
Green Infrastructure

Research into Practice

Centre for Sustainable Planning and
Environments, University of the West of
England, Bristol



University of the
West of England



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EXECUTIVE SUMMARY

The Centre for Sustainable Planning and Environments at the University of the West of England, Bristol have been commissioned by the Natural Environment Research Council (NERC) to conduct a review of how the evidence base for Green Infrastructure (GI) is being translated into practice. This review will inform the future investment in GI from Innovation Programme and Partnerships within NERC.

First, a **review of grey literature** identified the evidence related to the benefits of GI to biodiversity, ecosystem services and where these have been monetised. This is summarised as:

- There is **some evidence** presented on the role of GI in **enhancing biodiversity**. This primarily focuses on **green roofs, greenspaces** and **brownfields**. **Street trees** are recognised as being important where there is an absence of greenspaces, and **corridors, private gardens** and **greenery** in general are highlighted for their role in habitat connectivity. **Sustainable Drainage Systems (SuDS)** are highlighted for their role in improving water quality and therefore downstream biodiversity.
- **Supporting ecosystem services** are those that underpin the other services. There is **limited evidence** in the grey literature on the role of GI in providing supporting services.
- **Provisioning ecosystem services** are those that provide 'products' to people. There is **limited evidence** in the grey literature on the role of GI in providing these services.
- **Regulating ecosystem services** are those that improve or modify aspects of our environment, enhancing our safety and quality of life in urban environments. They are particularly important to our ability to adapt to climate change.
 - There is **substantial evidence** cited in most pieces of grey literature on the role of GI in improving **air quality**, regulating air and surface **temperatures** and for **stormwater management** through reducing surface water run-off, increasing rainwater retention and reducing pollution to surface water. There are three primary types of GI that appear to contribute to these regulating services: **trees, green roofs** and **greenspaces**. Although the use of the **SuDS** approach is clearly recognised for its role in flood risk management it is perhaps more limited than expected; this may be because the evidence has focussed on specific GI features and their ability to manage water.
 - There is **limited evidence** in the grey literature on the role of GI in delivering other **regulating services** including **noise abatement, carbon storage, soil regulation** and **pollination**.
- **Cultural ecosystem services** are those that provide people with opportunities for recreation, rest, relaxation and spiritual enhancement.
 - There is **substantial evidence** in the grey literature on the **recreational benefits** of GI, with beneficial outcomes often reported in terms of mental and physical health. These benefits have been related to **greenspaces, forests, community gardens**, and greater levels of '**greenness**'.
 - There is **some evidence** reported that **greenspaces** and **natural features** can contribute to **aesthetic experience** and **sense of place** in the built environment and that greater levels of '**greenness**' in the urban environment can provide health and well-being benefits. Several sources of grey literature cite studies that report increased social interaction and activity through the use of **greenspaces** and **community gardens** which can contribute to **social cohesion** and **social capital**. There is some evidence that new

greenspaces, community forests and **soft landscaping** in city centres have the potential to attract visitors. The impact of GI on **anti-social behaviour** or the perception of crime has also received some attention in the grey literature although it is recognised that this relationship is complex.

- There is **limited evidence** reported on the educational benefits of participating in outdoor learning in greenspace.
- There is **some evidence** that the ecosystem services provided by GI result in **economic benefits** to society and individuals. This has primarily focussed on the benefits to health and well-being (and resulting cost savings to health services) from **air quality** improvement and **physical activity, stormwater management, carbon storage** and **tourism**. Some grey literature also cites the economic benefits to the wider economy from greater commercial and residential **property values, economic activity** and **job creation**.

The review identified a large number of disciplines and sectors that are involved in publishing evidence and guidance on GI for a range of audiences. **Ecologists** and **landscape architects** appear to be significant advocates, the former primarily concerned with the benefits of contact with both urban and rural nature for human health and well-being as opposed to the benefits of GI to nature. Landscape architects seem to be more explicitly focussed on GI, the urban environment and providing guidance for high quality GI. In addition, specific types of GI also have attracted particular groups and professions, the most notable being for **urban trees** and **greenspaces**.

However, there appear to be significant gaps in some sectors in setting the standard for GI. With the exception of the TCPA, which has been a longstanding champion of GI, **planners** and **development surveyors** appear to be under-represented in the grey literature. This matters because these professions have a pivotal role in the planning, delivery and long term success of GI.

Seven organisations and networks with a role in sharing evidence and good practice related to GI were also explored, termed here 'amplifiers'. This included the networks: **Valuing Nature Network (VNN)**, **Living with Environmental Change (LWEC)**, **Adaptation and Resilience in the Context of Change (ARCC)**, **Biodiversity, Ecosystem Services and Sustainability (BESS)** and **Ecosystems Knowledge Network (EKN)**. These appear to be dominated by **ecologist** and **environmental science** communities which to be expected as several have been funded by NERC. **Construction Industry Research and Information Association (CIRIA)** has a long established record of reaching construction audiences, and through its work on SuDS may be able to gain traction with development surveyors. Only the **Green Infrastructure Partnership**, however, is solely focussed on GI and therefore provides a unique opportunity to share knowledge and good practice in GI.

A series of **case studies** are also presented covering a range of GI projects, geographical areas and intended outcomes. They, and the evidence base, demonstrate that there are numerous excellent examples of GI research and practice happening across the UK.

Second, in order to gain further insight into GI practices and their relationship with academic research there were **two events bringing together the GI community of research, policy and practice**. These were held in May 2016 in Birmingham and Glasgow. These events were extremely useful in exploring the patterns in access and use of grey literature and academic evidence, the disciplines and sectors that are underrepresented across research and practice, the role of different organisations and networks in sharing evidence and good practice and the needs of the GI community in terms of

research and knowledge exchange. Perhaps more importantly a number of suggestions were made as to how the current difficulties in accessing and using evidence related to GI could be addressed.

There is an **overload of evidence** from both academia and those responsible for grey literature and some, particularly practitioners are struggling to navigate their way through this. The most common reasons for this seemed to be due to lack of resources (time, funding, skills or knowledge) on their part and/or the way research findings are presented. A need was expressed for a centralised web-based system for the GI community with evidence, links to tools, key organisations and case studies.

The **evidence is not reaching out to all the sectors and disciplines** that it needs to in order to raise GI on the agenda of key decision makers and delivery agents. This includes policy makers, local authorities, financial professionals, development surveyors, planners, architects, urban designers, the general public, grey infrastructure professionals and public health professionals. There is a need to ensure that evidence is tailored for each individual audience, with the input of end-users, and shared through their networks and professional bodies.

Amplifier organisations were generally highly regarded. These organisations and networks were seen as important in the task of sharing evidence with the disciplines and sectors identified above. The different language and terminology used across the GI community was seen as problematic and amplifiers have a role to play here too.

Academic evidence was often respected (e.g. methodology, robustness) but was often seen as divorced from the needs of the end-user. Generally, the **involvement of end-users at the beginning and throughout the research process** was seen as essential to its usefulness in practice. This including end-users having a strong role in shaping the research question and the way findings are presented.

There is a **need for research funding for high quality monitoring and evaluation** studies in GI. This does not fit into current funding programmes as it is not discovery science or innovation but it critical to developing a greater understanding of the role of GI. Similarly, it was felt that applied research does not fit into traditional funding streams and this is hindering progress in GI.

A number of gaps exist in the evidence base. These include studies to examine the **benefits of GI**, for example, health outcomes, financial value particularly to property developers, contribution to natural capital, as well as **what works (and doesn't work)** in the planning, design, implementation and long-term management of GI. The events were seen as a useful starting point in bringing academics and end-users to start identifying research priorities and more effective mechanisms for collaboration.

DEFINITIONS OF GREEN INFRASTRUCTURE

“Green infrastructure is a network of multifunctional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities. Green infrastructure is not simply an alternative description for conventional open space. As a network it includes parks, open spaces, playing fields, woodlands, but also street trees, allotments and private gardens. It can also include streams, canals and other water bodies and features such as green roofs and walls.” (DCLG, 2016)

Green infrastructure is “the use of ecosystems, green spaces and water in strategic land use planning to deliver environmental and quality of life benefits. It includes parks, open spaces, playing fields, woodlands, wetlands, road verges, allotments and private gardens. Green infrastructure can contribute to climate change mitigation and adaptation, natural disaster risk mitigation, protection against flooding and erosion as well as biodiversity conservation.” (European Commission, cited in Scottish Government, 2011)

“Green infrastructure should be a strategic network of high quality green spaces and other natural features, designed and managed to deliver the ecological services and quality of life benefits required by communities now, and in the future. Green Infrastructure includes established green spaces and new sites and should thread through and surround the built environment and connect the urban area to its wider rural hinterland.” (Natural Resource Wales, 2015)

Green infrastructure is “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. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings.” (European Commission, 2013)

THE UK PLANNING CONTEXT

In England planning policy is defined by the *National Planning Policy Framework* (NPPF), published by the Department for Communities and Local Government in 2012 (DCLG, 2012). The document outlines the government’s objectives for a range of themes and sets expectations on how its policy goals need to be locally applied. The NPPF acts as an important reference point for local planning authorities, developers, communities and other stakeholders, both in the context of plan making and in the determination of planning applications. The NPPF is accompanied by more detailed guidance that extends the policy objectives of the NPPF. This online guidance, referred to as *Planning Practice Guidance* (PPG), is subject to regular updates (DCLG, 2016).

The NPPF includes an underlying presumption in favour of sustainable development (paragraph 14). A series of core planning policies permeate from this and include goals relating to the need for a planned system, with local plans being the principal point of reference in the determination of planning applications. Other ‘material considerations’, such as local traffic conditions and site history, can also be taken into account and consequently allow for an element of discretion to be applied to decision making. Local plans are expected to be developed via a creative and collaborative process, with

policies and proposals being developed to respond to the principles and requirements of the NPPF. Expectations are varied but include the promotion of high quality design, the provision of good quality amenity space, the re-use of previously developed land, and the encouragement of appropriate action to respond to flood risk (DCLG, 2012).

The definition of green infrastructure in the NPPF is shown above. Paragraph 114 sets out that local planning authorities should plan positively for the "*creation, protection, enhancement and management of networks of biodiversity and green infrastructure*". These principles extend to other parts of the NPPF, with paragraph 117 referring to the need for local planning policies to "*identify and map components of local ecological networks*" and promote their preservation, restoration and recreation (DCLG, 2012). More detailed guidance is included via PPG which includes some of the benefits of green infrastructure, the type of strategic measures that local planning authorities will need to take to secure these, and how green infrastructure can help to deliver wider policy goals (DCLG, 2016, paragraphs 27 to 32). Significantly, in paragraph 34, the guidance also sets out how green infrastructure should be considered in planning decisions (DCLG, 2016).

Similar policy goals exist for the rest of the UK, with each nation adopting the same plan-led approach to planning.

In Scotland, the *Scottish Planning Policy* (SPP) was published in June 2014 (Scottish Government, 2014a). The document includes a number of objectives relating to green infrastructure with a dedicated section on 'maximising the benefits of green infrastructure' (pages 50 to 52). These principles align with those expressed through the *Scottish National Planning Framework (NPF3)* that was also published in June 2014 (Scottish Government, 2014b). This document presents a spatial expression of how Scotland should be developed over a 20-30-year period. The policies outlined in SPP continue the principles of the Scottish Government guide *Green Infrastructure: Design and Placemaking* that presents advice on how green infrastructure can be incorporated into master plans (Scottish Government, 2011).

In Wales, *Planning Policy Wales*, the eighth edition, was published in January 2016 (Welsh Government, 2016). Although the term 'green infrastructure' is not explicitly used, the same principles are generally present. For instance, paragraph 11.1.11 outlines the need to protect formal and informal green space, with particular emphasis being given to promoting multi-functionality (Welsh Government, 2016). Additional *Technical Advice Notes* (TANs) provide further policy direction on a series of policy themes. There is not a dedicated TAN for green infrastructure, but note 5 on 'Nature Conservation and Planning' (2009) is particularly helpful in reinforcing some of the principles that underpin successful green infrastructure planning (Welsh Government, 2009). The objectives that are contained within *Planning Policy Wales* are given a spatial dimension through the *Wales Spatial Plan* (Welsh Government, 2008)

Lastly, in Northern Ireland, centralised policies are expressed through the *Strategic Planning Policy Statement* that was published by the Department of the Environment in September 2015 (DoE, 2015). Again, similar principles for the planning, design and management of green infrastructure are presented, with particular emphasis being given to the role of green infrastructure assets in the protection and promotion of ecosystem services. As with Wales, green infrastructure principles extend through a series of *Planning Policy Statements* and *Supplementary Planning Guidance* that the

Department of the Environment has also published, although there is not a specific document covering the topic. However, green infrastructure is promoted through the *Regional Development Strategy* that presents a vision to 2035 (DoE, 2012).

OUR APPROACH TO THE REVIEW

The Centre for Sustainable Planning and Environments at the University of the West of England, Bristol have been commissioned by the Natural Environment Research Council (NERC) to conduct a review of how the evidence base for Green Infrastructure (GI) is being translated into practice. This review will inform the future investment in GI from Innovation Programme and Partnerships within NERC.

There are a myriad of definitions of GI from numerous different sources. An examination of some examples adopted by the EC and UK governments reveals some key aspects that in combination are critical features of GI:

- It is a network of different elements including greenspaces, parks, open spaces, playing fields, woodlands, street trees, allotments, private gardens, wetlands, road verges, streams, canals and other water bodies, green roofs and walls;
- It is multifunctional, providing a range of benefits or ecosystem services (to people/communities) both, now and in the future;
- It is primarily urban or peri-urban, although it can be rural, but should provide connectivity between the built environment and the countryside;
- It is planned and developed strategically.

With these characteristics of GI in mind the approach taken in this review is to first conduct a desk study of current good practice, networks and expertise that exists in GI in the UK. Second, supplement this review with the views of the wider GI community gained through two events in May 2016.

The scope of the work is to:

- Review the grey literature as a means to assess how evidence from research and practice is reaching non-academic audiences;
- Bring together a suite of case studies that illustrate current good practice;
- Analyse key sectors and disciplines that are instrumental in the research, planning and delivery of GI;
- Analyse key geographic, organisational and institutional clusters of expertise and delivery;
- Examine the role of specific organisations and networks and their role in sharing GI research and good practice; here the term 'amplifiers' is used to describe organisations and networks fulfilling this role;
- Analyse and outline the gaps in research and the translation of research into practice.

This work is inherently UK-focused but examples of evidence and good practice from elsewhere have been drawn on where appropriate. The review has been framed using a typology of GI and the ecosystem services that it can deliver. The approach has prioritised grey literature that is UK-focused,

recent, representative of range of disciplines and stakeholders and freely available to download from the internet.

The analysis of sectors, disciplines, clusters of expertise and delivery has been drawn from the grey literature, case studies and the recent NERC Green Infrastructure Innovation Funds. Similarly, the organisations and networks have been drawn from similar sources as well as our own experiences.

The sections of this report detail the key questions each is seeking to answer, what was examined and the findings. These are supplemented with additional information from the two events.

INCORPORATING THE VIEWS OF THE GI COMMUNITY

In order to gain further insight into GI practices and their relationship with academic research there were two events bringing together the GI community of research, policy and practice. These were held in May 2016 in Birmingham and Glasgow. The aims of these events were to:

- Feedback on the findings of the desk study;
- Gain additional information to supplement the desk based activities;
- Provide an opportunity for networking;
- Disseminate examples of good practice in GI;
- Share future initiatives and funding opportunities coming from NERC.

There was a series of presentations at the events outlining the findings from the desk study and introducing some of the key initiatives and networks related to GI. There was also two interactive sessions which provided opportunities for networking and allowed participants to input into the review. These were structured around a number of questions which are highlighted throughout this report.

The first session, Speed Networking, was structured to provide participants with the opportunity to introduce themselves to most of the other participants. The Speed Networking was also used to consider a series of ten questions developed from the key findings that we felt could be answered relatively quickly with little discussion and serve as useful 'ice breakers' to relax participants and encourage communication. Some of these questions were developed more fully in the later session; others were more simplistic in nature and highlighted where further research is needed (e.g. examples of good practice). The Speed Networking was, as its name suggests, fast paced giving groups of three to five participants a minute each to give their thoughts on the questions before moving on to the next question with different participants; in this session each participant should have answered most of the questions.

The second session provided an opportunity for larger groups of participants to discuss one of three questions for twenty minutes each before moving tables. These were structured around three themes:

- Research evidence;
- Examples from practice;
- Dissemination and knowledge exchange.

The review and the findings from these events has been consolidated into a gap analysis to provide NERC with an overview of the current evidence and practice of GI in the UK to enable them to direct future investment where it is needed.

Programme

Registration and refreshments	09:30-10:00
Welcome address and purpose of the day Lynne Porter, NERC	10:00-10:15
Scoping review: Key findings Danielle Sinnett, Centre for Sustainable Planning and Environments, UWE	10:15-10:35
Format for the day Lynne Porter, NERC	10:35-10:45
Speed networking (coffee available throughout)	10:45-11:45
Birmingham: Green Infrastructure Partnership Julia Thrift, TCPA	11:45-12:10
Glasgow: Urban green infrastructure assessment Rohinton Emmanuel Glasgow Caledonian University	
CIRIA	12:10-12:30
Birmingham: Paul Shaffer, Associate	
Glasgow: Suzanne Simmons, Project Manager	
Lunch	12:30-13:30
Birmingham: Defra 25 year strategy Rob Bradburne, Defra	13:30-13:50
Glasgow: 10,000 Raingardens project Neil McClean, Associate, WSP Group, Chair, Scottish Infrastructure Forum	
Breakout session (coffee available throughout)	13:50-15:30
Birmingham & Glasgow: Ecosystem Knowledge Network Bruce Howard, NERC Knowledge Exchange Fellow	15:30-15:50
Birmingham only: Valuing Nature Programme Anita Weatherby, Centre for Ecology & Hydrology	
Future funding opportunities and next steps Lynne Porter, NERC	15:50-16:00
Close	16:00

EVIDENCE REVIEW

Approach and scope

The primary aim of the review is to examine the extent to which academic research is translated into practice. Therefore the focus is grey literature aimed at a non-academic audience and specifically that which may draw evidence from the academic literature. The scope was grey literature focused on presenting the evidence related to GI or some aspect of it (e.g. trees, greenspaces). There is a substantial amount of grey literature available so the following was used to prioritise those considered:

- Grey literature aimed at a UK audience, the only exception to this is Bowen & Parry (2015) which provides a very recent and thorough analysis of the health and well-being evidence;
- Grey literature written by a range of organisations for different disciplinary audiences;
- A mix of literature reviews, summaries of evidence and guidance to examine if, and how, academic evidence is used in these different types of grey literature;
- The grey literature was mainly focussed on GI in the urban environment although two Natural England (Sunderland, 2012; Rolls & Sunderland, 2014) reports considered more generally the benefits of investing in the environment;
- The grey literature was available to download from the internet at no cost with a cut-off date of 28th February 2016.

In total twenty-six pieces of grey literature were reviewed (Table 1), from nineteen different authors or organisations. These include twelve literature reviews, six guidance documents, two evidence summaries, five documents that are a mix between evidence summaries and guidance and one that is an evidence summary with some primary research (CABE Space, 2010). Grey literature that presented primary research only was not included as the aim of this review was to examine the use of academic evidence.

The evidence cited in the grey literature was organised by type of GI (e.g. street trees, greenspace), then by the ecosystem services delivered by these. Ecosystem services are used to describe the goods and services, or benefits, provided by nature to human health and well-being. It is a useful framework to consider the evidence for GI and so is used to structure this report and the summary table. However, as it presupposes the existence of 'nature' the benefits that GI might provide to nature conservation and biodiversity do not fit into it so are summarised separately, before the ecosystem services. Similarly, often the next step in the assessment of ecosystem services is some form of economic valuation of these services so this evidence is summarised at the end.

Only evidence that includes a citation has been presented in this review and grey literature that is known not to report primary evidence has been omitted.

The evidence in the grey literature is summarised by ecosystem service, organised by type of GI. A list of the academic literature is provided at the end of the report. An overview is provided in Table 2.

Table 1 Grey literature included in this report

Title	Year	Organisation (Authorship)	Literature review	Evidence summary	Guidance	Case studies
Health, Wellbeing and Open Space	2003	OPENSspace (Morris)	✓			
The Value of Public Space	2004	CABE Space	✓			
Green Infrastructure Guide	2008	NW Think Tank			✓	✓
Green Infrastructure: Connected and multifunctional landscapes	2009	Landscape Institute		✓	✓	
GI Guidance	2009	Natural England			✓	✓
Community Green: Using local spaces to tackle inequality and improve health	2010	CABE Space		✓		
Benefits of Green Infrastructure	2010	Forest Research	✓			
Multifunctional Urban Green Infrastructure	2010	CIWEM		✓		✓
Green Infrastructure in Urban Areas	2011	RICS		✓		✓
Economic Benefits of Greenspace	2012	Forestry Commission (Saraev)	✓			
Green Space Design for Health and Well-being	2012	Forestry Commission (Shackwell & Walter)			✓	✓
Microeconomic Evidence for the Benefits of Investment in the Environment	2012	Natural England (Sunderland)	✓			
Multifunctional Green Infrastructure	2012	Science for Environment Policy, EC	✓			
Planning for a Healthy Environment: Green Infrastructure Guide	2012	TCPA, Royal Society of Wildlife Trusts		✓	✓	
Trees in the Townscape	2012	Trees and Design Action Group			✓	✓
Air Temperature Regulation by Trees and Green Infrastructure	2013	Forest Research (Doick & Hutchings)	✓			
Green Infrastructure Contribution to Economic Growth: A Review	2013	Eftec, Sheffield Hallam	✓			✓
Urban Green Infrastructure	2013	Houses of Parliament	✓			
Cities Alive: Rethinking Green Infrastructure	2014	Arup		✓	✓	✓
Microeconomic Evidence for the Benefits of Investment in the Environment 2	2014	Natural England (Rolls & Sunderland)	✓			
Trees in Hard Landscapes	2014	Trees and Design Action Group			✓	✓
Demystifying Green Infrastructure	2015	UK Green Building Council		✓	✓	✓
Cities, Green Infrastructure and Health	2015	Landscape Institute (Kirby & Russell)	✓			
Green Bridges Guide	2015	Landscape Institute			✓	✓
Natural Capital: Investing in a green infrastructure for a future London	2015	GI Task Force		✓	✓	✓
The evidence base for linkages between GI, public health and economic benefit	2015	Bowen & Parry	✓			

Biodiversity

Biodiversity is not an ecosystem service but is intrinsically linked to the ability of ecosystems to deliver these benefits to people. In order for ecosystems to function sustainably it is generally understood that they must be biodiverse at some level, for example, even agricultural monocultures need some genetic biodiversity or diversity in the soil community in order to function and be resilient to threats.

There is a common understanding that GI inherently increases 'nature' in urban areas and there is a body of evidence that urban areas with greater amounts of GI, or where this is better connected internally and to the surrounding countryside, that includes native species and sensitive management practices are more biodiverse than areas without these features. However, this is not represented in the grey literature. There is some evidence reported of the potential for GI to contribute to biodiversity enhancement and protection (Forest Research, 2010; Sunderland, 2012), for example **green roofs, greenspaces, brownfield** and **derelict** sites are all cited as having benefits in terms of species diversity, particularly for invertebrates and birds (Forest Research, 2010; RICS, 2011; Sunderland, 2012; Rolls & Sunderland, 2014). **Street trees** are recognised as being important where there is an absence of greenspaces (Forest Research, 2010). The importance of **corridors, private gardens** and **greenery** in general are highlighted for their role in habitat connectivity (Forest Research, 2010; Sunderland, 2012). The role of **SuDS** in improving water quality is recognised for the resulting benefits to biodiversity as opposed to the biodiversity in the SuDS themselves (Forest Research, 2010).

The benefits of biodiversity are also generally pitched in terms of contact with nature (see Recreation, walking, physical activity section). However, Science for Environment Policy (2012) cites one study that reports that biodiversity increases species resilience.

Several other pieces of grey literature report on some of specific features or management of GI that can enhance biodiversity. For example the development of an 'ecological network' through the use of **green corridors** (Science for Environment Policy, 2012; TCPA & The Wildlife Trusts, 2012; Houses of Parliament, 2013) and organic farming practices (Sunderland, 2012).

Supporting services

Supporting services are those that underpin the other services. They are indicative of a well-functioning ecosystem and include services such as soil formation, water and nutrient cycling and photosynthesis. These services are generally under researched in the urban environment and therefore there is very little evidence presented in the grey literature relating to these services. They are often associated more with **agricultural and forest ecosystems** where the quality and productivity of the system is paramount and, particularly in soils, is degraded through intensive agriculture.

One area that has received considerable attention in the grey literature is related to water cycling, primarily through flood and surface water run-off. This has been included as a regulating service (see below). Clearly in many countries where water reuse is a significant driver the importance of GI for water cycling may receive more attention in the evidence and guidance.

In the case of urban soils much of the research activity has examined soil contamination which clearly impacts on their function. However, the focus has not been on how this impacts their ability to deliver ecosystem services instead it has primarily concentrated on the risk that such contamination may pose to human (and in a few cases) ecological receptors. For example, soils in urban areas are often characterised by greater contaminant concentrations, lower nutrient content and compaction of which will diminish their ability to deliver the ecosystem services that are underpinned by good soil quality. It is perhaps understandable that these services have not been prioritised in green infrastructure research as they are often invisible compared to the other services.

The exception to this is the role of **forests and forested wetlands** in soil and peat formation (Science for Environment Policy, 2012).

Provisioning services

Another area that is largely absent from the grey literature is that of provisioning services. These include the provision of food, fuel, timber and clean water. As with water cycling the focus on the beneficial impacts of GI on water has been on flood management which is a regulating service. Although there are obvious links to water quality in reducing the impact of floods this has not been explicitly covered in the grey literature.

In terms of provisioning services urban GI is most commonly used for food production and this is becoming increasingly common with a renewed interest in **allotments, community gardens** and 'grow your own'. There is considerable evidence in the academic literature concerning the health and well-being benefits of urban agriculture but this does not appear to be represented in the grey literature (see Social cohesion, social capital; Recreation, walking, physical activity sections). However, in these studies the outcomes are, for example, centred on the nutritional quality of 'grow your own', physical activity, community cohesion and other social benefits as opposed to the role of GI in delivering food *per se*. The exception was the use of a **buffer zone** between the rural and the urban fringe to promote sustainable organic agriculture (Science for Environment Policy, 2012).

Regulating services

There is evidence in the grey literature that GI can deliver a range of regulating services including improving air quality, water and climate regulation (see below). There is, however, limited evidence presented in the grey literature related to pollination, carbon storage or soil regulation. It is likely that there is a paucity in the academic evidence of the role of GI in soil regulation and carbon storage but there is a reasonable body of evidence related to the pollination in urban areas, linked to the biodiversity of GI.

Air quality

There is substantial evidence presented in the grey literature that GI, particularly trees, can improve air quality. Most of this evidence relates to the ability of **trees** to intercept, and thereby reduce, particulate pollution (Forest Research, 2010; RICS, 2011; Saraev, 2012; Sunderland, 2012; Eftic & Sheffield Hallam, 2013; Houses of Parliament, 2013) and absorb gaseous pollutants including SO_x, NO_x and O₃ (Forest Research 2010; Eftic & Sheffield Hallam, 2013). There is recognition that species

selection, tree health, planting position, weather and initial pollutant concentration plays a pivotal role in the extent to which trees can impact on both gaseous and particulate pollution (Forest Research, 2010; Sunderland, 2012; Rolls & Sunderland, 2014; Houses of Parliament, 2013). Some of the evidence cited in the grey literature relates these improvements in air quality to health benefits through reductions in respiratory problems and mortality in urban populations (RICS, 2011; Science for Environment Policy, 2012; Saraev, 2012). Often the evidence is from modelling but in one case refers to a cross-sectional study looking at the association between asthma prevalence in children and the frequency of street trees (Forest Research, 2010; Sunderland, 2012, Rolls & Sunderland, 2014). Some of the grey literature recognised that in some cases trees can have a negative impact on air quality either through the production of volatile organic compounds or by forming a barrier to contain air pollution (RICS, 2011; Sunderland, 2012; TDAG, 2014).

There is also some recognition in the grey literature of the beneficial role of **green roofs** in mitigating NO_x, PM and CO₂ pollution (Science for Environment Policy, 2012; Rolls & Sunderland, 2014). Some work looking more generally at the ability of greenspace to improve particulate pollution has also been used in the grey literature (RICS, 2011; Eftac & Sheffield Hallam, 2013).

Climate regulation (local)

The grey literature also highlights the role of GI in reducing air and surface temperatures through evapotranspiration and shade provision, thereby mitigating the urban heat island effect. This has an obvious benefit in terms of climate change adaptation and is likely to become more important in the future. There are three primary types of GI that appear to contribute to this: trees, green roofs and greenspaces, although some of the grey literature refers generally to GI or vegetation cover.

