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A physically-based and data-driven hydrological model for CSO mitigation through stormwater disconnection strategies

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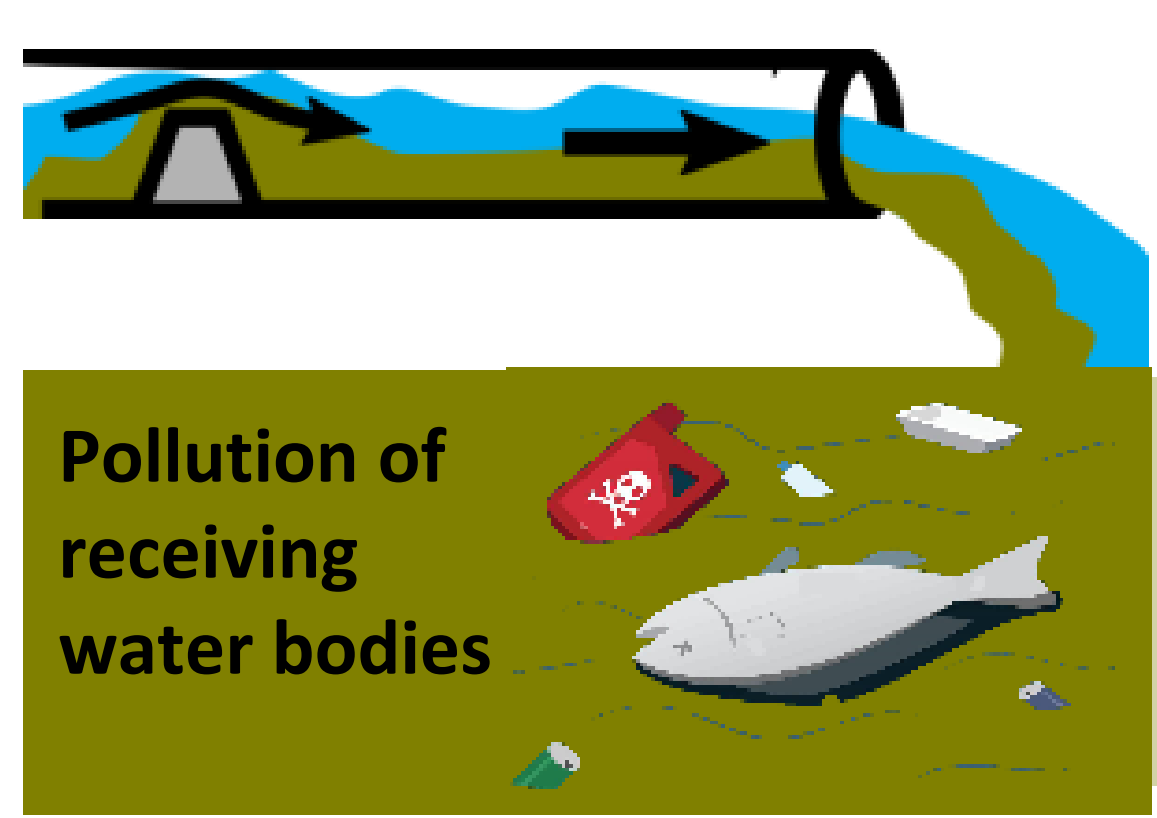
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Un modèle hydrologique basé sur les données physiques pour la réduction des déversements par des stratégies de déconnexion des eaux pluviales

A physically-based and data driven hydrological model for CSO mitigation through stormwater disconnection strategies

