

A high-resolution community global SWATplus water quality model

11 July 2024

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A close-up photograph of water being poured from a tap. The water is captured in mid-air, creating a dynamic, crystalline stream. The background is a soft, golden sunset with a bright sun low on the horizon, creating a bokeh effect of light circles. The overall mood is serene yet carries a sense of urgency due to the text overlay.

Quality Unknown: The invisible water crisis

Is Our Planet's Water Clean?

Home / News, Stories & Speeches / story

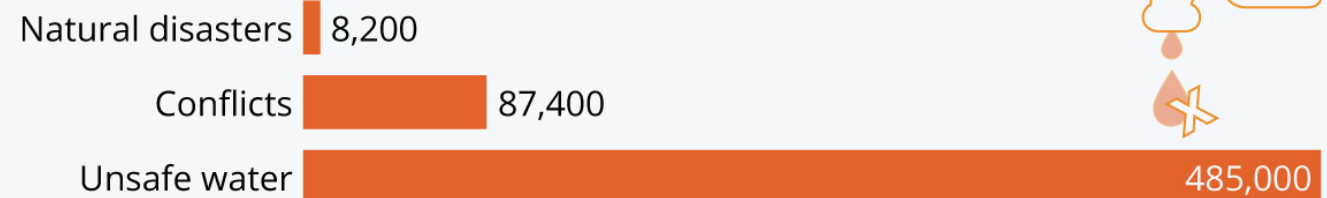
19 MAR 2021 | STORY | FRESH WATER

Globally, 3 billion people at health risk due to scarce data on water quality

UNEP / Lisa Murray

Unsafe Water Kills More People Than Disasters and Conflicts

Number of deaths in 2020, by selected sources

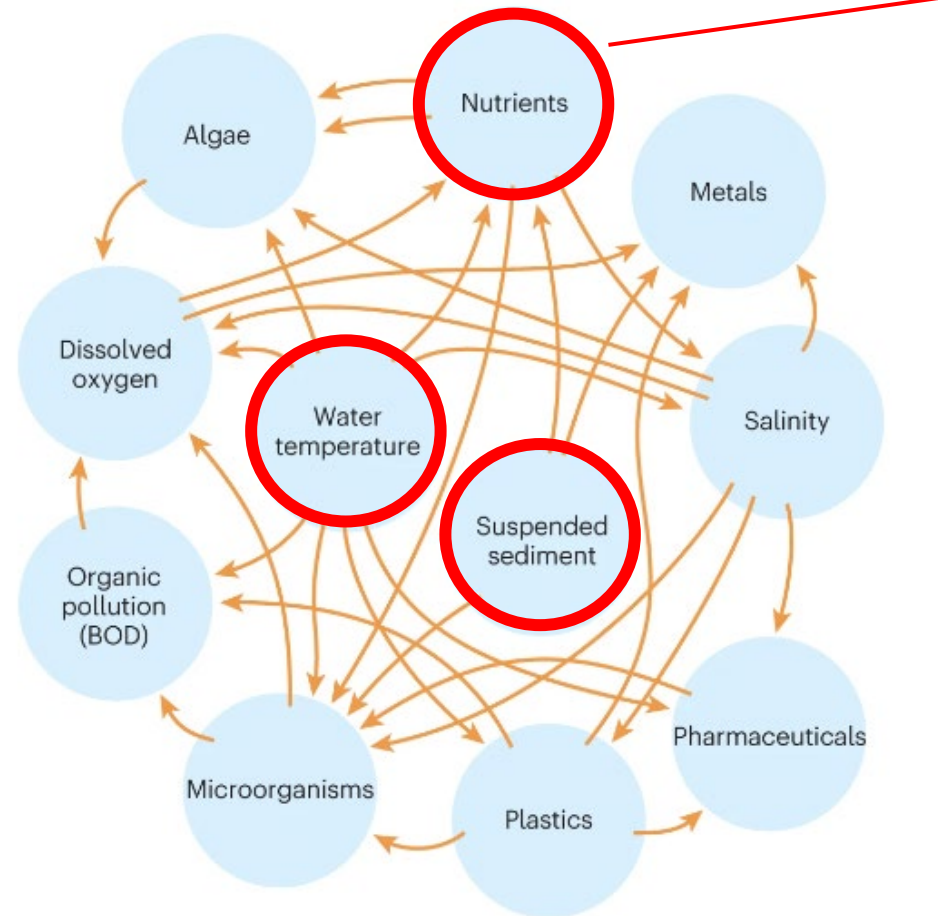


Uppsala Conflict Database Program

Which water quality variables?

By definition

- Chemical
- Physical
- Biological



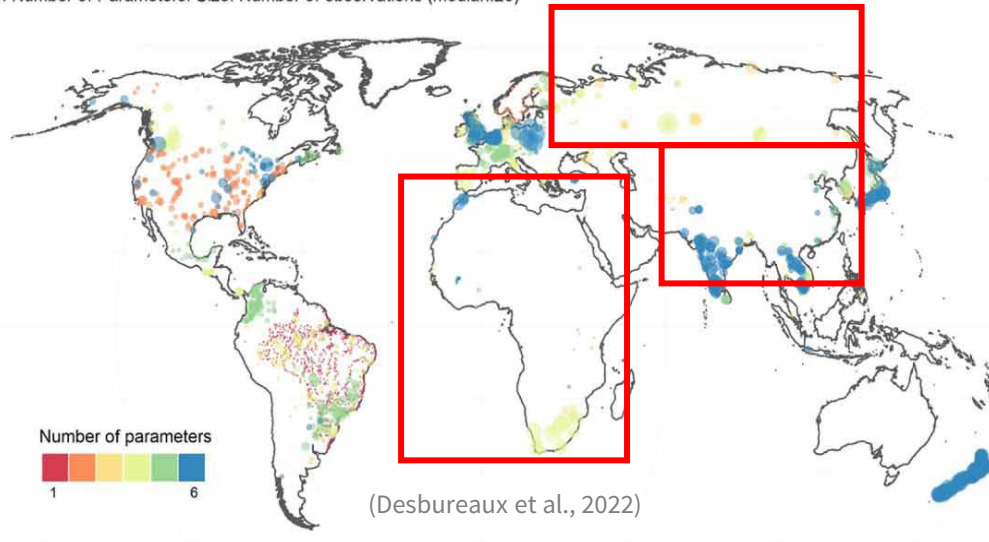
1. Total Nitrogen (TN)
2. Total Phosphorus (TP)

