Advancing Modelling for Better River Governance

Insights from SGGW

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Outline

- Activities within the LIFE SIP Vanduo project
  - Surface water modelling improvements
  - Connection to river basin management
- SGGW European projects
  - Integration of agricultural pollution and climate impact models
  - Different modelling tools, approaches for improved water management

LIFE SIP Vanduo – Integrated Water Management in Lithuania

Duration: 2024–2033 | Budget: €19M | Team: 200 experts | Partners: 15| Coordinator: APVA

Goal: Implement the National Water Sector Plan (2022–2027), prepare the next 2028–2033 plan and achieve good status of all Lithuanian surface and marine waters.

Work Packages:
1️⃣Management & Coordination
2️⃣Efficient Water Resources Management
3️⃣Measures to Improve Water Bodies
4️⃣Complementary Funds & Coordination
5️⃣Sustainability & Replication

Key Measures
🌾 Nutrient & pollution reduction in agriculture
🌊 Restoration of rivers & lakes (biomanipulation, morphology)
🏭 Advanced WWTP technology (Klaipėda pilot)
☔ Stormwater & micropollutant control
🤝 Cross-border cooperation (LV–EE–PL)

Impact:
✅ Improved water quality & ecosystem health
✅ Stronger institutions & monitoring systems
✅ Mobilized €825M in complementary funding
✅ Model for integrated water management in the Baltics

Targets by 2027:
✅Water bodies in good status – 38% ➜ 90%
✅At risk from agri-pollution – 490 ➜ 49
✅Hydromorphologically altered – 28% ➜ 23%
✅Baltic Sea indicators in good status – 0% ➜ 6%

SGGW – Scientific & Technical Lead for Surface Water Modelling

Warsaw University of Life Sciences (SGGW) in LIFE SIP Vanduo Project

Leads modelling in the LIFE SIP Vanduo Project, developing tools to assess and manage water quality in Lithuania.

Developing Integrated Modelling System

- Expands and maintains river basin tools:
  - Upgrades River Model System (SWAT+).
  - Integrates open-source WET Lake model.
- Assessing Climate Impact and Measures
  - Enhances models to simulate climate change scenarios.
  - Evaluates measures to reduce TN/TP pollution.
- Remote Sensing Development
  - Updates satellite-based systems for better land use classification and lake water quality screening.

Connection to river basin management objectives

Lithuania's custom River Modelling System (SWAT+)

By Lithuanian Environmental Protection Agency is used for:

💧 Environmental reporting (WISE, Nitrate Directive, HELCOM)

📊 Impact assessment (point sources, measures, climate change)

🔄 Integration of multiple pressures

🗺️ River Basin Management Planning

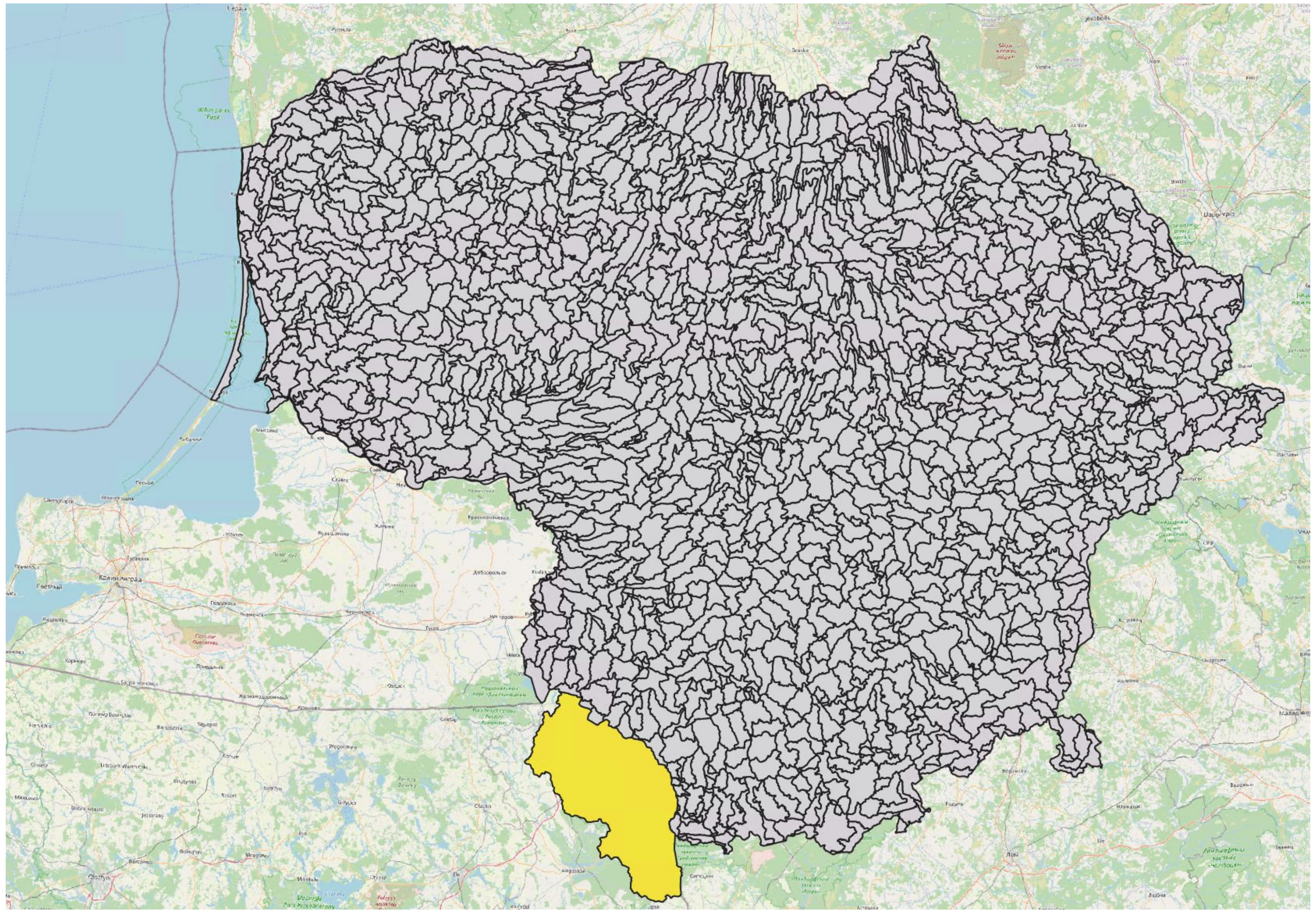
SGGW advising, QA, updating, upgrading, adding features

Transfer of tools to the Polish pilot area

✅ Approx. 2,006 km² transboundary area adjacent to Poland, with rivers flowing into Lithuania.

✅ The same modeling tools will be applied in this area.

✅ Better estimation of incoming discharge and loads to the Nemunas from its headwater region in Poland.