Looking first at the evidence coming through on GI in general, several pieces of grey literature refer to evidence suggesting that urban areas with **greater proportions of GI or percentage cover of vegetation** are associated with lower temperatures (CABE, 2004; Gill et al., 2007; Natural England, 2009; CIWEM, 2010; Forest Research, 2010; RICS, 2011; Science for Environment Policy, 2012; Sunderland, 2012; Doick and Hutchings, 2013; Houses of Parliament, 2013; Bowen & Parry, 2015). In some cases the grey literature relates these positive effects with outcomes including reduced use of air conditioning (Doick and Hutchings, 2013). Although this evidence does not refer to specific types of GI, the importance of **trees** is highlighted either within greenspaces or as an urban forest network (Natural England, 2009; Sunderland, 2012; Rolls & Sunderland, 2014, Doick and Hutchings, 2013; Eftac & Sheffield Hallam, 2013). Similarly, the incorporation of water features is also highlighted for their role (CIWEM, 2010).

The beneficial role of **green roofs** in reducing the urban heat island effect features in a number of grey literature sources (Science for Environment Policy, 2012). Although not specifically related to the urban heat island, the role of green roofs in providing insulation, therefore improving the energy efficiency of buildings is also mentioned (Science for Environment Policy, 2012; Doick & Hutchings, 2013).

There appears to be more evidence cited in the grey literature of the benefits of **parks and gardens** in mediating the urban heat island effect (Forest Research, 2010; Doick & Hutchings, 2013; Eftac & Sheffield Hallam, 2013; Science for Environment Policy, 2012). Some figures are highlighted in terms of

the size of greenspaces that are associated with lower temperatures; for example parks of at least 3 ha (Forest Research, 2010). The documents also point to the varied effects with different levels of paving in parks (Forest Research, 2010), different types, species and planting design of vegetation (Doick & Hutchings, 2013) and having smaller parks (Forest Research, 2010) and that these positive effects decrease further from the boundary of the space from 100 m to 2 km (Forest Research, 2010; Doick & Hutchings, 2013; Eftec & Sheffield Hallam, 2013). However others suggest a more nuanced picture, for example that a matrix of smaller **spaces, corridors, green roofs and street trees** may be more effective particularly for shade provision and if there is a need to mitigate flood risk as well as achieve urban cooling (CIWEM, 2010).

Some of the grey literature makes the connection between these positive impacts on urban temperatures and potential health outcomes through reducing the adverse effects of heat waves (Science for Environment Policy, 2012; Houses of Parliament, 2013).

Water regulation/purification

In addition to adapting to changing temperature, there is also substantial attention given to the role of GI in flood risk management as another means to adapt to climate change. Again the grey literature highlights the benefits of GI in stormwater management through reducing surface water run-off and increasing rainwater retention (CABE Space, 2004; Natural England, 2009; Forest Research, 2010; RICS, 2011; Science for Environment Policy, 2012; Doick & Hutchings, 2013), thereby reducing the pressure on traditional grey infrastructure. Many highlight the beneficial role of **increasing vegetation cover** across the urban environment (Natural England, 2009; CIWEM, 2010; RICS, 2011; Eftec & Sheffield Hallam, 2013; Science for Environment Policy, 2013).

As with temperature, the use of green roofs and trees within the mix of GI provision is given particular attention (CABE Space, 2004; CIWEM, 2010; Forest Research, 2010; RICS, 2011; Science for Environment Policy, 2012). For example **green roofs** have been suggested to retain up to 100% rainfall (Forest Research, 2010; Science for Environment Policy, 2012; Doick & Hutchings, 2013; Rolls & Sunderland, 2014). Similarly **tree** cover can offer improved reductions in surface water run off compared with other vegetation types (CIWEM, 2010; Forest Research, 2010; RICS, 2011; Eftec & Sheffield Hallam, 2013; Rolls & Sunderland, 2014), although the time taken to achieve these benefits will be far longer (Science for Environment Policy, 2012).

Sustainable Drainage Systems (SuDS) are increasingly forming a key component of the GI resource in the built environment. They can incorporate many different green and blue features to manage water and reduce flood risks through mimicking natural drainage processes. Although many of the grey literature sources refer to the ability of GI to manage water often they do not refer to evidence specifically citing the effectiveness of SuDS to achieve this. This may be because the evidence has only looked at specific components of GI as opposed to a formal SuDS approach. However, where the efficacy of SuDS is discussed attention is normally drawn to their ability to control floods, increase infiltration and aquifer recharge (CIWEM, 2010; Sunderland, 2012, Rolls & Sunderland, 2014).

The role of **wetlands** in flood protection is also highlighted (Science for Environment Policy, 2012). Floodplain and riparian **woodlands** are also cited as providing effective protection from flooding (Forest Research, 2010; Rolls & Sunderland, 2014).

As well as flood regulation several types of GI are also recognised for their ability to improve water quality by preventing pollutants from entering rivers and streams. These are often those also contributing to flood management including **trees**, **green roofs** (Forest Research, 2010, TDAG, 2014), **SuDS** (CIWEM, 2010; Science for Environment Policy, 2012; Sunderland, 2012), **bioretention systems** (TDAG, 2014), **wetlands** (Sunderland, 2012; Rolls & Sunderland, 2014) and **woodlands** (Forest Research, 2010). **SuDS** can also reportedly reduce the need for salt to be applied to roads (Science for Environment Policy, 2012).

Noise pollution

The use of vegetation as a barrier against noise is long established, but interestingly this is not reflected a great deal in the grey literature (or perhaps this is why). Where it is only a few types of GI are highlighted for their ability to absorb sound: **tall vegetation** (Sunderland, 2012, Rolls & Sunderland, 2014), **trees**, **shrubs** (WHO, 2010), **green walls** (Rolls & Sunderland, 2014) and **woodlands** (Saraev, 2012). In addition, **SuDS** have been reported to reduce road noise (Science for Environment Policy, 2012).

Carbon storage

There is some recognition in the grey literature that GI can provide some carbon storage benefits. This primarily appears to relate to **trees**, as a network in the urban environment (CABE Space, 2004; Rolls & Sunderland, 2014), as forest blocks (Science for Environment Policy, 2012), green belt or national-scale woodlands (Rolls & Sunderland, 2014).

Soil regulation

The only aspect of soil regulation that is referred to in the grey literature is soil erosion. Only Forest Research (2010) cites the beneficial role of **trees** and **woodlands** in reducing soil erosion by intercepting rainfall and the potential positive impact of this in breaking pollutant pathways in contaminated soils.

Cultural services

Aesthetic experience, sense of place

There is very little specific evidence presented that GI increases the aesthetic experience in the built environment. Forest Research (2010) highlights the benefits of improving the aesthetics of an area through **greenspace** provision to both people's enjoyment and inward investment.

However, numerous sources of grey literature cite various pieces of evidence suggesting that the general level of '**greenness**' in the urban environment and simply being able to see natural, green and blue settings reduces blood pressure and stress, and improves mood, attention span, cognitive function and self-esteem (Morris, 2003; CABE Space, 2004; Forest Research, 2010, Science for Environment Policy, 2012; Sunderland, 2012; Rolls & Sunderland, 2014; Houses of Parliament, 2013; ARUP, 2014; Bowen & Parry, 2015). These positive effects on attention, cognitive function and stress have been reported not just for residential settings, but there is some evidence that these can also be achieved in the workplace, even after very short periods of exposure (Bowen & Parry, 2015). They have

also been highlighted as beneficial to those recovering from surgery and prison inmates (Morris, 2003).

Several pieces of grey literature point to the importance of GI in providing or improving sense of place (Forest Research, 2010; RICS, 2011). This effect seems to be particularly associated with **greenspaces** and **natural features** (Forest Research, 2010; RICS, 2011; Saraev, 2012).

Social cohesion, social capital

There is evidence that GI can facilitate social interaction and, through this, increase social cohesion and social capital in communities. Several sources of grey literature cite studies that report increased social interaction and activity through the use of **greenspaces** (CABE Space, 2004; Forest Research, 2010; WHO, 2010; RICS, 2011; Houses of Parliament, 2013) and **community gardens** (Bowen & Parry, 2015). Some of these also related this specifically to social cohesion and social capital (Forest Research, 2010; WHO, 2010; RICS, 2011; Sunderland, 2012; Rolls & Sunderland, 2014; Bowen & Parry, 2015), particularly in neighbourhoods with different communities (Forest Research, 2010). There is also some evidence that the mental health benefits may be related to social interaction in greenspaces (Houses of Parliament, 2013).

Education, experience of nature

One of the negative consequences of urbanisation has been reported as the lack of connection to nature and, the resulting 'extinction of experience'. However, the educational benefits from GI are only highlighted in a couple of the pieces of grey literature (Morris, 2003; RICS, 2011). They report that the positive impacts of **greenspace** and outdoor learning in them include increased awareness of natural processes and stewardship of the environment.

Recreation, walking, physical activity

Numerous sources of grey literature cite evidence related to the recreational benefits of GI. Some of these imply a recreational use, for example walking, physical activity, community gardening, through proximity or access to GI, whereas others explicitly measure use in some way. The beneficial outcomes are often reported in terms of mental and physical health, although evidence for the latter has been reported to be stronger (Forest Research, 2010).

Proximity to **greenspace**, measured through assessments of the quantity of greenspace, has been associated with reduced levels of self-reported depression symptoms and improved mental health (CABE Space, 2010; CIWEM, 2010; Forest Research, 2010; Bowen & Parry, 2015; Kirby & Russell, 2015), including in those moving to urban areas with higher levels of greenspace than their previous neighbourhoods (Bowen & Parry, 2015). Similarly, those living in areas with greater amounts of greenspace have been reported to undertake more physical activity (Forest Research, 2010; WHO, 2010; ARUP, 2014; Bowen & Parry, 2015), have lower health inequalities and rates of diseases including chronic heart disease, upper respiratory tract infection, asthma, migraine and diabetes, improved birth outcomes, self-reported general health (CIWEM, 2010; Forest Research, 2010; Bowen & Parry, 2015) as well as lower levels, or risk of, cause-specific mortality and morbidity (Bowen & Parry, 2015). Conversely, lower levels of satisfaction with greenspace access is associated with increased levels of mental ill-health (Sunderland, 2012; Rolls & Sunderland, 2014).

Other evidence cited in the grey literature reports associations between the direct experience of GI and health outcomes. Spending time in **greenspaces** and **forests** can have a positive impact on mood, self-esteem, attention, meditation, blood pressure, stress levels, anxiety, frustration and general well-being (Forest Research, 2010; Houses of Parliament, 2013; Bowen & Parry, 2015). Again, these benefits have been reported over short periods of exposure to GI (Houses of Parliament, 2013), although they do appear to be greater with longer exposure (Bowen & Parry, 2015). Several sources of grey literature also cite studies where the use of greenspaces is associated with reduced risk of heart attacks, colon cancer and fracture of the femur (CABE Space, 2004), diabetes and obesity (Bowen & Parry, 2015), and increased physical activity (Natural England, 2011; Saraev, 2012) and longevity (Morris, 2003; CABE Space, 2004). **Community gardens** are also cited as having a beneficial role in increasing physical activity levels in participants (Bowen & Parry, 2015). **Contact with nature** or greater levels of **biodiversity** are also reported to have positive impacts on mental health and stress (Sunderland, 2012; Rolls & Sunderland, 2014; UK GBC, 2015).

There appears to be a strong link between mental health outcomes and physical activity in **green settings**. Several pieces of grey literature point to evidence that greater benefits to mental health are reported when physical activity, including walking, takes place in contact with **greenery** (Morris, 2003; Forest Research, 2010; Houses of Parliament, 2013) or in **greenspaces** (Houses of Parliament, 2013).

There is also some evidence that the positive impacts of **greenspaces** and **community gardens** on mental and physical health can be particularly beneficial to those recovering from illness, including reducing cancer-associated fatigue (Bowen & Parry, 2015).

Another group that have received specific attention are **children**. Here, evidence has been cited that recreational activities undertaken in **greenspace** have a greater beneficial impact on the symptoms of Attention Deficit Disorder and Attention Deficit Hyperactivity Disorder (CABE Space, 2004; Forest Research, 2010; Bowen & Parry, 2015), greater levels of creative play and development of interpersonal skills (Forest Research, 2010; TCPA & The Wildlife Trusts, 2012). The literature also reports that the access to, and use of, greenspaces is positively associated with greater levels of physical activity and lower Body Mass Index in children (Bowen & Parry, 2015; UKGBC, 2015).

It is impossible to ascertain causality from many of these associations (Houses of Parliament, 2013; Bowen & Parry, 2015) and there generally appears to be a lack of high quality longitudinal studies either in the academic literature or reported in the grey literature that would allow this to be determined. Indeed, some grey literature report studies that did not find significant associations between GI and various mental and physical health outcomes, including stress, depression, physical activity, obesity, mortality, foetal growth, blood pressure, heart rate (Bowen & Parry, 2015). In addition, many studies use self-reported health outcomes although more recent grey literature includes studies with objective measures (Bowen & Parry, 2015). These studies are often international and therefore it may be difficult to relate their findings directly to the UK.

Some sources highlight the balance that must be found between particular aspects of GI to achieve these benefits. For example, although the evidence for the multiple benefits of trees is relatively persuasive some species can be viewed negatively, for example, because of their size, leaf drop or risk of injury (Science for Environment Policy, 2012; TDAG, 2014). Similarly, the importance of design and maintenance is also stressed for greenspaces in particular so that issues around **safety or perceived**

safety do not detract from their use (WHO, 2010; RICS, 2011) especially as this disproportionately affects some groups (Sunderland, 2012). It is also reported that size and proximity to greenspace affects the likelihood of it being used for physical activity (WHO, 2010). The importance of species selection and management is also highlighted considering the health impacts from exposure to pollen, toxic berries, fruits and fungi, and pesticides (Morris, 2003; Science for Environment Policy, 2013).

Tourism

Three pieces of grey literature report on the benefits of GI to tourism, two of which are focused on the economic benefits of GI. Here measures such as increased visitor numbers are reported, where monetised benefits have been cited these are reported in the *Economic benefits* section.

There is some evidence that new **greenspaces**, **community forests** and **soft landscaping** in city centres have the potential to attract new visitors and shoppers to an area (Saraev, 2012; Science for Environment and Policy, 2012; Sunderland, 2012; TDAG, 2014).

The role of landscape quality is also highlighted for its importance in attracting tourism (Sunderland, 2012) however it appears that this is in relatively **rural settings**. For example, specific reference is made to the **countryside, villages and seashores** as well as the South West and North and West Norfolk (Sunderland, 2012).

Crime and perception of crime

Several pieces of grey literature cite evidence that the presence of GI is related to levels of anti-social behaviour and the perception of crime in an area. There is some evidence reported that **increased greenery** is associated with lower levels of some crimes (Forest Research, 2010; Eftec & Sheffield Hallam, 2013) and greater levels of perceived safety in the neighbourhood (Eftec & Sheffield Hallam, 2013). The presence of **trees** and **greenspaces** are particularly highlighted as being associated with lower crime levels and anti-social behaviour (CABE Space, 2010; Forest Research, 2010; TDAG, 2014).

However, the relationship between GI and anti-social behaviour is not straightforward as it is also reported that **trees** can be associated with greater criminality (Eftec & Sheffield Hallam, 2013) and **greenspaces** can increase fear of crime (WHO, 2010) and may be associated with anti-social behaviour (Rolls & Sunderland, 2014).

Economic value

Many of the reports reviewed cited evidence of some form of economic benefit as a result of the ecosystem services delivered by GI.

There is little evidence on **supporting services**, the exception to this being the role of **forests and forested wetlands** in soil and peat formation which are cited as delivering substantial economic benefits (Science for Environment Policy, 2012).

Several of the **regulating services** provided by GI have been highlighted for their economic contributions. These include:

- Improved health from the reduction of air pollution by **forests and forested wetlands** (Saraev, 2012; Science for Environment Policy, 2012) and **trees** (Eftec & Sheffield Hallam, 2013);
- Storm protection and water purification by **wetlands** (Science for Environment Policy, 2012; Sunderland, 2012);
- Reducing operational costs of buildings sheltered by **trees** (Eftec & Sheffield Hallam, 2012);
- Carbon dioxide sequestration by **trees** (Science for Environment Policy, 2012; Eftec & Sheffield Hallam, 2013) and **woodlands** (Sunderland, 2012; Rolls & Sunderland, 2014).

Turning to the **cultural services** the grey literature reviewed cites the economic benefits of landscape enhancement from **forest** creation (Science for Environment Policy, 2012). It is also highlighted that the recreational benefits outweighed the cost of providing woodlands (Morris, 2003) and that those visiting forests and national trails were willing to pay for these benefits (Saraev, 2012).

Several pieces of grey literature cited evidence on the economic benefits of GI as a result of improved health and well-being. This is primarily due to increased physical activity in **greenspaces** (Saraev, 2012; Bowen & Parry, 2015), **natural habitats** (Bowen & Parry, 2015) and **forests** (Saraev, 2012).

Most of these savings are accrued to society, for example through savings to the NHS. However, some studies point to the economic benefits of GI to the wider economy from increased visitors (Morris, 2003; Saraev, 2012; Science for Environment Policy, 2012; Sunderland, 2012, Rolls & Sunderland, 2014), greater commercial property values (Morris, 2003; Eftec & Sheffield Hallam, 2013), economic activity (Morris, 2003) and job creation (Forest Research, 2010; Eftec & Sheffield Hallam, 2013). Others cite several studies that have reported increased property prices in areas with a greater proportion of **trees** (RICS, 2011) and **greenspaces** (CABE Space 2004; Forest Research, 2010; RICS, 2011; Eftec & Sheffield Hallam, 2013). However, where greenspaces are associated with anti-social behaviour they may have a negative impact on property prices (Rolls & Sunderland, 2014). There also appears to be some variation depending on the land value, with those areas with lower land values having lower expectations that the landscape would affect property prices (Rolls & Sunderland, 2014).

Gaps in the evidence presented in grey literature

The evidence base reported in the grey literature is summarised in Table 2, organised by GI type and ecosystem service. The review of grey literature has allowed some insight into the evidence reaching practitioner audiences. However, it was not clear whether an absence of evidence was as a result of a true absence or whether this is simply not being used in the grey literature. The [Ecosystem services transfer toolkit](#) (Natural England, 2014) was used in attempt to answer this. This tool was queried using the 'urban' habitat and the strength of evidence cross-referenced with the findings from the grey literature. This revealed that:

- Certain ecosystem services are under-represented in the grey literature compared with the strength of evidence; these are pollination and urban biodiversity;
- Other ecosystem services are probably equivalent between the academic evidence and that reported in the grey literature: these are climate regulation, improvements to air and water quality and cultural services;

- There are genuine gaps in research concerning the role of certain types of GI, particularly elements of SuDS and soft landscaping (non-trees);
- The public health evidence has increased in robustness in recent years but more longitudinal data are needed on the health outcomes of GI interventions.

Next, the findings from the two GI event related to the access and use of grey literature are summarised.

Table 2 Overview of the amount of evidence presented in the grey literature (red=evidence in academic literature but largely absent from grey literature; orange=academic evidence reported in some of the grey literature; green=academic evidence featured in a range of grey literature)

Scale	Green infrastructure type and examples	Biodiversity	Supporting services			Provisioning services			Regulating services						Cultural services					Economic benefits		
			Soil formation	Photo synthesis	Primary production	Nutrient/water cycling	Food, fibre, fuel	Fresh water	Air quality	Climate regulation (local)	Water regulation/purification	Pollination	Noise abatement	Carbon storage	Soil regulation	Aesthetic experience, sense of place	Social cohesion, social capital	Education	Recreation, walking, physical activity		Tourism	Crime and perception of crime
Micro	Street trees (e.g. retained mature or newly planted tree/s; green verges)	Orange							Green	Green	Green			Orange						Orange	Orange	Orange
Building	Green walls/roofs (e.g. vertical/ rooftop garden; private garden)	Orange							Green	Green	Green	Red										
Site	Derelict/'waste' land (e.g. brownfield land; temporary green)	Orange	Red												Orange						Red	
	Water management space (e.g. SuDS; flood storage area)	Orange																				Orange
Neighbourhood	Parks and gardens (e.g. urban park; country park; playground)	Orange							Green	Green		Red					Green	Green	Orange	Green	Orange	Orange
	Urban agriculture (e.g. allotments; community garden; urban farm)							Orange										Red		Orange		
	Civic spaces (e.g. square; public open space; outdoor market place)																Red	Red				Red
	Institutional (e.g. school/ hospital grounds; cemetery, sports facility)																					
Settlement	Green/blue corridor (e.g. riverbank; cycle/foot path; railway cutting)	Orange										Orange	Orange									
	Natural and semi-natural space (e.g. meadow; woodland; wetland; lake)	Orange						Orange	Green	Green				Orange	Orange	Orange		Green		Green	Orange	Orange
Landscape	Agricultural/productive land (e.g. farmland; vineyard; orchard; forest)	Red	Orange	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red				Red	Red	Orange
	Coastal/wilderness (e.g. National Park; moorland; downs; mountains)	Red	Red			Red		Red			Red			Red	Red	Red				Red	Orange	Orange
GI with scale not specified or of mixed scales										Green	Green		Orange				Green		Green	Orange	Orange	Orange

Patterns in access and use of grey literature and academic evidence

We wanted to explore at the events how participants access and use evidence related to GI, the types of evidence they prefer and the mechanisms of translating research into practice that were most beneficial to them. In the speed networking sessions participants were asked: 'What is the one piece of grey literature related to GI that you would recommend and why?', 'How do you get to hear about new grey literature? How should you be able to hear about it?', 'Where do you go to get the latest academic evidence on GI?' and 'How often do you use the academic evidence, either directly or via grey literature, in your role?'

They were also asked to feedback any key pieces of grey literature or evidence that were missed in the review; these are listed in Appendix A and include tools, web resources and other resources.

In the breakout sessions participants were asked: 'What are the key mechanisms that help translate academic evidence into practice?', and 'What can be done to help you prioritise and select which of the many pieces of academic evidence you spend time examining? Is this an important question?'

Participants cited a wide range of individual grey literature documents and sources that they would recommend. Those particularly highlighted included:

- Planning for a health environment: Green infrastructure guide (TCPA, Royal Society of Wildlife Trusts), this was commended for being high quality, including good case studies and providing a good, quick overview;
- Fair Society, Healthy Lives (The Marmot Review), was commended for being very significant in terms of changing policy in GI, being evidence-based, feeding into a health white paper, being understood by public health officials and for facilitating the learning the of public health language;
- MEBIE and MEBIE2 (Natural England), as providing a robust, balanced assessment of evidence to support decision making coming from a reliable source;
- Demystifying Green Infrastructure (UKGBC), valued for its focus on the developer audience;
- SuDS Manual (CIRIA), for being good quality and free.

How participants hear about new grey literature related to green infrastructure

Participants reported hearing about grey literature through a variety of mechanisms. These included active processes where they searched for new publications, for example, using internet search engines, or websites of organisations including the GIP and CIRIA. The majority of methods, however, were more passive where the grey literature was promoted in some way through newsletters, (e.g. professional bodies, GIP and CIRIA), consultation activities, the organisations producing the grey literature, internal websites and online noticeboards, trade journals and social media (e.g. Twitter and LinkedIn). Participants own networks were also important for sharing the existence of grey literature with colleagues being the most frequently mentioned, but also professional peers, conferences or events, clients and students. In a few cases participants had access to staff dedicated to helping forge connections with academia, both informing professional staff of new research, publications, and opportunities, but also promoting the organisation to academics.

Some participants didn't have a clear strategy for finding and accessing grey literature, for example, reporting finding it by accident, and the difficulty in finding it unless you know where to look.

Participants were generally happy with the promotion of grey literature, but talked about the volume of grey literature that is available and their difficulty in keeping up to date. Potential solutions to this included: an annual national event to share news and activity and a centralised web-based repository (see below). It was felt that this could be particularly beneficial for people new to GI. Some participants also expressed difficulty in assessing the quality of the grey (and academic) literature (see below) and suggested that amplifier organisations and networks could have a role in providing an overview of new publications including some quality control, for example, through peer-review.

Participants felt that those producing grey literature could make better use of amplifier organisations and social media, using as many as possible to reach the maximum number of relevant end-users.

How participants access and use evidence related to green infrastructure

Participants highlighted a wide range of difficulties with accessing and using evidence in both grey literature and academic articles. Generally participants found academic evidence through narrower range of methods than the grey literature including academic search engines (e.g. Athens, Scopus, Google Scholar), discipline-specific alerts and systematic or literature reviews (e.g. grey literature).

However, the difficulties they face accessing academic evidence are similar to those experienced when accessing grey literature and can be broadly grouped around the following themes:

- *Multidisciplinarity of GI is also a barrier:* Although generally the multidisciplinary nature of GI is seen as a strength this can be a challenge when it comes to accessing evidence. Participants commented that locating evidence related to GI, or even knowing where to look, can be problematic. This was felt to be due to the diverse, prolific and dispersed nature of this information. The breadth of language used to discuss GI across different disciplines can hinder those trying to find evidence, particularly when terms other than GI are used. Participants suggested that finding the right keywords to enter into search engines or use to search documents was critical. It was commented there are a wide range of publishers, journals, and networks publishing around GI and that this added to the difficulty of locating evidence.
- *Uncertainty over the quality of evidence:* As highlighted above participants, particularly those from practice or working across unfamiliar disciplines, expressed difficulty in assessing the quality of the evidence presented in both academic articles and the grey literature. Social media was also highlighted as being particularly problematic as the robustness is often unknown yet it is given equal status as academic articles by some. Participants recognised that critically reviewing evidence required skills and training that they may not have. They also expressed frustration that often grey literature reviews do not provide an indication as to how evidence has been assessed during the review which means they do not know how robust the evidence cited is. Some participants stated that they trusted some organisations more than others in the balance of the evidence provided in their reviews (e.g. Natural England) and questioned potential bias introduced in grey literature through only including evidence that supported the purpose of the review even if it was rather weak (e.g. if the aim is GI advocacy).
- *Gaps, or perceived gaps, in the evidence:* Related to the comments about the quality of evidence, participants also felt that there appeared to be gaps in the evidence presented in

grey literature, but they were often unsure as to whether this was a genuine gap in research activity ('unknown unknowns') or whether it was not being included in grey literature (for example, if it was not supportive of GI). Participants from practice highlighted the challenges they face in accessing academic evidence which limits their ability to find evidence not included in grey literature. Some felt that the academic evidence is often there but needs to be promoted more effectively and disseminated either by academics or through a third party.

- *Structural barriers to access:* Some participants, again often from practice, stated that they did not have sufficient time to search and review academic evidence. In some cases this was linked to the issues around skills required as already highlighted, but other barriers including the length of academic articles and the language used in them were also mentioned as was the sheer volume of GI-related research being published. Another structural barrier to accessing evidence was cost, many practitioners expressed frustration at not being able to access academic articles as well as some grey literature (e.g. those produced by professional bodies). They highlighted difficulty in making the case to their organisation for subscribing to a journal where only a small proportion of articles may be of use, or that when purchasing a single article it was often not as useful as the abstract suggested. Interestingly, there appeared to be little awareness of 'open access' journal papers or university repositories of publications (e.g. eprints) but some highlighted that academics would often share papers if asked.

Suggestions to improve access to evidence

As well as highlighting the difficulties in accessing evidence related to green infrastructure participants suggested a number of mechanisms that could support them in this endeavour. First, it is worth noting that participants felt that it was important to support practitioners to prioritise academic evidence. The mechanisms suggested to achieve this were:

- *A central website or portal to collect and organise GI evidence:* at its simplest this could include signposting or links to evidence, tools and key organisations (including amplifiers), or a more sophisticated repository of academic (and other) evidence that is organised, reviewed and/or summarised as it becomes available (e.g. <http://www.conservationevidence.com/>). Suggestions were that this could be carried out by a panel or a government agency. This should include links to international research and its relevance to the UK, more innovative case studies and those at city-scale. However, some also felt that there is a plethora of websites already and another was not the solution.
- *Grey literature:* including books, technical summary documents and literature reviews were recognised for their value in bringing disparate strands of evidence together. Grey literature should be seen to be representing a range of disciplines and functions of GI; there was a feeling that some is too focussed on SuDS.
- *Alliances and communities:* Participants talked about the benefits of working across different sectors and suggested various potential activities, including study tours and visits, conferences (with an affiliated journal) and regular events, workshops or meetings. However, 'workshop fatigue' was mentioned as being an issue for the GI community. It was also felt that exchanges and other initiatives to embed academics into the practitioner world could be useful (e.g. secondments, knowledge exchange programmes or Knowledge Transfer Partnerships (KTPs). Interestingly, there was less focus on practitioners being embedded in academia. Although, mechanisms including practitioners continuing with study and thus taking academic findings back into their practice or using academic campuses as the site of knowledge exchange (e.g. new methods for green roofs and walls).

