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— L'eau dans la ville | Urban water

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L'eau dans la ville | Urban water

Les terrasses agricoles urbaines et la réduction du ruissellement pluvial : un cas d'étude lyonnais

Urban cultivated terraces and rainfall runoff reduction: a case study in Lyon

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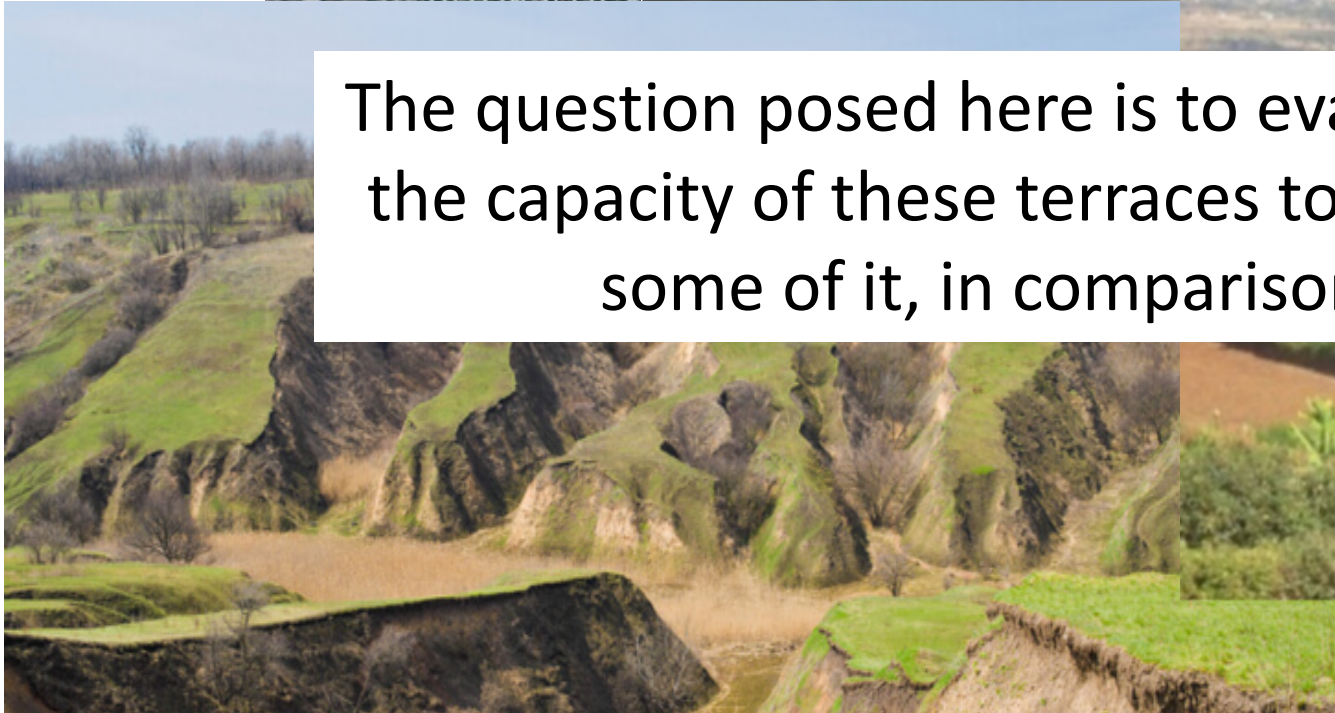
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Issues



The question posed here is to evaluate, in an urban environment, the capacity of these terraces to reduce runoff, but also to store some of it, in comparison with vegetated slopes.