Context

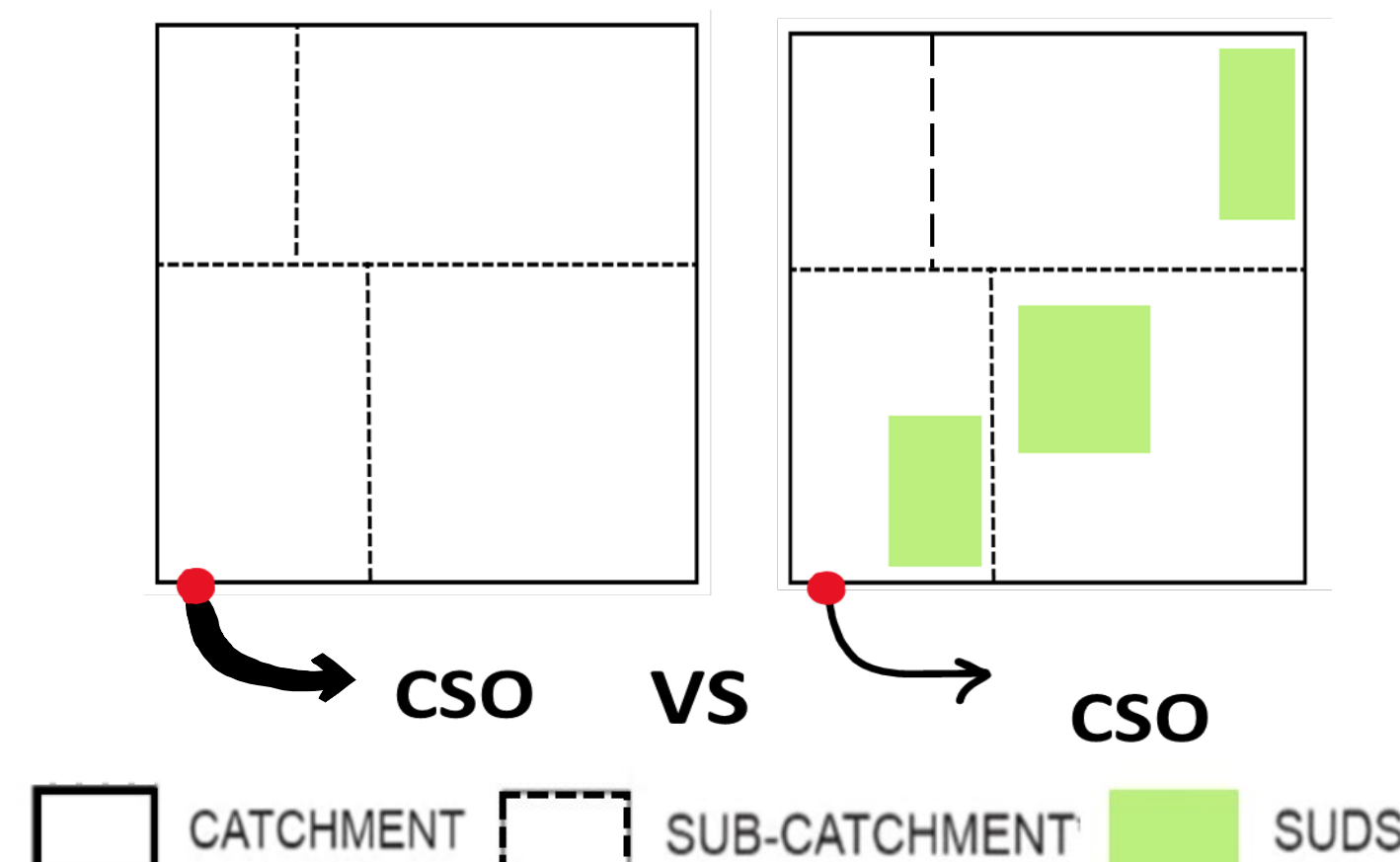
Combined Sewer Overflow (CSO) impacts



CSO mitigation through Sustainable Urban Drainage Systems (SUDS)



Modelling the effects of spatially distributed SUDS



Need for methods and knowledge to develop planning tools for CSO mitigation

- ISSUES
- Which model of the key processes involved to enable scenario exploration
 - How to build and feed the model in a context of data scarcity
 - Practically, which improvement can be expected depending on the SUDS configuration ?

Objectives

#1 Development of a physically-based parsimonious model for mitigating CSO volume through SUDS

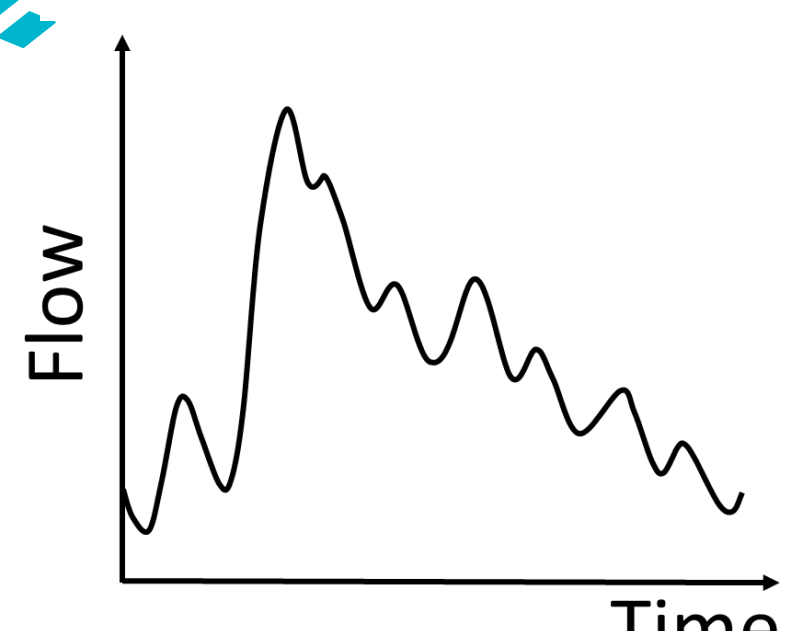
#2 Account for infiltration inflow and quantify its contribution to CSO

#3 Test the performance of global disconnection strategies to mitigate CSO volumes

