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# Taming Floods Naturally: Leaky Barriers and Digital Twins in the Pipp Brook Catchment

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# Natural Flood Management (NFM)

Set of techniques that mimic natural landscape processes with the aim to:

- Slow down the rainfall runoff
- Increase the runoff storage in the catchment
- Enhance runoff infiltration

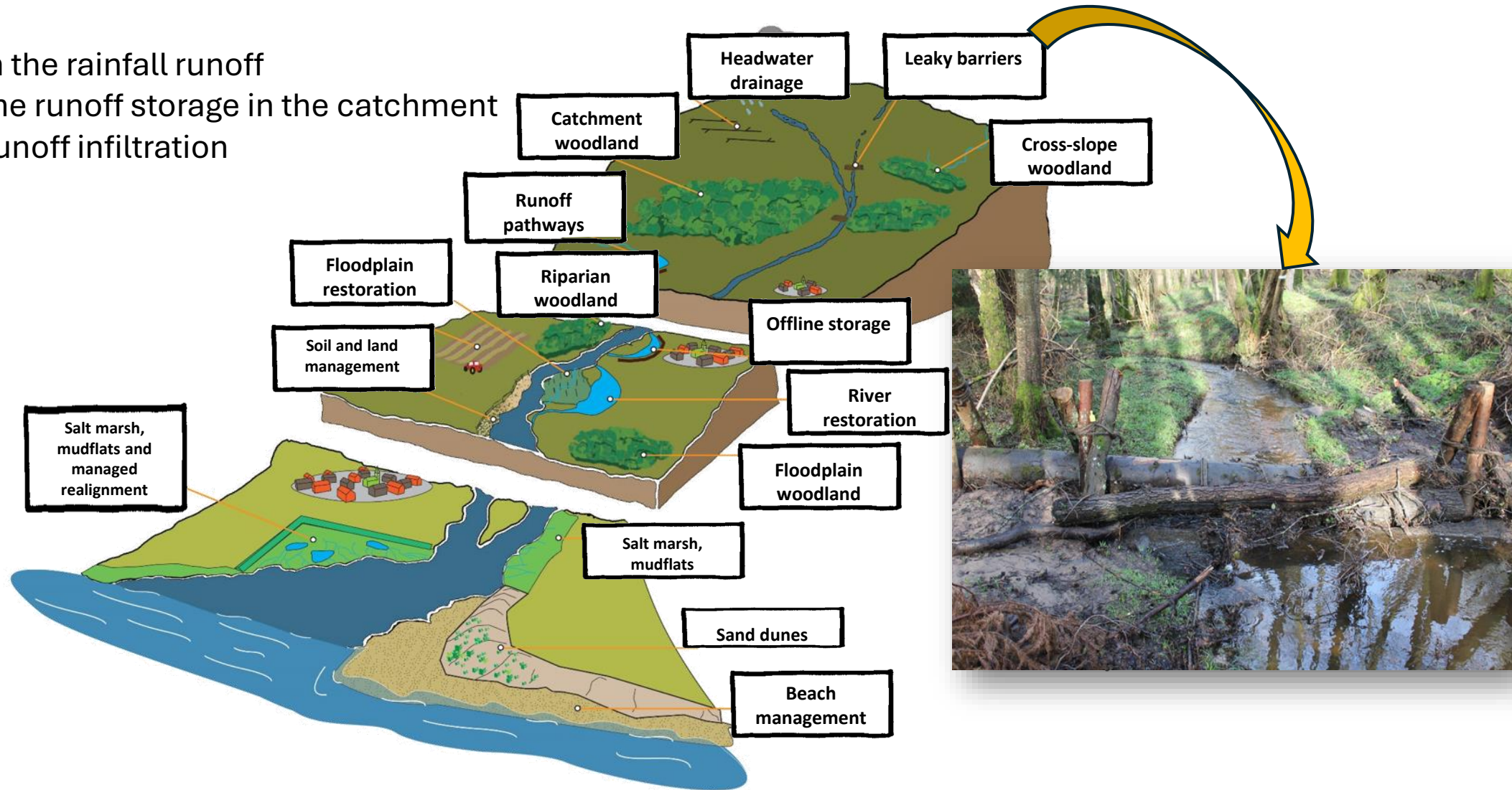


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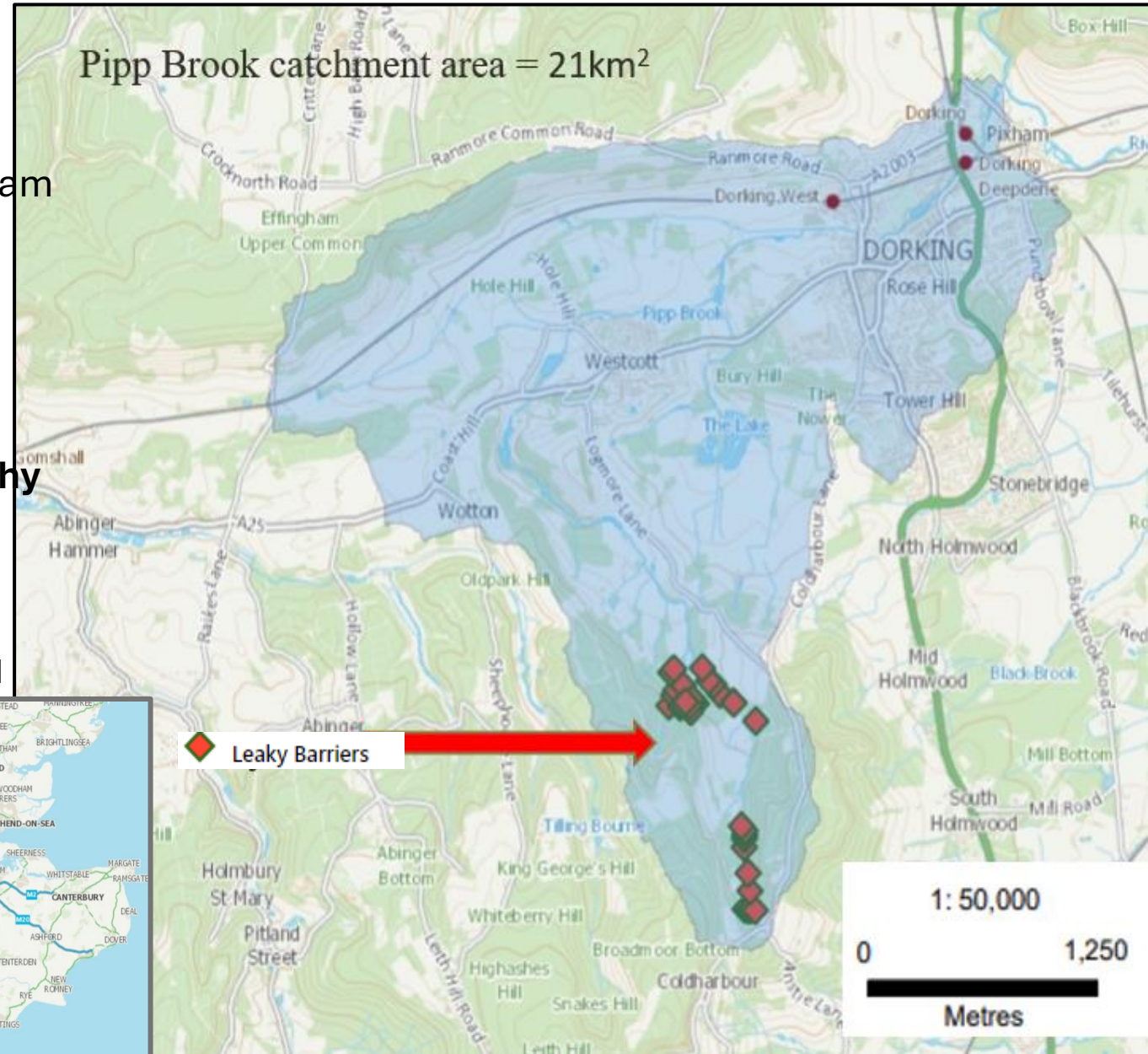
<https://www.gov.uk/government/publications/working-with-natural-processes-to-reduce-flood-risk>