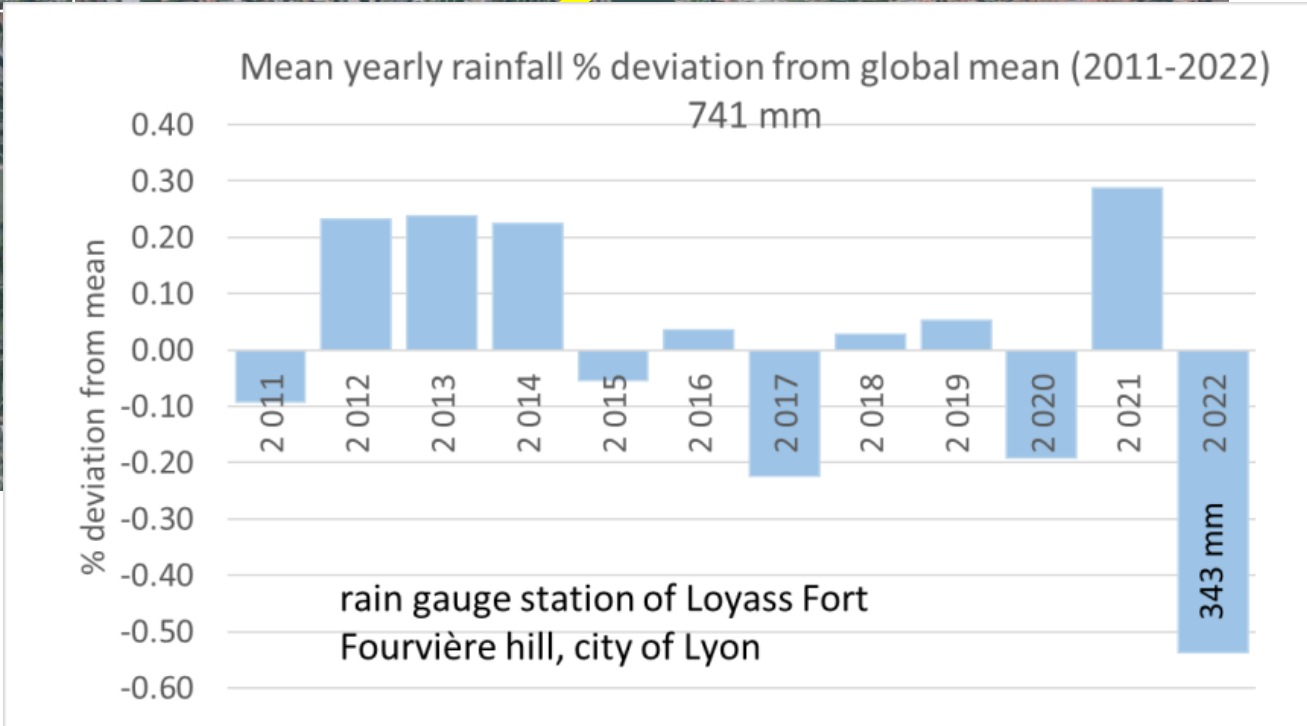
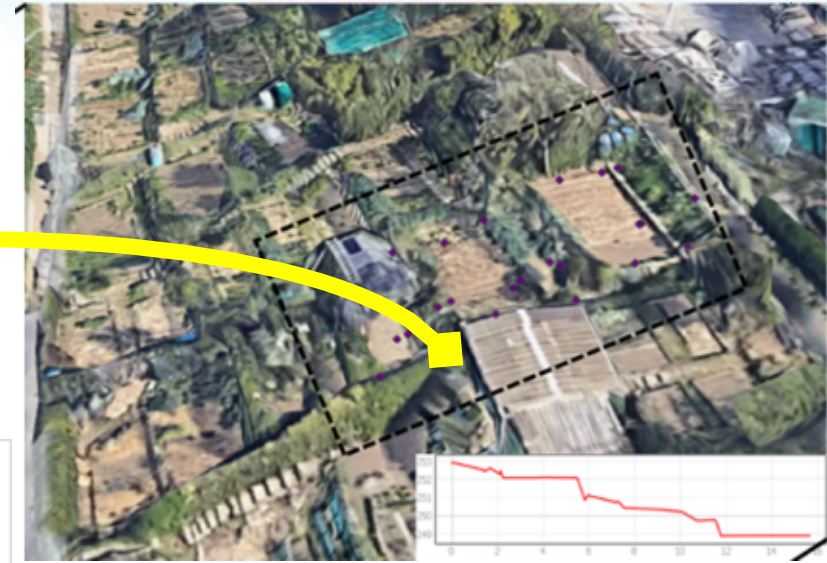
