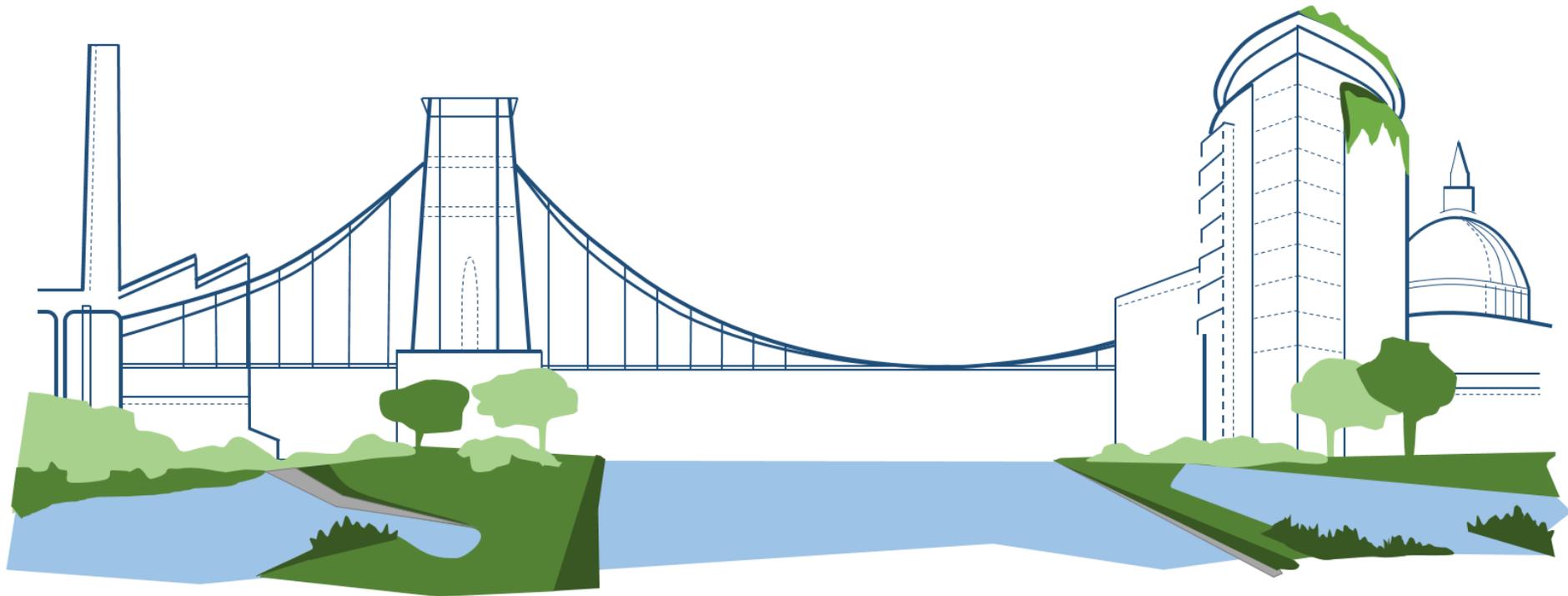
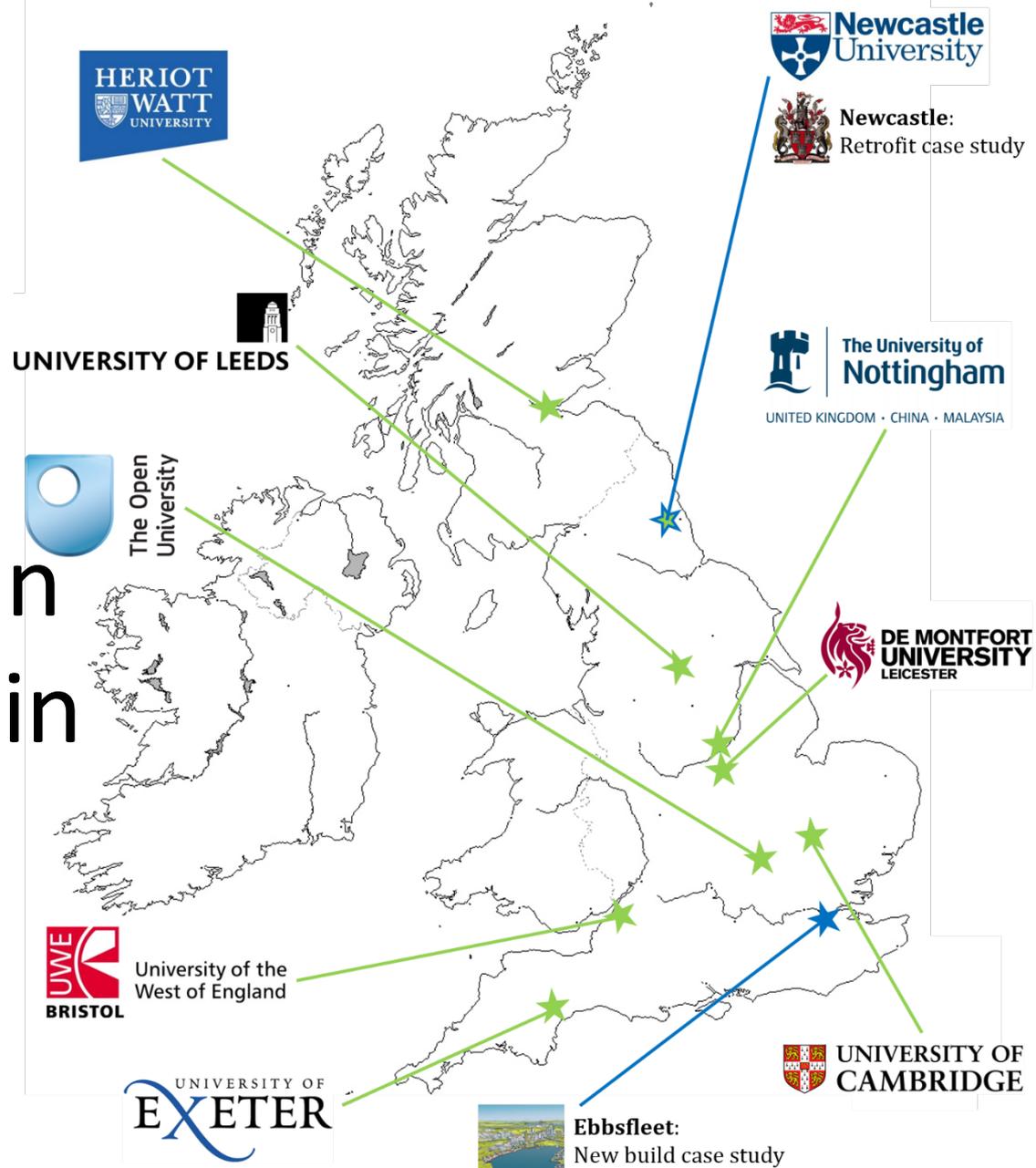