Methodology

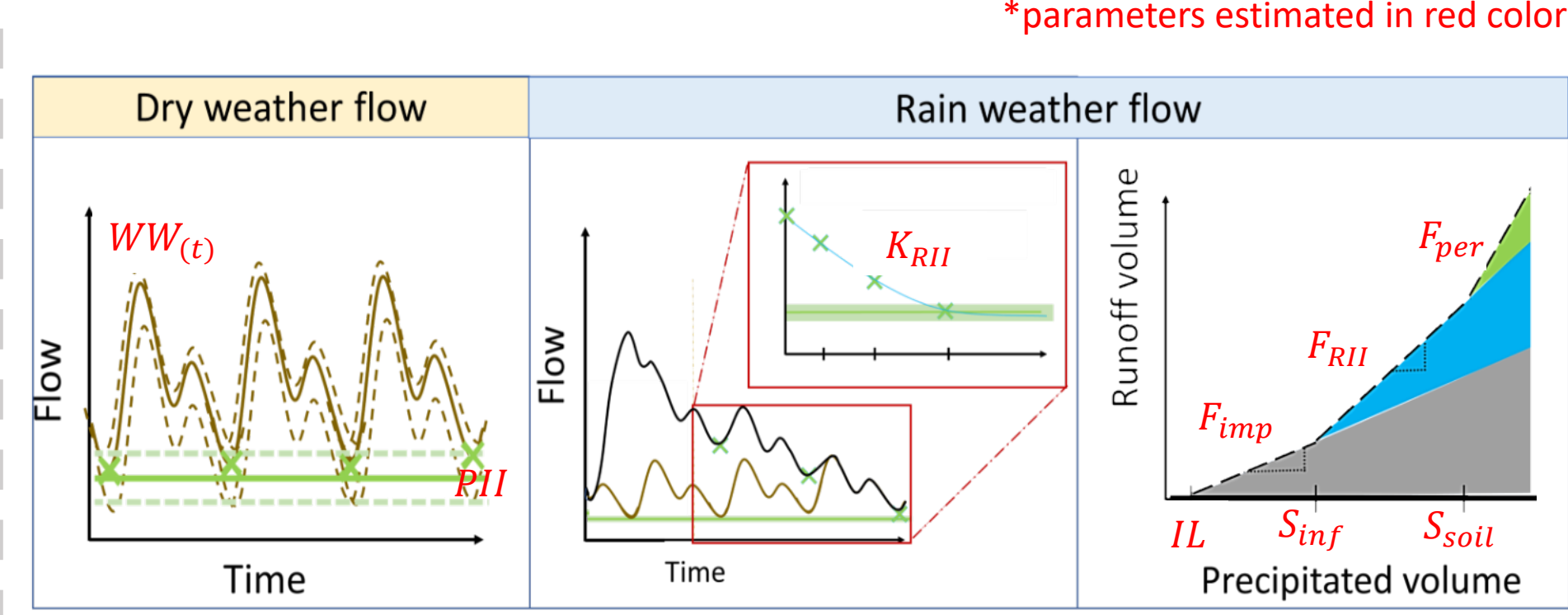
Data-driven model

Available data used to build the model



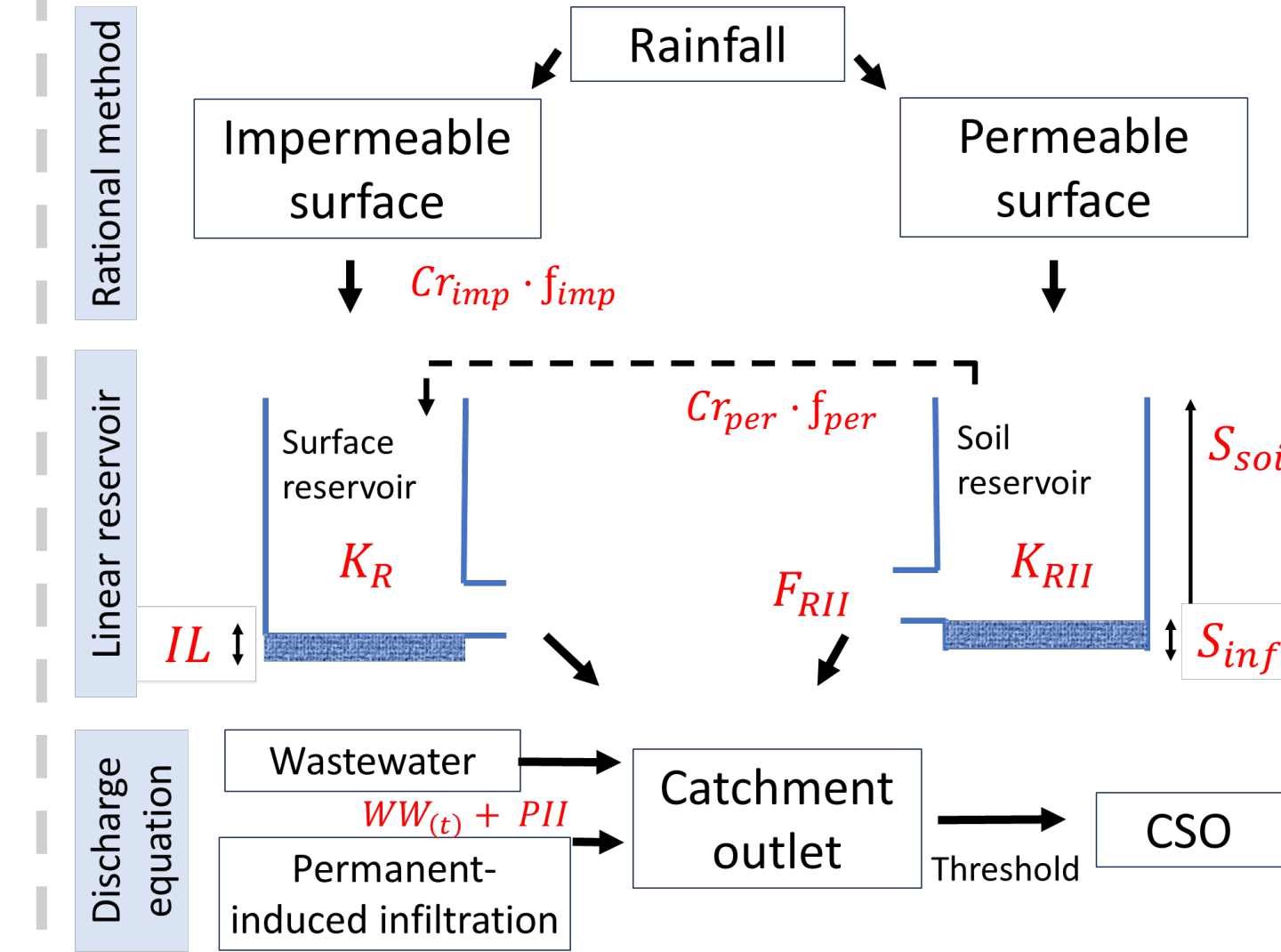
- Monitored flow rate at the catchment outlet
- Monitored rainfall
- Catchment characteristics