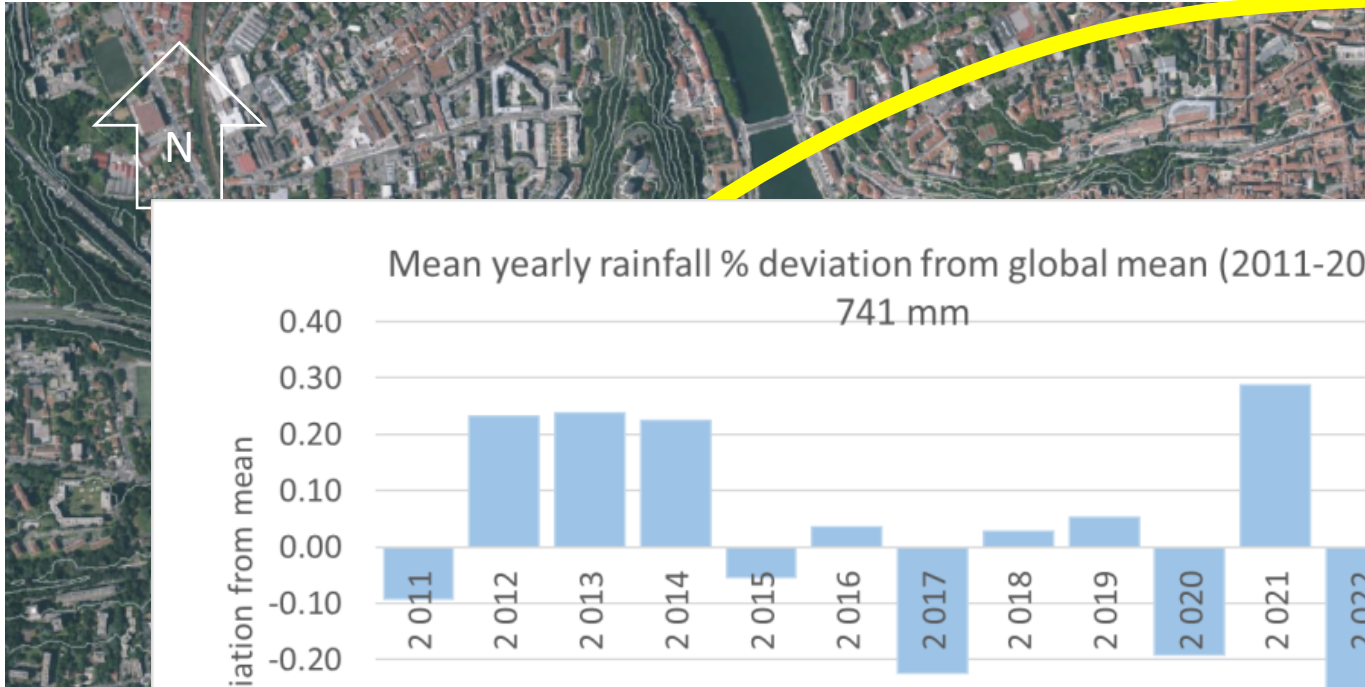