Achieving Urban Flood Resilience in an Uncertain Future



UK Urban Flood Resilience in an Uncertain Future Research Consortium



Urban Flood Resilience in and Uncertain Future

New EPSRC research consortium project

Building on the findings from previous EPSRC research recently completed:

- Blue Green Cities

Key findings:

- Benefits of SuDS and green infrastructure in flood risk and urban stormwater management
- Importance of communities in BGI adoption, implementation and management
- Advanced modelling of cityscape flooding (CityCAT)

Urban Flood Resilience in and Uncertain Future

New EPSRC research consortium project

Building on the findings from previous EPSRC research recently completed:

- Blue Green Cities

Key findings:

- Benefits of SuDS and green infrastructure in flood risk and urban stormwater

- FLOODMemory

Key findings:

- Longer term modelling and analysis of rainfall and flows is key to understanding major flood events
- Identification method of cluster flooding and rainfall
- Multiple flood event impact on river morphology and the impact of this on flood risk and inundation depth/extent

Urban Flood Resilience in and Uncertain Future

New EPSRC research consortium project

Building on the findings from previous EPSRC research recently completed:

- Blue Green Cities

Key findings:

- Benefits of SuDS and green infrastructure in flood risk and urban stormwater

- FLOODMemory

Key findings:

- Longer term modelling and analysis of

- FCERM.net

Key findings:

- Identification of flood risk knowledge, understanding in the technical community
- Risk and limitation examination of current outreach and research knowledge exchange
- Methods of pathways to impact for research into local authorities and technical community

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Details of the Blue-Green Cities consortium research...

Delivering and evaluating multiple flood risk benefits in Blue-Green Cities



Blue Green Cities

Overarching Aim:

To develop new strategies for managing urban flood risk as part of wider, integrated urban planning intended to achieve environmental enhancement and urban renewal in which multiple benefits of Blue-Green Cities are rigorously evaluated and understood.

'Blue-Green Cities aim to recreate a naturally oriented water cycle while contributing to the amenity of the city by bringing water management and green infrastructure together'

Wikipedia

https://en.wikipedia.org/wiki/Blue-Green_Cities

Blue Green Cities

Key research findings and outputs:

Community understanding, behaviours and preferences

- Amenity, biodiversity and sustainability
- Public preferences regarding BGI
- Public awareness and understanding
- Behaviour and maintenance
- ‘normal’, co-development and co-ownership

Communities Want to Have a Voice

Residents can be positive about BGI generally, but the facilities closest to them may be a separate issue. The choice or height of plants, and placement of trees, can provoke strong opinions.

There is no universal measure for ‘amenity’; gaining the greatest approval from local communities will require co-developing solutions that take into account their understandings and preferences.



‘I don’t hate nothin’ about them, I like the beauty of them. The trees, they put really nice trees in them, they could’ve been putting some ugly trees in!’

‘I really can’t maintain another the tree, I can’t take care of it ... I love trees, but not in my yard!’

‘That tree is blocking the light from my trees. So my trees are going to die for their tree.’

[Portland residents on trees in bioswales]

Maintenance is a Key Issue



‘I put sand and cement in there to stop the weeds going through.’
[Bristol Dings resident]

Maintenance will be a concern for Local Authorities and residents; flood functions and amenity benefits will depend upon appropriate maintenance and behaviour.

Engagement and discussion with local residents could help shape behaviour and improve willingness to engage with clearing and maintenance.