- *Feedback from practitioners:* Although the emphasis was clearly on academic evidence reaching practitioners more effectively, participants felt that it would be beneficial for practitioners to communicate back to academia where research findings were being turned into successful practice. It was highlighted that there is no mechanism for academics to easily trace how their research is used particularly where, for example, it has been cited in grey literature and then used in practice.

Summary

The review identified a strong evidence base for the beneficial role of GI in the grey literature. However, there are gaps, both in terms of the research being conducted and in the translation into grey literature. Many grey literature documents rely on very similar evidence that has been repackaged for a particular audience.

Participants at the events generally welcomed the grey literature available but feel that the evidence and guidance is often disparate and the sheer volume makes it difficult to navigate for non-experts. Similarly, they expressed some frustration with the accessibility of academic research and identified a number of barriers to translating this research into practice. More could be done to consolidate the evidence and guidance currently available and a number of suggestions were put forward by participants. These included a centralised resource and more effective collaboration across the GI community.

In the next section, a suite of GI case studies are presented as a way of exploring the expertise in terms of the types of GI project, disciplines and sectors involved in their delivery.

GREEN INFRASTRUCTURE EXPERTISE

Case studies

A selection of case studies are provided to give a flavour of the different types of GI projects and initiatives in the UK and internationally. They have been selected to represent a range of initiatives from policy to implementation, scales, types of GI, geographical coverage, and anticipated outcomes.

Clyde Gateway, Glasgow, Scotland

Dates	Scale	Type	Primary driver	Funding & delivery	Outcomes
2008-2028	City, 840 ha	Regeneration	Health and wellbeing	Glasgow City Council, South Lanarkshire Council, Scottish Enterprise	Improved recreational facilities and connectivity, improved natural environment



Cuningar Loop. Photo courtesy of Clyde Gateway.

Context

Clyde Gateway is a large scale regeneration programme. The task, over a 20-year period, is to transform an area covering over 840 hectares including some of the most historically deprived communities in the east end of Glasgow and Rutherglen.

One of the areas benefitting from key green infrastructure improvements is the 30 hectares of the Cuningar Loop. A new woodland park, partially opened in summer 2015 and fully in spring 2016, has been created on this restored landfill site as a result of a partnership between Clyde Gateway and Forestry Commission Scotland. The Woodland Park takes up 15 hectares of the overall site.

Cuningar Woodland Park is one mile from Rutherglen town centre and on the south bank of the River Clyde, directly located directly across from the Athletes' Village, constructed in the Dalmarnock area of Glasgow for the city's hosting of the 2014 Commonwealth Games. It has seen the creation of not only a new woodland with almost 15,000 trees being planted but a multi-functional area with newly

designed open spaces, trails, paths, picnic areas and a variety of recreational areas including an amphitheatre and the first bouldering park in Scotland. This will help promote physical health and wellbeing for the surrounding communities and visitors as well as social interaction through events. The whole project has a central focus on wellbeing, social interaction and opportunities for local communities and using green infrastructure to deliver these outcomes.



Cuningar Adventure Playground. Photo courtesy of Clyde Gateway.

Green infrastructure features

- Woodland area with nature trails for walkers and cycle routes
- Urban park for community events, including an amphitheatre
- Open spaces including wildflower meadows for picnics
- A boardwalk alongside the River Clyde.

Progress

Cuningar Loop Woodland Park fully opened in March 2016 with full access from Rutherglen. A new pedestrian bridge spanning the Clyde and linking to the site of the Athletes' Village in Dalmarnock is due to be completed in late summer 2016. The initial outcome has been very positive with the park being well used by local residents and well as by visitors from further afield.

References and further information

<http://www.clydegateway.com/index.php>.

<http://www.commonwoods.org.uk/cuningar>.

RainScape/GlawLif, Wales

Dates	Scale	Type	Primary driver	Funding & delivery	Outcomes
2013-2020	Most of Wales	Regeneration	Climate change adaptation	Glas Cymru which owns Welsh Water	Reduced risk of sewer flooding, improved public realm, habitat creation



RainScape/GlawLif. Photo courtesy of Welsh Water.

Context

RainScape is a Welsh Water approach that provides a sustainable solution to managing rain water, tackling the problem of too much surface water getting into our sewers at its root cause.

RainScape catches rain water and slows down the speed at which it goes into our sewer network or removes it completely. This helps reduce sewer flooding and pollution and creates greener, cleaner communities for us to live in.

An investment programme of £80m which involves some investment in green infrastructure SuDS, together with permanent surface water separation by constructing surface water sewers, will allow a move away from traditional, expensive and unsustainable methods of water management. Green infrastructure has altered and improved the way water enters the sewage system by harnessing fast flowing water, redirecting it, temporarily storing it, allowing a substantial proportion to evaporate naturally back into the atmosphere and ultimately reducing the speed at which any remaining flows enter the network or water courses. This approach has been inspired by those used in Malmö, Sweden and Portland, USA.



RainScape/GlawLif. Photo courtesy of Welsh Water.

Green infrastructure features

- Basins and planters
- Swales
- Filter strips
- Grass channels.

Progress

There are several projects in Wales which have used the RainScape approach to deliver required outcomes. Two which are worth highlighting have been recognised as exemplars in the UK. Llanelli, which is an urban area prone to flooding has benefitted from the introduction of green infrastructure along with SuDS as a way to tackle these historical problems. The scale of retrofitting sustainable drainage is one of the most ambitious projects of its kind. Results from early schemes show that the schemes already delivered are exceeding targets for reducing the volume of surface water, performing well in the prolonged wet weather periods of recent winters.

Another project was the construction of Welsh Water's water testing laboratory in Newport. Intended to be an exemplar in construction and adopting the RainScape approach, it redirects water from its 2300 m² roof into planters. The planters naturally remove any pollutants the rain the water, before it is discharged into an open pond, significantly reducing surface water run-off. Furthermore, harnessing the rain water and redirecting it to a pond has created an enhanced landscape, encouraging biodiversity by attracting insects, and wildlife, and improved wellbeing of employees, providing them somewhere to relax on breaks.

Reference and further information

www.rainscape.co.uk.

EcoCities and The Corridor, Greater Manchester, England

Dates	Scale	Type	Primary driver	Funding & delivery	Outcome
2009-2025	City	Retrofitting	Climate change adaptation	University of Manchester, City of Trees, Manchester Metropolitan University, EC, Bruntwood, Forestry Commission	Reduced air temperature



i-tree plot at All Saints Park, Manchester Metropolitan University. Photo courtesy of City of Trees.

Context

EcoCities is a collaborative and interdisciplinary project that explored the use of green infrastructure to reduce air temperatures and help Greater Manchester adapt to a changing climate. The Oxford Road corridor in Manchester, Corridor Manchester, (www.corridormanchester.com) provided a focus for some of the research. This area is key to the economic success of Manchester with thousands of people visiting the area on a daily basis whether to study, work, shop or visit the hospitals. EcoCities provided planners and designers with crucial evidence showing the role green infrastructure has in reducing temperature in urban spaces, and specifically within Corridor Manchester. This information has been used at the planning and design stage for new developments including the Brunswick Park, part of the University of Manchester Campus.

A number of specific interventions have taken place within the Corridor Manchester area, in partnership with City of Trees.

The i-trees project, funded by Manchester City Council, the University of Manchester, Manchester Metropolitan University and the European INTERREG Programme has been a significant piece of research by the University of Manchester in partnership with City of Trees (formerly Red Rose Forests), using empirical data to help us understand what we can do to make our cities more resilient to climate change.

A further research project by the University of Manchester and City of Trees, funded by INTERREG IVB and Forestry Commission examined the effect of growth conditions on the performance and cooling ability of street trees, exploring the impact of different tree planting specifications on tree welfare (*Pyrus calleryana* Chanticleer, non-fruiting pear) and temperature.

Research into the benefits of green roofs was funded by The University of Manchester / the Whitworth, Manchester Metropolitan University, Manchester City Council (Carbon Innovation Fund), City of Trees and INTERREG IV. In addition, street tree planting was funded by Manchester City Council, INTERREG IVB and Forestry Commission and the University of Manchester and Manchester Metropolitan University.



Green roof at the Whitworth, University of Manchester. Photo courtesy of City of Trees.

Green infrastructure features

- Increased tree planting in streets
- Increased park space
- Creating green roofs on existing buildings.



Green Roof, All Saints, Manchester Metropolitan University. Photo courtesy of City of Trees.

Progress

Recent developments within the University of Manchester and Manchester Metropolitan University and future campus are intended to benefit students and staff, as well as the local community. Green infrastructure features have been incorporated, such as green roofs on the Whitworth, the University of Manchester and Manchester Metropolitan University. In addition, research projects such as i-trees have enhanced the knowledge of the contribution of street trees to decreasing temperatures and decreasing surface water runoff.

The projects within Corridor Manchester are complemented by many other green infrastructure schemes, large and small which are being executed throughout the city. Other examples include: installing green roofs on existing buildings, street tree planting, wildflower planting, creating green walls (including at Deansfield-Castlegate tram stop) and planting sedum on the tram tracks.

The City of Trees initiatives mentioned above provided green infrastructure improvements but moreover have included research associated with the implementation, which together with the Ecocities programme has provided significant insight into climate change adaptation through retrofitting measures.

References and further information

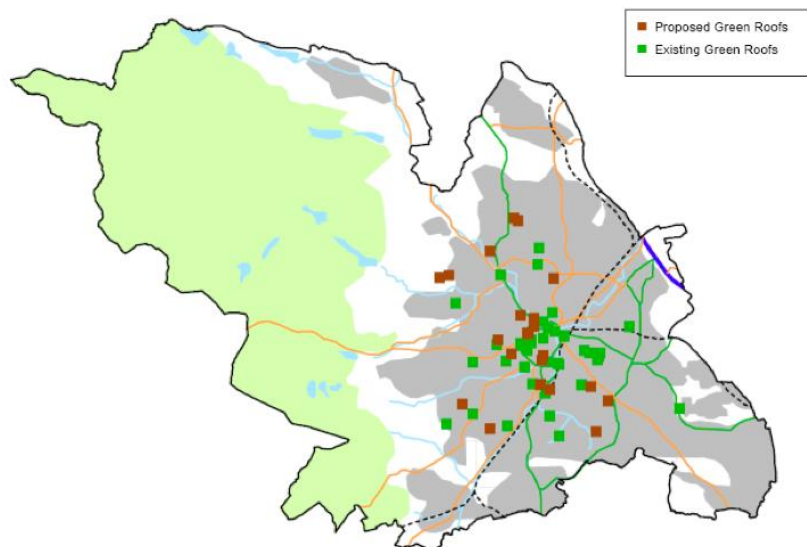
Cavan, G., Kazmierczak, A. (2011) Urban greening to adapt urban areas to climate change: The Oxford Road Corridor case study. EcoCities Project, University of Manchester: Manchester, UK Available from: <http://media.adaptingmanchester.co.uk.ccc.cdn.faelix.net/sites/default/files/Urbangreeningtoadapturbareastoclimatechange.pdf>.

Barlow, D. (2016) Good Year for Green Spaces. *Green and Blue Spaces*. Available from: <http://macf.ontheplatform.org.uk/article/good-year-green-spaces>.

The University of Manchester (2014) *Manchester's Corridor set to benefit from green fund*. Available from: <http://www.manchester.ac.uk/discover/news/article/?id=13110>.

The Green Roof Centre, Sheffield, England

Dates	Scale	Type	Primary driver	Funding & delivery	Outcome
2009-	City; Regional; National	New build; retrofitting	Climate change adaptation	European Development funding and EU & UK research funding	A goal to extensively incorporate green roofs into the urban landscape



Existing and Proposed green roofs in Sheffield (Green Roof Audit 2010)

Context

Since 1999, when green roof research was just beginning in Sheffield, green roofs have gone from strength to strength. The Green Roof Centre (GRC) is based in Sheffield and was founded in 2009 by the University of Sheffield, Groundwork Sheffield and four local authorities. One of its main aims is to be the first point of contact for green roof information and technology within the UK. Its role is becoming increasingly important in cities who are looking to manage temperature and rainfall rate as a result of climate change as well as encouraging biodiversity. It has advised on and supported many projects commercially. Its success in this sector could be attributed to targeting construction professionals and policymakers in its early days. The result of strategically informing and educating this audience has meant green roofs are acknowledged by this sector as being beneficial and cost effective and are increasingly becoming the norm in the South Yorkshire area.

The GRC through the University of Sheffield, has established a worldwide reputation for its contribution to green roof research and supporting the local region in its desire to include green roofs in its landscape. To underpin its reputation, the GRC has produced a UK specific Green Roof Code, funded by the European Commission Life+, to promote and encourage quality design and best practice. This enables key stakeholders to be kept informed of developments, technologies and continued benefits of green roofs and offers practical guidance for construction, installation and maintenance. The GRO Code was adopted by the National Federation of Roofing Contractors in 2011 as the national guidance.



Sharrow School, Sheffield, Courtesy of the Green Roof Centre.

Progress

The GRC has many examples of case studies, commercial and DIY, which are available on their website (www.thegreenroofcentre.co.uk/green_roofs/case_studies). One example listed is Angram Bank Children's Centre which is a multi-purpose venue offering different types of support for the local community. The building was incorporated into a bank and strategically constructed to benefit from maximum sunlight. The rather playful design includes a play area for the children located on the roof, where the green infrastructure - lawn, sedum and wildflowers are installed, making the roof a key part of the children's day and exposing them easily to the biodiversity which is then used to educate them. This was completed in 2009 and has an area of 300m².



Angram Bank Children's Centre, Sheffield. Courtesy of the Green Roof Centre.

References and further information

<http://www.thegreenroofcentre.co.uk/>.

University of Sheffield. *Background and History of Green Roof Activity in Sheffield*. Department of Landscape. Available from: <https://www.sheffield.ac.uk/landscape/phd-research/researchknowledge/greenroof/history>.

James Wilson Design (Ed) (2014) *The GRO Green Roof Code*. Groundwork Sheffield: Sheffield. Available from: <http://www.greenroofcode.co.uk/>.

GWL Terrein, Amsterdam, The Netherlands

Date	Scale	Type	Primary driver	Funding & delivery	Outcomes
1993	Neighbourhood, 6 ha	Regeneration; retrofitting	Provide a car-free residential development	Amsterdam City Council, KCAP, West8 Landscape Architects	High density, car free, ecologically sensitive development



GWL Terrain. Photo courtesy of GWL Terrain.

Context

The GWL Terrain development is a combination of retrofitting and new build on the former site of the Municipal Water Company in the Westerpark district of Amsterdam. This was a development built with sustainability and the environment at its heart, deliberately keeping it a car free zone and ensuring plenty of green infrastructure. The original buildings have been preserved, the pump house has become a café-restaurant and the water tower was kept as a reminder of the historical function of the site. The relatively high density of the development has been balanced by accessible and varied green infrastructure. There are a variety of interconnecting green squares and gardens, street trees, private gardens and shared allotments which grow fruit trees as well as vegetables all managed by the residents. Green infrastructure extends into green roofs to increase biodiversity, reduce stormwater runoff and provide effective temperature control of the buildings.

Green infrastructure features

- Green space instead of parking space
- A mix of public, private and shared gardens
- Blue infrastructure including an artificial canal to manage water levels
- A variety of trees planted and boundaries are marked with hedges
- Nesting boxes for swifts, incorporated into the building structure
- Green roofs
- Sustainable Drainage Systems.



GWL Terrain. Photo courtesy of GWL Terrain.

Progress

GWL Terrain has stood the test of time and remains a car-free, sustainable living space with good social cohesion. Residents regularly report through an annual survey that they are happy living there and feel a strong sense of belonging. Green infrastructure has played a key part in this by providing a relatively densely populated site with varied green spaces to use in a variety of ways. It has been a means for the community to meet and either work or relax together, providing a way to maintain physical health and promote wellbeing.

References and further information

<http://www.gwl-terrein.nl/?english>.

<http://www.gwl-terrein.nl/files/artikelen/carfree%20housing.pdf>.

Port Sunlight River Park, Wirral, England

Date	Scale	Type	Primary driver	Funding & delivery	Outcomes
2014	Site, 35ha	Regeneration	Improved recreational opportunities for residents	Biffa, The Land Trust, Wirral Borough Council, managed in collaboration with Autism Together	Restoration of a landfill site, improved connectivity to nearby green spaces



Port Sunlight River Park. Image courtesy of Land Trust.

Context

This site, located at Bromborough Dock, on the south bank of the River Mersey was a former landfill site in operation between 1991 and 2006. It was owned and managed by Biffa Waste Services Ltd. Bromborough Dock forms part of the Wirral Peninsula and due to its historic use, has become a prominent landmark, clearly visible from the opposite side of the River Mersey. The landfill meant that access to the riverside was restricted, and the landform had created a physical and mental divide between communities and the local environment. The River Dibbin running alongside the site was the access which made historic Port Sunlight village a port.

Green infrastructure features

- Extensive new planting including woodland and wildflowers
- An ecologically-important wetland
- Rare mudflats essential for wildfowl
- Adjacent to a Site of Special Scientific Interest (SSSI).

Progress

Port Sunlight River Park opened in August 2014. It is maintained and managed by Autism Together (AT) on behalf of the charity The Land Trust. The River Park is used regularly by walkers, runners, cyclists and provides a beautiful location for promoting physical exercise and improving mental health and wellbeing. The park has also improved local biodiversity; ground nesting birds visit the site between March and August and a wide variety of wildlife, including wildfowl and insects have been

recorded visiting on the site. The site is serviced by AT and involves tasks benefitting both the community and the members of AT, for example grass cutting, weeding, patrolling, clearing leaves and litter picking. There are also opportunities for local volunteers to get involved with maintenance, organising events, nature walks and plant or wildlife surveys.

References and further information

<http://thelandtrust.org.uk/space/port-sunlight-river-park/>

Mersey Estuary Conservation Group. Available from: <http://www.merseyestuary.org/port-sunlight-river-park.html>.

Gillespies (2012) Design and Access Statement. Available from: http://www.wirral.gov.uk/planning/docs/dmzfiles/15139_6.pdf.

Ecologia, Alphen aan de Rijn, The Netherlands

Dates	Scale	Type	Primary driver	Funding & delivery	Outcomes
1989-1992	Neighbourhood, 2.7 ha	Regeneration	Demonstration of sustainable urban planning	SenterNovem, Bouwfonds, Netherlands Ministry of Housing, Spatial Planning and the Environment, Ministry of Economic Affairs	Sustainable energy and improved water management, durability, sound insulation, health and wellbeing



Green and blue infrastructure in Ecologia. Image courtesy of Gerwen Architecten.

Context

Ecologia was designed as an environmentally focused project and was ahead of its time when it was conceived in the late 1980s. The area is part of a larger suburb in Alphen aan de Rijn. It was an early collaborative attempt at bringing together government, industry and trade during the design and construction phases and succeeded in using this interdisciplinary approach to create a high quality built environment. The site was built on reclaimed moorland with a waterway running alongside it. The waterway was incorporated into the development as a central pond, which is now essential for flood risk management. It also improves local water quality, provides a habitat for wildlife and is used as a venue for cultural events. In addition to the green infrastructure a walkable neighbourhood has been created through the provision of shared spaces, increased access to amenities and reduced vehicular access.

Green infrastructure features

- A pond, designed to improve flood risk management and as a cultural and community centre
- Wetland to integrate nature with the development
- Street trees and other soft landscaping to improve the walking environment
- Green roofs.



Housing in Ecolonia. Image courtesy of Gerwen Architecten.

Progress

Ecolonia has been established as a residential area for over twenty years. It has been considered a success in many ways, including with regard to green infrastructure. The central pond remains one of the key success factors. Rainwater harvesting is standard practice in Ecolonia, but the practical benefits of the pond include receiving water run off, which hasn't been captured, from roads and gardens and cleaning it naturally. The shallow pond is home to the right kind of plants that combine with good aeration and light to clean the water from pollutants. This ecosystem cleans the water freeing it from enough chemicals and pathogens so that it can be used to water produce being grown in the residents private and shared gardens. Wildlife is prolific in the pond, adding to the local biodiversity and the pond continues to form the backdrop for many community events.

Green roofs also continue to work well, attracting insects and with little maintenance being required. They add to the attraction of the development as do feature and strategically placed trellis' with vines and other climbing plants now covering them and creating 'green walls'.

References and further information

GerwenArchitecten – Ecolonia Alphen ad Rijn. Accessed 22 July 2016. Available from:

<http://patm.home.xs4all.nl/GERWEN.ARCHITECT/---Ecolonia.IAlphen.text.html>.

Sustainable Community Design. Accessed 04 May 2016. Available from:

<http://www.arch.umanitoba.ca/sustainable/contents.htm>.

Ecolonia. Accessed 04 May 2016. Available from:

<http://www.except.nl/overig/yale/sem5/sustainabledesign/Ecolonia.pdf>.

Lucien Kroll website. Accessed 04 May 2016. Available from: <http://homeusers.brutele.be/kroll/auai-project-BW.htm>.

Barton, H. (2005) Sustainable Communities: The potential for Eco-Neighbourhoods. Abingdon: Earthscan.

Pontcysyllte World Heritage Site, North Wales

Date	Scale	Type	Primary driver	Funding& delivery	Outcomes
2009	Area-wide	Regeneration	Anti-social behaviour	Canal & River Trust, Denbighshire County Council, Shropshire Council, Wrexham County Borough Council, European Council, Welsh Assembly Government	Increased economic prosperity and improved social cohesion, climate change resilience and biodiversity



Pontcysyllte Aqueeduct and Canal. Image courtesy of Pontcysyllte World Heritage Site.

Context

Green infrastructure is seen as a key mechanism to increasing tourism and reducing anti-social behaviour in this area. Communities near the World Heritage Site have been experiencing issues with anti-social behaviour and this designation provides an opportunity to regenerate the area and promote the historic environment as a tourist destination. High quality placemaking is fundamental to the project and by engaging communities at the design stage, it is hoped that they may foster a stronger sense of belonging and ownership and, as a result, form a better connection with their local environment and nature. The project explicitly recognises the social and economic value of green infrastructure as well as its role in improving climate change resilience, nature conservation and reducing health inequalities.

Green infrastructure features

- River corridors including upgrading the rights of way network where necessary
- Greenspaces and nature reserves
- Green corridors including disused railways and rights of way to improve connectivity throughout the World Heritage Site
- Environmental enhancement to improve the setting of historic sites including Offa's Dyke, abandoned mines and other industrial sites.



Community tree planting and litter pick. Image courtesy of Pontcysyllte World Heritage Site.

Progress

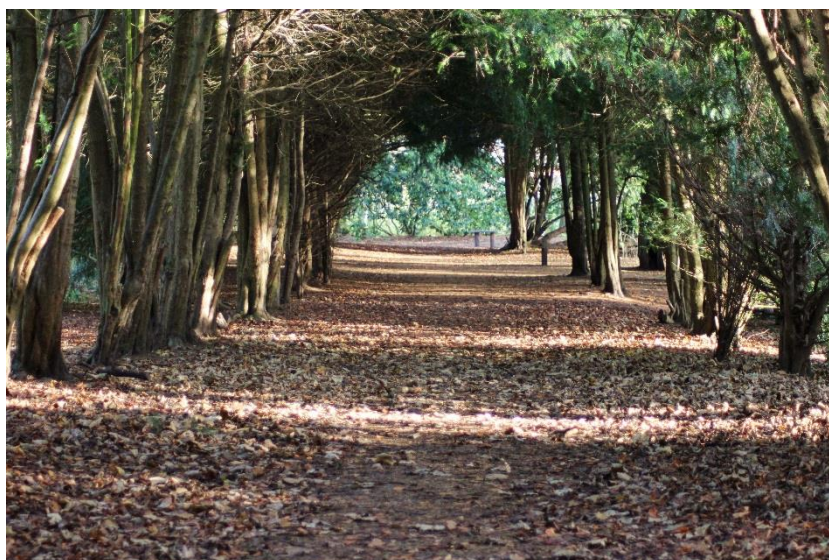
The project was completed in 2008 and in 2009 the area was inscribed by UNESCO as a World Heritage Site. Visitors have doubled in numbers since this accolade was awarded, boosting the tourism industry in the area and the economy. However, it has been discovered that although there has been an increase in tourists to the site, they often stay no longer than an hour. In 2015, a 10 year masterplan was developed to further improve Trevor Basin and the wider Wrexham area for visitors, these proposals include work to Trevor Basin to enhance visitor experience and encourage tourists to stay longer.

Reference and further information

<http://www.wrexham.gov.uk/MinutesData/EnvRegen/Reports/HAED0911S.pdf>.

Urban Forest Planting, Telford and Wrekin, England

Dates	Scale	Type	Primary driver	Funding & delivery	Outcomes
1970s-	City, 4,567 ha	Regeneration	Deprivation	Telford New Town Corporation, Telford and Wrekin Council with support from Shropshire Wildlife Trust	Social programmes for young people, improved wildlife conservation, positive community engagement



Urban woodland, Apley Woods in north Telford. Copyright: Julie Burroughs, Friends of Apley Woods

Context

Telford and Wrekin borough has a varied and rich natural environment comprising nationally and locally designated sites for biodiversity and geodiversity, areas of natural and semi-natural habitat including woodlands, rivers and streams, an extensive and productive rural area and a rich variety of urban green spaces which provide valuable public amenity, recreation, sport and play and safe havens for wildlife within built up areas.

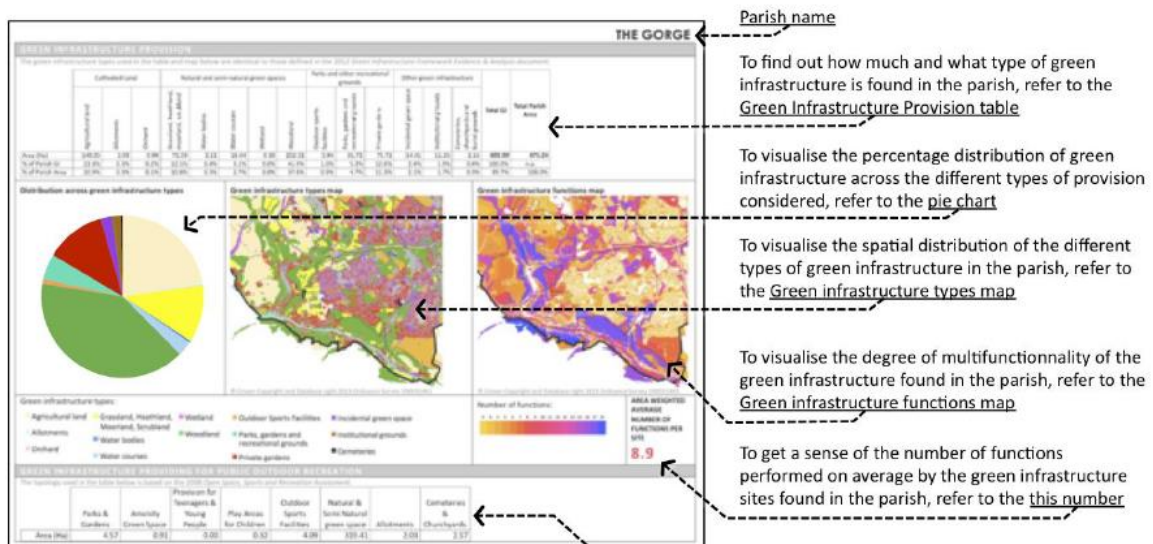
The natural environment is important in making the borough an attractive place to live as well as a valued destination for business, a destination for tourism and providing local communities with opportunities for recreation and leisure.

Approximately three quarters of the built up area of Telford is made up of green infrastructure and three fifths of the whole borough is open countryside. The green nature of the borough is key to its image and is an important reason why people choose to live and work in Telford & Wrekin. Green Infrastructure is also important to improving the health and wellbeing of residents.

The original planning of Telford as a new town intended a 'Forest City' contained within a landscape with trees, woodlands and open spaces and these features remain a defining characteristic of the town. The pioneering 'Green Network' designation within local Planning Policies has helped to provide protection for much of the green space in the borough.

The borough has over 2,500 hectares of forests and woodland, much of which is located in the urban part of the borough including the steep wooded slopes of the Ironbridge Gorge World Heritage Site. Woodlands and trees are a defining characteristic of Telford. The Council has a statutory duty to protect trees and woodland and also supports the protection and promotion of trees and woodlands because of their significant contribution to the appearance of the borough and its attractiveness to visitors, residents and investors.

The Council's approach to protecting its tree cover is set out in the Tree and Woodland Strategy (2016) and is based on the premise of 'the right tree in the right place.' Development should incorporate trees as an integral part of a scheme, respond to existing trees, hedgerows and woodlands designing the scheme and ensure protection measures before and during the development process along with appropriate management and protection for existing and new trees and hedgerows planted thereafter. As a significant land owner within the borough the Council owns and manages significant areas of woodland, shelter belts, hedgerows and trees both within and outside of designated sites.



Apart from the bottom table, all the information displayed on the 1st page of each parish profile is sourced from the 2012 *Green Infrastructure Evidence & Analysis Framework* document.

