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CERCA Centres de Recerca de Catalunya

Agència Catalana de l'Aigua

MERLIN

SWAT+ SOIL & WATER ASSESSMENT TOOL

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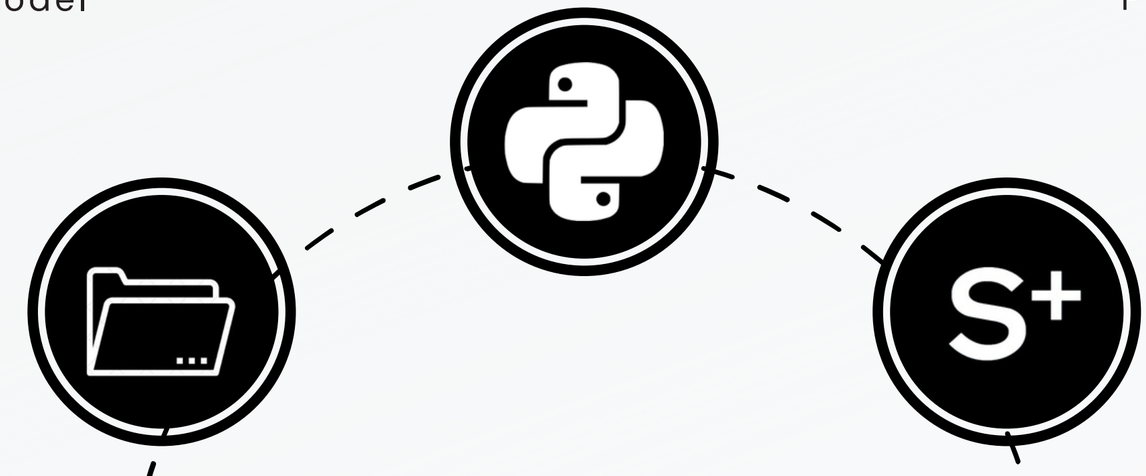
Model pollutant generation and attenuation

- We wanted to analyze, explain and predict point source pollution patterns under different scenarios
- Pollution load at WWTPs effluent (generation model)
- Attenuation and transport model using SWAT+
- Include both models in the calibration process

Modify TxtInOut outside the SWAT+ editor

- Difficulty modifying input and output SWAT+ files
- We developed pySWATPlus with Python
- Allow to manipulate SWAT+ input and output files and run SWAT+ with Python



Calibrate SWAT+ parameters

- Implement the possibility to calibrate SWAT+ parameters
- Possibility of multimodel calibration
- Implementation of pymoo Python library

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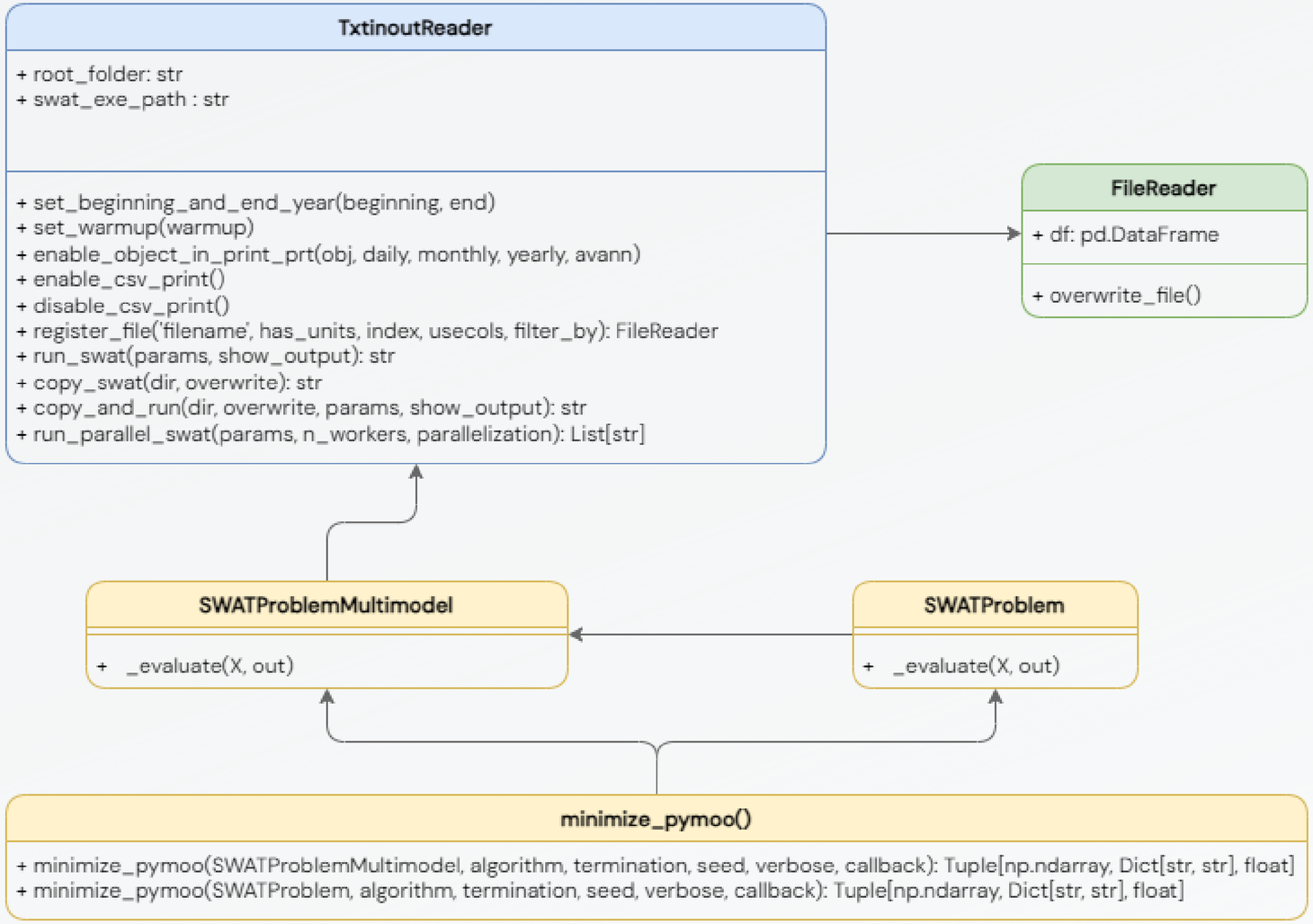