Examples of results to date…

Additional tools

✅Land Use Data Processing https://github.com/biopsichas/lu_update

✅Update Statistical Information https://github.com/biopsichas/swat_lt_stats_in

✅Point source impact estimation https://github.com/biopsichas/ps_in_ltswat

🟡Building SWAT+ with LT system for Polish area

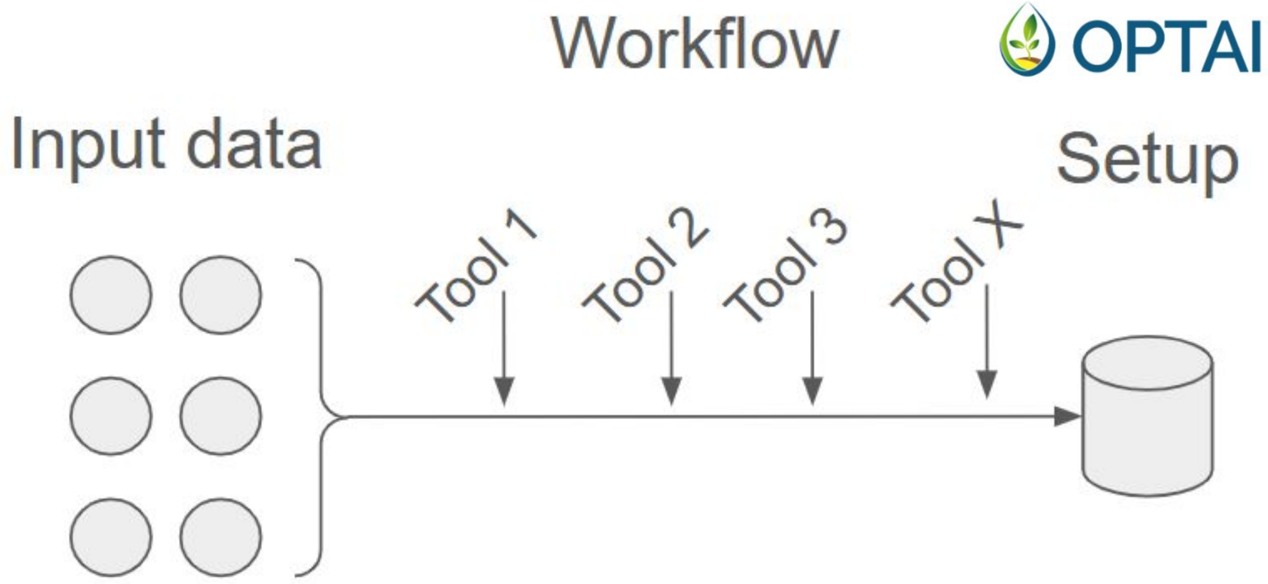
Articles

✅ From a test case to a trusted tool: Lithuania’s evolving SWAT system for water and agricultural management https://doi.org/10.22630/srees.9790

🟡SWATtunR: A Transparent and Reproducible Workflow for Scripted SWAT+ Calibration in R (in review)

New tools

- **SWATbuildR** - R tool for building SWAT+ setups;
- **SWATprepR** - SWAT+ model input data preparation helper. The package is presented in the article Plunge, Szabó, et al. (2024);
- **SWATfarmR** - R tool for preparing management schedules for SWAT model;
- **SWATdoctR** - A collection of functions in R and routines for SWAT model calibration and model diagnostics. The package is presented in the article Plunge, Schürz, et al. (2024);
- **SWATrunR** - R tool for running SWAT models for different parameters and scenarios.
- **SWATtunR** - R tool soft & hard calibration, validation package for SWAT+ models
- **SWATmeasR** - R tool for implementing NSWRMs in the SWAT+ models and running scenarios.



SWATprepR
SWAT+ input data preparation

SWATdoctR
Model diagnostics tool for SWAT+ model setups

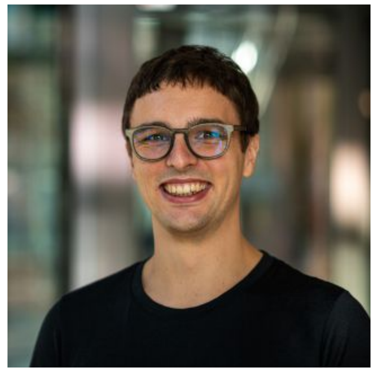
SWATrunR
Running SWAT simulations in R

SWATmeasR
Implementation of NSWRMs in SWATbuildR model setups

SWATbuildR
An object connectivity based SWAT+ model builder

SWATfarmR
Simple rule based management operation scheduling

SWATtunR
Tuning SWAT+ model parameters



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Michael Strauch

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Helmholtz Centre for Environmental Research - UFZ

OPTAIN

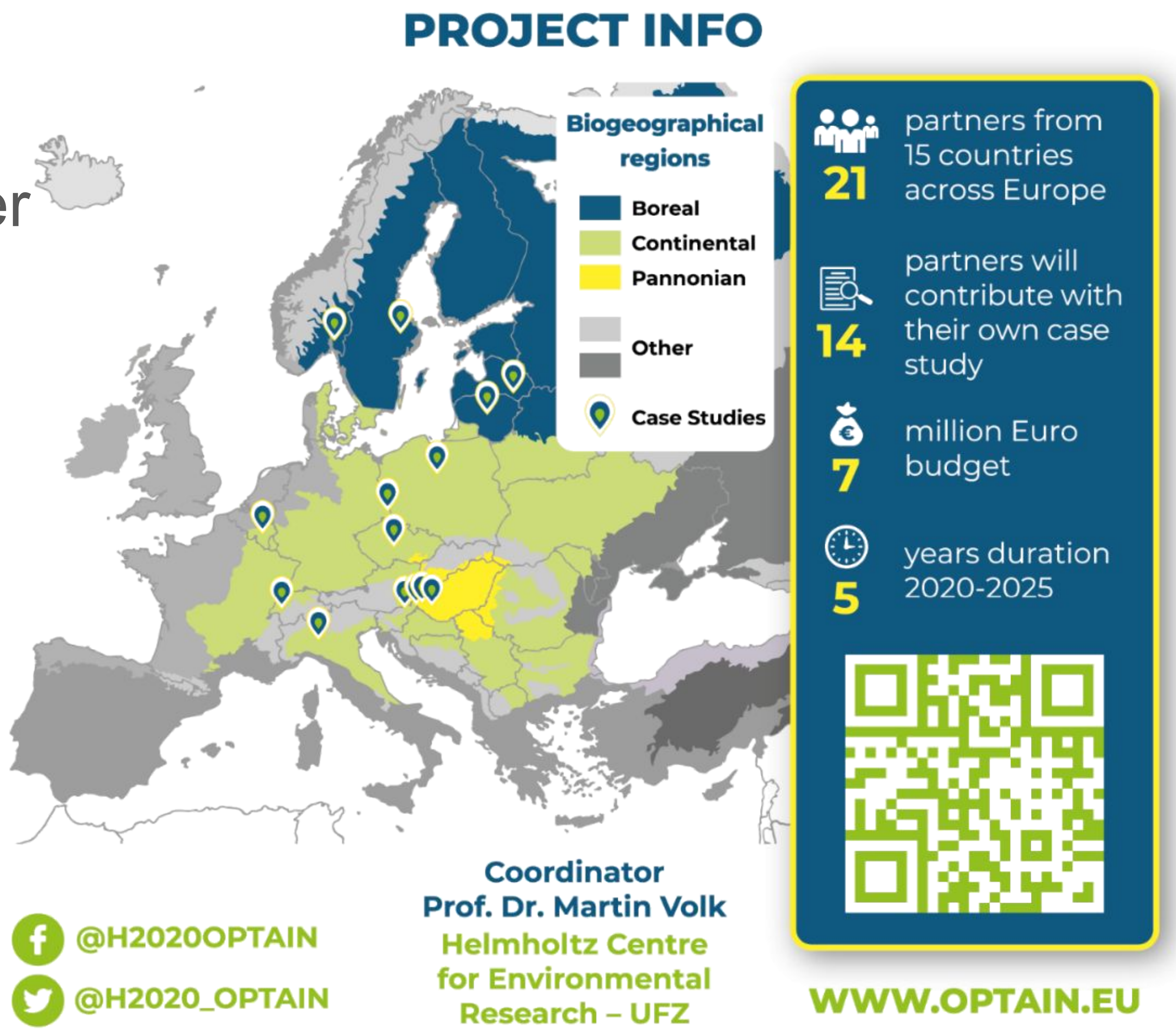
Optimal Strategies to Retain Water and Nutrients

OPtimal strategies to retAIN and re-use water and nutrients in small agricultural catchments across different soil-climatic regions in Europe 2020-2025

- Improve understanding of NSWRM multiple benefits
- Identify efficient, practical techniques for water & nutrient retention in small catchments (Boreal–Continental–Pannonian)
- Optimize spatial allocation and combinations using environmental & economic indicators

Core elements:

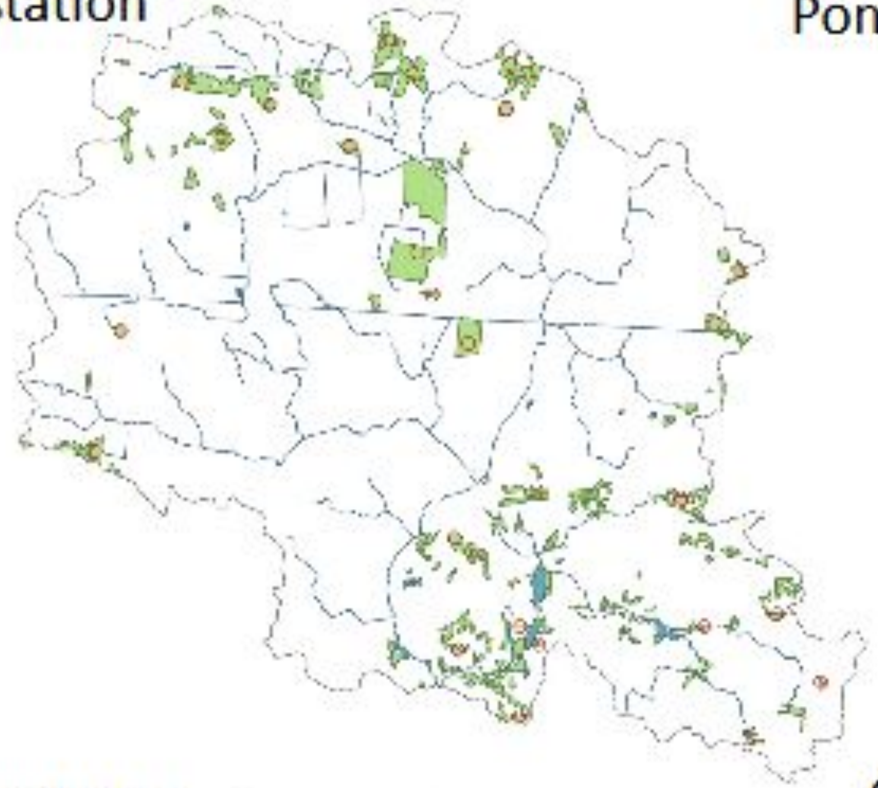
👥 Multi-Actor Reference Groups, 🌍 Potential & constraints, 🔬 Modelling , 🎯 Multi-objective allocation, 🧭 Policy recommendations, 📚 Learning environment



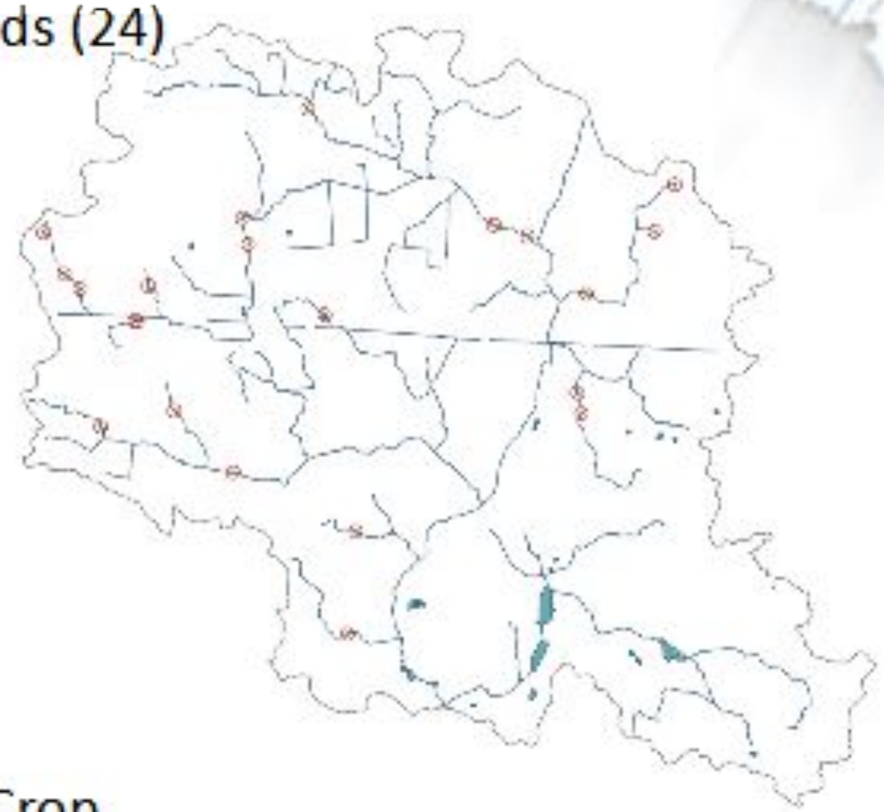
Location of measures (maximum potential implementation in simulated scenarios)

Location in country

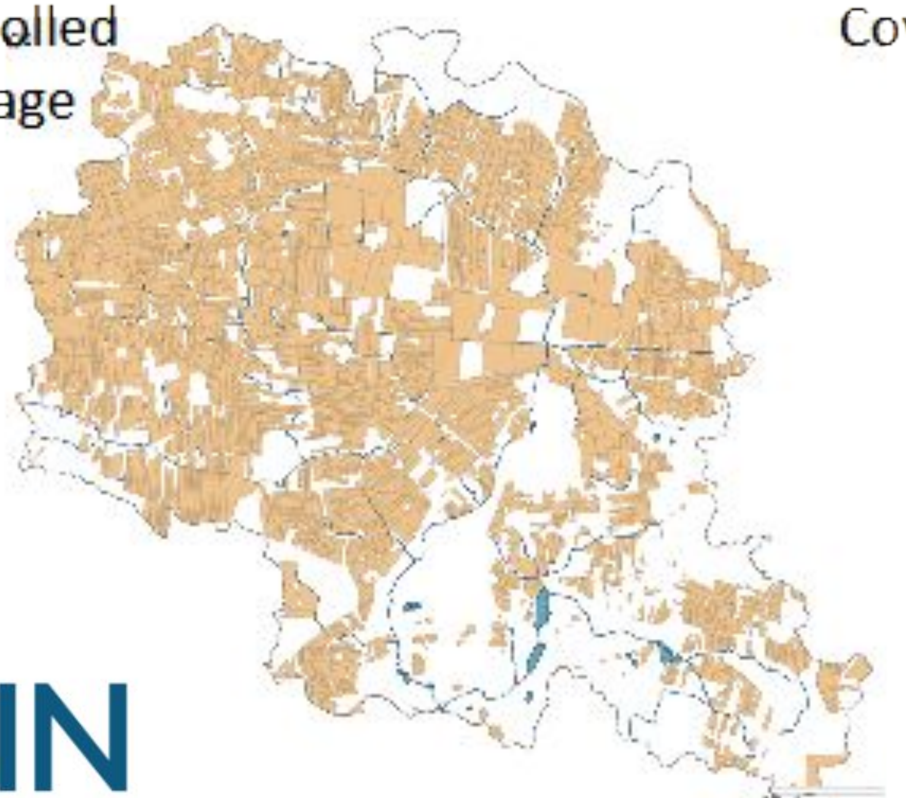
Afforestation



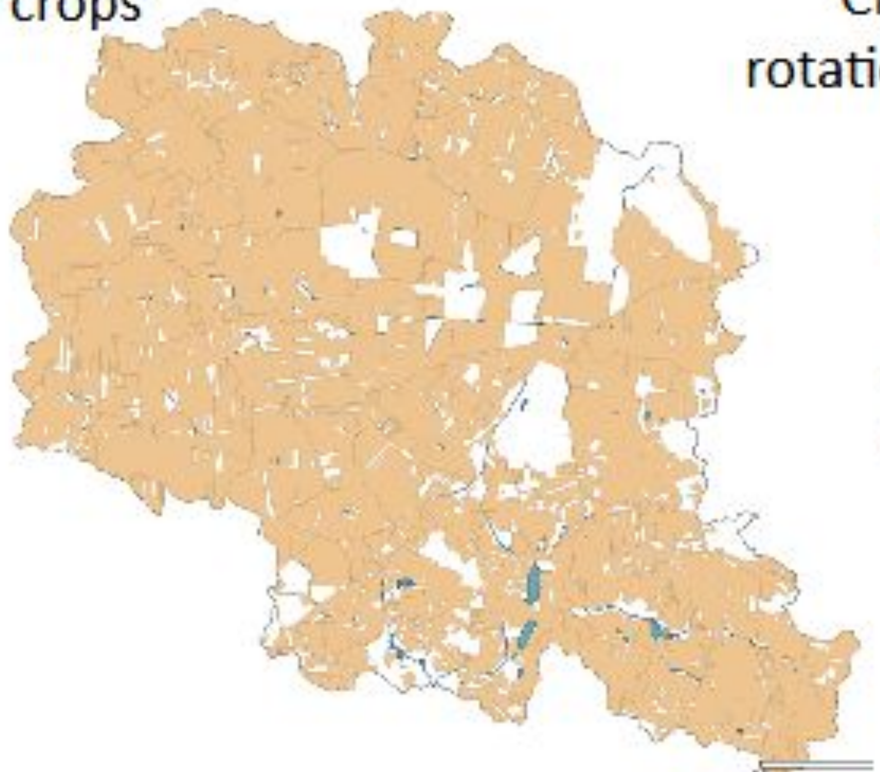
Ponds (24)