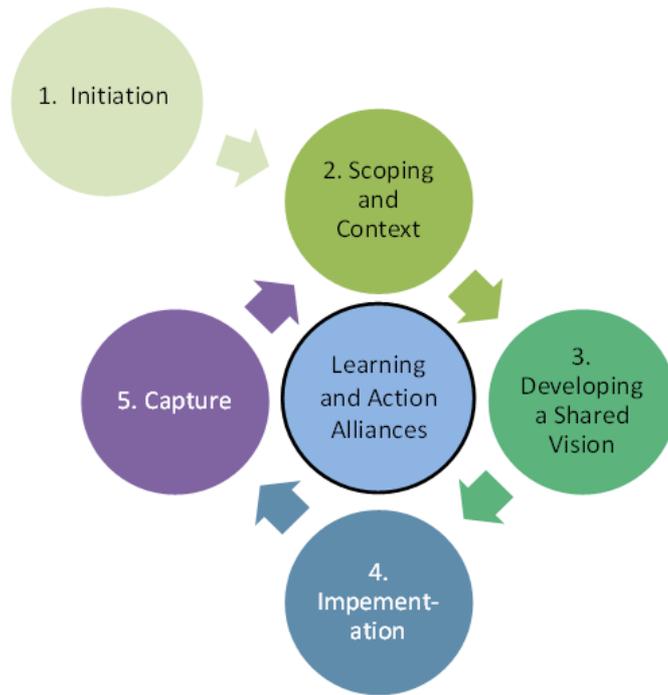


‘People dig soil out of their yard and dump it in the swale.’ [Portland resident]

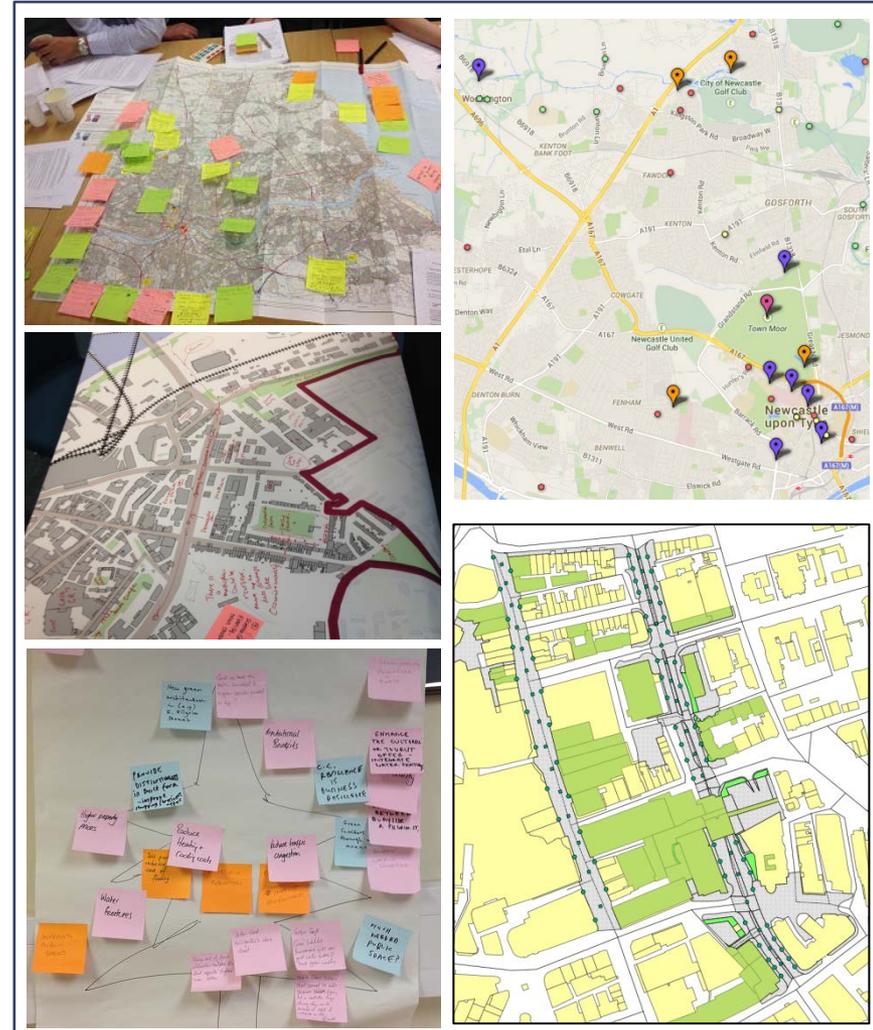
Blue Green Cities

Key research findings and outputs:

Local Action Alliance:



Establishing and running LAAs; five phases. Adapted from (Ashley et al., 2012)

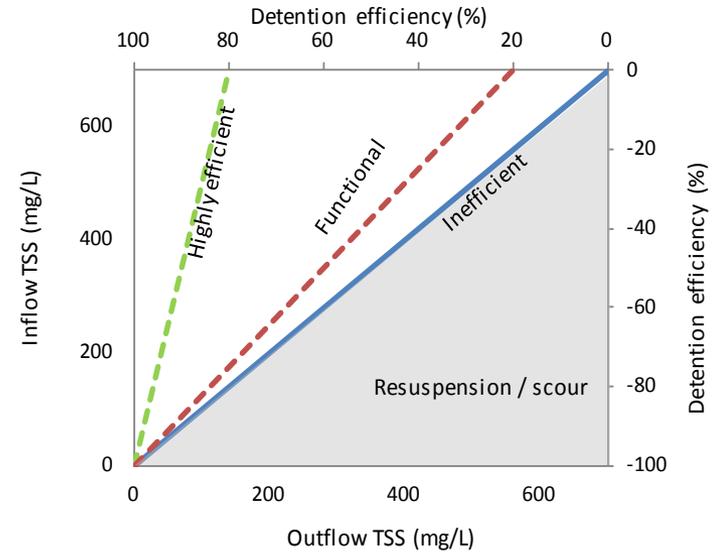
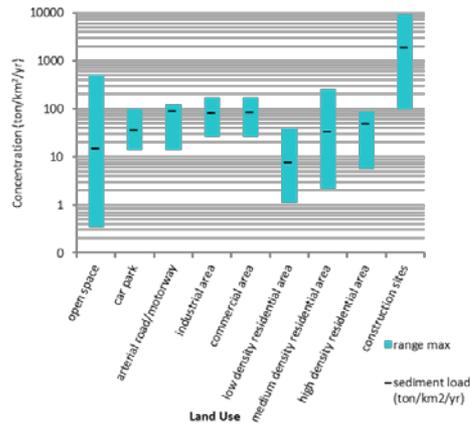