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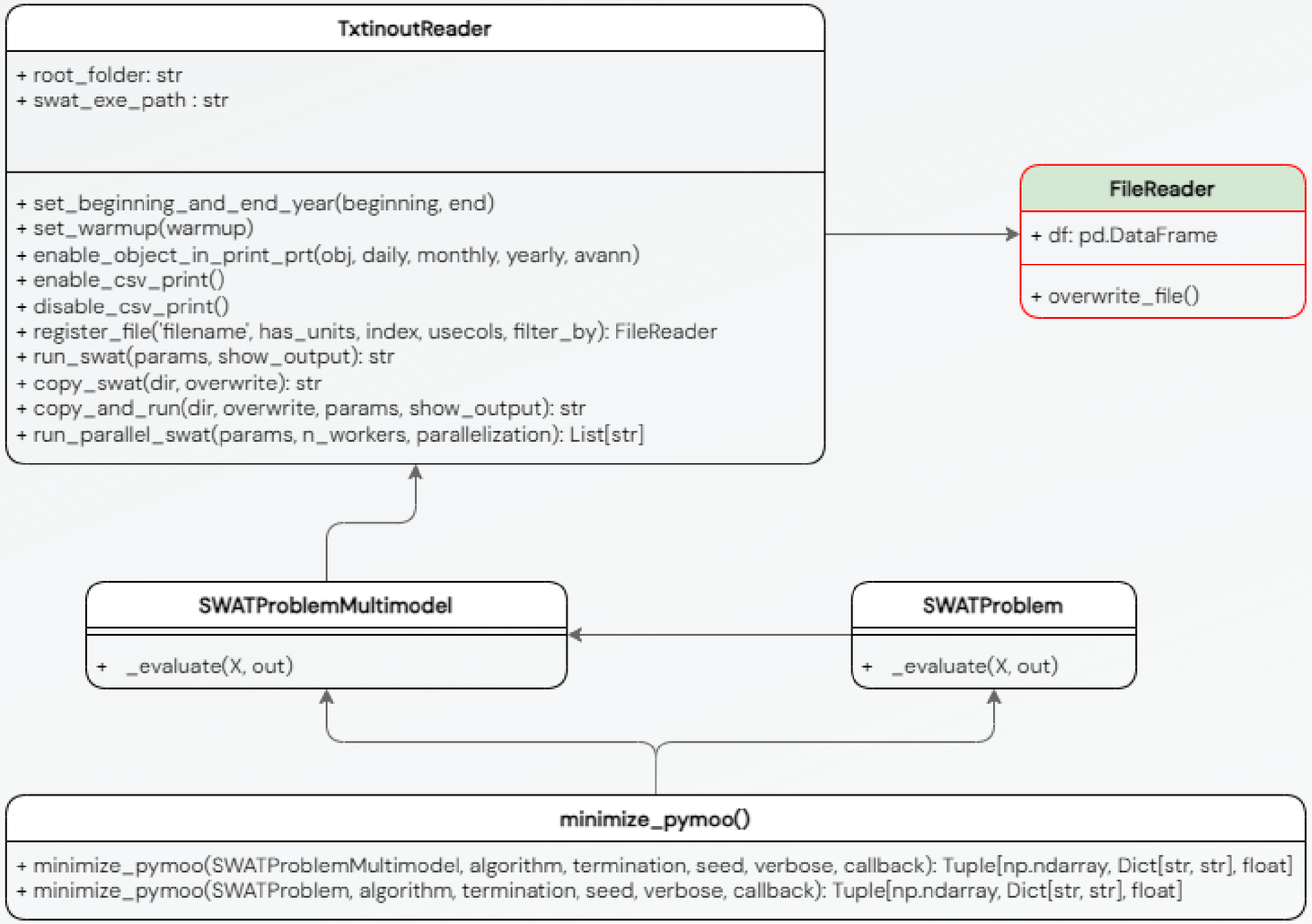

- The most basic class in the library
- Designed to read and write SWAT+ files

- Specify the location of the file
- File content is stored on a Pandas dataframe, easy to manipulate by the user
- Data is stored back in the same format

- FileReader is the basis for more advanced operations

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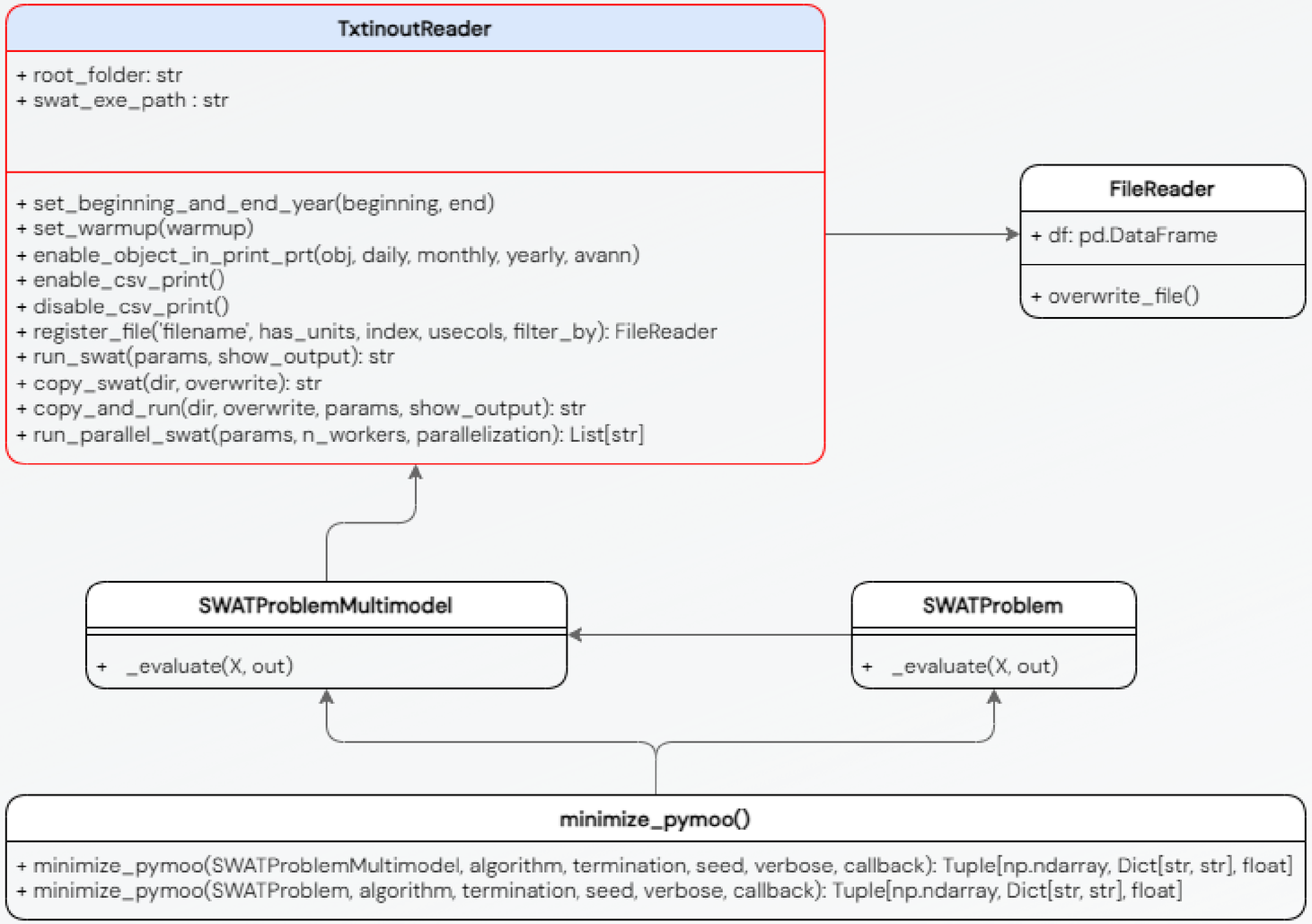

