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Flood resilience in an uncertain future: The role of Blue-Green Infrastructure

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EPSRC
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Flood risk

Urban flooding is one of the key global challenges of the 21st Century

5.2 million properties (England) and large proportions of the UK's key infrastructure are at risk

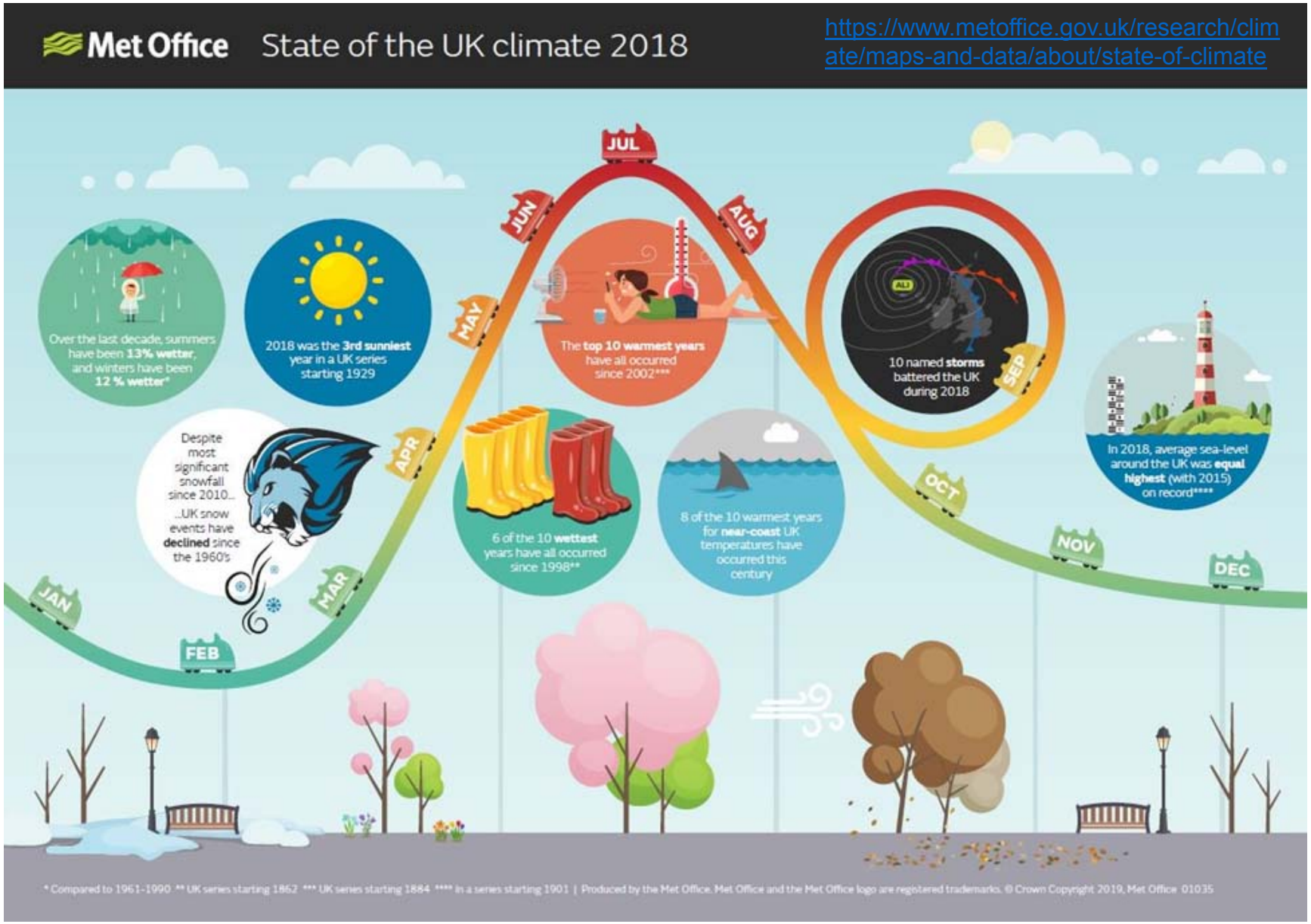
Annual expected damages (England and Wales) due to coastal and river flooding exceed £1 billion

