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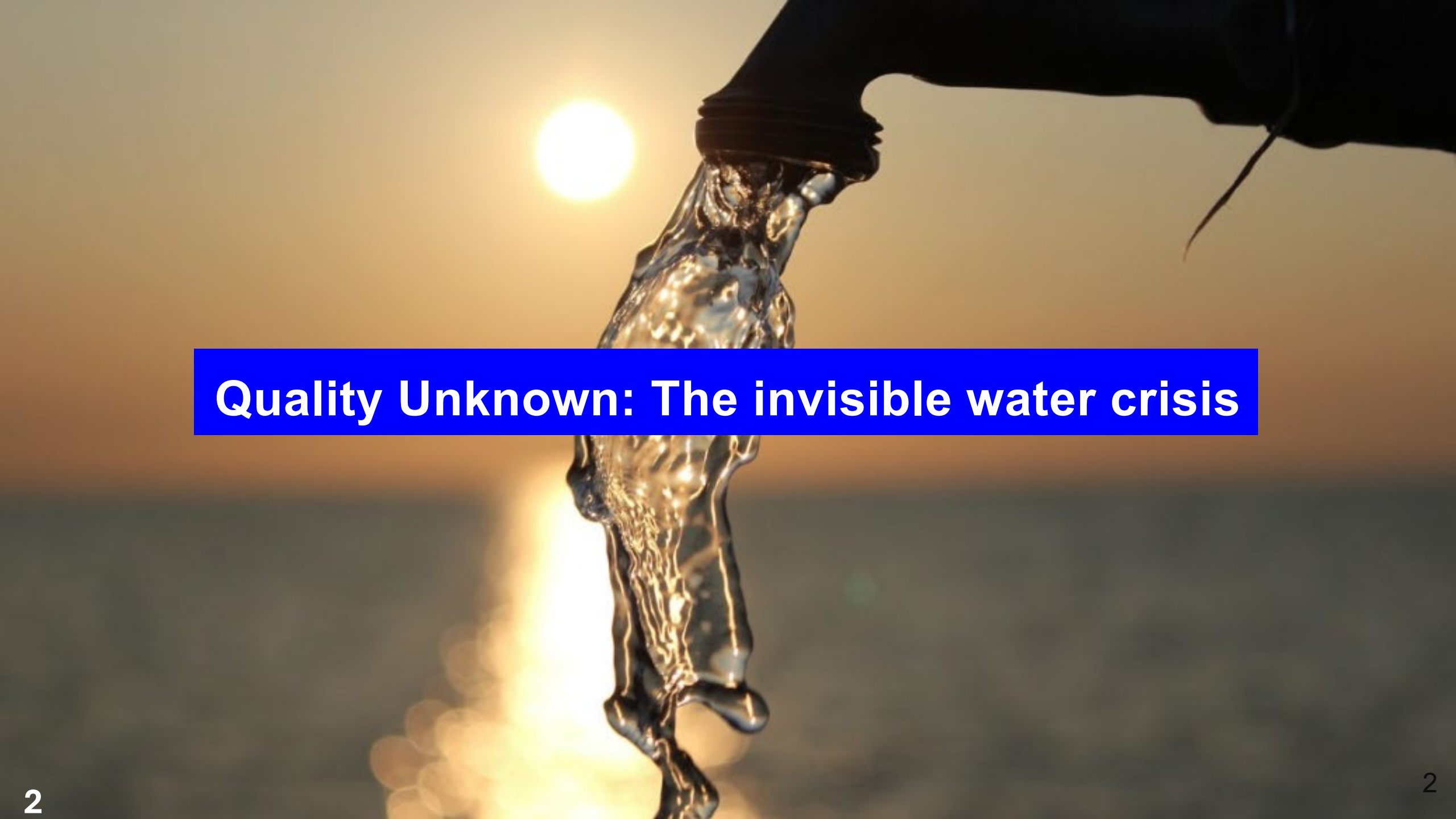
# A high-resolution community global SWATplus water quality model

11 July 2024

Albert Nkwasa, Celray James Chawanda, Ann van Griensven



# Quality Unknown: The invisible water crisis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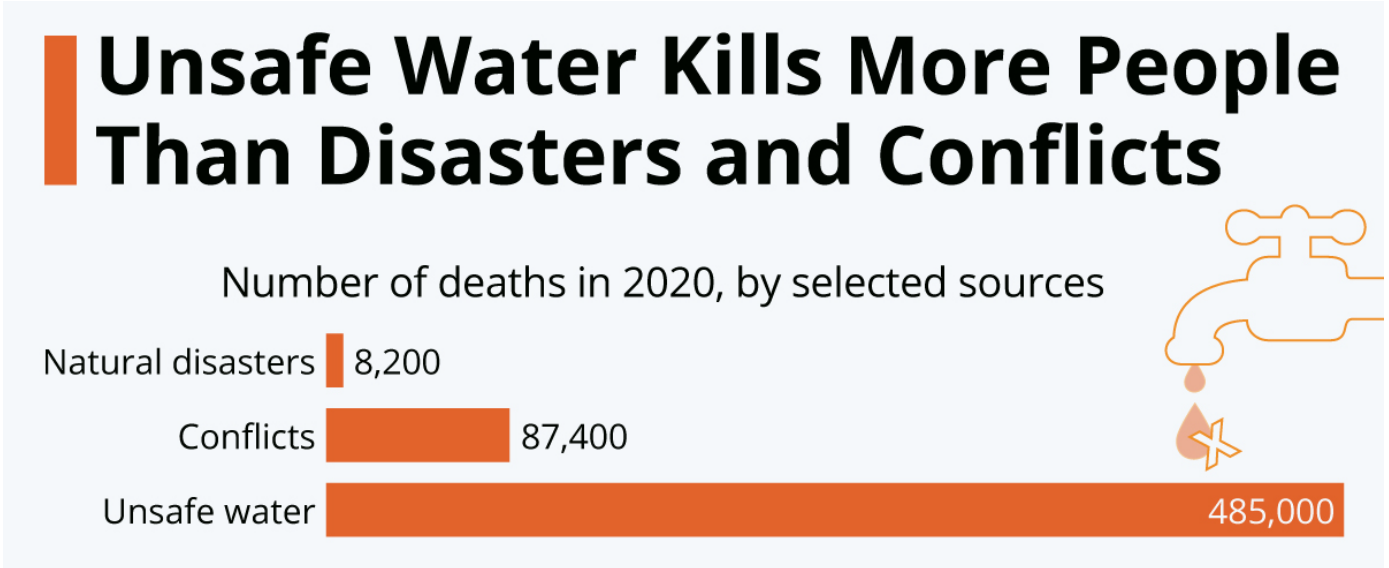
# Is Our Planet's Water Clean?

