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The Blue-Green Path to Urban Flood Resilience

Dr Emily O'Donnell

20.02.20

UK Flood Risk

- Flooding is the UK's most serious natural hazard
- UK annual expected damages due to flooding exceed £1 billion
- 5.2 million properties (1 in 6) and large proportions of the UK's key infrastructure are at risk (Environment Agency, 2014)
- Increasing urbanisation = elevated flood risk to people, property and critical infrastructure systems
- Stress on already overburdened drainage infrastructure

➢ Social justice – most deprived areas are often at highest risk, no insurance, less ability to prepare and adapt

Fluvial flooding

Source: Tewkesbury, Nov 2012. David Goddard/Getty Images

Pluvial flooding

- Surface water / extreme event flooding
- Flooding from intense rainfall

Too much rain and no where for it to go

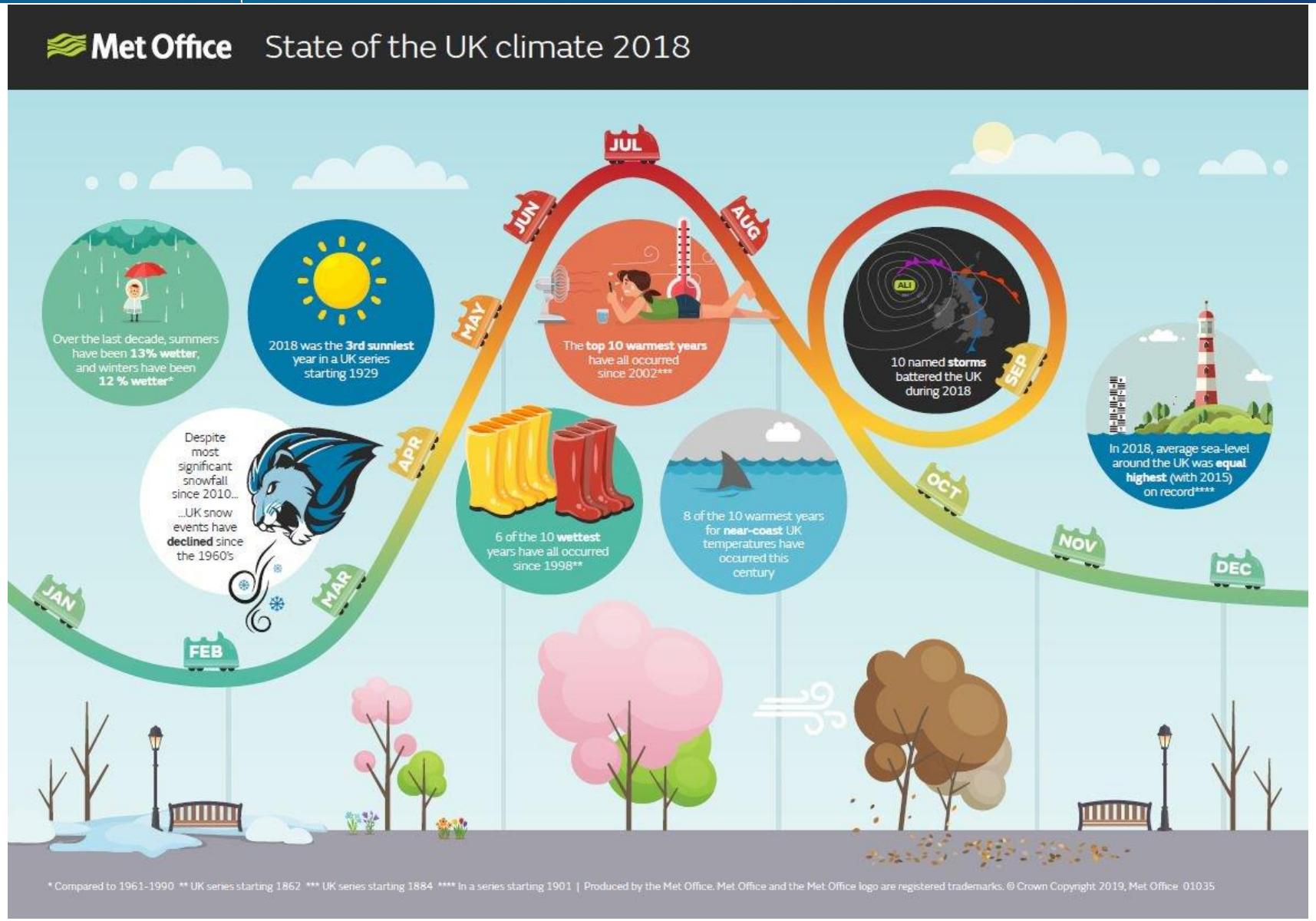
Very hard to predict

Difficult to manage

High risk in cities

Newcastle “Toon Monsoon” June 2012

UK Climate and Future Flood Risk



Future projections:

- wetter winters
- drier summers
- increased likelihood of more extreme storm events and intense rainfall leading to flash flooding

Committee on Climate Change, July 2019, *Progress in preparing for Climate Change: 2019 Report to Parliament*