Extraction of information



- Wastewater flow rate
- Permanent infiltration inflow rate
- Average flow between 3 and 4 am
- Total flow rate
- Depletion curve
- Impermeable runoff volume
- Rain infiltration volume
- Permeable runoff volume

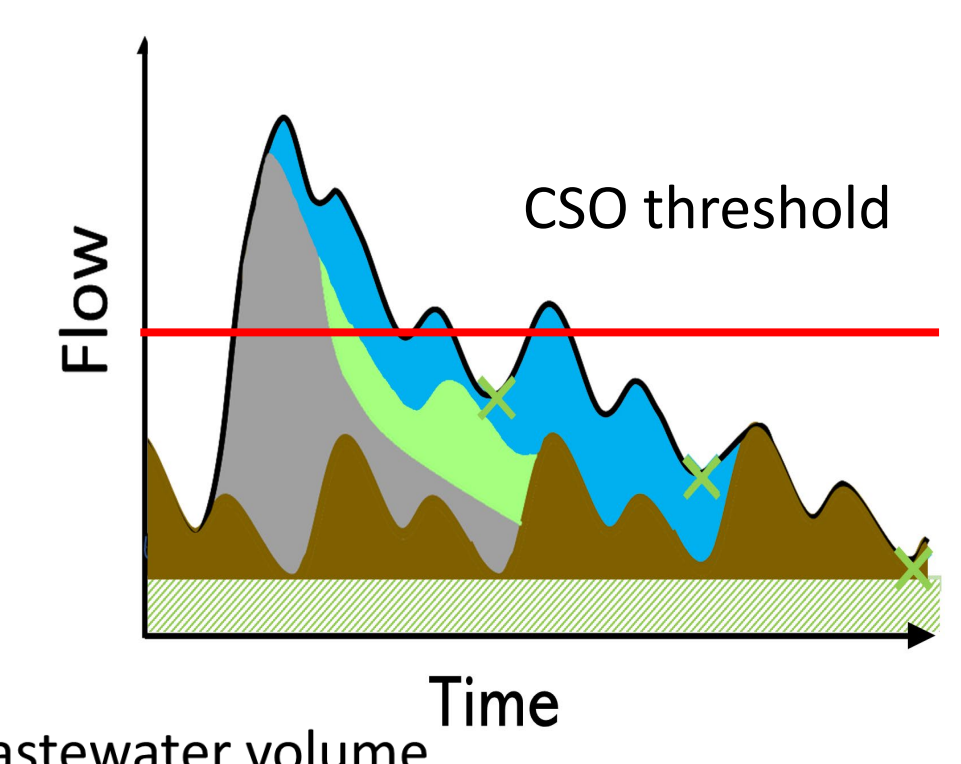
Conceptual model



#1 ✓

Outputs

- Decomposition of the hydrograph
- Global parameters calibrated
- CSO volumes and frequencies