Blue Green Cities

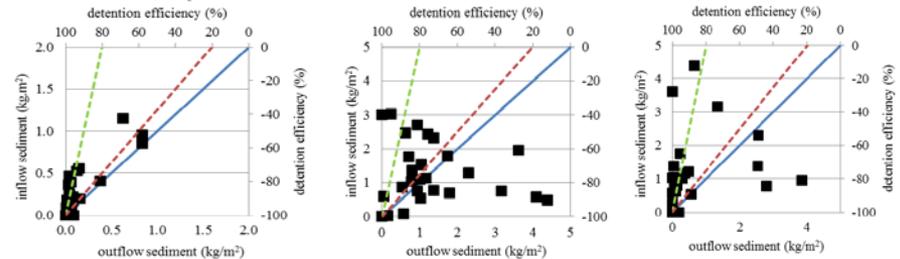
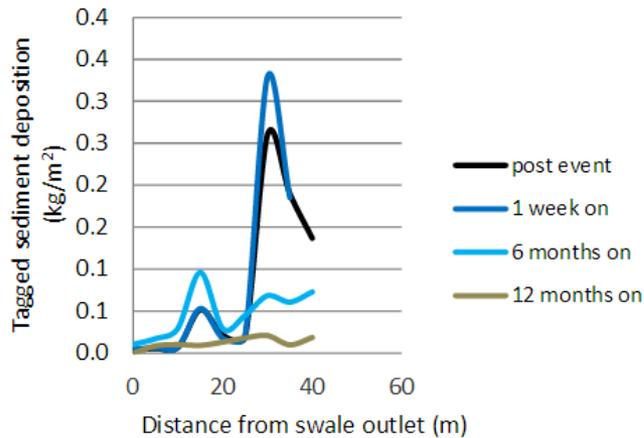
Key research findings and outputs:

SuDS asset performance:

Urban land use fine sediment loading rates



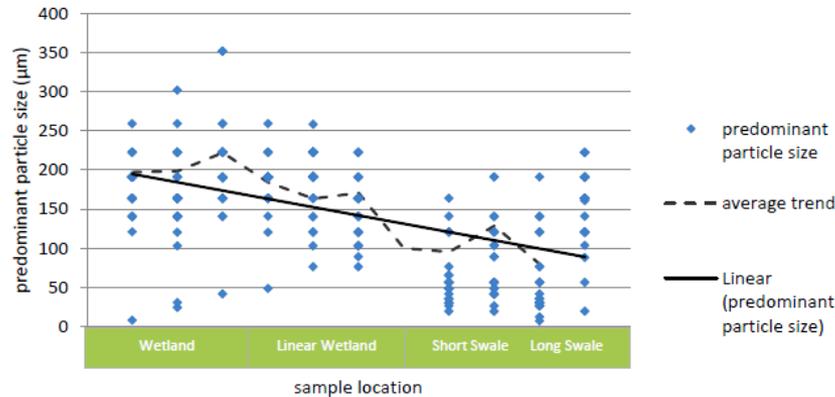
Tagged sediment monitoring through an established swale



Blue Green Cities

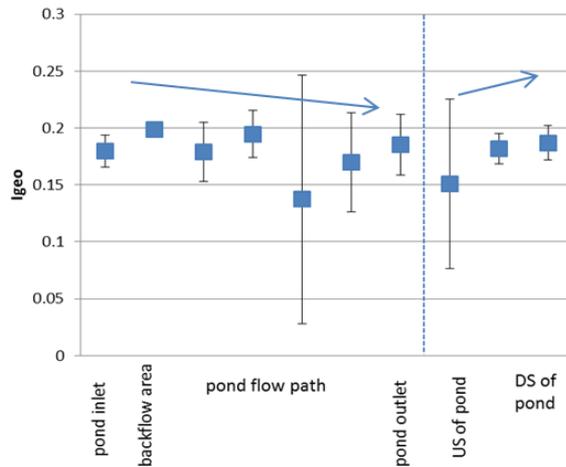
Key research findings and outputs:

SuDS asset performance:

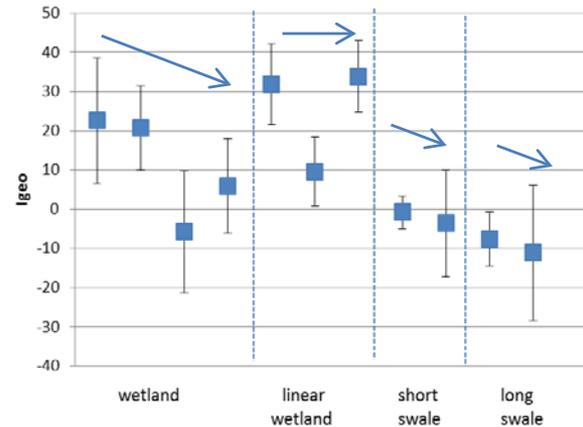


extremely contaminated ($I_{geo} > 5$)
 uncontaminated ($I_{geo} = 0$)