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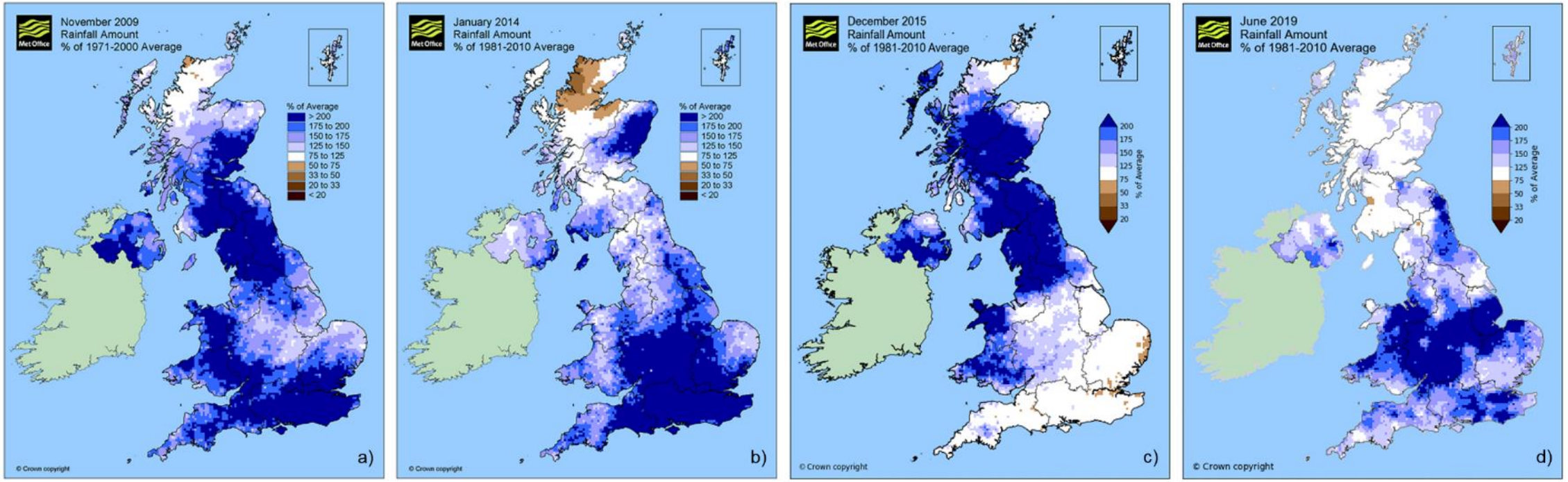
Trends in UK rainfall

November 2009 | January 2014 | December 2015 | June 2019



UK rainfall anomaly maps illustrating months that experienced two to three times the long-term average. Source: Met Office, 2019.

Note that the long-term average in a) refers to the period 1971-2000, and in b-d) refers to the period 1981-2010.

O'Donnell. E. and Thorne, C., (2020) The changing drivers of urban flooding

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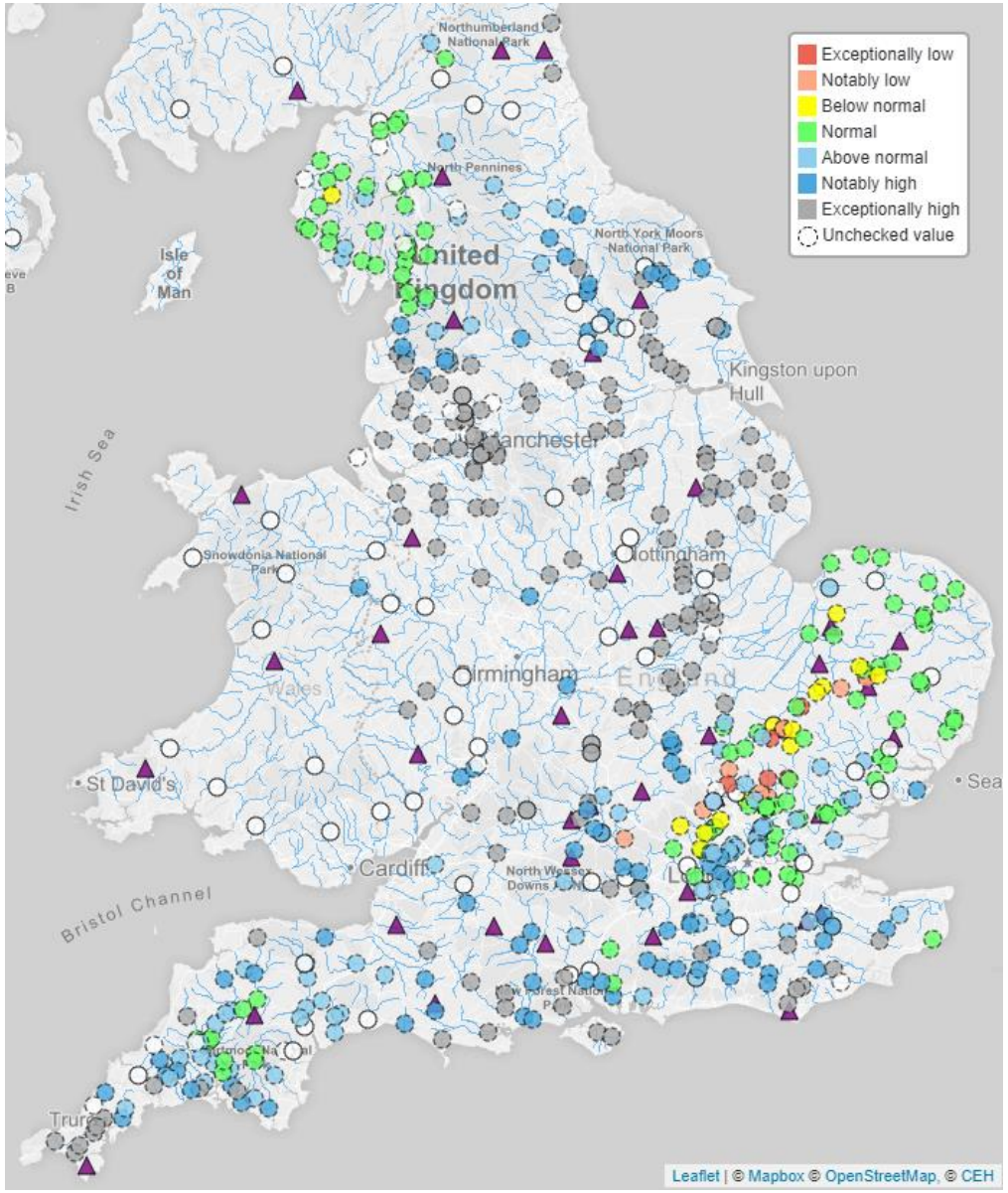
Proposed causes of floods (South Yorkshire Nov 2019)



Climatic

- Global heating affecting position of **jet stream** (October → anomalous southern track propelling a series of cyclonic systems across the UK)
- Too much **rain**!