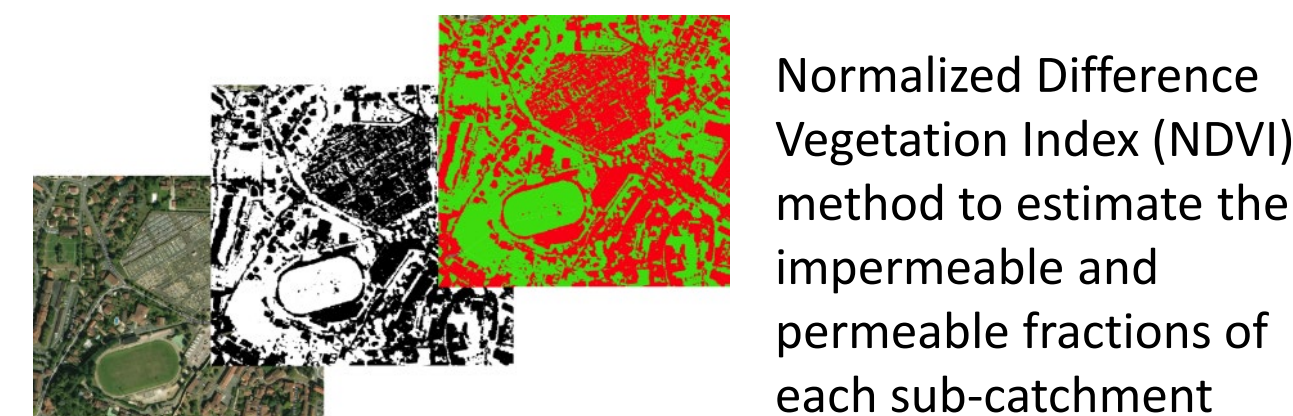


Spatial discretization

Procedure for the delimitation of the sub-catchment area

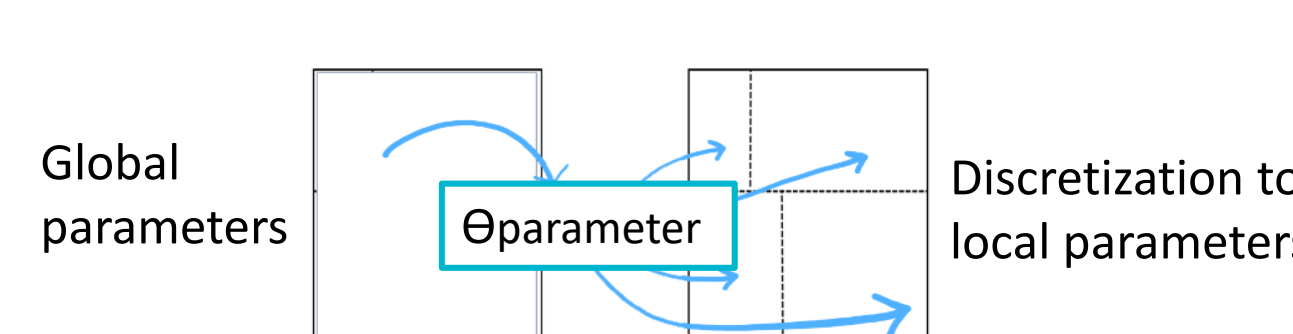
- Step 1: Catchment border based on available data
- Land use maps
 - Topography
 - Sewer network
- Step 2: Sewer network
- Simplification of the existing network
 - Creating an fictive network
- Step 3: Sub-catchment delimitation
- Based on the closest drainage pipe
 - Based on topography

Getting sub-catchment land use characteristics from available data



Example of Figeac, France

Distribution of parameters based on their global estimation



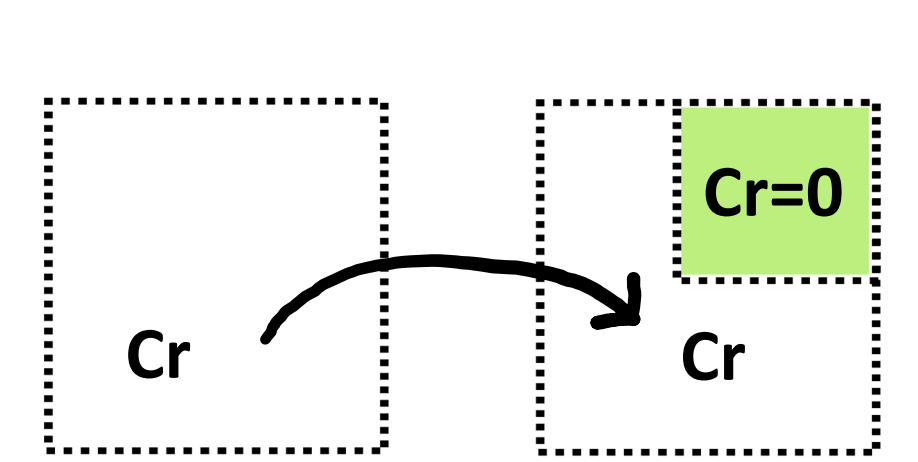
Calibration & evaluation

- Parameters distributed in each sub-catchment
- Two remaining parameters to be calibrated
- KGE criteria for the flow rate upstream the CSO
- Relative error of the total CSO volume

