Understanding the influence of leaf litter and sand on the water balance composition of blue-green infrastructure

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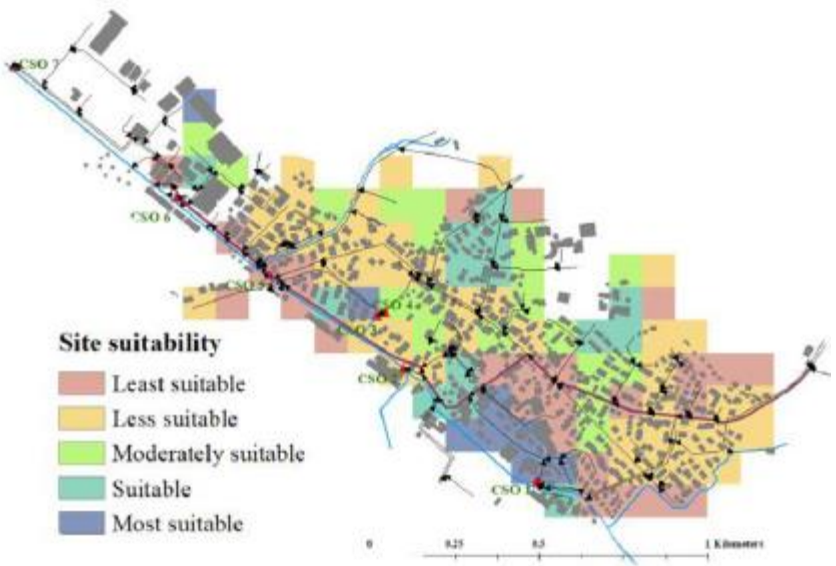
Many studies and guidelines emphasise the design, planning, and implementation of blue-green infrastructure (BGI)

Design

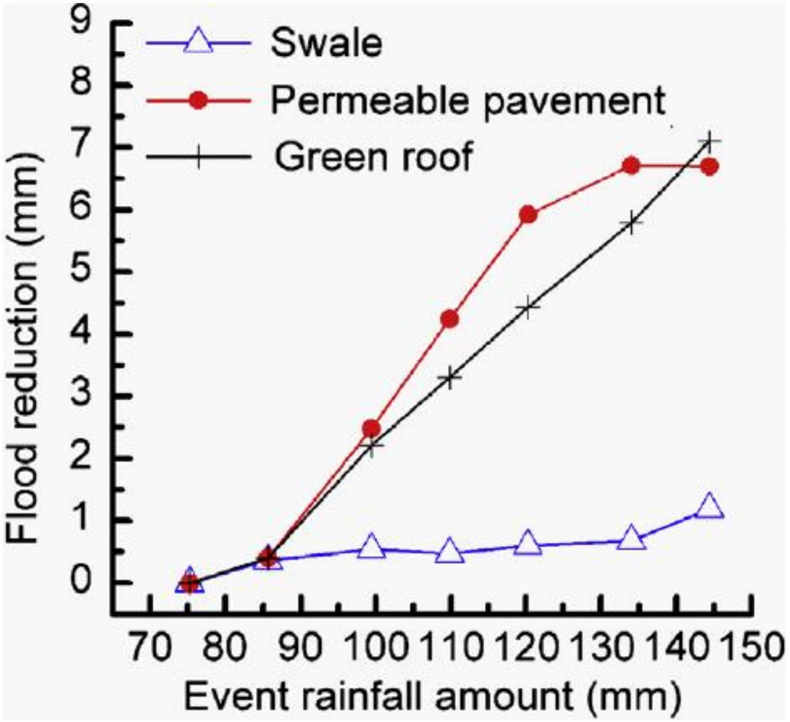
https://cis.ihs.com/cis/document/314088

Planning



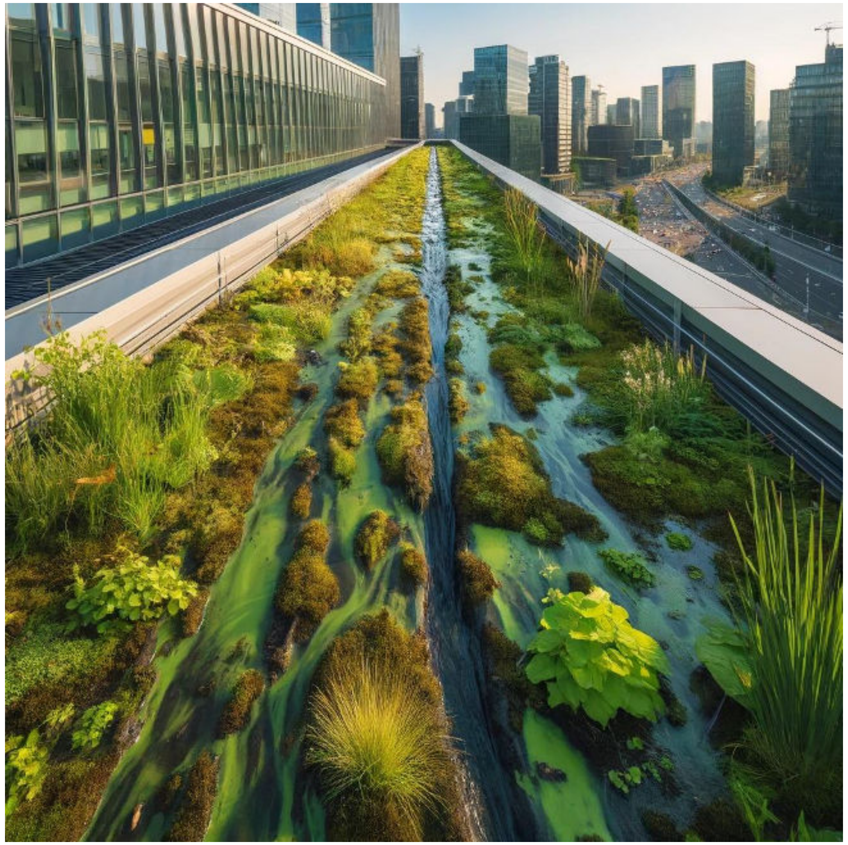
https://doi.org/10.1016/j.watres.2020.116780

