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Setting the Standard for Green Infrastructure: The Need for, and Features of, a Benchmark in England

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ABSTRACT

Green infrastructure is an essential component of health and sustainable places. The quality of green infrastructure often represents a missed opportunity to achieve this. This paper presents a review examining how built environment assessment systems evaluate the quality of green infrastructure. This was used to develop proposals for a new benchmark, which were examined by experts in terms of the demand, scope and operation. The findings suggest that current systems are not providing a robust assessment of green infrastructure and that a benchmark for green infrastructure would overcome some of the challenges associated with its planning, design and delivery.

KEYWORDS

Nature-based solutions; ecosystem services; strategic planning; urban ecology

Introduction

Green infrastructure is recognised as a vital component of sustainable, liveable, healthy places. There is a wealth of evidence that green infrastructure provides numerous benefits, or ecosystem services, to urban populations. These include: protecting and enhancing urban biodiversity (e.g. Sinnett, 2015), providing spaces for rest, relaxation, physical activity and play (e.g. Hunter *et al.*, 2015), and improving the aesthetic quality of the built environment (e.g. Swanwick, 2009), air and water quality (e.g. Ellis, 2013; Salmond *et al.*, 2016) and the ability of cities to adapt to the changing climate (e.g. Demuzere *et al.*, 2014). There are many definitions of green infrastructure (e.g. Benedict & McMahon, 2006; European Commission, 2013; MHCLG [Ministry of Housing and Local Government], 2018), but they share a number of characteristics, namely that it should provide a multifunctional network that is planned and delivered strategically. This means that across an area, be that neighbourhood, city or city-region, a network of different features should work in harmony to deliver a range of intended functions and, therefore, benefits to communities both now and in the future (Kambites & Owen, 2006; Laforteza *et al.*, 2013). The features that make up this network include many green and blue elements operating at different spatial scales: green roofs and walls, street trees, private gardens, parks, open spaces, playing fields, woodlands, allotments, wetlands, road verges, green corridors, and streams, canals and other water bodies

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(Burgess, 2015). Green infrastructure is primarily located in urban or peri-urban areas, although it should provide connectivity between the built environment and the countryside (European Commission, 2013).

Globally, many countries, regions and cities have developed policies and plans that set out their objectives for green infrastructure and how these will be delivered. In England, the National Planning Policy Framework requires local planning authorities to include provision for green infrastructure in local plans (MHCLG, 2018). Despite these positive steps in policy internationally, there are often significant problems with the planning, design, delivery and long-term management of green infrastructure. For example, although green infrastructure has been enthusiastically embraced in policy and guidance, translating these ideas into practice has proven difficult in many countries (Roe & Mell, 2013; Wilker *et al.*, 2016; Mell *et al.*, 2017). The reasons for this are varied. They include planning processes that allow policy to take precedence over local priorities (Roe & Mell, 2013; Wilker *et al.*, 2016) and a lack of agreement or certainty among the various actors as to the quality of green infrastructure or how to plan it effectively (Roe & Mell, 2013; Albert & Von Haaren, 2014; O'Neil & Gallagher, 2014; Khoshkar *et al.*, 2018). Where the need for green infrastructure is established and agreement reached on its design and extent there can be considerable uncertainty (or disagreement) over the most appropriate mechanisms for funding delivery, and long-term management and maintenance (Khoshkar *et al.*, 2018). Compounding these problems, there is considerable variation in the strategic planning of green infrastructure between municipal authorities and their expectations with regard to green infrastructure provision in new developments (Davies & Laforteza, 2017; Mell *et al.*, 2017; Scott *et al.*, 2017).

These challenges with green infrastructure planning, delivery and management result in an uneven picture across the UK and elsewhere, and in many areas, green infrastructure is underperforming (Ellis, 2013) and unable to provide the full range of its potential benefits. This affects both new green infrastructure, which is often delivered through development, and existing assets as dwindling budgets reduce the funding available to manage and maintain green infrastructure effectively (Heritage Lottery Fund, 2016; Jerome *et al.*, 2017). It is therefore critical that the benefits of green infrastructure are maximised whilst being mindful of the cost of delivery and maintenance.

