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Blue–Green Cities

Integrating urban flood risk management with green infrastructure

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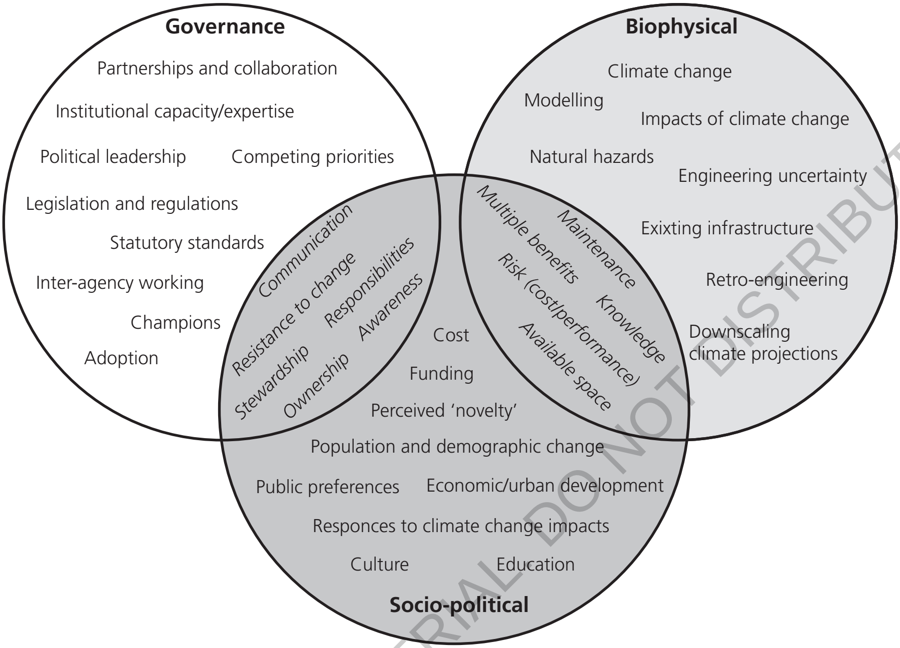
Figure 2.3 Uncertainties and barriers to the implementation of BGI



authority SuDS approval bodies (SABs) following implementation of Schedule 3 of the Flood and Water Management Act 2010 (HMG, 2010). As Schedule 3 and SABs were not implemented, these issues remain largely unresolved, and are particularly prevalent in new developments. A comprehensive summary of the uncertainties and barriers to the implementation of BGI is detailed in Figure 2.3. A third category (governance) has been added to the earlier bipartite division into biophysical or socio-political barriers to account for specific governance factors that have been shown to particularly hinder BGI and SuDS, such as policy arrangements, competing priorities for finite resources, and (lack of) institutional expertise.

2.3. Overcoming barriers to BGI

Overcoming barriers to the widespread implementation of BGI is challenging, particularly as many are systematic and embedded within organisational cultures, processes and practices. Concerted action and change are required at all stakeholder levels, from national government policy-makers – who have the power to change national legislation and determine clearer responsibilities for adoption and maintenance of BGI and SuDS – through to communities and individuals engaging and supporting BGI schemes and getting involved in stewardship opportunities (Table 2.2). Several of the strategies are further examined in Section 2.4 as best practice examples.

and open green spaces in Leicester (Figure 2.10). There were several drivers for the scheme alongside sustainable flood risk management, including creating new wildlife habitats and enhancing biodiversity in an area of poor ecological value, which help the city to achieve objectives set in the Leicester Biodiversity Action Plan 2011–2021 (Leicester City Council, 2011). More specifically, creation of the wetland and vegetation management has generated a mosaic of habitats (marsh wetland, native wildflower meadow and new woodland), which provide foraging and nesting habitats for birds and bats, and safe passage routes for badgers, other mammals and invertebrates. The site is also a key transit route for people. It is used by pedestrian commuters, and has enabled a nationally designated Sustrans cycle path to be rerouted from busy roads to the green corridor along the River Soar. It is well used for recreation, and has improved the local environment and aesthetics, contributing to creating a better sense of place, which links to the health and wellbeing objectives of the city (Leicester City Council, 2019b). The scheme was designed to be a catalyst for the economic regeneration of the River Soar corridor, and it has achieved this by reducing the flood risk to local commercial, industrial and brownfield sites (Environment Agency, 2014).

Figure 2.10 The Ellis Meadows urban flood alleviation scheme as part of the network of blue and green space along the River Soar in the city of Leicester. The circles illustrate the relative size of the parks and greenspaces (not to scale). (Adapted from the Leicester Riverside Environmental Strategy (Leicester City Council, 2019b))

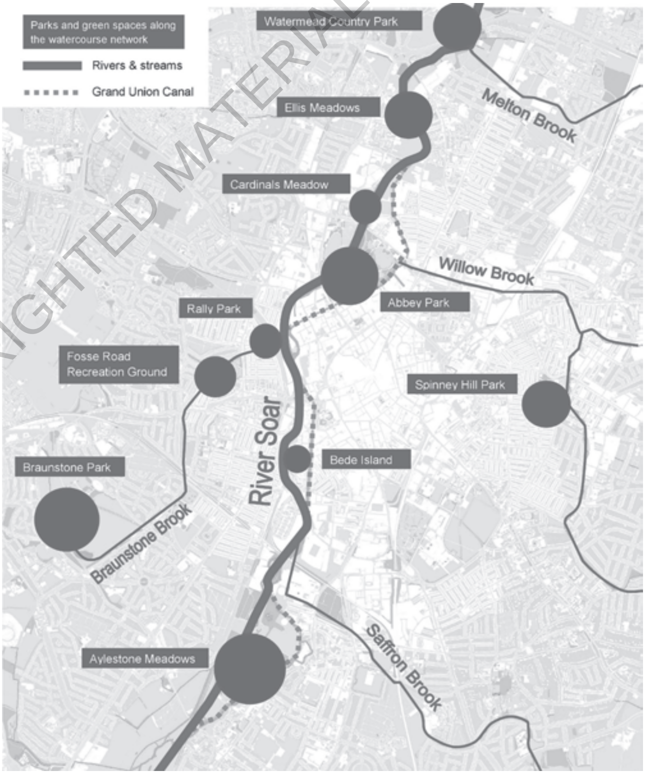
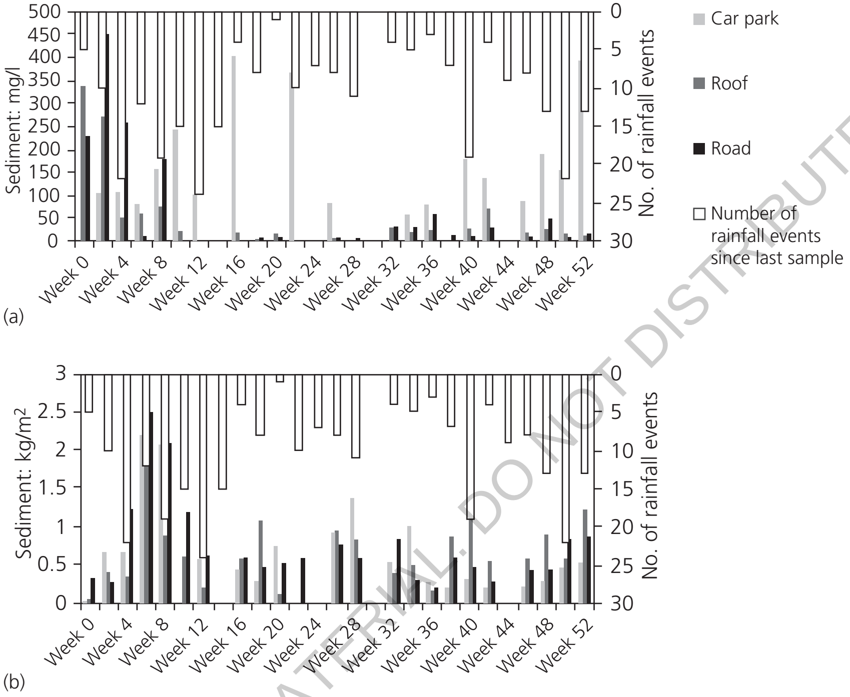


Figure 5.2 Monitoring results for rainfall events and transport/deposition of sediment sourced from the car park, roof and road at J4M8: (a) suspended concentrations and (b) deposition



The car park surface released sediment more slowly and sporadically, and it took 36 weeks to wash all of the tagged material into the drainage network.

