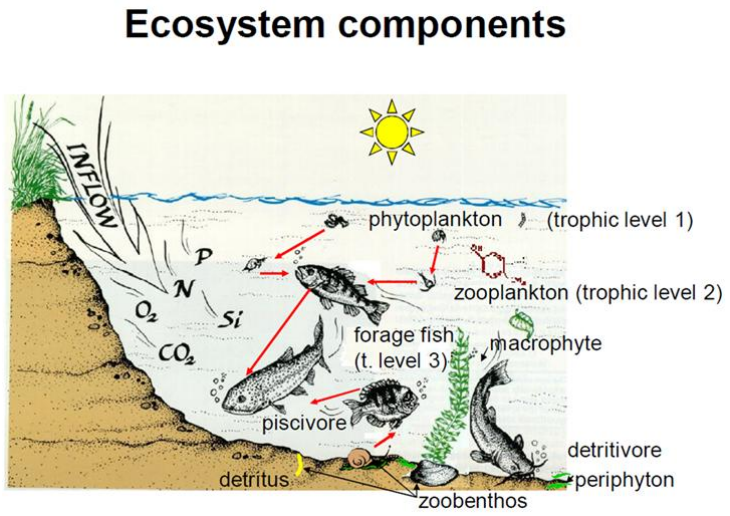
Kallavesi Model

”Modelling towards better environmental impact assessment”

Webinar 30 Sep 2026

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UNIVERSITY OF EASTERN FINLAND

SAVO-KARJALAN VESIENSUOJELUYHDISTYS SKVSY

Pohjois-Savon liitto

Euroopan unionin osarahoittama

Presentation Contents

- Objectives for this webinar
- Basic information and objectives of the Kallavesi project
- Modelling in this project
- The Aquatox model
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- The Aquatox model
- Modeling work in practise for Kallavesi
- Model creation and calibration
- Modeling scenarios
- Outlook towards the end of the project and after that

Webinar Objectives

- Make potential stakeholders aware of the project, as we need strong collaboration
- What are the future development directions and plans related to Lake Kallavesi, so that we can steer the project in the right direction, particularly regarding modelling?
- Enhance the project's modelling-related guidelines for the next steps
  - What is needed as an output of the project
  - How do you plan to utilize the results of the project
  - Find new collaboration and collaborators

Basic Project Information

- Project name: "Kallavesi Model - better and more efficient environmental impact assessment of water bodies"
- Start date 1 May 2025
- End date 30 April 2027
- Priority axis: 7 Just Transition Finland
  - 7.1 Regionally just transition away from peat
- The project is implemented as a group project
  - Group project ID R-02110
- Group project partners:
  - University of Eastern Finland (UEF): lead partner
  - Savo-Karjala Water Protection Association ry (SKVSY): sub-project partner
- Co-funding companies: Envineer Oy, Yara Suomi Oy, Vesi-Eko Oy, Kuopion energia, Boliden Kylylahti Oy, Mondi Powerflute Oy, Kuopion Vesi Oy

Roles in the Project

- The University of Eastern Finland's role in the project is to act as the project coordinator and, in practice, **to carry out the modelling**.
- In addition, the University of Eastern Finland's role includes coordinating the project by staying actively in contact with both the project partner and the target companies.
- *The Savo-Karjala Water Protection Association* provides the project with **strong regional knowledge of the state of Lake Kallavesi**, the factors affecting it, and possible risks and threats.
- SKVSY is responsible for local and regional project **communications**, and seeks to influence decision-making by various stakeholders and to improve environmental impact assessment throughout Finland.

Project Objectives

- The project's objective is to **develop the usability of water body modelling for environmental impact assessment** across various industries such as mining, the forest industry, water supply, and agriculture and forestry.
- The project aims to **apply existing modelling solutions to northern conditions**, taking into account local characteristics such as the local species, ecosystem structure, and the seasonal cycle, including ice cover.
- The project **makes close use of research carried out at the University of Eastern Finland** as well as the results of other regional projects, for example those related to the environmental impacts of agriculture.
- The project supports and **significantly complements the monitoring, surveillance, research and studies carried out on Lake Kallavesi**, as well as the understanding of the factors affecting the lake's condition that has been built on this basis.
- The project's objective is to safeguard the good ecological status and usability of Lake Kallavesi by **producing tools for assessing the impacts of measures affecting the water body and of climate change** before they are implemented.

What is ecological lake modelling?

