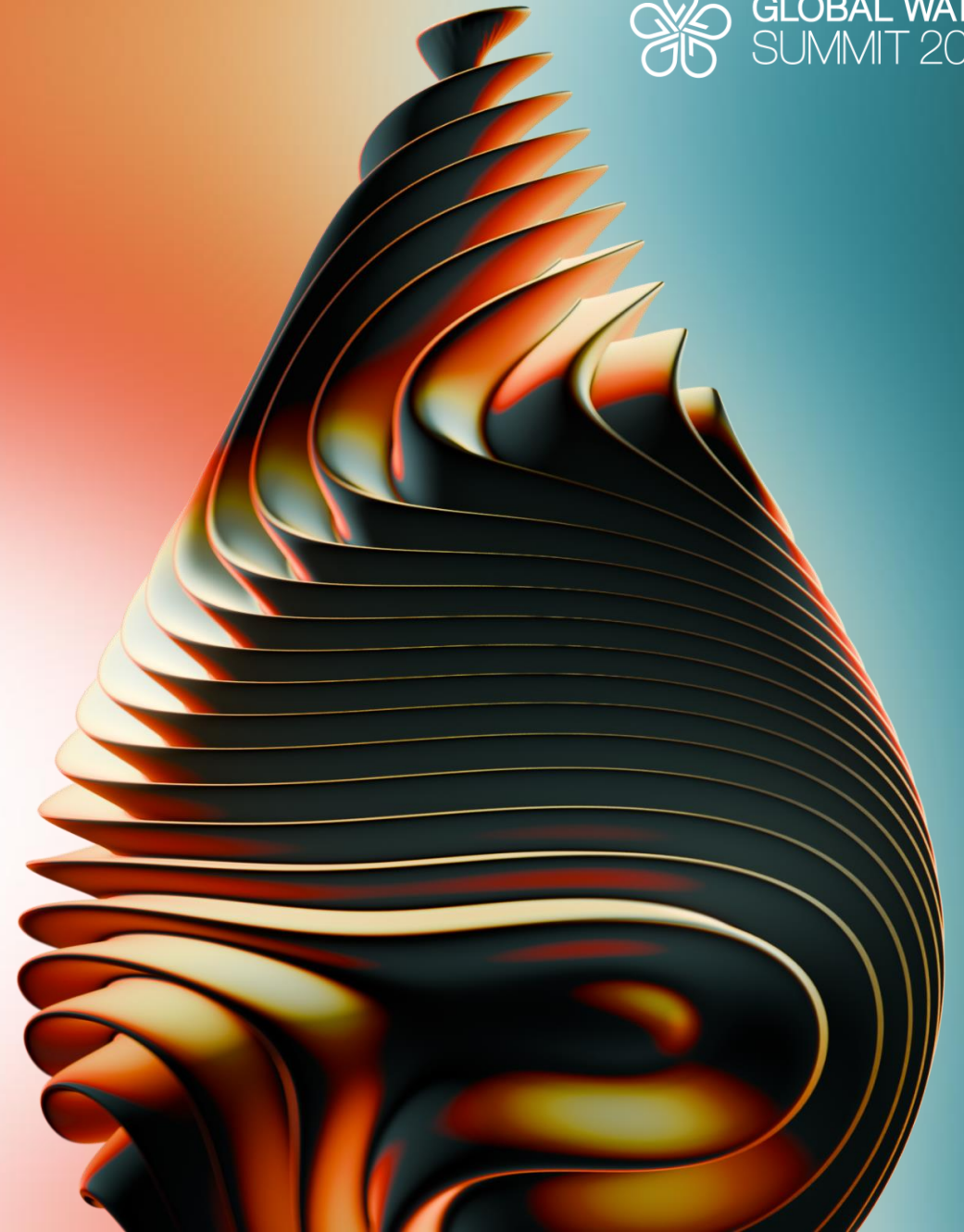




# Delivering the Water Transition: Sponge Cities

18 – 20 May | Madrid, Spain



# Sponge Cities

From ideas to implementation for urban water resilience

Presenters

18 May 2026

Joe Shuttleworth, Arup  
Almudena Barona, Arup

# Agenda

- 1) **Why Sponge Cities now?**
- 2) **Sponge Cities in practice**
- 3) **Panel: Practical barriers to delivering Sponge Cities**
- 4) **Arup Sponge Cities 2.0**
- 5) **Final Remarks and Questions**

# Why Sponge Cities now?

# Why 'Sponge Cities'?

## A simple concept to address a complex challenge

As global water challenges come closer to home, the 'sponge' city concept has captured imaginations and raised awareness, particularly in relation to 'too much' water...

**How can 'sponge cities' use nature to tackle climate-fuelled floods?**  
 by Kim Harrisberg | @KimHarrisberg | Thomson Reuters Foundation  
 Thursday, 24 March 2022 08:33 GMT

**Relevant people**  
 TRF Climate @TRF\_Climate

**What's happening**  
 War in Ukraine · LIVE  
 Peace talks with Russia set to begin on Tuesday as the war continues in Ukraine

**#nextGeneasylet**  
 Discover the next generation of travel with easyJet  
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**Los Angeles Times** · Yesterday  
 Will Smith stepped Chris Rock at the Oscars and people have a lot to say about it

**British Vogue** · March 27, 2022  
 And The Oscar For The Best Dressed Goes To...

**Politics** · Trending  
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**ABOUT OUR SERIES COVERAGE**  
 We examine how cities are reshaping the way people live.

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 Coal to crypto: The gold rush bringing bitcoin miners to Kentucky  
 'Invisible' solution to water shortages lies beneath our feet  
 Egypt erects sand barriers as rising sea swallows the Nile Delta  
 Ukraine war shatters HIV clinics, disrupts drug supplies  
 Ukraine crisis forces world to...

**What are 'sponge cities'?**  
 The term 'sponge cities' is used to describe urban areas with abundant natural areas such as trees, lakes and parks or other good design intended to absorb rain and prevent flooding.  
 Interest in harnessing nature - or using 'nature-based solutions' - to tackle climate shocks has grown in popularity in recent years.  
 Cities as diverse as **Shanghai, New York and Cardiff** are embracing their 'sponginess' through inner-city gardens, improved river drainage and plant-edged sidewalks.

Mar 22, 2022, 05:14am EDT | 421 views

### How Nature Can Help Make Our Cities More Resilient To Flooding

**Jamie Hallstone** Contributor  
 Sustainability  
 I write about air quality and the environment.

[Listen to article](#) 5 minutes

TOPSHOT - People make their way down partially flooded roads following the passage of Hurricane ... [-] APP VIA GETTY IMAGES

It seems that barely a month goes by without a new study warning us that freak weather events are set to become the "new normal".

In February, the Intergovernmental Panel on Climate Change (IPCC) warned in a new report that the world is already facing "unavoidable climate hazards" over the next two decades, including heatwaves, droughts and floods.

**Thread**

**TRF Climate** @TRF\_Climate

Do you live in a spongy city?

As climate change increases flood risks, cities need to be designed like giant sponges that allow water to drain away safely, researchers say.

A study ranked seven major cities on their 'sponginess'. Is yours on the list? 🇺🇸🇯🇵