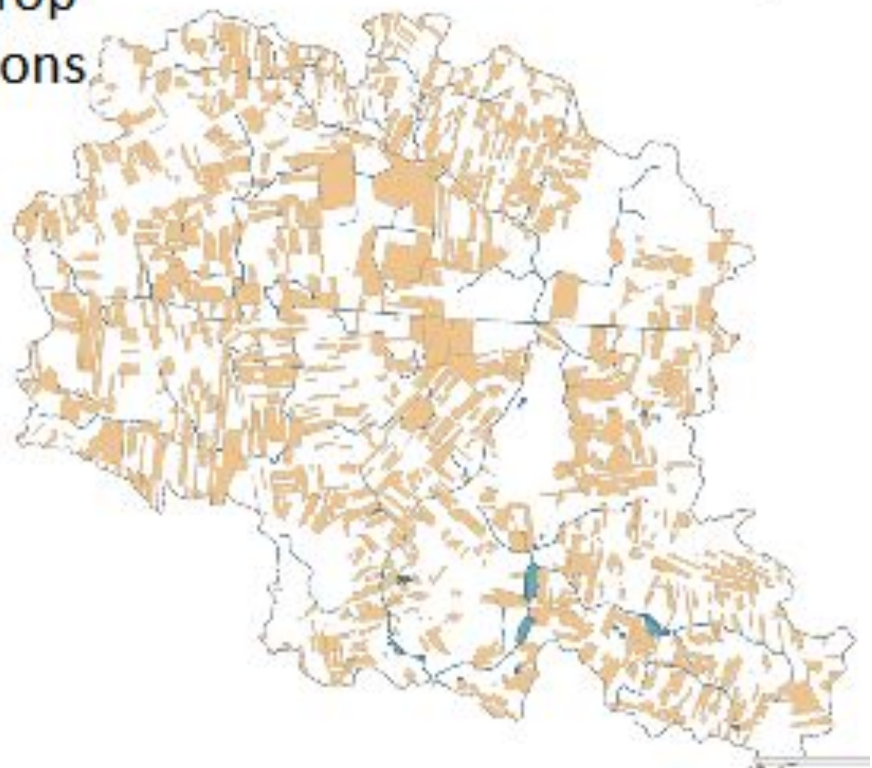
Controlled drainage



Cover crops

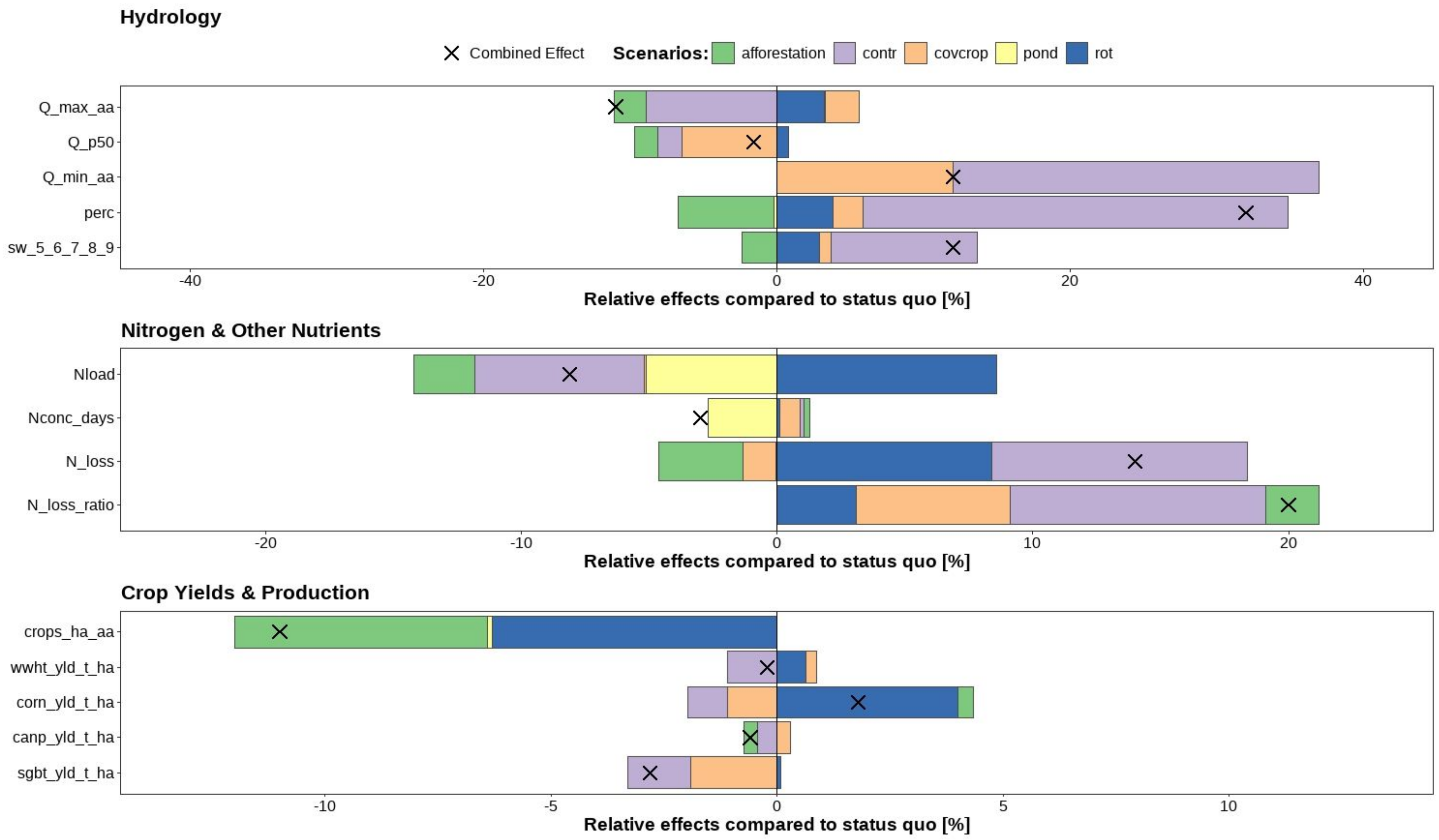


Crop rotations

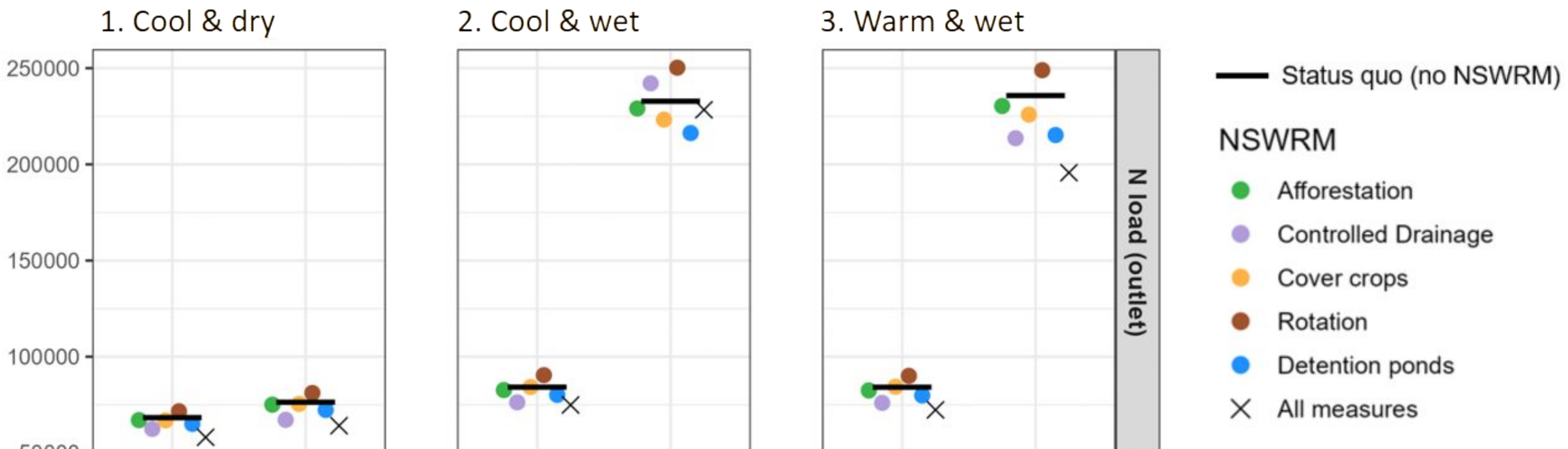


OPTAIN

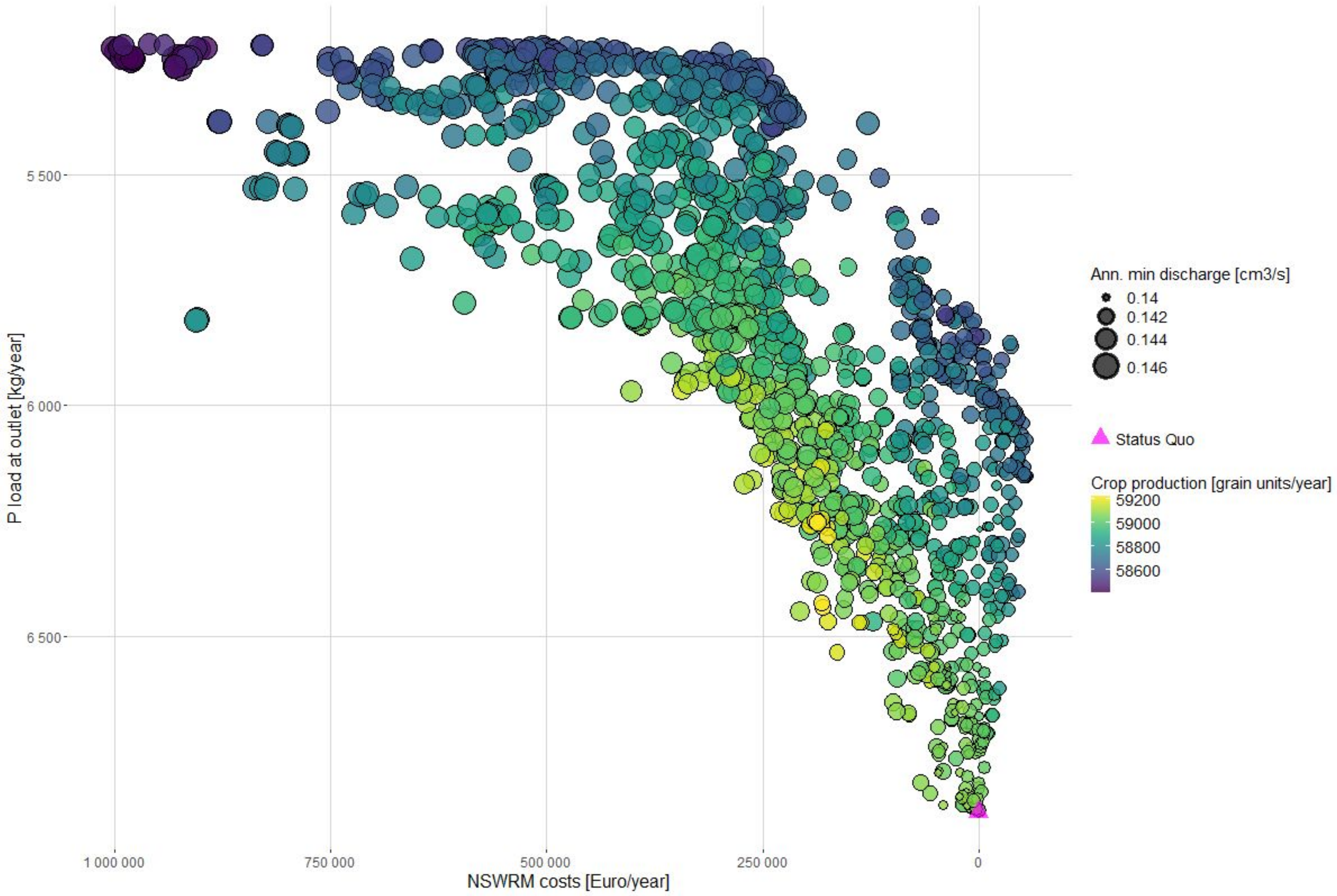
NSWRM effectiveness current climate

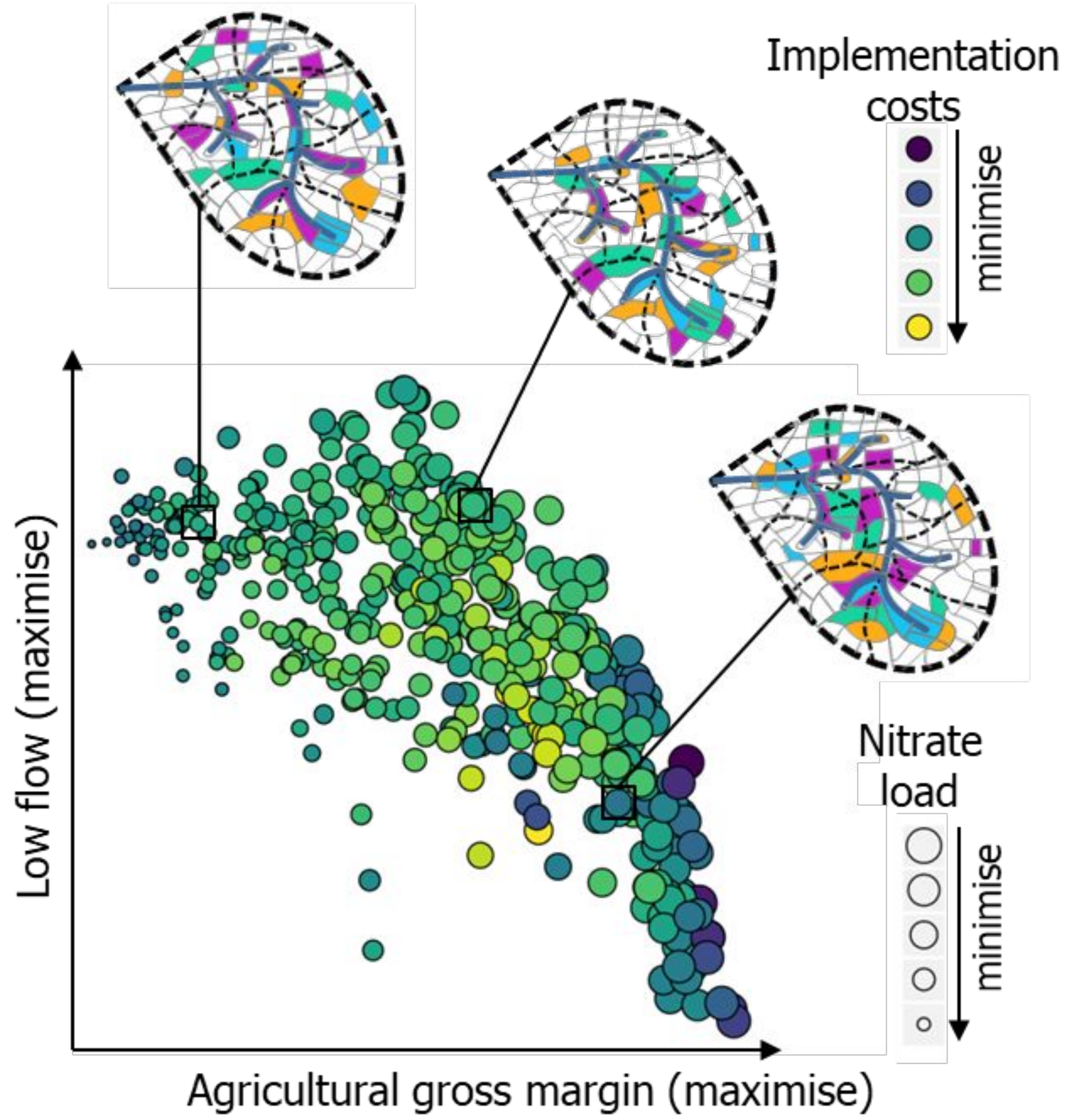


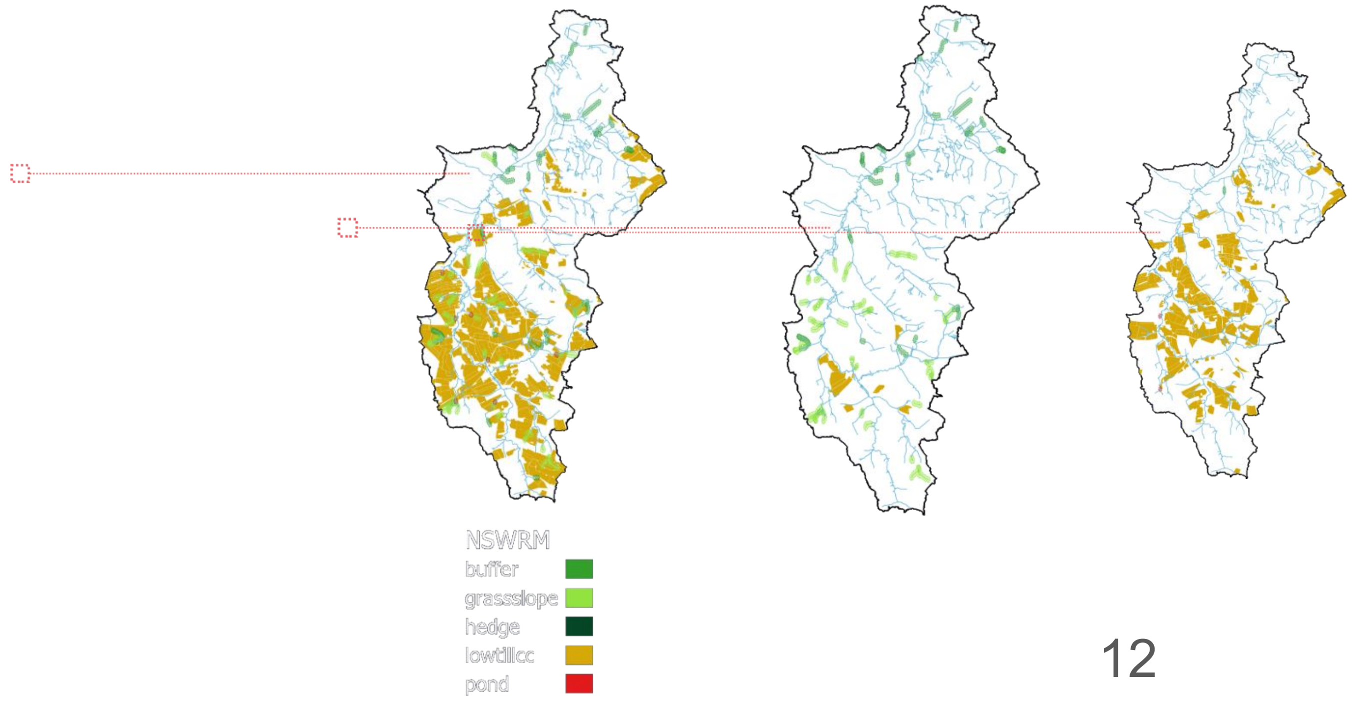
NSWRM effectiveness future climate (TN loads)



Multidimensional optimisation with COMOLA and ParetoPickR







Strauch, M. & C. Wittekind (2025): Results of stakeholder surveys on preferred NSWRM