Webinar “Beyond floods and droughts: from hydrological to socio-economical impacts of sponge measures”

Questions and Answers

Thursday 15 October 2026

Speakers:

- **Francesco Pagliacci, Associate Professor, University of Padua, Italy**
- **Ha Vu, International Institute for Applied Systems Analysis (IIASA)**

Questions for Francesco Pagliacci

1. In the drought resilience assessment of the water retention basin, are the values presented per farm or per hectare?

The water retention basin was built by one farmer on his own land, but the water stored for summer use benefits three farms, each with approximately 10 hectares of agricultural land. The estimated annual benefit of approximately €12,000 therefore represents the combined benefit to all three farms, covering approximately 30-35 hectares of farmland.
The assessment was based on information provided directly by farmers. They were asked to estimate the losses they avoided during a very dry period and a moderately dry period. These estimates were then combined and used to calculate the net present value of the benefit over a longer time horizon.

2. How were time and climate scenarios taken into account in this assessment?

Climate change scenarios were not explicitly considered in the assessment. The assessment is based on the most recent available data, which already reflect the effects of ongoing climate change, without assuming any specific future climate scenario.

3. Was any effort made to monetise the water quality benefit of the rain garden?

Not yet. Monetising this benefit would require a survey to assess citizens’ willingness to pay for improved water quality. Such a survey could be conducted, but it is currently beyond the scope of this part of the analysis.

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4. How were sponge measures incorporated into the FLO-2D PRO model?

The model was run by hydrologist colleagues, and sponge measures were assessed using the Low Impact Development (LID) tool available in FLO-2D PRO. Rather than modelling specific types of sponge measures, we focused on their hydrological function, particularly their capacity to retain or store stormwater. In other words, our approach aimed to determine the volume of water that needed to be retained within flood-prone zones to achieve a target flow depth and reduce flood risk.

To do so, we first identified flood-prone zones and selected potential areas for implementing sponge measures within each zone. The required storage volumes were then determined iteratively by adjusting the LID parameter controlling the volume of water retained in each computational grid cell until the mean maximum flow depth in the treated areas was reduced below a target threshold.

Since specific types of sponge measures were not explicitly modelled, we subsequently developed alternative scenarios showing how the required storage capacity could be provided through different measures, including retention basins, rain gardens, infiltration trenches, or combinations of these.

5. How detailed do the input data need to be to run the FLO-2D PRO model?

The level of detail required depends on the objectives of the analysis, the spatial scale, and the desired accuracy of the results. FLO-2D PRO does not require a single fixed spatial resolution and can be run using datasets of different resolutions. However, the input data should be sufficiently detailed to represent the relevant hydrological processes and terrain characteristics. Coarser datasets may be suitable for broader-scale assessments, while higher-resolution data are generally needed for local-scale flood modelling, particularly in urban areas where small topographic variations can significantly influence flow paths and water accumulation.

The main inputs include topographic data to represent the terrain and surface flow paths, land-use and soil characteristics to estimate runoff generation and surface roughness, and rainfall data to define precipitation events. The required spatial and temporal resolution of these inputs depends on the characteristics of the study area and the processes being simulated.

For our case study, we used a high-resolution Digital Terrain Model (DTM) with a spatial resolution of 1 m, together with land-use data, building footprints, and rainfall records to simulate pluvial flooding under different return periods. This level of detail was particularly useful for identifying localized flooding and potential areas for implementing sponge measures. However, a 1 m DTM is not a general requirement for running FLO-2D PRO.

For further technical details on input-data requirements, spatial resolution, and model setup, please refer to the official FLO-2D PRO Data Input Manual and FLO-2D PRO Documentation.

Questions for Ha Vu

6. Could you share the link to the study presented?

Link to the study: https://doi.org/10.5194/gmd-18-7987-2025

7. Is there a publication describing the full methodology of the empirical approach?

We're building the empirical study from scratch, it is only halfway through now, but we do aim for a published work, so we hope to be able to share it with you in the future.

8. Do you aim to produce an average or rough estimate of the benefits (in euros) of sponge measures across the three SpongeWorks demo sites (the Netherlands, France and Greece)?

No. Each basin faces different problems, so different measures are implemented in each of them. Some measures overlap, but they are not consistently the same across the basins.
An average in euros would not be meaningful either, because costs such as labour differ from one country to another: the investment cost of the same measure is not the same in the Netherlands as in Greece.