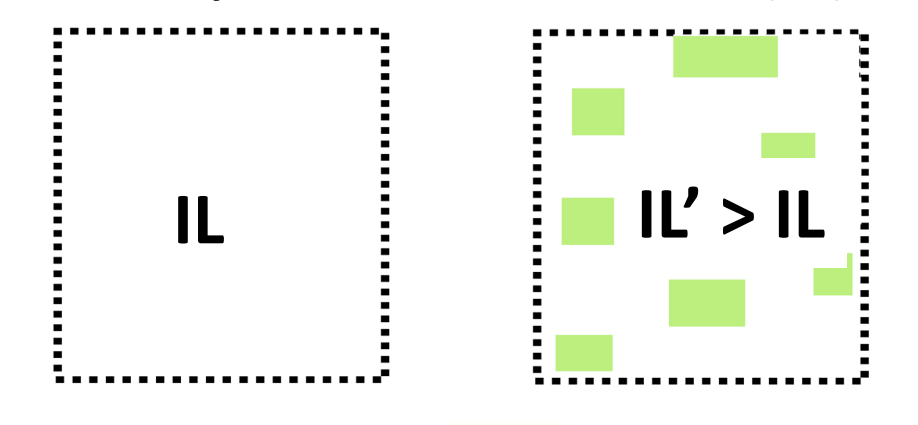
Global disconnection scenarios

Two approaches

Merge SUDS into an equivalent sub-catchment with specific properties

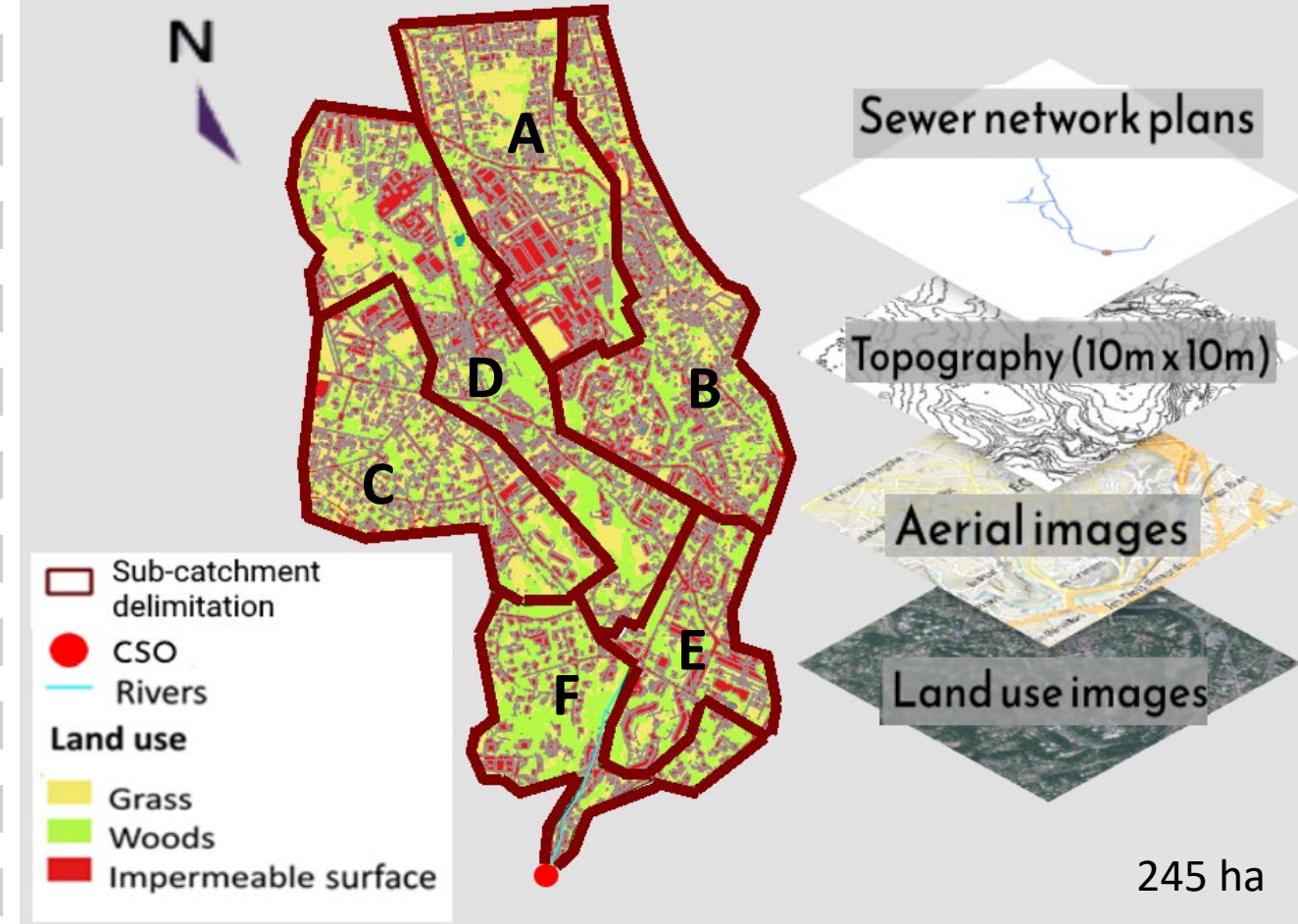


Modify the initial losses (IL)

