

Introduction to PHISHES: Integrated modelling for soil health

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PHISHES Objective

Call: HORIZON-MISS-2023-SOIL-01-02:
Soil pollution processes – modelling and inclusion in advanced digital decision-support tools



Ambition:

Bridge the missing link between data on soil health and actions to safeguard soils.

Objective:

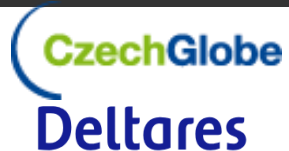
Produce an integrated simulation environment to quantitatively assess the influence of land-use change and soil pollution on soil functions and ecosystem services.

Research Question

“How do **soil use and soil contamination** influence **soil functions** and associated **ecosystem services**, in the presence of major drivers such as **climate change**, and how can we **predict the impacts** of mitigation and adaptation measures?”



PHISHES Consortium



WP1: PHISHES Digital Platform (PDP)

WP2: Impact of land use management on fate and transport of contaminants in soils

WP3: Response of soil ecosystem function/services to soil contamination

WP5: From healthy-soil land-use scenarios to management choices

WP4: PHISHES Test cases

WP6: Communication, dissemination, & exploitation

WP7: Project coordination & management

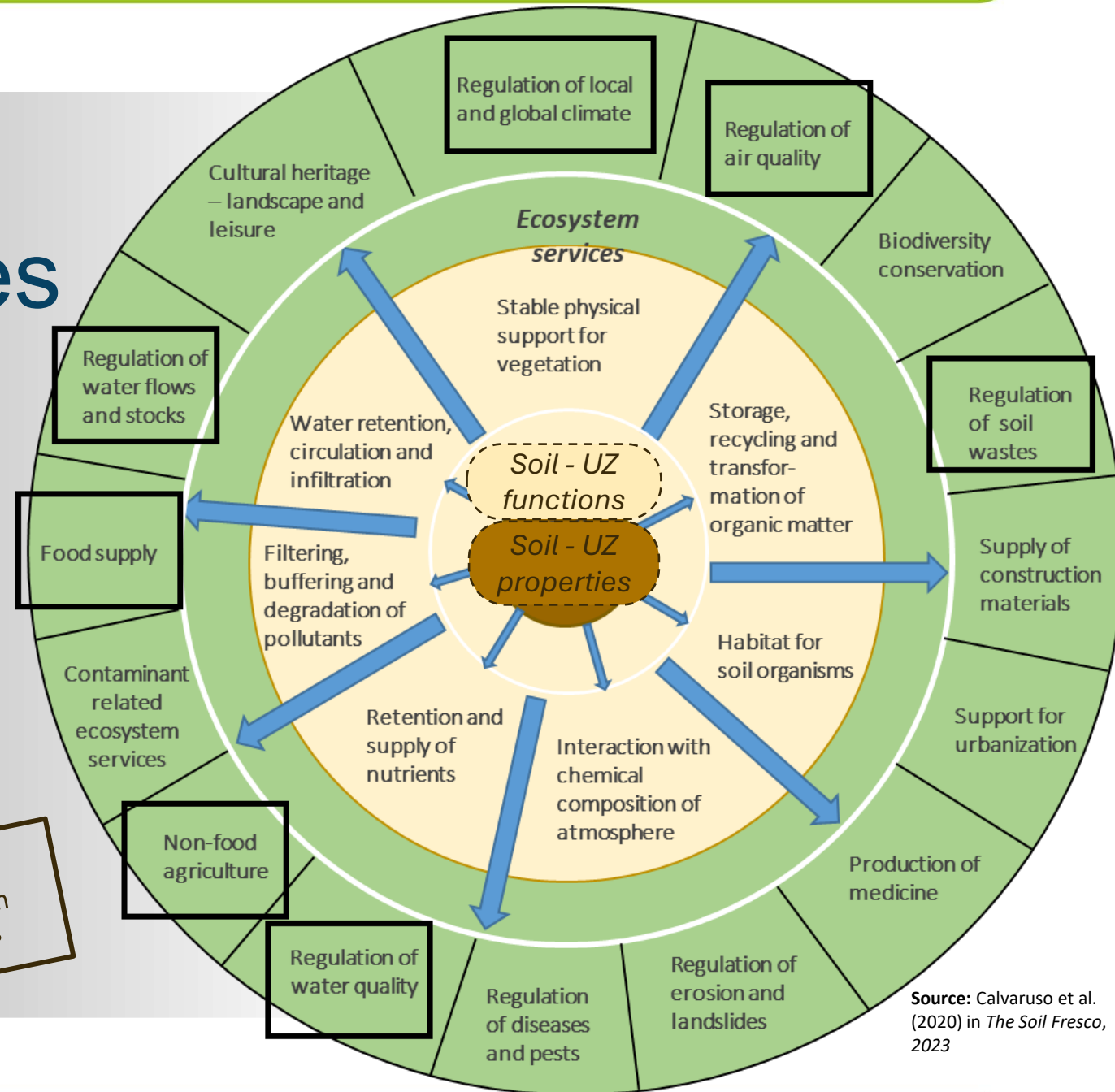


Soil Functions & Ecosystem Services

PHISHES approaches soil health within the framework of **soil multifunctionality**

“Predictive quantitative modelling as evidence to inform policy”

Targeted Ecosystem Services



Source: Calvaruso et al. (2020) in *The Soil Fresco*, 2023

PHISHES Test Sites



**Airport in
Örnsköldsvik**
Sweden



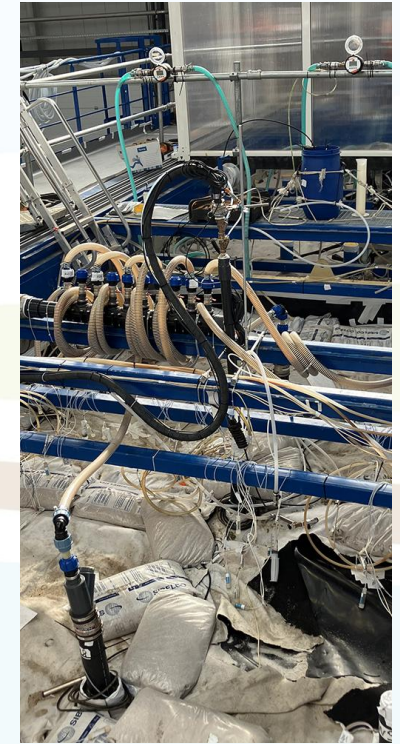
**Koprzywianka
River Basin**
Poland



**Rotterdam
Urban Area**
The Netherlands



**Zelivka River
Basin**
Czech Republic



**PFAS fate and
transport lab**
France



PHISHES scenarios

What land-use management choices will ensure soil health?

Measures:

- *Conventional Tillage* → *Conservation Agriculture*: reduced tillage, permanent soil cover, crop diversification
- *Remediation techniques*: e.g. phytoremediation
- *Hydrological modification*: e.g. increased water retention through stream modification
- *Spatial reduction in agricultural activity* / increase of other land-use types

Climate change:

- 3 possibilities included

Contaminant families:

