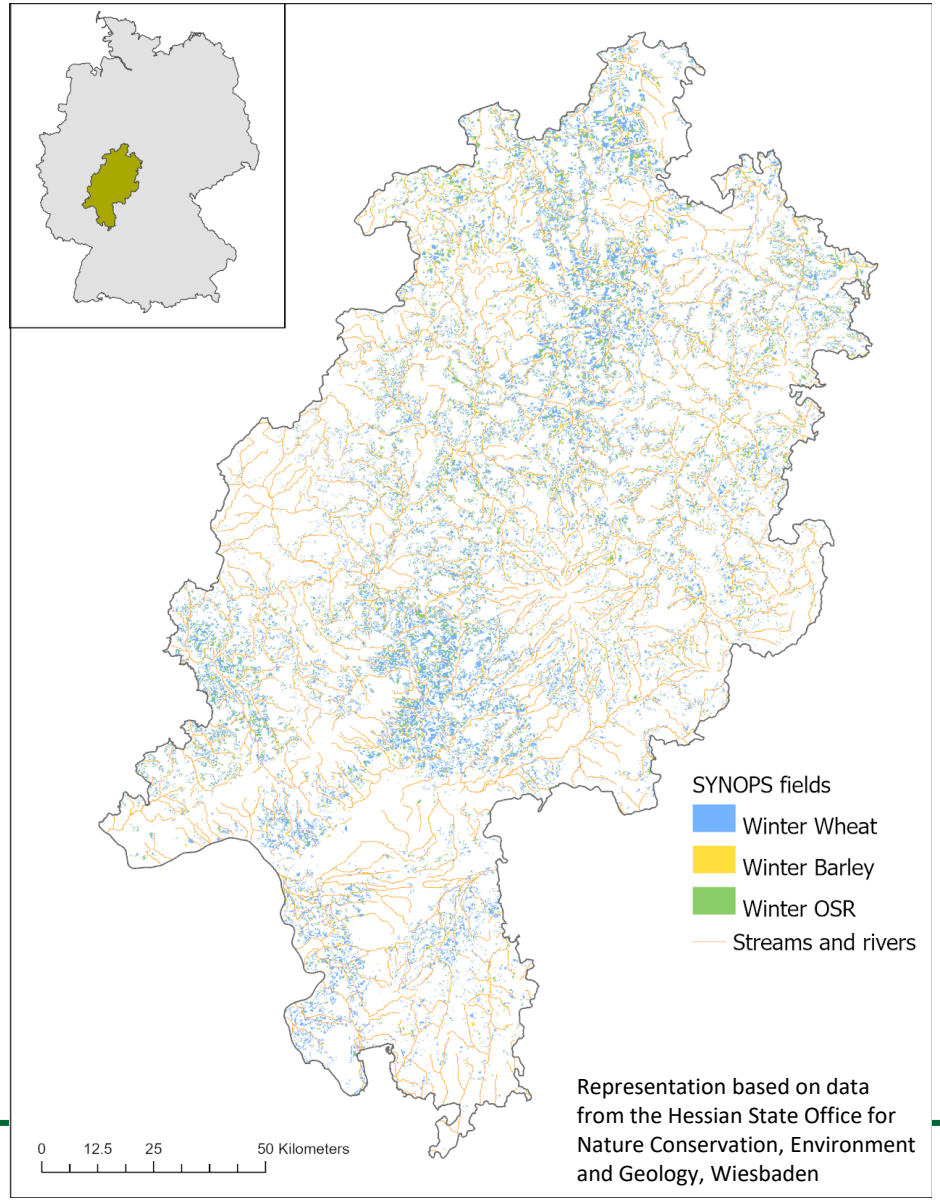
Annual mean PEC
Chronic NOEC fish; *Daphnia*; algae; *Lemna*