Social justice – most deprived areas are often at highest risk, less ability to prepare and adapt

https://www.theguardian.com/environment/2019/nov/12/flooding-caused-by-poor-management-and-floodplain-building

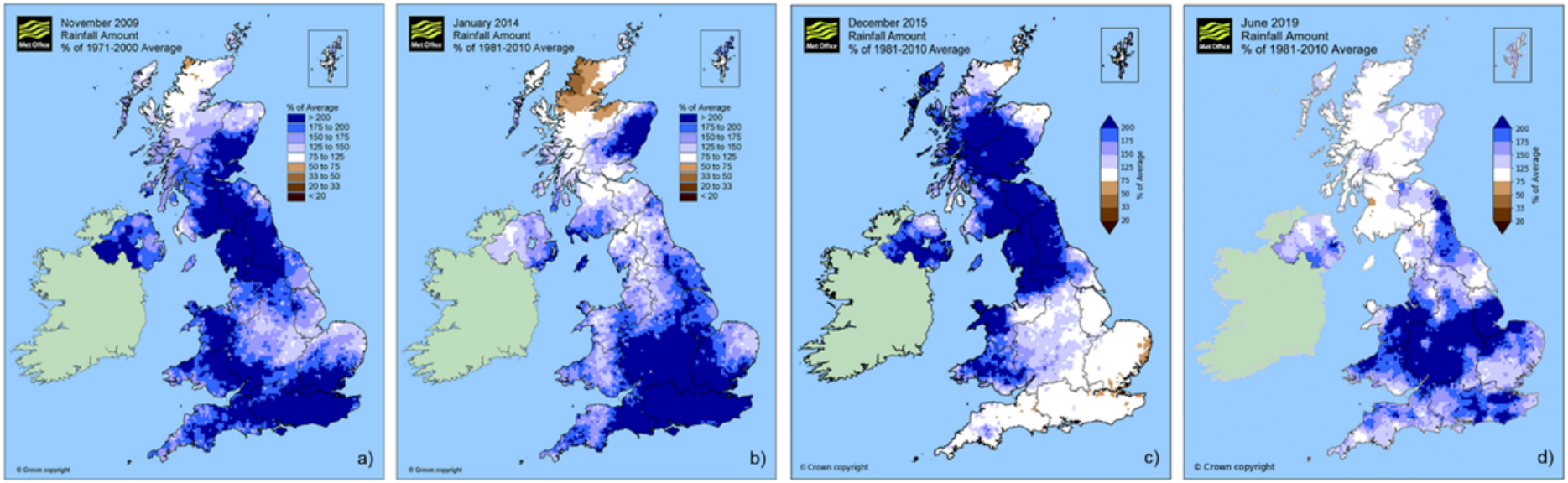
Future flood risk is increased by climate change, urbanisation, and ageing infrastructure

UK climate and future flood risk



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, and O'Donnell and Thorne (*accepted*).