3:25 PM - Mar 24, 2022 - Twitter Web App

67 Retweets 11 Quote Tweets 97 Likes

# What is a 'sponge city'?

## Addressing the whole water cycle

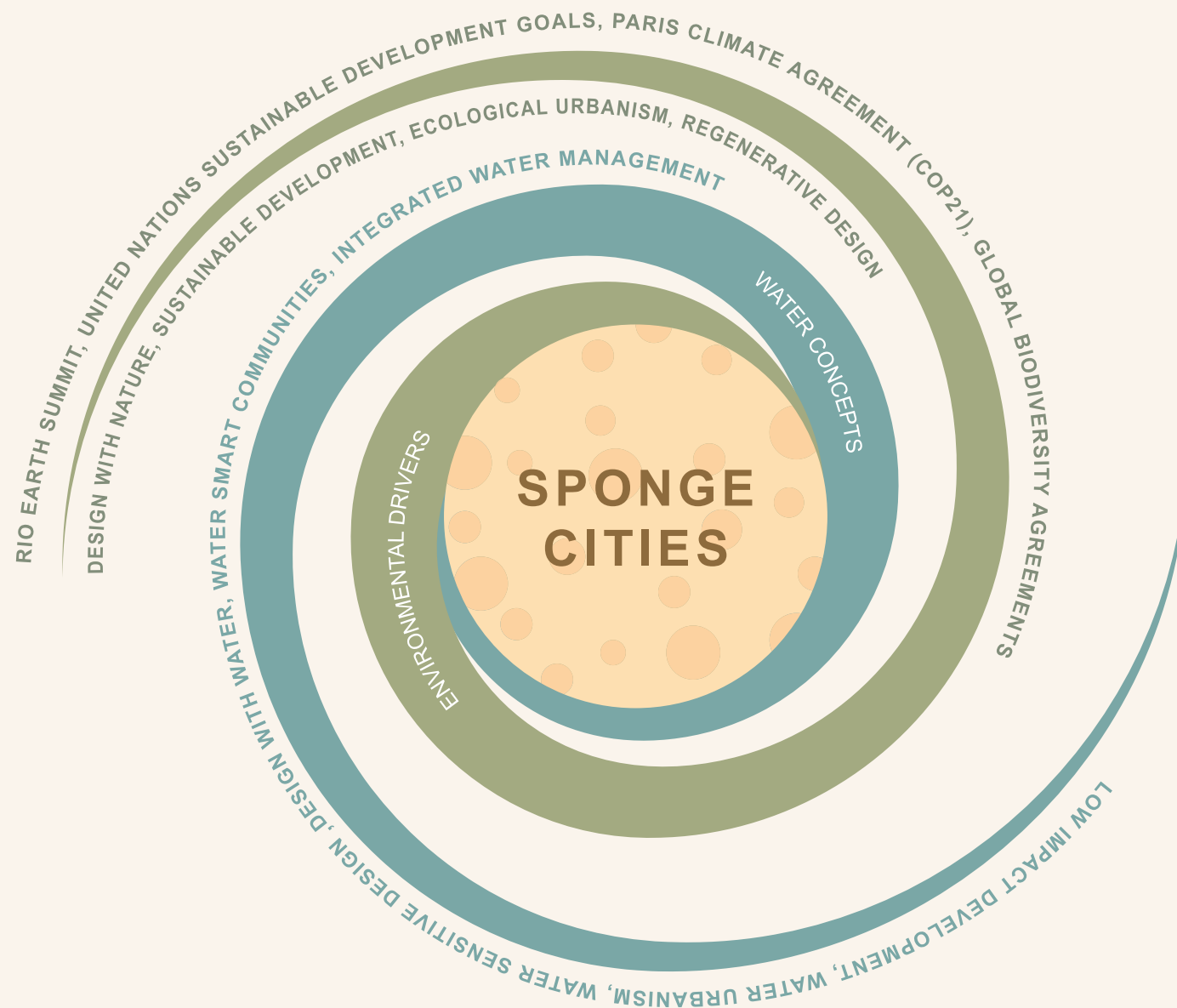
A **Sponge City** refers to a place where urban systems operate like a sponge to absorb, clean, store, and release water, balancing many different demands and delivering wider cross-sector outcomes



# Why 'Sponge Cities?'

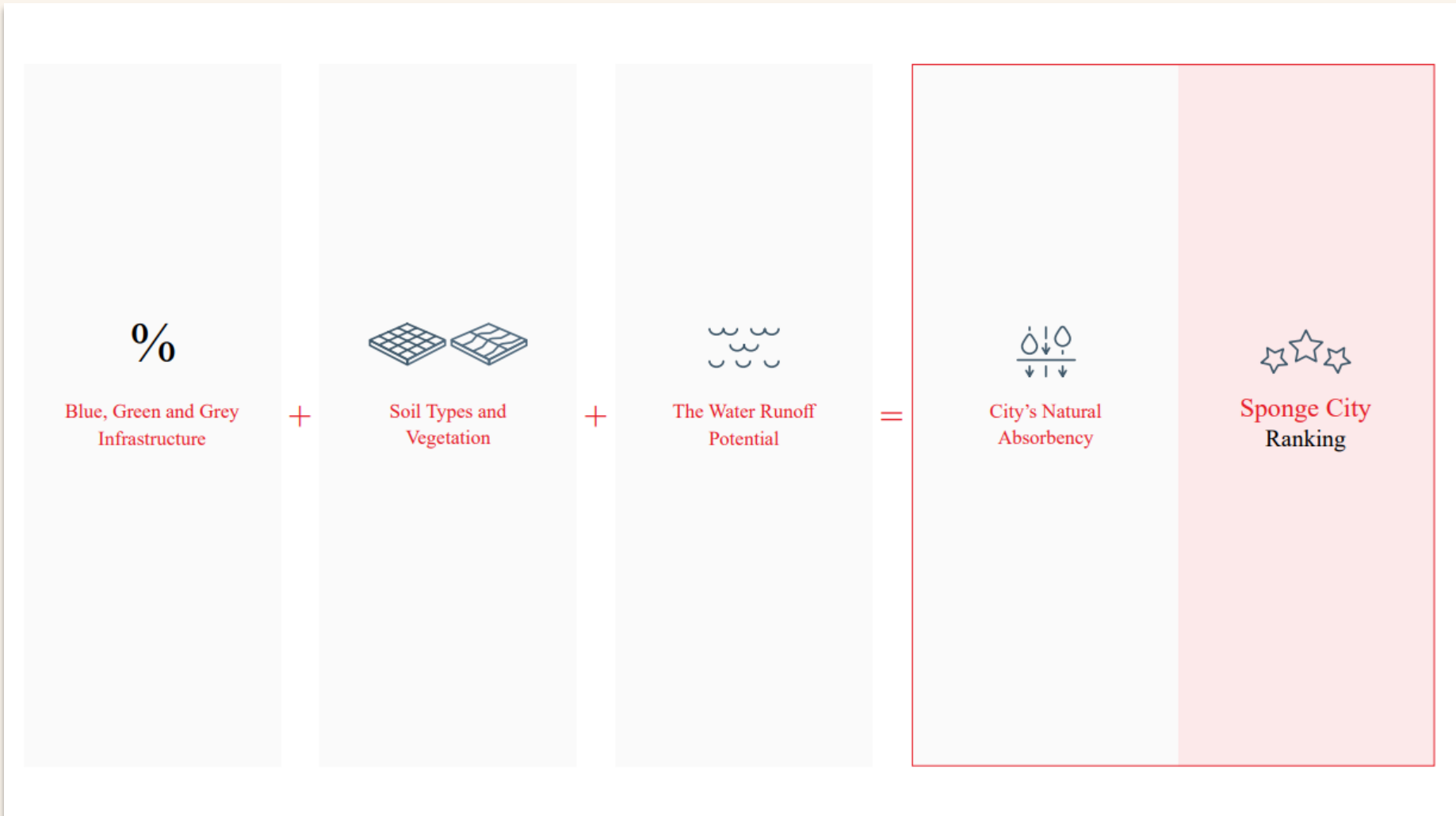
## Emergence of the concept

Water is increasingly at the forefront of addressing global environmental challenges.



# Our approach to measuring 'sponginess'

## Emergence of the concept



# Global Sponge Cities Snapshot

## A barometer of a city's water resilience



### Sponge Snapshot results

#### What we found

We evaluated each city's overall 'sponginess' based upon three factors:

- Amount of blue and green space
- Soil type factors
- Water runoff potential

City	Sponge Ranking	Overall % 'sponginess'	Green-Blue Area %	Soil Classification and Runoff Potential
Auckland	1	35%	50%	Moderately-high runoff (<60% sand and 10-20% clay)
Nairobi	2	34%	52%	High runoff potential (<50% sand and >40% clay); shallow soils and depth to bedrock
Singapore	3	30%	45%	Moderately-high runoff potential (<60% sand and 20-50% clay)
Mumbai	3	30%	45%	High runoff potential (<50% sand and 20-40% clay); shallow soils and water table and/or depth to bedrock
New York City	3	30%	39%	Moderately-low runoff potential (40-70% sand and <10% clay)
Shanghai	4	28%	33%	Moderately-high runoff potential (<50% sand and 20-40% clay)
London	5	22%	31%	Moderately-high runoff potential (<50% sand and 20-40% clay)

# Barriers and enablers for Sponge Cities

We know it works, what do we need to scale?

1. Policy frameworks that push the market towards spongier schemes?
  2. Funding and finance that enables more to be delivered?
  3. Integration of technology into water systems?
  4. More advanced planning tools that reduce the friction in design & delivery?
- ... to be discussed

# Sponge Cities in practice

📍 Mansfield, UK

# Mansfield Sustainable Flood Resilience

Largest blue-green surface water  
management programme in the UK.

7 Types of blue green  
infrastructure

ARUP

£85m  
Investment

20,000  
Blue-green solutions

58,000m<sup>3</sup>  
Flood water storage



# Mansfield Retrofit, UK

## Using nature-based solutions to mitigate and adapt to climate change

### Challenge

Mansfield is a town of around 100,000 inhabitants that suffers from **frequent flooding**.

The sewage treatment plant overflows every time there is heavy rain. No space for expanding this WWTP.

### Solution

We have developed an **urban catchment-scale flood resilience programme** using a suite of interventions in groundwater and surface water by applying Nature-based Solutions.

