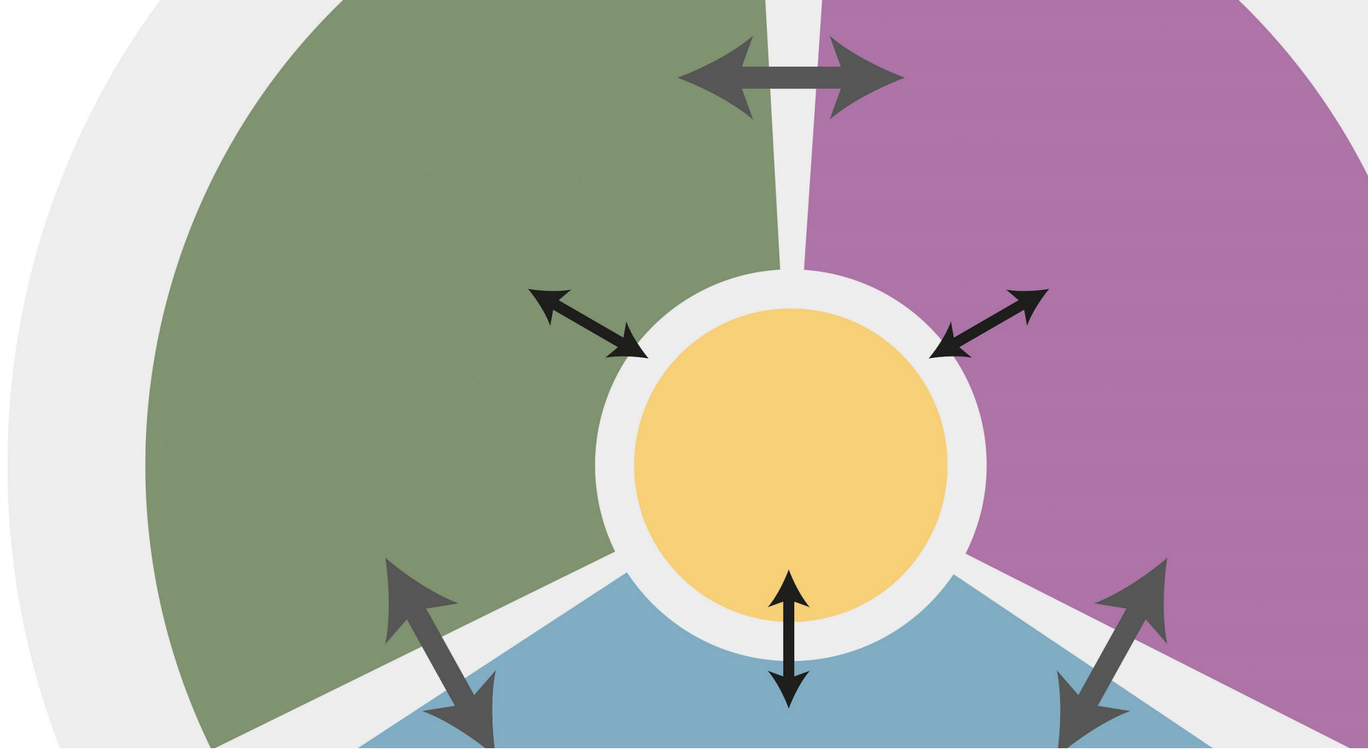
UNIVERSITÄT OSNABRÜCK

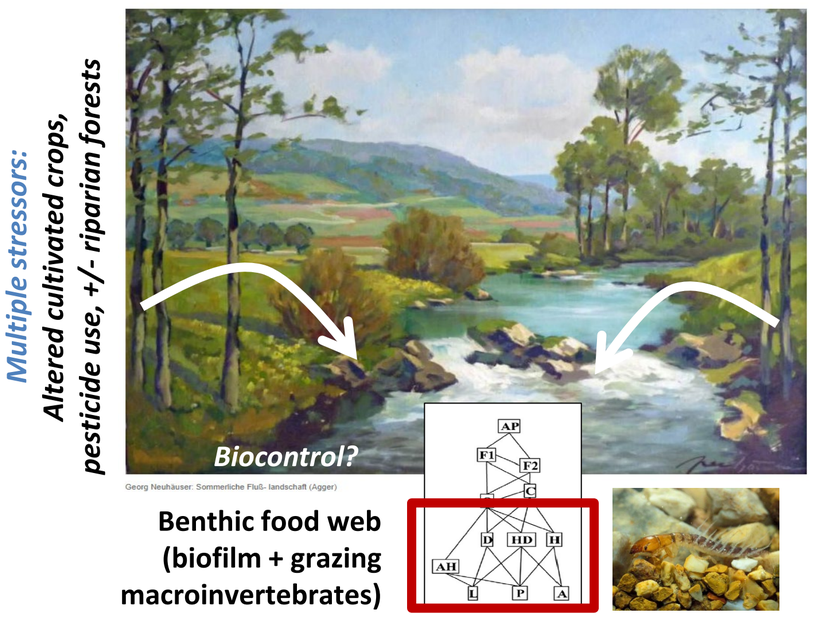
Biocontrol of eutrophication: Modeling food webs in small streams and their capacity to dam impacts from agriculture