Data and Modelling Gap

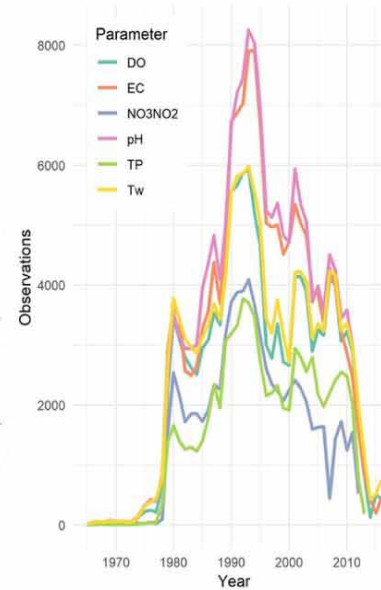
(1) GEMStat data (**Lacking & Incomplete**)

Spatial Distribution

Color: Number of Parameters. Size: Number of observations (median:20)



Temporal Distribution



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

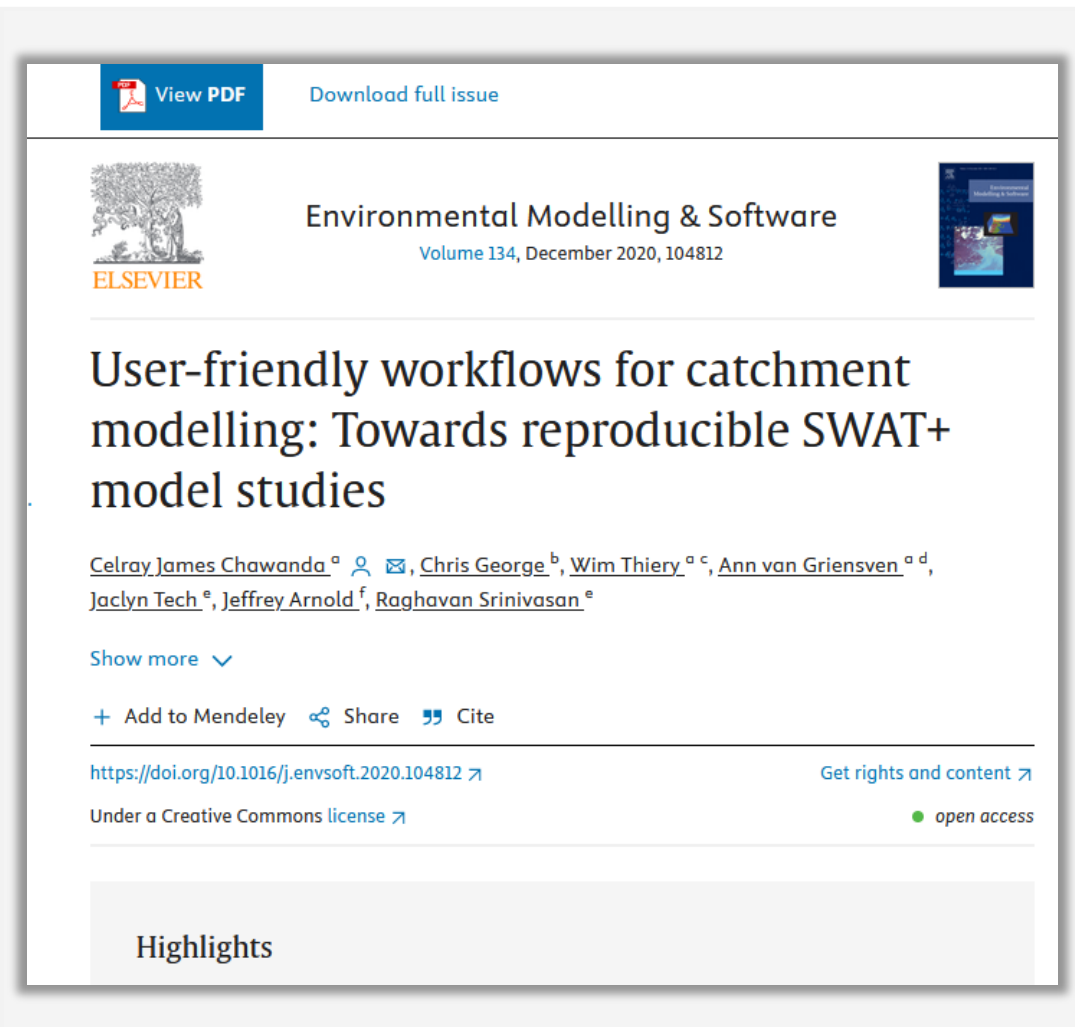
(2) Existing Large scale Models

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

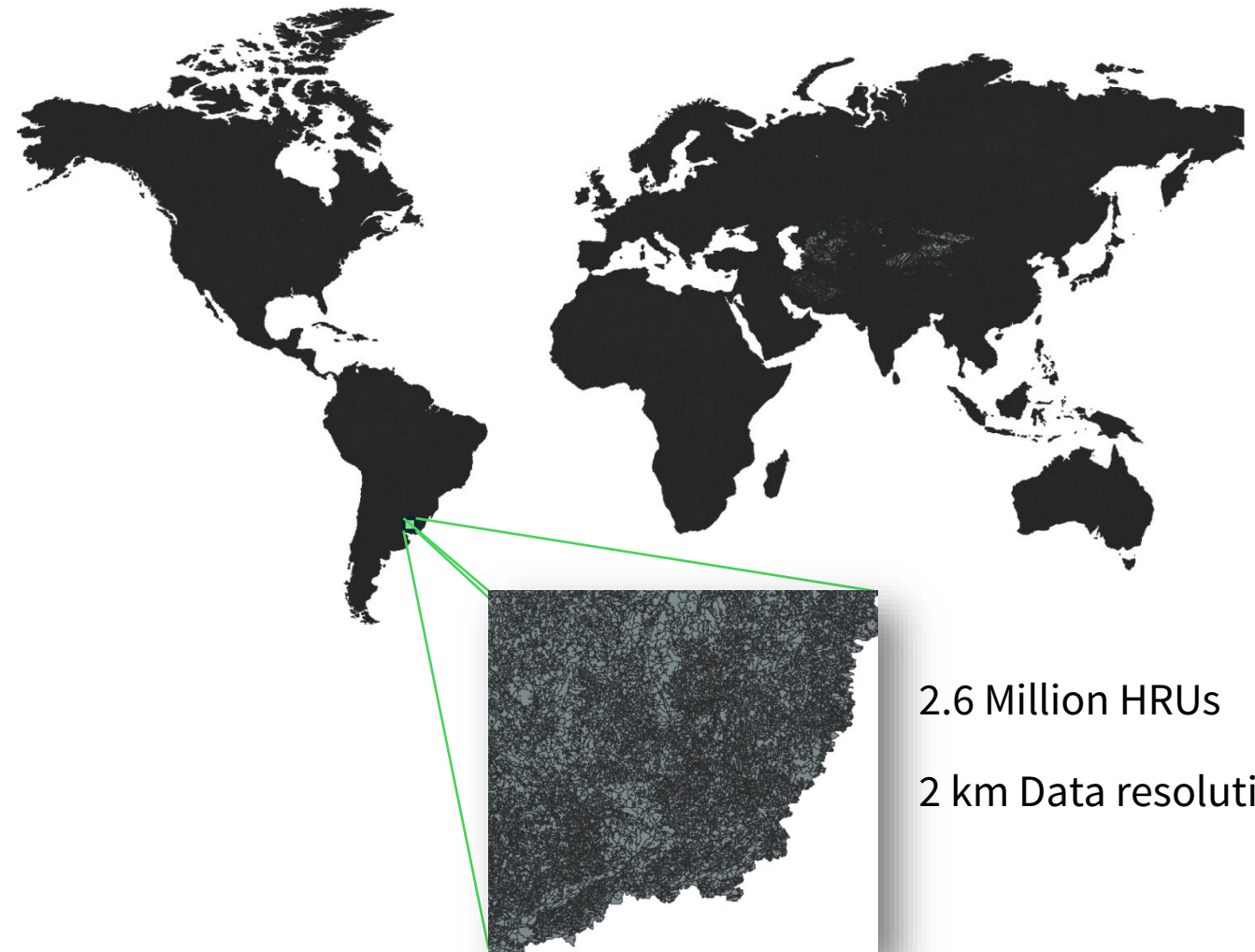
A sunset over a large body of water. The sun is low on the horizon, creating a bright, shimmering reflection on the water's surface. In the foreground, three people are silhouetted against the water, standing in a long, narrow boat and using long poles to navigate. The background shows a distant shoreline with trees and a few small structures. The overall scene is peaceful and serene.

