

Towards better representation of water bodies and water management on the CoSWAT+ GHM

Session C1: Model Development

Jose P. Teran
Celray James Chawanda
Ann Van Griensven




Conference October 2025



WATER AND CLIMATE
DEPARTMENT

Jose P. Teran

jose.pablo.teran.orsini@vub.be

Background & Introduction

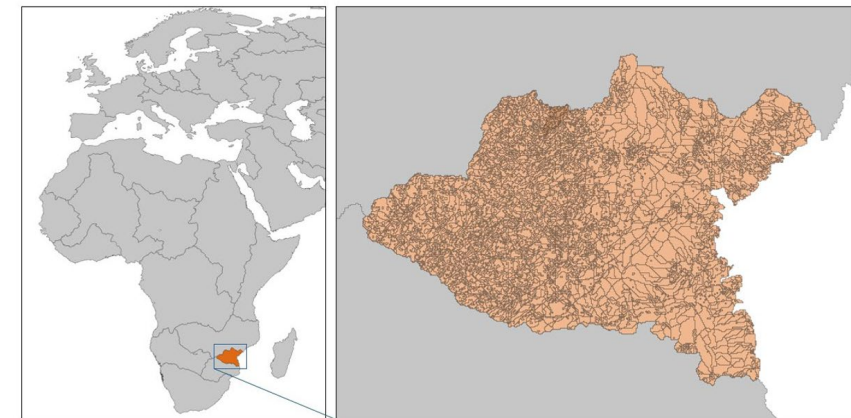
CoSWAT+ GHM & CoSWAT+ WQ

Community **SWAT+** Global **H**ydrological **M**odel & **W**ater **Q**uality Model (*Chawanda et al., 2025, Nkwasa et al., 2025*)

Global Coverage (**90** Large-scale **Basins**), **2 Km** Spatial Resolution; **2.63 Million HRUs**

Built with the **CoSWAT-Framework**; a containerized tool with a set of **Python scripts**.

Global outputs of river discharge, landscape hydrological processes (e.g., ET), **river** and **landscape TN** and **TP** loads.



*Model Regions and HRUs from
Chawanda et al., 2025*

CoSWAT+ GHM

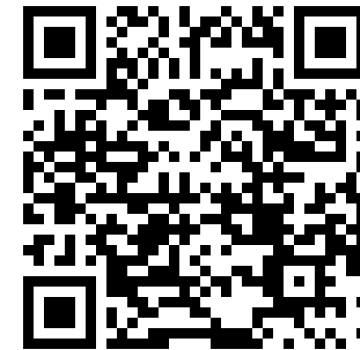
Limitations

No Lakes or reservoirs included on the model structure.

Global crop growth seasons, irrigation and other water demands not considered

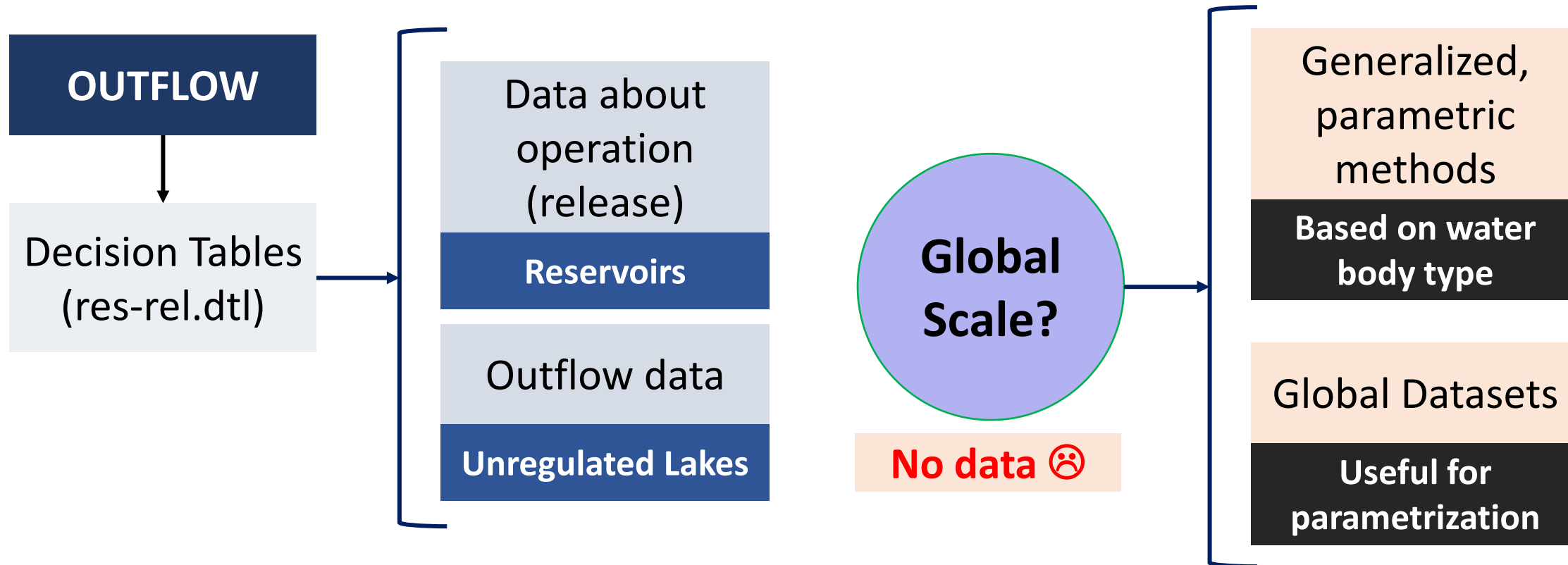
- Static Land Use
- Uncalibrated
- ...

More details (CoSWAT+ GHM)



CoSWAT+ GHM

Reservoirs & Lakes



Objectives

3 – **Implement** generalized methods to estimate reservoir/lake **outflow**

SWAT+ Source Code

1 – **Restructure** the CoSWAT+ GHM to include **Lakes & Reservoirs**

**CoSWAT -
Framework**

2 – **Develop** an algorithm to represent **irrigation** demand

4 – **Run simulations** and **compare** observations and previous version.