- It operates in the TxtInOut directory
- The folder must contain the SWAT+ model built, the compiled executable and the input files

- Users can run a comprehensive set of functionalities
- Users can run either a single or multiple SWAT simulations
- The simulations can be run in parallel

- It implements the FileReader class within the register_file method

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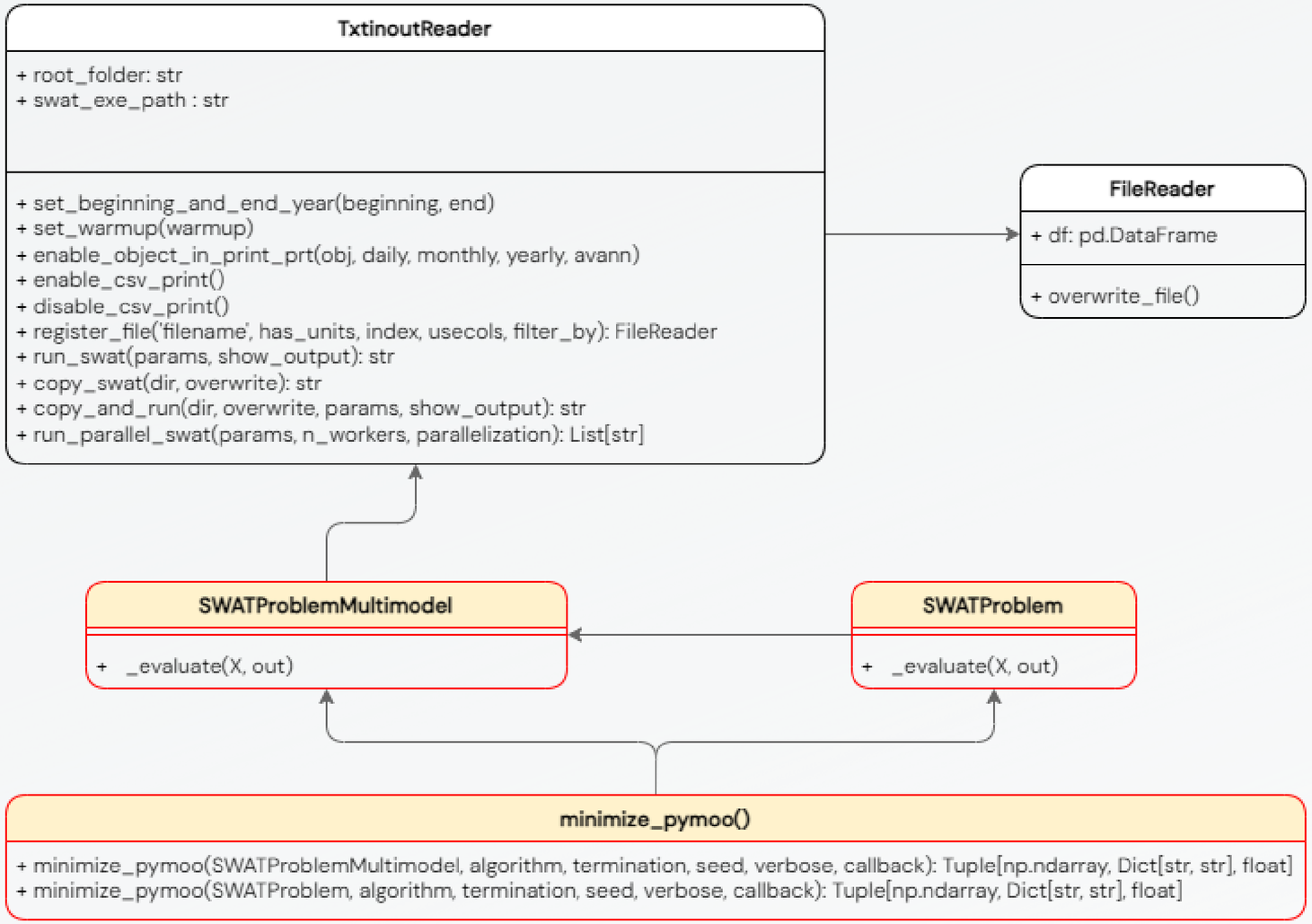

- Calibration runs the minimize_pymoo function from the pymoo Python library
- It needs either a SWATProblem or a SWATProblemMultimodel instance, the optimization algorithm and the termination criteria

- SWATProblem is for calibrating SWAT+ parameters
- SWATProblemMultimodel also allows to run another model prior to running SWAT+ while calibrating (in our case, the generation model)

- Both classes require a dictionary with the parameters to be calibrated, their upper and lower bounds, and other specific attributes