Some progress has been made in the academic community to provide tools for the assessment of green infrastructure features (e.g. Van Herzele & Wiedemann, 2003; Gidlow *et al.*, 2012). However, these are often for use across a relatively narrow range of existing green infrastructure features (e.g. greenspaces). Similarly, multiple organisations have produced a vast array of guidance related to green infrastructure. However, these are often limited to a narrow range of functions (e.g. water management, health and well-being), features (e.g. green spaces, trees, SuDS) or stages in the development process (e.g. design, funding arrangements) or for a particular locality (Sinnott *et al.*, 2018). Therefore, these tools and guidance documents do not seem to have been effective at addressing the uncertainty across the built environment sector regarding the quality of green infrastructure. There is a need for comprehensive guidance, or standards, to reduce the uncertainty and inconsistencies in the sector and provide some clarity as to what is expected in terms of green infrastructure.

Benchmarks and other assessment systems have been used extensively in the built environment sector to provide clarity and raise the standard of new developments (Cole, 2005; Haapio & Viitaniemi, 2008; Ameen *et al.*, 2015). In sustainable developments, the use of assessment systems has improved, for example, how energy, water and transport infrastructure have been incorporated into new development (Cole, 2005). Initially these focussed on individual buildings and were motivated by a desire to measure environmental performance (Haapio & Viitaniemi, 2008). In recent years, the scope of such assessment systems has been increased to include a range of development types in addition to individual buildings, and encompass the social and economic dimensions of sustainability (Ameen *et al.*, 2015). Many include some form of assessment related to green infrastructure features but it is not clear whether this is likely to deliver high quality green infrastructure.

This paper reports on a study that sought to first examine the extent to which built environment assessment systems consider the quality of green infrastructure. Following an initial review of these systems, a set of research questions were developed to investigate, via a series of stakeholder workshops, the potential for a new benchmark solely focussed on green infrastructure.

How Is Green Infrastructure Considered in Current Built Environment Assessment Systems?

This is the first time that existing built environment systems have been examined for their potential to achieve high quality green infrastructure. As we have already highlighted one of the challenges with the planning and delivery of green infrastructure is the lack of clarity on the type and extent to provide. This is despite the substantial number of existing benchmarks and other assessment systems available to built environment professionals. Some aspects of green infrastructure are included in these existing assessment systems and there are a number of tools available specific to different green infrastructure features. Thirteen of these assessment systems and tools were reviewed to examine how they consider green infrastructure as a way to ascertain the potential need for a stand-alone benchmark. The assessment systems were identified through recommendations and an online search, and were chosen to represent a range of development types, geographical coverage, scale and maturity. The review examined two aspects of the built environment assessment systems. First, we considered the extent to which the systems could be said to assess the quality of green infrastructure. For example, through the inclusion of criteria to assess the desirable characteristics of green infrastructure (i.e. the formation of a multifunctional network) and its associated functions or benefits (e.g. flood risk management, nature conservation, amenity space). Second, we considered the operational aspects of the systems including the type of development they are suitable for, process of assessment, stage in the development process they assess and the form and duration of the award given. We focussed on assessment systems commonly in use in the UK (e.g. BREEAM), but included international examples (e.g. LEED) and those specific to green infrastructure features (e.g. Green Flag Awards) to examine their potential for adoption, either in part or wholly, in the UK, to address the issues of uncertainty highlighted earlier. The technical guidance documents of each assessment system were reviewed and supplemented with email and

telephone communication with the hosting organisations where gaps in information remained. Table 1 summarises the key characteristics of the systems including the extent to which it provides an assessment of green infrastructure, types and stages of development addressed, training and support provided, nature of assessors and categories of award.