**River Flow, Reservoir
WB and storage**

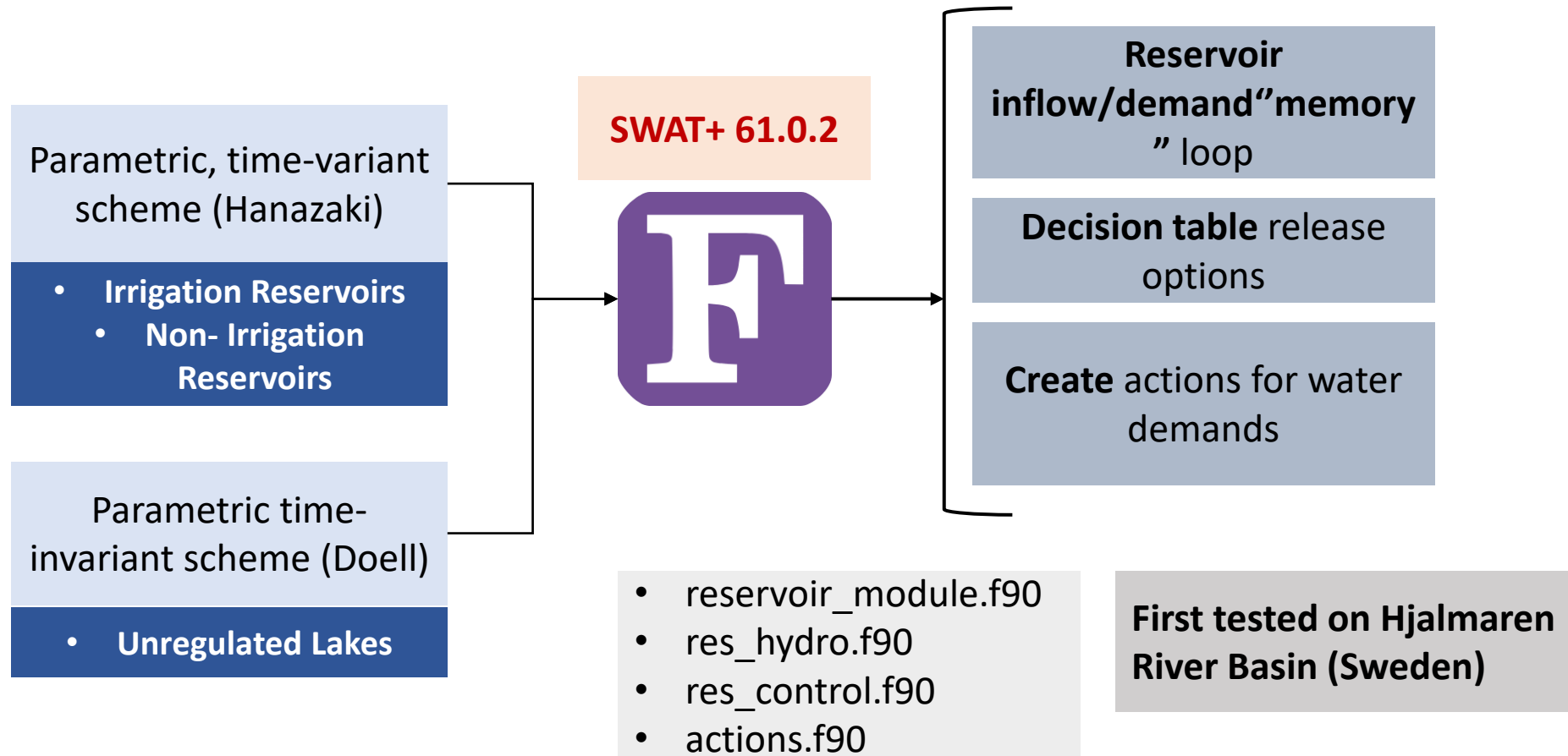
On 7 selected modelling regions



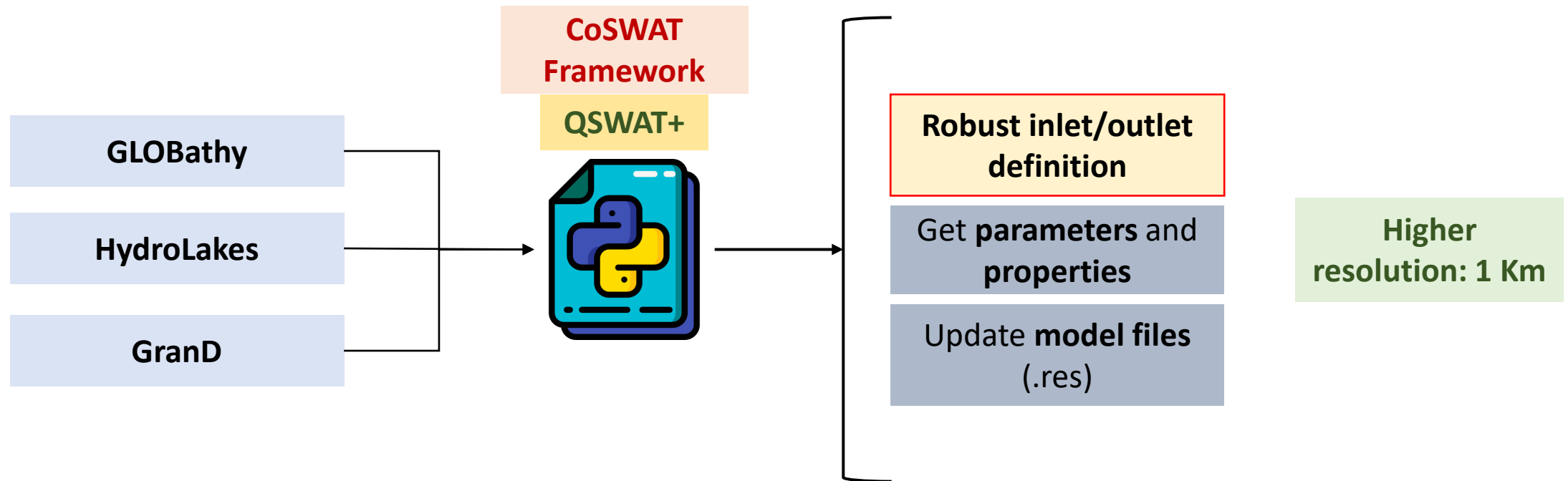
- Africa-Nile
- America-bravo
- America-colorado
- America-columbia
- America-mississippi
- America-Nelson
- Asia-Aral
- Asia-Mekong