PPP

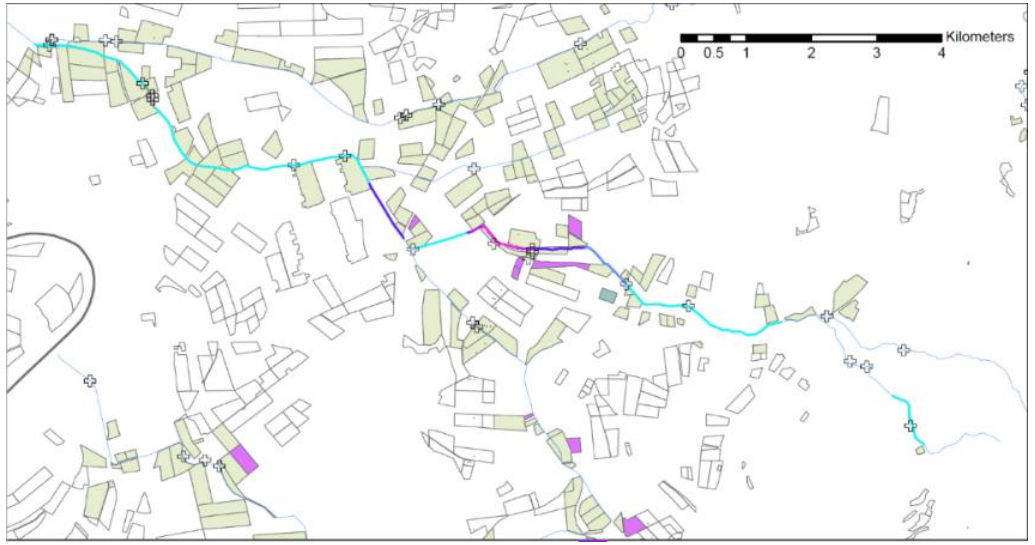
90th %ile daily PEC
Acute EC50 fish; *Daphnia*

7d-TWA PEC
Chronic NOEC fish; *Daphnia*; algae; *Lemna*

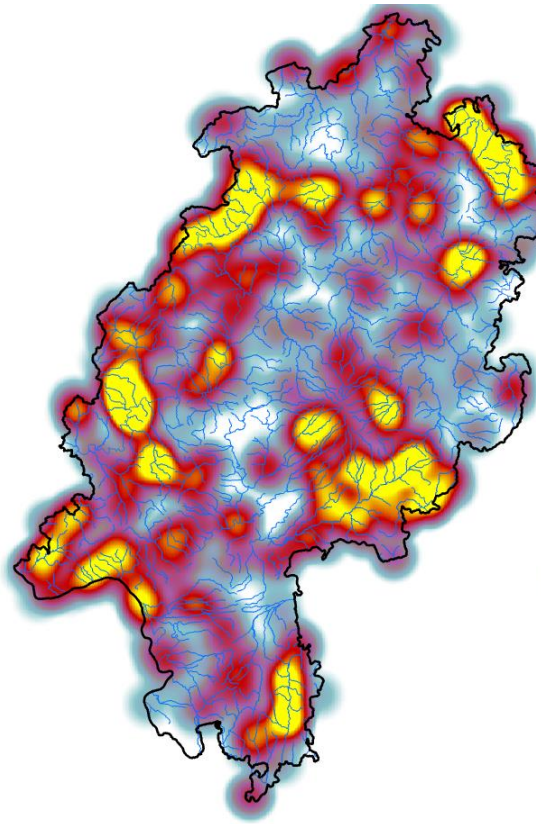
Plant Protection Product ETR estimation



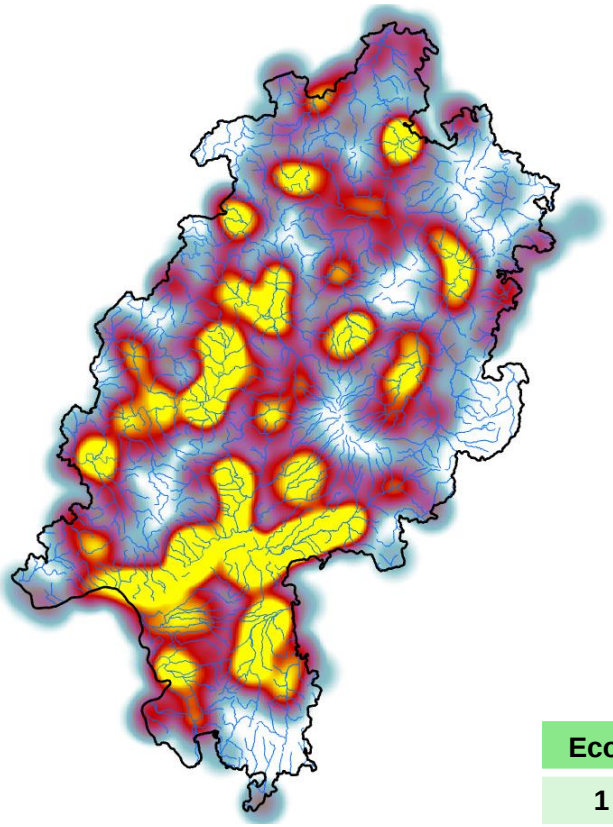
- Field level ETR for each PPP, then ∑ETR for field
- Each field linked to closest stream within 300m
  - High resolution hydrology from Hessian State Office for Nature Conservation, Environment and Geology
- Stream segments ∑ETR for all associated fields
- Stream segment assigned aggregated risk from all segments within 1000m upstream