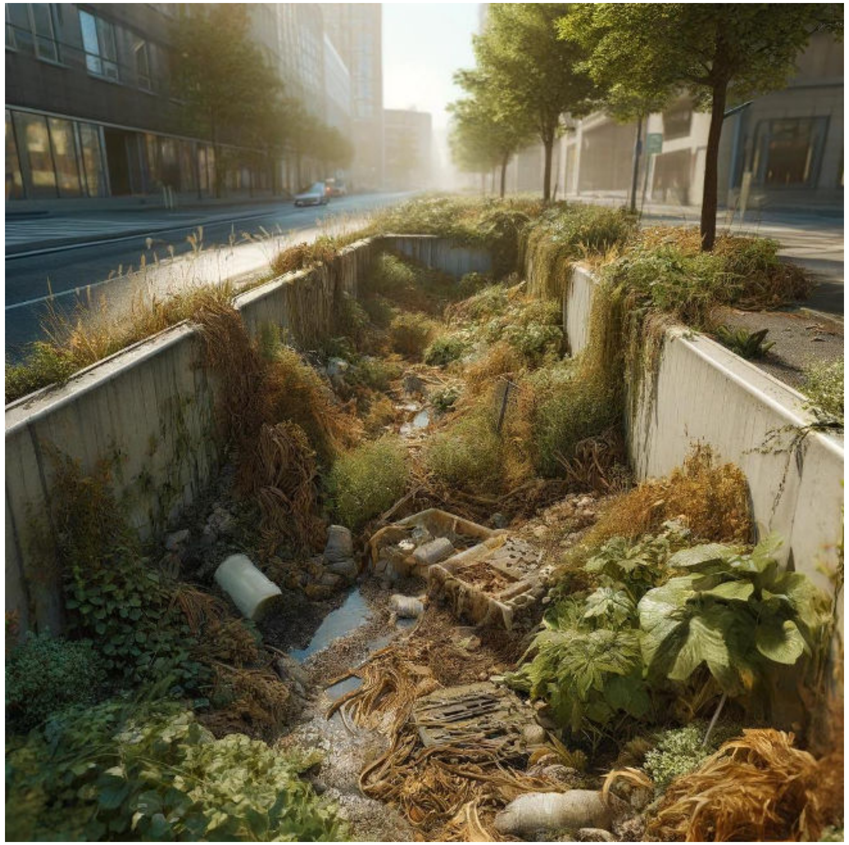
Implementation



https://doi.org/10.1016/j.jenvman.2013.08.026

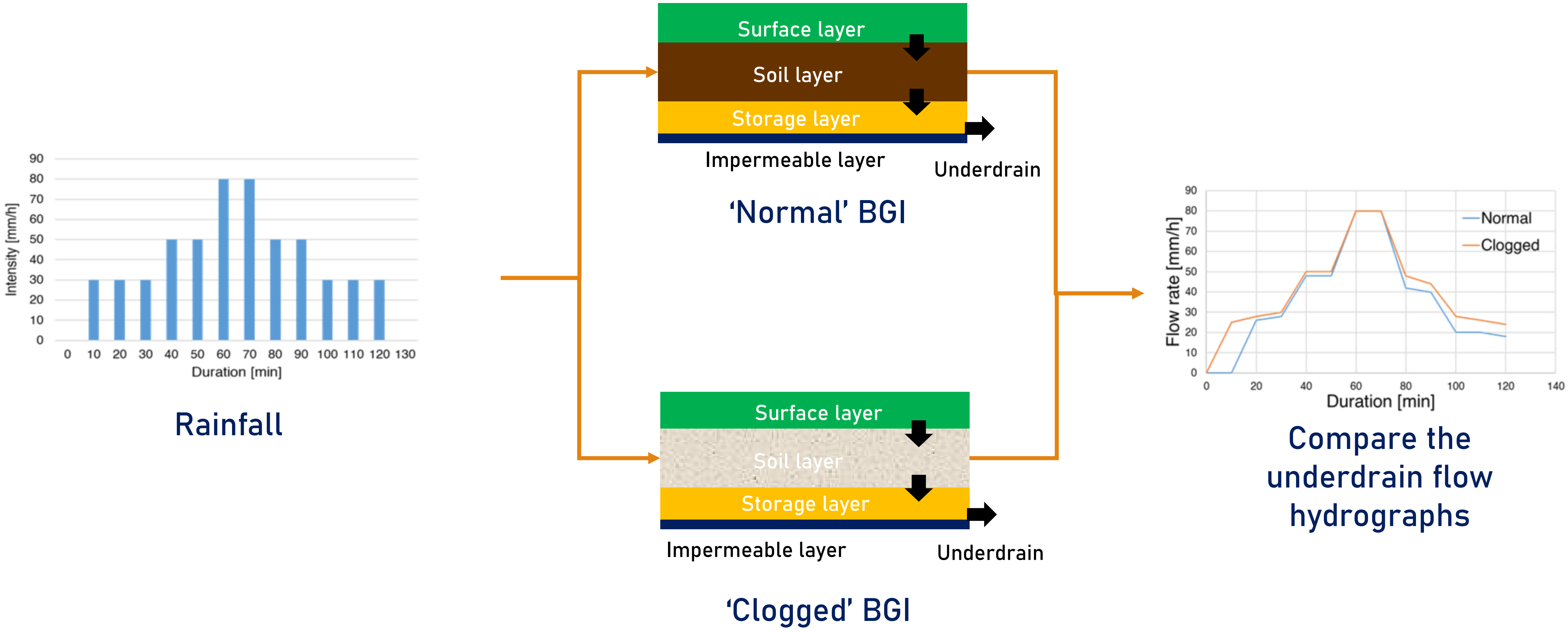
However, their maintenance requirements are understudied and overlooked, which could have severe consequences on their long-term performance