The bottom table is based on the 2008 Open Space, Sports and Recreation Assessment typology, and shows updated figures accounting for new public recreation open space that has been created between 2008 and June 2012.

Example of a Parish Profile from the Telford and Wrekin Local Green Infrastructure Needs Study. Image courtesy of Telford and Wrekin Council (2013)

Telford and Wrekin Council have, since the 1970s, been considering various ways of using green infrastructure to addressing social issues, housing needs and environmental improvements. In March 2016, a framework for 'Connecting Communities with Trees and Woodlands' was adopted which sets out a five year strategy for the management of the approximately 500 hectares of trees that grow in the Borough for the benefit of community health and wellbeing. The 'urban forest' as this has become known also includes other types of green infrastructure including hedgerows, woodlands and green spaces. It is primarily about the effective management of trees, which will take into account their species, size, age, position and health in relation to the environment they are growing in to ensure that the benefits for health and wellbeing, biodiversity and climate adaptation can be maximised. Their

economic management will also be considered with regard to landscaping to attract business and tourism, timber production and maintenance costs.

Green infrastructure features

- 500 hectares of trees, mostly within an urban context
- SuDS for water management
- Eight Local Nature Reserves and a further 11 proposed Local Nature Reserves, eight Sites of Special Scientific Interest and 47 Local Wildlife Sites
- 104 locally important green spaces owned by the Council and protected from development for use by local people under the Council's 'Green Guarantee'
- Improve permeability using green infrastructure to connect communities and nature.

Progress

As this framework is new, there is little to report on regarding progress, but given the Borough's track record on other green infrastructure projects and its ethos in being a cooperative council, working transparently and closely with communities, it would appear that the aims of the framework should be achievable.

References and further information

Telford and Wrekin Council (2013) Local green infrastructure needs study. Available from:

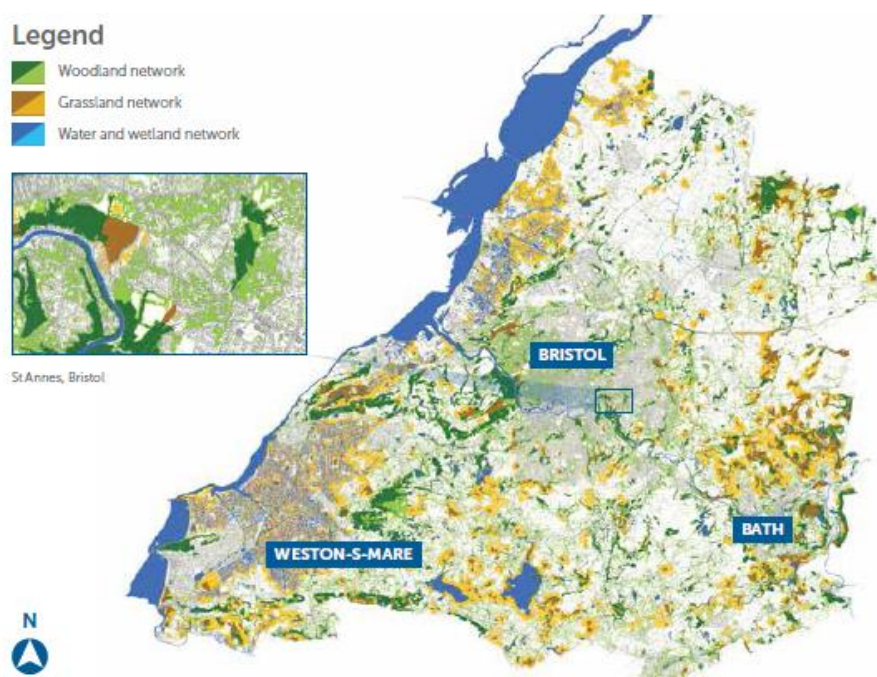
http://www.telford.gov.uk/downloads/file/4436/c3d_-_telford_and_wrekin_council_local_green_infrastructure_needs_study_june_2013.

Telford and Wrekin Council (2016) A tree woodland framework for Telford and Wrekin – Connecting Communities with trees and woodlands 2016-2021 Available from:

<http://apps.telford.gov.uk/CouncilAndDemocracy/Meetings/Download/MTgzNjM%3d>.

State of Environment Assessment, West of England

Date	Scale	Type	Primary driver	Funding & delivery	Outcomes
2016	Sub-region	Support	Evidence base for the benefits of the natural environment	West of England Nature Partnership, Wessex Water, Natural England, Environment Systems Ltd.	Series of ecosystem services maps for the West of England



Combined ecological networks in the West of England. Image courtesy of WENP.

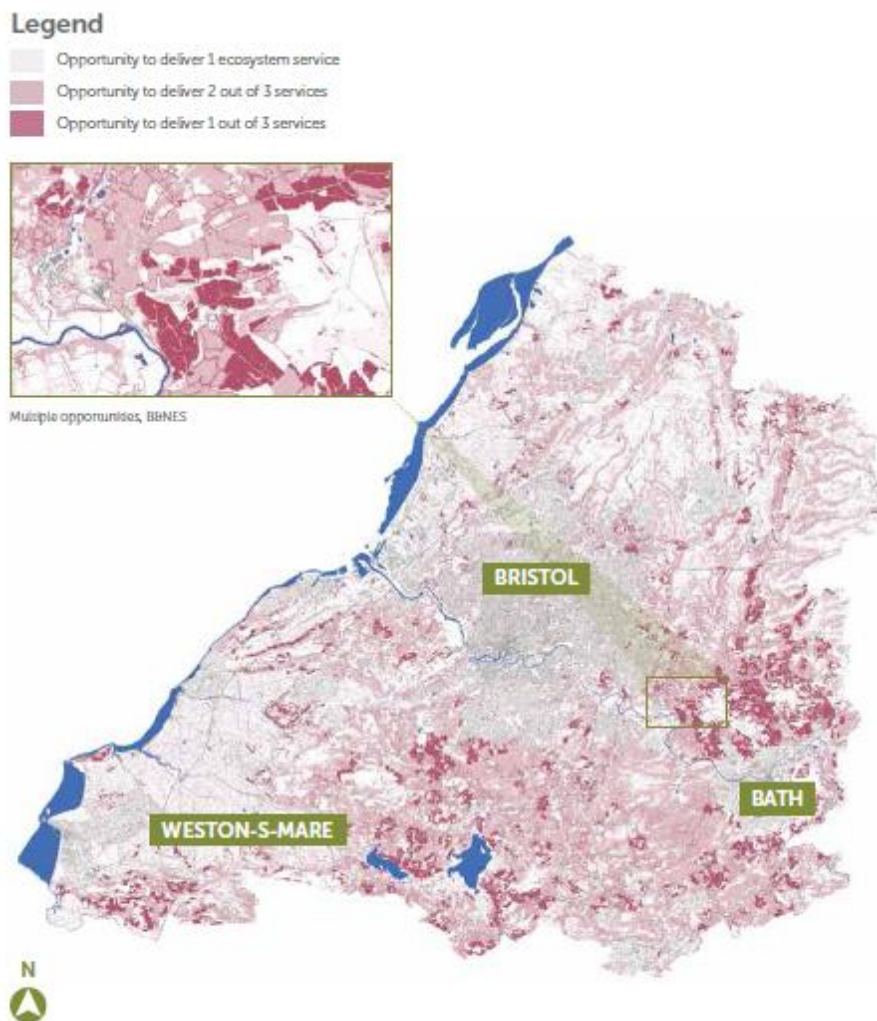
Context

The West of England Nature Partnership (WENP) covers the four unitary authorities of Bristol City, Bath and North East Somerset, South Gloucestershire and North Somerset. The West of England is set to see substantial growth in the coming years meaning that new housing and other infrastructure will need to be provided to support the increased population. But, the natural environment is extremely important to the success of the sub-region, providing food, jobs and recreation opportunities and enhancing the attractiveness of the area as a place to live, work and visit. A key output from the WENP has been an integrated assessment of the benefits provided by the natural environment in the sub-region. They have used the 'ecosystem approach' to produce a spatial representation of the extent to which the land improves water quality, and provides natural flood management, as well as the ecological networks in the sub-region. This work provides the evidence for decision makers to understand the contribution the natural environment makes, and has the potential to enable growth to be achieved sustainably. For example, 26,000 houses in Bristol are already at risk from flooding and 15% of land provides natural flood management so this work will provide the evidence to support decisions on where to locate new housing without reducing the capacity of the land to mitigate flood risk.

Green infrastructure features

- Woodland networks

- Grassland networks
- Wetland networks
- Agricultural land.



Opportunity map to deliver increased ecosystem services in the West of England. Image courtesy of WENP.

Progress

Over 200 data sets were overlain and analysed including those representing land cover, land management, underlying soil and geology, elevation, hydrological features, and grey infrastructure to provide seven downloadable maps. These include woodland, grassland, wetland and combined ecological networks, and land that improves water quality, provides natural flood management and multiple ecosystem services. In addition to an assessment of the current situation, further analysis has provided a series of 'opportunity maps' indicating where improvements in these ecosystem services and networks could be targeted, for example, by identifying land which could connect and strengthen woodland networks. The composite maps indicate areas where multiple ecosystem services are provided or multiple opportunities to improve them exist. In 2016, the West of England published its Joint Spatial Plan which sets out how the levels of growth in the area will be delivered sustainably and where new housing will be delivered. The work of the WENP has provided environmental evidence in the development of the Joint Spatial Plan to support this endeavour.

References and further information

<http://www.wenp.org.uk/wp-content/uploads/2016/05/60724-WENP-Report-LOW-RES.pdf>

<http://www.wenp.org.uk/>

Table 3 Summary of green infrastructure case studies

Case study	Scale	Type	Primary driver	Funding & delivery	Outcomes
Clyde Gateway, Glasgow, Scotland, 2008-2028 Further information	City, 840 ha	Regeneration	Health and wellbeing	Glasgow City Council, South Lanarkshire Council. Scottish Enterprise	Improved recreational facilities and connectivity, improved natural environment
Rainscape/GlawLif, Wales, 2013-2020 Further information	Most of Wales	Regeneration	Climate change adaptation	Glas Cymru which owns Welsh Water	Reduced risk of sewer flooding, improved public realm, habitat creation
EcoCities and The Corridor, Greater Manchester, England, 2009-2025 Further information	City	Retrofitting	Climate change adaptation	University of Manchester, City of Trees, Manchester Metropolitan University, EC, Bruntwood, Forestry Commission	Reduced air temperature
The Green Roof Centre, Sheffield, England, 2009- Further information	City, Regional, National	New build; retrofitting	Climate change adaptation	European Development funding and EU & UK research funding	A goal to extensively incorporate green roofs into the urban landscape
GWL Terrein, Amsterdam, The Netherlands, 1993 Further information	Neighbourhood, 6 ha	Regeneration; retrofitting	Provide a car-free residential development	Amsterdam City Council, KCAP, West8 Landscape Architects	High density, car free, ecologically sensitive development
Port Sunlight River Park, Wirral, England, 2014 Further information	Site, 35ha	Regeneration	Improved recreational opportunities	Biffa, The Land Trust, Wirral Borough Council, managed in collaboration with Autism Together	Restoration of a landfill site, improved connectivity to nearby green spaces
Ecolonia, The Netherlands, 1989-1992 Further information	Neighbourhood, 2.7 ha	Regeneration	Demonstration of sustainable urban planning	SenterNovem, Bouwfonds, Netherlands Ministry of Housing, Spatial Planning and the Environment, Ministry of Economic Affairs	Sustainable energy and improved water management, durability, sound insulation, health, wellbeing
Pontcysyllte World Heritage Site, North Wales, 2009 Further information	Area-wide	Regeneration	Anti-social behaviour	Canal & River Trust, Denbighshire County Council, Shropshire Council, Wrexham County Borough Council, EC, Welsh Assembly Government	Increased economic prosperity and improved social cohesion, climate change resilience and biodiversity
Urban Forest Planting, Telford, England, 1970s- Further information	City, 4,567 ha	Regeneration	Deprivation	Telford New Town Corporation, Telford and Wrekin Council with support from Shropshire Wildlife Trust	Improved wildlife conservation, community engagement, social programmes for young people
State of Environment Assessment, West of England, 2016 Further information	Sub-region	Support	Evidence base for the benefits of the natural environment	West of England Nature Partnership, Wessex Water, Natural England, Environment Systems Ltd.	Series of ecosystem services and ecological network maps for the West of England

ADDITIONAL CASE STUDIES					
Case study	Scale	Type	Primary driver	Funding & delivery	Outcomes
Connswater Greenway, Belfast, Northern Ireland, 2008-2016 Further information	City	Regeneration; flood alleviation	Environmental improvement	Big Lottery Fund, Belfast City Council, Department for Social Development, Department of Agriculture and Rural Development	Improved links for community across the area, improved natural environment
Barking Riverside, London, England, 2015- Further information	Neighbourhood, 179 ha	Regeneration	Housing delivery	Barking Riverside Ltd., Greater London Authority, London and Quadrant	10,800 new homes, new community facilities
Kidbrooke Village, London, England, 2009-2030 Further information	Neighbourhood, 109 ha	Regeneration	Improve health and wellbeing	Berkeley Homes	Improve biodiversity, health and well-being, quality of life and local economy
Green Alley Project, Chicago, USA, 1989- Further information	City	New build; retrofitting	Climate change adaptation	City of Chicago	Stormwater management, improved public realm
Green Gateshead, Newcastle-upon-Tyne, England, 2013-2030 Further information	City	Strategy	Climate change adaptation	Newcastle City Council	Green infrastructure delivery plan
Cambridge Southern Fringe, Cambridgeshire, England, 2008-2016 Further information	Area-wide	Strategy	Housing delivery	South Cambridgeshire District Council, Grosvenor, Universities Superannuation Scheme, Cambridge City Council, Barratt Homes, Cambridgeshire Wildlife Trust	Green infrastructure for residents, enhance existing habitats
Victoria Business Improvement District, London, England, 2010-2020 Further information	Area-based	Decision support	Evidence base	Guide developed by Arup with support from the Mayor of London and Natural England	Priority list of green infrastructure projects that can be put the business community
Dalzell Estate and Baron's Haugh, Motherwell, Scotland, 2015 Further information	Neighbourhood, 160 ha	Regeneration	Improve health and wellbeing	North Lanarkshire Council, Heritage Lottery Fund, Historic Scotland, Scottish Natural Heritage, WREN, RSPB Scotland	Increased wildlife, reconnected people with nature, training opportunities through volunteering
Green Grid Strategy, Peterborough, England, 2007 Further information	Regional	Regeneration; retrofitting; new build	Housing delivery	Peterborough Council, Local Transport Partnership, Big Lottery Fund, Breathing Places, Natural England	Improve quality of life, boost tourism industry, improve resource management
Curitiba, Brazil, 1970s- Further information	City, 43,202 ha	New build; retrofitting	Population growth	Federal Grants, Public-Private collaboration	Sustainable development at the city scale

ADDITIONAL CASE STUDIES CONTINUED					
Case study	Scale	Type	Primary driver	Funding & delivery	Outcomes
Green Ventilation Corridors, Stuttgart, Germany, 1980s- Further information	City	New build; retrofitting	Air quality improvement	City of Stuttgart, Verband Region, EC	New development prevented in corridors to ensure adequate ventilation to the city
Green Roofs, Basel, Switzerland, 1996- Further information	City	New build; retrofitting	Climate change mitigation	City of Basel, Energy Saving Fund	Standards for green roofs, reduced energy use, increased biodiversity
Green Infrastructure Project, Plymouth, England, 2010- Further information	City	Strategy	Housing delivery	Natural England, South Hams District Council, Plymouth City Council, Woodland Trust, Forestry Commission	Green infrastructure delivery plan
Community Climate Change Action Plan, Salford, England, 2008 Further information	City	Regeneration; retrofitting	Climate change mitigation and adaptation	New Deal for Communities, Salford City Council, Environment Agency, Salford University	Better awareness of climate change issues in the community
Copenhagen, Denmark, 1960s- Further information	City	Retrofitting	Climate change mitigation	Copenhagen City Council	Increased green infrastructure, walking and cycling levels, reduced energy use
Mersey Forest, North West England, 1990s- Further information	City region	Regeneration; retrofitting	Climate change adaptation	Mersey Forest, NWDA, local authorities, Forestry Commission, Natural England, EA	Numerous green infrastructure projects, green infrastructure embedded into policy
Green interventions, Metrolink Expansion Programme Further information	Micro	New build; retrofitting	Environmental improvement	Transport for Greater Manchester	Increased green infrastructure in a hard landscape
Green Living Spaces Plan, Birmingham, England, 2013 Further information	City	Strategy	GI planning	Birmingham City Council	Evidence-based plan using ecosystem services assessment
J4M8 Distribution Park, 2001-2009 Further information	Industrial estate, 76 ha	New build; retrofitting	Surface water management	Strawsons J4M8 Ltd., WSP Ltd., SEPA	Improved surface water management, pollution control habitat and visual appearance
Estuary Edges, Thames Estuary, England, Further information	Area-wide	Retrofitting	Habitat creation	Thames Estuary Partnership; Environment Agency	Concrete riverbanks replaced with natural habitats
Hartlepool Coastal Defences, England, 2006- Further information	Area-wide	Retrofitting	Coastal erosion and flooding	Mott MacDonald, Hartlepool Borough Council	Reduce coastal erosion, protect and enhance habitats, amenity
Grey to Green, Sheffield, England, 2013- Further information	Business district	Retrofitting	Surface water management	Sheffield City Council, North Midland Construction, University of Sheffield, Robert Bray Associates	Improved drainage, habitat creation, high quality public realm

Analysis of clusters of expertise

The grey literature and case studies reveal significant clusters of expertise in the UK's GI community (Figure 1; Table 4). These tend to be concentrated around universities with active research in this area which may demonstrate the extent to which cross-fertilisation between research and practice is taking place in GI.

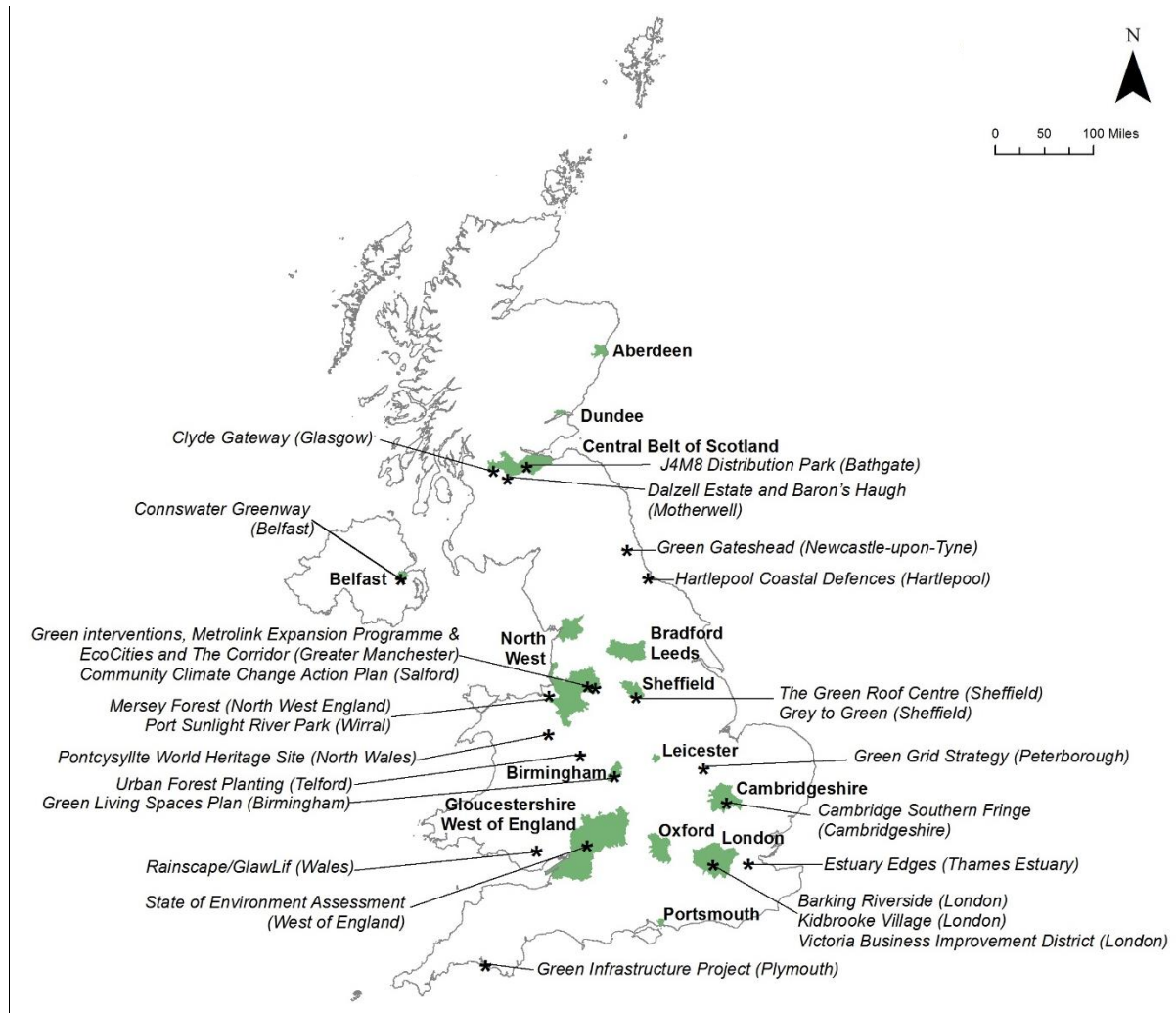


Figure 1 Map of green infrastructure expertise in the UK showing areas represented by the grey literature, NERC Innovation Funds (green areas) and case studies (*) (Contains National Statistics data © Crown copyright and database right 2016. Contains NRS data © Crown copyright and database right 2016. Source: NISRA : Website: www.nisra.gov.uk. Contains OS data © Crown copyright [and database right] 2016).

Table 4 Summary of geographic areas of GI expertise.

Where		Who
UK/GB		ARUP Chartered Institution of Water and Environmental Management CIRIA Ecosystem Knowledge Network Forest Research Forestry Commission Green Infrastructure Partnership Horticultural Trade Association Landscape Institute Land Trust Natural England (England only)
Scotland		Edinburgh City Council Glasgow Caledonian University Greenspace Scotland Heriot Watt University James Hutton Institute Scottish Natural Heritage University of Edinburgh University of Glasgow
Northern Ireland		Belfast City Council Belfast Public Health Queens University Belfast
Wales		Natural Resources Wales Welsh Water
England	North West	Liverpool John Moores University Red Rose Forest The Mersey Forest United Utilities University of Liverpool University of Manchester
	Yorkshire	Sheffield Hallam University South Yorkshire Forest University of Sheffield
	Midlands	Birmingham City Council University of Birmingham University of Leicester
	East of England	Peterborough City Council South Cambridgeshire District Council
	South West	Gloucestershire Wildlife Trust University of the West of England University of Exeter
	South East	HR Wallingford University of Oxford University of Portsmouth
	London	Eftec Greater London Authority Imperial College London London Tree Officers Association

The importance of proximity in collaboration and sharing good practice

In the speed networking sessions participants were asked: 'How important is physical proximity between organisations or case studies either for research or sharing good practice?' and 'Are any key case studies missing? Can you provide any up to date information on any of the case studies?' Table 3 was updated to include additional case studies highlighted at the events.

There were very mixed views on whether physical proximity is important in collaboration and the sharing of good practice. Interestingly, there were differences between the events. At the Birmingham event (which was dominated by academics) there were no obvious patterns to differing views, whereas at the Glasgow event academic participants tended to say it was not important and practitioners that it was very important.

A number of suggestions were given as to why physical proximity is important. These included particular resources only being available at the local level (e.g. local GI enthusiasts), easier collaboration and closer proximity to sites to make field work easier. A specific benefit of proximity is that it facilitates face-to-face meeting, which was seen to be preferable to virtual communication and particularly useful in being able to meet stakeholders. Participants also felt that proximity was important in developing a shared understanding of the local drivers for research and innovation, GI policy and provision at the local scale and the benefits (and ecosystem service deficits) which can be very geographically focused. Practitioners highlighted that when influencing politicians it was important to have local case studies as those too far afield were often not perceived as being relevant, local examples could also introduce competition to encourage adoption of GI in neighbouring areas. The pride and identity in a place was also viewed as important where a body of expertise could be established across universities, local authorities and other organisations. The importance of the regional scale was also recognised in this context, bringing together groups of universities, local authorities and partnerships (e.g. LEPs, LNPs) to facilitate shared learning.

However, other participants gave reasons why physical proximity was not important. The most common reason given was that the priority is collaborating with those with the right expertise for the project, not the proximity, and that to get a diverse and broad range of expertise meant having to work across the UK and internationally. The importance of relationships were also highlighted, for example, longstanding collaborations and trust, mattered more than physical nearness. It was often academics who felt proximity was less important and participants recognised that there would be variation between sectors. For example, developers may not be interested in sharing good practice internationally, although they are looking for graduates who have an understanding of international contexts. Some participants also felt that physical proximity is of limited importance in sharing good practice, as good examples will probably have lessons for others particularly in a global context. It was felt that even if GI projects are being developed completely locally then effort should be made to share the outcomes as widely as possible.

Analysis of disciplines and sectors

The review of the grey literature demonstrated that GI is an inherently multi- and interdisciplinary endeavour. A large number of disciplines and sectors are involved in publishing evidence and

guidance on GI for a range of audiences. As Table 5 shows some of these are very active in this endeavour and are strong advocates of quality GI.

Ecologists and landscape architects appear to be significant advocates, the former primarily concerned with the benefits of contact with both urban and rural nature for human health and well-being as opposed to the benefits of GI to nature. Landscape architects seem to be more explicitly focussed on GI, the urban environment and providing guidance for high quality GI.

Specific types of GI also have attracted particular groups and professions, the most notable being for urban trees and greenspaces. In the case of trees, this may be a direct response to the negative perceptions of trees in the built environment or because of a few tree-focused organisations. Greenspaces benefitted from very strong advocacy from CABI Space, amongst others, who championed their importance for urban populations and raised issues such as quality, training and maintenance. More recently, public health professions have also been highlighting the benefits of greenspaces to health and well-being.

However, there are also significant gaps in some sectors in setting the standard for GI. With the exception of the TCPA, which has been a longstanding champion of GI, planners appear to be under-represented in the grey literature. Development surveyors, architects and urban designers are also relatively absent from the grey literature compared with other disciplines. This matters because these professions have a pivotal role in the planning, delivery and long term success of GI.

Table 5 Disciplines and sectors represented in the grey literature communicating evidence and best practice in the different stages of green infrastructure.

Discipline Not very visible Visible Very visible	Professional bodies	National government	Local Authorities	NGOs/Advocacy groups	Private sector	Universities	Land managers
Policy	Planners Development surveyors Landscape architects Urban designers Ecologists Horticulturists	Planners Landscape architects Ecologists Natural scientists Economists	Planners Landscape architects				Foresters
Planning and design			Planners Landscape architects Urban designers		Planners Development surveyors Landscape architects Urban designers Horticulturists		
Delivery, monitoring and management			Parks managers Highways	Planners Ecologists	Development surveyors Ecologists Horticulturists	Ecologists Landscape architects	Development surveyors Ecologists Foresters
Advocacy	Planners Development surveyors Horticulturists Landscape architects Urban designers Ecologists Natural scientists	Public health	Public health	Planners Landscape architects Ecologists Natural scientists Economists			
Research and evaluation		Public health	Ecologists Natural scientists			Planners Public health Development surveyors Natural scientists Economists Landscape architects Urban designers Ecologists Horticulturists	
CPD	Planners Development surveyors Landscape architects Urban designers Ecologists					Planners Development surveyors Landscape architects Urban designers Ecologists	

The representation of disciplines and sectors in green infrastructure

In the events we were interested in exploring how the range of disciplines and sectors involved in GI is perceived in the community, whether their views accorded with the findings from the review. As part of the speed networking activity, participants were asked 'Which are the key disciplines or sectors that are under-represented in the grey literature and why do you think that might be?' and in the breakout sessions they were asked 'Do you feel that the grey literature reflects the multidisciplinary nature of GI? Which disciplines are missing and why does this matter?'

Participants generally felt that the multidisciplinary nature of GI was key to its success. However, there were contrasting views on whether the grey literature adequately addresses the multidisciplinary nature of GI. Some participants felt that it does, citing the multiple benefits of GI that are highlighted in the grey literature. Others felt that although that might be the intention, often the discipline of the author, organisation or funder heavily influenced the work making it weighted towards that discipline. Some participants felt that case studies that are often featured in grey literature tend not to be as multidisciplinary as the research evidence that is presented. However, one participant representing a research network reported struggling to identify truly multi- or interdisciplinary projects.

Participants suggested that grey literature could acknowledge and identify the disciplines that have not yet been engaged, and provide a clear rationale for how and why to bring multiple disciplines together at GI project inception (whether research or practice).