Spatial distribution of ecological status



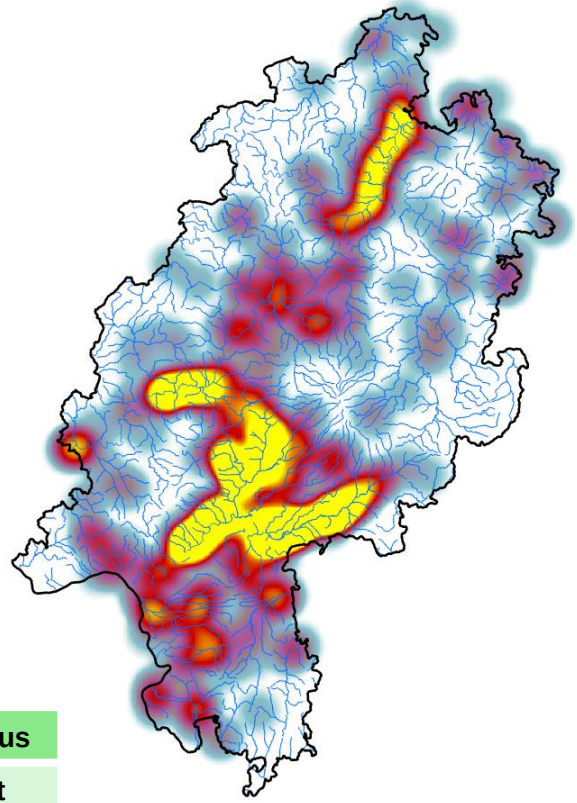
Ecological Status: 2
All BQEs



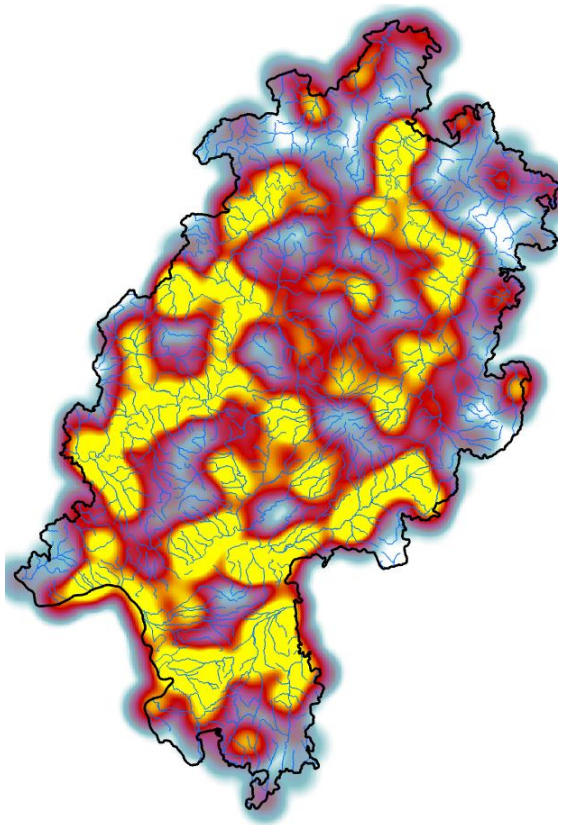
Ecological Status: 4
All BQEs

Same BQEs – different status

Ecological Status	
1	Best
2	
3	Moderate
4	
5	Worst



Ecological Status: 3
Fish



Ecological Status: 3