Bridge the data gap through modelling

Global Datasets used for setup

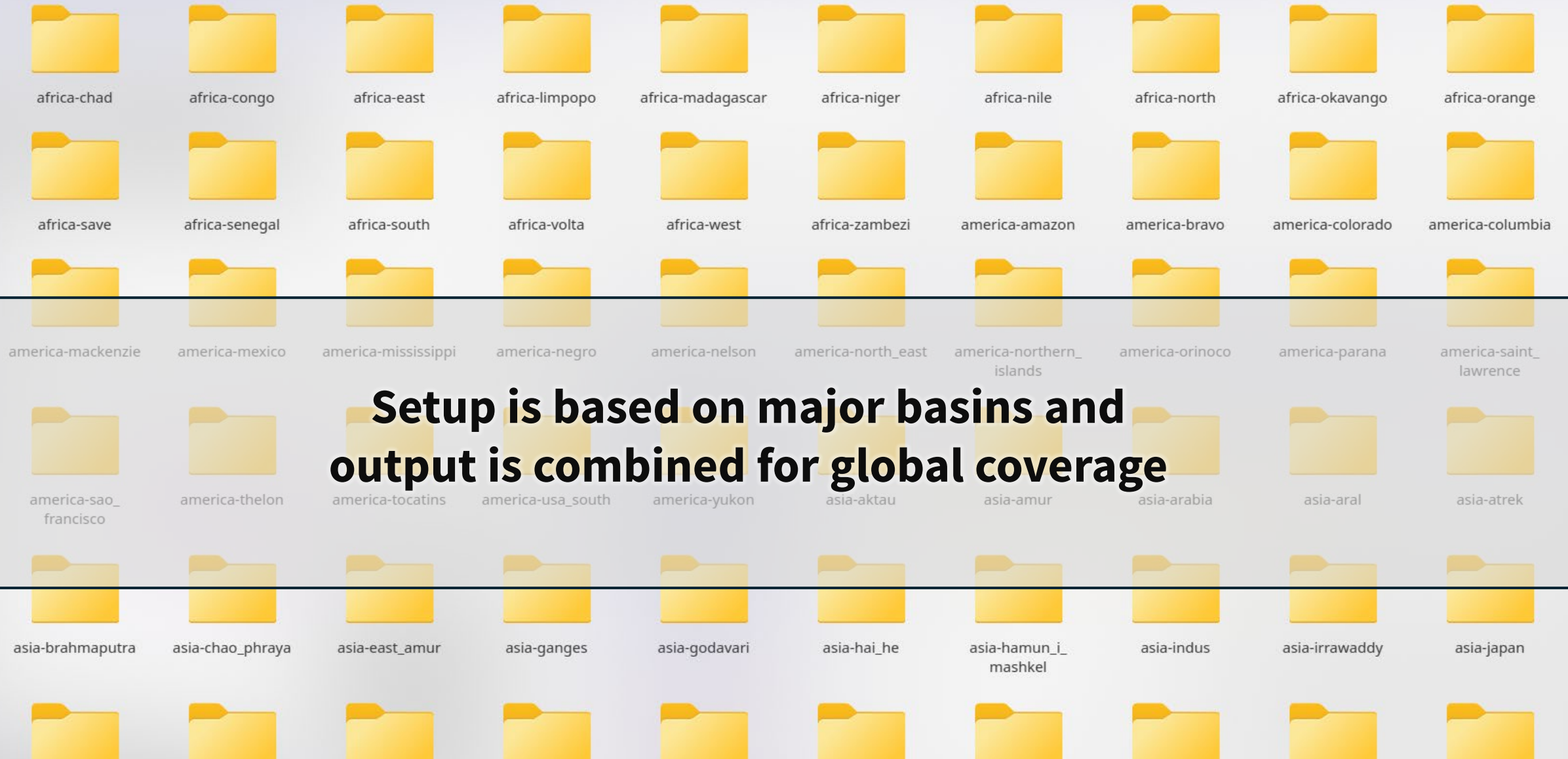


The screenshot shows the top portion of a journal article page. At the top left, there are two buttons: 'View PDF' and 'Download full issue'. Below these is the Elsevier logo and the journal title 'Environmental Modelling & Software', with the volume and issue information 'Volume 134, December 2020, 104812'. The main title of the article is 'User-friendly workflows for catchment modelling: Towards reproducible SWAT+ model studies'. Below the title, the authors are listed: 'Celray James Chawanda', 'Chris George', 'Wim Thiery', 'Ann van Griensven', 'Jaclyn Tech', 'Jeffrey Arnold', and 'Raghavan Srinivasan'. There are icons for 'Add to Mendeley', 'Share', and 'Cite'. A DOI link is provided: 'https://doi.org/10.1016/j.envsoft.2020.104812'. At the bottom of the article preview, it says 'Under a Creative Commons license' and 'open access'. A 'Highlights' section is partially visible at the bottom.

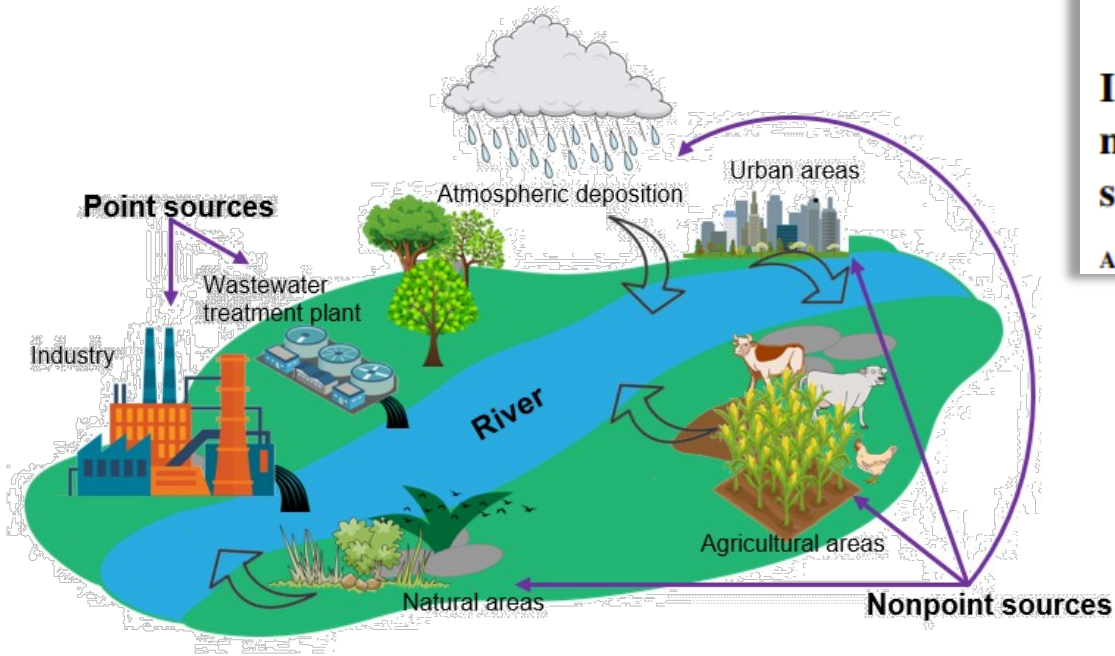


2.6 Million HRUs

2 km Data resolution



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>
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Hydrology and Earth System Sciences
 Open Access

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

Albert Nkwasa¹, Celra

1 One third of African rivers fail to meet the 'good ambient water

2 quality' nutrient targets

3 Albert Nkwasa^{1,2}, Celray James Chawanda^{1,3}, Maria Theresa Nakkazi¹, Ting Tang⁴, Steven J.

4 Eisenreich¹, Stuart Warner⁵, Ann van Griensven^{1,6}

5 ¹ Depar

6 ² Water Regionalization of the SWAT+ model for projecting climate
 7 Institute change impacts on sediment yield: An application in the Nile basin

8 ³ Texas Albert Nkwasa^{a,*}, Celray James Chawanda^a, Ann van Griensven^{a,b}

9 USA

^a Hydrology and Hydraulic Engineering Department, Vrije Universiteit Brussel (VUB), 1050 Brussel, Belgium