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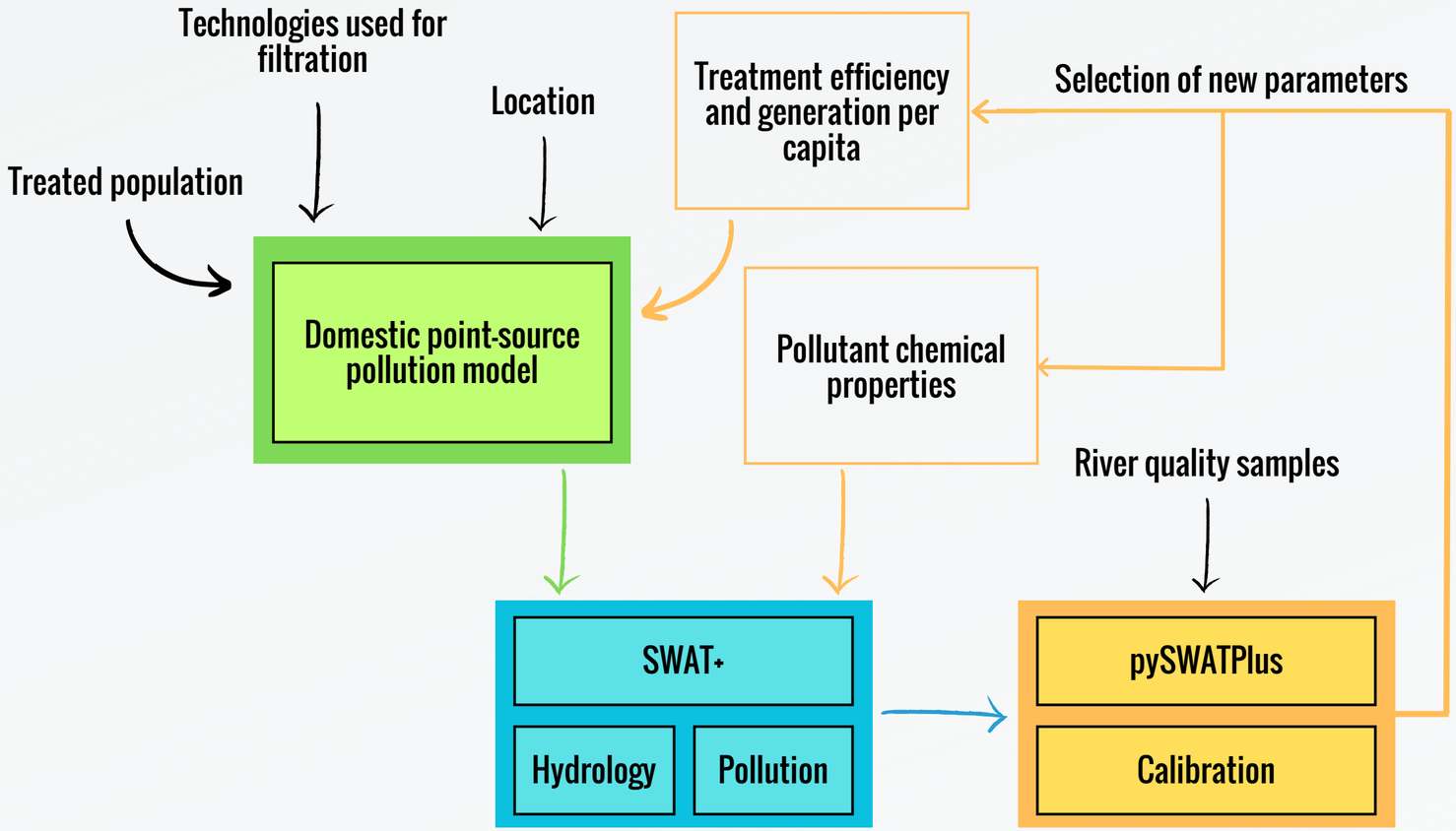

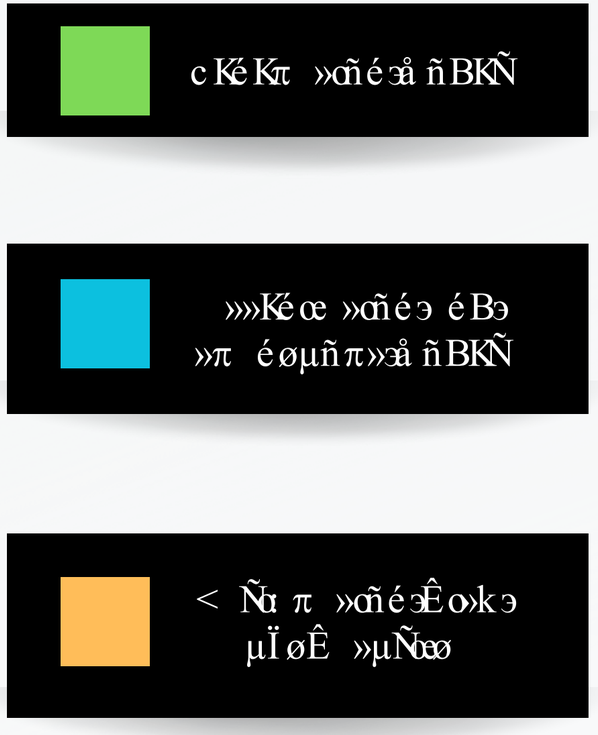

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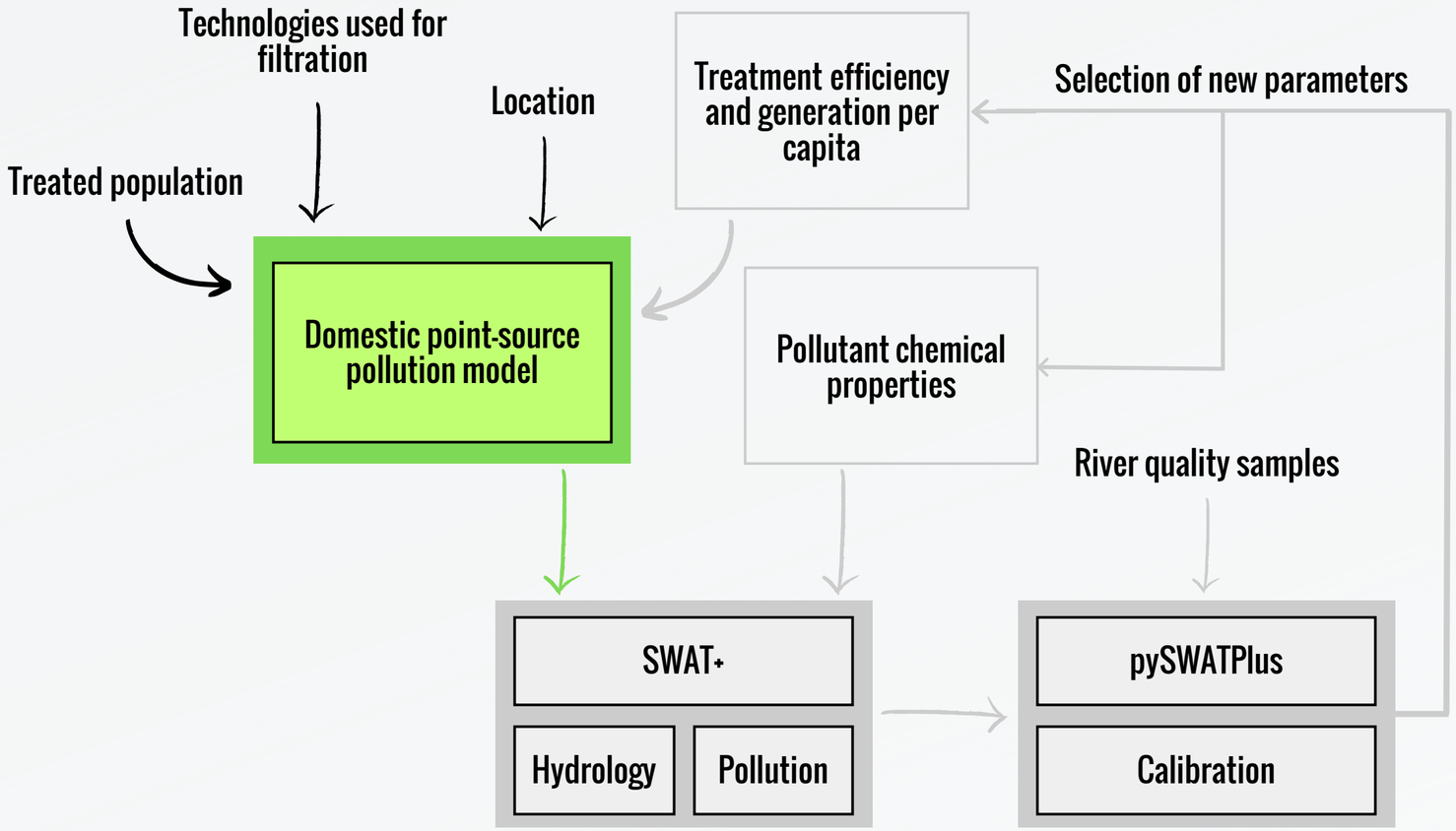