Macroinvertebrates

Same status – different BQEs

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

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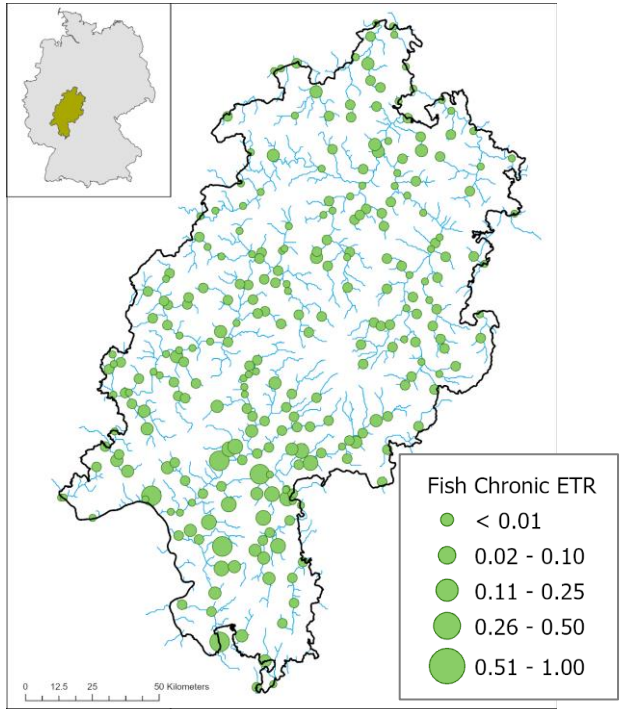
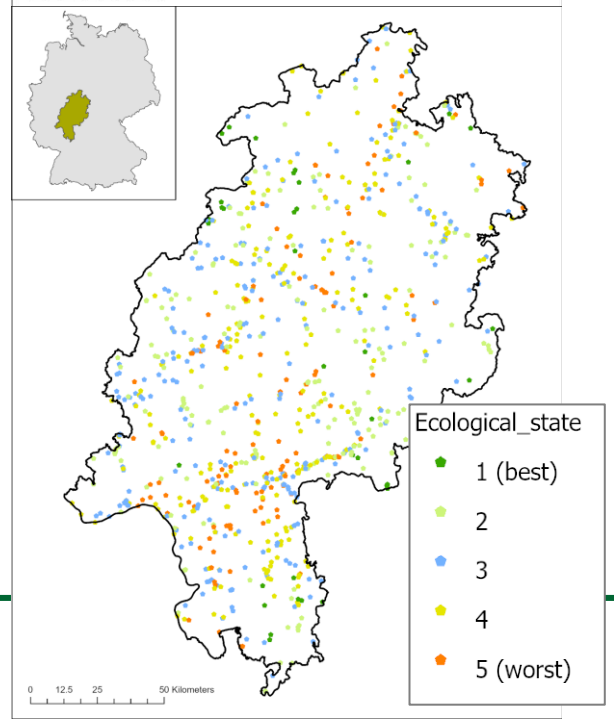
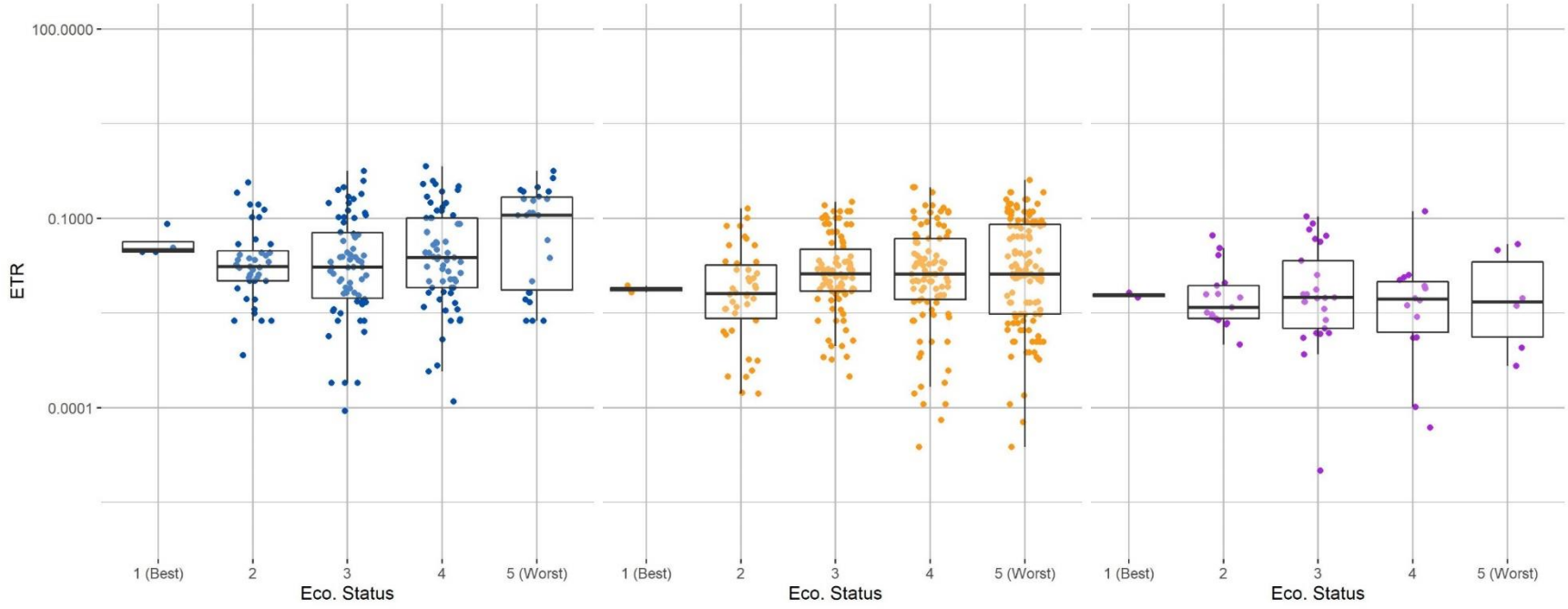
Surfactant ETR v ecological status