Methods

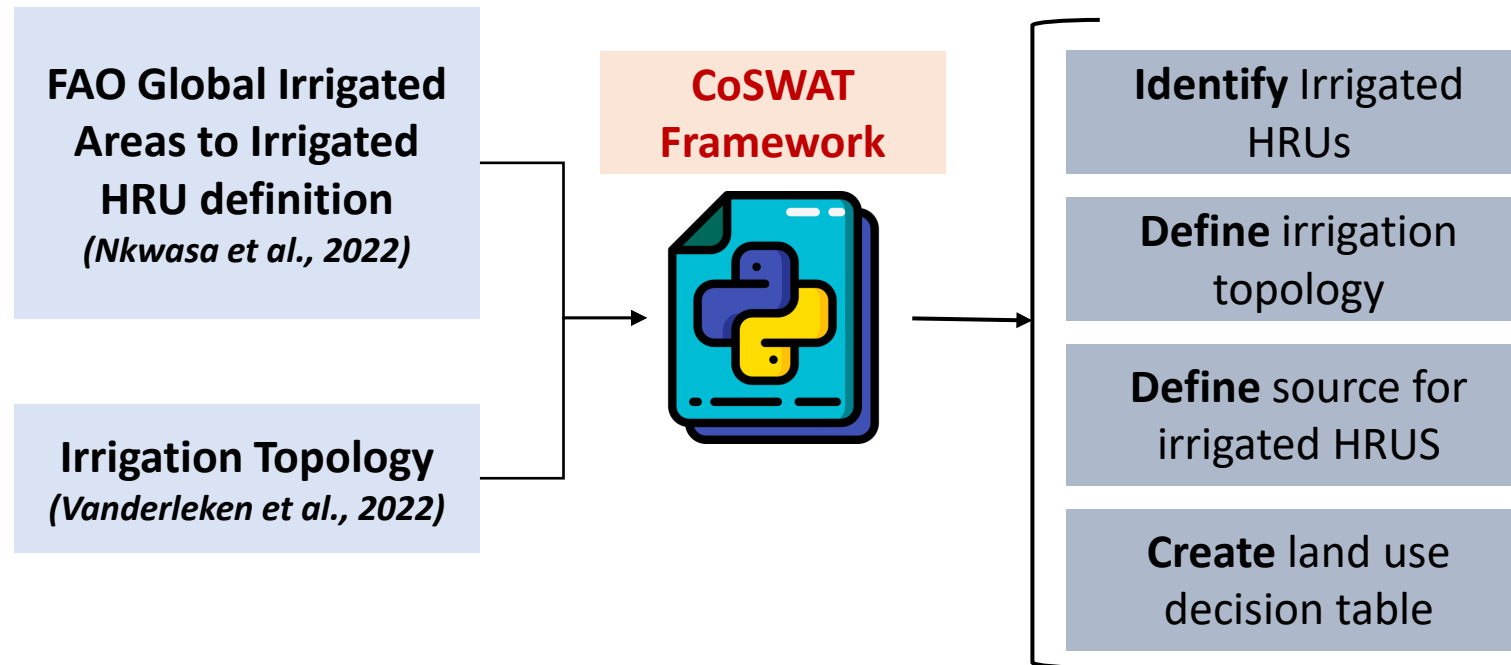
1 – **Implement** generalized methods to estimate reservoir/lake **outflow**



2 – Restructure the CoSWAT+ GHM to include **Lakes & Reservoirs**



3 – **Develop** an algorithm to represent **irrigation** demand



4 - Run simulations and **compare** observations and previous version.

Variables	Reference Data	Simulations	
Monthly River Flow	GRDC	Period: 1970-2020	On 7 selected regions
Monthly Reservoir Volume	Yasin et al. (2018), ResOps	CoSWAT+ GHM v2	1 km, Rivers Lakes & Reservoirs – SWAT+ 61.0.2
Yearly Reservoir Evaporation	GLEV	CoSWAT+ GHM v1	2 km, Rivers – SWAT+ 60.5.7