This suggested that the built environment assessment systems reviewed do not adequately address green infrastructure in their present form. Some of the systems, including BREEAM Communities, Building for Life 12, Envision and SITES do assess some elements of green infrastructure (Table 1) a finding reported elsewhere (Ameen *et al.*, 2015). For example, BREEAM Communities awards credits for running consultations on the proposed green infrastructure and acting on the results, and creating a green infrastructure plan (BRE [Building Research Establishment], 2012). Other credits are also awarded for individual functions of green infrastructure such as providing green spaces within suitable walking distances, producing strategies for management and ecology and including sustainable drainage systems (BRE, 2012). Similarly, SITES seeks to benefit human health and assesses the harmonisation of developments (and land use) with ecosystems, for example through a consideration of water demand, storm water runoff, wildlife habitats, carbon, energy, air quality and the restoration and recovery of ecosystems (SSI [Sustainable Sites Initiative], 2014). The Green Flag Award rewards high quality green space and the Biotope Area Factor is a measure of the proportion of green and permeable surfaces provided in the built environment (BSDUDE, 2016). What is missing, however, is a measure of the delivery of a coherent multifunctional network. Given that the definition of green infrastructure relies on the formation of this coherent network it is unlikely that this would be delivered via these systems as they do not explicitly require this to receive credits.

The systems reviewed either include land uses related to green infrastructure (e.g. green spaces, SuDS) or they consider individual functions of green infrastructure (e.g. nature conservation, place making). However, this means that it is likely that opportunities will be missed to create multifunctional spaces as the systems generally deal with these functions in isolation. Related to this, those systems such as BREEAM, Lotus and LEED that use credits to provide an assessment of the development do not have mandatory requirements for green infrastructure or related features allowing the user to bypass any inclusion of green infrastructure at all. It is therefore unlikely that used in isolation these systems would result in the delivery of high quality green infrastructure or provide greater clarity on what constitutes high quality green infrastructure.

In terms of the operation of the built environment assessment systems examined they were targeted towards individual buildings, mixed developments or both (Table 1), with some (e.g. BREEAM) having a range of other systems for specific types of project (e.g. retrofitting). Of the systems reviewed, eight mention assessing buildings and neighbourhoods at multiple stages of development and completion (Table 1). Similarly, of the systems specific to features of green infrastructure, the Biodiversity Benchmark includes an initial assessment and then a main assessment within six months. The Green Flag Award involves an initial assessment of each application followed by a judge visiting the site on announced and unannounced visits, and SITES includes an assessment path where part of the application is submitted at the end of the design phase and the rest at the end of construction. Generally however, a

Table 1. Summary of the key characteristics of the benchmarks, assessment systems and tool reviewed.

Name	Relevance to GI	Type/s of development	Training and support	Development stage	Nature of assessors	Categories of award	Duration of award
BREAM ^{1,2}	Credits related to GI e.g. ecology, SUDS	New construction; refurbishment; in-use	Trained assessors, technical manual, online	All, but in-use only needed for outstanding	Independent assessors; third-party certification	Pass to outstanding	Indefinite
BREAM Communities ^{2,3}	Credits related to GI e.g. strategy, green space	Masterplanning developments	Trained assessors, technical manual, online	Various pre-construction	Independent third-party assessors	Pass to outstanding	Indefinite
Building for Life ⁴	Questions related to GI e.g. nature, placemaking	Residential-led development	Technical manual	All, can be awarded pre-construction	Experts local to the scheme	Pass and outstanding	Indefinite
GSAS ⁵	Criteria related to GI e.g. ecology, landscape, water	Commercial districts	Training, technical guidance, online support	All, post-construction sign-off, optional in-use	Random verification of projects	1–6 stars	Indefinite
Green Building Index ⁶	Criteria related to GI e.g. planning, management	14 types of project with different emphasis	Consultation sessions, conferences	All, post-construction sign-off	Certifiers 'experienced professionals'	Certified to platinum	3 years
Green Star ⁷	Credits related to GI e.g. ecology, urban climate	Various, including new communities	Technical guidance, training	All, post-construction sign-off	Independent panel experts	1–6 stars	Indefinite
LEED ⁸	Credits related to GI e.g. open space, ecology	Various, including new neighbourhoods	Training, reference guides, online support	All, can be awarded pre-construction	Includes review by a third-party organisation	Certified to platinum	Indefinite
Lotus ⁹	Criteria related to GI e.g. ecology, water	Various, including multi-family residential	Training, technical manual	All, post-construction sign-off, optional in-use	Assessment committee	Certified to gold	3 years
Envision ¹⁰	Credits related to GI e.g. open space, biodiversity	Infrastructure projects	Training, case studies, technical manual	All, planning to demolition	Largely self-assessed; third-party verification	Bronze to platinum	Indefinite
SITES ¹¹	Context, water, soil, health and well-being, vegetation	Various, including open spaces, streetscapes	Technical manual	All, post-construction sign-off		Certified to platinum	Indefinite
Biodiversity benchmark ¹²	Improvements in biodiversity	Business practices	Introductory workshop, access to learning events	Initial assessment follow-up within 6 months	The Wildlife Trusts, third-party verification	Awarded	1 year
Green Flag Awards ¹³	Quality of green space	Green spaces and parks		Two stages: preliminary application; judge visit	Peer group of judges	Pass: 66%+	1 year
Biotope area factor ¹⁴	Green surfaces as proportion of total area	Any surface with greenery	Online guidance for making the calculations	Informs standards for new development	Self-assessment	Quota must be met	N/A