  October → saturated soils, more in November: Doncaster 77.8 mm in 24-hr (return period of > 60 years)

- New record river levels and flows: River Don at Doncaster 395.4 m^3/s 7-8th November (>250 years)

Centre for Ecology and Hydrology (2019) Briefing note https://www.ceh.ac.uk/news-and-media/blogs/briefing-note-severity-november-2019-floods-preliminary-analysis

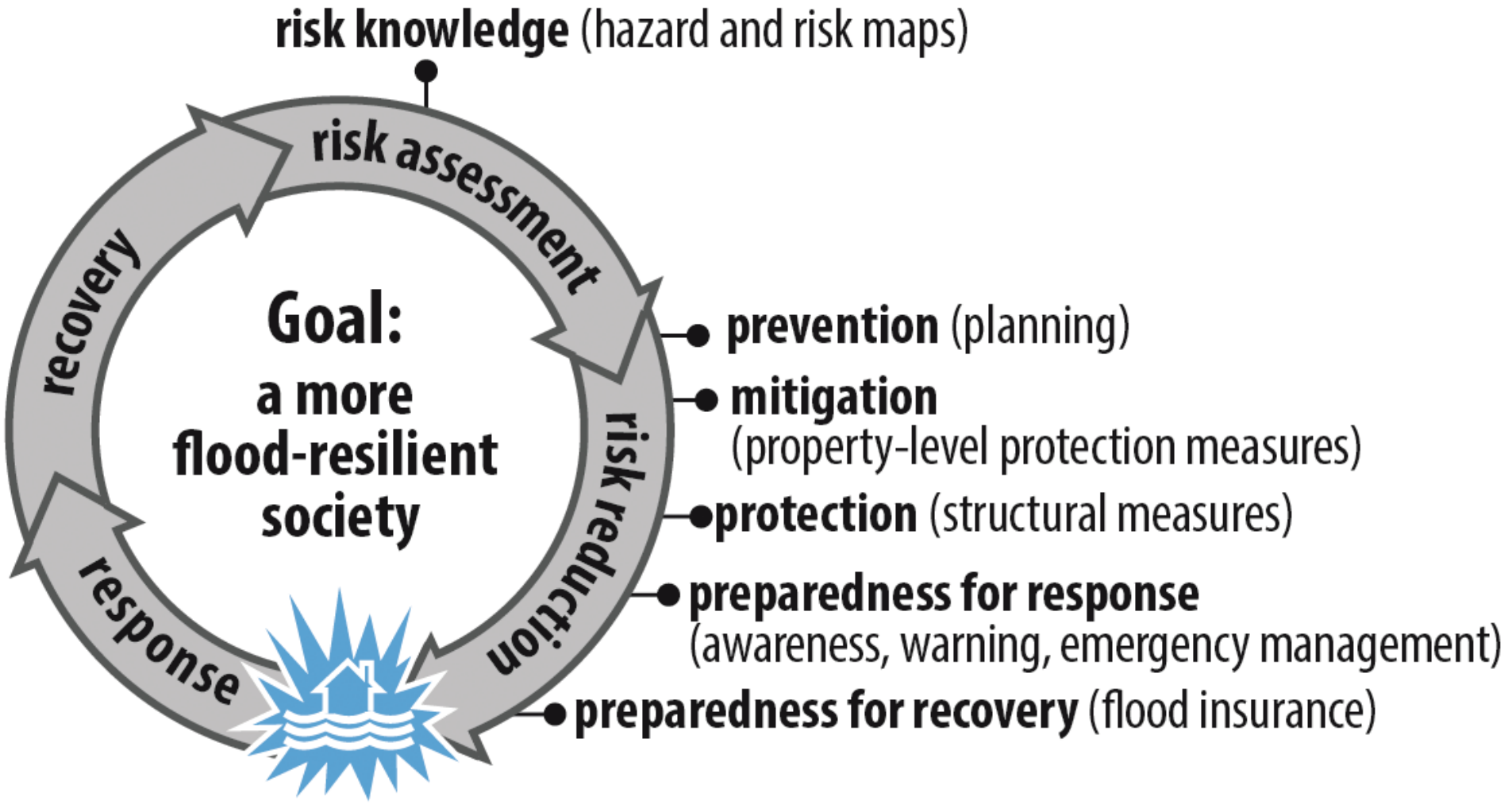
Proposed causes of floods (South Yorkshire Nov 2019)

Flooding caused by poor management and floodplain building, say exp...
Big floods likely to become more frequent because of climate breakdown
theguardian.com Guardian, 12th Nov 2019

Human

- Poor management of rural landscape impacting downstream urban communities
  - Intensive animal grazing, short grass, compacted soil = high runoff
  - Peat removal, burning of heather moorland, coarse draining = nothing to hold water back
- Building on floodplains
- Urban flood defences passing problem downstream
- Lack of warnings and action (increasing ***flood impacts - Fishlake***)

Flood resilience



Surminski and Thieken (2017), Promoting flood risk reduction: The role of insurance in Germany and England

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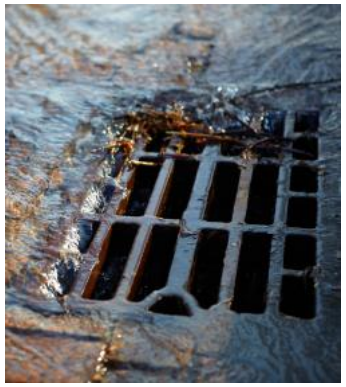
Traditional grey infrastructure



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London without the Thames Barrier during the Dec 2013 tidal surge

Source: Environment Agency

"what is required is a fundamental change in how we view flood management, from flood defence where we protect ourselves to one of resilience, living with and making space for water and the opportunity to get "more from less" by seeing all forms of water as providing multiple benefits."

Commission of Inquiry into flood resilience of the future titled 'Living with water', March 2015. All Party Group for Excellence in the Built Environment, House of Commons, London SW1A 0AA: p. 32.