# The Pipp Brook: catchment context

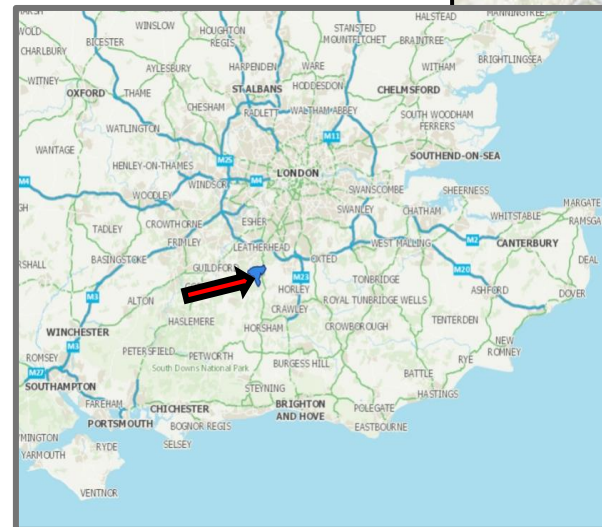
- The **Pipp Brook** is a tributary of the River Mole, upstream of the flood-vulnerable city of Dorking.

- Its catchment is:

- about 21 km<sup>2</sup>
- mainly covered by woodland and farmland
- relatively steep, prone to **rapid runoff and flashy flows**.



## Location in SE England



The steepness & land use of the Pipp Brook makes it a good candidate for NFM

# 30 leaky barriers at the Pipp Brook

As part of the first set of **NFM pilot projects** funded by the UK Government, the **Environment Agency** installed **30 leaky barriers** at the upper Pipp Brook in 2019.



The EA and the **University of Surrey** have **monitored** heavily the hydrometry of the catchment and hydraulic functioning of the leaky barriers to assess their flood attenuation impact.

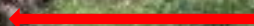


# Continuous monitoring of the leaky barriers since 2019

Fixed point photography  
(day & night)