¹BRE (2018), ²BRE [Building Research Establishment] (2016), ³BRE [Building Research Establishment] (2012), ⁴Building for Life Partnership (2016), ⁵GORD [Gulf Organisation for Research and Development (2017)], ⁶Green Building Index (2013), ⁷GBCA [Green Building Council of Australia] (2016), ⁸USGBC [United States Green Building Council] (2018a, 2018b), ⁹VGBC [Vietnam Green Building Council] (2015), ¹⁰Institute for Sustainable Infrastructure (2015), ¹¹SSI [Sustainable Sites Initiative] (2014), ¹²The Wildlife Trusts (2016), ¹³Green Flag Award (2016), ¹⁴BSDUDE (2016).

key limitation of existing systems was their reliance on evidence provided pre-construction, with no requirement for a post-construction assessment. This suggested such systems may not be adequate in overcoming the challenge of the quality of green infrastructure diminishing through the development process. Finally, the systems reviewed generally also rely on qualified, independent or third-party assessors to undertake or certify the assessments. For example, BREEAM have trained assessors, Building for Life 12 uses 'local' experts with knowledge of the local context and the Green Flag Award relies on volunteer judges.

The review informed the study in two ways. First, it suggested that the existing built environment assessment systems reviewed do not adequately assess the quality of green infrastructure as they do not often require the creation or enhancement of a multi-functional network. Second, the review found that the lack of mandatory criteria and post-construction assessment in many systems would fail to overcome some of the challenges associated with green infrastructure delivery. This identified a potential need for a new benchmark or assessment system focussed on green infrastructure to overcome some of the limitations outlined in existing systems. These findings were then presented to stakeholders working in green infrastructure planning, design and delivery in England to answer the following questions: (1) Is there a need and a market for a benchmark for green infrastructure in England? (2) What should the scope of a benchmark for use across England be? and (3) How should such a benchmark operate? Initially the focus is England, however, the challenges associated with green infrastructure delivery are often applicable internationally (e.g. Davies & Laforteza, 2017) so the findings in this study are likely to resonate with those seeking to establish high quality green infrastructure in other locations.

Stakeholder Workshops

The key findings of the review of existing assessment systems were developed into a series of proposals for a benchmark for green infrastructure. In order to examine the questions above these key findings and proposals were presented to a range of experts representing green infrastructure stakeholders. This was achieved through a series of five workshops in England. These were hosted by key end-user organisations representing relevant groups of professionals: the three professional bodies representing planners, surveyors and landscape professions The Royal Town Planning Institute (RTPI); Royal Institution of Chartered Surveyors (RICS) and Landscape Institute (LI); as well as The Royal Society of Wildlife Trusts (RSWT) a 'grassroots' movement of over 800,000 people with interests in understanding and protecting nature, including ecologists (Wildlife Trusts, 2018); Town and Country Planning Association (TCPA), a charity aimed at improving the planning system; and Forest Research, a Great Britain-based public sector research organisation conducting tree-related research. In total, 60 experts participated in the workshops representing residential and commercial property developers, wildlife trusts, local authorities, central government agencies, public health professionals, landscape architects, planners and environmental consultants and organisations responsible for the long-term management of green infrastructure including third sector organisations.