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

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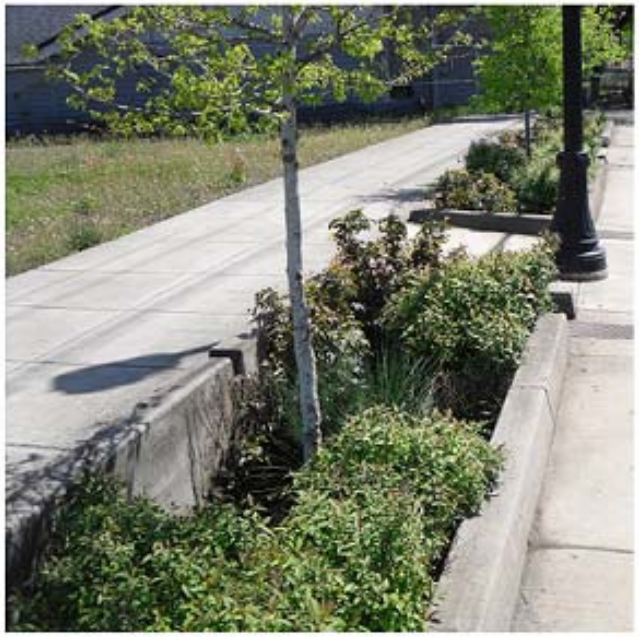
Traditional grey infrastructure

Blue-Green infrastructure

Photo credit:
Emily O'Donnell

Linear wetland → long swale → sediment basin