Adaptation

©Zero Hunger.

Study site location

The study area is located on the western slope of the Fourvière hill in the city of Lyon.



The instrumented plot covers an area of 38m² with an average altitude of 252m and a slope of 34%.

Soil characterization and data acquisition to calibrate and validate a soil hydrodynamics model Hydrus © 2/3D



Measurement of hydraulic conductivity at saturation



Topographic survey



Installation of soil moisture sensors



Soil sampling/Bulk density measurement

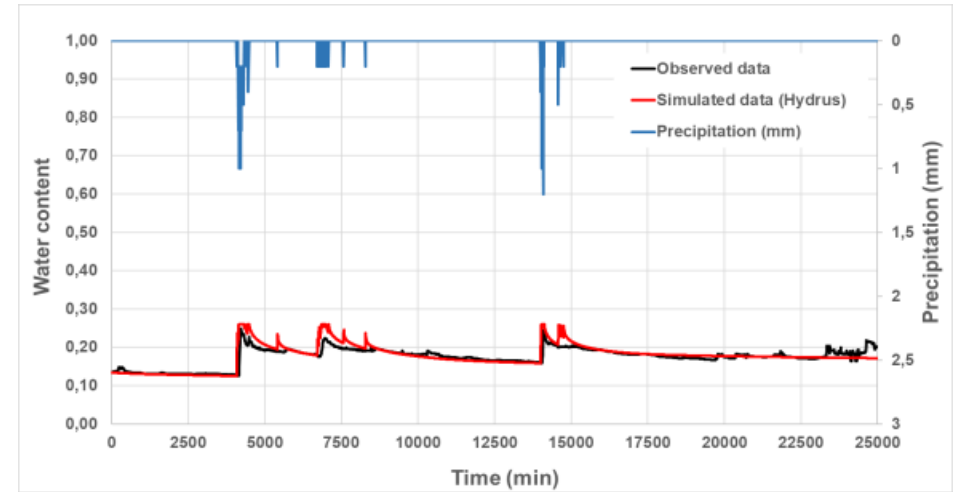


Calibration of soil moisture sensors

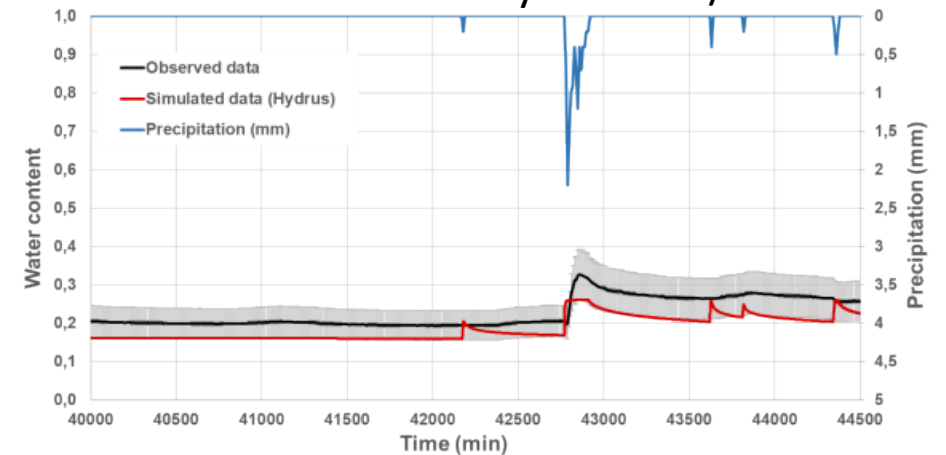


Automatic tipping bucket rain gauge.