- Predicts pollution generated in domestic wastewater
- Simulates its treatment processes in the WWTP

- The user must provide the treated population for each WWTP
- The user must provide the treatments applied in WWTP
- Primary treatment is always applied
- Secondary and tertiary treatments are optional

$$\text{pollutant load} = \text{coef} \times \text{treated\_population} \times (1 - \text{primary\_treatment\_efficiency}) \times (1 - \text{secondary\_treatment\_efficiency}) \times \sum_{i \in \text{applied tertiary treatments}} (1 - \text{tertiary\_treatment\_efficiency}_i)$$

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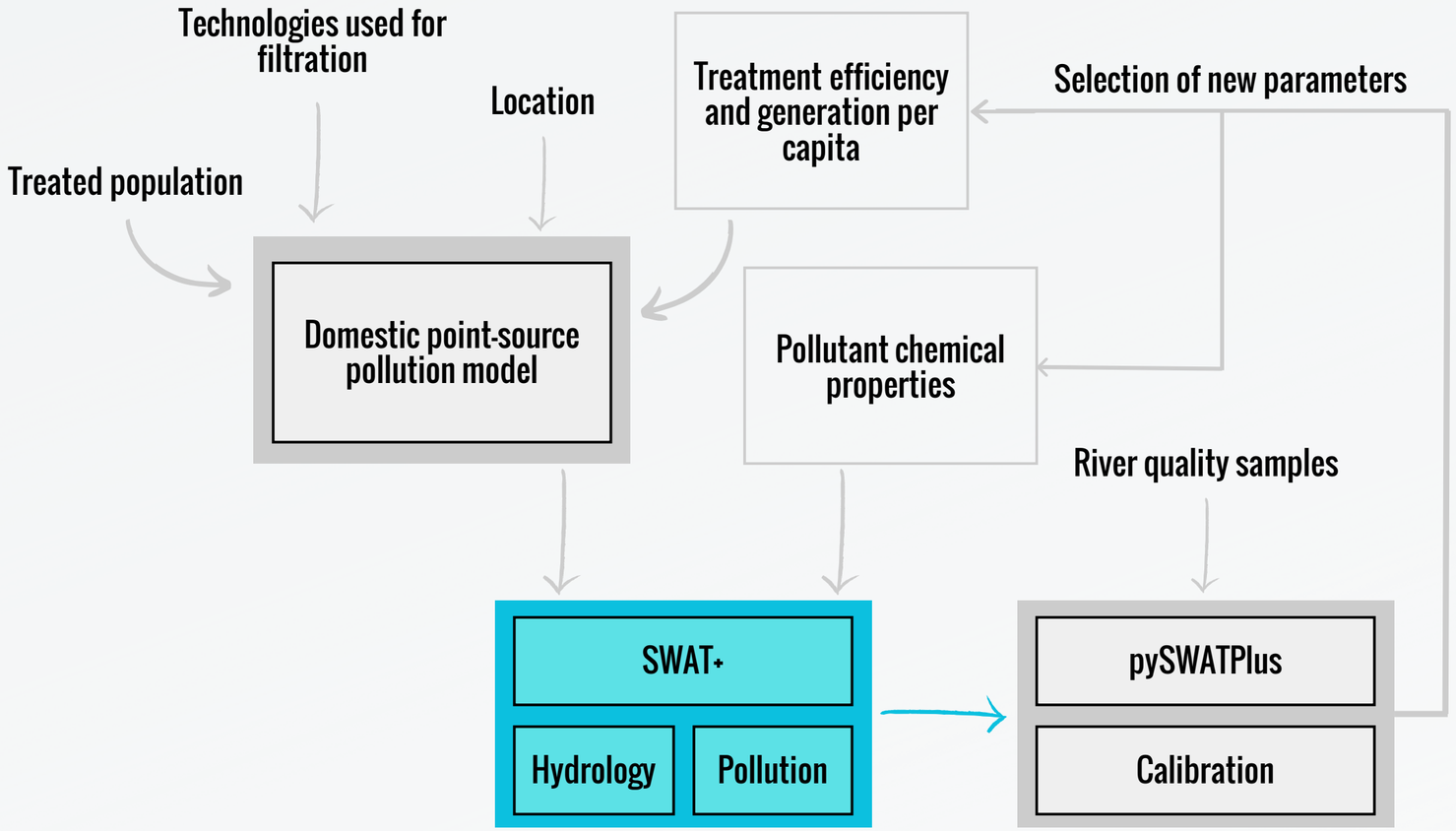

- We aim to model the attenuation and transport of pollutants in rivers and reservoirs
- We replicated the process that SWAT+ uses for pesticides

- For rivers, the modeled transformation includes:
  - Soil-liquid partitioning
  - Degradation
  - Volatilization (in water)
  - Settling (in water)
  - Outflow (in water)
  - Resuspension (in sediments)
  - Diffusion (in sediments)
  - Burial (in sediments)