The hosting organisations promoted the events via their own professional networks. Thus, attendees at the RICS, LI, RTPI and RSWT-hosted workshops had strong connections to development surveying, landscape architecture, planning and ecology respectively. The workshop hosted by TCPA/Forest Research, and to a lesser extent RSWT, targeted and attracted a broader range of participants, for example including the mineral extraction industry, construction sector, utilities and infrastructure companies, public health professionals and those responsible for long-term management.

Workshops took three hours, with a break for lunch. Participants were presented with a brief summary of the rationale for the research and the purpose of the workshop. This was followed by three short overviews, framed around the three research questions, of findings from the review, followed by a group discussion with sub questions as prompts, to test the three research questions:

- (1) Is there a need and a market for a benchmark for green infrastructure in England? Participants were provided with a summary of the challenges related to green infrastructure, and the findings from the review of existing built environment assessment systems in terms of both their coverage of green infrastructure and how assessments were made. They were then asked about their experiences of using existing systems, whether a new benchmark was needed, and if so, what its purpose would be and what barriers to its use might exist.
- (2) What should the scope of a benchmark for use across England be? Participants were provided with a set of proposals as to what a new benchmark could consider including the types and functions of green infrastructure that could be assessed, as well as aspects of planning and maintenance. The findings of the review informed the functions, and the availability of existing standards and criteria. Participants were then asked whether they felt they thought the proposed scope was appropriate.
- (3) How should such a benchmark operate? The findings from the review of the operation of the existing assessments were used to develop a set of principles for a new benchmark, for example, the point in the development process the assessment should take place, who should undertake the assessment and the process of certification. Participants were then asked their views on these principles as well as their experiences of different approaches, and the most effective point in the development process to be certified.

Two or three researchers took anonymised notes of the discussions; these were then compiled and synthesised into the findings presented below. Findings are also focussed on those specific to a benchmark for green infrastructure as opposed to those considered general good practice in any assessment method (e.g. need for good marketing).

Findings from Stakeholder Workshops

The workshops produced insights in key areas relating to the potential for a benchmark for green infrastructure. These are summarised and discussed based on the three research questions.

Need for a Benchmark for Green Infrastructure

In answer to the first research question, stakeholders suggested there is a need for a green infrastructure benchmark. In harmony with the review of assessment systems, workshop participants reported that the emphasis on specific green infrastructure features (e.g. green spaces) instead of the network, as well as the ability to score quite highly in a number of the systems, and therefore be certified as a sustainable development, without really considering green infrastructure were major limitations of existing assessment systems. Green infrastructure therefore was not considered to be robustly assessed in existing benchmarks, certainly not in a way that would meet the key characteristics of green infrastructure (Roe & Mell, 2013; O'Neil & Gallagher, 2014). Thus, this study has identified a gap in the market for a benchmark that assesses green infrastructure defined as a strategically planned, multifunctional network of green and blue features.

The need for a benchmark is related to the strength of planning policy for green infrastructure. In line with the literature (Scott *et al.*, 2017), participants reported differences in the sophistication of policy, the robustness of evidence used to develop policy, the overall creativity of ideas in delivering and maintaining green infrastructure, and in how policies are enforced. A range of reasons explain this disparity, including a perceived lack of knowledge and skills amongst planning policy teams to draft appropriate policy, and variations in the perceived importance of green infrastructure compared with other policy goals (e.g. provision of housing numbers). Ultimately, it is likely that the need for a benchmark is area-specific, being dependent on the policy requirements of the local development plan and the knowledge and demands of specific planning teams. For example, there may be less need in areas where there is robust policy in place, supported by knowledgeable planning teams and good enforcement. However, in areas that are 'easy wins' where there is a high demand for housing, and green infrastructure policy is relatively strong, a benchmark could be used to demonstrate to other areas and developers what is possible.