I_{geo} for Fe @ NGP



I_{geo} for Zn @ J4M8

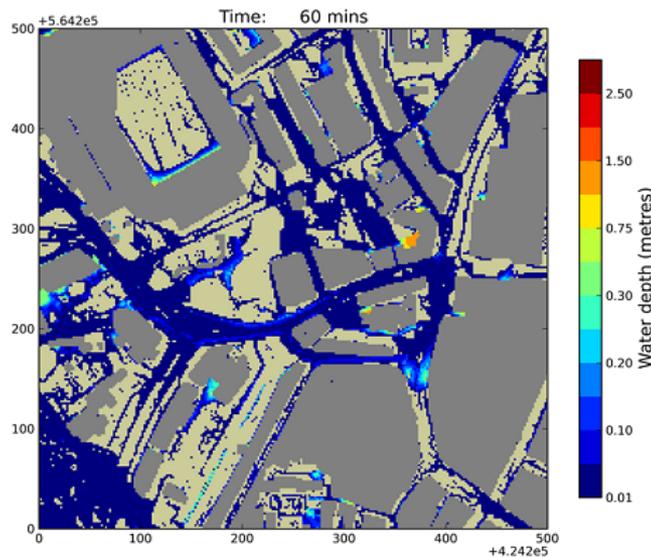


Blue Green Cities

Key research findings and outputs:

CityCAT linked surface-subsurface urban flood modelling:

- Inclusion of green roofs, water butts ... green infrastructure into urban runoff modelling
- Connection of subsurface pipe network to surface runoff model
- Pluvial flood modelling

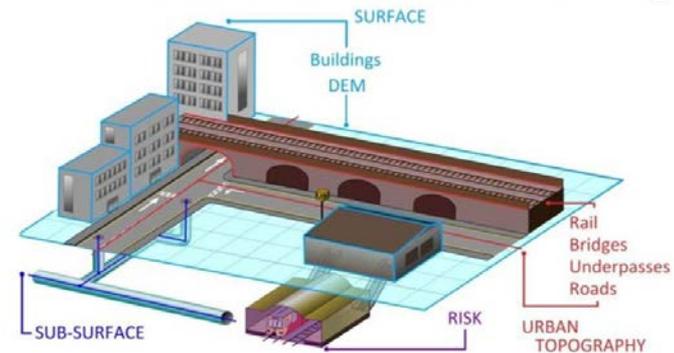


CityCAT: Combined sewer and surface water flood model

couples surface + subsurface drainage networks

models flooding due to:

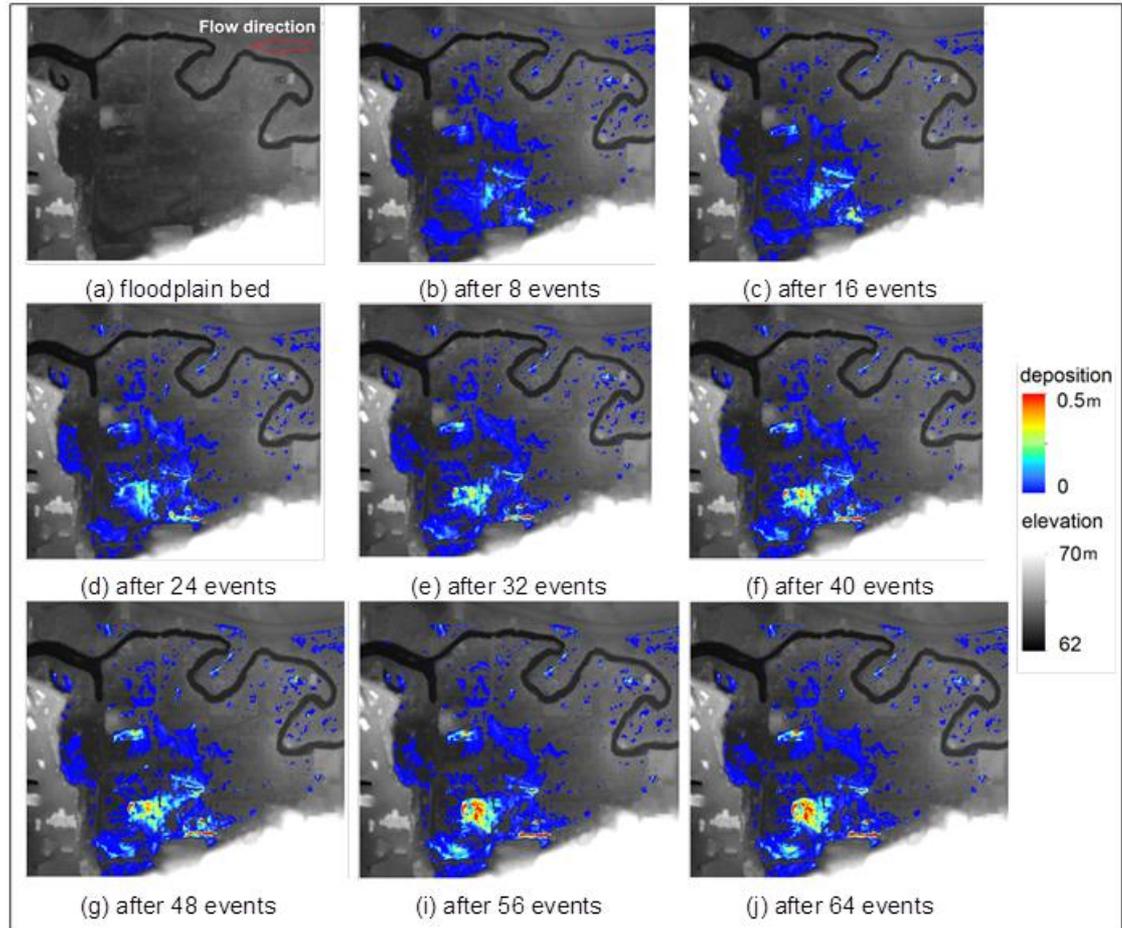
rainfall + blocked sewers + sewer surcharge