Leaky Barrier



Direction of flow



River level gauging  
equipment



Leaky Barrier

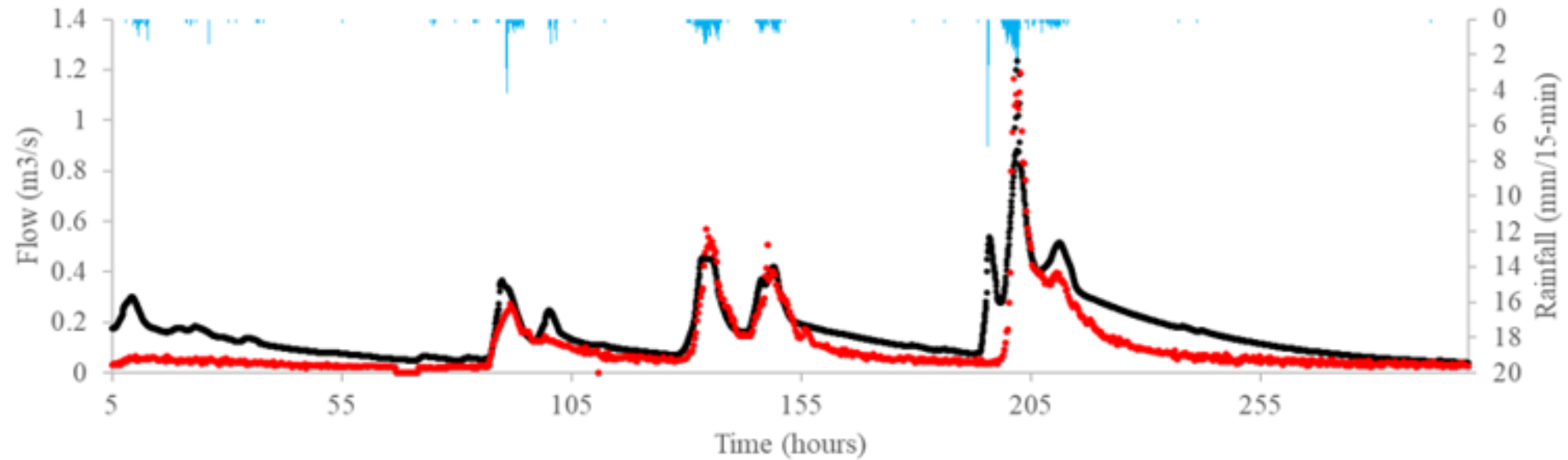


Direction of flow

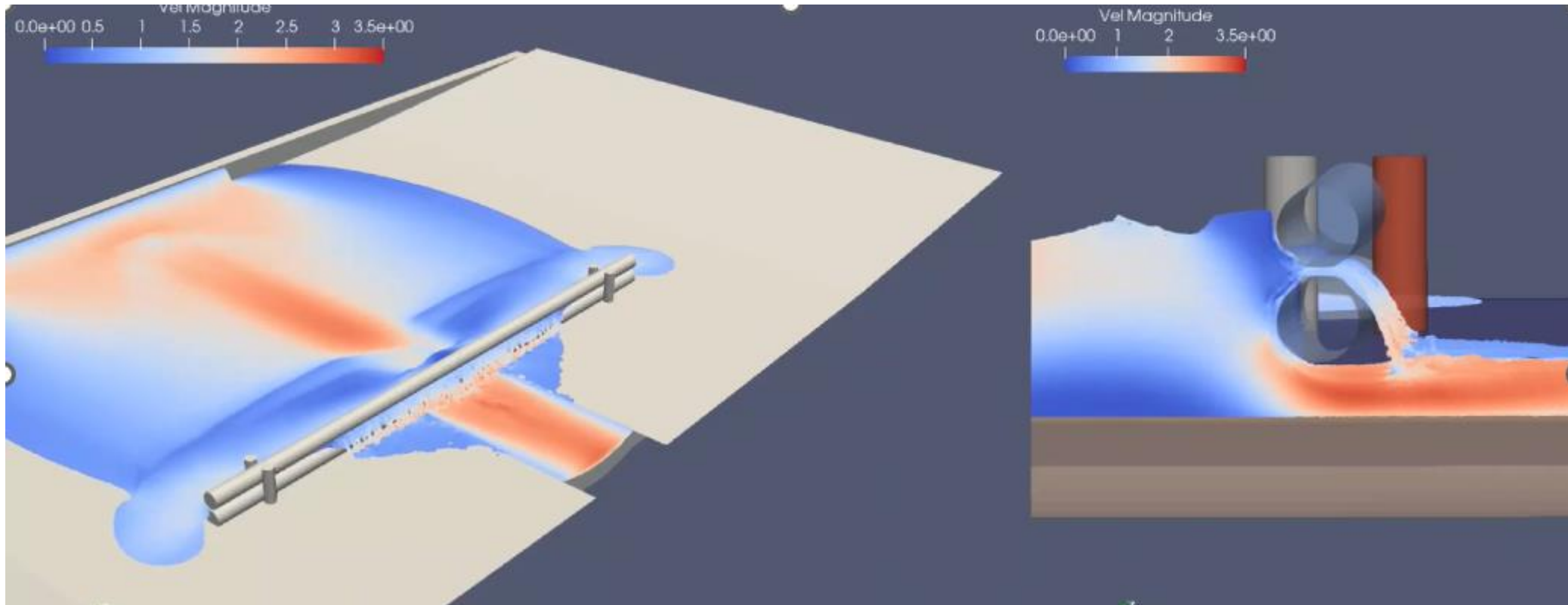


# Monitoring of the leaky barriers from 2019

Time series of rainfall, water depth and flow discharge **BEFORE** and **AFTER** the installation of LBs

