Understanding and improving the functioning of stormwater nature-based solutions (NBS_{SW}) under climate extremes. Towards a unified modeling framework for the GreenStorm project

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Context

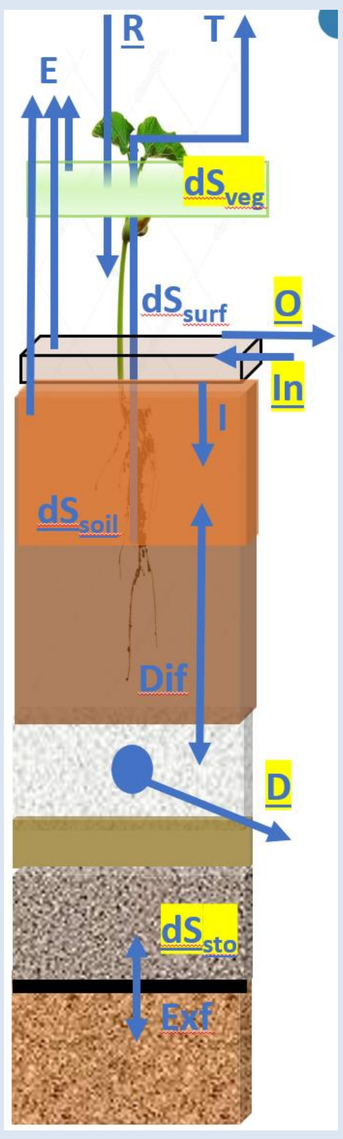
The European GreenStorm project (DUT Call 2022) aims to better deploy **nature-based solutions for the adaptation to different climate extremes**.
It focuses on stormwater management solutions (NBS_{SW}), across a diversity of types and climates.
A key step is to **develop and use a unified modeling framework at the facility scale** to improve both their design and performance assessment.
NBS_{SW} behavior is complex with a large number of processes and parameters in the soil-plant-atmosphere continuum.

Specifications for the unified modeling framework:

Adapted for:

- **NBS_{SW} diversity and variety of European climates** (including future climates).
- **NBS_{SW} performance for 3 types of extremes issues**: runoff retention during storms, cooling atmosphere during heatwaves (using evapotranspiration), vegetation resilience during drought periods.
- **Predictive mode** (i.e. properly design a NBS_{SW} without observation and calibration).

→ **Simulations at fine time steps (min) over long durations (year)**.
→ **Development & evaluation of the framework** based on the **NBS_{SW} monitoring database** from the GreenStorm project consortium