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Blue-Green infrastructure



Linear wetland → long swale → sediment basin

Green roof / ecoroof

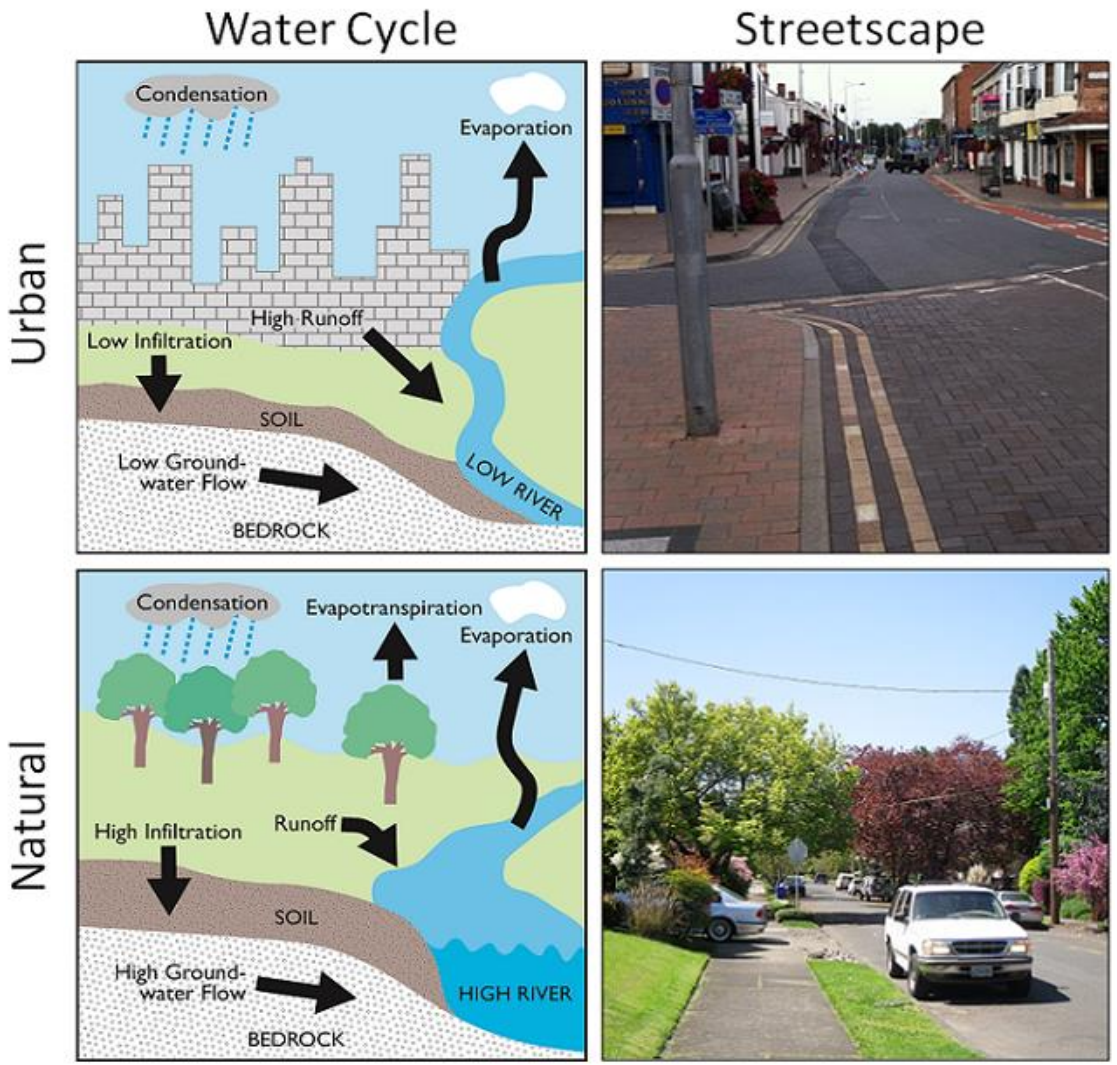
Rain garden / swale

Pond

Wetland

Green tram tracks

Blue-Green Cities



BLUE- **GREEN**

- Working with nature to manage water and deliver a range of other benefits to society, the economy and the environment
- Multifunctional landscape
- Blue-Green space connectivity

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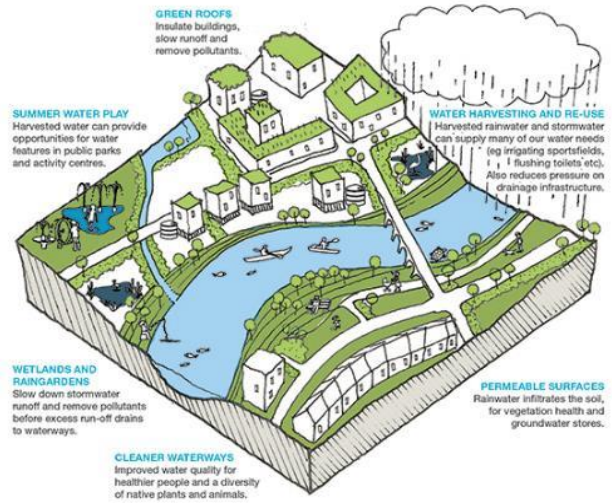
International Blue-Green initiatives