Rain garden / swale

Pond

Wetland

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Blue-Green Infrastructure – green roofs

Photo credit:
Noelwah Netusil

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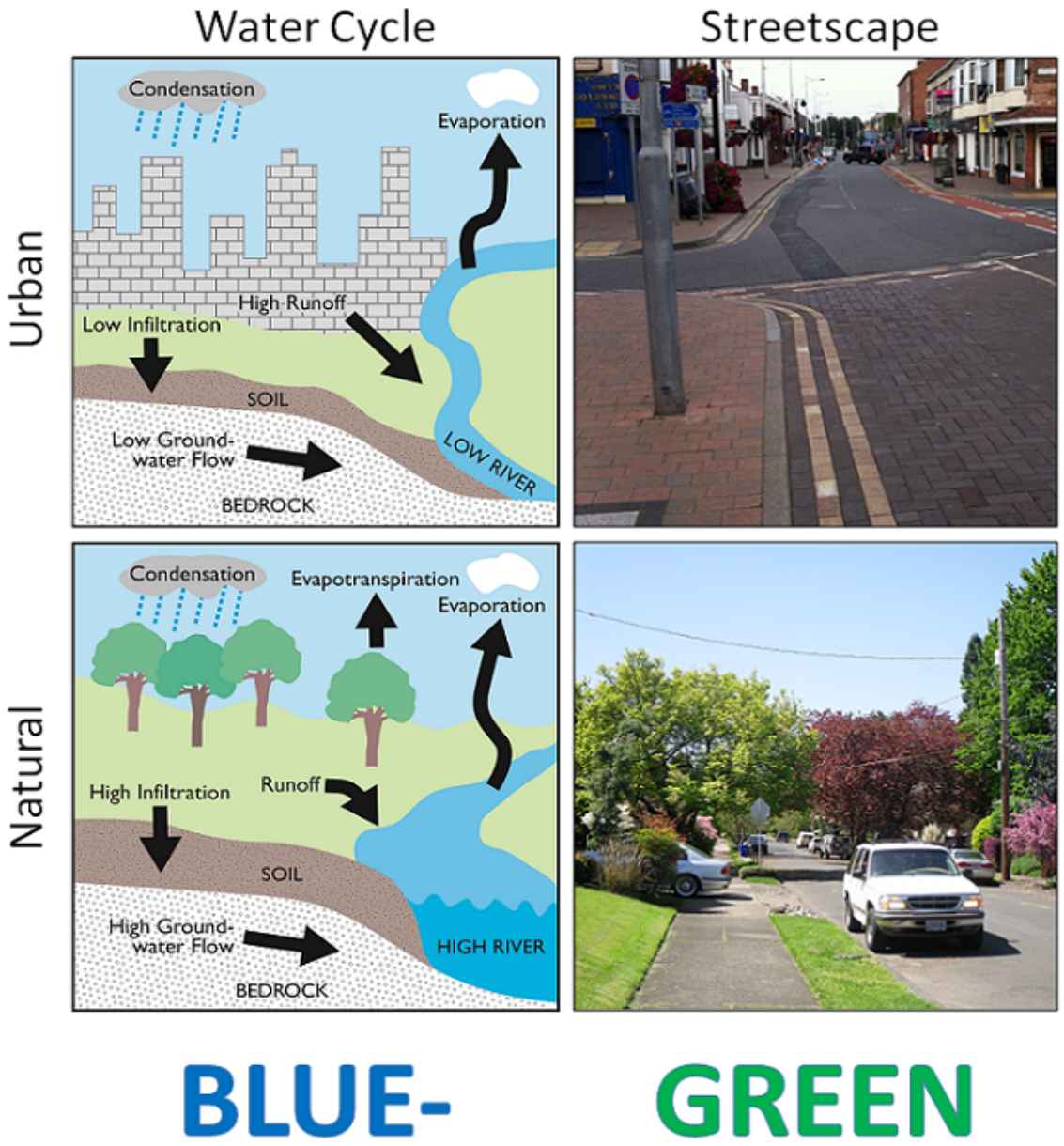
Blue-Green Cities



