# Integrated assessment of Lake Pusiano (Northern Italy) water quality and quantity through numerical modelling with low-frequency environmental data

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SWAT CONFERENCE 8-12 th JULY 2024
Strasbourg, France

# Object of this work

1

Evaluation of the nutrients loads and the study of the lake's response

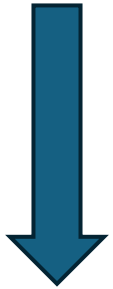
PRESENT CLIMATE CHANGE

ANTHROPIC PRESSURES

# Object of this work

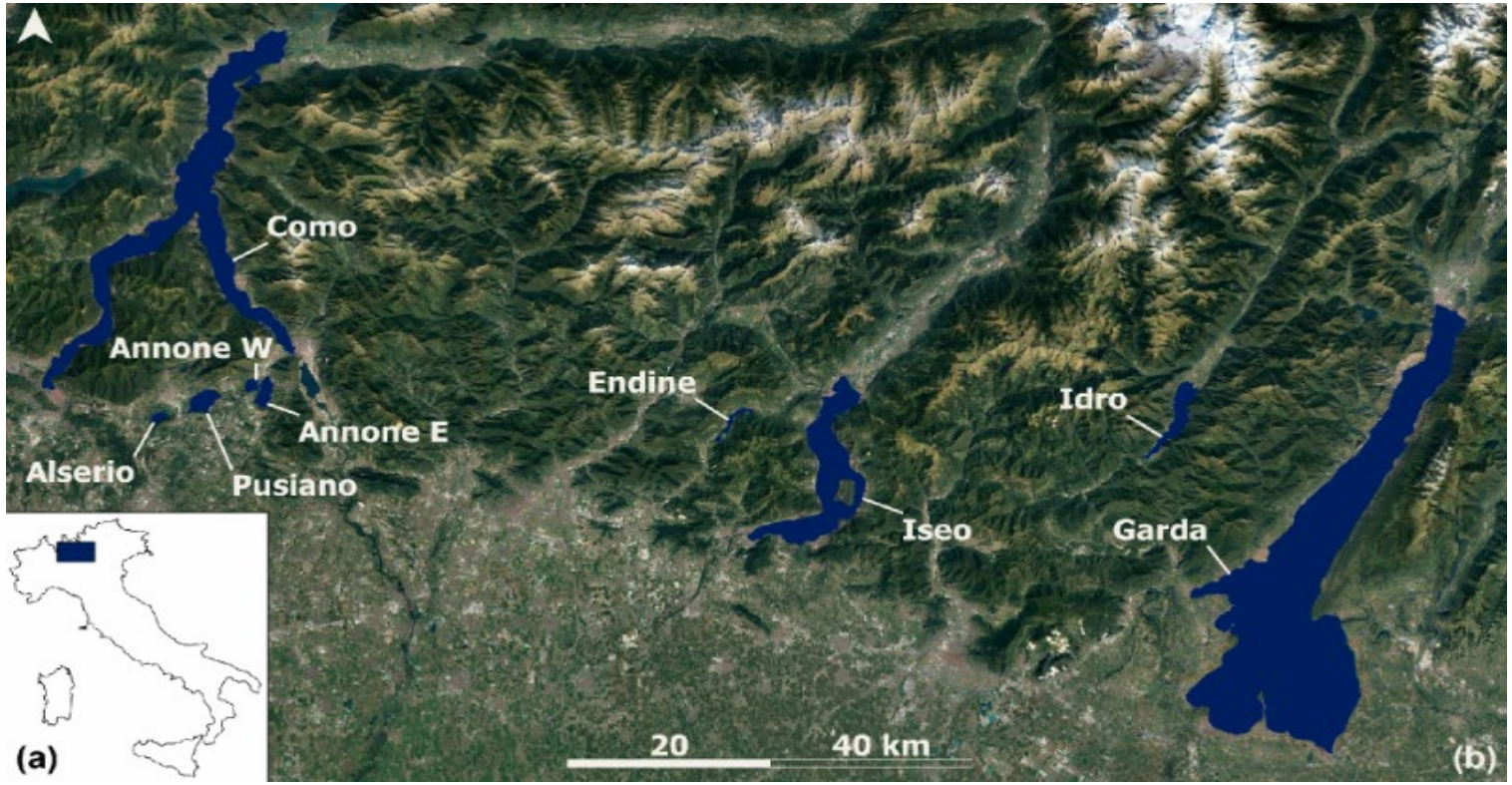
2

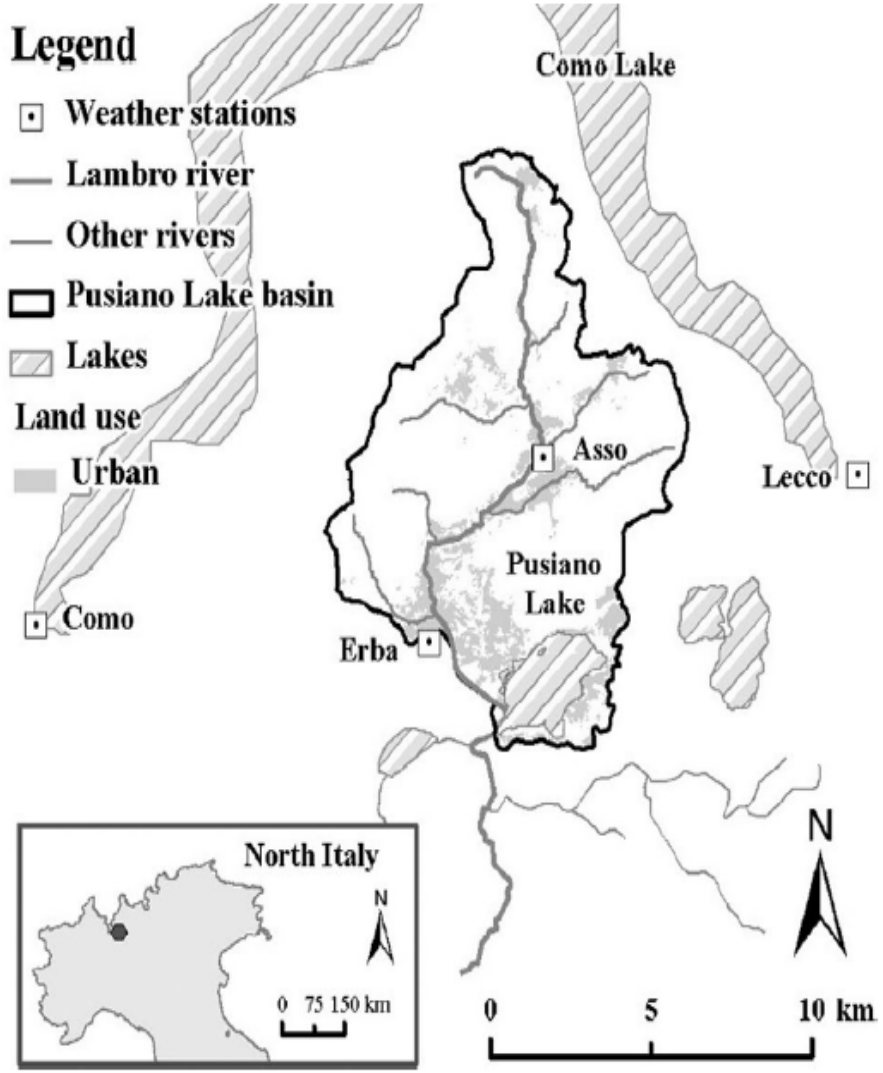
Nutrients reduction scenario (BMPs)