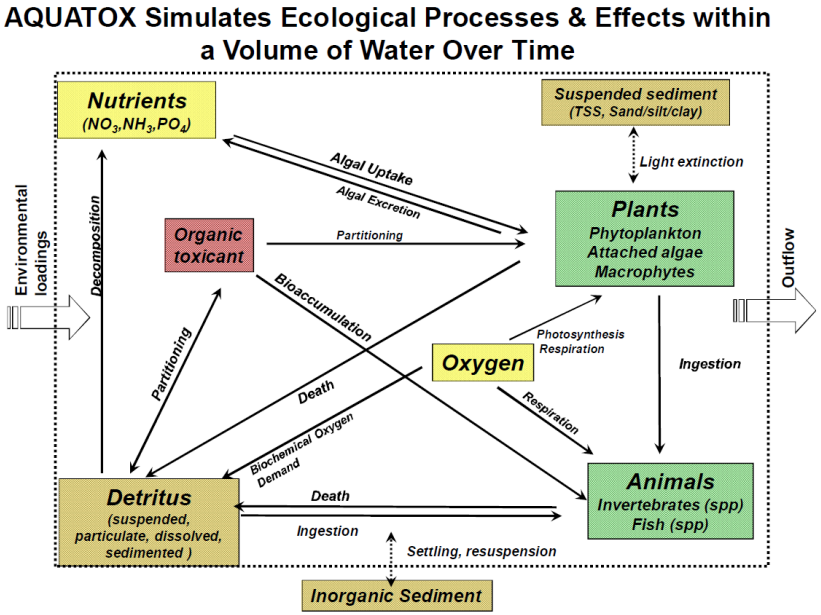
- Focuses on biological communities: plankton, fish, benthic animals, plants
- Studies food webs and the cycling of energy/substances
- Combines physics (water mass) and biology (organisms)
- Predicts the state of the ecosystem, risks, and the effects of protective measures
- NOTE! Ecological lake modelling requires input data, such as water flows and compound concentrations, from the previous level, i.e. water body modelling (produced, for example, using 3D modelling)

What tools do we use for modelling in this project?

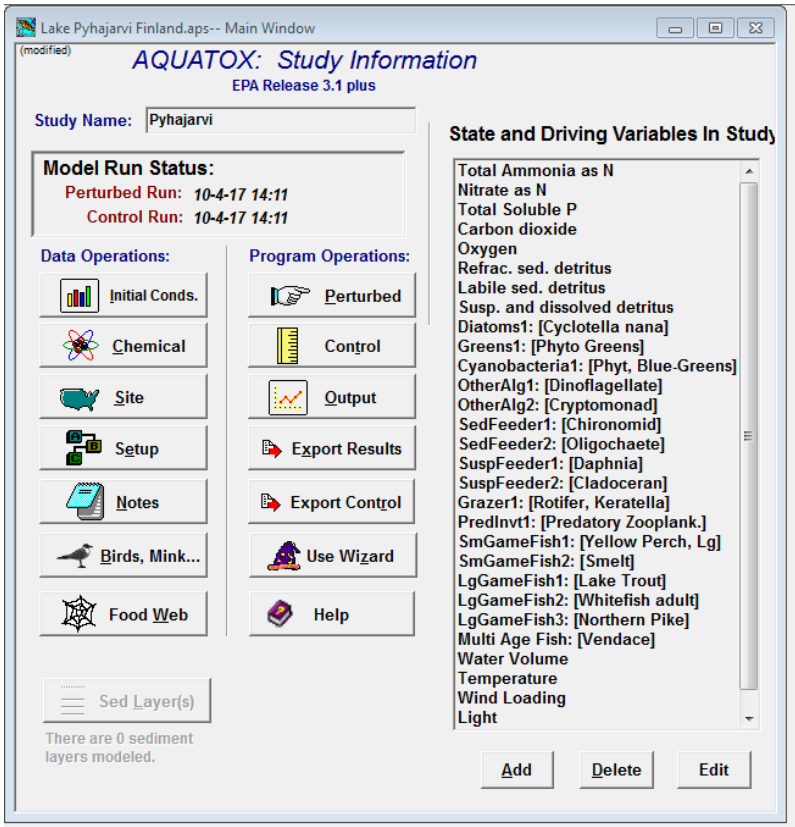
- For the ecological model, we have started with the Aquatox model developed by the US EPA, which we have used before
  - Before this, it has been used to model Pyhäjärvi (near Säkylä) and Lake Sulkavanjärvi (in Siilinjärvi, an Envineer–Yara collaboration)
- To produce flow data for the above model, we have started to use a 3D model called EEMS (commercial)
- Going forward, we will use the Vemala model to produce other input data (such as catchment area data)