Chronic ETR v ecological status:
fish (blue), macroinvertebrates (yellow), and macrophytes (purple)



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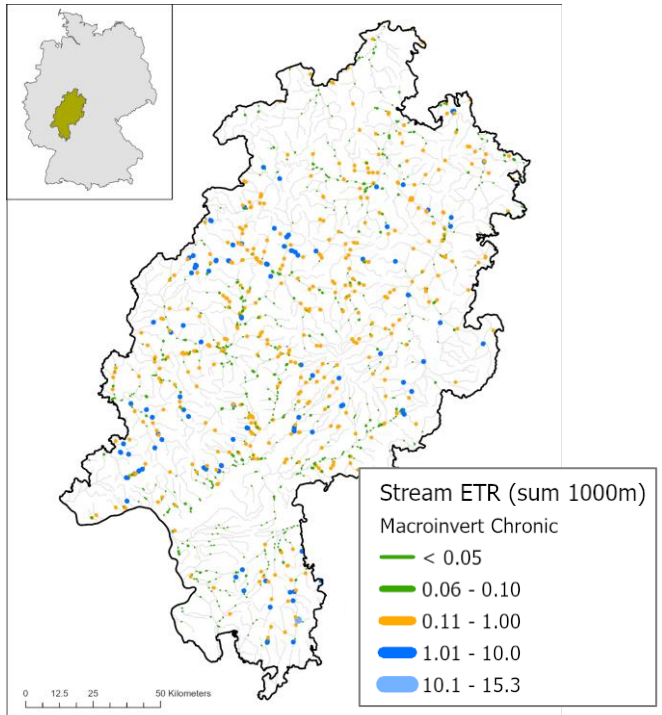
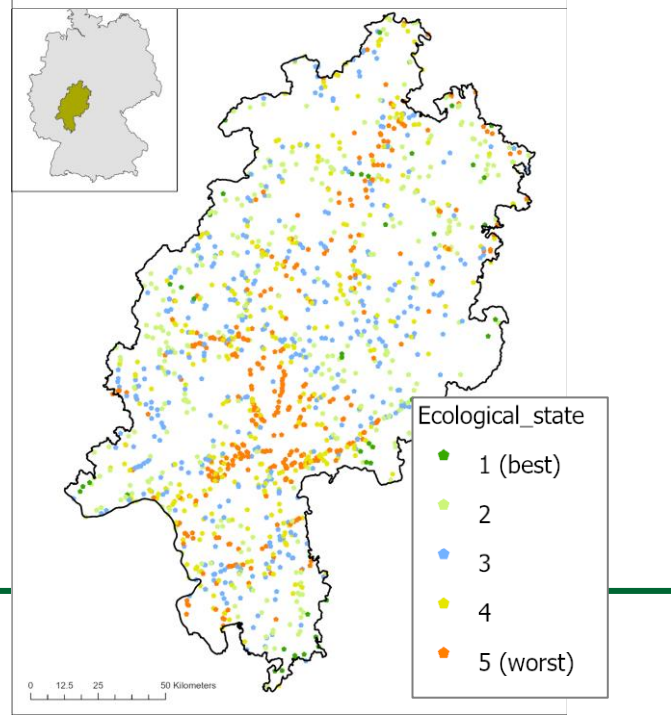
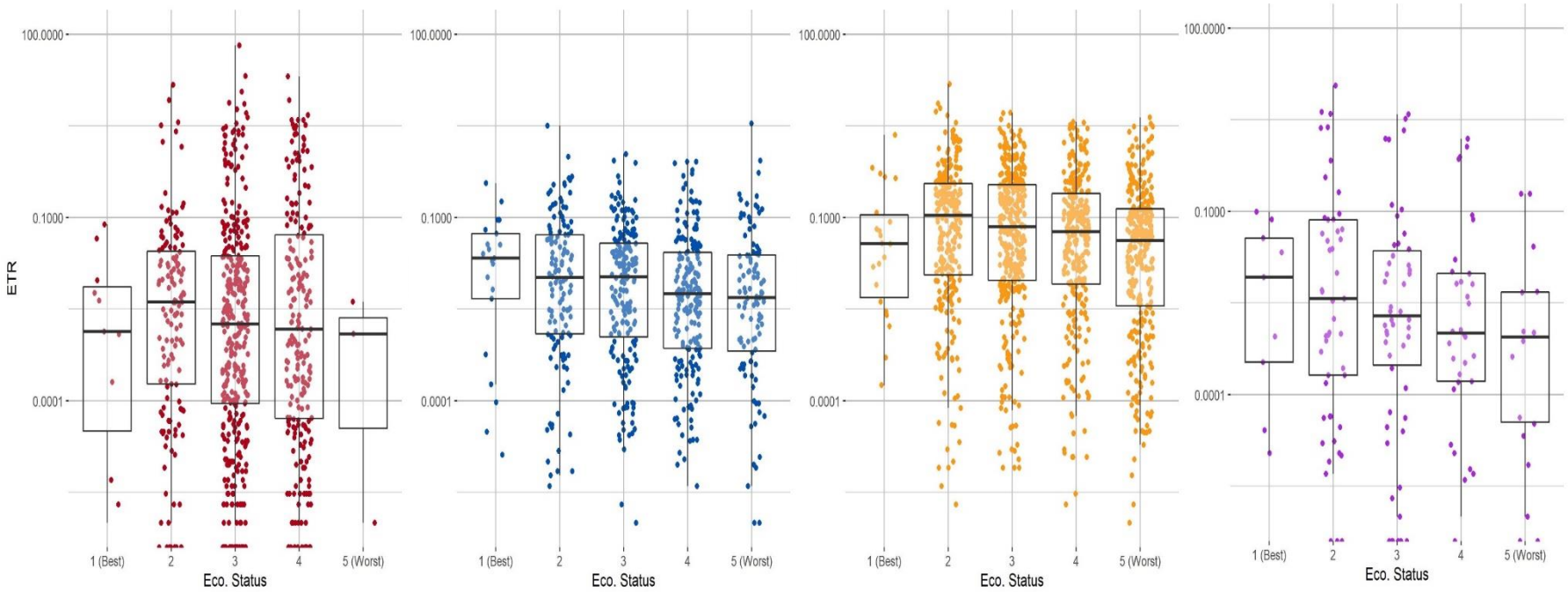
Thanks to Inka Marie Willms (BASF) for results visualization

PPP ETR v ecological status





Chronic ETR v ecological status:
algae (red), fish (blue), macroinvertebrates(yellow), macrophytes(purple)



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Conclusions

- Few ecological data sets sufficiently comprehensive, consistent and extensive for use in EU-wide chemical risk assessment
- Demonstrated capability for feasible geo-spatial analysis of the relationships between ecological status and chemical risk
- Case studies demonstrated that ecological risk assessment, and subsequent remediation or conservation measures, can be informed by using GIS approaches to identify locations where aquatic species assemblages may be at relatively higher risk
- Framing of landscape-scale risk assessment is a critical step that requires clear statement of the question to be addressed and must consider data handling, such as aggregation, required resolution, and methods for integrating data layers

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