Achieving target concentrations of total phosphorus

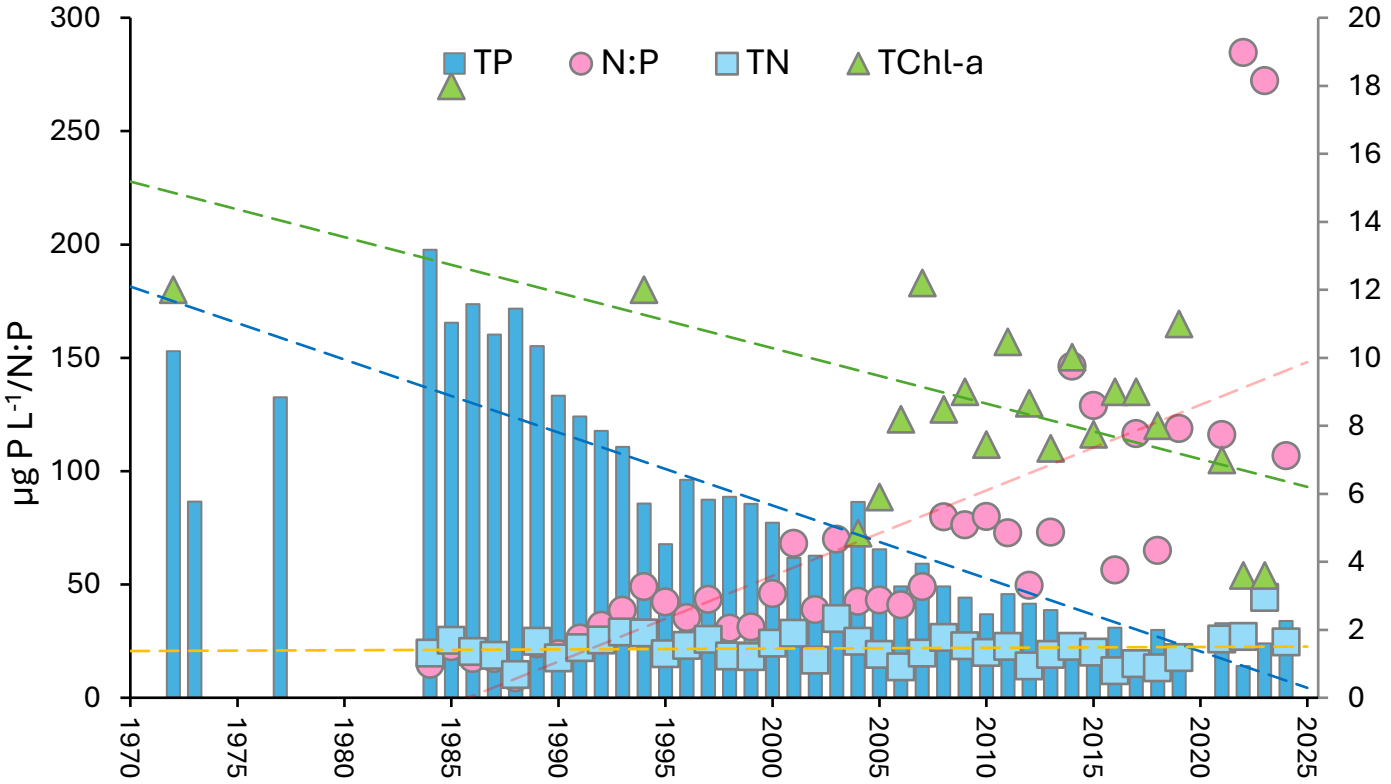
# Case study: Lake Pusiano



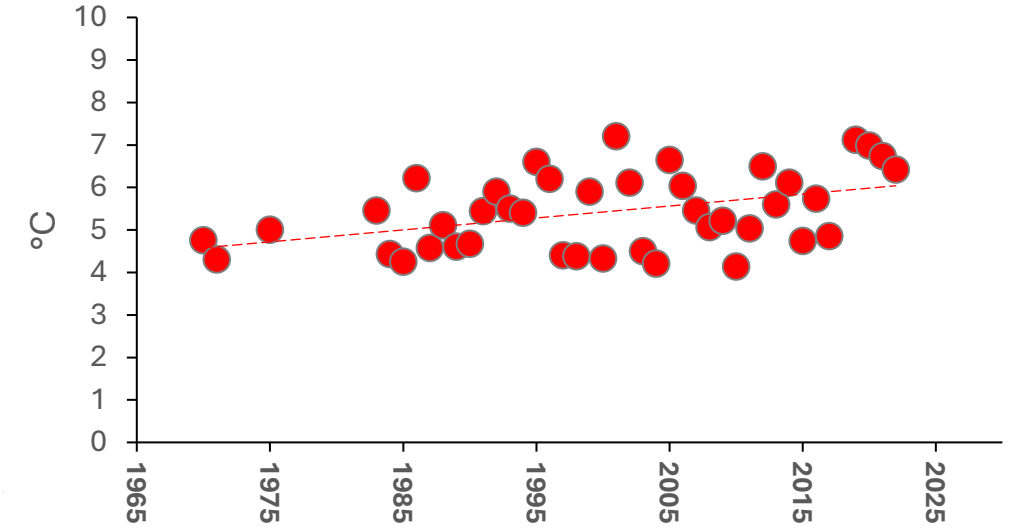




| | |
|---|---|
| Watershed area (without lake ) | 88 km$^2$ |
| Lake area | 5.2 km$^2$ |
| Max depth | 24 m |
| Trophic state | Currently mesotrophic |
| Turnover time | Warm monomictic lake |
| Residence time | 0.7 year |

# Case study: Lake Pusiano



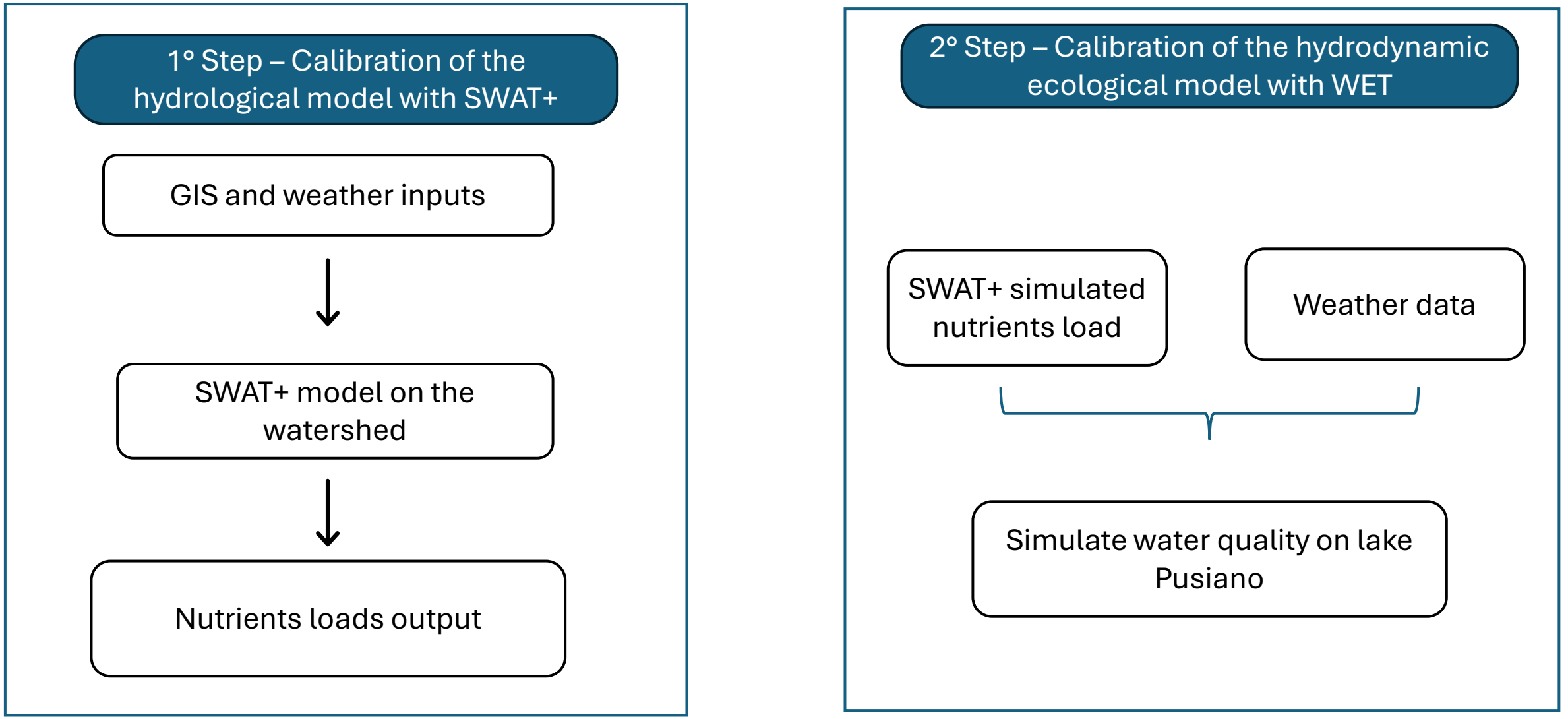

Long-term dynamics of total phosphorus (TP), total nitrogen (TN), N:P ratio and Chlorophyll-a