BLUE- **GREEN**

- Working with nature to manage water and deliver a range of other benefits to society, the economy and the environment
- Multi-functional landscape
- Blue-Green space connectivity
- Integration with existing and new grey infrastructure

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Multiple benefits of Blue-Green infrastructure

Photo credit:
Emily O'Donnell

Key benefits:

- Water management
- Cooling
- Education
- Improving water quality

Ellis Meadows Flood Alleviation Scheme (Leicester)

Photo credit: Emily O'Donnell

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

*https://news.leicester.gov.uk/news-articles/2018/july/ellis-meadows-thriving-as-new-home-for-nature-1/

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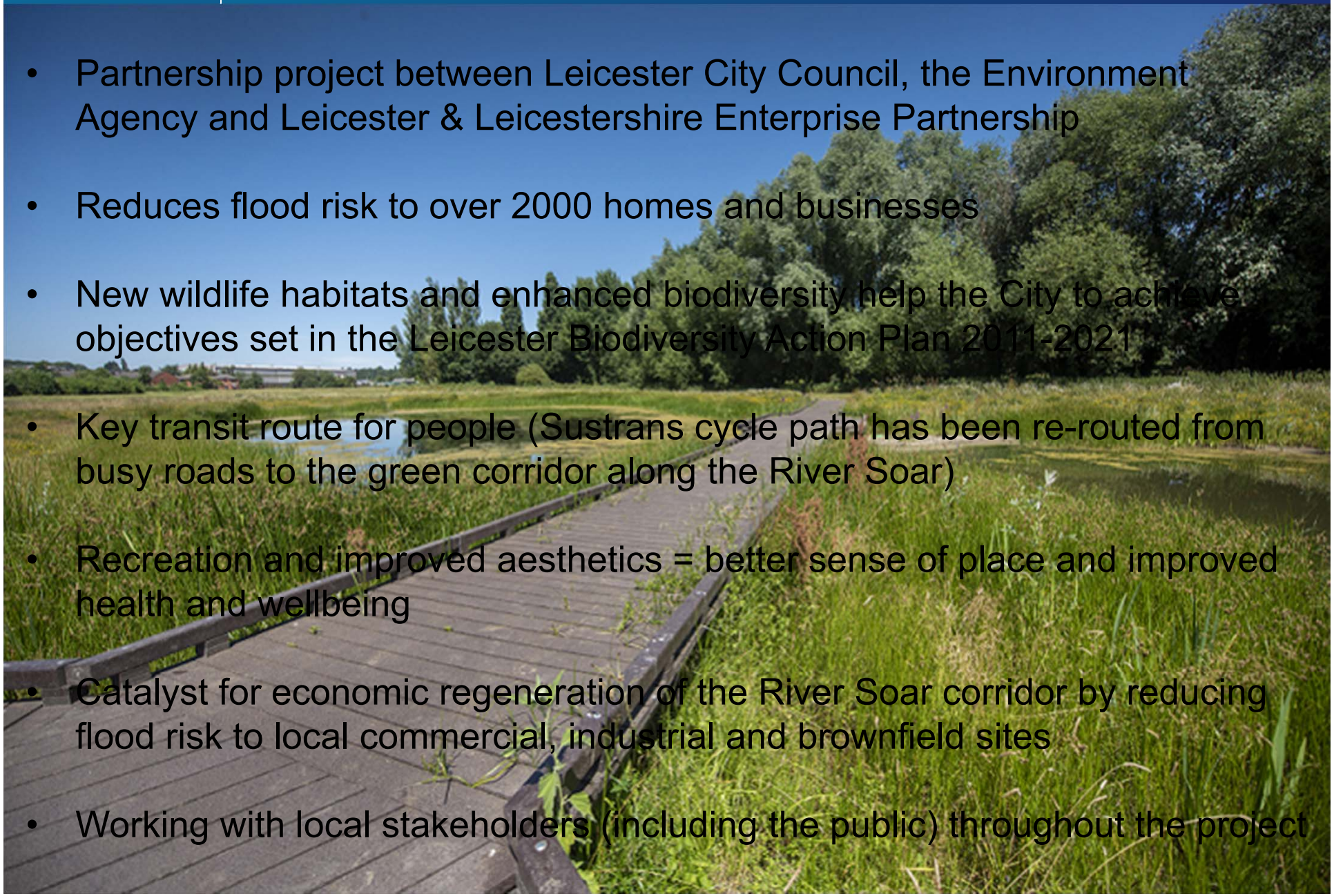
Ellis Meadows Flood Alleviation Scheme (Leicester)