implementation plans. Deliverable D5.3 EUHorizon 2020 OPTAIN Project, Grant agreement No. 862756

Keeping Nordic–Baltic waters within safe nutrient limits

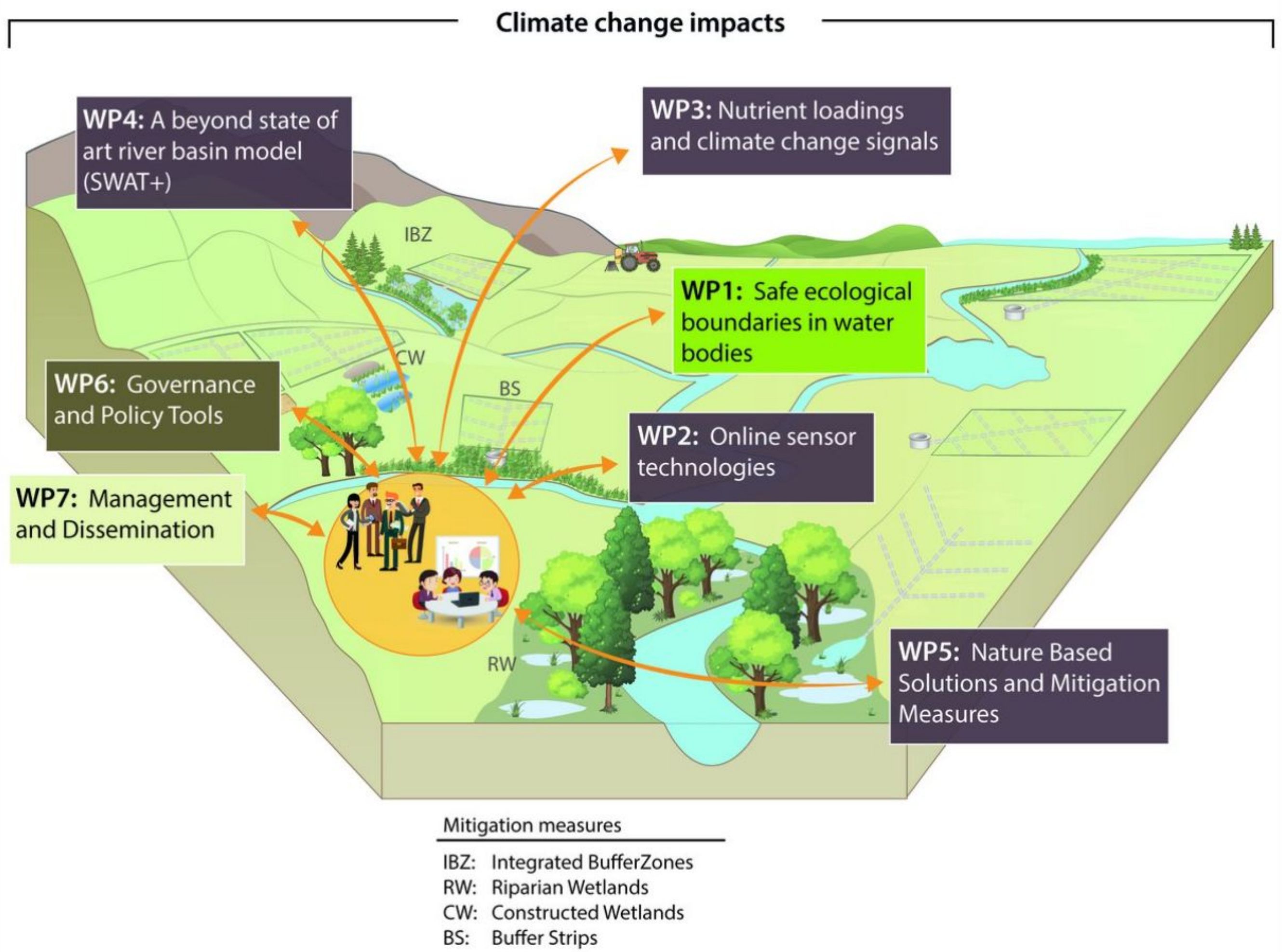
Reduce and maintain N & P concentrations within safe ecological boundaries.

Project duration:
01.09.2022
31.08.2025

- **Set nutrient boundaries** – Define ecologically safe limits for diverse water bodies
- **Improve monitoring** – Test high-frequency sensors vs. traditional sampling
- **Find tipping points** – Link nutrient loads to carbon balance & emissions
- **Unify modelling tools** – Develop harmonised basin-scale nutrient models
- **Showcase NBS & measures** – Demonstrate practical, nature-based solutions
- **Support governance** – Strengthen regional capacity to apply best measures

🗺️ Platform: Six pilot basins & monitoring sites under HELCOM / OSPAR

Overview of the workpackages



Cross-REalm modelling and assessment of Aquatic ecosystem services: Towards a science-based design of nature-based solutions to tackle Eutrophication.

CREATE

🌐 Link freshwater, coastal, marine ES models.