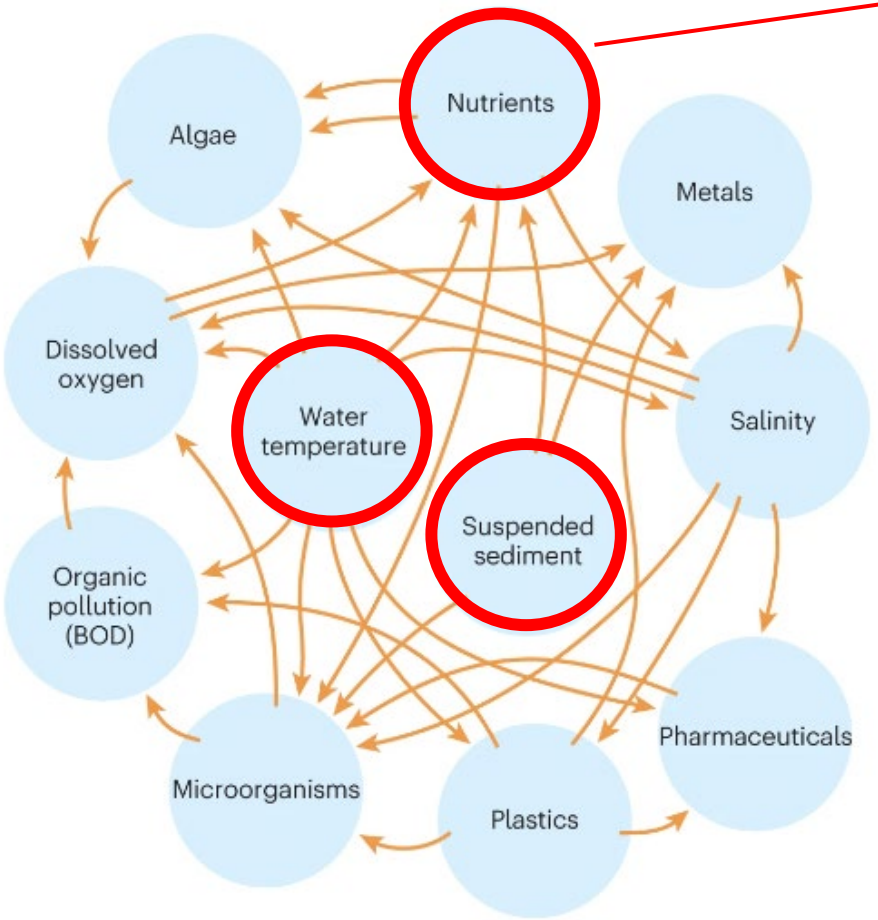

Uppsala Conflict Database Program



# Which water quality variables?

**By definition**

- Chemical
- Physical
- Biological

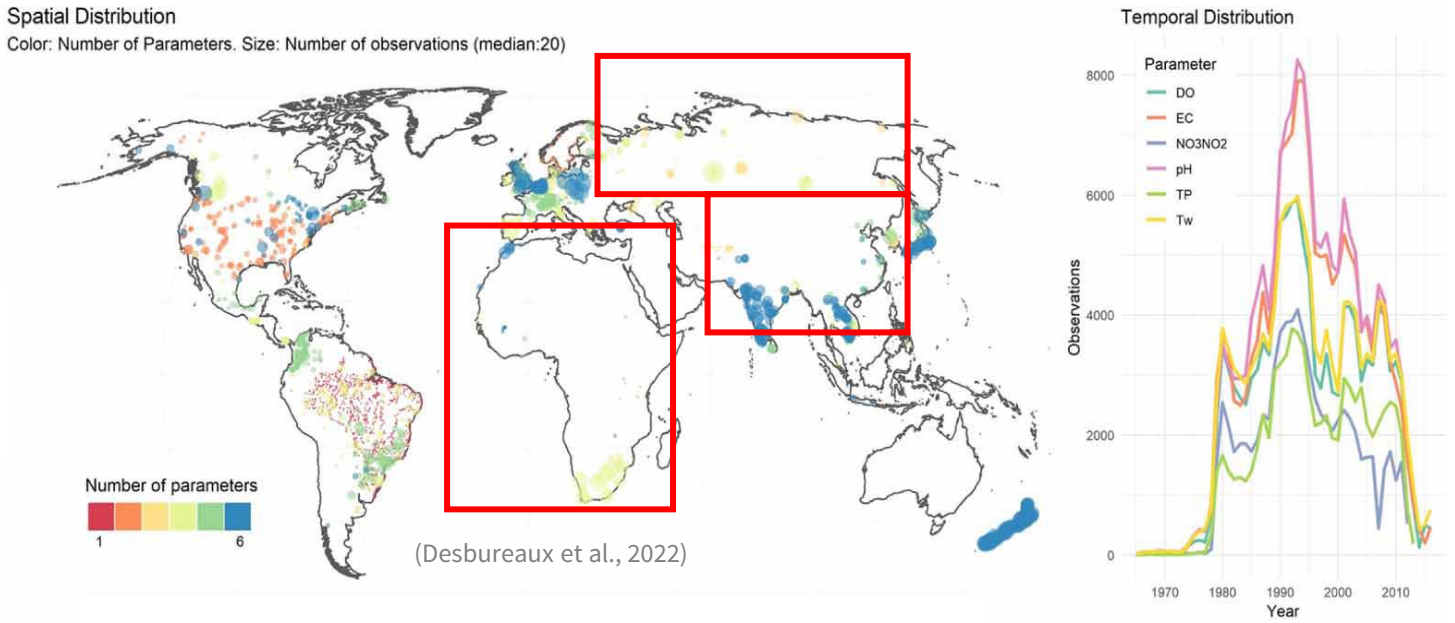



1.Total Nitrogen (TN)