Water Sensitive Urban Design



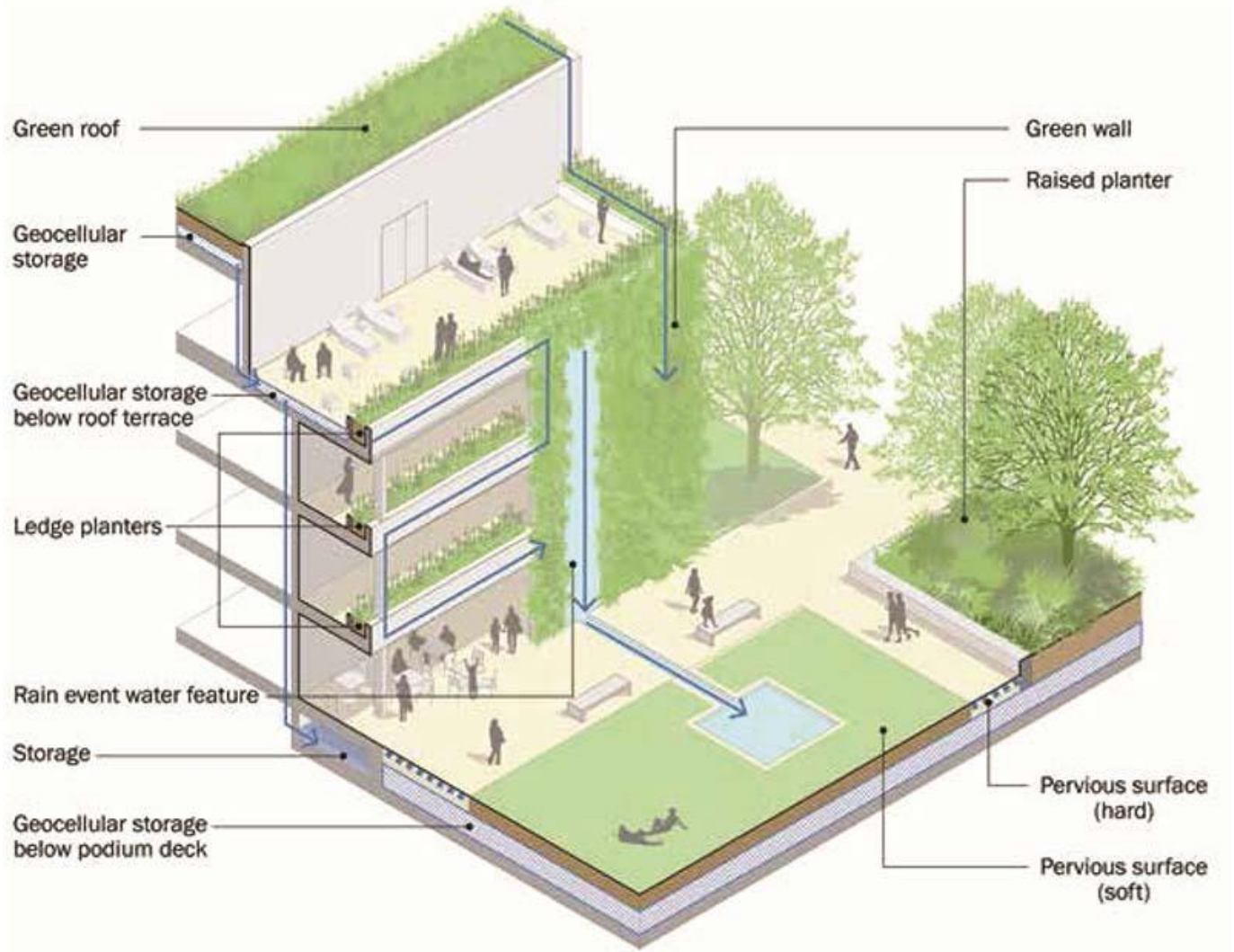
海绵城市 Sponge City

海绵城市是指城市能够像海绵一样，在适应环境变化和应对自然灾害等方面具有良好的“弹性”，下雨时吸水、蓄水、渗水、净水，需要时将蓄存的水“释放”或加以利用。

Green infrastructure (USA)

‘Room for the River’ (Netherlands)

Sustainable Urban Drainage Systems (SuDS)



- Source control
- Infiltration
- Pre-treatment
- Attenuation
- Retention

https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Disciplines-Resources/Case%20Studies/figure-8-typology-suds.jpg

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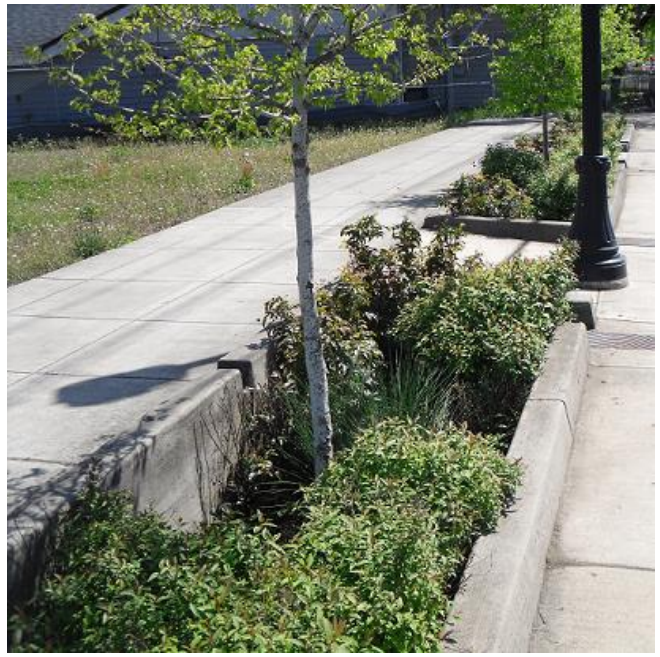
Portland, Oregon USA – green stormwater management