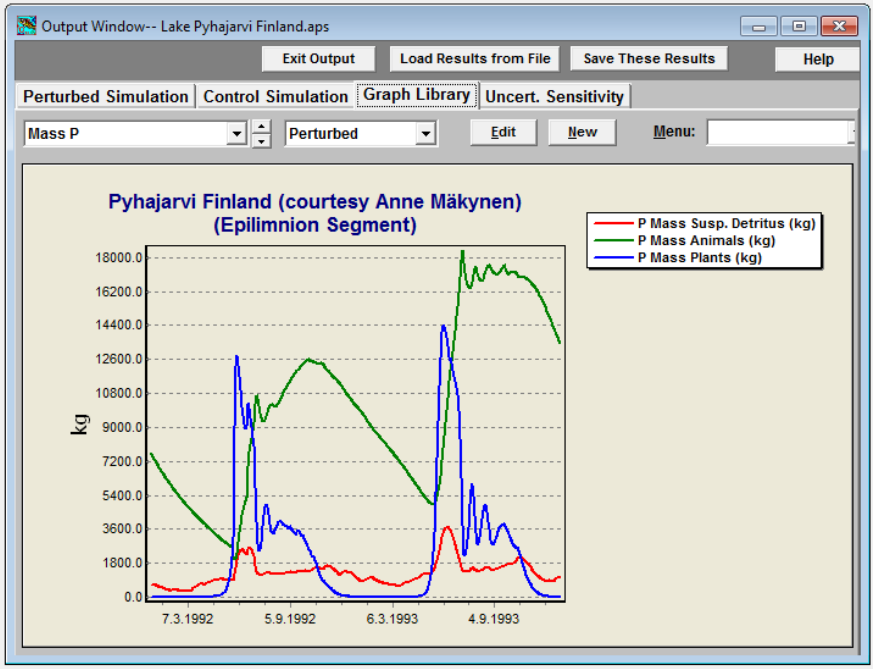
What Is the Aquatox Model?

- Aquatox is a software program for the ecological modelling of water bodies, developed by the US EPA since the 1970s
  - Freely downloadable
  - Versatile and comprehensive
  - Well documented
  - Source code available, but based on an old programming language
- Graphical user interface
- Some shortcomings, mainly related to the handling of sulfur compounds and heavy metals
- A complex model that requires extensive calibration
  - In previous projects, we have developed the calibration of the Aquatox model using evolutionary algorithms



What Does the Aquatox Model Look Like?





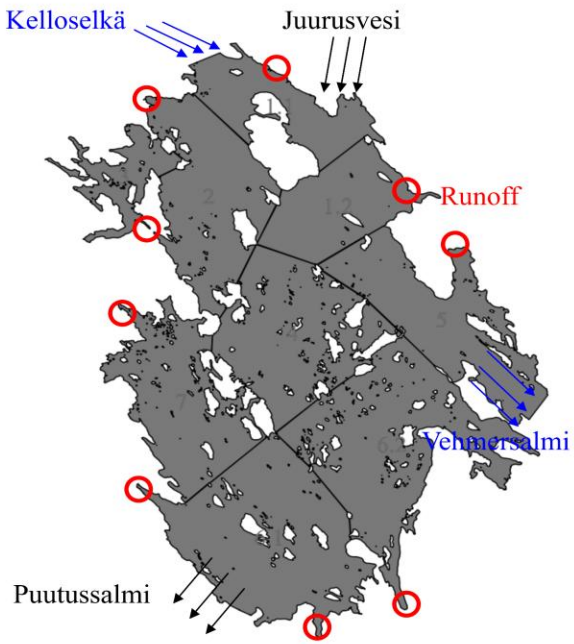
Modelling Stages

- Building the model
  - Defining the elements to be included in the model, such as species and fish species
  - Unfortunately, still a lot of manual work
- Calibrating the model
  - Defining the model's internal parameters, such as photosynthetic efficiency
  - There are about 300 of these in the Aquatox model => very complex
  - Can be done manually wit the help of sensitivity analysis included in the Aquatox
- Applying the model
  - Defining scenarios
  - Running scenarios
  - Interpreting the results, i.e. how, for example, water quality and biology changes across different scenarios

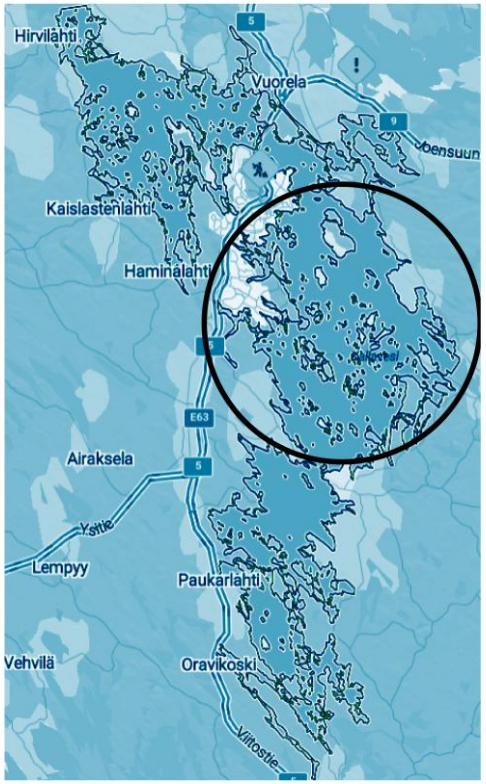
Modeling work in practise for Kallavesi

- We have defined the biology for the Kallavesi
- Part of Kallavesi has been divided into segments
- We have created and calibrated an Aquatox model for each segment using Hertta-database measurements
- Flow model for Kallavesi using EEMS has been constructed for that area
- Flows between segments are used for so called linked models in Aquatox
  - Models in segments interact with each other using the flows defined
- We have defined scenarios for Kallavesi
  - Basic scenarios to test the models
  - Complex scenarios to get more useful results

Kallavesi Model Area

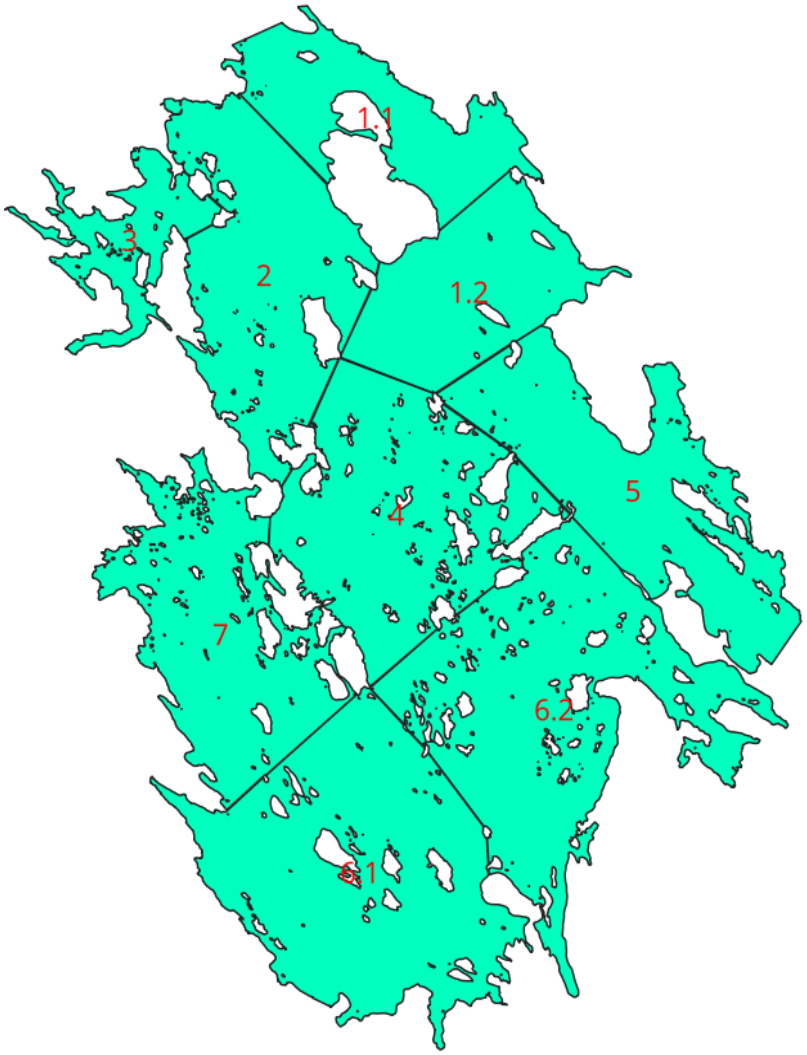


- We have focused on the middle part of the lake, the flow comes from two main sources, the upper Kelloniemi of average flow $85\,m^3/s$ and Juurusvesi with average flow of $76\,m^3/s$, and about 90% of the flow leaves the area from Puutossalmi and only about 10% from Vehmersalmi.

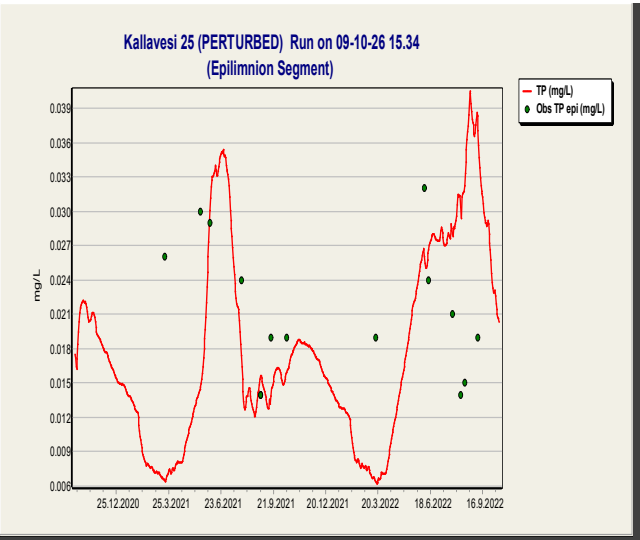


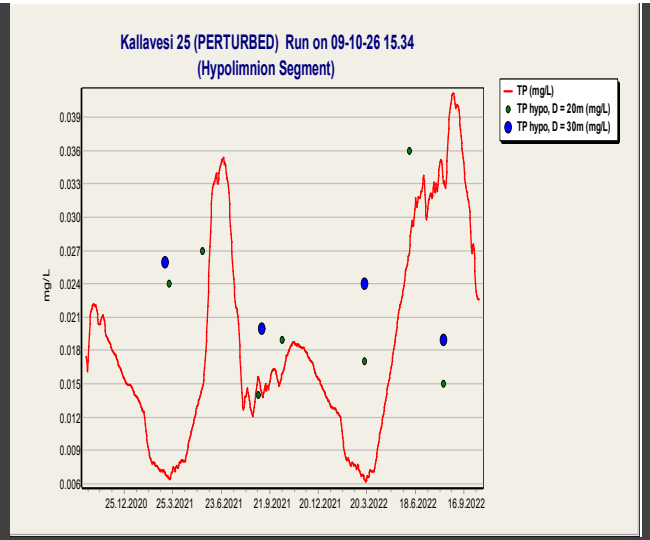
Kallavesi Lake Segmentation

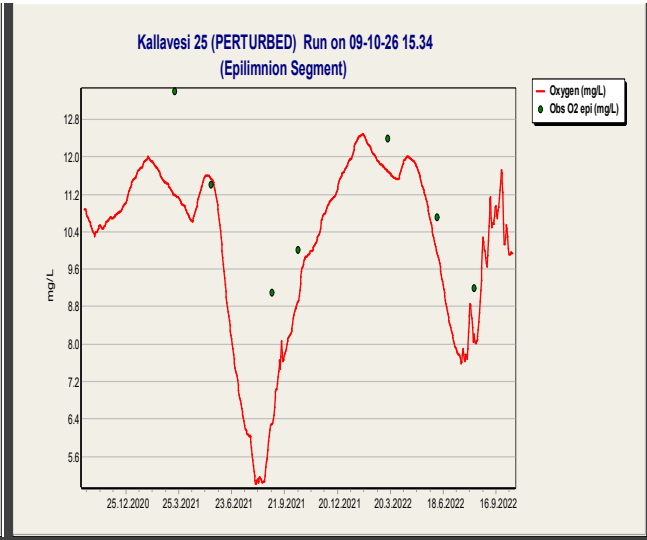
- The lake is so big and deep and it contains different heads, bights and straights, which affect the recycling of water, renewing the oxygen level, and may change the biota storage which may enhance or decrease water quality accordingly. To assess the lake in a better was we have thus segmented it into 9 pieces of different areas and shapes.

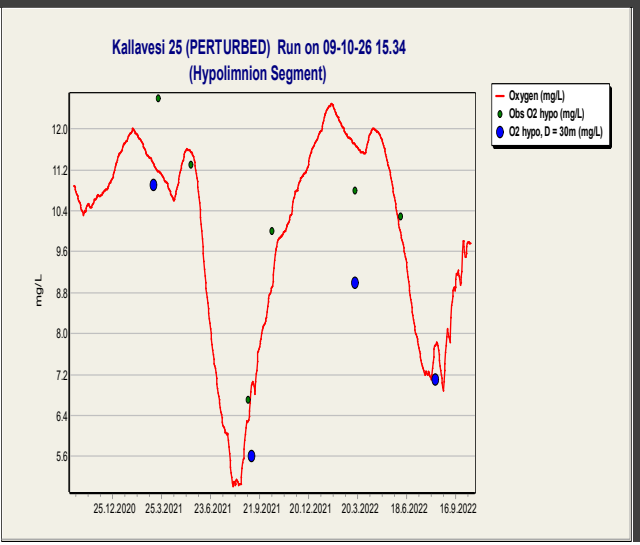


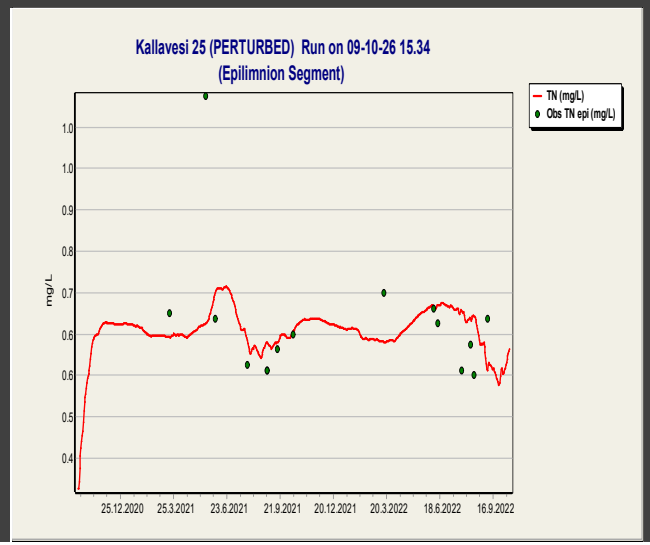
Example results from one segment (red line=model, points=Hertta database)

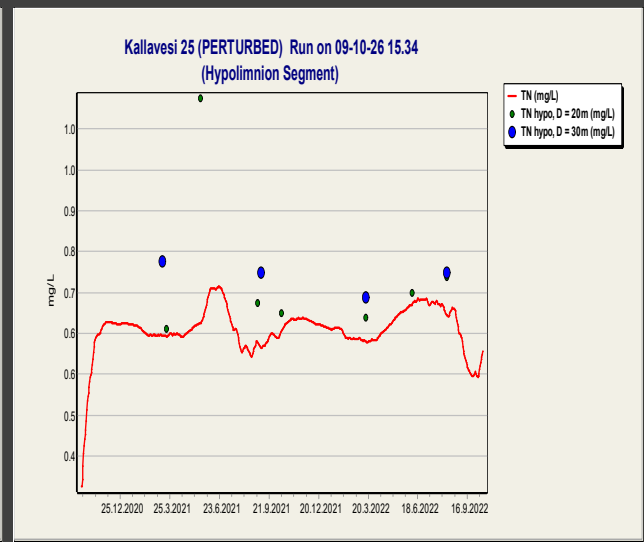










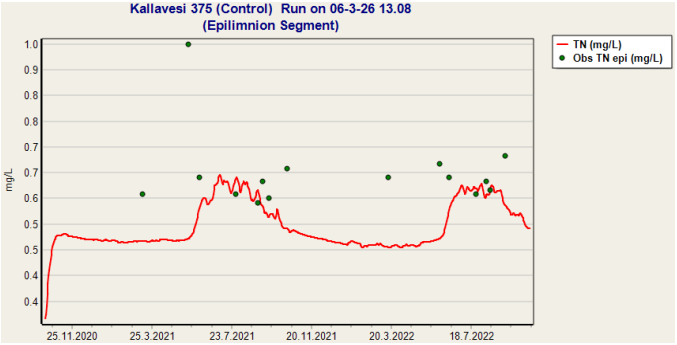


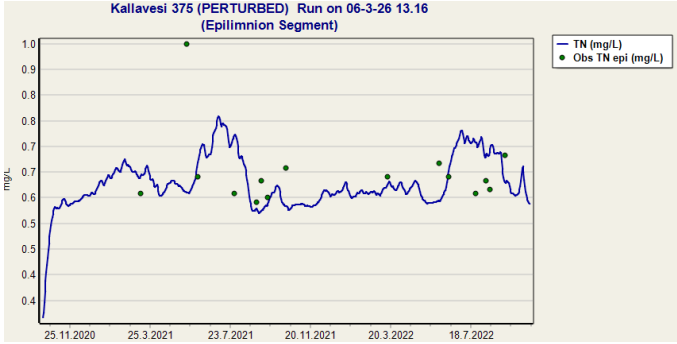
Basic Scenarios

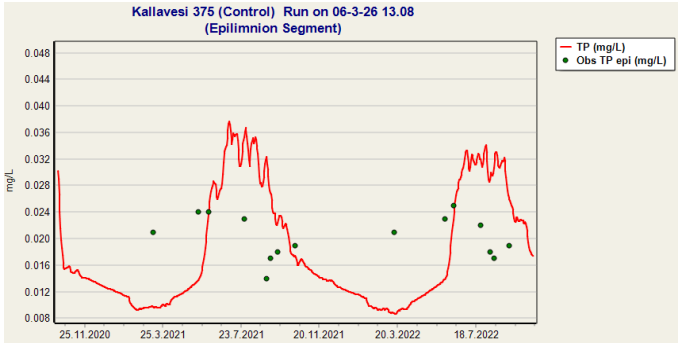
1. Changes in P-loading and N-loading (-20%, -10%, +10%, +20%, etc.)
2. Water level change (implemented through changes in water volume in AQUATOX)
3. Long-term run simulations with existing data and randomized inputs
4. Disturbance or disaster scenarios (removal of species, accidental chemical spills)
5. Chemicals pollution scenarios (wastewater discharges or contaminant inputs)
6. Changes in organic matter loading (-20%, -10%, +10%, +20% etc.)