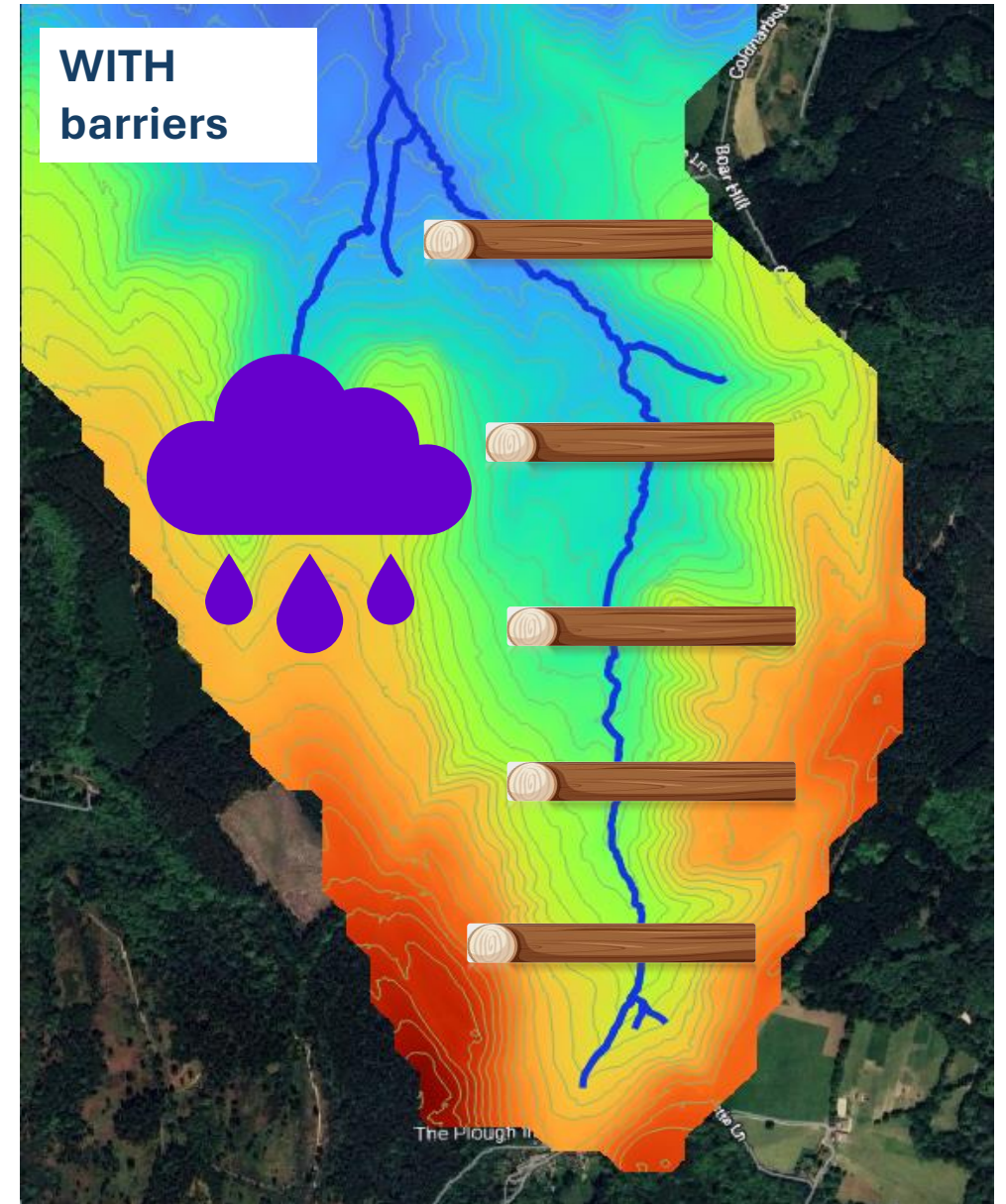