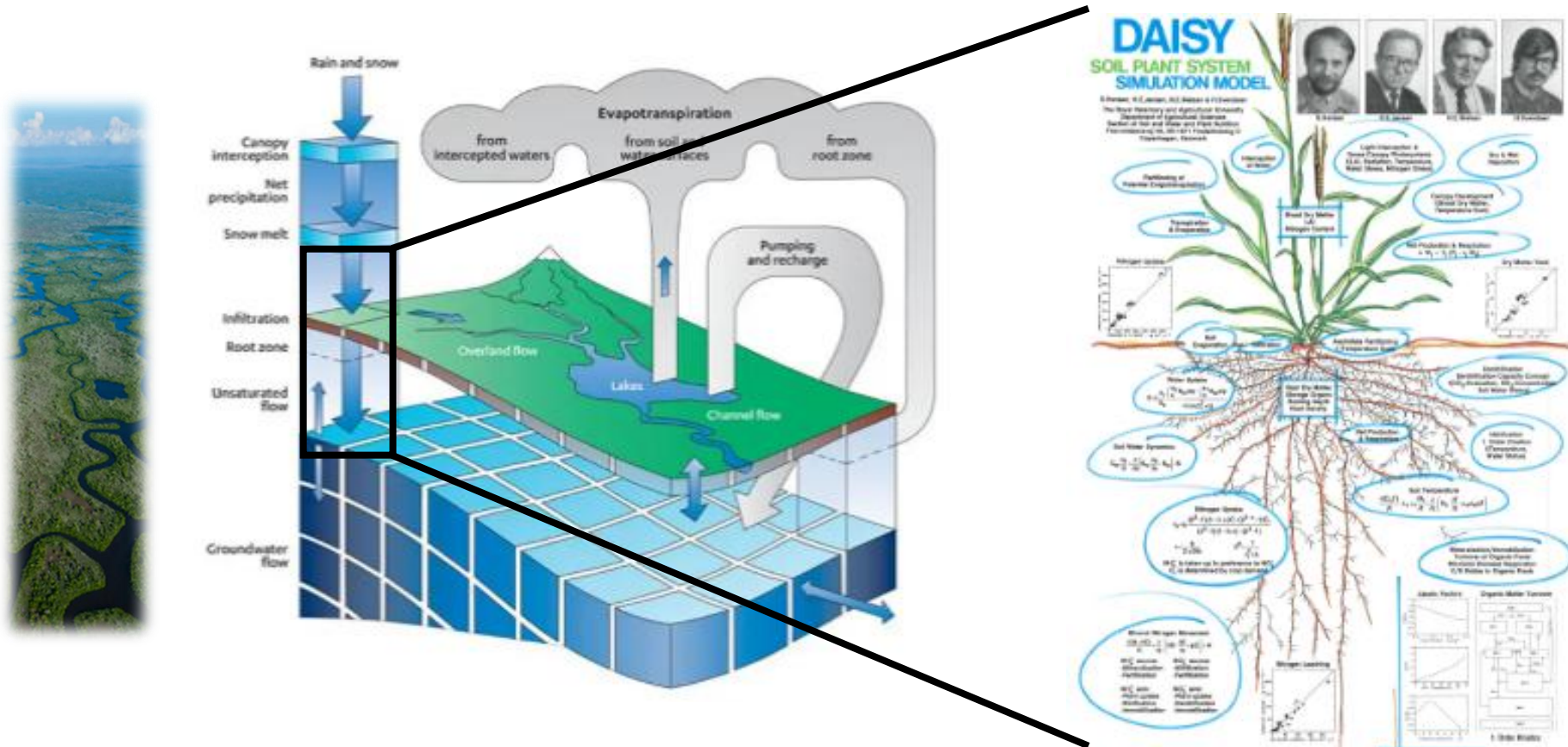
- Inorganic (metals, metalloids: As; Cd, Pb, etc.);
- Organic compounds (pesticides, PAHs, hydrocarbons, nitrification inhibitors), polyfluorinated pesticides
- Nutrients (nitrogen)
- Contaminants of emerging concern (PFAS)

Application of a **measure** under a specific predicted **climate** has what impact on the target **contaminant**?



PHISHES: Model Trains

4 model trains for 3 soil contexts:
urban, agricultural, and contaminated





PDP: PHISHES Digital Platform

Validated Soil Health Evidence Transferable Modelling Methodologies

- The PDP addresses the question: once we know the condition of our soils, **how do we evaluate the long-term consequences of different management choices?**
- The PDP **demonstrates the approach through test-site applications and provides resources** that enable technical users to reproduce the methodology elsewhere.

PDP User Groups:

- Technical users
Modellers, researchers
- Policy- and decision-makers
Water and soil authorities
- Information managers
e.g. the EU Soil Observatory
- Wider Society



PDP initial launch!

<https://phishes-pdp.eu>



PHISHES

PHysically-based Integrated Soil HEalth Simulation Digital Platform — PDP

Learn from case studies.
Apply methodology locally.

