OPTAIN

Funded by the European Union

Making Natural/Small Water Retention Measures Work: Data, Models and Optimisation Processes in OPTAIN

OPTAIN Project Overview

14 European case studies | 7 million Euro budget | 5,5 duration 2020-2026

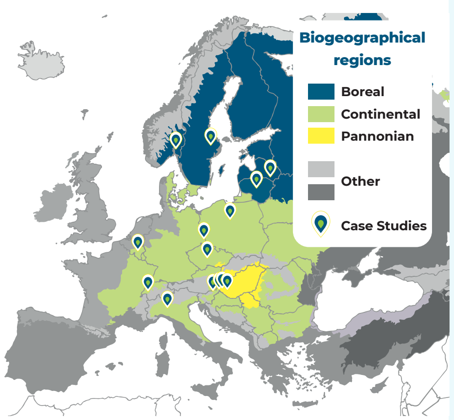


Figure 1. Map of OPTAIN case studies

OPTAIN (OPtimal strategies to reTAIN and re-use water and nutrients in small agricultural catchments across different soil-climatic regions in Europe) is an EU-funded research and innovation project implemented between September 2020 and February 2026 with a budget of almost 7 mil €. The project aimed to enhance the understanding of the potential practical implementation of Natural/Small Water Retention Measures (NSWRMs) in agricultural catchments across the Boreal, Continental, and Pannonian biogeographic regions, utilizing both scientific and stakeholder processes.

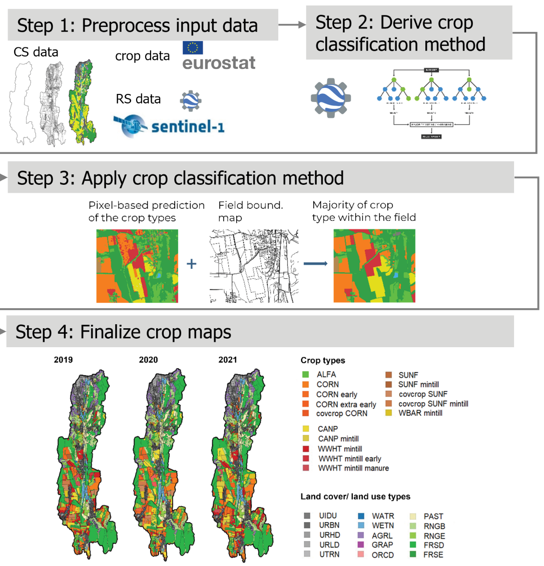
In collaboration with Multi-Actor Reference Groups (MARGs) across 14 European case studies, OPTAIN researchers developed and upgraded SWAT+ modelling workflows and optimisation tools to identify combinations of Natural/Small Water Retention Measures (NSWRMs) suitable for implementation in agricultural catchments. Through this approach, they assessed the potential of NSWRMs to retain water and nutrients while accounting for different climate projection scenarios.

Why was the integrated data–model–optimisation approach needed?

Water and nutrient management in agricultural landscapes is shaped by many complex interactions between climate, soils, land use, farming practices, hydrology, etc.. OPTAIN addressed this complexity by integrating harmonised datasets with process-based modelling and an optimisation approach.

This allowed the project to move beyond evaluating individual measures on selected locations and assess how different interventions perform together under changing environmental and management conditions.

How were data gaps addressed? (link)

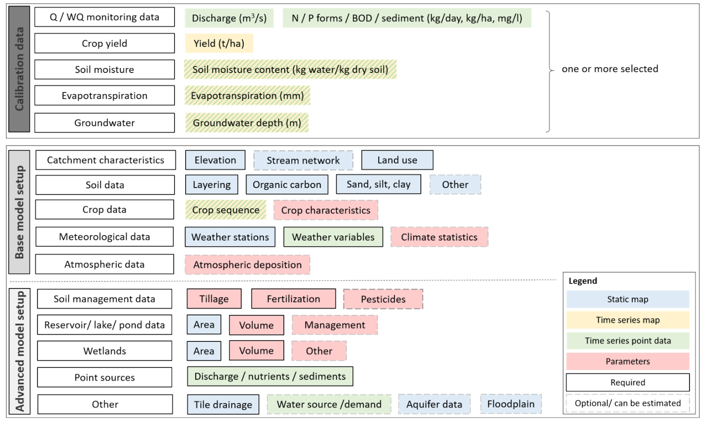


What types of data were used to analyse water and nutrient processes?

