Consumer Scotland
Luchd-Cleachdaidh Alba

Barriers to Blue-Green Infrastructure

Adapting to cope with surface water flooding caused by climate change

Literature review

October 2022

Contents

1. Executive Summary

1.1. In Scotland, the management of surface water, including flooding, is a significant and well-known challenge in the face of increasing urbanisation and increasing rainfall due to climate change. Traditional 'grey infrastructure[1]' is not up to the task of meeting this challenge, and innovative solutions to capture and manage surface water are needed in order to tackle this complex issue.

1.2. The Scottish Government has sought to address this issue in towns and cities via the uptake of sustainable urban drainage systems (SuDS), and the promotion of Blue-Green Infrastructure. Blue-Green Infrastructure (BGI) is defined by the European Commission as a "strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services"[2].

1.3. Implementing BGI into a space can provide a wide range of benefits; from alleviating climate change impacts such as flooding, urban island heating[3], and pollution levels, to wider social and wellbeing impacts that have been shown to be gained from greater access to such spaces.

1.4. The range of benefits BGI can provide is recognised by the Scottish Government and the country has begun to set out its approach to taking BGI forward. The Scottish Government's "Water-resilient places - surface water management and blue-green infrastructure: policy framework" makes a series of recommendations that will contribute to the review of BGI and develop a programme of work for delivery.

1.5. To support Scottish policy and strategy as it seeks to implement effective BGI on wider scale and to greater benefit, desk based research was initiated by Citizens Advice Scotland (CAS) between January-February 2022 to explore the range of barriers to successful implementation of BGI in the UK and Scotland. Research was subsequently completed following a move of the consumer advocacy role from CAS to Consumer Scotland in May 2022.

1.6. This report seeks to support Consumer Scotland identify the approaches to surface water management that can most effectively be taken to adapt communities for current and future climate change impacts. The report explores the barriers to effective implementation of BGI and the extent to which Scottish Government and Scottish Water strategies for BGI[4] are currently being met. This report is also intended to engage stakeholders on the issues identified. The barriers identified in the available literature were as follows:

Table 1: Barriers identified in the literature

Barrier Category	Examples available
Physical	Available space
	Quality of space

Organisational	Stakeholder cross-working Funding Legislation, regulation, and policy
Knowledge and information	Community engagement/empowerment Long term sustainability Vocabulary Consumer awareness Understanding full range of BGI benefits Knowledge exchange deficit

1.7. Based on the barriers found in the available literature and an exploration of how these might be best mitigated, the conclusion of this report seeks to inform recommendations for activities among stakeholders to progress the successful implementation of BGI across Scotland. There is scope to improve how BGI is discussed and presented at all stages. Actions to enhance this, drawn from the available literature, were primarily in relation to:

- **Enhancing stakeholder commitment to BGI through activities** - like shared policies, compulsory standards, and funding sources which support cross-stakeholder, cross-disciplinary, applications; and
- **Improving how BGI is communicated** - across and between stakeholder groups to enhance understanding and buy-in and support greater stakeholder collaboration through a shared language.

1.8. In general, the approaches and theories that were highlighted in the available literature as having the potential to solve some of the identified barriers to effective implementation of BGI, offer stakeholders some useful 'food for thought'. Including how these models should be developed and tested further with a wide range of stakeholder types and applied to a range of technologies and spatial categories to better determine their effectiveness in practice.

2. Background

What's the issue?

2.1. Flooding from rainwater run-off, otherwise known as surface water, is a significant problem in Scotland.

2.2. Instances of flooding in the UK have shown that impacts spread more widely than those typically associated with flooding, affecting other areas of the urban ecosystem. For example, flooding in the UK has previously led to power cuts impacting other services' delivery and recovery[5]; prevented water treatment and delivery services from operating successfully[6]; destroyed crops[7]; and disrupted natural habitats[8]. As well as disruption to the physical space and infrastructure, flooding also has lasting negative social and wellbeing impacts on the people affected[9].

2.3. The risk of surface water flooding is increasing in Scotland due to urbanisation. The creation of more impermeable surfaces such as roads, pavements, and roofs, and the loss of green spaces to housing and development, has increased the amount of rainwater that cannot be absorbed by the ground and instead runs off roofs, roads and pavements, and enters the drainage system. At the same time, climate change has increased the intensity of rainfall Scotland is subject to, further increasing the likelihood of flooding. Scotland's drainage systems, much of which date back to the Victorian era, are often being overwhelmed by this increased rainfall and run-off.

What's the solution?

2.4. In Scotland, the management of surface water, including flooding, is a significant and well-known challenge. Innovative solutions to capture and manage surface water are needed in order to tackle the complex and interdependent impacts flooding can have.

2.5. Blue-Green Infrastructure (BGI) is defined by the European Commission as a *'strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem service*'. BGI seeks to ensure urban and land-use planning acknowledges the range of benefits provided by the maintenance, management, development of 'blue' elements (rivers, canals, ponds, wetlands, floodplains and water treatment facilities), and 'green' elements, (trees, forests, fields and parks). BGI is sometimes referred to as green infrastructure (GI) or nature-based solutions (NBS), however BGI is subtly different in that it is specifically designed to turn or become 'bluer' during rainfall events to manage surface water and reduce flood risk.

2.6. Most BGI solutions are a form of sustainable urban drainage system (SuDS). There are four main categories of benefits defined in the literature that can be achieved by SuDS: water quantity, water quality, amenity, and biodiversity. These are referred to as the four pillars of SuDS design[10]. Most schemes of this kind use a combination of SuDS components to achieve the overall design objectives for the site. When these components form part of a wider network and create a Blue-Green Infrastructure, the range of benefits this can provide is also well researched[11][12][13][14].

2.7. In short, BGI provides a host of benefits to people and wildlife, and these benefits contribute to enhancing the urban environment as well as the health and wellbeing of those who populate it. The benefits of BGI offer improved resilience to climate change impacts, particularly higher temperatures, and increased likelihood of flooding. Table 2 provides a summary of the types and potential benefits of BGI techniques employed in the UK.

Table 2: Types of SuDS and their benefits[15]

Technique	Description	Potential benefits
Filter strips	Wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.	Water regulation
Swales	Broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff and can infiltrate the water into the ground (if ground conditions allow).	Water regulation Cooling effect
Tree/vegetation planting[16]	Not simply just to increase the aesthetic value of a site, planting strategically, such as developing 'tree pits', can itself contribute to increasing water attenuation capacity	Water regulation Cooling effect Air quality Carbon storage Amenity
Infiltration: such as soakaways, trenches, basins, and rain gardens	Depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.	Water regulation Water quality Amenity Biodiversity
Retention ponds	Basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.	Water regulation Cooling effect Water quality Amenity Biodiversity
Detention basins	Normally dry and in certain situations the land may also function as a recreational facility. However, basins can also be mixed, including both a permanently wet area for wildlife or treatment of the runoff and an area that is usually dry to cater for flood attenuation	Water regulation Cooling effect Amenity Biodiversity
Constructed wetlands	Densely vegetated water bodies that use sedimentation and filtration to provide treatment of surface water runoff	Water quality Cooling effect Amenity

		Biodiversity
Filter drains and perforated pipe	Trenches that are filled with permeable material. Surface water from the edge of paved areas flows into the trenches, is filtered and conveyed to other parts of the site. A slotted or perforated pipe may be built into the base of the trench to collect and convey the water.	Water regulation
Pervious surfaces	A type of source control SuDS[17], pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.	Water regulation
Green roofs	Type of source control SuDS which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.	Water regulation Cooling effect Biodiversity

2.8. The Scottish Government's *"Water-resilient places - surface water management and blue-green infrastructure: policy framework*[18]*"* recognises this range of benefits and begins to set out Scotland's approach to taking BGI forward, noting that, to do so effectively, "*Scotland should channel support towards actions that contribute to creating great places that are resilient to future flooding and drainage challenges, and away from activities that add to our future flooding and drainage burden*,"[19] and that Scotland "*should take a placemaking approach to achieving blue-green cities and water resilience involving partners in the public and private sectors, the third sector, individuals and communities*."