- This process has been replicated for reservoirs

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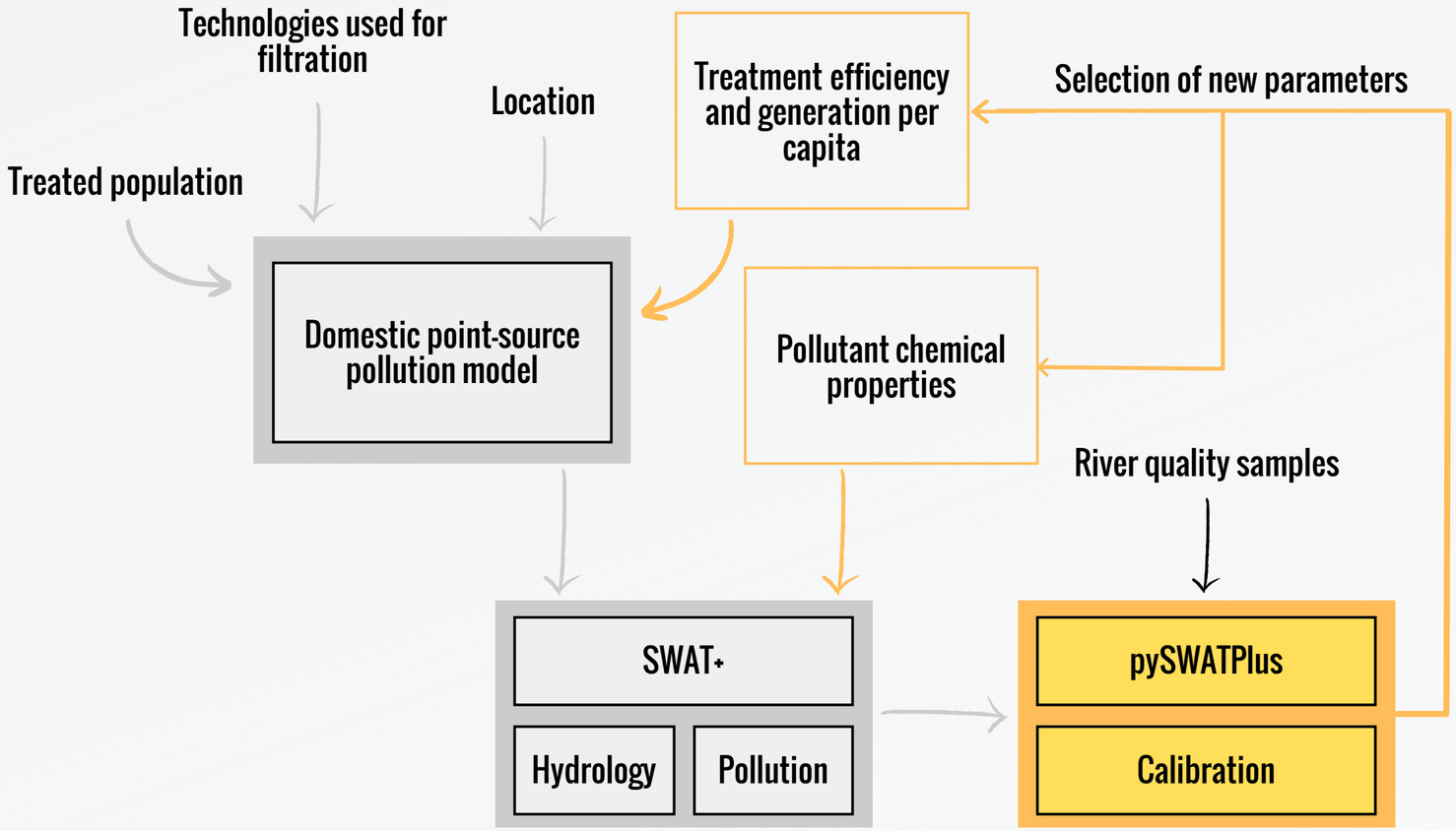

- We calibrate both models by using the multimodel option of pySWATPlus

- The calibration uses observations from quality samples of the river

- The library selects new parameters for both the Generation and the transport model
- Optimizes all the parameters based on the SWAT+ output

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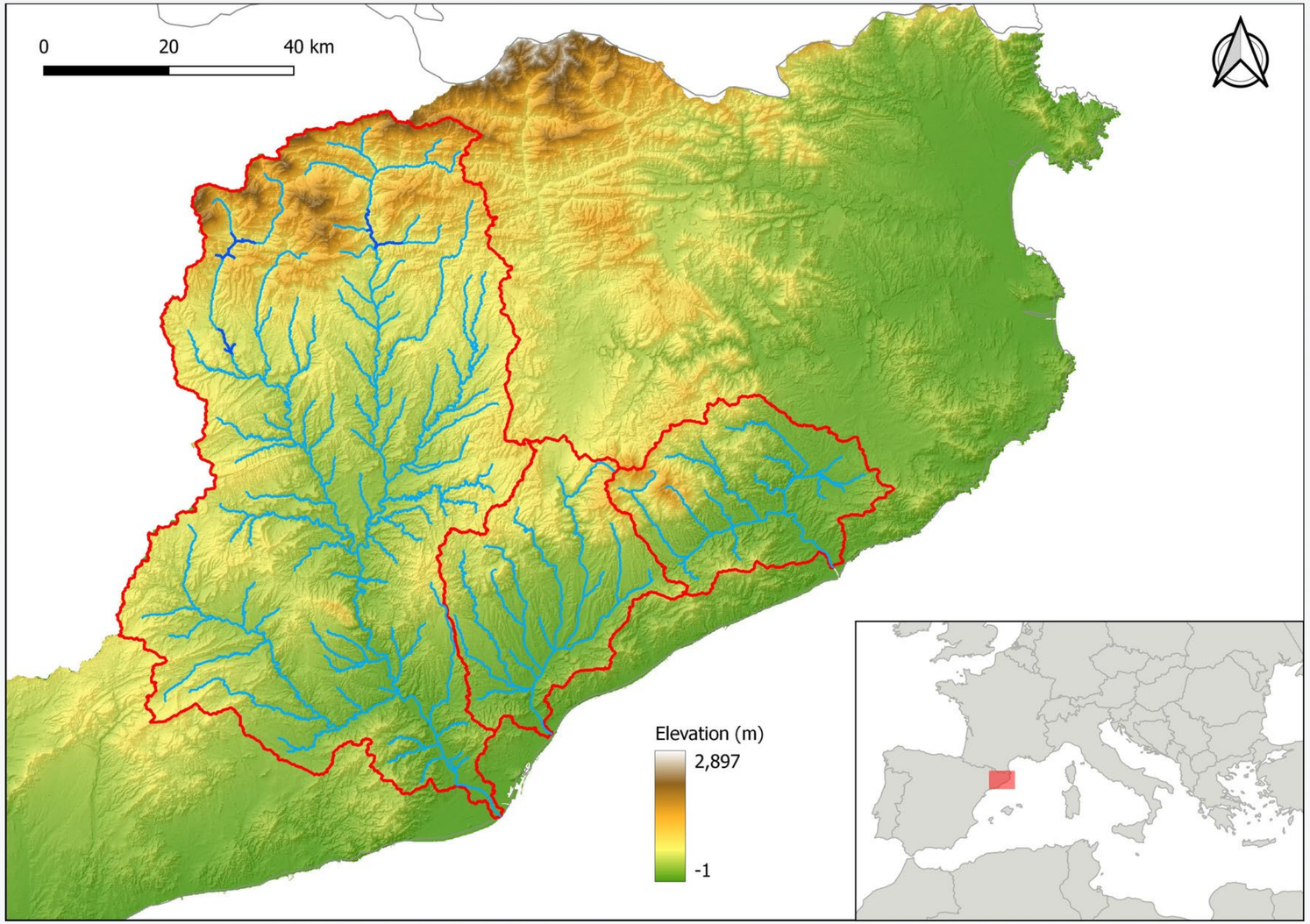