Inverse model calibration Hydrus © 2/3D



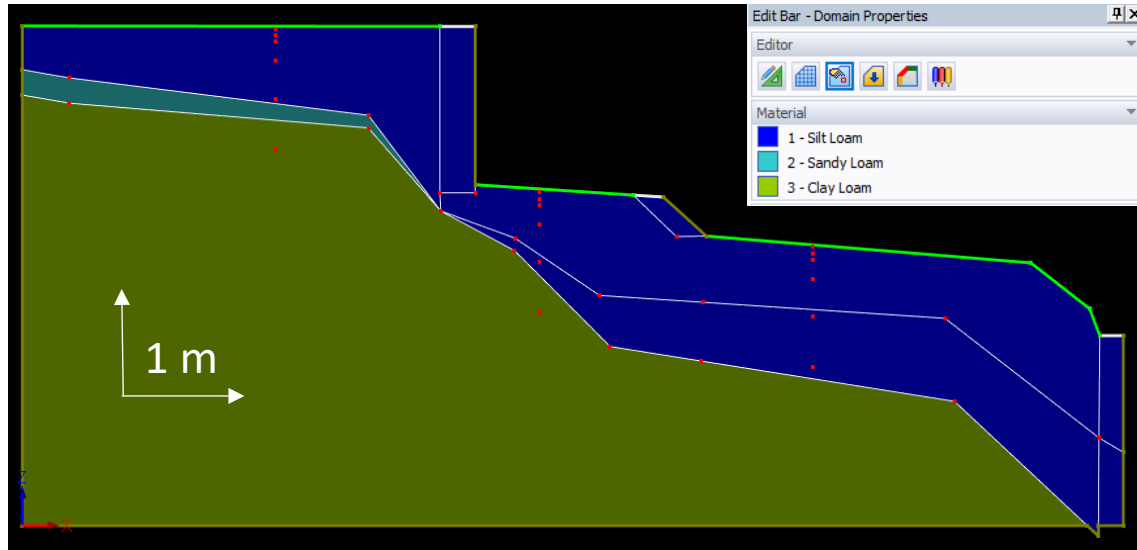
Model validation Hydrus © 2/3D



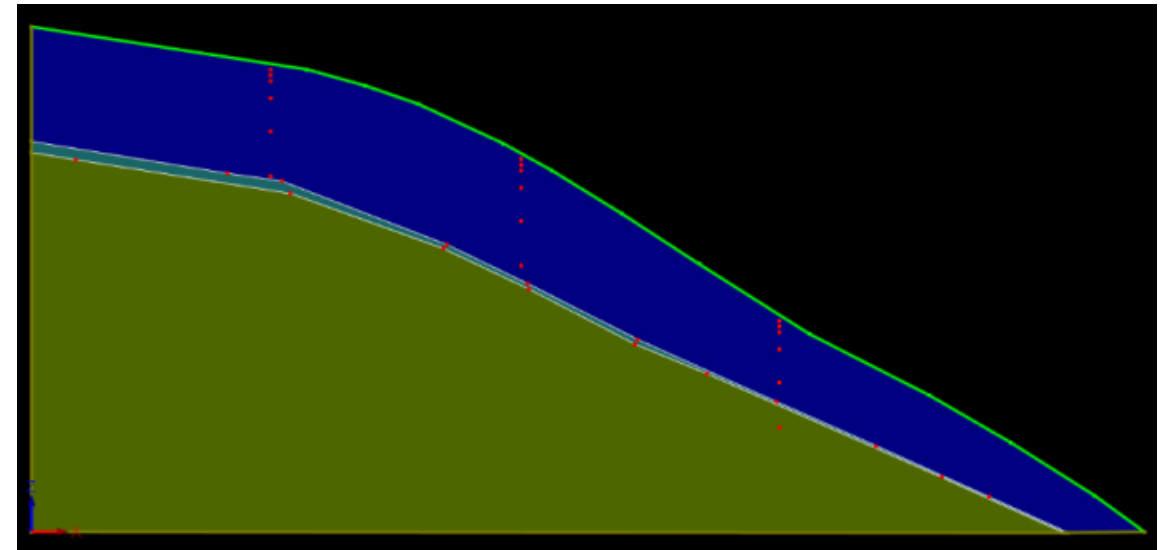
Using the validated model to simulate runoff on a slope with & without terraces