2.9. The Scottish *Government's* vision for the future of surface water management is as follows:

"Scotland's blue-green towns and cities are thriving water-resilient places designed to adapt to increased rainfall, river flooding and sea-level rise. They attract people, businesses and investors because they are great places to be and because they are resilient to climate change. They provide wide-ranging economic, social, environmental and well-being benefits to individuals, communities and the nation."[20]

2.10. These blue-green towns and cities can be achieved through the adoption of BGI across the country.

Purpose of this paper

2.11. Whilst there is good evidence of the benefits of BGI, which has supported the development of policies, activities, guidance and toolkits to support its implementation[21], the barriers are less well understood in the policy space. Without a good understanding of the barriers, the development and implementation of policy which can effectively address such barriers is likely to be hindered, and thus the ambition for water-resilient communities in Scotland harder to achieve.

2.12. The research and stakeholder discussions, undertaken by the Scottish Government to inform the policy framework, highlighted that the success of surface water management in future will only be ensured if all decision makers contribute to water resilience[22]**.** Although the Scottish Government and other relevant partners and organisations have a good understanding of this need and are working in a coordinated, cross-organisational way to resolve flood risks, achieving this consistently remains difficult.

2.13. To support the Scottish Government's ambitions to implement effective BGI on a wider scale and to greater benefit, this paper undertakes an analysis of relevant Scottish and UK research and evidence to better understand what barriers prevent the successful implementation of BGI in the policy and stakeholder landscape. The analysis will allow for a better understanding of what approaches to surface water management can be taken to successfully adapt communities to current and future climate change impacts.

2.14. We expect that the findings will be valuable in enhancing internal understanding on the topic of BGI, and will support the Consumer Scotland water policy team to best inform the future plans of the Scottish Government's approach to achieving water resilience.

3. Methodology

3.1. To inform the development of Scotland's BGI policy agenda, Citizens Advice Scotland (CAS) undertook desk research on the topic[23]. The outcomes of this have been written into this short literature review, and will be used by Consumer Scotland to inform and influence future stages of surface water management by the Scottish Government.

3.2. The requirement for this research exercise was to consider UK-based sources of evidence. However, whilst the themes and findings of the report are drawn from UK-based research, global references are included throughout the text where they relate to types of BGI and the benefits of BGI, to provide useful background information. In addition, papers which explicitly applied learning from other locations to implications for the UK have been referenced where relevant.

3.3. The evidence base was limited to open access texts freely available to the researcher at the time of writing. Key word search of 'blue green infrastructure' against the terms 'barrier' and 'challenge' were used to explore relevant academic articles on open-source websites[24], with further evidence of this kind found by utilising web browser extensions[25] to find additional open access articles.

Note on terminology

Some sources which referenced 'green infrastructure' (GI) and/or 'blue infrastructure' (BI) were included for assessment as to their relevance, given that BGI is an interconnected network of BI and GI, and operating on the assumption that the barriers affecting the two distinctly may also affect BGI too. Of course, BGI may have additional or distinct barriers.

While articles related to GI tended not to reference/be applicable to 'blue' elements, some examples where the secondary literature referred to what we would describe as BGI, simply as GI, were found.

Other phrases used interchangeably by researchers to refer to BGI (as we would define it) included 'sponge cities', 'blue-green cities', 'blue-green network', 'nature-based solutions' and 'sustainable drainage'. The implications for such a wide range of terms which describe the same type of activity/goal, are explored later in the report.

3.4. The search yielded 175 results. The exclusion criteria were as follows[26]:

- Conference papers were removed where they were not peer-reviewed, and where the findings were likely to appear in the presenter's portfolio of published research.
- Articles that did not demonstrate, in the abstract, that they would present barriers associated with BGI, were removed. If it was unclear as to whether some portion of the article would be dedicated to barriers, a scan of the article was undertaken.
- Articles that were focused on very specific aspects of BGI development were also removed e.g., modelling, assessment of specific techniques and technologies, as the challenges described in these articles are too specific and technical.
- A limitation of the open-source repositories used is the inability to filter searches by location. As such, abstracts/executive summaries were scanned and those that did not demonstrate that they either had evidence sourced in the UK, or applied evidence from elsewhere specifically to the UK, were removed.
- Articles published prior to 2012 were removed as the researcher considered these to be of limited value, given policy developments in this space since this time[27].

3.5. In addition to academic sources, a list of key stakeholders was developed by the researcher based on their own expertise in water policy. The stakeholders provided details of relevant policy, legislative, procedural, and guidance documents that were commissioned or published by them or their partners on the topic of BGI. Where relevant, these are referenced where they provide background or contextual information to the topic of BGI in Scotland and the wider UK. Sources that provide additional evidence as to the barriers to successful implementation of BGI, potential solutions and defining an approach to cross-stakeholder working for BGI, were also referenced.

4. Analysis of sources – Barriers to effective implementation of BGI

4.1. A wide range of potential barriers to the successful implementation of BGI in Scotland were found from the literature available. These are explored in the sections below.

Physical barriers

4.2. Available space and quality of the space were identified as the two key physical barriers:

Available space

Proportion of urban area (%)	**England**	**Scotland**	**Wales**	**Great Britain**
Natural land cover: *any land cover classified as being natural in type e.g. grasslands, orchards, forests. Excludes inland water bodies which are categorised separately as 'Blue space'*	30%	36.4%	30.2%	30.7%
Blue space	1.2%	1.4%	1.1%	1.2%
Functional green space: *any green space that has a specific function in its use e.g. public parks, playing fields, cemeteries, golf courses, and allotments*	7.1%	8.3%	4.8%	7.1%
Publicly accessible green space: *a subset of functional green space, removing spaces expected to have restricted entry e.g. golf courses*	4.9%	5.3%	3.4%	4.9%

4.3. There are approximately 1.77 million hectares of urban area in Great Britain. Of this, 30.7% is classified as natural land cover, compared with 31% in 2017. On average, Scotland has

the greenest urban areas. England has a greater proportion of functional green space relative to urban natural land cover (23.8%), compared with 22.9% in Scotland and 15.9% in Wales. Although, due to having greener urban spaces, Scotland has more functional green space relative to urban area (8.3%)[28].

4.4. In England, the area of available urban greenspace has declined over time. For example, data from the Adaptation Committee of the Committee on Climate Change shows that the total area has declined from 63% of urban area in 2001 to 55% in 2018[29]. The distribution of urban parks is also uneven with deprived communities facing more challenges in accessing high quality green spaces compared to more affluent areas[30]. It is estimated that the most affluent 20% of wards in England have five times the amount of greenspace compared to the most deprived 10% of wards[31]. In Scotland, a greater proportion of adults in deprived areas live more than a 10-minute walk away from their nearest greenspace compared to adults in the least deprived areas (14% compared to 10% in 2018)[32].

4.5. The lack of available land for BGI, physical limitations of their performance in that space, and delays in achieving the full range of benefits due to time needed to develop the site, e.g., tree maturity, were all examples of how the physical space may limit BGI. Both the amount and distribution of physical space was referenced in much of the literature as a potential barrier and noted to be important to consider when planning a BGI intervention.

Quality of space

4.6. In 2017, around three-quarters of adults in Scotland (74%) were satisfied or very satisfied with their nearest area of greenspace, while only 10% were dissatisfied[33]. However, local greenspace is perceived to be of a lower quality in deprived areas, with half of those from the 15% most deprived areas agreeing that the quality had reduced in the past 5 years[34].

4.7. There has been an increase in the proportion of adults visiting the outdoors at least once a week between 2012 and 2018, rising from 42% to 59%[35]. Use of green and open space in Scotland increased more recently due to Covid-19; however, inequalities in visiting persist, with those of high socio-economic status much more likely to visit than those of low socio-economic status[36].

4.8. The literature highlights that the performance and appreciation of BGI can be positively or negatively affected by the behaviours and attitudes of those using the space, i.e., that the quality of a BGI space is dependant to some extent on how it is used. How a BGI space is used is explored further later in the report[37].

Organisational barriers

Stakeholder cross-working

4.9. In Scotland, the management of surface water, including flooding, is a significant and well-known challenge for responsible authorities. Resolving surface water flooding issues requires a coordinated effort across organisations, as surface water flooding by its very nature is complex and can be caused by a combination of factors. However, such a coordinated approach is difficult to achieve given the limits in the current policy and regulatory framework: activities and actions are currently acknowledged to be largely

'issue-driven', with different organisations having different, distinct responsibilities for resolving specific issues[38].

4.10. While responsible authorities generally understand and agree what solutions are required to address specific identified issues, a nationally consistent approach is lacking, and organisations can struggle to achieve multiple benefits or align priorities, resources, and finances into truly joined-up services without taking a more outcome-based approach. Despite several successful examples across the country, in general, a fully unified approach to the management of surface water in Scotland encompassing existing-retrofit and new-build challenges is yet to be achieved. On a more positive note, organisations and stakeholders in Scotland have recognised a need to move away from an 'issue-driven' approach and are enthusiastic about contributing to a reform[39].

4.11. The literature supports the current policy view that BGI development and implementation is still fragmented, despite the theory and principles being embedded with government initiatives at many levels. The literature also supports the assessment that the underlying reasons for the organisational barriers are because organisations are naturally segmented into sectors, with different vested interests and priorities, and points to an integrated and multi-stakeholder approach as a key feature in optimising BGI performance.

4.12. Of course, such an approach highlights new complexities as to how best to collaborate and compromise to achieve a collective goal. This conflict is inherent and can only be improved through increased cross-working between stakeholders. Despite the challenge that weak governance and unclear responsibilities, due to several institutions being involved can bring, multi-institution collaboration can also ensure there is the resource, capacity and buy-in required to support the coordination of projects with multiple drivers, stakeholders, and novel technologies.

4.13. As BGI operates as a network to provide multifunctional attributes and benefits, there are a wide range of system and organisational interdependencies at play. To support the cross-stakeholder conversations and decision-making that needs to take place, the literature notes the importance of establishing dedicated spaces to do so.

4.14. Good practice examples highlighted in the literature were found in Learning Action Alliances (LAA)[40]. These offer a space for relevant stakeholders from a range of backgrounds to collaborate and build a consensus around priorities that can be developed and visionary projects that can be explored. Options can be freely discussed outside the constraints of existing formal institutional settings.

4.15. In Newcastle, for example, representatives from relevant stakeholder groups who can influence decisions about the adoption of BGI strategies across the city have been involved, including major stakeholders representing city council departments, environment, local interest groups, trusts and societies, water companies, academics, and major landowners. Groups like this can directly contribute to reducing the barriers which emerge from the relational complexities that inherently exist as part of the development of BGI[41].

4.16. As BGI utilises various components from other urban systems, its success is highly dependent on shared information between various agencies. Presently however, the current management structure does not reflect this complexity and mainly mimics traditional grey infrastructure[42] management[43]. In addition, there is variation in the scope and coverage of BGI policy across organisations: such differences perhaps reflect the different way BGI is perceived and defined in planning authorities and highlights that greater knowledge exchange is required to enhance a more collective understanding of and approach to BGI[44 45].

4.17. Organisational and agency partnerships will need to be reframed if SuDS and BGI implementation is to be effectively co-ordinated at both the planning and operational stages. These organisational dependencies have been found to be particularly important to systems performing multiple functions, since effective management of such systems require organisational collaboration amongst relevant agencies[46].

4.18. The links are different between SuDS and BGI due to their different intended functions and policy drivers. In Scotland, those with duties and powers relating to surface water management responsibilities in urban areas include Scottish Water, SEPA, and local authorities[47]. Homeowners and landowners also have responsibilities for managing water on their land set into legislation, as do engineers, developers, and technicians in designing and installing management technologies.

4.19. There are a wide variety of other players that can influence BGI planning and implementations, such as non-statutory bodies like Scottish Canals, Forestry Commission, and Nature Scotland, as well as advocacy groups and NGOs, and the general public. The lists highlight that there is little overlap with the group of agencies managing BGI, apart from the agencies with direct responsibility for water functions. Furthermore, wider stakeholders that might be affected by the application of BGI are often neglected. Thus, the functional complexity between the urban components and surface water management have not yet effectively been translated into governance interactions[48].

4.20. The importance of participatory processes to account for local conditions is generally accepted as good practice in the literature[49]. Involving practitioners in the design processes is crucial, as without it, prospective retrofits are unlikely to succeed. Co-designing solutions together with practitioners and stakeholders has been found to help to identify and mitigate a range of potential constraints related, for example, to local conditions, technological processes, availability of infrastructure, and future plans[50].Discussion forums, focus groups, and learning and action alliances[51]have been used with success to promote stakeholder participation in finding workable solutions for difficult problems related to flooding and water quality issues[52].

Funding

4.21. Funding is a frequently cited barrier to BGI, often in relation to the limited economic resource of the responsible organisations, as well as a lack of information on the cost-effectiveness of BGI longer-term[53 54 55] . Surface water management programs are typically enforced by public organisations that tend to select technologies to meet outcome criteria in the most cost-effective manner[56]. Additional services associated with BGI, such as

reducing urban heat island effects[57] or promoting recreational opportunities, have also been found to be drivers for adoption when these benefits are quantifiable[58].

4.22. This suggests that it is difficult to maintain clear institutional boundaries when assessing the market and non-market value of BGI because there are likely additional benefits beyond surface water management BGI brings, and not all of this is quantifiable[59].

4.23. Uncertainties about financing mechanisms for BGI can hinder effective policy development[60]. The impact of austerity on the planning resources has been noted as exacerbating this issue, as this has restricted the extent to which local authorities can embed multi-functionality into policy as well as achieve it on site[61].

Funding in a cross-stakeholder environment

4.24. Whilst establishing collaborative stakeholder working as a key principle towards the success of BGI as part of delivering water resilience places, it is difficult to achieve in practice and presents challenges. In a collaborative stakeholder setting, funding projects can become complex, as BGI projects tend to have a range of different objectives, programme lines, agendas, and timescales to contend with.

4.25. Consideration of how, in a collaborative setting, stakeholders prioritise, access, and share funding resources is required. Establishing a joint funding pot, for example, could support greater collaboration and streamline the way the project is run; to the benefit of all parties involved.

4.26. Better financing for multi-benefit projects i.e. funding pots that multiple partners can bid for together, was identified in the literature as a key enabler to unlock more innovation and uptake of BGI. To enable this approach, finance that will pay for these multi-partner projects needs to be made available to the right parties, and funding applicants need to be able to assess the wider benefits of their projects to put robust cases together[62].

4.27. There may be lessons for BGI to learn from innovations in the green finance sector. The New Markets for Land and Nature report[63], and the 'natural capital' approach promoted by HM Government's 25 Year Environment Plan[64] could provide a useful starting point to map and evaluate the wider benefits of BGI.

Cross-sector stakeholder collaboration: a path to success

4.28. Scotland, and the UK more widely, has recognised the need for meaningful and wide-ranging engagement with relevant stakeholders, to further climate change adaption strategies and activities, particularly in relation to surface water management to mitigate and adapt to flooding.

4.29. There is a high-level commitment from the government to transition from less to more stakeholder engagement in this space, where "decision makers in all sectors contribute to water resilience"[65].

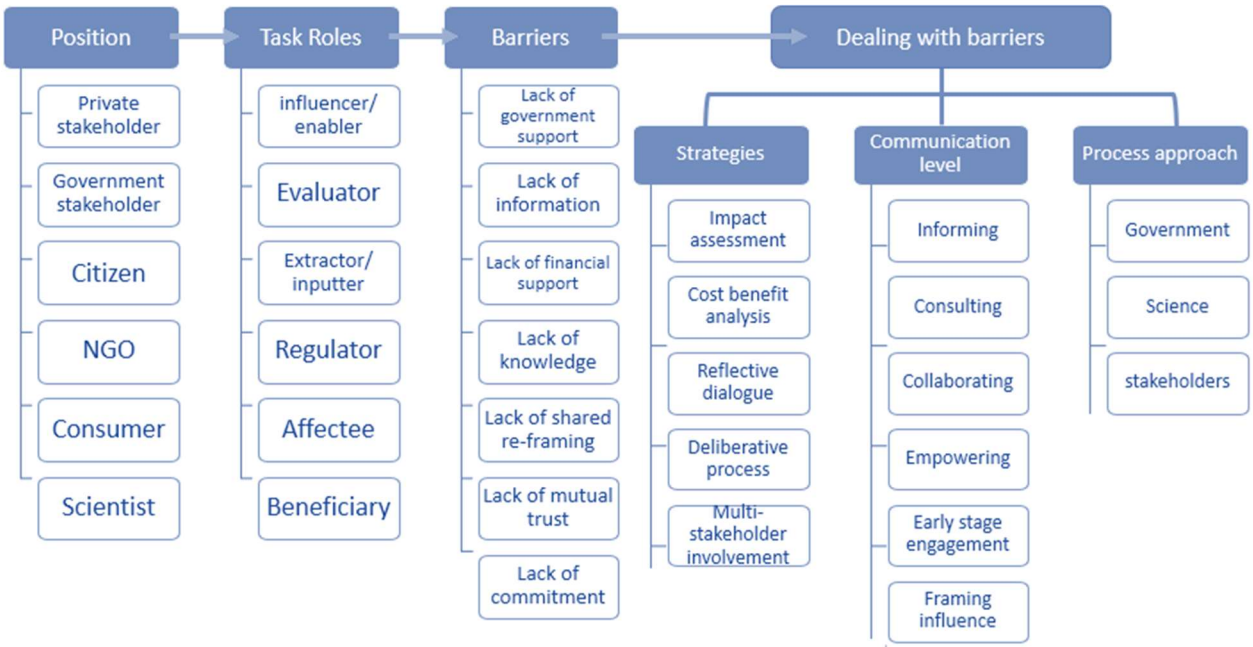
4.30. The literature shows that different types of stakeholders are motivated to contribute by different strategies, and that they face different barriers in this space. UK stakeholders in general identified a lack of shared vision, along with a lack of governmental support and insufficient policy strategies, followed by lack of public interest[66].

4.31. The identified need for more stakeholder engagement requires new ways of working together. Literature exploring UK stakeholders experience with cooperation to date found the following themes[67]:

- When experts and leaders are invited to discuss and exchange ideas, cooperation is not judged to be complicated
- When technical engineer solutions are sought, cooperation among these experts is not judged to be complicated
- When sustainable drainage solutions are sought, and when multiple stakeholder participation is needed, this is judged to be more complicated.
- Cooperation effects on flood management are judged to not necessarily be large, depending on how it is carried out.
- The current perceived lack of public leadership in this space could be mitigated with engagement with public representatives who feel the urgency, cooperate, and could invite others to take action.

4.32. A framework has been developed to support the identification of stakeholder contributions and barriers they are facing in this space.

Fig. 1 Template for engaging stakeholders in flood management, cited from Soma et Al (2018)



4.33. To help find best strategies for overcoming these barriers. The template has been tested on two UK stakeholder categories: a building real estate developer, and a public city flood management organisation, whose answers to the above questions are cited in table 4. While the sample of stakeholders are too few to claim representativeness of specific stakeholder groups, the application of the template to identify barriers is still insightful.

Table 4: UK stakeholder responses from Soma et Al (2018)

	Building Real Estate Developer	**Public City Flood Management**
Position	Both a government and private stakeholder	Government stakeholder
Task role	Carries out tasks as inputter, extractor, and influencer	Carries out tasks as regulator and influencer
Barriers	Lack of public leadership Lack of scientific documentation Lack of citizen awareness Lack of consumer demand	Lack of public leadership Lack of public coordination Lack of citizen awareness Lack of business awareness

4.34. Application of this framework could serve to mitigate complexity that can arise where multiple stakeholders and stakeholder types are involved, in order to support improved communication, engagement, and buy-in to BGI projects.

4.2.5 Legislation, regulation and policy

4.35. A list of the relevant legislation, regulation and policy related to surface water management and the implementation of BGI in Scotland is available via the Scottish Government[68] and Susdrain[69]. These sites also summarise where current responsibilities for managing and enforcing these activities in Scotland lie across relevant organisations.

4.36. Recent legislation and regulatory developments in this space have supported BGI to be utilised to a greater extent across the country, but more is needed in this space, as recognised by the Scottish Government in their latest policy on the matter[70].

4.37. BGI measures put in at the beginning of a design project are often 'value engineered' to bring down costs[71]. Large scale reductions in public spending, and the related reduced resources, capacity and skills in public sector organisations, government agencies and local authorities[72] means that any issues that are not statutory requirements are not routinely taken forward in decision making[73].

4.38. There is insufficient power within BGI regulations, policies and legislation to incentivise greater uptake of BGI activities among developers and practitioners. Although current legislation in England encourages the implementation of SuDS, it does not yet mandate it[74]. Scotland fares slightly better in its legislative journey to date, having mandated all surface water from new development to be treated by a SuDS before it is discharged into the water environment[75]. However, research reviewing the process of increasing SuDS uptake in Scotland found that, while the country benefitted from a strong legislative and

regulatory regime that has driven the transition agenda from traditional drainage to SuDS, it has weak enforcement of regulatory requirements and inspection policies. This results in reluctance by practitioners to implement the systems, particularly emerging techniques such as rain gardens and green roofs[76].

4.39. Despite concerns among stakeholders as to increased costs of development from using SuDS[77], recent studies have highlighted that using SuDS can maximise the number of unit plots on site and reduce the overall cost of implementation[78].

4.40. The Building with Nature Standards Framework[79] is a useful tool for developing policy across the UK. It has been designed to be applicable to a wide range of types and scales of development and policy areas. It supports and enhances effective delivery of BGI in the UK by promoting a shared understanding of 'what good looks like' across the whole life cycle of the site – from the policy framework to early-stage design, through to implementation and long-term management and maintenance. Developers and policy makers who wish to have an external verification that their project is an example of high-quality green infrastructure, and can demonstrate compliance with the Standards, can pursue an accreditation from the organisation.

Table 5: Building with Nature Standards Framework

Core standards: should be applied across all the below themes	
Optimises multi-functionality and connectivity	Optimises multi-functionality and connectivity within the boundary of the project and links with existing and planned for infrastructure in the surrounding area.
Positively responds to the Climate Emergency	Is designed to be climate resilient by incorporating mitigation and adaptations that respond to the impacts of climate change. The infrastructure is designed to promote low carbon behaviours and contributes to achieving zero carbon development by optimising carbon sequestration and demonstrating low carbon approaches to design, construction, and long-term maintenance.
Maximises environmental net gains	Is designed to actively mitigate any unavoidable harmful environmental impacts of development on soil and air quality and to minimise light and noise pollution. In addition, it delivers environmental net gains, including improving air and water quality and wherever possible includes quiet spaces for people and wildlife.
Champions a context driven approach	Positively responds to the local context, including the physical environment, such as landscape and urban character and social, economic, and environmental priorities, including the evidenced needs and strengths of existing and future local communities.

Creates distinctive places	Is integral to the project and is designed to reinforce local distinctiveness and/or create a distinctive sense of place.
Secures effective place-keeping	Is subject to management arrangements that demonstrate a commitment to effectively implement, establish and maintain features at all stages of the development process. This should include details of funding, governance, maintenance, monitoring, remediation and, where appropriate, community involvement and stewardship.
Wellbeing standards	
Brings nature closer to people	Is close to where people live, work, learn, play and/or visit, and is designed to optimise use and enjoyment for everyone across the year, to maximise health and wellbeing outcomes and to promote active living for existing and future communities.
Supports equitable and inclusive places	Is designed to encourage and enable everyone, including those from vulnerable or excluded groups, to use and enjoy it, to help reduce health inequalities and to build a shared sense of community and belonging.
Water standards	
Delivers climate resilient water management	Is integral to sustainable drainage using above ground features to manage flood risk, maintain the natural water cycle and improve water quality within the boundary of the project and at a catchment scale. The infrastructure is designed to be drought resistant and wherever possible, includes measures for the retention and reuse of rainwater.
Bring water closer to people.	Is designed to integrate water, including areas of standing water, flowing water, seasonal and ephemeral features, to bring additional amenity and wildlife benefits.
Wildlife standards	
Delivers wildlife enhancement	Optimises long term and climate resilient net benefits for nature, by retaining and enhancing existing ecological assets and creating locally relevant new habitats within the boundary of the project. Wildlife measures are secured at all stages of implementation and where applicable, across multiple phases of development.

Underpins nature's recovery	Creates effective links with existing and planned for ecological features and networks beyond the boundary of the project to support the creation and restoration of resilient ecological networks in the wider landscape.

4.41. The *Building with Nature Standards Framework* could be usefully employed or adapted to support a wide range of stakeholders to: better understand the wide range of benefits BGI can provide; develop and deliver programmes of work that aligns to key principles for the success of BGI, such as place-making and community engagement; better communicate with other stakeholders on the topic of BGI by sharing the same language and values.

4.42. A recent analysis across the 19 local authorities involved in Central Scotland Green Network (CSGN)[80], explored Local Development Plans in relation to their consideration of the principles established in the *Building with Nature Standards Framework.* The analysis found that BGI-related policies were highly variable and that several of these were incomplete, inconsistent, or weak[81], reinforcing the wider literature's conclusions that BGI is currently devalued/deprioritised in the planning process[82].

4.43. Of the policies analysed, those who scored highly in relation to coverage and wording tended to reflect more well-established policy areas such as enhancing biodiversity, active travel routes and open space standards. Whereas the lowest scoring tended to reflect newer policy areas such as public access to SuDS, maintenance specifications for BGI components, and the need for early discussions with stakeholders. These new policy areas are where local authorities have been found to lack the necessary experience or confidence to raise with developers[83].

4.44. The inclusion of phrases in regulation, policy and legislation, such as *'taking into account'* or *'where possible'* have been found to weaken policy in that they provide an 'out' should, for example, costs be perceived to be too high further down the delivery line[84]. The recent analysis of local authorities' policy and plans relating to BGI found that while most do recognise and express the multiple benefits, their effectiveness is likely hindered by the relatively weak wording used. For example, while the inclusion of the phrase "*new developments should seek to enhance biodiversity as part of the green network",* from West Dunbartonshire's Local Development Plan, is strong in its recognition of the biodiversity benefits BGI can bring, it is weak in that *'should seek to'* provides scope to scale back, or even abandon altogether at a later stage in the planning or delivery.

4.45. Drawing on the best practice available, a model policy was developed to support improvements to the design and content of all local plans across all the CSGN local authorities, which has wider application to other plans[85]. This is provided in Figure 2.

Fig. 2 Suite of model policies derived from best practice examples identified from the CGSN, adapted from Hislop, Scott, Corbett (2019)

Blue-Green Infrastructure primary policy

Blue-Green infrastructure is integral to place-making underpinned by the qualities of successful places, and should form part of the design process from the outset in order to provide the following benefits where possible: water regulation and quality, biodiversity enhancement, local amenity.

To achieve this developers should:

- Discuss with planning authorities and relevant stakeholders what BGI is appropriate for the site at pre-application meetings
- Appraise the site for BGI functions, undertake necessary surveying as to habitat, hydrological assessments, and demonstrate how these have influenced design
- Take opportunities to achieve multifunctionality by bringing BGI functions together

Water management policy

Development proposals will integrate naturalised SuDS features into design of BGI, and where they are part of open space obligations, will be safe and accessible, creating attractive and useful spaces

Biodiversity policy

Development proposals should conserve and enhance on-site habitats as well as those surrounding the site

Open space policy

Development proposals should meet local accessibility, quality and quantity standards for open space and be designed in collaboration with the community using the space in order to best meet needs

Access network policy

Development proposals should maintain and enhance quality and connectivity of access networks integrating active travel and recreation route into BGI

Stewardship policy

Development proposals provide details of BGI functions and maintenance requests, and who is responsible for these, and demonstrate funding arrangements for longer term sustainability of the site: this should all be evidenced before construction begins.

Knowledge and information barriers

Community engagement and empowerment

4.46. Much of the relevant literature points to co-creating solutions as an important part of implementing effective BGI. Consideration of how and why local residents might engage with water infrastructure in a practical way, is an important practise to adopt as part of the BGI process. Ensuring technical solutions align with community aspirations and needs, will make them more likely to be accepted and maintained in the long-term[86]. BGI is not just the responsibility, of governments, national, regional, or local level authorities, but their success also relies on meaningful engagement with the community in which the BGI will be placed.

4.47. Community engagement is needed to achieve changes in behaviour. This can be approached through communicating potential benefits to encourage communities to appreciate and value the space. The literature notes that these types of communications often focus on the amenity that BGI can provide, as this is a tangible benefit[87]. However, the literature also notes that the concept of amenity is rarely unpacked: the theoretical amenity provided by a SuDS or BGI network is not always reflective of how the community use or want to use the space in reality, which can result in misaligned targets and actions between the community and developers.

4.48. Social Practice Theory (SPT) is increasingly being used as a lens to explore behaviour change within the environmental social sciences, with respect to the greening of consumption and resource-use[88]. While there is, as of yet, no studies using SPT in practice to look at BGI and the community engagement that should surround its development, installation and across its life-time, it has been proposed as a framework which could be usefully applied to BGI; given the clear need to develop a strong understanding of communities and their needs, motivations, and capacities for contributing to the design and management of this type of infrastructure[89].

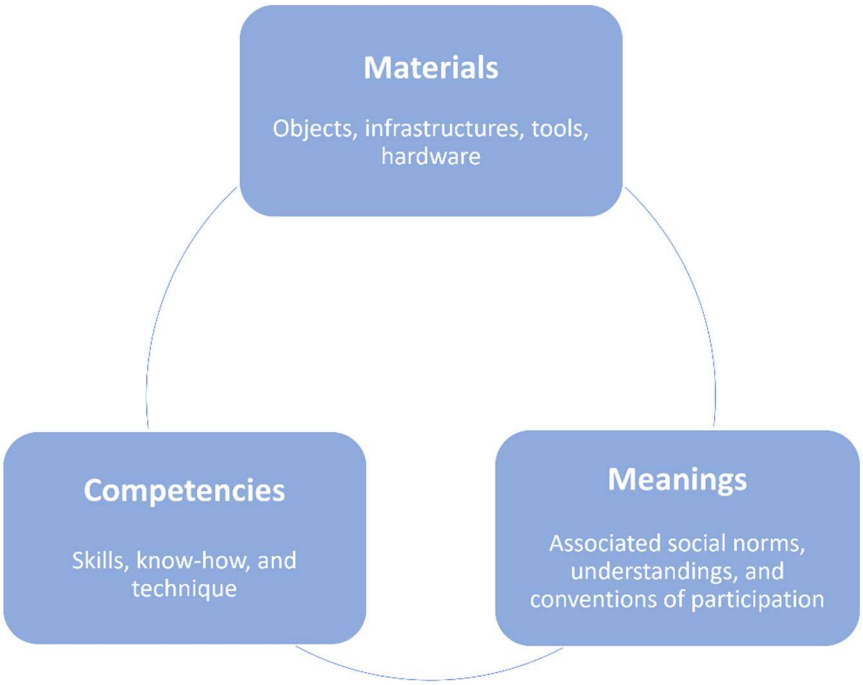
Social Practice Theory at a glance[90]

4.49. In contrast to other kinds of behavioural models, which focus solely on individual agency, SPT seeks to find a balance between structure and agency, on the assumption that human agency and social structures are shaped recursively: as activities emerge and are enabled by structures of rules and meanings, these structures are constantly re-enforced and legitimised in the flow of human action. As such, it is the practices themselves, featuring both structures and agents together, that form the basis of our social arrangements.

4.50. Attention is therefore no longer focused on individual decision making, but on 'the doing' of various social practices and the inconspicuous consumption which forms an integral part of many practices. Central to social practice theory is the idea that it is through these engagements with practice that individuals come to understand the world around them and develop a coherent sense of self.

4.51. Recent iterations of SPT have derived three interconnected elements which frame the re/production of practices, as set out in Figure 3.

Fig. 3: Three core elements of social practice



4.52. The literature found potential in the application of SPT to investigate BGI, in that SPT can enhance understanding of potential or actual effects on social practices (whether that be disruption or enhancement) due to changes introduced to a space. The literature noted that in future cases of retrofit, populations could be surveyed to identify existing practices and develop ideas around different groups' potential for stewardship activities. Engagement could then be orientated towards these groups to improve buy-in, sense of ownership, and stewardship potential. With new developments too, the literature noted that SPT could be usefully applied to hypothesise the ways the community may wish to use the space and drive interest in long-term stewardship of it. In both cases, an SPT approach may help with identifying and seeking to accommodate the varied needs of the users, providing alternative-use spaces for practices that might not fit with others, and discouraging less socially acceptable practices[91].

4.53. Emphasising BGI's recreational benefits (as relevant to the specific site and community) could improve sustainability of the site, as surveyed communities have been found to be more likely to express willingness to engage positively with stewardship practices if the amenities available included leisure, recreation or play rather than purely exercise or transit[92]. More research is required as to the application of SPT to BGI in order to test its usefulness in practice, but it appears to have the potential to provide practitioners with a deeper understanding of potential intersections between existing and new practices, and to support greater sense of ownership and vested interest from the community.

Long term sustainability

4.54. Debates around the longer-term sustainability of BGI centre principally around the uncertainty of maintenance costs needed to ensure projected benefits are delivered over installations' lifetimes.

4.55. Local stewardship has been proposed as one way of supporting longer-term BGI maintenance[93] [94] which might include dissuading negative behaviour such as littering, encouraging positive behaviours like cleaning and maintenance, or even facilitating creative use of the space as relevant, such as organising walks or classes. Given the need for consumer/community buy-in to BGI spaces to make them truly successful, and the tight financial constraints that relevant local and national organisations work to which may limit their ability to uphold best-use and maintenance of a site, facilitating volunteer-led maintenance of BGI is one way in which to take positive action on both these points.

4.56. Given that BGI is a relatively new innovation, there is uncertainty as to how these infrastructures will be used and maintained longer term. Meaningful community engagement is therefore particularly important to ensure longevity of a site, because the performance of BGI can be positively or negatively affected by the behaviours and attitudes of those that use and maintain them after their installation. While the benefits of BGI are widely reported, negative engagement with infrastructure can cancel these out in the minds of the community: this can arise particularly when the community has not had adequate time to participate in, or do not sufficiently value, projects[95]. Community engagement is therefore key to driving understanding of the value and impact of water infrastructure in their lives.

4.57. There remains a need to evidence the performance and benefits of BGI through long-term monitoring, this is not as extensive as researcher and practitioners would like it to be[96], and this hinders effective analysis of projects, their potential for applicability elsewhere, and longer-term implications for their sustainability[97].

Vocabulary and terminology

4.58. In assessing the available literature on the topic of BGI, a wide variety of phrases and terms were used interchangeably to refer to BGI activities. This can hinder the effective development, delivery and/or assessment of BGI; as previously mentioned, if decision-makers are expected to work collaboratively, they must be able to 'speak the same language' to do so effectively.

4.59. Previous research from Citizens Advice Scotland has found that among consumers and communities too, water sector terminology, including terms such as '*surface water management*' and *'blue-green infrastructure'* are not well understood and sometimes misinterpreted. The way this subject is communicated to consumers needs to be improved, to better meet them at their level of understanding. Enhancing familiarity and understanding of the phrases used should lead to increased engagement and buy-in from the consumer/community[98].

4.60. A cross-country, cross-stakeholder analysis, which explored barriers and opportunities to bridging the knowledge and practice gap that currently exists between academic and policy debate as well as how this insight is shared and translated into practice, interestingly

found that the problems that consumers/communities encounter with regards to awareness and understanding of the terminology the water sector uses, rings true of the wider stakeholder base as well. The lack of consistent language and terminology was pointed out as hindering the ability to communicate ideas and concepts effectively across different groups[99]. This is related too, to the section on legislation, regulation and policy, where it was found that the strength of the language used in policy and planning documents can serve as a barrier to incentivising action where it is weak, and the opposite where it is strong.

Consumer awareness

4.61. Recent surveying found that despite some consumers acknowledging that blue-green, or nature-based solutions, should be a priority in Scotland's response to climate change, most consumers do not yet see a role for themselves in supporting their delivery[100]. Despite the overall trend of increasing awareness and concern about climate change in the population[101], it appears that consumers, in general, are not yet aware of or have not bought into all of the ways they can contribute to lessening climate changes impacts, as an individual or as a community.

4.62. One of the key benefits of BGI is the fact that individual households and communities are able to play a part in their adoption and design: not only are consumers able to contribute to Scotland's adaptation to climate change in this way but of course BGI brings a host of potential benefits to a local area for that individual or community to enjoy.

4.63. Evidence shows that consumers are largely unaware of the link between water and climate change[102], and therefore the role water plays in climate adaptation and mitigation. Enhancing consumers' understanding of the role water plays in causing, and its potential to mitigate, climate change impacts, is the first step toward developing a consumer base which is able and willing to participate in developing BGI.

Understanding the full range of benefits

4.64. Multi-functionality and the provision of multiple co-benefits is fundamental to the growing appeal of BGI, as is the recognition that many of the unintended, adverse side effects of grey infrastructure can be avoided by leveraging natural processes and ecosystem services[103]. However, the full range of benefits BGI can offer at a specific site, especially in relation to amenity benefits, is as yet poorly understood in literature and in practice[104].

4.65. A lack of appreciation or full understanding of the range of benefits BGI can offer is cited as a potential barrier to its successful implementation, however this wide range of benefits, if understood from the perspective of those using the space and communicated effectively to all stakeholders, can be an enabler to the successful implementation of BGI[105].

4.66. BGI can be seen purely as a cost by local authorities, which can result in the wider range of benefits not being acknowledged, recorded, or monitored. In some cases, the full range of benefits BGI can offer can be difficult to quantify which can be problematic when measures are required to meet defined standards[106], which perhaps contributes to BGI initiatives being dropped.

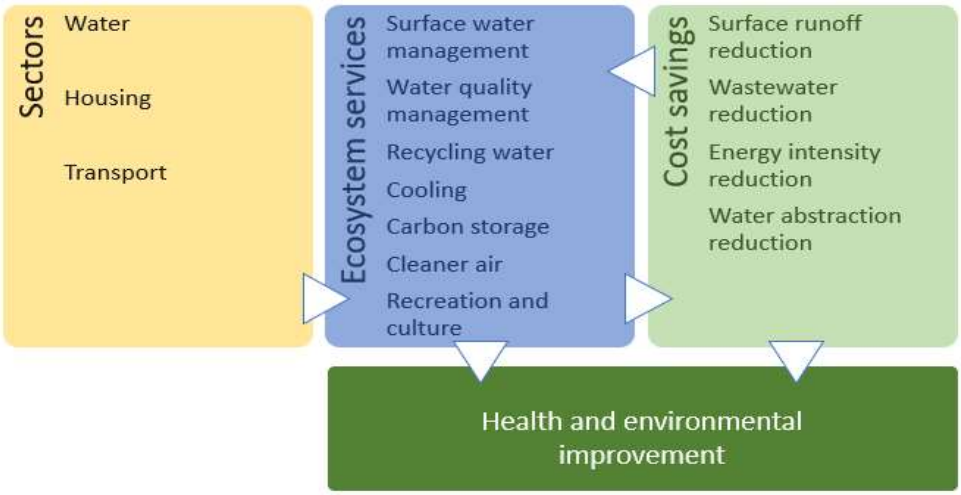
4.67. Systems thinking provides a means of assessing BGI through the ecosystem services[107] it provides across the multiple sectors it interfaces with (including transport and housing). It encourages stakeholders to link components together to support them to take a more collective, shared view of the system and make decisions that fulfil needs in the round. This approach can also help stakeholders understand their activities from a sustainable development perspective, accounting for environmental, social and economic factors. As a result, they will be able to assess the role of BGI in offsetting their impacts and contributing to cutting operational costs.

4.68. A mapping framework, adapted in figure 4, has been proposed in the literature which can support a greater understanding of the wide range of urban ecosystems BGI may be connected to[108]. This systems approach can be used for several applications:

- To map the impacts across the system with respect to economic, social and environmental concerns from a single stakeholder perspective,
- To link all relevant stakeholders based on their operational, causal and/or impact management,
- To gain a full understanding of the impact of developments and land use change on urban sustainability,
- To provide justifications for statutory requirements of mitigation measures responsibilities with respect to the urban sustainable development agenda, and
- To help local authorities reassess how the planning application process is used for mitigating environmental impacts.

4.69. Figure 4 sets out an example of systems thinking in relation to BGI's ability to provide benefits for water, housing, and transport sectors. While the map does not differentiate linkages by size of importance, it could be adapted to do so to explore and communicate the value of specific BGI developments.

Fig 4: System Thinking – linking BGI to urban ecosystems, adapted from Brown, Mijic (2018)



5. Conclusion

5.1. The approaches and theories that were highlighted in the available literature may address some of the identified barriers to the effective implementation of BGI. In particular two key themes have emerged that underpin this and Consumer Scotland is interested in exploring these in more detail with stakeholders:

5.1.1. How can surface water management policy facilitate stakeholder cross-working, community involvement and support stakeholder commitment to BGI?

5.2. Effective operation of BGI is heavily dependent on communities accepting some fundamental changes to how water is managed and incorporated within their communities. As part of developing frameworks that enable stakeholders to work together, there is a need to identify and consider where opportunities exist in frameworks for communities to participate and feed-into BGI design and delivery.

5.2.1. How can communication enhance understanding and buy-in, in order to encourage community engagement and stakeholder collaboration in BGI projects?

5.3. Consideration should be given to how the benefits and effectiveness of BGI can be monitored, evaluated and shared. Increasing the evidence base for stakeholders, communities and other interested parties, will support the development of longer-term modelling frameworks that enable the success and sustainability of BGI to be assessed.

Annexe – Analysis of barrier types from available literature

Barrier	Referenced
Space	(Brown, Mijic) (Deely) (Hoanng, Fenner) (Kristov)
Distribution	(Brown, Mijic) (Deely) (Hoanng, Fenner)
Funding	(Brown, Mijic) (Collins, Chan) (Deely) (Kristov) (Lawson) (Waylen)
Regulation, legislation, policy and planning	(Brown, Mijic) (Collins, Chan) (Duffy) (Deely) (Flynn) (Howarth) (Hoanng, Fenner) (Kapetas, Fenner) (Hislop, Corbett) (Connop) (Cuminsky) (Lawson) (Odonnell) (Waylen)
Stakeholder cross working	(Cotterill) (Collins, Chan) (Deely) (Flynn) (Hoanng, Fenner) (Hislop, Corbett) (Lamond, Everett) (Connop) (Cuminsky) (Lawson) (Howarth) (Maskrey) (ODonnell) (Soma) (Wells)
Vocab and terminology	(JNCC) (Deely) (Kristov) (Lamond, Everett)
How a space is used	(Brown, Mijic) (Lamond, Everett)
Customer expectations, responsibilities	(Kristov) (Lamond, Everett) (Lawson) (Maskrey) (Ostfeld) (Pacione)
Long term sustainability	(Stevens) (Everett, Lamond) (Cotterill) (Deely) (Flynn) (Kapetas, Fenner) (Lawson) (Waylen) (Fisher)
Guidance for local authorities, developers, practitioners	(Cotterill) (Collins, Chan) (Duffy) (Deely) (Hoanng, Fenner) (Connop) (Lawson) (Waylen) (Wells)
Understanding full range of benefits	(Brown, Mijic) (Collins, Chan) (Deely) (Flynn) (Hoanng, Fenner) (Kapetas, Fenner) (Kristov) (Ellis) (Howarth) (Lamond, Everett) (Lawson) (Odonnell) (Williams) (Wells)
Community engagement/empowerment	(Cotterill) (Deely) (Lamond, Everett) (Garvey) (Ellis) (Maskrey) (Odonnell) (Pacione)(Ostfeld) (Williams) (Wells)

[1] Grey infrastructure is typically human-engineered infrastructure for water resources such as water and wastewater treatment plants, pipelines, and reservoirs.
[2] JNCC highlighted the EU definition of BGI
[3] Urban island heating, also known as 'Heat Island Effect' is where metropolitan areas are significantly warmer than the surrounding rural areas due to increased human populations, buildings sitting closely together and pollution from human activities
[4] Strategies that relate to BGI, place-making and community empowerment
[5] Royal Academy of Engineering (2016) *Living without electricity: one city's experience of coping with loss of power* https://www.raeng.org.uk/publications/reports/living-without-electricity
[6] Farr (2021) *West-Lothian river flooded with raw sewage in heavy downpour sparking health fears* (9 July 2021) https://www.edinburghlive.co.uk/news/edinburgh-news/west-lothian-river-flooded-raw-21006335
[7] Morris, Brewin (2014) *The impact of seasonal flooding on agriculture: the spring 2012 floods in Somerset, England*. Journal of Flood Risk Management, 7 (2) https://onlinelibrary.wiley.com/doi/epdf/10.1111/jfr3.12041
[8] Vidal (2014) *Wildlife casualties of floods grow amid fears over 'polluted' wetlands* (23 February 2014) https://www.theguardian.com/environment/2014/feb/23/wildlife-uk-floods-species-habitats-lost
[9] CREW (2020) *Impacts of Flooding in North-East Scotland* https://www.crew.ac.uk/publication/impacts-flooding
[10] Woods-Ballard et Al. (2015) *SuDS manual* http://www.scotsnet.org.uk/documents/NRDG/CIRIA-report-C753-the-SuDS-manual-v6.pdf
[11]Geogriou, Chastin (2021) *This is how urban 'blue spaces' can improve our health* (18 March 2021) https://www.weforum.org/agenda/2021/03/blue-spaces-water-improve-mental-health-says-study/ evidence from Morison, Smith, Tiges, Chastin (2021) *Mechanism of Impact of Blue Spaces on Human Health: a systematic literature review and meta-analysis* International Journal of Environmental Research and Public Health 18(5) https://doi.org/10.3390/ijerph18052486
[12] Lawson et Al. (2015) *Evaluating the multiple benefits of a Blue-Green Vision for urban surface water management* http://eprints.whiterose.ac.uk/92857/
[13] Kapetas, Fenner (2020) *Integrating blue-green and grey infrastructure through an adaptation pathways approach to surface water flooding* Philosophical Transactions of the Royal Society A: mathematical, physical and engineering science 378(2168) https://doi.org/10.1098/rsta.2019.0204
[14] Fenner (2017) *Spatial evaluation of multiple benefits to encourage multi-functional design of sustainable drainage in Blue-Green cities* Water 9(12) https://doi.org/10.3390/w9120953
[15] For more information on the types of SuDS and their range of benefits: Susdrain https://www.susdrain.org/delivering-suds/using-suds/suds-components/suds-components.html; Woods-Ballard et Al. (2015) SuDS manual; Brown, Mijic (2019) Integrating green and blue spaces into our cities; Fenner (2017) Spatial evaluation of multiple benefits to encourage multi-functional design of sustainable drainage in Blue-Green cities; Sharp, Kenyon, Choe (2020) Designing Blue Green Infrastructure for water management, human health, and wellbeing; Lawson et Al (2015) Evaluating the multiple benefits of a Blue-Green Vision for urban surface water management
[16] GreenBlue Urban, Arup (2018) Sustainable tree planting in innovative SuDS scheme https://www.externalworksindex.co.uk/entry/141139/GreenBlue-Urban-Ltd/Sustainable-tree-planting-in-innovative-SuDS-scheme/
[17] Source control is an important principle in the implementation of SuDS: Source controls look to maximise permeability within a site to promote attenuation, treatment and infiltration reducing the need for offsite conveyance, helping to provide interception storage which can handle and treat some of the more frequent but smaller, polluting events
[18] Water resilient Places – surface water management and blue-green infrastructure: policy framework
[19] Scottish Government (2021) Water-resilient places – surface water management and blue-green infrastructure: policy framework https://www.gov.scot/publications/water-resilient-places-policy-framework-surface-water-management-blue-green-infrastructure/
[20] Scottish Government (2021) Water-resilient places – surface water management and blue-green infrastructure: policy framework