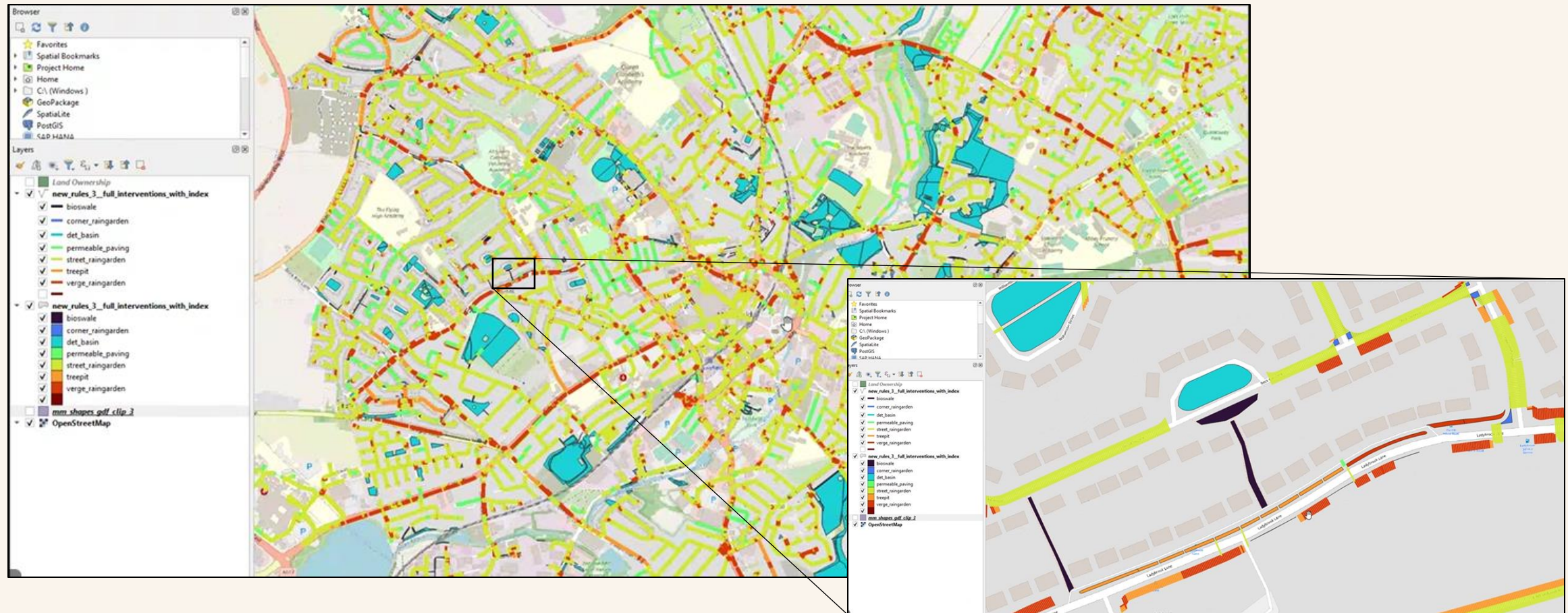


### Impact

By capturing surface water to free up capacity in combined sewers, Mansfield will be transformed into a ‘sponge city’. Following the interventions, stormwater overflows are eliminated, and the population is **protected from flooding**.

# Mansfield Retrofit, UK

## Identification of Nature-based Solutions and SUDS



# Mansfield Retrofit, UK

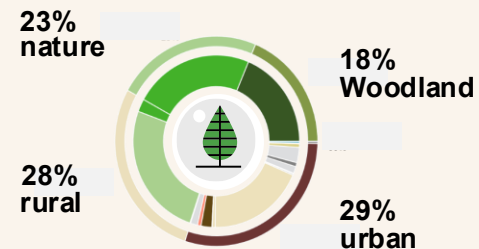
## Using Nature-based Solutions to mitigate and adapt to climate change

### Digital tool

1. Assessing different types of land use.
2. Explore and identify a range of NbS.
3. Multiple scenarios in terms of generating benefits.
4. Assess costs and benefits.



**107 km<sup>2</sup>** land-use types for the wider Mansfield area



Our digital tool delivered a comprehensive **assessment of the entire city**, pinpointing and quantifying every green intervention needed before a single design was drawn.

The result: ability to capture up to 58,000 m<sup>3</sup> of surface water using SUDs.

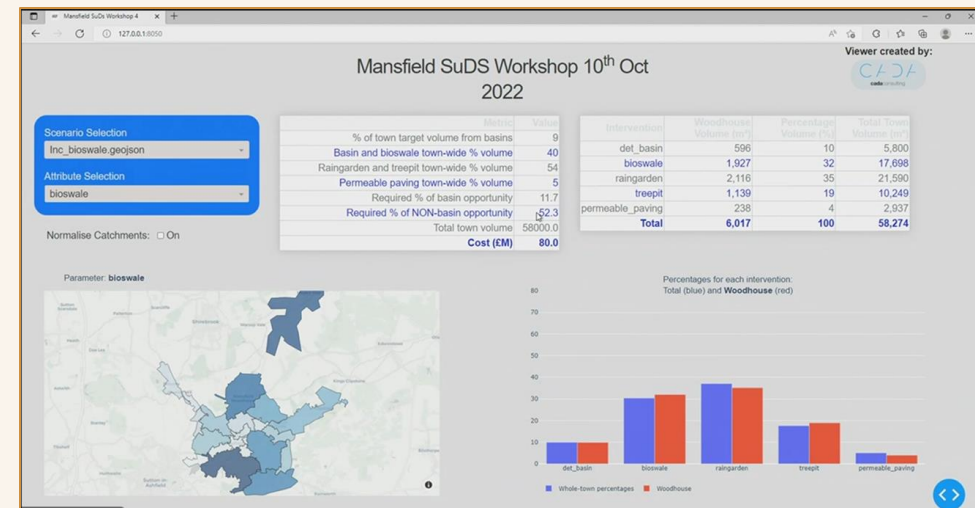
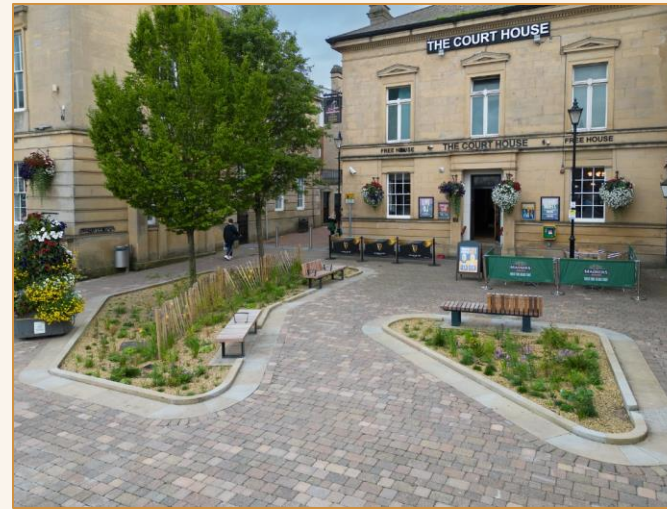
# Mansfield Retrofit, UK

## Impact beyond flood protection

Transformed public spaces have revitalised street life and delivered tangible health benefits: **cleaner air and purer natural waters**.

New vegetation actively reduces pollution and captures carbon, while the soil filters rainwater naturally. The project also drives significant **economic benefits**: creating approximately 390 new local jobs and new career pathways.

The greening of Mansfield benefits not only its people but also local **wildlife**. Water features and new vegetation across the city are restoring **greater plant diversity**, providing shelter and sustenance for invertebrates, birds, and animals.



📍 Shanghai, China

# Shanghai Urban Drainage Masterplan

Integrating blue, green, grey and non-physical interventions to deliver wider benefits for ecology, economy and public health

**>34m m<sup>3</sup>**

Stormwater capacity planned

**640km<sup>2</sup>**

Site area analysed



# Shanghai City Masterplan, China

## An opportunity to make the city more resilient

### Challenge

In just three decades, **Shanghai** has undergone explosive urbanisation and population growth.

The consequence: rapid development **has increased impervious surfaces** across the catchment, eroding green spaces and eliminating room for water.

Stormwater **runoff has increased by more than 50%**, driving recurrent flooding and polluting rivers and aquifers.

### Solution

We built a digital tool that maps land use across the city and identifies exactly where rainwater can infiltrate the ground or be stored for reuse, directly helping to **make the city more resilient**.



### Impact

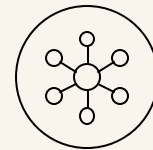
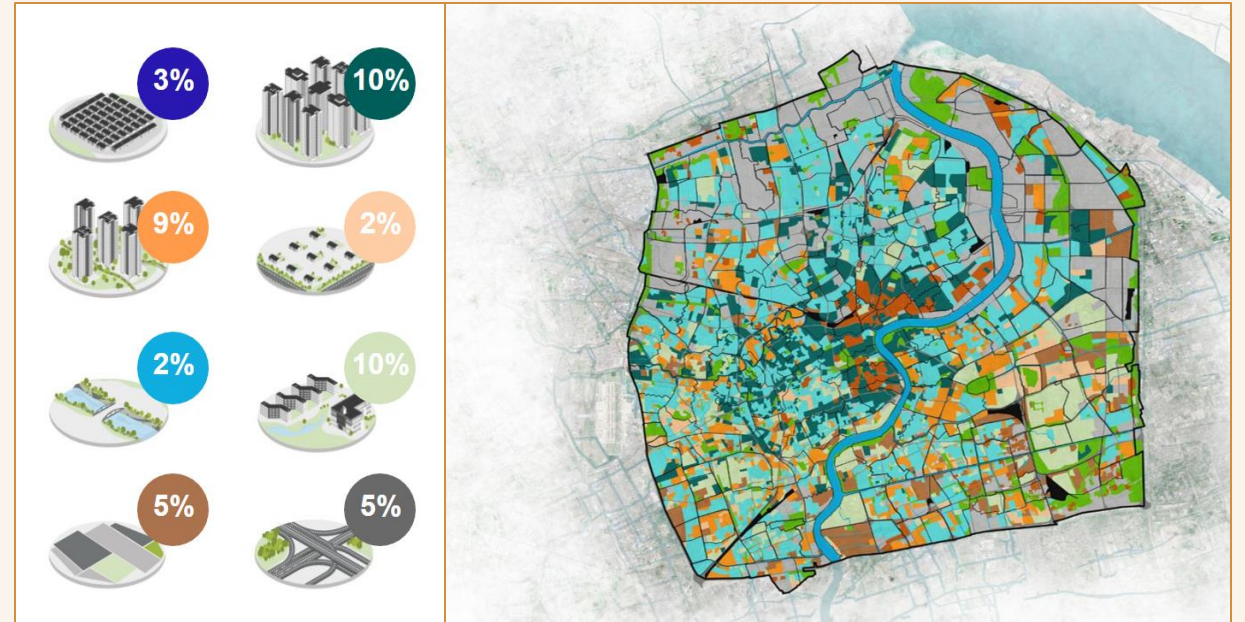
Challenged conventional thinking with a bold, integrated blue-green-grey strategy for Shanghai, uniting nature and infrastructure to achieve **ambitious design objectives, elevate well-being**, drive urban regeneration, and fundamentally strengthen water resilience.