HYDRUS 2D/3D



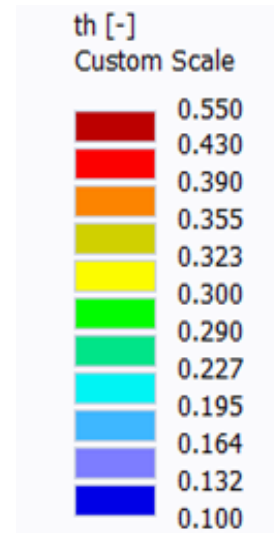
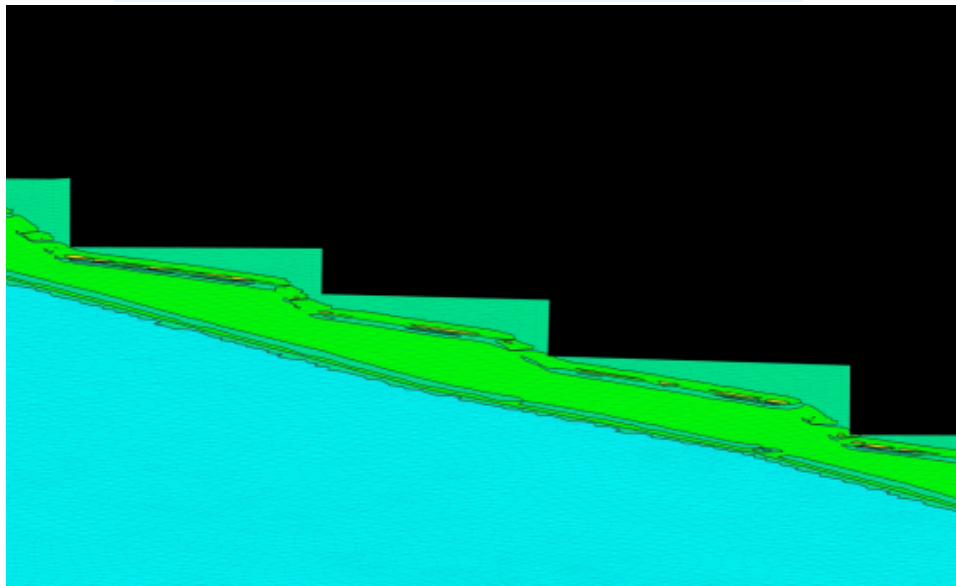
Digital model of the terraced slope



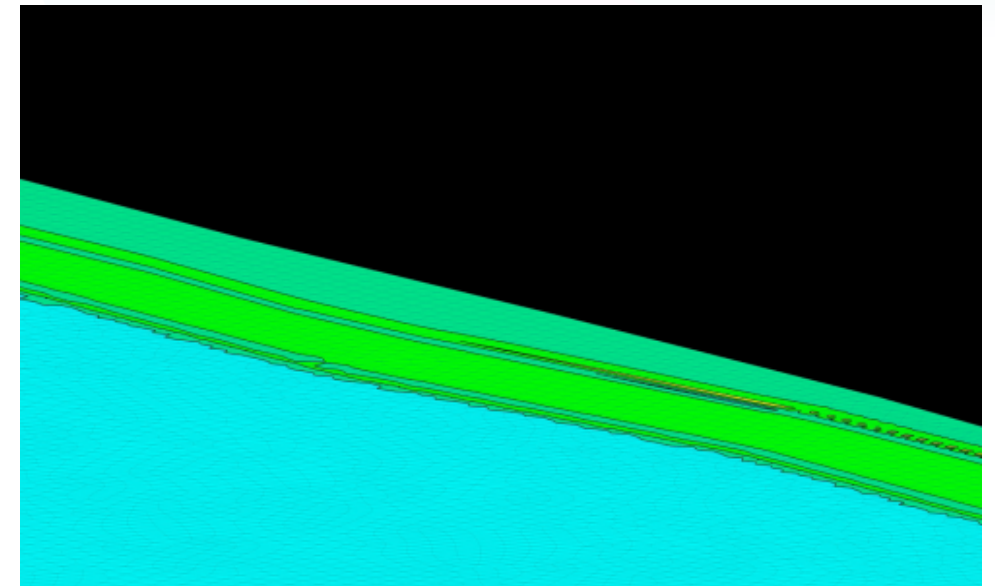
Digital model of the equivalent slope without terraces