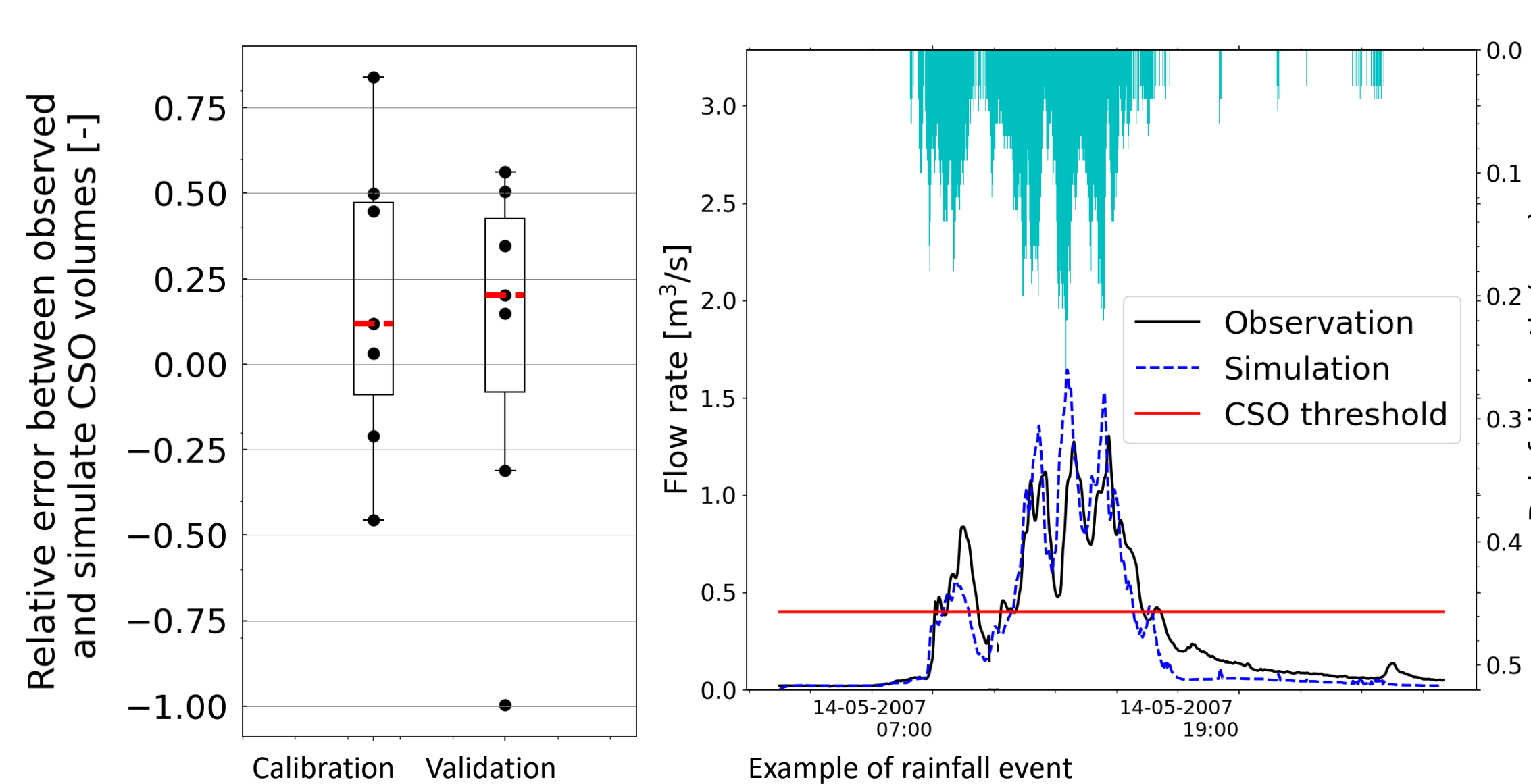


Results

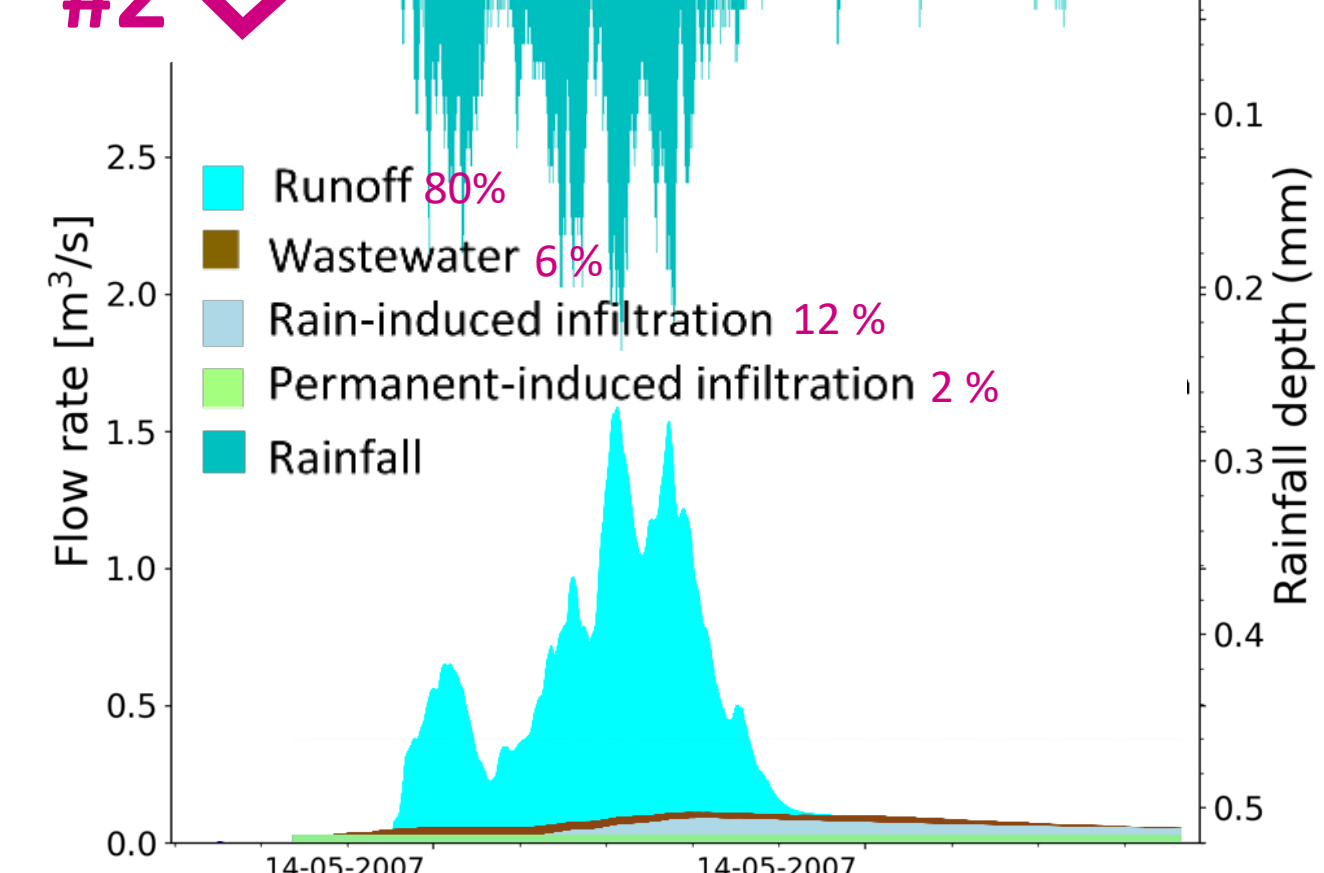
Sub-catchment delineation according to available geographic information