Participants highlighted the tension in GI research and practice in ensuring multidisciplinary. Although it was accepted that the success, and resulting benefits, of GI were dependent on a multidisciplinary approach, the reality is that research and practice is often carried out in one disciplinary silo. Academics particularly highlighted disincentives for working across disciplinary boundaries. Participants felt that both academic and grey literature could better emphasise the interconnectedness of the different elements of GI.

Alongside these concerns there was also recognition that specialised, targeted literature could be beneficial. It was also felt that as well as multidisciplinary knowledge, specialist, detailed knowledge is also necessary. The challenges of bringing disciplines together were also highlighted, and that communication even between sub-disciplines is often limited. Thus some considered that no one piece of grey literature can address different audiences competently and that grey literature should be targeted and not try to reach too many disciplines, to ensure that that evidence on a specific area of interest, for example SuDS, does not get lost within the bigger picture of GI. Conversely, others felt that grey literature targeted at a very specific audience may give a biased view of GI. The logical synthesis of these contrasting views that some participants voiced was that there needs to be 'nested' grey literature: some documents that cover overarching issues and perspectives, and others that are targeted and specific to disciplines or GI features.

Disciplines and sectors thought to be underrepresented

The question on which disciplines and sectors were missing in the grey literature understandably evolved into a discussion how better to engage these groups.

The sectors felt to be underrepresented were policy makers, central government, those making or influencing the decisions on whether to implement GI particularly senior managers in local authorities and economic development, general public, those responsible for managing GI, business analysts and economists.

In terms of disciplines that were felt to be underrepresented a slight distinction emerged between those felt to be underrepresented in terms of the evidence base being drawn from these disciplines and those to which grey literature should be targeted to. In the former group participants highlighted public health, geographers, geologists, air quality experts and ecologists. In the latter group it was generally those felt to be essential to the delivery of GI either in practical terms or in championing the benefits of GI, this included planners, development surveyors, quantity surveyors, public health professionals, water engineers, coastal engineers, architects, urban designers, air quality experts and transport professionals.

Refocusing the grey literature to engage these audiences

A range of additional content or repositioning of grey literature was proposed by participants. The main aim for doing so was to act as advocacy for GI or to address limitations in the delivery of GI. Crucially, this indicates that the grey literature should be targeted to specific audiences. These relate to both sectors and specific disciplines or groups of disciplines.

Three sectors were discussed by participants:

- **Policy makers** need to understand the impacts of national and local policy on GI delivery and this could be effectively incorporated into grey literature.
- **Local authorities** would benefit from more tailored evidence that highlights the options for GI with a comparison of costs as well as guidance that covers how the benefits of GI can be maximised for the local context, commissioning of GI projects, funding models for maintenance and examples of collaborations between local authorities. There was appreciation that the funding cuts to local authorities mean that GI is not prioritised so information that demonstrates the contribution of GI to local authority strategic objectives would be beneficial. This should be targeted to senior managers as short briefing papers with links to more detailed information. Participants felt that there is disconnect between academia and local authority practice which targeted grey literature could address.
- **Local communities** are important motivators of local authorities and are therefore should be addressed in the grey literature. For example, case studies of community based organisations could be important for demonstrating the benefits of big projects to communities.

In terms of disciplines that could be targeted in future grey literature the following were discussed:

- **Development surveyors** were felt to be key to the delivery of GI and could be better engaged with through targeted grey literature (the *UKGBC Demystifying green infrastructure* was highlighted as a good example of where this is starting to happen).
- **Planners** were also felt to be key to delivery. Regional and sub-regional planners were particularly highlighted as GI should be planned strategically at this scale. A greater focus on the spatial application of GI and its multifunctionality as well as an overview of what can be implemented with cost estimates of GI and non-GI options. Planners were felt to be especially limited in terms of time to review evidence so short summaries would be beneficial. Examples

of how GI is negotiated in new developments was also thought to be useful as well as examples of where the duty to cooperate had worked well.

- **Public health professionals** were felt to be particularly underrepresented. There was recognition that the health agenda is a key area where GI could contribute but there was acknowledgement that the evidence base needs to be improved to gain respect of public health, for example with health outcomes relevant to these professionals, and that grey literature with only robust studies could be provided (e.g. the new briefing papers from Natural England & University of Exeter).
- **Architects and urban designers** were felt to be a neglected audience of the grey literature, where the contribution of GI to wider public realm could be demonstrated. The engagement of RIBA was seen to be critical.
- **Economists and business analysts** were also felt to be neglected and, although the recent emphasis on the economic benefits of GI were welcomed it was felt that more could be done to target grey literature specifically at these groups as opposed to providing economic evidence for other disciplines. Similarly, **risk managers and contingency planners** were also highlighted as warranting targeted evidence, for example, branded or disseminated through their networks.
- **Grey infrastructure** professionals including **engineers, transport planners** are also underrepresented in the literature and have a significant role in GI. Participants felt that transport professionals are key to understanding the interactions between transport and green infrastructure, including road and rail networks providing important green corridors and understanding how street trees can be incorporated into the urban fabric. Similarly, engineers (including civil, structural, building, environmental, water, coastal and drainage.) have a key role in understanding how GI relates to grey infrastructure. Coverage of topics surrounding water, in a wide range of contexts, was felt to be incomplete. For example it was felt that the grey literature is dominated by SuDS and failed to adequately cover flood defence, water resources and drought, and coastal issues, including ecosystems, marine sectors and fishing.
- **Natural scientists** including ecologists, geographers, climate scientists, geologists and geotechnicians also need to be engaged with GI as they have a role in understanding, for example, the contribution to biodiversity of different types of GI, the impact of GI on geodiversity, how GI can help climate change adaptation and be resilient to the changing climate, and the interaction between GI and the subsurface.
- Disciplines responsible for **managing and maintaining GI** in both the public and private sector were also highlighted. Much grey literature focusses on the benefits of GI and its initial design and delivery but there is an appreciation in the sector that these benefits will only be realised with effective maintenance. Grey literature that focusses on the contractual and commissioning issues, different funding models, good practice in maintaining different types of GI and how to ensure resilience and performance over time was felt to be missing. It was acknowledged that there a limited evidence base for maintaining GI and monitoring performance (see below).
- Finally, some disciplines were highlighted that were felt to be peripheral to GI but important to include in discussions where appropriate, for example in grey literature specific to a particular function of GI; these included those with expertise in **air quality, GIS and spatial analysis, cultural ecosystem services** and **sociology**.

Summary

There was broad agreement between the findings of the review and participants. Some of the most influential stakeholders in the decision to implement GI, including policy makers, financial experts, developers, planners, local authorities and the general public, are inadequately addressed in the GI grey literature.

The disciplines and sectors involved in GI are generally appropriate but the planning and development surveyors are underrepresented in the grey literature and, due to their integral role in GI, need to be engaged. This could potentially be achieved through the professional bodies, the RTPI and RICS, and greater representation from the research communities in these disciplines.

Several suggestions were put forward to address this, but targeting grey literature to specific audiences in a format appropriate for them via their networks or professional bodies was seen as a sensible starting point.

In the next section a selection of organisations and networks that share evidence and good practice related to GI are introduced and the role of these within the GI community explored.

ORGANISATIONS AND NETWORKS THAT SHARE EVIDENCE AND GOOD PRACTICE

A selection of seven key organisations and networks that have some role in sharing the evidence and good practice related to GI are introduced here. This is not an exhaustive list but they have been selected to represent a range of organisations and networks, funding and membership models, aims and objectives. Collectively these are referred to as 'amplifier organisations' in that they have a role in ensuring the reach of research is increased than would be possible through academic channels alone. These organisations and networks have many other roles including brokering research collaborations, responding to consultations, however, here we are primarily interested in their role in sharing evidence and good practice hence we use the term amplifier whilst acknowledging that this is only one component of their work.

All of these networks, partnerships and organisations are active on Twitter which provides an immediate means to find out about their activities, funding announcements, new evidence and guidance.

Green Infrastructure Partnership

The Green Infrastructure Partnership (GIP) was set up by Defra in 2011 as a response to the Natural Environment White Paper *The Natural Choice: Securing the Value of Nature*. The specific aim of the GIP is to "support the creation, enhancement and promotion of green infrastructure (GI) in the UK to improve quality of life, health, ecological diversity, resilience to climate change and economic attractiveness" (GIP, n.d.).

In 2014, the management of the GIP moved to the Town and Country Planning Association (TCPA). Since then the GIP has expanded from 300 to 800 members representing the broad range of disciplines involved in GI. The GIP is free to join and produces a bi-monthly newsletter distributed to members via email and available from the website (<http://www.gip-uk.org/>). The newsletter contains information on all matters of relevance to the GI community including news (e.g. policy updates, projects and initiatives, key appointments), funding for GI projects and research, events, publications. The GIP actively seeks input from the membership on news items. GIP also organises and hosts events, for example a conference on 16th June 2016. It receives no direct funding but has some in-kind support from Arup, Forest Research, Landscape Institute, Groundwork UK, The Land Trust, National Trust, Natural England and Urban Regeneration and Greenspace Partnership.

The GIP provides an extremely valuable contribution in publicising the myriad of activities currently taking place within the GI sector. This is particularly useful given the vast array of different sectors involved which often make it very difficult to keep track of developments in this area. There is also a distinct advantage of having this specialised network as GI activities can easily become lost in broad organisations and networks where they may not be a core priority. A further strength of the GIP is its inclusive approach to the sharing of information which means it is not representing one discipline or sector.

Construction Industry Research and Information Association

The Construction Industry Research and Information Association (CIRIA) is another member-based organisation that provides a number of services targeted at the construction industry and related disciplines. Membership of CIRIA is not free but the range of services is comprehensive including substantial publications including newsletters, technical briefings and guidance, CPD events and conferences. CIRIA also convene a number of specialist groups and networks, including one dedicated to SUDS (Susdrain: <http://www.susdrain.org/>) and input into policy and research. Despite membership being paid, the web portal (<http://www.ciria.org/>) for CIRIA does contain some resources that are free to non-members including their SUDS Manual and Benefits of SuDS Tool (BeST). Non-members can also subscribe to receive their monthly 'highlights' newsletter. Although the focus of CIRIA is clearly much wider than GI their work has obvious relevance to the GI community particularly, that around SuDS, biodiversity in construction, large urban trees and brownfield land.

Valuing Nature Network

The Valuing Nature Network (VNN) supports the Valuing Nature research programme (<http://vang-nature.net/>) which aims "to improve understanding of the value of nature both in economic and non-economic terms, and improve the use of these valuations in decision making" (VNN, 2015). The programme runs from 2013 to 2018 and is supported by four research councils (NERC, Arts and Humanities, Economic and Social Sciences, and Biotechnology and Biological Sciences) and Defra. As its name suggests it primarily funds two main areas of interdisciplinary research related to the valuation of: the role biodiversity and ecosystem processes play in human health, and the links between ecosystem services and tipping points (VNN, 2015).

The VNN has been active since 2011 and is now in its second phase of activity (2015 to 2018). The network is free to join and has over 1400 members from academia, policy and practice. Members of the network receive regular newsletters with updates from the programme including opportunities for funding and events. This has included activities to improve knowledge exchange particularly between the academic and business communities, for example through the Business Impact School.

The VNN is not specifically-focussed on GI but there are clearly opportunities for the GI community to link with this programme in terms of the valuation of the ecosystem services provided by GI.

Living with Environmental Change Network

Living with Environmental Change (LWEC) started in 2007 as partnership between 22 public-sector organisations that fund, conduct and use research. The programme identified four interdisciplinary priority research areas: climate adaptation, climate mitigation, ecosystems, and health and well-being. In 2015 it evolved into a network of 20 public-sector organisations including RCUK, Defra, Natural England and the Forestry Commission to "enhance the impact of the UK's publicly funded research, evidence and innovation on informing responses to environmental change. It will do this by enabling funders to coordinate, leverage their resources and avoid duplication, resulting in more efficient use of public funds across the Network" (LWEC, n.d.). The Network achieves this through focussed sub-groups, for example 'ecosystem services', 'air quality and climate change', that disseminate research evidence to a range of stakeholders. These include publications such as 'climate change impacts

report cards', policy and practice notes and videos, all available from the LWEC website (<http://www.nerc.ac.uk/research/partnerships/lwec/>) and the now-archived Envirobase searchable database of environmental research conducted between 2005 and 2015 (<http://www.envirobase.info/>). Envirobase contains 29,000 records many of which are related to green infrastructure (e.g. examining the health and well-being benefits of greenspaces, the design of green roofs, climate change adaptation).

Adaptation and Resilience in the Context of Change

The Adaptation and Resilience in the Context of Change (ARCC) network was launched in 2009 through the LWEC programme. It is funded by EPSRC in partnership with ESRC and UKCIP to provide knowledge exchange between EPSRC-funded research, policy and practice in five key areas: extremes, health and well-being, infrastructure and interdependencies, smart adapting cities, and social and behavioural change. The objectives of ARCC are:

- "Building community cohesion to develop in-depth understanding and synergies across the network
- Provision and integration of knowledge to help ensure policy and practice have the best available evidence
- Enhanced accessibility and uptake of research outputs to meet the needs of a diverse stakeholder community in a timely manner" (ARCC, 2015).

These are being achieved through a number of key mechanisms detailed on the ARCC website (<http://www.arcc-network.org.uk/> including co-ordination of research outputs, events such as workshops and policy briefings, skills development for early career researchers particularly focussed on knowledge exchange and research impact. Membership of the network is free and members receive a monthly newsletter.

Although not specifically green infrastructure the remit of ARCC has strong links to many of the beneficial services provided by GI in the urban environment.

Biodiversity, Ecosystem Service and Sustainability

Biodiversity, Ecosystem Service and Sustainability (BESS) is a six-year research programme focussed on the relationship between biodiversity and ecosystem processes and their delivery. BESS started in 2011 and is funded by NERC with support from BBSRC, again as part of the wider LWEC initiative. The research programme has three themes: "Functional relationships between biodiversity and ecosystem services; Resilience of biodiversity-ecosystem service relationships to changing conditions and Monitoring and evaluation of ecosystem services" (BESS, 2011) and brings together four research consortia.

BESS is actively undertaking knowledge exchange between the research consortia and the users of this research. A range of activities are being carried out by the individual consortia and interested stakeholders can sign up to receive quarterly newsletters for the programme.

Again, BESS is not specifically related to GI but the individual consortia are conducting research which will provide evidence for the GI community, particularly Fragments, Function, Flows & Urban Ecosystem Services (F3UFS).

Ecosystems Knowledge Network

The Ecosystem Knowledge Network (EKN) is funded by NERC via the BESS programme, Defra and Scottish Government. Launched in 2012 its focus is the "connection between the environment and society", specifically the use of the ecosystem approach (EKN, 2015). The network is based in Oxford, but has a UK wide remit, bringing together different sectors and disciplines and sharing good practice. The EKN website (<http://ecosystemsknowledge.net>) provides information including practical case studies at both local and national levels, guidance, videos and tools. The network is free to join and members receive a substantial newsletter three times per year with information on a range of projects. They can also suggest activities and provide information on their projects for dissemination. The EKN also organises training courses, monthly webinars, conferences and other events which are detailed on the website.

The EKN is not specifically focused on GI, but as with those above includes numerous projects, guidance and events of relevance to GI, including the conference [Building Prosperous Cities: the role of natural capital and green infrastructure](#) on 27th September 2016. They have also published a Tool Assessor (<http://ecosystemsknowledge.net/resources/tools/tool-assessor>) that provides information about a range of toolkits used to analyse the environment.

The role of organisations and networks responsible for sharing evidence and good practice

We were interested in hearing from participants on their use of organisations that, amongst other activities, serve as amplifiers sharing evidence and good practice. In the speed networking sessions, participants were asked: 'Do you subscribe to amplifier organisations and networks and if so why? Or, if not, why not?' and 'What are most useful services provided by amplifier organisations and networks?'

In the breakout sessions, participants were asked: 'What characteristics does an amplifier organisation have to be in order to be credible or attractive to you?'

The benefits of using amplifier organisations

Many participants reported subscribing to amplifying organisations and networks, and doing so for a variety of reasons. Some valued amplifiers as centralised resources, useful for gathering information, or, 'horizon scanning' and serving an advocacy role for GI. Services that participants valued include: regular updates instead of having to go out to find what new information had emerged, dissemination of their own work and sharing knowledge in the built environment sector, networking and finding out about events and funding opportunities.

For example, organisations that translate and provide advice on new policy, helped to convert research to practice, publish funding opportunities or provided honest appraisal of tools were

commended. Delivery through newsletters, easy to read emails, short reports, webinars and seminars, case studies, organisation websites, workshops, site visits and telephone conferences were considered useful.

Participants stated that other key benefits of amplifiers were the forming of contacts and networking. Academics could make practitioner contacts (in order to learn what practitioners want) and vice versa, and strengthen understanding between practitioners of different disciplines. For example, the connection of tree experts and public health professionals. Providing opportunities for face to face contact was also valued.

Specific amplifiers that were discussed and their value to participants included (these were probably influenced by the ones that had been covered in the review and presented at the event):

- **Green Infrastructure Partnership (GIP)** was probably the most frequently cited organisation and its focus on GI was welcomed. Participants felt that the newsletter was particularly useful, especially the links to new grey literature, evidence and events.
- **Valuing Nature Network (VNN)** was referred to frequently. Participants cited the links to funding opportunities and events as being particularly useful.
- **Construction Industry Research and Information Association (CIRIA)** was also frequently mentioned. Participants cited the events, case studies, guidance documents and access to evidence as benefits but also used it to make contacts, especially to partner with stakeholders, and disseminate material. The benefits of it being a well-established organisation were also highlighted and the personal interface for members on the website praised.
- **Ecosystems Knowledge Network (EKN)** was also used by participants to find out about funding opportunities and find out about different organisations in order to partner with stakeholders
- Participants also reported using **Living with Environmental Change (LWEC)** and **Adaptation and Resilience in the Context of Change (ARCC)** to access evidence.
- **SuDSnet** an EPSRC network for practitioners (<http://sudsnet.abertay.ac.uk/>), regulators and academics, was also cited as providing opportunity to attend conferences, present work and learn about research, industry views, and products.
- Others referred to **Modern Building Services** (MBS; www.modbs.co.uk), **Chartered Institution of Water and Environmental Management** (CIWEM; www.ciwem.org), the **Institute of Civil Engineers** (ICE; www.ice.org.uk) and the **Landscape Institute** (www.landscapeinstitute.org) and their role in sharing evidence and good practice.
- The Glasgow event highlighted a number of Scottish networks and organisations that share research and good practice including **Glasgow and the Clyde Valley Green Network**, **Central Scotland Green Network**, **Greenspace Scotland** (who are also setting up a new network), **Green Roof UK**, **Centre for Environmental Change & Human Resilience** (University of Dundee, particularly the twitter account), **Edinburgh Living Landscape**, **Scottish Natural Heritage** and the **Scottish GI Forum**.
- Two international organisations were also highlighted: **EPA Green Stream**, **Wetlands International**.

However, some participants did not subscribe to amplifiers, often citing LinkedIn and Twitter, colleagues and other contacts as the sources for their information. The quantity of information from amplifiers, particularly email traffic, for participants with limited time, was given as a reason for not

engaging with them. Linked to this, some participants felt that there were too many and that the subject breadth of some meant sorting through material that was not relevant to them. Several reported that a lack of resources meant that they did not have time to read the newsletters or attend conferences or engage with organisations that charge for membership, publications and/or events.

What qualities makes an amplifier organisation or network credible useful and attractive?

Participants also identified a number of key characteristics that they felt an amplifying organisation or network should possess as evidence of usefulness, credibility and attractiveness. These centred on three key themes: the trustworthiness of the organisation, the form and quality of the information provided and their ability to bring different parties together whilst retaining a clearly defined focus.

Trust was clearly important to a number of participants. An amplifier could win trust by having a good track record, for example, being well-known for conveying credible messages, acknowledging that credibility takes time to develop so those organisations that were longer established may be viewed as more credible. However, some commented that older organisations need to remain adaptable and receptive to new issues. Trust was also strongly linked to an organisation being neutral, independent, objective, well-balanced and transparent. The objectives of the organisation should be clear and accessible, and it should present itself in an honest 'up-front' manner. The source of funding was seen to be key to demonstrating transparency with some participants feeling that an amplifier's independence is protected by being funded from a wide range of sources. In addition, it was felt that funders should be 'reputable' and it should be clear that the source of funding would not influence the stance of the amplifier. There was some scepticism about whether such independence would attract funding and some suggested the funding of amplifiers can arouse suspicion. Another important aspect of funding is that it should be stable and constant. If it is not, the amplifier could become preoccupied with finding funds and its other activities may deteriorate. Also related to trust was having a large network of subscribing members, representative of a broad range of interests which should help maintain independence and credibility.

Second, the information transmitted should have value for practitioners, it should be relevant and worthwhile. The amplifier should be scientifically literate and understand what constitutes high quality research, this would help it share robust evidence (which would also maintain trust and credibility). Some participants suggested a 'broker' between the academic and the amplifier to achieve this. As well as good contacts with policy and practice links to academia were also seen as vital. Amplifiers have an opportunity to do more than pass on material, and the publishing of good quality, useful outputs could enhance the portfolio of an amplifier. The form in which information provision is achieved is also important; participants focused on ease of use, for example, a good, up to date website with no defunct links, concise and consistent information. It was clear that a balance is needed between providing too much information, that becomes overwhelming, yet ensuring information is up-to-date. The use of social media was viewed as valuable and one suggestion included agreed GI community hash tags. As well as providing quick, accessible information, the amplifier should provide links to more detailed sources, for example, citing the academic sources used.

The third theme was the importance of the amplifier bringing disparate disciplines and key players together, while retaining a well-defined interest. A mixed membership of practitioners and academics, a range of organisations and different disciplines was seen as important as was a clear understanding

of the relationships between them. Although it was recognised that this could be difficult. But an amplifier should also have a clear mission statement, strategic goals and a clearly differentiated 'unique selling point'.

Suggestions to improve amplifiers and networks

Participants gave suggestions of how amplifying organisations and networks could improve. Many of these link to the additional mechanisms for making research evidence and grey literature already identified with amplifier organisations seen as the obvious choice to provide this service. However, a number of activities of amplifiers were also identified for improvement. Although the good work of these organisations and networks in bringing people together was highly valued, it was suggested that more should be done. Organisations that are 'in the know' should be made visible to those that are outside and not 'in the know', for example by linking with new or existing profession-specific amplifiers targeted at developers, transport engineers, health professionals and insurers.

Participants suggested that amplifiers should seek to understand the user community and their needs. For example, some felt that their role should be as facilitators for GI as opposed to advocates. For example, they could assist with terminology, which can be difficult in GI and communication between disciplines, if not through providing a homogenised language, then through bringing the right individuals together. Amplifiers could further develop the help they provide in simplifying GI evidence for people with limited time. Amplifiers could also encourage inclusion of GI sceptics in discussions.

Summary

The networks and organisations summarised here appear to be dominated by ecologist and environmental science communities which is to be expected as many have been funded by NERC. Their focus is primarily on ecosystem services, often in predominantly rural environments, or adaptation. In both cases GI is recognised as key to delivery, especially for urban populations. CIRIA is different in that its audience is in many ways broader than the more academic networks. It has a long established record of reaching construction audiences, and through its work on SuDS has been able to gain traction in more traditional green infrastructure communities. Only the Green Infrastructure Partnership, however, is solely focussed on GI and therefore provides a unique opportunity to share knowledge and good practice to those interested in GI.

Participants were generally positive about their experience of amplifier organisations. The Green Infrastructure Partnership was particularly highly regarded for its focus on GI, but all were praised for the work they undertake. It does not appear that there is a need for a new amplifier, but participants would welcome more emphasis on bringing new disciplines and sectors in to the GI community.

TRANSLATING GREEN INFRASTRUCTURE EVIDENCE INTO PRACTICE

Finally, we explored at the events participants thoughts on the role of academic evidence, what is missing and how it is, or could be, presented to a non-academic audience.

In the speed networking sessions participants were asked: 'How much credence would you give to academic literature compared to a) your own experience b) the experience of your professional peers?' and 'Do you feel adequately equipped to use the evidence and good practice related to GI?'

In the breakout discussions participants were asked: 'How can academic evidence be better tailored to your needs? What should it be addressing?', 'What makes evidence useful? Which is most useful: evidence, guidance, case studies or a combination of all three?' and 'If you could fund one piece of research in your field, what would it be about?'

Is the green infrastructure evidence available useful to practitioners?

Generally, participants felt that the presentation of evidence in grey literature was more usable and useful to them than that from academic literature. They commented that it was presented in a way that relevant to them with more appropriate language, for example, in terms of GI function, and that the use of case studies in many examples was particularly helpful. Similarly, the collation of evidence from a range of disciplines was useful given the multidisciplinary nature of the evidence. However, there were some concerns that the quality, and thus usefulness, of grey literature often varies. Some of it was seen as duplicating previous documents (e.g. case studies, guidance) and some suffered from insufficient resourcing, whilst other grey literature could be very good. Where it comes across in the grey literature that the evidence is weak in some areas it can result in conflicts in practice. The time lag in producing grey literature was also seen as problematic as this often meant that it is out-of-date when it is published, compared with policy, research and practice. Here it was felt that evidence can be obtained earlier either directly from the researchers or through the experiences of colleagues.

There was debate about the value of academic evidence. Some participants said they would only use academic evidence, whilst others, mainly practitioners, said they never use it as they found it too detailed and would be more likely to trust evidence from colleagues. Many of the limitations of academic research seemed to stem from end-users not being involved in the research process from the start. For example, there was concern that research seems to be driven by the interests of the academics rather than the needs of the end-user; that evidence may come from a well-resourced project, undertaken in a methodically sound way, but be divorced from the practitioners who can make a real-world difference; research is aimed at generating more funding for the researcher; and changes recommended in academic evidence are often naïve, being too expensive or working against the broader policy. Some participants felt that research was often conducted in isolation from policy, whilst others felt that it is too often focused on policy creation and production rather than implementation. There was a feeling that as well as being more involved in the research inception and design, end-users should also be more involved in the peer-review process as they will provide a different perspective to academics. Finally, there was concern that research can be skewed towards certain areas that are in vogue, and lacking in other areas, so that a comprehensive evidence base, giving both academic and practitioner insights was missing. Another form of academic evidence thought to be useful was the systematic review. However, there was some concern that reviews can be misleading as they quickly become out-of-date in the large, constantly developing, evidence base related to GI. Academics also felt that reviews were useful, and could quickly raise their profile, but they are often not valued in the Research Excellence Framework (REF; on which research is judged) so are often not supported by their institutions.

Participants were asked about the usefulness of guidance and case studies. They felt that guidance conveys research findings in a succinct, accessible and industry-relevant way. However, it was noted that those writing the guidance should be aware of exactly how to pitch it, how it will be used, and that it can date rather quickly, particularly case studies or reviews. There was also some danger of guidance creating or reinforcing disciplinary silos.

Case studies were also thought useful by some participants. They can be useful in presenting a number of different issues in one study. Guidance case studies can be useful, and are a very popular feature on CIRIA's website. However, the purpose of case studies should be clear. As noted above, participants commented that the same case studies are often used and that even different ones overlap with each other by covering the same topics, which can limit their added value. It was suggested there should be a broader range of case studies made available, those examining where implementation has gone wrong would be welcomed (although it was acknowledged that those responsible might not want to advertise these), as would those covering a longer time period which included some evaluation. There is a need for more location-based case studies, linking in with the views of practitioners that local examples resonant with councillors and local policy makers.

It was felt that evidence, guidance and case studies were all important, but that case studies should play a supportive role to guidance. It was commented that, in general, all types of literature could increase their impact if presented with a clear (preferably emotional) narrative. The relative importance between evidence, guidance and case studies also depended on the audience of these materials.

What components and qualities of evidence make it useful?

There was considerable agreement on what makes evidence useful. In terms of grey literature, an analysis of the quality of the evidence as opposed to simply presenting research, knowing the author or organisation is reputable, and providing sources, perhaps as superscript to maintain readability were all valued. Interestingly, given some of the misgivings about academic research, some participants trusted that the academic research was of higher quality, and therefore more useful, than other forms of evidence. However, participants were mindful that having a sound methodology and demonstrating robustness and reliability are critical.

Evidence was also deemed more useful when the presentation for the evidence was appropriate to the audience, recognising that evidence should be repackaged for different audiences. For example, brevity is extremely important for some audiences and infographics can be useful in conveying information quickly. There was feeling that collaborating with end-users could aid academics in the presentation of their work. This would help to tailor outputs to the needs of the audience and would ensure the right language and terminology is used, especially in writing briefings and executive summaries.