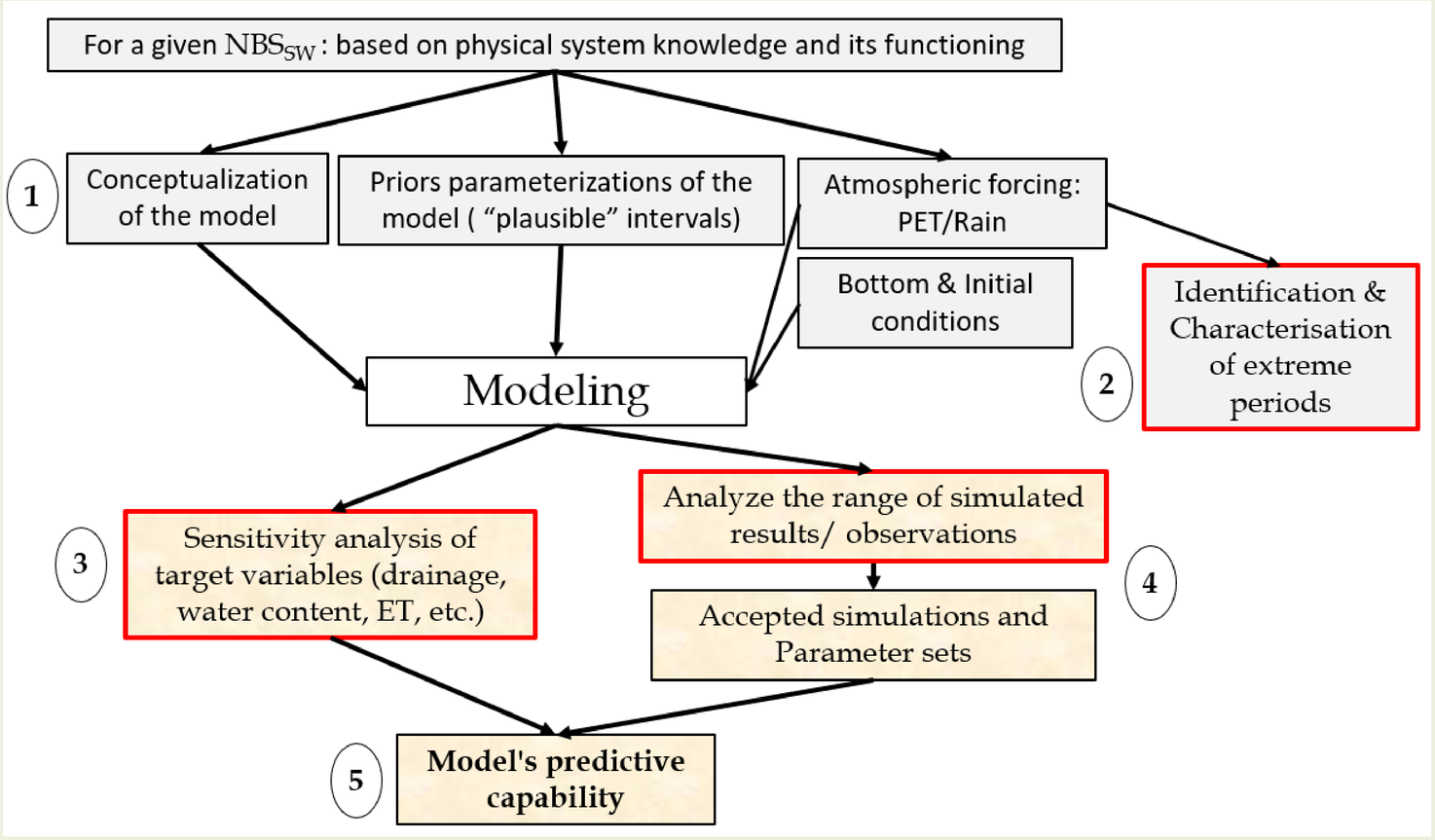
Modeling approach

Based on **a generic diagram of hydrological functioning** accounting for :
- a diversity of layers
- the range of fluxes and stocks documented in our monitoring database (underlined),

Hydrus software (Simunek, 1998) was selected: physically-based simulations, in partially saturated porous media, with a detailed consideration of vegetation

Limitations identified with Hydrus (yellow highlights)
→ consolidation of the modeling framework ongoing
(via independent modules or modifications within the 1D code)

Evaluation methodology



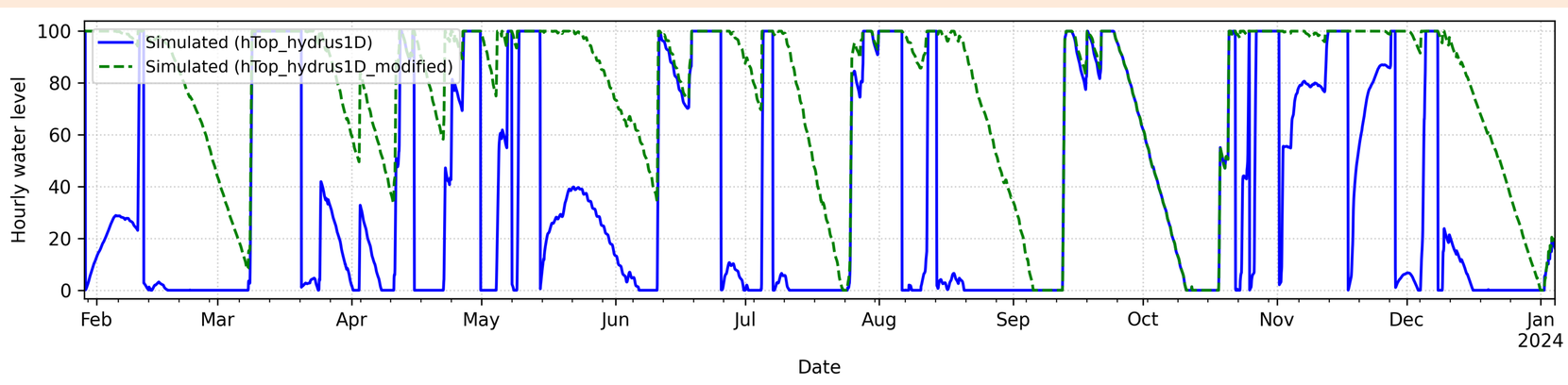
→ Need to **interface Hydrus with Python environment**
Pre & post processing in the Python codes

Example of Hydrus enhancement: implementation of a regulated outflow (e.g., orifice) at the surface

- Surface reservoir water balance is sometimes inaccurate due to a sudden drop in water level from the maximum storage to 0

- During transition from a constant head condition to a flux condition in surface
→ modification of the code

- Implementation of a regulated outflow in progress



Perspectives

Apply the evaluation methodology on green roofs, rain garden, and rain tree
→ consolidation of the method

Try to develop Hydrus (1D) & its environment to be able to represent a wide range of NBS_{SW}

References

The European GreenStorm project: https://arceau-idf.fr/en/projects/greenstorm

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