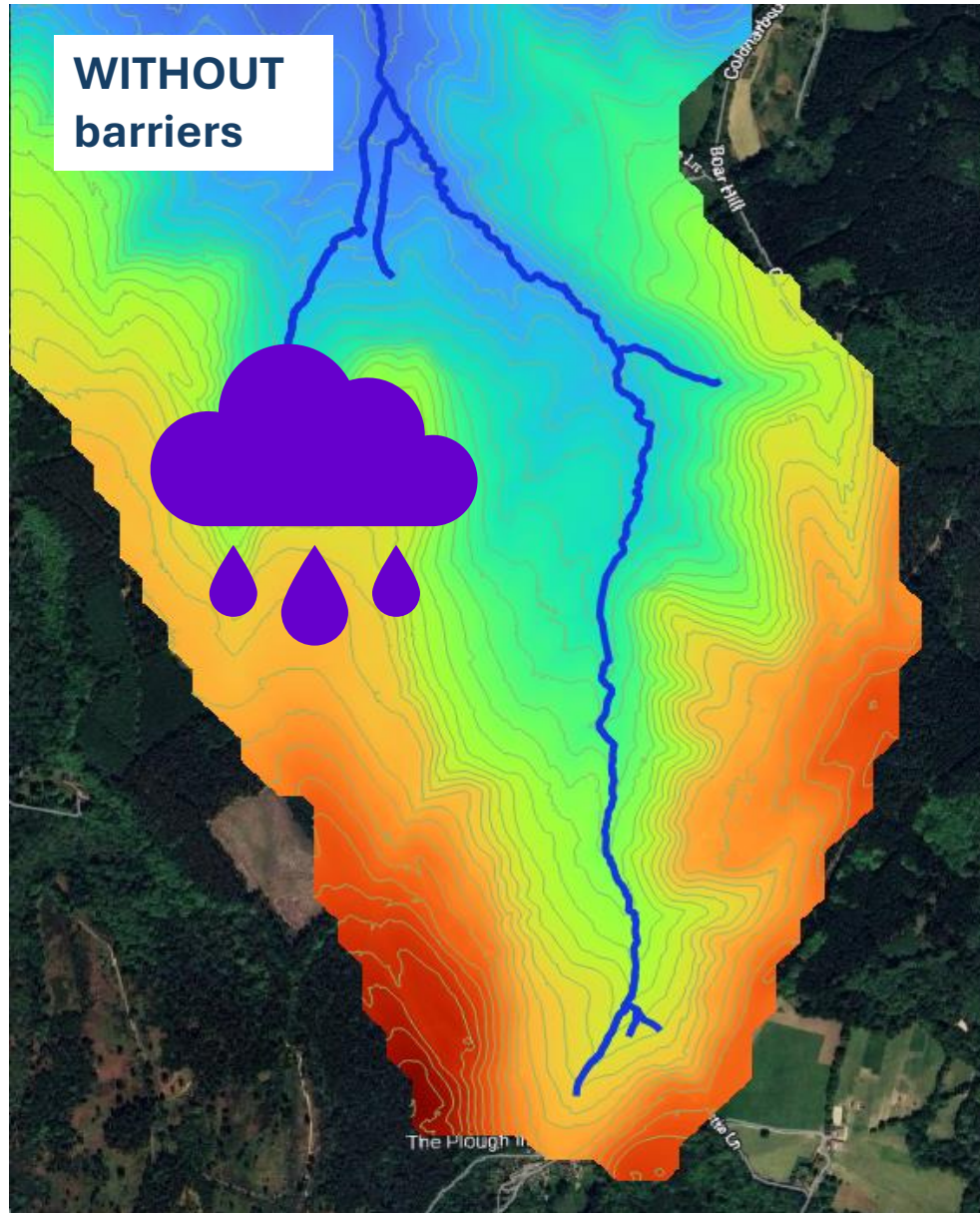