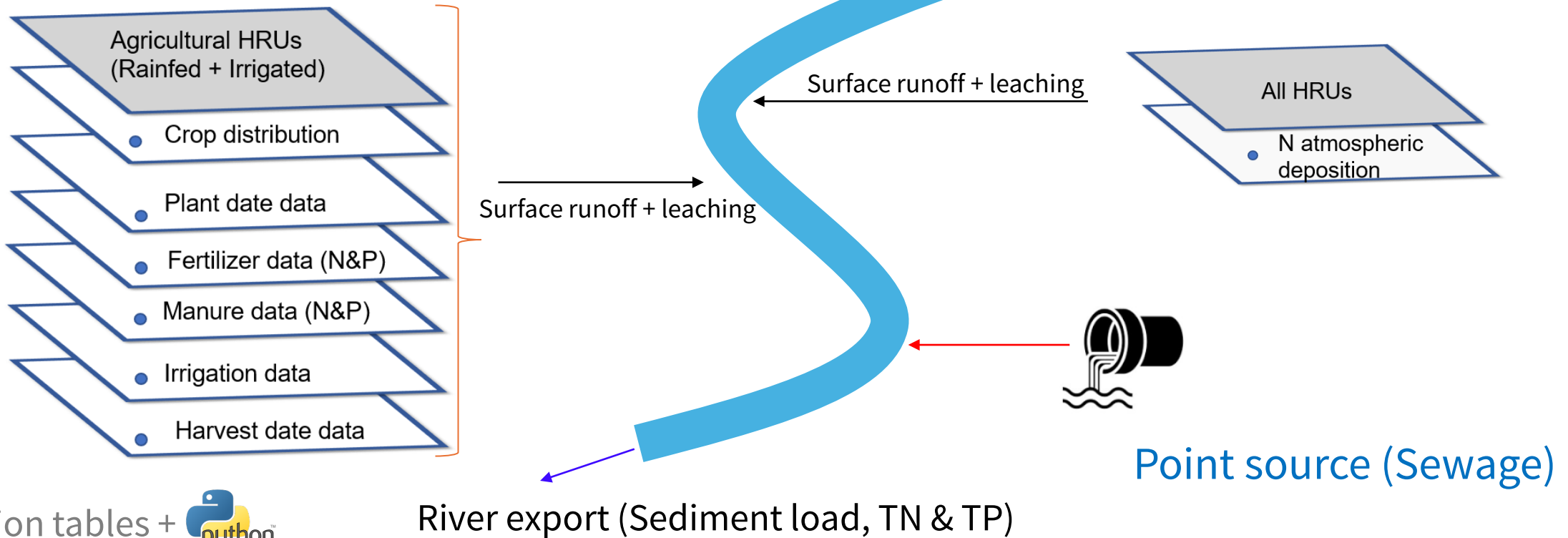
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ARTICLE INFO