2. Total Phosphorus (TP)

# Data and Modelling Gap

## (1) GEMStat data (**Lacking** & **Incomplete**)



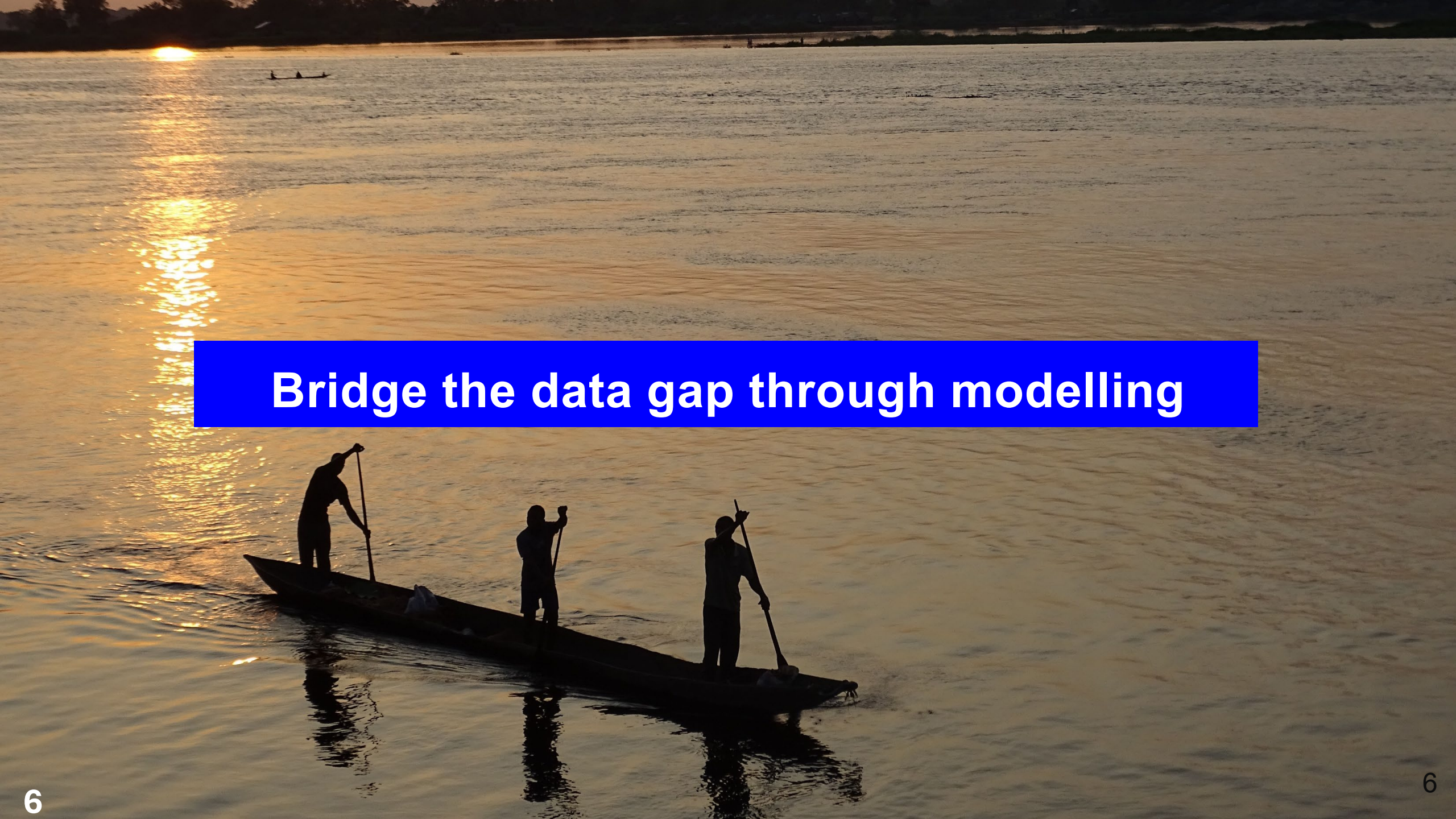




- Limited observation data
- Mostly > 30-year-old data

## (2) Existing Large scale Models

- Only 2 global models (Nutrients)
- Run at multi-yearly time step
- Spatial resolution of ~ 55 km by 55 km
- Lack model evaluations



# Bridge the data gap through modelling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# Global Datasets used for setup

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ELSEVIER

Environmental Modelling & Software

Volume 134, December 2020, 104812

## User-friendly workflows for catchment modelling: Towards reproducible SWAT+ model studies

Celray James Chawanda [a], Chris George [b], Wim Thiery [a c], Ann van Griensven [a d], Jaclyn Tech [e], Jeffrey Arnold [f], Raghavan Srinivasan [e]