Digital twins of the upper Pipp Brook were built: **WITH** and **WITHOUT** barriers  
They were calibrated and validated with measured time series



Sample SPH model of a leaky barrier

Different return period rainfall events were simulated in the models **WITH** and **WITHOUT** barriers, to assess their effect



# How effective are the leaky barriers at flood mitigation?

## How is flow discharge attenuated at the downstream end of the scheme?



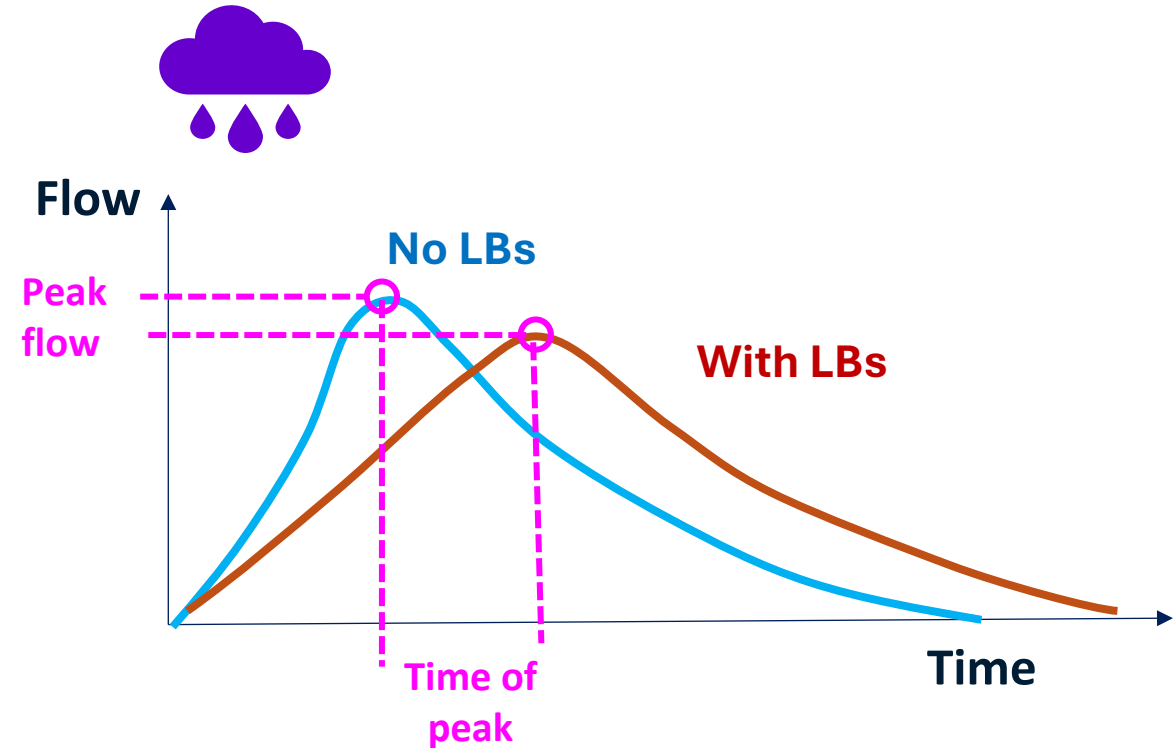
For low **return periods of up to 5 years**, the leaky barriers cause:

- **modest reduction in peak flow** (up to 4% reduction)
- **significant delay in the timing of the peak** (up to 15 minutes over 3 hours)