A2. Ecosystem dynamics

Motivation & Innovation

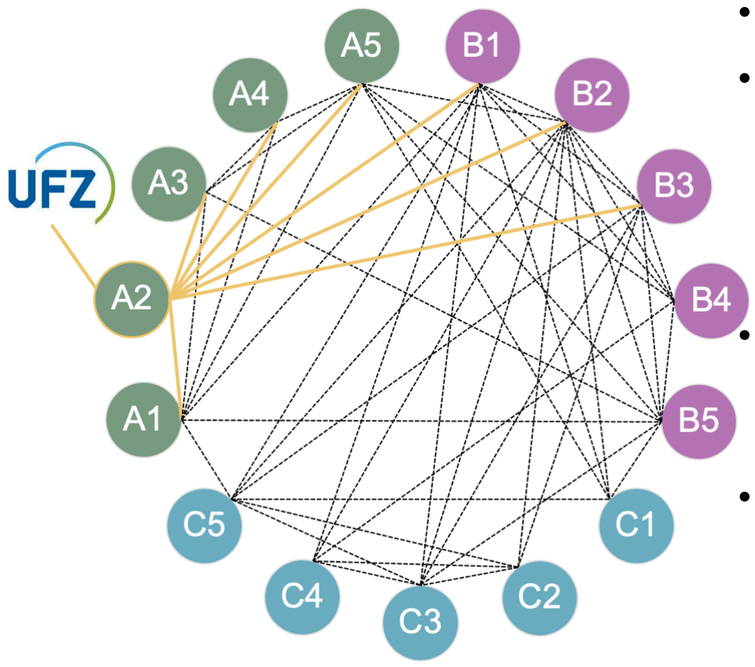
- Intensive agriculture can cause **water quality problems** such as ‘eutrophication of streams’[2]
- Insufficient: mere fertilizer reduction[5] (hysteresis)
- Often overseen: **capacity of instream food webs** to ‚biocontrol‘ eutrophication[3] (ecosystem service)
- But: exposure to **multiple stressors** from climate and agriculture with unclear combined impacts



Benthic food web (biofilm + grazing macroinvertebrates)

- Needed: **Modeling framework** for causal understanding, prediction and decision-support

Linkages



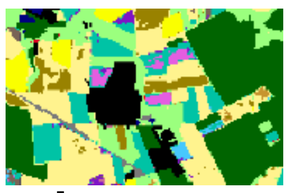
- Uses geo-data from A1
- Complements A3 and A4 by addressing small streams, low trophic levels & stressors from agriculture
- Uses scenarios for trans-formed agriculture (A5, B1)
- Uses expertise from UFZ (ecological modeling + landscape analysis + river ecology)
- Provides insights for C5

Objectives

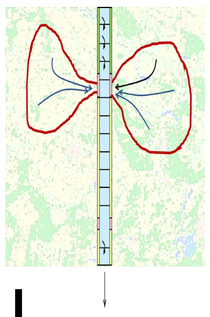
- To study the **biocontrol capacity** of food webs in small streams and their response to **multiple stressors** from agriculture in their catchment,
- To study the relevance of the **stressor regime**[1] (spatial pattern of occurrence, timing, frequency) and the impacts of **altered agricultural practices**,
- To identify **biocontrol-friendly** practices,
- To study the role of the **landscape context**

Scientific Design

- Innovatively linking a **next-generation hydro-ecological simulation model** (MASTIFF[6]) with **geo-data** from remote sensing (A1) and **scenarios** of alterated agricultural practices (A5, B1)
- Developing a **pesticide module**[4] for integration in MASTIFF (using expertise of Prof. A. Focks (IUSF))
- Integrating **food web data** from partners at UFZ



Land use classification map using
remote sensing products[7] (A1) +
crops with specific cultivation practices +
scenarios of altered agricultural land use (B1, A5))



Calculating the integral pressure
from the crop-specific stressors in the catchment on a stream section
(Land Use Intensity Index for Streams (LUIS)
=> Link to UFZ research)

MASTIFF
Multiple **A**quatic **St**ressors **i**n **F**lowing **F**ood webs

Simulating and analyzing
the induced dynamics
of the instream food web
and its biocontrol capacity

Principal Investigator

Prof. Dr. Karin Frank (IUSF and UFZ)

- Ecological theory and modeling
- Ecosystem functioning under climate risks and transformative land use change
- Mechanistic approach to multiple stressors based on disturbance / resilience theory

References

[1] Brooks, P. R., & Crowe, T. P. (2019). Combined Effects of Multiple Stressors: New Insights Into the Influence of Timing & Sequence. *Frontiers in Ecology & Evolution 7*, Article 387.

[2] EEA (2020). Water & agriculture: Towards sustainable solutions. EEA. Report 17/2020.

[3] Iannino, A., et al. (2021). Feedback between bottom-up & top-down control of stream biofilm mediated through eutrophication effects on grazer growth. *Scientific Reports 11*, 21621.

[4] Jager, T., et al. (2011). General unified threshold model of survival. A toxicokinetic-toxicodynamic framework for ecotoxicology. *Environmental Science & Technology 45*(7), 2529-2540.

[5] Martin, S. L., et al. (2021). The land use legacy effect. Looking back to see a path forward to improve management. *Env Res Lett 16*, 035005.

[6] Meier, L., et al., & Frank, K. (2022). MASTIFF: A mechanistic model for cross-scale analyses of the functioning of multiple stressed riverine ecosystems. *Ecological Modelling 470*, 110007.

[7] Preidl, S., et al. (2020). Introducing APiC for regionalised land cover mapping on the national scale using Sentinel-2A imagery. *Remote Sensing of Environment 240*, 111673.