Images generated using ChatGPT 4.0
Prompts: (Left) generate an image of a clogged green roof
(Right) generate an image of an unmaintained bioretention cell

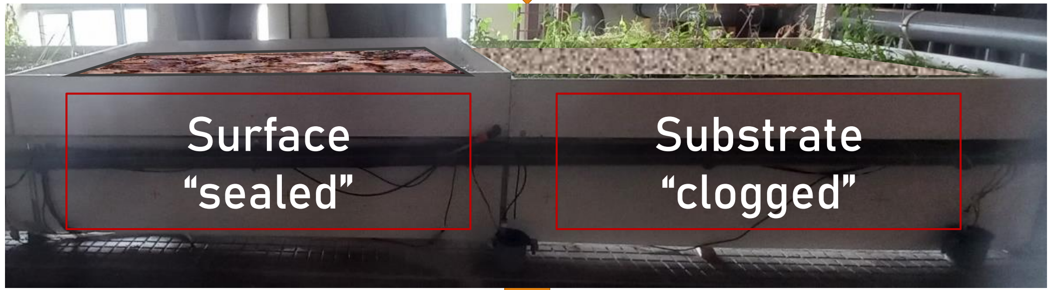
The objective of our study was to study the hydrological performance of BGI for different maintenance conditions



We used the facilities at CITEEC (A Coruña, Spain) to quantify hydrologic performance of BGI at different maintenance conditions

Rain generator

Two modified BGI to represent different maintenance conditions



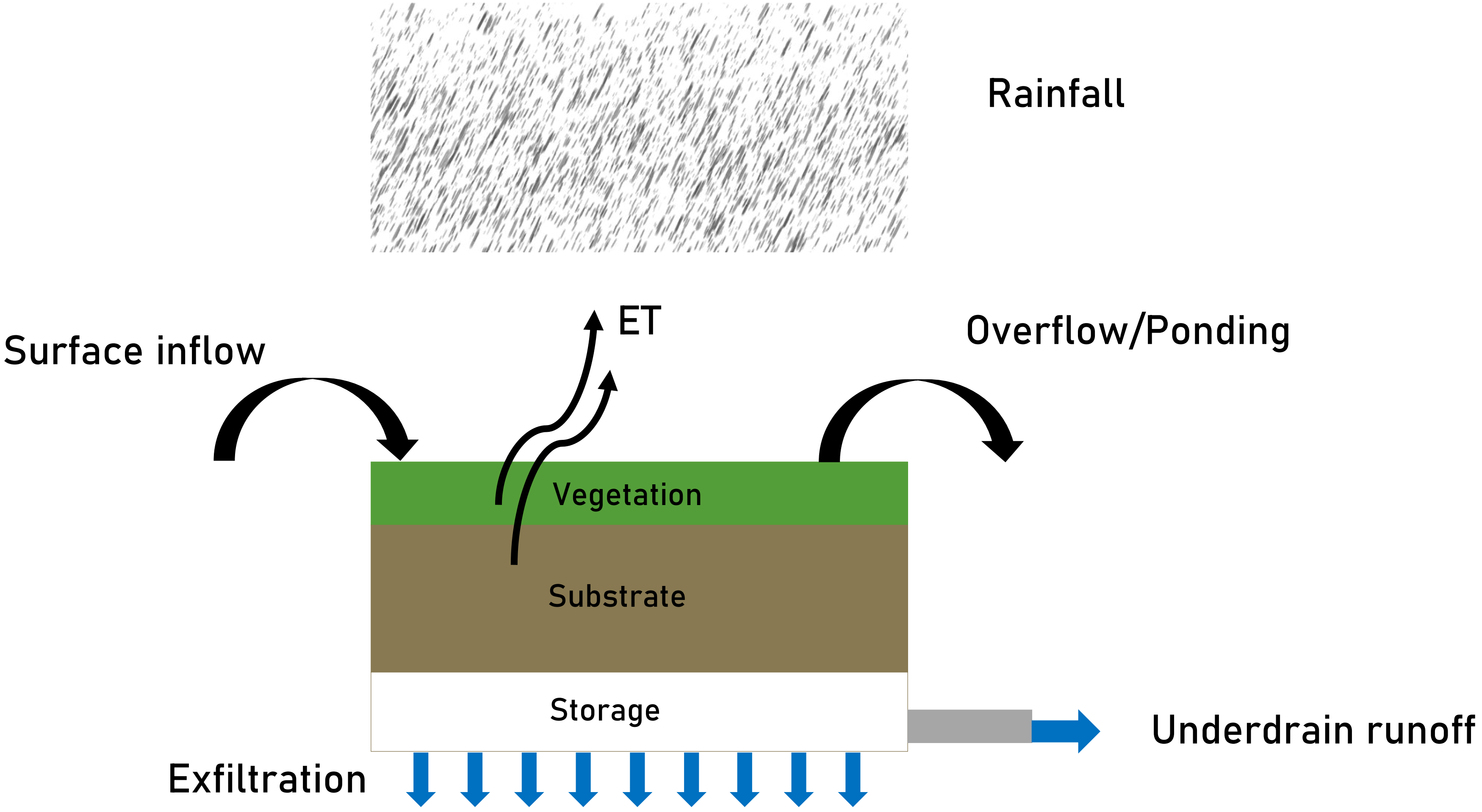
Measurements:

- Underdrain flow (from drain)
- Soil moisture (in the substrate)