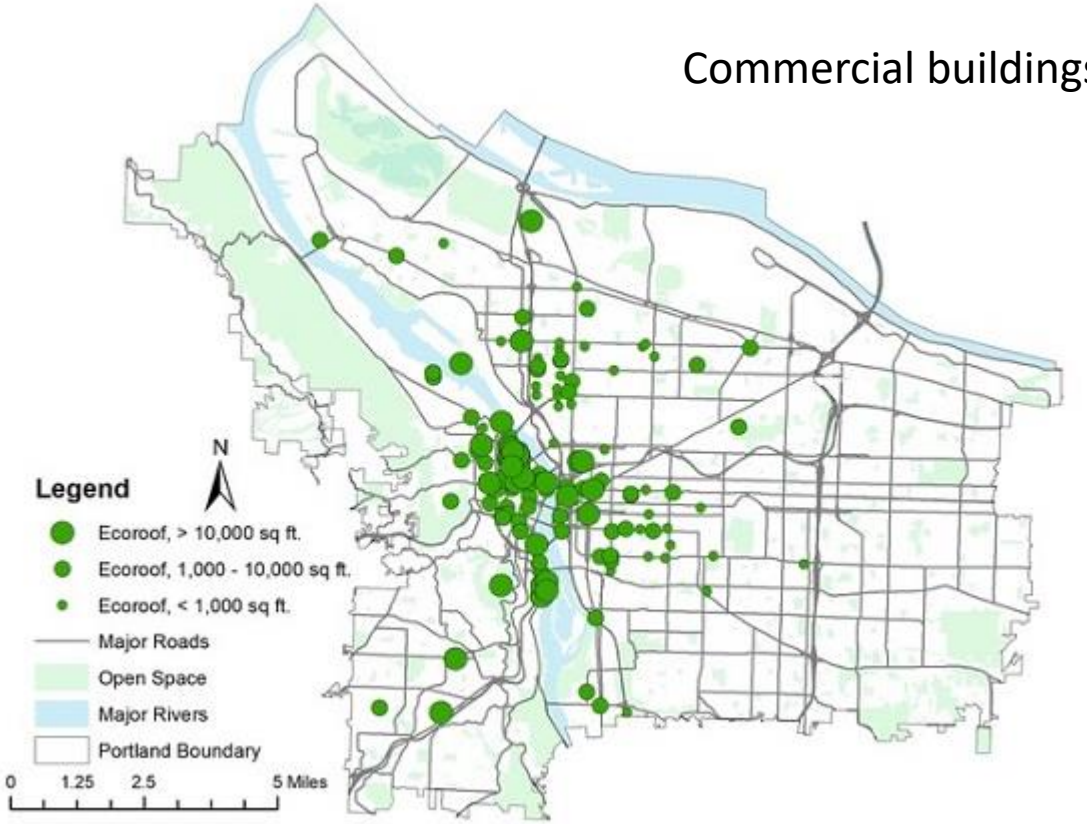


- >2000 street bioswales
- >600 eco-roofs
- Tens of thousands of street trees
- Culvert removal
- Land acquisition
- River and floodplain restoration
- 'Grey to Green' (2008-2013) = $55 million (compared with $1.4 billion 'Big Pipe')

Portland ecoroofs

(>400 in total) incentives to mandates

Commercial buildings



Ecoroof Location in Portland by Building Use (Source: Portland State University, Portland's Greenroof information Thinktank (GRiT), and Portland State University's Home Ecology Research (HERE) Lab).

(less blue-green) Blue-Green infrastructure

Permeable paving, water butts and planters

Water and sediment management benefits

Controlling the water at source, slowing conveyance, attenuation and storage = reduce flood risk

Improves water quality

Increasing extent and health of GI

Surface water as an amenity

Limit flows entering man-made drainage systems

Biological breakdown of sediment pollutants

Improves resilience

Managing flows above ground

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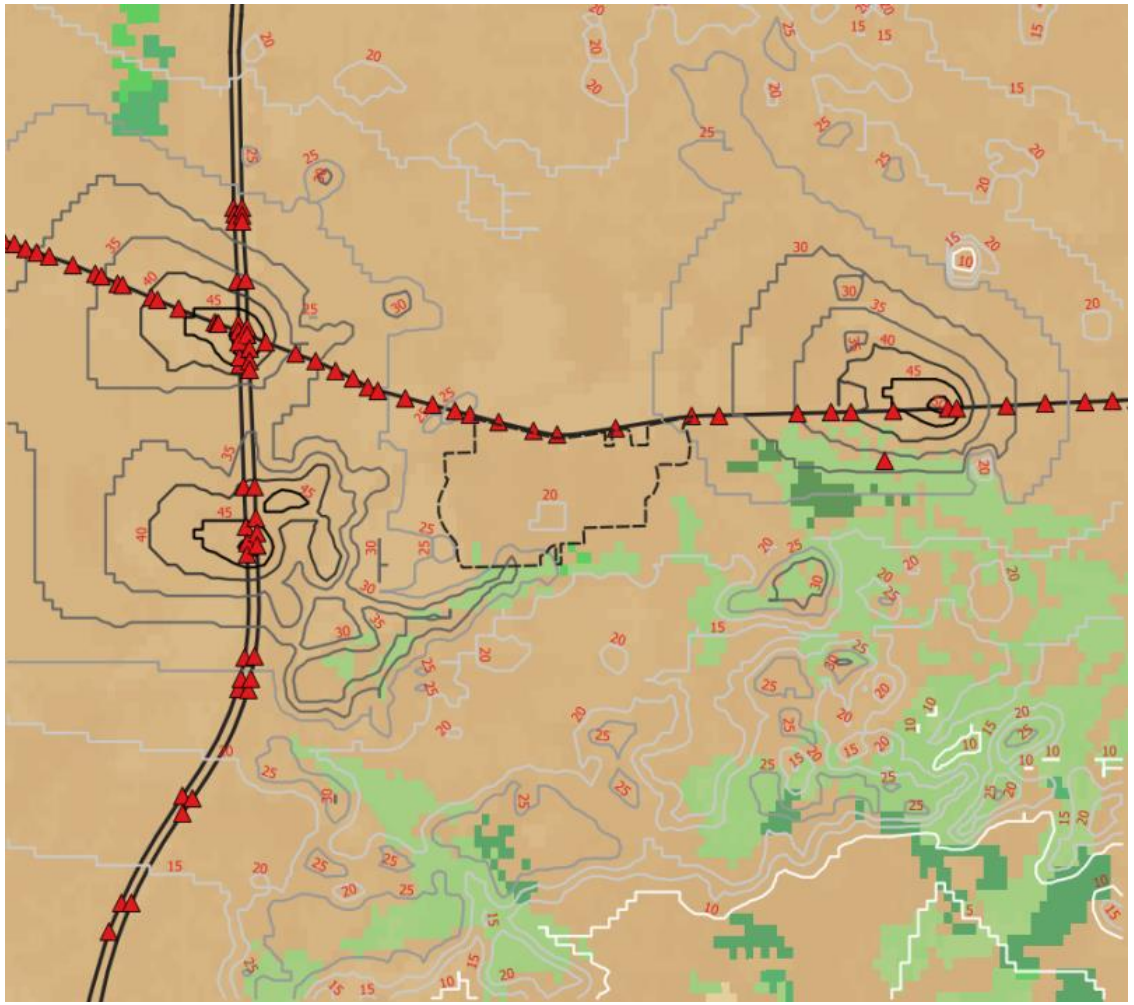
Environmental benefits: habitat and biodiversity