With respect to sediment deposition, variability was greatest within the wetland (rate = 0.01–30 kg/m^2, average = 0.79 kg/m^2), which received runoff directly from the roof source and indirectly (via a buffer strip) from the car park. The swale samples exhibited the second highest variability (rate = 0.001–12 kg/m^2), though the average rate (0.78 kg/m^2), was virtually identical to that in the wetland. In the linear wetland, the average deposition rate was significantly higher (1.1 kg/m^2) than in either the wetland or the swale, probably due to there being a higher density of vegetation in this location.

Tagged-sediment trapping within the treatment train fluctuated throughout the 12-month monitoring period, with rates gradually declining through time, as inputs from the source areas decreased. The deposition of resuspended sediment sourced from within the treatment train was calculated by comparing the mass delivered to the sample location (i.e. suspended sediment sourced from the runoff surface and resuspension of sediment previously deposited upstream), the mass leaving the sample location (i.e. sediment transferred downstream), and the masses in suspension at the time of sampling and collected in the sediment trap.

growth, while building resilience to future climate change. In summary, the lessons learned from the project are that

- This multifunctional project has been proven to successfully reduce the frequency and extent of flooding. This is important, as it demonstrates that BGI really is effective in managing flood risk.
- The beneficiary community has shown that it appreciated the effort made to discuss the project plans and objectives prior to implementation, and is positive about the outcomes.
- The advantages of agencies working together have been demonstrated with reductions in fluvial and sewer flood risks, together with environmental and social benefits that clearly would not have been possible had the responsible authorities worked in isolation.
- Water quality benefits have proven more elusive. This may be due to limited active involvement in the project by local businesses and landowners. It is apparent that land use in the area around an urban stream project is crucial and that cooperation is essential to provide the best water quality benefits in a multifunctional restoration.

UK: River Somer, Midsomer Norton, Somerset

Not all urban stream restoration projects in the UK are focused on flood risk management, although flood risk is always a consideration. However, many urban streams are little more than open drains that provide no social or environmental benefits, and restoration opportunities exist along such streams even though flooding may not be a pressing problem. This is illustrated by the River Somer, which runs through Midsomer Norton, Somerset. Prior to restoration, the Somer was an unattractive eyesore, having been confined to a straight concrete conduit as part of a past flood alleviation project and with no wildlife or local community interests (Figure 6.7).

Figure 6.7 River Somer at Midsomer Norton prior to restoration (for more details, see the River Restoration Centre, 2013). (Photograph: courtesy of Woodland Water and Gardens and D. Longley)

is a hydrodynamic model capable of mapping urban inundation and assessing the effects of blue–green features on the spatial extent of flooding and flood depths (Glenis *et al.*, 2010; see also Chapter 3 of this book). The modelled area covered the urban core of Newcastle, which is outlined in grey in Figure 9.1. This area includes parts of the wards of Wingrove, Westgate, Ouseburn, South Jesmond and North Jesmond. CityCAT was run for each return period flood, with the current flood risk management infrastructure in place. It was then run again for an alternative scenario under which BGI was put in place in the CityCAT model.

Subsequently, model outputs for the urban core were extrapolated to estimate flood depths and damages across the entire administrative area of Newcastle (outlined in black in Figure 9.1) by applying terrain analyses to estimate flood depths and using the appropriate depth–damage curves for land uses and building types. Terrain information was gathered from the OS MasterMap topographical layer, while building-type information was gathered from the OS Gazetteer Database. The OS MasterMap identifies eight land use categories (residential high density, residential low density, commercial, industrial, mines/construction, recreation, nature and water), while 104 building-type categories are identified in the Gazatteer database (including, for example, commercial, residential, hospitals, banks and schools).

Data made available by Newcastle City Council and Northumbria Water were used to define the current flood risk management condition, which relies mostly on GI. To create the BGI scenario, hypothetical BGI interventions were added to the CityCAT model, in selected areas of the city where a learning and action alliance founded by the Blue–Green Cities research

Figure 9.1 Newcastle upon Tyne, UK, showing the urban core (inner line in grey) and the city's administrative boundary (outer line in black) (Blue–Green Cities Research Project, 2016)