- Partnership project between Leicester City Council, the Environment Agency and Leicester & Leicestershire Enterprise Partnership
- Reduces flood risk to over 2000 homes and businesses
- New wildlife habitats and enhanced biodiversity help the City to achieve objectives set in the Leicester Biodiversity Action Plan 2011-2021
- Key transit route for people (Sustrans cycle path has been re-routed from busy roads to the green corridor along the River Soar)
- Recreation and improved aesthetics = better sense of place and improved health and wellbeing
- Catalyst for economic regeneration of the River Soar corridor by reducing flood risk to local commercial, industrial and brownfield sites
- Working with local stakeholders (including the public) throughout the project

Ebbsfleet Garden City – UK Healthy New Town

International Design Competition Winner: HALO (Hives, Arcs, Links and Organics)

Developed by Bradley Murphy Design, in collaboration with John Thompson Partnership, Peter Brett Associates and Sebastien Boyesen.

https://www.landscapeinstitute.org/news/ebbsfleet-design-competition-winner-announced/

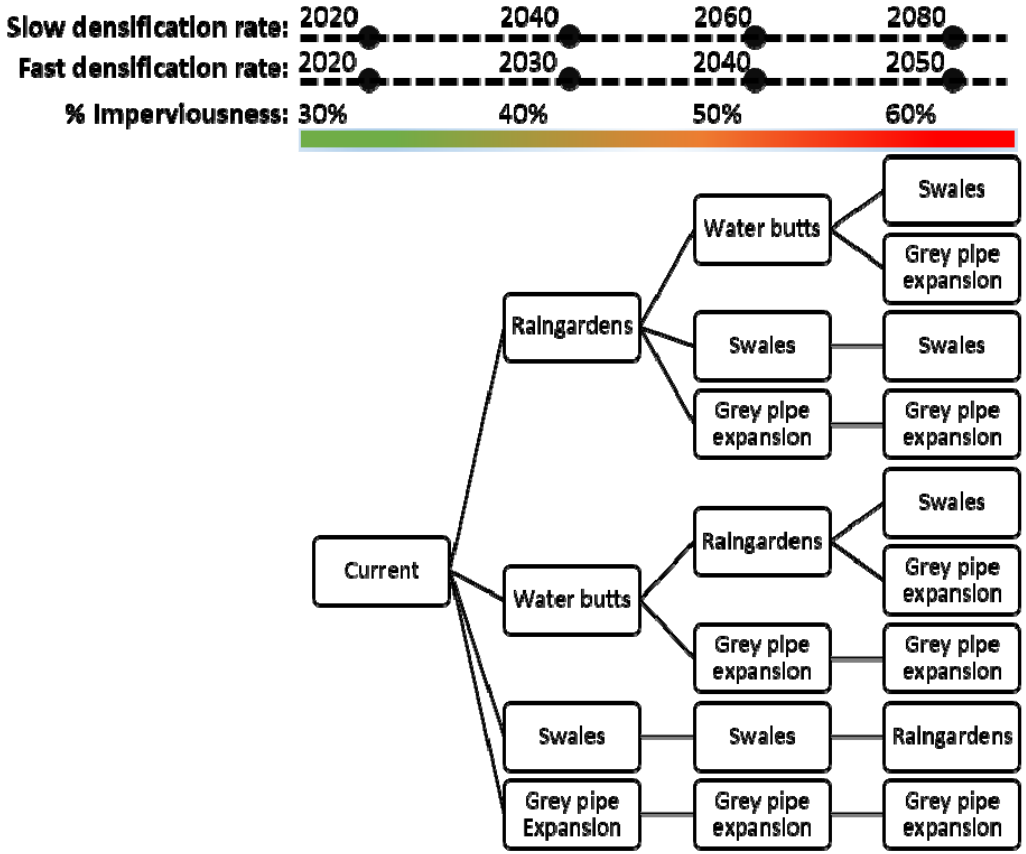
Integrating Blue, Green and Grey

Benthemplein Water Plaza, Rotterdam

Photo credit: Ossip van Duivenbode
http://www.urbanisten.nl/wp/?portfolio=waterplein-benthemplein