# Shanghai City Masterplan, China

## An opportunity to expand the city

### Mapping opportunities through intelligent land-use analysis

We created **Terrain**: a tool that gives planners unprecedented insight into how land is being used by harnessing the power of data analysis, machine learning and automation applied to satellite images.



**Terrain** takes a data-driven approach to rapidly classify patterns of land use and quantify the scale of opportunities for nature-based sustainable solutions that strengthen a city's resilience against climate change and natural hazards.

It empowers cities to rebuild smarter, integrating biodiversity into the urban planning.

# Shanghai City Masterplan, China

## An opportunity to expand the city

Terrain transforms satellite imagery using **machine learning** and data automation to convert raw images into actionable intelligence. This enables us to generate **detailed land-use maps** at regional scale with entirely new classification systems, analysing **2 hectares of land per second**.

This precision reveals exactly where water can infiltrate, where nature-based solutions will retain surface water, and where to enhance tree cover and permeable pavements, delivering **transformative benefits**:

- Cleaner water and air
- Dramatically reduced road flooding
- Accelerated climate adaptation
- Rainwater captured and reused
- Restored urban biodiversity
- Measurable reduction in heat island effect



**Panel:**

**Practical barriers to delivering Sponge Cities**

# Your Panellists



**Joe Shuttleworth**

Host and Lead Presenter  
Arup



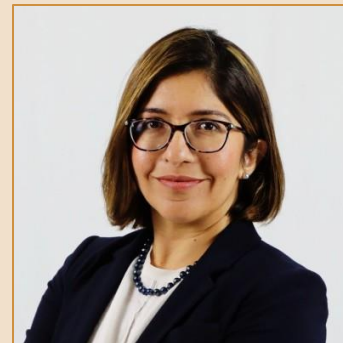
**Will Sarni**

Practice Lead, Water & Nature  
Earth Finance



**Alexis de Kerchove**

Senior Director, Sustainability  
Xylem



**Rabia Chaudhry**

Water Supply Resilience Director  
DC Water

**4 PROVE OUTCOMES**

Real-time water quality monitoring.

**3 ACT IN REAL TIME**

Shared operational view across agencies.

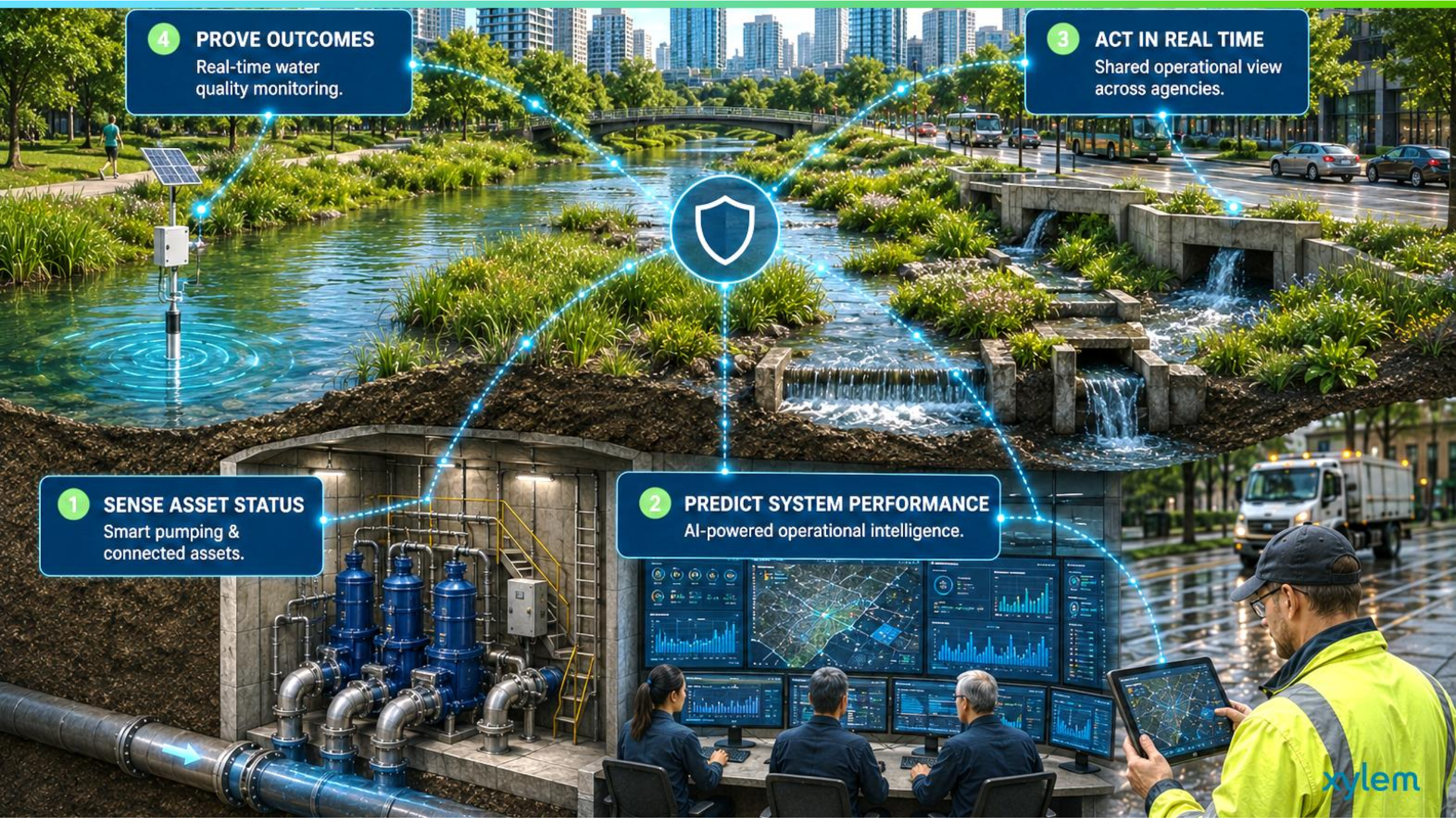


**1 SENSE ASSET STATUS**

Smart pumping & connected assets.

**2 PREDICT SYSTEM PERFORMANCE**

AI-powered operational intelligence.



## Topics for our panellists:

- *What does 'Sponginess' mean to me?*
- *From ambition to implementation*
- *How do we make the funding work?*
- *What is the role of technology?*
- *How do we convene and influence the right stakeholders?*

# Sponge Cities 2.0

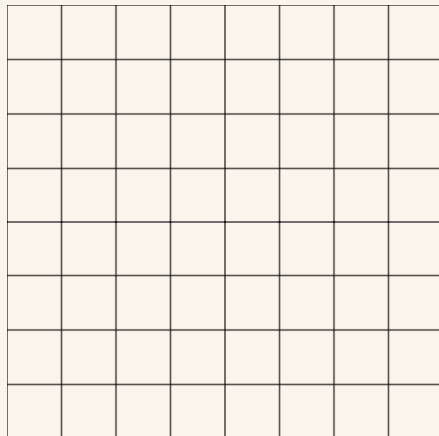
# Parallel Raster Inundation Model

PRIMo

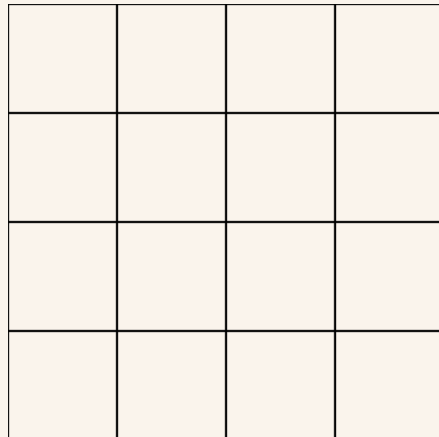
ACCURACY

+

SPEED

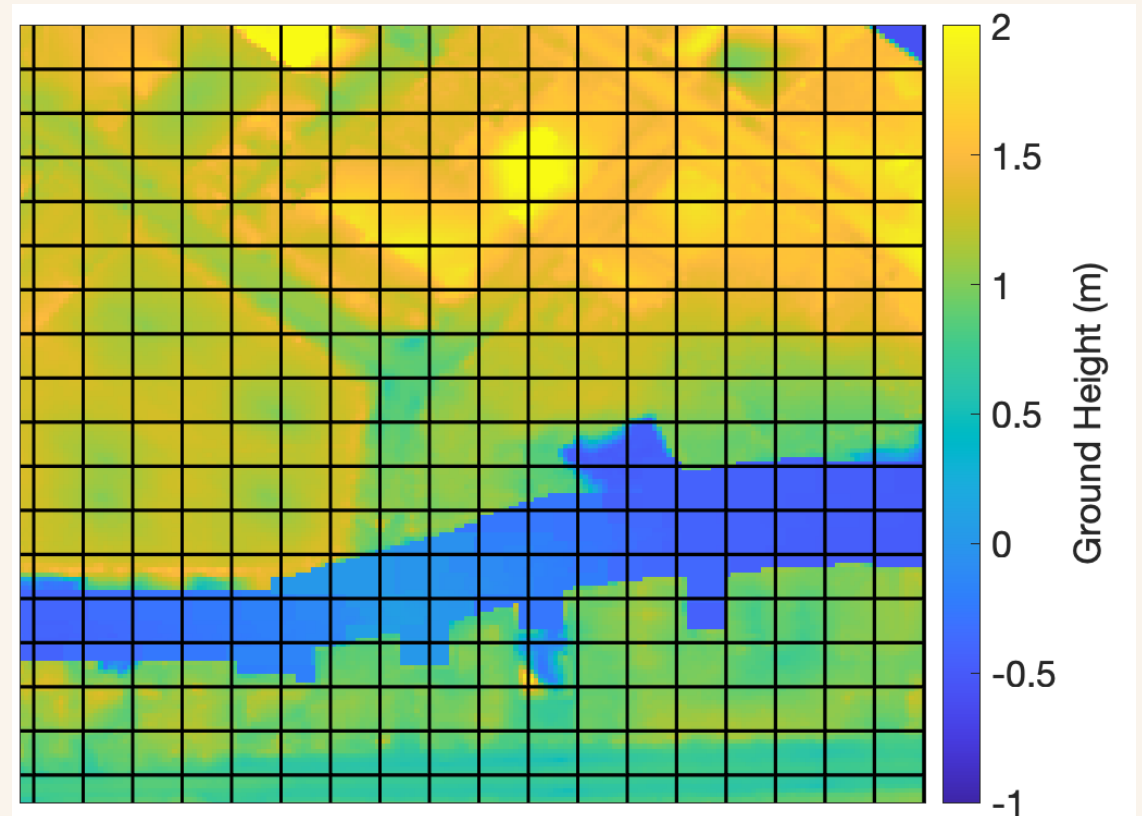


Fluxes



Conservation Equations  
&  
Flood Infrastructure  
(e.g., levees, culverts,  
gates, storm drains)  
&  
Groundwater  
Interactions

Dual Grid: Coarse (10 m)/Fine (1 m)



Sanders and Schubert, AWR, (2019): <https://doi.org/10.1016/j.advwatres.2019.02.007>

Kahl et al., AWR, (2022) <https://doi.org/10.1016/j.advwatres.2022.104287>

Schubert et al., EF, (2024) <https://doi.org/10.1029/2024EF004549>

Sanders et al., AWR, (2025)

<https://doi.org/10.1016/j.advwatres.2025.105057>

# Fast and Accurate Predictions with Complex Topography

## 1963 Baldwin Hills Dam-Break Flood in Los Angeles County

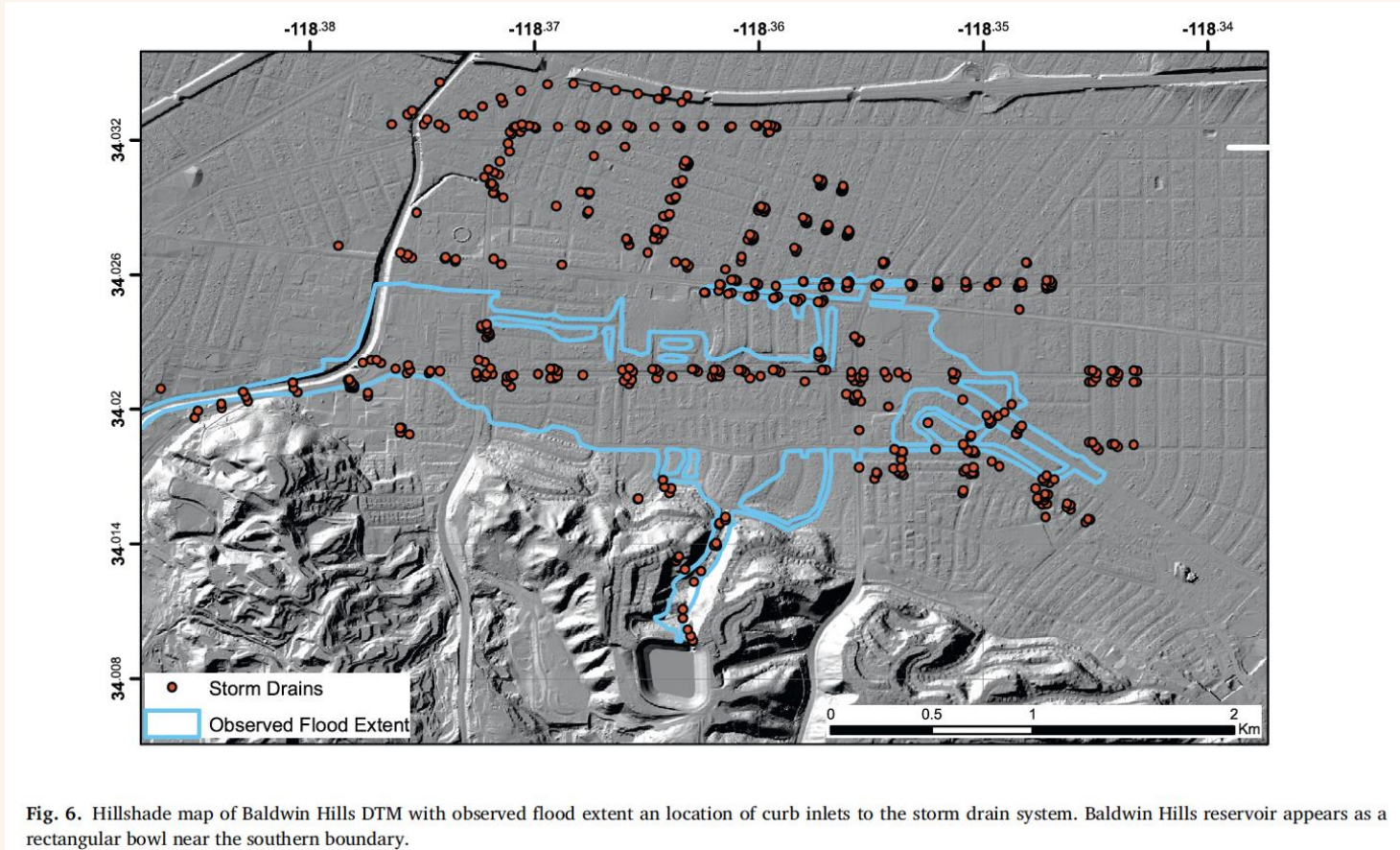
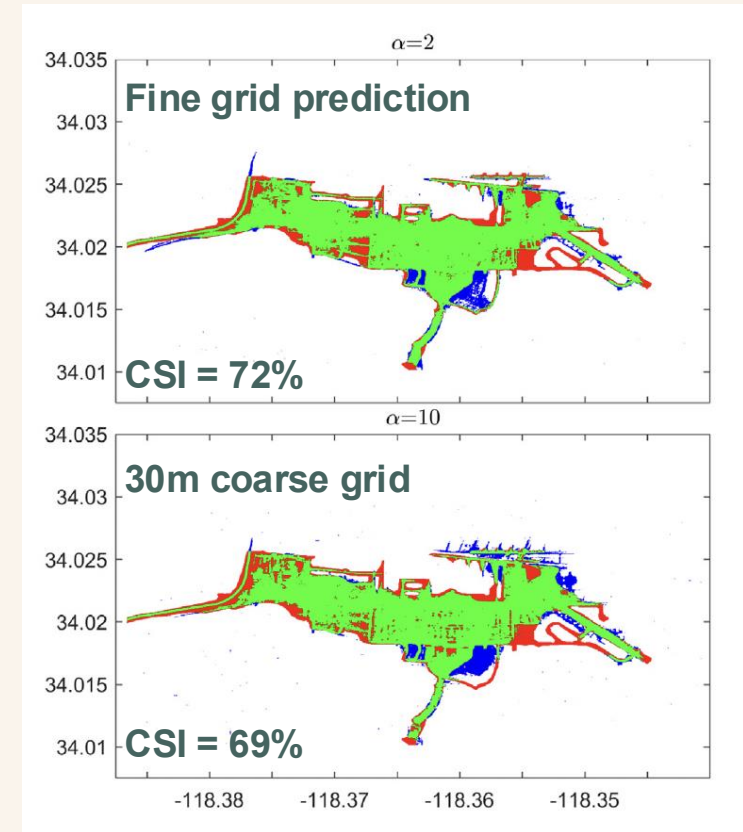


Fig. 6. Hillshade map of Baldwin Hills DTM with observed flood extent and location of curb inlets to the storm drain system. Baldwin Hills reservoir appears as a rectangular bowl near the southern boundary.

Sanders and Schubert, AWR, (2019):  
<https://doi.org/10.1016/j.advwatres.2019.02.007>

CSI=Critical Success Index  
 (accuracy metric)

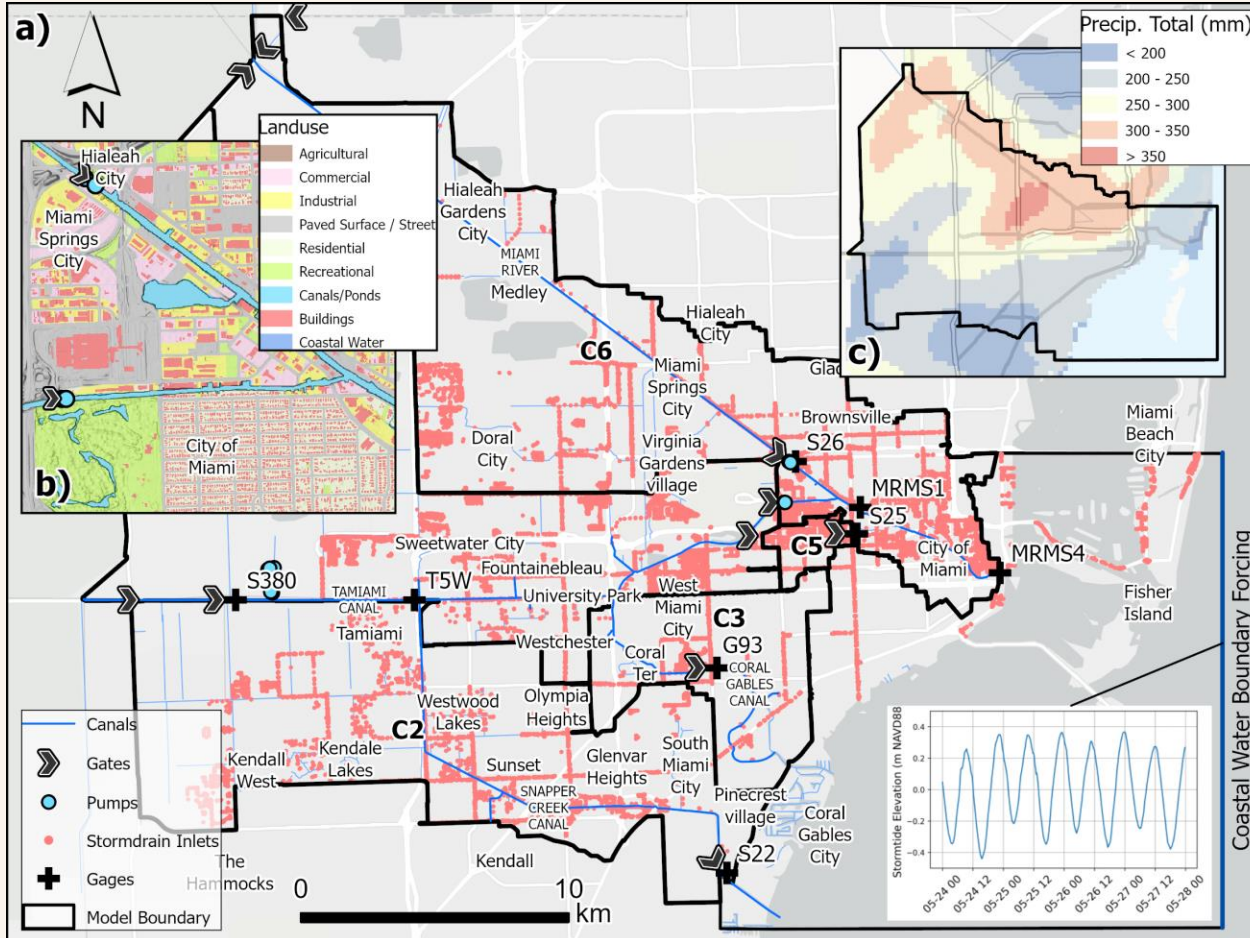
Speed=400X



■ Agreement 
 ■ Overprediction 
 ■ Underprediction

# Fast and Accurate Predictions with Complex Drainage Infrastructure

## Miami-Dade County



Gates

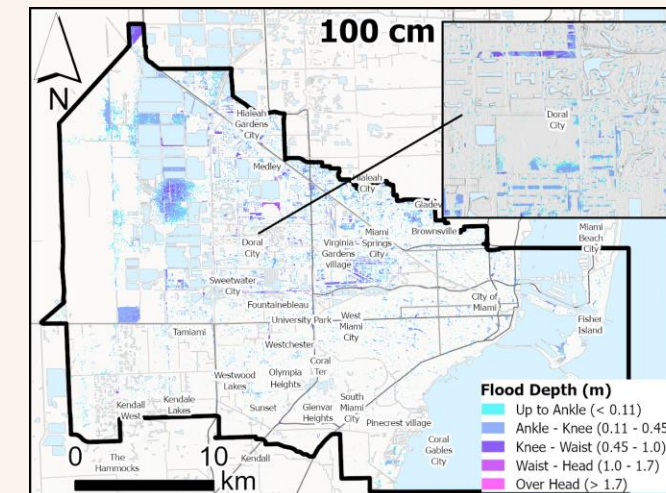
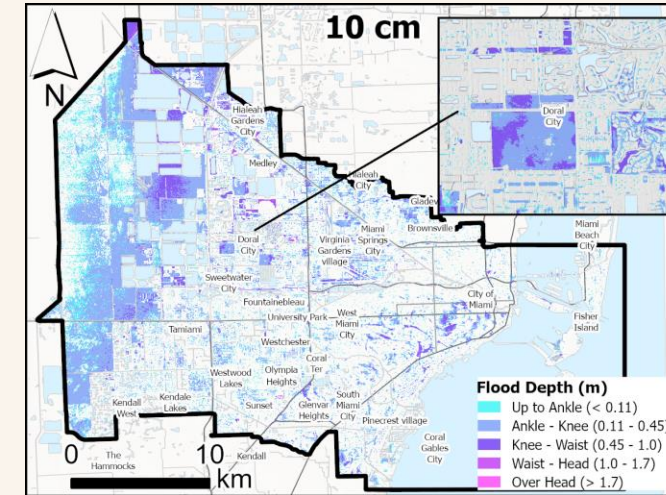
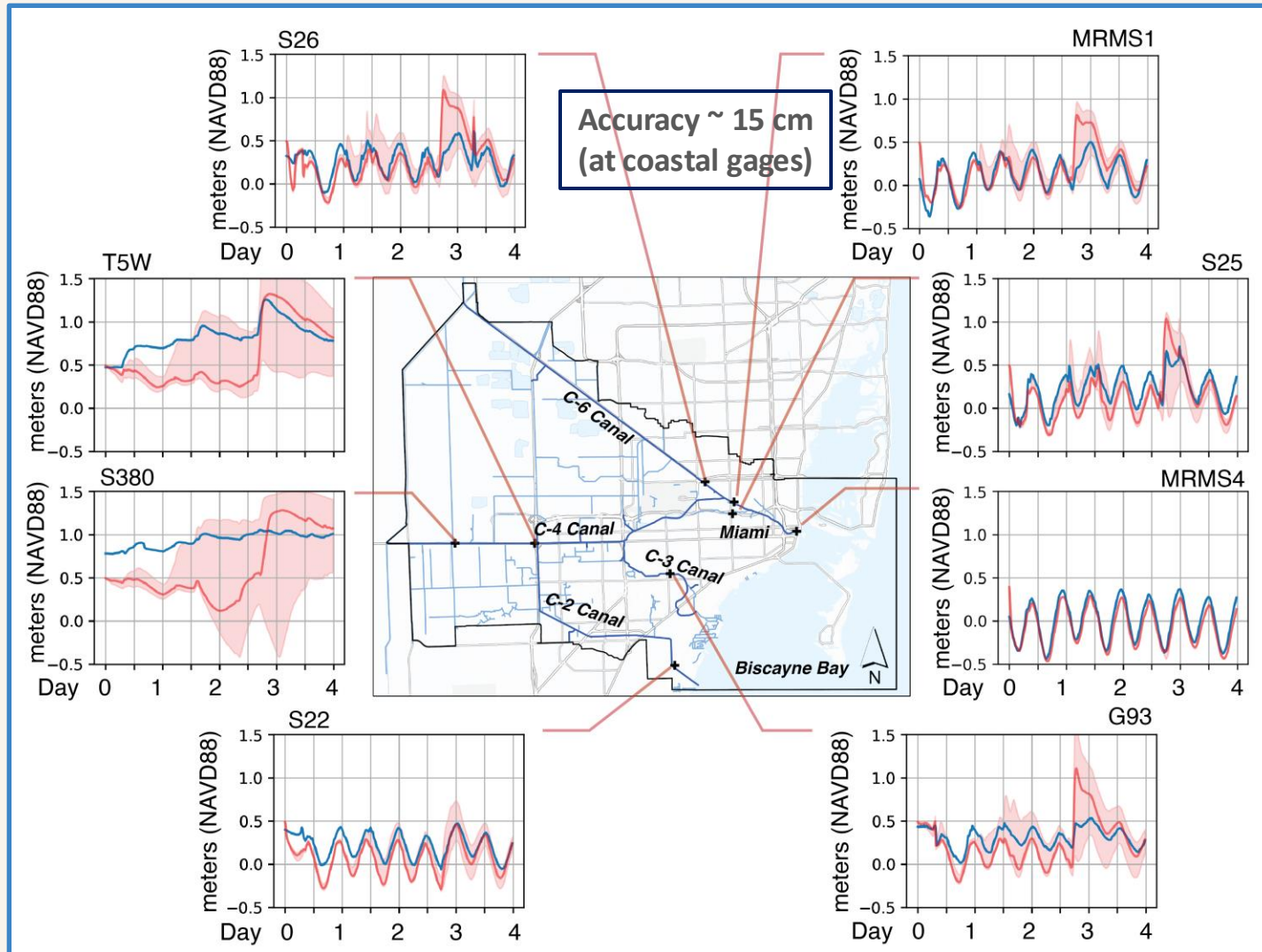


Infiltration Trenches

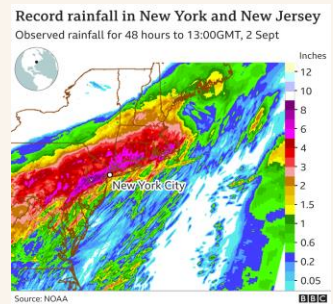
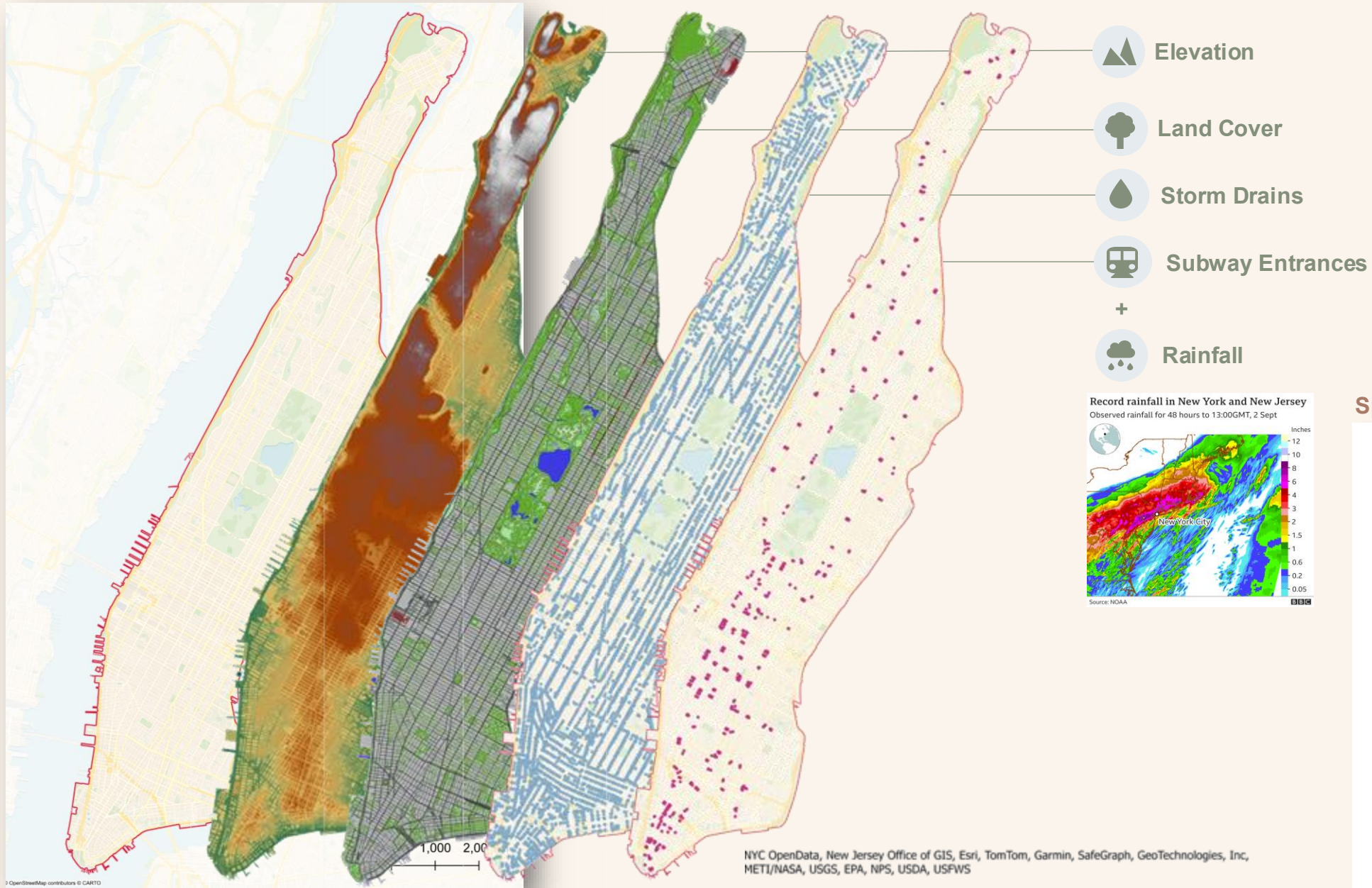


Storm Drains

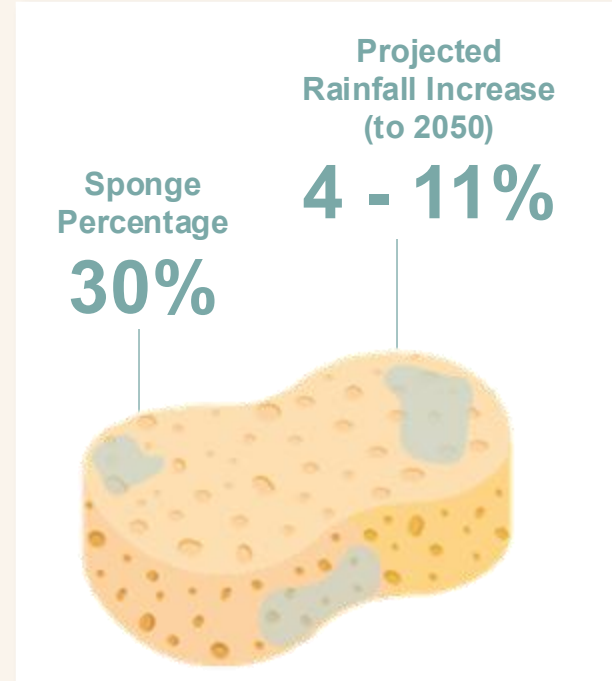
# Flood Dynamics Sensitive to Groundwater Interactions



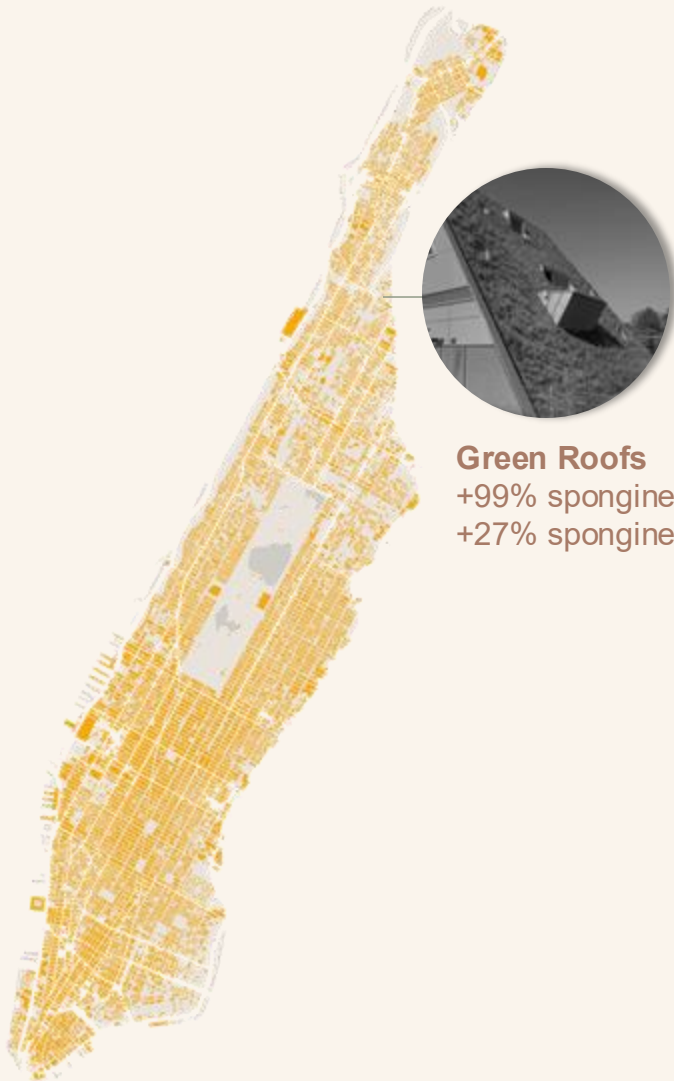
Sanders et al., AWR, (2025):  
<https://doi.org/10.1016/j.advwatres.2025.105057>



**Sponge City Snapshot NYC**



# Interventions



**Green Roofs**  
+99% sponginess (>1000m<sup>2</sup>)  
+27% sponginess (>7500m<sup>2</sup>)

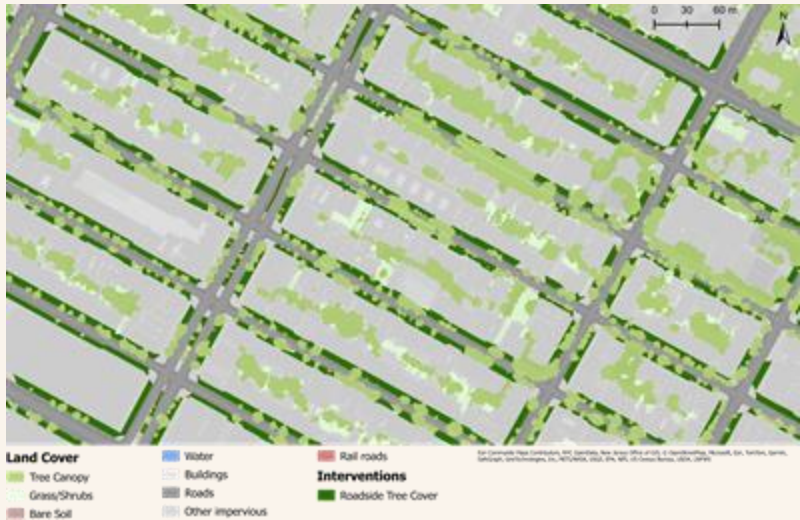


**Roadside Tree Planting**  
+3-4% sponginess



**Permeable Parking**  
+22% sponginess

# Interventions





*"Hurricane Ida is pictured as a category 2 storm" by NASA Johnson, CC BY-NC-ND 2.0*

## Hurricane Ida

2021

150<sub>mph</sub>

maximum winds at landfall

Shutdown of much of  
NYC transport system

120 deaths

Including 18 in NYC



## Green Roofs

**63%** reduction in buildings flooded to > 1 foot

**523** properties protected

**79%** reduction in area of road flooded to >1 foot

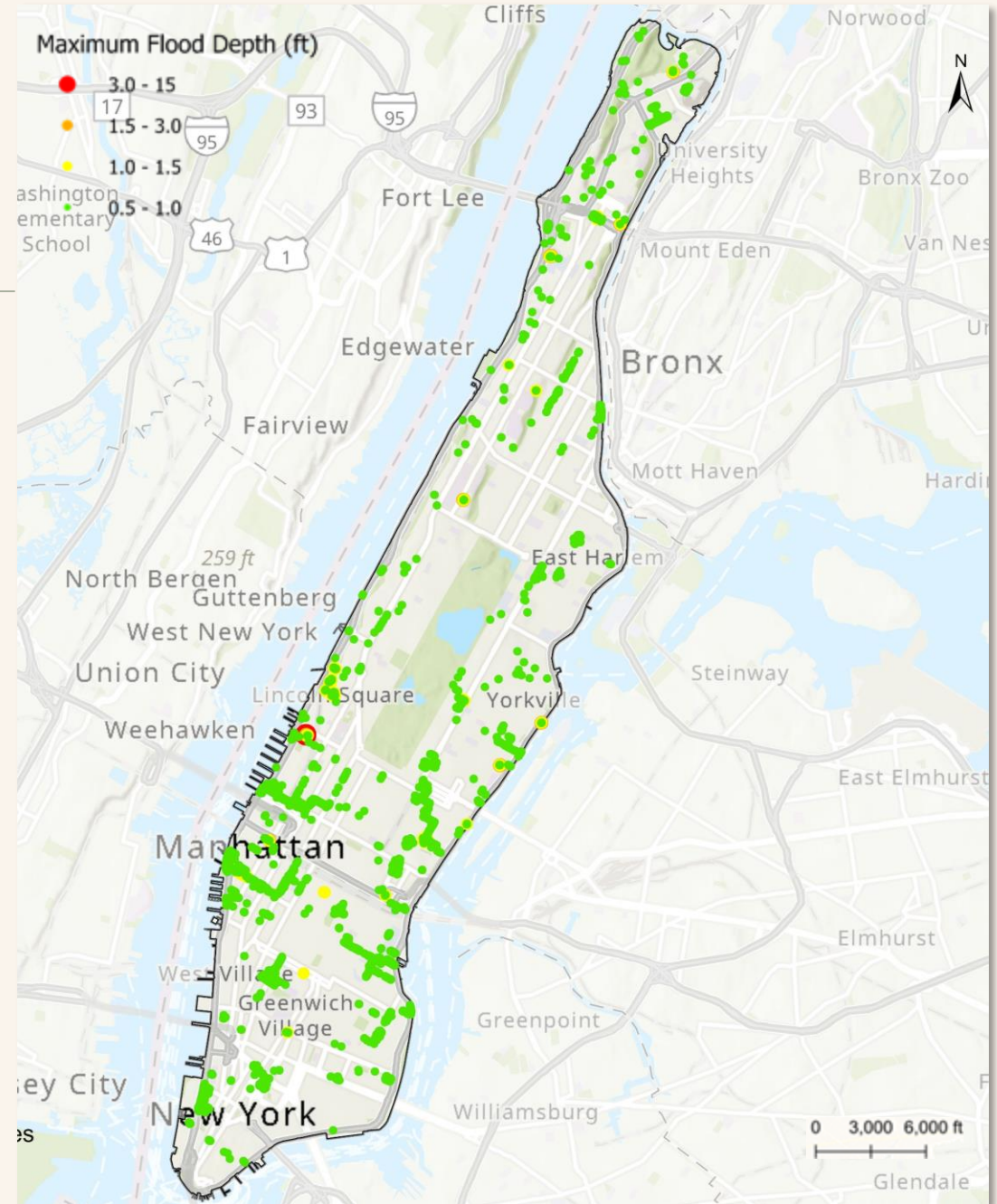
# Permeable Parking



**21%** reduction in buildings flooded to > 1 foot

**202** properties protected

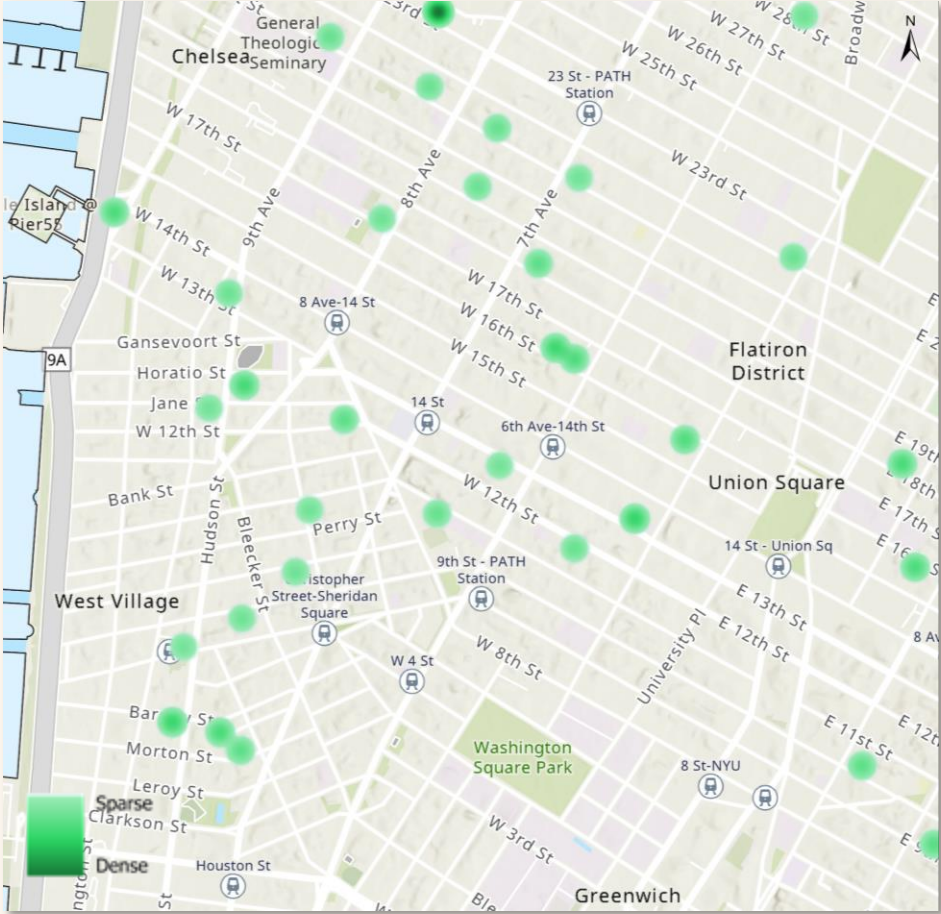
**77%** reduction in area of road flooded to >1 foot



# Green Roofs & Permeable Parking



# Green Roofs & Tree Planting



# Final Remarks and Questions

## Contact us

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