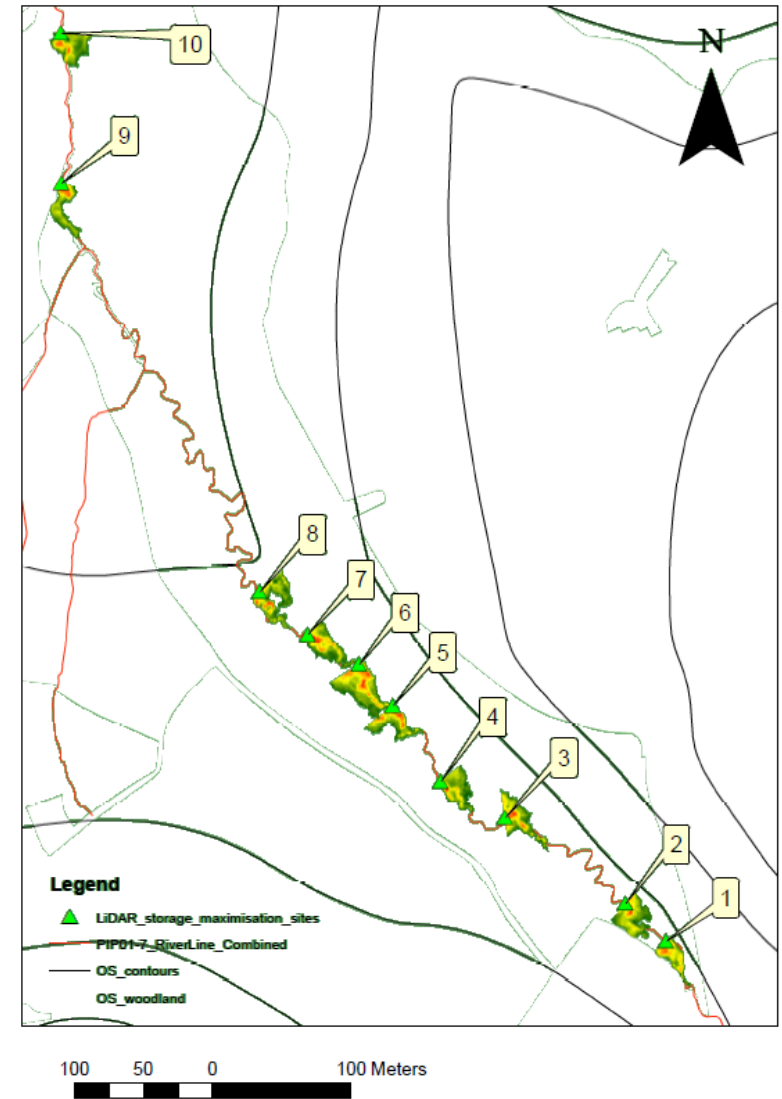
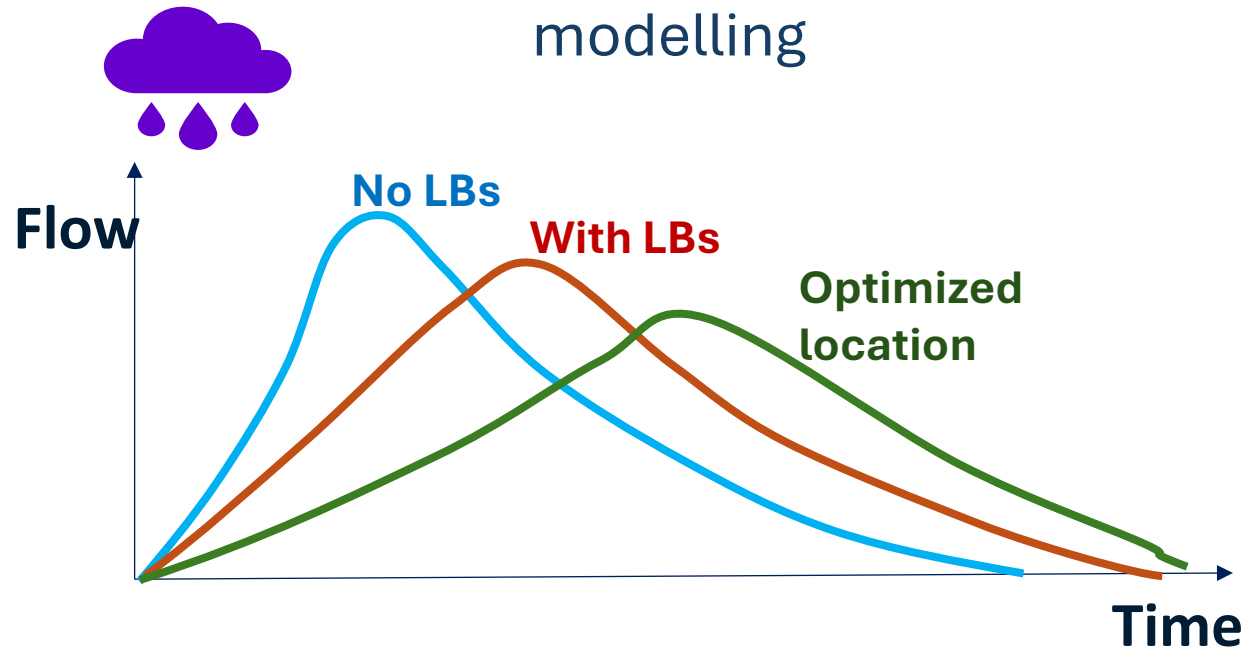
For **return periods of 10 to 50 years**, the leaky barriers cause:

- **negligible reduction in peak flow**
- **modest delay in the timing of the peak** (up to 5 minutes over 3 hours)



# Can we increase flood mitigation effect by optimizing the barrier location?

**Yes.** Significant improvement by optimizing their location through modelling



Further details at PhD dissertation: *LEAKY BARRIERS FOR NATURAL FLOOD RISK MANAGEMENT- MODELLING THEIR EFFECTIVENESS TO INFORM PRACTICE* by Benjamin Richard Tonkin.  
Supervised by B. Marti-Cardona, S. Hughes

Thank you for your attention

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