The PHISHES Digital Platform brings together data, processing tools, modelling tools and scenario analysis capabilities within a single framework — giving predictive insight into how soil use, contamination and drivers such as climate change affect soil functions and the ecosystem services they support.

SOIL FUNCTIONS

What soil can do in its natural state — forming itself, cycling nutrients and regulating water — through the interaction of its biological, chemical and physical components.

Source: Bünamann et al., 2018

ECOSYSTEM SERVICES

The goods and services people draw from soil and land — food, clean water, carbon storage and habitat — on which societal welfare depends.

Source: Millennium Ecosystem Assessment, 2005

Four model trains, three contexts

PHISHES couples existing, widely-used modelling tools into four model trains, extending what each can do alone and connecting soil functions to ecosystem services.

Agricultural context

2 MODEL TRAINS

MIKE SHE — Daisy

Small agricultural watersheds with long-term monitoring networks, enabling fine spatial and temporal resolution.

MIKE SHE — MIKE Eco Lab Plant Growth

Agricultural landscape management and land use change

Urban context

1 MODEL TRAIN

MODFLOW 6 coupled modules

Groundwater modules plus a reservoir module; a coupling with Daisy is also proposed.

Contaminated sites

1 MODEL TRAIN

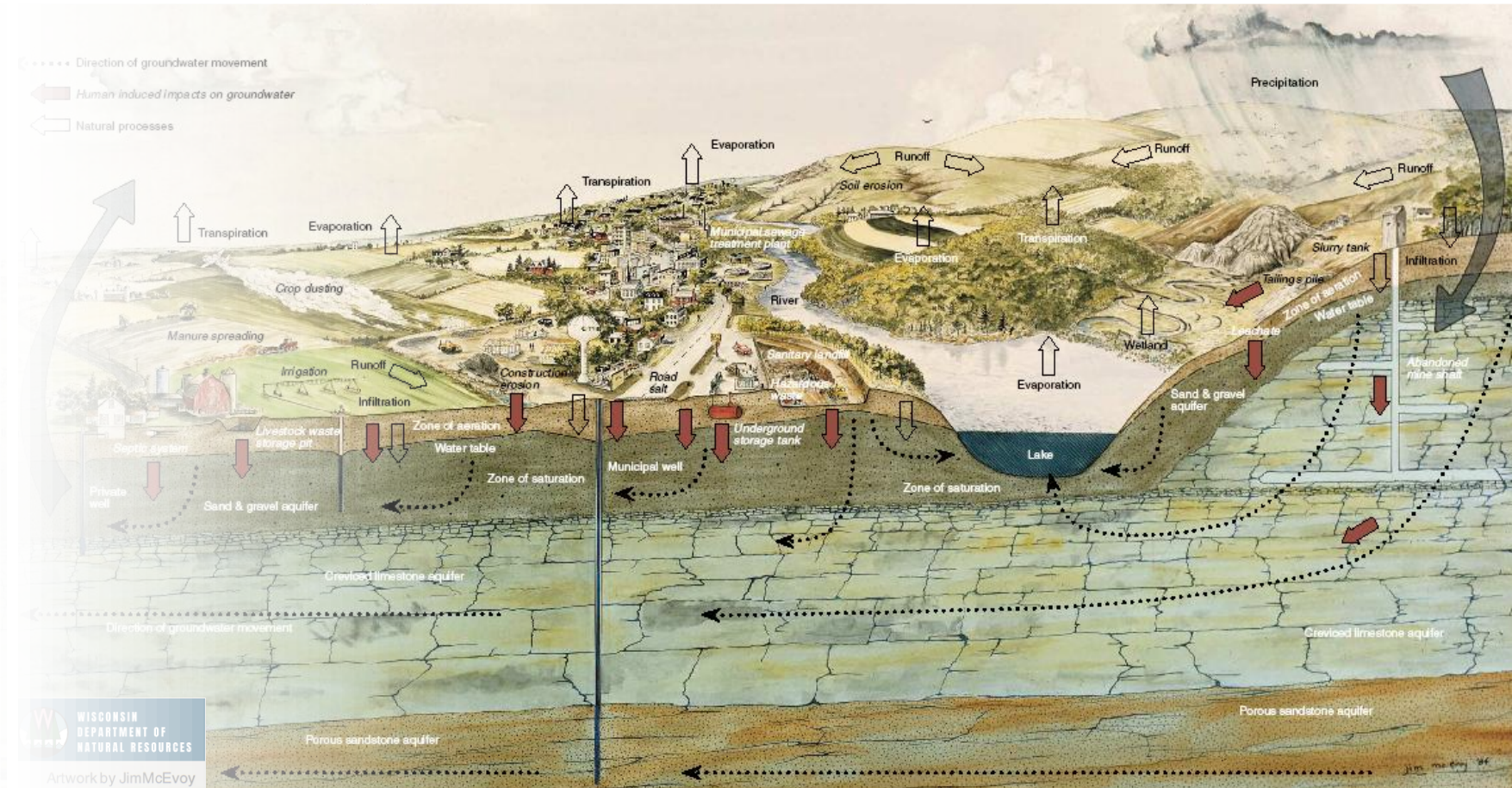
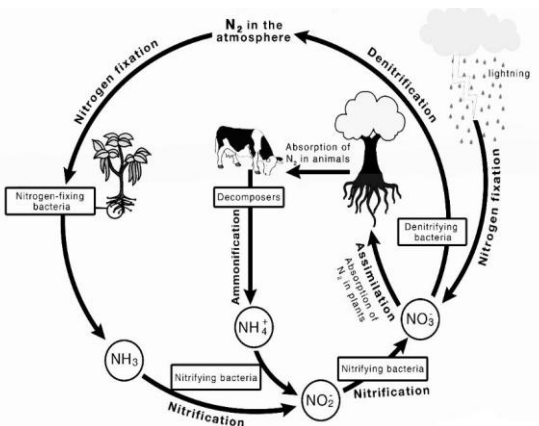
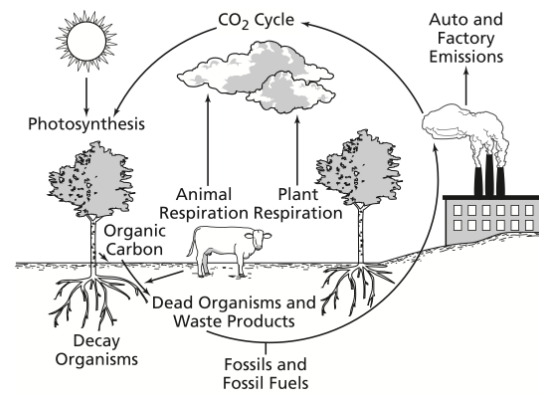
HYDRUS—PHREEQC — MODFLOW 2005 — MT3D