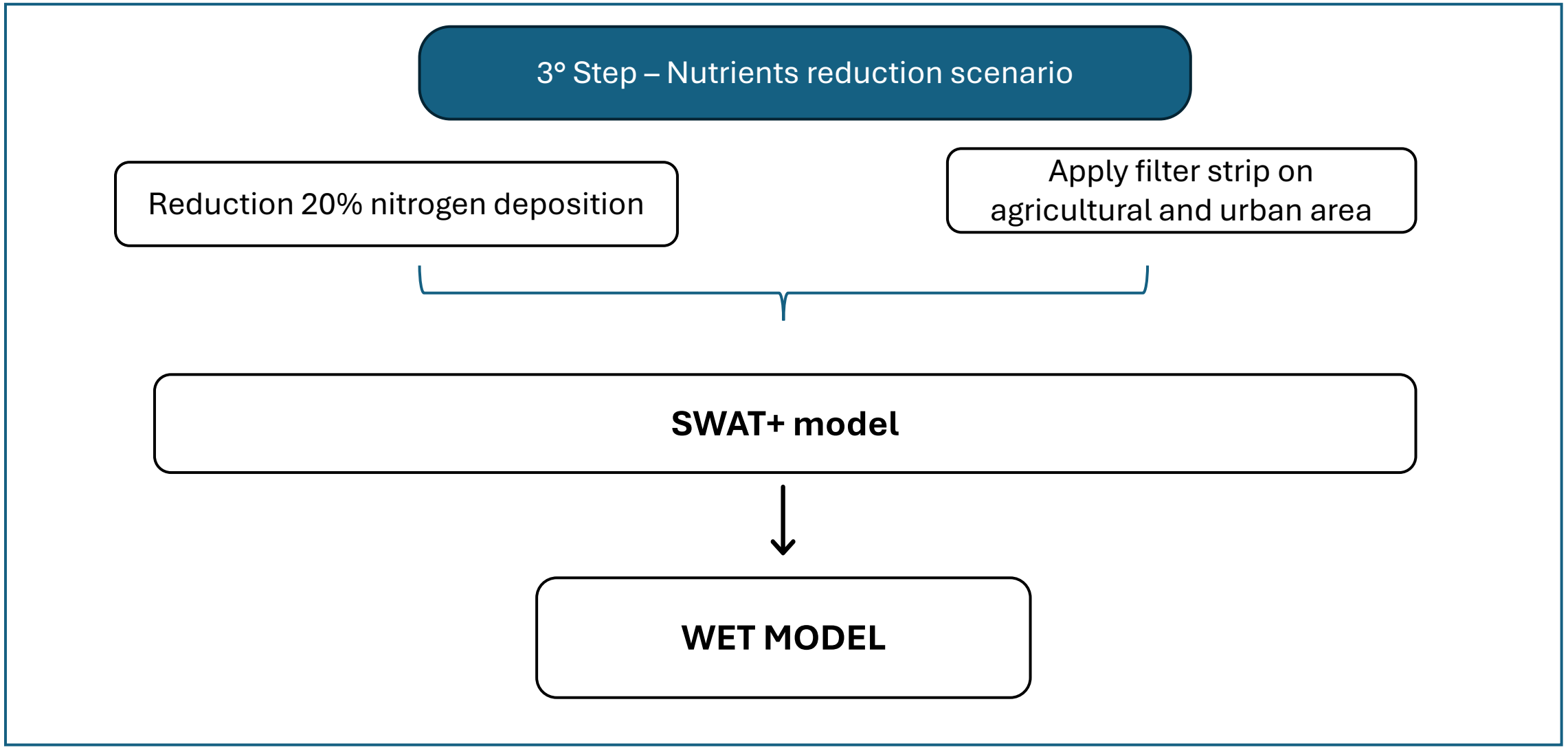

Temperature increase

Lake Pusiano - 06/02/2024

# Methodology

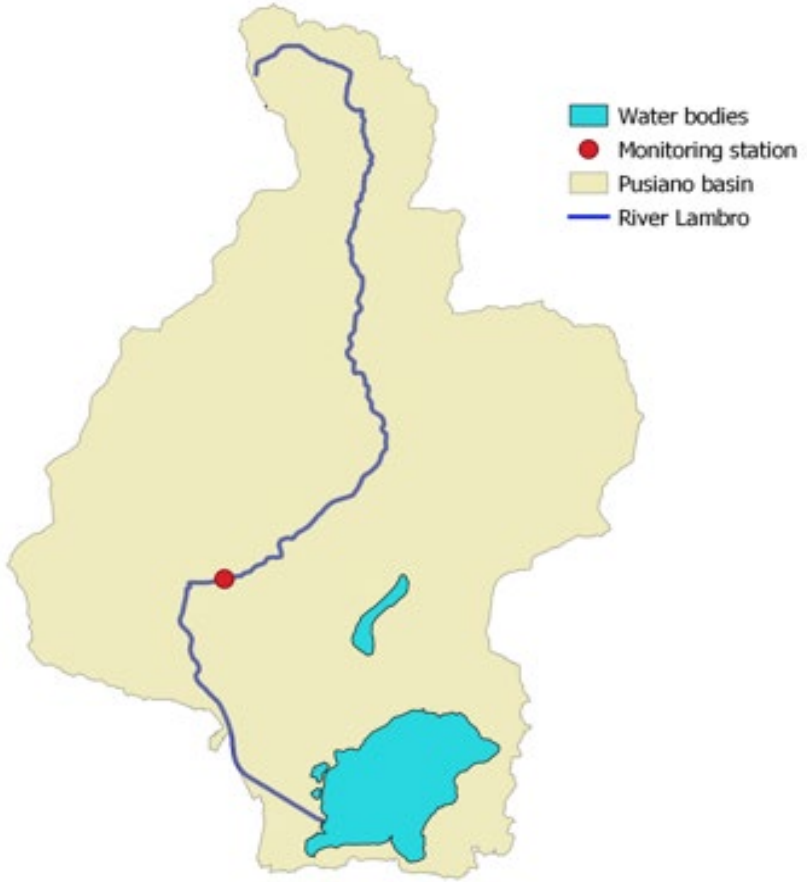


# Methodology



# Hydrological model setup

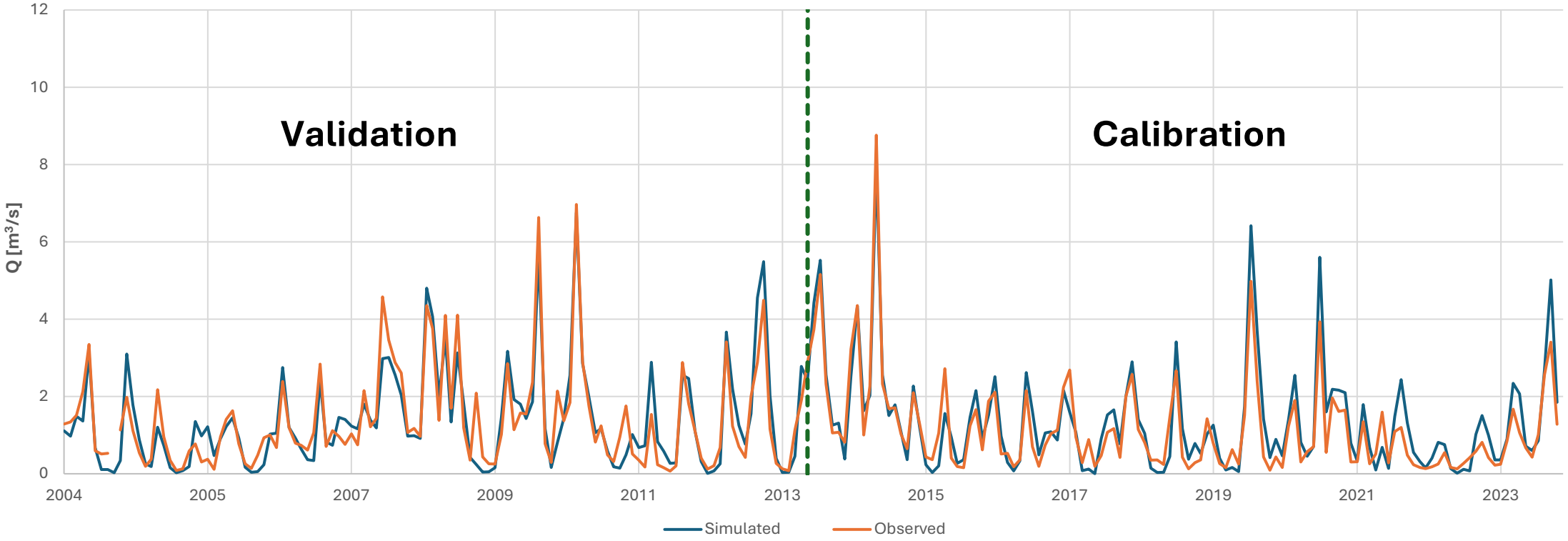
| Variable | Frequency | Time period |
|---|---|---|
| Discharge | Daily | 2004-2023 |
| NO3 and PO4 | **Quarterly** | 2009-2023 |
| Meteo data | Daily | 2004-2023 |
| Nitrogen deposition | Annual | 2005-2021 |