ABSTRACT

Water quality model setup

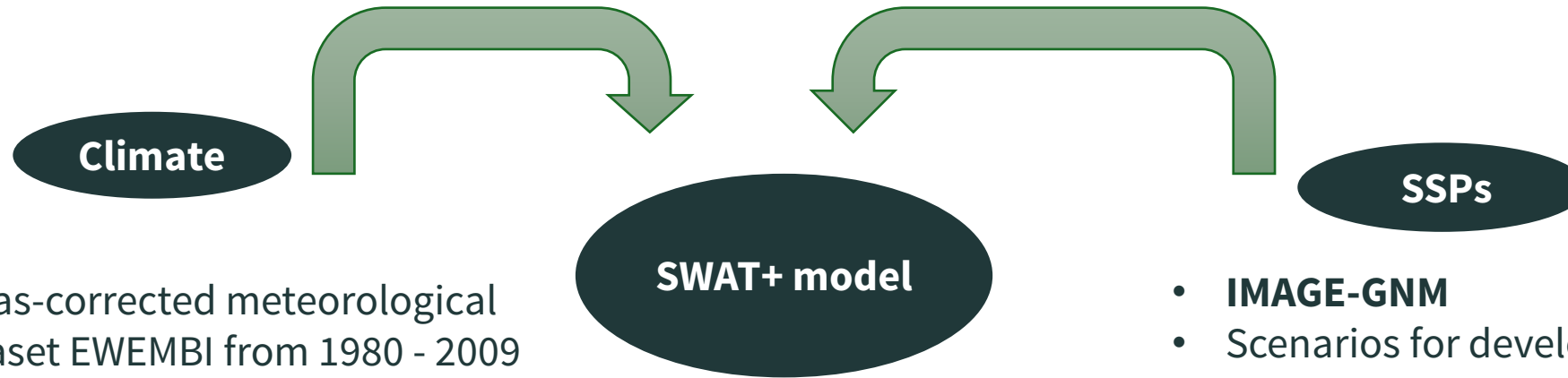
Non-point sources



<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

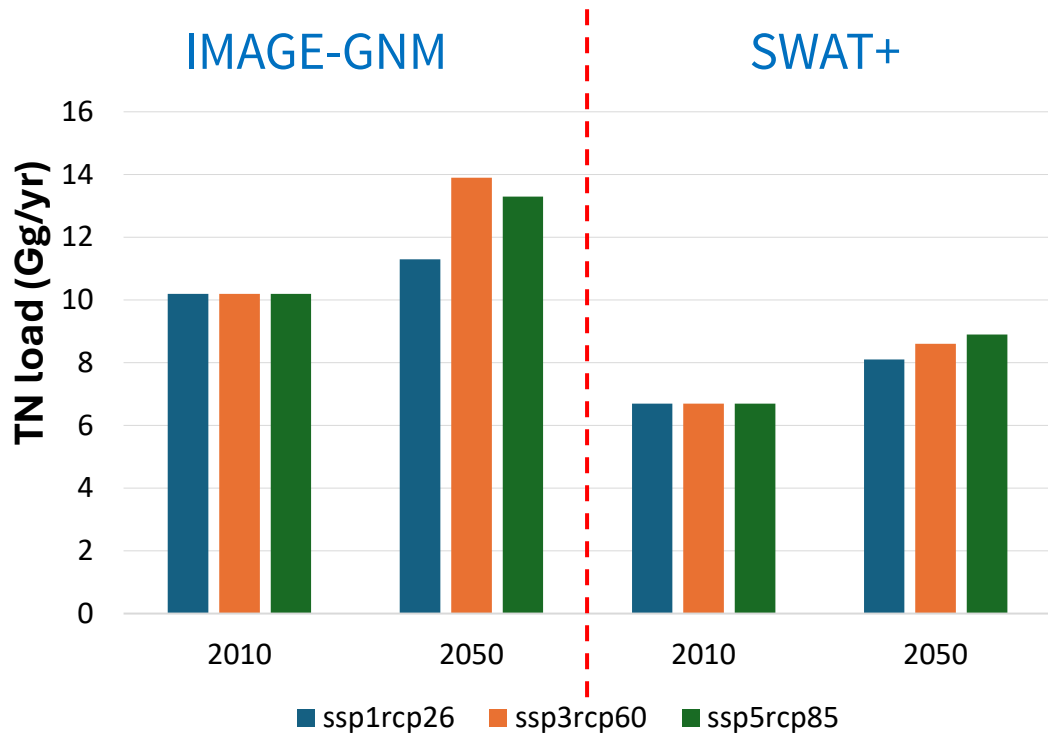
- **IMAGE-GNM**
- Scenarios for development of socio-economic and global environmental (**SSP1, SSP3, SSP5**) – (2010 – 2015)
- Nitrogen and Phosphorus fertilizer & manure
- Wastewater discharge (point sources)
- Atmospheric deposition (Nitrogen)

UNCALIBRATED GLOBAL MODEL

An aerial photograph of a coastal region. The land on the left is a patchwork of agricultural fields in various shades of