PFAS-contaminated sites from AFFF use, and mine tailings enriched in trace metals.



Plant Growth Module (PGM)

Holistic Modelling { C & N cycling added to integrated hydrology
Transpiration that responds to meteorological forcing



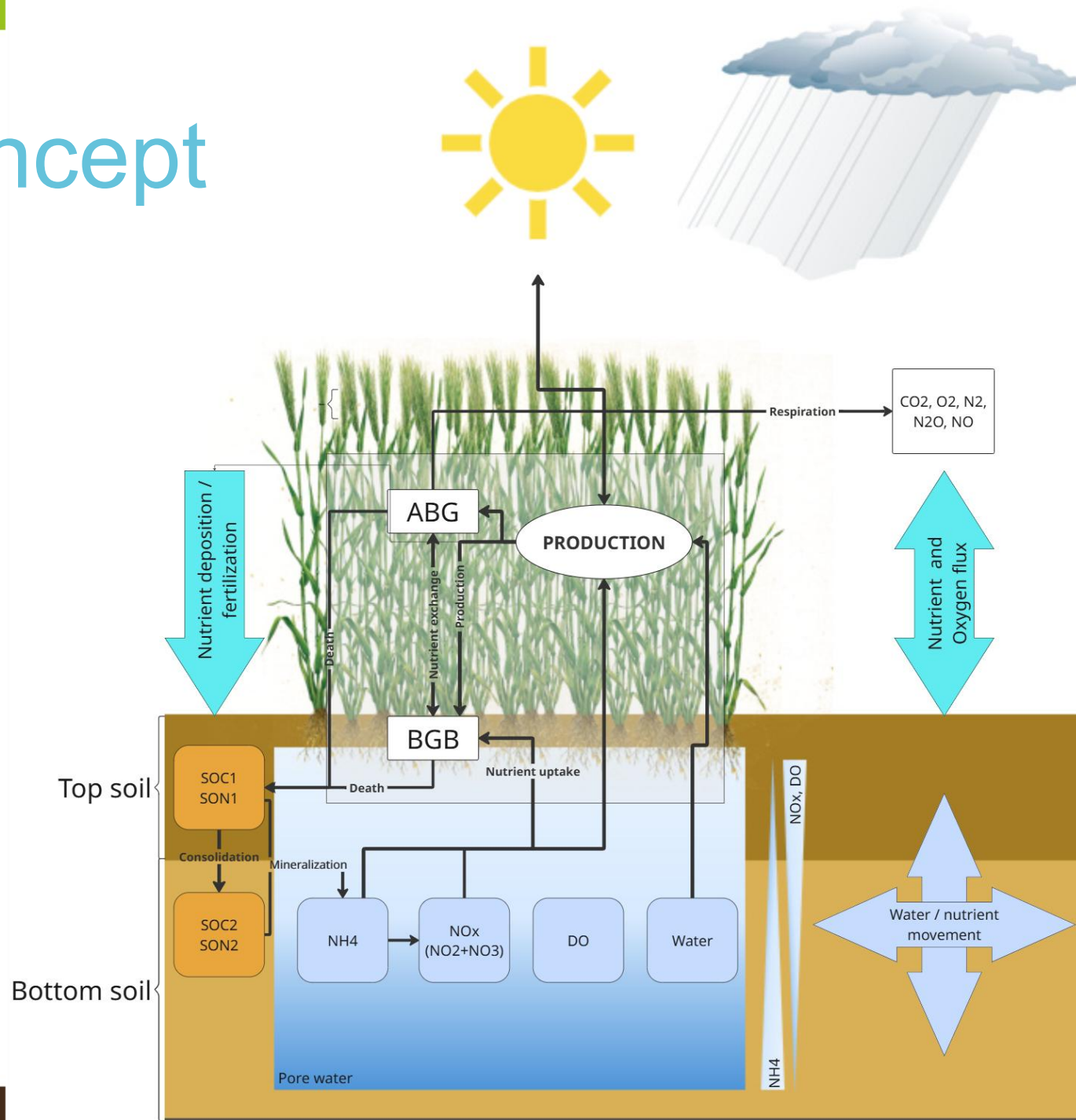


PGM Modelling concept

- Plant related processes
- Carbon cycling
- Nitrogen cycling
- Water movement
- Above and below ground