Flood resilience under future uncertainty

Adaptation pathways for long-term planning & infrastructure design

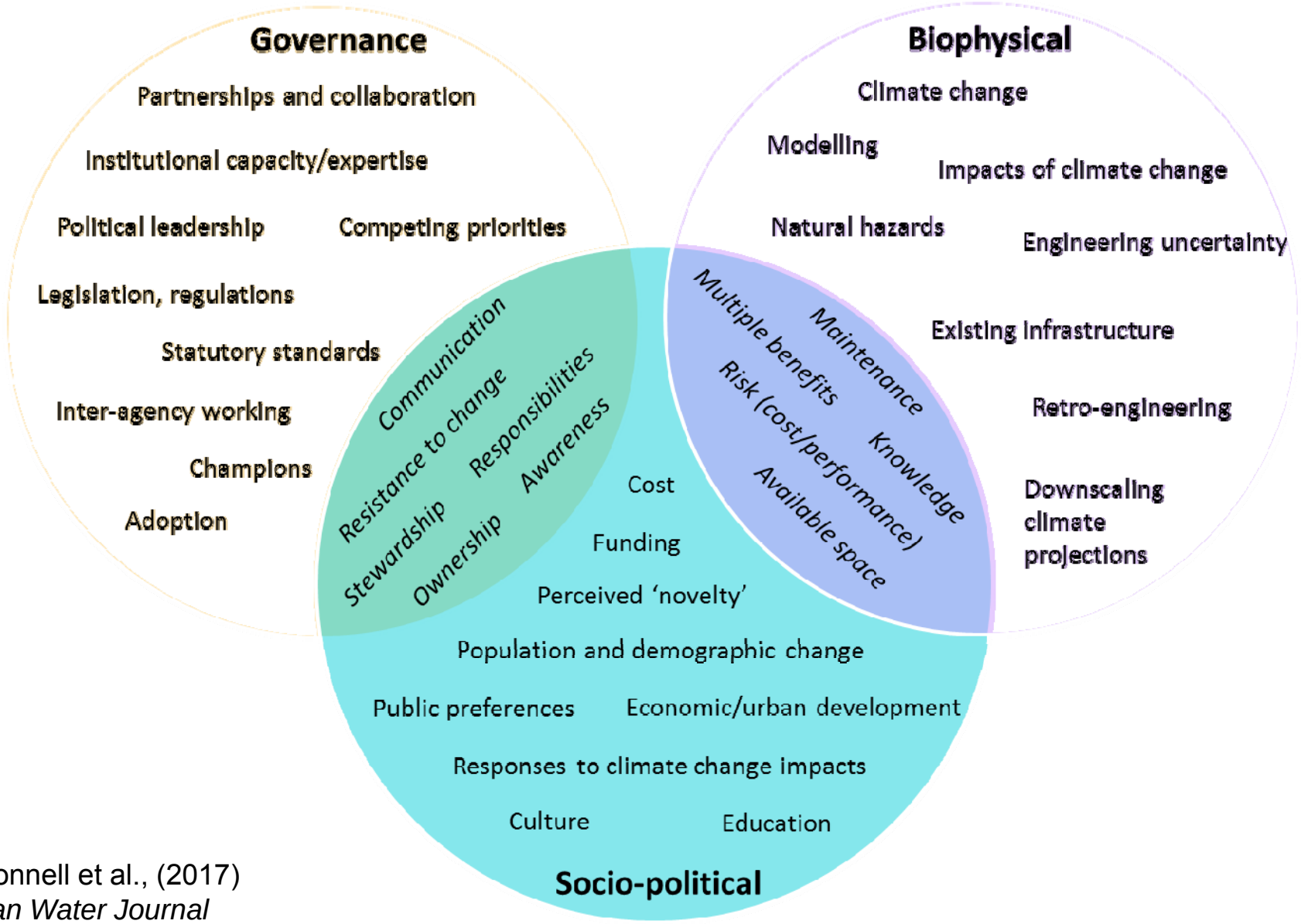


Pathways	Current Criteria	Additional Criteria		
	Standard CBA	Adaptiveness	Ease of Implementation	Multiple Benefits
1	Medium	High	High	High
2	Medium	Medium	Medium	High
3	High	High	Medium	Medium
4	Medium	Medium	High	Low
5	Medium	Medium	Medium	High
6	Medium	High	Medium	Medium
7	Medium	Low	Medium	Low
8	High	Medium	Medium	High
9	Medium	Low	Medium	None