brown, tan, and green, with some buildings and roads. A large, irregularly shaped plume of bright green water extends from the shoreline into the darker blue water of the bay or ocean. The plume has a complex, swirling pattern, suggesting it is a result of nutrient runoff. A blue banner with white text is overlaid across the middle of the image.

Increase in nutrient pollution in all scenarios

TN & TP - historical & future river loadings



TN simulations

SSP1-RCP26

SSP3-RCP60

SSP5-RCP85

IMAGE-GNM

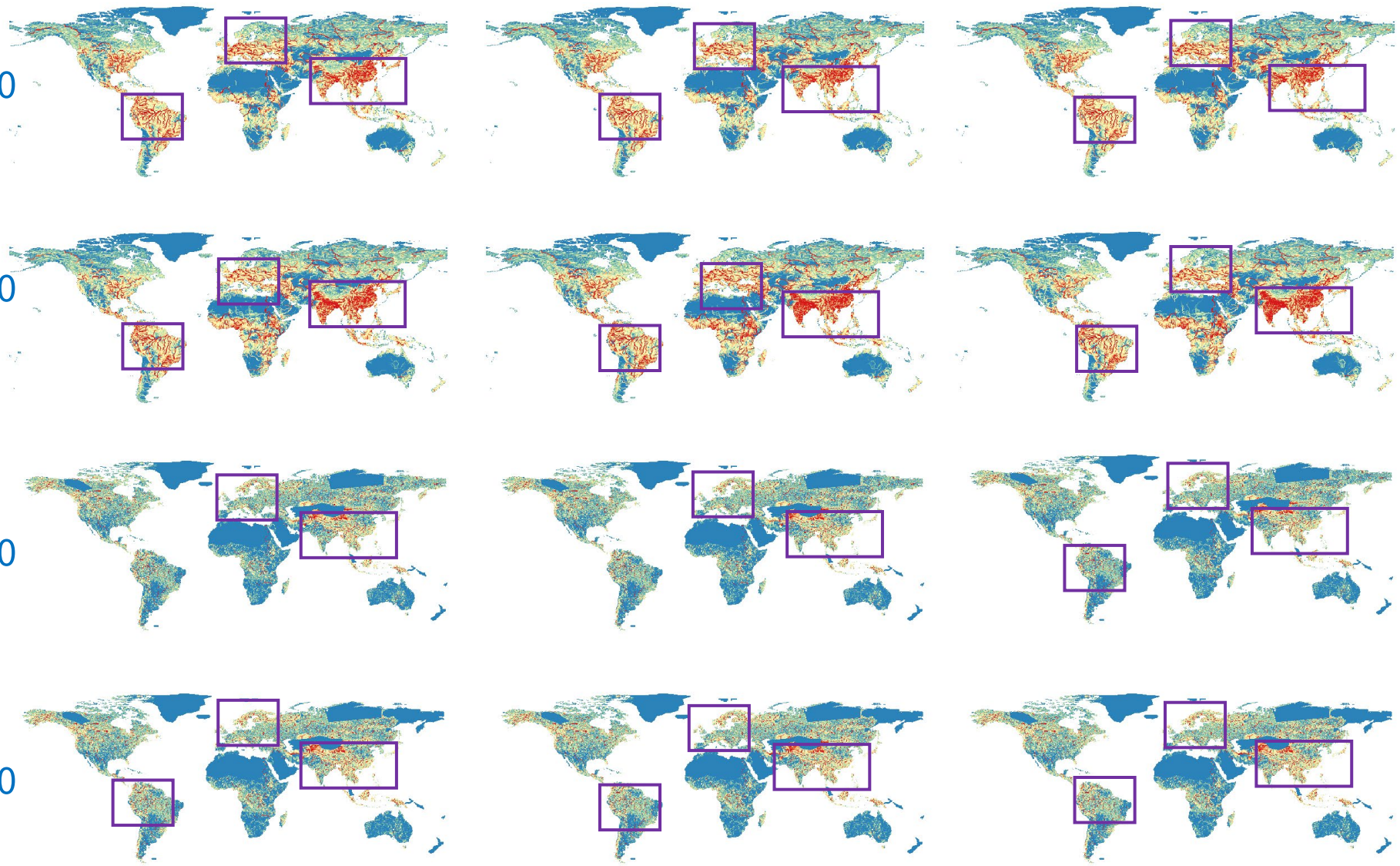
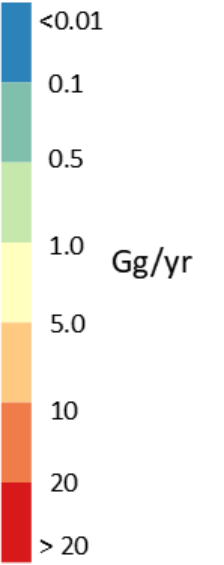
2010