Suggestions for making research and evidence be more useful

Linked to the discussion above of what qualities make GI evidence useful, suggestions were made as to what could render evidence more useful. Most of the recommendations for improvement centred on collaboration or funding:

- **Early collaboration between academia and practice** Greater thought should be given at the start of a project to how the research is to be used and researchers need to be aware of the necessary delivery structures to ensure their work has an impact (for example, knowing the type of evidence that planning officers can use in decision making). Events such as those held during this project were felt to be useful in bringing academics and end-users together to discuss the usefulness of research.
- **Collaboration with end-users throughout the research process** Practitioners and other partners should be involved in setting research questions, planning (including funding decisions), co-design, co-production, publishing and dissemination of good research, with some suggesting that the more partners involved in this the better. There was a feeling that at present, research doesn't transfer into policy and so policy makers should be brought into the research process. Although others thought policy makers (or the intended users of the research) had to think a bit more laterally for how research could assist with their role. There was a feeling that impact is too often an afterthought for academics and it needs to be more embedded in the research design.
- **Collaboration across disciplines** Although it was acknowledged as challenging participants felt that GI research teams should be multidisciplinary and involve disciplines representative of end-users, there was frustration that GI research often omitted built environment disciplines who may have a greater understanding of how the outcomes of the research can be delivered.
- **Research findings should be tailored to end-users** Thus evidence should be and specific and appropriate to, and knowledgeable of, its audience and developed in collaboration with end-users. The aim should be to provide evidence that can be used as effective communication tools to influence key decision makers, for example, robust case studies.
- **Improved funding structures and opportunities** End-users should be funded in research grants as many NGOs or public sector bodies do not have the money to engage at present especially if they are being invited to join multiple bids. More funding should be available for co-designed and translational research; particularly to rebalance funding between discovery science as opposed to translational and impact-led research. For example, £100K is available for NERC's Innovation Funding, but £5m is not uncommon for large discovery science programmes. Whereas high quality evaluation wouldn't fit into either of these categories. This could alleviate some disconnect between REF outputs and impact. Heritage Big Lottery Fund was praised for emphasising impact and benefits to end-users, although funded GI projects had to relate to heritage.
- **Funding across research councils** This include more flexible funding that demonstrates relevance across multiple research councils. A more joined-up approach that coordinates the disparate funds and projects so that the package of GI research can be viewed in its entirety. It was commented that the UK lacks a tradition, found in the US for example, of industry funding research. Although KTPs are valuable there are often not an option for small companies involved in GI technology.

Green infrastructure research priorities

Participants suggested a number of specific topics that they thought should be researched. These can be summarised as follows:

- **Monitoring and evaluation** There was frustration that funding is often available to implement GI or research new aspects of GI but not for high quality monitoring and evaluation of what works (and doesn't work). Particularly the evaluation of the effectiveness of GI as a longitudinal study.

- **Valuation** Research to explore the monetised benefits of GI were seen as critical to demonstrate the benefits of GI. This should include value for property enhancement, cost savings from the use of GI compared with other options, how GI contributes to natural capital, whole life costs and benefits of GI assets (although this has been done to some extent for SuDS). At a national level, demonstrating the benefits of GI for GDP, through the broader range of social and economic returns would also be useful. Two particularly important groups of end-users for this research were developers and local authorities. For example, using cost benefit analysis to inform developers' decision making (e.g. the cost-effectiveness of cheap and low maintenance SuDS). It was noted that translation of air quality benefits into financial savings has increased impact in that field.
- **Health impacts of GI** Understanding the health impacts of GI was thought to be important, in order to influence policy. For instance further exploration of the relationship between greenspace, and diabetes, mental health, and obesity would be helpful. There was a desire for this to be robust enough to satisfy the requirements of public health professionals (e.g. linking in with monitoring and evaluation).
- **Design of GI** Industry wants information on what techniques and approaches work so that it can implement them. For example, more research is needed on how to maximise the benefits of GI from species selection through to the design of GI as a component of placemaking. The preferences of the public were particularly highlighted as research gap; for example, on biodiversity and different cultural groups. Decision making tools could be developed to help decide the best sites for, and types of, GI although other participants felt that the assessment of GI would be insufficiently objective to achieve this.
- **Implementation of GI:** There was also frustration that even in areas of strong GI policy the delivery of GI, especially as part of new development is poor. Research, for example taking an action research approach, which explores the decision making through the development process would be extremely useful. Linked to this research that focused on the knowledge, skills and competencies of planning staff in relation to GI could also be useful, including the links between planning, landscape and ecology (and other relevant professionals).
- **Management of GI** Again, linked to the needs of industry the management of GI is often extremely under resourced so more cost-effective techniques and approaches would be useful. For example, work involved in sowing meadows tends to be underestimated.
- **Spatial aspects of GI** There is a need to explore GI as a spatial entity, which would aid monitoring and evaluation studies, those examining the value of GI and the impacts of GI deficits. However, it was acknowledged that this is hindered at present by the lack of a robust dataset in England (currently being developed by Ordnance Survey).
- **Other specific topics included** GI at the coastal interface, rural GI, the relationship between GI and resilience (including how resilient specific GI assets are), the relationship between the sub-surface and surface level GI.

Summary

Participants were positive about the increasing evidence base related to GI, both in terms of the services it provides and how it can be delivered. However, there was frustration that academic research is often not reaching the end-users. It is critical that end-users are effectively engaged at the start of the research process and form an integral part of the research team. The events provided a useful beginning to this process with participants from practice and research providing their suggestions on the research needs of the community both in terms of funding streams and topics.

LITERATURE CITED

Biodiversity

- Angold, P., Sadler, J., Hill, M., Pullin, A., Rushton, S., Austin, K., Small, E., Wood, B., Wadsworth, R., Sanderson, R., Thompson, K. (2006) Biodiversity in urban habitat patches. *Science of the Total Environment* 360(1-3), 196-204.
- Baker, P., Harris, S. (2007) Urban mammals: what does the future hold? An analysis of the factors affecting patterns of use of residential gardens in Great Britain. *Mammal Review* 37(4), 297-315.
- Fernández-Juricic, E. (2000) Avifaunal use of wooded streets in an urban landscape. *Conservation Biology* 14(2), 513-521.
- Fernández-Juricic, E., Jokimäki, J. (2001) A habitat island approach to conserving birds in urban landscapes: case studies from southern and northern Europe. *Biodiversity and Conservation* 10, 2023-2043.
- Funk, A., Reckendorfer, W., Kucera-Hirzinger, V., Raab, R., Schiemer, F. (2009) Aquatic diversity in a former floodplain: remediation in an urban context. *Ecological Engineering* 35(10), 1476-1484.
- Gibson, C. (1998) *Brownfield: red data*. The values artificial habitats have for uncommon invertebrates. ENRR 273. English Nature, Peterborough.
- Hale, J., Fairbrass, A., Matthews, T., Sadler, J. (2012) Habitat composition and connectivity predicts bat presence and activity at foraging sites in a large UK conurbation. *PLoS ONE*, 7(3).
- Hardy, P., Dennis, R. (1999) The impact of urban development on butterflies within a city region. *Biodiversity and Conservation* 8(9), 1261-1279.
- Harrison, C., Davies, G. (2002) Conserving biodiversity that matters: practitioners' perspectives on brownfield development and urban nature conservation in London. *Journal of Environmental Management* 65, 95-108.
- Helden, A., Leather, S. (2004). Biodiversity on urban roundabouts - *Hemiptera*, management and the species-area relationship. *Basic and Applied Ecology* 5, 367-377.
- Irvine, K., Devine-Wright, P., Payne, S., Fuller, R., Painter, B., Gaston, K. (2009) Green space, soundscape and urban sustainability: an interdisciplinary, empirical study. *Local Environment: The International Journal of Justice and Sustainability* 14, 155-172.
- Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.J., Tew, T.E., Varley, J., Wynne, G.R. (2010) *Making Space for Nature: a Review of England's Wildlife Sites and Ecological Network*. Report to Defra. Department for Environment, Food and Rural Affairs, London. Available at: <http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf>.
- Mabry, K., Barrett, G. (2002) Effects of corridors on home range sizes and interpatch movements of three small mammal species. *Landscape Ecology* 17, 629-636.
- Morimoto, T., Katoh, K. (2005). The effect of greenways connecting urban parks on avifauna in the winter period (in Japanese, English summary). *Journal of the Japanese Institute of Landscape Architecture* 68 (5), 589-592.
- Rudd, H., Vala, J., Schaefer, V. (2002) Importance of backyard habitat in a comprehensive biodiversity conservation strategy: a connectivity analysis of urban green spaces. *Restoration Ecology* 10(2), 368-375.

Schrader, S., Boning, M. (2006) Soil formation on green roofs and its contribution to urban biodiversity with emphasis on Collembolans. *Pedobiologia* 50(4), 347-356.

Stolze, M., Piorr, A., Haring, A., Dabbert, S. (2000) *Environmental impacts of organic farming in Europe*. University of Hohenheim, Germany,

Urban, M., Skelly, D.K., Burchsted, D., Price, W., Lowry, S. (2006) Stream communities across a rural-urban landscape gradient. *Diversity and Distributions*, 12(4), 337-350.

Zaghi, D., Calaciura, B., Spinelli, O. (2010) *Literature study on the impact of biodiversity on human health*. Comunità Ambiente Srl, report for the European Commission (Directorate General Environment).

Supporting services

Weber, T. (2007) Ecosystem services in Cecil County's Green Infrastructure: Technical Report for the Cecil County Green Infrastructure Plan. The Conservation Fund, Maryland.

Provisioning services

Naumann, S., McKenna D., Kaphengst, T., Pieterse, M., Rayment, M. (2011) *Design, implementation and cost elements of Green Infrastructure projects*. Final report. European Commission, Brussels.

Regulating services

Air quality

Beckett, K., Freer-Smith, P., Taylor, G. (1998) Urban woodlands: their role in reducing the effects of particulate pollution. *Environmental Pollution* 99 (3), 347-360.

Broadmeadow, M.S.J., Freer-Smith, P.H. (1996) *The improvement of urban air quality by trees*. Arboriculture Research and Information Note. AAIS, Farnham.

Bolund, P., Hunhammar, S. (1999) Ecosystem services in urban areas. *Ecological Economics* 29, 293-301.

Clark, C. (2005) Optimization of Green Roofs for Air Pollution Mitigation. *Proceedings of 1st North American Green Roof Conference: Greening Rooftops for Sustainable Communities*, Washington DC, 4-6th May 2005. The Cardinal Group, Toronto.

Donovan, R.G., Owen, S.M., Stewart, H.E., MacKenzie, A.R., Hewitt, C.N. (2005) Development and application of an Urban Tree Air Quality Score using the Birmingham, United Kingdom, area as a case study. *Environmental Science & Technology* 39(17), 6730-6738.

Hwang, K.Y. (2004) Restoring Cheonggyecheon Stream in Downtown Seoul. Available at: http://www.globalrestorationnetwork.org/uploads/files/LiteratureAttachments/270_restoring-cheonggyecheon-stream-in-the-downtown-seoul.pdf.

Lovasi, G.S., Quinn, J.W., Neckerman, K.M., Perzanowski, M.S., Rundle, A. (2008) Children living in areas with more street trees have lower prevalence of asthma. *Journal of Epidemiology and Community Health* 62, 647-649.

Nowak, D.J. (1994) *Air pollution removal by Chicago's urban forest, Chicago's Urban Forest Ecosystem*. Results of the Chicago Urban Forest Climate Project, United States Department of Agriculture.

Nowak, D.J., Crane, D.E., Stevens, J.C. (2006) Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry & Urban Greening*, 4, 115-123.

Pugh, T., MacKenzie, A., Whyatt, J., Hewitt, C., (2012) Effectiveness of green infrastructure for improvement of air quality in urban street canyons. *Environmental Science & Technology*, 46(14), 7692-7699.

Speak, A., Rothwell, J., Lindley, S., Smith, C. (2012) Urban particulate pollution reduction by four species of green roof vegetation in a UK city. *Atmospheric Environment* 61, 283-293.

Tallis, M., Taylor, G., Sinnett, D., Freer-Smith, P. (2011) Estimating the removal of atmospheric particulate pollution by the urban tree canopy of London, under current and future environments. *Landscape and Urban Planning*, 103, 129-138.

Tiwary, A., Sinnett, D., Peachey, C.J., Chalabi, Z., Vardoulakis, S., Fletcher, T., Leonardi, G., Grundy, C., Azapagic, A., Hutchings, T.R. (2009) An integrated tool to assess the role of new planting in PM10 capture and the human health benefits: a case study in London. *Environmental Pollution* 157, 2645-2653.

Weber, T. (2007) Ecosystem services in Cecil County's Green Infrastructure: Technical Report for the Cecil County Green Infrastructure Plan. The Conservation Fund, Maryland.

Climate regulation (local)

Akbari, H., Rosenfeld, A., Taha, H. (1990) Summer heat islands, urban trees and white surfaces. *ASHRAE Transactions* 96(1). American Society of Heating, Refrigeration, and Air Conditioning Engineers, Atlanta, Georgia.

Bolund, P., Hunhammar, S. (1999) Ecosystem services in urban areas. *Ecological Economics* 29, 293-301.

Bonan, G.B. 2008. *Ecological Climatology: Concepts and Applications*. 2nd edition. Cambridge University Press, Cambridge.

Bowler, D.E., Buyung-Ali, L., Knight, T.M., Pullin, A.S. (2010) Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning* 97, 147-155.

Brown, R., Vanos, J., Kenny, N., Lenzholzer, S. (2015) Designing urban parks that ameliorate the effects of climate change. *Landscape and Urban Planning* 138, 118-131.

Ca, V.T., Asaeda, T., Abu, E. (1998) Reductions in air conditioning energy caused by a nearby park. *Energy and Buildings* 29, 83-92.

Chang, C.R., Li, M.H., Chang, C. (2007) A preliminary study on the local cool-island intensity of Taipei city parks. *Landscape and Urban Planning* 80(4), 386-395.

Del Barrio, E.P. (1998) Analysis of the green roofs cooling potential in buildings, *Energy and Buildings*, 27, 179-193.

Dimoudi, A., Nikolopoulou, M. (2003) Vegetation in the urban environment: microclimatic analysis and benefits. *Energy and Buildings* 35, 69-76.

Doick, K., Peace, A., Hutchings, T. (2014) The role of one large greenspace in mitigating London's nocturnal urban heat island. *Science of the Total Environment* 493, 662-671.

Emmanuel, R., Loconsole, A. (2015) Green infrastructure as an adaptation approach to tackling urban overheating in the Glasgow Clyde Valley Region, UK. *Landscape and Urban Planning* 138, 71-86.

Feyisa, G., Dons, K., Meilby, H. (2014) Efficiency of parks in mitigating urban heat island effect: An example from Addis Ababa, *Landscape and Urban Planning* 123, 87-95.

Frumkin, H. (2002) Urban sprawl and public health. *Public Health Reports* 117(3), 201-217.

Gill, S.E., Handley, J.F., Ennos, A.R., Pauleit, S. (2007) Adapting cities for climate change: the role of green infrastructure. *Built Environment* 33 (1), 115-133.

Givoni, B. (1998). Impact of green areas on site and urban climates (Chapter 9). In: B. Givoni (ed.) *Climate considerations in building and urban design*. John Wiley & Sons, New York. pp. 303-330.

Haines, A., Kovats, R.S., Campbell-Lendrum, D., Corvalan, C. (2006) Climate change and human health: Impacts, vulnerability, and mitigation. *Lancet* 367(9528), 2101-2109.

- Heidt, V., Neif, M. (2008) Benefits of urban greenspace for improving urban climate. In: M.E. Carreiro, Y.C. Song, J. Wu (eds.) *Economy, planning and management of urban forests: international perspectives*. Springer, New York, pp 336-345.
- Heisler, G.M. (1986) Effects of individual trees on the solar radiation climate of small buildings. *Urban Ecology* 9, 337-359.
- Hwang, K.Y. (2004) Restoring Cheonggyecheon Stream in Downtown Seoul. Available at: http://www.globalrestorationnetwork.org/uploads/files/LiteratureAttachments/270_restoring-cheonggyecheon-stream-in-the-downtown-seoul.pdf.
- Jauregui, E. (1990–91) Influence of a large urban park on temperature and convective precipitation in a tropical city. *Energy and Buildings* 15, 457-463.
- Jim, C. (2015) Assessing climate-adaptation effect of extensive tropical green roofs in cities. *Landscape and Urban Planning* 138, 54-70.
- Liu, K., Baskaran, B. (2003) Thermal performance of green roofs through field evaluation. *Proceedings of 1st North American Green Roof Conference: Greening Rooftops for Sustainable Communities*, Chicago. 29-30th May 2003. The Cardinal Group, Toronto.
- Mavrogianni, A., Davies, M., Batty, M., Belcher, S.E., Bohnenstengel, S.I., Carruthers, D., Chalabi, Z., Croxford, B., Demanuele, C., Evans, S., Giridharan, R., Hacker, J.N., Hamilton, I., Hogg, C., Hunt, J., Kolokotroni, M., Martin, C., Milner, J., Rajapaksha, I., Ridley, I., Steadman, J.P., Stocker, J., Wilkinson, P., Yea, Z. (2011) The comfort, energy and health implications of London's urban heat island. *Building Services Engineering Research and Technology* 32, 35-52.
- McPherson, E.G. (1993) Evaluating the cost effectiveness of shade trees for demand-side management. *The Electricity Journal* 6, 57-65.
- Meier, A.K. (1990–91) Strategic landscaping and air-conditioning savings: A literature review. *Energy and Buildings* 15, 479-486.
- Pérez, G., Rincón, L., Vila, A., González, J.M., Cabeza, L.F. (2011) Behaviour of green facades in Mediterranean continental climate. *Energy Conversion and Management* 52(4), 1861-1867.
- Potchter, O., Cohen, P., Bitan, A. (2006) Climatic behaviour of various urban parks during hot and humid summer in the Mediterranean city of Tel Aviv, Israel. *International Journal of Climatology* 26, 1695-1711.
- Rydin, Y., Bleahu, A., Davies, M., Dávila, J.D., Friel, S., De Grandis, G., Groce, N., Hallal, P.C., Hamilton, I., Howden-Chapman, P., Lai, K.-M., Lim, C.J., Martins, J., Osrin, D., Ridley, I., Scott, I., Taylor, M., Wilkinson, P., Wilson, J. (2012) Shaping cities for health: complexity and the planning of urban environments in the 21st century. *Lancet* 379(9831), 2079–2108.
- Saito, I. (1990–91). Study of the effect of green areas on the thermal environment in an urban area. *Energy and Buildings* 15, 493-498.
- Salcedo Rahola, T.B., Oppen, P., Mulder, K. (2009) *Heat in the city: an inventory of knowledge and knowledge deficiencies regarding heat stress in Dutch cities and options for its mitigation*. National Research Programme Climate Changes Spatial Planning, Amsterdam, Netherlands.
- Shashua-Bar, L., Hoffman, M.E. (2000) Vegetation as a climatic component in the design of an urban street: an empirical model for predicting the cooling effect of urban green areas with trees. *Energy and Buildings* 31, 221-235.
- Susca, T., Gaffin, S.R., Dell'Osso, G.R. (2011) Positive effects of vegetation: Urban heat island and green roofs. *Environmental Pollution* 159(8-9), 2119-2126.
- Taha, H.G., Akbari, H., Rosenfield, A. (1988) *Vegetation canopy micro-climate: A field project in Davis, California*. Lawrence Berkeley Laboratory Report No. 24593. Lawrence Berkeley, Davis, California, USA.

Whitford, V., Ennos, A.R., Handley, J.F. (2001) City form and natural processes: indicators for the ecological performance of urban areas and their application to Merseyside, UK. *Landscape Urban Planning* 20(2), 91-103.

Wong, N., Chen, Y., Ong, C., Sia, A. (2003) Life cycle costs analysis of rooftop gardens in Singapore. *Building and Environment* 38, 499-509.

Yu, C., Hien, W.N. (2006) Thermal benefits of city parks. *Energy and Buildings* 38, 105-120.

Water regulation/purification

Archer, D. (2007) The use of flow variability analysis to assess the impact of land use change on the paired Plynlimon catchments, mid-Wales. *Journal of Hydrology* 347, 487-496.

Archer, N., Bonell, M., Coles, N., MacDonald, A., Auton, C., Stevenson, R., (2013) Soil characteristics and landcover relationships on soil hydraulic conductivity at a hillslope scale: A view towards local flood management. *Journal of Hydrology*, 497, 208-222.

Armson, D., Stringer, P., Ennos, A., (2013) The effect of street trees and amenity grass on urban surface water runoff in Manchester, UK. *Urban Forestry & Urban Greening*, 12(3), 282-286.

Carter, T., Butler, C. (2008) Ecological impacts of replacing traditional roofs with green roofs in two urban areas. *Cities and the Environment* 1, 9-17.

Costanza, R., Perez-Maqueo, O., Martinez, M.L., Sutton, P., Anderson, S.J., Mulder, K. (2008) The value of coastal wetlands for hurricane protection. *Ambio* 37(4), 241-248.

Danielsen, F., Sørensen, M.K., Olwig, M.F., Selvam, V., Parish, F., Burgess, N.D., Hiraishi, T., Karunakaran, V.M., Rasmussen, M.S., Hansen, L.B., Quarto, A., Suryadiputra, N. (2005) The Asian tsunami: a protective role for coastal vegetation. *Science* 310(5748), 643.

Denman, L (2006), *Are Street Trees And Their Soils An Effective Stormwater Treatment Measure?* Paper presented at the 7th National Street Tree Symposium. Found at: http://contextsensitivesolutions.org/content/reading/are_street_trees_and_their_soil_/resources/STREETTREES_LizDenman.pdf

Duffy, A., Jefferies, C., Waddell, G., Shanks, G., Blackwood, D., Watkins, A. (2008) A cost comparison of traditional drainage and SUDS in Scotland. *Water Science & Technology* 57, 1451-1459.

Dunn, A.D. (2007) *Green Light for Green Infrastructure*. Pace Law Faculty Publications Paper 494.

Dunn, A.D. (2010) *Siting Green Infrastructure: Legal and Policy Solutions to Alleviate Urban Poverty and Promote Healthy Communities*. Pace Law Faculty Publications Paper 559.

Flynn, K., Traver, R. (2013) Green infrastructure life cycle assessment: A bio-infiltration case study. *Ecological Engineering* 55, 9-22.

Foster, J., Lowe, A., Winkelman, S. (2011) *The Value of Green Infrastructure for Urban Climate Adaptation*. Washington DC: Center for Clean Air Policy.

Frumkin, H. (2002) Urban sprawl and public health. *Public Health Reports* 117(3), 201-217

Funk, A., Reckendorfer, W., Kucera-Hirzinger, V., Raab, R., Schiemer, F. (2009) Aquatic diversity in a former floodplain: remediation in an urban context. *Ecological Engineering* 35(10), 1476-1484.

Gambrell, P.R. (1994) Trace and toxic metals in wetlands: a review. *Journal of Environmental Quality* 23, 883-891.

Gill, S.E., Handley, J.F., Ennos, A.R., Pauleit, S. (2007) Adapting cities for climate change: the role of green infrastructure. *Built Environment* 33 (1), 115-133.

Gilliam, J.W. (1994) Riparian wetlands and water quality. *Journal of Environmental Quality* 23, 896-900.

- Hamin, E.M., Gurran, N. (2009) Urban form and climate change: Balancing adaptation and mitigation in the U.S. and Australia. *Habitat International* 33, 238-245.
- Harlan, S.L., Brazela, A.J., Prashada, L., Stefanovb, W.L., Larsen, L. (2006) Neighbourhood microclimates and vulnerability to heat stress. *Social Science & Medicine* 63, 2847-2863.
- Hatt, B.E., Fletcher, T.D., Deletic, A. (2008) Hydraulic and pollutant removal performance of fine media stormwater filtration systems. *Environmental Science & Technology*, 42, 2535-2541.
- Heal, K.V., Hepburn, D.A., Lunn, R.J., Tyson, J. (2006) Sediment management in sustainable urban drainage system ponds. *Water Science & Technology* 53, 219-228.
- Jackson, B.M., Wheeler, H.S., McIntyre, N.R., Chell, J., Francis, O.J., Frogbrook, Z., Marshall, M., Reynolds, B., Solloway, I. (2008) The impact of upland land management on flooding: insights from a multiscale experimental and modelling programme. *Journal of Flood Risk Management* 1(2), 71-80.
- Jeffries R., Darby, S.E., Sear, D.A. (2003) The influence of vegetation and organic debris on flood-plain sediment dynamics: case study of a low-order stream in the New Forest, England. *Geomorphology* 51, 61-80.
- Lowrance, R., Altier, L.S., Newbold, J.D., Schnabel, R.R., Groffman, P.M., Denver, J.M., Correll, D.L., Gilliam, J.W., Robinson, J.L., Brinsfield, R.B., Staver, K.W., Lucas, W., Todd, A.H. (1997) Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. *Environmental Management* 21(5), 687-712.
- Marritz, L. (2011) *Stormwater Quality Benefits of Bioretention with Trees*. Posted on the DeepRoot blog on August 1, 2011. Available at: www.deeproot.com/blog/blog-entries/stormwater-qualitybenefits-of-bioretentionwith-trees.
- Mentens, J., Raes, D., Hermy, M. (2006) Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century? *Landscape and Urban Planning* 77, 217-226.
- Meyerhoff, J., Dehnhardt, A. (2007) The European Water Framework Directive and economic valuation of wetlands: the restoration of floodplains along the River Elbe. *European Environment* 17, 18-36.
- Morris, J., Camino, M. (2010) *Economic Assessment of Freshwater, Wetland and Floodplain Ecosystem Services*, Report to the Economics Team of the UK National Ecosystem Assessment, Cranfield University. Cambridge: UK National Ecosystem Assessment.
- Napier, F., Jefferies, C., Heal, K.V., Fogg, P., Arcy, B.J., Clarke, R. (2009) Evidence of traffic related pollutant control in soil-based Sustainable Urban Drainage Systems (SUDS). *Water science & technology* 60, 221-230.
- Nisbet, T.R., Orr, H., Broadmeadow, S. (2004) *A guide to using woodland for sediment control*. Forest Research, Farnham.
- Nisbet, T., Silgram, M., Shah, N., Morrow, K., Broadmeadow, S., (2011) Woodland for water: woodland measures for meeting water framework directive objectives. *Forest research monograph*, 4, 156.
- O'Connell, P.E., Beven, K.J., Carney, J.N., Clements, R.O., Ewen, J., Fowler, H., Harris, G.L, Hollis, J., Morris, J., O'Donell, G.M., Packman, J.C, Parkin, A., Quinn, P.F., Rose, S.C., Shepherd, M., Tellier, S. (2005). *Review of impacts of rural land use and management on flood generation*. Impact study report. DEFRA, London.
- Oberndorfer, E., Lundholm, J., Bass, B. Coffman, R.R., Doshi, H., Dunnett, N., Gaffin, S., Köhler, M., Liu, K.K.Y., Rowe, B. (2007) Green roofs as urban ecosystems: Ecological structures, functions and services. *Bioscience* 57(10), 823-833.
- Primavera, J.H. (2005) Mangroves, fishponds and the quest for sustainability. *Science* 310 (5745), 57-59.

Pyke, C., Warren, M.P., Johnson, T. LaGro Jr., J., Scharfenberg, J., Groth, P., Freed, R., Schroeer, W., Main, E. (2011) Assessment of low impact development for managing stormwater with changing precipitation due to climate change. *Landscape and Urban Planning* 103, 166-173.

Seters, T. van, Rocha, L., Smith, D. and Macmillan, G. (2009) Evaluation of green roofs for runoff retention, runoff quality, and leachability. *Water Quality Research Journal of Canada* 44(1), 33-47.

Speak, A., Rothwell, J., Lindley, S., Smith, C., (2013) Rainwater runoff retention on an aged intensive green roof. *Science of the Total Environment* 461, 28-38.

Stovin, V., Jorgensen, A., Clayden, A. (2008) Street trees and stormwater management. *The Arboricultural Journal* 30, 1-4.

Stovin, V., Gianni V., Hartini, K. (2012) The hydrological performance of a green roof test bed under UK climatic conditions. *Journal of Hydrology* 414, 148-161.

Thomas, H., Nisbet, T. (2007) An assessment of the impact of floodplain woodland on flood flows. *Water and Environment Journal* 21(2), 114-126.

Van Renterghem, T., Botteldooren, D. (2009) Reducing the acoustical façade load from road traffic with green roofs. *Building and Environment*. 44 (5), 1081-1087.

Vellidis, G., Lowrance, R., Gay, P., Wauchope, R.D. (2002) Herbicide transport in a restored riparian forest buffer system. *Transactions of the ASAE* 45, 89-97.

Villarreal, E.L., Semadeni-Davies, A., Bengtsson, L. (2004) Inner city stormwater control using a combination of best management practices. *Ecological Engineering* 22 279-298.

Xiao, Q., McPherson, E., Simpson, J., Ustin, S. (1998) Rainfall interception by Sacramento's urban forest. *Journal of Arboriculture* 24, 235-244.