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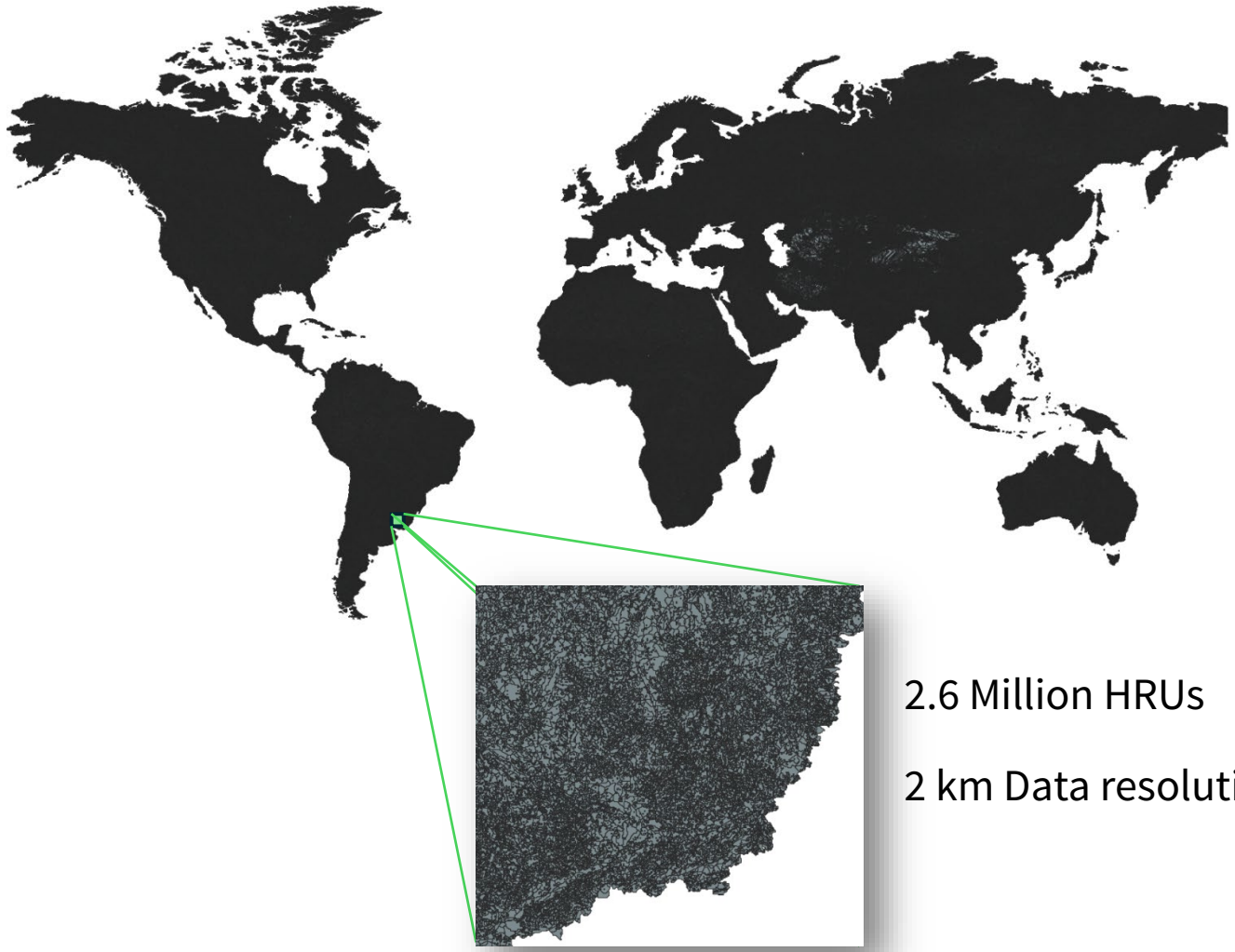
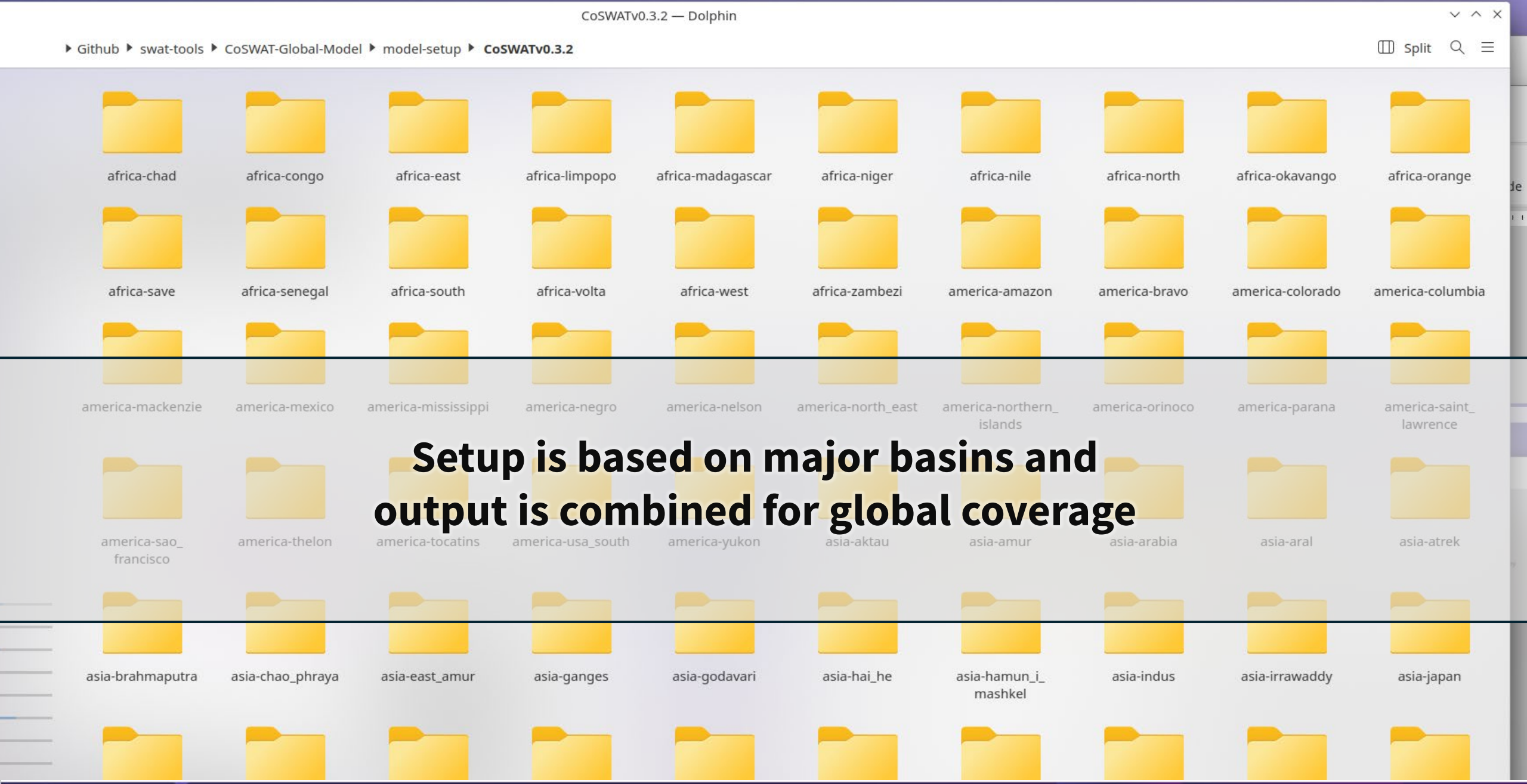
Highlights



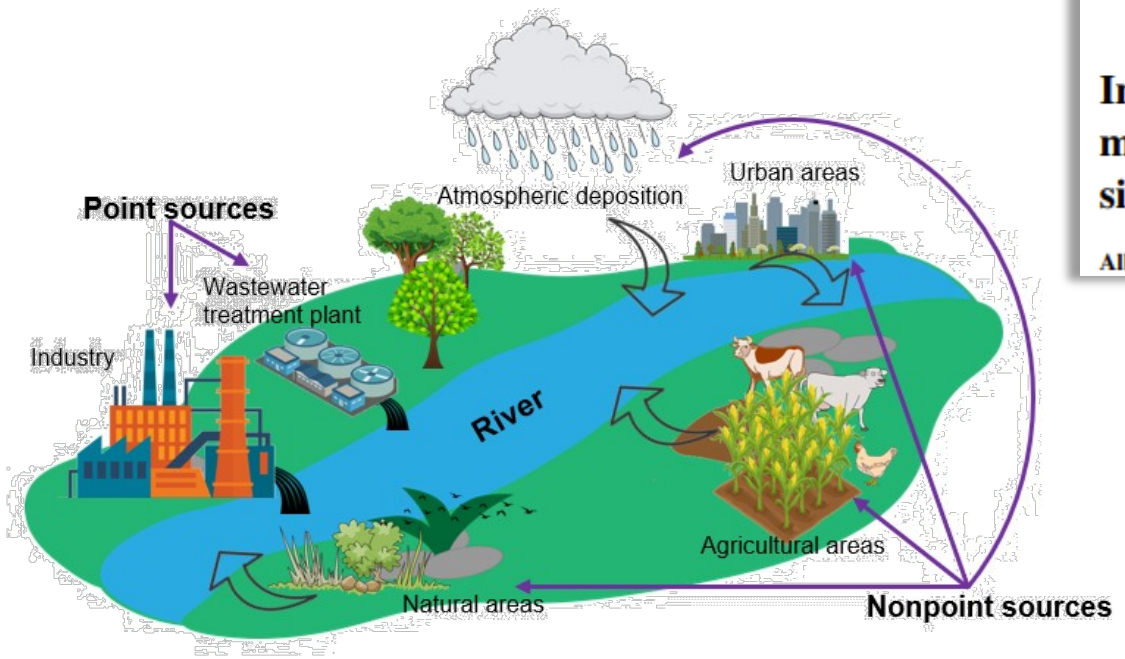
2.6 Million HRUs

2 km Data resolution




# Setup is based on major basins and output is combined for global coverage

# Water quality model setup




https://github.com/ankwasa

Hydrol. Earth Syst. Sci., 26, 71–89, 2022
https://doi.org/10.5194/hess-26-71-2022


Hydrology and Earth System Sciences
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EGU

**Improved representation of agricultural land use and crop management for large-scale hydrological impact simulation in Africa using SWAT+**

Albert Nkwasa[1], Celra

**One third of African rivers fail to meet the 'good ambient water quality' nutrient targets**

Albert Nkwasa[1,2], Celray James Chawanda[1,3], Maria Theresa Nakkazi[1], Ting Tang[4], Steven J. Eisenreich[1], Stuart Warner[5], Ann van Griensven[1,6]

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**Regionalization of the SWAT+ model for projecting climate change impacts on sediment yield: An application in the Nile basin**

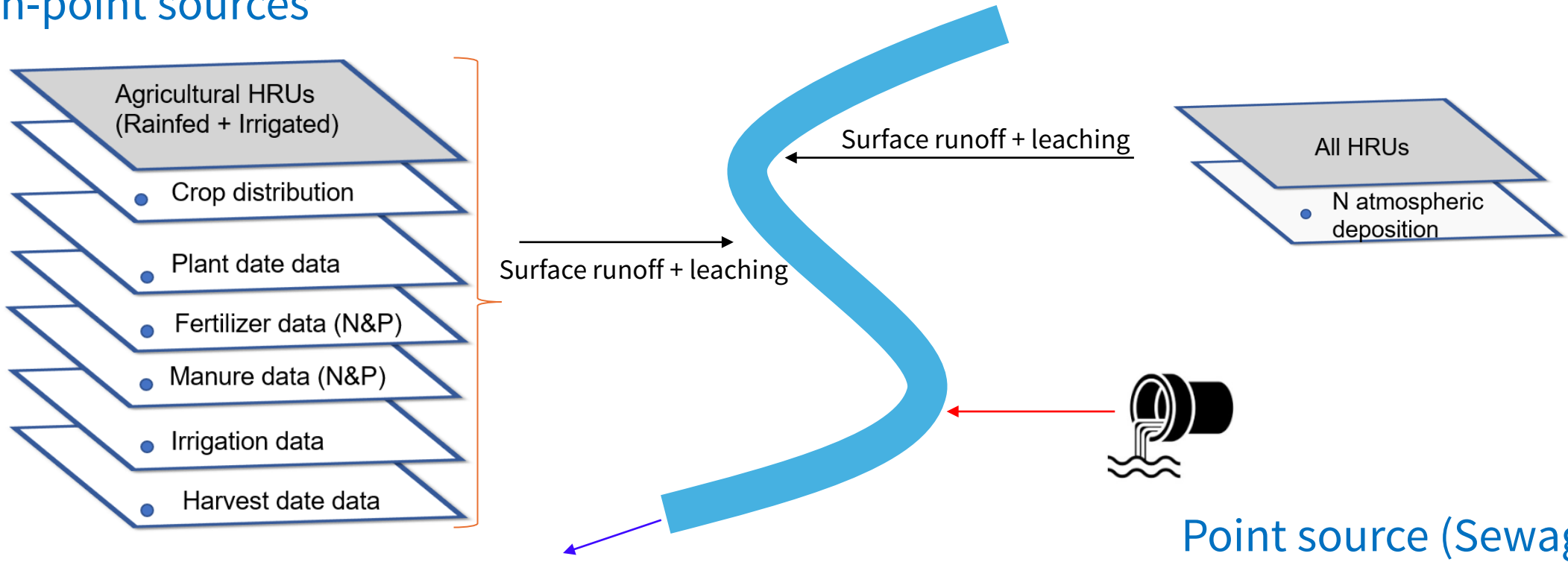
Albert Nkwasa [a,*], Celray James Chawanda [a], Ann van Griensven [a,b]

[a] Hydrology and Hydraulic Engineering Department, Vrije Universiteit Brussel (VUB), 1050 Brussel, Belgium
[b] Water Science & Engineering Department, IHE Delft Institute for Water Education, 2611 AX Delft, the Netherlands

ARTICLE INFO ABSTRACT

# Water quality model setup

## Non-point sources

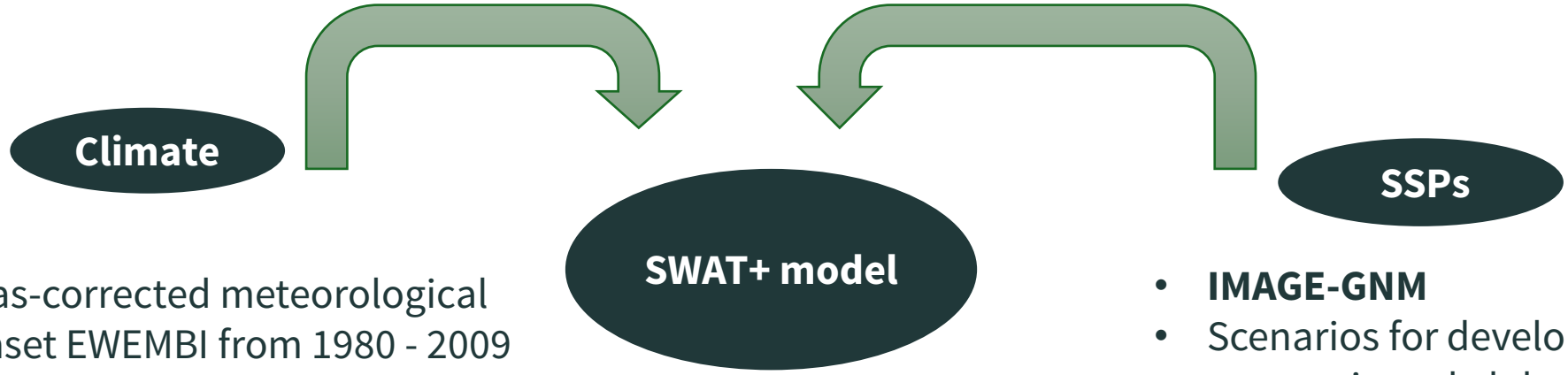



Decision tables + python

https://github.com/ankwasa

*(Nkwasa et al., 2022a; Nkwasa et al., 2022b)*

# Methods and Data for historical & future runs



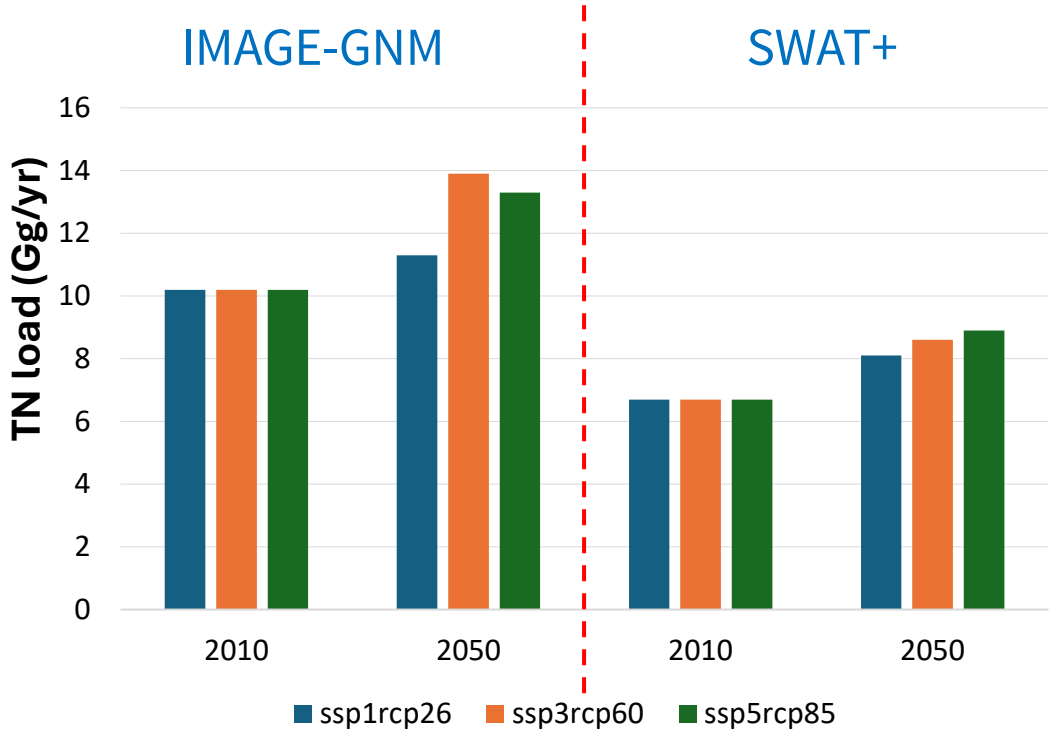

- **ISIMIP2b:**
- **Current**: bias-corrected meteorological forcing dataset EWEMBI from 1980 - 2009
- **Future**: bias-corrected global climate data (2010 – 2050)
  - for **four GCMs** (GFDL-ESM2M, IPSL-CM5A-LR, MIROC5, HadGEM2-ES) and
  - **three climate scenarios** (RCP2.6, RCP6.0, RCP8.5),
  - at **0.5° x 0.5°** resolution
- **Climatic variables**: Precipitation, temperature, solar radiation, wind speed, relative humidity

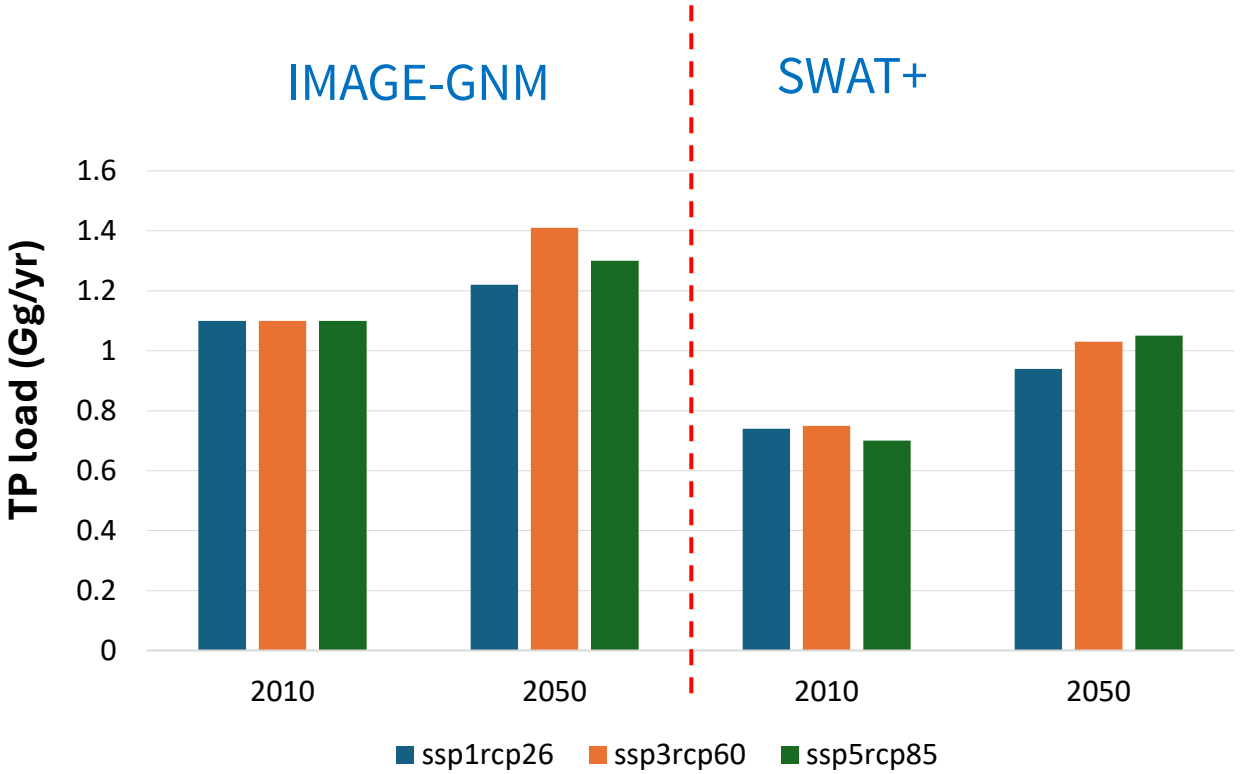
- **IMAGE-GNM**
- Scenarios for development of socio-economic and global environmental (**SSP1, SSP3, SSP5**) **–** (2010 – 2015)
- Nitrogen and Phosphorus fertilizer & manure
- Wastewater discharge (point sources)
- Atmospheric deposition (Nitrogen)