2050

SWAT+

2010

2050



TP simulations

SSP1-RCP26

SSP3-RCP60

SSP5-RCP85

IMAGE-GNM

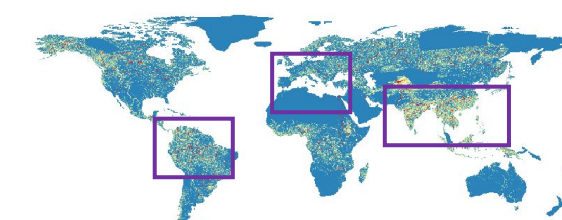
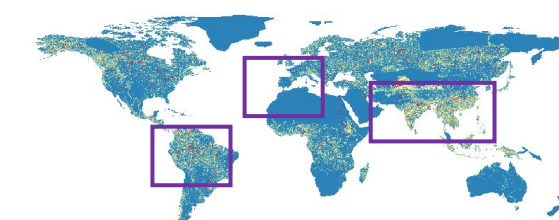
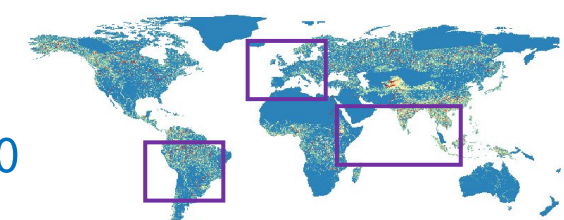
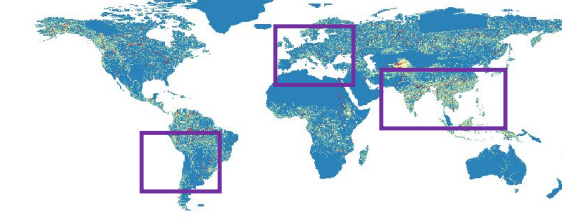
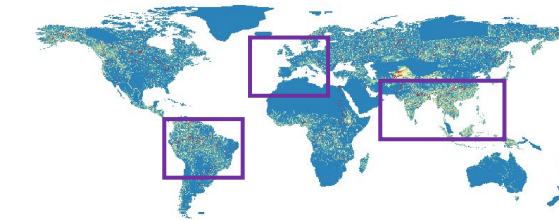
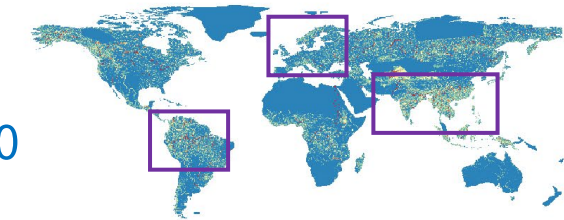
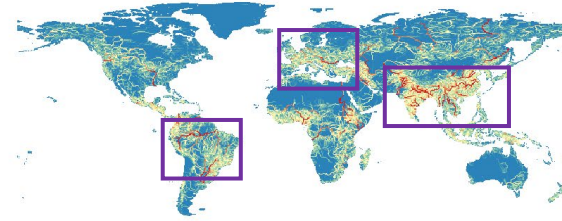
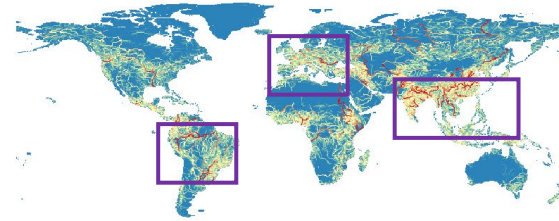
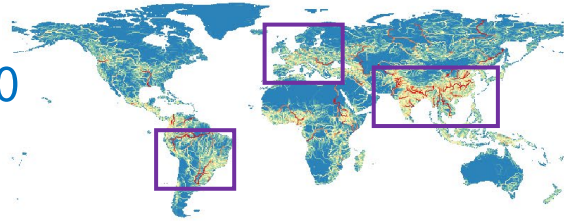
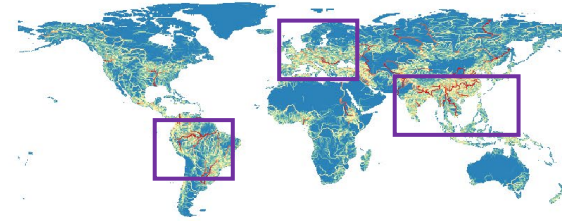
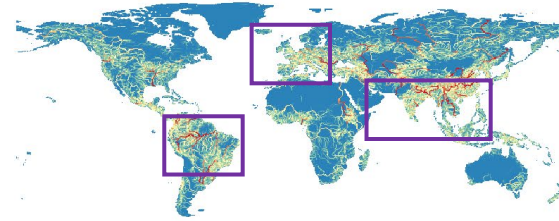
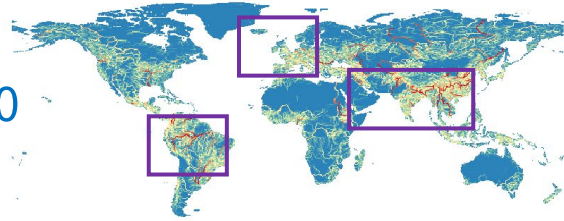
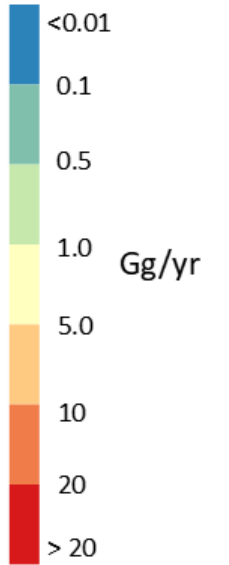
2010

2050

2010

2050

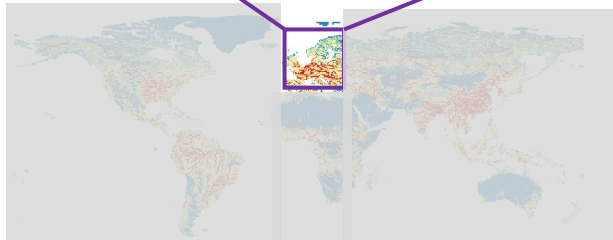
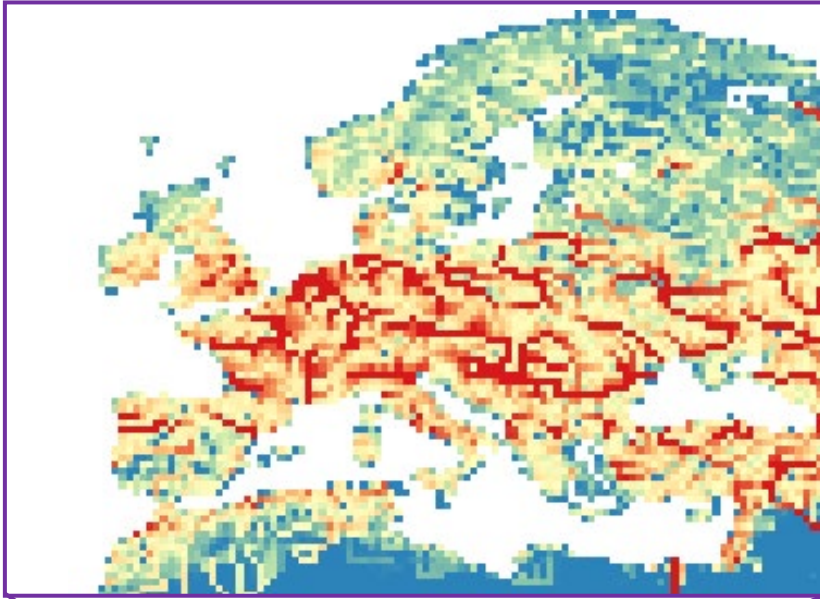
SWAT+



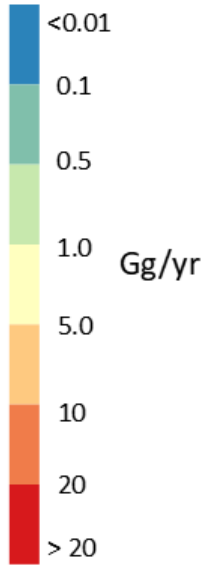
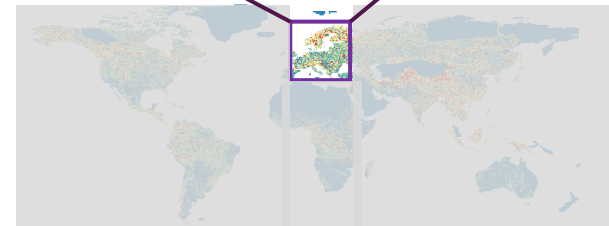
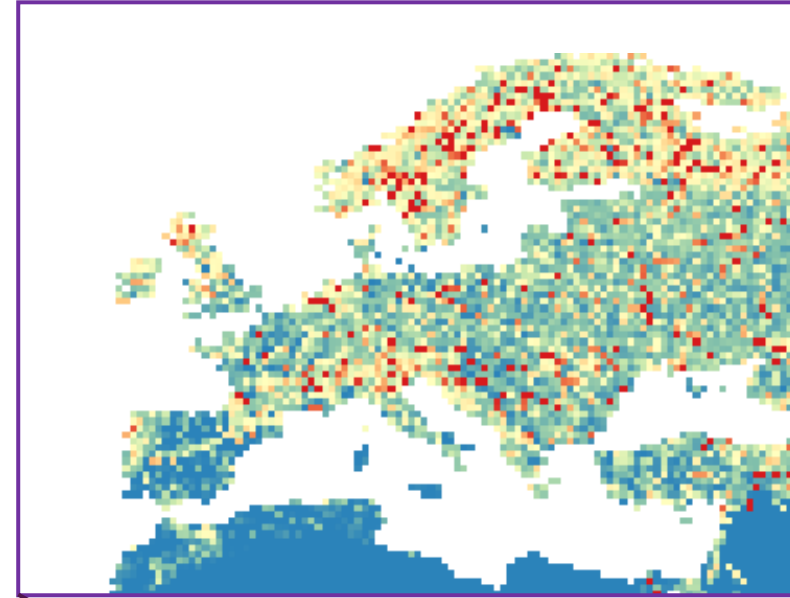
TN simulations – Europe

SSP5-RCP85

IMAGE-GNM



SWAT+



Why the differences?

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

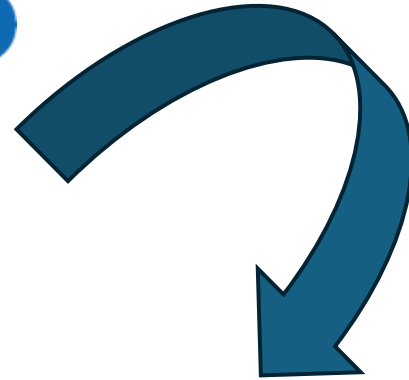
Key take-aways & outlook

- Overall, regional **bright** and **dark** spots are captured
- Focus should be on **trends** and **hotspots** 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

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/

Thank you.

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