9. The ECHO analysis relies on calibrated assumptions about farmer behaviour. What are these assumptions, how are they defined, and do they differ depending on the area studied?

ECHO is an economic optimization framework maximizing the net present value of net benefits of water using sectors. In the agricultural sector net benefits are composed of the benefits from crop production (i.e. revenue) minus its costs. Costs include production costs and water costs.
A crucial assumption is therefore the standard profit maximization of farmers, as commonly assumed in most economic models. This assumption hinges on rational behaviour of farmers, acting to their best economic interest. Mathematically benefit maximization means that marginal costs of any additional unit of agricultural production must equal marginal benefits gained from its production. Through integrating further benefits beyond only revenues from crop sales, the aggregated societal benefits can reflect ecosystem services and other non-monetary benefits that are often not directly assessed by farmers.
Costs and benefits are parameterized with local data in each geographical area of application. For example, datasets for crop production costs for various production systems differ between all river basins where the framework is applied. To ensure the model reproduces the crop areas and yields observed locally, it is calibrated using Positive Mathematical Programming (PMP). PMP anchors agricultural benefits in these observed yields and lets yields decline as a crop expands onto less suitable land, so each additional hectare adds less than the one before.
The modeling framework also offers a certain degree of flexibility that allows modelers to incorporate the most relevant components such as site-specific valuations of ecosystem services as benefits.
A technical description of the ECHO framework's agricultural net benefits can be found in Kahil et al. (2025) chapter 2.2.7.

Questions for both speakers

10. How robust is the science on the carbon sequestration effect of sponge measures?

Francesco Pagliacci: The literature on this topic is vast and well consolidated, but the effect depends strongly on the measure and the site. Therefore, I would describe carbon sequestration as a potential co-benefit whose magnitude requires site-specific assessment.

Ha Vu: Not very robust with our current approach for the application in SpongeWorks. We mainly rely on benefit transfer and external publicly available model such as InVEST. At the current stage, we're only focusing on estimating the carbon impact of SpongeFutures, which are simulation of various land-use scenarios. To study the carbon sequestration impact of Sponge measures robustly will require ex-post monitoring data.

11. Can sponge measures also affect other greenhouse gases, such as nitrous oxide and methane, either positively or negatively?

Francesco Pagliacci: Yes. Changing soil moisture and oxygen availability can affect both gases. Methane can increase in waterlogged, oxygen-poor conditions, such as wetlands and ponds. Nitrous oxide can either increase or decrease. The key implication is that carbon storage alone does not establish the climate benefit. Different gases must be assessed together.

12. How transferable are these sponge measures and assessment frameworks to contrasting hydroclimatic zones, such as monsoon-dominated catchments or arid regions in Asia and Africa? Is an initial regional baseline study essential to calibrate local soil-water dynamics before adapting these strategies?

Francesco Pagliacci: Sponge measures and their assessment frameworks can be adapted to different hydroclimatic zones, but their transfer requires local calibration. Sponge measures and nature-based solutions are highly place-specific: because they mimic natural processes, an initial assessment is essential to understand rainfall patterns, soil characteristics, water availability and local socio-economic conditions. There is hardly any one-size-fits-all solution. Measures suited to monsoon-dominated catchments may need substantial adjustment for arid regions, where water dynamics and management priorities differ. Projects spanning a diverse range of case studies with different characteristics are therefore particularly valuable: they help local stakeholders identify feasible options and adapt them to their own contexts.

Ha Vu: This is also why both SpongeScapes and SpongeWorks work with many different demo basins and sites. Landscapes vary widely from one location to another, and each faces its own challenges, so different measures need to be tested in different places. There is no one-size-fits-all solution.

13. What are the main barriers and enablers to carrying out more of these types of assessments beyond the SpongeWorks and SpongeScapes projects?

Francesco Pagliacci: The main barriers include limited local data, a lack of scientific expertise, and insufficient funding for monitoring and assessment. Capturing the full range of benefits is also challenging, particularly for those benefits such as biodiversity, water quality, and social well-being, which are harder to express in monetary terms.

Key enablers include accessible assessment methods, long-term monitoring and collaboration among researchers, public authorities, and local stakeholders. Building capacity and embedding assessment in routine planning and funding decisions can help sustain this work beyond individual projects. Sharing methods and lessons across case studies can also make future assessment easier to carry out, while allowing for adaptations to local conditions.