O'Donnell et al., (2019)
Blue-Green Systems

- Designing optimal solutions in public spaces

Barriers to Blue-Green Infrastructure



O'Donnell et al., (2017)
Urban Water Journal

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)
Urban Water Journal

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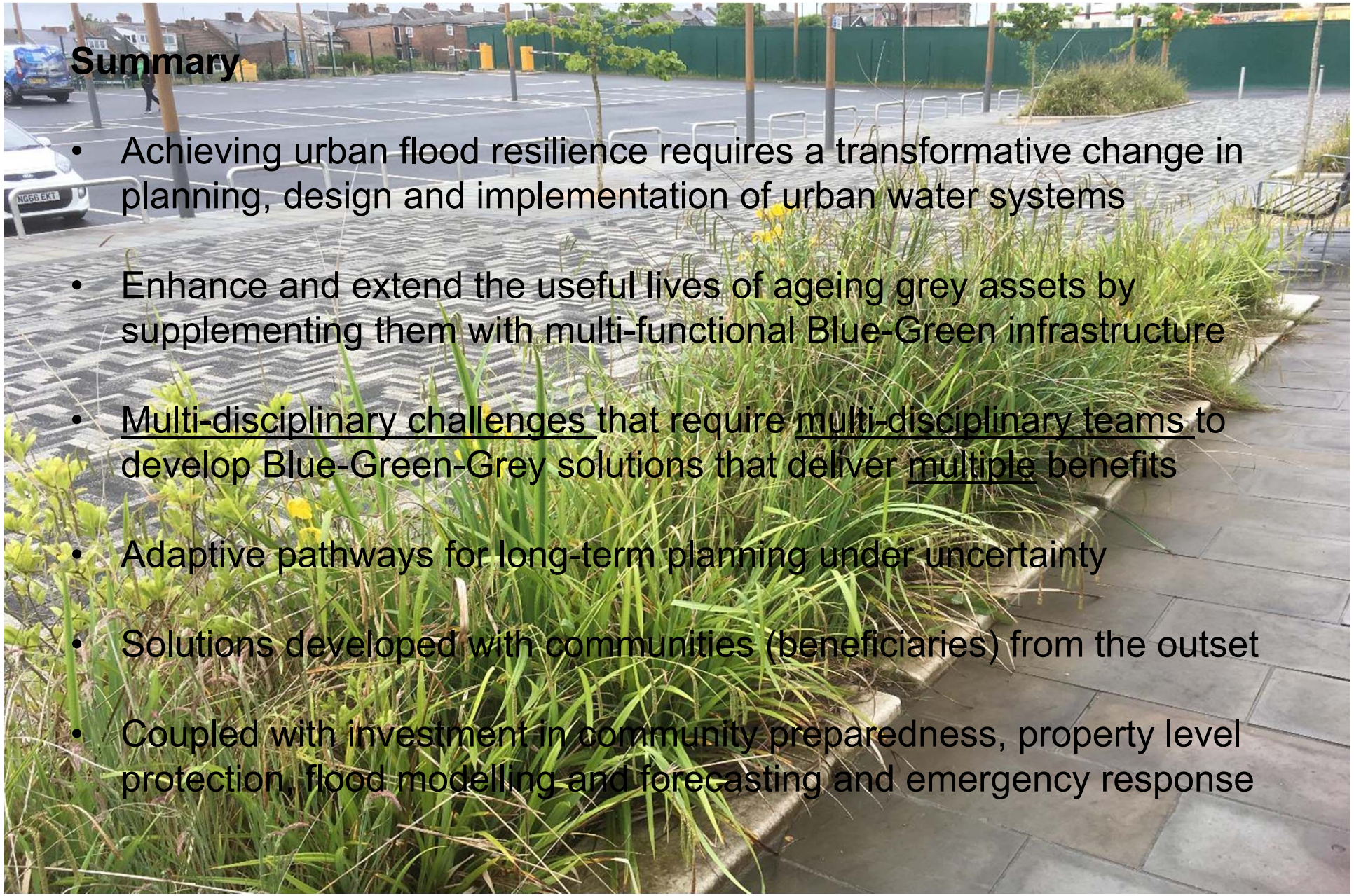
The Blue-Green Path to Urban Flood Resilience



Summary

- Achieving urban flood resilience requires a transformative change in planning, design and implementation of urban water systems
- Enhance and extend the useful lives of ageing grey assets by supplementing them with multi-functional Blue-Green infrastructure
- Multi-disciplinary challenges that require multi-disciplinary teams to develop Blue-Green-Grey solutions that deliver multiple benefits
- Adaptive pathways for long-term planning under uncertainty
- Solutions developed with communities (beneficiaries) from the outset
- Coupled with investment in community preparedness, property level protection, flood modelling and forecasting and emergency response

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Department for Infrastructure An Roinn Bonneagair
Public Health England
water industry forum
sniffer knowledge brokers for a resilient Scotland
RTPI mediation of space · making of place
HR Wallingford Working with water
ARUP
ATKINS
NWG living water
Royal HaskoningDHV Enhancing Society Together
Stantec
RICARDO Ricardo Energy & Environment
SWECO