As simple as possible, to be applied at scale

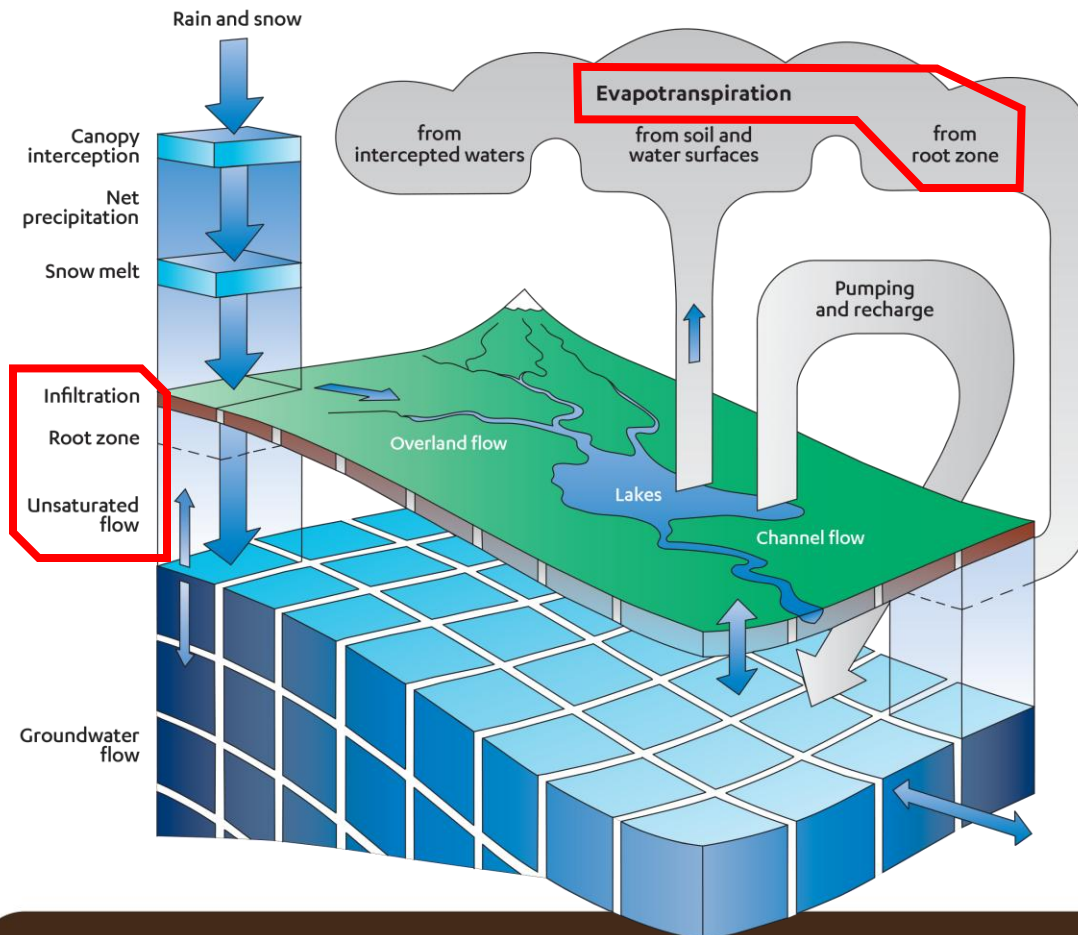
As complicated as necessary, to produce useful scenarios



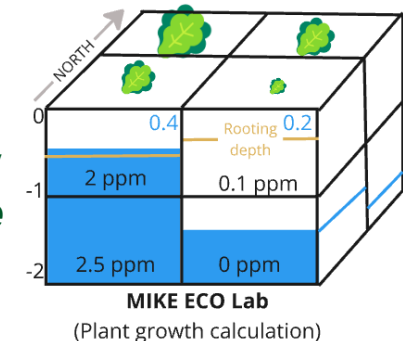


PGM Coupling with MIKE SHE

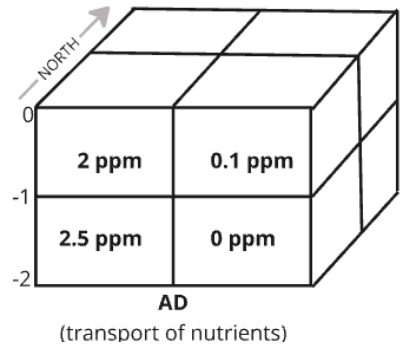
1D UZ + 3D SZ $\rightarrow$ 2-way coupling