Whitford, V., Ennos, A.R., Handley, J.F. (2001) City form and natural processes: indicators for the ecological performance of urban areas and their application to Merseyside, UK. *Landscape Urban Planning* 20(2), 91-103.

Noise regulation

Bolund, P., Hunhammar, S. (1999) Ecosystem services in urban areas. *Ecological Economics* 29, 293-301.

Barth, F.G., Schmid, A. (eds.) (2001) *Ecology of sensing*. Springer Verlag, Berlin.

Foster, J., Lowe, A., Winkelman, S. (2011) *The Value of Green Infrastructure for Urban Climate Adaptation*. Washington DC: Center for Clean Air Policy.

Greenspace Scotland (2008) *Health Impact Assessment of Green space: A guide*. Health Scotland. Greenspace Scotland, Scottish Natural Heritage and Institute of Occupational Medicine.

Leonard, R.E., Parr, S.B. (1970) Woodland trees as a sound barrier. *Journal of Forestry* 68, 282-283.

Van Renterghem, T., Botteldooren, D. (2009) Reducing the acoustical façade load from road traffic with green roofs. *Building and Environment* 44(5), 1081-1087.

Wong, N., Tan, A., Tan, P., Chiang, K., Wong, N., (2010) Acoustics evaluation of vertical greenery systems for building walls. *Building and Environment* 45(2), 411-420.

Carbon storage

Davies, Z.G., Edmondson, J.L., Heinemeyer, A., Leake, J.R., Gaston, K.J. (2011) Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale. *Journal of Applied Ecology* 48, 1125-1134.

Naumann, S., McKenna D., Kaphengst, T., Pieterse, M., Rayment, M. (2011) Design, implementation and cost elements of Green Infrastructure projects. Final report. European Commission, Brussels.

Strohbach, M., Arnold, E., Haase, D. (2012) The carbon footprint of urban greenspace - A life cycle approach. *Landscape and Urban Planning* 104, 220-229.

Valatin, G., Starling, J. (2010) *Valuation of ecosystem services provided by UK woodlands*. The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge.

Whitford, V., Ennos, A.R., Handley, J.F. (2001) City form and natural processes: indicators for the ecological performance of urban areas and their application to Merseyside, UK. *Landscape Urban Planning* 20(2), 91-103.

Soil regulation

Center for Urban Forest Research (2002). *Control stormwater runoff with trees*. Fact Sheet No. 4.

Hutchings, T. (2002). The opportunities for woodland on contaminated land. Information Note 44. Forestry Commission, Edinburgh.

Nisbet, T.R., Orr, H., Broadmeadow, S. (2004) A guide to using woodland for sediment control. Forest Research, Farnham.

Cultural services

Aesthetic experience, sense of place

Alcock, I., White, M., Wheeler, B., Fleming, L., Depledge, M. (2014) Longitudinal effects on mental health of moving to greener and less green urban areas. *Environmental science & technology*, 48 (2), 1247-1255.

Benedict, M.A., McMahon, E.T. (2003) Green infrastructure: Smart conservation for the 21st Century. *Renewable Resource Journal* 20(3), 12-17.

Burgess, M., Harrison, C.M., Limb, M. (1988) People, parks and the urban green: a study of popular meanings and values for open spaces in the city. *Urban Studies* 25, 455-473.

Depledge, M., Stone, R., Bird, W. (2011) Can natural and virtual environments be used to promote improved human health and wellbeing? *Environmental Science & Technology* 45(11), 4660-4665.

Grahn, P., Stigsdotter, U. (2003) Landscape planning and stress. *Urban Forestry and Urban Greening* 2(1), 1-18.

Greenspace (2007) *The park life report: the first ever public satisfaction survey of Britain's parks and greenspaces*. Greenspace, Reading.

Hansmann, R., Hug, S., Seeland, K. (2007) Restoration and stress relief through physical activities in forests and parks. *Urban Forestry and Urban Greening* 6, 213-225.

Hartig, T., Evans, G.W., Jamner, L.D., Davis, D.S., Garling, T. (2003) Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology* 23, 109-123.

Hartig, T., Evans, G.W., Jamner, L.D., Davis, D.S., Gärling, T. (2003) Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology* 23, 109-123.

Henwood, K. (2002) *Issues in health development: Environment and health: Is there a role for environmental and countryside agencies in promoting benefits to health?* Health Development Agency, London.

Kaplan, R. (1992) The psychological benefits of nearby nature. In Relf, D. (ed.) *The Role of Horticulture in Human Well-Being and Social Development: A National Symposium*. Timber Press, Portland, Oregon pp. 125-133.

Kim, J. and Kaplan, R. (2004) Physical and psychological factors in sense of community: new urbanist Kentlands and nearby Orchard Village. *Environment and Behavior* 36(3), 313-340.

Lee, K., Johnson, K., Williams, K., Sargent, L., Williams, N. (2015) Forget siestas, 'green microbreaks' could boost work productivity. *The Conversation*. Available at: <http://theconversation.com/forget-siestas-green-micro-breaks-could-boost-work-productivity-42356>.

Peters, K., Elands, B., Buijs, A. (2010) Social interactions in urban parks: Stimulating social cohesion?, *Urban Forestry and Urban Greening* 9, 93-100.

Pretty, J., Peacock, J., Hine, R., Sellens, M., South, N., Griffin, M. (2007) Green exercise in the UK countryside: Effects on health and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning and Management* 50(2), 211-231.

Qureshi, S., Kazmi, S.J.H., Breuste, J.H. (2010) Ecological disturbances due to high cutback in the green infrastructure of Karachi: Analyses of public perception about associated health problems. *Urban Forestry and Urban Greening* 9(3), 187-198.

Roe, J. Thompson, C., Aspinall, P., Brewer, M., Duff, E., Miller, D., Mitchell, R., Clow, A. (2013) Green space and stress: Evidence from cortisol measures in deprived urban communities. *International Journal of Environmental Research and Public Health* 10, 4086-4103.

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., Depledge, M. (2011) Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology* 45(5), 1761-1772.

Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., Miller, A. (2012) More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning* 105, 221-229.

Ulrich, R. (1984) View through window may influence recovery from surgery, *Science* 224, 420-421.

Ulrich, R.S., Parsons, R. (1992) Influences of passive experiences with plants on individual well-being and health. In Relf, D. (ed.) *The Role of Horticulture in Human Well-being and Social Development: A National Symposium*. Timber Press, Portland, Oregon pp. 93-105.

Venn, S.J., Niemela, J.K. (2004) Ecology in a multidisciplinary study of urban green space: the URGE project. *Boreal Environment Research* 9, 479-489.

Wells, N.M. (2000) At home with nature: effects of "greenness" on children's cognitive functioning. *Environment and Behavior* 32, 775.

Social cohesion, social capital

Armstrong, D. (2000) A survey of community gardens in upstate New York: implications for health promotion and community development. *Health and Place* 6 319-327.

Bell, S., Hamilton, V., Montarzino, A., Rothnie, H., Travlou, P., Alves, S. (2008) *Greenspace and quality of life: a critical literature review*. Greenspace Scotland, Stirling.

Berman, M., Jonides, J., Kaplan, S. (2008) The cognitive benefits of interacting with nature. *Psychological science* 19(12), 1207-1212.

Cohen, D., McKenzie, T., Sehgal, A., Williamson, S., Golinelli, D., Lurie, N. (2007) Contribution of public parks to physical activity. *American Journal of Public Health* 97(3) 509-514.

Gobster, P. (1998) Urban parks as green walls or green magnets? Interracial relations in neighborhood boundary parks. *Landscape and Urban Planning* 41, 43-55.

Gobster, P. (2002) Managing urban parks for a racially and ethnically diverse clientele. *Leisure Sciences* 24, 143-159.

Grahn, P., Stigsdotter, U., (2003) Landscape planning and stress. *Urban Forestry and Urban Greening* 2, 1-18.

- Green space Scotland (2008) *Health Impact Assessment of Green space: A guide*. Health Scotland, Green space Scotland, Scottish Natural Heritage and Institute of Occupational Medicine.
- Kingsley, J., Townsend, M. (2006) 'Dig In' to Social Capital: Community Gardens as Mechanisms for Growing Urban social connectedness. *Urban Policy and Research* 24(4), 525-537.
- Kuo, F., Bacaicoa, M., Sullivan, W. (1998) Transforming inner-city landscapes trees, sense of safety, and preference. *Environment and Behaviour* 30(1), 28-59.
- Kuo, F., Sullivan, W., Coley, L., Brunson, L. (1998) Fertile ground for community: inner-city neighborhood common spaces. *American Journal of Community Psychology*, 26(6) 823-851.
- Maas, J., Verheij, R., Spreeuwenberg, P., Groenewegen, P. (2008) Physical activity as a possible mechanism behind the relationship between green space and health: a multilevel analysis. *BMC Public Health* 8(1).
- Peters, K., Elands, B., Buijs, A. (2010) Social interactions in urban parks: Stimulating social cohesion? *Urban Forestry and Urban Greening* 9, 93-100.
- Ravenscroft, N., Markwell, S. (2000) Ethnicity and the integration and exclusion of young people through urban park recreation provision. *Managing Leisure* 5, 135-150.
- Sullivan, W., Kuo, F., DePooter, S. (2004) The fruit of urban nature: vital neighbourhood spaces. *Environment and Behavior* 36(5), 678-700.
- Weldon, S., Bailey, C., in collaboration with O'Brien, L. (2007) *New pathways to health and well-being: summary of research to understand and overcome barriers to accessing woodland*. Forestry Commission, Scotland.
- Zoellner, J., Zanko, A., Price, B., Bonner, J., Hill, J. (2012) Exploring community gardens in a health disparate population: Findings from a mixed methods pilot study. *Progress in Community Health Partnerships: Research, Education and Action* 6(2), 153-165.

Education, experience of nature

- Fjørtoft, I., Sageie, J. (2000) The natural environment as a playground for children: landscape description and analyses of a natural playscape. *Landscape and Urban Planning* 48, 83-97.
- Grahn, P. (1989) Att Uppleva Parken. Parkens Bydelsa För Äldre, Sluka Och Handikappade Skildrede Genom Dagböcker, Intervjuer, Teckningar Och Fotografier. Alnarp, Sveriges Lantbruksuniversitet.
- Kaplan, R., Kaplan, S. (1989) *The Experience of Nature: A Psychological Perspective*. Cambridge, Cambridge University Press.
- Ulrich, R. (1984) View through window may influence recovery from surgery, *Science* 224, 420-421.

Recreation, walking, physical activity: mental health outcomes

- Alcock, I., White, M., Wheeler, B., Fleming, L., Depledge, M. (2014) Longitudinal effects on mental health of moving to greener and less green urban areas. *Environmental Science and Technology* 48(2), 1247-1255.
- Amoly, E., Dadvand, P., Fornas, J., Lopez-Vicente, M., Basagaria, X., Julvez, J., Pedrerol, Alvarez- Pedrerol, M., Nieuwenhuijsen, M., Sunyer, J. (2014) Green and blue spaces and behavioural development in Barcelona schoolchildren: The BREATHE Project. *Environmental Health Perspectives* 122(12), 1351-1358.
- Annerstedt, M., Norman, J., Boman, M., Mattsson, L., Grahn, P., Wahrborg, P., (2010) Finding stress relief in a forest. *Ecological Bulletins*, 53, 33-42.
- Aspinall, P., Mavros, P., Coyne, R., and Roe, J. (2015) The urban brain: analysing outdoor physical activity with mobile EEG. *British Journal of Sports Medicine* 49, 272-276.

- Barton, J., Pretty, J. (2010) What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology* 44(10), 3947-3955.
- Berman, M., Jonides, J., Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science*, 19(12), 1207-1212.
- Bowler, D., Buyung-Ali, L., Knight, T., Pullin, A. (2010) Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning* 97(3), 147-155.
- Bratman, G., Daily, G., Levy, B., Gross, J. (2015) The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning* 138, 41-50.
- Cohen-Cline, H., Turkheimer, E., Duncan, G. (2015) Access to green space, physical activity, and mental health: a twin study. *Journal of Epidemiology and Community Health*, 69 523-529.
- Croucher, K., Myers, L., Bretherton, J. (2007) *The links between greenspace and health: a critical literature review*. Greenspace Scotland, Stirling.
- Depledge, M., Stone, R., Bird, W. (2011) Can natural and virtual environments be used to promote improved human health and wellbeing? *Environmental Science & Technology* 45(11), 4660-4665.
- Duerden, F. (1978) *Rambling Complete*. Kaye and Ward, London.
- Edensor, T. (2000) Walking in the British countryside: reflexivity, embodied practices and ways to escape. *Body and Society* 6(3-4), 81-106.
- Faber-Taylor, A. Kuo, F. (2009) Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders* 12(5), 402-409.
- Foresight Mental Capital and Wellbeing Project (2008) Final Project Report, Executive Summary. The Government Office for Science, London.
- Fuller, R., Irvine, K., Devine-Wright, P., Warren, P., Gaston K. (2007) Psychological benefits of greenspace increase with biodiversity. *Biology Letters* 3, 390.
- Grahn, P., Stigsdotter, U. (2003) Landscape planning and stress. *Urban Forestry and Urban Greening* 2, 1-18.
- Green space Scotland (2008) *Health Impact Assessment of Green space: A guide*. Health Scotland, Green space Scotland, Scottish Natural Heritage and Institute of Occupational Medicine.
- Grinde, B., Patil, G.G. (2009) Biophillicia: does visual contact with nature impact on health and well-being? *International Journal of Environmental Research and Public Health* 6(9), 2332-2343.
- Guite, H., Clark, C., Ackrill, G. (2006) The impact of the physical and urban environment on mental well-being. *Public Health* 120, 1117-1126.
- Hansmann, R., Hug, S., Seeland, K. (2007) Restoration and stress relief through physical activities in forests and parks. *Urban Forestry and Urban Greening* 6, 213-225.
- Hu, Z., Liebens, J., Ranga Rao, K. (2008). Linking stroke mortality with air pollution, income and greenness in the northwest Florida: an ecological geographical study. *International Journal of Health Geographics* 7, 20.
- Kuo, F., Bacaicoa, M., Sullivan, W. (1998) Transforming inner-city landscapes trees, sense of safety, and preference. *Environment and Behavior* 30(1), 28-59.
- Liu, G., Wilson, J., Qi, R., Ying, R. (2007) Green neighbourhoods, food retail and childhood overweight: differences by population density. *American Journal of Health Promotion* 21(4), 317-25.
- Lyytimäki, J., Petersen, L., Normander, B., Bezáák, P. (2008) Nature as nuisance? Ecosystem services and disservices to urban lifestyle. *Environmental Sciences* 5(3), 161-172.

- Maas, J., Verheij, R., Groenewegen, P., de Vries, S., Spreeuwenberg, P. (2006) Green space, urbanity and health: how strong is the relation? *Journal of Epidemiological Community Health* 60, 587-592.
- Maas, J., Verheij, R., Spreeuwenberg, P., Groenewegen, P. (2008) Physical activity as a possible mechanism behind the relationship between green space and health: a multilevel analysis. *BMC Public Health* 8(1), 1.
- Maas, J., Verheij, R., de Vries, S., Spreeuwenberg, P., Schellevis, F., Groenewegen, P. (2009) Morbidity is related to a green living environment. *Journal of Epidemiology and Community Health*, 63(12), 967-973.
- Madge, C. (1997) Public parks and the geography of fear. *Tijdschrift voor economische en sociale geografie* 88, 237-250.
- Maller, C., Townsend, M., Pryor, A., Brown, P., Leger, L. (2005) Healthy nature, healthy people: contact with nature as an upstream health promotion intervention for populations. *Health Promotion International* 21, 1.
- Miles, R., Coutts, C., Mohamadi, A. (2011) Neighbourhood urban form, social environment and depression. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 89 (1).
- Mind (2007) *Ecotherapy: the green agenda for mental health*. Mind week report, Mind, London.
- Nakau, M., Imanishi, J., Imanishi, J., Watanabe, S., Imanishi, A., Baba, T., Hiria, K., Ito, T., Chiba, W., Morimoto, Y. (2013) Spiritual care of cancer patients by integrated medicine in urban green space: a pilot study. *Explore* 9(2), 87-90.
- Ottosson, J., Grahn P. (2005) A comparison of leisure time spent in a garden with leisure time spent indoors: on measures of restoration in residents in geriatric care. *Landscape Research* 30, 23-55.
- Oxford Brookes University (2001) Outdoor Conservation Work Beats Depression. Press release NR/85/01 November 23rd, <http://www.brookes.ac.uk/news/greengym85.ht>.
- Park, B., Tsungetsugu, Y., Kasetani, T., Kagawa, T., Miyazaki, Y. (2010) The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiences 24 forests across Japan. *Environmental Health and Preventative Medicine* 15(1), 18-26.
- Physical Activity Task Force (2002) Let's Make Scotland Active: A Strategy for Physical Activity. A Consultation. PATF. <http://www.scotland.gov/consultations/health/patf2.p>.
- Play England (2008) Design for Play: A guide to creating successful play spaces. Play England, London. Available at: http://www.playengland.org.uk/resources/design-for-play?originx_2757hp_70994779705616h30y_2008630728a.
- Pretty, J., Peacock, J., Hine, R., Sellens, M., South, N., Griffin, M. (2007) Green exercise in the UK countryside: Effects on health and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning and Management* 50(2), 211-231.
- Pretty, J., Peacock, J., Sellens, M., Griffin, M. (2005) The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research* 15(5), 319-337.
- Reklaitiene, R., Grazuleviciene, R., Dedele, A., Virviciute, D., Vensloviene, J., Tamosiunas, A., Baceviciene, M., Luksiene, D., Sapranaviciute-Zabazlajeva, L., Radisauskas, R., Bernotiene, G., Bobak, M., Nieuwenhuijsen, M. (2014) The relationship of green space, depressive symptoms and perceived general health in urban population. *Scandinavian Journal of Public Health* 42, 669-679.
- Skelton, D., Young, A. (1999) Physical Activity in Later Life: Further Analysis of the Allied Dunbar National Fitness Survey and the Health Education Authority Survey of Activity and Health. Health Education Authority.

Spees, C., Joseph, A., Darragh, A., Lyons, F., Wolf, K., (2015) Health behaviours and perceptions of cancer survivors harvesting at an urban garden. *American Journal of Health Behaviour* 39(2), 257-266.

Takano, T., Nakamjura, K., Watanabe., M. (2002) Urban residential environments and senior citizens' longevity in megacity areas: The importance of walkable green spaces. *Journal of Epidemiology and Community Health* 56, 913–918.

Taylor, A., Kuo, F., Sullivan, W. (2001) Coping with ADD: the surprising connection to green play setting. *Environment and Behaviour*, 33(1), 54-77.

Taylor, A., Wiley, A., Kuo, F., Sullivan, W., (1998) Growing up in the inner city – green spaces as places to grow. *Environment and Behaviour* 30(1), 2-27.

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., Depledge, M. (2011) Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology* 45(5), 1761-1772.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczyk, A., Niemela, J., James, P. (2007) Promoting ecosystem health and human health in urban areas using Green Infrastructure: A Literature review. *Landscape and Urban Planning* 81, 167-178.

Van den Berg, A., Hartig, T., Staats, H. (2007) Preference for nature in urbanized societies: stress, restoration, and the pursuit of sustainability. *Journal of Social Issues* 63(1), 79-96.

Van den Berg, A., Maas, J., Verheij, R., Groenewegen, P. (2010) Green space as a buffer between stressful life events and health. *Social Science & Medicine* 70(8), 1203-1210.

Villeneuve, P., Jerrett, M., Su, J., Burnett, R., Chen, H. Wheeler, A., Goldberg, M. (2012) A cohort study relating urban green space with mortality in Ontario, Canada. *Environmental Research* 115, 51-58.

Wallace, A. (1993) *Walking, Literature and English Culture*. Clarendon Press, Oxford.

White, M., Alcock, I., Wheeler, B., Depledge, M. (2013) Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychological Science* 24(6), 920-928.

Zoellner, J., Zanko, A., Price, B., Bonner, J., Hill, J. (2012) Exploring community gardens in a health disparate population: Findings from a mixed methods pilot study. *Progress in Community Health Partnerships: Research, Education and Action* 6(2), 153-165.

Recreation, walking, physical activity: physical health outcomes:

Almanza, E., Jerrett, M., Dunton, G., Seto, E., and Pentz, M. (2012) A study of community design, greenness, and physical activity in children using satellite, GPS, and accelerometer data. *Health and Place* 18, 46-54.

Bell, J. Wilson, J. and Liu, G. (2008). Neighbourhood greenness and 2 year changes in body mass index of children and youth. *American Journal of Preventative Medicine* 35(6), 547-533.

Bird, W. (2004) *Natural Fit: Can Green Space and Biodiversity Increase Levels of Physical Activity?* Royal Society for the Protection of Birds, Sandy.

Bixby, H., Hodgson, S., Fortunato, L., Hansell, A., Fecht, D. (2015) Associations between green space and health in English cities: an ecological, cross-sectional study. *PloS One* 10(3).

Björk, J., Albin, M., Jacobsson, H., Ardó, J., Wadro, J., Östergren, P.O., Skärbäck, E. (2008) Recreational values of the natural environment in relation to neighbourhood satisfaction, physical activity and well-being. *Journal of Epidemiology and Community Health* 62(4), e2.

Boulware, D., Forgey, W., Martin, W. (2003) Medical risks of wilderness hiking, *The American Journal of Medicine* 114, 288-293.

- Cohen, D., McKenzie, T., Sehgal, A., Williamson, S., Golinelli, D., and Lurie, N. (2007) Contribution of public parks to physical activity. *American Journal of Public Health* 97(3), 509-514.
- Coombes, E. Jones, A. and Hillsdon, M. (2010) The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social Science and Medicine* 70, 816-822.
- Cox, D. (2002) *Key Scottish health issues*, paper presented at the Health and Well-Being: Trees, Woods and Natural Spaces in Scotland Expert Consultation, Dumfries, 19/06/2002.
- Croucher K., Myers L., Jones R., Ellaway A., Beck S. (2007) *Health and the Physical Characteristics of Urban Neighbourhoods: A Critical Literature Review, Final Report*. Glasgow, Glasgow Centre for Population Health.
- Dadvand, P., Sunyer, J., Basagaña, X., Ballester, F., Lertxundi, A., Fernandez-Somoano, A., Estarlich, M., García-Esteban, R., Mendez, M., Nieuwenhuijsen, M. (2012) Surrounding greenness and pregnancy outcomes in four Spanish birth cohorts. *Environmental Health Perspectives* 120(10), 1481-1487.
- Foster, C., Hillsdon, M., Jones, A., Grundy, C., Wilkinson, P., White, M., Sheehan, B., Wareham, N., Thorogood, M. (2009) Objective measures of the environment and physical activity – results of the environment and physical activity study in English adults. *Journal of Physical Activity and Health* 6, Suppl 1.
- Grazuleviciene, R., Danileviciute, A., Dedele, A., Vencloviene, J., Andrusaityte, S., Uzdanaviciute, I., Nieuwenhuijsen, M. (2015) Surrounding greenness, proximity to city parks, and pregnancy outcomes in Kaunas cohort study. *International Journal of Hygiene and Environmental Health* 218, 358-365.
- Greenspace Scotland (2008) *Health Impact Assessment of Green space: A guide*. Health Scotland, Green space Scotland, Scottish Natural Heritage and Institute of Occupational Medicine.
- Grisso, J., Kelsey, J., Strom, B. (1991) Risk factors for falls as a cause of hip fracture in women. *New England Journal of Medicine* 324, 1326-1331.
- Hakim, A., Curb, J., Petrovitch, H., Rodriguez, B., Yano, K., Ross, G., White, L., Abbott, R., (1999) Effects of walking on coronary heart disease in elderly men The Honolulu Heart Program. *Circulation* 100 (1), 9-13.
- HCN (2004) *Nature and Health: The influence of nature on social, psychological and physical well-being*. Publication No. 2004/09E; RMNO publication nr A02ae. Health Council of the Netherlands, The Hague.
- Hillsdon, M., Panter, J., Foster, C., Jones, A. (2006) The relationship between access and quality of urban green space with population physical activity. *Public Health* 120, 1127-1132.
- Hystad, P., Davies, H., Frank, L., Van Loon, J., Gehring, U., Tamburic, L., Brauer, M. (2014) Residential greenness and birth outcomes: evaluating the influence of spatially correlated built-environment factors. *Environmental Health Perspectives* 122, 1095-1102.
- Janssen, I., Rosu, A. (2015) Undeveloped green space and free-time physical activity in 11 to 13 year old children. *International Journal of Behavioural Nutrition* 12 (26).
- Jones, A., Hillsdon, M., Coombes, E. (2009) Greenspace access, use, and physical activity: Understanding the effects of area deprivation *Preventive Medicine*, 49(6), 500-505.
- Kaczynski, A., Henderson, K. (2007) Environmental correlates of physical activity: a review of evidence about parks and recreation. *Leisure Sciences* 29(4), 315-354.
- Laurent, O., Wu, J., Li, L., Milesi, C. (2013) Green spaces and pregnancy outcomes in Southern California. *Health and Place* 24, 190-195.
- Liu, G., Wilson, J., Qi, R., Ying, R. (2007) Green neighbourhoods, food retail and childhood overweight: differences by population density. *American Journal of Health Promotion* 21(4), 317-325.

- Lundberg, A. (ed.) (1998) 'Introduction' and 'Environmental change and human health', Environment and Mental Health. Lawrence Erlbaum, London, 1-4 and 5-25.
- Maas, J., Verheij, R., Groenewegen, P., de Vries, S., Spreeuwenberg, P. (2006), Green space, urbanity and health: how strong is the relation? *Journal of Epidemiological Community Health* 60, 587-592.
- Maas, J., Verheij, R., Spreeuwenberg, P., Groenewegen, P. (2008) Physical activity as a possible mechanism behind the relationship between green space and health: A multilevel analysis. *BMC Public Health* 8, 206.
- Maas, J., Verheij, R., de Vries, S., Spreeuwenberg, P., Schellevis, F., Groenewegen, P. (2009) Morbidity is related to a green living environment. *Journal of Epidemiology and Community Health* 63, 967-973.
- Markevych, I., Fuertes, E., Tiesler, C., Birk, M., Bauer, C., Koletzko, S., von Berg, A., Berdel, D., Heinrich, J. (2014) Surrounding greenness and birth weight: results from the GINIplus and LISAplus birth cohorts in Munich. *Health and Place* 26, 39-46.
- McMorris, O., Villeneuve, P., Su, J., Jerrett, M. (2015) Urban greenness and physical activity in a national survey of Canadians. *Environmental Research* 137, 94-100.
- Mitchell, R., Popham, F. (2008) Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet* 372(9650), 1655-1660.
- Mourato, S., Atkinson, G., Collins, M., Gibbons, S., Mackerron, G., Resende, G. (2010) *Economic assessment of ecosystem related UK cultural services*. Economic assessment of ecosystem related UK cultural services. The Economics team of the UK national ecosystem assessment, London School of Economics, London.
- Natural England (2011) Green space access, green space use, physical activity and overweight. Commissioned report NECR067.
- Nielsen, T., Hansen, K. (2007) Do green areas affect health? Results from a Danish Survey on the use of green areas and health indicators. *Health and Place* 13, 839-850.
- Ottosson, J., Grahn P. (2005) A comparison of leisure time spent in a garden with leisure time spent indoors: on measures of restoration in residents in geriatric care. *Landscape Research* 30, 23-55.
- Oxford Brookes University (2001) Outdoor Conservation Work Beats Depression. Press release NR/85/01 November 23rd, <http://www.brookes.ac.uk/news/greengym85.ht>.
- Pearce, J., Maddison, R. (2011) Do enhancements to the urban built environment improve physical activity levels among socially disadvantaged populations? *International Journal for Equity in Health* 10, 28-37.
- Physical Activity Task Force (2002) Let's Make Scotland Active: A Strategy for Physical Activity. A Consultation. PATF. <http://www.scotland.gov/consultations/health/patf2.p>.
- Potestio, M., Patel, A., Powell, C., McNeil, A., Jacobson, R., McLaren, L. (2009) Is there an association between spatial access to parks/green space and childhood overweight/obesity in Calgary, Canada? *International Journal of Behavioural Nutrition and Physical Activity* 6(77).
- Potwarka, L., Kaczynski, A. and Flack, A. (2008). Places to Play: Association of park space and facilities with healthy weight status among children. *Journal of Community Health* 33, 344-350.
- Rodgers, S., Lyons, R. (2008) Does the built environment's walkability help determine health? Poster submission In: *HEPA Europe, European network for the promotion of health-enhancing physical activity*, Glasgow, 8-9th September 2008.
- Slattery, M., Potter, J., Caan, B., Edwards, S., Coates, A., Ma, K., Berry, T. (1997) Energy balance and colon cancer-beyond physical activity. *Cancer Research* 57(1), 75-80.

Skelton, D., Young, A. (1999) Physical Activity in Later Life: Further Analysis of the Allied Dunbar National Fitness Survey and the Health Education Authority Survey of Activity and Health. Health Education Authority.