Blue Green Cities

Key research findings and outputs:

Sediment deposition on reconnected/restored floodplains:

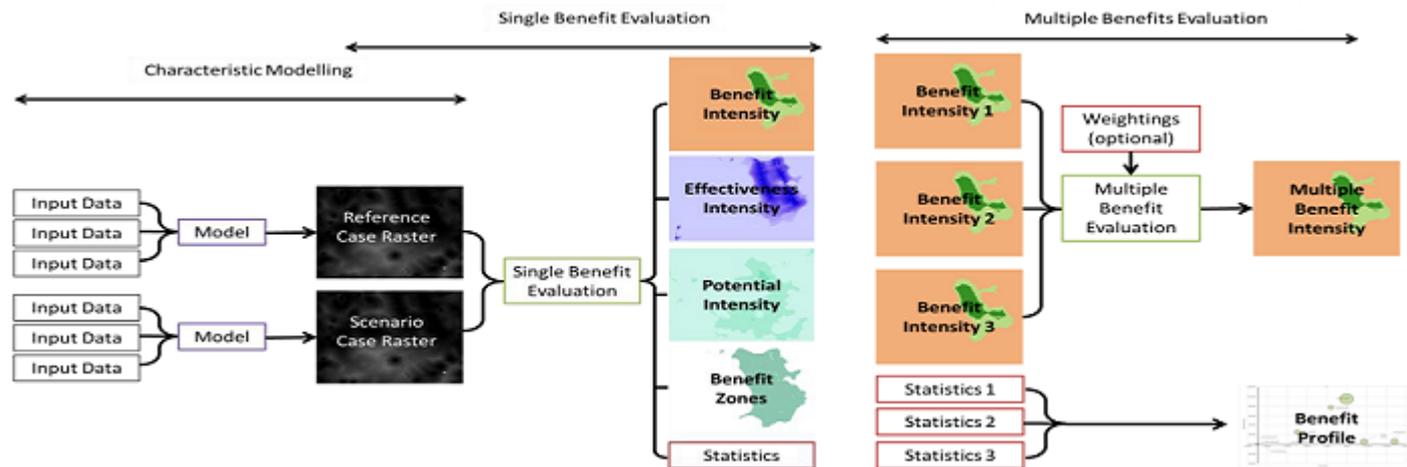


Cumulative sediment depositions after 8, 16, 24, 32, 40, 48, 56 and 64 events

Blue Green Cities

Key research findings and outputs:

Multiple Benefits Toolbox



- Designed to show potential multiple benefits from Blue-Green Infrastructure and Sustainable urban Drainage Scheme approach to stormwater management

Blue Green Cities

Key research findings and outputs:

Multiple Benefits Toolbox

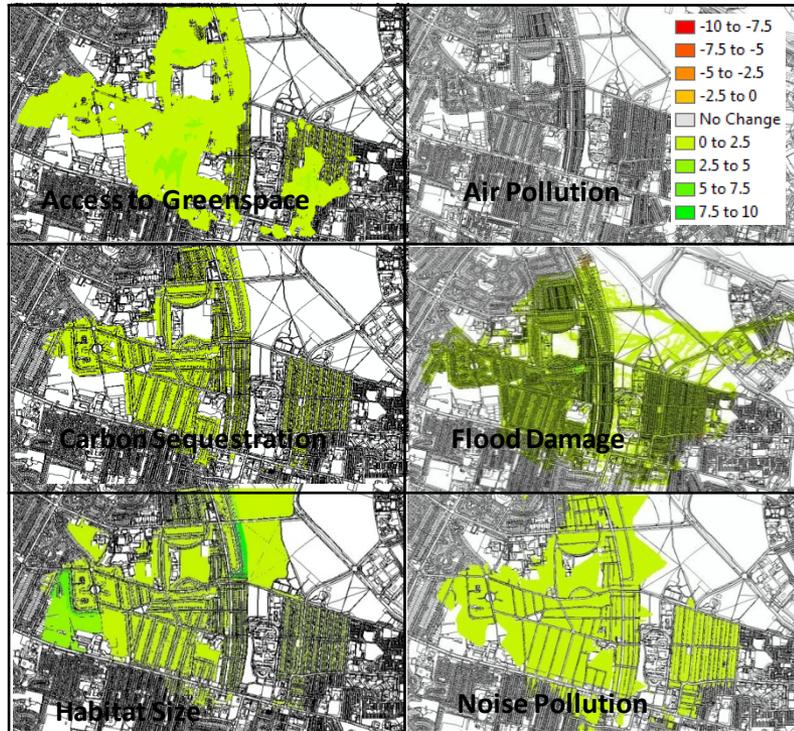


Figure 1. Spatial Distribution of Individual Benefit Intensities for Wingrove

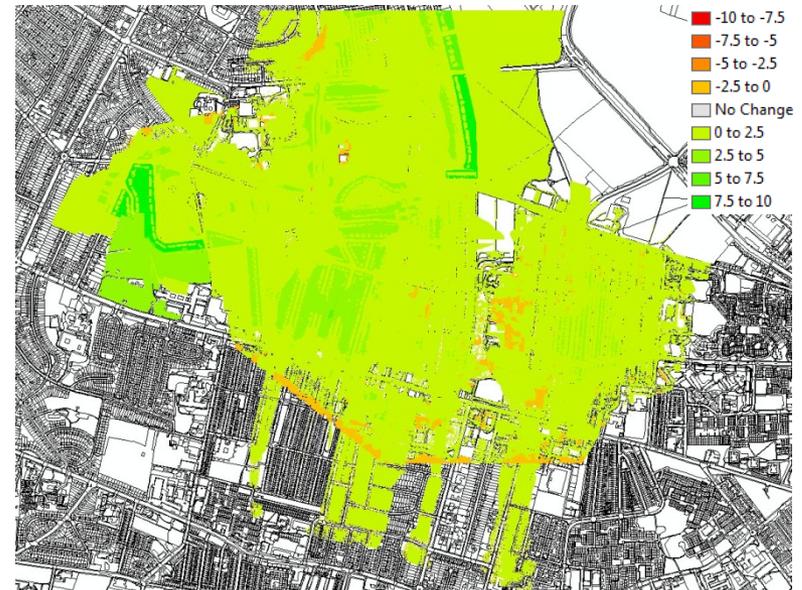


Figure 2. Spatial distribution of multiple benefit intensity for Wingrove

<http://onlinelibrary.wiley.com/doi/10.1111/jfr3.12267/epdf>

<http://www.bluegreencities.ac.uk/publications/multiple-benefit-toolbox.aspx>

Blue Green Cities

New CIRIA guidance documents.... *out later this year...*

Blue Green Infrastructure – Perspectives on Planning, Evaluation and Performance
Part 1: Planning & Evaluation

C Thorne¹, E O'Donnell², S Maskery³, J Lamond⁴, G Everitt⁵, F Chan⁶, D Guan⁷, D Mendoza⁸, C Kilsby⁴, V Glennis⁴, N Wright², S Ahilan², R Fenner⁶, L Hong⁶, M Morgan⁶, I Holman⁷, J Mant⁷, L Smith⁸, H Haynes⁹, S Arthur⁹, D Allen⁹

¹University of Nottingham
²University of the West of England
³University of East Anglia
⁴Newcastle University
⁵Leeds University
⁶University of Cambridge
⁷Cranfield University
⁸London School of Economics
⁹Heriot Watt University



Blue Green Infrastructure – Perspectives on Planning, Evaluation and Performance
Part 2: Asset Performance

C Thorne¹, E O'Donnell², S Maskery³, J Lamond⁴, G Everitt⁵, F Chan⁶, D Guan⁷, D Mendoza⁸, C Kilsby⁴, V Glennis⁴, N Wright², S Ahilan², R Fenner⁶, L Hong⁶, M Morgan⁶, I Holman⁷, J Mant⁷, L Smith⁸, H Haynes⁹, S Arthur⁹, D Allen⁹

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New research advancing urban flood resilience knowledge ...

Achieving Urban Flood Resilience in an Uncertain Future



Urban Flood Resilience in and Uncertain Future

Overarching Aim:

To establish coordinated planning, design and operation of closely coupled urban water systems necessary to achieve transformative change in urban flood risk and water management.

‘How to we future proof our cities to ensure they are resilient in future climate, governance, economic, social and environmental uncertainty’