Results-1

Extended model with terraces

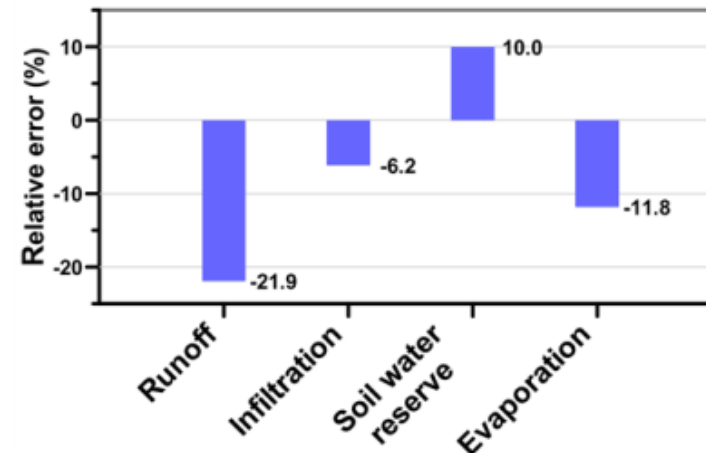


Extended model without terraces



- Annual balance in 2022 on the upper first meter of the 5 ha, after equilibration of the reservoirs by one year simulation.

Relative difference = $100 * (\text{terrace} - \text{hill}) / \text{terrace}$



The terraces :

- Reduced runoff by 22%
 - (approx. 1123 m³)
- Increase soil water storage by 10%
 - (approx. 2370 m³).