Calibration and validation

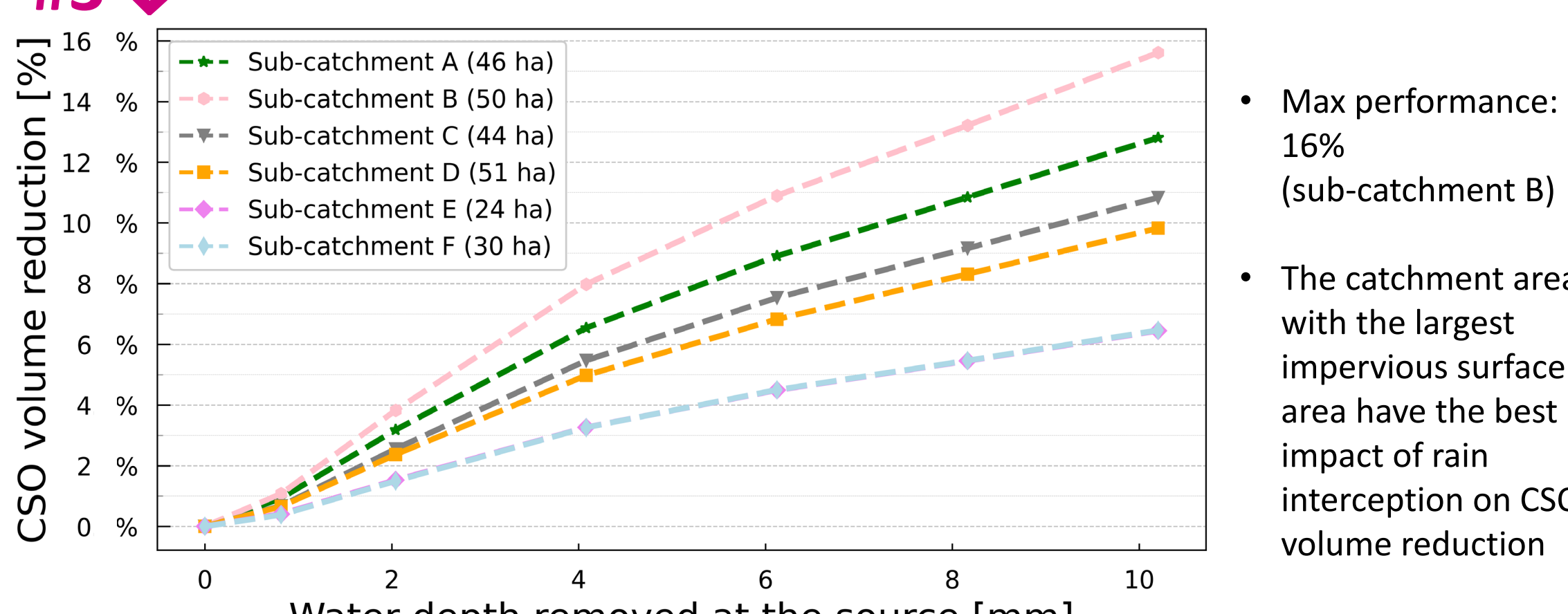


#2 ✓



#3 ✓

Performance of SUDS



- Max performance: 16% (sub-catchment B)
- The catchment areas with the largest impervious surface area have the best impact of rain interception on CSO volume reduction

Conclusions & perspectives

- The observations of each component's behaviors guided the construction of a **simple and parsimonious model**
 - Nine parameters** have been calibrated from data pretreatment using observed data
 - An approach was propose for **catchment discretization** (even in case of scarce data)
 - The model shows the **capability to replicate the observed hydrograph and the proportion of each component that reached the CSO structure**
 - The different **scenarios tested** within each sub-catchment **indicate the effort required to reduce CSO volumes by sub-catchment**
- Perspectives :
- Identify and characterize the priority sub-catchment to disconnect
 - Implement of simplified infiltration models to simulate SUDS at catchment scale