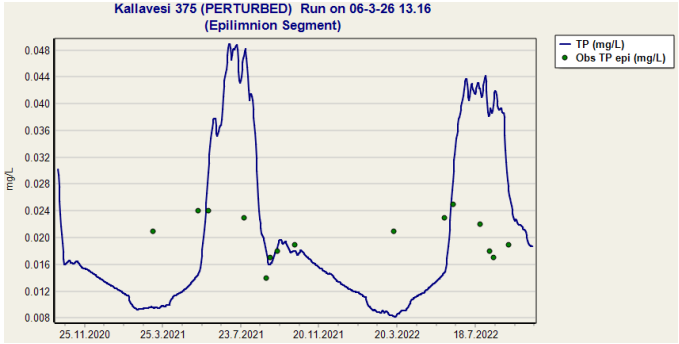
Baseline water volume

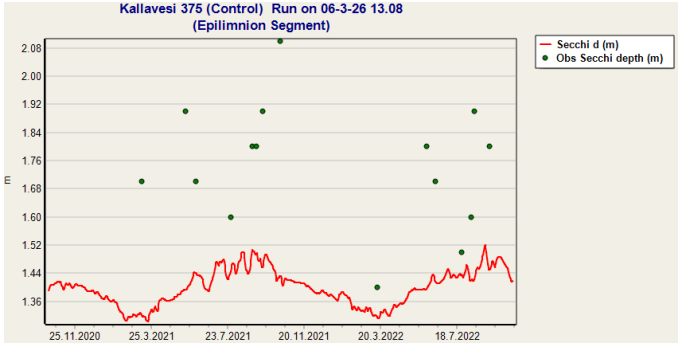
Water volume increased by 30%

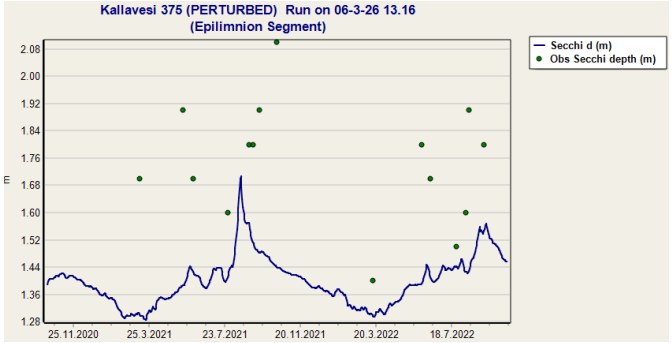








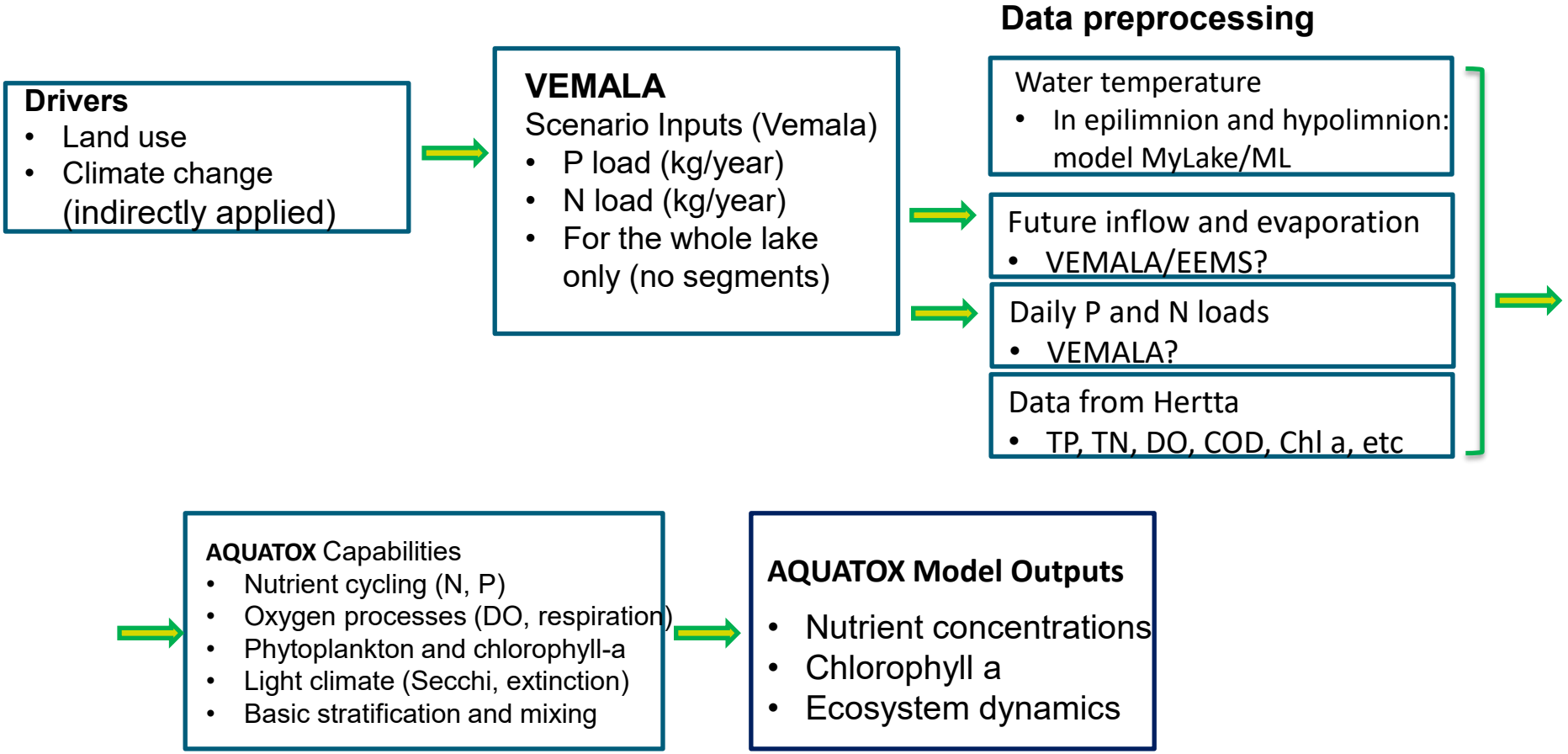




Complex scenarios defined in the workshops

1. Applying Vemala's scenarios on the effects of **land use changes** and climate change on loading and water body concentrations.
2. The effects of **browning**, especially on phytoplankton and chlorophyll concentrations.
3. The impact of **point sources** of pollution and measures implemented on the ecological status.
4. **Risk management of raw water quality** with regard to harmful substances (NH4-N, blue-green algae, organic matter, harmful substances).

Applying Vemala's scenarios on the effects of land use changes and climate change on loading and water body concentrations.



Outlook towards the end of the project and after that

- What we are going to do next:
  - Finalising the models
  - Automatizing the calibration using AI
  - Testing the scenarios
  - Creating reports
  - Publishing the reports and models
- After the project
  - Applying EU project
  - Creating new applicativie projects with industrial partners
- Already during the project, we will invite you to a more detailed seminar or webinar