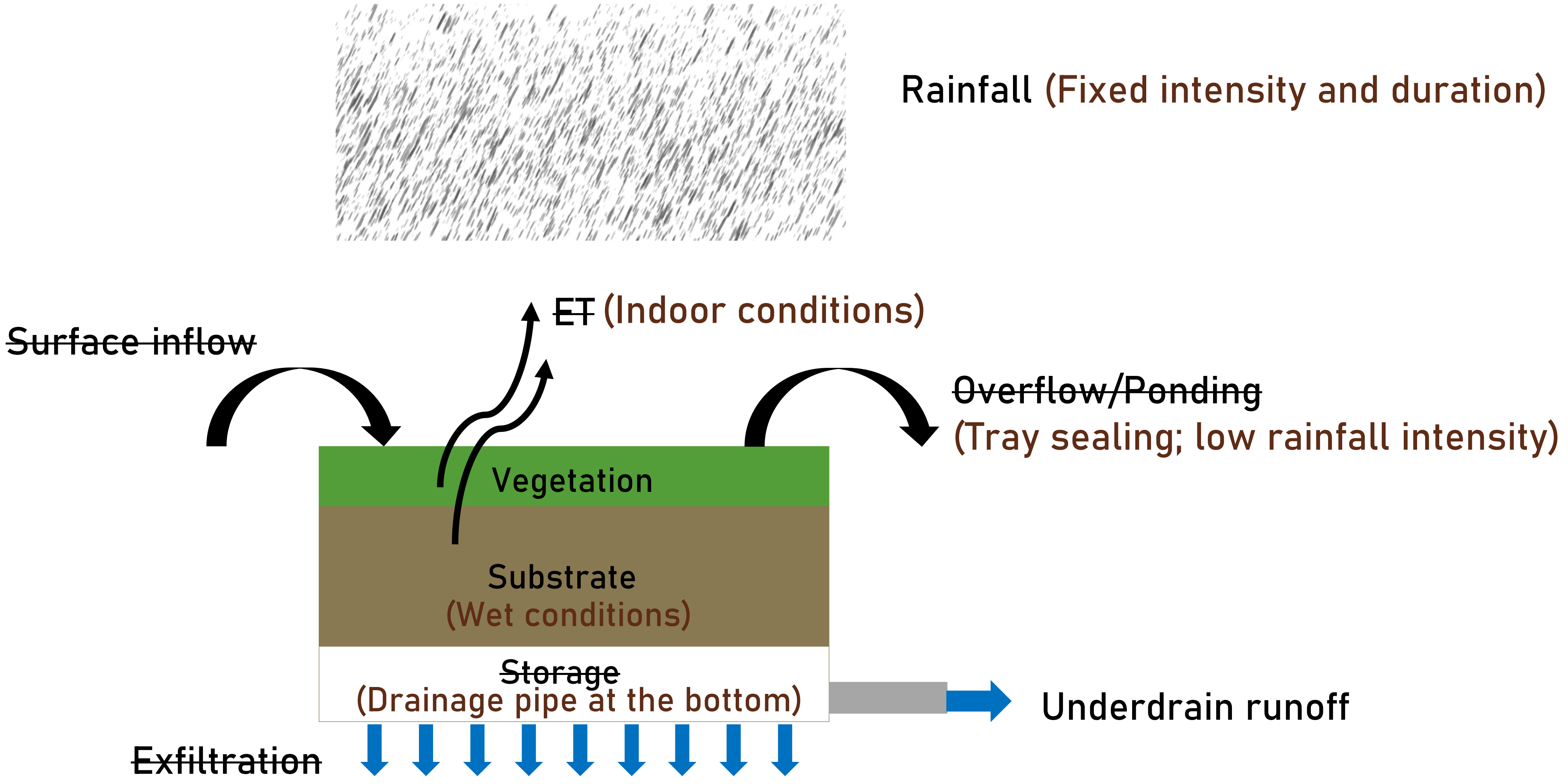
Co-UDlabs

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N°101008626

Water balance components of a typical BGI



We simplified the BGI arrangement and the test conditions to see the hydrological response in the underdrain flow only