[21] For example, in England, the Environment Agency has worked in partnership with CIRIA and others to update B£ST (Benefits Estimation Tool –valuing the benefits of blue-green infrastructure). The updated tool and accompanying updated guidance were published in February 2019. The tool, guidance and case studies are available on the Susdrain website https://www.susdrain.org/resources/best.html
[22] Scottish Government (2021)
[23] Research was undertaken between January-February 2022 by an internal researcher to CAS. Whilst the research was initiated at Citizens Advice Scotland (CAS), it was completed following a move of the consumer advocacy role from CAS to Consumer Scotland in May 2022.
[24] The following research repositories were searched for open access papers: CORE https://core.ac.uk/ MDPI https://www.mdpi.com/ research gate https://www.researchgate.net/
[25] https://openaccessbutton.org/ and https://unpaywall.org/
[26] 37 articles remained
[27] SEPA published its National Flood Risk Assessment in December 2012, which supported the development of Scotland's Flood Risk Management Strategies and associated Local Plans. The second cycle of flood risk management policy and planning in Scotland began in 2019 and is ongoing.
[28] Ibid
[29] Committee on Climate Change (2019) UK Housing: Fit for the Future? https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/
[30] Commission for Architecture and the Built Environment (2010) Urban Green Nation: Building the Evidence Base https://www.designcouncil.org.uk/resources/report/urban-green-nation
[31] House of Commons Communities and Local Government Committee (2017) Public Parks. Seventh Report of Session 2016-17 https://publications.parliament.uk/pa/cm201617/cmselect/cmcomloc/45/45.pdf
[32] Scottish Government (2018) The Scottish Housing Survey https://www.gov.scot/publications/scotlands-people-annual-report-results-2018-scottish-household-survey/
[33] Scottish Government (2017) *The Scottish Household Survey* https://www.gov.scot/publications/scotlands-people-annual-report-results-2017-scottish-household-survey/
[34] Greenspace Scotland (2018) *Third State of Scotland's Greenspace Report* https://www.greenspacescotland.org.uk/statistics
[35] Scottish Government (2018)
[36] Olsen, Mitchell (2021) S&SR Environment and Spaces Group Report: Covid-19 Green and open Space Use in Autumn 2020 https://www.gla.ac.uk/media/Media_779126_smxx.pdf
[37] Section 4.3.1 Knowledge and information – community engagement and empowerment
[38] Scottish Government (2021)
[39] Ibid
[40] O'Donnell, Lamond, Thorne (2017) Recognising barriers to the implementation of Blue-Green Infrastructure: A Newcastle case study Urban Water Journal, 14(9) https://doi.org/10.1080/1573062X.2017.1279190
[41] Hoang, Fenner (2016) *System interactions of storm water management using Sustainable Urban Drainage Systems and Green Infrastructure Urban Water Journal 13(7)* https://doi.org/10.1080/1573062X.2015.1036083
[42] Grey infrastructure is typically human-engineered infrastructure for water resources such as water and wastewater treatment plants, pipelines, and reservoirs.
[43] Hoang, Fenner (2015) System interactions of storm water management using Sustainable Urban Drainage Systems and Green Infrastructure
[44] Flynn, Davidson (2016) *Adapting the social-ecological system framework for urban storm water management: the case of green infrastructure adoption* Ecology and Society 21(4) http://dx.doi.org/10.5751/ES-08756-210419
[45] JNCC (2019*) Roadmap for the BGI Manual: Bridging the knowledge gap in the field of Blue Green Infrastructure* https://data.jncc.gov.uk/data/354f40aa-1481-4b7f-a1eb-82c806893409/BGI-Manual-Report.pdf
[46] Hoang, Fenner (2015) System interactions of storm water management using Sustainable Urban Drainage Systems and Green Infrastructure
[47] Duties and powers in full set out here https://www.gov.scot/publications/flood-risk-management-scotland-act-2009-surface-water-management-planning/pages/3/
[48] Hoang, Fenner (2015) *System interactions of storm water management using Sustainable Urban Drainage Systems and Green Infrastructure*
[49] CIRIA (2019) *Blue-Green Infrastructure Perspectives on Planning, Evaluation and Collaboration* cited in Krivtsov et Al (2021) *Mitigating Polluted Runoff from Industrial Estates by SuDS Retrofits: Case Studies of*

Problems and Solutions Co-Designed with a Participatory Approach Sustainability 13(22) https://doi.org/10.3390/su132212357

[50] Ibid

[51] Ashley et Al (2012) *Learning and Action Alliances to build capacity for flood resilience* cited in Krivtsov et Al (2021)

[52] Ibid

[53] Brown, Mijic (2019) *Integrating green and blue spaces into our cities: making it happen* *https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Integrating-green-and-blue-spaces-into-our-cities---Making-it-happen-.pdf*

[54] Flynn, Davidson (2016) *Adapting the social-ecological system framework for urban storm water management: the case of green infrastructure adoption* Ecology and Society 21(4) http://dx.doi.org/10.5751/ES-08756-210419

[55] Collins, Cheshmehzangi, Chan, Lei (2020) *Identifying enablers and barriers to the implementation of the Green Infrastructure for urban flood management: A comparative analysis of the UK and China* Urban Forestry & Urban Greening 54 https://doi.org/10.1016/j.ufug.2020.126770

[56] Flynn, Davidson (2016)

[57] Urban Heat Island Effect is where metropolitan areas are significantly warmer than the surrounding rural areas due to increased human activities such as urbanisation and pollution

[58] Nowacek et al. (2003) Madden (2010) as cited in Flynn, Davidson (2016)

[59] Flynn, Davidson (2016)

[60] Scott, Holzinger, Sadler (2017) cited in Hislop, Scott, Corbett (2019) *What Does Good Green Infrastructure Planning Policy Look Like? Developing and Testing a Policy Assessment Tool Within Central Scotland UK* Planning Theory & Practice 20(5) https://doi.org/10.1080/14649357.2019.1678667

[61] Gray, Barford (2018) cited in Hislop, Scott, Corbett (2019)

[62] Brown, Mijic (2019)

[63] Green Alliance (2016) *New markets for land and nature. How Natural Infrastructure Schemes could pay for a better environment* https://green-alliance.org.uk/wp-content/uploads/2021/11/New_markets_for_land_and_nature.pdf

[64] HM Government (2018) *A green future: our 25 year plan to improve the environment* *https://www.gov.uk/government/publications/25-year-environment-plan*

[65] Scottish Government (2021)

[66] Soma et Al (2018) *Incentives to contribute to flood adaptation in cities: Stakeholder analyses in Belgium, the UK and the Netherlands* Wageningen Economic Research https://library.wur.nl/WebQuery/wurpubs/533507

[67] Ibid

[68] Scottish Government (2021)

[69] https://www.susdrain.org/delivering-suds/using-suds/legislation-and-regulation/scotland.html

[70] Scottish Government (2021)

[71] Brown, Mijic (2019)

[72] Committee on Climate Change (2017) *Progress in preparing for climate change* https://www.theccc.org.uk/publication/2017-report-to-parliament-progress-in-preparing-for-climate-change/

[73] Brown, Mijic (2019)

[74] Ministry of Housing, Communities, and Local Government (2021) *National Planning Policy Framework* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

[75] https://www.sepa.org.uk/media/219048/wat-rm-08-regulation-of-sustainable-urban-drainage-systems-suds.pdf

[76] Duffy et Al (2013) Source control SuDS delivery on a global scale and in Scotland including approach by responsible organisations and professional groups https://rke.abertay.ac.uk/en/publications/source-control-suds-delivery-on-a-global-scale-and-in-scotland-in

[77] Collins, Cheshmehzangi, Chan, Lei (2020) & Campbell and D'Arcy (2012) as cited in Duffy et Al (2013)

[78] Duffy et Al (2013)

[79] https://www.buildingwithnature.org.uk/newsblog1/2021/6/16/building-with-nature-refreshes-green-infrastructure-standards-for-the-uk-built-environment-sector-ab3h7

[80] https://centralscotlandgreennetwork.org/

[81] Hislop, Scott, Corbett (2019)

[82] Hansen, Pauliet (2014) McWilliam et Al. (2015) Wilker et Al. (2016) cited in Hislop, Scott, Corbett (2019)

[83] Hislop, Scott, Corbett (2019)

[84] McWulliam et Al. (2015), Hanley, Barbier (2009) as cited in Hislop, Scott, Corbett (2019)
[85] Hislop, Scott, Corbett (2019)
[86] Cotterill, Bracken (2020) *Assessing the effectiveness of Sustainable Drainage Systems (SuDS) : interventions, impacts and challenge* Water 12(11) https://doi.org/10.3390/w12113160
[87] Charlesworth, Warwick (2011), cited in Lamond, Everett (2019) *Sustainable Blue-Green Infrastructure: a social practice approach to understanding community preference and stewardship* Landscape and Urban Planning 191 https://doi.org/10.1016/j.landurbplan.2019.103639
[88] Lamond, Everett (2019)
[89] Ibid
[90] Information adapted from Shove et Al. (2012) cited in Lamond, Everett (2019)
[91] Lamond, Everett (2019)
[92] Ibid
[93] Ibid
[94] Ibid
[95] Cotterill, Bracken (2020)
[96] Ibid
[97] Collins, Cheshmehzangi, Chan, Lei (2020)
[98] Citizens Advice Scotland (2022) *Building Back Blue* https://www.cas.org.uk/publications/building-back-blue
[99] JNCC (2019) *Roadmap for the BGI manual: bridging the knowledge gap in the field of Blue Green Infrastructures* https://hub.jncc.gov.uk/assets/354f40aa-1481-4b7f-a1eb-82c806893409
[100] Citizens Advice Scotland (2022)
[101] Smith (2021) *'Concern for environment reaches record high in YouGov top issues tracker'* (9 November 2021) https://yougov.co.uk/topics/politics/articles-reports/2021/11/09/concern-environment-reaches-record-high-yougov-top
[102] Citizens Advice Scotland (2022)
[103] O'Donnell et Al. (2017) *Recognising barriers to the implementation of Blue-Green Infrastructure: A Newcastle case study Urban Water Journal, 14(9) https://doi.org/10.1080/1573062X.2017.1279190*
[104] Lamond, Everett (2019)
[105] Collins, Cheshmehzangi, Chan, Lei (2020)
[106] Brown, Mijic (2019)
[107] Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits
[108] Brown, Mijic (2019)