***UNCALIBRATED GLOBAL MODEL***

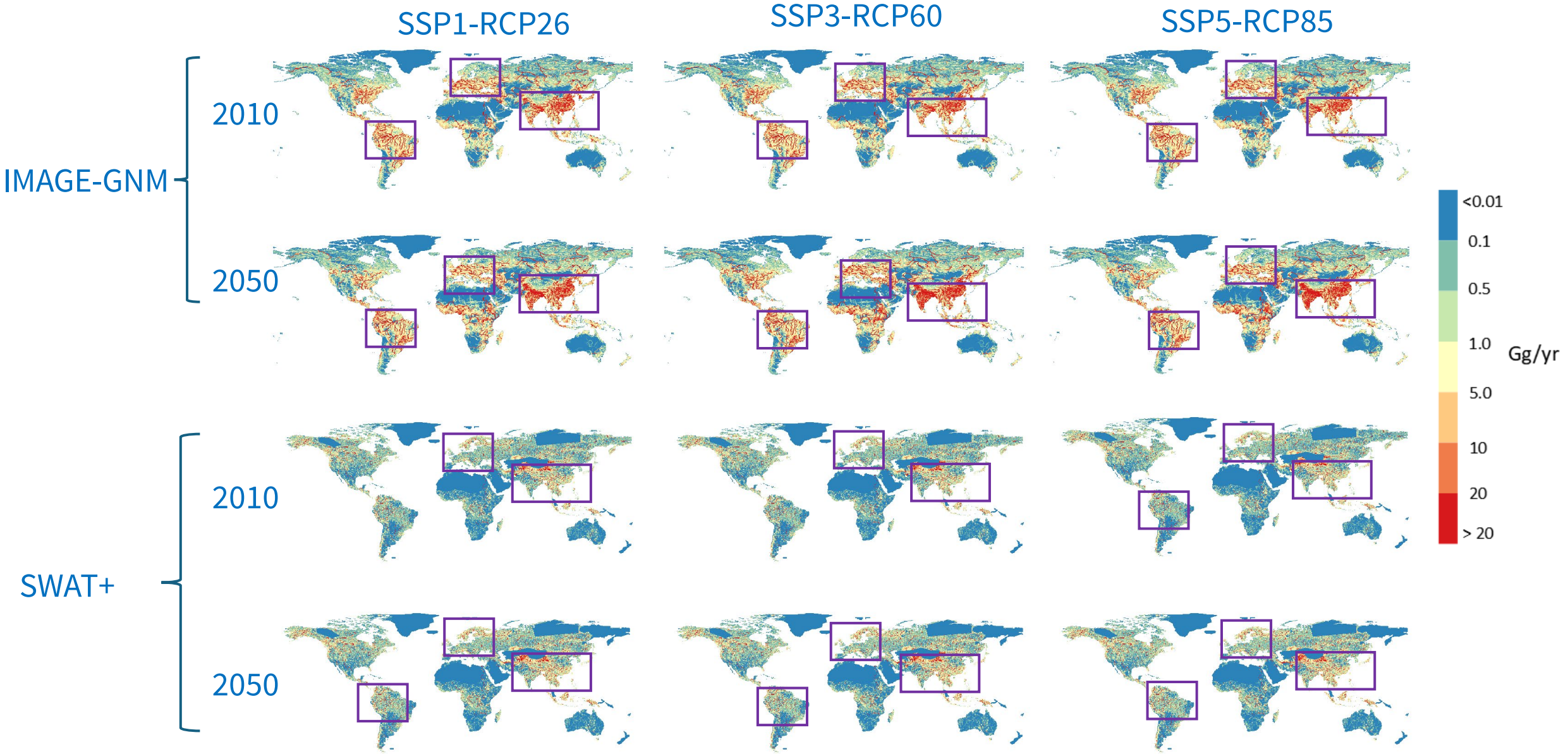

Increase in nutrient pollution in all scenarios

# TN & TP - historical & future river loadings

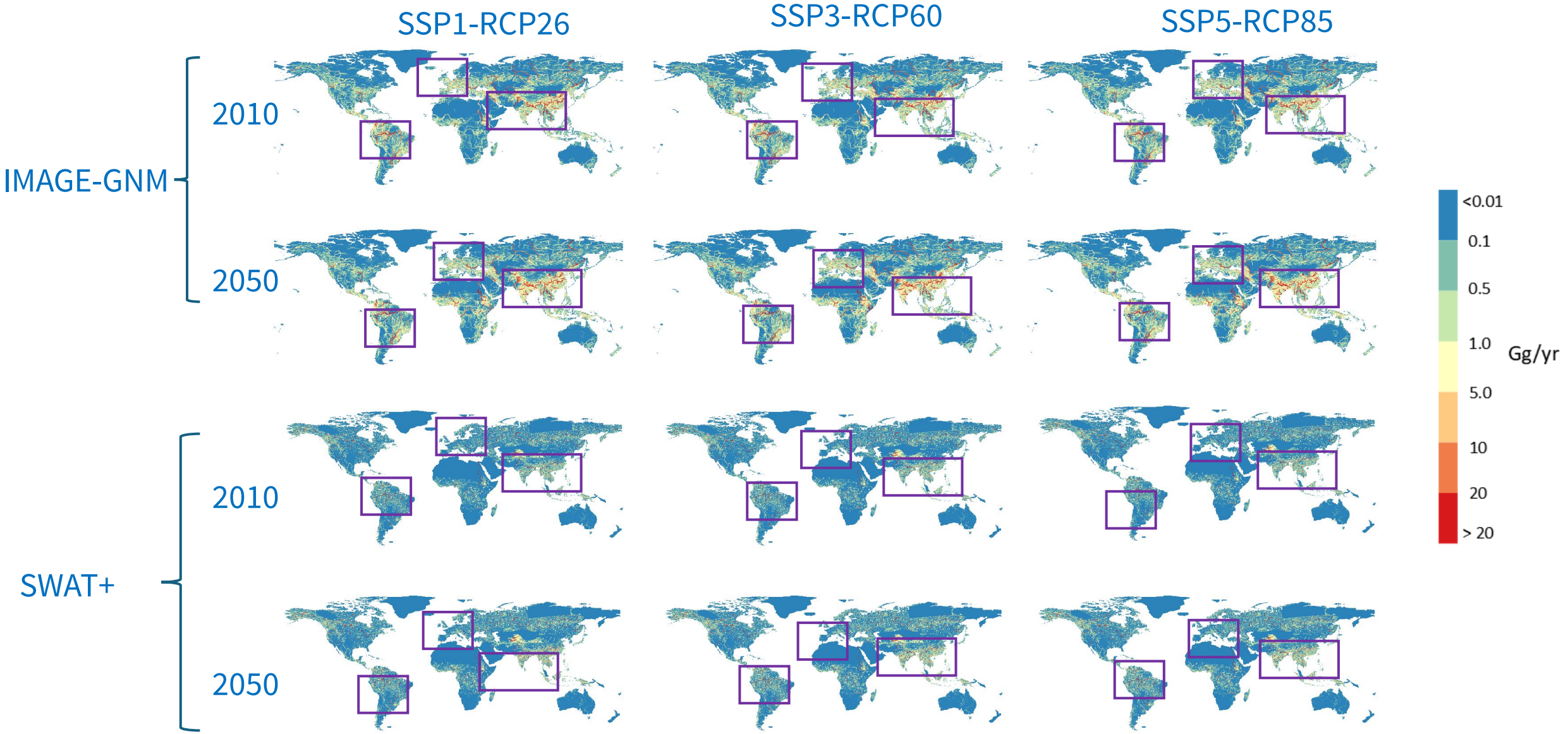


# TN simulations



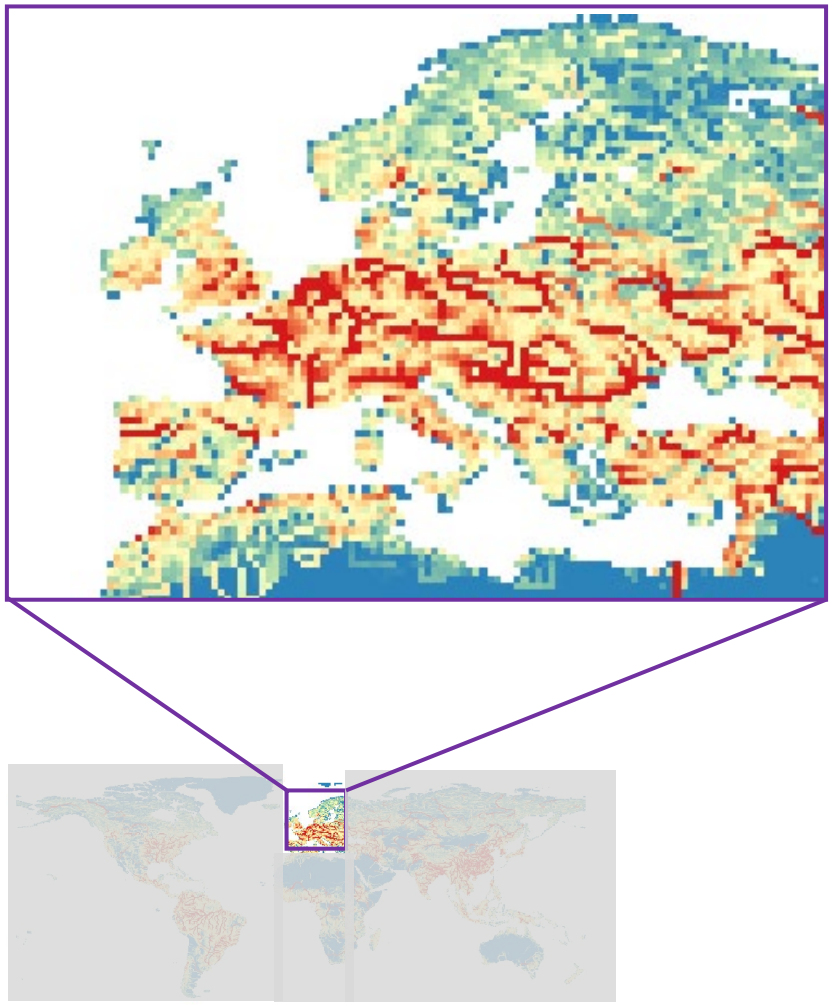
# TP simulations



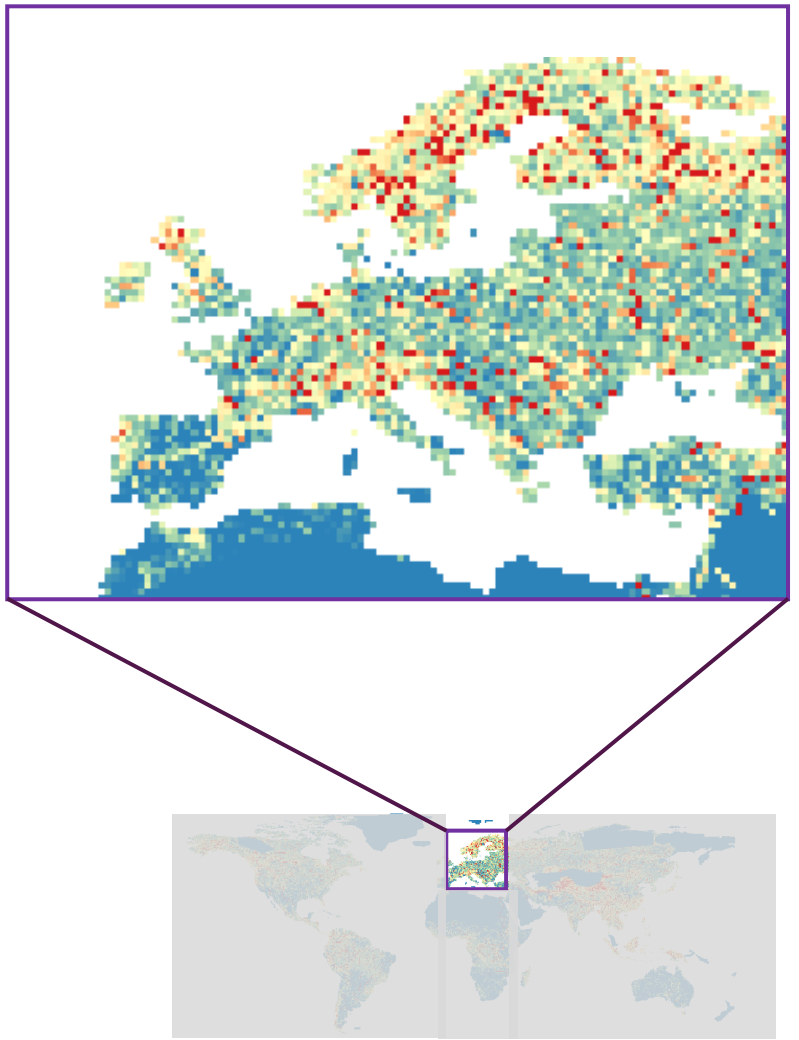
# TN simulations – Europe

SSP5-RCP85

IMAGE-GNM



SWAT+



# Why the differences?

- Different model structures
- Different climate GCM forcings
- Run at different spatial and temporal resolutions

# Key take-aways & outlook

- Overall, regional **bright** and **dark** spots are captured
- Focus should be on **trends** and h**otspots** but not absolute values
- Both **TN** and **TP** river loads **increase** under all scenarios upto 2050
- SWAT+ model simulates **less load magnitude** compared to IMAGE-GNM model
- **Model calibration** and **reservoir** management operations to be implemented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# Access to the simulation runs

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

**Global water quality sector**

DKRZ repository: /work/bb0820/scratch/water_quality/SWATplus/_doc/global/

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# Thank you.

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