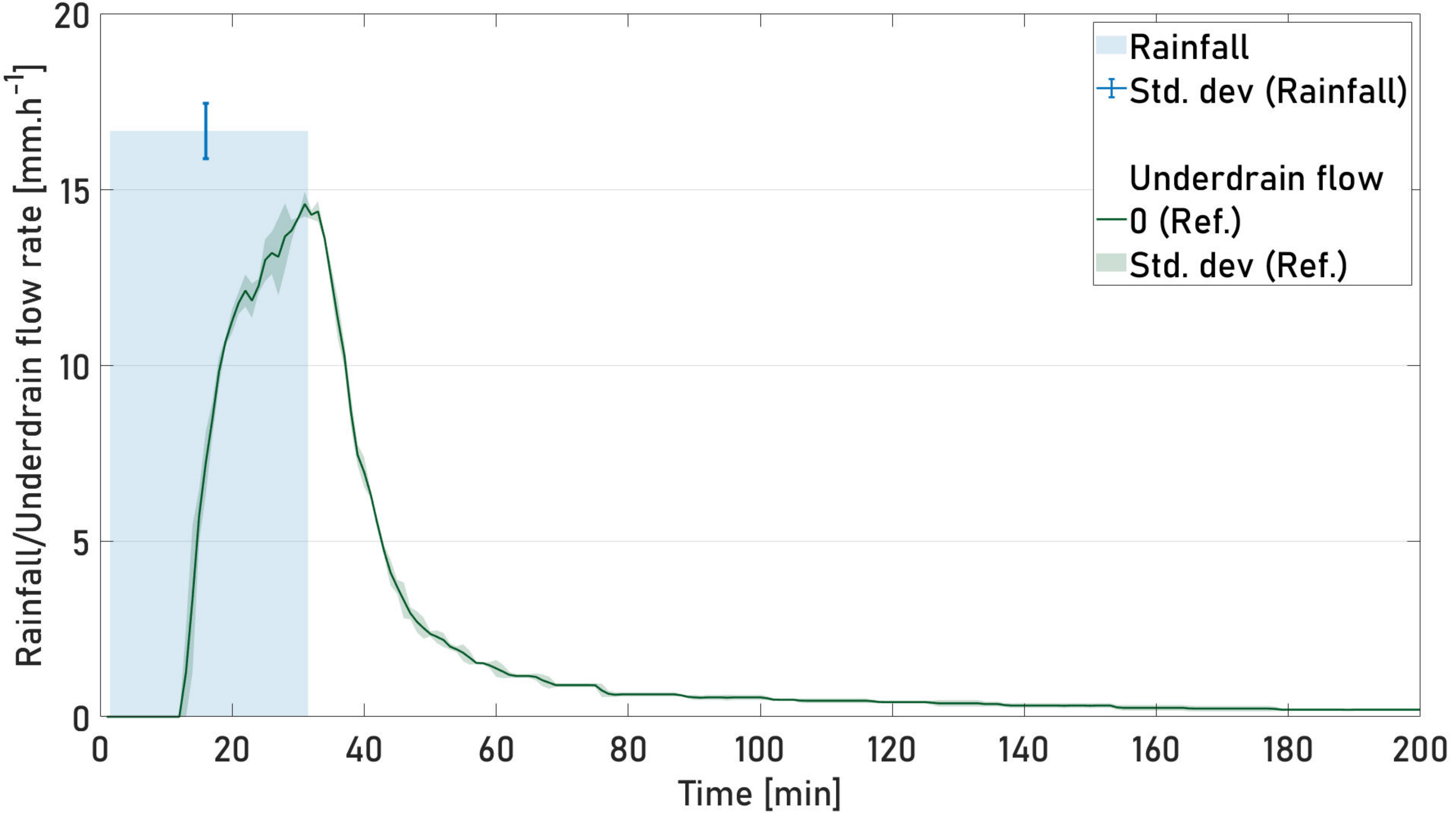


Underdrain flow characteristics from the green roofs (reference condition)

Box 1

Box 2

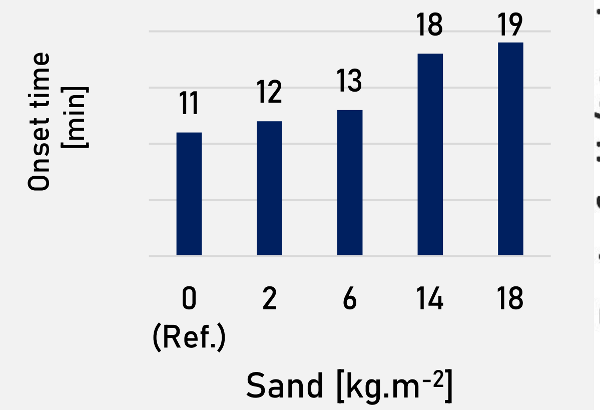
Thirty min of rainfall with a fixed intensity produced a typical underdrain flow hydrograph (initial delay, sharp rise, peak, gradual recession)