- The study focused on the Catalan River Basin District (16,000 km²)
- Different medium-sized rivers managed by the Catalan Water Agency (ACA)

- Due to data availability we focus on the Llobregat, Besòs and Tordera basins
- Simulation times were adjusted according to the availability of observation data

- We simulated two pollutants:
  - Venlafaxine
  - Ciprofloxacin
- We conducted 1500 simulations for each scenario
- We calibrated 15 parameters per scenario

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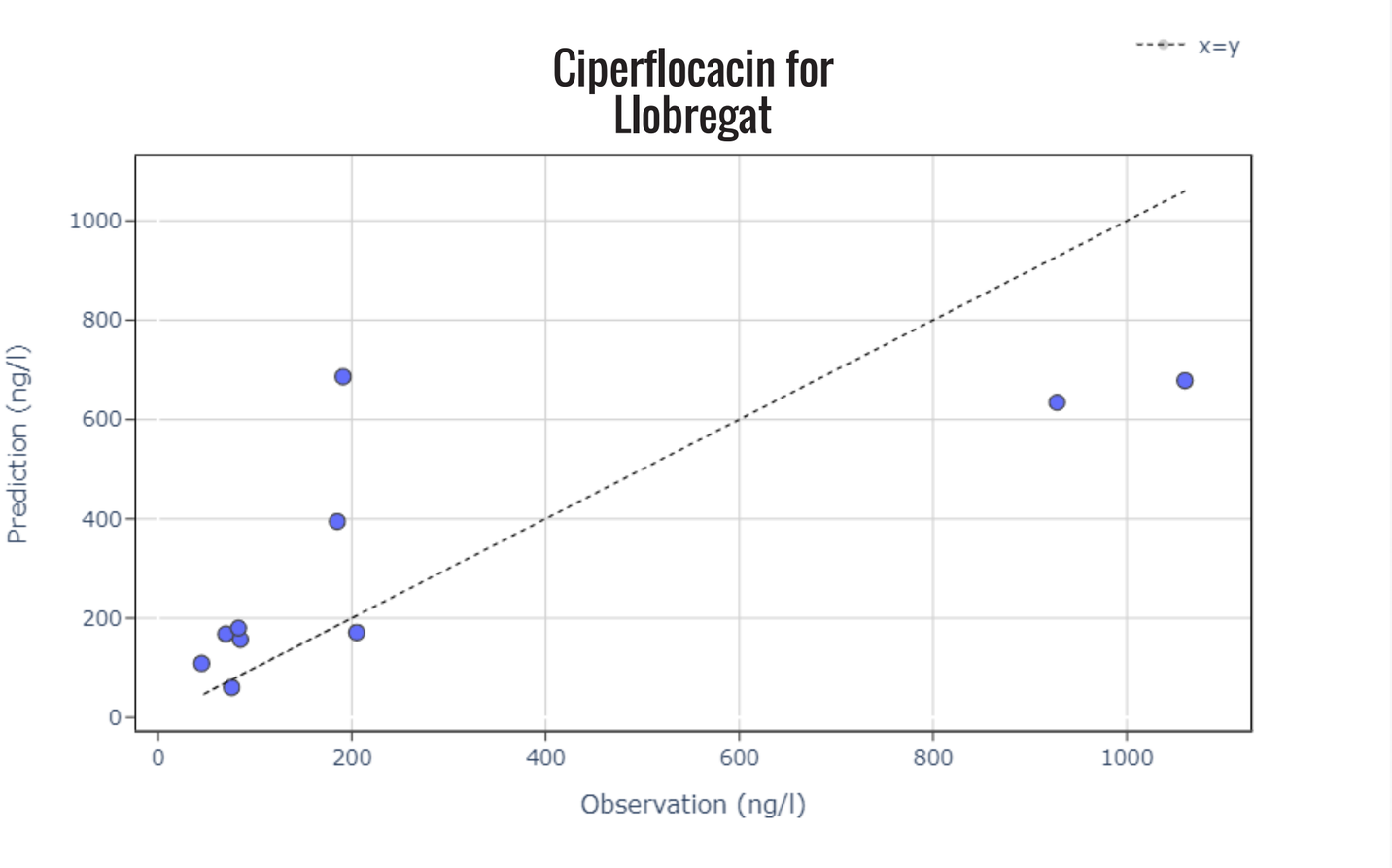