🗺️ Map ES: Key services, trade-offs, synergies.

📍 Spatially prioritize NBS for max ES benefits.

🧩 Integrate scales: Copernicus, Sentinel, monitoring, UAV data.

💡 Build decision tools for NBS prioritization.

🏛️ Promote policy integration for NBS in water/ES management.

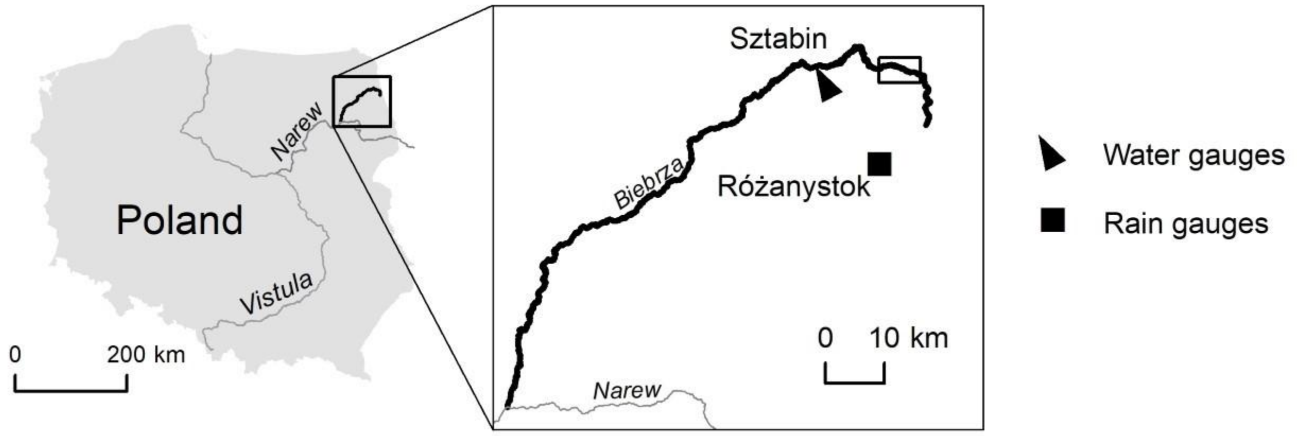
Project duration:
01.03.2025
29.02.2028

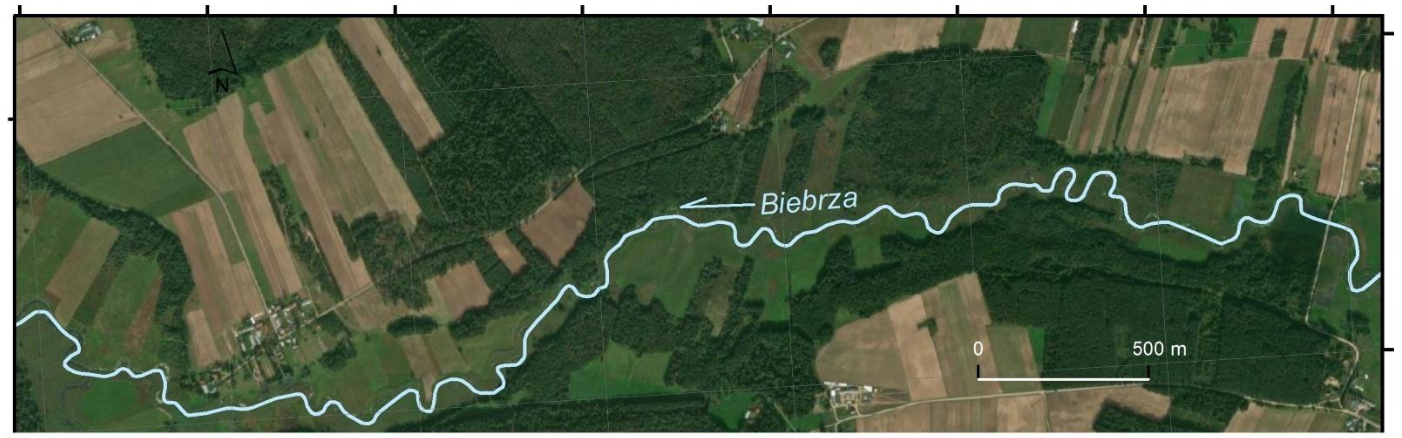
Evidence and Solutions for improving SPONGE Functioning at LandSCAPE Scale in European Catchments for increased Resilience of Communities against Hydrometeorological Extreme Events

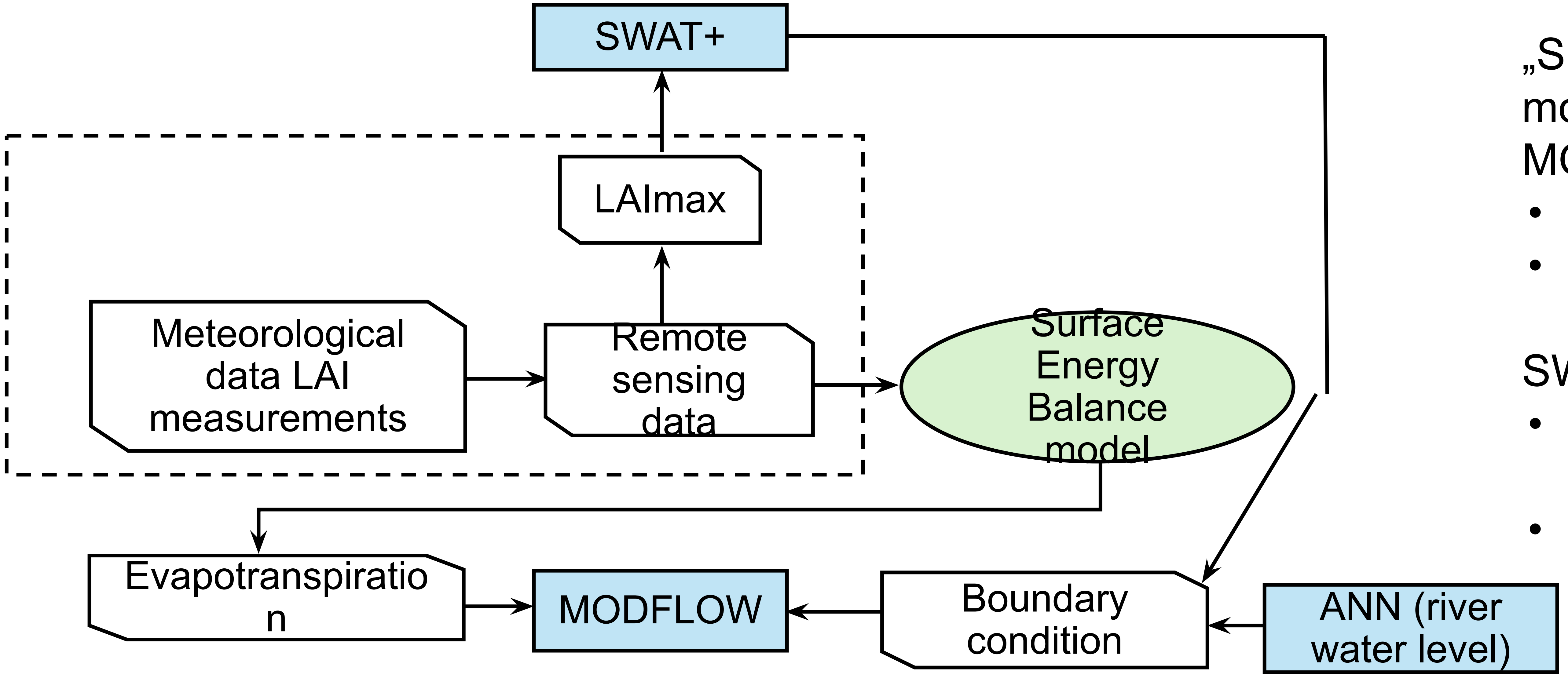
Project duration:
01.10.2023
30.09.2027

- Develop an evidence-based framework to assess sponge functioning
- Test sponge performance under varying hydrometeorological conditions
- Develop methods to upscale from local measures to landscape-level strategies
- Engage regions and communities in sponge planning
- Ensure user-friendly access to data and knowledge