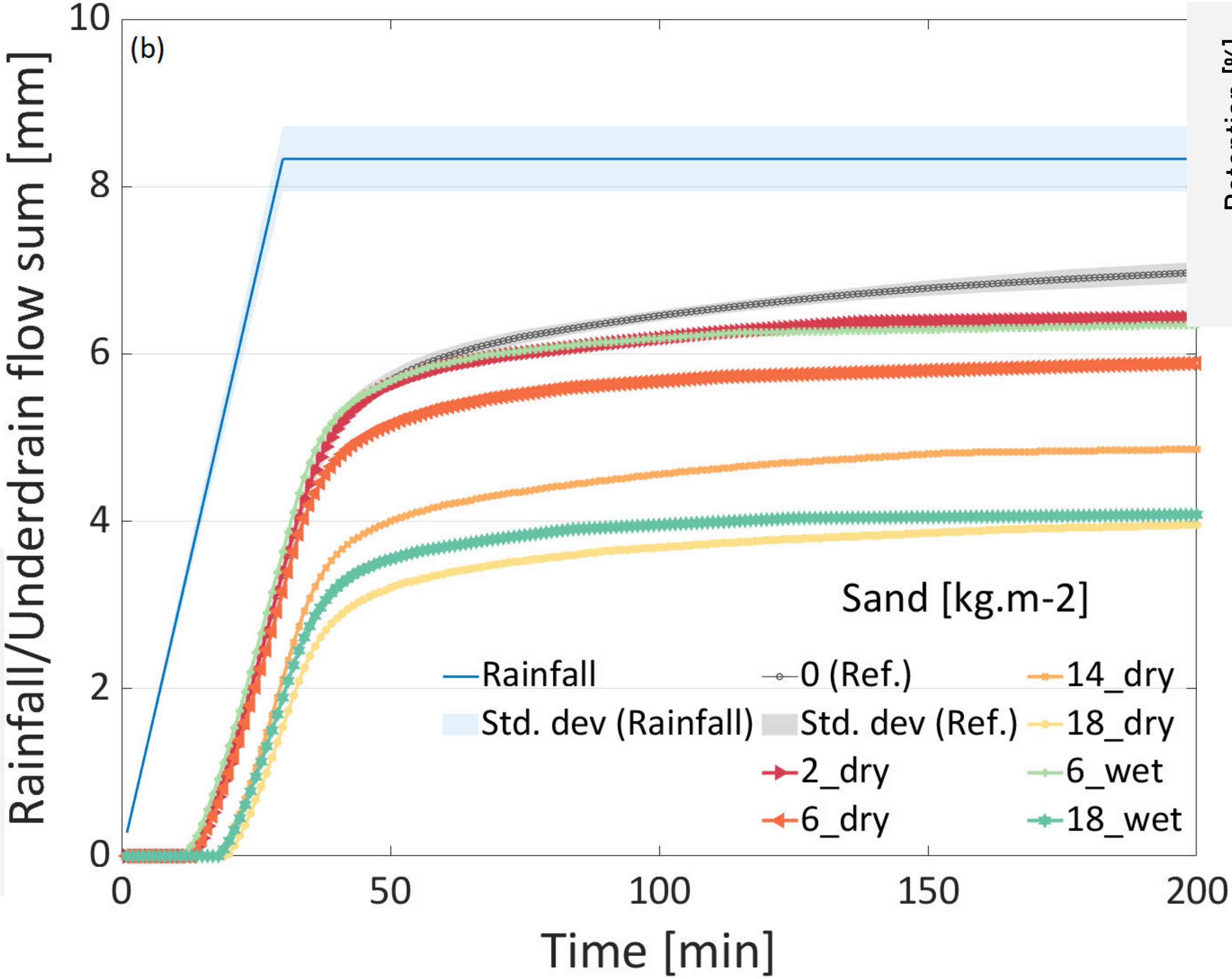


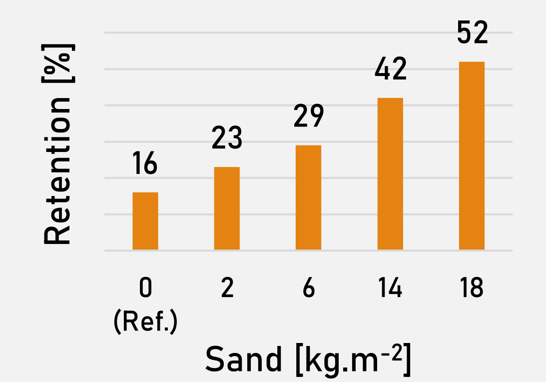
How does leaf litter and sand accumulation affect the BGI's water balance?

In one Box, we added different *volumes of sand* and analysed the underdrain flow response

Time to start is delayed with increasing sand accumulation; total underdrain flow volume is also reduced.



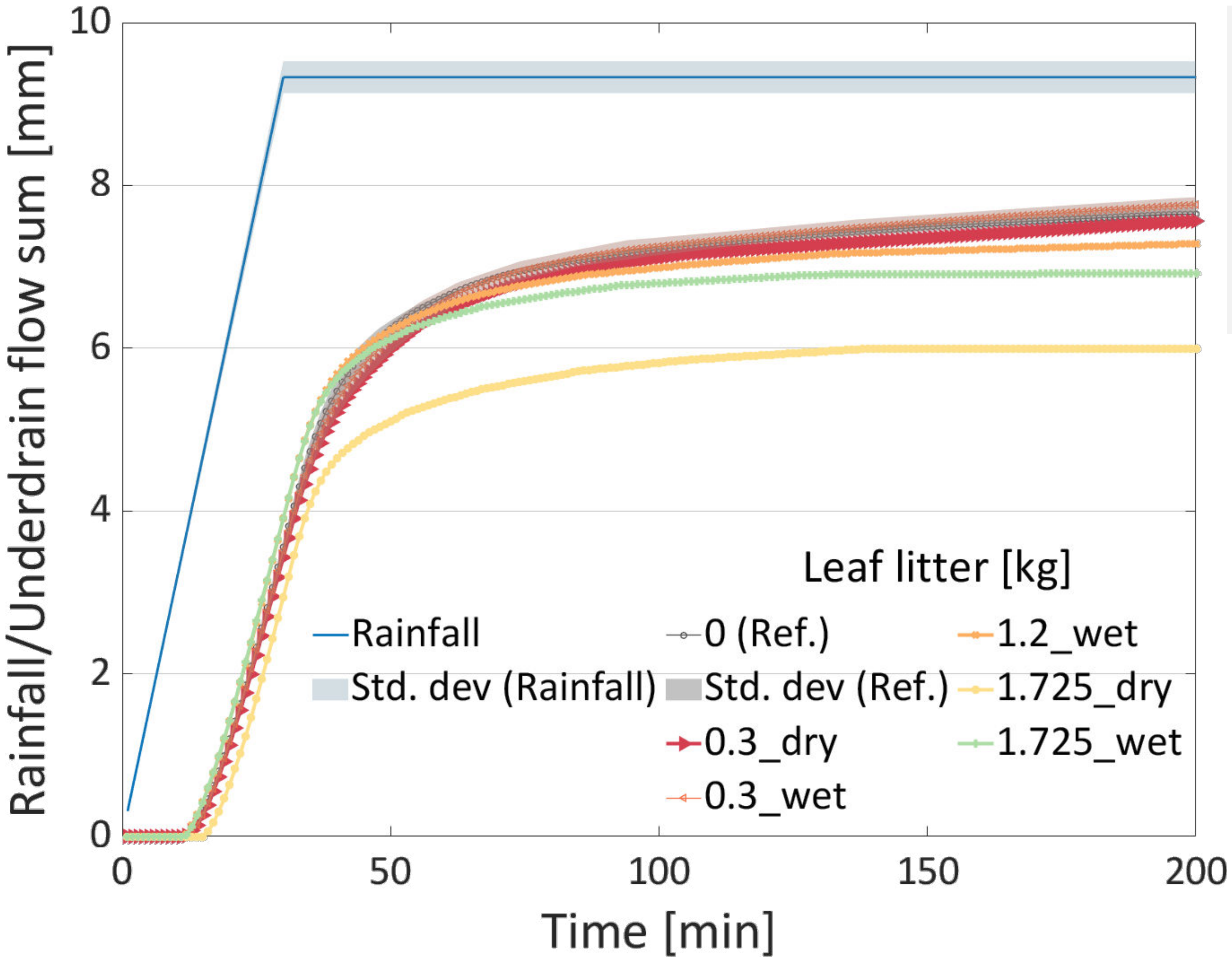


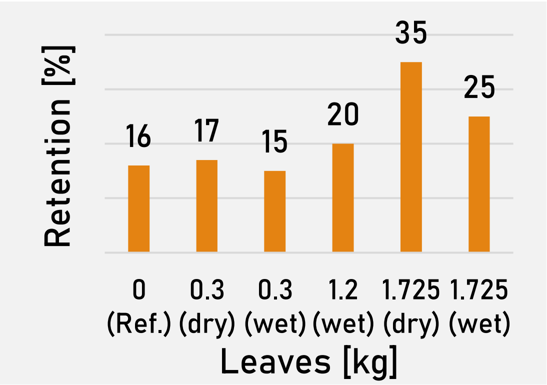


In another Box, we added different *amounts of leaf litter* and analysed the underdrain flow response

Incremental leaf litter
0.3 -1.725 kg (0.08 – 0.45 kg.m^{-2})

Leaves absorbed rainfall, increasing overall retention.





How does leaf litter and sand accumulation affect the BGI's water balance?

Underdrain flow was delayed and reduced; storage was increased

- Could pose waterlogging issues in the long-term
- Increased soil wetness could yield higher surface runoff after prolonged rainfall

Value of the experimental data

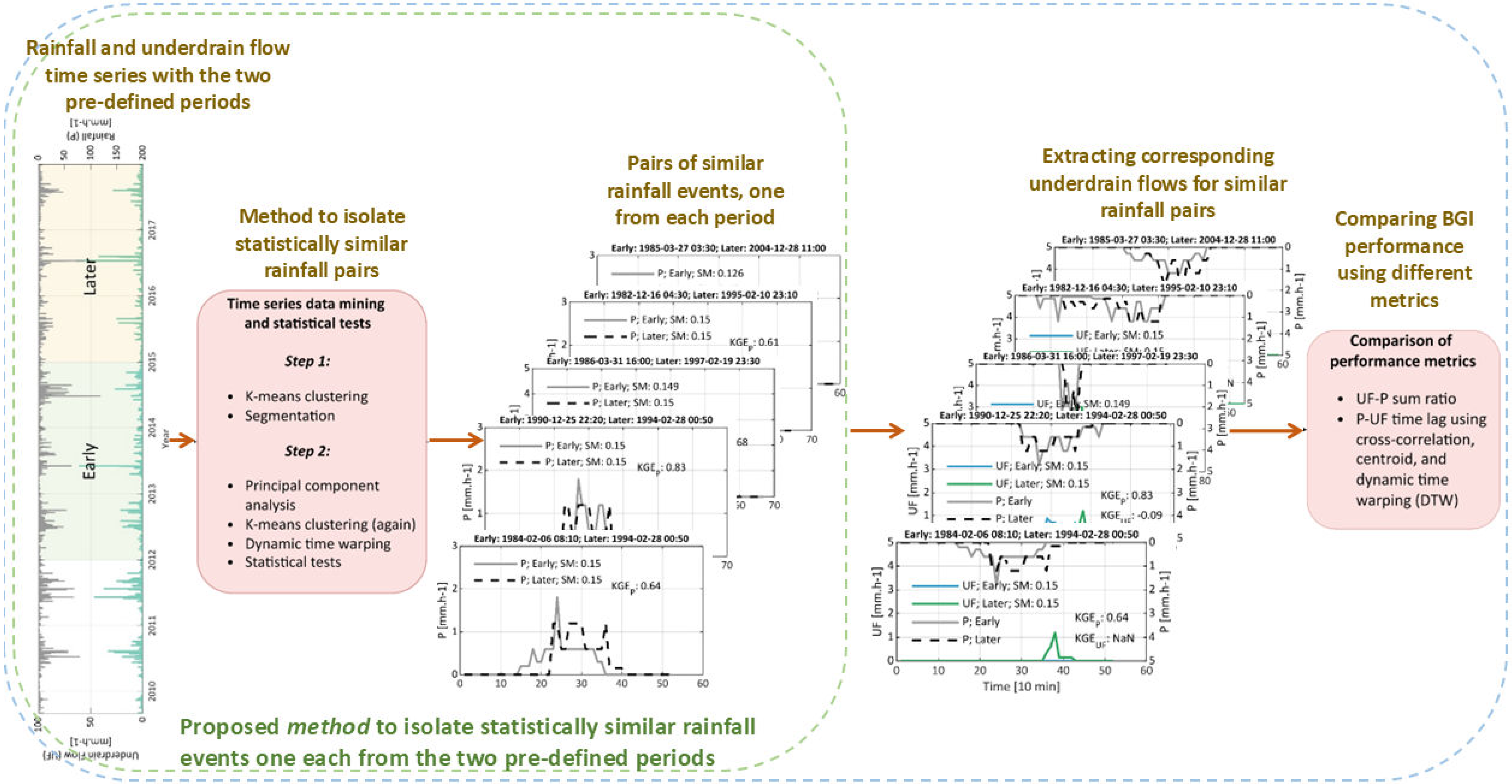
» Quantifies the effect of clogging and surface sealing on BGI performance

» Helps to understand the influence of shock events that bring high amounts of pollutant loads

» Supports validating models that simulate the influence of incremental sediment build-up

» Sheds light on the monitoring and maintenance requirements of BGI

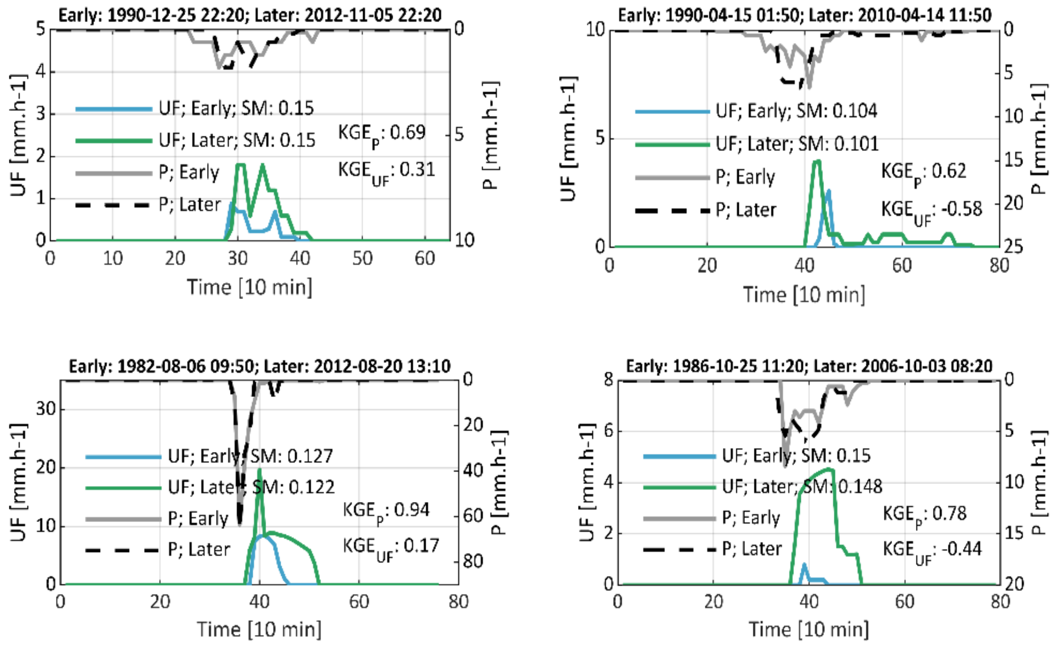
This experimental work led to other studies to emphasise monitoring and maintenance requirements of BGI

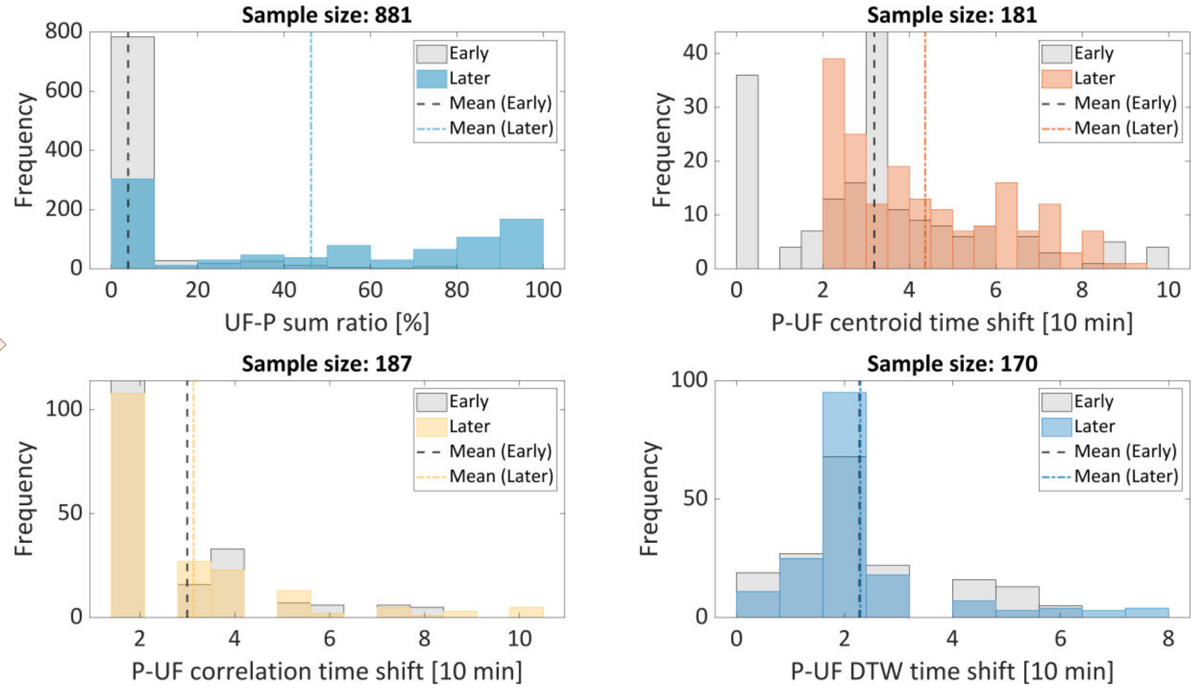


Workflow to analyse BGI hydrological performance over time

Joshi, P., Maurer, M. & Leitão, J.P. (in preparation). "Not evergreen? Exploring temporal dynamics in the hydrological performance of blue-green infrastructure (BGI)"

We isolated similar rainfall for different periods and compared the corresponding BGI performance





Conclusion

» Hydrological performance of green roofs under different maintenance scenarios were quantified using experiments

» Sand accumulation and leaf litter affected the water balance

- Slower underdrain flow onset time and lower volume
- May bring waterlogging issues in the long-term

» Results emphasise BGI monitoring and maintenance

For more details, please refer to this paper

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Data in Brief

Volume 59, April 2025, 111337

Data Article

Dataset on the impacts of sand and leaf litter on the hydrological performance of green roofs as surrogate for infiltration-based blue-green infrastructure (BGI)

Prabhat Joshi [a b], Juan Naves [c], Jose Anta [c], Max Maurer [a b], João P. Leitão [a b]

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