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PBIAS	-10.617

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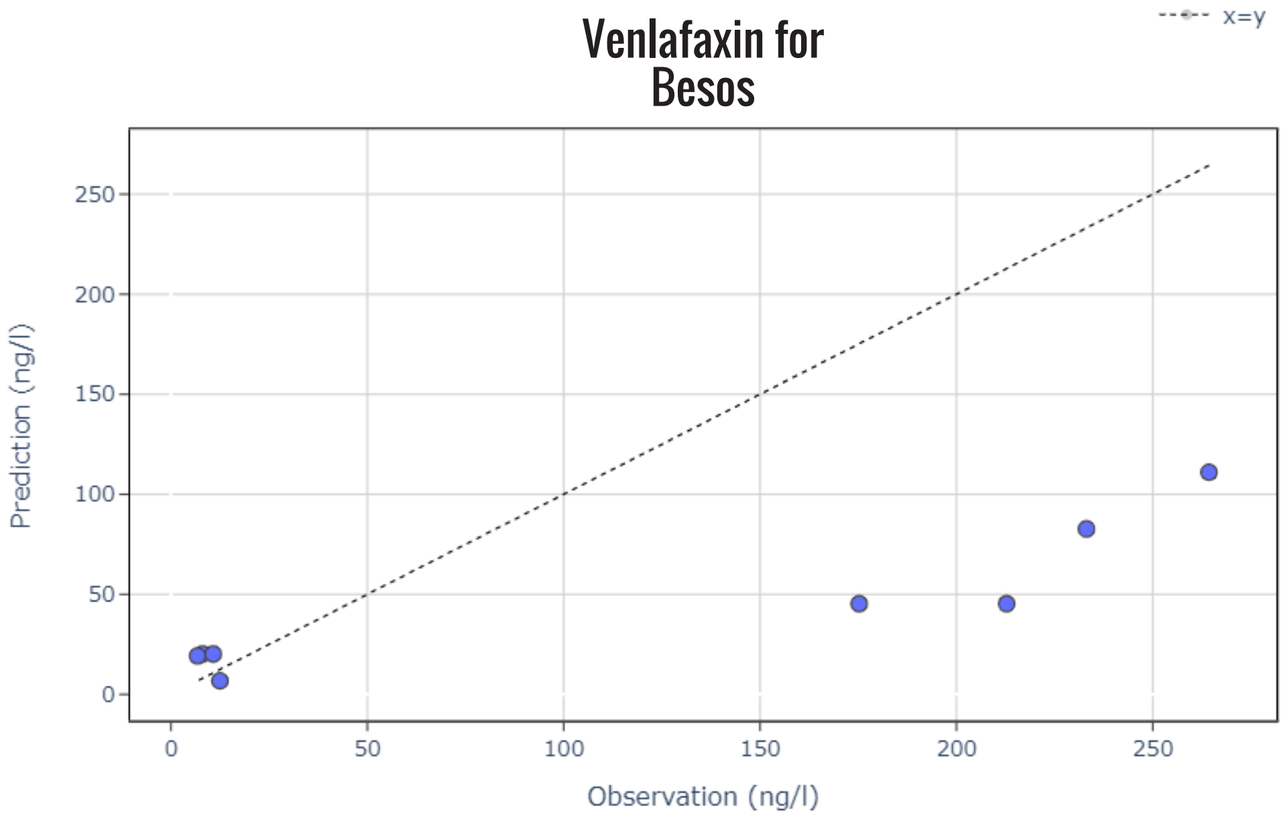

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PBIAS	62.01

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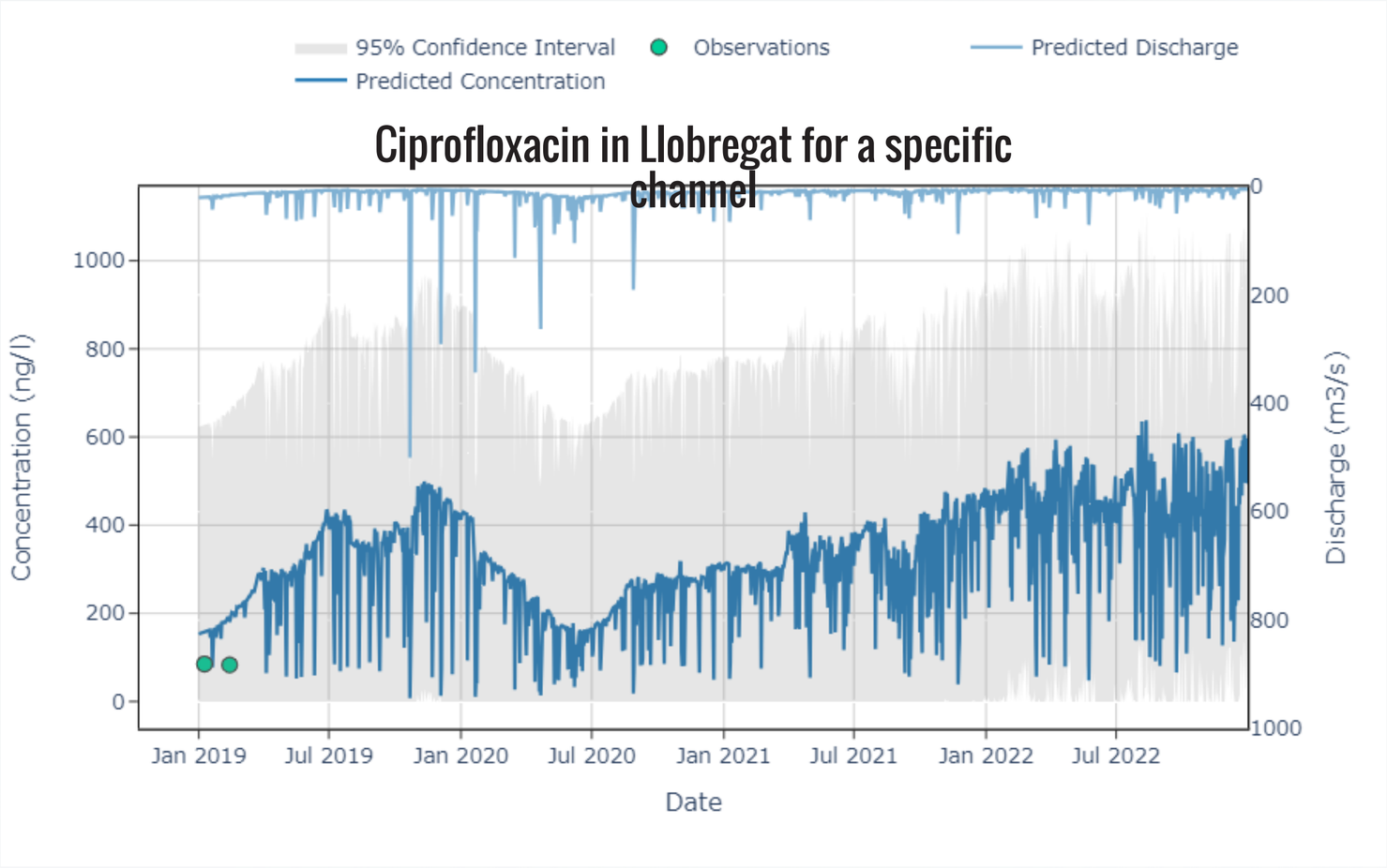

- Seasonal patterns
- Drought starting in 2021
- Correlation Between concentration and discharge

- Not enough quantity and quality of observations
- Difficulty to see normal dynamics from 2021

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- Designed to manipulate input and output files
- Designed to run SWAT+ with Python
- Designed to perform calibration
- Available on the SWAT official GitHub repository!

PYSWATPLUS

- Successfully developed a model to simulate pollution generation
- Successfully modified SWAT+ and SWAT+ Editor code to simulate pollution attenuation and transport

GENERAL MODEL

- Publish a paper with all the details (Coming soon)
- Include industrial pollution in the generation model
- Get more observations
- Get better quality observations

FUTURE WORK

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PySWATPlus:

- https://github.com/swat-model/pySWATPlus

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Designer and main developer of the pySWATPlus library

Main developer of all the modifications in the SWAT+ FORTRAN code and the SWAT+ Editor code

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