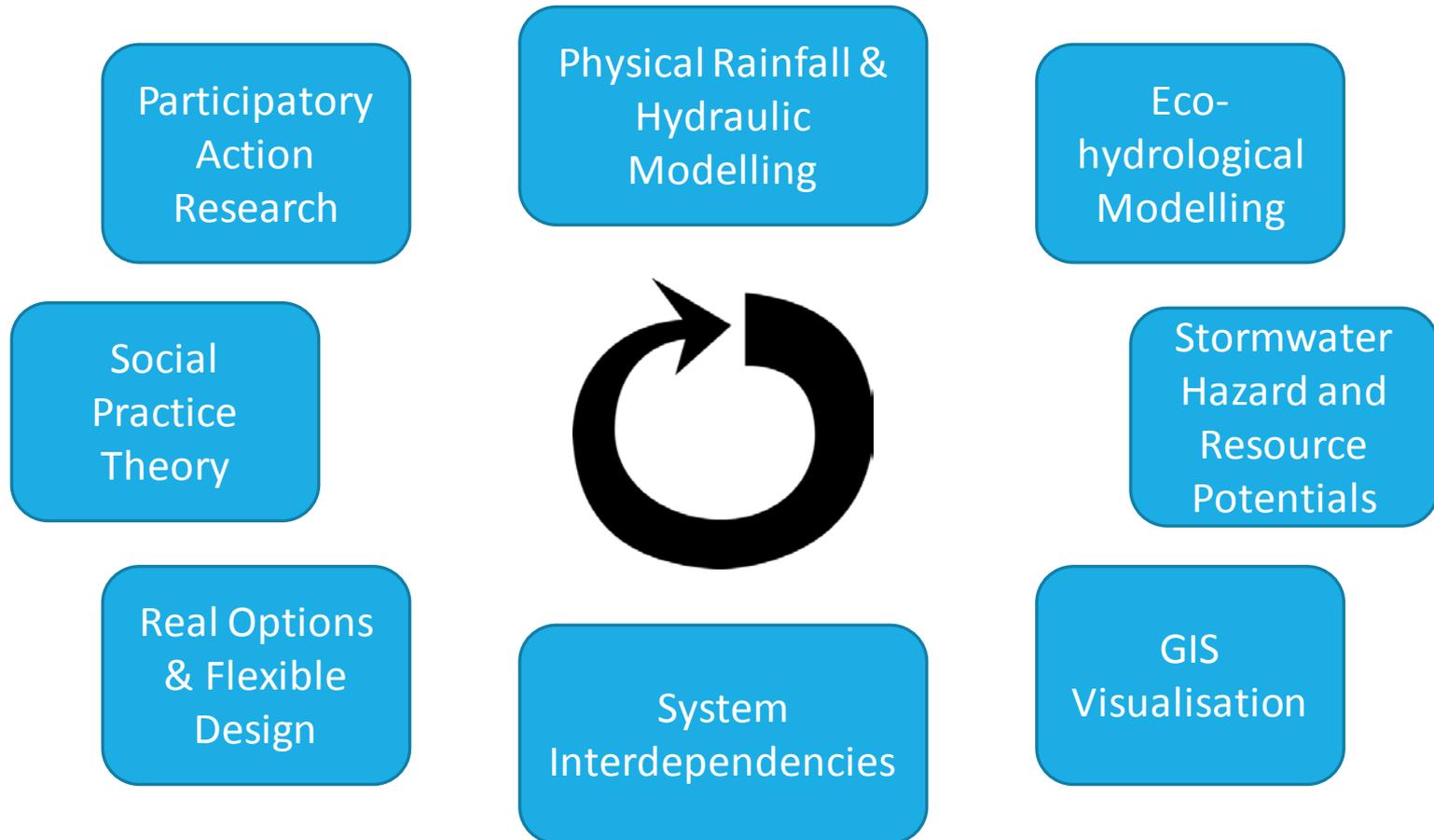
Urban Flood Resilience in and Uncertain Future

Research questions... How can we:

- 1. Adapt** flood and water quality treatment infrastructure– to meet the future challenges
- 2. Integrate** cutting edge models and data to assess the potential for BG+G infrastructure to meet these challenges
- 3. Align** engineered and natural systems and process to
 - realise potential of urban water (resource)
 - become inter-operable (link to other urban systems)
- 4. Co-produce** engineering, scientific and local knowledge, and apply it to adaptive flood and water infrastructure design for resilience
- 5. Evolve** stakeholder interactions to support flood resilience and water security

Urban Flood Resilience in and Uncertain Future

Research that aims to bring together



Urban Flood Resilience in and Uncertain Future

HWU research focus...

Resilience under Change

- *Co-optimize BG+G systems under future climate change and socio-economic change*
- *Understand long term BGI flood and water quality benefits and risks*
- *Evolve single 'design flood' analysis towards a 'stormwater cascade'*
- *Consider the potential of urban stormwater and a resource*

Urban Flood Resilience in and Uncertain Future

HWU research focus...

Activities

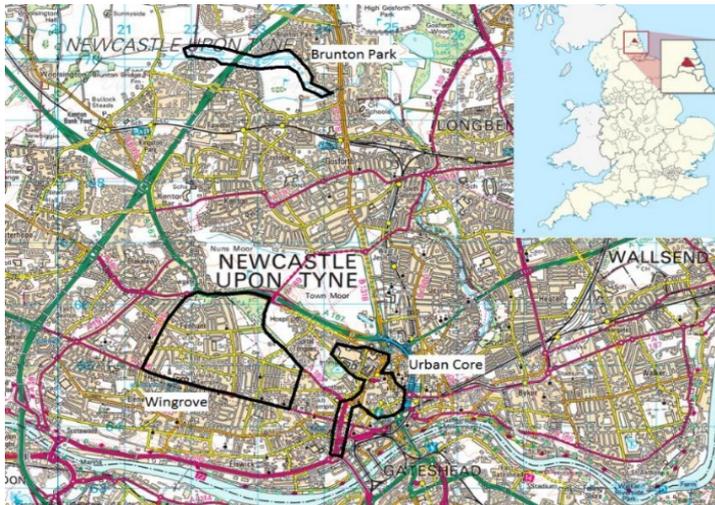
- *Quantify the performance of BGI systems... long term maintenance? multiple event influence? flood storage?*
- *Evaluate innovative SuDS devices implementation
new build ... up lift ... retrofit*
- *Optimise design for resilience
climate change, future policy priorities, 'real options'*

Urban Flood Resilience in and Uncertain Future

Case Study Sites

Newcastle (Urban Core and Great Park Development)

Ebbsfleet (Greater London)



Urban Flood Resilience in and Uncertain Future

Potential Scottish Case Study Sites

J4M8 Distribution Park



Houston Industrial Estate



Acknowledgement

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

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- Water Industry Forum
- UKWIR
- Atkins
- Ebbsfleet Development Corporation
- Newcastle City Council