The OPTAIN modelling process was based on extensive spatial and temporal datasets, including topography, land use, soil properties, hydrology, agricultural management, water use, NSWRM costs and observational data, such as water flow, water quality, sediments, meteorological and crop yield data.

Particular emphasis was placed on collecting data for each agricultural field in the catchment to enable analysis of the effectiveness of management-related NSWRMs. Applying uniform data collection and preparation protocols across all case studies provided a reliable basis for comparing modelling results.

SWAT input data requirement



How were data gaps and inconsistencies addressed?

Data availability and quality vary widely across Europe. OPTAIN therefore developed harmonised and replicable workflows to address data gaps and inconsistencies related to soil physical and chemical properties (link), as well as crop classification. Standardised datasets were generated for all case studies, accompanied by automated data-processing scripts, to facilitate reliable comparison and analysis of information, despite the original data varying widely in format and completeness.

How was the water and nutrient dynamics modelled at field and catchment scale?

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

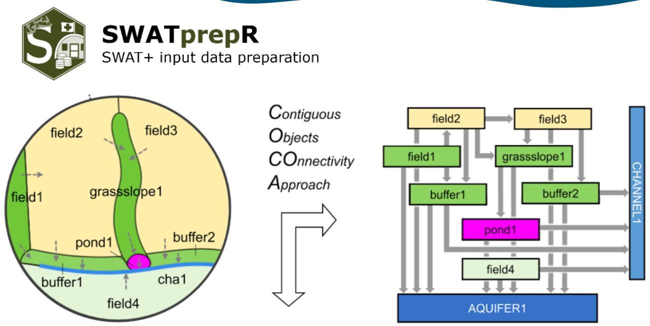
SWATfarmR
Simple rule based management operation scheduling

SWATtunR
Tuning SWAT+ model parameters

OPTAIN used process-based modelling to simulate hydrology and nutrient transport, as well as the impact of land management and retention measures at both the field and catchment levels.

The SWAT+ model formed the core modelling framework and was extended using R-based tools and workflows (link), to enable transparent, replicable, and harmonised simulations across all 14 case studies.

A new modelling approach within SWAT+ called COCOA (Contiguous Object COnnectivity Approach) was developed in order to represent landscape features at the field scale and account for connectivity between land objects (e.g. adjacent fields, buffers, and landscape features).



The performance of individual measures and combinations of measures was tested using a wide range of indicators related to flood and drought buffering capacity, agricultural production, and water quality mitigation. Retention measure performance was simulated for present and future climates, providing information on climatic resilience against floods, droughts and water quality issues.

How were effective combinations and locations of measures identified?

With OPTAIN models and optimisation approaches trade-offs and synergies between different objectives, such as water and/or nutrient retention, costs and feasibility were explored. The CoMOLA multi-objective optimisation tool was used to identify most efficient combinations of retention measures in the catchment and field landscapes. Through this approach the project identified many potential "Pareto-optimal" solutions that support an informed and science-based decision-making process.

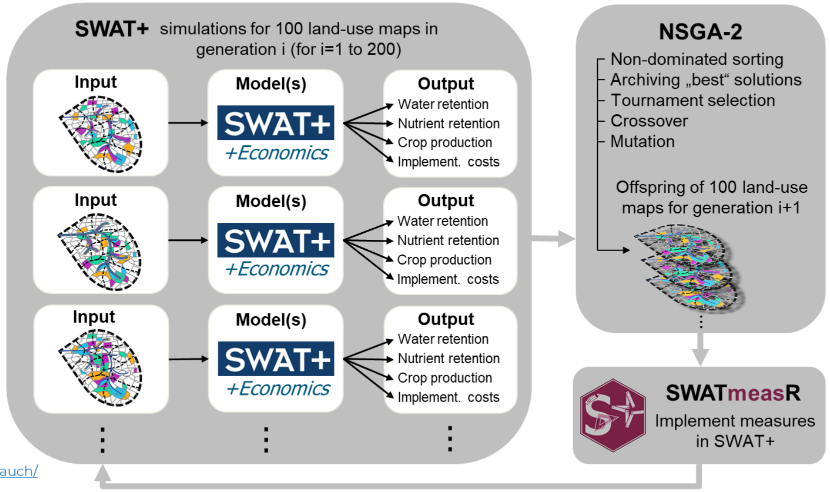
How to optimise?