# Calibration of Nutrients

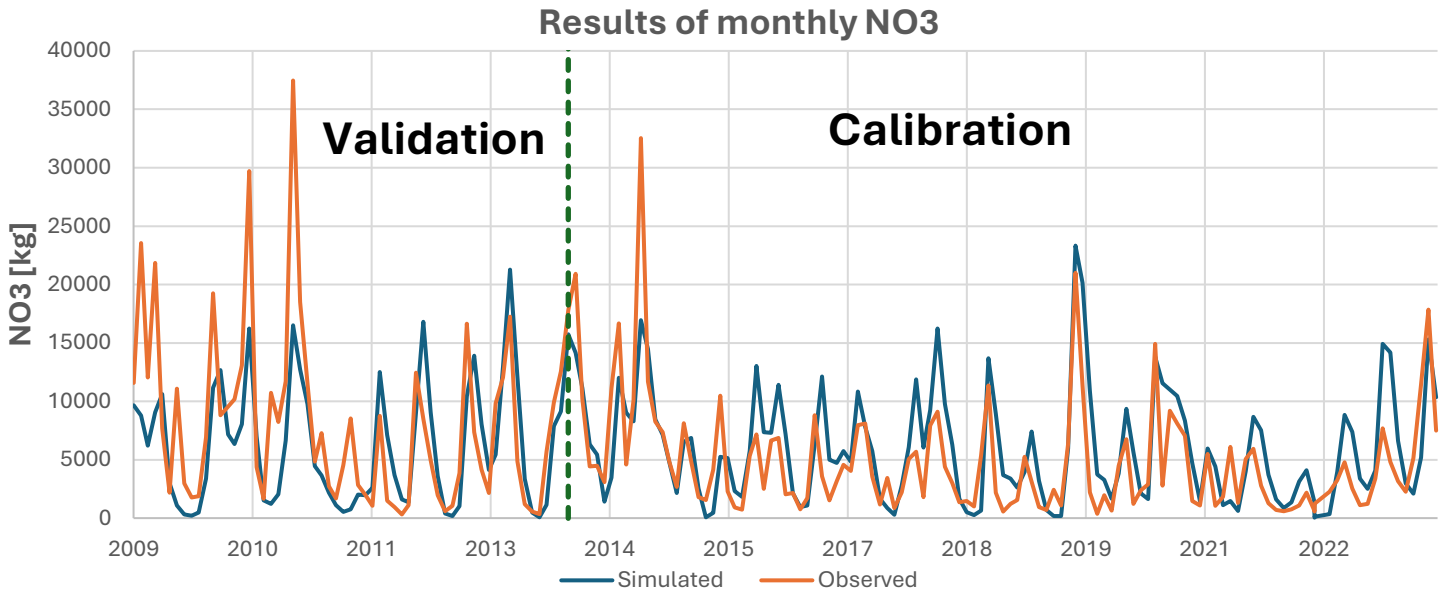
**Field measured $NO_3$ and $PO_4$ concentration** → **LOADEST** → **Continuous daily $NO_3$ and $PO_4$ loads**

# SWAT+ results at monitoring station: monthly discharge

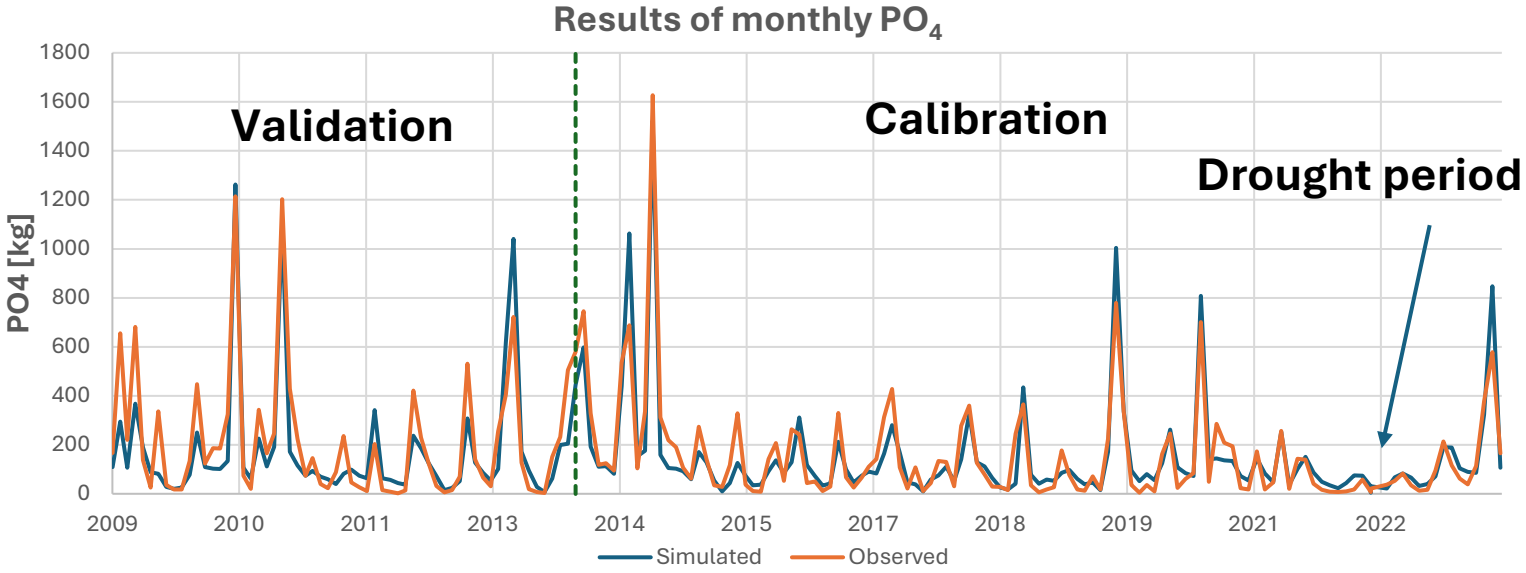



| Period | $R^2$ | Pbias | KGE |
|---|---|---|---|
| Validation 2004-2013 | 0.72 | 2.9% | 0.78 |
| Calibration 2014-2023 | 0.74 | -13.3% | 0.80 |

# SWAT+ results at monitoring station: monthly nutrients

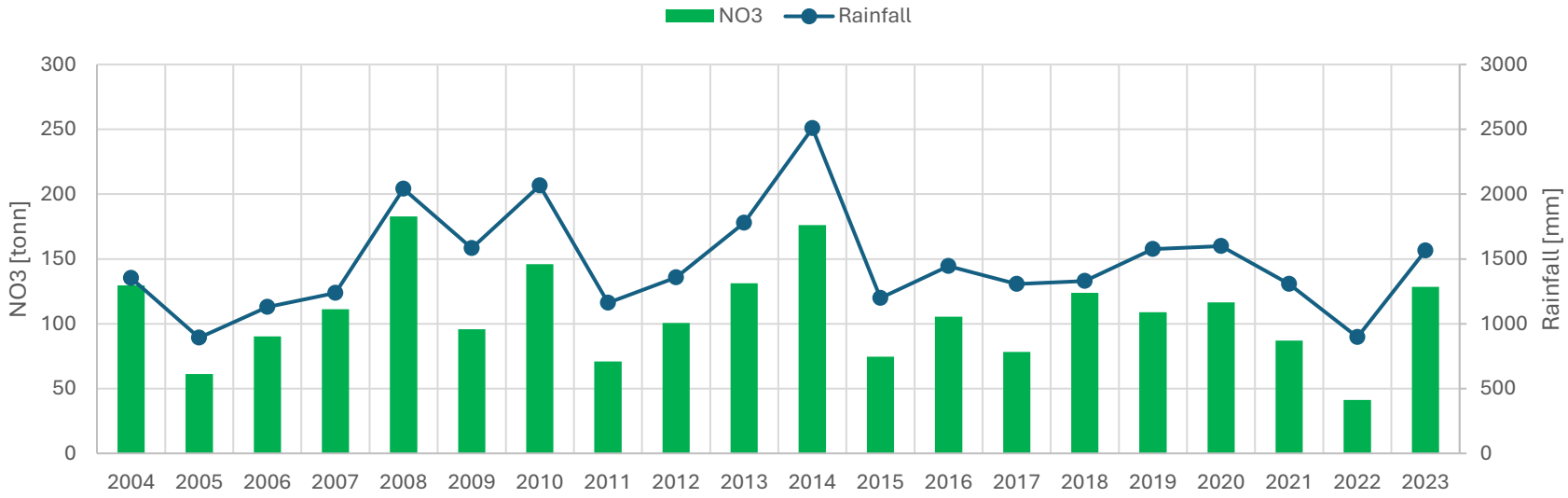



| Period | $R^2$ | Pbias | KGE |
|---|---|---|---|
| Calibration 2014-2023 | 0.55 | -21% | 0.66 |
| Validation 2009-2013 | 0.47 | 23.4% | 0.50 |



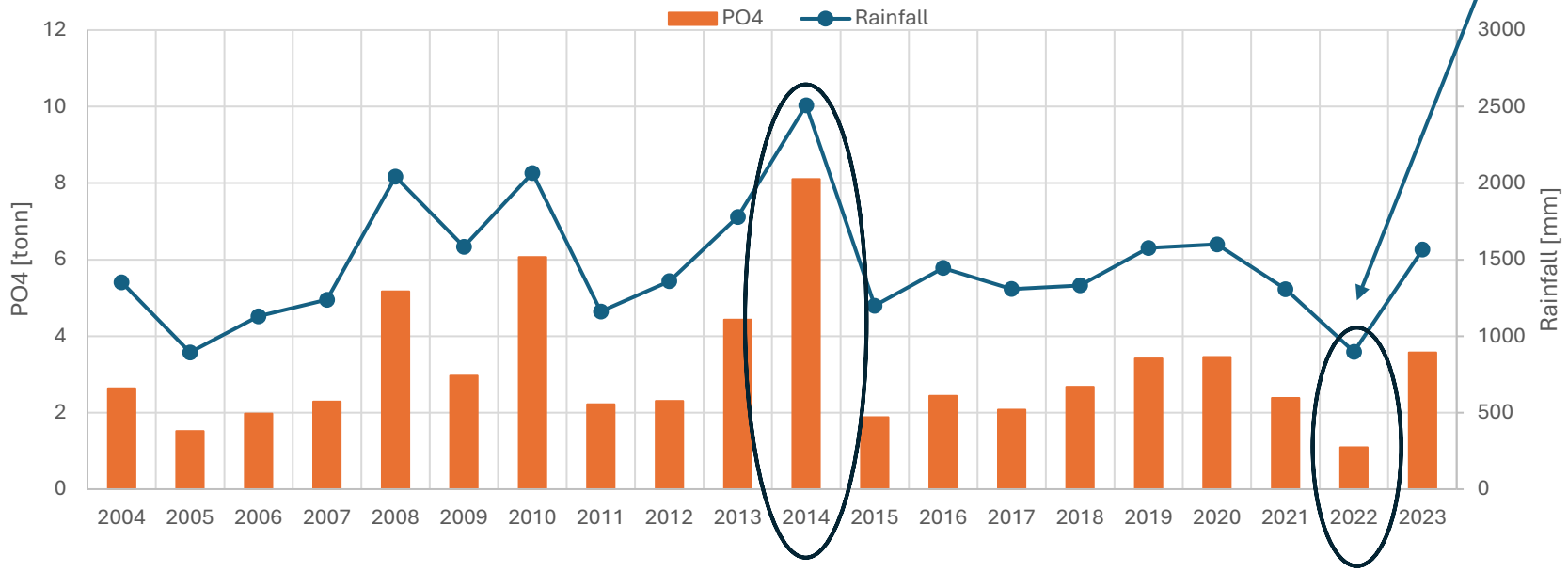

| Period | $R^2$ | Pbias | KGE |
|---|---|---|---|
| Calibration 2014-2023 | 0.86 | 3.3 % | 0.92 |
| Validation 2009-2013 | 0.79 | 17.3 % | 0.79 |

## Comparison annual rainfall and simulated $NO_3$ load




R=0.88

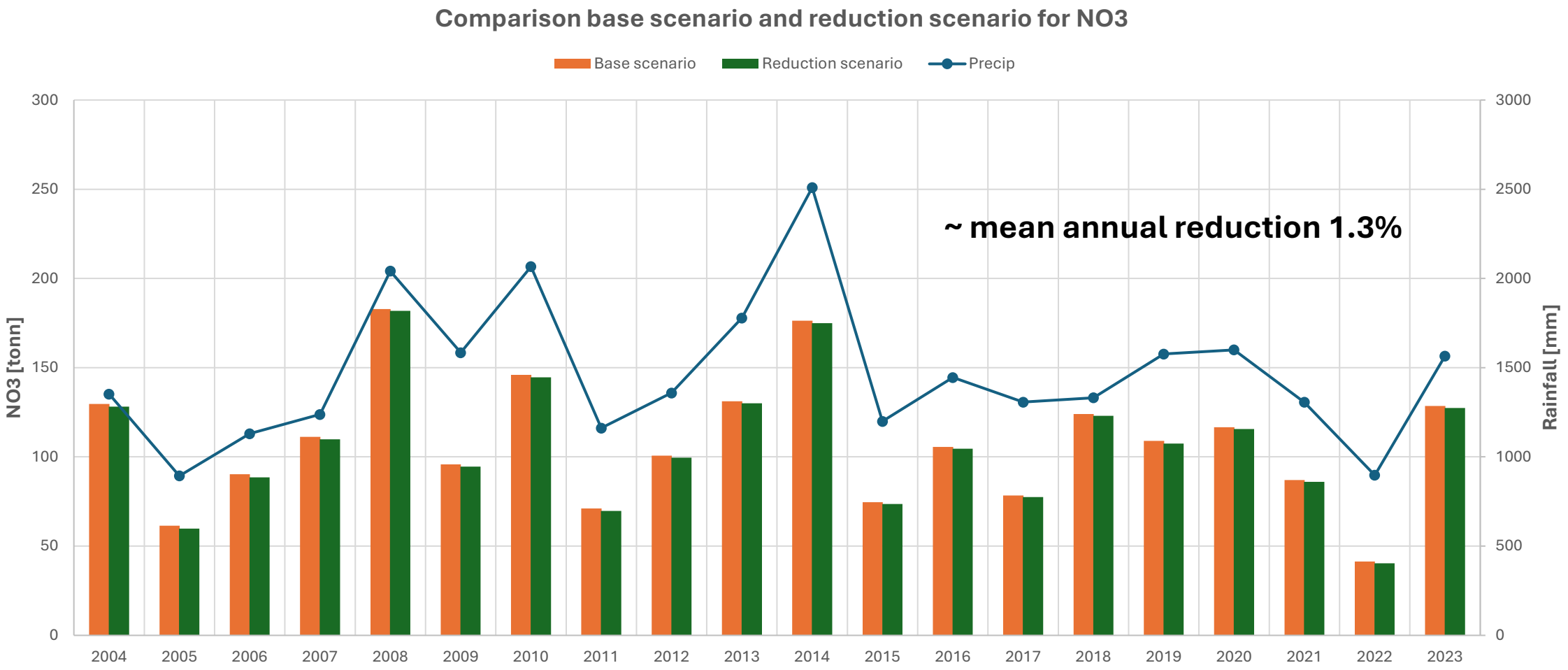
## Comparison annual rainfall and simulated $PO_4$ load



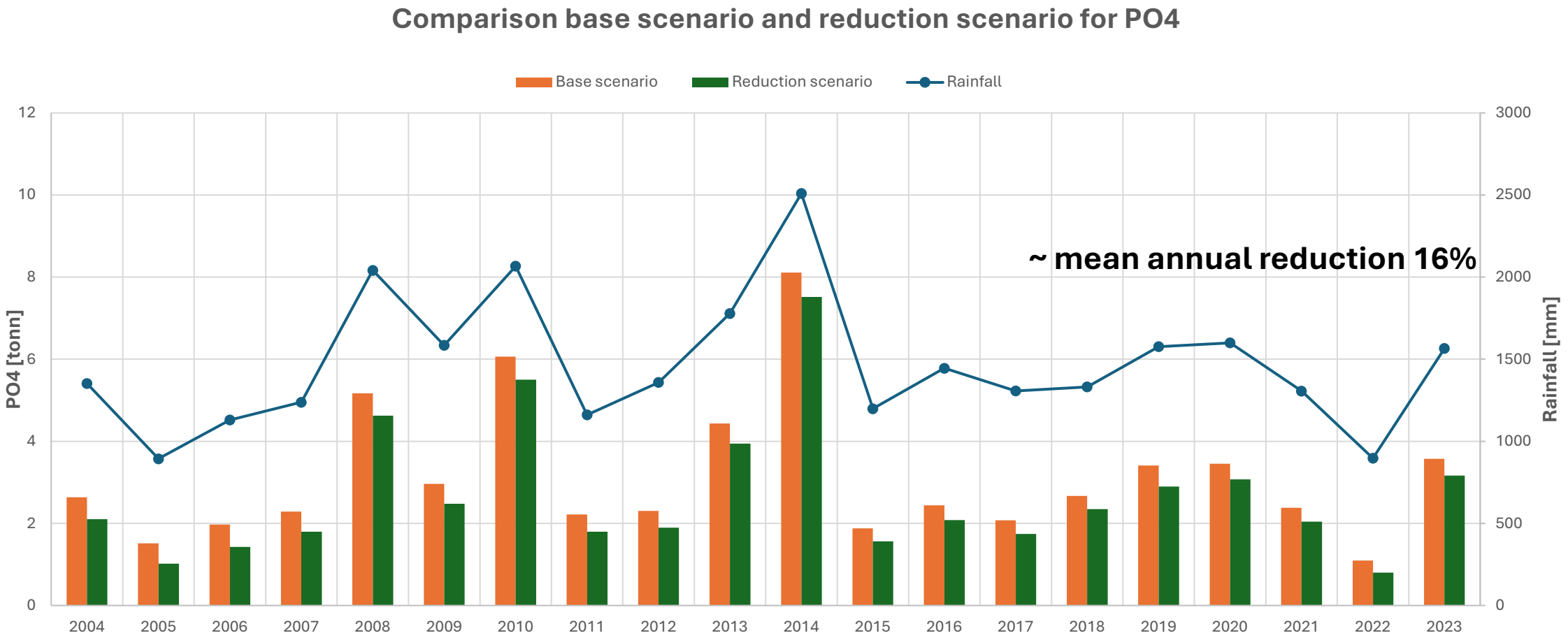

**Drought period**

R=0.97

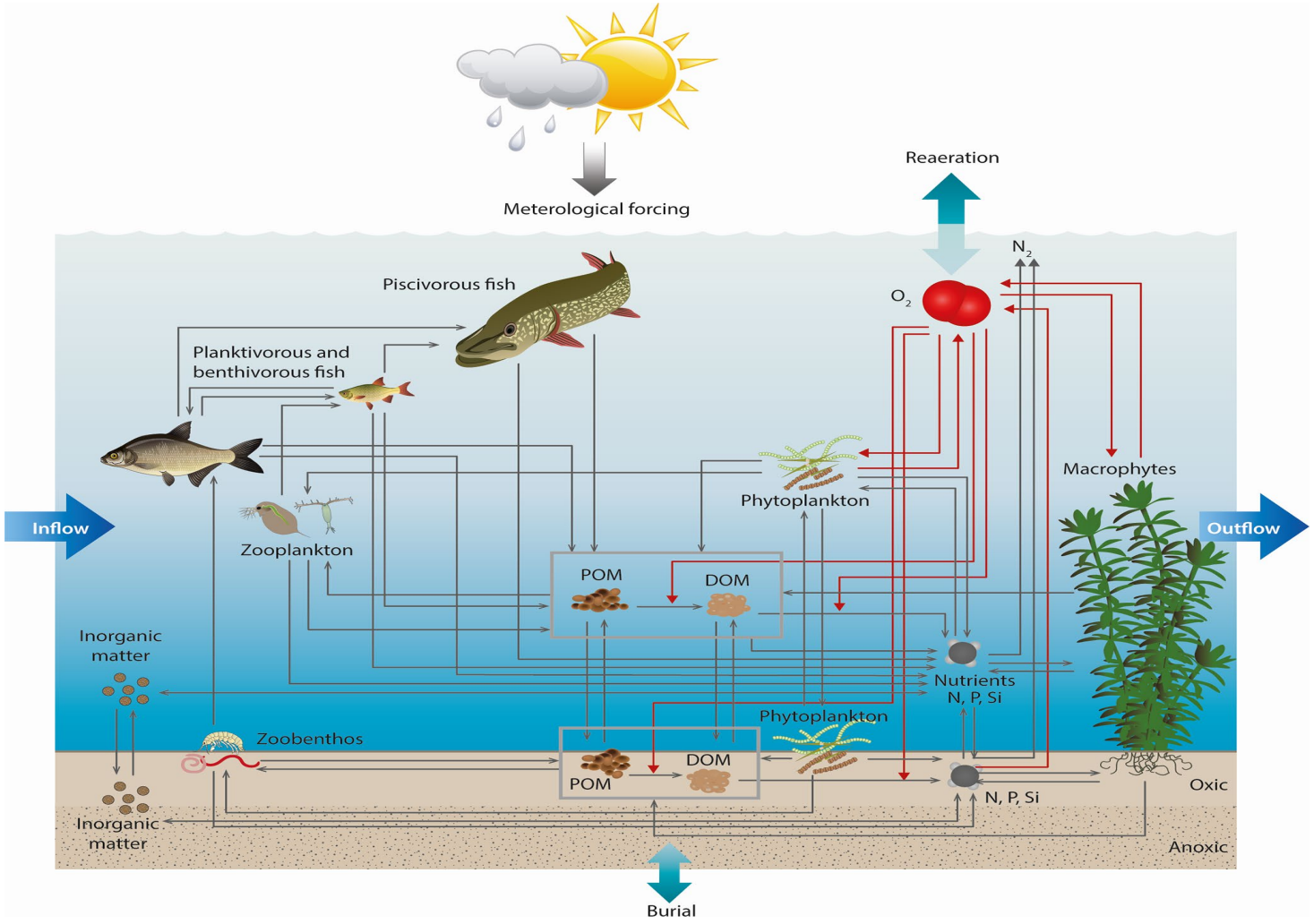
# Reduction scenario result: $NO_3$



# Reduction scenario result : $PO_4$



# Lake model setup




WET
Water Ecosystems Tool

Calibration period from 2009 to 2023

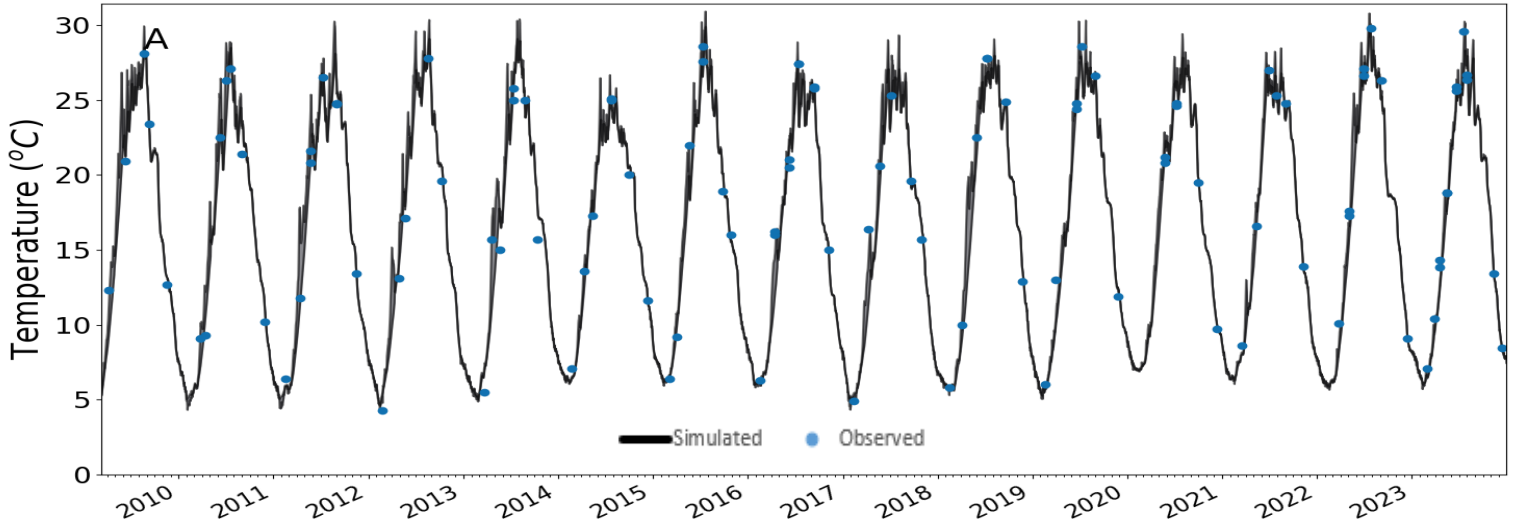
Calibrated variables :

- Temperature
- Oxygen
- TN , $NO_3$ ,$NH_4$
- TP ,$PO_4$
- Chl-a

**Quarterly frequency**

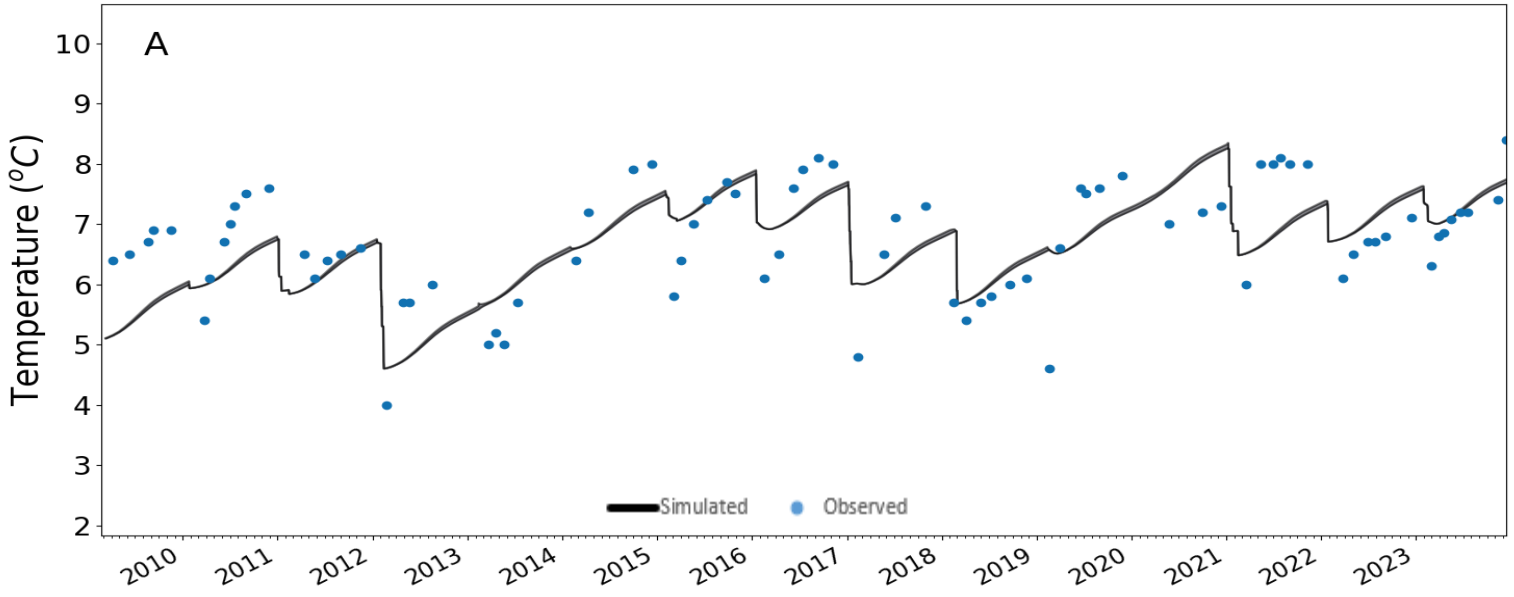
# Lake model results : temperature

WORK IN PROGRESS!




**Epilimnion layer**

| R | MAE (°C) |
|---|---|
| 0.99 | 0.93 |

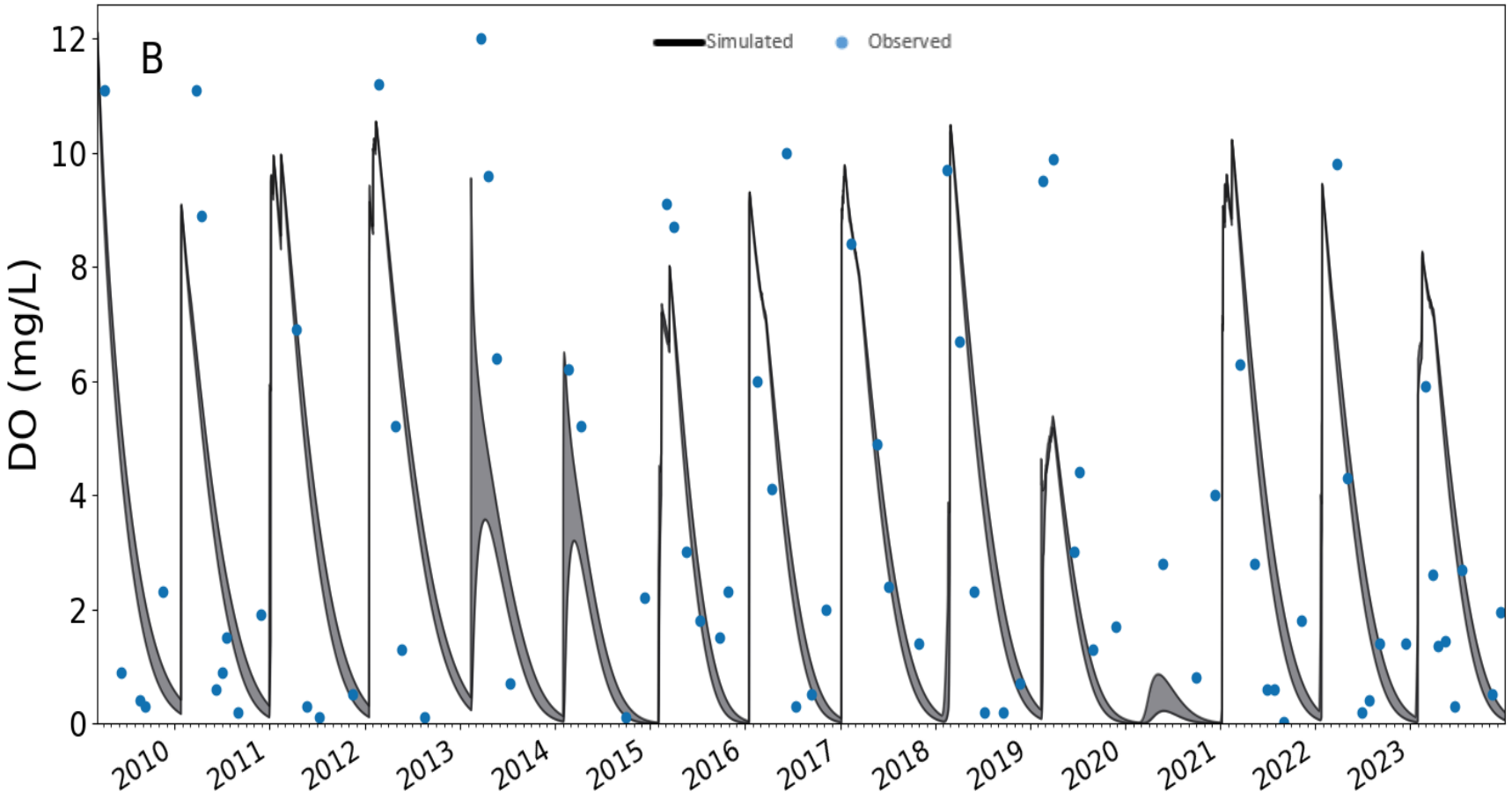



**Hypolimnion layer**

| R | MAE (°C) |
|---|---|
| 0.65 | 0.62 |

# Lake model results : Oxygen

WORK IN PROGRESS!

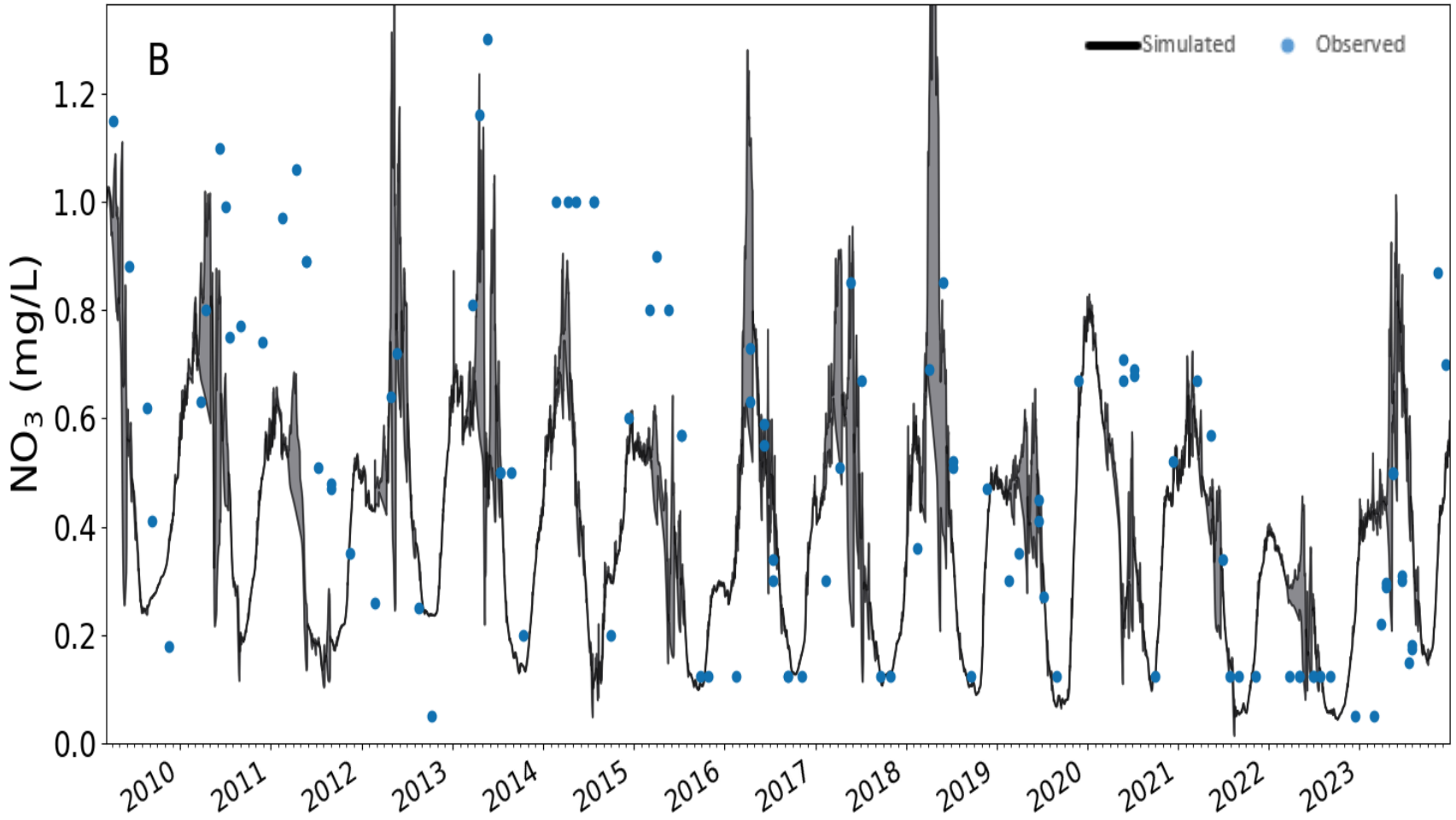



**Hypolimnion layer**

| R | MAE (mg/l) |
|---|---|
| 0.6 | 2.27 |

# Lake model results : NO3

WORK IN PROGRESS!

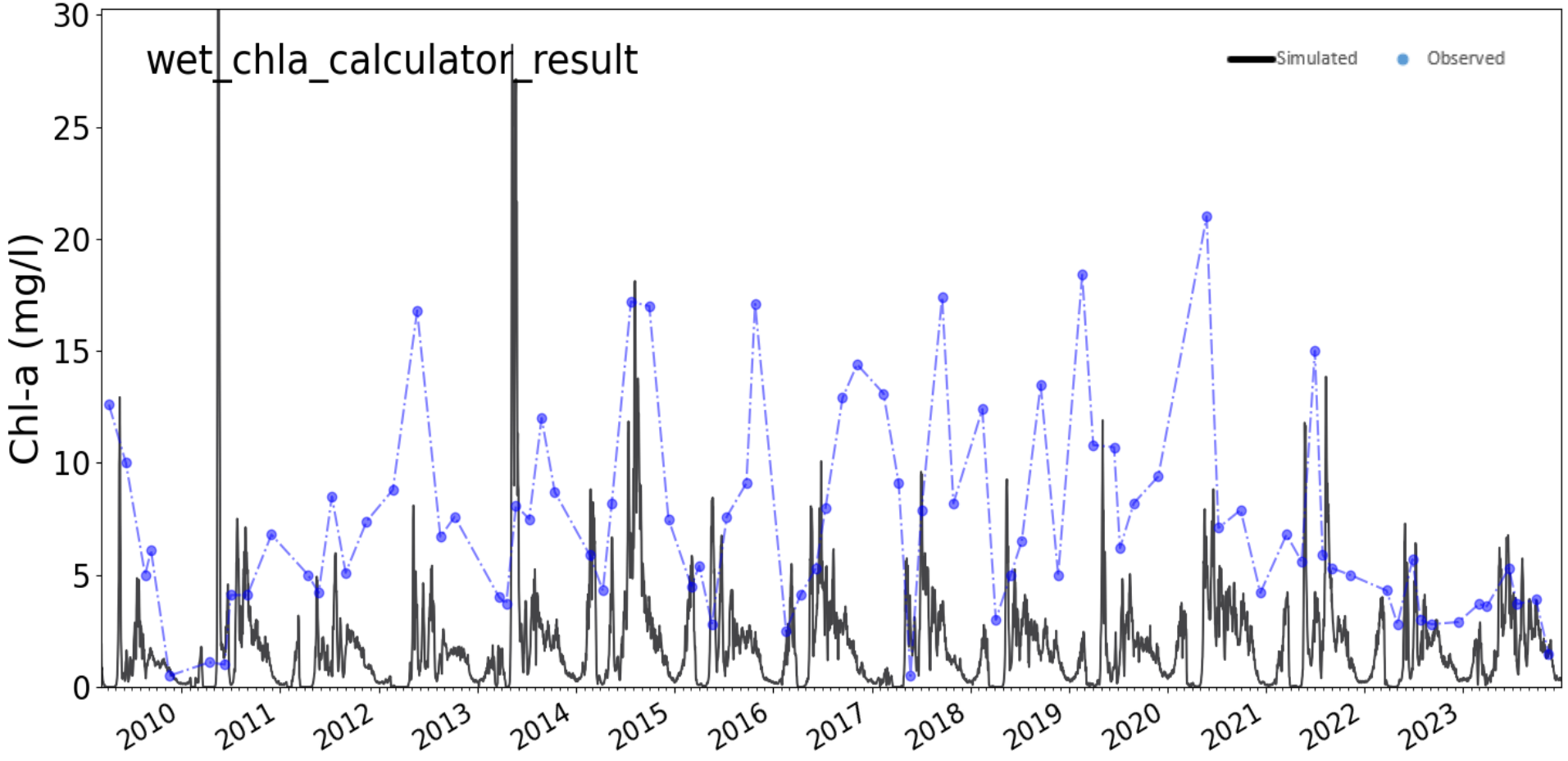



**Epilimnion layer**

| R | MAE (mg/l) |
|---|---|
| 0.5 | 0.22 |

# Lake model results : Clorofille

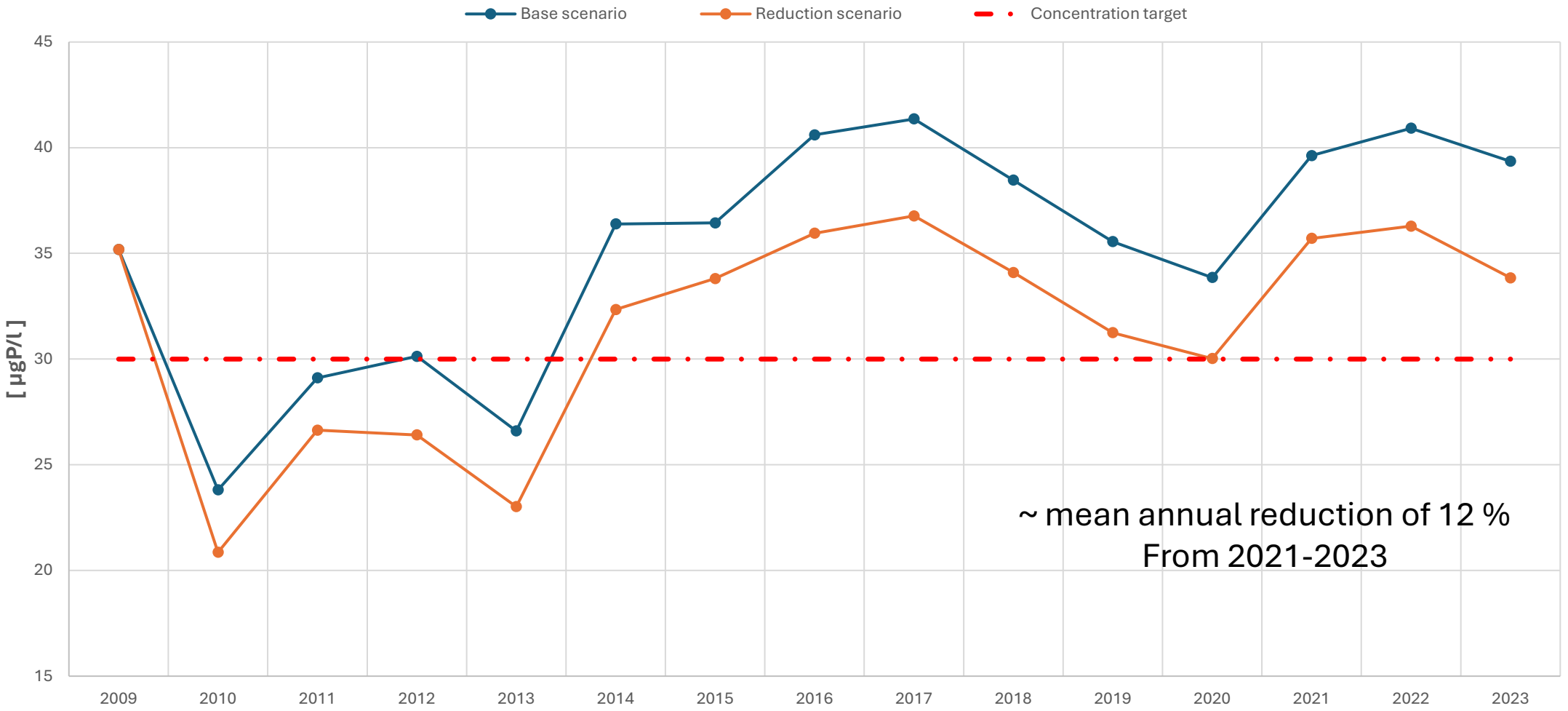
WORK IN PROGRESS!




**Epilimnion layer**

| R | MAE (mg/l) |
|---|---|
| 0.15 | 5.87 |

# Comparison scenarios of the volume-weighted TP concentration at spring mixing



# Conclusions:

- Evaluation of the nutrients loads with SWAT+
- Simulation the lake using the nutrients loads simulated with SWAT+
- The reduction of nutrients is not consistent

# What's next?

- Optimization of the lake model
- Use remote sensing data
- Climate change scenario
- Combine climate change scenario and nutrients reduction scenario

# Thank for the attention.

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