Despite the general support for a benchmark for green infrastructure, two key areas need to be considered. First, there needs to be more certainty on the commercial interest for the benchmark, which was seen by stakeholders as essential to its success. This would depend upon the degree of compulsion with which the benchmark could be applied, especially as it was recognised that developers would need to accommodate the majority of costs. If participation in the benchmark depended upon developers voluntarily opting-in, this would inevitably depend on its perceived benefits compared to other assessment mechanisms. Therefore, any benchmark for green infrastructure would need to complement existing systems and demonstrate 'added value' to customers. This is significant given the plethora of assessment systems available in the sector, lack of clarity over which system to use and the risk that the one most favourable to the applicant's particular project will be selected (Haapio & Viitaniemi, 2008). Where benchmarks are not mandatory there is also a risk that only high quality developments may be put forward for assessment (Haapio & Viitaniemi, 2008) which would undermine the aim of the benchmark to raise the standard of green infrastructure. However, participants also noted that a benchmark for green infrastructure could be attractive to developers if it helped them market their developments or secure planning permission particularly; others were concerned that it would have little traction in a system where the developer increasingly has the advantage.

The associated technical guidance for a benchmark would also be useful for those wishing to ensure that green infrastructure was high quality without necessarily having to apply for a benchmark (for example, development management officers, and councillors seeking to impose planning conditions). One of the benefits of assessment systems is that they can result in increased communication between stakeholders in terms of what is desirable (Cole, 2005). Another is that they can ‘transform the market’ by raising expectations and increasing demand for developments that meet these standards (Cole, 2005). The improved certainty and communication between stakeholders, and potential to raise the standards across the sector were seen as the main benefits of any new benchmark.

Collectively, the findings suggest that there is a need for a new benchmark for green infrastructure which ensures that a multifunctional network is delivered. But the degree to which this would be taken up by the sector depends on its purpose being clearly defined and differentiated from the other assessment systems on the market.

Nature of Applicant and Project

The need for a benchmark for green infrastructure will also depend on the target audience. Although the key audiences for the benchmark would be developers and those working on their behalf, and local authority planners, other audiences were also suggested by stakeholders; either linked to specific types of project, for example, infrastructure providers, mineral extraction companies, neighbourhood-planning groups and regeneration organisations, or to particular outcomes, for example public health professionals, insurers or horticulturists. Using the benchmark to increase public awareness of, and demand for, green infrastructure may also encourage developers and local authorities to improve the standard of green infrastructure. Participants supported an aspiration to create a benchmark that would be suitable for any type of new development as well as policy, for example so that a local authority could apply for their green infrastructure strategy to be awarded the benchmark. Participants also suggested that the benchmark could be awarded to retrofitted green infrastructure, for example, green roofs on individual buildings or the regeneration of social housing estates. Ultimately, initial development and testing should be focussed on ‘large scale major development’ and policy whilst being mindful that the benchmark should be suitable for use in ‘small scale major developments’ and retrofitting initiatives in the future. The reviewed systems are marketed to a varied customer base and have been developed to be suitable for a range of project scales and types. This suggests that systems can be developed to be attractive to different types of customer, and there is acceptance in the sector that systems should be flexible enough to be used across a range of projects.

To summarise, the findings suggest that the initial focus should be on collaborating with developers and local authorities to develop a benchmark for larger developments and policies, whilst being mindful of future aspirations for a broader range of applications. We now turn to the second research questions which sought to examine the scope of a new benchmark for green infrastructure.

Scope of a Potential Benchmark for Green Infrastructure

Turning to the second question the stakeholders discussed the scope of a new benchmark and what it should assess in terms of the specific features and quality of green infrastructure. Informed by the review of benchmarks, the benchmark should include standards related to water management, nature conservation, health and well-being, and high design and environmental quality incorporating a mix of mandatory and optional standards. These overlap with many of the key functions for green infrastructure (Kambites & Owen, 2006; O'Neil & Gallagher, 2014).

Building on the review of benchmarks, stakeholders suggested that mandatory standards could include a demonstration that individual green and blue features create and/or contribute to a multifunctional network, respond to local priorities and make provision for long-term management and maintenance. This suite of mandatory standards would be crucial in overcoming some of the challenges in current green infrastructure delivery, and address gaps in existing assessment systems. These standards should also assess procedural elements that have been shown to facilitate the long-term delivery of green infrastructure (e.g. effective consultation, long-term governance and funding; Kambites & Owen, 2006; Roe & Mell, 2013; O'Neil & Gallagher, 2014). There was also agreement that the benchmark should consider green infrastructure at the landscape scale; seen as a major limitation in other assessment systems. The need for this landscape-scale approach was felt to be particularly critical in small projects to ensure they form part of a coherent network as well as those, such as high speed rail, that extend across a range of geographies. The benchmark should be flexible enough that it could be applied to the local context in terms of character, priorities, policy and guidance. This would mean that instead of, for example, specifying particular types of green infrastructure, or outcomes, the precise form the green infrastructure takes would be based on local need.

Several of the assessment systems reviewed include criteria relevant to green infrastructure (Table 1). Given that applicants may be working towards other assessment systems a benchmark for green infrastructure should, where possible, incorporate these or at the very least not contradict them. Standards in the benchmark should be simple, focused and easily interpreted and evidence-based. Built environment assessment systems have been criticised for their complexity (Ding, 2008) and lack of 'rigour and factual basis' (Retzlaff, 2009, p.11). Several of the systems reviewed also focussed on quantitative criteria (e.g. proximity to green spaces or proportion of land area greened) whereas stakeholders suggested the importance of focusing on the quality rather than quantity of green infrastructure assessed, using a mix of quantitative and qualitative evidence. Qualitative evidence was considered essential for assessing the quality of green infrastructure (O'Neil & Gallagher, 2014) with detailed technical guidance to reduce the issues of subjectivity (Chen *et al.*, 2009) and complexity with this type of evidence (Van Herzele & Wiedemann, 2003).

Fit with Policy and Development Processes

In discussing the third question, related to the operation of the benchmark, stakeholders identified a number of stages in the policy and development processes where the benchmark could be applied. These can be summarised as follows.

Stakeholders stated that the benchmark could contribute to local policy development. For example, it could help shape how local planning policy considers green infrastructure, across a sub-region or local authority, or in a neighbourhood-planning group in terms of both the evidence requirements and the objectives for the area. As already mentioned it could also be awarded to green infrastructure frameworks or strategies to demonstrate their robustness and quality, which could give those delivering green infrastructure the confidence that their schemes would contribute to a wider network of green infrastructure.

The benchmark and/or the associated technical guidance could assist in a range of planning activities. This could include as a tool to (a) appraise development sites in advance of their potential inclusion in a development plan document; (b) shape the green infrastructure evidence required by local authorities when assessing applications for planning permission; (c) assist with the drafting of planning conditions and agreements following permission being granted and (d) influence spending from mechanisms such as the Community Infrastructure Levy imposed on new development. Given the intention that the benchmark could be applied to both plan making and development management activities, participants noted that it would need to be able to function at a range of spatial scales. Many sub-regions in England are currently developing joint spatial strategies, which could provide an opportunity for a new benchmark as these ‘combined authorities’ will have more power over planning policy.

Where the benchmark would be used in new development, the stage of development at which assessment is carried out is important and a one-stage assessment pre-construction would be inadequate. The benchmark should assess early parts of the design and development process, such as community engagement activities, also highlighted by Wilker *et al.* (2016) as being key to the success of green infrastructure. Similarly, stakeholders highlighted that often the design and quantum of green infrastructure is set very early on in the development process, for example, where assumptions are made on the number of homes that can be delivered on a site, and this creates an expectation regarding the amount of land available for other uses. Therefore, the benchmark would need to be considered as early as possible. This resonates with the measurement of the environmental performance of buildings, where engagement with the assessment system at the design stage ensures the greatest benefits (Ding, 2008). The benchmark would then act as a point of discussion between stakeholders. However, there was also concern that planned green infrastructure is often not delivered or maintained adequately in the long-term, and so granting an award subject to post-construction sign-off was seen as essential. However, having to wait for an entire development to be built before the benchmark was awarded would act as a deterrent to adoption, especially in phased development or where the benchmark could be used in marketing activities. Therefore, it was suggested that an ‘in principle’ option should be available pre-completion, for example, when outline or detailed planning permission is sought to allow developers to work towards the benchmark as early as possible with the final award only being granted as each phase or the whole development is completed.