**WORK
— IN —
PROGRESS**

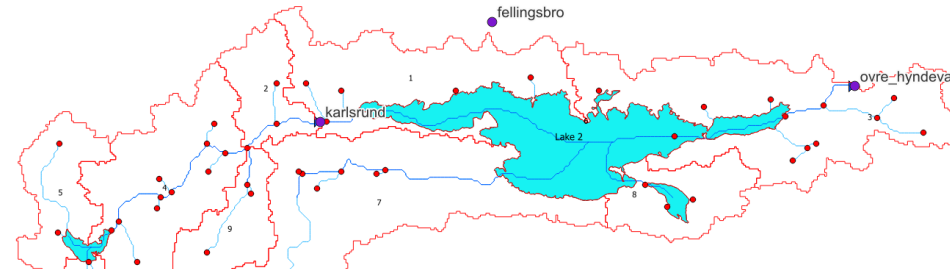


**Weather data
preparation**

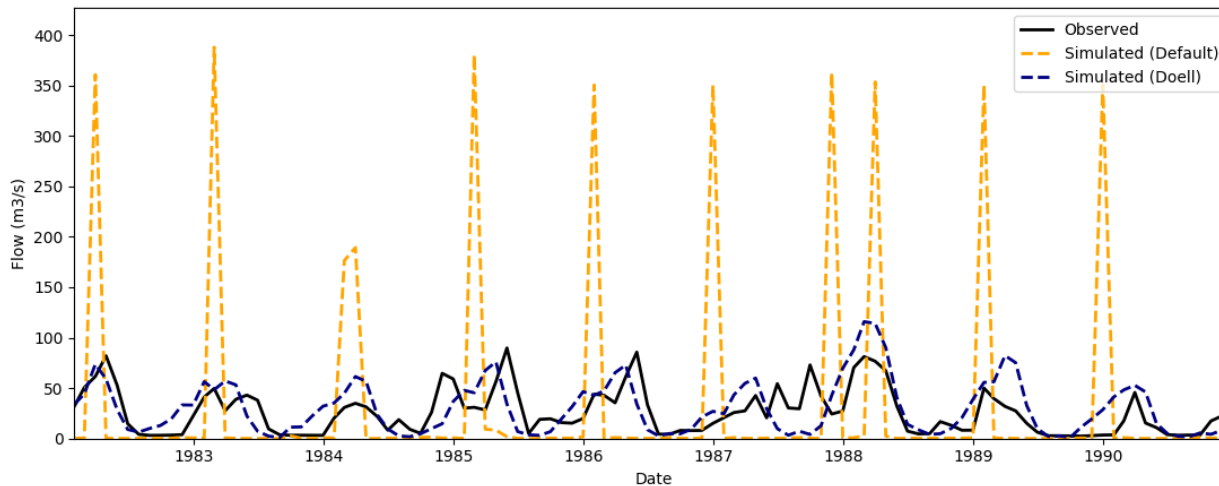
Results & Discussion

1 – Implement generalized methods to estimate reservoir/lake **outflow**

First tested on Hjalmaren River Basin (Sweden)