Result-2

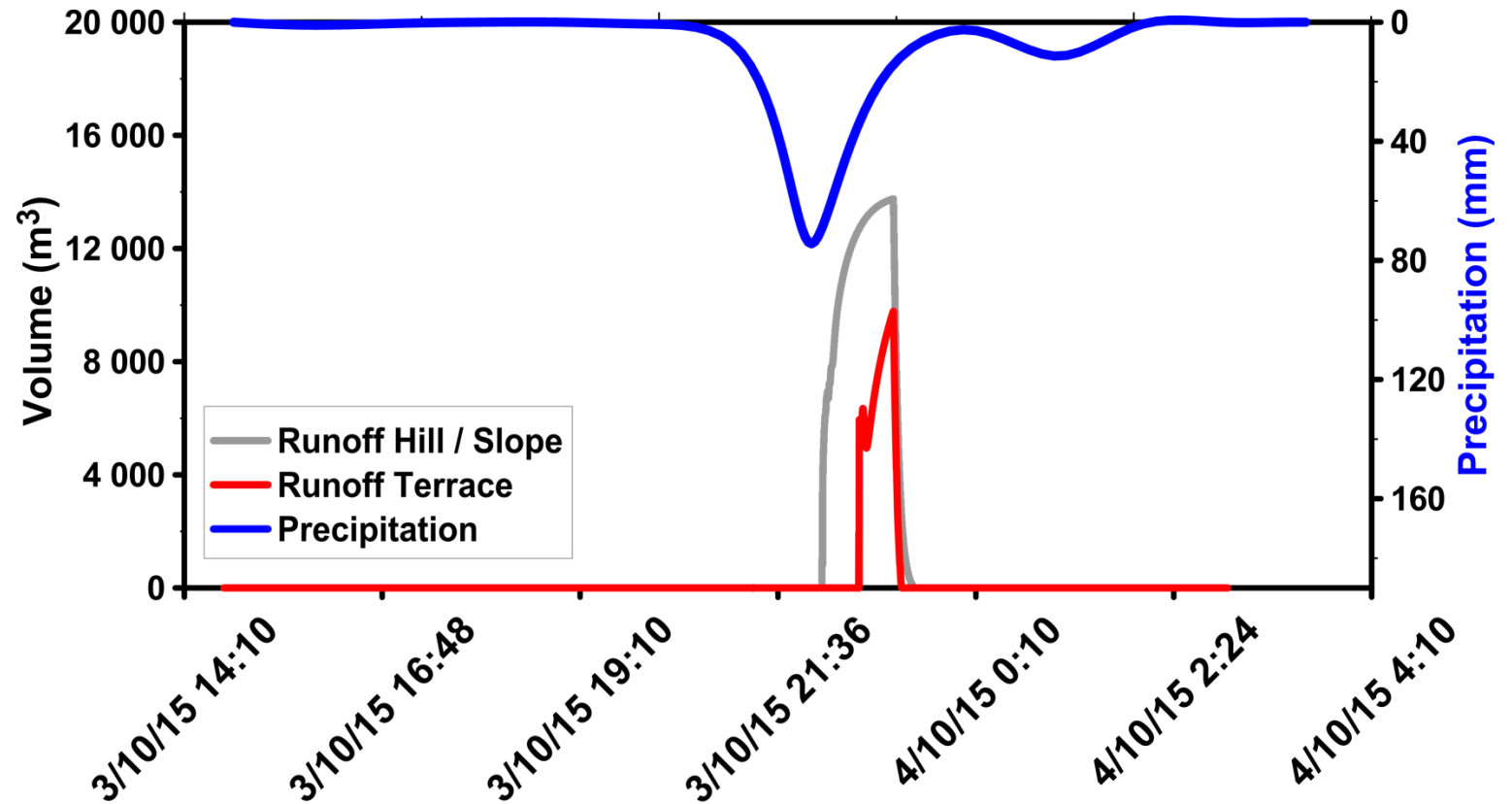
Simulation of a major rainfall event with a cumulative rainfall of 74mm in 1 hour, which corresponds to a 100-year rainfall in Lyon.

The simulation covers 5 ha of sloping with and without terraces.

The terraces made it possible to :

- Reduce total runoff by 75%.
- Reduce peak runoff by 30%.
- Delayed onset of runoff by 40 minutes.

→ The terraced surface simulated with Hydrus© produces a runoff volume of 583m³, compared with 2453m³ for an equivalent surface without a terrace.



Working tracks

- NDVI, NDMI and DeltaTr indices derived from satellite images show the important role of vegetation and terraces in:
 - Store part of the infiltrated water over a fairly long period;
 - Maintain a ground temperature 12% lower than in urban areas;
 - Contribute to biodiversity.
 - to be confirmed by field measurements
- The city of Lyon has a number of vegetated slopes.
 - An interesting example is the Rases wetland in the commune of Francheville. This valley receives (part of) the urban runoff from a 4 km² slope. Some head-of-slope meadows could be terraced to maintain humidity over longer periods. And this would reduce the loss of resources and the risk of flooding in the highly urbanized lower slopes.



In magenta: planted areas with slopes in the range of 10% to 50%.

Conclusion and outlook

- Simulations have confirmed the beneficial effects of terraces on water storage and runoff attenuation (intensity and duration).
- Terraces are not recognized structures in the strict sense of the term under French law, and their construction often includes other regulatory works such as raising, scouring and the construction of retaining walls.
- Economic costs of a retaining structure (estimation)
 - €381 per linear metre for a wall 1 m high
 - €7,000 for earthworks permit fees
 - € low cost for management and maintenance of structures
- Continue and extend research into the design of terraces (location, dimensions, waterproofing techniques, construction materials, etc.) to optimize their impact on water storage and runoff reduction.



Thank you for your attention and to...

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- To the partners of “Les Jardins de l'Eglantier”, who granted us access to the site.

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