Integrated surface-groundwater modelling framework to assess „sponge" measures







„Sponge" scenarios to be modelled

MODFLOW

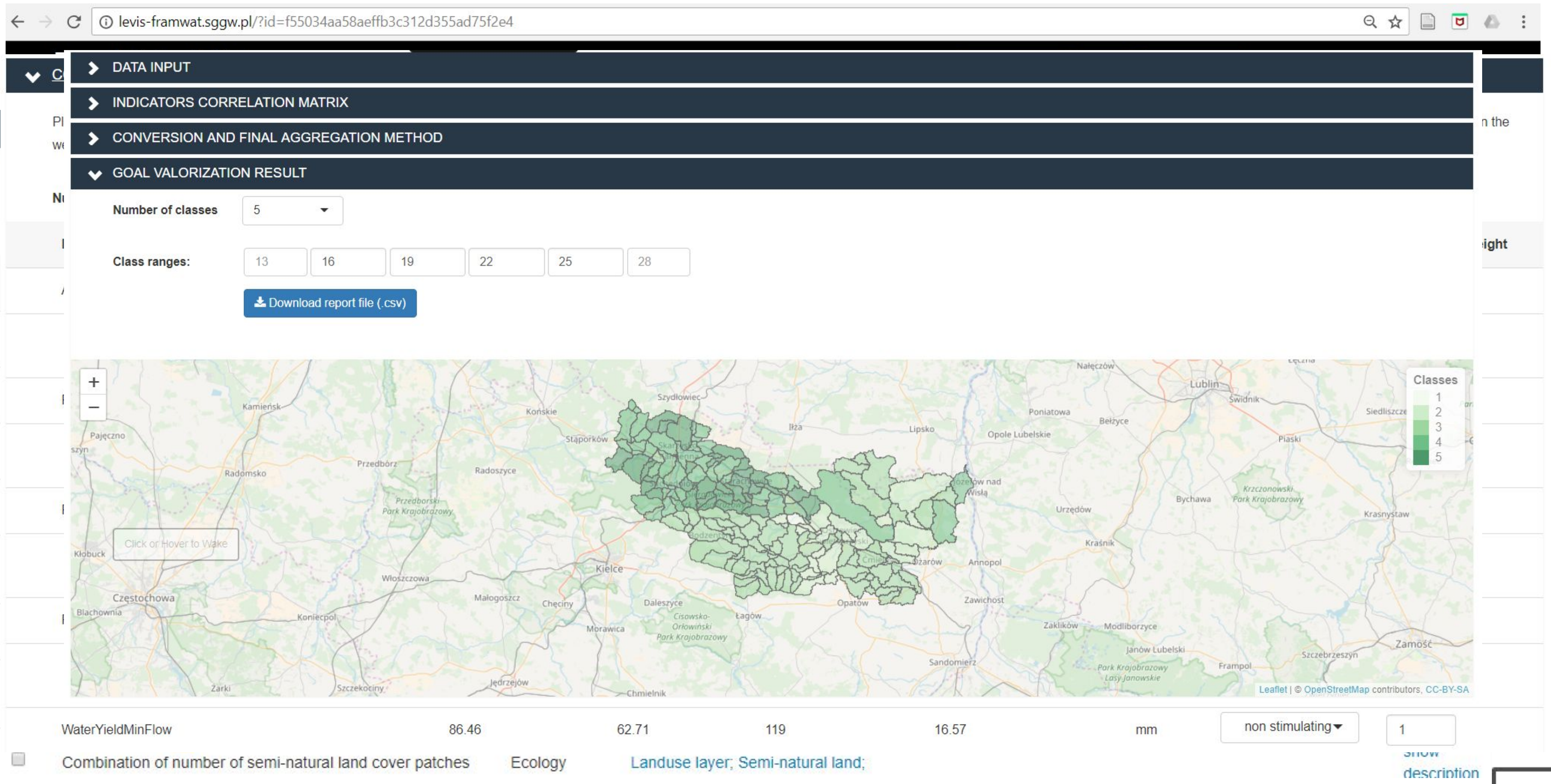
- Rewetting of drained wetlands
- Abandonment of mowing of wetland vegetation

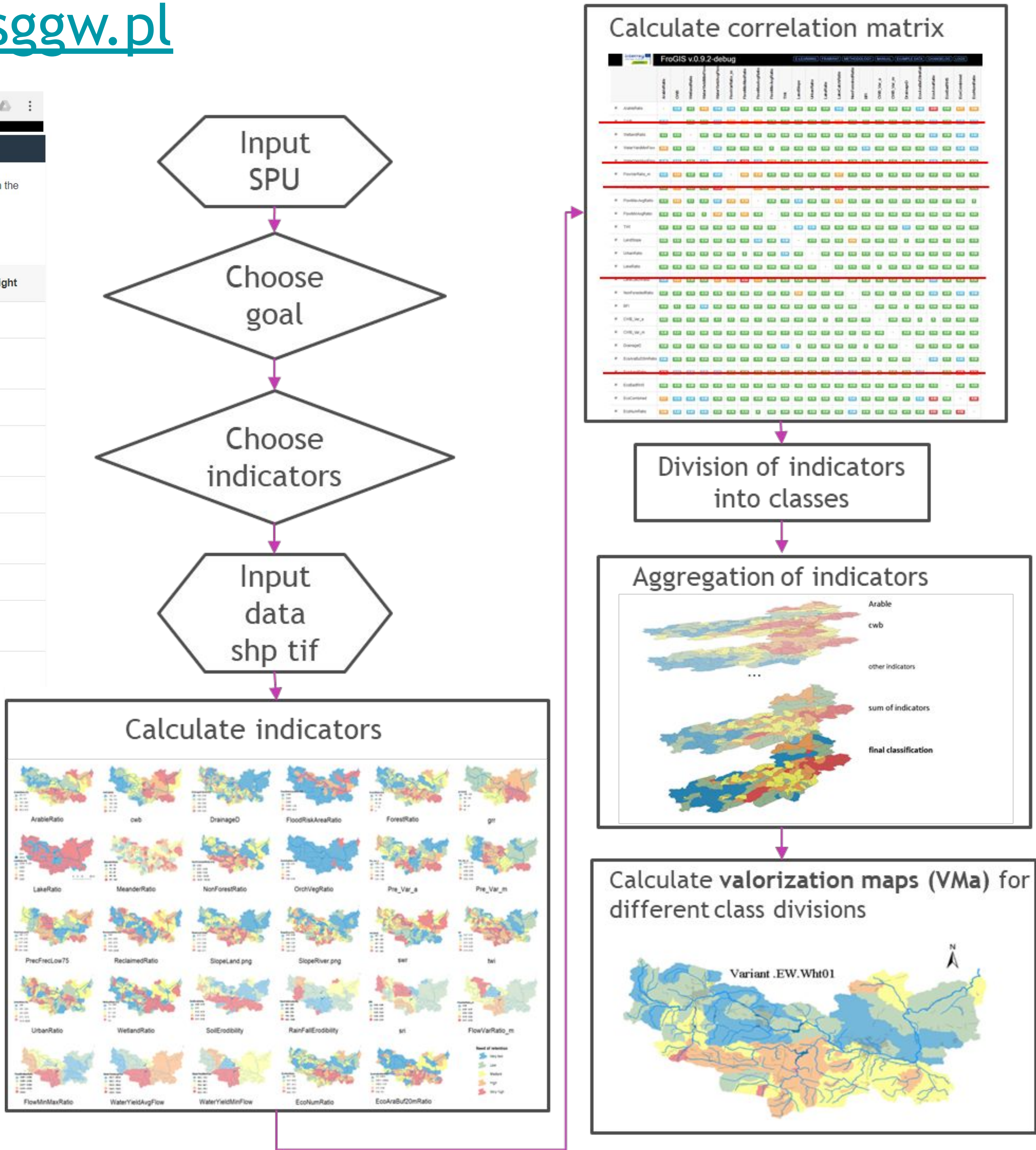
SWAT+

- Ditch blocking on drained fields
- Extensification of agriculture (corn => permanent grassland)

FroGIS

https://waterretention.sggw.pl





Web application for analysis of needs and possibilities of water retention at the catchment scale
Open source, freely available online, can by installed on Unix, OS or Windows

Final remarks

- Scripted workflows
- Integration of multiple models
- Integration of multiple data sources
- Cross validation
- Adaptation to climate change and green infrastructure

Thank you