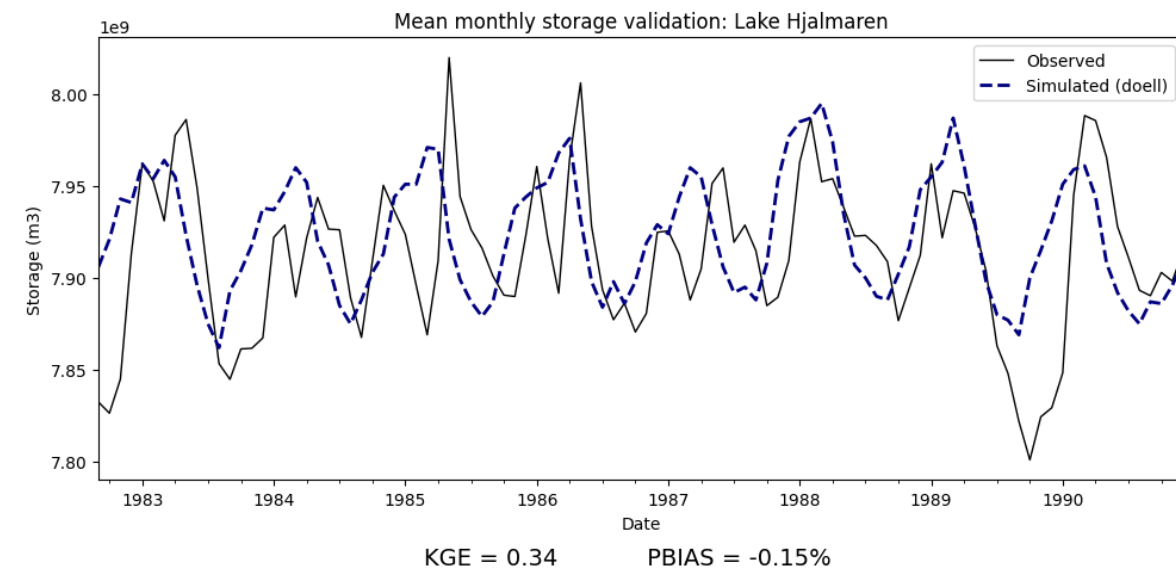


Flow evaluation for Hjalmaren Submodel - Station 138: ovre

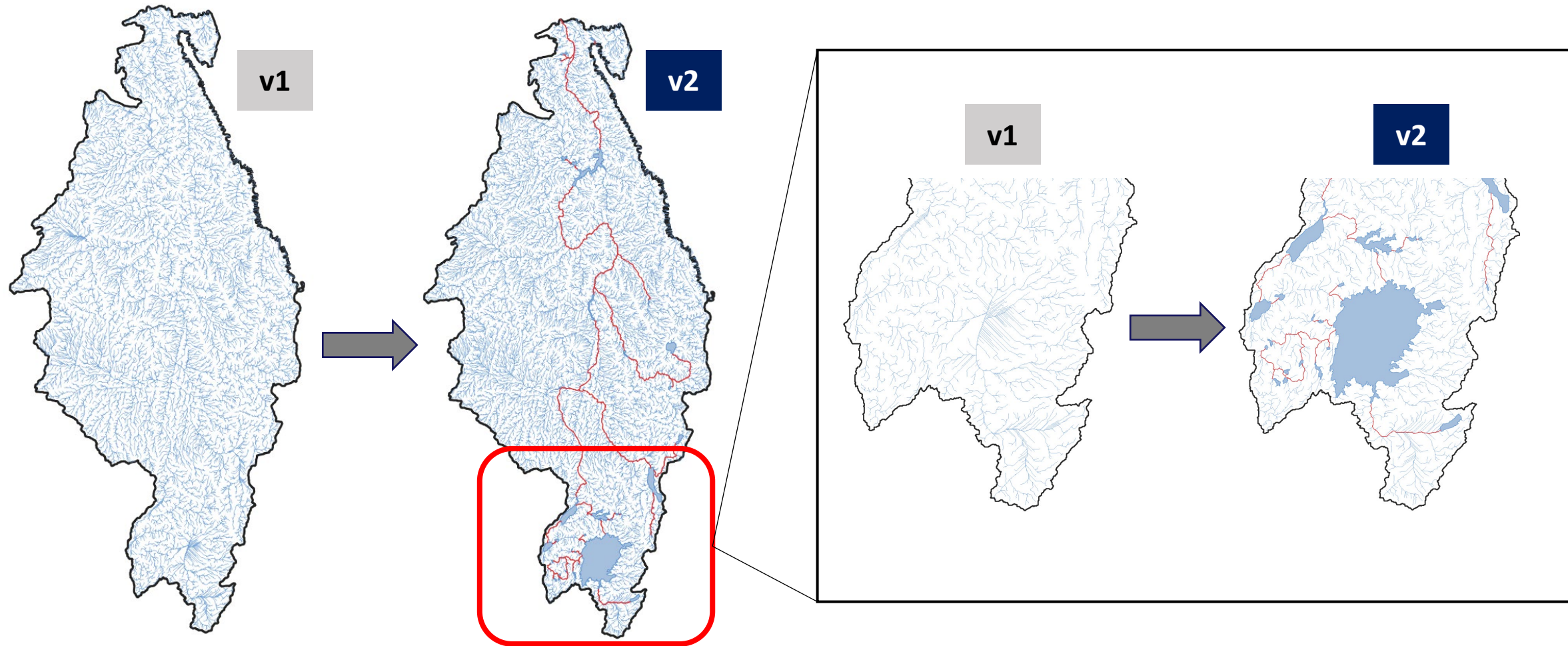


FLOW	PBIAS	KGE
Default	-30.60	-2.67
Doell	-18.90	0.58

* Default: Drawdown days



2 – Restructure the CoSWAT+ GHM to include **Lakes & Reservoirs**

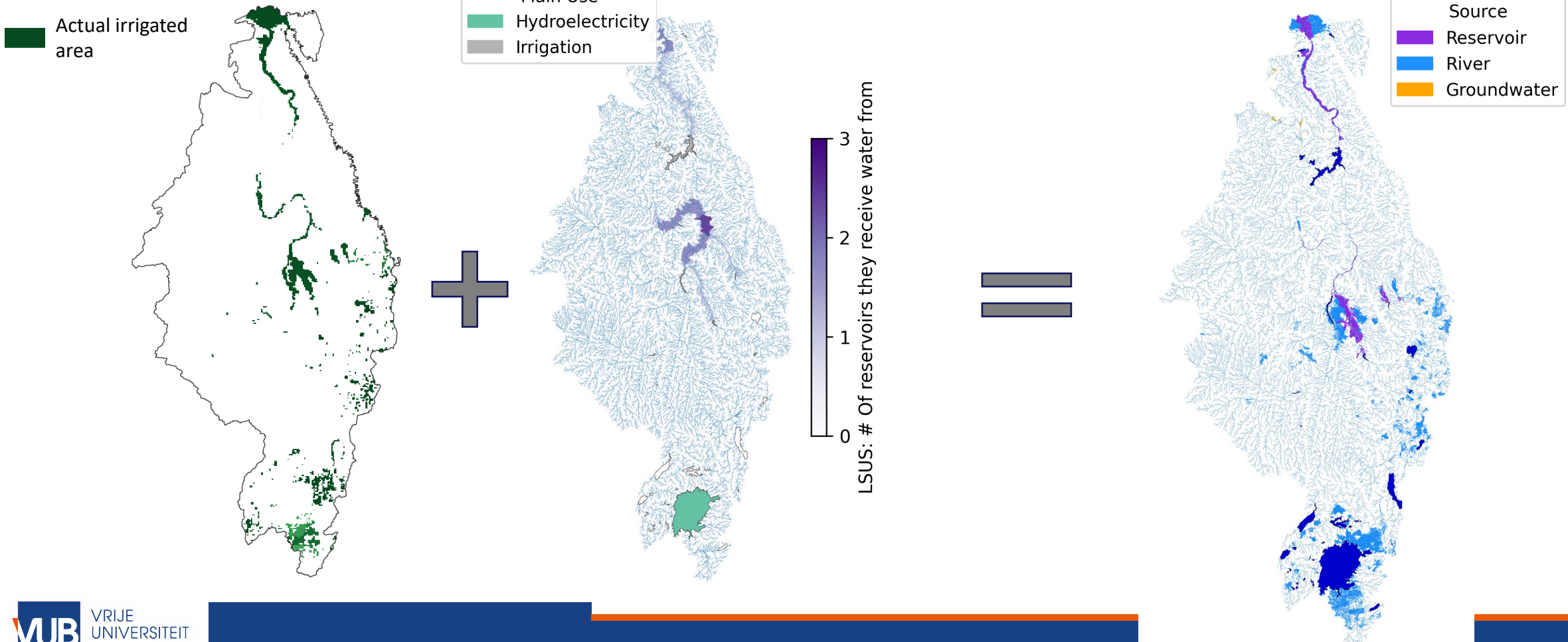