These findings suggest that a benchmark that is applicable to all stages of the development process from local policy development, through to development management and delivery would provide an effective way of ensuring that uncertainties related to the quality of green infrastructure are reduced.

Operation of the Benchmark for Green Infrastructure

The workshop discussion also focussed on the operation of the benchmark in terms of the levels of award and the certification process. In contrast to existing systems that offer a range of awards (Table 1), stakeholders preferred to see two levels of award but stressed the importance of setting these at the right level. This would mean that projects already delivering high quality green infrastructure would be able to secure the benchmark (i.e. current best practice), but that the 'gold standard' would only be achieved by exemplary projects. This would ensure that the benchmark would raise the standard of green infrastructure in lower quality development, whilst ensuring that exceptional quality is rewarded, instead of setting the bar so low that the benchmark is rendered meaningless or so high that it is perceived as being unattainable. However, there was an implicit understanding that the standards should evolve over time as green infrastructure practice improves.

Existing built environment assessment systems are supported by technical guidance and suitably qualified assessors. Stakeholders suggested that an assessment team, potentially including a community voice, rather than an individual, may be beneficial given the multi-disciplinary nature of green infrastructure. In line with existing systems (e.g. BREEAM) assessors should be both internal and external to the applicant team, so that internal assessor/s would coordinate the benchmarking process, provide expertise to the client, and compile evidence for the application. The independent external assessor, preferably an organisation with experience of running an existing system, would then certify the decision.

In terms of the longevity of the award the standards and associated technical guidance would need to be regularly reviewed as good practice evolves over time. This could be achieved, for example, through a standards committee. In addition, the benchmarked scheme would need to be reviewed at five yearly intervals to ensure that the standard of green infrastructure has been maintained, with some participants suggesting that this could be funded, for example, through service charges for maintenance or developer contributions.

Ultimately, these findings suggest that the operation and governance of the benchmark is as important as the standards in ensuring that it is credible and attractive to potential users. A common point for discussion throughout the workshops was the need for thorough testing of the benchmark on live developments and policy documents. For example, to ensure that the standards are set at the right level and that the benchmark performs in a range of developments and at all stages in the development process, including where construction is phased.

Conclusions

This study has identified a number of challenges facing the planning, design, delivery and long-term management of green infrastructure. One way of overcoming these challenges is a designated benchmark for green infrastructure. Existing assessment systems in the built environment are not fit for purpose in evaluating either the multifunctionality or the connectivity characteristic of high quality green infrastructure. This means that developments are securing accreditation for their sustainability yet a key component of sustainable urban environments is inadequately assessed. Unless green infrastructure is high quality it

is unlikely to provide benefits for health and well-being, climate change adaptation or nature conservation. However, the market place is crowded, so any new benchmark must be attractive to the development sector and planners; providing more certainty and a robust assessment of quality that is both achievable and flexible. The key recommendations from the review of existing systems and engagement with green infrastructure experts suggests that the new benchmark will need to be: relevant to both policy and larger new developments in the first instance; fit with the development process providing a number of opportunities for assessment at the different stages of planning; and, crucially, post-construction. In addition, it should be simple; focussing on the key benefits that green infrastructure can provide in terms of health and well-being, water management, nature conservation and high environmental quality and how these can be delivered with an emphasis on the creation of a multifunctional network and long-term management and maintenance. Critically, it must recognise that a one-size fits all approach is not appropriate and that green infrastructure must reflect and enhance the local character and priorities of the area for it to be successful. Achieving this will be challenging but it is essential to raise the standard of green infrastructure in our towns and cities to support the delivery of sustainable and healthy places.

The green infrastructure benchmark has been discussed in relation to England, however, many of the concerns it addresses are shared internationally. Although, there may be different foci of what aspects of green infrastructure are important in different countries, such as the importance of trees providing shade in hotter countries.

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