ECO Lab for plant
growth and physiology
Plant Growth Module



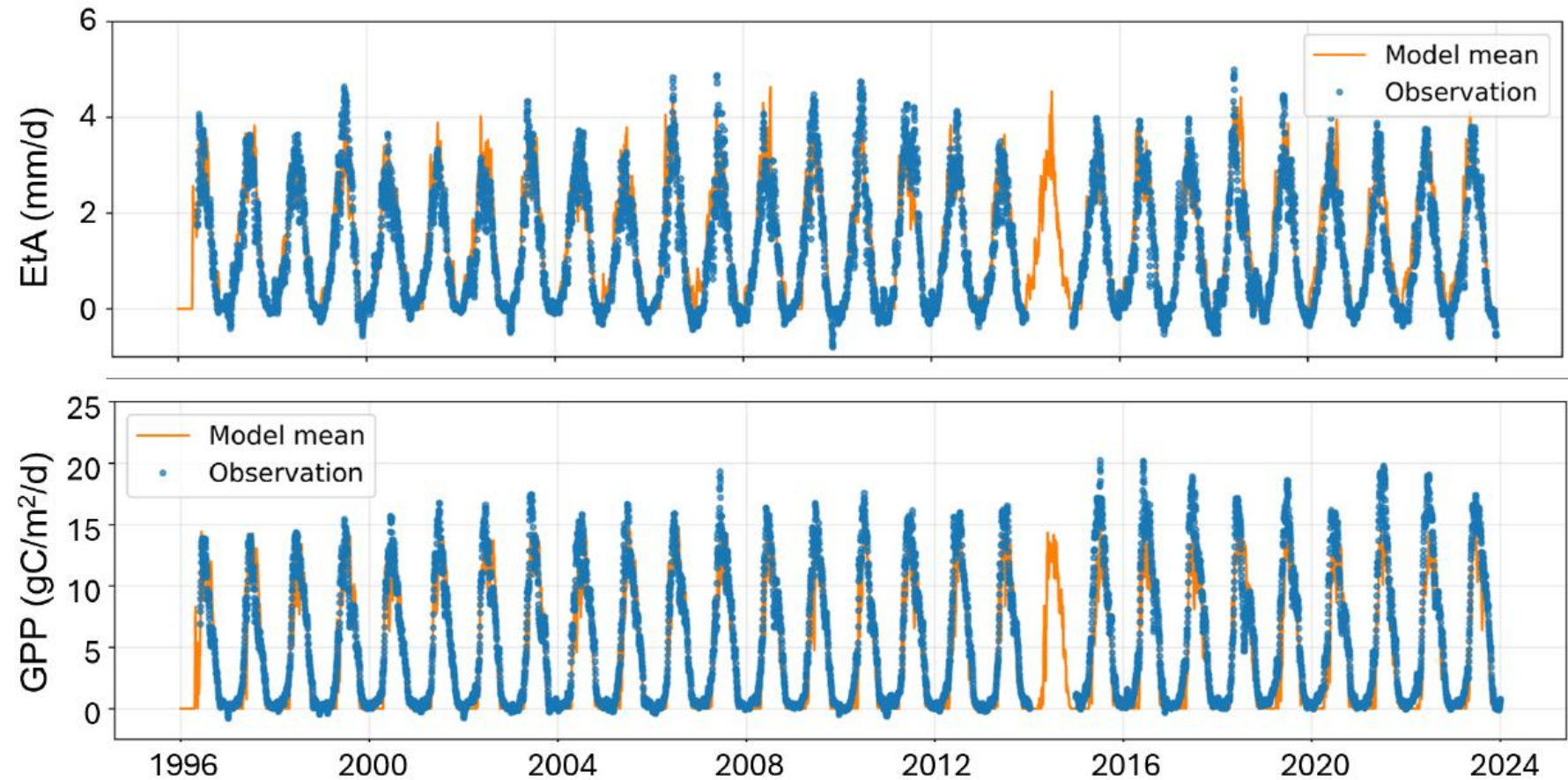
ECO Lab for
pollutant transport
Water Quality Module





PGM Application in a Beech Forest

- Stand scale
- Located in Sorø, DK
- Over long term, able to reproduce both evapotranspiration and gross primary production





Take-away Message

PISHES is tackling:

- Predictive management scenarios involving climate change
- Model trains to produce results linked to →
 - Soil functions & ecosystem services
 - Soil descriptors under the Soil Monitoring Law
- 5 test cases for model train validation
- 4 contaminant categories
- 3 soil contexts

All disseminated through the PDP (PHISHES Digital Platform)
to service both technical and non-technical users
in their work to ensure healthy soils.

FOR MORE INFORMATION:

 Visit Our Website:

<https://www.phishes-project.eu/>

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