Environmental benefits

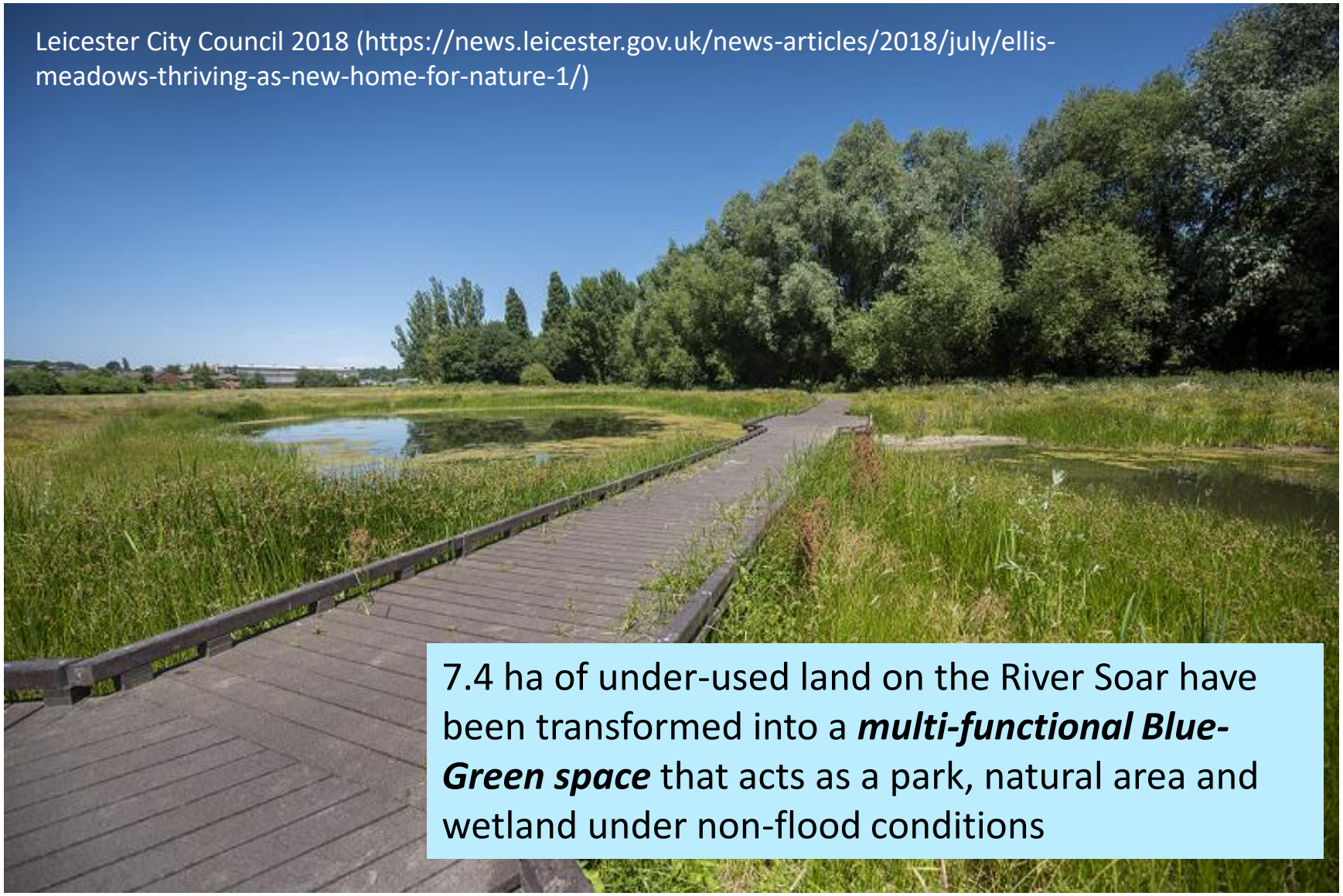
- Improved air quality, e.g. accumulation of SO_2, $No_{x,}$ PAHs
- Reduction in noise
- CO_2 sequestration
- Improved soil quality and nutrient cycling
- Reduced energy consumption, e.g. reducing conductive heat loss and providing shading, lowering air temperatures through transpiration
- Reducing urban heat island effect
- Improving water quality



Social and cultural benefits

- Recreation
- Aesthetics
- Amenity
- Wellbeing and liveability (stress relief, restorative benefits)
- Encourages community cohesion, social interaction
- Physical and mental health

Ellis Meadows Flood Alleviation Scheme (Leicester)



Leicester City Council 2018 (https://news.leicester.gov.uk/news-articles/2018/july/ellis-meadows-thriving-as-new-home-for-nature-1/)

7.4 ha of under-used land on the River Soar have been transformed into a ***multi-functional Blue-Green space*** that acts as a park, natural area and wetland under non-flood conditions

Ribblesdale Road rain gardens – completed May 2013

Scheme Description

This pilot retrofit SuDS project was a result of collaboration between the Environment Agency, Nottingham City Council, Groundwork Greater Nottingham and Severn Trent Water. The construction phase was completed in May 2013.

The scheme was designed to achieve the following objectives;

- Document and evaluate the design and construction of a series of rain gardens within an existing highway setting.
- Maximise surface water interception, attenuation and infiltration.
- Test the effectiveness of rain gardens in managing surface water from the public highway.
- Encourage participation from local residents in the design and future management of the rain gardens.
- Evaluate the effectiveness of the scheme as an engagement tool around the sources of urban diffuse pollution and flood risk.
- Highlight the role that retrofit SuDS can play in improving the quality and reducing the volume of surface water flowing to urban watercourses.

https://www.susdrain.org/case-studies/case_studies/greening_streets_retrofit_rain_gardens_nottingham.html

October 2013

Blue Green Infrastructure project – Day Brook

My Nottingham
@MyNottingham

5th Feb 2020

We've completed flood alleviation work on Valley Road. 👍

The Blue Green Infrastructure project will lower flood risk for 160 properties near the Day Brook 🙌🙌🙌

Now that the river realignment is complete, landscaping work will begin in the spring 😀

Sally Longford and Dave Trimble

- Realignment of the river channel
- New paths for improved public access
- Creation of new wildlife habitats
- Improved flood risk management
- Funded by European Regional Development Fund Flood Defence Grant in Aid (FDGiA) and Local Levy

Resilience (Blue-Green+Grey)

Blue-Green infrastructure can have a **significant impact** on **local** surface water flood risk but it is **very challenging** to significantly impact on **low probability high consequence floods** at river catchment scale using such techniques.