3 – Develop an algorithm to represent **irrigation** demand

Irrigated Areas

Irrigation Topology

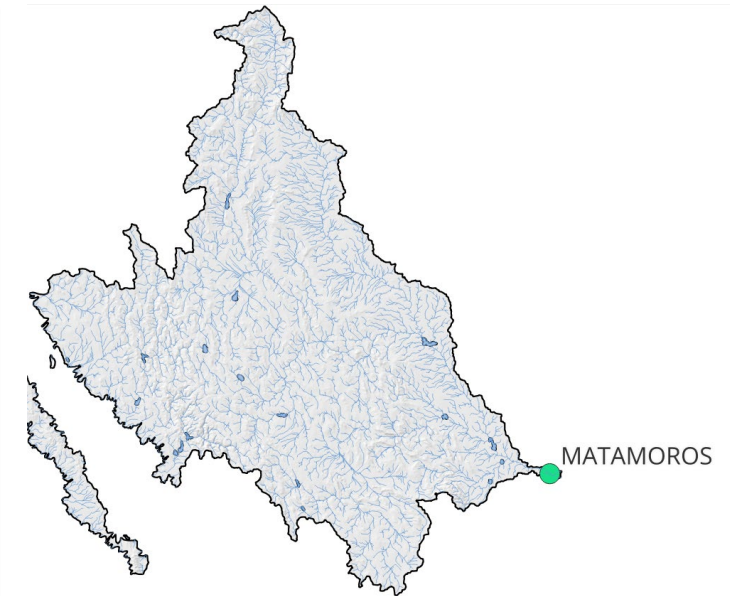
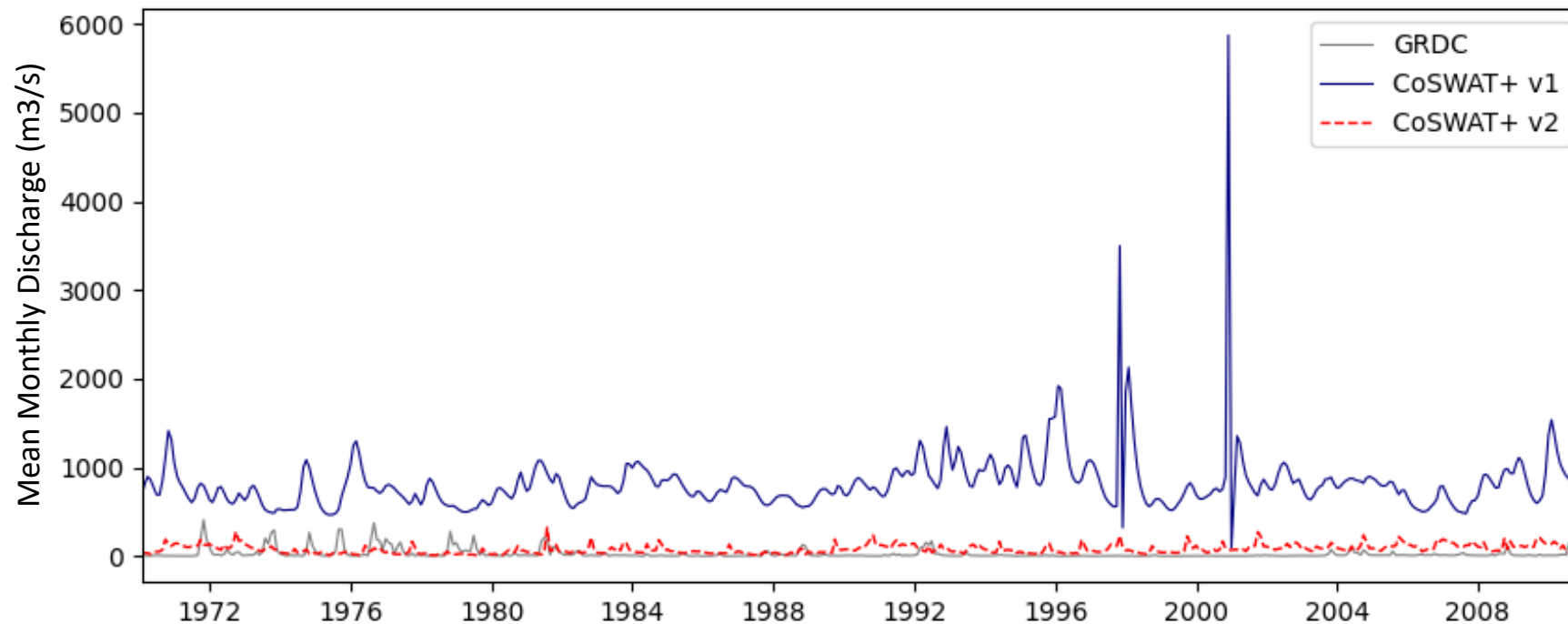
Irrigated HRUs & source



4 - Run simulations and **compare** observations and previous version.

River Flow

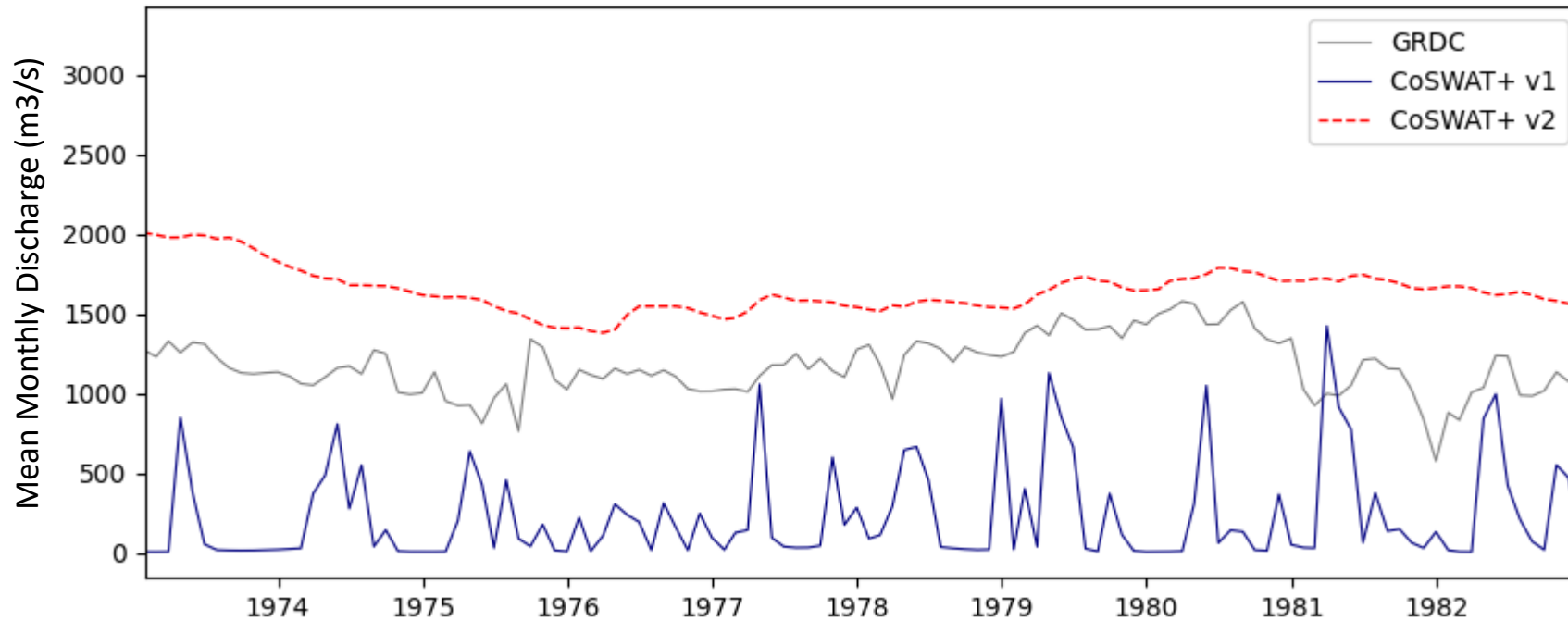
Station: MATAMOROS-4351900 - river: RIO BRAVO



4 - Run simulations and **compare** observations and previous version.

River Flow

Station: OWEN RESERVOIR-1472300 - river: VICTORIA NILE

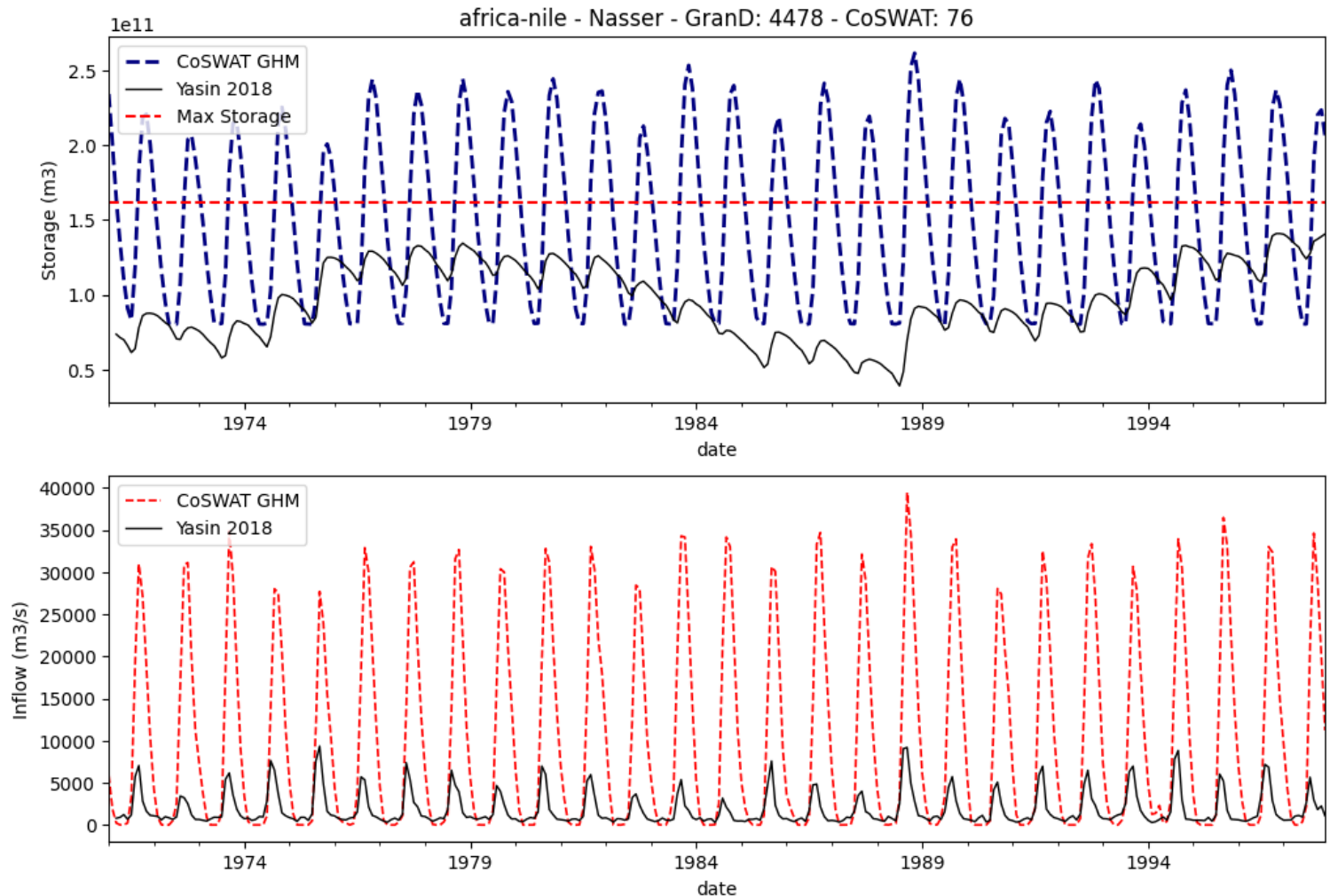


4 - Run simulations and **compare** observations and previous version.