Constrained
Multi-objective
Optimization of
Land use
Allocation

Strauch et al. (2019)
https://doi.org/10.1016/j.envsoft.2019.05.003

More details in

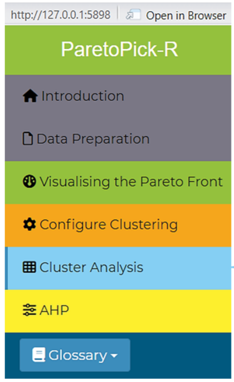
Software available at
https://github.com/michstrauch/CoMOLA_SWATplus



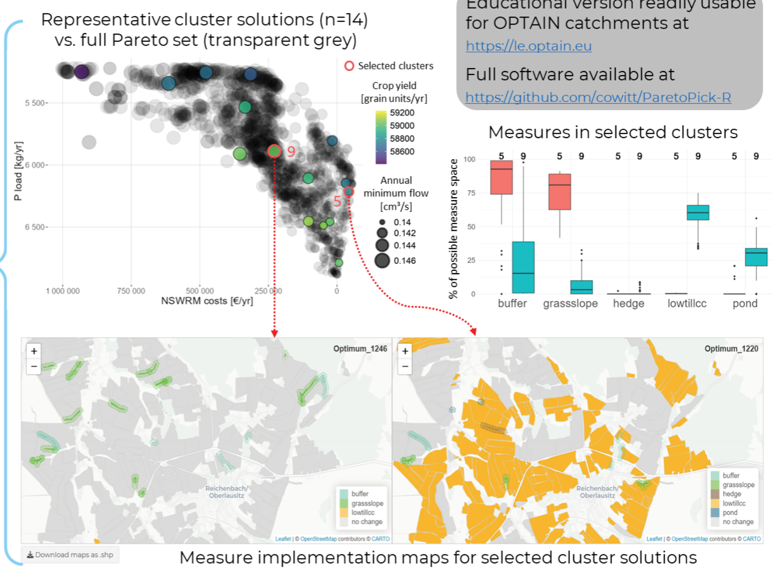
What resulted from combining modelling, optimisation and stakeholder input?

Modelling and optimisation processes embedded in efficient stakeholder collaboration throughout the whole project, showcase that effective water and nutrient retention depend on selecting the right NSWRMs in the right locations. The results demonstrated that local conditions influence NSWRM performance, which trade-offs have to be made and where potential win–win solutions are feasible, while supporting constructive dialogue between scientists, farmers, and decision-makers.

Explore the results interactively



Learn about the app



Educational version readily usable for OPTAIN catchments at
https://le.optain.eu

Full software available at
https://github.com/cowitt/ParetoPick-R

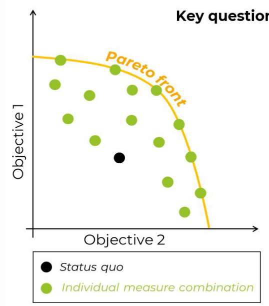
How do these results support practice and policy?

The modelling and optimisation results provide evidence-based options for farm advisors, water managers and authorities. With this, OPTAIN supports science-based, stakeholder-collaborative agri-environmental planning, climate adaptation strategies and policy development related to water quality and land management.

How can these approaches be used beyond OPTAIN?

The harmonised data preparation workflows, modelling frameworks, optimisation methods and R tools developed in OPTAIN are designed to be transferable and reusable. With appropriate adaptation to local data and stakeholder contexts, they can support future research projects, river basin management processes and decision-making across Europe and beyond. You can find them here on OPTAINs Learning Environment (le.optain.eu).

Pareto what?



Key question: **Where should measures be implemented to achieve the best balance between competing goals?**

In OPTAIN, these goals include:

- maximise **water retention**,
- maximise **nutrient retention**,
- maximise **agricultural production**, and
- minimise **implementation costs**

⇒ Pareto-optimal solutions show combinations of measures where improving one objective (e.g. water quality) would require accepting trade-offs in another (e.g. costs or production).

⇒ This helps decision-makers compare realistic options and select solutions that best match local priorities.

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