Spees, C., Joseph, A., Darragh, A., Lyons, F., Wolf, K. (2015) Health behaviours and perceptions of cancer survivors harvesting at an urban garden. *American Journal of Health Behaviour* 39(2), 257-266.

Takano, T., Nakamura, K., Watanabe, M. (2002) Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of Epidemiology and Community Health*, 12.

Tamosiunas, A., Grazuleviciene, R., Luksiene, D., Dedele, A., Reklaitiene, R., Baceviciene, M., Vencloviene, J., Bernotiene, G., Radisauskas, R., Malinauskiene, V., Milinaviciene, E. (2014) Accessibility and use of urban green spaces, and cardiovascular health: findings from a Kaunas cohort study. *Environmental Health* 13(1), 20.

The Diabetes Prevention Research Group (2002) Reduction in the incidence of Type 2 diabetes with lifestyle intervention or Metformin. *New England Journal of Medicine*, 346, 393-403.

Watt, J., Ball, J. (2009) *Trees and the risk of harm. Report for the national tree safety group*. Hendon: Middlesex. Available at: [http://www.forestry.gov.uk/pdf/NTSG-Report-1_Trees-and-the-Risk-of-Harm.pdf/\\$FILE/NTSG-Report-1_Trees-and-the-Risk-of-Harm.pdf](http://www.forestry.gov.uk/pdf/NTSG-Report-1_Trees-and-the-Risk-of-Harm.pdf/$FILE/NTSG-Report-1_Trees-and-the-Risk-of-Harm.pdf).

Witten, K., Hiscock, R., Pearce, J., Blakely, T. (2008) Neighbourhood access to open spaces and the physical activity of residents: A national study. *Preventative Medicine* 47, 299-303.

Zlot, A., Schmid, T. (2005) Relationships among community characteristics and walking and bicycling for transportation or recreation. *American Journal of Health Promotion* 19(4), 314-317.

Tourism

Deloitte, Oxford Economics (2010) *The Economic Contribution of the Visitor Economy: UK and the Nations*. Visit Britain. Available at: www.visitbritain.org/Images/Economic%20case%20for%20the%20Visitor%20Economy%20-%20Phase%202%20-%2026%20July%202010%20-%20FINAL_tcm139-192073.pdf.

Ecotec (2008) *The economic benefits of green infrastructure: the public and business case for investing in green infrastructure and a review of the underpinning evidence*. Report for Natural Economy Northwest (NENW). Available at: <http://www.naturaleconomynorthwest.co.uk/resources+reports.php>.

Hill, G., Courtney, P., Burton, R., Potts, J. (2003) *Forests' role in Tourism: Phase 2*. Summary report - Final for the Forestry Group (Economics & Statistics) of the Forestry Commission. Forestry Commission, Edinburgh.

National Trust (1999) *Valuing our Environment: a study of the economic impact of conserved landscapes and of the National Trust in the South-West 1998*. The National Trust.

Naumann, S., McKenna D., Kaphengst, T., Pieterse, M., Rayment, M. (2011) *Design, implementation and cost elements of Green Infrastructure projects*. Final report. European Commission, Brussels.

Rayment, M., Lewis, P., Henderson, R., Broom, G. (2000) *Valuing Norfolk's Coast: The economic benefits of environmental and wildlife tourism*. RSPB, Sandy.

The Countryside Agency (1998) *The economic impact of recreation and tourism in the English Countryside 1998*. The Countryside Agency, Wetherby.

Wolf, K.L. (2014) City trees and consumer response in retail business districts. In: Musso, F., Druica, E. (eds.) *Handbook of Research on Retailer-Consumer Relationship Development*. IGI Global, Hershey, PA, pp. 152-172.

Crime and perception of crime

- Branas, C., Cheney, R., Macdonald, J., Tam, V., Jackson, T., Ten Have, T. (2011) A difference-in-differences analysis of health, safety, and greening vacant urban space. *American Journal of Epidemiology* 174(11) 1296-1306.
- Croucher, K., Myers, L., Bretherton, J. (2007) The links between greenspace and health: a critical literature review. Greenspace Scotland, Stirling.
- Donovan, G., Prestemon, J. (2012) The effect of trees on crime in Portland, Oregon. *Environment and Behaviour* 44(1), 13-30.
- Dunse, N., White, M., Dehring, C. (2007) *Urban Parks, Open Space and Residential Property Values*. Research Paper Series 7(8). Royal Institute for Chartered Surveyors, London.
- Faber Taylor, A., Kuo, F.E., Sullivan, W. (2002) Views of nature and self discipline: evidence from inner-city children. *Journal of Environmental Psychology* 22, 49-63.
- Garvin, E., Cannuscio, C., Branas, C. (2012) Greening vacant lots to reduce violent crime: A randomised control trial. *Injury Prevention* injuryprev-2012-040439.
- Kuo, F., Sullivan, W. (2001) Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behaviour* 33(3), 343-367.
- Kuo, F.E (2001) Coping with poverty: impacts of environment and attention in the inner-city. *Environment and Behaviour* 33(1), 5-34.
- Kuo, F.E., Sullivan, W.C. (2001) Aggression and violence in the inner-city: effects of environment on mental fatigue. *Environment and Behaviour* 33(4), 543-571.
- Kuo, F.E., Sullivan, W.C. (2001) Environment and crime in the inner-city: effects of environment via mental fatigue. *Environment and Behaviour* 33(3), 343-367.
- Sullivan, W. (2005) Forest, Savanna, city: Evolutionary landscapes and human functioning. In: Barlett, P. (ed.) *Urban place: Reconnecting with the natural world*. MIT Press, Cambridge, MA, pp. 173-188.
- Wolfe, M., Mennis, J. (2012) Does vegetation encourage or suppress urban crime? Evidence from Philadelphia, PA. *Landscape and Urban Planning* 108(2-4), 112-122.

Economic benefits

- Bennett, R., Tranter, R., Beard, N., Jones, P. (1995) The value of footpath provision in the countryside: a case study of public access to urban-fringe woodland. *Journal of Environmental Planning and Management* 38(3), 409-417.
- Bennett, R.M., Tranter, R.B., Blaney, R.J.P. (2003) The value of countryside access: a contingent valuation survey of visitors to the Ridgeway National Trail in the United Kingdom. *Journal of Environmental Planning and Management* 46(5), 659-671.
- Bird, W. (2004) *Can green space and biodiversity increase levels of physical activity?* Royal Society for the Protection of Birds, United Kingdom.
- Christie, M., Hanley, N., Garrod, B., Hyde, T., Lyons, N., Bergmann, A., Hynes, S. (2006) *Valuing forest recreation activities*. Final Phase 2 Report to the Forestry Commission. Aberystwyth University, University of Stirling and Socio-Economic Research Services Ltd., Aberystwyth.
- Costanza, R., Perez-Maqueo, O., Martinez, M.L., Sutton, P., Anderson, S.J., Mulder, K. (2008) The value of coastal wetlands for hurricane protection. *Ambio* 37(4), 241-248.
- Dehring, C., Dunse, N. (2006) Housing density and the effect of proximity to public open space in Aberdeen, Scotland. *Real Estate Economics* 34, 553-566.

- Deloitte, Oxford Economics (2010) *The Economic Contribution of the Visitor Economy: UK and the Nations*. Visit Britain. Available at: www.visitbritain.org/Images/Economic%20case%20for%20the%20Visitor%20Economy%20-%20Phase%202%20-%202026%20July%202010%20-%20FINAL_tcm139-192073.pdf.
- Dunse, N., White, M., Dehring, C. (2007) *Urban Parks, Open Space and Residential Property Values*. Research Paper Series 7(8). Royal Institute for Chartered Surveyors, London.
- Ernst and Young (2003) *How Smart Parks Investment Pays Its Way*. New Yorkers for Parks, New York.
- Garrod, G. (2002) *Social & Environmental Benefits of Forestry Phase 2: Landscape Benefits*. Centre for Research in Environmental Appraisal and Management, University of Newcastle upon Tyne.
- Garrod, G., Willis, K. (1992) Valuing goods' characteristics: an application of the hedonic price method to environmental attributes. *Journal of Environmental Management* 34(1), 59-76.
- Gensler and the Urban Land Institute (2011) *Open Space: An asset without a champion?* Report for the Urban Investment Network.
- GLA Economics (2003) *Valuing Greenness: Green spaces, house prices, and Londoners' priorities*. Greater London Authority, London.
- Henneberry, J., Rowley, S., Swanwick, C., Wells, F., Burton, M. (2004) *Report of a Scoping Study for South Yorkshire Forest Partnership and White Rose Forest*. Final Report: Creating a Setting for Investment. Sheffield, University of Sheffield.
- Hill, G., Courtney, P., Burton, R., Potts, J. (2003) *Forests' role in Tourism: Phase 2*. Summary report - Final for the Forestry Group (Economics & Statistics) of the Forestry Commission. Forestry Commission, Edinburgh.
- Kaplan, R. (1992) The psychological benefits of nearby nature. In: Relf, D. (ed.) *The Role of Horticulture in Human Well-Being and Social Development: A National Symposium*. Timber Press, Portland, Oregon, pp. 125-133.
- Luther, M., Gruehn, D. (2001) Putting a price on urban green spaces. *Landscape Design* 303, 23-25.
- Luttik, J. (2000) The value of trees, water and open spaces as reflected by house prices in the Netherlands. *Landscape and Urban Planning* 48(3-4), 161-167.
- McPherson, E. (1993) Evaluating the cost effectiveness of shade trees for demand-side management, *The Electricity Journal* 6(9), 57-65.
- Meyerhoff, J., Dehnhardt, A. (2007) The European Water Framework Directive and economic valuation of wetlands: the restoration of floodplains along the River Elbe. *European Environment* 17, 18-36.
- Morris, J., Camino, M. (2010) *Economic Assessment of Freshwater, Wetland and Floodplain Ecosystem Services*, Report to the Economics Team of the UK National Ecosystem Assessment, Cranfield University. UK National Ecosystem Assessment, Cambridge.
- Mourato, S., Atkinson, G., Collins, M., Gibbons, S., Mackerron, G., Resende, G. (2010) *Economic assessment of ecosystem related UK cultural services*. Economic assessment of ecosystem related UK cultural services. The Economics team of the UK national ecosystem assessment, London School of Economics, London.
- National Trust (1999) *Valuing our Environment: a study of the economic impact of conserved landscapes and of the National Trust in the South-West 1998*. The National Trust.
- Naumann, S., McKenna D., Kaphengst, T., Pieterse, M., Rayment, M. (2011) *Design, implementation and cost elements of Green Infrastructure projects*. Final report. European Commission, Brussels.
- New York City Economic Development Corporation (NYCEDC) (2011) *August 2011 Economic Snapshot*. Available at: <http://www.nycedc.com/podcast/19-economic-impact-parks>.

Patel, I.C. (1992) Socio-economic impact of community gardening in an urban setting. In: Relf, D. (ed.) *The Role of Horticulture in Human Well-Being and Social Development: A National Symposium*. Timber Press, Portland, Oregon, pp. 84-87.

Prastholm, S., Jensen, F., Hasler, B., Damgaard, C., Erichsen, E. (2002) Forests improve qualities and values of local areas in Denmark. *Urban Forestry & Urban Greening* 1(2), 97-106.

Rawlings, R., Mustow, S., Pinney, C., Sterne, S. (1999) *Environmental rules of thumb*, Technical Note for the Department of the Environment, Transport and the Regions. The Building Services Research and Information Association, Bracknell.

Rayment, M., Lewis, P., Henderson, R., Broom, G. (2000) *Valuing Norfolk's Coast: The economic benefits of environmental and wildlife tourism*. RSPB, Sandy.

Read, D.J., Freer-Smith, P.H., Morison, J.I.L., Hanley, N., West, C.C., Snowdon, P. (eds.) (2009) *Combating climate change: a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change*. Forestry Commission, Edinburgh.

Regeneris Consulting (2009) *The Economic Contribution of The Mersey Forest's Objective One-Funded Investments*, Final Report to the Mersey Forest. Regeneris Consulting, Altrincham.

Ruijgrok, E.C.M. (2006) *Kentallen Waadering Natuur, Water, Bodem En Lanschap. Hulpmiddel Bij Mkba's*. Witteveen en Bos, Rotterdam.

Scottish Natural Heritage (2002) The health, social, economic and environmental benefits of open-air recreation. Scottish National Heritage. Available at: <http://www.snh.org.uk/pdfs/access/rs-spbm.pdf>.

Tyrväinen, L. (1999) Monetary valuation of urban forest amenities in Finland. Academic dissertation, Research Papers 739. Finnish Forest Research Institute, Vantaa.

Tyrväinen, L. (2001) Economic valuation of urban forest benefits in Finland. *Journal of Environmental Management* 62(1), 75-92.

Valatin, G., Starling, J. (2010) *Valuation of ecosystem services provided by UK woodlands*. The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge.

Weber, T. (2007) *Ecosystem services in Cecil County's Green Infrastructure: Technical Report for the Cecil County Green Infrastructure Plan*. The Conservation Fund, Maryland.

REFERENCES

ARUP (2014) *Cities alive. Rethinking green infrastructure*. Arup, London.

Bowen Parry (2015) *The evidence base for linkages between GI, public health and economic benefit*. Government of Victoria.

CABE Space (2004) *The Value of Public Space: How high quality parks and public spaces create economic, social and environmental value*. CABE Space, London.

CABE Space (2010) *Community Green: Using local spaces to tackle inequality and improve health*.

Chartered Institution of Water and Environmental Management [CIWEM] (2010) *Multifunctional Urban Green Infrastructure*. Chartered Institution of Water and Environmental Management, London

Department for Communities and Local Government [DCLG] (2012) National Planning Policy Framework. Available at: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>.

Department for Communities and Local Government [DCLG] (2016) Planning Practice Guidance. Green infrastructure. Available at: <http://planningguidance.communities.gov.uk/blog/guidance/natural-environment/green-infrastructure/>.

Department of the Environment [DoE] (2012) *Regional Development Strategy 2035*. Available from: http://www.planningni.gov.uk/index/policy/regional_dev_2035.htm.

Department of the Environment [DoE] (2015) *Strategic Planning Policy Statement for Northern Ireland*. Available from: <http://www.planningni.gov.uk/index/policy/spps.htm>.

Doick, K., Hutchings, T. (2013) Air temperature regulation by urban trees and green infrastructure. Forest Research, Farnham.

Eftec, Sheffield Hallam (2013) Green Infrastructure's contribution to economic growth: a review. A Final Report for Defra and Natural England. Eftec, London.

European Commission (2013) Green Infrastructure (GI) - Enhancing Europe's Natural Capital. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0249>.

Forest Research (2010) Benefits of green infrastructure. Forest Research, Farnham.

GI Task Force (2015) Natural Capital: Investing in a green infrastructure for a future London.

Houses of Parliament (2013) Urban green infrastructure. POSTNOTE Number 448. The Parliamentary Office of Science and Technology, London.

Kirby, V., Russell, S. (2015) Cities, Green Infrastructure and Health. Landscape Institute, London.

Landscape Institute (2009) Green Infrastructure: Connected and multifunctional landscapes. Landscape Institute, London.

Landscape Institute (2015) Green Bridges Guide. Landscape Institute, London.

Morris (2003) Health, Wellbeing and Open Space. OPEN Space.

Natural England (2009) Green infrastructure guidance. Natural England.

Natural Resources Wales (2015) Wales Green infrastructure forum. Available at: <https://naturalresources.wales/people-and-communities/green-spaces/wales-green-infrastructure-forum/?lang=en>.

NW Think Tank (2008) Green Infrastructure Guide.

Royal Institution of Chartered Surveyors [RICS] (2011) Green infrastructure in urban areas. RICS Practice Standards, UK. RICS, London.

Rolls, S., Sunderland, T. (2014) Microeconomic Evidence for the Benefits of Investment in the Environment 2. Natural England.

Saraev, V. (2012) Economic Benefits of Greenspace. Forestry Commission, Edinburgh.

Science for Environment Policy (2013) The multi-functionality of green infrastructure. In-depth report. European Commission, DG Environment News Alert Service.

Scottish Government (2011) Green infrastructure: Design and Placemaking. Available at: <http://www.gov.scot/resource/doc/362219/0122541.pdf>.

Scottish Government (2014a) Scottish Planning Policy. Available at: <http://www.gov.scot/Publications/2014/06/5823>.

Scottish Government (2014b) Scottish National Planning Framework 3. Available at: <http://www.gov.scot/Publications/2014/06/3539> [last accessed 10 August 2016].

Sunderland, T. (2012) Microeconomic Evidence for the Benefits of Investment in the Environment. Natural England.

TCPA, Royal Society of Wildlife Trusts (2012) Planning for a Healthy Environment: Green Infrastructure Guide.

Trees and Design Action Group (2012) Trees in the Townscape.

Trees and Design Action Group (2014) Trees in Hard Landscapes.

UK Green Building Council (2015) Demystifying Green Infrastructure.

Welsh Government (2008) People, Places, Futures: The Wales Spatial Plan. Available at: <http://gov.wales/topics/planning/development-plans/wales-spatial-plan/?lang=en>.

Welsh Government (2009) Technical Advice Note 5: Nature Conservation and Planning. Available at: <http://gov.wales/topics/planning/policy/tans/tan5/?lang=en>.

Welsh Government (2016) Planning Policy Wales. 8th edition. Available at: <http://gov.wales/topics/planning/policy/ppw/?lang=en>.

APPENDIX A: ADDITIONAL GREY LITERATURE

Armour, T., Job, M., Canavan, R. (2012) The benefits of large species trees in urban landscapes: a costing, design and management guide. CIRIA. Available at: <http://www.brebookshop.com/samples/326911.pdf>.

Brookings Institute (2014) Rise of innovation districts: A new geography of innovation in America. Available at: <http://www.brookings.edu/about/programs/metro/innovation-districts>.

Butlin, T., Chambers, C., Ellis, F. (2011) The value of mapping green infrastructure. Mersey Forest. Available at: http://www.merseyforest.org.uk/files/The_Value_of_Mapping_Green_Infrastructure_pdf.pdf.

CABE Space (2004) Green space strategies: A good practice guide. CABE, London. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/files/green-space-strategies.pdf>.

CABE Space (2005) Does money grow on trees? CABE, London. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/files/does-money-grow-on-trees.pdf>.

CABE Space (2009) Making the invisible visible: The real value of park assets. CABE, London. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/publications/making-the-invisible-visible>.

CABE Space (2010) Community green: Using local spaces to tackle inequality and improve health. CABE, London. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/publications/community-green>.

CABE Space (2010) Urban green nation: Building the evidence base. CABE, London. Available at: <http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/publications/urban-green-nation>.

Campaign to Protect Rural England, Natural England (2010) Green Belts: a greener future. Available at: <http://publications.naturalengland.org.uk/publication/38005?category=9002>.

CIRIA (2014) Enhancing hard infrastructure for improved multifunctionality. Available at: <http://www.ciria.org/CMDownload.aspx?ContentKey=2b05dd2a-0d2a-4f3c-9783-6bb274e613d8&ContentItemKey=55f0f858-fcd5-4e19-ab2b-fce7d66fa0d5>.

CIRIA (2015) The SuDS Manual. Available at: http://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx.

Cousins, P. Land Use Consultants (2009) Economic contribution of green networks: Current evidence and action. Commissioned by Scottish Natural Heritage. Available at:
<http://gtgkm.org.uk/documents/economic-contribution-of-green-networks-1285344532.pdf>.

Cranfield University (2014) Horizon Scanning: The greening of urban areas to 2060. A report for Natural England. Natural England. Available at: http://www.cranfieldfutures.com/wp-content/uploads/2014/06/Future_of_Urban_Settlements-FinalReport.pdf.

Cross River Partnership (2016) Green Capital: Investing in a green infrastructure for a future city. Available at: https://www.london.gov.uk/sites/default/files/green_capital.pdf.

Dales, N.P., Brown, N. Lusardi, J. (2014) Assessing the potential for mapping ecosystem services in England based on existing habitats. Natural England research report NERR056. Available at: <http://publications.naturalengland.org.uk/publication/5280919459987456>.

Department for Environment, Food and Rural Affairs (2015) What nature can do for you: A practical introduction to making the most of natural services, assets and resources in policy and decision making. Defra, London. Available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396840/pb13897-nature-do-for-you.pdf.

Department for Transport, Local Government and the Regions (2002) *Green spaces, better places*. Final report of the urban green spaces taskforce. DTLR, London. Available at:
http://www.ocs.polito.it/biblioteca/verde/taskforce/gspaces_.pdf.

Environment Agency (2011) Estuary Edges: Ecological design guidance. Available at:
<http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/sectors/100745.aspx>.

European Environment Agency (2010) 10 messages for 2010 - Urban ecosystems. EEA, Copenhagen. Available at: <http://www.eea.europa.eu/publications/10-messages-for-2010-urban-ecosystems>.

Forestry Commission (undated) Trees and climate change. Available at:
[http://www.forestry.gov.uk/pdf/eng-trees-and-climate-change.pdf/\\$FILE/eng-trees-and-climate-change.pdf](http://www.forestry.gov.uk/pdf/eng-trees-and-climate-change.pdf/$FILE/eng-trees-and-climate-change.pdf).

Gensler, Urban Land institute (2011) Open Space: An asset without a champion? Available at:
http://www.gensler.com/uploads/documents/Open_Space_03_08_2011.pdf.

Gillespies (2014) Bradford City Centre Green Infrastructure Study. Available at:
<https://www.bradford.gov.uk/NR/rdonlyres/B1E2649F-C9ED-4CD0-88B2-EE4E0A0A059A/0/BCCAAPGreenInfrastructureStudy.pdf>.

Green Infrastructure Task Force (2015) Natural Capital: Investing in a green infrastructure for a future London. Available at: <https://www.london.gov.uk/WHAT-WE-DO/environment/environment-publications/green-infrastructure-task-force-report>.

Historic England (2009) Soft wall capping. A better way of conserving ruins? Available at: <https://historicengland.org.uk/images-books/publications/soft-capping-historic-walls/>.

Horticulture Innovation Partnership (2015) Ornamental and Landscape Horticulture Research and Development Strategy. Available at: http://www.hip.org.uk/assets/uploads/publication/HIP_RD_Full_Strategy_2015.pdf.

Konijnendijk, C., Annerstedt, M., Busse Nielsen, A., Maruthaveeran, S. (2013) Benefits of Urban Parks: A systematic review. A report for IFPRA. Copenhagen and Alnarp. Available at: <http://www.worldurbanparks.org/images/Newsletters/IfpraBenefitsOfUrbanParks.pdf>.

Leeds City Council (2013) Core Strategy. Leeds Local Development Framework. Development Plan Document. Green infrastructure Background Paper CD27. Available at: <http://www.leeds.gov.uk/docs/CD27%20Green%20Infrastructure%20Background%20Paper.pdf>.

MacKenzie, R. (undated) Cities are for life - not just for people. Available at: <http://www.birmingham.ac.uk/research/impact/original/cities.aspx>.

Natural Capital Committee (2014) The State of Natural Capital: Restoring our natural assets. Available at: <http://www.naturalcapitalinitiative.org.uk/wp-content/uploads/2014/06/1f06ffa9eaf0af134d7022af36fe17cf.pdf>.

Natural Economy North West (2010) Green Infrastructure prospectus. Available at: http://www.greeninfrastructurenw.co.uk/resources/Prospectus_V6.pdf.

Natural England (2008) Green Infrastructure Strategies: an introduction for local authorities and their partners. Natural England report NE139. Available at: <http://publications.naturalengland.org.uk/publication/36010?category=9002>.

Natural England (2012) Valuing ecosystem services: Case studies from lowland England. Annex 5 - Dearne Valley Green Heart: Yorkshire. Natural England commissioned report NECR101. Available at: <http://publications.naturalengland.org.uk/file/2329094>.

Natural England (2013) Green infrastructure case studies. Available at: <http://publications.naturalengland.org.uk/category/47004>.

Natural England (2013) Green Infrastructure - Valuation tools assessment. Natural England commissioned report NECR126. Available at: <http://publications.naturalengland.org.uk/publication/6264318517575680>.

Natural England (2014) Ecosystem Services Transfer Toolkit. Natural England commissioned report NECR159. Available at: <http://publications.naturalengland.org.uk/publication/5890643062685696?category=38019>.

Natural England (2014) NEWP32 Transport green corridors: options appraisal and opportunity mapping. Natural England commissioned report NECR168. Available at: <http://publications.naturalengland.org.uk/publication/5485064148221952?category=38019>.

Natural England (2015) Green Bridges: A literature review. Natural England commissioned report NECR181. Available at:

<http://publications.naturalengland.org.uk/publication/6312886965108736?category=38019>.

Natural England (2015) Summary of evidence: Land use. Natural England information note EIN009. Available at:

<http://publications.naturalengland.org.uk/publication/6684569048711168?category=9002>.

Naumann, S., Davis, M., Kaphengst, T., Pieterse, M. Rayment., M (2011) Design, implementation and cost elements of green infrastructure projects. Final report to the European Commission, DG Environment, Contract no. 070307/2010/577182/ETU/F.1, Ecologic institute and GHK Consulting. Available at: http://ec.europa.eu/environment/enveco/biodiversity/pdf/GI_DICE_FinalReport.pdf.

North West Development Agency, Natural England (2008) Green infrastructure solutions to pinch point issues in North West England. Available at:

http://www.greeninfrastructurenw.co.uk/resources/Critical_GI_23rd_March_lores.pdf.

Policy Exchange (2013) Park Land: How open data can improve our urban green spaces. London. Available at: <http://www.policyexchange.org.uk/publications/category/item/park-land>.

Policy Exchange (2014) Green Society: Policies to improve the UK's urban green spaces. London. Available at: <http://www.policyexchange.org.uk/publications/category/item/green-society-policies-to-improve-the-uk-s-green-spaces>.

Royal Horticultural Society (2015) Why we all need greening grey Britain. Available at: <https://www.rhs.org.uk/communities/pdf/Greener-Streets/greening-grey-britain-report>.

Scottish Natural Heritage (2015) Natural benefits: The contribution of the natural environment to Community Planning Partnership priorities. Available at:

<http://www.snh.org.uk/pdfs/publications/heritagemanagement/natural%20benefits.pdf>.

Scottish Natural Heritage (2016) Green infrastructure. Policy Background. Guidance for applicants. Available at:

https://www.greeninfrastructurescotland.org.uk/sites/default/files/Green%20Infrastructure%20-%20guidance%20for%20applicants%20-%203%20Policy%20Background%20-%2004%20July%202015_0.pdf.

South Yorkshire Forest Partnership, Sheffield City Council (2012) The Value Project: Final report. Demonstrating the value of prioritising investments in green infrastructure. Available at:

<http://www.value-landscapes.eu/cmsFiles/VALUE-Project-Final-Report.pdf>.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB. Available at:

<http://www.teebweb.org/mainstreaming-the-economics-of-nature-a-synthesis-of-the-approach-conclusions-and-recommendations-of-teeb-launch-of-final-teeb-report/>.

The Trust for Public Land's Centre for City Park Excellence (2008) How much value does the city of Philadelphia receive from its Park and Recreation system? A report for the Philadelphia Parks Alliance. Available at: http://cloud.tpl.org/pubs/ccpe_PhilParkValueReport.pdf.

United Nations Environment Programme. (2014) Green Infrastructure Guide for Water Management: Ecosystem-based management approaches for water-related infrastructure projects. Available at: <http://www.medspring.eu/article/green-infrastructure-guide-water-management-ecosystem-based-management-approaches-water>.

University of Exeter (2016) Natural England Evidence Summaries on green space and health. Available at: <https://beyondgreenspace.wordpress.com/2016/07/15/natural-england-evidence-summaries/>.

Victoria Business Improvement District (2010) Green Infrastructure Audit: Best Practice Guide. Available at: https://www.london.gov.uk/sites/default/files/bestpracticeguide_a4-10.pdf.

West of England Green Infrastructure Group (2011) West of England: Strategic green infrastructure network. Available at: http://www.bathnes.gov.uk/sites/default/files/westofengland_gi_framework.pdf.

Other useful resources

BeST (Benefits of SuDS Tool) Available at: http://www.ciria.org/News/CIRIA_news2/New-tool-assesses-the-benefits-of-SuDS.aspx.

National Ecosystem Approach Toolkit (NEAT Tree). Available at: <http://neat.ecosystemsknowledge.net/>.

E2STORMED. Available at: <http://www.e2stormed.eu/>.

Green Bronx Machine. Available at: <http://greenbronxmachine.org/>.

Conservation Evidence. Available at: www.conservationevidence.com.

Greenspace Scotland. Available at: <http://greenspacescotland.org.uk/>.

UK National Ecosystem Assessment. Available at: <http://uknea.unep-wcmc.org/>.

Scottish Green Infrastructure Forum: Available at: <http://www.sgrf.org/>.

Scottish Universities GI Research Group (SUGIR). Available at: <http://www.sgrf.org/index.php/sugir>.