Storage



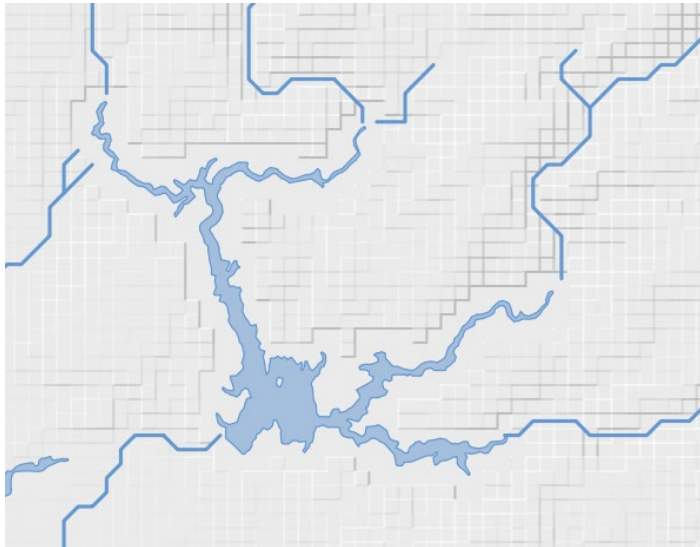
Nasser Lake (Aswan Dam):
Irrigation



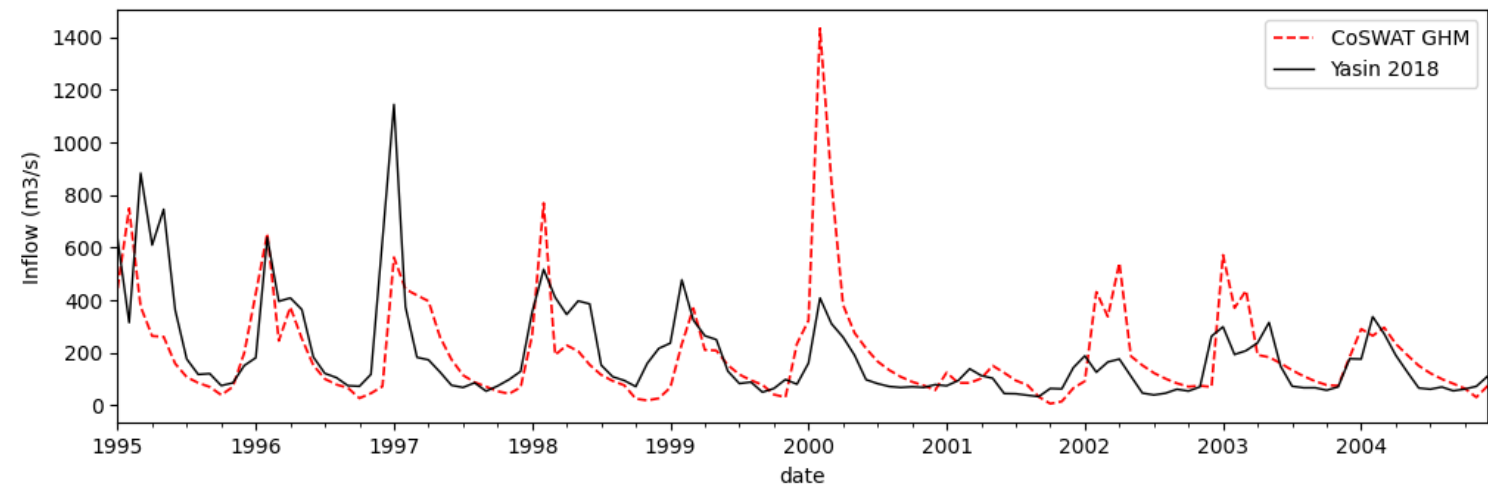
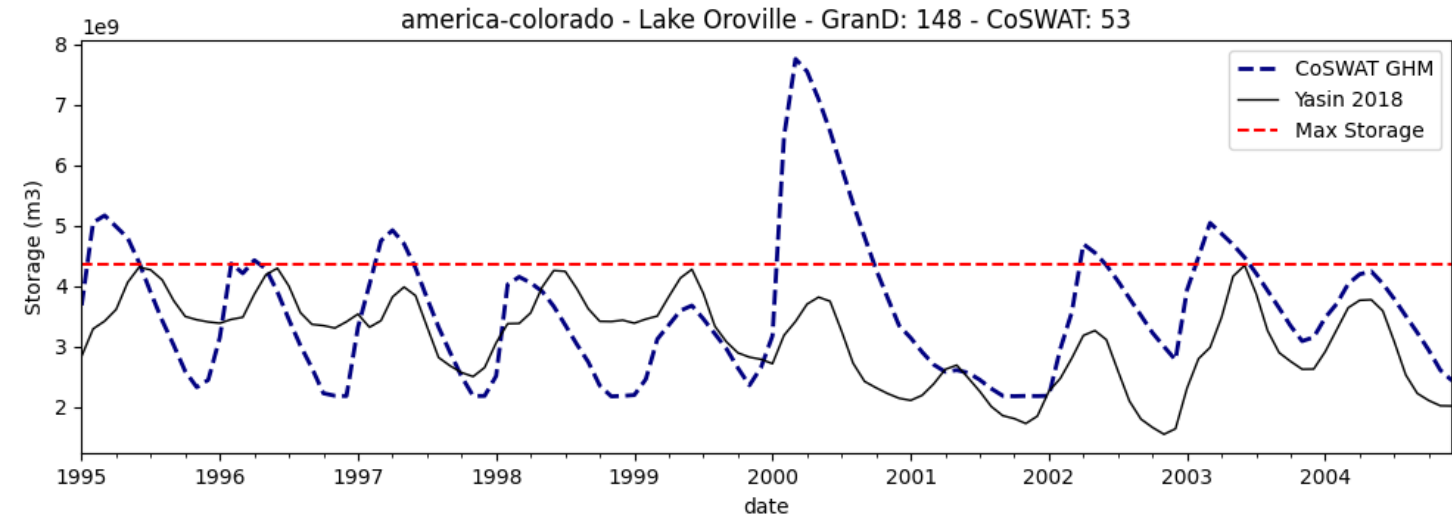
For storage: KGE = -0.557 r = 0.315 PBIAS = -54.97%

4 - Run simulations and **compare** observations and previous version.

Storage



Lake Oroville: Flood Control



For storage: KGE = 0.127 r = 0.384 PBIAS = -15.54%

Conclusions & next steps

Potential for a global impact model useful for global water and lake sectors



River flow simulation can be improved in main rivers

Reservoir/lake schemes with good potential for local cases

Reservoir storage performance is conditioned by many processes that are being over/underestimated

HMBC & Reservoir Parameter calibration in selected regions could improve river & lake/reservoir representation.

Weather data issues are fixed, need to re-run ✓

Complete validation with new results & move to WQ 

Thank you!

COSWAT+



WATER AND CLIMATE
DEPARTMENT

Jose P. Teran
jose.pablo.teran.orsini@vub.be