Resilience (Blue-Green+Grey)

- Blue-Green + Grey = multiple benefits
- Day-to-day accrual of non-flood benefits
- Multifunctional infrastructure to meet strategic objectives of different departments/organisations
- Healthier, happier and resilient communities
- Extend lifetime of existing grey assets
- Designing for (safe) exceedance

CIRIA https://www.ciria.org/Resources/Free_publications/c738.aspx

Resilience - extend lifetime of existing grey assets

Source: flikr (eutrophication&hypoxia)

Investment in sewer system expansion and treatment plant upgrades has taken priority over improving the current sewer system.

Rehabilitation of intra-urban assets is not keeping pace with deterioration.

For example, Thames Water's sewer pipes are, on average, 80 years old

34% are over 100 years old

Thames Water. 2018 PR19 - Appendix 4 - Resilience. https://corporate.thameswater.co.uk/-/media/Site-Content/Thames-Water/Corporate/AboutUs/Our-strategies-and-plans/PR19/Appendix-4-Resilience.pdf.

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New ideas – Benthemplein Water Plaza, Rotterdam

Benthemplein Water Plaza, Rotterdam

Images:
http://www.urbanisten.nl/wp/?portfolio=waterplein-benthemplein

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Drijvend Paviljoen (floating pavilion), Rotterdam

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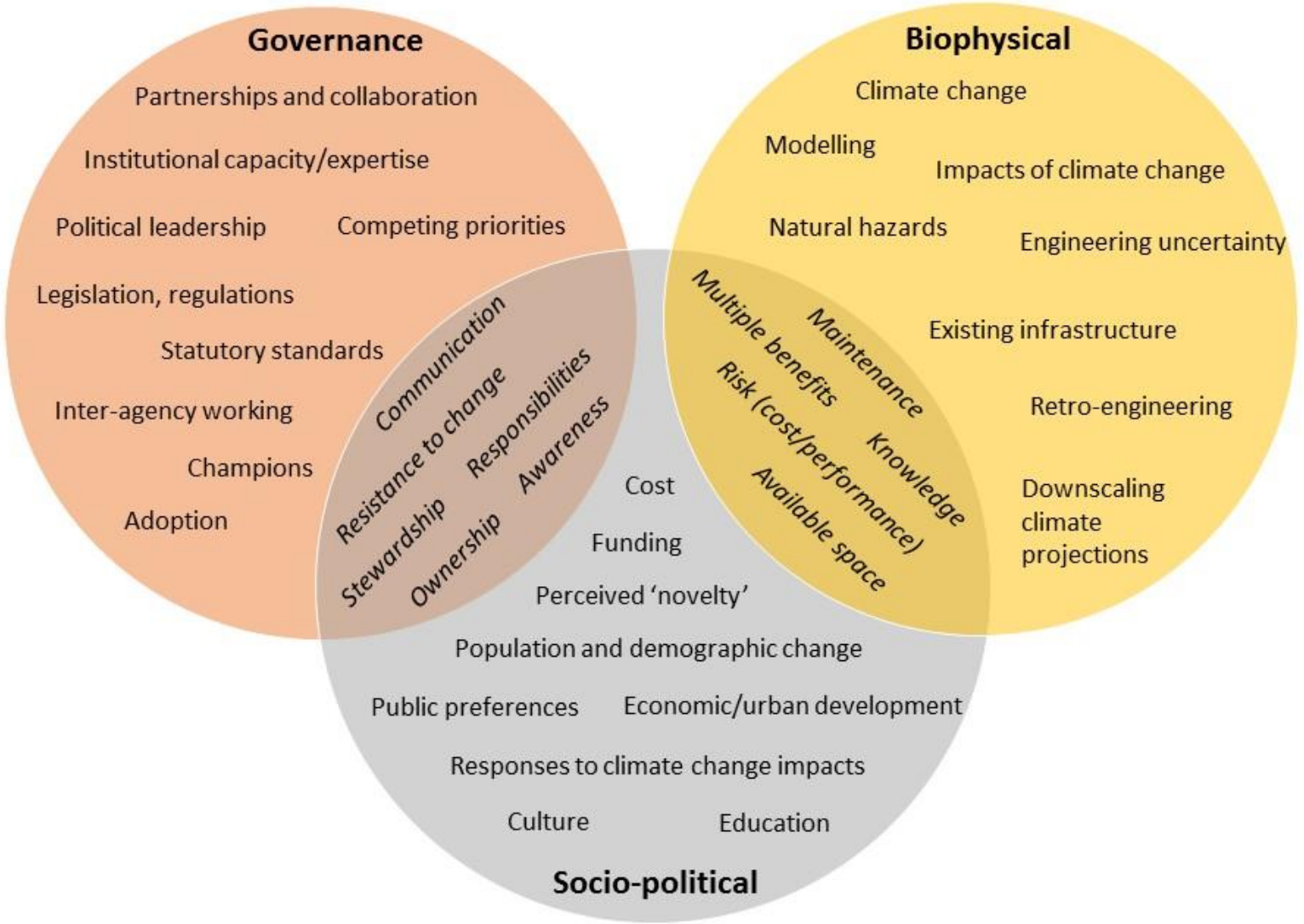
Barriers to Blue-Green infrastructure implementation



O'Donnell et al., (2017) Recognising barriers to implementation of Blue-Green infrastructure: a Newcastle case study.

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Overcoming the barriers to Blue-Green infrastructure delivery

1. Promote multi-functional space and identify, quantify and monetise the multiple benefits
2. Improve education and communication, raise awareness, community engagement
2. Partnership working from the project outset
4. Changes in legislation, regulations, industry standards, planning guidelines
5. Exemplars (examples of best practice, local and international)

O'Donnell et al., (2017) Recognising barriers to implementation of Blue-Green infrastructure: a Newcastle case study.

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Acknowledgement

The research presented in this presentation is being conducted as part of the Urban Flood Resilience Research Consortium with supported from: